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PRESIDENTIAL ADDRESS

BUGS, BOUNTIES, BALANCE, AND MODERN AMERICANESE*

HENRY MEYER

President, Wisconsin Academy of Sciences, Arts, and Letters, May 2, 1959 to May 7, 1960

In his address last year entitled *"Naturalists, Biologists, and People,"*[1] Dr. Dicke gave us some thought provoking ideas, many of which have continued to make the news throughout the year. Today, I should like to attempt to carry on the discussion of some of the things he mentioned by talking about *"Bugs, Bounties, Balance, and Modern Americanese."* I too must begin by defining my terms.

Bugs: I know Dr. Dicke would give a different definition of a true bug than the one I shall give. I think he would give a definition of a true bug which would go something like this—a member of the class Insecta, order Hemiptera, a form having sucking, piercing mouth parts, the beak arising from the front of the head; wings when present membranous at the tips and thicker at the base; gradual metamorphosis. This is not the kind of bug I am thinking of. A definition of the bug I have in mind would not be that of a professional entomologist, but more nearly the definition of a member of the group referred to as "the people." In other words, a bug would be anything we want to be rid of, particularly if it is responsible for an unpleasant condition or situation. If this is an acceptable definition, the bug might be an insect, a worm, or a surplus of a farm commodity such as butter or wheat. Yes, it would even include "bug-juice", the name given to poor liquor in certain parts of our country; and would cover Dutch-elm disease, and, for the purposes of my talk, might even include a baby! Certainly the population boom is creating a problem of concern the world over. One of the causes of the expanding population is the increased production of babies.

Bounties: A common definition of a bounty is a grant or allowance from a government or state for the killing or destruction of noxious animals or beasts of prey. For this year, because of the bounty on the fox, our state had paid out $76,384.00 before the

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* Retiring Presidential Address, delivered at the 90th Annual Meeting on May 7, 1960, at Madison, Wisconsin.

[1] Dicke, Robert J.: "Naturalists, Biologists, and People;" *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters,* Vol. XLVIII; Madison, Wisc., 1959.

first of April.[2] This goes on in spite of the fact that competent conservationists and wildlife authorities have spoken out against it. My interpretation of a bounty is not restricted to this type which Dr. Schorger has paraphrased as "Mutiny on the Bounty."[3] For the sake of my talk I hope you will accept the definition of a bounty as—the price we pay to get rid of the bugs as we defined them a moment ago. For, one way or the other, it is we the people who supply the monies to provide the funds required to support our governments.

Balance: The word balance has many connotations depending upon the circumstances. It may mean an instrument for determining the exact weights of physical objects, or it may mean a symbol or emblem of human values so that we speak of "balance of justice." It may mean to waver or to hesitate. Of certainty the term may be used too in what Dr. Dicke referred to as "Balance of Nature" which he defined as a "rather vague idea that is freely expressed by naturalists and people . . . based on the assumption that at one time all the wildlife in this country was in perfect biological harmony . . . some kind of biological Utopia prevailed."[4] None of the definitions so far given express what I have in mind. I should like to use the term balance as a modifier of attitude, particularly the moral attitudes we use in paying the bounties that are required to get rid of the bugs.

Americanese: It is because there are so many varied usages of commonly used terms that I have introduced the term Americanese to my title. Some time ago Senator Barry M. Goldwater (R.—Arizona) put into the Congressional Record what he called a word list designed to help certain senators to understand what the Southerners were saying. Among the words included in his list were the following:

> "SANE—Speaking, i.e., I can hardly hair what he's sane.
> BONE—Blessed event, i.e., I was bone a Southerner.
> WRETCHED—The long name for the nickname of my brother Dick."[5]

Permit me to illustrate a bit more exactly with the use of this material I clipped from a newspaper quite some time ago. You might be confused and think it something composed by the poet Virgil:

O civili si ergo
Fortibus es in ero
No villi
Demis trux
Si vatcinum
Copula dux

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[2] Scott, Walter E.: "Information on Bounties" (personal communication 4 April 1960).
[3] Shorger, A. W.: "Mutiny on the Bounty;" *Wisconsin Academy Review;* Vol. V, No. 1; Madison, Wisc., 1958.
[4] *Op. Cit.:* Dicke, Robert J.
[5] Goldwater, Barry M.: *Congressional Record,* Vol. V, Tuesday, 8 March 1960, p. 4488.

Inasmuch as this represents one form of Americanese many have difficulty in understanding, I'll just let this sign remain before you while I go on with my talk. Before I finish I will give a translation for the benefit of those who may need it. To complete my list of definitions I will define Americanese as a form of expression completely understandable to certain individuals but misinterpreted or not understood by others because of local situations. Now I should like to go on with my talk.

Informing the Public: The impact of science on society is continually increasing. It is encouraging to note that the opportunity to become informed is being enhanced through all the agencies of public communication; *i.e.,* the press, T.V., radio, and the movie. The extent to which this is going on is reflected in the general topics of conversation at meal time for an average family. The list of topics ranges from air pollution, atomic fall out, detergents, fluoridation, chlorination, waste disposal and its relation to water supply, chemical control of animals and plants, *i.e.,* insecticides, herbicides, and hormonal and chemical means of stimulating growth to population concentrations, and racial integration.

These are all essential to our welfare because they are concerned with the water we drink, the air we breathe, the food we eat, the shelter which protects us. They are all related to environmental health, but because of some misuse and misunderstanding too many people may regard all chemical control of the environment as health hazards. Certainly the agencies of communication must be used properly so that our communities are intelligently informed on these important topics.

Community Concept: A community is an association of populations of many different species. It, like any living thing, owes its success to raw materials and food, ability to reproduce, and protection. If these are present it grows, develops, passes through a phase of apparently stable maturity, grows old, and ultimately dies. The history of the area may properly be called communal succession. In any community, as with all levels of organic existence, turnover occurs continuously; individuals die out or emigrate and are replaced by others. During the period when the number of individuals remains relatively constant it may be said to be balanced.

The kinds of individuals in a community can be classified into producers, transformers (reducers), and consumers. The interrelations of these in the community have often been illustrated by the so-called food pyramids for both aquatic and terrestrial environments, *i.e.,* for water: algae (producer), herbivore (primary consumer), carnivore (secondary consumer); for land: grass-herbivore-carnivore. In each instance the cycle may vary in length. For several years I served as a member of the zoology staff at the University of Tennessee. One of the members of our department had a slight speech defect and made it hard for him to pronounce his L's. This caused one of his lectures to be dubbed the "pants en animus." The theme of the lecture was that every animal must eat a plant; if it does not eat a plant, it must eat an animal that has eaten a plant, etc. Both plants and animals produce waste products, and when they die they leave organic decay products that must be returned to the soil or water to complete what in reality is a basic energy cycle of the community whereby solar energy is utilized in the metabolism of both plants and animals.

Change and Death: One of the most fundamental attributes of protoplasm is that it has the ability to change. If this is true for one species, it must be true for an entire community from one of microscopic limits to those of more nearly global proportions. A common definition of death is that it is an irreversible gelation of protoplasm, hence the name rigor mortis. In a community there may be variable degrees of death. Because this may be true for community or individual, Clark Kuebler, formerly President of Ripon College, warned one graduating class to beware "lest you develop rigor mortis of the mental variety before that of the corporal variety comes upon you."

I have been concerned with the teaching of introductory courses in college biology for several years. Since the development of phase-contrast microphotography some excellent films have become available. Recently I have made frequent use of one which is simply called "Protoplasm" with Professor Seifritz of the University of Pennsylvania as narrator. The film records the activities of a very lowly form of life called a slime-mold. I like this particularly because the film with the lecture points out the following things essential to understanding life:

1. Each organism is related to another in an interdependent way in the community.
2. Ceaseless energy transactions are necessary to produce biological motility.
3. Variations in the rate and nature of the energy transactions are responsible for rhythmic activities.
4. Living things grow in spirals and exhibit tensile strength and elasticity. "Protoplasm has a twist in it."
5. Living things are responsive and adaptive. Injections with various chemicals and drugs show how "it meets exigencies and heals itself and seems to exhibit intelligence." After all we are made of protoplasm.[6]

Man and the Universe: The increasing rationale has profoundly changed the conception of the world in which civilized man is living. Our earth is no longer considered to be a large disc, nor is it

[6] Seifritz, ________: "Seifritz on Protoplasm;" University of Pennsylvania; n.d.

merely a planet in a solar system but it is part of a galaxy which is but one nebula of the universe which perhaps contains billions of nebulae. In spite of our space-age mindedness, it does appear to be some time in the future before earth-man will be able to colonize some place of abode other than the earth. So for the evening our primary interests will remain earthy. I am, however very interested in following the developments of project "Ozma." Wouldn't it be nice to be able to say "Hello, out there!" and to get an answer!

Not only has our conception of our world continued to change, but also our evaluation of man and his place as an inhabitant of this globe has changed. Last year, 1959, was the centennial year since the publication of the *Origin of the Species*. The pre-Darwinian beliefs associated with special creation and fixity of species are no longer adhered to by the majority of biologists and by the general assemblage so often called the progressive people. The fact that evolution has occurred and is still taking place is receiving increasing acceptance in spite of the incompleteness of our knowledge as to how it occurs.

The ability of protoplasm to change and evolve new varieties is regarded as one of its principal attributes. Evolution is regarded as a natural process which includes all forms of life, from the lowest protist to the highest plant or animal. Each form is a protoplasmic descendant of the ancestral type from which it evolved. In this sense the fungal mycelia, the insect vectors, the elms, the oaks, the bird-lovers, the economic biologists, and the ordinary people have a certain togetherness when we consider the evolution of life forms. In each community an interaction of species types is found. Within each community some of the species are reproductively more successful than others, and within a community each species, including our own, must evolve for its own sake if it is to survive and reproduce continuously so that it may be capable of evolution.

Man and Evolution: The heart of the Darwin-Wallace concept of evolution which forms the primordial framework upon which modern interpretations of the process are founded is based on two principles: 1) struggle for existence, and 2) variation within a population.

The first of these principles asserts that each species tends to multiply in geometric progression, *i.e.*, a species population which doubles its numbers in the first generation has a potential to quadruple its number in the next, and to multiply to an eightfold in the next, *etc.* Field observations indicate that this does not generally attain, and the size of the population may remain fairly constant for relatively long periods of time. This leads to the conclusion that in many instances not all the young become adults and not all adults survive to reproduce. Therefore the interpretation of struggle for existence.

The second of the basic principles asserts that not all individuals of a species are alike. In any population variation exists and the individuals which have favorable variations will have a competitive advantage over others and will survive in greater numbers.

The explanations relating to the causes of variation, the nature of genetic transmission, the roll of mutations, the nature of the gene-duplication and gene action in the gene-environment are beyond the scope of this talk. The modern cytogeneticists and cytochemists are gradually gaining information which when understood and properly presented will aid us in gaining insight with regard to the mechanism of evolution. For the purposes of this discussion it is sufficient to agree with what Dr. George G. Simpson told our parent organization, the A.A.A.S., in his presidential address last December. Dr. Simpson said that Darwin "opened the door" for a new view of man and this causes us to reflect upon the duties of man "if there is any future."[7]

Evolution is a process which is amoral. Nevertheless by this process the most adaptable and self-conscious organism, man, has evolved. Man is self-conscious because he is capable of being aware of his own origin and, so far as we can discern, the only organism that has a true language which he is able to store beyond his individual memory. And finally, he is an organism with moral qualities for he can control his environment, and this leads to responsibility.

To whom and for whom is man responsible? He certainly is, in part, responsible to himself and for himself and for this planet called earth and all of its inhabitants. Thus, a land and community ethic must have evolved along with that of a moral character.

Land Ethic: One of the essays of George Bernard Shaw is entitled "The Adventures of the Black Girl in Her Search for God."[8] The essay is a brief study of comparative religion, and in it the reader is presented a succession of gods, each perhaps an improvement on the previous one. In none of them discussed, however, is there satisfactory development of man's ethical relationship to the soil. Aldo Leopold in *A Sand County Almanac*[9] extends man's relation to land and to the plants and animals which grow upon it. Extension of ethics to these elements, he points out, is an ecological necessity which, although asserted since the days of the prophets Ezekiel and Isaiah, has not been affirmed by many actions of modern civilized man.

I earlier defined a community as an association of populations of many different species. Leopold's land ethics enlarges the bound-

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[7] Simpson, George G.: "The World into Which Darwin Led Us;" *Science;* Vol. 131, No. 3405, Washington D. C., April, 1960.

[8] Shaw, George Bernard: *The Adventures of the Black Girl in Her Search for God;* Dodd, Mead, & Co., New York, 1933.

[9] Leopold, Aldo: *Sand County Almanac;* Oxford University Press, New York, 1949.

aries of the community to include soils, waters, plants and animals, or collectively, the land.[10] Conservation thus becomes an extension of man's moral character because through it we attempt to establish the idea that nature and man are interdependent and that environmental health for the entire community demands a reciprocal relationship.

Protoplasm has been defined as the living stuff. Wilderness may be defined as the natural raw material out of which man and civilizations have evolved. The kinds of wilderness have in part determined the nature of civilizations and the various cultures associated with each. Wilderness is said to be a resource which can shrink and not grow.

It has been estimated that when our people go to the polls to elect a new president in November a potential of 100,000,000 votes can conceivably be cast. This is an indication of the rapid growth of our population. The population growth is producing increasing concentrations in urban areas. If we are to maintain a high standard of living (don't ask me to define this) our land usage must be diversified. Our agricultural lands must be properly managed so as to produce food for all. Our water supplies must be utilized for transportational, agricultural, industrial, domestic, and recreational purposes without conflict. Wilderness and reclaimed areas must be maintained as areas to provide proper recreational opportunities without despoilation.

Technology and Land Usage: Scientific developments in many fields play leading roles in the progress and economy of nations. Increasing mechanization and automation is continuing to alter land utilization. This has been particularly noticeable with agricultural lands. The mechanical revolution made it possible to bring larger areas under cultivation with less man power. Application of genetics to plant and animal breeding has increased the yield and the quality of the products produced. Along with these we now have the rapid expansion of agricultural chemicals which is producing accelerated changes in the environments of plants and animals. The efficient use of commercial inorganic fertilizers certainly has produced many beneficial results. The use of chemicals as poisons to control the flora and fauna has made it possible to determine to a great extent the nature of the biota in selected places. This, too, has been of importance and has had many beneficial applications.

There are however, certain instances where the use of specific insecticides, fungicides, and herbicides have been used to control organic pests but have not been species specific and have destroyed beneficial forms along with the pests. The honey bee is one of the insect friends of the farmer that has often been the innocent victim

[10] *Ibid.;* Leopold.

of pesticides intended for other insects.[11] The nation was alerted on "Black Monday"[12] 9 November 1959, when Secretary of Health, Education, and Welfare, Flemming removed cranberries from the market because it was feared that the weed killer aminotriazole might be carcinogenic in man. Although Secretary Flemming tried to indicate his good faith in the cranberries later released for sale by advocating and extolling the qualities of proper berries, the terrific economic blow to the grower was an expensive bounty to pay in this instance because of improper usage of an herbicide on the part of a few.

Dutch Elm Disease and Oak Blight: Currently there continues to be much interest in the protection of our Wisconsin Elm trees from Dutch Elm Disease. Tree lovers have reason to fear, for it is a fungus disease, and there are many who fear that the spread of the fungus by the bark beetle will bring about a destruction of our elms that may rival that produced by the chestnut blight. Many people in this room heard this afternoon concerning the rapid spread of this from Mr. Hafstad. The general public has been less concerned about the Oak blight which was spreading through oak populations for many years. George S. Avery in 1957 pointed out the dangers of this tree disease to one of our most important lumber resources. Oak constitutes in dollar value about one-tenth of our commercial lumber, being a wood of many uses besides that of making the best bourbon-whiskey barrels. The oak is also a tree of enormous value for its ornamental use as a shade tree. The spores of the *Ceratocystis fagacearum* are partial to the members of the beech family, which includes, besides all the oaks, the chestnuts and the beeches. Dr. Avery points out that the spores are also capable of existing on ash, hickory, dogwood and others but its wilting effects are most pronounced on the oaks. The spores of the oak wilt fungus are spread in numerous ways in areas where the oaks grow close to each other. Transmission has been known to occur through natural root grafts. Besides, the fungal mycelial mats produce a fruity odor which is attractive to insects. Birds and squirrels are also attracted to them and may serve as possible carriers. Dr. Avery reported that more than 500 centers of infection were from Ohio; other areas from Pennsylvania through Minnesota and Iowa have many centers of infection. Dr. Avery did not report the number of infections for Wisconsin other than including it with other states with heavy infection centers.

To control the disease requires drastic methods because thus far treatment with antibiotics has been without success. The infected

[11] Smith, M. V.: "Honey Bees and Pesticides;" *Welch Biology and General Science Digest;* Vol. 9, No. 2, Chicago, 1960.
[12] DuShane, Graham: "Cranberry Smash;" *Science;* Vol. 130, No. 3387, Washington D. C., November, 1959.

trees must be girdled, while still wilting, to kill the trees and prevent the formation of the fungus mats and thus stop the aerial spread of the disease. The roots of the infected trees must be killed because the fungi can live in them for three years. The branches and twigs should be immediately burned. However, the useful lumber can be saved. This is all a very expensive operation but with the proper cooperation of timbermen and home owners it is believed that oak wilt can be brought under control. Dr. Avery feels that it is doubtful that the disease can be completely erradicated, but if we are willing to *pay this bounty* oak wilt can be reduced from a menace to a nuisance.[13]

Each year since 1957 the committee on bird protection of the American Ornithologists' Union has expressed concern over the rapidly increasing use of insecticides and herbicides in both the United States and Canada. This (use of these chemicals) has been done before there is any adequate research on the effects of these sprays on wildlife. A year ago it was pointed out to this group that there was "accelerated inference or coincidence" with regard to robin mortality associated with D.D.T. poisoning. If the report of the A.O.U.'s committee reported in the January, 1960, issue of the *Auk* is correct there is a distinct difference in the opinions of competent ornithologists and that of the economic entomologists, for I quote: "To recite all the accumulating evidence of the harmful effects of aerial dispersal of highly toxic pesticides would extend this report beyond a permitted length."[14] I point this out because it shows that there is a distinct need for further research in environmental health which would bring about a close cooperation between related groups of scientists. There seems to be a real area for cooperation to be worked out. The trees of our cities and our forest areas need protection from pathogenic forms. We must learn to protect them without creating undue environmental hazards lto wildlife or to man. We must not have the "only one-way attitude." We must find the other ways and this can lead to better ways. This can only be accomplished by research and cooperation at all levels. Chemical control of the environment should be a matter of continuous study. Spray programs should be carried out under the supervision of individuals who are really informed with regard to safe dosages for given situations. Continuing vigilance should be necessary to determine what the effective safe dosage will be from year to year.

Up to the present, as far as I know, a practical means of producing immunity to fungal disease has not been found. Are we to as-

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[13] Avery, George S.: "The Dying Oaks;" *Scientific American;* Vol. 196, No. 5, New York, May 1957.

[14] Kalmbach, E. R., *et al:* "Report to the American Ornithologists' Union by the Committee on Bird Protection, 1959;" *The Auk;* Vol. 77, No. 1, 1960.

sume that this is not possible? I think not, but the only way we can find out is through increased research. This takes money, lots of money. Leroy E. Burney, Surgeon General of the United States Public Health Service, has suggested the establishment of an Environmental Health Unit within the service. He admits that it would be easy to set up such a unit by legislation. The second step, that of financing the unit would be hard.[15] Yet this is the bounty we must pay if we are going to maintain the proper land ethics.

Population Control: There is much current interest in space exploration. The race for space supremacy is important in many ways. Whether or not national success at getting pay-loads into orbit is a measure of superiority and security is an open question. I for one do not doubt the importance of continuing our efforts to explore space. I do, however, feel that there are other areas that are equally important and equally in need of study. One of these is population control.

I have already indicated that our world civilizations have evolved out of the wilderness areas of the planet earth. The command in the eighth chapter of Genesis "to be fruitful and multiply and replenish the earth" is one that seems to have been followed. The ability of a species to replace its death losses has been called its biotic potential. Man has been doing this at a high rate and the result is that the earth is undergoing a population expansion of world wide concern. The relation of births to increasing populations has led to the discussion of birth control. Birth control has become a topic of political, social, economic, and religious importance on local, national, and international levels.

Birth control relates to the individual. The unwanted child, whether born in wedlock or out of wedlock has long been a matter of social concern. It is one of the earth's greatest sorrows. A second sorrow is the sorrow of the barren womb. These two sorrows are related, for they both are concerned with human reproduction. If it is proper and humane to aid in the removal of sorrow by helping the barren to conceive, is it necessarily improper and inhumane to aid in the prevention of sorrow through birth control at the individual level? In each instance, individuals are involved and must be made aware of the fact that help may be made available. This can only follow enlightenment through education. Liberal education should always be concerned with the search for knowledge and truth so that wisdom can be cultivated which will help man regard his potentialities, individually and collectively, to continue to occupy this planet earth. In a highly interdependent world intercultural studies of international scope are becoming increasingly important.

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[15] DuShane, Graham: "Hazards of the '60's;" Science, Vol. 131, No. 3409, Washington, D. C., April 1960.

In order to implement such a program of liberal education on a global scale we again come to the problem of bounty. It will take money, lots of money, to provide teachers and scholarships for studying languages, and the so-called humanities as well as for the study of the sciences. Language barriers must be broken so that there may be a free intercourse of ideas between cultures. If through enlightenment by education a given nation or cultural group arrives at a decision to consider methods of limiting population, it is my opinion that we should give assistance. However, each country must be free to develop its own program as determined by its culture and religion.

I have already made several references to land usage. I should like to urge action with regard to conservation of our shrinking wilderness areas. Each year new areas are becoming agricultural and industrial. As this occurs swamps and wet lands are being drained, waters are being diverted, wooded areas are being cut down, natural ecological situations are being changed at an alarming rate. We in Wisconsin are all proud of our scenic areas and should be concerned with preserving the remnants of our wilderness and reclaimed wildlife areas. We should also maintain the beautiful roadsides that so enhance the development of beauty in our industrial and agricultural areas. Professor Hickey and Mr. Eugene Roark have recently called to the attention of the membership of this academy several instances of land-use conflicts that are related to the loss of our natural areas.[16] How can we minimize and prevent future continuous shrinkage or destruction? This can be accomplished by a program of action. In order to be able to act rationally we should be familiar with some of the causes for loss of or injury to wilderness areas. Permit me to list a few of them:

1. Creation of new agricultural lands through the drainage of wet lands or the removal of forests.
2. Real estate developments associated with recreational usage.
3. Highway building and the extension of public utilities to new areas.
4. Destruction by fire of forest areas, grasslands, and marshlands. (Many of these fires are the result of human carelessness.)
5. Despoilation through the action of pathogenic organisms of plant and animal origin.

The prevention of continual shrinkage of the wilderness areas can partially be diminished through direct purchase of lands by the state and national government. This would make possible increased acreage for preservative and scientific areas. Perhaps some of the money now being spent on fox bounties could more appropriately be used for this. We should urge interested citizens to aid in supplying funds to be used for this purpose. We should give support to

[16] Hickey, Joseph J. and Roark, Eugene: "Can't We Save Some of Wisconsin's Natural Resources?" (Bulletin to Academy 29 April 1960.)

those who are urging the National Park Service to create an Ice Age National Park in our state.

In areas where new development (industrial, agricultural, or recreational) are being made, we can urge care in the building of highways and the extension of utility lines. The ruthless use of the chain saw and potent (improperly applied) herbicides and insecticides can be discouraged. Local and county governments can be advised to establish zoning regulations which would aid in maintaining ecological communities in healthy condition.

We must urge increases in the budgets for conservation departments and school programs so that they can do more effective work in conservation education. These are the bounties we must pay or we will lose our wilderness and its wildlife.

Summary: I have defined a bug as a problem we want to be rid of and have said that a bounty is the price we must pay to get rid of the bug. By balance I indicated that I refer to man's moral attitude toward his complete environment and its problems. I think the ethics of living expressed by David Starr Jordan in his *Days of a Man* are appropriate:

> "*Wisdom* is knowing what to do next, *Virtue* doing it.
> *Religion*, our conception of the reason right action is better than wrong.
> *Prayer*, the core of our endeavor."

He goes on to cite the zoologist Thoburn's conception of prayer:

> "Prayer is not a plea to change the world about us but our own resolve to do our best in the loftiest affairs of life. If our prayer aims to realize hope in action it will be answered."[17]

To return to our Americanese:

O see Villie, see her go,
Forty buses in a row.
No Villie,
Dem is trucks;
See vat's in 'em?
Couple o' ducks!

Let's hope they're not dead ones!

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[17] Jordan, David Starr: *Days of a Man;* Vol. II, World Book Company, New York, 1922, p. 773.

SCIENCES

EVIDENCES OF DISSECTED EROSION SURFACES IN THE DRIFTLESS AREA*

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Evidences of dissected erosion surfaces in the Driftless Area of the Upper Mississippi Valley have been discussed for many years without agreement. Bain (1906) thought that the upland surface extends across the region. Trowbridge (1912–21) postulated two peneplains, one on the crests of cuestas, the other in the vales. Martin (1932) saw only the effect of rock differences in gently dipping formations. Evidences included: the even skyline, beveling of rock formations, a bridge connecting two cuestas, the level plain of central Wisconsin, level tops and terraces on quartzite, entrenched meanders, and upland gravels. The writer concludes that every one of these evidences which were taken to show former base leveled surfaces can be interpreted in another manner. The skyline is a will-o-the-wisp, always distant. Beveling of dolomite depends on length of time since overlying formations were eroded. The "bridge" is where a weak formation is thin. Level places on folded quartzite were marine erosion during Ordovician submergence. Although entrenched meanders may show uplift, they are indecisive. The break in slope between uplands and valley sides is determined by resistant layers of bedrock. The inverted parabolic profile on dolomite agrees with Gilbert's (1909) explanation of creep. No remnant of a pre-valley landscape can be proved. The plain of central Wisconsin is lacustrine. Topography on escarpments is youthful and there is no proof of two levels on dip slopes. The hypothesis of pediplanation lacks evidence.

The validity of the evidences which were once taken to disclose dissected erosion surfaces in the Upper Mississippi Valley has been debated for more than half a century. Agreement between different geologists has never been attained. Now that the entire region has been mapped topographically, photographed from the air, and in part mapped geologically in detail, it is possible to reappraise the reliability of the evidences which have been presented, for the issue is not yet closed.

Basic Facts Which Bear on the Problem. The major phenomenon which led to interpretation of ancient dissected erosion surfaces in

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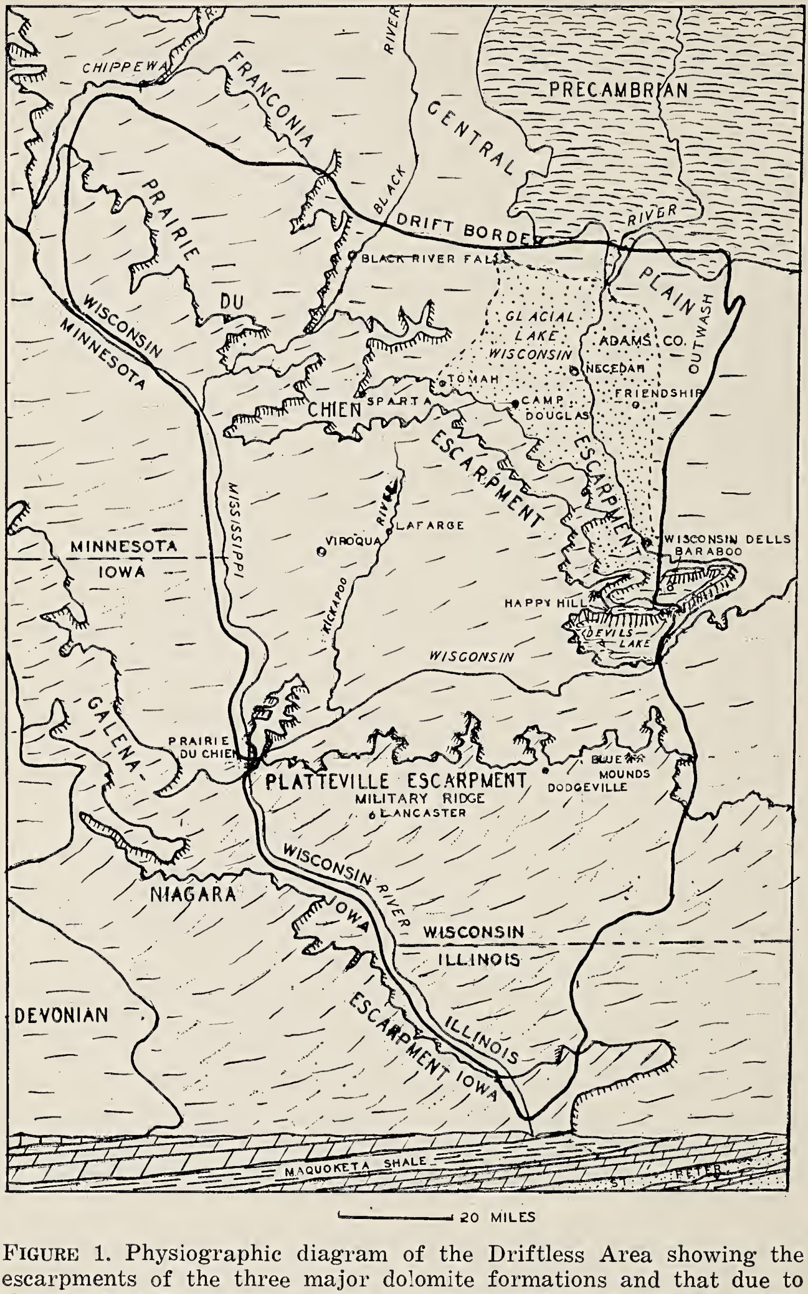


FIGURE 1. Physiographic diagram of the Driftless Area showing the escarpments of the three major dolomite formations and that due to the resistant Franconia sandstone. Valleys within the cuestas which expose lower formations were omitted.

the Driftless Area is the fact that the entire region is commonly referred to as "two story." Agricultural development, and in fact all human activity, is sharply divided into (1) uplands, and (2) valley bottoms. Only in a few localities are there benches intermediate between the two major levels. Cultivation extends as high on valley sides as soil erosion will permit and the steeper slopes of the valleys are chiefly in forest. Some of the uplands were treeless prairies. On uplands slopes are relatively gentle and locally the term "rolling ground" is applied to them. An observer who stands on one of the uplands gets the strong impression that he is looking at an old surface of low relief into which valleys were eroded in relatively recent time. To check this impression we must first consider the nature and position of the different bedrock formations.

Bedrocks. The bedrock formations of the Driftless Area are nearly horizontal sedimentary rocks which are commonly classified as "soft rocks." The different units or formations dip gently to the southwest away from the Wisconsin arch of Precambrian "hard rocks." The dip is in few places as much as 20 feet to the mile far below the least which is visible to the eye and is very irregular in detail. There are some small folds and faults which have little visible effect on the upland level.

The youngest bedrock formation which is preserved in the Driftless Area is the group of dolomites generally lumped under the name "Niagara" of Silurian age. In places these dolomites contain much chert. They are confined in surface distribution to the higher hills which are locally known as "mounds." None of the mounds is situated north of Wisconsin River. Beneath the light colored dolomites of the Niagara is a shale known by various names, "Cincinnati", "Richmond", or "Maquoketa." The shale is dolomitic where fresh and is blue-gray in color. It is generally regarded as of Ordovician age. There are several thin layers of gray dolomite interbedded in the shale. The outcrop area of shale is comparatively small, for it is confined to a band around the outliers of Niagara dolomite and to a few ridge crests in the southern part of the Driftless Area. Beneath the shale lies a sequence of dolomite, some limestone, and a little shale, all of Ordovician age. Geologists divide these rocks in descending order into "Galena", "Decorah", and "Platteville" formations, but the materials are so much alike that there is little reflection of these divisions in the topography, which is a rolling upland which extends from Illinois north to the vicinity of the Wisconsin River with one extension along the Mississippi River for some distance north of the boundary farther east (Fig. 1). Under the carbonate rocks is the outcrop of the incoherent "St. Peter" sandstone. The surface distribution of this sandstone is almost confined to a narrow belt along the edge of the younger formation. The St. Peter varies greatly in thickness. Locally it is absent but where it is thick the lower part consists of layers of red non-dolomitic shale, chert rubble, and chert-sandstone conglomerate. These basal beds are rarely exposed, but it is clear, especially from records of drilling, that they rest upon various older formations, some of which are of Cambrian age. Beneath the St. Peter and its associated basal beds lies another dolomite unit which has received various names, "Lower Magnesian", "Oneota-Shakopee",

FIGURE 2. Break between upland on Prairie du Chien dolomite at right and Platteville dolomite at left. Steep slope is due to St. Peter sandstone which makes crags and towers at nearby points. Locality is at north end of section shown in Fig. 5. The bevel of the lower dolomite ends against this escarpment of youthful topography. The theory which ascribes the two levels on the dolomites to different erosion cycles leaves the question of how old age topography could be formed so close to a youthful escarpment.

and "Prairie du Chien." Within the dolomite are several thin layers of sandstone, one of which is often called "New Richmond." These thin sandstones do not appear to affect the topography of the outcrop area to a material extent. The Prairie du Chien dolomites are very cherty and cap a rolling upland. (Fig. 2)

Beneath the oldest Ordovician formation, the Prairie du Chien, lies a considerable thickness of sandstone with a little shale and siltstone. This sequence is what was termed "Potsdam" sandstone in older reports. Many systems of subdivisions into formations have been proposed since the days of Owen, one of the earliest geologists to visit the Driftless Area. In the system of classification now in use the units in descending order are "Jordan" and "Madison" sandstones which make steep slopes and cliffs. Some geologists include them in the underlying "Trempealeau" formation which consists mainly of dolomitic siltstone and dolomite. These lower layers form a slight bench on many hillsides. Under the Trempealeau is the dolomitic "Franconia" sandstone part of which was once termed "Mazomanie." It makes a bench which is locally slightly terraced. The Franconia caps lower hills north of the Prairie du Chien escarpment (Fig. 1), locally it makes crags and cliffs although over most of its outcrop slopes are moderate. Below the Franconia is the cliff-making "Galesville" member of the "Dresbach" formation. In many outcrops it is strikingly white in contrast to darker overlying formations. Under the Galesville is the shaly "Eau Claire" member which caps some ridges of a lower bench. Beneath the Eau Claire lies a variable thickness of coarser grained "Mt. Simon" sandstone with a few layers of shale. The Mt. Simon thins out gradually upon an irregular surface of the Precambrian crystalline rocks. Locally, for instance at Baraboo, Black River Falls, and in northeastern Adams County there are isolated inliers of these hard rocks which project as mounds and bluffs through the weaker sandstone above. Baraboo, Adams County, and Necedah occurrences are all quartzite. At Black River Falls it is a low-grade iron formation.

History of Investigation. So far as the writer has been able to discover, the first suggestion of a former old-age topography in the Driftless Area was by Kümmel (1895) who described some entrenched meanders in southwestern Wisconsin. In 1896 and 1897 Hershey discriminated both in the Driftless Area and in adjacent territory uplands which he regarded as dissected peneplains. In 1896 Van Hise suggested that the even surface of the Precambrian in central Wisconsin is the same age as the upland of the region to the southwest. In 1900 Salisbury and Atwood described the region around Baraboo including the Dells of Wisconsin River and the vicinity of Camp Douglas. The report clearly stated that the plain around Camp Douglas is a peneplain which has not yet been dissected. In 1903 Weidman demonstrated with cross sections that the subdued erosion level on the Precambrian of central Wisconsin can be traced south under the Cambrian and younger rocks and is hence much older than any land surfaces to the south. From 1903 to 1907 various papers by Grant and Bain described the topography of the region south of Military Ridge. All of them stated that the upland of that region is the same as that to the north of Military Ridge. This hypothesis is shown in Fig. 3A. In evaluating this conclusion it must be remembered that there were then no accurate topographic maps of the area and that travel over it was very slow prior to the development of the automobile and must have been mainly limited to the mineralized area on the Galena-Platteville upland. When Lawrence Martin visited the area, he was able to travel much more widely because he had the use of a car. In 1916 his conclusion was published that instead of a dissected peneplain the topography consists of a series of eroded cuestas whose form is due solely to the nature of the bedrock formations (Fig. 3C). The writer shared

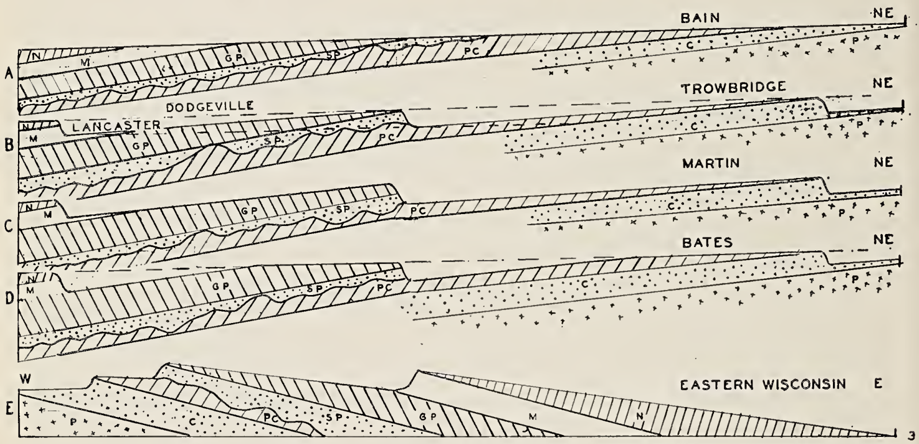


FIGURE 3. Diagram showing basic ideas of different hypotheses of the origin of the topography of the Driftless Area.

A. Bain regarded the uplands as all parts of a single erosion surface which once covered the entire area. It is not possible to pass a straight line through the uplands showing that they are remnants of the same surface so the hypothesis is contrary to fact.

B. Trowbridge recognized this relationship and postulated two erosion levels, one survives on the crests of the cuestas, the other in the vales between them.

C. Martin recognized only the effects of differential erosion and did not regard any parts of the upland as remnants of a peneplain.

D. Bates found that the crests of the cuestas line up as if remnants of a former peneplain and that the dolomites are beveled on the crests and not in the vales. A single peneplain corresponding to Trowbridge's Dodgeville surface was deduced.

E. In eastern Wisconsin no straight line can be drawn through the crests of the cuestas although each of them displays bevel of the formation. Each upland is progressively lower going west.

many of Martin's trips and in 1907 worked with W. C. Alden in the region just east of the Driftless Area. Although in the field Alden privately expressed doubt of the significance of the even skyline, his report of 1918 describes three cycles of erosion of which the first developed the "Dodgeville peneplain" of the Driftless Area. The process of leveling was clearly stated as due to meandering rivers which had reached base level. From 1916 to 1924 the writer worked on the detailed mapping of three quadrangles in western

Wisconsin, no reports on which have ever appeared. A report on the Tomah and Sparta quadrangles in collaboration with W. H. Twenhofel and Lawrence Martin was completed in 1922 but was refused publication by the U. S. Geological Survey partly on account of disagreement over the classification of the Cambrian formations but also because of Martin's opposition to the recognition of any peneplain in the area. In 1921 a report based on work by Trowbridge and some of his students (Shipton, Hughes) appeared. In this report Trowbridge denied the views of Martin and instead postulated two upland surfaces. The older one (Dodgeville) beveled the formations of the cuesta tops and the lower one (Lancaster) had only been developed in the vales between these cuestas (Fig. 3B). A surviving remnant of the older surface was recognized on the Baraboo quartzite. Here the problem rested until 1932 when Martin's report was republished with no change in his views. In 1939 a report by Bates on the region around the Kickapoo River appeared. He had drawn, but not included in the report, many projected profiles of the Driftless Area in which geology was shown. Bates recognized only one peneplain level which truncated the crests of the cuestas and was absent in the vales (Fig. 3D). In the latter the upland is a stripped formation whereas on the crests there is a marked bevel. In Horberg's paper of 1946 on the glaciated surfaces of Illinois several distinct erosion surfaces were recognized. The lack of harmony between these surfaces and the dip of the formations was shown by maps and a cross section.

What Is a Peneplain? Before reappraising the evidence of dissected erosion surfaces presented by the authors listed above, it is essential to define the term "peneplain." Space forbids a complete summary of the development of this term, but we may pass to the original concept as expounded in textbooks. As first proposed, the logical endpoint of a long undisturbed erosion period is a *peneplain.* The climate under which this erosion took place was for the most part not mentioned but may be presumed to be one like that of the eastern United States. Many writers refer to this as "normal climate." We must also realize that the word "plain" means a surface which looks level to the unaided eye and not necessarily to the surveyor's instrument. Later some students of erosion expanded the term peneplain to include all reasonably level surfaces regardless of agency of erosion or climate. To the writer this seems to be an expansion of the original meaning. Johnson (1916) spelled the word "peneplane" because he concluded that the ultimate surface of erosion should be a geometric plane. In much, if not all, of the theoretical discussions of this problem the methods by which stream divides were destroyed was not discussed. The relative importance of slopewash, creep, and solution was ignored. A few stated definitely that leveling was due to lateral erosion of streams. Horton (1945) appears to be the first or one of the first to recognize that in time the force of surface runoff becomes equal to the resistance of the soil to erosion. Comparison was made at the upper limit of rill erosion on slopes under normal rainfall. Obviously resistance to erosion is closely related to soil, vegetation, and climate. Horton ignored both mass movement of the soil and solution. Crickmay (1933) appreciated the problem of the removal of divides and definitely concluded that lateral stream erosion is the dominant process. It should be noted that advocacy of such an idea is tantamount to the theory of pediplanation discussed below.

Weathered Material on a Peneplain. A common suggestion of the manner in which divides were removed was that weathering got ahead of erosion thus leaving a thick mantle of clay which yielded readily to slopewash. Some suggested that (Penck, 1953) mass movement was favored by this clay mantle. However, this hypothesis does not stand up well under analysis. Weathering requires the penetration of ground water. Ground waters move only when impelled by pressure. Such pressure could only be due to differences of elevation. It is an open question how thick a mantle of clay could be formed with the postulated low relief of a peneplain.

Stairways of Peneplain Remnants. In many areas, including the Driftless Area, geologists have described stairways of distinct erosion levels close together. Horberg describes just such a series of levels in Illinois. So far as the writer can determine, Crickmay (1933), Rich (1938), and King (1949) are almost the only geologists to question such an interpretation which seems to be an outgrowth of the "treppen" concept of Penck. Several different questions may be asked about this theory of steps in level: (1) Why are not the older surfaces progressively more and more dissected and weathered down in proportion to their increasing age? (2) Which is more rapid, scarp retreat or stream cutting? (3) What protected the older levels from complete destruction by the same processes that made the younger surfaces? (4) Do erosion surfaces grow laterally or vertically? (5) Is lateral stream erosion more important than weathering? It should be noted that if we lean toward the last named idea, we are approaching the hypothesis of pediplanation and departing from the original concept of the peneplain.

Modern Peneplains. It has been remarked by many geologists that there are no undissected peneplains extant today. Such a statement involves abandonment of the interpretation of the central plain of Wisconsin as such a surface and applies only to surfaces of erosion governed by sea level. If we observe surfaces of considerable elevation above sea level, there are many areas underlain by either shale or limestone which are undissected and are level enough to be called "plains." Adjacent to such plain areas are regions underlain by sandstone which have rather rugged relief because this rock can support steeper slopes than can shale or limestone. There are many such areas in Kansas and Oklahoma. Factors which must be considered in the discrimination of modern base-leveled surfaces are: (1) vegetal cover, (2) amount of rainfall and soil moisture, (3) the angle of repose, that is the angle at which equilibrium is attained between the forces of erosion and the forces of weathering and erosion, (4) the mechanical hardness of the bedrock, and (5) the solubility of the bedrock.

Pediplanation. It has long been known (Rich, 1935) that in relatively dry climates in western United States the bedrock adjacent to mountain ranges is eroded into sloping "pediments," most of which have a thin veneer of water-transported material. It must be recognized that in order to produce such surfaces we must have widespread erosion both by slopewash and ephemeral streams. There has been much argument as to which process is dominant, but that discussion cannot be followed in detail here. That large surfaces called "pediplains" are produced by the same agencies has recently been advocated mainly by King of South Africa. It is clear that to produce such large surfaces requires rock which weathers into a mantle which is easily moved by water for which process sparse vegetation is a requirement. This means that pediplanation takes place mainly on crystalline rocks which weather into granules or on sandstone. Some shales weather into loose rather than tightly packed clay. On all of these bedrocks "wash slopes" which are concave upward can be developed if vegetation is sparse. Such vegetation requires (1) either light or seasonal rainfall, (2) brush rather than grass, (3) semi-arid or arid climate, or (4) poor soil. One of the stumbling blocks in the way of acceptance of this hypothesis of pediplanation is that many geologists seem to be reluctant to accept changes of climate. In this discussion we should realize that arid or semi-arid climates are actually of greater extent today than are climates of the so-called "normal" type. That climatic changes have occurred in the past is demonstrated not only by glaciation but by the occurrence of evaporites. The theory of pediplanation explains not only erosion levels with a cover of gravel much of which seems too coarse for transportation on a true peneplain but also the presence of stairways of levels or terraces. It has been suggested that grass, which more than any other vegetation restrains erosion, appeared only relatively recently in the history of the earth. In connection with climatic changes it seems possible that our present distribution of climates is a holdover from the Pleistocene glaciations.

Uplands. Turning back to the Driftless Area, it is necessary to recall that almost the only criterion of past peneplanation which was applied in early days was the "even skyline." It is true that this phenomenon is very striking to any observer who looks out from a high point in the area and it at once suggests that he sees an old subdued erosion surface which has rather recently been uplifted and dissected by narrow valleys. But if one is critical, one soon notes that the appearance of an old dissected plateau is best seen at a distance. It is a veritable "will-o-the-wisp" which everywhere retreats before the observer only to close in behind him. Many valleys are concealed by the ridges. Viewed on good maps or from the air the landscape is seen to be thoroughly dissected and it is difficult indeed to discover the division between old and new erosion, or between the pre-valley surface and the narrow steep-sided valleys with sandstone cliffs. The break in slope between valley sides and rolling upland is almost everywhere at a stratum which is more resistant than the adjacent beds. Such resistant layers include: (1) the iron-oxide cemented Glenwood sandstone member of the Platteville formation and (2) the quartzitic "clinkstone" at the top of the Cambrian. Only at a few localities where the "clinkstone" is absent has the writer found a cliff of basal Prairie du Chien dolomite below a break in slope at the border of the upland. The flat top of West Blue Mound, 1716 feet in elevation, is apparently controlled by the top of a very cherty part of the Niagara dolomite. A well drilled on this top showed dolomite only in the basal 10 feet of 85 feet of boulders of Niagara chert mixed with clay. Why there was an unusual amount of chert at the locality is unknown. East Blue Mound is 230 feet lower and has a similar flat top. This summit was shown by road cuts to be fixed by a layer of dolomite in the Maquoketa shale. Apparently no one has ever suggested that either of these level summits is a remnant of a peneplain. The break in slope at the base of the Platteville formation where the St. Peter sandstone is present below is equally sharp. At no place has the writer found that the break in slope lies at a higher horizon than the iron-oxide cemented beds of the Glenwood member of the Platteville. The upland of the Franconia sandstone is marked in many places and is wide enough to permit farming. It is, however, by no means as definite a rolling surface as are the dolomite uplands. The resistant layer which causes the break in slope at the border of the Franconia upland varies. It may be (1) a micaceous siltstone, the Tomah member, (2) a thin layer of dolomite, the Birkmose member, or (3) a firm layer of poorly sorted coarse sandstone which is in many places dolomitic where not weathered, the Wood Hill or

Ironton member. The break in slope at the margins of all uplands is bordered by rougher topography on the underlying weak formations of sandstone. In that bordering belt there are cliffs and crags with steep slopes adjacent, a topography decidedly unlike the smooth rather gentle slopes on the dolomite.

Natural outcrops of dolomite are virtually unknown on uplands except very near to the border. No upland is continuous with that on the next lower dolomite so that the old idea of one upland surface throughout the entire Driftless Area is contrary to fact. To be sure, the rolling dolomite uplands do resemble what some geologists thought a peneplain ought to look like. During the time that the manuscript of the Tomah-Sparta folio was being considered in Washington, someone wrote on the margin of the section describing the upland on the Prairie du Chien dolomites: "good description of a peneplain." It is supposed that this was a remark of M. R. Campbell. The moral is that the older geomorphologists paid little attention to the nature either of the residual material or the bed rock but regarded only slopes. We must realize that shale disintegrates into clay which is somewhat like the clay which remains after the solution of limestone and dolomite, whereas sandstone weathers into a rubble of hard fragments in sand. The removal of these residual deposits by rain wash and mass movement must differ with the nature of the source rock and have a profound effect on the resulting landscape.

A factor which affects the topography of the Driftless Area is the mantle of silty loess which lies on all slopes gentle enough to retain it. The mantle is thickest near the Mississippi River. Many of the older road cuts showed the abrupt base of the loess where it lies on the red stony residuum from dolomite. Many years ago Chamberlin and Salisbury (1885, pp. 239–258) reported on the thickness of mantle rock and gave an average of 13.55 feet apparently for the upland on the Galena-Platteville formations. It is not clear that this included loess, but it probably did. For the entire Driftless Area their figure is only 7.08 feet. These students of the area had access to many of the old lead pits which are now filled. Outside of the lead-producing region their data must have been scanty. The writer attempted to obtain information from well drillers and has examined many sets of cuttings from upland wells. The drillers' answer to questions was invariably: "What do you mean by solid rock?" This implies a gradation from stones scattered through clay to more or less solid bed rock. The records of five wells on the Prairie du Chien upland suggest a figure for loose material which is several times that ascribed to the region to the south, namely an average of 55 feet. Fifty-five analyses collected by Steidtmann (1924) range from 1.37% insoluble matter to 26.26% for the

Prairie du Chien and from 0.82% to 28.46% for the Galena to Platteville. The averages are 8.5% and 9.4% respectively although the scatter is entirely too large to give much confidence in these averages. The samples were probably selected as representative of the reasonably pure phases of the limestons and dolomites and do not include either chert or shale. Since the bulk density of the mantle rock is probably not over half that of the parent bedrock, we may estimate that it would take over 100 feet of bedrock to yield 20 feet of residuum. The problem is to find out if all residuum is still present or if not, how much has been removed. Exact data on this point is lacking, but it seems from the cross sections that a large amount has been removed in past times. A confusing factor is the extremely irregular original thickness of the Prairie du Chien dolomites. A control in leaching which should not be lost sight of is Shaler's old idea of control by stream spacing (Shaler, 1899).

Upland Divides. If one descends a stream course from the upland on dolomite to the adjacent valley which is eroded in sandstone, one will find that there are pebbles and cobbles of dolomite which are moved whenever there is a heavy rain or when the snow melts. These rock fragments were derived from the broken and weathered bedrock. Many probably moved to the stream course by creep or mass movement. Lower down the stream course debris from the firmer layers of sandstone appears. If one descends from the upland between valleys, one will find a mantle of weathered material which overlies a fairly regular surface of the sandstone with a rather abrupt contact. There is no gradation of mantle rock to bedrock on hillsides as there is on uplands. If one analyzes the ground waters of the Driftless Area, one will find that all appear to be saturated with dissolved carbonates. It is difficult to decide which is more important in removing dolomite: solution or removal of fragments. The relative abundance of chert in residual deposits favors the dominance of solution. The analyses of ground waters show that dolomite dissolves as dolomite with no accumulation of magnesite. Another problem is present, the relative importance of slopewash versus mass movement in the removal of residual clays of dolomites from the divides. Horton showed that for a certain distance from a divide the force of slopewash is not enough to overcome the resistance of the soil to removal. The idea is logical and it must be noted that many of the divides of the Driftless Area were originally prairie with a dense cover of grass. Grass is more resistant to erosion by slopewash than most, if not all, other forms of vegetal cover. It should also be realized that very few valley heads of this area extend to the divides. Slopewash, however, is not the only method of removal of material. Where there is clay, mass movement or creep also occurs or possibly occurred under a wetter climate than that of the present. The inspection of the new maps and air photographs discloses that divides are predominantly convex upward. Terraces on slopes are rare although some occur in positions where their relation to bedrock is not known. Gilbert (1909) showed that if the thickness of residuum is essentially uniform, it must be in process of removal, for it is formed all over the slope at once. Observation shows that approximately uniform thickness of mantle rock is common on slopes underlain by dolomites. In order to bring about this approximate uniformity of thickness it is evident that the speed of removal must increase down slope at a uniform rate. The mantle must be entirely removed both at stream courses and at the break in slope to talus-clad valley sides. The force which produces this mass movement of mantle rock must be the component of gravity parallel to the slope. This quantity is proportioned to the sine of the angle of slope in degrees. Since the slopes are almost all rather gentle, it is accurate enough to say that this force is proportioned to the tangent of the angle of slope since for small angles sine and tangent are nearly the same. Hence, the velocity of motion, V, is related directly to the technical definition of slope, S, (the tangent of the angle in degrees) and we may then write that V : S. Now to secure uniform thickness of mantle rock, V must be in direct proportion to distance from the divide, h. Hence V : h and therefore S : h. The fall in the given horizontal distances, h, is then measured by horizontal distance times average slope. Thus we can write f : h times S/2. By substitution f : h times h/2 or f : $h^2/2$. This is the equation of an inverted parabola. It makes no difference except to the "constant of proportionality" whether we measure distances in feet or in miles. The check on the actual occurrene of the above theory is to plot horizontal distances and fall from divides on logarithmic coordinates. We can write the equation $f = h^2$ as $\log f = 2 \log h$. When this is plotted, the result is a straight line whose slope indicates the value of the exponent 2. Figure 4 is an actual example which agrees exactly with the theory. In 20 trials some variation in value of the exponent was discovered, but all yielded straight lines when thus plotted. The average exponent proved to be 1.96 which considering the scale of the maps made from air photographs instead of actual surveyed points is about as close as can be expected. Part of the deviation may be due to difficulty in locating the true divide on gentle slopes. Another factor is variation in thickness of the mantle rock including loess. A value of the exponent less than 2 probably indicates that the thickness of loose material decreases down the slope and values above 2 mean a down slope thickening. Gilbert's theory is definitely substantiated. Such slopes represent an equilibrium condition, meaning that the mantle must be undergoing removal at the same rate as it is formed. Creep may not be going on now at the rate at which it did during glaciation of the surrounding region. The evidence of the parabolic slopes shows that material is being or has been removed from the entire slopes. Hence, there can be no remnants of a topography which antedates the erosion of the valleys. Divides have been lowered concurrently with the

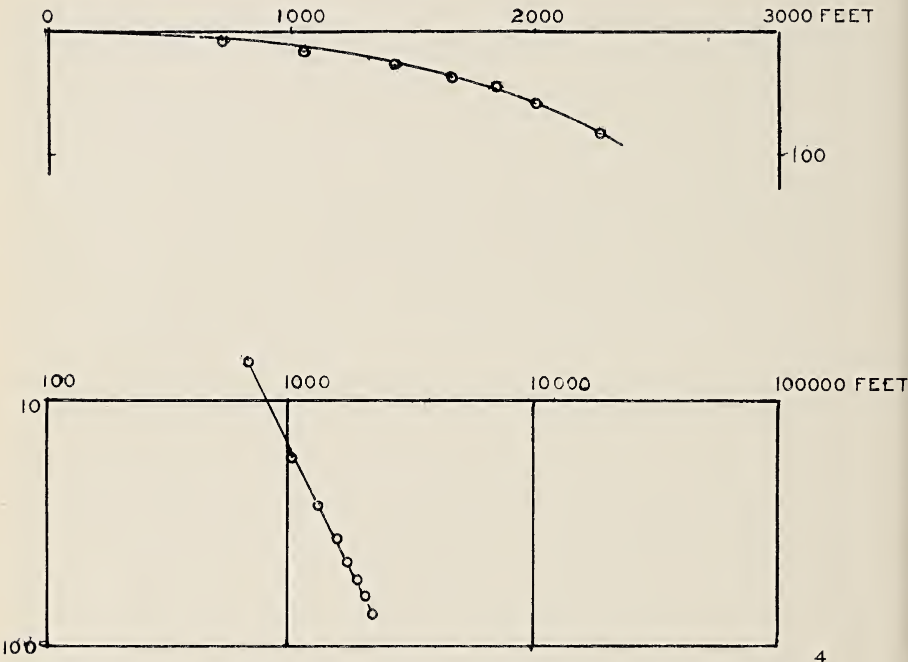


FIGURE 4. Profiles of slope below a divide in southwestern Wisconsin on Galena dolomite. The upper diagram is on ordinary coordinates and shows that the divides are smoothly convex, a fact confirmed by map study. The lower profile is on logarithmic coordinates and indicates that the fall is proportioned to the square of the horizontal distance from the divide. This type of inverted parabolic slope develops when residual material is of nearly uniform thickness and is being removed by mass movement at a rate close to that at which it is formed by weathering. Material is either being removed at present or has recently been in motion. Removal extends to the divide so that no proved remnant of pre-valley topography can be recognized.

formation of valleys. This fact removes the validity of the evidence formerly used to deduce the erosional history of the area. It should be noted in this place that the slopes on the uplands are Wood's "waxing slopes" and those of the valley sides are his "constant slope" type, that is talus or gravity slopes where material is restrained from further movement by friction. The exponent of these slopes is unity.

Beveling of Bedrock Formations. Although it has long been realized that the discovery of old erosion surfaces is extremely difficult[1] where the bedrocks are as nearly horizontal as they are in the Driftless Area, it has often been postulated that the original thickness of each formation should be preserved throughout its outcrop area if it was not beveled by peneplanation where the control was local base level. Construction of accurate cross sections where the dip is checked by well records discloses that there is a distinct beveling. Some comparisons of thickness of dolomite on different parts of a cuesta have, however, been unfair, for they compared the thickness of small outliers with that on wide ridges. The surviving thickness is unquestionably related to the width of the interval between valleys. The major factor which this older view of beveling ignores is that dolomite is water-soluble. True, it is not as soluble as pure high-calcium limestone as shown by the paucity of caverns in the Driftless Area compared to those in the limestone of Kentucky. It has been demonstrated above that solution is probably a very important factor in the lowering of divides. Hence, it follows that the control of amount of thinning of an exposed dolomite formation is the length of time that it has been uncovered from overlying formations. Since in gently inclined formations which are present in the Driftless Area the escarpments are slowly worn back exposing the underlying material, it follows that if this is a dolomite it must thicken gradually as the distance from the next escarpment decreases. This condition is exactly what sections disclose. In the case of several escarpments there are remnants of the weak formation for some miles from the cuesta face. It was often stated that the upland shows no trace of the minor faulting and folding which has been discovered in southwestern Wisconsin. The largest fault or monocline which has been definitely proved has a displacement of only about 100 feet and most folds are less than that. When we consider both the imperfections of the human eye in detecting vertical differences of level at a distance and the rolling nature of the uplands, it is small wonder that these structures appear to be beveled.[1] A still stronger item of evidence is found in eastern Wisconsin (Fig. 3E) where the three dolomites are each beveled and yet no nearly straight line can be drawn across the crests as can be done in southwestern Wisconsin. Each cuesta is lower than the next to the east. This region was glaciated, yet the cuestas are progressively lower toward the west away from the most active glacial action in the center of the Green Bay Lobe. Although the back slopes of the dolomite cuestas appear very much like old age topography, the escarpments on the weak formation outcrops are steep

[1] Davis, W. M., Personal communication.

[1] The detailed cross sections which the writer prepared are all too large to reproduce with this paper and hence were omitted.

and craggy (Fig. 2). The latter raise the question how old age topography could originate so close to youthful forms. At Blue Mounds it is readily seen that the Galena dolomite is about 100 feet thicker under the Mounds than a short distance away. This variation is not evidence of peneplanation but rather of the protection afforded by the overlying shale. It measures how much the dolomite has been weathered down by solution since the erosion of the cover of Maquoketa shale. As we approach the cuesta caused by the Niagara dolomite of northern Illinois there is some shale still preserved on the uplands and parts of the shale outcrop are very flat. It is not clear that these flat areas are remnants of the surface which existed prior to the erosion of the valleys, for they are very close to much higher land with a craggy escarpment. The older students of the area must have thought that shale is peneplaned much more rapidly than dolomite and probably they emphasized the role of lateral stream erosion to account for the abrupt change in level.

Breaks Between Uplands. The striking contrast between the surface on the dolomites and the nature of the landscape on the weak formations has been noted above. To the writer it offers an insuperable objection to the theory of peneplanation whether we accept the idea of two peneplain levels or not (Fig. 3B). There is no material difference in degree of dissection of the back slopes of the dolomite uplands as Trowbridge's theory of two surfaces of different ages demands. One can travel on back slopes of the cuestas from the older Dodgeville surface down to the younger "Lancaster" surface without finding any visible appearance of difference in age with either a gradual transition or a sharp break. It is true that the lower surface is more dissected than the upper south of Wisconsin River, but this condition is the natural result of the shorter distance from Military Ridge (See Fig. 1) to a major drainage line than is the case down dip to the south. This difference is exactly the opposite from that demanded by the two level theory.

Bridge Between Two Upland Surfaces. Trowbridge concluded that the divide between the Kickapoo and Mississippi rivers in western Wisconsin is a surviving bridge or connection between two cuestas which indicates the former extent of the "Dodgeville" peneplain. Just why such a remnant should have been left so close to the largest stream of the region, the Mississippi, was not explained. It has been suggested that the Mississippi River was forced into its present course by some of the earlier ice sheets which advanced from the west in the same way that the Ohio River was diverted across former divides. No westward continuations of the tributaries which enter the east bank of the Mississippi have been discovered and the gradual narrowing of the inner valley between the bluffs is easily explained by the southerly dip of the formations which brings the Prairie du Chien dolomite down from the crests of the bluffs at La Crosse to near river level at Prairie du Chien. The same phenomenon of downstream narrowing of the interval between the bluffs is also observed on Wisconsin River. Some early students of the area actually took this phenomenon to indicate a reversal of direction of flow.

Returning to the Kickapoo-Mississippi divide Figure 5 is an accurate section along its course where the dip of the formations was taken from wells which have been drilled at the villages on it. This section demonstrates that the appearance of connection is due simply to the small thickness of the St. Peter sandstone (Fig. 2) at the

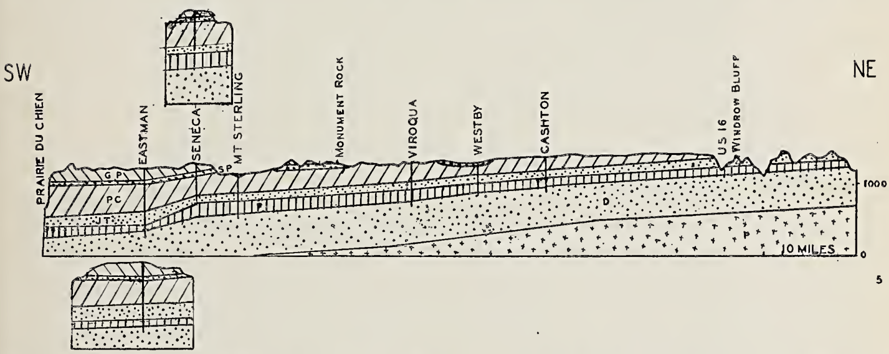


FIGURE 5. Profile of the Kickapoo-Mississippi divide in southwestern Wisconsin. This area was regarded by Trowbridge as a "bridge" connecting two cuestas. The uplands on the two dolomite formations are at the same level because there is a local abnormally steep dip. Moreover, the St. Peter sandstone is relatively thin so that its escarpment is inconspicuous. See Figure 2. Note that the two short sections at right angles to the main profile demonstrate that the Prairie du Chien upland extends south on the spurs. GP = Galena-Platteville, SP = St. Peter, PC = Prairie du Chien, JT = Jordan-Trempealeau, F = Franconia, D = Dresbach, P = Precambrian.

north edge of the outlier of Platteville dolomite. There is an escarpment at the contact of the two levels just as everywhere else. The lower level on the Prairie du Chien dolomite can be followed along the spurs south to Wisconsin River and is just as distinct as along the north side of Military Ridge. Note the transverse sections of the ridge in Figure 5. At the time the former interpretation was first made of this ridge it must be realized that it had not been surveyed topographically. The low escarpment shown in Figure 2 was doubtless explained as due to post-Dodgeville erosion. The evidence afforded by the divide is not competent to indicate that there was once a peneplain across the entire area.

Relation of Dip of Strata and Slope of Upland. Both Trowbridge and Horberg (1921, 1946) attached much importance to the dis-

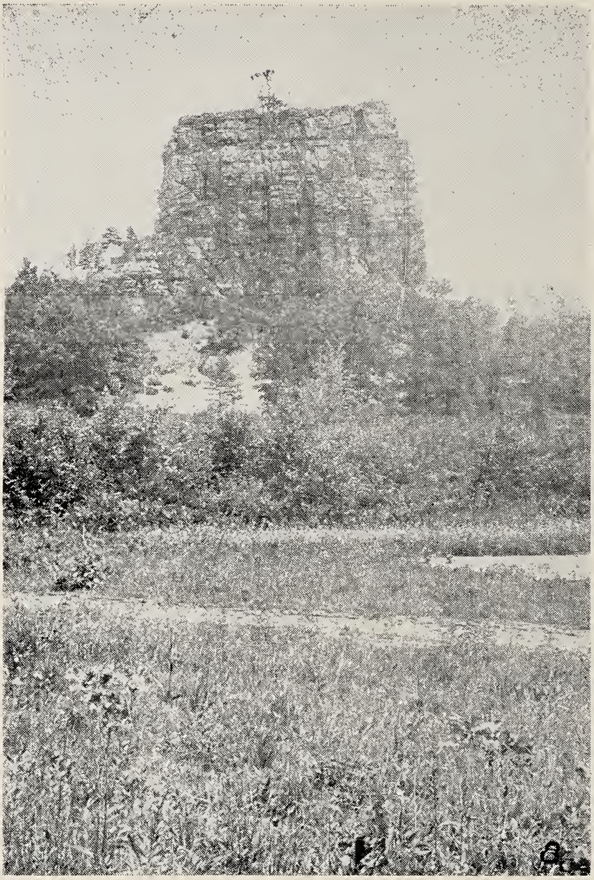


FIGURE 6. Butte of Galesville sandstone near Camp Douglas rising from lacustrine plain of central Wisconsin which was once described as a peneplain. The relationship could only be explained by lateral stream erosion of the plain which is graded to the post-Cary rock gorge at the Dells of the Wisconsin.

cordance between the general slope of the uplands and the dip of the underlying strata. Trowbridge (1921, pp. 66–68) used diagrams showing relations at corners of a triangle between surface slope and dip of the strata, whereas Horberg relied on maps where both phenomena were shown by contours. To evaluate this evidence in the light of present knowledge of the region one must realize: (1) gradual beveling of water-soluble formations such as dolomite has been previously explained as the result of solution whose amount increases with length of time that overlying material has been removed; (2) choice of the locations on the uplands is subject to error, for they were taken to demonstrate a point although perhaps also because the elevation of the bottom of the dolomite was known there; (3) the computation involves the assumption that the base of the dolomite is a mathematical plane and not irregular as detailed mapping shows; and (4) elevations ascribed to the upland involve the same assumption of a plane surface whereas as shown above it is rolling with no truly level areas except a few on the shale in northern Illinois. It has been noted before that the failure to find any recognizable reflection of small folds and faults in this general

FIGURE 7. Happy Hill upland on tilted Baraboo quartzite. The old maps showed this upland much wider than it really is. The soil is clay which contains both quartzite and Paleozoic chert fragments. The writer ascribed it to marine erosion during Ordovician submergence. Elevation is over 1480 feet.

level is due principally to their slight amount of displacement of the strata but also to the higher rate of erosion of the higher areas. Another factor is that of distance. "Distance lends enchantment to the view" is here well exemplified. Vertical differences are everywhere small compared to horizontal distances and cannot be observed accurately with the unaided eye at any considerable distance. Although at first inspection the evidence presented on lack of harmony between uplands and rock structure appears impressive, it is in the writer's opinion incompetent to prove the former existence of peneplained surfaces whose form approached a mathematical plane.

Distinction Between Upland Levels. It has been explained previously that no distinction between upland levels can be observed on the back slopes of the cuestas, clear though it may be at the escarpments (Fig. 2). It was, however, noted by Trowbridge and his associates that in the west end of the Baraboo quartzite area there is also a marked distinction. The summit upland on the quartzite lies at an elevation about 200 feet higher than the upland on the Prairie du Chien dolomite to the west. The upper level is locally called "Happy Hill" and is discussed in the paragraph below. The contact of the two levels is definite and abrupt with no gradation such as might be expected were both the result of peneplanation.

FIGURE 8. Happy Hill from the east. The upland at 1460 to 1480 feet elevation cuts across strata of quartzite which dip about 25 degrees to the right. Conglomerate found along the break in slope was derived from wave erosion of quartzite at a higher level. The notch at the right strongly resembles a shore cliff and is regarded by the writer as the shore of Prairie du Chien time. Paleozoic sandstone and conglomerate in foreground as loose blocks.

Happy Hill. Happy Hill, the level quartzite upland, is well seen along the road from North Freedom to the south as shown in Figure 7. Examples of this level occur on many bluffs of the area west of the border of the glacial drift. Elevations were surveyed accurately only recently[1] and range from 1462 to slightly over 1480 feet above sea level. Elevation is closely related to size of summit area. Close inspection shows that although level enough for marginal farming, the uplands slope gradually toward the margins where the slope steepens markedly as shown in Figure 6. The width of the largest area of this surface is shown on the old Denzer Quadrangle

[1] North Freedom Quadrangle, 1958, replaced Denzer Quadrangle of 1898.

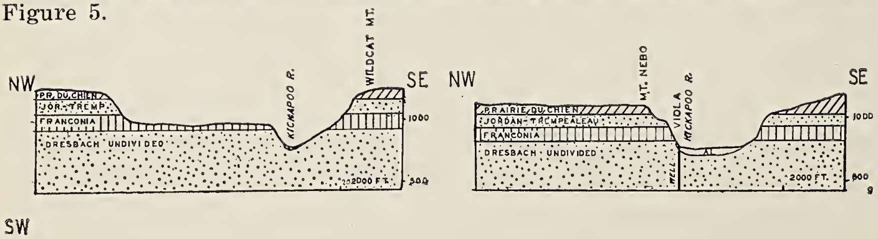
as over two miles, but the new resurvey, the North Freedom Quadrangle, shows only three fourths of a mile. The Happy Hill upland is clearly not structural, for it truncates the strata of the Baraboo quartzite to a marked degree. The quartzite dips northwest at about 25 degrees (Fig. 7). Happy Hill does not seem to have been discussed by some of the early geologists but was correlated by Hughes and Trowbridge with the "Dodgeville" peneplain. G.-H. Smith and Martin regarded it as remnants of a dissected peneplain of Precambrian age. (Martin, 1916, p. 68; 1932, p. 74; Smith, 1921, pp. 128–129) In order to interpret this surface, or rather series of surfaces on different bluffs, as remnants of a former peneplain it is necessary to answer several problems: (1) exactly how could interstream ridges in such resistant rock be destroyed so completely and (2) why should this hard rock have been beveled so completely when only 25 miles to the south the eminences of Blue Mounds survived? East Blue Mound consists wholly of shale and West Blue Mound has only 85 feet of Niagaran chert on its top. The soil on Happy Hill is a heavy clay with many angular fragments of quartzite. It was termed "Baraboo silt loam" by the soil survey (Geib, 1925). Many of the quartzite fragments have been gathered into stone fences. Search of freshly plowed ground reveals many Paleozoic chert fragments. The chemical nature of the soil does not suggest that it was derived from weathering of the quartzite although the soil report suggests that this was the origin. It is more probable that it is residual from dolomite which once overlay the bluffs and it must include some loess. The presence of the chert fragments from Paleozoic dolomite definitely shows that this is not a post-Paleozoic surface as was thought by Trowbridge. The quartzite weathers into a rubble which makes it difficult to see how divides could be lowered by slopewash. There is no gravel which might suggest lateral erosion by streams except on part of East Bluff at Devils Lake. To the writer interpretation of these flats as remnants of a peneplain either post-Paleozoic or Precambrian is highly improbable. Under this idea we would have to explain the survival of the remnants on the tops of the quartzite bluffs during the long time during which the surrounding Precambrian rocks were reduced to a surface of low relief fully a thousand feet lower. In 1931 the writer suggested (Thwaites, 1931, p. 745) that the crests of the bluffs were eroded by the waves of the Ordovician sea as they were being submerged. The fact that the air photographs and new map show no level tops over three quarters of a mile wide greatly aids this interpretation. Projection of the Paleozoic section to the south (Thwaites, 1935) suggests that the level of these hill tops corresponds to the base of the Ordovician Platteville dolomite. The Platteville transgresses all older formations to the northeast. It lies upon St. Peter sandstone in Wisconsin and upon Precambrian in Ontario (Cohee, 1948). The postulated agency, waves, is clearly competent to level rather low islands of those days provided only there was for a time a near stillstand of land and sea. To check this interpretation the writer sought for conglomerate at the borders of the level hilltops. Several outcrops of boulder conglomerate were discovered, the material of which could only have come from rocks above their level which were eroded during their formation. The only occurrence of gravel on one of these hills at Devils Lake is associated with potholes on the top of the bluff and for 80 feet down its side. Salisbury (Salisbury, 1895; Chamberlin, 1874) stated that the potholes extend back from the edge of the bluff where they were reported in an old dug well. The writer dug test pits and examined the sides of this well by removing stones from the curbing and discovered only clay with scattered stones which is present on other bluffs (Alden, 1918, pp. 99–102). This situation raises the question of the reliability of Salisbury's evidence. It could have been obtained by asking "leading questions." The writer concluded that the gravel has no relation to the origin of the bluff crests but is simply an incident of the erosion of the Paleozoic cover. Certainly the high velocity of water needed to form potholes on this level surface of quartzite required fall from some formation which was later eroded or weathered away. This checks with the nature of the gravel which contains a high proportion of Paleozoic chert pebbles including Ordovician fossils (Thwaites and Twenhofel, 1920; of peneplanation. (Thwaites, 1958, pp. 147–148).

Terraces in Quartzite. The northwest slopes of the higher unglaciated hills of Baraboo quartzite show terraces on the spurs the tops of which do not exceed 1300 feet elevation (Fig. 8). Early students of the region (Salisbury and Atwood, 1900, pp. 63–69; Trowbridge, 1921, pp. 353–357) regarded these as the continuation of the lower or "Lancaster" peneplain on the Prairie du Chien dolomite west of the quartzite. Formation of terraces in such resistant rock as quartzite would require lateral erosion by streams although this point was not discussed in the early reports. Paleozoic conglomerate occurs just below the terraces. The slopes above the terraces are quite steep and the form of the notch in the bluffs is strikingly like a shore terrace. The writer suggests that the terraces are the product of marine erosion during Prairie du Chien time. The westernmost terrace is covered by basal Prairie du Chien strata. The objection that a shore feature could not survive so long is met by the fact that the cliff was soon buried with sediment and its exhumation is an event of relatively recent time. Minor terraces also associated with conglomerate have been found at other localities in the region. To the writer the evidence of the terraces supports his suggested interpretation of the Happy Hill bluff tops, namely marine erosion during submergence rather than any phase of peneplanation (Fig. 6). (Thwaites, 1958, pp. 147–148).

Central Wisconsin Plain. Although the plain of central Wisconsin, which extends north of the escarpment of Galesville sandstone overlain by Franconia sandstone, has never been used as an evidence of regional peneplanation of the Driftless Area, it was regarded by Salisbury and Atwood (1900, p. 51) as "one of the best examples of a base-leveled plain known." Hence it is discussed here although this interpretation seems to have been abandoned by later geologists. Pictures of the striking buttes and mesas of the Camp Douglas region (Fig. 6) which rise from this plain found their way into text books (Chamberlin and Salisbury, 1909, p. 132; Salisbury, 1907, p. 152). Judging not from their statements but from Alden (1918, p. 104) it seems that the early students ascribed the formation of this plain to lateral stream erosion. This is the only origin which could be reconciled with the obvious youthful character of the escarpment and the isolated buttes. Such features as that shown in Figure 6 are obviously incompatible with formation of a peneplain by weathering and slopewash. If the level of the plain had been established by streams, it is evident that they flowed at the level they now do which is fixed by the rock gorge of the Dells of the Wisconsin. The Dells were formed rather late in the Wisconsin stage of glaciation which would necessitate a very youthful age of the surface. In Preglacial time the level of the streams was controlled by the quartzite bottom of the gorge at Devils Lake. However, modern knowledge, based in part on soil surveys and in part on the many borings of the Civilian Conservation Corps plus a few sample-controlled well records, definitely prove that the surface of the plain is lacustrine, not erosional. The steep sides of the Galesville sandstone bluffs may be due in large part to erosion by the waves of Glacial Lake Wisconsin which covered this region until the erosion of the gorge at the Dells. Some of the wells show that the drift on the plain consists of two parts. The lower material next the bedrock is weathered fluvial deposits, probably early Pleistocene outwash, and the surficial part is relatively fresh lake deposits of fine sand and clay. The relief of the bedrock is unknown in detail, for much of the region is sparsely inhabited. From the numerous bluffs which project through the lake deposits it seems as if it must certainly be considerable. One can, therefore, safely discard the evidence of what was once thought to be a modern peneplain.

Entrenched Meanders. Entrenched (sometimes spelled intrenched) meanders may also be termed meandering valleys as distinguished from floodplain meanders with low banks. It is difficult to find such

FIGURE 9. (In two parts, section and map) Entrenched meanders of Kickapoo River. The bluffs of the outer valley are capped by Prairie du Chien dolomite. The terrace is underlain by the Cambrian Franconia sandstone. This terrace is absent farther downstream where erosion does not extend as far beneath the Franconia. It is not a record of a halt in uplift. For explanation of letters see Figure 5.



meanders without either good topographic maps or air photographs. Now that the entire Driftless Area is covered in both ways it is possible to study these meanders. Several facts stand out: (1) there are no entrenched meanders in the valleys of the major streams such as the Mississippi, Wisconsin, and Chippewa; (2) very small streams also show few if any examples of this phenomenon; (3) entrenched meanders are found in medium-sized stream valleys where the bluffs are capped by dolomite; (4) there are no entrenched meanders where the bluffs are wholly sandstone; (5) all known entrenched meanders have an alluvial fill in the bottom; (6) many entrenched meanders have smaller meanders on this alluvial fill; (7) the alluvial fill is due to aggradation of major valleys which carried glacial meltwaters and hence were filled to considerable depth by outwash which made the tributary streams aggrade their valleys to meet the higher outlets. This relationship of two sizes of meanders is often termed "misfit." Since entrenched meanders were the first criterion used to demonstrate uplift (Kümmel, 1895, pp. 714–716), it is important that we consider them briefly. Space forbids any extended discussion of the fascinating problems of meandering streams. Some of the misfit streams of southwestern Wisconsin are shown in Figures 9 and 10.

Causes of Meandering. Meandering occurs when a stream possesses a lateral component of force which causes it to erode the banks first on one side and then on the opposite. Statistical study by Leopold and Wolman (1957) shows that this condition is most marked when the slope of the stream is low. These authors did not prove any relation between meander size and slope or discharge of the stream. Friedkin (1945) proved by experiment that there is a relation between length of meanders and both discharge and slope. Discharge is related to the normal channel width, for vegetation is almost entirely excluded from that. Meanders form only where the banks are reasonably firm material, for in very soft deposits braiding occurs instead. Map study shows that the size of meanders is related to discharge, for big streams have larger meanders than do small ones. Meanders must stop enlarging when the erosive force directed against the bank is equal to the resistance of the bank to erosion. Elementary physics demonstrates that if we consider bends in a stream as segments of circles the force of unit mass of water against the bank is related directly to the square of the velocity and inversely to the radius of curvature. Since with other things equal, the square of velocity of a stream is directly proportional to the slope, we can say that this relationship may also be written as slope divided by radius. As meanders grow, they affect the lateral force in two ways: (1) increased length of channel diminishes slope and velocity and (2) increase in radius also decreases force. The two

FIGURE 10. Entrenched meanders of Balltown Quadrangle Wisconsin. The bluffs are capped by Galena dolomite. The meanders are apparently of the "ingrown" type and originated when the surface was much higher than it now is but was not necessarily a peneplain.

phenomena finally bring about a state of equilibrium which might be perfect were it not for the changes of discharge of almost all streams. Lateral force of streams can erode high banks as well as the low banks of a flood plain but evidently the former will be worn back more slowly than the latter. In every case there is a slight component of lateral force which is directed downstream so that meanders gradually move downstream in a process called "sweep". Destruction of meanders by cutting off inside the bend or at the neck is obviously much slower where the banks are high and made of rock than in the case on a floodplain. Rich (1914) long ago divided meandering valleys into (1) "ingrown", and (2) "intrenched". The former are bends which enlarged themselves during downcutting, the latter are meanders which are eroded down vertically without such enlargement. Initiation of such meanders certainly began when the streams were high above their present level. At that time the banks were composed of strata which were long ago eroded away. During the long history of these streams we cannot be sure either of climatic conditions or of material of the banks when these entrenched meanders began. The writer can see no compelling reason for thinking that they began on a peneplain although they do demonstrate uplift of the region. In soft sandstone, downstream sweep has destroyed all trace of meanders. Their disappearance in large streams is probably due to the greater total force of those streams. In fact one might say that size of meanders is related to the total force of a stream which is related to both discharge and slope.

Upland Gravels. Many geologists have thought that gravels on an upland are positive proof that it was once a peneplain. Probably these people were thinking of a surface which originated from lateral erosion by streams which process is now thought of as a feature of pediplanation. Little attention seems to have been directed to the slopes of the streams which transported this gravel. It is not difficult (Nevin) to compute the velocity of water required for a given maximum size of pebbles, but it is almost impossible to translate this velocity into slope. The velocity of a stream of water is related to three factors: (1) slope, (2) size of stream expressed either as mean depth or as cross section area divided by width of bottom (hydraulic radius), and (3) kind of bottom. Of these the size of the stream is most important and is hardest to estimate.[1]

Pediplane Theory. So far as the writer is aware, the theory of pediplanation has never been applied as an explanation of the uplands of the Driftless Area. Geologists in this country seem to have avoided that hypothesis, perhaps because of the climatic change that it requires. It appears to the writer that the presence of some

[1] See explanation of Mannings Formula in textbooks on hydraulics.

gravel, the Windrow Formation (Thwaites and Twenhofel, 1920; Andrews, 1958) on the uplands of the Driftless Area is more in line with the idea of pediplanation than it is with the theory of peneplanation. In fact a number of geologists in the past seem to have ascribed leveling to lateral stream erosion which is part of the theory of pediplanation. On the other hand the gravels are very scattered and residuum from the dolomites does not appear favorable for erosion by slopewash or ephemeral streams as the theory of pediplanation requires. In parts of Wisconsin it is not possible to discriminate a former plain which truncated the cuestas (Fig. 3E) although such a construction is possible in the southern part of the Driftless Area (Fig. 3D). The surfaces in Illinois described by Horberg have scattered gravel on some of them. Pediplanation could account for the stairway of levels which have been discriminated. Potter (1955; Lamar and Reynolds, 1951) described so-called Lafayette gravel in Illinois but do not appear to have developed a definite hypothesis of its origin beyond the discrimination of alluvial fans. Potter correlated the Windrow Formation of Wisconsin and Iowa with these gravels of Illinois and farther south, but to the writer this is far from established. The Windrow gravels are almost all preserved because of their resistance to erosion which is due to limonite cement and could, therefore, be much older. All factors considered, the pediplanation hypothesis must be discarded for the Driftless Area although it might

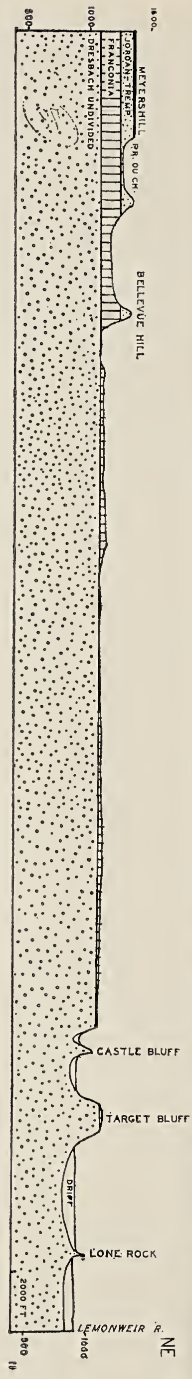


FIGURE 11. Profile on a divide from the Prairie du Chien upland at left to the castellated sandstone bluffs at Camp Douglas. The divide forms a bench on the front of the Prairie du Chien upland which is obviously due to the relative resistance of the Franconia sandstone above the weaker Galesville member of the Dresbach formation. Note that the sandstone bench does not show the bevel which occurs on the dolomite uplands. For explanation of letters see Figure 5. Figure 6 is a photograph of one of the Camp Douglas bluffs.

be acceptable in Illinois. We can simply say that the evidence is insufficient for an intelligent conclusion. The Windrow gravel is observed filling a narrow depression in Devonian limestone at Mitchell, Iowa. Farther west exactly similar material occurs in Cretaceous conglomerate.

Franconia Upland. The Franconia sandstone along with many outliers of younger formations caps a much dissected upland northeast of the Prairie du Chien cuesta. (See Fig. 1) (Shipton, 1916). This upland is little discussed in the literature although Shipton suggested that it is another dissected peneplain. It lies much lower than we would expect the "Dodgeville" surface and might perhaps be regarded as part of the "Lancaster" peneplain. It does not display the bevel of the capping formation as the dolomite cuestas do. It does not have as wide rolling uplands between valleys as characterize the dolomite surfaces. This surface occurs not only outside the Prairie du Chien escarpment but also in valleys within it. (Fig. 11) Figure 9 shows the relations of the Franconia bench within the Kickapoo Valley of western Wisconsin. There the bench is found only where preglacial erosion extended well below the bottom of the Franconia. There is no continuation of the bench downstream as there should be were it due to a halt in uplift of the region. It is a feature due entirely to weathering and erosion controlled by the nature of the bedrock and has no bearing on the hypothesis of former peneplanation. The large meanders of the La Farge Quadrangle did not originate on this bench but long before as is shown by similar features downstream (Thwaites, 1928).

Relation of Stream Courses to Rock Structure. The writer is not aware that any geologist has used the discordance of stream courses within the Driftless Area as an evidence of peneplanation. Trowbridge postulated (Trowbridge, 1921, pp. 97–103) a complex theory of stream capture to explain the relation of Mississippi River to the structure of bedrocks displayed in the bluffs of the present time. Flint (1941) described similar phenomena on the flank of the Ozark dome to the south. Antecedence to the present structure, superposition on a peneplain, and glacial diversion were hypotheses which some have considered. The simplest idea is superposition from strata which were disconformable to those now preserved. The Devonian, Pennsylvanian, and Cretaceous were all in this relation to the older sediments. The former extent of these younger formations is unknown. Streams which had become adjusted to these overlying formations could have been let down onto older rocks and thus have brought about the present relations. Surely this is the most plausible theory.

Conclusions. The writer has tried above to show that every one of the criteria which was formerly used to demonstrate ancient peneplanation of the Driftless Area can be accounted for by another interpretation. The sole possible exception is an apparent bevel of some local structures. The alternative explanations appeal to the writer, as they did to Martin, more plausible than those formerly offered. The level skyline is certainly an optical illusion. Beveling of the dolomites is clearly related to the length of time since the protecting strata above were removed, for these are water-soluble formations which were greatly reduced by solution. The upland topography on dolomites displays inverted parabolic slopes in accordance with Gilbert's theory thus showing mass movement to an extent that makes it impossible to be sure that there is any surviving pre-valley topography. Cuestas are the dominant feature of the landscape and examination of the backslopes fails to demonstrate two peneplain levels. The cuesta escarpments are sharp youthful topography out of harmony with the idea that they separate peneplains of different ages. The ridge parallel to the Mississippi River which was supposed to connect two cuestas is in fact no different from other ridges except that in it the weak St. Peter sandstone is thinner than it is in other localities. Beveling of minor faults and folds by the upland is an uncertain criterion of peneplanation because of not only the falibility of the human eye with such small displacements but also the more rapid erosion of higher places. Happy Hill on quartzite is plausibly accounted for by marine erosion during Ordovician submergence. The terrace which extends the Prairie du Chien upland along the flanks of the quartzite bluffs resembles a marine cliff formed during the deposition of that formation, buried and later exhumed. The plain of central Wisconsin was not used as a line of evidence although it was at one time thought to be a modern undissected peneplain. It actually is a lake plain. Entrenched (or intrenched) meanders are common in the Driftless Area in medium-sized stream valleys. They appear to indicate uplift, but it is not necessary to assume that they originated on a peneplain. Size of meanders is related to total energy of a stream although flat country fosters development of meanders. The patchy Windrow gravels of the uplands do not prove either a peneplain or a pediplain. These gravels may be as old as Cretaceous. The pediplain hypothesis, although possible, is inadequately supported by the known evidence. The bench on the resistant Franconia sandstone does not show the features of a dolomite upland. It occurs both outside the Prairie du Chien cuesta and in valleys within it in a manner that is wholly out of harmony with the idea of successive uplifts. In accounting for discrepancies between the courses of stream and bedrock structure the simple idea of superposition from formations which are now wholly eroded away appears to have been neglected. The writer suggests that like the lawyers we move that all the evidence on former peneplanation be "stricken from the record as incompetent, irrelevant, and immaterial." If this should be done, we are faced with the choice of either turning to the theory of pediplanation which lacks evidence or returning to Martin's explanation. The latter hypothesis attached more importance to both the nature of the bedrocks and their weathered residuum than was formerly given (Shaler, 1899). It does not deny that possibly, indeed probably, there were many changes in level of sea and land during the long erosional history of the Driftless Area but simply that the evidence of either complete or nearly complete cycles of erosion in this area is not convincing.

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A STUDY OF THE EFFECTS OF DIVERTING THE EFFLUENT FROM SEWAGE TREATMENT UPON THE RECEIVING STREAM*

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The Madison Lakes problem at Madison, Wisconsin, has been a subject of nationwide discussion, intensive investigation, and legislative and legal action for many years. In the early history of the city, Lake Monona received raw sewage and later treated sewage effluent from the City of Madison. In 1926, the Nine-Springs plant was placed in operation and the effluent from this installation was carried via Nine-Springs Creek to the Yahara River above Lakes Waubesa and Kegonsa. The enrichment of these lower Madison Lakes by the highly nutritious effluent produced nuisance algal growths, offensive odors, and periodic fish kills. These conditions led to innumerable complaints, much debate, and eventually legislative and legal action which forced the diversion of the effluent from the Madison Metropolitan Sewerage District's Nine-Springs Treatment Plant around the lower Madison Lakes.

The route chosen for the diversion of the Nine-Springs effluent necessitated five miles of 54-inch pipeline and nearly four miles of open ditch which leads southward and enters Badfish Creek below Oregon (Fig. 1). Badfish Creek was straightened and improved to a width of at least 16 feet for ten of its 14.5 miles of length. The unimproved portion, after some meandering, enters the Yahara River which, after six miles, discharges into the Rock River. Two cascade-type aerators were placed in the ditch to improve the condition of the effluent prior to its discharge into Badfish Creek.

Badfish Creek is a small meandering stream which flows through typical oak opening agricultural lands in Dane and Rock Counties. Some years ago, the Dane County portion was straightened and widened to serve as a drainage ditch. From the Dane-Rock County line to its junction with the Yahara River, however, it has a substantially larger natural flow and a correspondingly greater channel capacity. Portions of the stream have had a history of being marginal trout water.

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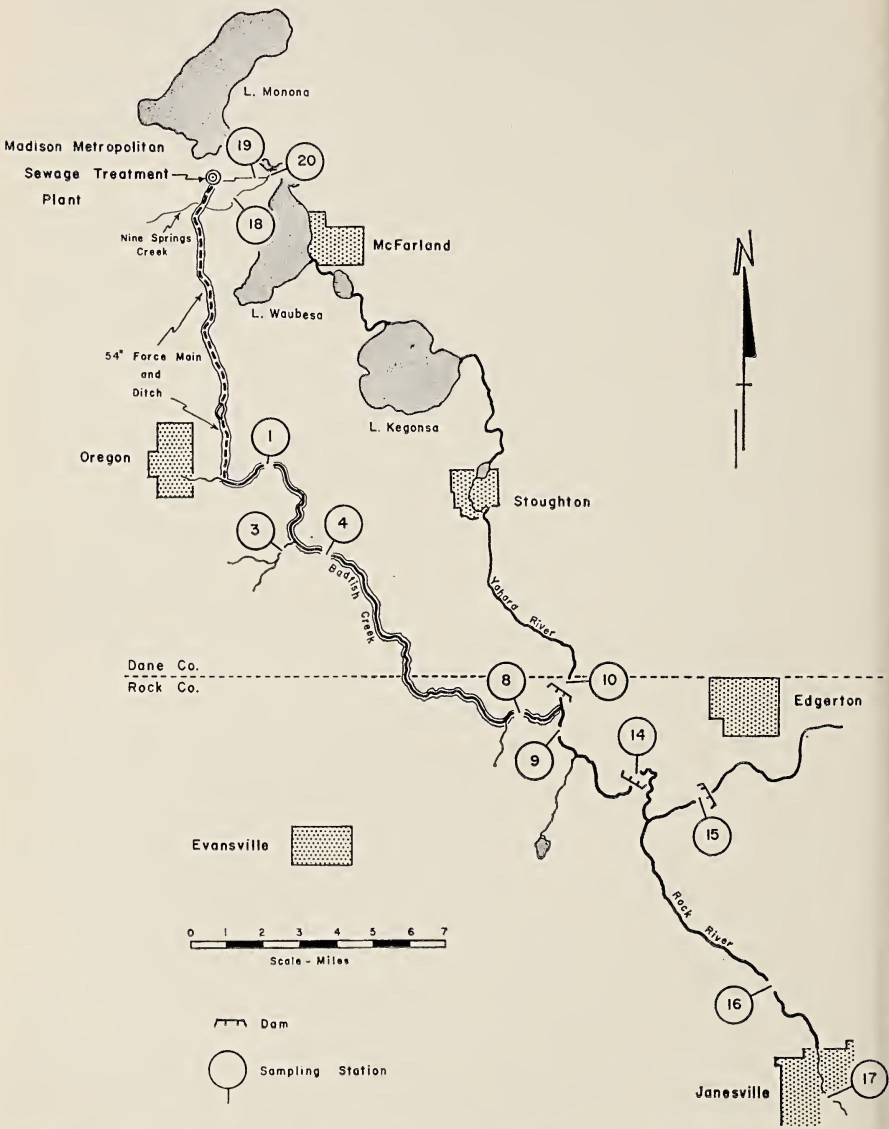

FIGURE 1. Map showing diversion route of Madison Metropolitan Sewage Treatment Plant effluent. Sampling stations are indicated by number inside of small circles.

Near its headwaters, Badfish Creek receives the effluent from the Oregon sewage treatment plant. This is a complete type treatment plant, utilizing the trickling filter secondary treatment process. It discharges about 65,000 gallons of effluent per day. The effluent is not chlorinated. In December, 1958, the Madison Metropolitan Sewerage District began pumping effluent from its Nine-Springs Sewage Treatment Plant to the Badfish Creek. A pumping station was made necessary because the effluent passes over a divide 80 feet higher than the sewage treatment plant.

The Nine-Springs Sewage Treatment Plant provides primary and secondary treatment for all wastes from the Madison Metropolitan area of 85 square miles and a population of about 135,000. The flowage through the plant averages about 20 million gallons per day. Primary treatment consists of screening, grit collection, and sedimentation. About one-fourth of the sewage receives secondary treatment by the trickling filter process, and about three-fourths of the sewage receives secondary treatment by the activated sludge process. The effluent receives chlorination.

Badfish Creek has an average slope of over six feet per mile. There are no major stagnant water areas in either the Badfish Creek, Yahara River, or Rock River downstream from the discharge of the Nine Springs effluent. It was, therefore, the purpose of this study to determine the chemical and biological effects on a flowing stream which might result from the discharge of an effluent of considerable volume with a high nutrient composition.

Methods

The sampling stations for this study are indicated by number on Figure 1. Badfish Creek is approximately 16½ miles long, and for the purpose of this study, three sampling stations were chosen. Station 1 is approximately one mile below the confluence with the ditch carrying the Nine Springs effluent. Station 4 is approximately four miles downstream from Station 1 and is also located in the improved section of the stream. It was so chosen because the U. S. Geological Survey in cooperation with the Madison Metropolitan Sewerage Commission and the Committee on Water Pollution established a gauging station at this point, the purpose of which was to acquire continuous water level data. Station 8 is the farthest downstream station on Badfish Creek and is approximately 1½ miles above the confluence with the Yahara River.

Three stations were similarly chosen on the Yahara River, one above the confluence with Badfish Creek (Station 10) and two below this confluence (Stations 9 and 14). The distance of the Yahara River which is now affected by the effluent is approximately 6.4 miles. On the Rock River, Station 15 is approximately two miles above the confluence of the Yahara and Rock Rivers, and Stations 16 and 17 are located six and ten miles respectively downstream from the confluence with the Yahara River.

Water samples for chemical and phytoplankton determinations were collected bi-weekly for a 26-sample period prior to diversion, and a similar period subsequent to diversion. Chemical determinations were made in accordance with the procedures outlined in the Tenth Edition of Standard Methods of Water Analysis and Sewage.

FIGURE 2. Ditch immediately below 54″ pipe outfall. Note foam on water surface.

The results of these determinations were considered on a paired-date basis before and after diversion, and are tabulated in Table 1.

To concentrate the phytoplankton, 500 ml. of stream water were placed in one-liter glass settling cylinders to which were added 20 ml. of commercial formalin to preserve the sample, and 10 ml. of a detergent (Joy) to settle the sample. Sedimentation of the plankton was complete in 24 hours, after which the supernatant was carefully siphoned from the cylinder, and the concentrate was washed into 100 ml. centrifuge tubes. These were spun at 2,000 r.p.m. for six minutes. The supernatant in the tube was decanted and the concentrate was washed into screw-capped storage vials and brought to the nearest 5 ml. by the addition of 4% formalin and the use of a volume standard.

Enumeration of the phytoplankton was carried out according to the procedures outlined by Prescott (1951). The concentrate in the storage vials was thoroughly mixed. A large-pore dropper delivering a known number of drops per c.c. was used to deliver one drop of the concentrate on a glass slide. Five low-power fields and ten high-power fields were observed on this slide, and the magnification as well as number of each species of organisms was recorded. This

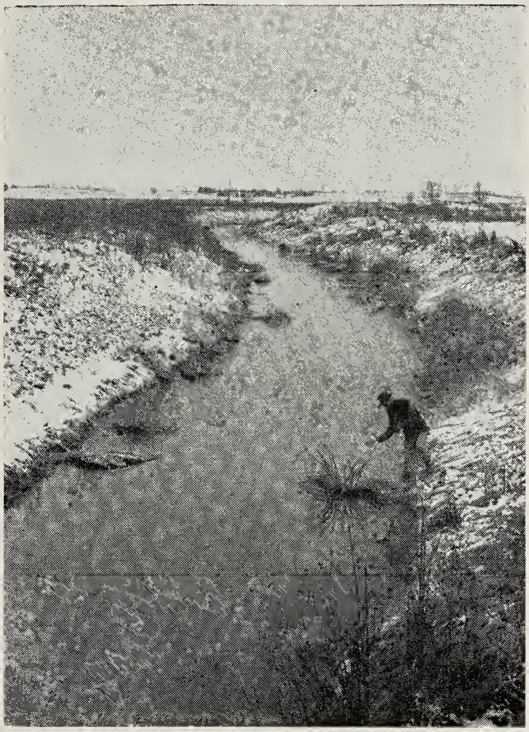

FIGURE 3. Ditch about 1½ miles below pipe outfall. Roundstem bulrush can be noted in some sections of stream.

procedure was repeated on three such mounts so that a total of 15 low-power fields and 30 high-power fields were observed. The number of a particular type of organism in one liter of water was determined by the following formula:

$$\text{No./L.} = \frac{(\text{Ave. No./field})\ (\text{No. fields/coverslip})\ (\text{No. drops/ml.}) \cdot 1000}{\text{Concentration factor}}$$

$$\text{The concentration factor} = \frac{\text{ml. of original sample}}{(\text{ml. of concentrate})\ (0.94)},$$

where 0.94 accounts for the dilution of the sample by the addition of formalin and the detergent.

In converting to volumetric units, the average volume in cubic microns of each species was obtained by measuring 20 individuals. When it was observed that the species size was significantly different between two samples, a second set of measurements was made.

FIGURE 4. Station 1 on Badfish Creek before improvement.

The volume contributed by each species was expressed in parts per million by use of the following formula:

$$\text{Volume (p.p.m.)} = \text{(No. Org./L) (Ave. Species vol. in cu. microns)} \times 10^{-9}.$$

Bottom fauna were collected and examined at seven stations on Badfish Creek. Collections were made on four different occasions, two of which were prior to diversion and two subsequent to diver-

FIGURE 5. Station 1 on Badfish Creek following diversion.

FIGURE 6. A section of the lower Badfish Creek.

sion. The samples were collected with either a square foot sampler or a Petersen dredge. In the latter case, the organisms were washed from the rubble and retained in a U. S. Standard No. 35 screen. Identification and enumeration of the organisms were completed, and the number of each species was calculated on a square foot basis.

The important chemical data and the phytoplankton were analyzed statistically (Table 1). The mean and the 95 percent confidence interval were calculated on 26 paired dates prior and subsequent to diversion for nitrogen, phosphorus, B.O.D., and phytoplankton. The coefficient of variation on these data normally did not appear excessive, especially when one considers the possibility of climatic and seasonal influence.

Although phytoplankton was determined to the species level wherever possible, no attempt has been made to consider any but broad groupings in this paper. The volumetric concentration in p.p.m. for each of those broad groups is shown in Figures 7, 8, and 9 for each of the stations studied.

Results

Physical Aspects

As the effluent leaves the 54″ pipeline, it enters a rather straight ditch with steep banks. The first approximately one-half mile of this ditch often carries a blanket of detergent foam (Fig. 2). Approximately one mile farther down stream, the banks of the ditch become less steep, and as early as one year following the onset of diversion, there was some evidence of vegetation encroachment, principally round-stemmed bulrush (Fig. 3). Badfish Creek itself was dredged to a bottom width of 16 feet for approximately four miles, and a bottom width of 20 feet for the remaining six miles of improved stream. This made a tremendous change as indicated by the "before" (Fig. 4) and "after" (Fig. 5) at Station 1 which is located a short distance down stream from the ditch entrance into Badfish Creek. Along with the changes wrought by physical disturbance, there is a change in flow produced by the introduction of approximately 20 million gallons per day of effluent. Prior to diversion, Badfish Creek at about its mid point between its origin and confluence with the Yahara River had an average flow of 9.6 c.f.s. for the 2½ years in which records were kept. Following diversion, the flow averaged 43 c.f.s. for the summer portion of the period of study. In the unimproved portion of Badfish Creek there was little gross physical change noted as a result of diversion (Fig. 6).

Badfish Creek originally contained many riffle areas with a bottom composed principally of small rock and gravel. The bottom was, of course, altered in the improved section, yet remains a coarse gravel over much of the area.

Concurrent with the discharge of considerable quantities of suspended solids, a sludge deposit has built up over most of the upstream portions of Badfish Creek. In some areas, especially in small pockets along the side of the stream, this deposit approaches six to ten inches in depth. In most of the upstream region, as well as the ditch itself, the sludge is of sufficient thickness to produce a suitable habitat for a bountiful population of midge larvae.

Chemical and Bacteriological Aspects

The organic nitrogen (Table 1) shows a sizeable increase at all stations in Badfish Creek following diversion. At Station 1, the mean concentration of organic nitrogen was 0.73 $\pm$.16 p.p.m. prior to diversion, and 4.13 $\pm$ 1.14 p.p.m. following diversion. This is over a five-fold increase in concentration. At Station 4, the stream was carrying 30 pounds per day of organic nitrogen prior to diversion, and 286 pounds per day following diversion. There is a progressive decrease in concentration as one moves downstream on Badfish Creek, both in 1956 and 1959. The early samples show some effect of the discharge of effluent from the Oregon sewage treatment plant, whereas the later samples show the combined effect. In the Yahara River, there appears to be no statistical difference between either the stations located above and below the entrance of Badfish Creek, or between the samples collected before or after diversion. There is an indication, however, as shown at Station 10 for the 1959 samples that the organic nitrogen is somewhat less in the Yahara River above the entrance of Badfish Creek, than it is below this confluence. The decrease at this point may be a result of diversion. Samples taken from the Rock River show no statistical difference either between stations on the same river or between the 1956 or 1959 samples. Total organic nitrogen in a stream is a measure of the nitrogen combined by biological processes, and in this case, the increase in Badfish Creek is due to the addition to the stream of the Nine Springs effluent.

The inorganic nitrogen as shown in Table 1 includes the sum total of ammonia, nitrite, and nitrate nitrogen. Here, again, there is an indication of the effect of Oregon Sewage Treatment Plant effluent on Badfish Creek in the 1956 samples. The 1959 samples, however, indicate a five-fold increase in concentration and nearly a 30-fold increase in pounds per day over the 1956 data. Again, there is a decrease in concentration as one moves downstream. The Yahara River indicates no statistical differences between the three stations in 1956, but does indicate a significant difference between Station 10 above the confluence with the Badfish as compared with

TABLE 1

SUMMARY OF BIOLOGICAL AND CHEMICAL DATA BEFORE AND AFTER DIVERSION ON BADFISH CREEK, YAHARA RIVER, AND ROCK RIVER—BASED UPON 26 BI-WEEKLY DATES EXTENDING FROM JUNE 6, 1956 TO MAY 22, 1957, AND MARCH 4, 1959 TO FEBRUARY 17, 1960

	Sta.	Range		Mean ±95% Confidence Interval		Standard Deviation		Coefficient of Variation (%)		Pounds Per Day[1] Range		Pounds Per Day[1] Mean	
		1956	1959	1956	1959	1956	1959	1956	1959	1956	1959	1956	1959
Phytoplankton[2]....	1	0.12–40.93	0.37–10.16	6.53 ±4.04	2.74 ± .95	10.03	2.28	153	83				
	4	1.09–15.43	0.55–12.45	3.98 ±2.58	3.24 ±1.78	3.20	2.70	80	83	56–791	247–1,435	259	622
	8	1.35–16.74	0.22–13.99	6.35 ±1.54	4.86 ±1.70	3.85	4.06	60	83				
	10	0.04–37.43	0.11–56.87	10.62 ±4.19	12.70 ±6.34	10.17	14.35	95	112				
	9	0.33–24.38	0.39–30.71	7.59 ±2.55	9.09 ±3.10	6.73	7.51	83	82				
	14	0.16–37.38	0.15–52.53	9.56 ±3.79	11.63 ±5.49	9.41	13.32	98	114				
	15	0.58–62.19	0.53–57.55	25.59 ±8.59	18.37 ±6.15	20.38	14.91	82	81				
	16	0.55–56.51	1.03–62.20	25.43 ±7.07	21.36 ±6.96	17.15	16.89	67	79				
	17	1.06–62.24	0.23–53.67	24.64 ±7.61	19.50 ±6.56	18.08	15.93	73	81				
Organic N.[2].......	1	0.33–2.20	1.33–11.74	0.73 ± .16	4.13 ±1.14	0.40	2.69	55	65				
	4	0.27–2.00	0.93–9.50	0.61 ± .17	3.22 ± .89	0.41	2.17	67	67	13–71	206–447	30	286
	8	0.21–2.30	1.03–7.10	0.54 ± .18	2.59 ± .66	0.42	1.59	77	61				
	10	0.60–4.34	0.00–2.44	1.61 ± .41	1.29 ± .25	0.96	0.63	60	49				
	9	0.64–2.32	0.94–3.34	1.30 ± .19	1.49 ± .23	0.48	0.56	37	38				
	14	0.60–2.70	0.60–2.65	1.54 ± .27	1.58 ± .23	0.66	0.54	43	34				
	15	0.90–3.71	0.94–3.54	1.99 ± .25	1.77 ± .27	0.60	0.65	30	37				
	16	0.88–3.51	0.74–3.34	1.86 ± .29	1.78 ± .29	0.71	0.69	38	39				
	17	0.94–3.31	0.84–3.24	1.86 ± .25	2.14 ± .56	0.60	1.42	32	66				
Inorganic N.[2]......	1	1.98–5.53	13.4–21.1	3.73 ± .35	17.98 ±2.07	0.87	2.03	23	11				
	4	1.73–3.64	10.0–18.7	2.65 ± .08	15.17 ± .91	0.21	2.20	8	15	89–143	2,171–4,246	110	3,153
	8	1.38–4.49	7.2–17.6	2.34 ± .31	11.42 ± .97	0.77	2.35	33	21				
	10	0.09–1.24	0.09–2.82	0.47 ± .14	0.62 ± .25	0.34	0.61	72	98				
	9	0.10–2.18	1.09–11.31	0.66 ± .21	3.53 ±1.11	0.52	2.73	79	77				
	14	0.10–1.51	0.80–4.64	0.55 ± .16	2.00 ± .37	0.40	0.93	73	46				
	15	0.09–0.68	0.10–3.32	0.27 ± .07	1.34 ± .47	0.17	1.18	63	88				
	16	0.09–0.91	0.15–3.10	0.29 ± .08	1.42 ± .41	0.21	1.01	72	71				
	17	0.05–1.13	0.19–3.09	0.30 ± .10	1.43 ± .39	0.26	0.97	86	68				
Soluble P.[2]........	1	0.30–1.56	5.5–12.0	1.07 ± .12	8.22 ± .64	0.33	1.51	30	18				
	4	0.10–0.30	4.4–7.3	0.19 ± .02	5.96 ± .37	0.05	0.90	25	15	7–12	996–1,701	9	1,351
	8	0.01–0.12	3.0–8.4	0.08 ± .01	5.22 ± .64	0.03	1.56	37	30				

Soluble P.[2] (cont.)	10	0.46–1.30	0.23–1.5	0.94 ± .10	0.88 ± .12	0.26	0.33	28	38				
	9	0.16–1.30	0.56–6.4	0.83 ± .12	1.86 ± .52	0.33	1.28	40	69				
	14	0.40–1.28	0.58–2.6	0.81 ± .10	1.22 ± .49	0.28	0.41	35	34				
	15	0.01–0.19	0.01–0.68	0.05 ± .02	0.22 ± .01	0.05	0.02	95	8				
	16	0.01–0.41	0.15–0.94	0.18 ± .04	0.46 ± 0	0.11	0.01	61	3				
	17	0.02–0.44	0.13–1.40	0.17 ± .04	0.48 ± .02	0.10	0.03	63	6				
B.O.D.[2]	1	1.8–7.7	4.1–39.4	3.63 ± .60	21.01 ± 8.13	1.46	18.80	40	89				
	4	0.8–5.4	3.1–55.8	2.11 ± 2.30	17.25 ± 5.59	5.29	13.56	250	79	39–113	755–2,333	75	1,602
	8	0.6–8.8	3.3–38.4	2.12 ± .64	13.99 ± 4.44	1.56	10.75	74	77				
	10	1.3–14.5	1.5–7.70	6.14 ± 1.75	3.89 ± .89	4.23	2.17	69	56				
	9	1.8–15.7	2.5–19.7	4.90 ± 1.24	5.86 ± 1.44	3.08	3.55	63	61				
	14	1.5–14.3	2.4–15.4	5.90 ± 1.50	5.08 ± 1.13	3.70	2.79	63	55				
	15	3.5–17.1	2.2–15.3	7.61 ± 1.38	5.23 ± 1.17	3.46	2.91	45	56				
	16	2.7–14.3	2.1–12.9	7.18 ± 1.26	5.46 ± 1.19	3.09	2.94	43	52				
	17	3.0–15.4	2.4–10.2	7.00 ± 1.42	4.95 ± .89	3.51	2.21	50	45				
D.O.[2]	1	3.1–13.4	0.1–8.9										
	4	7.8–15.9	1.7–10.7							368–636	413–1,749	475	904
	8	6.6–16.7	2.2–11.1										
	10	4.2–21.6	5.9–17.5										
	9	8.9–19.3	3.9–16.7										
	14	5.6–15.4	2.9–15.7										
	15	4.4–20.9	3.0–25.8										
	16	6.6–18.3	6.4–22.0										
	17	5.3–18.1	6.1–20.5										
pH	1	7.5–8.2	7.4–8.1										
	4	7.7–8.6	7.5–8.2										
	8	7.7–8.8	7.7–8.1										
	10	8.0–9.9	7.7–9.2										
	9	8.2–9.8	7.0–8.9										
	14	8.1–9.6	7.7–8.9										
	15	8.3–9.2	7.7–9.1										
	16	7.8–9.7	7.6–9.3										
	17	7.9–9.4	7.8–9.2										
M.P.N. (x 10^3)	1	7–540	3.3–790										
	4	0.5–160	4.9–350										
	8	0.4–240	0.8–1,200										
	10	0.02–18	0.2–49										
	9	0.08–35	0.8–130										
	14	0.05–54	1.3–430										
	15	0.2–35	0.5–210										
	16	0.2–17	0.3–170										
	17	0.2–54	0.3–160										

[1]Pounds of material per day on 9 bi-weekly paired dates (June 1–October 1) for Station 4. Flow in c.f.s. in 1956 ranged from 8.0–10.0 with a mean of 8.7; in 1959 the flow in c.f s. ranged from 40.0–48.0 with a mean of 43.0.

[2]Parts per million.

Stations 9 and 14 below the confluence in 1959. The two latter stations are much increased, demonstrating the influence of a heavy concentration of inorganic nitrogen which is being transported by Badfish Creek. The Rock River demonstrates no statistical difference between the mean data for the three stations in 1956, and between the mean data for the three stations in 1959. The latter samples are all considerably higher in concentration, but it is thought that this is the result of factors other than the diversion.

The sizeable increase in inorganic nitrogen in Badfish Creek, as demonstrated by the post-diversion samples, is due primarily to an increase in the ammonia nitrogen. There appears to be a slight increase in the nitrite nitrogen, particularly at Stations 4 and 8. However, this is easily overshadowed by the large increases in ammonia nitrogen. At Station 10, the slight increase in the 1959 data over that which is presented for 1956 is due to an increase in nitrate nitrogen, whereas at Stations 9 and 14, the increase is shared by all three types with the greatest contribution being the ammonia nitrogen transported from Badfish Creek. The increases displayed by the Rock River samples are due primarily to increases in all three forms of nitrogen with some indication that increases in the ammonia and nitrite nitrogen might influence the *total* inorganic nitrogen concentration to a greater extent in the samples collected from the two down-stream stations.

Like inorganic nitrogen, soluble phosphorus is a nutrient material available for growth utilization by plant life. Soluble phosphorus is characteristically high in sewage effluent as compared to natural drainage. Badfish Creek, prior to diversion, clearly shows the effect of the Oregon Sewage Treatment Plant effluent through an increased soluble phosphorus concentration. Station 1 was quite high and decreasing amounts were found at Stations 4 and 8. Following diversion, Badfish Creek displayed a terrific increase in the soluble phosphorus content. Although the variability between the stations makes it impossible to determine the magnitude of the increase, it was in the neighborhood of 30 times. Consideration of soluble phosphorus in pounds per day past Station 4 reveals nine pounds in 1956 compared to slightly over 1,300 pounds in 1959. The Yahara River samples were all quite high in 1956, and no doubt indicated the concentrations which were being discharged from Lakes Waubesa and Kegonsa. There was no statistical difference between any of the three stations on the Yahara River in 1956. In 1959, after diversion, however, Station 10 above the confluence with Badfish Creek demonstrated about the same concentration of soluble phosphorus as did this station in 1956. Stations 9 and 14 on the Yahara River below the confluence with Badfish Creek indicated about a two-fold increase as compared to Station 10 above. The Rock River indicated a similar differential between Station 15 above the confluence with the Yahara and Stations 16 and 17 below the confluence. The waters discharging past the above station carried a lesser concentration of soluble phosphorus in both years. This would be expected since the diversion route would exert no change on the conditions which might be found in the Rock River.

Badfish Creek experienced some rather high B.O.D. (biochemical oxygen demand) values and likewise some rather low D.O. (dissolved oxygen) values during the post-diversion study. The maximum B.O.D. found during the study, following diversion, was 55.8 p.p.m. at Station 4, but the highest sustained B.O.D. was a mean of 21.01 $\pm$ 8.13 p.p.m. found at Station 1. Similarly, the lowest D.O. recorded at Station 1 following diversion was 0.1 p.p.m., at Station 4, 1.7 p.p.m., and at Station 8, 2.2 p.p.m. Considering the summer period (June 1 to October 1) there were 75 pounds of B.O.D. per day and 475 pounds of D.O. per day prior to diversion at Station 4. However, after diversion in 1959 for this same period, the water at Station 4 was carrying 1,600 pounds of B.O.D. per day and only 900 pounds of D.O. to satisfy this demand. Thus, there was a deficit of 700 pounds of D.O. per day in this area. The Yahara and Rock Rivers did not appear to be appreciably affected by the B.O.D.-D.O. relationship. However, the two lower stations on the Yahara did exhibit D.O. readings which are considered below normal for that stream. If one considers a D.O. of 3 p.p.m. or below as presenting conditions critical for the survival of fish and other desirable forms of aquatic life, the summertime D.O. levels on Badfish Creek are of interest. For example, at Station 1, eight of nine samples taken between the June 1–October 1 period contained less than 3 p.p.m. of D.O. At Station 4, four of nine samples contained less than 3 p.p.m. D.O., and at Station 8, five of nine samples displayed this condition.

The most probable number of coliform organisms per 100 ml. was quite variable throughout the course of the study (Table 1). As pointed out earlier, the effluent from the Oregon Sewage Treatment Plant was not chlorinated and did show an effect upon Badfish Creek prior to diversion with an above-normal concentration of coliform organisms. Following diversion, the MPN determinations for Badfish Creek were higher than those recorded for 1956. The influence of the Nine-Springs effluent was perceptible also in the Yahara River. The MPN determinations for the Rock River ranged higher at all three stations than similar samples in 1956. This phenomenon was undoubtedly due to factors other than those of diversion.

Biological Aspects

The phytoplankton volume throughout the course of the study displayed considerable variability as would be expected (Table 1). However, the mean volume, although showing an increase for the larger rivers, showed no statistical difference either between the three stations on a given river or between the two periods of study for the same station. It thus appears that a sizeable increase in nutrients in a flowing water situation has no substantial effect upon a volumetric production of phytoplankton.

The phytoplankton volume of Badfish Creek was generally lower than that of the Yahara River or Rock River (Figs. 7, 8 & 9). Although there was little change in phytoplankton volume evidenced as a result of diversion, the change was most pronounced at Station 1 on Badfish Creek. There was an indication of a volumetric reduction following diversion which suggested inhibited growth. The blooms of *Euglena* which were present before diversion at Station 1 did not appear in the 1959 samples. *Oscillatoria sp.* did appear in the samples following diversion, and quite possibly came from the rather extensive growth of this genus over the bottom deposits. The principal diatoms occurring in the 1956 samples consisted of *Navicula, Nitzschia, Gomphonema,* and *Synedra.* In the 1959 samples, populations were dominated by species of *Navicula* and *Nitzschia* with other genera appearing only occasionally and in very small numbers. On the occasions when green algae appeared, these consisted of *Chlamydomonas* and *Closterium,* both in the 1956 and 1959 samples. In general, the 1959 samples, especially at Station 1, appeared more heterogeneous to class and more homogeneous to genera than those collected in 1956.

The tendency toward inhibited growths was apparent although much reduced at Station 4, following diversion. In 1956, the greatest diatom volume appeared in late summer, and consisted principally of *Navicula* with several other genera represented in varying numbers. The 1959 samples did not reveal as great a volume, nor as great a variety of species, but did indicate a more equal representation between the diatoms, blue-green algae, and green algae in the phytoplankton.

At Station 8, the principal constituents of the diatom population prior to diversion were *Navicula* and *Nitzschia* with *Synedra, Cyclotella, Gomphonema,* and *Cocconeis* contributing to the total volume regularly. In 1959, *Navicula* and *Nitzschia* were the principal constituents of the diatom population, with the other genera appearing only occasionally and contributing less to the total volume. Green algae and blue-green algae appeared occasionally in the 1959 samples and not in the 1956 samples, although the total plankton volume was rarely affected by these occurrences. The *Euglena* group

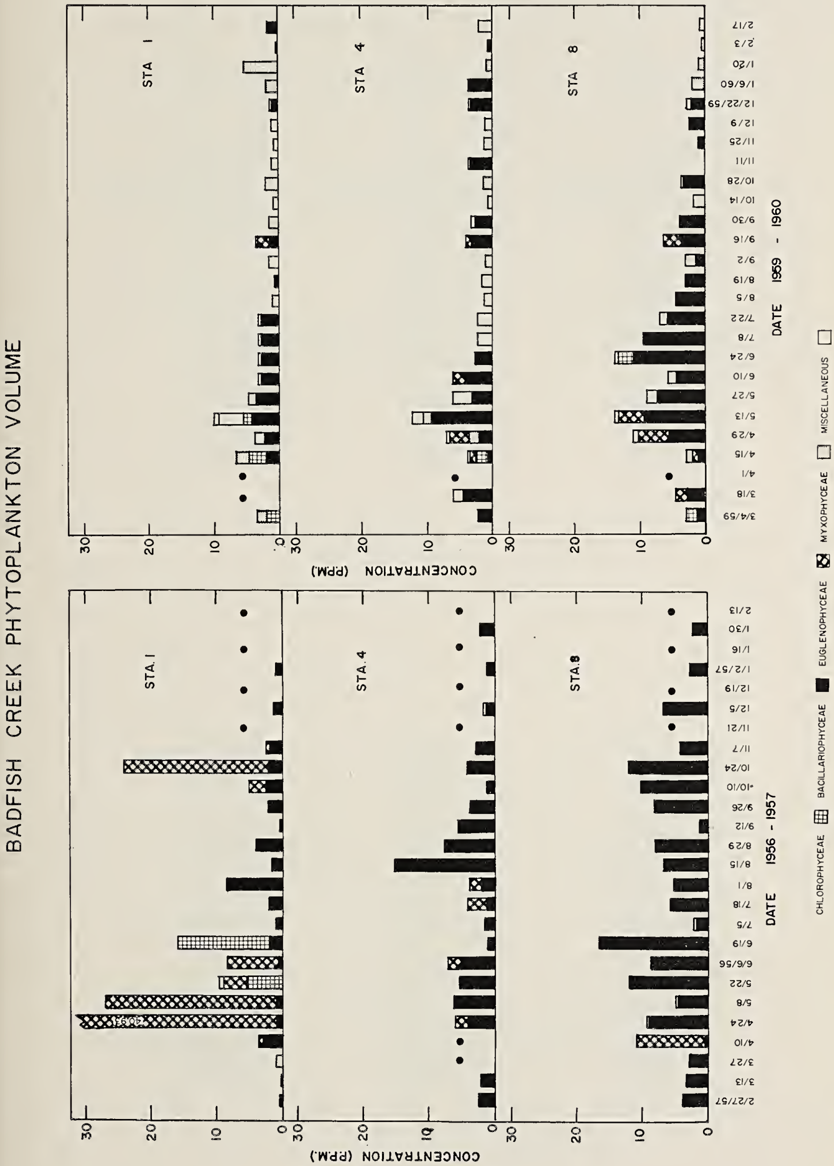

FIGURE 7. Badfish Creek Phytoplankton Volume.

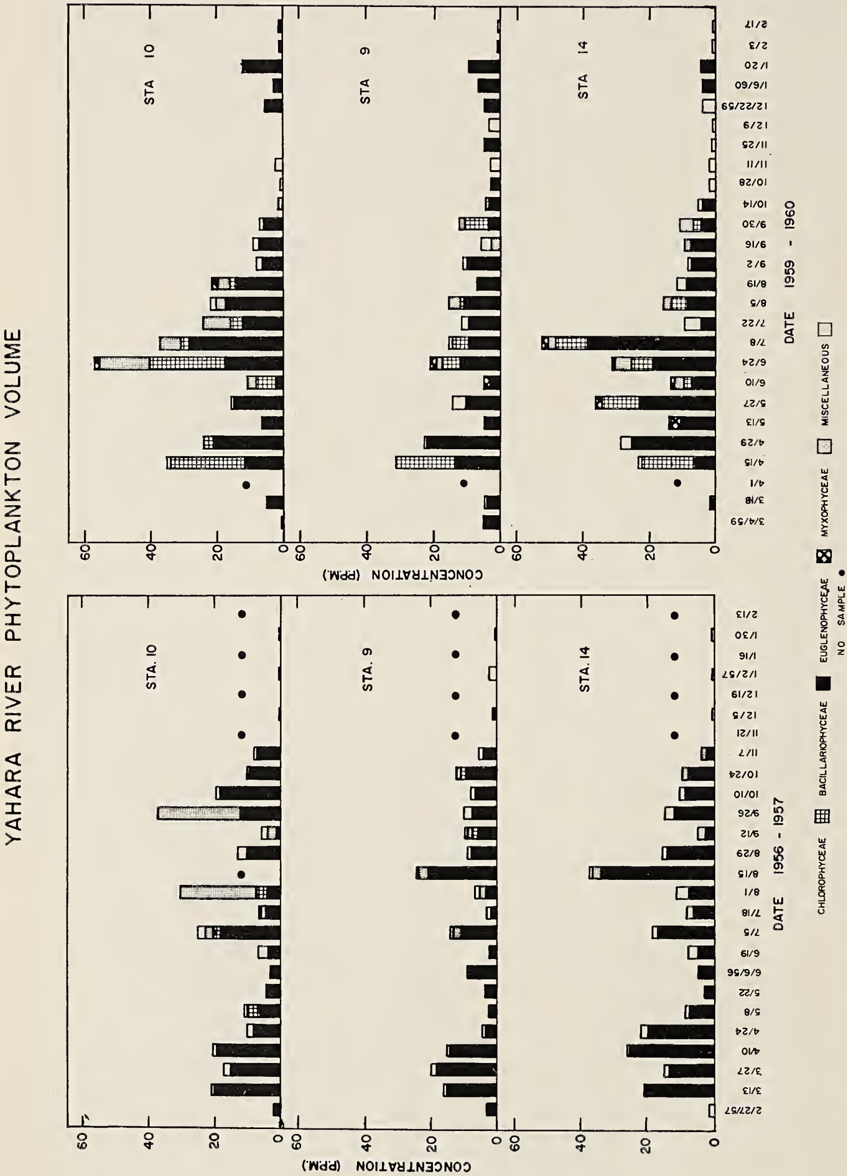

Figure 8. Yahara River Phytoplankton Volume.

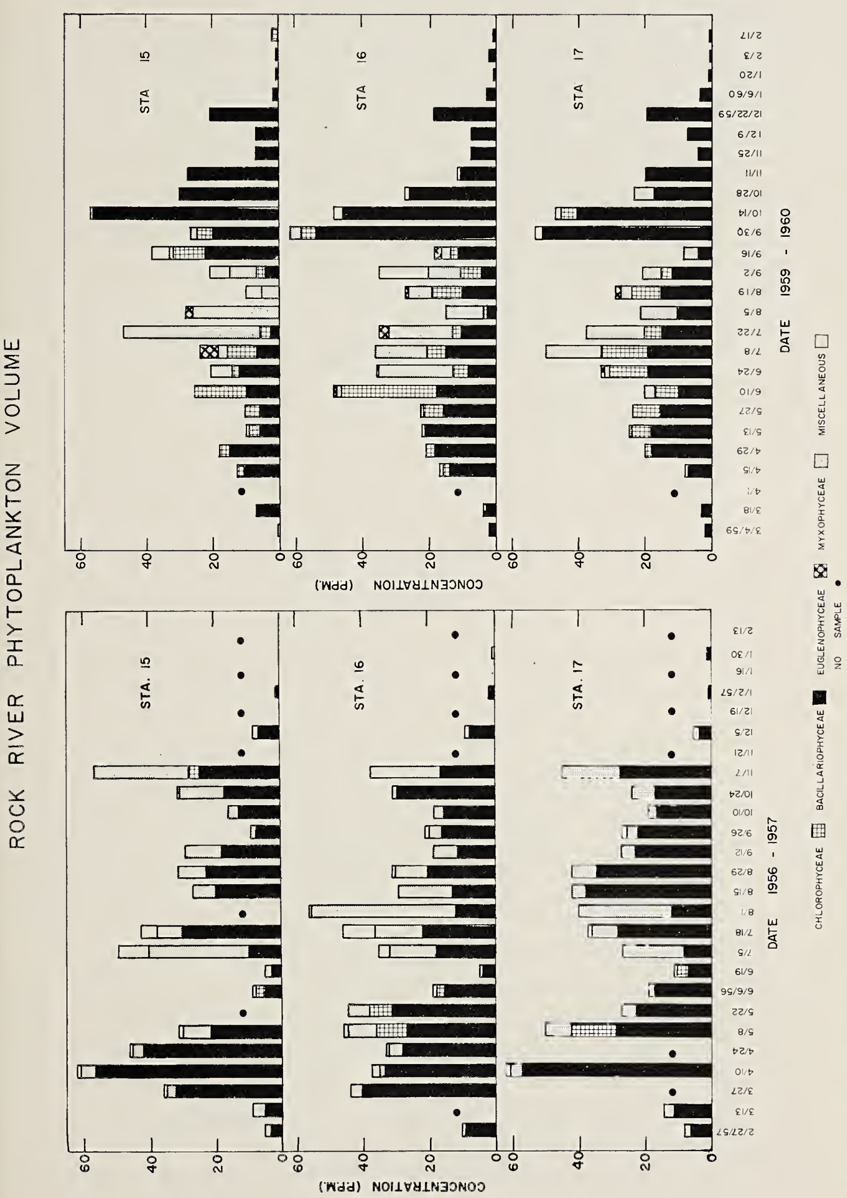

FIGURE 9. Rock River Phytoplankton Volume.

appeared more often in the 1959 samples, but they, too, seldom affected the total phytoplankton volume.

The phytoplankton volumes on the Yahara River stations reveal little change subsequent to diversion. The diatom population at Station 10 above the confluence with Badfish Creek prior to diversion was dominated by *Melosira* with species of *Navicula, Nitzschia* and *Cyclotella* appearing regularly but in lesser numbers. After diversion, the same genera of diatoms were encountered, but the volume became more equally proportioned among those present, and no particular genus predominated. Blue-green algae appeared in both the 1956 and 1959 samples with *Anacystis* and *Aphanizomenon* predominating. The most commonly recorded genera of green algae were *Scenedesmus* and *Ankistrodesmus, Chlamydomonas,* and *Coelastrum* in both the 1956 and 1959 samples. On only two occasions in the spring and early summer of 1959 did the green algae volume exceed the diatom volume.

Stations on the Yahara River below its confluence with Badfish Creek generally revealed a greater proportionate volume of green algae following diversion. Blue-green algae at these stations were noted only occasionally and contributed little to the total volume. The diatom population, especially in the summer months, appeared similar both before and after diversion. In midwinter of 1959, a bloom of *Cyclotella* approached a population of 7,000 organisms per ml. and extended over a period of six weeks. The species were very small and contributed little to the total volume.

The phytoplankton in the Rock River revealed no detectable difference between stations in a given year. The prominent genera in both 1956 and 1959 were *Stephanodiscus, Melosira,* and *Cyclotella. Navicula* and *Nitzschia* appeared consistently scattered but rarely exceeded one p.p.m. in volume. *Cyclotella* was a major constituent of the population during the entire year. During December, 1958 and January, 1959, it was the principal genus found, and populations at this time approached 30,000 organisms per ml.

All stations on the Rock River revealed a substantial volume of blue-green algae during all except the winter months. This consisted principally of *Anacystis* and *Aphanizomenon.* Green Algae appeared more prominent in the 1959 samples, particularly in the spring and summer months. Volumes of green algae exceeded 10 p.p.m. only rarely. The principal constituents were *Closterium* and *Coelastrum* in 1956 and *Coelastrum* in 1959. *Scenedesmus* appeared regularly but the volume seldom exceeded 2 p.p.m. in any particular sample.

The organisms which dwell upon and within the bottom deposits were studied at seven separate stations on four different dates in

Badfish Creek. Pre-diversion surveys were conducted on August 1, 1956 and March 1, 1957, whereas post-diversion surveys were conducted on September 17, 1959 and December 1, 1959. Prior to diversion at Station 1, the stream was 3 to 6 feet wide and approximately 6 inches deep. It gradually increased in width downstream until a width of around 30 feet was attained before the confluence with the Yahara River. The depth at this point, however, was still relatively shallow, varying between 6 and 18 inches. The bottom material at the sampling stations consisted principally of rock and coarse gravel, and at some points gravel mixed with sand. Submerged aquatic vegetation was abundant prior to diversion, and at some points, streamers of filamentous algae were attached to the submerged vegetation. In September, 1959, following diversion, the improved portion of Badfish Creek still maintained a coarse gravel bottom, and in the Station 1 area, the stream was already choked with submerged vegetation. In the downstream areas, this vegetation appeared to be less dense than in 1956. Long streamers of filamentous green algae (*Stigeoclonium* and *Rhizoclonium*), some of which were estimated to be 50 feet in length, were attached to bottom materials at numerous locations. In the upper areas of the stream, there was a green blanket of *Oscillatoria* covering the bottom. Sludge had deposited along the edge of the stream and covered portions of the vegetation. A definite sewage odor was present in the Station 1 area in September, and this odor extended the full length of Badfish Creek in December, 1959. Much of the stream bottom was covered with a slimy mat of the blue-green algae *Oscillatoria,* and, especially in the December survey, much of the vegetation was covered with a prolific growth of a stalked protozoa belonging to the family *Epistylidae.* These formed a gray mass not unlike a dense growth of fungus.

The degradation of the stream following diversion is apparent when one examines the community of biological life living upon and within the bottom materials. Prior to diversion, between 10 and 14 different invertebrate species were recovered from each of the samples collected. Following diversion, the number of species was reduced to about five.

Prior to diversion, also, a balanced community of intolerant and tolerant organisms were observed. At nearly every station, caddis fly larvae (*Cheumatopsyche* and *Hydropsyche*), mayfly nymphs (*Baetis* and *Caenis*), and riffle beetle larvae were found in association with cranefly larvae, horsefly larvae, scuds, and miscellaneous midges. Very tolerant forms such as sludge worms (*Tubificidae*) were also found, but occurred in very low numbers. In some locations, the intolerant caddis fly larvae formed the bulk of the total population.

Following diversion, all stations in the ditch and in the improved portion of Badfish Creek supported a bottom-dwelling population comprised of sludge worms (*Tubificidae*) and at least three species of very tolerant midge larvae (*Tendipes plumosus, T. tendipediformis,* and *T. decorus*). These are all considered to be very tolerant organisms and were found to be living in the sludge deposits on the bottom and along the sides of the stream. Near the lower end of Badfish Creek in the unimproved portion, tolerant and very tolerant bottom-dwelling organims predominated. Occasionally, an intolerant form was observed, but this was only one among many of the more tolerant forms.

Summary

1. Studies have been conducted on the biological and chemical effects resulting from the diversion of approximately 20 million gallons a day of effluent from the Madison, Wisconsin, Metropolitan Sewage Commission Treatment Plant upon a small stream which originally had a flow of 9.6 cubic feet per second. This stream, Badfish Creek, discharges into the Yahara River, and the Yahara River into the Rock River. The effects upon all three river systems were investigated.

2. In addition to physical and biological observations, and bottom fauna studies made at intervals, 26 bi-weekly samples were collected and analyzed from selected stations before and after diversion for chemical and phytoplankton determinations.

3. Considering that 10 of the 14.5 miles of stream were improved to a bottom width of 16 and 20 feet, that the flow was increased nearly five-fold, and that a deposition of solid materials created substantial sludge deposits in some areas, a tremendous physical change, especially in the upper regions, was exerted upon Badfish Creek as a result of diversion.

4. The water chemistry of Badfish Creek especially responded to diversion with substantial increases in organic nitrogen, inorganic nitrogen (influenced principally by ammonia nitrogen), phosphorus, and B.O.D. The dissolved oxygen was reduced to a critical level many times throughout the summer, and a D.O. deficit of 700 pounds per day existed at Station 4 during this period.

5. Phytoplankton populations were of substantially the same concentration between the three stations on a given stream, and between the two periods of study for similar stations on the same stream, but were greater in the Yahara River than in Badfish

Creek, and greater in the Rock River than in the Yahara River. There was an indication of a population depression following diversion at the upper stations on Badfish Creek, and a difference in genera encountered between the pre- and post-diversion samples.

6. Submerged aquatic vegetation was abundant prior to diversion, and already in 1959 had become abundant in the dredged portion of the creek. Perhaps it is yet too early to judge, but the submerged plants do not now present a porblem. Long streamers of filamentous algae were attached to plants and bottom materials at numerous locations. A blanket of *Oscillatoria* covered much of the bottom of the upper creek.

7. A study of bottom organisms indicated severe stream degradation following diversion. Stream biota changed from a balanced population containing several species and many intolerant organisms, prior to diversion, to a population containing few species and only very tolerant sludge worms and midge larvae following diversion.

8. The benthos in Badfish Creek exhibited a much greater response than the phytoplankton to the addition of nutrients, suspended solids, and B.O.D. contained in the effluent of the Nine-Springs Sewage Treatment Plant.

Acknowledgment

Grateful acknowledgment is extended to Theodore F. Wisniewski, Director of the Committee on Water Pollution for his guidance and encouragement throughout the course of this study, to Miss Dorothy McNall, Chemist of the State Laboratory of Hygiene, for determining the chemical results, to Lawrence A. Ernest and Floyd Stautz, Basin Engineers of the Committee on Water Pollution, for collecting the majority of chemical and phytoplankton samples, to Miss Lorraine Jones, stenographer with the Committee on Water Pollution, and to the many others who "became a part" of an extended study of this type.

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A STUDY OF INSECT TRANSMISSION OF OAK WILT IN WISCONSIN[1]

L. H. McMullen, R. D. Shenefelt and J. E. Kuntz[2]

The role of insects (chiefly Nitidulidae and *Drosophila*) in the overland spread of the oak wilt organism, *Ceratocystis fagacearum* (Bretz) Hunt, has been well established (Dorsey *et al*, 1953; Griswold, 1953; Himelick *et al*, 1954; Himelick and Curl, 1958; Jewell, 1956; Leach *et al*, 1952; McMullen *et al*, 1955; Norris, 1953; Thompson *et al*, 1955). The work reported here consisted of: a) studies of insects associated with mycelial mats, b) studies of insects associate with wounds in healthy trees and c) insect transmission studies. This paper includes the work of McMullen *et al* (1955) with results that were not available at that time.

All trees used in the following experiments were northern pin oaks (*Quercus ellipsoidalis* Hill) unless otherwise specified.

Studies of Insects Associated with Mycelial Mats

Regular collceions of insects from mycelial mats were initiated in September, 1953, and continued during 1954 from mid-April (when new mats began forming) until November (when mats were no longer forming). Mat production ceased during the summer about June 11 and began again about July 22. Most of the collections were made in areas adjacent to Griffith State Nursery in Wood County, although on occasion, areas in Juneau and Adams Counties were examined.

Mats which had caused the bark to crack and which were easily reached from the ground were selected for examination. The bark over the mat was removed and both sections of the mat (that on the wood and that on the bark) were examined. Insects found were transferred to vials and later sorted and recorded in the labora-

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tory. The mats were removed from the trees, placed in metal containers and re-examined in the laboratory.

Since the numbers of mats examined, their ages and conditions varied greatly from one collection date to another, no criterion for seasonal populations of the insects was established. However, during certain periods, populations of some of the insects were obviously higher than at other times.

TABLE 1

NITIDULIDS COLLECTED FROM MYCELIAL MATS OF *Ceratocystis fagacearum* (BRETZ) HUNT, WISCONSIN 1954

SPECIES	TOTAL NUMBER COLLECTED	INCLUSIVE DATES	PEAKS IN INCIDENCE
Colopterus truncatus (Rand.)	917	Apr. 19–Oct. 20	May and early June, Sept.
C. semitectus (Say)	13	May 11–Sept. 24	May and early June
C. maculatus (Erichs.)	1	May 20	...
Carpophilus hemipterus (L.)	1	Sept. 2	...
C. sayi Parsons	12	May 19–Sept. 24	Late May and early June
Epuraea corticina Erichs.	46	Apr. 23–Oct. 20	Sept. and Oct.
E. terminalis Mann.	2	Sept. 24	...
E. avara (Rand.)	1	Sept. 11	...
Prometopia sexmaculata (Say)	4	Aug. 26–Sept. 24	...
Lobiopa undulata (Say)	4	May 14	...
Glischrochilus sanguinolentus (Oliv.)	2	Apr. 20–Oct. 15	...
G. fasciatus (Oliv.)	52	Apr. 30–Oct. 20	May and early June, Sept. and Oct.
G. quadrisignatus (Say)	6	June 2–Sept. 30	...

Table 1 presents the species of Nitidulids collected during 1954 along with the total number of each species and an indication of the periods of greatest abundance. The collections during the fall of 1953 were very similar to those of 1954, with the exception that two specimens of a new species of *Epuraea* were taken on September 14.

In addition to the Nitidulids, *Drosophila* sp. were nearly always present on the mats but not in great numbers. A small black Staphylinid was quite common. Three other species of Staphylinidae were also occasionally taken. Cucujids were common in April and May and again in August. The Histerid, *Platysoma lecontei* Mars., occurred occasionally in May and June and again in September. A species of Orthoperidae was common in May and was taken occasionally in July and August. Collembola were common on overmature, deteriorating mats.

Studies of Insects Associated with Wounds in Healthy Trees

The study of insects associated with wounds was initiated in 1953. During April, blazes were made on ten trees (2 to 4 inches dbh.) and were examined at irregular intervals. Again in September hatchet wounds were made in twenty-five trees (of the same size) and examined at weekly intervals during the fall and again the following spring.

During 1954 collections were made from trees wounded throughout the season. Ten trees were wounded on April 22, ten different trees on April 29, and so on at weekly intervals, whenever possible, through October 19. In each series five trees were large (5.5 to 22 inches dbh.) and five were small (2 to 4 inches dbh.). Seven wounds were made on the main trunk of each tree. Six were hatchet cuts and the seventh was a T-shaped wound about 2 inches by 2 inches in size. In all cases the wound extended into sapwood and the bark was separated partially from the sapwood.

The wounds were examined one week after they were made until May 29. After that date, examinations were made twice during the week (three to four days after wounding and again at the end of the week). When the wounds were examined the bark had to be lifted and usually broke off. For this reason, when two collections per week were made, one-half of the T-wound and three of the hatchet cuts were examined each time.

The insects were removed from the wounds with forceps, transferred to vials, and taken to the laboratory for identification.

No insects were found in the wounds made in April or September of 1953.

During 1954, the series of wounds made prior to May 22 did not appear to be attractive to insects. After June 11 *Colopterus truncatus, C. semitectus,* and *Carpophilus sayi* became quite common for a few weeks. All three species were abundant on the large trees for three weeks until June 26. *C. truncatus* however was found on the small trees until August 30.

Table 2 presents a list of the Nitidulidae collected from the wounds, along with the numbers collected on both the large and the small trees. Many *C. truncatus* escaped and its occurrence was much higher than the numbers indicate. In addition to the Nitidulids an unidentified small black Staphylinid (apparently the same species as that collected from the mycelial mats) and *Drosophila* sp. were common on the wounds during the same period as the three common Nitidulid species.

TABLE 2

OCCURRENCE OF NITIDULIDAE ON ARTIFICIAL WOUNDS IN HEALTHY *Quercus ellipsoidalis* HILL, WISCONSIN, 1954

SPECIES	NUMBERS COLLECTED	
	Small Trees	Large Trees
Colopterus truncatus (Rand.)	39	56
C. semitectus (Say)	6	12
Carpophilus sayi Parsons	1	59
Epuraea avara (Rand.)	1	0
E. erichsoni Reitter	0	1
Stelidota octomaculata (Say)	0	4
Glischrochilus fasciatus (Oliv.)	0	2
Total	47	134

Of collections from natural wounds, one made on June 11, 1954, is particularly noteworthy. The wound consisted of a small round hole leading to a larger cavity about ¾ by ¼ inches on the main trunk of a northern pin oak in Wood County. The outer hole was covered by a flap of bark and sap was oozing from the wound. The following insects (in the indicated numbers) were taken from this wound: *Colopterus maculatus*—2, *Colopterus* sp.—1, *Cryptarcha ampla* Erichs.—2, *S. strigatula* Parsons—2, *Glischrochilus fasciatus*—20, and *G. quadrisignatus*—4.

Oak Wilt developed subsequently in ten of the large trees and two of the smaller ones. All unwounded trees in the test area remained healthy. Both small trees in which the disease developed were wounded on the same date, but expressed symptoms about one month apart, although they were within 15 feet of each other. The possibility of root transmission of the disease in this case cannot be overlooked.

The incidence of wilting trees, expressed in percent infection, occurring among the wounded trees is shown in Figure 1 along with the occurrence of Nitidulids in the wounds. None of the trees wounded on dates not included in Figure 1 wilted.

Insect Transmission Studies

In 1952 two experiments were carried out. On July 29 and August 5 five Cucujids, collected from a mycelial mat, and seven *Rhizophagus bipunctatus* (Say), reared on cultures of *C. fagacearum*, respectively, were introduced into a wound in each of two otherwise normal trees. The wound in each tree was made with a ¼-inch bit and extended well into the sapwood. The external opening was tightly covered with plastic screen and tape, In September of 1953 six tests were made with Nitidulidae collected from oak wilt mats. The insects were placed on perithecia-bearing mats for approximately two hours and were then placed in glass containers and transported to selected trees. A hatchet cut was made on the main trunk of each of the trees. The insects were transferred to cylindrical plastic cages, 4 inches by 5 inches in size, with one end covered with muslin. The cages were fastened to the trunk over the wounds, the open side of each cage being sealed

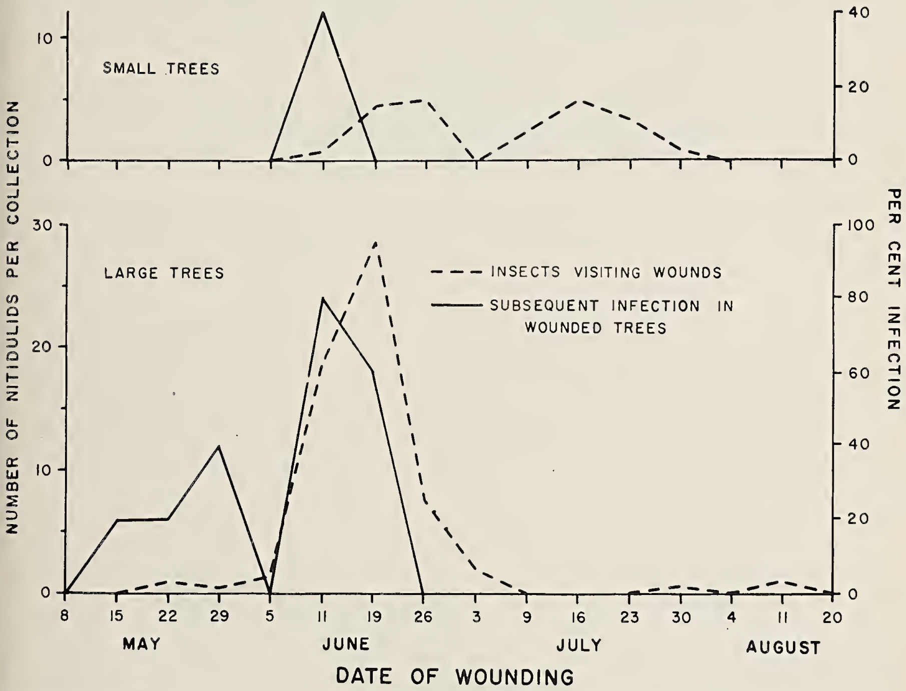

FIGURE 1. The relationship between time of infection in wounded trees and time of insect visitation to the wounds.

tightly to the tree with a plastic sealing compound. The cages were left in place over winter and those remaining the following spring were removed.

During 1954, similar experiments were carried out from May 1 to October 15. The test insects, collected from both sporulating mycelial mats and banana baits, were exposed overnight to the mats or to laboratory cultures of the fungus. The insects were then transferred to glass containers and transported to selected trees. A T-shaped wound (2 inches by 2 inches) was made on the main trunk of each tree with a wood chisel and the bark partially separated from the sapwood. The insects were transferred to a plastic cage similar to that used in 1953 which was fastened over the wound in the same manner. The inoculum to which the insects had been exposed was sometimes placed in the cages with the insects. When the cages were removed five to seven weeks later, the wounds were covered tightly with masking tape to prevent the entry of other insects. Trees with wounds over which empty cages were placed served as checks. Mycelial mats (commonly infested by mites) were placed in some of the check cages. The trees were examined after testing at weekly intervals until November 1, and again in May and August, 1955.

TABLE 3

EXPERIMENTS IN WHICH *Ceratocystis fagacearum* WAS TRANSMITTED TO WOUNDED TREES BY INSECTS EXPOSED TO THE FUNGUS, WISCONSIN, 1953–54

Tree No.	Insect Species	Source of Inoculum	No. of Insects Per Tree	Date[1]	
				Caged	Wilted
1	*Glischrochilus fasciatus* (Oliv.)...	mat[2]	2 and 9[3]	Sept. 16 & 24/53	July 1
N2	*Epuraea* sp. (prob. *avara* (Rand.)	mat	4	May 1	July 16
N17	Cucujidae (unidentified)........	mat	20	May 15	July 2
N22	*G. fasciatus*..................	mat	9	May 15	Aug. 8
N27	*G. sanguinolentus* (Oliv.)........	mat	6	May 22	Sept. 15
N29	*Colopterus truncatus* (Rand.)....	mat	25	May 22	July 16
N38	*G. fasciatus*..................	culture	8	May 29	July 16
N40	*Epuraea peltoides* Horn and *E. avara*....................	culture	15	May 29	July 22
N41	*E. peltoides* and *E. avara*.......	mat[2] [4]	15	May 29	July 16
N42	*Lobiopa undulata* (Say).........	culture	8	May 29	July 16
N55	*E. peltoides* and *E. avara*.......	culture	12	June 5	July 16
N57	*G. fasciatus*..................	culture[4]	8	June 5	July 16
N60	*G. fasciatus*..................	culture[4]	3	June 12	Aug. 21
N61	*G. quadrisignatus* (Say).........	culture[4]	5	June 12	July 16
N65	*Stelidota octomaculata* (Say).....	culture	11	June 19	July 22
N66	*S. octomaculata*................	culture[4]	12	June 19	July 22
N76	*G. fasciatus*..................	culture	4	July 9	Sept. 15
N104	*E. peltoides*..................	mat[4]	12	Aug. 7	May/55
N110	*S. octomaculata*................	mat	15	Aug. 14	May/55
N111	*G. quadrisignatus*..............	mat[4]	7	Aug. 14	May/55
N113	*Drosophila* sp..................	mat[4]	100	Aug. 14	Sept. 24
N116	*G. quadrisignatus*..............	mat	5	Aug. 21	May/55
N119	*G. fasciatus*..................	mat[4]	5	Aug. 21	May/55
N120	*S. octomaculata*................	mat	10	Aug. 21	May/55
N121	*S. octomaculata*................	mat[4]	10	Aug. 21	May/55
N124	*S. octomaculata*................	mat[4]	11	Aug. 28	May/55
N127	*G. quadrisignatus*..............	mat[2]	4	Aug. 28	May/55
N135	*G. fasciatus*..................	mat[2]	5	Sept. 3	Aug./55
N166	*G. fasciatus*..................	mat[2] [4]	5	Oct. 1	Aug./55

[1]All dates 1954 unless otherwise indicated.
[2]Perithecia in inoculum.
[3]Insects placed over same wound twice.
[4]Inoculum caged with insects.

Of a total of 138 tests (not including the checks), perithecia were present in the inoculum used in 26 and the inoculum was placed in the cages of 79. There were 41 check trees, on 14 of which inoculum was placed in the cages.

Neither of the trees tested in 1952 developed oak wilt. Table 3 gives a summary of the positive tests of 1953–54. Table 4 provides a resume of the experiments in which insects failed to transmit the fungus. *C. fagacearum* was isolated from all diseased trees except the two which wilted by August, 1955, and inoculations with twelve of the isolates were positive.

TABLE 4

EXPERIMENTS IN WHICH *Ceratocystis fagacearum* WAS NOT TRANSMITTED TO WOUNDED TREES BY INSECTS EXPOSED TO THE FUNGUS, WISCONSIN, 1953–54

INSECT SPECIES	NO. OF NEGATIVE TESTS	NO. OF INSECTS PER TREE	INCLUSIVE DATES OF CAGING
1953			
Nitidulidae			
Epuraea sp. (spp.)	4[1]	4 to 8	Sept. 16 to Sept. 24
Carpophilus sp.	1	3 to 5[2]	Sept. 16 to Sept. 24
1954			
Nitidulidae			
Colopterus truncatus (Rand.)	8	15 to 40	May 15 to Oct. 1
C. truncatus and *Epuraea* sp. (prob. *corticina* Reit.)	1	6 and 1	May 1
C. truncatus and *Glischrochilus fasciatus* (Oliv.)	1	2 and 1	May 7
Carpophilus sayi Parsons	2	5	Sept. 3
Epuraea sp. (prob. *corticina*)	1	5	May 15
Epuraea spp. (prob. *corticina* and *avara* (Rand.))	1	5	May 15
Epuraea peltoides Horn and *E. helvola* Erichs	1	10	May 24
Stelidota octomaculata (Say)	10	5 to 50	June 5 to Aug. 28
Lobiopa undulata (Say)	7	3 to 10	May 15 to Aug. 7
Cychramus adustus Erichs	1	6	June 30
Glischrochilus sanguinolentus (Oliv.)	2	4 to 6	July 24 to Sept. 14
G. fasciatus	36	3 to 9	May 1 to Oct. 15
G. quadrisignatus (Say)	30	2 to 8	May 1 to Oct. 15
G sanguinolentus and *G. fasciatus*	1	2 and 2	May 15
Histeridae			
Platysoma lecontei Mars	1	2	June 12
Staphylinidae			
Unidentified	2	7 to 14	May 15 to May 22
Orthoperidae			
Unidentified	2	23 to 28	May 15 to May 22
Drosophilidae			
Drosophila sp.	3	12 to 100	June 30 to July 16
Checks	41	0	May 1 to Oct. 15

[1]One tree was *Quercus macrocarpa* Michx.
[2]Insects were placed over the same wound twice.

Of 32 tests in which perithecia were present in the inoculum, five were positive; of 112 tests in which endoconidia only were present in the inoculum, 24 trees wilted. None of the check trees nor any untreated trees in the experimental area developed oak wilt symptoms.

Figure 2 indicates the incidence of wilting which occurred in trees wounded and caged on given dates throughout the 1954 sea-

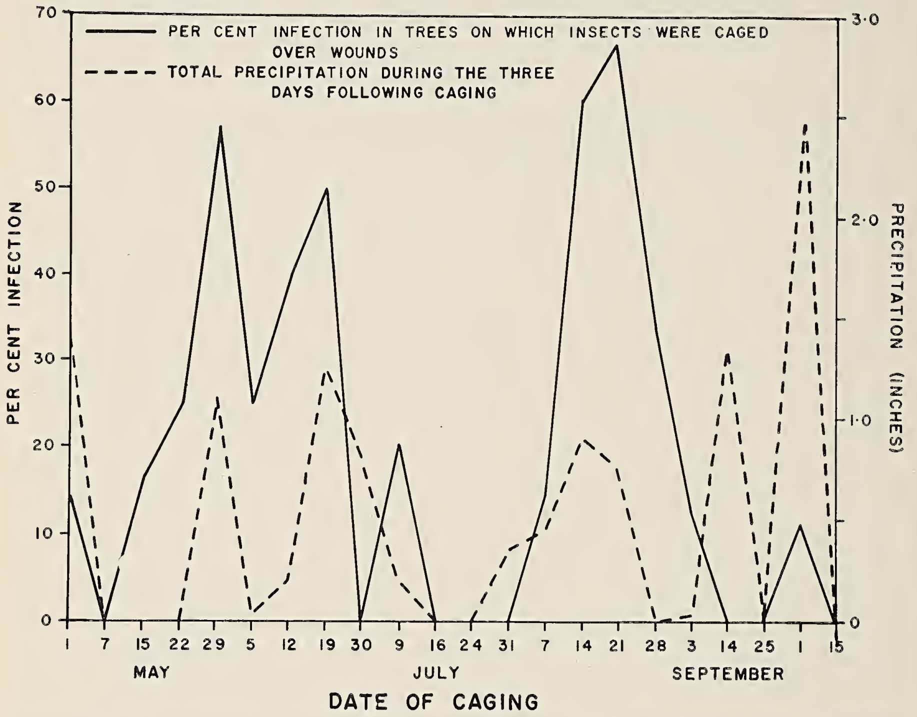

FIGURE 2. The relationship between precipitation and the incidence of wilt in the caging tests.

son. It is evident that there were two peaks in the incidence of wilting trees, one in May and June and the other in August. Previous reports had indicated positive results only in the spring.

In an attempt to explain the two peaks in the incidence of the disease in the experiments, and more particularly the one in August, precipitation records were obtained from Griffith State Nursery, approximately three miles from the site of the experiments. Since wounds are susceptible entry points for the fungus for a short time only (Zuckerman, 1954; Kuntz and Drake, 1957), the total precipitation for three days following the date of caging was used. This three-day total is shown in Figure 2 along with the percent infection for each date the caging experiments were carried out.

Discussion

Many insects, chiefly Nitidulidae and *Drosophila,* occur on both mycelial mats and on wounds, where there is, in the former, a source of inoculum and, in the latter, an infection court for the fungus. Both locations also provide food for the insects involved. It is logical to expect that these insects could carry spores of *C. fagacearum* from the mycelial mats to the wounds.

In Wisconsin six species of Nitidulidae, *Drosophila* sp. and Staphylinidae have been collected from both mycelial mats and wounds. Of the Nitidulids, *Colopterus truncatus,* C. *semitectus, Carpophilus sayi* and *Glischrochilus fasciatus* were the most common on wounds and on mycelial mats. Without doubt further species could be added to the list occurring in both locations with more collecting. That these species are capable of carrying and placing inoculum in a wound suitable for infection was demonstrated by the wounding and insect transmission studies. The fact that Cucujidae, which are predacious, were successful in transmitting the fungus in the one test with them, indicates that such insects as these are also capable of carrying the fungus. However, they are probably secondary and would not be present if their hosts were not also present. The Staphylinid species, common on both mycelial mats and on wounds, may be predacious or attracted as are the Nitidulids and *Drosophila.*

The time of insect visitation to wounds plays an important role in the natural spread of the disease. As is indicated in Figure 1, the insects visited the trees mainly in June, although on the smaller trees the insects were present till the end of July. Trees that were wounded at the time of greatest abundance of insect wound visitors had the greatest incidence of wilting. This statement is particularly true for the large trees, but there appears to be little relationship between abundance of insects on the wounds and infection in the series of wounded saplings. The high incidence of insects on the wounds in these trees began about one week later and lasted about three weeks longer than in the larger trees. Relatively few insects were collected from the wounds in the small trees that subsequently wilted. It is possible that the condition of the wounds at the time of greatest insect abundance was not suitable for infection, or that the insects which visited the wounds in the saplings did so at a time when there was a scarcity of inoculum. As was noted earlier, mat production had ceased about June 11 but the insects continued to visit the wounds in the saplings until the end of July.

Morris *et al* (1955) found that Nitidulids tended to remain on mats as long as they were suitable for the insects. Since wounds are susceptible to infection for a relatively short period after they are made Morris *et al* hypothesized that "if mats in the right stage of decline are not available at the time wounds are made or shortly thereafter, infection through these wounds is improbable". The present evidence supports this theory. Mat production ceased by about June 11 and at that time there was an abundance of deteriorating mats. The trees in which wounds were made that week and the week following had the highest incidence of insects and the highest incidence of infection. Presumably, the insects, no longer finding the mats suitable, moved to the wounds which were now attractive and in so doing carried the fungus with them. Such a relationship would appear to be an important factor in the long-distance transmission of oak wilt and may explain why the incidence of such transmission varies from year to year.

The relatively high percentage of trees which wilted subsequent to the caging experiments made in August was surprising. The majority of successful results from such transmission tests have been reported as occurring in the spring. In addition, in the trees in which wounds were left open for natural insect visitation, no wilt occurred in the trees treated in August. The latter can be explained by the fact that the incidence of insects on the wounds at that time was very low.

In caging tests such as those described here, the insects are given little opportunity but to enter the wounds. Since artificial inoculation gives good results at any time during the season (Kuntz and Drake, 1957), it would seem surprising that when insects, carrying the oak wilt fungus, entered wounds, the trees would not wilt at any time during the season. Figure 2 indicates that there was a close association between periods of high rainfall and peaks in the percentage of treated trees which wilted. It was also noticed that moisture sometimes collected on the bottom of the cages. Although no records of the latter feature were taken, it probably was associated with the rainfall. Even in the tests made in late May and June the occurrence of rainfall may have enhanced the possibility of infection. However, the authors feel that, since at this time the trees are in a state of rapid growth and high physiological activity which would be conducive to the exudation of sap in the wounds, there would be enough moisture in the wounds to enhance the possibility of infection.

Successful transmission experiments occurred after the insects were exposed to inoculum with both enodconidia and ascospores and endoconidia alone. Norris (1953), Dorsey *et al* (1953) and Himelick *et al* (1954) obtained infection when the insects they had used had been exposed to perithecia. Craighead *et al* (1953) placed mycelial mats bearing perithecia in two plots of wounded trees in which they obtained infection. In another plot, in which no infection occurred in wounded trees, mycelial mats bearing endoconidia only were present. Jewell (1956) and Himelick and Curl (1958) reported successful transmission in caging experiments in which endoconidia only were used as inoculum. In the evidence reported here positive results were obtained in approximately the same percentage (18.5 percent for endoconidia and ascospores, and 21.4 percent for endoconidia alone) with both types of inoculum. Such results indicate that the presence of ascospores in the inoculum does not enhance the possibility of inoculation by insects. Although the possibility that the insects used in the tests had been in contact with ascospores prior to the time of their collection is realized, in nine experiments which gave positive results, the insects were collected in banana bait traps north of the known range of oak wilt and were exposed only to mats or cultures without perithecia.

Summary

Studies of insects associated with mycelial mats of the oak wilt fungus and with wounds on healthy trees, and transmission tests with insects support the theory that certain sap-feeding insects play an important role in the long-distance spread of the oak wilt disease. Six species of Nitidulidae, *Drosophila* sp., and one species of Staphylinidae were collected from both mycelial mats on diseased trees and wounds on healthy trees. Infection by the fungus occurred only from mid-May to mid-June in trees in which wounds, made throughout the season, were left open for natural insect visitation. The incidence of infection was closely correlated with the numbers of insects visiting the wounds. Evidence, which indicated that the condition of myelial mats of the fungus at the time of wounding is important, is presented.

In caging experiments carried out from May 1 to mid-October, oak wilt developed in 29 of 144 test trees. Positive results occurred during two periods; one in May and June, and the other in August. Precipitation was high during these periods and moisture may have enhanced the possibility of infection, particularly in August. The presence of ascospores in inoculum to which the insects were exposed did not increase the percentage infection as compared to inoculum containing endoconidia only.

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NOTES ON WISCONSIN PARASITIC FUNGI. XXVI

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The collections referred to in this series of notes were, unless indicated otherwise, made during the season of 1959 which was, owing to a persistent combination of high temperature and high humidity, the most favorable in many years in southern and central Wisconsin for the development of fungi of all sorts.

Powdery mildews, unidentified as to species, have been noted on the following hosts, not previously reported as bearing these fungi in Wisconsin: *Callistephus chinensis* (cult.) Dane Co., near Cross Plains, November 1, 1958; *Rosa heliophila.* Dane Co., Madison, November 4, 1958; *Amelanchier canadensis.* Dane Co., Madison, October 15, 1958; *Asarum canadense.* Sauk Co., Ferry Bluff, August 10.

Microsphaera alni (Wallr.) Wint. is quite common on *Corylus americana* in Wisconsin, but a specimen on this host, collected in Gov. Dodge State Park, Iowa Co., July 21, is highly atypical both in its development on the host and in its microscopic characters. In most of the Wisconsin specimens, which have usually been collected in September or October, there is very little superficial mycelium and the small cleistothecia are quite uniformly distributed over the leaf surface. In the recent collection there is quite profuse and noticeable, but highly localized, superficial mycelium, mostly in areas spanning the principal veins, around and along which the closely clustered fruiting bodies are developed. The specimen seems well matured, insofar as production of asci and ascospores is concerned, for in fact most of the asci have broken down, freeing the spores. The appendages are long and lax, with only the most rudimentary suggestion of the elaborate dichotomy so characteristic of *M. alni.* Measurements of cleistothecia indicate that they run larger, about on the order of 4 to 3, than in the typical specimens. J. J. Davis placed in the herbarium, as questionable *M. alni,* a similar specimen on *Corylus americana,* collected July 22, 1900 at Madison.

Mycosphaerella sp., collected at Madison, September 1, occurs on dead distal portions of leaves of *Andropogon scoparius* that were still green at the base. On the same leaves, mingled with the perithecia, and of similar size and shape, are pycnidia of a *Phyllosticta.* The *Mycosphaerella* perithecia are somewhat lenticular, opening widely, about 65–75 μ in breadth, dark olivaceous, wall cells pseudoparenchymatous; asci hyaline, broadly clavate, often somewhat curved, about 40 x 12 μ; ascospores hyaline, broadly fusoid, with a submedian isthmus-like constriction, about 15–16 x 6–6.5μ. The *Phyllosticta* pycnidia are about 55–65 μ wide, noticeably flattened, fuscous, wall cells pseudoparenchymatous, conidia hyaline, ellipsoid, broadly ellipsoid, or subfusoid, biguttulate, 9–14 x 4–5 μ. It seems likely the *Mycosphaerella* and *Phyllosticta* are stages of the same fungus.

MYCOSPHAERELLA sp. is amphigenous on tiny, angled, reddish spots along the midribs of living leaflets of *Desmodium canadense,* collected near Swan Lake, Columbia Co., July 2. The perithecia are approx. 100 μ diam., somewhat flattened, widely ostiolate, deep sooty gray, with the individual wall cells relatively thin-walled, large and pseudoparenchymatous; asci curved-obclavate, short-stipitate, 35–42 x 10–12 μ; ascospores hyaline, slightly constricted at the approximately median septum, with one cell slightly broader than the other, 11–13 x 4.5–5 μ. Perhaps parasitic.

MYCOSPHAERELLA sp., appearing parasitic, occurs in small amount on conspicuous, pale brown, orbicular lesions, about 1–1.5 cm. diam., on leaves of *Helianthus strumosus,* collected near Verona, Dane Co., July 26. The epihyllous, globose, black perithecia are about 125 μ diam., and scattered on the spots; ascospores fusoid, hyaline with a faint greenish tinge, 11–13 x 3–4 μ; asci clavate, 45–50 x 7–9 μ.

LEPTOSPHAERIA sp. occurred on living leaves of *Muhlenbergia tenuiflora,* collected at the New Glarus Woods Roadside Park, Green Co., September 21. The ellipsoid spots are approx. 1–2 cm. long, brownish-ashen with dark brown border. Perithecia scattered, black, subglobose, slightly beaked, somewhat erumpent, about 125 μ diam.; paraphyses hyaline, slender, thread-like; asci clavate, straight or somewhat curved, 48–50 x 11–13; ascospores fusoid, olivaceous, 3-septate, 20–22 x 4 μ. Evidently not *Leptosphaeria muhlenbergiae* Rehm, said to have asci 140 x 15 μ.

Leaves of *Iris virginica* var. *shrevei,* collected at Madison, September 10, bear an interesting Ascomycete, so far unidentified as to genus, which appears to belong in the Hemisphaeriales. The almost completely superficial disciform to subglobose ascostromata are blackish with a thin-walled, imperfectly closed, upper area. The cells comprising the walls are pseudoparenchymatous in the central portion and elongate and radiately arranged at the margins, as shown when the rounded fruiting structures are crushed flat in a microscopic mount. The ascostromata are amphigenous, scattered to gregarious along the central portion of the elongate host leaves, and are approx. 75–200 μ. Paraphyses are fairly numerous, hyaline, slender, flexuous, slightly capitate. The asci are broadly clavate or subcylindric, straight or moderately curved, approx. 60–65 x 14–16 μ, the ascospores hyaline, continuous, ellipsoid or verging on allantoid, 20–22 x 5–5.5 μ. Although the host leaves were dead at the time of collection, there are no other fungi present, and it seems quite likely the organism in question developed parasitically.

Cenangium acuum Cooke & Peck, which occurs on needles of *Pinus strobus,* is perhaps correctly considered a saprophyte, but a massive development of this fungus on a ten year old white pine in a plantation in the University of Wisconsin Arboretum at Madison, September 28, suggests a possible parasitic relationship. All the terminal needle tufts were affected, with the upper two-thirds of the individual needles dead and straw-colored and bearing the innate-erumpent fruiting bodies, while the lower third remained green and fresh.

Melampsorella caryophyllacearum Schroet., occurring on *Stellaria longifolia* near Kempster, Langlade Co., June 9, had produced the telial stage along with the uredia. G. B. Cummins, who determined the presence of the telia, states that in his experience they are very rarely collected, and that he had difficulty finding telial material to use in illustrating his *Illustrated Genera of Rust Fungi.* In the Wisconsin specimen the teliospores have germinated, producing a fuzzy white overlay on the sori.

Phoma sp. (?) occurred on languishing twigs of *Salix petiolaris,* collected at Madison, June 13. The twigs are blackened and buds aborted for several inches below the tip on which there is often, nevertheless, a terminal cluster of leaves. The black hue is owing to closely crowded, black, applanate, widely ostiolate, rather imperfect pycnidia, approx. 50–75 μ diam., which are quite superficial. The pycnidia are composed of small, dark, angled, thick-walled cells. The conidia are hyaline, short-cylindric, 3–4 x 1.5–2 μ. Of uncertain status, but possibly parasitic. In any event it would seem that the closely appressed fungus must be in some degree detrimental to the host.

Phoma sp. (?) was collected on twigs of *Celtis occidentalis* at Wyalusing State Park, Grant Co., May 12. The pycnidia are brownish, subglobose, about 80–100 μ diam., rather thin-walled, somewhat erumpent, more or less closely clustered on the yellowish, dead tips of otherwise living, foliage-bearing twigs. Conidia are very numerous, hyaline, biguttulate, cylindric, suballantoid, or subfusoid, 5–8 x 2.5–3 μ. Very conspicuous on the numerous small trees infected, where almost all the twigs were affected.

Phyllostictae undetermined as to species have been collected on a number of hosts. Descriptive notes are as follows 1) On the spermogonial surface of aecia, presumably those of *Uromyces acuminatus,* on *Polygonatum biflorum,* collected near Cambria, Columbia Co., July 2. The rather large and prominent pycnidia are closely clustered, sordid pallid brownish, thin-walled, with hyaline conidia about 12–18 x 4–5 μ. The conidia are in the approximate range of those of *Phyllosticta cruenta* (Fr.) Kickx., but the pallid pycnidia do not seem characteristic. The relation, if any, to the rust is obscure; 2) On *Tradescantia subaspera* (cult.) collected at Madison, August 29. Infection proceeds from the leaf tip inward until the entire leaf becomes dead and brown. The pycnidia are numerous, clustered or scattered, amphigenous, subglobose, pallid brownish, ostiolate, approx. 90–150 μ diam. Conidia hyaline, cylindric to subfusoid, frequently biguttulate, (10–)12–15(–20) x 3.5–5 μ, continuous so far as observed. A number of mounts were examined, but no septa were noted. Nevertheless, the aspect of the specimen suggests *Ascochyta,* in the nature of the lesions and in the relatively large thin-walled pycnidia, as well as in relation of spore width to length. 3) On *Smilax herbacea* collected at Gibraltar Rock County Park, Columbia Co., July 31. This seems intermediate between *Phyllosticta pallidior* Peck and *P. cruenta* (Fr.) Kickx., with a suggestion of *Stagonospora smilacis* (E. & M.) Sacc. The lesions are orbicular to irregularly subdendritic, sordid whitish with narrow dark brown margins, approx. 1–2 cm. diam., in contrast to the sharply defined circular lesions characteristic of *S. smilacis.* The conidia are spherical, broadly ovate to ellipsoid or occasionally subcylindric, contents granular, 8–11(–14) x 6–8 μ. A very few of the subcylindric spores show an imperfectly defined median septum. This seems to be but one more in the large and often puzzling series of Phyllostictae on Liliaceae of the tribes Uvularieae, Polygonateae, and Smilaceae. 4) On juvenile leaves of *Populus grandidentata* collected August 12 in the Aldo Leopold Memorial Tract, Sect. 1, Town of Honey Creek, Sauk Co. The orbicular blackish-brown lesions are large, up 4 cm. diam., and markedly zonate. Pycnidia are relatively few, epiphyllous, clustered, fuscous, subglobose, approx. 150–165 μ diam. Conidia are hyaline, fusoid, subfusoid, ellipsoid, or broadly ellipsoid, (5.5–)6.5–10(–11) x 2–2.5(–3) μ. This does not correspond well with any of the other species described on *Populus.* 5) Sparingly on large, up to 2 cm., conspicuous, orbicular, blackish-purple lesions on leaves of *Ulmus rubra,* collected September 1 near Cross Plains, Dane Co. The epiphyllous, flesh-colored, scattered, flattened pycnidia are mostly about 100 μ diam. by about 60 μ high. The hyaline, short-cylindric conidia are 3–5 x 1.5–2 μ, borne on slender, closely ranked conidiophores produced mostly from the floor of the pycnidium. Possibly closely related to *Phyllosticta ulmicola* Sacc., but certainly not typical of that species. 6) On *Rumex* *obtusifolius,* collected near Verona, Dane Co., May 24. The spots are rather small, rounded or irregular, with narrow dark purple margins. The pycnidia are sordid flesh-colored, very inconspicuous, epiphyllous and clustered, subglobose, approx. 100–150 μ diam., the conidia hyaline, short-cylindric to broadly ellipsoid, (1.5–)2–2.5 (–3) x 3.5–6.5(–7.5) μ. A good many of the spots also bear the conspicuous black fruiting bodies of a *Discosia*-type saprophyte. I have found no report of any *Phyllosticta* on this host, nor does the fungus in question correspond with any of the few Phyllostictae so far described on *Rumex.* 7) In association with *Phytophthora thalictri* Wils. & Davis on leaflets of *Thalictrum dasycarpum* collected at Wildcat Mt. State Park, Vernon Co., August 5. The thin-walled, translucent, subglobose pycnidia are pallid brown, rather widely ostiolate with a ring of darker cells about the ostiole, scattered on the *Phytophthora* spots, approx. 75–125 μ diam. The numerous hyaline conidia are broadly ellipsoid to cylindric, 3.5–5 x 1.5–2 μ. Whether the *Phyllosticta* preceded the *Phytophthora* is unknown. 8) On *Mitella diphylla,* collected at the Marathon County Park at the Dells of the Eau Claire River, Town of Easton, June 10. This is evidently the same thing which Davis (Trans. Wis. Acad. Sci. Arts Lett. 19(2):711. 1919) assigned provisionally to *Phyllosticta mitellae* Peck in a collection on the same host made at Melvina, Monroe Co. The Davis specimen is not in the Wisconsin Herbarium, but according to his note the pycnidia were light brown and the conidia oblong to elliptical, 4–6 x 2–3 μ. In the Marathon Co. specimen the conidia are of about the same size and the pycnidia are up to 125 μ diam., as opposed to the minute black pycnidia, 60–75 μ diam. of Peck's description, together with subglobose conidia 5–6.5 μ. It thus seems doubtful that the Wisconsin specimens are Peck's *P. mitellae,* although Seaver accepted the Davis report in his compilation of the Phyllostictae for the *North American Flora.* 9) On *Fragaria virginiana,* collected near Cross Plains, Dane Co., October 15. The rounded or broadly elliptic lesions are most conspicuous, with zonate banding in various shades of yellow or orange through reddish to light brown to purplish-brown or deep purplish, from about 1–4 cm. diam. Pycnidia are erumpent, black, subglobose, markedly rostrate, amphigenous but mostly epiphyllous, approx. 150–250 μ, tending to be rather evenly and remotely scattered over the lesions. The conidiophores are moderately crowded, approx. 20–25 x 1.5 μ, somewhat wider at their bases and tapering at the tip, hyaline, and lining most, if not all, the inner surface of the pycnidium. Conidia are hyaline, subelliptic or short rod-shaped, indistinctly biguttulate, 4.5–6.5 x 1.5–2 μ. It may be that this is *Phyllosticta fragaricola* Desm. & Rob., but such European exsiccati as are available for study have proved to be sterile, so adequate comparison with authentic material has not been feasible. 10) On *Prunus virginiana,* at Madison, July 25. The conspicuous, orbicular, purplish-brown spots are distinctly zonate, approx. .5–1.5 cm. diam., often confluent; pycnidia epiphyllous, tending to be zonately arranged, subglobose, pale brown, erumpent and almost superficial, approx. 75–125 μ diam., or rarely somewhat larger; conidia hyaline, ellipsoid to cylindric, 5–7 x 2–2.5(–3) μ. This is definitely not *P. virginiana* (Ell. & Halst.) Seaver, nor does it seem to match any of the other species described on *Prunus.* What appears to be an immature specimen of this same fungus was found on the same host near Daleyville, Dane Co., in early June. 11) Epiphyllous and usually solitary on small, angled, whitish spots on *Ceanothus americanus,* from Blue Mounds State Park, Iowa Co., September 21. The smoky-brown pycnidia are subglobose, about 125–150 μ diam. The conidia are hyaline, slender, rod-like or suballantoid, 4–5 x 1 μ. Not *P. ceanothi* Miles which has globose conidia, 6–8 μ. 12) On newly developed leaves of *Plantago rugelii* at Madison, September 10. Tehon and Daniels, in their notes on parasitic fungi, discuss several Phyllostictae on species of *Plantago,* and offer a key in which the Madison specimen cannot be fitted. The spots are mostly rounded, 1.5–3 mm. diam., centers pallid brownish or ashen, very thin and translucent, margins elevated, with the whole surrounded by a comparatively wide dark purplish halo. The large, subglobose pycnidia, up to 200 μ diam., or perhaps slightly more, are scattered to gregarious, smoky yellowish-brown, the ostiole marked by a conspicuous ring of darker cells, amphigenous, so far as can be judged on such thin spots. The numerous hyaline conidia are ellipsoid or short-cylindric, 3.5–5 x 1.5–2 μ. *Phyllosticta rugelli* Tehon & Stout (Mycologia 21:184. 1929) has very small pycnidia, only 35–65 μ diam., with a "long-papillate ostiole". 13) On *Helianthus strumosus* at Wildcat Mt. State Park, Vernon Co., September 9. This may possibly be an immature development of *Ascochyta rudbeckiae* (Ell. & Ev.) Greene, but does not correspond well with other specimens that I have so referred. The conspicuous spots are reddish-brown, orbicular to angled, subzonate, with imperfectly defined darker margins, approx. .5–1.5 cm. diam., occasionally confluent; pycnidia epiphyllous, scattered, black, globose, approx. 100–140 μ diam., almost completely superficial, but nevertheless quite firmly attached to the substratum, the wall of small, more or less isodiametric, thick-walled, dark cells; conidia hyaline, often biguttulate, broadly ellipsoid to cylindric, 7–13 x 2.5–3 μ. 14) In association with *Septoria nabali* B. & C. on *Prenanthes alba* at Ferry Bluff, Sauk Co., August 10. The *Phyllosticta* seems to be present, principally at least, on spots which are lighter in color than those bearing *S. nabali* only. The *Phyllosticta* pycnidia are sooty-brown, about 80–

90 μ diam., the conidia are hyaline, subfusoid to cylindric, approx. 3–5 x 1.5–2 μ.

PHYLLOSTICTA BACTERIOIDES Vuill. was reported (erroneously as *P. bacteriospora* Vuill.) by J. J. Davis as occurring on *Tilia americana* from Mellen, Ashland Co. Vuillemin describes this species as having pycnidia usually about 50 μ diam. (extremes 42–73 μ) and spherical. Conidial dimensions are given as 3.4–3.8 x 0.6 μ. The Mellen specimen does not correspond to this description, but does match two so far undetermined specimens collected by the writer in 1959. On the other hand, a specimen collected by Davis at Haugen, Barron Co., August 28, 1923 does in the main correspond to Vuillemin's description and remains filed as *P. bacterioides*.

CONIOTHYRIUM sp., which may well have been parasitic, occurs on leaves of *Poa pratensis*, collected near Cross Plains, Dane Co., September 1. The elongate lesions, mostly about 5–25 mm., are whitish to straw-colored, involving the entire leaf width and usually delimited at each end by a narrow, bright reddish-brown margin, the whole strikingly conspicuous in contrast to the deep green of the rest of the leaf, which is frequently strongly curved at the point of the lesion. The pycnidia are scattered to gregarious, subglobose, approx. 90–150 μ diam., under low magnification appearing blackish against the pallid lesion, but by transmitted light pale brownish, except around the rather wide ostiole where the cells are somewhat thicker and darker. The olivaceous conidia are narrowly ellipsoid to ellipsoid or subfusoid, occasionally subcylindric, (5–)6.5–8(–8.5) x 2.2–3 μ.

CONIOTHYRIUM (?) sp., which in its pycnidia simulates those of *Phyllosticta minima* (B. & C.) Ell. & Ev., occurs with and outnumbers pycnidia of the latter species, whose spores have been only imperfectly differentiated, on spots characteristic for *P. minima* on leaves of *Acer saccharinum*, collected at Wildcat Mt. State Park, Vernon Co., September 9. In mass the conidia show considerable color, but viewed individually they are subhyaline with a greenish tinge, so that they might almost equally well be considered as belonging to *Phyllosticta*. They are broadly ellipsoid, ovoid, or short-cylindric, 4–5 x 2.5–3 μ, as opposed to 8–9 x 5–6 for *P. minima*.

CONIOTHYRIUM sp. occurred in a possibly parasitic relationship on leaves of *Prunus virginiana*, collected near Verona, Dane Co., August 23. The spots are rounded, (1.5–)2–3(–5) mm. diam., with rather wide dull purplish margins and paler centers. The epiphyllous, black, subglobose pycnidia are scattered and are about 125–150 μ diam., the dilutely smoky conidia ellipsoid or short-cylindric, 4–6.5 x 2.5–3 μ.

ASCOCHYTA pycnidia are hypophyllous and scattered on rounded to elongate, dead, purplish areas on leaves of *Anemone cylindrica* collected at Madison, August 4. Relationship to the host is uncertain as *Puccinia anemones-virginianae* Schw. is also present on most of the spots. The pycnidia are dark brown, subglobose, about 100–125 μ diam., the conidia pallid greenish, 8–13 x 2.5–3, uniformly septate.

ASCOCHYTA AQUILEGIAE (Rabh.) Hoehn., as it occurs on European species of *Aquilegia,* both in Europe and cultivated in America, has two classes of spores, typical *Ascochyta* about 10–15 x 3–5 μ, and *Phyllosticta*-type about 5–8 x 2–3.5 μ. These evidently are produced within the same pycnidia. In two specimens collected on the native *Aquilegia canadensis* in Wisconsin, one by J. J. Davis at Sturgeon Bay in 1929, the other by the writer near Jonesdale, Iowa Co., in June 1959, only the *Phyllosticta* spores are present. As indicated in my Notes XV (Amer. Midl. Nat. 48:45. 1952), the lesions are so characteristically those of *Ascochyta* that there seems little doubt of the identity or close connection of the forms on European *Aquilegia* and on the native *A. canadensis.*

Solidago flexicaulis leaves, collected September 21 at Blue Mounds State Park, Iowa Co., bear conspicuous, orbicular, zonate, grayish-brown lesions on which large pycnidia (presumably), completely reminiscent of those of *Ascochyta compositarum,* are sparingly scattered. However, all that were examined were empty.

Fruiting structures which simulate those of *Phyllachora* and are, perhaps, in some cases stages of it, are often found on various grasses. Very commonly these bodies contain phragmospores of the *Stagonospora* type, but in a specimen on *Andropogon gerardi,* collected near Swan Lake, Columbia Co., September 18, some of these structures were found to be producing, in vast abundance, slender, continuous, hyaline scolecospores, about 12–15 x .7 μ, which are perhaps microconidia connected with an ascigerous stage. Other such structures contained phragmospores of the type mentioned. The relationships remain obscure.

SEPTORIA on *Sporobolus asper,* collected at Nelson Dewey Memorial Park near Cassville, Grant Co., June 23, was sent to R. Sprague for determination. He has tentatively assigned it to *Septoria andropogonis* J. J. Davis, although he states it is not typical. In mass the spores are bright yellow-brown, but individually appear almost hyaline. It was thought the fungus was a species of *Phaeoseptoria,* a genus on which Sprague is the acknowledged authority, but as indicated he does not consider it so, and points out further that the obviously parasitic nature of this specimen is in contrast to all species of *Phaeoseptoria* described up to now. He finds that the spores measure 48–68 x 3.3–4.1 μ, longer than for typical *S. andropogonis*. Length of spores may, of course, be strongly influenced by environmental conditions.

SEPTORIA (?) sp. is present in large dead areas on leaves of *Desmodium acuminatum,* collected near Verona, Dane Co., July 26. The scattered to clustered pycnidia are thin-walled, pallid-brownish, epiphyllous, subglobose, approx. 125–175 μ diam. The hyaline conidia are long-clavate (subacuminate at one end, obtuse at the other), more or less curved and irregular, 1–3(–4) septate, 20–37 x (2.5–)3–3.5(–4) μ. Very likely a parasite, but obvious saprophytes are also present, so the relation to the host of the fungus described is not clear. It could, without doing violence, be about as well referred to *Stagonospora.*

SEPTORIA sp. occurs in scanty amount on small, rounded, translucent spots on leaves of *Circaea latifolia,* collected near Verona, Dane Co., July 3. The single pycnidium examined is flesh-colored, thin-walled but fully formed, narrowly ostiolate, subglobose, 150 μ diam. The spores are obtuse at one end, tapering gradually to a point at the other, from almost straight to curved or flexuous, hyaline, indistinctly 2–3 or more septate, (17–)25–40 x (2–)2.5–3 μ (at thickened end). I have found no report of *Septoria* on *Circaea.*

SEPTORIA sp. is present on dead areas on leaflets of *Aralia racemosa* collected near Verona, Dane Co., August 23. The pycnidia, closely gregarious in small groups, are epiphyllous, black, globose, about 55–65 μ diam., thick-walled, widely ostiolate, with a definite short beak. The hyaline spores are straight to slightly flexuous or curved, appear continuous, and are approx. 13–20 x .8–1 μ. Pathogenicity is uncertain, as the leaves also bear *Ramularia repens* Ell. & Ev.

SEPTORIA sp., collected on *Aster laevis* at Janesville, Rock Co., June 27, is centered directly on a lesion which also bears an aecial fructification of *Puccinia stipae* Arth. The *Septoria* is obviously not *S. atropurpurea* Peck, the only species up to now reported from Wisconsin on *Aster laevis.* The fungus is amphigenous on a pallid brownish area of the lesion, the pycnidia surrounding and among the pore-like aecia of the rust. The pycnidia are light brown, thin-walled, subglobose, about 100 μ diam., and rather widely ostiolate and imperfect. The spores are filiform-acicular, mostly strongly curved, occasionally distinctly spirally so, hyaline, 30–45 x 1 μ. It is taken for granted that rusts are parasitic, but the relation of *Septoria* and host here is unclear.

GLOESPORIUM Desm. & Mont., one of the longest-established and most widely applied fungus generic names, is dropped by J. A. Von

Arx in a monographic paper entitled "Revision der zu *Gloeosporium* gestellten Pilze" (Verh. K. Nederl. Akad. Wetensch. Natuurk. Tweede Reeks, Deel LI, No. 3, 153 pp. 1957). Von Arx finds the type species, *Gloeosporium castagnei* Desm. & Mont., to be identical with *Marssonina populi* (Lib.) Magn. *Marssonina* is proposed for conservation and the species of *Gloeosporium* are assigned to various genera, mostly erected by European authors, notably the prolific Fr. Petrak, in the fairly recent past. Von Arx is to be congratulated for his restraint in describing only the two new genera of his own. The paper purports to list all hitherto described species of *Gloeosporium,* whether critically dealt with or not, but several omissions have been noted, as is probably inevitable in a work of this magnitude. The author has obviously made a serious and intensive effort and his work deserves careful attention and study. It seems regrettable that it was not possible to preserve the name *Gloeosporium,* in however restricted a sense.

COLLETOTRICHUM sp. on *Smilax ecirrhata,* from near Cross Plains, Dane Co., July 20, appears strongly parasitic, but the circular, pale brown lesions, with narrow darker brown border, are similar to those produced by *Stagonospora smilacis* (Ell. & Mart.) Sacc. and it may have been primary, although no pycnidia were formed. The hyaline, cylindro-fusoid conidia of the *Colletotrichum* are pinkish in mass, 14–17 x 3–4 μ, while the setae are dark brown, slender, subacute, variable in length from acervulus to acervulus, and tend to be marginal. There is much uncertainty about *Colletotrichum* on Liliaceae, both as to specific identities and as to parasitism.

COLLETOTRICHUM sp., collected on leaves of *Carya ovata* near Pine Bluff, Dane Co., July 24, is perhaps parasitic. The small acervuli are epiphyllous, about 60–90 μ diam., clustered on small, immarginate, dull greenish-purple areas and are consistently present on a number of leaves, but the picture is obscured by evidence of insect activity on the reverse side of the leaves. The setae are few per acervulus, dark brown, thick-walled, from almost straight to slightly curved, acuminate, once or twice septate, 60–125(–170) x 2.5–5 μ, the conidia hyaline, falcate, 17–20 x 3–3.5 μ.

COLLETOTRICHUM URTICAE H. C. Greene (Amer. Midl. Nat. 50: 507. 1953) was described on *Urtica dioica* and later collected on *Laportea canadensis.* On both hosts the spots are small (1–2.5 mm.), rounded, ashen to grayish, and very sharply defined. On the latter host, near Cleveland, Manitowoc Co., August 19, there was collected an extremely inconspicuous fungus which may perhaps be a manifestation of *C. urticae.* The lesions, however, are large and conspicuous, blackish-brown, indeterminate, appearing to originate at the leaf tip, and involving from the upper one-third to almost the entire leaf. Epiphyllous on these lesions are tiny acervuli, approx. 30–40 μ diam., with usually a single seta, occasionally two, 40–65 x 3–4.5 μ, clear brown, continuous, apex subotuse to acuminate, base somewhat inflated. The conidia are cylindric or subfusoid, appearing at times to be produced several simultaneously from a single condiophore, rarely showing a tendency to catenulation, 13–18 x 3–3.5 μ. The dimensions are not far from those of *C. urticae,* but the gross aspect of the infection is completely different.

MARSSONIA POTENTILLAE (Desm.) Magn. has been reported for Wisconsin on *Potentilla norvegica* var. *hirsuta* (*P. monspeliensis*) on the basis of two collections by J. J. Davis at Spooner, Washburn Co., in 1911, identified at that time as *Gloeosporium fragariae* (Lib.) Mont., which is now considered as synonymous with *M. potentillae.* A re-examination of these specimens raises doubt as to their identity with *M. potentillae.* They are characterized by large, orbicular, grayish-brown blotches, up to 2 cm. diam., on which the acervuli are clustered, whereas in collections on other species of *Potentilla* there is little or no spotting and the acervuli are scattered. The conidia in the specimens on *P. norvegica* var. *hirsuta* are slender-cylindric or subfusoid and almost straight, with no septation noted in any spores. In specimens on other hosts, however, the conidia are strongly curved, boomerang-shaped, acute at one end, blunt at the other, and distinctly uniseptate.

MARSSONINA sp. occurs consistently on gall spots on living leaves of *Acer negundo,* collected at Madison, June 24, 1951. The orbicular spots, about .2–.5 cm. diam., are pallid with reddish borders, and with considerable hypertrophy of vein tissue on the under side. The acervuli are amphigenous, subcuticular, scattered to gregarious, sordid carneous to pallid brownish, approx. 100–150(–200) μ diam.; conidiophores hyaline, closely ranked, simple, about 5–7 x 2 μ; conidia hyaline, straight to slightly curved, subcylindric, long-obovoid, subfusoid, or occasionally definitely fusoid, 7–14 x 2.5–4.5 μ. Parasitism is questionable, but it seems likely. The occurrence of characteristic fungi on leaf galls is of considerable interest and might well repay intensive study.

Quercus alba leaves, collected at Madison, September 28, and near Verona, September 30, bear a fungus which it seems may possibly be an imperfectly developed *Marssonia,* although it seems very different from *M. martini* (Sacc. & Ell.) Magn., commonly found on this host and characterized by very sharply defined, small, rounded, pallid spots. In this specimen the hypophyllous acervuli are subepidermal and moderately sunken, about 200–250 μ diam., scattered to loosely clustered on immarginate, extensive, dull pinkish areas. The conidia vary from rarely obclavate, to cylindric, broadly cylindric, or ellipsoid, or occasionally curved *Marssonia*-like, hyaline, continuous so far as observed, 18–36 x 6.5–9 μ.

Botrytis, perhaps *B. vulgaris* Fr., occurred on the fruit, in all stages of development, of red raspberry, *Rubus strigosus*, observed near Verona, Dane Co., July 26. Entire clones were devastated, with almost no fruit escaping. At least a weak degree of parasitism would seem indicated.

Anemone canadensis leaves in the fall are often closely studded on the under surface with prominent, black, subgloboid, non-fruiting structures suggesting immature perithecia. Such leaves were collected at the Faville Prairie near Lake Mills, Jefferson Co., in September 1958, and overwintered out-of-doors in a wire cage. When this material was examined in late May 1959, characteristic conidia and conidiophores of *Didymaria didyma* (Ung.) Schroet. were being produced in profusion from the apices of the abovementioned subgloboid black structures, providing another instance of what seems to be a rather widespread type of adaptation to overwintering of various fungi, with early infection of the emerging shoots of the host plants. No evidence of an accompanying perfect stage was detected.

Cladosporium sp., appearing parasitic, occurs on telia of *Coleosporium asterum* (Diet.) Syd. on *Solidago altissima*, collected at Madison, September 21, 1958. The scattered conidiophores are dilute brown, several-septate, from simple and flexuous to mildly geniculate and tortuous, about 65–100 x 3–4 μ; conidia grayish-olivaceous, smooth, subcylindric, broadly ellipsoid or subfusoid, 1-septate or continuous, catenulate, 10–13 (–20) x 4–5 μ.

Cladosporium sp. which appears definitely parasitic occurs on leaves of *Muhlenbergia frondosa*, collected at Poynette, Columbia Co., September 18. The sharply defined spots are narrowly elongate, mostly about .5–1 cm. long by .5–.7 mm. wide, the central portion cinereous with relatively wide tan margins. The conidiophores are amphigenous, scattered or very loosely clustered, clear brown, ranging from almost straight and without geniculation to tortuous and strongly geniculate, 1–5 septate, approx. 45–100 x 3.5–5 μ; conidia pallid olivaceous-gray, subcylindric or subfusoid, apices conic with noticeable scar, sometimes at both ends, indicating catenulation, mostly appearing slightly roughened, 18–25 (–28) x 5–6 μ. A few of the longest spores have 3 septa, but the uniseptate condition appears normal.

Heterosporium sp. occurs on leaves of *Populus deltoides*, collected at Madison, September 7, 1958. The orbicular spots, approx.

.5 cm. diam. are dull cinereous to grayish-brown with very narrow blackish-brown borders and the fungus is amphigenous on the central part of the spots. The cylindric conidia, when mature, are 3 septate, slightly constricted at the septa, closely and finely echinulate, smoky olivaceous, 14–20 x 5–7 μ. The clear-olivaceous conidiophores are fairly closely fascicled, continuous to 1–2 septate, simple and straight, or mildly geniculate, short, approx. 25–50 x 4–5 μ. The spots are somewhat reminiscent of those caused on this and related host species by *Septoria musiva* Peck, and thus it seems possible that they represent a suppressed development thereof, with the *Heterosporium* secondary.

CERCOSPORELLA, collected on *Eupatorium altissimum* at Madison, August 31, suggests, in its macroscopic aspect and in the nature of its conidiophores, CERCOSPORELLA CANA Sacc., common on species of *Erigeron.* The conidia, however, are quite different. I find no report of *Cercosporella* on *Eupatorium* and this may be distinct, but as the Cercosporellae on Compositae are in a state of considerable confusion, for the present no formal description is offered. The conidiophores are fascicled, amphigenous but mostly hypophyllous, hyaline, septate, thick-walled, often curved below and diverging, narrowing usually toward tip which is often noticeably geniculate-denticulate, approx. 40–60 x 5–6.5 μ; conidia hyaline, narrowly obclavate to almost acicular, 4–6 septate, approx. 80–115 x 3–4 μ, base obconic.

CERCOSPORA sp. occurs on drab bluish areas, often involving entire leaves of *Isopyrum biternatum,* collected near Antigo, Langlade Co., June 9. The conidiophores are scattered to loosely fasciculate, appearing continuous, grayish, mostly distinctly and rather closely geniculate, about 40–55 x 4–6 μ. The conidia are hyaline, slender, tapering obclavate, markedly flexuous, with subacute tip, base truncate with prominent scar, 8–10 septate, 150–175 x 5–6 μ. *Cercospora merrowi* Ell. & Ev., reported from Wisconsin on *Isopyrum,* has, according to Chupp, conidia which are cylindro-obclavate to cylindric, subhyaline to pale olivaceous-brown, plainly 1–6 septate, straight to mildly curved, occasionally catenulate, subtruncate base, tip obtuse, 20–60 x 4–7 μ. *Cercospora isopyri* Hoehn., the only other species reported on *Isopyrum,* is considered to be probably a species of *Helminthosporium.*

CERCOSPORA sp. on *Epilobium adenocaulum,* collected at Blue Mounds State Park, Iowa Co., September 21, is quite unlike *Cercospora epilobii* Schneider, the only species listed by Chupp as occurring on *Epilobium,* and which he considers to be actually a *Didymaria.* The current specimen has rounded pallid spots, somewhat sunken, with narrow, brownish border, small, mostly not over 1 mm. diam. The fungus is epiphyllous, the fascicles few per spot, rather compact, with half a dozen or so conidiophores which are deep brown, several-septate, somewhat tortuous, several times geniculate near the tip, 75–115 x 5 μ; conidia hyaline, subflexuous, acicular to slender-obclavate, multiseptate, truncate at base which is 3–4 μ wide.

CERCOSPORA sp., present in small amount on dead areas on leaflets of *Aralia racemosa,* collected near Verona, Dane Co., August 23, does not correspond closely to any of the eight species listed in Chupp's key to Cercosporae on Araliaceae, but bears considerable similarity to *C. araliae-cordatae* Hori, as described. In the Wisconsin specimen the hyaline, very slender-obclavate (almost acicular) conidia are flexuous, obscurely multiseptate, about 5 μ wide at the truncate base, and up to 325 μ in length; conidiophores dilute clear brown, straight, simple or once geniculate, often somewhat wider at the blunt, truncate tip (up to 6 μ), several times septate toward base, diverging in loose fascicles of about 4–6, approx. 75–150 μ in length.

CERCOSPORA sp. occurs on *Myosotis virginica,* collected at Red Rock, south of Darlington, Lafayette Co., June 4. There are no sharply defined spots. The conidiophores are scattered over indeterminate reddish-brown areas which often involve the entire leaf. Conidiophores are mostly epiphyllous, scattered, as noted, mildly-several-geniculate, 1–2 septate, with subconic tip, grayish, arising from a small cluster of pseudoparenchymatous cells of similar hue, mostly very short, but exceptionally up to 35 x 3 μ; conidia slender and acicular, indistinctly multiseptate with contents somewhat granulose, 30–75 x (2–)2.5(–3) μ. Chupp in his *Monograph of Cercospora* does not report anything on *Myosotis.* The present material, while seemingly quite distinct, is hardly profuse enough for formal descriptive purposes.

CERCOSPORA sp., collected in small quantity on *Rudbeckia triloba* at Madison, October 1, is not *Cercospora tabacina* Ell. & Ev., the only species named by Chupp as occurring on *Rudbeckia.* In *C. tabacina* the fungus is in effuse patches, whereas in the present specimen it is hypophyllous on small purplish spots. The conidia are hyaline (colored in *C. tabacina*), slender-obclavate, multiseptate, base truncate with prominent scar, approx. 75–115 x 4–4.5 μ. The conidiophores lack the tortuous, constricted aspect of those of *C. tabacina.* Those measured are about 90–175 x 3.5–4.5 μ, clear brown, several-septate, once or twice geniculate, few in the fascicle and tending to diverge widely.

Carex albursina leaves, collected July 9 near Albany, Green Co., bear an interesting and plainly parasitic sporodochium-producing fungus which I am unable to place as to genus. The spots are one to several per leaf, where several, often clustered, small (1–) 1.5–3 mm., rounded, variously angled, or elongate, centers pallid brownish, margins relatively wide and reddish-brown. The spots are thin and translucent, with the tissue often rupturing. Sporodochia one to several per spot, amphigenous, mostly hypopyllous, pulvinate, pale flesh-colored when freshly collected, later turning somewhat darker, composed of closely compacted, but discrete hyphae which are more or less vertically oriented to the substratum, 40–95 μ wide at base by approx. 25–50 μ in height above the substratum; conidia hyaline, broadly ellipsoid or subfusoid, 5–7 (–8.5) x 3.5–4 μ, produced on the surface of the sporodochia without presence of differentiated conidiophores.

Muhlenbergia schreberi, collected near Cross Plains, Dane Co., October 15, bears a highly unusual fungus which appears superficial, but which may be parasitic. The general aspect is that of a member of the Perisporiales, but microscopic examination belies this. The conspicuous feature is the presence of numerous rounded, disciform, black, perithecium-like structures, mostly about 150–250 μ diam., from which are produced many radiating appendages. The aforementioned structures are non-ostiolate and thick-walled, the individual cells of the wall being in themselves thick-walled and dark, rounded to squarish, approx. 8–10 μ diam. When crushed, the fully developed bodies are seen to be filled with what appear to be thick-walled, subglobose or broadly ovoid, hyaline chlamydospores, 7–17 x 8–14 μ, more or less readily separable from one another. The hyaline walls are mostly about 2.5–3 μ thick. The profusely produced appendages are deep brownish at the more or less bulbous base, fading to almost hyaline at the long-attenuate apex, multiseptate, about 5–6 μ at base and 3 μ wide throughout most of their length, more or less flexuous or tortuous, up to 525 μ long. The whole appears attached to the host by a delicate subiculum, the cells of which are organized into strands irregular in appearance and difficult to describe satisfactorily. There are also present in most of the mounts examined, brownish, coarsely echinulate, 1–3 septate, subcylindric phragmospores, about 18–30 x 7–10 μ and reminiscent of *Heterosporium*. None have been seen attached, however, so their possible connection remains conjectural.

SCLEROTIOMYCES COLCHICUS Woronichin, a probably non-parasitic, but still detrimental fungus, was collected on leaves of *Polymnia canadensis* at Wildcat Mt. State Park, Vernon Co., September 9, adding another to the already large list of Wisconsin plants observed bearing this fungus. As in all previous specimens, it is strictly epiphyllous.

Additional Hosts

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

Albugo bliti (Biv.) O. Ktze. on *Amaranthus powellii.* Dane Co., Madison, August 19, 1956. Also on *Amaranthus powellii* X *retroflexus* (det. J. D. Sauer). Sauk Co., Devils Lake State Park, September 16.

Syzygites megalocarpus Ehrenb. ex Fr. (*Sporodinia grandis* Link) on *Calvatia gigantea.* Dane Co., Madison, September 11. Coll. R. Bere.

Microsphaera alni (Wallr.) Wint. on *Carya ovata.* Dane Co., near Pine Bluff, September 23.

Uncinula salicis (DC.) Wint. on *Salix cordata.* Columbia Co., Poynette, September 18.

Phllactinia corylea (Pers.) Karst. on *Corylus cornuta* (*rostrata*). Vernon Co., Wildcat Mt. State Park, September 9.

Phyllachora puncta (Schw.) Orton on *Panicum wilcoxianum.* Dane Co., near Cross Plains, September 1.

Cronartium ribicola Fisch. II, III on *Ribes missouriense.* Dane Co., Madison, August 25.

Coleosporium viburni Arth. II, III on *Viburnium prunifolium* (cult.). Dane Co., Madison, October 18.

Coleosporium asterum (Diet.) Syd. ii, III on *Aster puniceus.* Columbia Co., Poynette, September 18.

Melampsora paradoxa Diet. & Holw. II, III on *Salix babylonica.* Dane Co., Madison, September 28.

Melampsora abieti-caprearum Tub. II, III on *Salix bebbiana.* Dane Co., Madison, October 13.

Tranzschelia pruni-spinosae (Pers.) Diet. III on *Prunus maritima* (cult.). Dane Co., Madison, October 19.

Phragmidium Americanum (Peck) Diet. III on *Rosa heliophila* (*pratincola*). Dane Co., Madison, November 4, 1958.

Phragmidium subcorticinum (Schr.) Wint. II, III on Hybrid Tea Rose (Condesa de Sestago). Dane Co., Madison, October 1958. Coll. D. L. Coyier. Although the taxonomy of *Phragmidium* as it now stands leaves much to be desired, this specimen corresponds quite closely to the description given in Arthur's Manual.

Puccinia caricina DC. I on *Ribes lacustre.* Forest Co., near Alvin, June 26, 1957. Coll. H. Gale and M. Christensen. On a phanerogamic specimen in the University of Wisconsin Herbarium.

PUCCINIA DIOICAE P. Magn. I on *Aster ericoides.* Trempealeau Co., Perrot State Park at Trempealeau, June 17. At same station on *Solidago sciaphila,* June 16.

PUCCINIA DIOICAE P. Magn. ii, III on *Carex assiniboinensis.* Bayfield Co., Mason, September 3. Coll. J. H. Zimmerman.

PUCCINIA ATROFUSCA (Dudl. & Thomp.) Holw. I on *Artemisia caudata.* Burnett Co., Crex Meadows near Grantsburg, July 14.

PUCCINIA ASTERIS Duby on *Aster lateriflorus.* Iowa Co., Gov. Dodge State Park near Dodgeville, September 11.

UROMYCES PERIGYNIUS Halst. III on *Carex assiniboinensis.* Bayfield Co., Mason, September 3. Coll. J. H. Zimmerman.

CINTRACTIA CARICIS (Pers.) Magn. on *Carex emoryi* Dewey. Trempealeau Co., Perrot State Park at Trempealeau, June 16.

CERATOBASIDIUM ANCEPS (Bres. & Syd.) Jacks. on *Galium triflorum.* Vernon Co., Wildcat Mt. State Park, August 5. On *Verbena urticaefolia.* Same station and date.

PHYLLOSTICTA PALLIDIOR Peck on *Polygonatum biflorum.* Columbia Co., near Cambria, July 2. So far as I am aware this is the first collection of this globose-spored species on *Polygonatum* in Wisconsin. As I indicated earlier (Amer. Midl. Nat. 41:741. 1949) *Polygonatum* usually bears *Phyllosticta cruenta* (Fr.) Kickx. which has elongate spores on the order of 15–20 x 4–6 μ. There has been much confusion concerning Phyllostictae on *Polygonatum, Smilacina* and *Uvularia* and my 1949 discussion was aimed at clarification of the situation. The conidia in the present specimen run slightly smaller than the 10 μ diam. they often display in well-developed specimens on *Smilacina,* but they are definitely larger than the 5–7 μ diam. of *Phyllosticta discincta* J. J. Davis, occurring on *Uvularia.*

PHYLLOSTICTA NEBULOSA Sacc. on *Silene cserei.* Green Co., near Albany, May 30.

PHYLLOSTICTA SUCCINOSA H. C. Greene on *Ribes missouriense.* Dane Co., near Pine Bluff, July 24.

PHYLLOSTICTA VIOLAE Desm. on *Viola incognita.* Iowa Co., Gov. Dodge State Park near Dodgeville, June 2.

PHYLLOSTICTA SOLIDAGINIS Bres. on *Solidago sciaphila.* Sauk Co., Ferry Bluff, Town of Prairie du Sac, August 10. The pycnidia are quite inconspicuous.

ACTINONEMA ROSAE (Lib.) Fr. (*Diplocarpon rosae* Wolf) on *Rosa blanda.* Rock Co., Janesville, June 27.

ASCOCHYTA SILENES Ell. & Ev. on *Silene cserei.* Marquette Co., near Roslin, June 9.

ASCOCHYTA NEPETAE J. J. Davis on *Leonurus cardiaca*. Columbia Co., Gibraltar Rock County Park, July 31. Also, two specimens from Madison, August 7, 1952 and July 13, 1957, and a specimen from near Poynette, Columbia Co., September 3, 1952. The 1952 collections were very small and inadequate, but the later specimens are much more ample and seem referable to Davis' species. Davis based his description on a single rather small specimen and does not specify the range of pycnidial diameter, which I find to be quite variable, from about 80–150 μ or rarely more. He states the conidia are 10–14 x 3 μ, which, with extensions, is the general range of the conidia on *Leonurus* and in other specimens on *Nepeta*, collected by me.

ASCOCHYTA COMPOSITARUM J. J. Davis on *Solidago ulmifolia*. Dane Co., Madison, August 26. On *Aster azureus*. Dane Co., near Cross Plains, September 1. On *Aster shortii*. Green Co., New Glarus Woods Roadside Park, July 21. On *Helenium autumnale*. Gov. Dodge State Park near Dodgeville, July 21. (The specimen on *Helenium* is the small-spored form originally designated as var. *parva* by Davis, but later included under the species proper in his emended concept). On *Prenanthes alba*. Dane Co., Madison, August 25.

DARLUCA FILUM (Biv.) Cast. on *Puccinia punctata* Link var. *troglodytes* (Lindr.) Arth. II on *Galium triflorum*. Columbia Co., Gibraltar Rock County Park, July 31. On *Uromyces phaseoli* (Pers.) Wint. II on *Phaseolus vulgaris*. Dane Co., Madison, September 8.

STAGONOSPORA SIMPLICIOR Sacc. & Berl. f. ANDROPOGONIS Sacc. on *Andropogon scoparius*. Dane Co., Madison, September 1. There are no sharply defined lesions, but the large phragmospores, about 40 x 10 μ, are characteristic.

STAGONOSPORA ALBESCENS J. J. Davis on *Carex grayii*. Rock Co., Avon, September 3. Here the spores are about 9–11 μ, and mostly 7, but occasionally 9 septate. On *Carex interior*. Langlade Co., near Kempster, June 9. The spores run somewhat smaller than the 45–65 x 10–13 μ of the original description, but otherwise seem characteristic. Also on *Carex prairea* Dewey. Dane Co., Madison, June 14. Here the spores are 45–55 x 10–12 μ and are uniformly 6 septate. Associated with the *Stagonospora* on *C. prairea* is a mature *Mycosphaerella* with perithecia about 80 μ diam., broadly clavate asci about 30 x 12 μ and hyaline ascospores about 13 x 5 μ with septum median and lower cell slightly smaller. Spots may or may not be well defined in specimens of *Stagonospora albescens*, tending not to be on filiform leaves, such as those of *C. prairiea* and *C. interior*, where the entire upper leaf is involved. It seems likely that *S. albes-*

cens and *S. caricinella* Brun. intergrade. Davis (Trans. Wis. Acad. Sci. Arts Lett. 18:264. 1915) discusses the latter species at some length.

SEPTORIA CARICIS Pass. on *Carex emoryi* Dewey. Trempealeau Co., Perrot State Park at Trempealeau, June 16.

SEPTORIA NEMATOSPORA J. J. Davis on *Carex interior*. Langlade Co., near Kempster, June 9.

SEPTORIA DENTARIAE Peck on *Dentaria diphylla*. Marathon Co., County Park at Dells of Eau Claire River, Town of Easton, June 10. The infected leaves also bear oospores of *Albugo* in astonishing profusion, with only slight evidence of the preceding conidial stage.

SEPTORIA CRATAEGI Kickx on *Crataegus mollis*. Rock Co., Avon, September 3.

HAINESIA LYTHRI (Desm.) Hoehn. on *Oenothera rhombipetala*. Sauk Co., Spring Green, September 11.

COLLETOTRICHUM GRAMINICOLA (Ces.) Wils. on *Agropyron smithii*. Iowa Co., near Arena, September 9.

COLLETOTRICHUM LUCIDAE H. C. Greene on shoot leaves of *Populus tremuloides*. Dane Co., Madison, July 5. The fungus is identical microscopically with the type which occurred in the same locality on *Salix lucida* (Trans. Wis. Acad. Sci. Arts Lett. 45:190. 1956) and, with allowance for host difference, the lesions are very similar. The fungus appears very strongly parasitic on both these salicaceous hosts.

SPHACELOMA MURRAYAE Jenkins & Grodsinsky on *Salix alba* var. *vitellina*. Dane Co., Madison, September 14.

CERCOSEPTORIA CRATAEGI (Ell. & Ev.) Davis on *Crataegus mollis*. Rock Co., Avon, September 3.

RAMULARIA VARIATA J. J. Davis on *Mentha spicata*. Iowa Co., Gov. Dodge State Park near Dodgeville, June 2.

Ramularia minax J. J. Davis on *Solidago gigantea*. Vernon Co., Wildcat Mt. State Park, August 5. In the virtual absence of trichomes on this host the fungus loses somewhat of its characteristic appearance on other species of *Solidago*, where ascension of the trichomes is a feature.

CERCOSPORA CARICIS Oud. on *Carex cephalophora*. Trempealeau Co., Perrot State Park at Trempealeau, June 17. On *Carex sparganioides*. Iowa Co. Gov. Dodge State Park near Dodgeville, July 21.

CERCOSPORA DESMODIICOLA Atk. on *Desmodium illinoense*. Dane Co., Madison, September 10.

TUBERCULINA PERSICINA (Ditm.) Sacc. on *Puccinia atrofusca* (Dudl. & Thomp.) Holw. I on *Artemisia caudata.* Burnett Co., Crex Meadows near Grantsburg, July 14. On the uredinoid aecia of *Uropyxis amorphae* (Curt.) Schroet. on *Amorpha fruticosa.* Trempealeau Co., Perrot State Park at Trempealeau, June 16. Additional evidence, if any is needed, of the truly aecial nature of these fructifications, as I do not know of any case where *Tuberculina* has been reported on other than the aecial stage of a long cycle rust.

PSEUDOCEOSPORA VITIS (Lev.) on *Vitis aestivalis.* Dane Co., near Verona, September 4. A very distinctive fungus with strikingly coremoid conidiophores.

ADDITIONAL SPECIES

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

ALBUGO IPOMOEAE-PANDURANAE (Schw.) Swingle on *Ipomoea purpurea* (cult.). Dane Co., Madison, June 25.

NECTRIA EPISPHAERIA (Tode) Fr. on *Xylaria polymorpha.* Dane Co., Brigham County Park near Blue Mounds, October 18. Coll. & det. J. L. Cunningham.

PUCCINIA PLUMBARIA Peck I on *Phlox divaricata.* Columbia Co., Muir Park near Poynette, May 8.

SOROSPORIUM EVERHARTII Ell. & Gall. on *Andropogon scoparius.* Sauk Co., near Spring Green, September 11. Also on *Andropogon gerardi.* Dane Co., Madison, September 9, 1946. This was erroneously reported on *A. gerardi* as *Sphacelotheca occidentalis* G. P. Clint which thus appears not to have been collected in Wisconsin so far.

Phyllosticta eminens sp. nov.

Maculis orbicularibus, pallido- vel rufo-brunneis cum marginibus modice latis et fuscis supra, sordido-carneis cum marginibus dilutis purpureis infra, conspicuis, confluentibus interdum, ca. .5–2 cm. diam., plerumque ca. 1 cm.; pycnidiis nigris, subglobosis vel globosis, ostiolatis, superficialibus vel fere, amphigenis, plerumque hypophyllis, sparsis vel gregariis, ca. (60–)100–200 μ diam.; conidiis hyalinis, obtusis, cylindraceis vel ellipsoideis late, 3.5–5 x (1.5–) 2–2.5 μ.

Spots orbicular, pallid- to reddish-brown with fairly wide fuscous border on upper leaf surface, sordid pinkish with dull purplish border below, conspicuous, some times confluent, approx. .5–2 cm. diam., mostly about 1 cm.; pycnidia black, subglobose to globose, ostiolate, superficial or nearly so, amphigenous but mostly hypophyllous, approx. (60–)100–200 μ diam., scattered or gregarious; conidia hyaline, obtuse, cylindric to broadly ellipsoid, 3.5–5 x (1.5–) 2–2.5 μ.

On living leaves of *Salix* (the host appears to be a hybrid of *Salix amygdaloides* and some other species, perhaps *S. fragilis*). Bank of Wisconsin River at Walnut Eddy, Wyalusing State Park, Grant County, Wisconsin, U. S. A., September 24, 1959.

A very interesting species, in which the pycnidia vary from almost entirely superficial and seated on an inconspicuous whitish subiculum, to pycnidia in which, at most, the lower quarter is imbedded in the substratum. The latter condition seems more frequent in epiphyllous pycnidia which are many fewer in number than those on the lower surface.

Phyllosticta erysimi sp. nov.

Maculis parvis, 1.5–3 mm. diam., pallido-brunneis, depressis, marginibus fuscellioribus, elevatis, suborbicularibus vel irregularibus, confluentibus aliquoties, saepe marginatis; pycnidiis fuscis, subglobosis vel planioribus nonnihil, erumpentibus, amphigenis, ostiolis prominentibus, ca. 175–225 μ diam. sparsis vel gregariis; conidiis numerosis, parvis, hyalinis, bacilliformibus, rectis vel curvis leniter, 3–5 x 1–1.5 μ.

Spots small, 1.5–3 mm. diam., one to several per leaf, pallid brownish, sunken with elevated margins, margins somewhat darker, suborbicular to irregular in shape, sometimes confluent, often marginal on the narrow leaves; pycnidia sordid blackish-brown, subglobose or somewhat more flattened, erumpent, amphigenous, ostiole prominently marked by a ring of darker cells, about 175–225 μ diam., scattered to gregarious; conidia very numerous, small, hyaline, rod-shaped, straight or slightly curved, 3–5 x 1–1.5 μ.

On living leaves of *Erysimum inconspicuum* (S. Wats.) MacMill. (*E. parviflorum* Nutt.). Prairie remnant along Wisconsin Highway 39, Sect. 4, Town of York, Green County, Wisconsin, U. S. A., June 4, 1959. I have not found any report of *Phyllosticta* on *Erysimum* or closely related hosts.

PHYLLOSTICTA DEARNESSII Sacc. on *Rubus strigosus*. Vernon Co., Wildcat Mt. State Park, August 5 and near Verona, Dane Co., September 4. On this host the conspicuous reddish-brown orbicular spots are about 1 cm. diam., with the pycnidia usually borne individually on tiny lighter areas within the spot. Pycnidia are from about 125–160 μ diam., the bacilliform conidia 3.5–5 x 1.2–1.5 μ. Also on *Rubus parviflorus* (cult.). Dane Co., Madison, October 15.

Phyllosticta minor Ell. & Ev. on *Vinca minor* (cult.). Dane Co., Madison, May 28. Apparently a well-marked species, with globoid conidia about 5 μ in diam.

Phyllosticta tuberosa Ell. & Mart. on *Asclepias tuberosa*. Sauk Co., Ferry Bluff, Town of Prairie du Sac, August 10. The specimen corresponds closely with the description and with N. Amer. Fungi No. 1161. *Phyllosticta tuberosa, Septoria asclepiadicola* Ell. & Ev., and *Stagonospora zonata* J. J. Davis all produce remarkably similar lesions on this host.

Phyllosticta taraxaci Hollos on *Taraxacum officinale*. Dane Co., Madison, July 8. Sufficiently similar to Hollos' description to warrant inclusion, in my opinion. In the Madison specimen the spots are orbicular, .3–1 cm. diam., brownish, somewhat zonate with wide purplish margins; pycnidia epiphyllous, brownish, subglobose, thin-walled, approx. 60–80 μ diam., scattered; conidia hyaline, ellipsoid, 3.5–5 x 2–2.5 μ. Hollos gives a pycnidial diameter of 80–90 μ, and 5–6 x 1.5–2 μ for the conidial dimensions.

Ascochyta solidaginis sp. nov.

Maculis orbicularibus, conspicuis, subzonatis, cinereis vel brunneo-cinereis obscuris, marginibus angustis, fuscis, .7–2.5 cm.; pycnidiis epiphyllis, sparsis, fuscis, subglobosis, ca. 250–300 μ diam.; conidiis hyalinis, angusto-cylindraceis, guttulatis, (6–)8–10 x 1.5–2 μ, uniseptatis.

Spots orbicular, conspicuous, subzonate, cinereous to dull brownish-cinereous, with narrow dark margin, .7–2.5 cm.; pycnidia epiphyllous, scattered, fuscous, subglobose, about 250–300 μ diam.; conidia hyaline, narrow-cylindric, guttulate, (6–)8–10 x 1.5–2 μ, uniseptate.

On living leaves of *Solidago altissima*. Parfrey's Glen, Town of Merrimac, Sauk County, Wisconsin, U. S. A., September 16, 1959.

Because of the narrow leaves, not over half an inch wide, the spots are seldom full orbs, but usually impinge on the margins and occasionally occupy the full leaf width. The very large pycnidia are a distinctive feature of this species. They are not translucent, as are those of many Ascochytae.

Stagonospora cypericola sp. nov.

Maculis nullis, foliis pallido-brunneis superne; pycnidiis fuscis, ostiolatis, globosis, immersis, sparsis, 90–125 μ diam.; conidiis hyalinis, obtusis, cylindraceis vel curvis leniter, guttulatis, (20–)25–30 (–33) x 6–7.5(–8) μ, (1–)2–3(–4) septatis.

No sharply defined spots, distal portions of leaves pale brownish and dead; pycnidia dark brown, ostiolate, globose, deeply imbedded in leaf tissue, scattered, 90–125 μ diam.; conidia hyaline, ends obtuse, cylindric or slightly curved, guttulate, (20–)25–30(–33) x 6–7.5(–8) μ, (1–)2–3(–4) septate.

On leaves of *Cyperus filiculmis* var. *macilentus*. University of Wisconsin Arboretum at Madison, Dane County, Wisconsin, U. S. A., July 30, 1959.

The fungus is in excellent maturity and seems distinct and well-characterized. The basal portions of the host leaves are still green and living and there appears to be no doubt as to active parasitism. This is similar to, but does not seem to be identical with, an undetermined *Stagonospora* reported on dead leaves of this host in my Notes XVIII (Trans. Wis. Acad. Sci. Arts Lett. 42:71. 1953), since the conidia of *S. cypericola* are wider and longer, and the pycnidia of somewhat less diameter. *Stagonospora cyperi* Ell. & Tracy, as described, has conidia 12–16 x 2.5–3 μ.

Stagonospora lactucicola sp. nov.

Maculis orbicularibus, rufo-brunneis, marginibus angustis fuscis, conspicuis, .5–2.5 cm. diam., zonatis plus minusve; pycnidiis amphigenis, pallido-brunneis, muris tenuibus, ostiolatis, subglobosis, sparsis vel gregariis, ca. 125–180 μ diam.; conidiis hyalinis, obtusis, cylindraceis, guttulatis, (12–)15–20 x (4–)5–6.5 μ, 1, 2, plerumque 3 septatis.

Spots orbicular, reddish-brown with narrow fuscous margin, conspicuous, .5–2.5 cm. diam., more or less zonate; pycnidia amphigenous, pallid brownish, thin-walled, ostiolate, subglobose, scattered or gregarious, approx. 125–180 μ diam.; conidia hyaline, obtuse, cylindric, guttulate, (12–)15–20 x (4–)5–6.5 μ, 1, 2, or mostly 3 septate.

On living leaves of *Lactuca biennis*. Wildcat Mountain State Park near Ontario, Vernon County, Wisconsin, U. S. A., August 5, 1959. Earlier, smaller specimens were collected at Parfrey's Glen, Sauk Co., August 24, 1956, and at Gov. Dodge State Park, Iowa Co., July 24, 1957.

SEPTORIA MISSISSIPPIENSIS R. Sprague on *Muhlenbergia tenuiflora*. Grant Co., Wyalusing State Park, September 24. Det. Sprague, who states that the specimen appears somewhat stunted.

SEPTORIA AMPELINA B. & C. on *Vitis riparia*. Dane Co., Madison, July 27; Sauk Co., Ferry Bluff, August 10; Dane Co., near Verona, August 23; Dane Co., near Pine Bluff, August 24. These specimens all correspond closely with No. 1166, issued by the former Division of Vegetable Physiology & Pathology of the U. S. D. A., collected on cultivated grape at Manhattan, Kas. in 1889.

Melasmia samaricola sp. nov.

Maculis nullis; fructificationibus intraepidermidibus, nigris, applanatis, rotundis, plerumque .2–.6 mm. diam., saepe confertis et confluentibus; peridiis exilibus fragilibusque, brevi rumpentibus, acellularibus, punctato-striatulis, fusco-olivaceis; conidiophoris virido-olivaceis, cylindraceis, confertis in ordinibus basilaribus, plerumque simplicibus, ca. 15 x 3 μ, ramosis aliquoties et longioribus nonnihil; conidiis hyalinis, late ellipsoideis, obovoideis, subfusoideis, vel cylindraceis, 7–11 x 2.5–5 μ.

Spots none; fruiting bodies developing intraepidermally, black, applanate, rounded, mostly about .2–.6 mm. diam., frequently crowded and confluent on both surfaces of fruits; peridium very thin and fragile, soon rupturing, acellular, punctate-striatulate, smoky-olivaceous by transmitted light; conidiophores greenish-olivaceous, cylindric, closely compacted in a basal layer mostly simple, about 15 x 3 μ, occasionally branched and then somewhat longer overall; conidia hyaline, broadly ellipsoid, obovoid, subfusoid, or occasionally cylindric, 7–11 x 2.5–5 π.

On still green samaras of *Ulmus carpinifolia* Gleditsch (cult.) University of Wisconsin Campus, Madison, Dane County, Wisconsin, U. S. A., May 19, 1959.

The spores of *Melasmia ulmicola* B. & C., occurring on the leaves of various elms, are much smaller and of the micro bacilliform type. Dr. J. A. Stevenson was kind enough to compare this specimen with others in the National Fungus Collections and he informs me that they have nothing like it, and it appears to be new and hitherto undescribed.

Cylindrosporella conspicua sp. nov.

Maculis magnis et conspicuis, obscuro-brunneis supra, obscuro-purpureis infra, cum acervulis hypophyllis, confertis, sordido-fuscis; acervulis subcuticularibus, elevatis leniter, ca. 150–225 μ diam.; conidiophoris hyalinis, non ramosis, confertis prope, 10–12 x 1.5 μ; conidiis hyalinis, angusto-cylindraceis, subfusoideis, vel allantoideis raro, 5–9 x 1.5–2(–2.5) μ.

Lesions large and conspicuous, dull sordid brownish above, dull purplish on the under surface which is thickly beset with the sordid-fuscous acervuli; acervuli subcuticular, only moderately elevated, approx. 150–225 μ diam.; conidiophores hyaline, simple, closely crowded, 10–12 x 1.5 μ; conidia hyaline, narrow-cylindric, subfusoid, or rarely allantoid, 5–9 x 1.5–2(–2.5) μ.

On living leaves of *Salix glaucophylloides* Fern. (or a variety thereof). On Milwaukee Railroad right-of-way, ¼ mi. N of Swan Lake, Pacific Township, Columbia County, Wisconsin, U. S. A., September 18, 1959.

The lesions usually extend from margin to margin of the relatively wide leaves and frequently involve up to three-fourths of the leaf. The leaf tissue adjacent to the numerous acervuli mostly has a rusty-reddish cast, so that, although the lesion is basically dull purplish, as indicated, it has a reddish overlay.

A less well matured specimen of the same fungus on the same host was briefly described as an undetermined *Gloeosporium* in my Notes XXIV, and was collected in the same general area near Cambria, Columbia Co., September 10, 1957. The generic designation here used follows the treatment of Von Arx in his revision of the fungi assigned to *Gloeosporium*.

COLLETOTRICHUM PYROLAE (Trel.) Parmelee (Can. Jour. Bot. 36: 872. 1958) replaces *Ovularia pyrolae* Trel. for the fungus whose type was collected in 1884 near Stoughton, Dane Co., with subsequent Wisconsin collections at Manitowish, Iron Co., and near Verona, Dane Co. Setae are absent, but Parmelee is following Von Arx's recent treatment, in which species assigned to *Colletotrichum* may have setae or not.

Cercoseptoria andropogonis sp. nov.

Foliis sordido-brunneolis; conidiophoris obsoletis vel fere, hypophyllis; conidiis ex pulvinulis substomatibus flavo-brunneis, ca. 20–25 μ diam.; conidiis hyalinis, flexuosis leniter, attenuatis, indistincte 3–4 septatis, ca. 35–60 x 2–2.5(–3) μ.

Leaves sordid brownish in affected areas which may be extensive; conidiophores obsolete or nearly so, hypophyllous; conidia essentially produced from compact yellow-brown substomatal tubercles about 20–25 μ diam.; conidia hyaline, moderately flexuous, tapered at both ends, indistinctly 3–4 septate, approx. 35–60 x 2–2.5(–3) μ.

On living leaves of *Andropogon scoparius*. Perrot State Park at Trempealeau, Trempealeau County, Wisconsin, U. S. A., June 17, 1959.

Since there is some ambiguity in applying the terms "hypophyllous" and "epiphyllous" to grasses, it should be noted that the infection in this case is on the abaxial side of the leaf. Numerous still attached, more or less mature, conidia are present on the substomatal tubercles and radiate out through the stomata, superficially resembling conidiophores, but there are no scars marking points of attachment of dispersed conidia, geniculations, or other characteristic features of conidiophores.

CURVULARIA SPICATA (Bainier) Boedijn on *Triplasis purpurea*. Iowa Co., near Arena, September 11. Det. R. A. Shoemaker. The fungus is on dead areas, but it seems likely it developed parasitically.

CERCOSPORA PTERIDIS Siemaszko on *Pteridium aquilinum* var. *latiusculum*. Dane Co., near Verona, August 23. This fits Chupp's expanded conception of the species. The yellowish, obclavate conidia, only moderately tapered, are multiseptate, 6–7.5 μ at the base, which is often somewhat constricted and extended, approx. 140–165 μ long. The straight, simple, long-cylindric, rarely once-geniculate conidiophores are fascicled, about 50–65 x 5–6 μ, continuous to 1–2 septate.

CERCOSPORA DEUTZIAE Ell. & Ev. on *Deutzia lemoemoinei* (cult.). Dane Co., Madison, October 19.

Cercospora nyssae-sylvaticae sp. nov.

Maculis circulis vel elongatis nonnihil, 2–5 mm. diam., centris cinereis, marginibus latis comparate, fusco-purpureis; conidiophoris amphigenis, plerumque fasciculatis arcte, stromatibus nullis vel parvis; conidiophoris pallido-brunneis, 1–2 septatis, plerumque geniculatis admodum, raro ramosis supra, ca. 65–100 x 4–5 μ; conidiis hyalinis, angusto-obclavatis vel subacicularibus, multiseptatis, basibus truncatis, cicatricibus prominentibus, (65–)80–165 x 3–4.5 μ.

Spots rounded or somewhat elongate, 2–5 mm. diam., centers cinereous with rather wide dark purplish margins; conidiophores amphigenous, mostly closely fascicled and tufted, stromata lacking or only moderately developed; conidiophores pale brown, once or twice septate, usually markedly geniculate throughout much of their length, rarely branched near apex, approx. 65–100 x 4–5 μ; conidia hyaline, narrowly obclavate to subacicular, long-tapering, multiseptate, base truncate with prominent scar, (65–)80–165 x 3–4.5 μ.

On living leaves of *Nyssa sylvatica* (cult.). University of Wisconsin Arboretum at Madison, Dane County, Wisconsin, U. S. A., October 18, 1959.

The conidial tip is very narrowly tapered, as opposed to subobtuse in *Cercospora nyssae* Tharp, which differs in many other particulars from *C. nyssae-sylvaticae* and is, so far as I have been able to determine, the only other species described on this host.

Some of the conidia present in mounts of this fungus are relatively short and narrowly subcylindric. In line with observations made in previous seasons on other Cercosporae, these short conidia are believed to be due to the retarding effect of a brief period of cold weather which occurred shortly before the collection was made.

CERCOSPORA VIBURNICOLA Ray on *Viburnum carlesii* (cult.). Dane Co., Madison, September 13. Some of the hyaline, acicular conidia measure as much as 170 μ in length. On this host the fungus is mostly, if not entirely, hypophyllous and very difficult to detect among the stellately branched hairs with which the host leaves are thickly beset.

PETRAKIA ECHINATA (Pegl.) Syd. on *Acer saccharinum*. Vernon Co., Wildcat Mt. State Park, September 9. The Wisconsin specimen corresponds closely to European material on *Acer pseudoplatanus*.

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN NO. 43. PRIMULACEAE-PRIMROSE FAMILY

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The following notes and distribution maps of the species of Primulaceae in Wisconsin are based on collections in the herbaria of the Universities of Wisconsin (WIS), Minnesota (MINN), and Iowa, the Milwaukee Public Museum (MIL), the University of Wisconsin–Milwaukee, Beloit College, Eau Claire State College, and Northland College, Ashland. Dots indicate the specific location where a specimen was collected, triangles county records without specific locality. Numbers within the enclosures in the lower left-hand corner of each map represent the specimens used in this study that were flowering or fruiting in respective months. These numbers do not include specimens in bud, very young fruit, or in vegetative condition. While, therefore, a small percentage of collections was not counted, the addition of all the numbers gives a rough, though low, estimate of the amount of herbarium material available for this study. The individual monthly figures indicate when a species is apt to flower or fruit in Wisconsin.

We wish to thank the curators, especially Drs. A. M. Fuller, Milwaukee Public Museum, G. B. Ownbey, University of Minnesota, R. Pohl, Iowa State College, P. J. Salamun, University of Wisconsin–Milwaukee, and F. C. Lane, Northland College, for the loan of their Wisconsin Primulaceae, James D. Ray, Southern Florida University, Tampa, for checking the *Lysimachia* key, H. W. Vogelmann, University of Vermont, for his determination of *Primula,* J. W. Voigt and A. J. Hendricks, Southern Illinois University, for loaning a fine series of the rare *Dodecatheon frenchii,* Mrs. Katharine S. Snell of the University of Wisconsin Herbarium, for meticulous aid in preparation of maps and manuscript, and Jacqueline Patman for the construction of the *Dodecatheon* graph. Many of the field trips and some of the herbarium work were supported by grants from the Research Committee of the University of Wisconsin on funds supplied by the Wisconsin Alumni Research Foundation.

Dodecatheon amethystinum, the Jeweled Shooting Star, on a vertical, north-facing, cool, and moist dolomite cliff in the Scientific Area of Wyalusing State Park, Grant County. With *Cystopteris bulbifera*. May 20, 1960; Photograph by H. H. Iltis.

KEY TO WISCONSIN GENERA OF PRIMULACEAE

[Adapted from Fernald, 1950 (pp. 1136–1143) and Gleason, 1952 (3:34–42)]

A. Leaves forming a *basal rosette*. Flowers in bracteate umbels, white, pink, or purple, borne terminally on a leafless stem.

B. Corolla lobes about 1 mm. long, white, inconspicuous, shorter than the calyx lobes. Delicate, wiry annuals or biennials branching from the base, usually less than 6 cm. tall. -- 1. ANDROSACE

BB. Corolla lobes 4–25 mm. long, showy, white to pink or purple, longer than the calyx lobes. Perennials, with slender to robust solitary scapes, these usually 6–50 cm. tall (sometimes shorter in *Primula*).

C. Corolla salverform, the lobes spreading. Corolla-tube longer than calyx. Calyx lobed, the lobes ascending. Stamens inserted on corolla-tube, included. Leaves usually less than 5 cm. long, shallowly dentate. Rare on cliffs and behind dunes. ------------------------ 2. PRIMULA

CC. Corolla-lobes strongly reflexed from the base. Corolla-tube shorter than calyx. Calyx deeply cleft, reflexed at anthesis. Stamens inserted at the very corolla base, exserted and forming a cone. Leaves usually more than 10 cm. long, usually entire. -------- 3. DODECATHEON

AA. Stems leafy, the leaves various (alternate, opposite or whorled). Flowers racemose, paniculate, or solitary, white, yellow, orange, blue or red.

D. Leaves opposite or whorled (if alternate, plants robust with dense terminal spikes *or* with yellow flowers).

E. Leaves opposite or in *several* whorls.

F. Flowers scarlet-red or blue. Small prostrate weedy annuals with circumscissile capsules and opposite leaves. ------------------------ 4. ANAGALLIS

FF. Flowers yellow or orange-yellow (rarely white). Slender to robust perennial herbs with opposite or whorled, very rarely alternate leaves. ---------------------------- 5. LYSIMACHIA

EE. Leaves in a *single* terminal whorl, the stem with several alternate, minute scale-leaves. Flowers white, 7-merous, on slender peduncles from axils of the whorled leaves. Common, in woods -------- 6. TRIENTALIS

DD. Leaves alternate. Flowers white. Ovary adnate at base to the base of the calyx. Slender herb with *lax ebracteate racemes*. Rare in S. E. Wisconsin. ------- 7. SAMOLUS

1. ANDROSACE, L.

[Robbins, G. T. North American Species of *Androsace*. Am. Midl. Nat. 32:137–163. 1944]

ANDROSACE OCCIDENTALIS Pursh. Map 1

Diminutive annual, usually branched from the base, the umbels supported by conspicuous bracts. Corolla very small, white, included in the calyx.

Locally abundant in very few places, on open sandy hillsides, shores, river terraces, roads, and on sandstone bluffs. On the high and open glacial sand terraces of the Wisconsin River opposite Sauk City, *Androsace occidentalis* is locally abundant together with various other annuals, some of which are likewise rare or local in Wisconsin, such as *Draba reptans, Polanisia dodecandra, Arabis lyrata, Myosotis virginica* and *Plantago purshii.*

Flowering in April and May, and fruiting into June.

2. PRIMULA L. Primrose

PRIMULA MISTASSINICA Michx. Birds-Eye-Primrose Map 2

Small rosette perennials with spatulate, minutely dentate leaves (these rarely yellow-farinose beneath), slender scapes 5–23 cm tall, umbellate inflorescences with 2–15 wheel-shaped, pink flowers, and delicate, elongate cylindrical capsules.

In Wisconsin either on rocky or sandy shores of the Great Lakes, or on cliffs at the Wisconsin Dells and in St. Croix County. This geographic division corresponds to a morphologic-taxonomic separation of the species into two fairly clearly characterized geographic varieties, as interpreted by Dr. H. W. Vogelmann, who has checked all our collections.

Var. *mistassinica:* leaves narrow, relatively thick, oblanceolate-spatulate, pointed, 2–3 (–4) cm long and ca. 0.5–1.0 cm wide; flowers with a conspicuous yellow eye at the corolla mouth.

On open rocky *sandstone* shores, ledges, wet cliffs and cracks in pavement of red sandstone, on the Apostle Island and Squaw Bay, Bayfield Co., both on Lake Superior; and locally abundant on *limestone* pavement, moist sandy ridges, shores, and beaches on Washington Island and at the Ridges Sanctuary at Baileys Harbor, in Door County on Lake Michigan. A collection from the Herbarium of the University of Wisconsin at Milwaukee (duplicate WIS) reports the species from "N. E. Two Rivers, May 16, '84, F. Walsh". This could be near the present Point Beach State Park, Manitowoc County, a well collected area with many rarities. Since the species has not been collected there (excepting the above record), a careful search for it should be made.

Flowering from May 16 to June 16 on Lake Michigan and in late June and early July on Lake Superior; fruiting from late July to late September.

Var. *noveboracensis* Fern.: leaves thinner than those of the typical variety, oblanceolate to obovate-spatulate, generally rounded at the apex, 2–5 cm wide; flowers (*fide* Fernald) supposedly without the central yellow "eye" (though many of the Wisconsin specimens do not seem to differ in this respect from the typical variety!).

At the Wisconsin Dells on cool, moist, vertical, sandstone cliffs, fissures, and ledges above or near the waters of the Wisconsin River, at the Pines Hotel, the mouth of Coldwater Canyon and on Blackhawk Island (there with *Asplenium trichomanes, Sullivantia renifolia, Campanula rotundifolia, Dryopteris disjuncta, D. phegopteris,* and *Cheilanthes feei*), as well as on damp or wet sandstone cliffs and ledges near the Boy Scout Camp below Houlton and near Somerset, both along the St. Croix River, St. Croix County.

Flowering from April 21 to June 2 and fruiting from late July to the end of August.

Though locally abundant, *Primula* is a plant whose rarity in most of Wisconsin is no doubt due to the great scarcity of cool, rather moist cliff habitats, where competition from other plants is low. Many of our rarest plants, with similar relic distributions and arctic or boreal affinities, are cliff plants also and several of their classic stations more or less coincide with those of *Primula.* Thus *Asplenium viride* occurs on Washington Island, *Pinguicula vulgaris* on the Apostle Islands, *Rhododendron lapponicum* at the Wisconsin Dells, and *Arenaria dawsonensis* on cliffs along the St. Croix River near Houlton. Farther north, in Door County, Wisconsin or in upper Michigan (Manistique), *Primula* is not quite so specific as to its habitat and may grow in sandy, moist, grassy depressions (swales) behind the dunes, as well as on limestone pavements. The only stations of *Primula* south of the Wisconsin Dells are in Apple River Canyon of northwestern Illinois' Driftless Area, whose vertical "Primrose Rocks" have been described so beautifully by Pepoon (1917), and in Central Iowa, on rocks at Iowa Falls, Hardin County (*fide* Robt. Davidson).

Though Dr. Vogelmann assures us that the two varieties remain distinct in the greenhouse, it seems to us that the thinner, larger leaves and more slender pedicels of var. *noveboracensis* are due, in part at least, to the cooler, more shady and less extreme environments of the shady cliffs, as compared to that of the more exposed shores of the Great Lakes. In Door County populations there are occasional specimens that in most every way agree with some from the Wisconsin Dells, while among the very variable Wisconsin Dells collections there are a few that are very close to those typical of the Great Lakes shores.

In both varieties pale-flowered forms have been found (at Bailey's Harbor, Door Co., and at the Wisconsin Dells). Dr. Vogelmann writes that the typical forma *leucantha* Fernald comes from Gaspe and Newfoundland and is rather different from the white-flowered Wisconsin collections, which to him seem just pale-flowered forms of otherwise typical plants.

3. DODECATHEON L. American Cowslip: Shooting Star.

[Fassett, N. C. *Dodecatheon* in Eastern North America. Am. Midl. Nat. 31:455–486. 1944; Thompson, Henry J. The Biosystematics of *Dodecatheon*. Contr. Dudley Herb. 4:73–154. 1953.]

Glabrous perennials with solitary scapes from a cluster of basal leaves, the showy nodding flowers with reflexed petals and a cone of strongly exserted stamens; fruits stiffly-erect, valvate, cylindric capsules. (The following key adapted from Fassett, *loc. cit.* p. 458. 1944).

A. Capsule stout, cylindrical but often ovoid, mostly less than three times as long as broad, dark reddish brown, with walls of firm, rather woody texture 130–325 microns thick, rarely splitting to the base; living flowers with corolla lobes ranging from lilac to white with many pale intermediates; leaves marked with red at base even in pressed specimens. Calyx-lobes on expanding flowers 3–7 mm (mostly 4–5 mm) long, and on fruits 4–9 mm (mostly 5.5–7.0 mm) long; anthers 6.5–10.0 mm (mostly 7–8 mm) long; capsules 10.5–18.0 mm long; flowers 4–125 on each inflorescence. Prairies and open woods in Southern Wisconsin ______________ 1. *D. meadia*

AA. Capsule cylindrical-oblongoid, mostly more than three times as long as broad, light brown to reddish brown or yellowish, with thin walls often of almost papery texture 35–120 microns thick, these rather easily bent inward with prossure from a pencil, often splitting to the base; living flowers with corolla lobes pink or deep wine- or rose-purple, or very rarely white, but only rarely with a series of intermediates; leaves rarely marked with red in living plants and without red markings in pressed specimens; calyx-lobes about ⅓ as long as the corolla (measuring each from the base of the calyx lobes) 2–5 mm (mostly 3 mm) long on expanding flowers, and on fruits 3–6 mm (mostly 4–5 mm) long; anthers 5.0–7.5 mm long; capsules 8–14 (–16) mm long; flowers 2–10 (–24) on each inflorescence. Cliffs and bluffs along the Mississippi River ________________________________ 2. *D. amethystinum*

1. DODECATHEON MEADIA L. SSP. MEADIA[1] Shooting Star Map 3

Widespread and once common in moist, mesic, and dry "high lime" prairies (Curtis and Greene 1949:86), as well as in open

[1] *Dodecatheon frenchii* (Vasey) Rydb. (*Dodecatheon meadia* L. var. *frenchii* Vasey; *D. meadia* L. ssp. *membranaceum* Knuth), French's Shooting Star, was reported for Wisconsin by Fassett (1927; 1944) Thompson (1953), and Channell and Wood (1959: 278), on the basis of two collections (both at WIS): "Crawford Co. June 27,

deciduous woods and "oak openings", or on moist to dry bluffs or sandstone cliffs, either wooded or open, now frequently collected from prairie relics along railroads. Flowering from early May through June.

2. DODECATHEON AMETHYSTINUM[2] (Fassett) Fassett, Rhodora 33: 224. 1931. Jewelled Shooting Star Map 4, 5

Dodecatheon meadia L. var. *amethystinum* Fassett, Rhodora 31:52. 1929.

[Type: Lightly wooded bluff, Prairie du Chien, Crawford Co., Wis., *Fassett 7548* (WIS)]

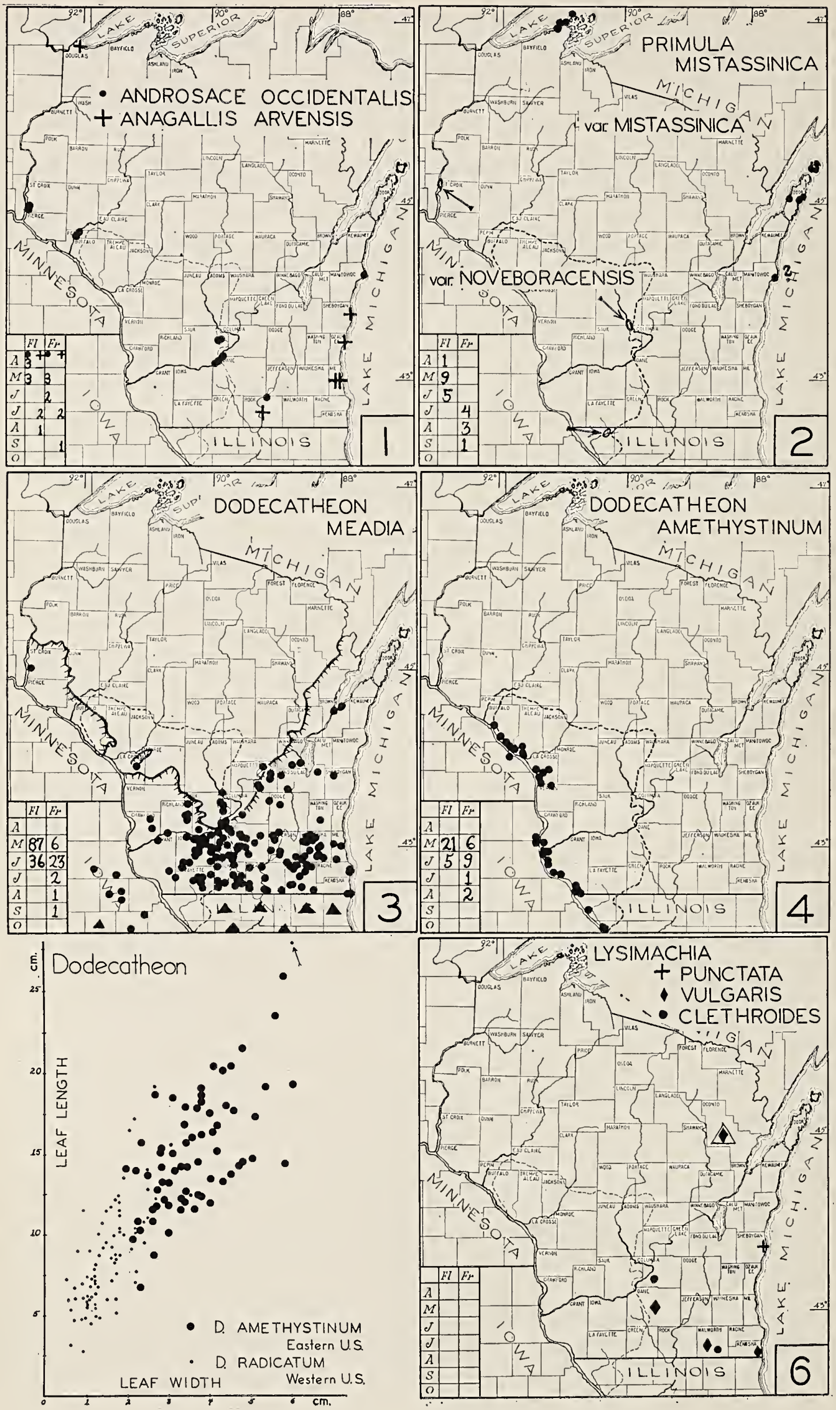
A. Corolla-lobes pale pink to deep red-purple
______________________ *D. amethystinum* f. *amethystinum*

AA. Corolla-lobes white ______ *D. amethystinum* f. *margaritaceum*

1895, W. R. Schuman" and "Milwaukee, I. A. Lapham". These two collections are clearly collections of typical *D. meadia,* even if a little broader-leaved and more abruptly narrowed than usual. Dr. Voigt, who knows *D. frenchii* better than anyone else (cf. Voigt and Swayne, 1955), shares this opinion. Fassett, like some other botanists of that period, was apparently misled through "phytogeographic suggestion" by Fernald's Nunatack Hypothesis and its application to the Driftless Area and by the fact that a number of other species of rocky habitats (e.g. *Saxifraga forbesii*), which, like *D. frenchii,* occur in a very narrow belt in Southern Illinois, do indeed occur disjunctly in the "Driftless Area" of Wisconsin. A very similar error, made by Hopkins (1937: 116, 122) for a species of *Arabis,* was later corrected by Rollins (1941: 325).

After viewing the fine series of *D. frenchii* specimens loaned us by Southern Illinois University through the courtesy of Dr. Voigt, we share Dr. Voigt's opinion that this taxon, which is restricted to the Salem Hills of Southern Illinois and a few local areas in Kentucky is indeed a distinct species. Despite its pale flowers, it seems in many ways to have closer affinity to the *D. amethystinum-D. pulchellum* (*D. radicatum*) group rather than to *D. meadia.* Such a relationship is suggested by the general preference for moist, rocky habitat, its geographic distribution just south of the glacial boundary, the more delicate habit, the few-flowered inflorescences, the much thinner capsules (!) and the very great similarity in general appearance, of pressed specimens at least, to those of *D. amethystinum.* In fruit *shape* and sepal length it resembles more *D. meadia.* Nevertheless, *D. frenchii* may represent a population which, like *D. amethystinum,* migrated east from the western mountains under more favorable (i.e. glacial?) conditions and has since become isolated and restricted to local and specialized habitats. Despite the large amount of work published on *Dodecatheon* of the Eastern United States, it is clear that these taxa are as yet not well understood. Cytogenetic and geographic-ecologic work is badly needed here.

[2] Thompson (1953), without comment, reduced *D. amethystinum* to synonymy under *D. radicatum* Greene, a widespread and polymorphic western species, whose correct name according to more recent treatments appears to be either *D. pauciflorum* Greene or *D. pulchellum* (Raf.) Merr. However, while *D. amethystinum* and the western taxon are no doubt closely related and several of the western plants in the Wisconsin herbarium have leaves as large as those of *D. amethystinum,* the latter has on the average much longer, broader, and more toothed leaves (see graph 5 next to map 4) as well as longer pedicels and peduncles. In addition to quantitative morphological differences, ecological ones exist as well, the western plants more generally preferring damp or wet, alpine, subalpine, or montane meadows. *D. amethystinum* appears to be an ecotype adapted to considerably more shade as well as to a more moderate climate. In the western species independently evolved "homologous ecotypes" paralleling *D. amethystinum* appear to occur rather rarely and then only in specially favorable habitats. It seems clear that on ecological and morphological, as well as geographic grounds the eastern population of this complex should be segregated from the western population with at least subspecific rank. In the present treatment the taxon is recognized as a full species, awaiting its reduction to a geographic subspecies until the nomenclatorial confusion in the western group has been resolved.


• ANDROSACE OCCIDENTALIS
+ ANAGALLIS ARVENSIS
1
PRIMULA
MISTASSINICA
var. MISTASSINICA
var. NOVEBORACENSIS
Fl Fr
A 1
M 9
J 5
J 4
A 3
S 1
2
DODECATHEON
MEADIA
Fl Fr
M 87 6
J 36 23
J 2
A 1
S 1
3
DODECATHEON
AMETHYSTINUM
Fl Fr
M 21 6
J 5 9
J 1
A 2
4
Dodecatheon
LEAF LENGTH
cm.
LEAF WIDTH
cm.
• D. AMETHYSTINUM
Eastern U.S.
· D. RADICATUM
Western U.S.
LYSIMACHIA
+ PUNCTATA
♦ VULGARIS
• CLETHROIDES
6
LAKE SUPERIOR
MICHIGAN
LAKE MICHIGAN
MINNESOTA
IOWA
ILLINOIS

D. A. f. *amethystinum.* Restricted to the cliffs and high bluffs along or near the Mississippi River,[3] from northernmost Illinois north to Buffalo County; most frequently on mossy damp rock outcrops or earth slopes in cool woods on north-facing bluffs or in deep ravines, on cliffs of Ordovician limestone (or sandstone?), on the edge of open woods, on top of steep bluffs, and sometimes on the edge of, or on, small upland prairies. In the "East Wilderness Scientific Area" of Wyalusing State Park, Grant Co., it grows on the face of vertical, damp, north-facing cliffs, at the very base of the cliff on mossy talus, on drier east-facing cliffs, and on the high and rather dry sunny crests of the limestone outcrop, there in or at the edge of open woods. Flowering from early May to early June, preceding *D. meadia* by about two to three weeks.

D. A. f *margaritaceum* Fassett, in Am. Midl. Nat. 31:475. 1944.

[Type: Wooded, north-facing bluff, McCartney, Grant Co., Wisc., *Fassett 10313* (WIS)]

This is a rare white-flowered form.

Dodecatheon amethystinum is one of the most interesting as well as beautiful species of the Wisconsin flora. Its distribution is restricted to the unglaciated "Driftless Area" of Wisconsin and adjoining Illinois, Iowa, and Minnesota (indicated by a dash line on map 4) and to a few unglaciated river bluffs in Missouri, central Pennsylvania, and West Virginia. This highly disjunct distribution, as well as the association of the species with unglaciated habitats, suggests that in pre- or inter-glacial times it was more widespread and that the present relic range is a consequence of the glacial ice destroying plants as well as suitable habitat. A related and equally feasible hypothesis might be advanced in favor of a post-glacial eastward migration of a western montane species in the "open" habitat along the retreating icesheet margin. *D. radicatum* is the possible montane original species which subsequently underwent slight morphological evolution. Whether a pre-glacial relic or a post-glacial immigrant, its present range seems to be in either case determined by the availability of cool cliff habitats, habitats which are all but absent in the glaciated territory. A good photograph of this plant in the "wild", in a typical mossy "rock garden", was published by Wherry (1943).

In studying the Wisconsin distribution of both *D. media* and *D. amethystinum* one notes that their ranges do not overlap in any

[3] A specimen in the University of Oklahoma Herbarium (photo WIS), labelled as coming from "near Lancaster (Grant Co.) Wisc., Ann Fishman, June 6, 1935," is the only collection of this species "inland" from the Mississippi River Valley. It has not been mapped by us, since no other collections of the speces are known from this otherwise well-collected area, and since to a non-botanist "near Lancaster" could well mean the Mississippi Bluffs only about 18 miles away.

way; the former is completely lacking from immediate vicinity of the Mississippi River, the latter is restricted to it. While the ecology of the two species differs (as do the flowering dates), there would seem to be abundant habitats for *D. meadia* in the prairie on top of the Mississippi River bluffs. The absence of this species there, as well as the total restriction of *D. amethystinum* to the immediate vicinity of the river, is a mystery. Both Drs. J. T. Curtis and J. A. Steyermark have informed us that *D. amethystinum* grows and even seeds well under garden cultivation. Seedlings are commonly found under natural conditions beneath cliffs in bare rocky soils.

One factor limiting the distribution of *D. amethystinum* in Wisconsin may well be lack of continuous springtime moisture in all but the massive cliffs along the Mississippi River. It was observed on a Plant Geography class field trip to the Wyalusing State Park "East Wilderness Scientific Area" that the plants on strictly north-facing, very shady cliffs with seepage were in full bloom and had fresh rosettes, while in an adjoining side valley, on a more exposed east-facing cliff which lacked seepage, nearly all plants were badly wilted or had dead, brittle leaves (this was in the particularly dry spring of 1958). Should the habitat dry out during the summer, the plants go into dormancy. This was observed in Horsethief Hollow, south of McCartney, in late July. Here in the shadiest dry portions only the dried-up fruiting scapes were visible, while on the very top bevel of the cliff, in a still green, sunny prairie patch, the rosettes were fresh, though beginning to yellow. The few colonies from somewhat inland, as on a "goat" prairie at Coon Valley, or on the bluffs above Tamarack Creek Bog, are found on somewhat drier habitats, and may be ephemeral colonies whose seed source was the Mississippi River bluffs.

At Wyalusing State Park, as well as elsewhere, *D. amethystinum* seems to be restricted to the Lower Magnesian and the Galena Dolomites, both of Ordovician age, and seems to be completely lacking from the intervening thick layers of St. Peter sandstone. The shallow soil of ledges and crevices in which this species grows is generally rich in organic material, and has a slightly acidulous reaction, with a pH[4] of 6.3, 6.4, 6.8, or 6.9. Dolomite immediately underneath this soil had a pH of 8.2 to 8.65. Only one plant, growing in nearly pure rock chips at the very base of an overarching cliff, was found in alkaline "soil", with a pH of 7.4. *Dodecatheon meadia* was found NW of Middleton, Dane County, on dry, mesic, and moist prairies, with soil pH of 5.7–7.0, 6.8–7.0, and 7.0–7.3, respectively. In the case of the dry prairies, it is frequently found in shallow soils underlain by dolomite.

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[4] For the pH readings (Beckman pH meter) we are indebted to Dr. Grant Cottam.

While a very large number of typical prairie species are regularly associated with *D. meadia, D. amethystinum* has in many instances more specific and rarer associates, especially when growing on cliffs. Thus, in the Scientific Area at Wyalusing State Park, on one high mossy cliff it grew side by side with *Camptosorus rhizophyllus,* and the Driftless Area endemic *Solidago sciaphila,* while in the crevices of a vertical, moist cliff near the base of the bluff *Cystopteris fragilis, C. bulbifera, Mitella diphylla, Ribes missouriensis,* and *Smilacina racemosa,* as well as *Sullivantia renifolia* and *Solidago sciaphila,* were its associates. On the other hand, on a steep rocky slope near the very top of the bluff, at the eastern-most end of the Scientific Area, shaded by Sugar Maple, Basswood, and Paper-birch, hundreds of the Jewelled Shooting Stars grew intermixed with a wide array of common and widespread species, including *Hepatica acutiloba, Aquilegia canadensis, Solidago flexicaulis, Mitella diphylla, Aster cordifolius, Cystopteris bulbifera, Aralia nudicaulis, Polygonatum canaliculatum, Claytonia virginica,* and *Parthenocissus vitacea.* Certainly, similar habitants with nearly identical plants are common in many parts of the Driftless Area as well as other parts of Wisconsin, yet these are without *D. amethystinum.*

5. LYSIMACHIA L. (Including *Steironema* Raf.) Loosestrife.

[Ray, J. D. The genus *Lysimachia* in the New World. Illinois Biological Monographs 24:1–160. *pl. 1–20.* 1956.]

Leafy-stemmed perennials, with opposite or whorled, rarely alternate leaves, and 5-merous, yellow or orange-yellow, rarely white flowers in racemes, panicles, or singly in the axils of leaves.

A. Flowers or fruits borne singly in the axils of leaves, the plants often appearing paniculate because of the short floriferous upper branches and reduced upper leaves; corolla lobes (except in No. 3) over 10 mm long.

B. Plants evergreen with round leaves and creeping stems. -- 7. *L. nummularia.*

BB. Plants not evergreen, with elongate leaves and erect stems.

C. Leaves villous, punctate; robust introduced herbs with large yellow flowers and whorled or opposite middle leaves ---------------- 2. *L. punctata.* (See also No. 1)

CC. Leaves glabrous (or sparingly pubescent beneath in No. 3); plants native.

D. Middle leaves linear, rather firm, with revolute margins, the lateral veins not evident; plants usually of low alkaline prairies ------------------------ 12. *L. quadriflora.*

DD. Middle leaves elliptic to ovate, rather thin, with flat margins, the lateral veins evident.

E. Middle leaves whorled, (3–)4–5(–7) at a node, or rarely alternate; corolla lobes 6 mm or less long; -------------------------------- 3. *L. quadrifolia.*

EE. Middle leaves opposite; corolla lobes generally over 8 mm. long.

F. Median leaves ovate to ovate-lanceolate, 3–6 cm broad; petioles long-ciliate to the broad, obtuse to subcordate leafblade base ---------- 9. *L. ciliata.*

FF. Median leaves narrowly lanceolate, generally less than 3 cm wide; leafblade base cunneate, attenuate to obtuse.

G. Stems slender, usually (1–)2–4 mm in diameter at base, with slender rhizomes; basal leaves persistent; medial leaves sessile or subsessile; *blades* bristly ciliate at base; petioles none; leaves linear to elliptic (rarely lanceolate to oblanceolate), green above and pale below; generally of dry habitats, often in prairies or open woods -------------------- 11. *L. lanceolata.*

GG. Stems stout, (3–)4–6 mm in diameter at base, without rhizomes; basal leaves not persistent; medial leaves petiolate; *petioles* ciliate at base, only sparingly so to blade; leaves linear to lanceolate, green above and below; plants of moist habitats, often along rivers and lakes ---------------------------- 10. *L. hybrida.*

AA. Flowers or fruits in racemes or panicles, (occasional solitary axillary flowers may also be noted) the corolla lobes (except No. 1) less than 6 mm long.

H. Calyx lobes dark-glandular margined. Robust herbs with corolla lobes 10 mm or more long --------------------- 1. *L. vulgaris.* (see also No. 2)

HH. Calyx lobes not dark-glandular margined.

I. Flowers yellow.

J. Inflorescences 1 to 10, pedunculate, very dense, head-like racemes borne in the axils of the middle leaves -------------------------------- 8. *L. thyrsiflora.*

JJ. Inflorescence usually a single terminal raceme, often with subtending solitary and axillary flowers or rarely with 1–2 smaller lateral racemes subtending the main terminal one.

K. Plants exhibiting a transition from that of solitary and axillary flowers below to an elongated open raceme above ---------- 4. X *L. producta*

KK. Plants with a dense terminal raceme with very small bracts; leaves lanceolate to elliptic; inflorescence glabrate; corolla orange yellow ------------------------------ 5. *L. terrestris.*

II. Flowers white; plants with a terminal spike-like raceme and alternate leaves, rare adventive-- 6. *L. clethroides.*

Sect. LYSIMASTRUM Duby

1. LYSIMACHIA VULGARIS L. Common Garden Loosestrife Map 6

Robust perennial to 1 m tall, with ovate-lanceolate, subsessile leaves, 3–4 whorled at a node or leaves sometimes alternate or opposite; flowers showy, yellow, in leafy panicles or whorled in the uppermost axils of leaves. Calyx-lobes dark-margined, 5 mm long.

Introduced as a garden plant from Europe and occasionally escaped, as along the railroad in East Madison, an extensive colony on a meadow 3 mi. SW from Kenosha, and sporadically elsewhere.

2. LYSIMACHIA PUNCTATA L. Garden Loosestrife Map 6

Similar to the above, but with short-petioled leaves, more elongate inflorescences, flowers in a succession of whorls, and with longer, linear calyx lobes that are green throughout.

Occasionally planted and probably only very rarely, if ever, escaped. *Goessl s.n.* 1904, (WIS), from Sheboygan, is the only collection and may have originated in his garden.

3. LYSIMACHIA CLETHROIDES DUBY Map 6

Tall pubescent herb with alternate, lance-elliptic, punctate leaves; racemes elongate, dense, pointed and resembling those of *L. terrestris,* but with smaller, *white* flowers.

The two Wisconsin collections (WIS), one from near Poynette and the other from a large colony near the Yerkes Observatory at Williams Bay, represent naturalized garden escapes. Native to China and Japan.

Sect. NUMMULARIA (Gilib.) Endl.

4. LYSIMACHIA NUMMULARIA L. Moneywort. Map 7

Low, creeping, glabrous perennial herb with opposite, orbicular to broadly elliptic leaves 1–2 cm in diam., and large, yellow, solitary, long-pedicelled flowers.

Locally abundant in the southern half of Wisconsin, in low damp ground, along the major streams, in alluvial bottomland woods, in thickets, marshes, mudflats, stream banks, pastures, and in disturbed, moist weedy areas.

Flowering from late June to mid-July.

Introduced from Europe, where it has been cultivated, sometimes in "hanging gardens" and as a cover plant in shady places.

5. Lysimachia quadrifolia L. Whorled Loosestrife. Map 8

Erect, unbranched stoloniferous herbs 2–7 dm tall; leaves lanceolate to lance-ovate, subsessile, punctate, whorled with (3–) 4–5 (–7) at a node (very rarely alternate); flowers rich orange-yellow, on very slender pedicels one-half to two-thirds the length of the leaves, borne singly in the axils of the 3 to 7 uppermost leaf-whorls.

Throughout most of Wisconsin, but nearly completely lacking on the limestones of the eastern third and southwestern corner, usually in wooded or semi-wooded acidulous, mesic to moist, frequently sandy or rocky habitats (quartzite, granite, sandstone): in woods of oak, oak-hickory, Black Oak-Sugar Maple, pine woods with Birch, Aspen or Poplar, Basswood-Maple-Paperbirch, less frequently in sandy or moist prairies, edges of bogs, on beaver dams (!), in open, poorly drained river-bottom woods, or along sandy roadsides.

Flowering from early June to the end of July and fruiting from mid-July into mid-September.

The mesophytic *L. quadrifolia* hybridizes with the hydrophytic *L. terristris* to form X *L. products* (No. 6, which see).

6. X Lysimachia producta Fern. Hybrid Loosestrife.
Map 9, arrows

Lysimachia terrestris (L.) B.S.P. X *L. quadrifolia L.*

Resembling plants of *L. terrestris,* but with much more open and elongate terminal racemes, longer pedicels (13–22 mm) and longer bracts (1–2 cm), which grade imperceptibly into the foliage leaves, and with the lowest flowers borne in the axils of full-sized leaves.

Rare in Wisconsin, known so far from only four collections, all from the Wisconsin River Valley, and all but one from the vicinity of the Wisconsin Dells, where both parental species are common: Adams Co.: Near Elephant Back, n. of the Dells, *Orport* 5 (ILL-cited by Ray *l.c.* p. 76); Juneau Co.: Wet sand near marsh by Highway 12–13 bridge, Lyndon Station, *Zimmerman 3154* (WIS); Oneida Co.: Newbold, *Cheney 1572* (WIS)—mounted with 3 normal plants of *L. quadrifolia;* Sauk Co.: Sauk City, *T. J. Hale* s.n. (WIS)—mounted with a normal plant of *L. terrestris.*

7. LYSIMACHIA TERRESTRIS (L.) B.S.P. Swamp Loosetrife; Swamp Candles. Map 9

Strict herbs 25–75 cm tall; leaves opposite or rarely alternate, narrowly elliptic-lanceolate, strongly ascending (or elliptic and divergent in shade forms), punctate, the lowest scale-like; elongate jointed reddish-brown bulbets occasionally conspicuous in the leaf axils; inflorescence of unbranched plants a single terminal, many-flowered, elongate and open raceme of orange-yellow short-pedicelled flowers, as many as 10 racemes on a branched plant, occasionally 1 or 2 small lateral racemes at the base of the terminal raceme (see below under X *L. conmixta* Fern.).

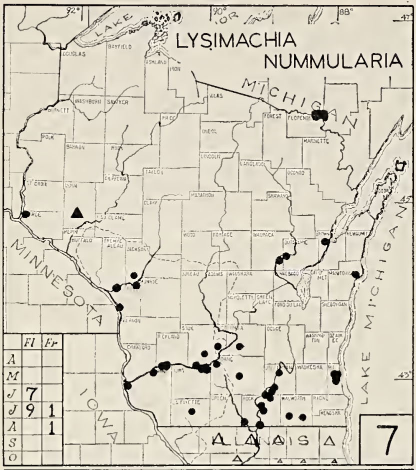
In open wet (acidulous?) habitats throughout most of Wisconsin, lacking in most of the well-drained Driftless Area and (excepting stations on Lake Michigan) from the area underlain by Niagara Dolomite; in muddy or sandy lake-shores, marshes, low wet prairies, sedge meadows, tamarack swamps, cranberry and leatherleaf sphagnum bogs, roadside ditches, and rarely along rivers or in woods. Flowering from mid-June to early September and fruiting from late July to October.

The species is variable in Wisconsin in regards to leaf width and amount of divergence of leaves, the ones collected in woods having more broadly elliptic, and more divergent leaves.

X LYSIMACHIA CONMIXTA Fern. (L. *terrestris* (L). B.S.P. X *L. thyrsiflora* L.) in Wisconsin?

In about 15% of the Wisconsin *Lysimachia terrestris* collections we find one or two small, lateral, pedunculate racemes at the very base of the terminal raceme. These lateral racemes do not differ from the terminal one except by their generally smaller size and that of the flowers and pedicels. Nearly identical specimens from other states (e.g. *Gleason 9736* from Michigan) have been considered by Ray (*loc. cit.*) as hybrids between *L. terrestris* and *L. thyrsiflora,* under the name of *L. conmixta.* With one or two exceptions we do not believe these Wisconsin plants or many of those cited by Ray to be hybrids.

Firstly, *these plants,* except for the extra inflorescence, *do not deviate in any apparent morphological way from typical single-racemed plants of L. terrestris.* Secondly, a tendency for lateral, secondary inflorescences seems to be inherent in other racemose-flowered *Lysimachias.* Thus, in *L. thyrsiflora,* it is relatively common to find axillary racemes with small subsidiary lateral racemes at or near their bases (a condition not mentioned by Fernald, Gleason or Ray, though occurring in ca. 20% of all Wisconsin collections!). As far as these "abnormal" or "hybrid" plants of *L. terrestris* are concerned, they seem to us, therefore, simply plants that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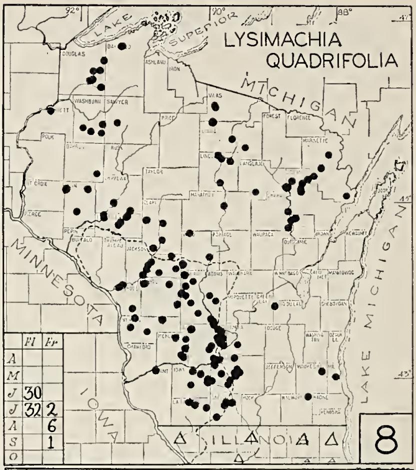
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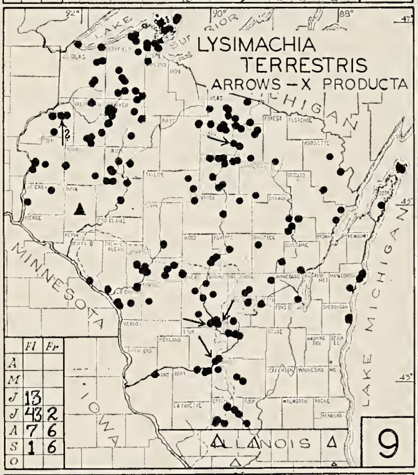
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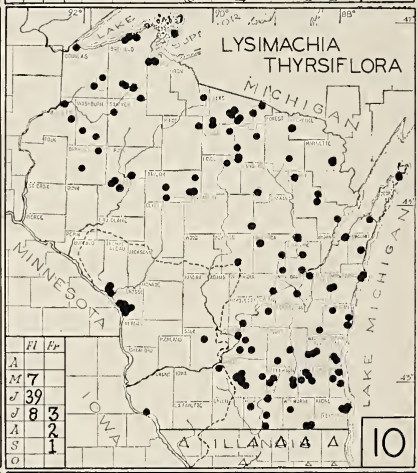
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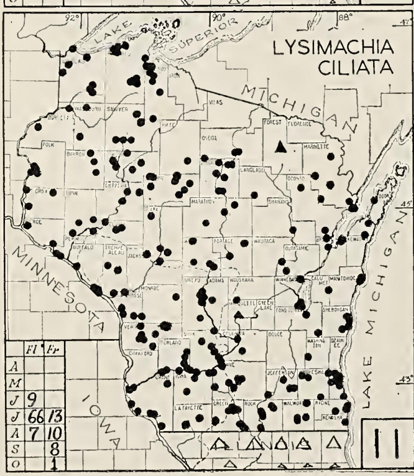
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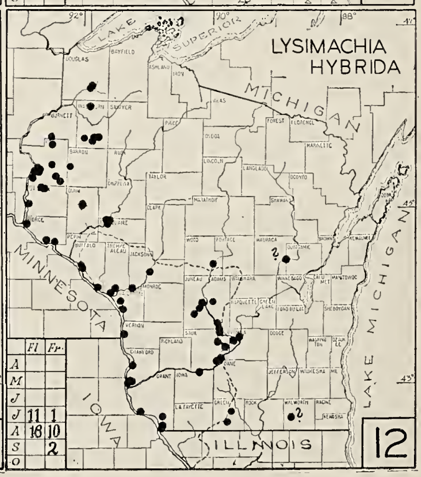
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have an extra lateral inflorenscence or two, a condition which we suppose to be within the normal variational amplitude of *L. terrestris.*

Of the two Wisconsin plants cited by Ray as *L. conmixta* (both collected by Schallert and deposited in the Duke University Herbarium), one (*#765*), though slightly abnormal, is clearly *L. thyrsiflora.* Its seemingly "terminal" inflorescence is actually a lateral one, which, due to an old amputation of the main plant axis (by a cow?) was nutritionally favored and subsequently increased in length to becoming "terminal" in position. The second specimen (*#74*), with lateral inflorescences much like those of *L. thyrsiflora* and a terminal one much like certain short-pedicelled forms of *L. terrestris,* is intermediate enough to be considered a hybrid. Though even here a word of caution, for *Hansen s.n.* (Rock Co., WIS), has a short, bifid, *terminal* inflorescence, yet is in every other way clearly *L. thryrsiflora.*

It is deplorable that there is not one clear description of a putative hybrid plant. Fernald, who discussed this hybrid in 1910 and twice in 1950, had hardly anything to say beyond that it was "intermediate" between the parents, while Ray, who followed Fernald, evidently increased the concept of this "hybrid" to include, in addition to intermediate plants, slightly abnormal plants of both species as well, so that his description is too inclusive to be meaningful. Despite questioning Ray in his interpretation of this hybrid, we do not deny that the great variability of *L. terrestris* in raceme and pedicel length, raceme density, and petal width may be indeed due to introgression with *L. thyrsiflora,* though detailed studies on this have never been made, or that perfectly good hybrid populations exist in New England and Guebec. Fernald (1950:201) was certainly right when he suggested the study of this hybrid as "an alluring problem for some of the very modern students of evolution".

Sect. NAUMBERGIA (Moench) Duby

8. LYSIMACHIA THYRSIFLORA L. Tufted Loosestrife. Map 10

Naumbergia thyrsiflora (L.) Reichenb.

Stems erect, 25–80 cm tall, thick and spongy at base, with long, thick rhizomes; leaves opposite, narrowly to broadly elliptic, pointed at both ends and sessile, punctate, the middle ones bearing 1 to 10 short-peduncled, very dense, spike-like racemes, 1–4 cm long, of small, cream-yellow to deep yellow flowers; stamens long-exerted; corrolla lobes narrow, black-dotted when dry.

Throughout most of the glaciated areas, in wet woods, marshes, bogs and swamps, and lake and river shores; e.g., in Black Spruce or Tamarack (*Larix*) bogs, often with Poison Sumach (*Rhus* *vernix*), *Sphagnum-Ericaceae* bogs, "quaking" sedge mats (with *Drosera rotundifolia, Chamaedaphne, Sarracenia purpurea, Arethusa,* etc.,—Oconto Co.), sedge meadows, Willow-Alder swamps and thickets, wet woods with Aspen, Paper Birch, Red Maple, Basswood and Hemlock (*Tsuga*), wet lowland Black Ash-Thuja-elm-yellow birch woods, in shallow water along lakes and streams, in Cattail marshes and around cold springs, rare in southern flood-plain forests (Grant Co.) and in the Driftless Area, excepting a few bogs and spring holes in the La Crosse region (cf. Hansen, 1933).

Flowering from (early) late May to late July and fruiting from late June to late August.

A very distinct species that may hybridize with *L. terrestris* to form X *L. conmixta* (see note under *L. terrestris*).

Sect. STEIRONEMA (Raf.) Gray

9. LYSIMACHIA CILIATA L. Fringed Loosestrife. Map 11

Steironema ciliatum (L.) Baudo

Tall, much branched, often robust herbs with slender rhizomes, to 1 m tall; leaves ovate-lanceolate, 3–6 cm broad, obtuse to sub-cordate at base, with elongate, pronouncedly long-ciliate fringed petioles; corolla 2–3 cm in diam., the lobes fringed; seeds 1.9–2.2 mm long (*fide* Ray).

Very common throughout (excepting about six of the northern-most counties), in a great variety of moist or wet, open or shady habitats of both upland and lowland forests, especially in flood-plain forest, along streams, rivers and lakes, in Aspen-Birch low-lands, Tamarack bogs, marshes, damp meadows and low prairies.

Flowering from late June into early August, and fruiting from end of July to October.

10. LYSIMACHIA HYBRIDA Michx. Map 12

Steironema hybrida (Michx.) Raf.

Steironema lanceolatum (Walt.) Gray var. *hybridum* (Michx.) Gray

Lysimachia lanceolata Walt. ssp. *hybrida* (Michx.) Ray

Rather robust herbs (35–) 40–80 (–105) cm tall, with subsessile basal offshoots or autumnal rosettes (no *rhizomes!*); basal leaves *not* persistent; stems (3–) 4–6 mm in diam. near base, unbranched or more usually with many elongate lateral branches from all but the lowest nodes forming an open paniculate inflorescence, the branches usually much longer than the subtending leaves; leaves longest near base of plant, more or less abruptly contracted to a ciliate petiole; seeds 1.2–1.8 mm long (*fide* Ray).

Mostly in the Wisconsin and Mississippi River valleys, and in the latter's tributaries, and in the NW. Wisconsin lake region; in seasonally very wet herb communities, on wooded or open, often sandy margins of rivers, streams, ditches, sloughs, swales, ponds, lakes, mud flats, marshes, and wet, muddy soil of dried-up temporary pools along the Wisconsin River, etc.

Flowering from the middle or end of July to the end of August, and fruiting from the beginning of August through September.

According to Deam (Fl. of Indiana, p. 749) the plant starts its yearly growth under water, hence the lowest leaves decompose and disappear. In Wisconsin, it is easily distinguished from *L. lanceolata* to which it has been reduced as a subspecies by Ray. The only difficulties are encountered in plants whose tops have been eaten by animals and whose smaller lateral shoots mimic plants of *L. lanceolata.* If in fruit, *L. hybrida* may be told by the smaller seeds. It flowers about 3 weeks after *L. lanceolata.* The two species never grow together (excepting a collection of each from "Witches Gulch", Wisconsin Dells?).

11. Lysimachia lanceolata Walt. Map 13

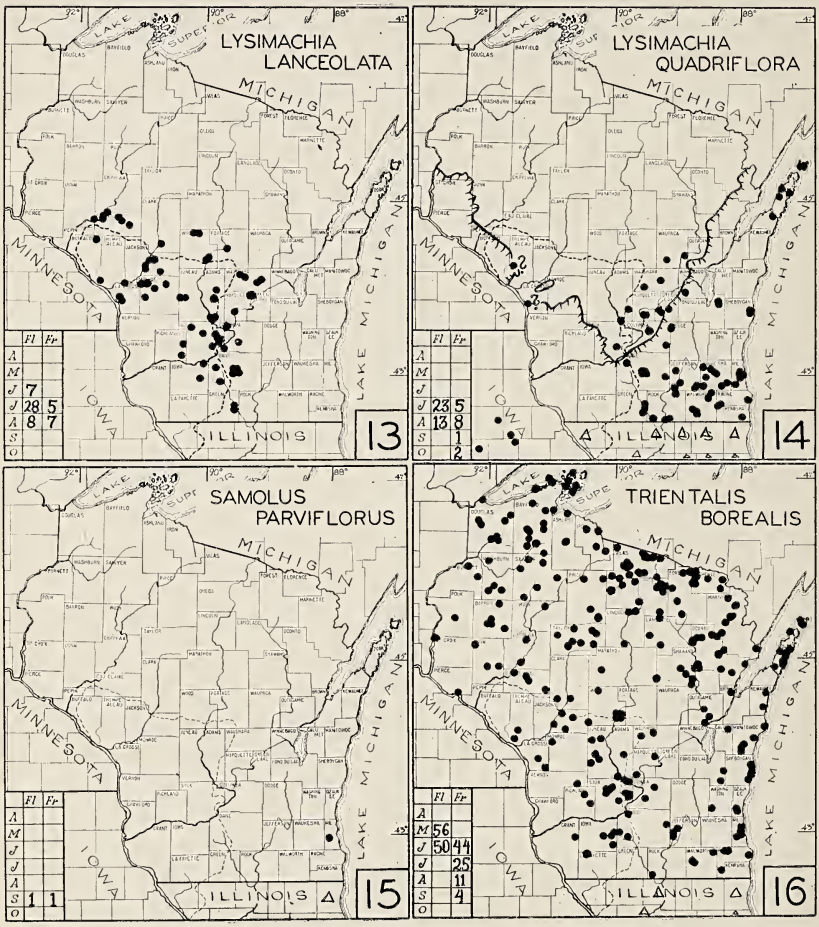
Steironema lanceolatum (Walt.) Gray

Slender herbs 10–35 (–40) cm tall, propagating by slender subterranean rhizomes; basal leaves orbicular to obovate, generally persistent; stems 1.5–2.0 (–2.5) mm in diam. near base, unbranched or with a few short branches above the 5th to 7th node; longest leaves towards the top of the plant, gradually narrowed to the base, sessile or subsessile or rarely short-petioled, the blades ciliate at base; seeds 1.7–2.0 mm long (*fide* Ray).

In southwestern Wisconsin, in dry, mesic, or moist, more or less sandy prairies or prairie openings, in very sandy prairies on edge of Jack Pine-Black Oak scrub, on sandstone cliffs in *Pinus strobus* relics, on sandy roadsides, sand terraces, open dunes (along Mississippi R.) and in open to fairly dense, generally sandy and mesic to moist woods of Aspen, Oak-Hickory, Oak-Pine, White Pine—Red Oak—Red Maple, etc.

Flowering from the end of June to the middle of August, and fruiting from the end of July to September.

Large specimens of this species resemble small plants of *L. hybrida.* However, *L. lanceolata* does not grow in as wet habitats. Its range coincides well with the distribution of sandstones, and is nearly exactly complementary to that of *L. quadriflora* which grows in glaciated areas underlain by limestone.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12. Lysimachia quadriflora Sims. Map 14

Steironema quadriflora (Sims) Hitchc.

Erect, slender, square-stemmed herbs, 3–7 dm tall, unbranched or with few short, strongly ascending branches above; leaves linear, somewhat stiff and revolute, sessile; flowers 15–24 mm in diam., grouped at the tip of stems and branches.

Widespread from southeastern Wisconsin to Door County, apparently lacking (see below) in the well-drained "Driftless Area"; in wet, open, grassy, non-acid habitats, as sedge bogs, marshes, low prairies (with *Liatris pycnostachya, Cacalia tuberosa, Eryngium yuccaefolium*—Green Co.), and in marly, alkaline sedge-grass meadows (= "Fens" of Curtis, 1959) (e.g., with *Lobelia kalmii, Gentiana procera, Solidago riddellii, Galium labradoricum, Aster junciformis, Dryopteris thelypteris, Hypericum kalmianum* and *Potentilla fruticosa* at Muir (Ennis) Lake, Marquette Co.) or occasionally around calcareous springs.

Flowering from early July to the end of August, and fruiting from late July to October.

Two herbarium specimens report this species from deep within the "Driftless Area", apparently erroneously. The "La Crosse" collection (WIS) was made by L. H. Pammel, many of whose records from this area were evidently mislabelled (Tom Hartley—personal communication). It has never been found there since. The Trempealeau County collection (WIS) is labelled as coming from "Arcadia" by Hansen, who published this record (as *Steironema quadriflora,* from "Tamarack Creek Bog") in his study of the Tamarack Bogs of the Driftless Area (Hansen 1933:292).

Though this station has been visited by the senior author, by Hartley, who carefully searched for this plant, and by many other botanists, the species has not been collected there since. Two factors seem to indicate that this report is based on a mislabelled specimen. The above bog appears to be in most portions a typical acid *Larix-Sphagnum* bog (see list of species in Hansen, 1933:292), while *L. quadriflora* generally grows in calcareous habitats. Seconly, the specimen itself, apparently diseased shows a number of round dots, which in the Wisconsin Herbarium collections occur in this particular manner only in one other collection, namely one made by the same collector (Hansen) in Sauk County and dated a year later. It seems, therefore, that the Trempealeau collection may well be part of the one made in Sauk County and inadvertently mislabelled by Hansen. In general, the Wisconsin distribution of marly sedge meadows and fens (and therefore the distribution of most stations of this species) corresponds largely to glaciated areas underlain by limestones, such as the Ordovician Galena and Lower Magnesian Dolomites and the Silurian Niagara Dolomite.

5. ANAGALLIS L.

A. ARVENSIS L. Scarlet Pimpernel. Map 1

Low spreading, glabrous, annual herbs resembling common chickweed, with opposite, ovate sessile leaves, small bright red 5-merous flowers (these blue in a form as yet not found in Wisconsin), and small, round, many-seeded capsules on slender peduncles.

An Old World weed of fields and lawns, very sporadic and infrequent in Wisconsin, flowering in July and August, and fruiting from July to early September.

6. SAMOLUS L.

S. PARVIFLORUS Raf. Map 15

S. floribundus H. B. K.

Slender, branched herb less than 2 dm tall, with entire, obovate, alternate leaves and terminal bractless racemes of small white flowers, the slender pedicels bracteolate.

Collected once in a ditch west of Reynold's Woods, Town of Greenfield, Milwaukee County, *W. Finger,* Sept. 11, 1903 (MIL), here at the northern-most limit of its range.

7. TRIENTALIS L.

T. BOREALIS Raf. Chickweed-Wintergreen, Northern Star, Starflower. Map 16

T. americana Pursh.

Slender, glabrous, rhizomatous perennials, with (5–)7 (–9) lance-elliptic, slenderly pointed, unequal leaves borne in a single rosette at the *top* of the 1–2 dm tall leafless stem; flowers 1–3, on delicate stalks, usually 7-merous, the white petals fused into a sharp-pointed, flat star 12–20 mm in diam.; fruit a small spherical capsule, its segments deciduous with age, exposing 6–8 (–12) greyish-white, thin-coated seeds persistently attached to the placenta.

Very common in all types of northern forests, from wet to xeric (cf. Curtis, 1959), rather rare in SW Wisconsin, in a great variety of wooded, often sandy habitats, especially in White Pine-Red Pine-Hemlock-Northern Hardwoods and after cutting or fire, their successional precursors (e.g., Aspen-Poplar-Balsam Fir-Red Maple-Jack Pine (*Q. banksiana*)-Black or Hills Oak), in Sugar Maple-Basswood, Beech-Hemlock-Yellow Birch-Sugar Maple, as well as in wet woods and Tamarack (*Larix*)-Spruce (*Picea mariana*)-Cedar (*Thuja*) bogs, there often growing in sphagnum (in Hope Lake

Bog. Jefferson Co., with *Sarracenia purpurea, Cypripedium acaule, Menyanthes,* etc.), in SW Wisconsin in Pine relics, these often on top of high sandstone cliffs or bluffs.

Flowering from mid-May to the 3rd week of June and fruiting from mid-June to early September.

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GROWTH AND DEVELOPMENT OF THE GREATER WAX MOTH, *Galleria mellonella* (L.). (LEPIDOPTERA: GALLERIIDAE)[1]

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The greater wax moth, *Galleria mellonella* (L.), is of biological interest because of its food habits, ecological adaptations, developmental patterns, and adaptability as an experimental form for a variety of entomological investigations. It has been used in studies of pathogens and antigens (Chorine 1929, Boczkowzka 1935, Olivier 1947), comparative biochemistry (Crescitelli 1935, Niemerko 1950), comparative nutrition (Haydak 1940, 1941), digestive processes (Roy 1937, Waterhouse 1959), symbiosis and parasitism (Florkin, Lozet, and Sarlet 1949, Lozet and Florkin 1949, Sarlet and Florkin 1949), and comparative arthropod anatomy (Metalnikov 1908, Borchert 1933, El-Sawaf 1950). It is an insect of world-wide distribution, and is occasionally a serious pest in apiaries. The larvae feed on the waxy brood combs and pollen stores of the honey bee, *Apis mellifera* L.

Although a number of developmental studies of the greater wax moth have been published (Metalnikov 1908, Chase 1921, Andrews 1921, Borchert 1935, Schmelev 1940, Haydak 1940, El-Sawaf 1950), most were conducted under suboptimal conditions of diet and temperature. In the interest of developing the insect's potential as an experimental organism for physiological investigations, a study was undertaken to determine its growth and metabolic characteristics under carefully controlled laboratory conditions.

METHODS AND MATERIALS

Rearing and maintenance of stock cultures

Stock cultures of the greater wax moth were maintained in large crystallizing dishes (190 x 100 mm.). The dishes were covered with a circular piece of plate glass, 210 mm. in diameter, in the center of which was a 15 mm. cotton-plugged hole. The glass cover was held in place by means of a grease layer around the lip of the crystallizing dish. The center hole was necessary both for ventilation and for the prevention of an accumulation of water condensate. Dietary medium was added to form a loose layer of about 30 mm.

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depth. Approximately 100 eggs were introduced into each culture dish. The dishes were then maintained in total darkness in a 35° C. incubator.

As the larvae matured and spun cocoons, they were removed from the cultures and placed in cheese cloth-covered 2.5 liter battery jars. Moth emergence, mating, and oviposition took place in the battery jars. In order to obtain eggs, square pieces (100 x 100 mm) of waxed paper were pleated and fastened at one end to form small fans, which were put into battery jars. The moths laid eggs in the pleats, from which they were easily recovered. Eggs were collected daily, and all rearing experiments were started with randomized mixtures of eggs collected on the same date.

Rearing experiments were conducted by methods similar to those described above, except smaller containers were used. Cultures were maintained in stender dishes (60 x 25 mm.), the covers of which had cotton-plugged center holes. Each stender dish contained 17 g. of diet and supported the growth of about 25 wax moth larvae.

TABLE 1

ARTIFICIAL DIETARY MEDIUM FOR LABORATORY REARING OF THE GREATER WAX MOTH, *Galleria mellonella* (L.)

CONSTITUENT	AMOUNT (G.)	CONCENTRATION (MG./G.)
Honey, strained	25.0	236
Glycerol	22.0	207
Water	10.0	94
Pablum, mixed cereal	34.0	322
Brewers yeast powder	10.0	94
Beeswax, yellow	5.0	47
Total	106.0	1000

The basal dietary medium (Table 1) was prepared as follows. The pablum, yeast powder, and beeswax were mixed with sufficient diethyl ether to dissolve the wax. After thorough mixing, the ether was evaporated off, leaving the pablum and yeast evenly coated with beeswax. The honey, glycerol, and water were mixed together and then added to the dry ingredients and mixed thoroughly. The resulting diet was friable and somewhat sticky. If refrigerated for about 24 hours, it became slightly rubbery in consistency and lost its stickiness.

Measurement of growth characteristics

Larval growth curves were obtained by weighing subsamples of 20 larvae periodically during the larval growth period. They were weighed on a torsion balance (Roller-Smith) to the closest 0.1 mg. They were then preserved in alcohol for head-width determinations. Head-width measurements were made under a binocular microscope with a calibrated ocular micrometer. Head-width was determined as the number of millimeters from side to side at the widest point. Analytical treatment of the data was by standard statistical procedures (Snedecor 1946).

Measurement of metabolic rates

Metabolism was measured in terms of oxygen consumption and carbon dioxide production through the use of Warburg reaction vessels and standard manometric techniques (Umbreit *et al.* 1957). Calibration of flasks and manometers under conditions in which the flasks contained nutrient media and living wax moth larvae of unknown total volume, required the use of a special gas calibration method (Hoopingarner and Beck 1960). Twelve to 16 hours prior to flask calibration and metabolic measurement, individual larvae were placed on basal diet contained in Warburg vessels. After this period of conditioning, only larvae which had constructed feeding tunnels were used for determinations of metabolic rates. After respiratory exchange measurements were completed, the larvae were weighed, dried at 100° C. to a constant weight, extracted with ether in a Soxhlet extractor for eight hours, and again weighed.

Results and Discussion

Preliminary experiments, in which the growth of wax moth larvae on their natural diet of brood comb and pollen was compared to growth on artificial diets, established that the diet shown in Table 1 allowed optimum growth. Previous workers have reported that the larvae are capable of utilizing beeswax as a source of dietary lipids (Dickman 1933, Waterhouse 1959). Beeswax was not found to be a required nutrient, however, as larval growth and maturation would occur in its absence (Haydak 1941). In the present study, the inclusion of beeswax in the laboratory diet improved larval growth to a highly significant degree (Table 2). It was observed that beeswax had an effect on the physical consistency of the diet, rendering the diet somewhat less compressible. Paraffin wax had a similar effect on the consistency of the medium, but had a less stimulating effect on larval growth. Since paraffin is indigestible, its stimulatory effect was attributed entirely to the altered physical properties of the diet. Larval growth was significantly better in the presence of beeswax than in the presence of paraffin, and this effect was interpreted to indicate that the beeswax contributed to the nutritional suitability of the diet. It was not determined whether the beeswax contributed required nutrient factors or contained chemosensory feeding stimulants.

On the basis of these experimental results, the artificial diet was routinely formulated to include 5 percent yellow beeswax. Brewers yeast powder was added to the diet as a supplemental source of B vitamins and protein. Larval growth was retarded only slightly in the absence of yeast powder.

TABLE 2

EFFECTS OF BEESWAX AND PARAFFIN ON LARVAL GROWTH OF THE GREATER WAX MOTH

Wax	Dietary Content (%)	Average Weight (12 days) (mg.)	Statistical Analyses	
			Control	Wax Type (T)
NONE (Control)	0	77.1	....	....
Yellow beeswax	2	126.5	**	1.51
Paraffin wax	2	114.4	**	
Yellow beeswax	4	157.3	**	2.10*
Paraffin wax	4	123.9	**	
Yellow beeswax	10	152.7	**	4.67**
Paraffin wax	10	95.7		

*Difference significant at the 0.05 level of probability.
**Difference significant at the 0.01 level of probability.

TABLE 3

EFFECT OF CROWDING ON LARVAL GROWTH OF THE GREATER WAX MOTH

Larvae Per Vial	Average Weight at Indicated Temperature and Age	
	24° C. 18 days	35° C. 12 days
	(mg)	(mg)
1	45.5	59.0
6	67.6	64.1
12	57.8	66.1
18	55.1	58.6

In some growth experiments it was desirable to rear the larvae singly; whereas in other experiments large numbers were to be reared in a single container. Because this species produces large

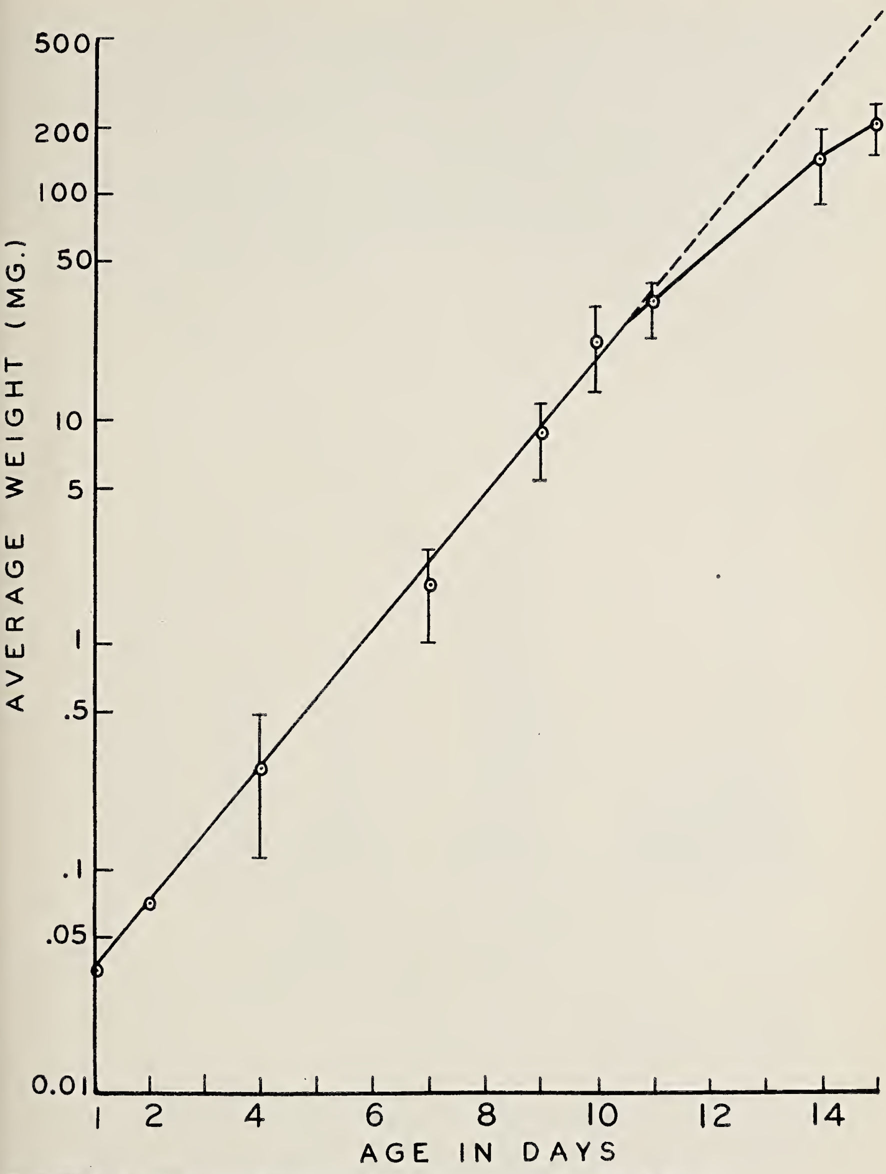

FIGURE 1. Larval growth curve of the greater wax moth at 35° C.

quantities of heat (Bell 1940, Smith 1941, Roubaud 1954), and displays peculiar mass behavior, it was thought that mass and isolated rearings might yield different growth characteristics. This hypothesis was tested in a series of rearings in which different numbers of larvae were reared in small vials (23 x 85 mm), each of which contained the same amount of diet. The results (Table 3) demonstrated that the growth of isolated larvae was not significantly different from that of larvae reared in large groups. Within the limits tested, over-crowding had little or no effect on larval growth. As mortality was negligible in all replicates, it was apparent that cannibalism did not occur.

Using from 20 to 25 larvae per stender dish, larval growth characteristics were determined at an incubation temperature of 35° C.

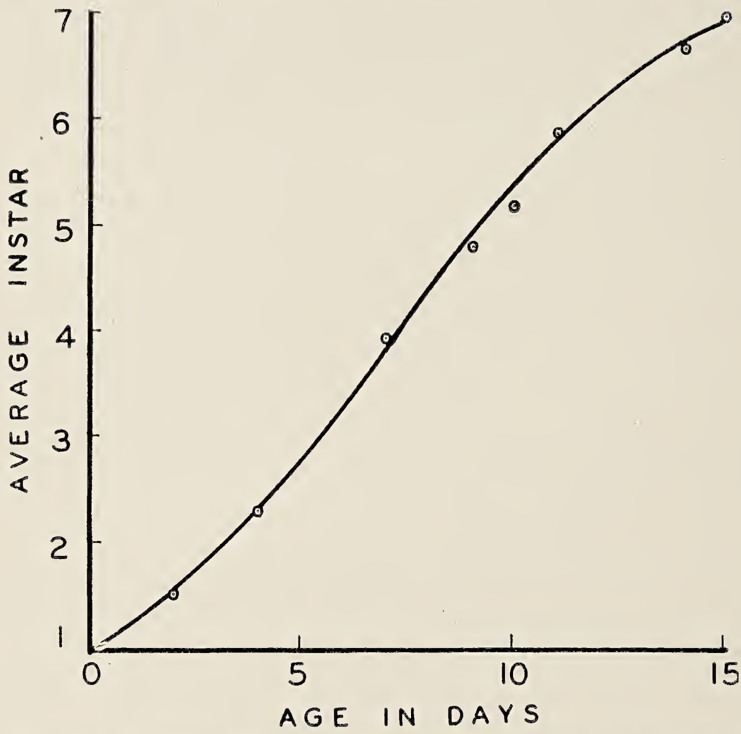

FIGURE 2. Larval growth of the greater wax moth, in terms of instar progression.

and under continuous darkness. The body-weight growth curve (Figure 1) shows that the larvae attained their maximum average weight fifteen days after hatching. The slope of the growth curve up to approximately 10 days was indicative of a daily doubling of body-weight. Had this curve continued to the 15th day, the larvae would have attained an average weight of 590 milligrams (dashed line in Figure 1). The growth rate declined after 10 or 11 days, and the final larval weight approached an average of 200 milligrams. Even among relatively fast growing insects, the growth rate displayed by the wax moth larvae was fantastically high. The range lines around the plotted points indicate the observed standard deviations. The average larval weights of one and two day old larvae were obtained by weighing large groups simultaneously, and the number of such mass weighings was insufficient to permit calculation of standard deviations.

The average weight of the larvae did not increase after an age of 15 days, although they did not spin cocoons until about the 18th day. From the 15th to 18th days the larvae spun tent-like masses of silk and were in seemingly constant motion, crawling around the inside of the rearing dishes.

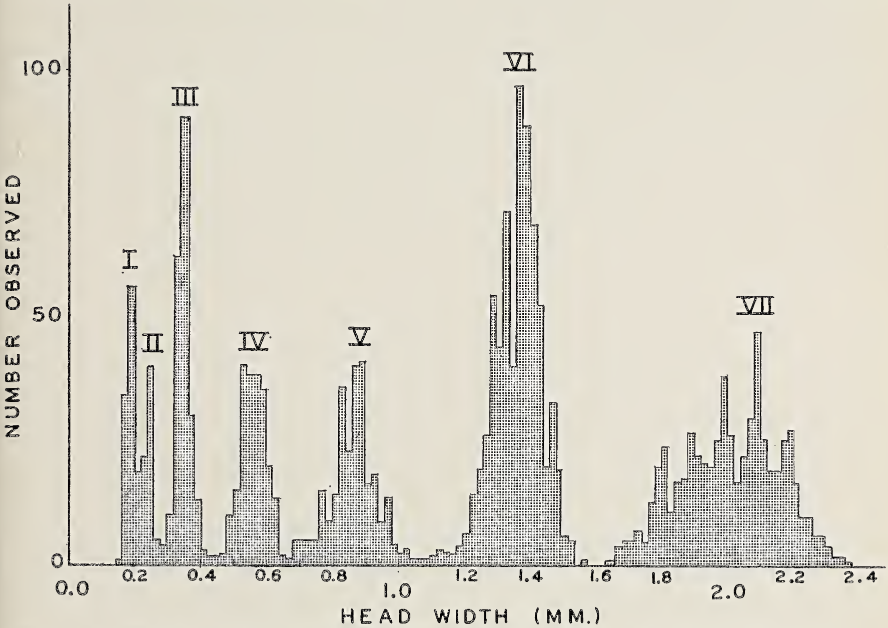

FIGURE 3. Frequency histogram of head capsule width of larvae of the greater wax moth, showing seven larval instars.

The duration of the several larval growth stages is shown in Figure 2. During the 15 day growth period, the larvae passed through 7 larval instars, each representing a stadium of two to three days duration. As was found when growth was measured in terms of weight increase, growth in terms of advancing from instar to instar was at an exceptionally high rate.

Larval instars were identified by measurements of the head capsule widths of population samples taken at different times during the growth period. The head-width measurements were plotted as a frequency histogram (Figure 3). The distributions of head-width measurements were taken as an indication of the number of distinct growth-stages present in the population samples. (Petersen and Haeussler 1928, Gaines and Campbell 1935). This technique for determining the number of larval instars in the life cycle of lepidopterous insects is based on the finding of Dyar (1890) that the head-width of such larvae increases by a fairly constant ratio at each larval molt. Certain limitations of the method have been noted (Beck 1950), but it is reasonably accurate under constant and approximately optimal rearing conditions. As shown in Figure 3, the head-widths formed a series of seven normal distributions which overlapped but very little. The arithmetic means of these distributions were taken as the average head capsule widths of separate larval instars. The first such distribution (I) was determined separately from the others, in that it represents the head measurements of larvae known to be newly hatched and unfed; these larvae were but an hour or two in age at the time of measurement. All of the other measurements were obtained from daily samples of a large larval population, all members of which were of an identical age, within an error of less than 24 hours. About 2100 larval head capsules were measured. The characteristics of the seven larval instars are shown in Table 4. The growth ratios shown were obtained by dividing the average head width of one instar by that of the previous instar. Head-width range for a given instar was predicted by multiplying the growth ratio observed by the observed head-width range of the previous instar. This calculation provided a means of determining whether or not the range of measurements fell within the expected range of a similar normal distribution. The close agreement between predicted and observed head-width ranges, and the approximately similar growth ratios found throughout the series indicate that the accidental omission of an instar from the series was extremely unlikely. The possibility of a sex difference in head-width was tested experimentally in the last (7th) instar. The head-widths of full-grown larvae were measured, and the larvae were then isolated for pupation and moth emergence. The sex of the emerging moths was associated with the measurements made. A T-test showed a highly significant difference occurred, with mature female larvae averaging 0.12 mm. greater than males in head capsule width.

Previous literature on the biology of the greater wax moth indicated the occurrence of 8 or 9 larval instars in the normal life cycle (Chase 1921, El-Sawaf 1950). Chase (1921) found that a few specimens completed their development in 7 instars. Milum and Geuther (1935) reported that supernumerary molts could occur under unfavorable rearing conditions. It seems logical to interpret the results obtained by previous workers as reflecting the different experimental conditions employed. It is probable that seven instars represents the minimum, typical number under optimal conditions of temperature, humidity, and nutrition. That earlier workers failed to use optimum rearing conditions is also indicated by the slower growth reported.

TABLE 4

Larval Head Capsule Growth Characteristics of the Greater Wax Moth

INSTAR	I	II	III	IV	V	VI	VII
Average head width: (mm)	0.191	0.252	0.362	0.564	0.867	1.366	2.010
Growth ratio	....	1.319	1.436	1.558	1.537	1.575	1.508
Head width range observed: (mm) low	0.16	0.23	0.32	0.44	0.68	1.08	1.65
high	0.22	0.29	0.42	0.65	1.05	1.58	2.38
Head width range predicted: (mm) low	....	0.21	0.33	0.49	0.68	1.07	1.59
high	....	0.29	0.42	0.65	1.00	1.65	2.33
Number larvae measured	103	69	210	217	271	692	588

Larval growth was somewhat variable, as indicated by the standard deviations plotted in Figure 1. At the outset of this study, it was hoped that larval growth rates could be used as the basis for the assay of the biological activity of certain types of organic compounds other than insecticides. Although this proved possible, the usefulness of wax moth larvae in such an application was greatly reduced by the variability of growth rates. Genetic selection for uniform growth was therefore undertaken. Sibling matings were used, and the selected strain was perpetuated by mating the earliest pupating individuals of each generation. Selection was also for size. Several separate matings were effected at each generation, and the selected strain was continued by rearing a randomly selected group of eggs produced from one such mating. After four generations, the standard deviation in larval weights was significantly smaller than that of the parental generation. Still greater improvement was observed in the F_7 generation. The F_8 generation was used successfully as a bioassay organism. The selection program is currently continuing.

Some of the metabolic characteristics of the greater wax moth were determined during the larval growth period. This phase of the investigation involved respiratory measurements of over 200 individual larvae. Although there was more than a desirable variation from one individual to the next, the salient trends are summarized in Table 5. Dry matter and fat content determinations were not run on the smaller (10 mg.) larvae. The results show that the water content of the insects declined as the larvae matured, and the fat content increased concurrently. Respiratory rates, expressed as QO_2 values, declined as the insects increased in weight. The declining rates of oxygen consumption were not the result of the deposition of increasing amounts of fat, as the decline persisted when the respiratory rates were calculated on a fat-free, dry weight basis. Respiratory quotients calculated from the respiratory measurements varied from 0.80 to 0.98, with no apparent systematic changes as the larvae matured. It was observed that the insect's respiratory rate dropped sharply during periods immediately preceding ecdysis. The nature of such a stadial cycle was not determined. The respiratory measuurements shown in Table 5 were made at 25° C. A number of determinations were also made at 35° C., and yielded Q_{10} values averaging 1.70, indicating that a rise in ambient temperature resulted in a sharp increase in the rate of respiratory exchange.

TABLE 5

GROWTH AND METABOLISM IN LARVAE OF THE GREATER WAX MOTH

LIVE WEIGHT	DRY WEIGHT	WATER WEIGHT	FAT CONTENT		OXYGEN CONSUMPTION (QO_2=MM 3/MG*HR)		
(mg.)	(% live wt.)	(% live wt.)	(% live wt.)	(% dry wt.)	(*live wt.)	(*dry wt.)	(fat free dry wt.)
<5.0	....	....	....	....	33.9	....	....
5.0 to 10.0	....	....	....	....	34.7	....	....
10.1 to 20.0	20.6	79.4	5.0	20.0	22.3	108.3	135.4
20.1 to 40.0	23.1	76.9	5.4	23.5	22.1	95.7	125.1
40.1 to 100.0	25.9	74.1	7.6	28.8	15.0	57.9	81.3
>100	31.8	68.2	13.1	40.6	9.3	29.2	49.2

The respiratory rates observed among the larvae tested were much higher than those reported for other insect species (Prosser 1950), (Roeder 1953). The respiratory rates of feeding, growing wax moth larvae weighing about 30 mg. were roughly comparable to those reported for houseflies in full flight. The very high growth rates found among wax moth larvae (Figure 1) would be expected to entail a high metabolic rate. A number of previous workers have observed that wax moth larvae produce appreciable amounts of heat energy; the temperature of a thriving culture may be as much as 25° C. above the environmental temperature (Smith 1941, Roubaud 1954). Such unusual heat output would necessarily be indicative of a very high rate of respiratory metabolism.

Summary and Conclusions

1. The greater wax moth, *Galleria mellonella* (L.), was cultured on a dietary medium composed of mixed cereal pablum, brewers yeast powder, yellow beeswax, water, glycerol, and honey. Growth on such a diet was at an apparently optimum rate.

2. At 35° C. under continuous darkness, larval weight increased from an average of 0.02 mg. at hatching to an average of 200 mg. at 15 days of age. Larval weights doubled daily during the first 10 days of larval life.

3. Seven larval instars were expressed under the rearing conditions employed. Characteristic head-widths and growth ratios were determined for each instar. Female larvae of the seventh instar had significantly wider heads than did male larvae of the same developmental stage.

4. During the larval growth period, the insects progressively increased in percent dry matter and percent fat. The rate of oxygen consumption was extremely high among small larvae, but declined as the larvae matured.

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FOOD INGESTION IN CRASPEDACUSTA SOWERBII[1]

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INTRODUCTION AND METHOD

The hydroid stage of the fresh water coelenterate *Craspedacusta sowerbii* consists of a colony of one to ten or more polyps. A typical polyp (Fig. 1) may be divided into three areas; the main body portion, a thinner neck area and a terminal capitulum, on which nematocysts are heavily concentrated and in the center of which is situated the polyp's mouth. A typical polyp is, on maturity, about 0.8 mm. in length. Polyps may reproduce by forming any of three types of bud. Frustule buds, elongated and sausage shaped in form, become freed from their parent polyp, creep along the substrate as frustules and subsequently develop into new colonies. Polyp buds resemble the head and neck of an adult polyp although reduced in scale. Polyp buds remain attached to their parent and eventually develop into adult polyps. Medusa buds begin as clear blisters which become sessile medusae and then break free of the parent polyp. Under favorable conditions, freed medusae will develop to maturity, attaining a diameter of one cm. or more. A mature medusa will produce gametes and so initiate the sexual portion of *Craspedacusta's* life cycle. Under natural conditions, however, reproduction by mature medusae appears to rarely, if ever, occur and effective reproduction is asexual. The bud forms of *Craspedacusta* are shown in Figs. 2–4.

This paper reports a study of the process of food ingestion by the polyp stage of *Craspedacusta*. Particular emphasis in the study was directed towards the influence of feeding on bud formation. A total of 74 colonies was utilized in the study. These colonies averaged 2.4 polyps per colony. *Craspedacusta* colonies are easily cultured in the laboratory (McClary, 1959). Cultures were started by pipetting frustules into finger bowls filled with aged filtered tap water. The finger bowls were maintained at 30° C. and kept in complete darkness to avoid algal contamination. Frustules typically developed into young colonies within ten days. When colonies were between 18 and 25 days of age (as measured from time of initial frustule seeding) they were removed from 30° C. to room temperature (19–24° C.) and used for the experiments here described. In these ex-

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periments polyps were fed brine shrimp nauplii. A feeding typically consisted of a single shrimp nauplius, although large polyps were given two nauplii. Only one polyp in each colony was fed. In certain of the experiments the nauplii used were dyed with neutral red to facilitate subsequent observation. The use of dyed food did not appear to result in any measurable difference from the use of undyed food. Similarly, the use of more than one nauplius in some feedings did not appear to cause results that were different from the use of a single nauplius.

Previous work indicated that wounding a polyp tends to result in the appearance of a polyp bud at the wound site (McClary, 1960). Wounds of this type (opening the side of a polyp's body) were carried out in some of the present experiments and were accomplished by means of a micro-knife fashioned from a steel needle. Polyp form was recorded in drawings made with the aid of a binocular microscope fitted with an occular micrometer.

Results

Effect of feeding on general polyp form

The 74 polyps utilized in the present study were fed brine shrimp nauplii immediately on removal from 30° C. to room temperature. Stages in the ingestion and absorption of a brine shrimp nauplius are shown in Fig. 5. Nauplii offered to a polyp were typically held securely by nematocysts of the capitulum. After contact with food the capitulum often bent against the body wall, further securing the food. Widening of the mouth and subsequent ingestion usually proceeded rapidly and nauplii were commonly ingested within 15 minutes. After ingestion of food a swelling in the neck area was often observed. Ingested food was passed to the lower body region of a polyp and, in addition, moved into adjoining polyps. When ingested food was still largely concentrated in the coelenteron it was clearly demarcated. As the ingested material became absorbed, this demarcation was obscured. Careful observation indicated that food material was absorbed into endoderm cells in the lower body region of the polyp. After a period of about five days, this portion of the polyp no longer appeared opaque, although it remained somewhat denser than the rest of the polyp body. At no time did the neck area of a polyp appear to concentrate food material as was the case with the lower body region. Polyps observed in the present study often showed characteristic markings one or two days after feeding. Markings of this type consisted of linear and circular patterns of very dense granular material. Although very near the body surface, this material apparently was for the most part endodermal in nature.

Effect of feeding on bud formation

Frustule Buds

Before initial feeding, none of the 74 colonies used in the present study had produced frustule buds. After the initial feeding the 74 colonies were observed for a period of six days. During this time 14 colonies each produced a frustule bud. These buds typically appeared about five days after feeding and were freed from their parent within 24 hours. All of the frustule buds appeared on polyps which had been fed. None of the unfed polyps produced buds. Ingested food material appeared to become concentrated in the developing frustule buds. In some of the buds observed, the developing bud and the adjacent polyp tissue were equally concentrated with food material. In other cases, the concentration was slightly heavier in the bud. Although freed frustules show polarised morphology (Reisinger, 1957; Lytle, 1959), in the present study they showed no differential concentration of food material. In some cases, polyps carrying a developing frustule bud were fed a second time. The second feeding consisted of a dyed nauplius, so that material from the second feeding could be distinguished from the first. Material from the second feeding collected in both the developing bud and in polyp tissue, as did the material from the initial feeding. The path of ingested food in relation to frustule bud appearance is shown in Fig. 6.

Medusa Buds

On removal from 30° C. to room temperature, the 74 colonies were examined for the presence of medusa buds. Three polyps, each on different colonies, were found to carry medusa buds in early stages of development. One polyp on each of the 74 colonies was then fed and observed for a six day period, as described above. The three polyps carrying medusa buds were among those fed. During this time a polyp in each of twelve other colonies developed a medusa bud. Each of these polyps was one of those previously fed. Of these latter twelve buds, five became arrested in development, not progressing beyond the stage shown in Fig. 7B. Two others were operated on, their distal portions being removed, and they subsequently ceased development. The remaining five developed normally. The five buds which spontaneously ceased development were first observed, on the average, about 30 hours after removal from 30° C. The time lapse in the case of the normally developing buds was about ten hours. Portions of ingested food appeared to be drawn both into the lower region of the polyp body and into a ring of opaque material at the site of a developing medusa bud. This area apparently consisted of endodermal cells and presumably corresponded to the region which has been shown by histological

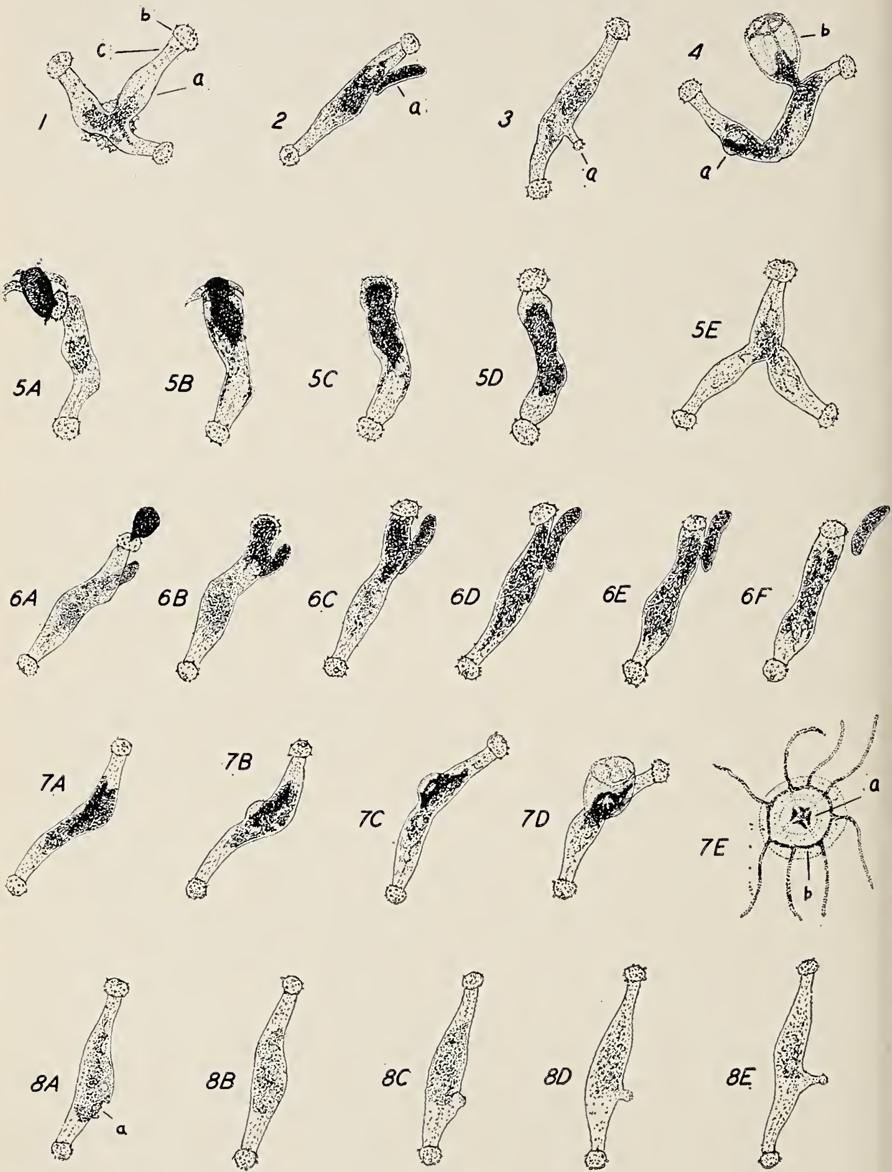
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PLATE I

FIGURE 1. Polyps of typical colony. a = Polyp body. b = Polyp capitulum. c = Polyp neck.

FIGURE 2. Typical frustule bud. a = Frustule bud.

FIGURE 3. Typical polyp bud. a = Polyp bud.

FIGURE 4. Typical medusa buds. a = Young medusa bud. b = Mature medusa bud.

FIGURE 5. Food assimilation by colony.

A–D. Ingestion of brine shrimp nauplius at intervals of 10 minutes.

E. Different colony four days after feeding. Note linear and circular markings.

FIGURE 6. Effect of second feeding on colony carrying a developing frustule bud.

A. Polyp taking brine shrimp.

B–F. Passage of food into polyp and frustule tissue. Time from feeding to B, 30 minutes; to C, two hours; to D, six hours; to E, 12 hours; to F, 22 hours.

FIGURE 7. Food assimilation by developing medusa bud.

A. Colony 16 hours after being fed. Note young bud.

B–D. Development of medusa bud.

E. Oral view of freed medusa. Note food material concentrated in stomach and ring canal. a = Stomach. b = Ring canal.

Time from feeding to B, 23 hours; C, 44 hours; D, 80 hours; E, 100 hours.

FIGURE 8. Development of polyp bud at site of wound on polyp body.

A. Wounded polyp. a = Wound.

Time from wounding to B, 16 hours; C, 25 hours; D, 40 hours; E, 46 hours.

study to constitute the developing manubrium of the bud (Payne, 1924). Food material remained concentrated in the manubrium area of the developing bud until the latter became freed of its parent polyp, three to four days after initial appearance. In the newly freed medusa the opaque material apparently concentrated in the stomach area and then moved into the manubrium wall and the ring canal. Some material was also evident in the umbrellar tissue. Eight of the polyps with medusa buds were fed a second, dyed nauplius about 24 hours after the initial feeding. As was the case with the second feeding of polyps carrying developing frustule buds, material from the second feeding collected in both bud and polyp tissue. Bud development was similar, whether parent polyps were fed only once, or fed twice. The path of ingested food in relation to medusa bud appearance is shown in Fig. 7.

Polyp Buds

After the above described observations were completed, one polyp on each of 48 colonies was selected for a study of polyp budding. An attempt was made to determine whether polyp bud production was influenced by feeding. Of the 48 polyps, twenty which appeared to carry little stored food were divided into two groups, ten being wounded, ten held as controls. In a three day period of observation two of the wounded polyps produced polyp buds at the wound site. One of these buds appeared one day after wounding, the other two days. None of the controls produced a polyp bud during the three day period. Sixteen of the 48 polyps appeared to be heavily food laden and these were similarly divided, eight being wounded, eight held as controls. None of the sixteen polyps produced a polyp bud during the observation period of three days. Of the remaining 12 polyps, six were fed just after being wounded and six were fed, but not wounded. One of the six wounded polyps produced a polyp bud on the third day of observation. None of the six controls produced polyp buds during the period. Food material did not appear to concentrate in developing polyp buds. Instead, the tissue of a developing polyp bud remained clear, resembling the capitulum and neck area of an adult polyp. In one case, a polyp carrying a polyp bud was given a second dyed nauplius 24 hours after the initial feeding. Material from the second feeding followed a path similar to that from the first feeding, concentrating in the polyp tissue rather than in the bud. The relation of polyp bud appearance to ingested food is shown in Fig. 8.

A polyp which had developed an arrested medusa bud later produced one of the polyp buds described above. In no other case did more than one bud appear on a given polyp during the study.

Discussion

Several workers (Fowler, 1890; Payne, 1924; Persch, 1933; Dejdar, 1934) have postulated that the vacuolated cells which are common in the endoderm of the polyp body function in the assimilation of food. The results of the present study, which indicate that ingested food initially concentrates in the endoderm tissue at the base of the polyp, confirm this.

The only experimental work known to the writer on the effect of variable nutrition rates in *Craspedacusta* is that of Lytle (1959). This worker has found that at high nutrition rates colonies tend to channel food material into frustule bud production, at the expense of medusa and polyp bud production. At low nutrition rates Lytle has found medusa bud production to be reduced relatively more than production of other bud types.

In the present study, no frustule buds were produced by colonies prior to initial feeding. After colonies were fed for the first time a considerable number of frustule buds were produced. Visual observation showed that the ingested food concentrated in developing frustule buds. These facts indicate that at least initially frustule budding is dependent on, and a result of, food intake. Although ingested food material did concentrate in the developing medusa buds, the fact that some medusa buds were present before colonies had been fed indicates that buds of this type may not be as directly related to nutrition as is the case with frustule buds. In the experiments here described temperature appeared to be the controlling factor in regard to medusa bud appearance, as medusa buds which appeared more than a few hours after the removal of colonies to room temperature tended to be arrested in development. Under similar conditions a temperature of 27° C. or more has been found necessary for polyps to develop medusa buds (McClary, 1959). That this is not always the case is indicated by a study in which polyps produced medusa buds at temperatures as low as 19° C. (Lytle, 1959). Although the number of polyp buds produced in the present experiments was limited, the pattern of their appearance indicated that feeding, at least over a short time period, was not a direct cause of the formation of polyp buds. Wounding, or opening of a polyp's tissue, on the other hand appeared to cause a tendency for polyp bud appearance.

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GROWTH OF TREE SEEDLINGS IN HYDROPONICS[1]

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"Hydroponics" or "soilless cultures" are terms which refer to the production of plants in nutrient solutions. This method provides a striking illustration of the far-reaching effect of nutrients on the growth of plants. Under the influence of dissolved salts, field crops and vegetables produce much greater yields than they do in most fertile prairie soils (Laurie, 1940; Hewitt, 1952; Carleton and Swaney, 1953).

Recent investigations have shown that trees possess a capacity to respond to nutrients in solution not dissimilar to that of herbaceous plants. During the past 15 years, the members of the Wisconsin Soils Department have achieved a gratifying success in the use of hydroponics for the acceleration of the growth of deciduous and coniferous seedlings (Olson, 1944; Spyridakis, 1959). In some instances, the stock raised in nutrient solutions attained within the brief period of 7 months a size fully comparable to 3-year-old transplants raised in nursery soils (Figure 1). This rapid growth was achieved in part through the proper adjustment of the content and the ratio of nutrients, pH value, specific conductance and redox potential of nutrient solutions.

Aside from the rapid growth, hydroponics offer several advantages in the production of nursery stock. The most important of these is the possibility of closely controlling the morphological development of seedlings through regulation of the composition of nutrient solution and a periodic pruning of root systems. With proper handling, the problem of the control of parasitic organisms and weeds is practically eliminated. In northern environments, the use of hydroponics permits a considerable extension of the growing season, and with artificial aeration of solutions, five to ten times as many seedlings can be produced per unit area as in nursery beds.

Depending on the scope of production, hydroponic seedlings can be raised in containers of any size, including small glazed jars. In a mass production, however, seedlings of woody plants are usually grown in metal tanks lined with plastic or asphalt to prevent dam-

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age from toxic substances. The seedlings are supported by one-half inch metal mesh screens, suspended about 3/8″ above the level of the nutrient solution. The seed bed is made of a thin layer of vermiculite placed on the screen over a layer of packed Excelsior. After the tanks are filled with water, the seed is broadcast and covered with a thin layer of vermiculite. The seed beds are kept moist, preferably with distilled water, until the germination is completed. At

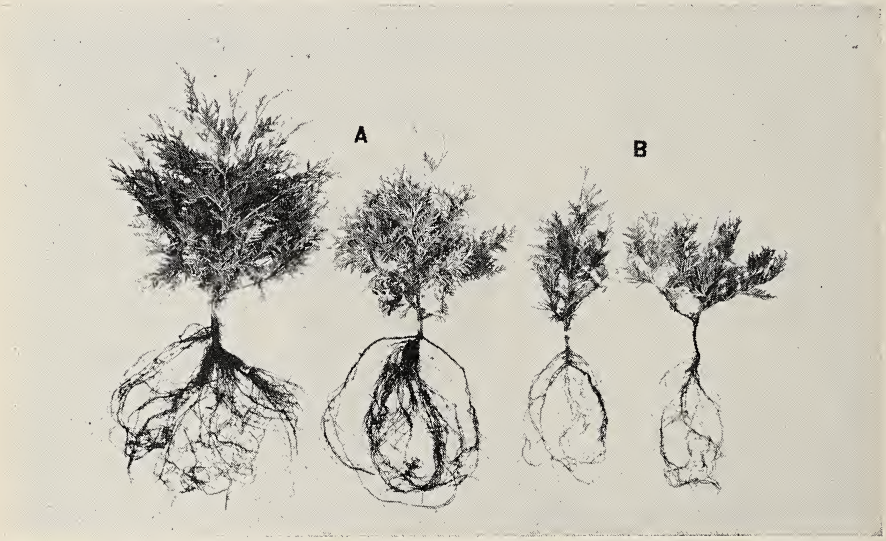

FIGURE 1. A comparison of hydroponic and nursery stock: A—Seedlings of white cedar raised for four months in a nutrient solution and for one growing season in a nursery bed; B—Three-year-old nursery transplants of the same species.

this time, water is replaced by nutrient solution. During the first ten days the solution is kept at one-third of the normal concentration.

Aeration is provided by an electrically driven pump and a combination of tygon and glass tubing placed on the bottom of tanks. The air stream is broken into fine bubbles by means of carborundum thimbles. The aeration of cultures is regulated in accordance with results of determinations of free oxygen and redox potential. The composition of nutrient solutions is subject to a wide variation depending on the species and the age of the stock, as well as light and temperature conditions. However, during the period of February to May, the following composition of solution for young seedlings proved to be satisfactory under Wisconsin conditions:

Constituents of stock solution	Concentration, g/liter
$NH_4H_2PO_4$	0.200
KNO_3	0.200
$Ca(NO_3)_2 \cdot 4H_2O$	0.225
$MgSO_4 \cdot 7H_2O$	0.175
NH_4NO_3	0.150
$FeC_6H_5O_7 \cdot 3H_2O$	0.015
H_3BO_3	0.003
$MnCl_2 \cdot 4H_2O$	0.002
$ZnSO_4 \cdot 7H_2O$	0.002
$CuSO_4 \cdot 5H_2O$	0.001
$H_2MoO_4 \cdot H_2O$	0.001

Nutrient solutions are usually prepared from U. S. grade chemicals and are changed at about 2-week intervals. The level of the solution is maintained by a periodic addition of water. To preclude the growth of microorganisms, nutrient solutions are supplemented with 37% formaldehyde, applied at a rate of 0.01 ml per liter. As a rule, it is desirable at the beginning of seedlings' growth to adjust the reaction of the media to pH 4.5 by an addition of diluted hydrochloric acid. However, an intensive feeding of stock causes a rapid depletion of bases and may lower the reaction of the solution below the critical limit of pH 3.5, thereby necessitating a replacement of the solution. A decrease in the content of electrolytes is indicated by values of specific conductance below 0.5 millimhos per centimeter, corresponding to an electrolyte concentration of 0.6 g per liter. The content of free oxygen of less than 2 ppm or a negative redox potential at pH 7.0 indicates the need for additional aeration.

In the production of hydroponic stock for practical purposes, the cultures are usually started in February. By May the plants attain sufficient size and vigor to be transplanted into nursery beds for inoculation with symbiotic fungi, further development and hardening. At the end of the growing season, the stock is available for either fall or spring field planting.

The transplanting into nursery beds extends the period of stock production to about 7 months. Nevertheless, past experience has shown that this appreciably increases the field survival of seedlings. According to the results of trials, conducted during the past three years on cut-over areas and in partially cut forest stands, the hardened hydroponic stock showed an average survival of about 90 percent.

The production of tree seedlings in hydroponics is not without certain economic and technical difficulties. In cold climates, this practice requires heated and lighted growing rooms. The control of the composition of nutrient solutions demands a constant attention of a qualified technician. Considering these limitations, the use of hydroponics is likely to be limited in the foreseeable future to the production of tree seedlings for landscape plantings. A possible intrusion of water cultures into forest nursery practice could be expected only with regard to very slowly growing species which attain plantable size in nursery beds in a period of not less than five years.

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LIME AND FERTILIZER INCORPORATION FOR ALFALFA PRODUCTION[1]

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Literature dealing with methods of applying lime and fertilizer for alfalfa production indicates that very few lime placement studies have been carried out with this important forage crop where adequate amounts of lime were used, in spite of the fact that alfalfa has long been known to be sensitive to acid soil conditions. Equally incongruous is the fact that while the split application has been most often recommended where heavy lime and/or fertilizer applications are required (1, 5, 10, 11), no study has been reported in which this method was compared with other methods of placement.

The investigation reported herein was undertaken to compare the effects of the split application method of applying lime and fertilizer on alfalfa-brome hay with those where each material was applied in a single application, either before or after plowing.

EXPERIMENTAL PROCEDURE

A field experiment using farm machinery was established in the spring of 1952 on a Spencer silt loam soil. Preliminary soil sampling in the fall of 1951 indicated the field to be uniform with respect to soil reaction, available phosphorus, and available potassium. The field was divided into 7 plots, each plot being 50 by 220 feet in size or approximately ¼ acre.

Treatments used in the experiment are shown in the accompanying table.

All lime and fertilizer applications were made with a ten-foot lime and fertilizer spreader and worked in to a depth of about 3 inches with a field cultivator. Regardless of the method of application each plot was cultivated the same number of times, namely, once lengthwise and once crosswise both before and after plowing. Following the lime and fertilizer applications the plots were seeded with a mixture of 6 pounds of inoculated Ranger alfalfa, 6 pounds of Canadian bromegrass, 2 pounds of red clover and 2½ bushels of Ajax oats per acre using a grain drill with grass seeder attachment. Soil samples were taken in the fall of the seeding year and in

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[1] Contribution from the Soils Dept., Univ. of Wis. Published with the approval of the Director, Wis. Agr. Exp. Sta., Madison, Wis.

[2] Associate Professors and Professor of Soils, respectively.

the fall of the first hay year. In each instance 16 random borings to a depth of 8 inches were made in each plot and the corresponding one-inch segments of each of the 16 cores were composited and oven-dried at 60° C. Each soil sample was analyzed for available phosphorus (Truog method); exchangeable potassium, calcium, and magnesium as determined with the Beckman Model DU Flame Photometer using neutral, normal NH_4Ac for the extractant; and soil reaction at saturation percentage by the glass electrode method. In addition, tests for free carbonates were made with Patel-modified, Collin calcimeter (7) on samples obtained in the fall of the first hay year.

Plot Number	Method of Application[1]	
	Lime[2]	Fertilizer[3]
1	One-half before and one-half after plowing	All after plowing
2	All after plowing	Same as 1
3	Same as 1	One-half before and one-half after plowing
4	None (plot worked before and after plowing	None (plot worked before and after plowing
5	Same as 1, except that 7 tons lime per acre applied	Same as 3
6	Same as 1	All before plowing
7	All before plowing	Same as 6

[1]All materials were worked in after each application.
[2]5 tons Grade A dolomitic lime per acre (neutralizing value of 102% $CaCO^3$ equivalent and sieve size of 92% through 8 mesh and 35% through 100 mesh).
[3]1000 pounds 0–10–30 per acre.

Yields and tissue samples were taken at early bloom stage shortly before the first and second cuttings were made. The yield of hay from each plot was calculated to 15% moisture. A sample of approximately 50 alfalfa branches was taken at random from the swath for chemical analysis.

Alfalfa tissue samples from both cuts of the first year hay were analyzed for total nitrogen by the Kjeldahl method, phosphorus by the Vanadate method, and potassium, calcium, and magnesium with the Beckman model DU Flame Photometer. Prior to the phosphorus and cation determinations, the tissue was digested by the perchloric acid method and taken up in 0.4 *N* HCl. Alfalfa tissue samples from both cuts of the second year hay were analyzed for total nitrogen, potassium, calcium, and magnesium as above except that the tissue was dry ashed at 450° C. after which the cations were taken up in 0.4 *N* HCl.

Alfalfa stand counts from each plot were taken at two different dates (4/22/54 and 5/17/54) of the second hay year.

Results and Discussion

Effect of Method of Incorporation on Distribution of Lime and Fertilizer in the Plow Layer

Figure 1 shows the change in soil reaction and the distribution of phosphorus and potassium in the plow layer as influenced by the method of fertilizer and lime incorporation. The high concentration of potassium in the 0–1 inch depth irrespective of the method of fertilizer application (lower graph Fig. 1) is thought to be the result of potassium being returned to the soil surface through leaching of the mature oat plants (nurse crop) by rain and/or through root excretion. Similar observations have been reported by Deleano (2) and Halliday (3). That the accumulation of potassium at the soil surface was not due to the lack of proper mixing during the tillage operations is borne out by the fact that on the plot where no fertilizer was used, and where an even distribution of available potassium in the plow layer should be expected, the available potassium content of the 0–1 inch depth was more than twice that of the next highest layer. Other evidence to indicate the upward transposition of potassium is seen in the plots receiving fertilizer. Here it will be noted that where all of the fertilizer was applied before plowing there was half as much available phosphorus in the 0–1 depth as compared to the treatment where all of the fertilizer was applied after plowing. In contrast, the method of application had little effect on the available potassium content of the 0–1 inch layer in these same plots. Since the phosphorus and potassium were applied as a mixed fertilizer their distribution should have similar if tillage and method of incorporation had been the determining factors involved.

It will be noted that the method of applying and working in all of the lime and fertilizer before plowing gives a fairly even distribution of the phosphate and lime (as indicated by pH) in the plow layer. This might be expected since the furrow slice is not completely inverted by the moldboard plow but rather leans up against the preceding furrow. As a result when the lime and fertilizer are plowed under they tend to be distributed somewhat vertically in the plow layer. It is for this reason also that a disproportionately higher concentration of lime and fertilizer is found in the upper half of the plow layer when the application is split, since a portion of the lime and fertilizer applied before plowing remains in the upper part of the plowed layer when the furrow is turned. While these data indicate that a more uniform distribution of lime and fertilizer would result if two-thirds to three-fourths of the lime and fertilizer were applied and worked in before plowing and the remainder after plowing, there is no data to show that this method would be superior as far as alfalfa is concerned.

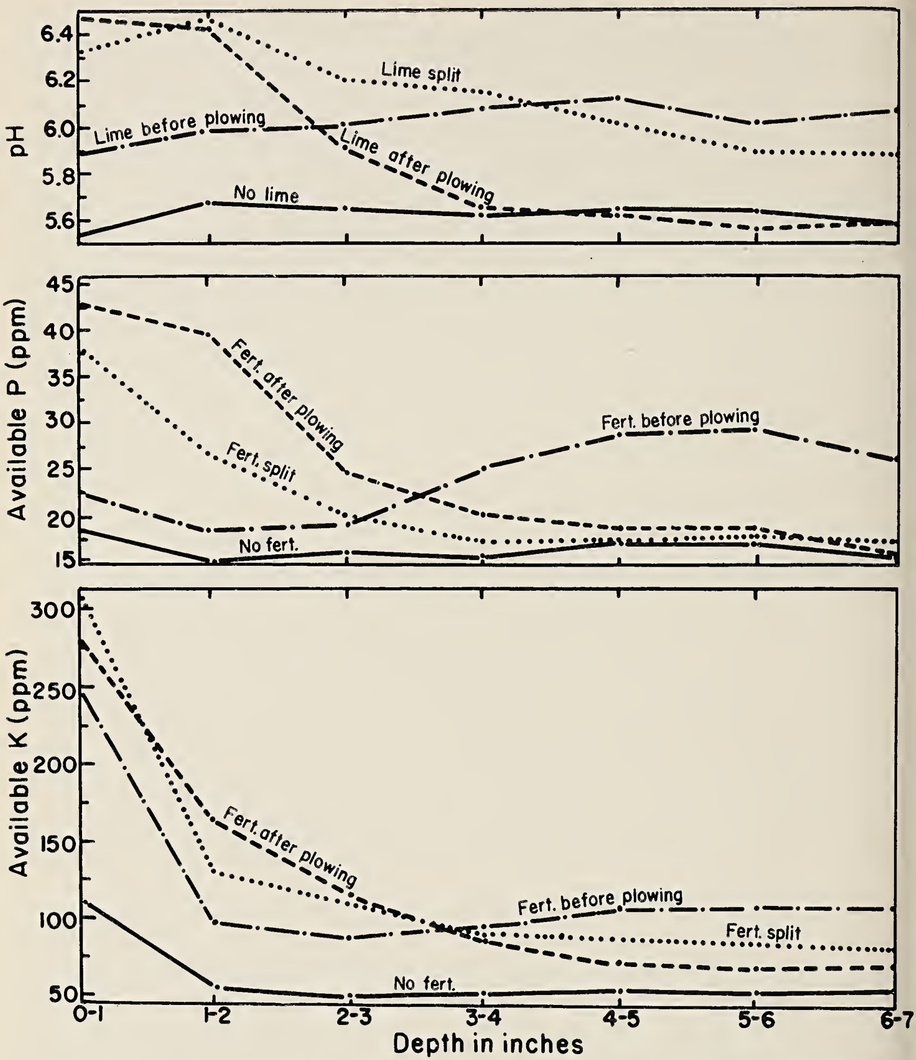

FIGURE 1. Soil reaction and available phosphorus and potassium contents at various depths in the plow layer as influenced by method of lime and fertilizer incorporation. (Materials applied 4/28/52; soil sampled 10/4/52).

In addition to pH, a second method used for evaluating the distribution of lime as influenced by the method of application was to measure the amount of unreacted lime occurring throughout the plow layer, (Table 1). It will be noted that the distribution of unreacted lime resulting from different methods of incorporation approximates the general pattern of lime distribution as determined by pH measurements. These data also indicate the striking influence of the method of placement on the effectiveness of the applied lime in neutralizing soil acidity throughout the plow layer.

The 1.4 tons of lime per acre that reacted to produce an average pH of 6.4 in the plow layer of the plot receiving the split application treatment is in close agreement with the laboratory results obtained by Nimlos[3] which indicate that at equilibrium 1.3 tons of $CaCO_3$ per acre had reacted in raising the pH of Spencer silt loam from 5.6 to 6.4. If these values are assumed to be reasonably accurate, it follows that the amount of unreacted lime obtained in the plot where all of the lime was applied before plowing is much too low. In this regard it should be pointed out that prominent lime streaks were noted in the plow layer of this plot and it is believed that this banding effect prevented representative sampling of the unreacted lime.

TABLE 1

EFFECT OF METHOD OF LIME INCORPORATION ON pH AND AMOUNT OF UNREACTED LIME AT DIFFERENT DEPTHS IN THE PLOW LAYER

DEPTH OF SOIL (IN.)	METHOD OF LIME APPLICATION					
	All After Plowing		½ Before & ½ After Plowing		All Before Plowing	
	pH	Tons Per Acre Unreacted Lime	pH	Tons Per Acre Unreacted Lime	pH	Tons Per Acre Unreacted Lime
0–1	6.8	1.39	6.7	0.83	5.9	0.20
1–2.............	6.6	1.26	6.7	0.61	6.0	0.30
2–3.............	6.3	0.54	6.6	0.73	6.1	0.36
3–4.............	6.0	0.47	6.2	0.63	6.2	0.29
4–5.............	5.7	0.14	6.2	0.51	6.1	0.27
5–6.............	5.6	0.00	6.2	0.23	6.1	0.31
6–7.............	5.5	0.00	6.0	0.06	6.1	0.20
0–7.............	6.1	3.80	6.4	3.60	6.1	1.93

5 tons lime per acre applied 4/28/52; soil sampled 8/28/53.

Effect of Method of Incorporation of Lime and Fertilizer on Yield of Alfalfa-Brome Hay

The data in Table 2 indicate that it made little or no difference in the yield of hay whether the lime and fertilizer were each applied in one application, either before plowing (Plot 7) or after plowing (Plot 2), or by spitting each application (Plot 3). Simi-

[3] Nimlos, T. J. Evaluation of the Patel and Woodruff methods of determining the lime requirement of a soil. M. S. Thesis, University of Wisconsin, Madison, Wisconsin, 1955.

larly it will be noted that the application of 7 tons of lime per acre (Plot 5) resulted in no additional increase in yield. The somewhat larger 3-year total yield obtained from the treatment where the lime was split and all of the fertilizer was applied after plowing (Plot 1) is complicated by the fact that a shelterbelt of trees, 3 rows wide and 10 to 15 feet high, was located 50 feet from the western border of the plot. It is believed that the higher yield from Plot 1 is due to the entrapment of snow by the shelterbelt and the consequent effect on the moisture supply. Alfalfa stand counts were taken on two different dates in the spring of the second hay year. The average of these counts revealed no difference in stand of alfalfa due to the method of lime and fertilizer incorporation, being an almost identical 4 plants per square foot for all of the treated plots. The stand of alfalfa on the untreated plot averaged 1¾ plants per square foot. A very high percentage of the hay harvested from the untreated plot consisted of quack grass and broadleaf weeds.

TABLE 2

EFFECT OF LIME AND FERTILIZER PLACEMENT ON YIELD OF ALFALFA-BROME HAY

PLOT NUMBER	METHOD OF APPLICATION	YIELD IN TONS PER ACRE AT 15% MOISTURE				
		1953	1954	1955	3-Yr. Total	Annual Average
4	No Lime No Fertilizer	2.2	1.9	0.7	4.8	1.6
2	Lime—After* Fert.—After	3.0	2.6	3.3	8.9	3.0
1	Lime—Split* Fert.—After	3.2	3.2	4.1	10.5	3.5
3	Lime—Split Fert.—Split	2.8	2.7	3.7	9.2	3.1
5	Lime—Split** Fert.—Split	3.1	2.6	3.4	9.1	3.0
6	Lime—Split Fert.—Before*	3.4	2.7	3.6	9.7	3.2
7	Lime—Before Fert.—Before	3.1	2.9	3.4	9.4	3.1

*After = applied after plowing; Split = one-half applied before plowing and one-half after plowing; Before = applied before plowing.

**All limed plots received 1,000 pounds 0-10-30 and 5 tons Grade A lime per acre with the exception of Plot 5 where 7 tons of lime per acre were applied.

Effect of Method of Incorporation of Lime and Fertilizer on Chemical Composition of Alfalfa

The chemical composition of alfalfa in the first and second year hay failed to indicate any difference due to method of lime and fertilizer incorporation. The total nitrogen and base content of alfalfa harvested from the untreated plot was less than that from any of the treated plots. However, the application of 7 tons of lime per acre did not increase either the nitrogen or base content over that of the alfalfa harvested from the plots receiving 5 tons of lime per acre regardless of the method of application.

In contrast to the correlation between soil pH and the nitrogen content of alfalfa reported by other investigators (4), (6), the results of this study show no such relationship in spite of differences in the pH of the plow layer resulting from the various methods of lime incorporation (Table 1). This disparity in the case where all of the lime was applied after plowing (Plot 2), may be explained by the fact that while the average pH of the plow layer was 6.1, the pH of the upper 3 inches was 6.6. Thus it is believed that root development and nodulation were stimulated sufficiently in the higher pH regions to compensate for the lack of root development in the more acid zone (8). In the treatment where all of the lime was applied before plowing (Plot 7) some balling or banding of the lime in the moist soil resulted and this did not give as good a distribution throughout the plow layer as where the same amount of lime was applied one-half before and one-half after plowing. Although the pH of the plow layer where all of the lime was plowed down was a very nearly uniform 6.1, it should be emphasized that this represents the average value at any given depth. This does not preclude more acid or basic zones at these depths as has previously been reported by Purvis and Davidson (9), who also found rather large pH differences of one unit within a radius of 1 to 2 cm. Consequently, it is thought that excellent nodule development occurred in the areas of higher lime concentration and accounted for the consistently high nitrogen content of alfalfa harvested from this treatment.

These results are somewhat in contrast to the commonly observed fact that when the pH of a soil decreases to around 6.0 or below alfalfa begins to lose some of its thriftiness even though phosphorus and potassium may be adequate. Yet it would appear that when sufficient lime is applied to an acid soil the alfalfa, because of the local high pH zones, will not be adversely affected even though the lime has not reacted sufficiently to raise the average pH of the plow-layer above 6.0 to 6.1.

Summary

The application of one-half the lime and fertilizer before and one-half after plowing has been considered the best method of applying heavy amounts of lime and fertilizer to strongly acid, infertile soils prior to seeding alfalfa. However, the extra labor involved for farmers and bulk vendors when the application of each material is split raises the questions of how successfully alfalfa can be grown when all of the lime and/or fertilizer is applied at one time and whether it is better to apply all of the lime and fertilizer before plowing or after plowing in those cases where the applications cannot be split.

The results obtained in a field study with alfalfa-brome grass where 5 tons of Grade A lime and 1,000 pounds of 0–10–30 per acre were applied by different methods to Spencer silt loam are as follows.

All lime applied and worked in before plowing resulted in a distribution of lime in the plow layer that more closely approximated that of the split application than did the method of applying all of the lime after plowing and working it in.

Regardless of the method of incorporation, the potassium content of the surface two inches of soil sampled in the fall of the seeding year was two to four times higher than that in any succeeding two inch depth of the plow layer. Phosphorus distribution throughout the plow layer was similar to that of lime.

Stand counts of alfalfa taken in the spring of the second hay year showed no differences due to method of lime and fertilizer incorporation.

Chemical analyses of alfalfa from both cuts of the first two years of hay revealed no differences in composition due to method of lime and fertilizer incorporation.

Total yields of alfalfa-brome hay for three years indicated that it made no difference whether the lime and fertilizer were each applied in one application (either before or after plowing) or in two, half before and half after plowing.

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DESCRIPTION AND EXPERIMENTAL ANALYSIS OF CHICK SUB-MANDIBULAR GLAND MORPHOGENESIS[1]

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A number of experimental studies involving tissue interactions during embryonic development of gland rudiments have been completed in recent years (cf. Grobstein, 1956). Among these studies, the embryonic sub-mandibular gland of the mouse has served to demonstrate the importance of an epithelio-mesenchymal interaction for epithelial morphogenesis (Grobstein, 1953c). With the demonstration that certain inductive tissue interactions can cross the class barrier between chick and mouse (Grobstein, 1955), it seemed profitable to investigate the morphogenetic processes in the salivary gland development of the chick embryo and the possible relationship between components of the embryonic chick and mouse salivary glands.

Before undertaking such an investigation, however, the description of the embryonic chick sub-mandibular gland development *in situ* required re-investigation. The embryonic development of the chick salivary gland *in situ* is described in part I of this paper. Part II will pertain to an experimental approach analyzing the characteristic *in vitro* morphogenesis and epithelio-mesenchymal interaction of the embryonic chick sub-mandibular gland and the epithelio-mesenchymal interaction resulting from the reciprocal exchange of embryonic mouse and chick salivary components.

PART I

Development of the Embryonic Chick Sub-mandibular Gland

The only previous reference to the embryonic development of this gland was that of Reichel (1883) who in his survey of the salivary gland of birds stated that the sub-mandibular gland of *Gallus domesticus* forms on the eighth day as small spherical ingrowths of oral epithelium into the mesenchyme of the lower jaw near the back of the tongue and on either side of the tongue. Further description on the embryonic development of the gland seems to be lacking. In contrast to the dearth of information concerning the

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embryogeny of the sub-mandibular gland, considerable work has been done on the adult sub-mandibular gland of the chicken. A thorough histological study of the adult salivary glands of the chicken has been completed by Calhoun (1933) who states that all salivary glands of the fowl present the same general histological structure. A cytological study of the adult salivary glands was completed by Chodnik (1948) in which he discussed the relationship of Golgi material and mitochondria to the secretory activity of the salivary epithelium. McCallion and Aitken (1953) by means of histochemical studies have shown the distribution of basophilia, mucus and muco-polysaccharides, acid and alkaline phosphatase, lipase and glycogen in the anterior sub-mandibular gland of the fowl.

Materials and Methods

Sub-mandibular glands for this study were obtained from chick embryos produced by crosses of Bantress Cockrels with Arbor Acre White Rock Pullets. The developmental stages examined were Hamburger-Hamilton stages 35–46. In addition glands of four day, three week, and adult chickens were examined. The head was removed and immersed in tyrode solution and the lower jaw and tongue were removed to permit gross morphological observations. Sub-mandibular glands of stages 35–42, and 44; 1 day, 4 day, and 21 day chicks; and adults were fixed in Bouin's, serially sectioned at 5–8 microns and stained with hematoxylin and eosin.

Results

The sub-mandibular gland of *Gallus domesticus* arises on the eighth day as an invagination of the buccal epithelium into the mesenchyme of the lower jaw. The adjacent mesenchyme has not condensed to form the capsular structure that will eventually surround the epithelium. Simple cuboidal epithelial cells comprise the solid invaginated structure at nine days and can be seen to possess large nuclei which may contain several nucleoli (fig. 1, 2). By ten days the design of growth is one of tubular elongation distally to the mandibular symphysis and medially toward the midline of the lower jaw. The tubular construction is a solid spherical mass of cells with a large amount of intercellular material visible in the central portion of the tubule (fig. 3). The epithelial cells in the periphery of the mass appear more organized than the loosely packed cells within the center of the mass. A concentric layer of mesenchymal cells has begun to surround the tubular structure.

Beginning at about eleven days the tubules begin to undergo cavitation. The lumen first appears in the older portion of the tubes and then proceeds distally until it reaches the distal regions by fifteen days. As can be seen in figure 4 the hollowing involves a more definite alignment in the cells of the tubule. Several layers of mesenchymal cells now surround the tubular structures.

In late fourteen-day and early fifteen-day glands, an infolding of the tubes takes place leading to the formation of peninsular-like structures projecting into the lumen (fig. 5). By sixteen days this process has produced a major change in the configuration of the tubules leading to an increase in the area available for secretory activity (fig. 6). The compound tubular structures now consist of a single layer of tall prismatic cells (fig. 7) whose nuclei are oval, darkly staining bodies located at the base of the cells. The cell size, shape, and nuclear arrangement is very homogeneous in these late embryonic stages.

Further development of the gland involves continued infolding forming more tubular units whose secretions flow into a common cavity which opens into a single common duct (fig. 8, 9). In the adult gland the secretory cells vary in shape, size, and cell components. A more detailed description of the adult sub-mandibular gland can be found in Calhoun (1933), Chodnik (1948), and McCallion and Aitken (1953).

The development of the chicken sub-mandibular gland may be compared with the development of the sub-mandibular gland in mammalian embryos. While both the mammalian and chick glands arise as ingrowths of oral epithelium which subsequently become surrounded by capsular mesenchyme, their further morphogenetic patterns are distinctly different.

Previous comparisons of avian and mammalian glands based on their adult structure and function have been unable to resolve the degree of homology (cf. Heidrick, 1893). The comparison of the embryogeny can be seen to be equally inconclusive, showing close similarity in origin, yet drastic difference in morphogenetic pattern. An experimental approach to the question of avian and mammalian salivary gland homology, based on analytical studies such as those of Grobstein (1953c) and Borghese (1950b) on the developing mouse sub-mandibular gland is indicated.

Part II

Experimental Analysis of Chick Sub-mandibular Morphogenesis

The tissue of the embryonic mouse and sub-mandibular salivary gland has become a useful tool for experimental analysis of tissue interaction. Borghese (1950a) found that the embryonic sub-mandibular gland of the mouse continued morphogenesis *in vitro* in all but its earliest stages. He also investigated the question of reciprocal influence of the epithelium and mesenchymal tissue on the development of the gland (Borghese, 1950b).

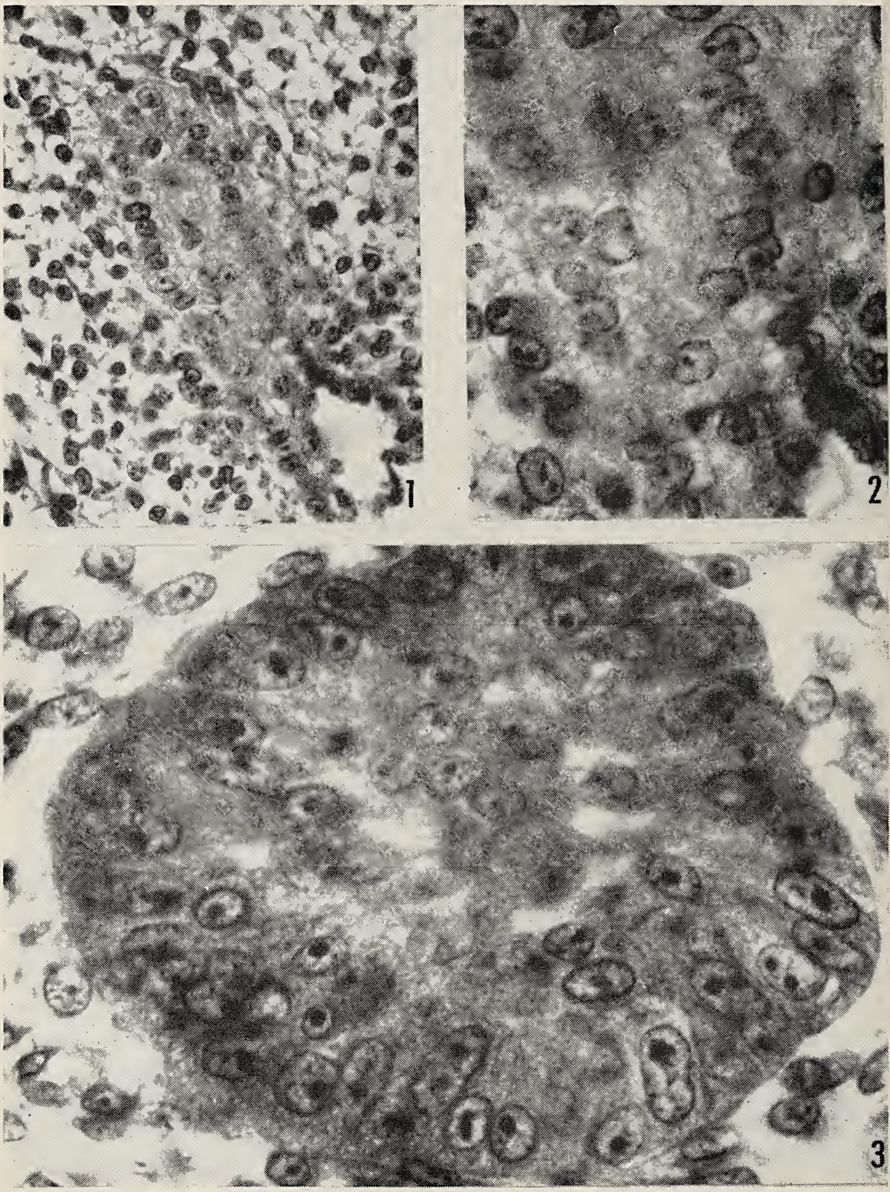
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PLATE I

Explanation of Figures

All figures are cross sections prepared with hematoxylin and eosin.

Figure 1. Nine-day gland. × 464

Figure 2. Nine-day gland. × 1144

Figure 3. Ten-day gland. × 1144

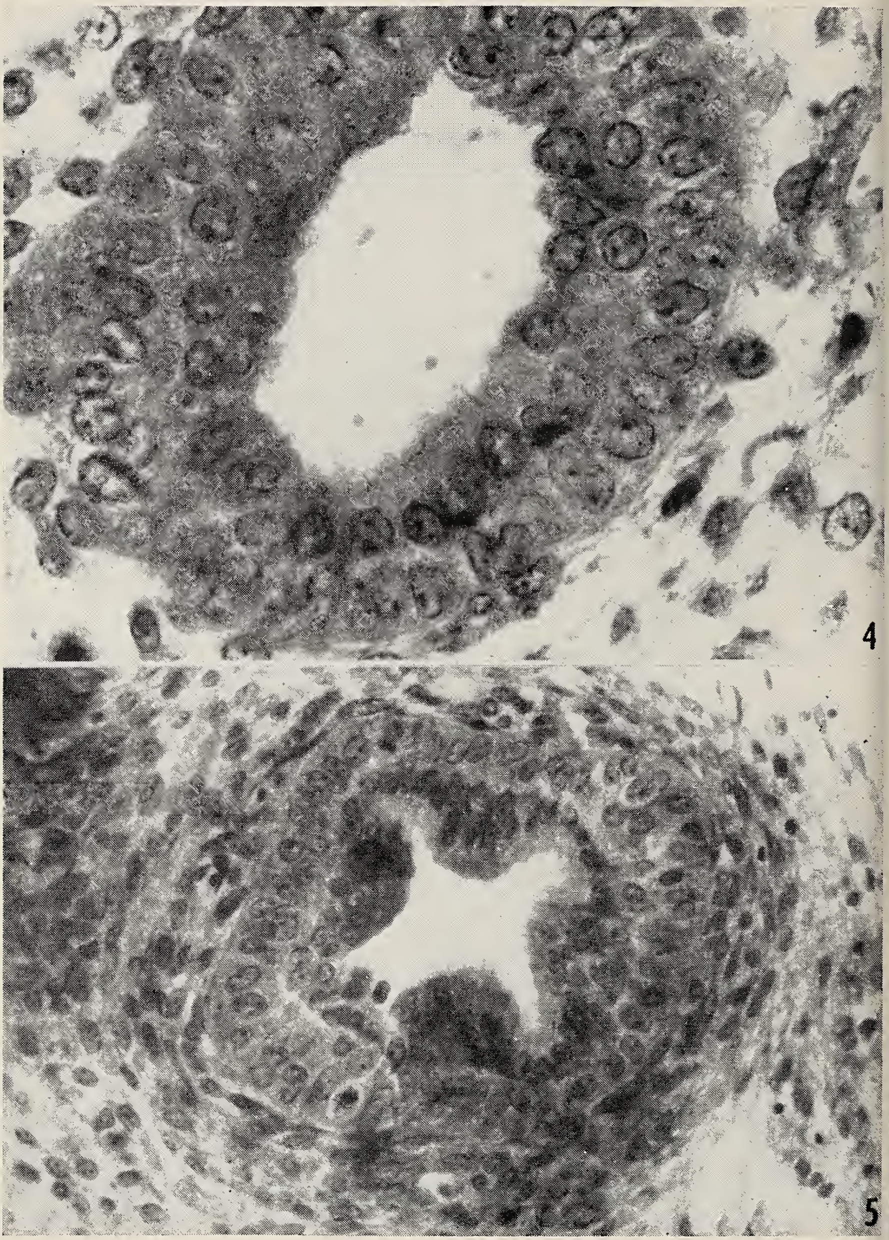
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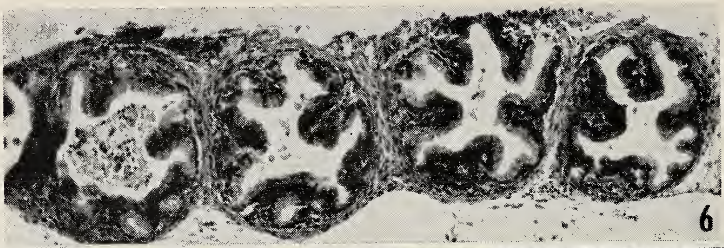
PLATE II

Explanation of Figures

All figures are cross sections prepared with hematoxylin and eosin.

Figure 4. Thirteen-day gland. × 1144

Figure 5. Fifteen-day gland. × 464



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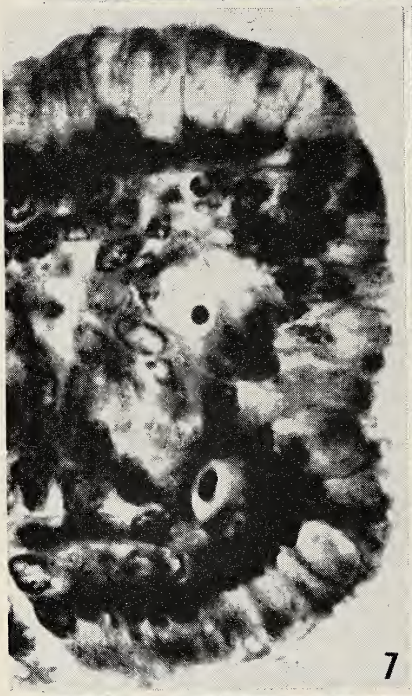

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PLATE III

Explanation of Figures

All figures are cross sections prepared with hematoxylin and eosin.

Figure 6. Eighteen-day gland. × 120

Figure 7. Eighteen-day gland. × 1144

Figure 8. Four-day chick gland. × 120

Figure 9. Four-day chick gland. × 1060

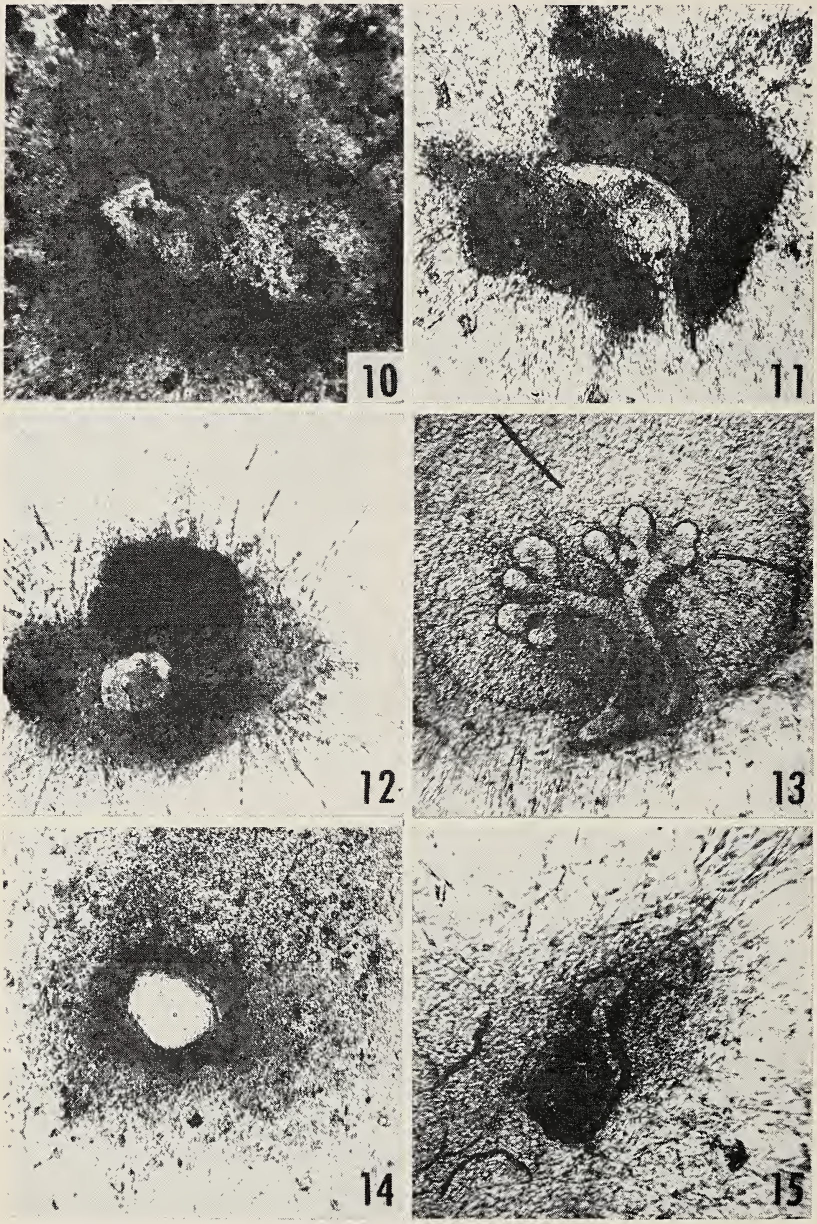
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PLATE IV

Explanation of Figures

All figures are photographs of living cultures at the glass-clot interface. All cultures × 50.

Figure 10. Intact portion of 12-day embryonic chick sub-mandibular gland. Fourth day in culture.

Figure 11. Twelve-day chick sub-mandibular epithelium combined with 12-day chick salivary mesenchyme. Fourth day in culture.

Figure 12. Twelve-day chick sub-mandibular epithelium combined with 13-day mouse salivary mesenchyme. After four days in culture.

Figure 13. Intact 13-day embryonic mouse submandibular gland. Third day in culture.

Figure 14. Thirteen-day mouse sub-mandibular epithelium combined with 12-day mouse lung mesenchyme. Fourth day in culture.

Figure 15. Thirteen-day mouse sub-mandibular epithelium combined with 12-chick salivary mesenchyme. Fourth day in culture.

Grobstein (1953a) using a slightly different experimental technique showed that the sub-mandibular gland of the mouse at the earliest recognizable stage is capable of normal morphogenesis. By treatment of the gland with trypsin, Grobstein (1953a) found it possible to cleanly separate the mesenchymal and epithelial components of the gland. When the epithelia were cultured alone they either spread into thin sheets or underwent swelling or cavitation and produced cysts. Recombining the epithelium with capsular mesenchyme allowed normal morphogenesis. In later work Grobstein (1953c) demonstrated conclusively that characteristic mouse sub-mandibular gland morphogenesis occurs only when the epithelial portion is in direct combination with living mouse sub-mandibular capsular mesenchyme. Combined with other mesenchymatous tissue the epithelium did not spread or undergo morphogenesis but remained as an inactive rounded mass or an inflated cyst.

In part I of this paper it was demonstrated that the embryonic chick sub-mandibular rudiment also consists of an epithelial portion surrounded by a zone of thickened mesenchymatous tissue although the developmental pattern of the gland is different from that of the mouse sub-mandibular gland. From these observations certain questions were brought to mind. Would the embryonic chick sub-mandibular gland cultured in vitro undergo characteristic morphogenesis and could this be demonstrated to be dependent upon epithelio-mesenchymal interaction? This being true what morphogenetic pattern would result from the reciprocal exchange of mouse and chick salivary mesenchyme?

It was felt that these studies might yield information concerning the intensity and gradation of response associated with the formation of an organized pattern within a tissue system. Such information may be useful in the quest of an analytical system relative to the problem of tissue interaction in developmental processes.

Materials and Methods

Salivary glands for the experimental study were obtained from 10 and 12 day chick embryos from crosses of Bantress Cockerels with Arbor Acre White Rock Pullets and from 13 day mouse embryos produced by crosses of BALB/c females with C_3H males. Rudiments were removed essentially according to the procedure outlined by Grobstein (1953c). Dissections were performed in horse serum-tyrode solution (1:1) and tissues were stored in an atmosphere of 5 percent CO_2 in air during the operative procedures. Salivary mesenchyme was obtained by cutting away the outer portion of the capsular mesenchyme; the remaining mesenchyme was removed from the epithelium by use of trypsin according to the procedures of Grobstein (1953a). These procedures allowed the epithelium to be cleanly separated from the mesenchymal portion.

Culture procedures used were essentially those of Grobstein (1955). Plasma clot cultures were made by orienting pieces of mesenchyme around the epithelial portion of the gland in a clotting mixture of adult chicken plasma and nutrient medium (1:1). The nutrient medium consisted of tyrode solution, horse serum, and 9-day chick embryo juice (2:2:1) to which antibiotics were added. After clotting, one ml. of nutrient medium was added as a supernatant; this was changed every other day. Cultures were incubated at 37.5 C. in an atmosphere of 5 percent CO_2 saturated with water vapor. Cultures were maintained for four days and only cases that were healthy and scoreable at the end of the culture period were included in the results.

RESULTS

I. Investigations on the epithelial morphogenesis of the chick salivary gland

Intact portions of 10, 12, and 14 day chick sub-mandibular glands were cultured *in vitro* (fig. 10). The pattern produced in all cases was elongation and increase in size of the epithelial component. The mesenchyme remained in close proximity to the epithelium and did not undergo abnormal spreading. All three stages yielded a morphogenetic pattern similar to that seen *in situ* (cf. part I).

The isolated epithelium was explanted in combination with several pieces of capsular mesenchyme and by the first day in culture the mesenchyme had fused to surround the epithelium. The activity of the epithelium in recombination was compared with the epithelium cultured in isolation (Table 1). In 12 out of 15 cases involving the 10-day epithelia, characteristic morphogenesis was demonstrated while in the three remaining cases the epithelia spread between the pieces of mesenchyme before the mesenchyme could surround them. Epithelia cultured in isolation spread rapidly forming thin sheets. In the 12-day recombinations characteristic morphogenesis was evident in all cultures (fig. 11) while the epithelia cultured in isolation underwent random spreading.

These results suggest that the mesenchyme plays an active role in chick salivary epithelial morphogenesis *in vitro.*

II. Morphogenesis in vitro of mouse salivary epithelium (table 2)

The 13-day mouse sub-mandibular gland has been well analyzed *in vitro* by Borghese (1950a and b) and Grobstein 1953a, b, and c). The results described here are merely confirmatory and are cited only to serve as comparisons for the heterospecific exchanges dis-

TABLE 1

EFFECT OF MESENCHYME FROM VARIOUS SOURCES ON THE CHICK SUB-MANDIBULAR EPITHELIAL RUDIMENT

Source	No. of Cases	Spreading	Rounding	Growth	Morpho-genesis
Chick salivary mes. (12-day)	9	0	0	9	9
Chick salivary mes. (10-day)	12	3	0	9	9
Chick bursae mes. (9-day)	4	2	2	0	0
Mouse lung mes. (11-day)	9	2	7	0	0
Mouse salivary mes. (13-day)	11	0	11	0	0
Chick salivary epithelium in isolation	10	10	0	0	0

TABLE 2

EFFECT OF MESENCHYME FROM VARIOUS SOURCES ON THE MOUSE SUB-MANDIBULAR EPITHLIAL RUDIMENT

Source	No. of Cases	Spreading	Rounding	Growth	Morpho-genesis
Mouse salivary mes. (13-day)	20	0	2	18	18
Mouse lung mes. (12-dav)	9	0	9	0	0
Mouse limb bud mes. (12-day)	6	0	6	0	0
Chick salivary mes. (10-day)	8	0	8	0	0
Chick salivary mes. (12-day)	26	0	9	17	12*
Chick salivary mes. (12-day precultured)	13	8	5	0	0
Chick limb bud mes. (5-day)	8	0	8	0	0
Mouse salivary epithelium in isolation	8	6	2	0	0

*Partial morphogenesis

cussed in section III. When the intact sub-mandibular gland of the 13-day mouse embryo is isolated *in vitro* the epithelium undergoes characteristic morphogenesis consisting of epithelial elongation and subsequent formation of branched adenomeres. The trypsin-isolated epithelium recombined with its capsular mesenchyme exhibits characteristic morphogenesis (fig. 13). When trypsin-isolated epithelial rudiments are recombined with non-salivary mesenchyme e.g. mouse lung mesenchyme (fig. 14), mouse limb bud, or chick limb bud, the epithelial rudiments round up and show no indication of morphogenesis. Epithelial rudiments cultured in isolation undergo random spreading or round up into inactive spherical masses. These results confirm the findings of Grobstein (1953c) that only mesenchyme from the same rudiment type as the epithelium appears to be able to support characteristic morphogenesis.

III. Investigation on the interaction between mouse and chick salivary gland components

Twelve-day chick salivary mesenchyme was cultured in combination with trypsin-isolated mouse salivary epithelium (Table 2). An influence ranging from rounding to growth to partial morphogenesis of the epithelium was observed. A general effect of rounding up was exhibited in 9 of 26 cases. In 5 out of 26 cases the epithelium did not round up or demonstrate partial morphogenesis but did elongate and increase in size. Partial morphogenesis, the formation and maintenance of one or more adenomeres that usually form on the second day in culture and do not undergo further branching, was illustrated in 12 out of 26 cases (fig. 15). This effect of the 12-day chick salivary mesenchyme is rapidly lost when precultured for 24 hours.

In additional experiments involving the combination of 10-day chick salivary mesenchyme or 5-day chick limb bud mesenchyme with mouse salivary epithelium different results were obtained. It was found that these mesenchymes did not produce any degree of morphogenesis but instead caused a rounding up of the epithelial rudiments.

These experiments demonstrate that 13-day mouse salivary epithelium in combination with 12-day chick salivary mesenchyme can result in partial morphogenesis, a result not duplicated by other mesenchymes tested.

Twelve-day trypsin isolated chick salivary epithelium was cultured in combination with 13-day mouse salivary mesenchyme (Table 1). The epithelium rudiments showed no sign of morphogenesis but merely rounded up (fig. 12). A similar result was obtained when non-salivary mesenchyme of the mouse e.g. 11-day lung mesenchyme or non-salivary mesenchyme of the chick e.g.

9-day bursae mesenchyme was cultured with the 12-day chick salivary epithelium.

Whether or not the mesenchymes tested have exhibited only a general mesenchymal effect or if there is any further degree of specificity involved is a difficult question to ascertain. The chick salivary epithelium in its characteristic morphogenesis does not demonstrate as dynamic a pattern as that seen in the mouse salivary epithelium but merely exhibits an increase in size and elongation. An intermediate phase of such a pattern would be difficult to detect.

Discussion

The data presented here demonstrate that the chick salivary mesenchyme plays an active role in chick salivary epithelial morprogenesis *in vitro*. Apparently the interaction between the mesenchyme and epithelium of the embryonic chick salivary gland is operationally similar to that seen in the mouse salivary system (cf. Grobstein, 1953c) i.e. an interdependency of the mesenchyme and epithelium exists leading to a characteristic morphogenetic pattern. The pattern resulting from interaction of the two chick salivary gland components *in vitro* appears to be characteristic and similar to that seen in the intact gland *in situ*. The properties that are essential for permitting characteristic morphogenesis apparently are possessed only by the chick salivary mesenchyme since heterogenous mesenchyme leads to rounding up and/or spreading. The characteristic pattern exhibited by the chick epithelium is different from that seen in the mouse in that there is no adenomere formation and mainly involves tubular elongation. The interdependency of the epithelium and mesenchyme exhibited in the chick salivary gland parallels to some extent other epithelial-mesenchymalinteractions in the embryonic chick (e.g. Gruenwald, 1952; Zwilling, 1956; Saunders, Cairns, and Gasseling, 1957) and in the embryonic duck (e.g. Gomot, 1958).

With the demonstration that chick and mouse tissues could interact *in vitro* (Grobstein, 1955) and that an intimacy at the cellular level could be established between chick and mouse cells (Moscona, 1957), it seemed valid to analyze the *in vitro* morphogenesis resulting from combinations involving the components of mouse and chick salivary glands.

The experimental results suggest that epithelial morphogenesis involves three relatively distinct phases: rounding, growth and elongation, and specific patterning. The first phase of epithelial morphogenesis could be thought of as an anti-spreading effect, significant in maintaining or establishing the organization of the epithelial component which is essential to morphogenesis (Grobstein, 1953c). This effect seems to be relatively non-specific in that it is shared by mesenchyme in general and is even exhibited by killed mesenchyme. The universality of this phase *in situ* as well as *in vitro* as a preliminary to morphogenesis can not be overemphasized.

The second phase of morphogenesis, growth and elongation, is demonstrated by the effect of 12-day chick salivary mesenchyme on mouse salivary epithelium. In this situation the mesenchyme allows more than a rounding up of the epithelium and in some cases promotes a pattern which is similar to but not as distinct as the characteristic morphogenetic pattern. This therefore represents an intermediate phase of mouse salivary epithelial morphogenesis. This pattern exhibited by the mouse salivary epithelium when combined with 12-day chick salivary mesenchyme is similar to that produced when mouse salivary epithelium is combined with precultured mouse salivary mesenchyme (Grobstein, 1953c). Grobstein's description of the precultured mouse salivary mesenchyme also fits the appearance of the 12-day chick salivary mesenchyme, both tissues being less dense and less cohesive than normal 13-day mouse salivary mesenchyme. The fact that 10-day chick salivary mesenchyme is even less cohesive than 12-day chick salivary mesenchyme may, in this sense, account for its inability to do more than support rounding of the epithelium. It is possible then, that the architecture of the mesenchyme is important in determining the degree of morphogenesis.

The third phase of morphogenesis is complete characteristic patterning resulting from the combination of epithelium with its specific mesenchyme. This is a readily definable and recognizable phase of development which has been analyzed in a large number of epithelio-mesenchymal interactions (see review by Grobstein, 1956).

The effect of chick salivary mesenchyme on mouse salivary epithelium may be one involving intensity (quantity) and/or specificity (quality) of morphogenetic factors. The chick salivary mesenchyme may be able quantitatively to support morphogenesis of mouse salivary epithlium to a certain point only, thus resulting in partial morphogenesis. The similarity between chick salivary mesenchyme and mouse precultured salivary mesenchyme is, in this sense, highly suggestive. On the other hand it is possible that the action of the 12-day chick salivary mesenchyme on mouse epithelium is qualitatively distinct from that of the mouse salivary mesenchyme. That epithelio-mesenchymal interactions involve a great degree of specificity has been amply demonstrated (see review by Grobstein, 1956), and the suggestion has been made that a variety of mesenchymes may have differing effects on a given epithelium (Auerbach, 1960); further, experiments involving exchange of mesenchyme between species (Zwilling, 1956; Chen and Baltzer, 1954) demonstrate the possibility of an intermediate pattern.

The role of the epithelium in salivary gland morphogenesis must also be considered. Clearly, the contribution is an active one, as demonstrated by the differing morphogenetic responses of chick and mouse epithelia to the same mesenchyme. The present study, then, serves to emphasize the exceeding complexity of tissue interactive processes.

Summary

1. The *in situ* development of the embryonic chick submandibular gland has been described.

2. Twelve-day intact embryonic chick sub-mandibular gland rudiments continue characteristic morphogenesis *in vitro*.

3. Trypsin isolated 12-day chick salivary epithelia when recombined with autogenous mesenchyme demonstrate characteristic morphogenesis.

4. The morphogenetic pattern resulting from the reciprocal exchange of mouse and chick salivary mesenchyme has been described. Twelve-day chick salivary mesenchyme exerts an effect on the mouse salivary epithelium that is not readily duplicated by other mesenchyme tested. The reciprocal combination involving mouse salivary mesenchyme and chick salivary epithelium results only in a generalized mesenchymal effect.

5. The results are discussed in relation to the possible phases involved in epithelial morphogenesis and in terms of the nature of the epithelio-mesenchymal interaction in general.

Acknowledgments

I wish to express my sincere thanks and appreciation to Dr. Robert Auerbach for his patience and continued guidance in this investigation and for giving so generously of his time and to William D. Ball for his technical help.

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THE SAXEVILLE METEORITE

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Standard catalogs of meteorites list an "iron with silicate inclusions" from the vicinity of Saxeville in Waushara County, Wisconsin. Slices and fragments are preserved in various major collections, but no general description has hitherto been published. This study is based on 236 grams in the collection at Lawrence College. A brief history of the meteorite is given, followed by observations on its composition and structure. The metallic portion consists mainly of granular-octahedral Ni-Fe, with scattered blebs of schreibersite and troilite. Stony portions show a crystalline mosaic structure and consist of about 46% pyroxene, 32% olivine, 0.5% plagioclase, and 21.5% Ni-Fe and troilite. No chondrules have been observed. The metal seems to be in the form of a vein, or veins, intruded along fractures in the stony material and to a limited extent replacing it.

History

Prior's "Catalogue of Meteorites" (Prior, 1953) lists a specimen from Waushara County, Wisconsin, known as the "Pine River", or "Saxeville". It is described as an "octahedrite with silicate inclusions". The mass as found is said to have weighed 3600 grams (3.6 kg.), but only 687 grams are accounted for in major collections: 236 grams in the U. S. National Museum; 110 grams in the Chicago Natural History Museum; 58 grams in the S. H. Perry collection; and 283 grams in the H. H. Nininger collection.

This meteorite was found many years ago by Mr. D. M. Waid, a farmer living about five miles southwest of Saxeville. According to Mr. Alanson C. Kimball of Pine River (personal communication), Mr. Waid, then a young man, was driving a team of horses along the "Old Back Road" between Saxeville and Waupaca. He had stopped to rest the team somewhere near the east end of Long Lake (Section 8, T 20 N, R 12 E) when his attention was attracted by a dark, rusty-looking rock lying beside the road. It was so unusual in appearance, and so heavy for its size, that he put it on the wagon and brought it back to the family farm. As a boy, Mr. Kimball frequently visited the Waid farm. He saw the meteorite lying in the woodshed, where it was used as an anvil for cracking hickory nuts. It was originally "about the size of a watermelon", but gradually succumbed to oxidation and abuse, and crumbled into fragments.

Mr. Glen D. Waid, a nephew of D. M. Waid who subsequently inherited the farm, agrees in general with Mr. Kimball's story but says (in a letter to the writer dated March 3, 1960) that the meteorite measured about 5 x 5 x 6 inches before it started to fall apart.

In 1932, Mr. Kimball was a student at Lawrence College and attended a lecture on the subject of meteorites by Professor Rufus M. Bagg of the Geology Department. What he heard reminded him of the strange rock on the Waid farm, and he decided to go and see if it was still there. All that could be found at this time were three very rusty chunks, which were lying about the yard. These were brought back to Professor Bagg, who identified them as fragments of a meteorite.

One of these chunks, weighing 1166 grams, has remained in the Lawrence College collection ever since. The other two were cut up with a diamond saw and distributed to various museums and private collectors. A last remnant from the sawing remains in the Lawrence collection. This is a piece of 220 grams bounded by saw cuts on two sides. We also have ten small fragments amounting to 16 grams.

A number of points in the foregoing story merit further consideration. In the first place, if the locality of the find as given by Mr. Kimball is correct, the appropriate name for this meteorite is "Saxeville", rather than "Pine River"—the Saxeville post office being about three miles from the discovery site, whereas Pine River is at a distance of five miles.

The latitude and longitude of the find as given in Prior's Catalogue (N 44° 8′; W 89° 5′) is inexact. This is the location of a point about five miles south and two miles west of Pine River. The latitude and longitude of the "Old Back Road" adjacent to the east end of Long Lake is N 44° 13′; W 89° 6′.

The date of the find (1931) as given by Prior is more nearly the date of recognition. The exact date of the find is unknown. However, the finder, D. M. Waid, was about 80 years old in 1949 according to a letter received by the writer from Glen D. Waid in October of that year. If D. M. Waid was "a young man" (say, 25 years old) when he found the meteorite, as both Mr. Kimball and the nephew agree, then the date of the find must have been around 1894. (Mr. Waid himself died soon after 1949, so the exact date of his discovery—if he himself recalled it—will probably never be known.)

Prior's data concerning the date and location of the find, and the total weight of material collected, were presumably borrowed from an earlier brief notice concerning this meteorite in A. D. Nininger's "Third Catalog of Meteoritic Falls" (1940). The information given here was apparently obtained from the U. S. National Museum, and it may reasonably be assumed that the National Museum was simply reporting information obtained, either directly or indirectly, from Professor Bagg.

As regards the weight of material originally collected, it seems probable that the figure "3.6 kg." represents the combined weight of the three fragments brought in by Mr. Kimball. Unfortunately, it now appears that two of these fragments were not pieces of the meteorite at all. The large chunk (1166 grams) in the Lawrence College collection was recently sectioned and found to consist mainly of garnet and amphibole, with no visible particles of either Ni-Fe or troilite. It seems likely that this is just a rusty piece of metamorphic rock. Mr. R. N. Buckstaff of Oshkosh has in his collection a sawed fragment of the "Pine River meteorite", received from Professor Bagg, which is identical in appearance with the garnet-amphibole rock in the Lawrence collection. Since the latter was uncut, it appears that two of the three original fragments were actually metamorphic rock, and only one a meteorite. The original weight of this one genuine fragment is unknown—probably less than two kilograms.

The present known distribution of the meteorite is as follows:

- Lawrence College
  - 220 g. Sawed block
  - 16 Small, stony fragments
- Buckstaff collection
  - 275 Slice
  - 30 Small, stony fragments
- U. S. National Museum
  - 182 Slice?
  - 32 Slice?
  - 22 Slice?
  - 58 Slice?
- H. H. Nininger collection
  - 130 Slice
- British Museum (Natural History)
  - 140 Slice
- Chicago Natural History Museum
  - 102 Total—probably one slice
- Milwaukee Public Museum
  - 134 Slice

This gives a known total of 1341 grams. The "metamorphic" fragment in the Buckstaff collection has not, of course, been included. Differences between the distribution shown above and that given in Prior's Catalogue are explained in part as follows: The 58 grams listed in Perry's collection by Prior went to the U. S. National Museum, increasing their total from 236 to 294 grams. Nininger cut in half the 283-gram specimen ascribed to him by Prior and traded one piece (140 grams) to the British Museum, retaining 130 grams for his own collection.

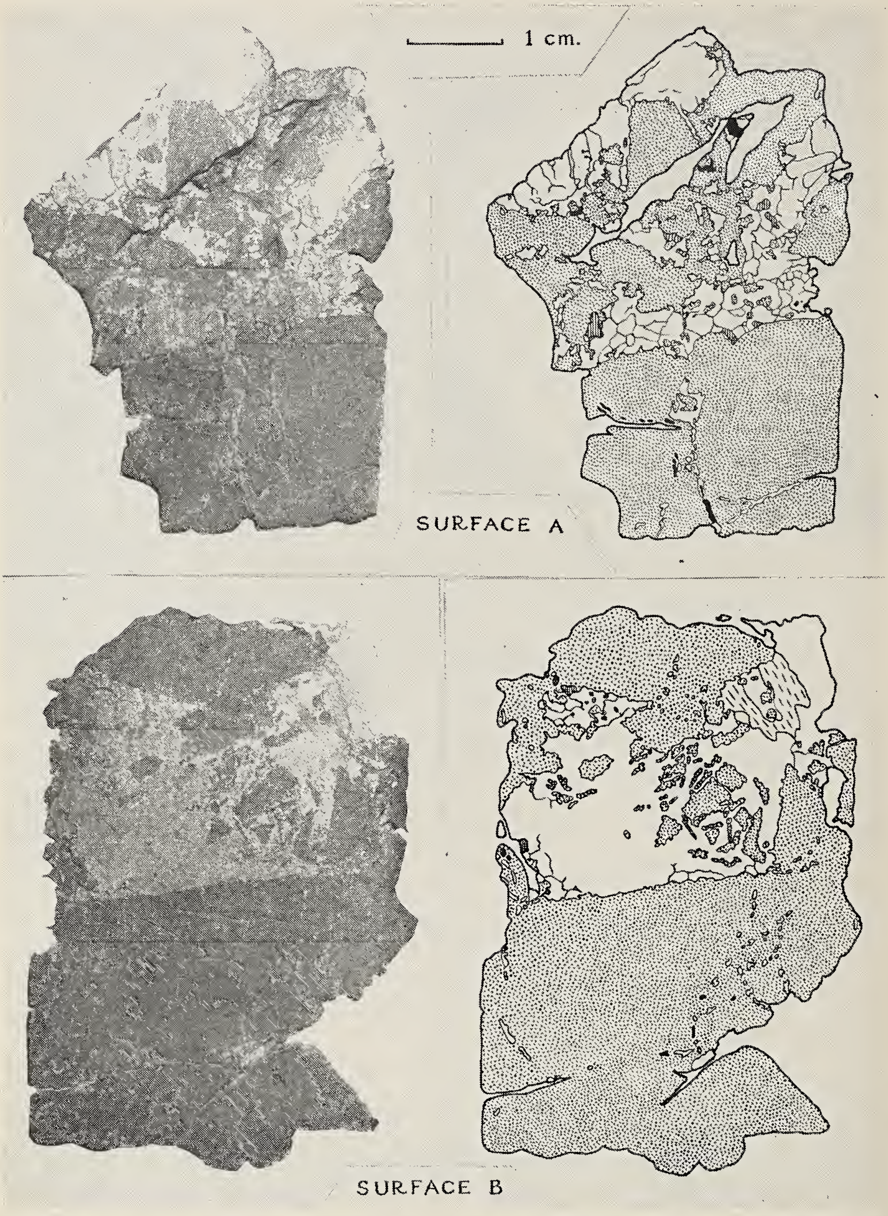

FIGURE 1. Two polished surfaces of the Saxeville meteorite. In the diagrams at the right, blank areas represent Ni-Fe; dots, stony material; vertical lines, schreibersite; solid black, troilite; short diagonal lines, Ni-Fe with abundant minute dark inclusions.

Description

Figure 1 shows details revealed by polishing the two sawed surfaces of the 220-gram specimen in the Lawrence collection. These two surfaces are at right angles to each other, with the right side of surface A adjoining the left side of surface B.

The lower half of both surfaces is stony, with only minor seams and patches of metal. The upper half shows angular fragments of stone in a metallic matrix. From the statements made by Mr. Kimball and Mr. Glen Waid to the effect that the meteorite "crumbled away" as it lay exposed in the woodshed, it seems likely that the metallic portion was originally enclosed in a considerably larger mass of stony material, and so was vein-like in character. Smaller veins may have been present in some of the fragments that flaked off.

The stony material is heavily iron-stained and presents a uniform dark brown color on sawed and polished surfaces. Thin sections reveal a crystalline mosaic, made up mainly of very small granules, but with occasional irregular patches of larger crystals. Figure 2 is a tracing made from a photomicrograph. In this small field, the mineral composition is:

Orthorhombic pyroxene	45.6 percent
Olivine	32.1
Plagioclase feldspar	.5
Opaques	21.8

Determination of grain boundaries, and in some cases identification of the mineral present, is rendered difficult by the prevalence of limonite stain. For this reason, Rosiwal analysis of larger areas of thin section has not been attempted. The percentages given above are probably fairly representative.

Grain boundaries shown in figure 2 are not necessarily the original crystal boundaries. In many cases, adjoining grains of the same mineral show only slight differences in optic orientation and are probably fragments resulting from the crushing of originally larger crystals. Undulatory extinction is common.

The feldspar shows distinct polysynthetic twin lamellae of uniform width. There is no evidence of zoning. So much material would have to be crushed in order to obtain a sufficient quantity of the feldspar for determination of its indices of refraction by immersion that this method of establishing its precise composition has not been attempted.

The paragenetic sequence is obscure. Plagioclase grains are enclosed by pyroxene and are probably early. The wedging out of some pyroxene crystals between rounded grains of olivine suggests that the olivine is also early. The olivine-feldspar relationship is not

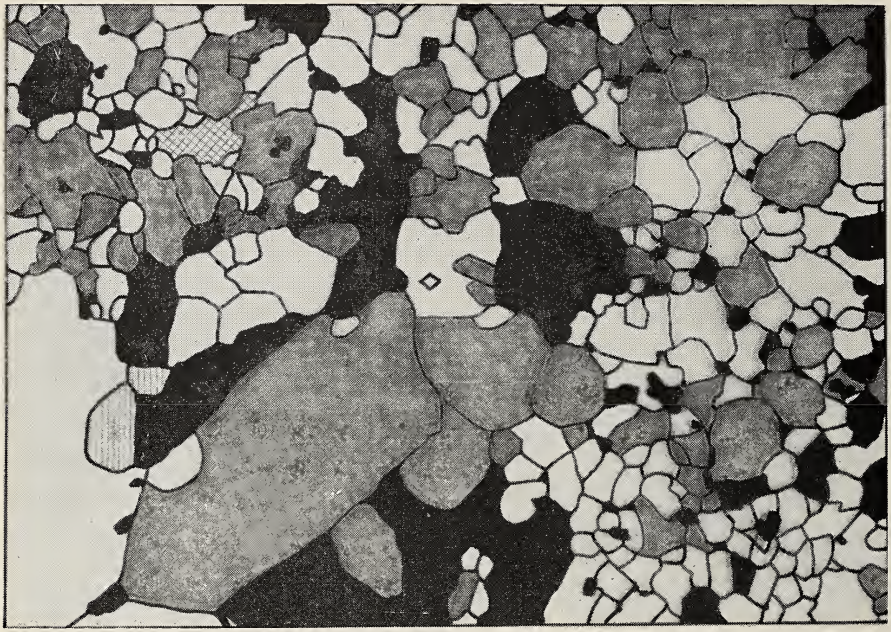

FIGURE 2. Tracing of photomicrograph of stony portion of the Saxeville meteorite, showing boundaries of silicate grains. White is pyroxene; grey, olivine; parallel lines, feldspar; cross-hatched, a hole in the thin section; black, opaque minerals. Area shown measures 1 x 1.4 mm.

FIGURE 3. Etched surface of Saxeville specimen at the Milwaukee Public Museum, showing structure of the metal.

clear. Some of the opaque grains appear to be early, since they are enclosed by single crystals of silicate minerals; others are apparently late, filling spaces between the olivine and pyroxene grains. The opaques have not been studied in detail. They appear to be Ni-Fe and troilite. No chromite has been noted.

No chondrules have yet been recognized, and evidence of original fragmental structure is lacking. In general, the texture resembles that of terrestrial periodotites.

A conspicuous feature of the metallic portion of the specimen illustrated in figure 1 is the network of dark grey limonitic veinlets dividing the Ni-Fe into roughly ovoidal, or polyhedral grains. This network shows most distinctly on surface A. The limonite also has a tendency to form narrow borders along contacts between metal and silicate masses. Occasional irregular veinlets run through the silicates.

Figure 3 shows an etched surface of the 134-gram specimen at the Milwaukee Public Museum—which happens to be dominantly metallic. As suggested by the pattern of limonite veinlets in the specimen shown in figure 1, most of the metal is in the form of irregular granules half a centimeter or less in length. Locally, however, there are distinct bands of kamacite arranged in an octahedral pattern. These bands are rarely more than three or four millimeters long, and their width is less than a millimeter.

The small area of metal measuring 1.2 by .8 cm. at the top of surface A, figure 1, was etched prior to final polishing and studied in some detail. This shows octahedral structure with bands of kamacite between .3 and .7 mm. in width (fine to medium octahedrite). An irregular border of kamacite about .5 mm. wide separates the metal with octahedral structure from adjoining masses of silicate. Thin strips of taenite separate the kamacite bands. No plessite fields were observed in the area etched.

S. H. Perry shows a number of interesting photomicrographs of metallic portions of the Saxeville meteorite in his paper on "The Metallography of Meteoric Iron" (Perry, 1944). He remarks (page 127) that "This iron . . . might be provisionally designated as an atypical coarsest octahedrite with accessory silicates." Apparently the octahedral structure in Perry's material is much coarser than that described above. According to Dr. E. P. Henderson of the U. S. National Museum (personal letter to the writer dated January 12, 1960), there are many more photomicrographs of this meteorite in a 9-volume album of photomicrographs of meteoritic iron prepared by Perry for various major museums. These the writer has not seen.

Figure 1 shows the presence of small, irregular patches of schreibersite scattered through the metallic portion of the specimen. Eight or nine such patches are readily seen on surface A, and there are five or six on surface B. Almost invariably, the screibersite is outlined by a narrow border of limonite. Some cohenite may be associated with the schreibersite; no tests were made for this mineral. Troilite also occurs in small patches about equal in number, and similar in size and shape, to those of schreibersite. However, the troilite patches are not limited to the metallic portion of the meteorite, but occur also in a stony matrix.

Most contacts between silicate masses and metal are frayed and highly irregular in detail. The impression given is that metal has replaced silicate. This impression is strengthened by the form of the metallic veinlet which traverse the lower, stony portions of the two polished surfaces shown in figure 1. Their uneven width certainly does not suggest simple fracture filling.[1]

Acknowledgments

Dr. E. P. Henderson of the U. S. National Museum very kindly read the first draft of the writer's manuscript, checked his description of the polished surfaces shown in figure 1, and made a number of very helpful suggestions based on his knowledge of this and other meteorites. Dr. A. L. Howland of Northwestern University examined the thin sections of stony material, estimated the percentages of various minerals present, and pointed out various criteria for identifying them. The writer's indebtedness to both of these gentlemen is gratefully acknowledged. However, they are by no means to be held responsible for such errors and inadequacies as this paper may now contain. Sincere thanks are also due to Mr. John D. Hankey of the Institute of Paper Chemistry for the preparation of a number of excellent photomicrographs, one of which was selected as a basis for the writer's figure 2.

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[1] Since this paper was written, Dr. Brian H. Mason of the American Museum of Natural History has examined the minerals in a fragment of stony material obtained from Mr. Buckstaff in Oshkosh. Dr. Mason finds the pyroxene to be very nearly pure enstatite, with a gamma index close to 1.664. The olivine is close to forsterite. (Personal communication)

BIOLOGICAL AND BIOCHEMICAL ASPECTS OF THE DEVELOPMENT OF POLYARTERITIS IN RATS*

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It has been demonstrated by numerous investigators (1, 2, 3) that estrogens exert a deleterious effect on the reproductive systems of male vertebrates. Perry (4, 5) has demonstrated that treatment with follicle-stimulating hormone (FSH) subsequent to the estrogen treatment results in polyarteritis nodosa in six to twelve months. Polyarteritis nodosa is an acute and sometimes recurrent disease of unknown etiology which occurs in higher chordates and man. It is frequently fatal and occurs at any age. The condition has been considered as due to infections, toxins, viruses, and allergies. It has been demonstrated that treatments which produce stress conditions result in the development of polyarteritis nodosa in laboratory animals. Rich and Gregory (6) have produced polyarteritis in rabbits after treatment with sulfanilamide. Selye and associates (7) have produced polyarteritis nodosa in rats by employing unilateral nephrectomy followed by high salt and protein diets and treatment with certain pituitary and adrenal hormones. Zondeck and others (8, 9) have demonstrated that treatment of rats with estrogen results in production of pituitary neoplasms.

In this work, the biological and biochemical aspects of the development of polyarteritis nodosa produced by hormonal treatment have been studied.

METHODS

The animals used in this investigation were adult male rats of the Holtzmann strain. They were divided into three groups. One group was maintained as controls and placebos to be used in establishing norms for the various studies.

Another group received 01. milliliter injections of estradiol proprionate (Ovocylin-Ciba, 1 mg/ml) subcutaneously every other day until ten injections had been received. These were immediately followed by 0.1 milliliter injections of FSH (Armour-300 gamma/ml) every other day until a total of ten had been received.

* Paper read at the 90th annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters. This study was supported in part by a grant from the Committee on Growth and Cancer, Marquette School of Medicine.

Earlier studies (4, 5) indicated that an altered pituitary is the site of the disease. The present work is, in part, concerned with evidence in support of this hypothesis. Polyarteritis nodosa does not develop in hypophysectomized animals treated with estrogen and FSH either before or after pituitary removal. Therefore the third group received homotransplants of pituitary tissue in which polyarteritis was developing. The method employed was as follows: pieces of pituitary tissue were excised from afflicted animals under aseptic conditions and inserted into the cerebral hemispheres of normal host rats by means of a trocar, which consisted of a large needle and stilet.

All three groups were maintained on a commercial ration and water, both ad libitum.

The criteria for the diagnosis of polyarteritis nodosa were as follows. (1) The presence of grossly visible nodules along the courses of greatly thickened arteries, particularly the mesenteric and splenic arteries, was taken as positive evidence of the existence of polyarteritis, provided that histologic sections revealed the characteristic pathology of the malady. (2) In the absence of grossly visible appearances, skip serial microscopic sections stained with hematoxylin and eosin were made from the testes, pancreas, thymus, and likely intestinal regions. The presence of numerous typically polyarteritic arterioles in these organs was considered as positive evidence of a response.

In addition to the previously mentioned histological studies, serial sections of pituitary glands stained with hematoxylin and eosin were made routinely and checked for the presence of neoplastic alterations. Serial sections of one adrenal gland from each animal were checked for the presence of adenomata. Alternate glands were chromated and checked to determine whether the tumors were of cortical or medullary origin.

Blood was obtained at sacrifice by rapid exsanguination from the jugular vein. During the development of polyarteritis, blood specimens could be obtained without sacrificing the animals by bleeding them from the caudal vein.

The relative serum protein fractions were determined by analysis with the Spinco Model R Durrum type cell. Whatman 3MM filter paper was used as the supporting medium. The buffer was prepared from standard Veronal buffer of ionic strength 0.075 to which NaCl was added to bring the total ionic strength to 0.10 and the pH to 8.45. The buffer was also made 0.2% (v/v) with respect to the non-ionic detergent Sterox SE. Ten microliter serum samples were separated for 24 hours at a constant voltage of 120 volts. The temperature of the cell was maintained at 10–15° C. during the entire separation. Following the separation, the electrophoretograms were heated for 30 minutes at 120° C. to denature the proteins. A modification of the standard clinical bromphenol blue technique, for the specific staining of the separated protein fractions, was employed. Excess dye was removed by three washes in 5% acetic acid, followed by a wash in a sodium acetate-acetic acid buffer which restores the basic color of the bromphenol blue. The strips are then scanned with the Spinco Model RA Analytrol which photoelectrically scans the dye uptake along the length of the electrophoretogram. Subsequent integration of the areas under the peaks of the resulting curves permit the calculation of the relative concentrations of the separated fractions. Serum lipoprotein fractions were determined on 20 microliter samples of serum by means of the same procedures of separation as outlined above. For the identification of the separated lipoprotein fractions, the method of Strauss and Wurm (10), which uses Fat Red 7B as a selective stain for lipoproteins and lipids, was used. Photoelectric scanning and integration of the areas under the curves were performed to determine the relative serum lipoprotein fractions.

Total serum proteins were determined on 0.1 milliliter serum aliquots using the Biuret reaction as routinely employed in clinical laboratories.

Analyses of serum sodium and calcium were performed employing standard clinical techniques which use the Coleman Model 21 flame photometer.

Standard clinical procedures were also employed for the analyses of serum chloride and inorganic phosphate phosphorus using a photovolt colorimeter.

Results

As early as four months and up to twelve months after completion of treatment, the animals became afflicted with the disease. Those that survived were sacrificed when they appeared to be nearing the terminal stages of the disease. At autopsy there was noted a definite testicular tubular atrophy. In addition there were noted the existence of extensive nodulation of the arterioles of the testes, alimentary canal, pancreas, and thymus. With the passage of time the larger arteries of these organs became involved. Sections of the spleen, lymph nodes, and even hypertrophied hemolymph nodes in the animals revealed large numbers of macrophages laden with brown staining granular pigment, which because of certain tests for iron is tentatively considered to be hemosiderin.

The pituitaries of the animals developing even incipient polyarteritis nodosa became hypertrophied and exhibited as much as a ten-fold increase in weight and volume compared with normal pituitaries. Approximately 50% of the animals had in their pituitaries tumorous cell with many of the morphological characteristics of malignancy. To date there has been no observed metastasis of the tumorous cells to the other organs.

A consistent and readily detectable indication of the onset of the syndrome was found in the appearance of adrenal cortical adenomata. These tumors account for enlargement of the glands to two or more times normal volume.

The study on the relative serum protein fractions is summarized in table I. In the albumin values, the rats sampled during the development of the disease had 70% of the relative concentration of albumin observed in the normal rats. The rats that had received pituitary implants had 50% of the normal concentration of albumin at sacrifice and rats in the terminal stages of the disease had 40% of the normal concentration of albumin.

TABLE 1

	Normal Serum N=21	Implants N=7	Treated N=10	P.A. N=7
Albumin	20.6—43.6% $\bar{X}$=35.2%	11.5—25.5% $\bar{X}$=17.1%	8.4—41.7% $\bar{X}$=25.8%	7.1—26.2% $\bar{X}$=14.7%
Alpha	11.9—43.3% $\bar{X}$=24.4%	8.3—36.2% $\bar{X}$=16.7%	7.6—54.0% $\bar{X}$=28.7%	20.4—36.2% $\bar{X}$=27.6%
Beta	18.7—33.6% $\bar{X}$=25.0%	23.2—60.0% $\bar{X}$=23.0%	18.8—30.3% $\bar{X}$=24.2%	23.1—56.0% $\bar{X}$=31.3%
Gamma	7.1—24.8% $\bar{X}$=14.6%	16.8—42.6% $\bar{X}$=29.5%	10.7—42.6% $\bar{X}$=21.6%	16.2—36.9% $\bar{X}$=27.6%
T. Protein in gm. %	3.8—7.2 $\bar{X}$=5.9	4.2—9.4 $\bar{X}$=7.1	4.8—16.8 $\bar{X}$=7.9	6.0—7.1 $\bar{X}$=6.3

The alpha globulins of rats developing the disease were 115% normal value. The rats in the terminal stages of the disease had 110% of normal and the rats with implants had 70% of the normal value for alpha globulin.

Rats in the terminal stages of the disease had beta globulin values 120% of the normal value. The rats with implants and the rats developing the disease had beta globulin values which were about normal.

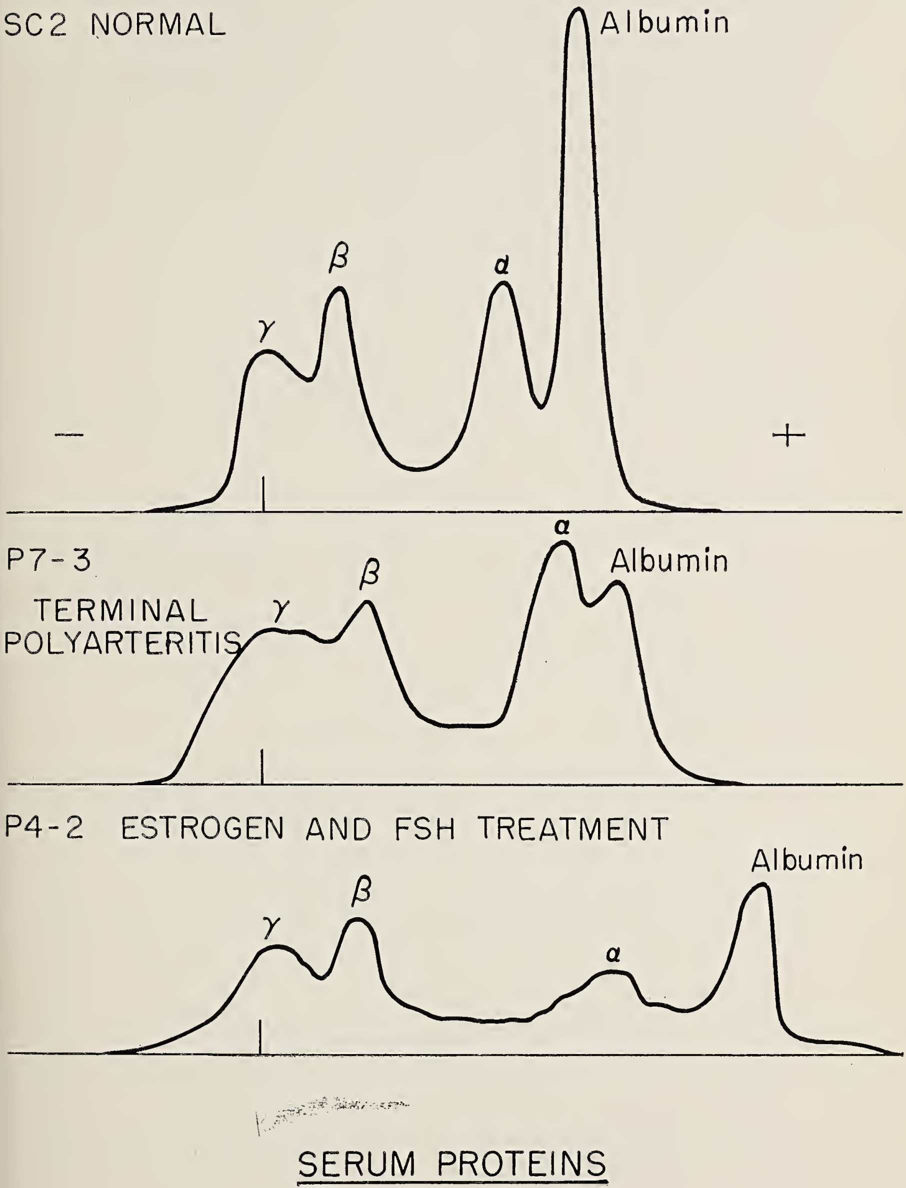
SC2 NORMAL
Albumin
β
d
γ
—
+
P7-3
TERMINAL
POLYARTERITIS
γ
β
α
Albumin
P4-2 ESTROGEN AND FSH TREATMENT
Albumin
β
γ
α
SERUM PROTEINS

FIGURE 1.

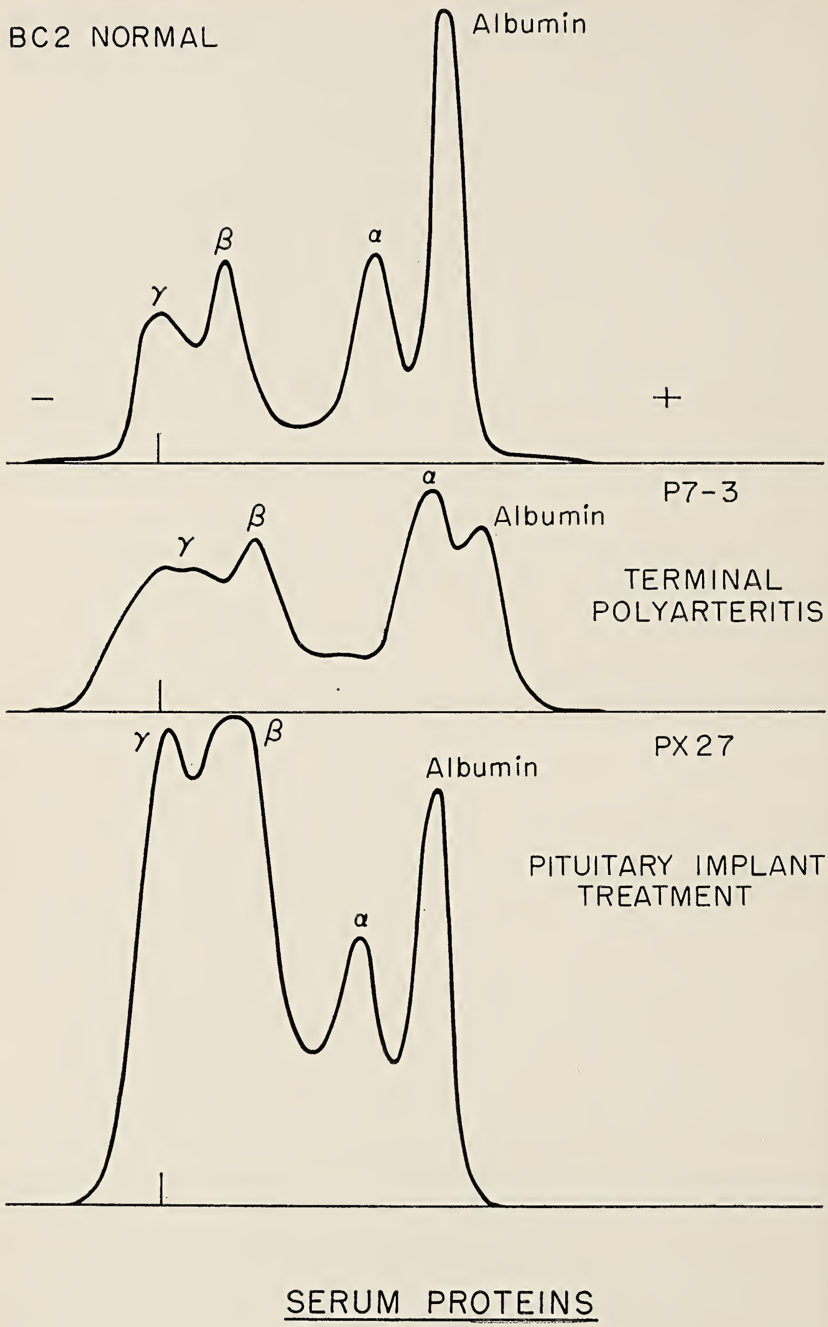
BC2 NORMAL
Albumin
β
α
γ
−
+
P7-3
α
Albumin
β
γ
TERMINAL POLYARTERITIS
PX 27
γ
β
Albumin
PITUITARY IMPLANT TREATMENT
α
SERUM PROTEINS

FIGURE 2.

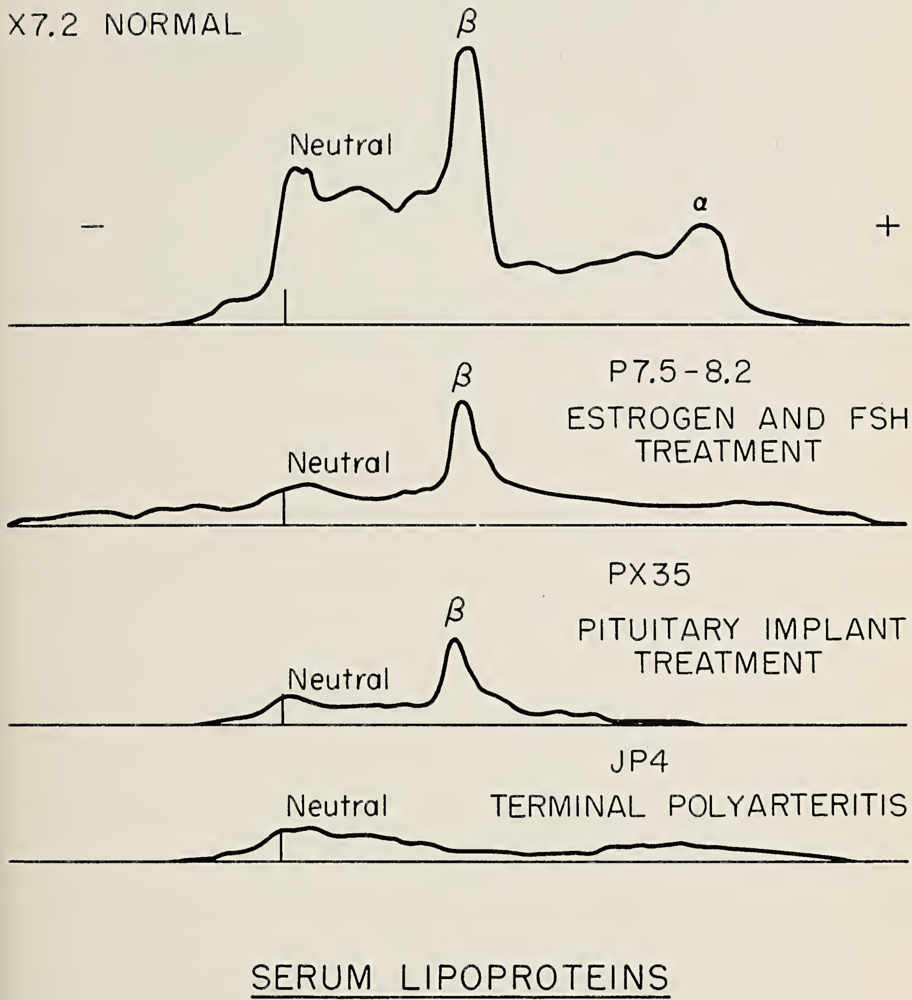
X7.2 NORMAL
β
Neutral
α
−
+
P7.5-8.2
ESTROGEN AND FSH
TREATMENT
β
Neutral
PX35
PITUITARY IMPLANT
TREATMENT
β
Neutral
JP4
TERMINAL POLYARTERITIS
Neutral
SERUM LIPOPROTEINS

FIGURE 3.

Both rats with implants and those in the terminal stages of the disease had gamma globulin values 200% of normal. The rats developing the disease had gamma globulin values 150% of normal.

Figures 1 and 2 are typical separations of normal serum and sera from the three experimental groups.

Figure 3 indicates typical separations of lipoproteins from the sera of these rats. The lipoproteins of the normal rat serum are distributed among three electrophoretic fractions—the alpha, beta, and neutral fractions. Rats developing the disease lack an alpha lipoprotein fraction and possess only the beta and neutral fraction. The same observation can be made for the rats with implants.

Rats in the terminal stages of the disease do not possess an alpha or beta lipoprotein fraction. We found only a neutral lipid fraction.

In table I are also listed the values for the total serum protein content in gm %. For rats in the terminal stages of the disease, the mean value for the total serum protein content is about the same as the value in the normal sera. Rats with implants had a total serum protein value 115% of the normal. The rats in which the disease was developing had a value 130% of normal value.

TABLE 2

	Normal N=30	FSH & Estrogen N=35	Implant N=18	P.A. N=9
Sodium meq/l	105—156 $\bar{X}$=136	90—197 $\bar{X}$=148	144—182 $\bar{X}$=156	133—162 $\bar{X}$=145
Calcium meq/l	4.4—5.5 $\bar{X}$=4.8	2.1—5.6 $\bar{X}$=4.1	3.6—5.2 $\bar{X}$=4.6	
Phosphorus mg %	8.6—10.5 X=9.7	11.0—12.1 $\bar{X}$=11.5		
Chloride meq/l	92—116 $\bar{X}$=107	91—123 $\bar{X}$=116	93—104 $\bar{X}$=99	

Table 2 lists the results of the electrolyte studies. The rats in the terminal stages of the disease had an increase of 7% in their mean serum sodium value. The rats in which the disease was developing had 9% increase and the rats with implants had 15% increase in serum sodium values from normal.

With regard to the serum calcium values, no significant variations were observed among the rats in which the disease was developing, those with implants, and the normal rats.

The rats in which the disease was developing had an increase of 18% over the normal value for inorganic phosphate phosphorus.

There was an increase of 8% over the normal in serum chloride values in rats in which the disease was developing and a decrease of 8% compared with the normal in the rats in which pituitary tissue had been implanted.

Discussion

With regard to the biological facets of this investigation, it is first to be noted that the hormonal injection procedure, which essentially sets up an endogenous stress situation, produces polyarteritis nodosa in adult male rats in four to twelve months after the completion of treatment. This lends strong support to the thesis that polyarteritis is due to the existence of an endocrine stress within the subject. Because of the observed increase in total serum protein in rats in which the disease was developing, which increase accompanies decreases in albumin concentration and increases in the globulin concentrations, we should like to suggest that there is occurring an antibody reaction to the administered FSH and/or increased amounts of adrenalcorticotrophic factors of normal or abnormal nature emanating from the neoplastic pituitaries.

The results of the lipoprotein studies suggest that the tumor cells of the pituitaries and adrenals selectively metabolize lipoproteins. Such selective metabolism parallels a similar observation by Kent and Gey (11) that tumor cells growing in vitro selectively metabolize serum glycoproteins.

The results of the electrolyte studies parallel results obtained by Friedman et al (12) which indicate similar abnormalities in animals receiving cortisone. Such abnormalities have long been associated with pituitary adrenalcorticotrophic secreting pituitary tumors. These results suggest that the polyarteritis nodosa may very well be a reaction secondary to a primary reaction which is the development of pituitary neoplasms.

Conclusions

1. Polyarteritis nodosa can be successfully induced in normal male rats by treatment with estrogen and FSH.

2. Polyarteritis nodosa can be successfully induced in normal male rats by the implantation into the hosts of pituitary tissue from afflicted animals.

3. The serum protein distribution in the experimental animals in which polyarteritis had or was developing was characterized by decreased concentrations of albumin and increasing concentrations of the globulins, particularly gamma globulin.

4. The serum lipoprotein distribution in the experimental animals indicated a growing loss of lipoprotein fractions with the development of the affliction.

5. The total serum protein content was elevated in the rats with implants and the rats in which the disease was developing, but unaltered from normal in the rats in the terminal stages of the disease.

6. The serum sodium was increased in all experimental classes.

7. The serum calcium was unchanged from the normal values in the groups studied.

8. The serum phosphate phosphorus was increased in the rats in which the disease was developing.

9. The serum chloride was increased in the rats in which the disease was developing and decreased in the rats with implants.

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ERRATA—VOLUME XLVIII (1959)

The following changes should be made in the article:

FLEAS COLLECTED FROM COTTONTAIL RABBITS IN WISCONSIN

GLENN E. HAAS and ROBERT J. DICKE

p. 129, first line of paragraph beginning *Behavior on host*—Insert word "Not" before word "unlike."

p. 131, fifth line of paragraph beginning *Disease*—change "(1949) reported that fleas . . ." to read "(personal communication, 1956) reported that our fleas . . ."

p. 131, eighth line of paragraph beginning "The spores . . ." delete the words "in ethenol."

ARTS AND LETTERS

CAMUS SPEAKS OF MAN IN PRISON*

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The accidental death of Albert Camus on January 4, 1960 at the age of forty-seven defined the limits of his literary works. "It is from death that they receive their definitive meaning" he wrote in the "Myth of Sisyphus".[1] Some manuscripts, unpublished and incomplete, remain to be incorporated in the total artistic creation of this French author to whom the Nobel Prize was awarded in 1957. The last complete literary work of Camus is the volume of six short stories entitled "Exile and the Kingdom," which was published in 1957. The first two stories had appeared singly, "The Adulterous Woman" in 1954[2] and "The Renegade" in 1956.[3] The two lectures delivered by Camus in Sweden in December, 1957, complement this book by defining the responsibility of the artist in contemporary society.[4]

In an earlier analysis of "The Fall," it was demonstrated that the concept of the judge-penitent of Camus limits man, as the cause of his own suffering and guilt, to judging the responsible exercise of freedom in others only if he has completely denied his own self-interest. "Humanity to move upward toward the summits must become its own *judge-penitent*. The *democracy of guilt* will engender between men that solidarity which will enable them to continue the quest for harmony with life."[5]

This concept of the judge-penitent and its attendant stigma of guilt postulates man as a prisoner who must come to terms with his little-ease, his "malconfort". Camus regarded this "instrument of torture of the Middle Ages, the cell in which a man could neither stand nor lie down, as the restriction which encompasses man and makes him realize his guilt."[6]

In spite of the opinion of M. Gaëtan Picon that "Exile and the Kingdom" does not emanate directly from "The Fall",[7] even though

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* Paper read at the 90th Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

[1] Albert Camus, "Le Mythe de Sisyphe" (Paris, Gallimard, 1942), p. 155.

[2] Cf. Roger Quilliot, "La Mer et les prisons" (Paris, Gallimard, 1956), p. 271.

[3] Cf. John Cruickshank, "Albert Camus and the Literature of Revolt" (London, Oxford University Press, 1959), p. 237.

[4] Albert Camus, "Discours de Suède" (Paris, Gallimard, 1958).

[5] Robert F. Roeming, "The Concept of the Judge-Penitent of Albert Camus", TRANSACTIONS of the Wisconsin Academy of Sciences, Arts and Letters, XLVIII (1959), p. 148.

[6] Ibid., p. 147.

[7] Gaëtan Picon, "Lettres", MERCURE DE FRANCE, CCCXXX, (May, 1957), p. 129: " 'L'Exil et le Royaume' ne répond nullement à 'La Chute,' ne s'ajoute pas à elle

the latter was originally conceived as a short story to be included in this volume, each of the stories is a variation on this theme of man accommodating himself to his little-ease. The prisoner of the Middle Ages was isolated in his cramped cell not only to make restitution through punishment but also through enforced meditation to gain a full realization of his guilt. Without hope of immediate escape he was to bring his own life into meaningful harmony with spiritual values which transcended the confines of his cell. The cell itself was designed to distort man and divest him of his physical dignity so that from such humility he could rise with transcendent spiritual dignity. In the same manner man is portrayed in these stories as a prisoner who must find the spiritual meaning of his apparently hopeless confinement.[8] This paradox of despair as the source of hope is the extension of Camus' philosophy of the absurd and its fundamental manifestation expressed in man's aspiration for the eternal and his subordination to duration and death.

As he did in previous works, especially in "The Fall", Camus continues by means of the stories in "Exile and the Kingdom" to interpret Judeo-Christian concepts in terms of his liberal humanism. As such these stories are parables, each of which adds to his analysis of the state of man.[9] The title of each story "The Adulterous Woman", "The Renegade", "The Silent Men", "The Guest", "The Artist at Work", and "The Growing Stone" is symbolic of the exile to which man in various physical manifestations can be condemned. Without referring to the detail of these six stories, the outlines of the philosophy which unites them can be delineated.

Camus regarded any art form as a means of philosophical, humanistic expression. "A profound thought", he wrote, "is in a continuous state of development, it is wed to the experience of a life and is fashioned in it. Likewise, the unique creation of a man fortifies itself in the successive and multiple appearances which are his works. . . . No doubt a series of works can only be a series of approximations of the same thought."[10]

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comme le segment au segment pour composer la ligne: mais oppose une tentative de plénitude aux réussites de l'abstraction." ("Exile and the Kingdom" in no way corresponds to "The Fall," does not connect itself to it like one segment to another segment in order to form a line: but opposes an attempt at completeness to the successes of abstraction.)

[8] Cf. Albert Camus, "L'Artiste et son temps" in "Discours de Suède", p. 70: Je crois qu'il [l'espoir] est au contraire suscité, ranimé, entretenu, par des millions de solitaires dont les actions et les oeuvres, chaque jour, nient les frontières et les plus grossières apparences de l'histoire, pour faire resplendir fugitivement la vérité toujours menacée que chacun, sur ses souffrances et sur ses joies, élève pour tous. (I believe that it [hope] is on the contrary roused, revived, maintained by millions of solitary individuals whose actions and whose works, each day, deny the frontiers and the most scurrilous appearances of history in order to have constantly menaced truth, which each one on his sufferings and his joys raises up for all, shine forth brightly though fleetingly.)

[9] Cf. Ibid., p. 64: Chaque grande oeuvre rend plus admirable et plus riche la face humaine, voilà tout son secret. (Every great work renders the face of man more admirable and more precious, that is its entire secret.)

[10] "Le Mythe de Sisyphe", pp. 154 and 155.

Since a parable alludes to the truth rather than stating it in finite terms, it is a most suitable art form for the probing intelligence of Camus. He believed that "truth is mysterious, elusive, always to be won anew."[11] Definitive truth is to him an instrument of evil. In the story "The Renegade" the hate-filled priest who willingly became the servant of the tyrannical Fetish realized this when in telling his story he states his conviction that "solely the reign of malice is devoid of defects, I had been misled, truth is square, heavy, thick, it does not admit distinctions, good is an idle dream, an intention constantly postponed and pursued with exhausting effort, a limit never reached, its reign is impossible. Only evil can reach its limits and reign absolutely."[12] As if, therefore, to emphasize his conviction that the ultimate truth of life is still to be won, Camus has composed these stories in a manner which causes his contemporaries to seek their meaning with effort equal to that with which they were wrought.

"Exile and the Kingdom" reinterprets the fundamental concept of the Old and New Testaments that man is an exile excluded from the Kingdom of God because of his sinful nature and can only be redeemed through the sacrifice of a blameless victim. Though he denies the existence of God and through this denial the concept of sinful nature, Camus, nevertheless, regards man as an exile, a prisoner isolated and shut out from the community of man by his deliberate or inadvertent cruelty. This cruelty may often be caused by man's inability or conscious refusal to accept responsibility for another human being or to take a positive action in his behalf when the occasion to do so presents itself.[13] The latter is true in the case of Daru, a schoolmaster alone on a winter enclosed plateau, who, having been given custody of an Arab prisoner and not convinced of his guilt, neither harbors him nor secures his freedom, but sets him on the path that leads to the prison and then returns to his solitude. Similarly, the sullen and silent coopers forced to return to work after their strike had failed could not find a word to comfort the employer, whose child had just died.

The fundamental characteristic of human life in these stories is solitude. All the protagonists are spiritually alone. Though they may spend their days among other men, the presence of these in-

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[11] Albert Camus, "Speech of Acceptance upon the Award of the Nobel Prize for Literature, December 10, 1957" (New York, Knopf, 1958), p. XII.

[12] Albert Camus, "Exile and the Kingdom," translated by Justin O'Brien (New York, Knopf, 1958), p. 54.

[13] Again and again Camus emphasized the point that abstention is an exercise of responsibility. In "The Fall" Clamênce's refusal to aid the drowning woman did not relieve him of responsibility. In "L'Artiste et son temps" he said, "A partir du moment où l'abstention elle-même est considérée comme un choix, puni ou loué comme tel, l'artiste, qu'il le veuille ou non, est embarqué. Embarquê me paraît ici plus juste qu'engagé." ("From the very moment that abstention itself is considered as a choice, criticized or praised as such, the artist, whether he wishes it or not, is embarked. Embarked seems to me more correct than engaged." "Discours de Suede", p. 26.

creases this solitude. In fact in such cases it is forged from such associations. The physical random juxtaposition of men in the daily activities of life without spiritual communication is an aimless wandering among phantoms. These formless masses, whether they be Arabs shrouded in their burnooses, Negroes operating a river ferry in the heart of Brazil, or the numerous flattering disciples of an artist, all pass through these stories accentuating the solitude of the individual because he is excluded from an appreciation of them as men and recognizes them only as "faces that seemed cut out of bone and leather."[14]

The more intimate relationships of human beings do not mitigate this solitude. Through them man only assumes the function of a necessary mirror by which the ego of another can be identified and a constant awareness of it maintained. The wife of the artist Jonas centered all her own interests around those she judged to be his. Marcel, the husband of the adulterous woman, by a reverse process considered his wife only from his own limited business interests and she assumed in his eyes the role of a business associate. In both cases external evidence indicates that solidarity between husband and wife had been achieved. Yet the maintenance of this solidarity only accentuates the lack of fulfillment which the individual senses from the void within him. "Immense solitudes were whirling within her"[15] expresses the experience of all the characters.

This solitude is a source of evil in two respects. It is a source of power for man whose natural inclination is to enslave. The wife reduces her artist husband Jonas to a state of incapacity to create by being constantly solicitous about his well being. The solitude which separates the condemned Arab from the schoolmaster Daru gives the latter power to send him on his way to death.

This solitude is evil also because it is sterile. It reduces man to impotence and deprives him of his freedom. This sterility is exemplified by the city of salt in the story "The Renegade." Without spiritual contact with man the individual sees life only as black and white. The city of salt has only these two colors accentuated by the dazzling sun. But this truth like salt cannot be productive since it is based on emotion not logic and can be dissipated like salt in the rain when it is subjected to scrutiny. This sterility breeds cruelty because it seeks to destroy the exercise of free minds, to cut out tongues so that man, like the renegade, is reduced to servile actions and bestial tongueless babblings.

Camus has thus established a thesis which is expressed in variations in the six stories. Man is a prisoner of space and time. The

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[14] "Exile and the Kingdom", p. 13.
[15] Ibid., pp. 26 and 27.

economic and social forces of his environment restrict his freedom, which is the only power for good at his disposal. These restrictions continue to intensify his self-interest, which in essence is a refusal to accept responsibility in behalf of his fellowman. His desire to make his own life meaningful in terms of the restrictions which his environment imposes increases his solitude and deforms him as a human being. He becomes cramped in his little-ease and yet cannot escape its rigid walls. The solitude he has forged reduces his once free mind to sterile activity like that of an automaton.

Camus evokes this sterile state of imprisoned and solitary man in numerous images. When Janine entered the hotel room she "felt the cold coming from the bare, whitewashed walls. She didn't know where to put her bag, where to put herself. She had either to sit down or to remain standing, and to shiver in either case. . . . She was aware only of her solitude, and of the pentrating cold, and of a greater weight in the region of her heart."[16] In the heart of Brazil the French engineer D'Arrast experiences the same solitude in a contrasting environment. "This land was too vast, blood and seasons mingled here, and time liquefied. Life here was flush with the soil, and, to identify with it, one had to lie down and sleep for years on the muddy or dried-up ground itself. Yonder, in Europe, there was shame and wrath. Here, exile or solitude, among these listless and convulsive madmen who danced to die."[17] The artist who built a small loft in the hallway so that he could find a place to work "was not painting, but he was meditating. In the darkness and this half-silence which, by contrast with what he had known before, seemed to him the silence of the desert or of the tomb, he listened to his own heart. The sounds that reached the loft seemed not to concern him any more, even when addressed to him."[18]

The schoolmaster Daru experiences the same indifference to man. Forced to accept an Arab prisoner as his guest for the night he must share his room with him. "In this room where he had been sleeping alone for a year, this presence bothered him. But it bothered him also by imposing on him a sort of brotherhood he knew well but refused to accept in the present circumstances."[19]

The mind of man, however, revolts against this sterile confinement, the absurd prison of time and space. In the vast kingdom of man the individual is but a small insignificant particle. Camus had native roots in the infinity of space. In his Algerian homeland he had the vast sea to the north and the boundless desert to the south. The infinite is the source of his inspiration and his optimism. Boundless space, the vastness of the starry night, the intensity of

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[16] Ibid., p. 14.
[17] Ibid., p. 198.
[18] Ibid., p. 152–153.
[19] Ibid., p. 102.

silence are the symbols of freedom, of the power of the mind to unite with the universe.

The kingdom which man must seek in order to liberate himself from his little-ease is without time and space. It is solidarity with the whole human race. It is the realization of participating as a free man in the quest for elusive truth. "Since the beginning of time," Camus says to imprisoned man, "on the dry earth of this limitless land scraped to the bone, a few men had been ceaselessly trudging, possessing nothing but serving no one, poverty-stricken but free lords of a strange kingdom."[20]

This kingdom is open to man if he will sacrifice himself, which is in essence his self-interest, accept responsibility for his fellow and suffer with him. The solidarity of mankind is, therefore, absurdly forged by his own cruelty since he is the cause of his own suffering.[21] This the engineer D'Arrast learned when he took on his own head the heavy stone which the Brazilian had vowed to carry in the religious procession but could not. In sharing this burden after having tried to avoid responsibility in deciding the fate of the drunken Chief of Police, he found a new kinship with the natives. That he had been recognized as a brother is verified by the simple command: "Sit down with us."[22]

This then is the exhortation that Camus addresses to man, without reference to time or space. "Cast off that hate-ridden face, be good now, we were mistaken, we'll begin all over again, we'll rebuild the city of mercy. . . . Yes, help me, that's right, give me your hand. . . ."[23]

These words of Camus "give me your hand" and "sit down with us" emphasize his consistent devotion to his humanistic ideals and fulfill his definition of art. "No master work," he said in a talk he gave in Turin in 1954, "has ever been based on hatred or contempt. On the contrary, there has never been a work of true art that has not in the end added to the personal freedom of everyone who has known and loved it."[24]

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[20] Ibid., p. 24.

[21] Cf. Claude Vigée, "Albert Camus: l'Errance entre l'Exil et le Royaume," *La Table Ronde* (February, 1960) p. 125: Tel nous apparaît donc, dans son oeuvre, le mirage du Royaume: lieu de la fraternité partagée entre les hommes et le monde, conquise sur l'absurde par un sacrifice de soi rédempteur, ou par une participation sans réticence au sacrifice d'autrui, comme nous enseigne l'histoire de "La Pierre qui pousse". . . . (Such then the mirage of the Kingdom appears to us: a place of brotherhood [a brotherhood which is] shared among men and the world, won over the absurd by a sacrifice of oneself as redeemer, or by participation without reservation in the sacrifice of another, as the story of "The Growing Stone" teaches us. . . .)

[22] "Exile and the Kingdom", p. 213.

[23] Ibid., p. 61.

[24] Quoted from Albert Maquet, "Albert Camus: (New York, Braziller, 1958), p. 198: The same sentence is repeated in "L'Artiste et son temps", p. 58: "Mais aucune oeuvre de génie n'a jamais été fondée sur la haine et le mépris."

CALM BETWEEN CRISES: PATTERN AND DIRECTION IN RUSKIN'S MATURE THOUGHT*

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In the spring of 1870, after the excellent reception of his first lecture as the first Slade Professor of Fine Arts at Oxford, John Ruskin wrote to his mother, "I really think the time has come for me to be of some use."[1] Six months earlier, upon enthusiastically accepting his appointment to the new chair, Ruskin had written to his friend Sir Henry Acland, "The last ten years have ripened what there was in me of serviceableness, and chastised much of my hasty stubborn and other foolish, or worse, faults. . . . For instance, I now recognize in Tintoret faults before entirely hidden from me, because I can now measure him by standards I then [when finishing *Modern Painters*] knew not, and because my own character is more formed."[2]

Such calm self-criticism would have seemed strange coming from the still maturing, impetuous author of *Modern Painters* and *The Stones of Venice*.[3] However, Ruskin had turned fifty in 1869; his famous books on art were ten years behind him; and in the 1860's he had been busy forming his ideas on ethics and sociology. By 1870, his marriage was a thing forgotten; for a number of years he had been reconciled to Rose La Touche's refusal; and, although his father was dead, his mother was still alive. After 1870 Ruskin was to be distracted by his many and varied projects as well as to be troubled by his frequent and prolonged mental breakdowns. But coming just as his thought was reaching full maturity, the Oxford appointment afforded Ruskin an opportunity to 'sum-up' before an intelligent audience. It should not be surprising, then, that he said his Inaugural Lectures on Art were "the most important piece

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* Paper read at the 90th Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

[1] Letter dated 16 February 1870, *The Works of John Ruskin* . . . , eds. E. T. Cook and Alexander Wedderburn, 39 vols. (London, 1903–12), XX, xlviii. Further quotations are from this edition which will be cited as *Works*.

[2] Letter dated 19 August 1869, *Works*, XX, xix–xx. See also Wm. Hardman, *A Mid-Victorian Pepys: the Letters and Memoirs of Sir William Hardman*, ed. S. M. Ellis (London, 1923), p. 95, and E. T. Cook, *Works*, XX, xlviii.

[3] For an excellent account of the development of Ruskin's maturing thought, see Francis G. Townsend, *Ruskin and the Landscape Feeling: a Critical Analysis of His Thought During the Critical Years of His Life, 1843–56*, Illinois Studies in Language and Literature, XXXV, No. 3, Urbana, 1951.

of my literary work done with unabated power, best motive, and happiest concurrence of circumstance."[4]

A return to academe is not very dramatic. It is hardly so biographically engaging as Ruskin's earlier turn from art to ethics after *The Stones of Venice* and the last volumes of *Modern Painters*. Yet for those whose interest is either in the main Victorian writers as prophets and thinkers or in main Victorian habits of mind, this later turning point in Ruskin's life ought to prove much more significant. Ruskin believed that the Slade Professorship was his first responsible position; hence, he wrote his Inaugural Lectures with a new self-conscious care and seriousness.[5] As a result here can be found a convergence of the diverse movements of Ruskin's thought, early and late; here more cogently than elsewhere he adjusted and corrected previous ideas at the same time that he introduced new ones. The lectures, thus, attained a consistency not usually associated with Ruskin and in them for the first time can be seen how his ideas on morality, art, and ethics follow one upon another.

(This statement should not be taken to mean that Ruskin was consistent in the way that a philosopher tries to be consistent, nor does it imply that Ruskin was conscientiously any more logical than is the average well-educated man. Yet it does rest on the assumption that a high native intelligence educated by experience brings to a true maturity a sound basis upon which thought can be analysed, refined, and built. Needless to say, insight and reflection can work together productively without knowing how or caring why.)

This study, then, will attempt to show the general pattern and overall direction of Ruskin's mature thought as expressed in his Inaugural Lectures on Art. Although it will emphasize his final ideas on art and ethics, his basic philosophy of life will have to be suggested first because for Ruskin art and ethics "are founded on the same primal order."[6] Then, because Ruskin's social schemes simply did not work, it will be helpful to see where his ideas on ethics went astray, so that we may view his last years of frustration and distraction with somewhat fuller understanding. But above all, analysis of the interrelationship of Ruskin's thought on man, art, and ethics may stand as an *exemplum* to major ideas and moods which run throughout the Victorian period.

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[4] *Works,* XX, 13. See also, pp. xviii–xlix for E. T. Cook's account of Ruskin's pleasant and dedicated first years at Oxford.

[5] See his comments, *Works,* XX, 47, 49, 60 n., 61 n., et passim. Citations in the text will be from Vol. XX which contains these lectures and *Aratra Pentelici,* the fall lectures, which will be used to clarify and support the spring lectures.

[6] *The Laws of Fesole* (1879), *Works,* XV, 467.

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Ruskin's general philosophy was "moral"; his writings are crowded, and perhaps clouded, by the repetition of the words *moral, morals,* and *morality.* The *NED* attests that each of these words has escaped, historically, constant or single definition, and Ruskin's writing is a perfect example of the fact because he, like all of us, used the words loosely. But we can see that he understood their basic significance when he said that morality is "*an instinct in the hearts of all civilized men*" which enables them to "acknowledge, instinctively, a relation of better and worse, and a law respecting what is noble and base."[7]

The human ability to distinguish good from bad, and to choose correctly or wrongly is, of course, the traditional humanistic concept which allows reason to become operative as the guiding force in life. But Ruskin did not believe in the Aristotelian idea of warring passions or in the Christian idea of the recurring curse of original sin. With him, as with Wordsworth and the intuitional philosophers, man was born fundamentally good and pure: "There is no black horse in the chariot of the soul. . . . They [the human instincts] are all good" (88). Hence, *goodness,* not reason, was for Ruskin the basic human attribute which gives meaning to and actuates morality. And it must be noted that for Ruskin who was no professional philosopher the words *good, noble, courageous, gentle,* and *great* were synonymous.[8]

With Ruskin as with Socrates and a myriad of others, the first step in morality was to "know thyself." However, because of his basic assumption concerning the nature of man, he adapted that humanistic *dictum* to: "the first thing we should want to know [is], what stuff we are made of—how far we are . . . good, or good for nothing." And the way to find out is to apply this test: if you knew beyond doubt that you would die in seven days and had no knowledge of, or belief in, an hereafter of any sort or condition, then, "the manner in which you would spend the seven days is an exact measure of the morality of your nature." If your natural goodness were strong, you would, first, "set your affairs in order" and, then, provide "for the future comfort . . . of those whom you loved," because, in support of goodness, man has two main instincts, powers, or energies through which goodness is enlarged: "the energies of Order and of Love." This test, then, defines Ruskin's basic phi-

[7] *Works,* XX, 49, 268. See also *Val D'Arno* (1873), *Works,* XXIII, 131, where Ruskin repeats this view when summarizing his moral philosophy, and where he quotes Carlyle and Kant on the "miracle" of man's instinctive feeling for right and wrong. (The italics here and throughout the quotations are Ruskin's; when revising his works, he emphasized what he believed were his most important ideas.)

[8] Cf. the usage in Bertram Morris, "Ruskin on the Pathetic Fallacy, or How a Moral Theory of Art May Fail," *The Journal of Aesthetics and Art Criticism,* XIV (December 1955), 248–266.

losophy of innate human goodness supported and enlarged by an exercise of the instincts for order and love, for the test "will mark to you the precise force, first of your absolute courage [i.e., basic goodness], and then of the energy in you for the right ordering of things, and the kindly dealing with persons."

Because this definition of morality might seem abrupt and limited, I should like to quote at some length what Ruskin said further about the "energies of Order and of Love" in practice:

> Now, where those two roots are set, all the other powers and desires find right nourishment, and become, to their own utmost, helpful to others and pleasurable to ourselves. And so far as those two springs of action are not in us, all other powers become corrupt or dead; even the love of truth, apart from these, hardens into an insolent and cold avarice of knowledge, which unused, is more vain than unused gold.
>
> These, then, are the two essential instincts of humanity: the love of Order and the love of Kindness. By the love of order the moral energy [of goodness] is to deal with the earth, and to dress it, and keep it; and with all rebellious and dissolute forces in lower creatures, or in ourselves. By the love of doing kindness it [goodness] is to deal rightly with all surrounding life. And then, grafted on these, we are to make every other passion perfect; so that they may every one have full strength and yet be absolutely under control.[9]

Thus Ruskin's philosophy of life was: know that you are basically good, pure, and noble and that, by following the laws of love and obeying the laws of universal order, you may become Good, Noble, and Great. As Ruskin said in 1883 in a sentence which he called the heart of his moral philosophy, morality begins, and consists "to the end, in truthful knowledge of *human power* and *human worth* [i.e., the moral attribute of goodness]; in respect for the natural claims of others [i.e., love]; and in the precision and thoroughness of our obedience to the primal laws of probity and truth [i.e., order]."[10]

II

Ruskin's philosophy of art follows easily from his general philosophy simply because an artist is a man. For Ruskin, the picture is the measure of the artist, and to adapt Milton's version of the classical maxim, he who would be a great artist, ought himself to be a true picture. That is, to be great, art must be "the work of *manhood* in its entire and highest sense"; it must be *"the expression of a mind of a God-made great man."*[11]

But to be a good man is one thing and a great artist is another. The connecting point, as Ruskin had early discovered, is the cre-

[9] *Works,* XX, 85–88. Ruskin said in 1877 that the passages here summarized and quoted were central to all his writings on morality (*Works,* XVIII, 204).

[10] The 1883 Preface to *Modern Painters,* II, *Works,* IV, 6. See also, *Works,* XX, 91–93, and *The Bible of Amiens* (1884), *Works,* XXXIII, 173.

[11] *The Stones of Venice, Works,* XI, 201; *Modern Painters,* III, *Works,* V, 189.

ative imagination of the artist.[12] Hence his definition of the imagination is just as basic to his philosophy of art as was his definition of goodness to his moral philosophy. What ties the two areas of inquiry together is the fact that the imagination is the "highest faculty of the human mind" which sees "the eternal difference between good and evil" (52–53). Because it is morally grounded in goodness the imagination was to follow the moral energies of order and love. The pull of order on the imagination leads to art created, as Aristotle said, "in accordance with true reason";[13] the pull of love leads to *harmony* and *beauty* (55, 90, 207–209, and 298). Thus the artistic imagination contains highly refined Aristotelian reason which sees *truth* through order, and a sharply defined instinct for *beauty* because "beauty is exactly commensurate with the imaginative purity of the passion of love" (90). Imagination, then, is both "noble and truhtseeking" (242).

But how does an artist with a noble and truthseeking imagination actually go about creating *beauty* and *truth?* Again with echoes of "know thyself," Ruskin said that "the first morality of a painter, as of everyone else, is to know his business" (81). As a result he naturally must first have the "skill" of painting what his morally rooted imagination has seen in the order of life. Then he must subdue subjective emotion to the discipline of external form, because only through form can the "truth" of life be shown (95 and 265–271). The artist has to pierce through flux and appearance to imitate the permanent order and essential forms of nature. *Not* by proceeding now in the subjective manner of *Modern Painters* but only by being guided by the Aristotelian principle of imitation can the artist relate "the utmost ascertainable truth respecting visible things" (46). Once truth is obtained, "the laws and forms of beauty" will follow (55).

The *law* of beauty is "harmony" and comes into painting because the artist has mastered total morality and the skill of orderly painting (95–96 and 297–298). And the *form* of beauty takes its definition from the natural result of a good man's skillful and harmonious creation; that is, beauty "is what one noble spirit has created, seen and felt by another of similar or equal nobility" but possibly lacking the artist's creative imagination (209). In summary, then, fine art is that "which demands the exercise of the full faculties of the heart and intellect"; for the heart with its energy of love leads to beauty, and the intellect with its instinct of order leads to

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[12] See Van Akin Burd, "Ruskin's Quest for a Theory of the Imagination," *Modern Language Quarterly,* XVII (March 1956), 60–72.

[13] *Works,* XX, 45. Ruskin quoted the Greek from Aristotle's definition of art in *Ethics,* vi. 4; I have used the editors' translation. Ruskin's new respect for Aristotle and imitation in contrast to his earlier contempt in *Modern Painters* is seen best in his lecture on "Likeness," *Works,* XX, 272–300.

truth (46). Such exercise of the moral energies of love and order calls for imagination, but to have imagination the artist "must have the right moral state first" (73).

III

At the end of his work on *The Stones of Venice* Ruskin decided that it was impossible for an artist to have the moral state conducive to the creation of art unless the nation in which he lived was itself moral; by the time he had finished *Modern Painters,* he realized that the art of England was not so fine as he had first thought. Hence, in 1860 he turned his attention to the ethical state of the English people with the hope of correcting the cause of artistic decadence, and by the time he had assumed his Oxford chair, he had worked out his ethical philosophy.

In his moral philosophy Ruskin thought Everyman was basically good; in his ethical philosophy, he believed that all men had an instinct for work, which he called variously *duty, industry, useful energy,* and *useful action* (40, 87, 93, 264). Realizing that people might doubt this ethical instinct, Ruskin asked, "Does a bird need to theorize about building its nest? . . . All good work [i.e., moral, human work] is essentially done that way."[14] Man can do good work, or "noble deeds," instinctively because along with the moral attribute of goodness, God gave man the ethical attribute of industry (116). In fact He reinforced this instinct after the fall with the commandment that man must work; thus it is doubly true that "life without industry is guilty" (93). But by obeying God's will men can enlarge their instinct for industry, which in turn will teach them the laws of eternal righteousness and mercy. As a result, just as the end of morality was a man apt "for the right ordering of things, and the kindly dealing with persons," so also the end of all men's useful work will be a society full of justice and brotherly love. Work is the way, for "all things lovely and righteous are possible for those who believe in their possibility, and who determine that, for their part, they will make every day's work contribute to them"; Ruskin's credo led him to see in the future "an Ecclesia of England" (117). But Victorian England was not a "lovely and righteous . . . Ecclesia"; it was ugly and evil.

Surveying the scene, Ruskin concluded, as had Carlyle, that " 'the triumphs of modern industry' . . . do not seem to produce nobler [i.e., better, greater] men and women" (xxvii) because the industrial revolution had led some of the people to live in the folly of "*imagining that they can subsist in idleness upon usury*" (40). Believing that the "general productive and formative energy, of any

[14] *Sesame and Lilies* (1865), *Works,* XVIII, 167.

country, is an exact exponent of its ethical life" and that living on capital income, or "usury," was not productive, he was sure that he had found the reason why the ethical state of England was not good (39).

But Ruskin was Victorian enough to find hope for England in a bit of dated racism. He believed that the "instinct for beauty" was inherited, but only within races with a noble "ethic" (36, 79). Because they have the instinct for beauty, these races show that they are in some "kind of moral health"; therefore, for them "*absolute* artlessness . . . is impossible; they have always, at least, the art by which they live—agriculture or seamanship; and in these industries, skillfully practiced, you will find the law of their moral training" (84). Agriculture and seamanship skillfully practiced, in contrast to "usury," are "productive"; hence, they reveal moral health and contribute to the betterment of the ethical state of a nation. Because the English was one of those races so blessed with the "instinct for beauty," there was hope for England (40–41); however it lay not in the industrial revolution, but in the "elementary practice of manual labor" (264). For Ruskin, then, the function of ethics was to cultivate and nurse the basic ethical attribute of industry in the English people.

Having no doubt in his ethical philosophy Ruskin set about to put it into practice. By his test of morality, a man whose affairs were in order, and who dealt kindly with others was moral. The beginning of social morality, then, was simple; it lay "*in getting our country clean, and our people beautiful*" (107). Ruskin was sure that cleaning up the country would put order into English society, and that giving the people beauty would teach them the instinct of love (108–115). Once order and love were in society, "agriculture by hand, then, and absolute refusal or banishment of unnecessary igneous forces," would insure the proper environment for the instinct for industry to develop which, in turn, would lead to fine art [i.e., refined morality] and a just and merciful nation (114 and 89–90). When the triumphs of the industrial revolution were banished or curtailed, every man's work would have to be "productive," and Ruskin's ethical theory would become reality. However, the industrial growth of England continued, and although he never gave up his ethical scheme, Ruskin became more and more disillusioned.

IV

Ruskin's idea of work as a means of ethical salvation was as old as Genesis and as new as *Sartor Resartus*. But Ruskin was frustrated in his ideas for the same reason as was Carlyle. Neither had a sense of history which was sufficient to cope with the fact and reality of an industrialized England. But unlike Carlyle, Ruskin's moral response to human suffering made him persist in his dreams. Although his road building scheme and his St. George's Guild could not succeed in Victorian England, the moral and ethical thought behind them is a tribute to Ruskin's determination not to be caught up in the philosophic relativism and economic rationalism of his time.

The failure of his theories stems from the fact that, when Ruskin started *Modern Painters,* he believed in the efficacy of the landscape feeling, the Wordsworthian impulse from the vernal wood which taught that each man was basically good. But, after finishing Volume V and *The Stones of Venice,* when he knew that there was evil in society, he turned to ethics without looking back to individual men as the cause of evil. Morally corrupting evil was an external, and the way to destroy it was by external means. In itself, his moral philosophy was not too "wrong-headed." If each man looks inward, believes he is good, and wills to improve his goodness by following a positive, constructive discipline and by living in love and charity with his neighbor, the end is no dfferent than if each man finds both good and evil within his soul, but wills to follow goodness only, by always choosing aright. However, not all men are good, or choose to be good. Hence when Ruskin's basic philosophy is extended to the philosophy of art, it is only a partial, incomplete theory simply because not all great painters have been good men. When extended to ethics, it is mere fantasy.

The ethic of a country is the sum of the moralities of all men. The populace is not a single, noble *tabula* which will be good if you erase the evil impressions which it has received and give it only kind and orderly impressions. The moral fibre of each man's *tabula* varies. All men may be capable of good, but not all men will be good just because they work with their hands, and live in beautiful houses and orderly towns. Because there is no single formula for social salvation, ethics cannot be legislated. Progress to complete social morality must be as slow as it takes to reach and teach each man, first, individual morality, and, then, his ethical responsibility.

The heart of Ruskin's fallacy is best seen when he discussed Plato's image of the chariot: "There is no black horse in the chariot of the [individual] soul," but when "Plato uses [the chariot] as an image of moral government," "it is among the most beautiful pieces of mysticism to which eternal truth is attached" (88). How the black horse appeared in society was, indeed, a piece of mysticism for Ruskin, because there was no evil in the people who made up society. If the people were good, then the evil horse in society which Ruskin wished to whip away was made of straw.

Ruskin was frustrated in his ideals because he never saw the basic contradiction in his jump from morality to ethics. Unfortunately, it is easier for us to see the frustration and contradiction than it is to see the ideal for which Ruskin was aiming. We call him inconsistent; yet few men have been more consistent in their love of their fellow men and in their dedication to understanding and correcting the evils that abound in modern society. His failings were not a lack of intelligence and moral sensibility, even though he may have lacked the rational objectivity to comprehend fully what was going on around him. I think it not amiss to see Ruskin caught in the rebound from Wordsworthian, intuitional romanticism that moves through the Victorian period and that leads to the reawakened interest in classical humanism so clearly discernible in the twentieth century, in France and America as well as in England. If we should ever make a full return from basically romantic to basically classic premises of taste and judgment, Arnold may be the most important writer in England advocating the change, but Ruskin well may be the most important figure exemplifying the transition itself. For example, we have already noted his final advocacy of Aristotelian imitation of external form as interpreted through right reason. Furthermore, the disillusionment which Ruskin experienced during the last quarter of the century is perhaps another instance of how he was a child of his period. Thus, if we find that a major source of his dejection came from the philosophical dilemma which arose out of his switch from morality and art to ethics, perhaps the present analysis of Ruskin's attempt to synthesize his ideas may shed light on a major source of the general Victorian pessimism.

In any case the Inaugural Lectures on Art allow us to see for the first time how Ruskin's mature ideas on morality, art, and ethics all follow one upon another. To overlook this period of calm between crises needlessly complicates and confuses any study of Ruskin and his ideas. Perhaps students of Ruskin would do well in the future to keep in mind that he is reported to have said, "I have taken more pains with the Oxford Lectures than with anything else I have ever done, and I must say that I am immensely disappointed at their not being more constantly quoted and read" (xxii).

THE CREATIVE WRITER AS POLYGLOT: VALERY LARBAUD AND SAMUEL BECKETT

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Twentieth century writers have instinctively felt the need to express themselves in more than one language. Few writers before 1900 had achieved literary distinction in a second language; John Gower, Chaucer's contemporary, did his major work in English, French and Latin, but he stands as a fairly isolated case.[1] There is certainly nothing to challenge the astonishing surge of modern authors who have made polyglot tendencies an essential aspect of their craft.

Rilke, Eliot and Pound, among the poets, have experimented widely with foreign languages. Rilke, profiting from his stay in France as Rodin's secretary, turned out some late lyrics in French. Eliot wrote four French poems for the 1920 collection of his verse; offered a loose translation of the final section of one of these, "Dans le Restaurant," as part IV of *The Waste Land;* and used foreign language borrowings in all his major poetry. Pound is famous for the Chinese ideograms and other obscure references in *The Cantos* and for his "translations" from the Chinese, Cavalcanti, Fontenelle, etc.

Among the novelists, James Joyce exhibits the most impressive linguistic range. His life was divided among four European capitals—Dublin, Paris, Trieste and Zurich—which gave him fluency in English, French, Italian and German. His last two works show not only a competence with innumerable languages and dialects but also an unmatched creative vigor which has given birth to the portmanteau words and verbal plays of *Finnegans Wake.*

A more unusual case is Vladimir Nabokov who had a successful literary career in Russian until about 1940 when he moved to America and started writing exclusively in English. Works like *Pnin* and *Lolita* convince us of his stylistic fluency in his adopted language. He was forced to make virtually the same linguistic adjustment as Joseph Conrad who was born of Polish parents in the Ukraine, but unlike Conrad whose published works are exclusively in English Nabokov not only changed language but readjusted literary standards. The recent *Invitation to a Beheading,* Nabokov's

[1] There are, of course, writers like Dante who divided their talents between Latin and the vernacular. Yet for Dante, the literary language was always Italian, the "vulgar", while Latin was saved for the more didactic works like his *De Monarchia.*

first Russian work to appear in English,[2] shows the remarkable difference between the American and Russian phases of the same literary personality.

We might endlessly multiply the number of contemporary writers who either use their vast linguistic acquaintance as a literary device or write in several languages. For the first group, cosmopolitanism seems a genuine concern; linguistic and literary boundaries have ceased to offer a serious challenge. Valery Larbaud has echoed this feeling convincingly in a diary notation which dates from 1912:

> . . . Tout écrivain français est international, il est poète, écrivain, pour l'Europe entière et pour une partie de l'Amérique par surcroît. . . . Tout ce qui est "national" est sot, archaïque, bassement patriotique. . . . C'était bon dans des circonstances particulières et à des époques particulières, mais tout cela est révolu. Il y a un pays d'Europe.[3]

Valery Larbaud was himself one of the most astonishing "littérateurs" of his time. This French writer who died in Vichy in 1957 was active as a novelist, poet, critic and translator. He deservedly prided himself on reviving neglected literary reputations and introducing new talents. His biographer G.-Jean Aubry speaks of a youthful translation of Coleridge's *Rime of the Ancient Mariner,* published at the age of twenty and redone ten years later. We are told also of Larbaud's early devotion to Whitman which ended in some translations and a preface.[4] He may be said to have done for Walt Whitman in France what the Symbolist poets of an earlier generation had done for Edgar Poe.

Larbaud wrote an important preface to Faulkner's *As I Lay Dying* which accompanied Maurice Coindreau's 1934 French translation of the novel (*Tandis que j'agonise*). He made the same kind of seminal observations about Faulkner's technique as he had made thirteen years earlier in his now-famous December 7, 1921 lecture on James Joyce.

These translations and prefaces, however, do not stand as mere exercises in technique. They are part of a skillful pattern which runs through Larbaud's work; the critic and translator always make way for the creative writer. When Larbaud goes further afield and uses his other linguistic accomplishments—he apparently had mastered not only English but also Italian, Spanish and Portuguese—he seems to enrich his own novels and short stories. One never ceases to be impressed by the number of writers Larbaud

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[2] This work was translated by Nabokov's son Dmitri "in collaboration with the author."

[3] Quoted in Saint-John Perse, "Valery Larbaud ou l'honneur littéraire," *La Nouvelle Nouvelle Revue Française,* September 1957, p. 398.

[4] See Georges May, "Valery Larbaud: Translator and Scholar," *Yale French Studies,* number 6, p. 86. I am indebted to this article for many of my remarks on Larbaud's translations.

has translated into French. A partial list would include Samuel Butler, Francis Thompson, Liam O'Flaherty, Robert Louis Stevenson, Arnold Bennett, Edith Sitwell, Archibald MacLeish, James Joyce, Walter Savage Landor from the English; Bruno Barilli, Ricardo Bacchelli, Gianna Manzini, Emilio Cecchi from the Italian; Ricardo Güiraldes, Alfonso Reyes, Ramón Gómez de la Serna, Gabriel Miró from the Spanish.

But these are more than mere renderings from one language to another. They are, in almost every instance, the work of a polyglot endowed with a distinguished literary sensibility. The Samuel Butler translations, which occupied five years of Larbaud's time and prevented him from handling the translation of Joyce's *Ulysses* by himself, were a herculean task and one of the most successful renderings of Butler in any language. "Valery Larbaud's translations of *Erewhon, The Way of All Flesh, Life and Habit, Erewhon Revisited* and the *Note-Books* appeared in the 20's: they stand as an unmatched model of courage, energy, probity, love, intelligence and ingenuity; they are the most eloquent reply to those who, emulating La Bruyère or Montesquieu's geometer, still maintain that a translator does not need to think."[5]

Larbaud's translations come very close to being "original" versions. There are certainly Whitmanesque elements in Larbaud's early collection of poetry, *Les Poésies de Barnabooth;* and in turn the Whitman translations impress one as the closest French equivalent of the original verse—given the differing conditions of French and English prosody. The mature style of Samuel Butler blends in curiously with Larbaud's prose style of the 1920's and the result is a Butler which reads almost as well in French as in English. (The only French translation I know of which rivals its sympathetic understanding of the original is Proust's Ruskin.) Larbaud seems as much at ease with poetry as with prose; one cannot accuse him of favoring one medium over the other in his translations.

This remarkable record points up the creative aspect of translation. Larbaud has always remained faithful to De Sanctis' rule for the translator: *"A modo suo, e con tono e con accento suo."* His large fortune which has permitted him the leisure of sustained periods of travel and wide non-professional reading has helped support his own image of the *"riche amateur"* and *"l'homme européen."* But with this seeming extravagance and lack of professionalism has gone the sacred position Larbaud has always accorded the translator. His *Sous l'Invocation de Saint Jérôme* (1946) is a series of appreciative and interpretive essays on the role of translation from the time of Saint Jerome's *Vulgate* through the present

[5] Georges May, pp. 87–88.

day. Larbaud acknowledges the thankless task of a profession which reproduces but which does not "create" in the accepted sense. He asks for more sympathetic understanding for a "calling" which deserves a position closer to the more creative disciplines. He explains convincingly the difficulty of the translator's task: ". . . *pour rendre ce sens littéraire des ouvrages de littérature, il faut d'abord le saisir; et il ne suffit pas de le saisir: il faut encore le recréer.*"[6]

Despite Larbaud's singular dedication to translation, his career does not stop here. As an occasional essayist he has also put to the test his astonishing command of languages. Not only has he written widely about foreign literature and analyzed specialized problems in English, Romance and Germanic linguistics, but has also occasionally written in one or the other of his adopted languages. Such articles as "La influencia francesa en las literaturas de lengua castellana" which appeared in *El Nuevo Mercurio* (April 1907) and "Figuras del simbolísmo francés: Edouard Dujardin" which appeared in *La Nacion* (March 15, 1925) attest to his written knowledge of Spanish. His English seems even more natural, less acquired than his Spanish if one reads his "Rebirth of American Poetry" which appeared in *Living Age* (December 3, 1921) or any of his Paris letters which appeared in *The New Weekly* (London) between March 21 and August 8, 1914. In the two volumes of the *Journal inédit*, which Gallimard brought out in 1954 and 1955, one finds a great deal of English interspersed with the French and occasional passages in other languages. Larbaud has appropriately commented in the first volume: ". . . *à force de lire l'anglais, ma pensée avait pris l'habitude de s'exprimer spontanément dans cette langue.*"

But these spurts of foreign-language writing are after all only occasional and are mere mechanical evidences of Larbaud's skill as a polyglot. More genuine certainly are the numerous foreign expressions which appear so functionally in his fiction. Larbaud seems virtually incapable of relying wholly on his native French in his stories and novels. For example, the dedication of the title story of his volume of three novellas *Amants, heureux amants . . .* (1923) gives us notice of its polyglot tendencies: "to James Joyce, my friend and the only begetter of the form I have adopted in this piece of writing." "The form" obviously refers to the stream-of-consciousness method which runs through Larbaud's stories in this collection. But it may also have some connection with Joyce's reliance on foreign languages as a fictional technique, as a means for expanding his literary point of reference.

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[6] Valery Larbaud, *Sous l'Invocation de Saint Jérôme*, Paris, Gallimard, 1946, p. 70.

The final novella in the volume, *Mon plus secret conseil,* depends a great deal on Larbaud's knowledge of other languages. There is almost a systematic plan at work which causes the narrator to use Italian when he remembers a passionate embrace with one of his lovers, English when the sophistication of another woman controls the direction of his thoughts, Greek when his devotion to literature seems more important than his liaisons.[7] One characteristic passage which exploits Larbaud's reliance on several languages is the following which concludes *Mon plus secret conseil:*

> Et vers Irène je vais . . .
> M'endormir dans la pensée d'Irène.
> Irène, ti voglio
> tanto
> tanto bene
> moglie mia!
> Comme on est bien seul et bien soi au seuil du sommeil
> Comme
> moi en ce moment, entrant
> en moi-même, sous le
> voile . . . Le petit ani-
> mal inquiet rentrant sous
> non, dans, son terrier. Ciao!
> Cette espèce de
> petit renoncement au monde: pratique, quotidien, de poche:
> le sommeil. Irène?
> L'effort pour l'oublier? pour renoncer aussi à
> ça, à ces liens?
> A Paris, je verrai . . .
> J'aurais dû
> emporter le service à faire le thé en voyage.
> Cette petite flamme bleue dan
> la boîte propre, luisante,
> (métal argenté, Drew and Sons,
> Piccadilly Circus)
> "So when I am wearied . . ." you petite
> flamme bleue dans le soir en voyage
> quand la Face de la Terre pâlit. Ah! . . .
>
> Pouvoir renoncer à Irène serait bien. . . . Quelle ruse employer envers moi-même? La distance? Ne pas même passer rue de Magdebourg voir sa maison. Entreprendre un long travail très absorbant. Renforcer l'égoïsme. Cultiver ma timidité . . . ah ah! Oh, Dio! dormire, dormire . . . Si, già. . . .
>
> Passer le mois de mai en Sicile? . . .
> Ou à Corfou? . . .

English and Italian blend in with the French here to reinforce the multi-lingual sensibility on the verge of sleep. This is a good example of the instinctive readiness of the Larbaud character to think in several languages and to reverse language as he reverses mood.

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[7] See Melvin J. Friedman, "Valery Larbaud: the Two Traditions of Eros," *Yale French Studies,* number 11, p. 97.

The Joycean strains are of course evident in this passage—both the interior monologue technique and the polyglot tendencies. Larbaud's background as first critic and defender of *Ulysses* and translator of certain sections of the work have been justly rewarded in Larbaud's own fiction. But Larbaud, unfortunately, took no part in the French translation of the Anna Livia Plurabelle section of Joyce's *Work in Progress,* published in 1931 in the *Nouvelle Revue Française.*

Samuel Beckett, another polyglot, was on hand for this occasion. Beckett, also a friend and critical defender of the Irish writer, began his literary career with an essay on Joyce which appeared in *Our Exagmination round his Factification for Incamination of Work in Progress* (1929). He helped with the 1931 translation of "Anna Livia Plurabelle" and then remained virtually silent as a translator until the 1950's. Unlike Valery Larbaud, Beckett's achievement has never been principally measured by his translations. He belongs to the second group of polyglots, those who write in more than one language.

Beckett wrote most of his stories, novels and poems in English until he published the first volume of the *Molloy-Malone meurt-L'Innommable* trilogy in 1951.[8] From then on he has written virtually everything in French, including his first attempts at playwriting, *En attendant Godot* (1953) and *Fin de partie* (1957). The exceptions have been *All That Fall,* a radio drama which was broadcast over the B.B.C. Third Programme in 1957, and the succession of monodramas, including *Krapp's Last Tape* and *Embers,* which were originally published in *Evergreen Review* and have since been collected in a volume by Grove Press.

As soon as Beckett took to writing in French he set himself up as his own translator. (Perhaps Nabokov got the idea from him when he assisted his son with *Invitation to a Beheading.*) He enlisted the help of Patrick Bowles with *Molloy*—probably feeling uncomfortable in his first attempt at translating a work of this length into English—but has since relied on his own devices.[9]

Beckett's bilingual facility, which has become apparent in the Fifties, has allowed him to rely on the language which has seemed most congenial in handling a given fictional situation. Few writers have been "ambidextrously" suited to change language whenever

[8] One noteworthy exception is "Poèmes 38–39", a group of poems he published in French in *Les Temps Modernes* in November 1946.

[9] Beckett has been less active in the task of translating his English work into French. He performed admirably with his "self-translation" of *Murphy.* But in the case of the recent translation of *Krapp's Last Tape* (in French *La Dernière Bande*), for example, the work was done by Pierre Leyris although as Guy Verdot wrote in the March 12, 1960 *Le Figaro Littéraire* "l'auteur y revint jusqu'au bon à tirer." (p. 3)

they have felt aesthetically disposed. As I have said before, Beckett seems to be quite a different writer when he uses French from what he had previously been when he relied solely on English.[10] The lighthearted, jovial qualities which abound in *Murphy* and *Watt* are nowhere evident in the trilogy written in French. Likewise, among the plays, *All That Fall,* despite its tragic overtones, thrives on comic relief, while *En attendant Godot* and *Fin de partie* thrive on the trapped and isolating ingredients of a Sartre or a Genet. Beckett seems intent on changing literary personality as he changes language.

The final proof that Beckett did not arbitrarily change language in the Fifties is that he did revert to his native English for the occasional monodramas and radio plays he wrote from 1957 on. The Irish wit, recalling his Dublin youth, seems so much a part of everything he has written in his native English, while the French undercurrent of neo-existentialism and "absurdism" goes well with the works written in his acquired French.

Beckett, unlike Larbaud, rarely uses more than a single language in a given work. His knowledge of languages is perhaps quantitatively more restricted than Larbaud's, although he is surer in his second language, French, than Larbaud is in his—whether it be English or Spanish. It is not quite accurate to speak of Beckett as being only bilingual as he has shown facility in Spanish through his translation of a large number of Mexican poems into English for inclusion in *An Anthology of Mexican Poetry* (1958). He has apparently also supervised to some extent the translation of *En attendant Godot* into German and Italian:

> *Godot* a été publié en turc, en hébreu, en persan, et Beckett ne laisse à personne le soin de revoir les textes en allemand et en italien, deux langues qu'il possède aussi bien que le français et l'anglais.[11]

But still Beckett's type of the polyglot favors the profound immersion in two languages which can be used interchangeably. When he translates from one to the other, even though the original seems more suitable because Beckett has willfully chosen it the translation is naturally a very apt substitute. However competent a translator Larbaud is when he undertakes turning Samuel Butler into French, however much he has mastered the theoretical code of the translator, one must still prefer Beckett's trilogy in Beckett's own translation. The idea of genuinely "original" versions in two languages is quite intriguing.

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[10] See Melvin J. Friedman, "The Achievement of Samuel Beckett," *Books Abroad,* volume XXXIII, number 3 (1959), pp. 278–279; and "The Novels of Samuel Beckett: An Amalgam of Joyce and Proust," *Comparative Literature,* volume XII, number 1 (1960), p. 53.

[11] Guy Verdot, "Beckett continue d'attendre Godot," *Le Figaro Littéraire,* March 12, 1960, p. 3.

Thus we have with Valery Larbaud and Samuel Beckett the two types of the polyglot. Larbaud uses his knowledge of languages as a literary device. His translations of other writers serve to enrich his own work. Samuel Beckett, on the other hand, alternates between French and English as the mood dictates. Although he knows fewer languages than Larbaud and is infinitely less cosmopolitan, Beckett has the more professional awareness of the writer who can explain a literary situation equally well in two languages.

HENRY JAMES AND THE AMERICAN LANGUAGE

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In *The American Language* and its *Supplements,* H. L. Mencken derides Henry James's opinions on American speech. It is true that "The Question of Our Speech,"[1] which James delivered in June of 1905 as an address at Bryn Mawr College, was written in ignorance of scientific aspects of language study, and displayed snobbish denigration of pronunciations of which James disapproved. One remark so displeased Mencken that he quoted it scornfully three times: James had referred to the sound of the American final *r* as resembling "a sort of morose grinding of the back teeth."[2] But Mencken disliked James heartily for his Anglophile sympathies and in typical fashion labeled James's remarks as "shrill complaints" or "pronunciamentos." He could find only one considerable statement to quote with approval, for it was a description of the migration of English to America rather than a consideration of the development of the American language:

> Keep in sight the interesting historical truth that no language, so far back as our acquaintance with history goes, has known any such ordeal, any such stress and strain, as was to await the English in this huge new community it was so unsuspectingly to help, at first, to father and mother. It came *over*, as the phrase is, came over originally without fear and without guile—but to find itself transplanted to spaces it had never dreamed, in its comparative humility, of covering, to conditions it had never dreamed, in its comparative innocence, of meeting; to find itself grafted, in short, on a social and political order that was both without precedent and example and incalculably expansive.[3]

For James's further remarks, Mencken had generally only contemptuous reference, with side glances at James's supposed depreciation of anything American. Mencken's bias unfortunately prevented his being accurate, either in interpretation or even in simple bibliographical reference.

He was unjust, for one thing, in failing to show that James had expressed appreciation of the American language ten years before William Archer published the article which he cites as the first public recognition of American. According to Mencken,

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[1] Published, with inclusion of passages deleted at Bryn Mawr, in *Appleton's Booklover's Magazine,* August. James alternated this lecture with "The Lesson of Balzac," *Atlantic,* August. Both were issued under a combined title, Boston, 1905.

[2] *The American Language* (New York, 1936), p. 349. *Supplement II* (New York, 1948), p. 24, p. 90, n.

[3] "The Question of Our Speech," p. 38 f., cited in *The American Language,* p. 138.

> The revolutionary theory that the American language actually has some merit seems to have been launched by William Archer, a Scotsman, in an article entitled "American Today," printed somewhat prudently, not in England, but in *Scribner's Magazine* for February, 1899. "New words," he said, "are begotten by new conditions of life; and as American life is far more fertile of new conditions than ours, the tendency toward neologisms cannot but be stronger in America than in England. American has enormously enriched the language not only with new words, but (since the American mind is, on the whole, quicker and wittier than the English) with apt and luminous colloquial metaphors.[4]

Quite aside from Archer's opinions, the passage bristles with Mencken's inaccuracies. The article was in fact entitled "The American Language," and it was printed, whether prudently or not, in the *London Pall Mall Magazine* for October, 1899,[5] and merely given favorable notice in "The Point of View" section of the American *Scribner's Magazine* for December, not February, 1899. The article received its first American publication in Archer's volume *America Today* (New York, 1899), "The American Language" forming the concluding section of the book. In it, Archer took to task extremists on both sides of the argument over language, pointed out that pronunciation is a matter of habit regardless of time or place, and praised America as "a great source of strength and vitality" to English because it doubles or trebles the points of contact with nature and life.[6]

But Archer's comments came ten years after Henry James had published "An Animated Conversation" in *Scribner's Magazine* for March, 1889, naming American as the language of the United States and praising its possibilities. This piece was written during a period of strained feeling between England and the United States, with the general purpose of reminding James's readers of the bonds which transcend temporary differences between two countries, language being one of the greatest. In spite of growing differences between English and American, James's spokesman is made to say that the work of association of the great English-speaking peoples is going forward all the time and is forming an immeasurable pattern; when American is sufficiently cultivated, and when Americans have learned it themselves, it will be time enough to discuss whether the English and the Americans will have to agree upon their signs.[7]

The "conversation" form was not one James used frequently, and it is to be distinguished from the farces which, like Howells, he

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[4] *The American Language*, p. 45.

[5] Vol. XIX, pp. 188–196. None of the misinformation of Mencken's original passage is corrected in the *Supplements*.

[6] p. 239. The letters which Archer included to form the bulk of the volume appeared in the *London Pall Mall Gazette* and *Pall Mall Magazine*. Those to the *Gazette* appeared also in the New York *Times*.

[7] *Essays in London* (New York, 1893), 316 f. This widely-distributed book publication of the "Conversation" antedates Archer by a number of years.

occasionally published. Where the magazine farce is a short dramatic piece generally void of ideas and intended only as light reading, the conversation has the simpler characteristics of dramatic form but with exposition of points of view its chief object. Setting is merely sketched; characterization is minimal; and there is a complete absence of dramatic climax. The conversation permits the author to present conflicting points of view in a way not usually possible in the traditional critical forms; he can be persuasive, through his characters, in a fashion which formal criticism does not allow. As a modern development from Platonic dialogues, the conversation is a very light-weight performance, relieved by persiflage to the point where it is sometimes almost trifling in tone. Even as a vehicle of ideas, it is primarily an entertainment.

"Daniel Deronda: A Conversation" (*Atlantic,* December, 1876) shows what James could make of the form for purposes of criticism; it also provides some useful parallels for the interpretation of "An Animated Conversation." In the earlier piece, three characters of varying temperaments discuss the recent novel of George Eliot, with the novelist-critic who approximates James himself holding the balance of opinion. That Constantius presents James's viewpoint is clear enough from other essays and reviews of George Eliot in which James similarly discusses observation and invention in the creating of character, and improvisation in fiction; or in which he compares George Eliot with George Sand and Turgenev. The conversation form permits James a quasi-dramatic criticism of *Daniel Deronda* which expresses opinions with which he does not agree, but to which he can give adequate exposition while also setting forth his own views. The advantages of the form are obviously slight, and James resisted whatever temptation he might have felt to use it in dealing with other works in the very large body of his critical writing.

"An Animated Conversation" has somewhat better excuse, for its purpose is to display feelings and points of view as they are expressed by a group of English and American men and women during the later stages of a social evening in London. There is not so much an argument as an exchange, and while there are serious considerations underneath the banter, the climaxing statement is a matter of feeling rather than logic. The conversation gives the reader the sense that he has participated in a social occasion with people who have ideas but who are not bent on defending them point by point; or, at one greater remove, the reader can feel that this is the only type of persuasion which appealed to a gifted author who lacked the ability to write argumentative prose because, aside from questions of his craft, ideas interested him primarily as they were expressed through such and such characters.

Darcy is the character of greatest interest, and he is clearly James's representative. He is specifically an expatriate American who repudiates "rigid national consciousness" and who maintains that insistence on national differences is stupid, as James had said to his brother William only a few months earlier when he wrote, "I can't look at the English-American world, or feel about them, any more, save as a big Anglo-Saxon total, destined to such an amount of melting together that any insistence on their differences becomes more and more pedantic."[8] Darcy develops the point on the feminization of literature which James emphasized in his article on Mrs. Humphry Ward two years later. It is Darcy, also, who acknowledges that the position of the American language is not yet clear, but that the evolution of the language was inevitable. His remark is an anticipation of the passage from James's lecture of 1905 which Mencken cited:

> A body of English people crossed the Atlantic and sat down in a new climate on a new soil, amid new circumstances. . . . They invented new institutions, they encountered different needs. They developed a particular physique, as people do in a particular medium, and they began to speak in a new voice. They went in for democracy, and that alone would affect—it *has* affected—the tone immensely. *C'est bien le moins* that the tone would have had its range and that the language they brought over with them should have become different to express different things. A language is a very sensitive organism. It must be convenient—it must be handy. It serves, it obeys, it accommodates itself.[9]

Darcy, too, is made to express the concern for international copyright which James felt keenly; after the pirating of earlier years, he considers it time the money situation be worked out.

James even uses Darcy to defend his expatriate position as a writer. Another of the American participants in the conversation accuses Darcy of having become provincialized through "the foolish habit of living in England," and he goes on, "He has lost all sense of proportion and perspective, of the way things strike people on the continent—on the continents—in the clear air of the world. He has forfeited his birthright." Darcy defends himself. "On the contrary, I have taken it up, and my eye for perspective has grown so that I see an immensity where you seem to me to see a dusky little *cul-de-sac*." To the question whether it's not best to observe one's own people in one's own country, he replies that there are plenty of Americans in London, and they exist there in magnificent relief; taken together with the English, they form a compendium.[10] The "immensity" is of course the "big Anglo-Saxon total" which James more and more considered a reality transcend-

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[8] *Letters,* I, 141 f.
[9] *Essays in London,* p. 316 f.
[10] *Ibid.,* pp. 307f, 312 f.

ing national differences, so that in terms of his own craft he deliberately sought to destroy distinctions. "I am deadly weary of the whole 'international' state of mind," he wrote to William. "I have not the least hesitation in saying that I aspire to write in such a way that it would be impossible to an outsider to say whether I am at a given moment an American writing about England or an Englishman writing about America." And far from being ashamed of this ambiguity he would be proud of it, for it would be "highly civilized."[11]

The discussion of the American language in "An Animated Conversation" must be considered within this general context of James's attitudes. For the language is not the chief subject; it is considered in relation to the problem of international differences. Disputes over fisheries are passing things, and Darcy finds insistence on differences merely stupid. Of greatest importance is the formation of the great Anglo-American world, "I don't say we are all formed—the formation will have to be so large . . . but we are forming. The opportunity is grand . . . the opportunity for two great peoples . . . to unite in the arts of peace—by which I mean of course in the arts of life. It will make life larger and the arts finer for each of them."[12] It will be an immense and complicated problem, but such an opportunity has never before existed. One of the women suggests that for each of them there is the personal solution of social intercourse and association, and Darcy takes this up; the modern intimacy has so multiplied contacts that the problem is no longer academic and official, but practical and social. Everyone is involved in the creation of a great harmony which Darcy expresses in almost ecstatic tones:

> We are weaving our work together, and it goes on forever, and it's all one mighty loom. And we are all the shuttles directed by the master-hand. We fly to and fro, in our complicated, predestined activity, and it matters very little where we are at a particular moment. We are all of us here, there and everywhere, wherever the threads are crossed. And the tissue grows and grows, and we weave into it all our lights and our darkness, all our quarrels and reconciliations, all our stupidities and our strivings, all the friction of our intercourse and all the elements of our fate. The tangle may seem great at times, but it is all an immeasurable pattern, a spreading, many-coloured figure. And the figure, when it is finished, will be a magnificent harmony.[13]

To the question whether the differences between English and American don't strike an odd note in this harmony Darcy replies that they provide amusement and prevent tameness. "Amusement" is a term which James uses with great seriousness for anything

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[11] *Letters,* I, 141 f.
[12] *Essays in London,* p. 290 f.
[13] *Ibid.,* p. 314 f.

which provides an intellectual springboard for reflection and imaginative insights. "We shall never do anything without imagination—by remaining dull and dense and literal," Darcy remarks.[14]

To Darcy, the differences of language are a small matter in the cultivation of the general harmony. When one of the Americans reminds him that he has criticized the American idiom, he points out that his criticism has been of its incomplete formation.

> You have heard me criticise it as neglected, as unstudied; you have never heard me criticise it as American. The fault I find with it is that it's irresponsible—it isn't American enough . . . it has grown up roughly, and we haven't had time to cultivate it. That is all I complain of, and it's awkward for us, for surely the language of such a country ought to be magnificent.[15]

To the Englishman who remarks that Americans have come so late that they have not fallen on a language-making age, Darcy points out that though this may be true, the Americans have always had the resource of English. "Our great writers have written in English. That's what I mean by American having been neglected."[16]

James made an exception for Lowell, however, in the laudatory essay published less than two years later (*Atlantic,* January, 1892) and also included in *Essays in London.* Together with the "Conversation", this helps to define his position. James obviously does not speak as a trained linguist or phonologist; his chief concern is with Lowell's contribution to Anglo-American understanding in his official capacity as Ambassador, and in personal, individual relationships such as James spoke of in the "Conversation". The remarks on American come in James's praise of "The Biglow Papers," which he greatly admired. And he praised Lowell's linguistic sense, with its outcome in style, as perhaps the thing on which his reputation would chiefly rest.[17] Lowell had "put his finest faculty for linguistics at the service of the Yankee character," and James based his praise on his feeling that Lowell knew more about rustic American speech than all others together who claimed to know anything of it; he honored it with a scientific interest.[18] Lowell strove to show that New England speech was not English corrupted but English conserved, the speech of an older England than the contemporary nation which found it queer. Lowell "was capable of writing perfect American to bring out this archaic element," though generally he kept the two tongues apart.[19] James found "The Biglow Papers" delightful, but could conceive nothing less like them than American newspaper style, which he later claimed

[14] *Ibid.,* p. 306.
[15] *Ibid.,* p. 317.
[16] *Ibid.,* p. 319.
[17] *Ibid.,* p. 43.
[18] *Ibid.,* p. 45.
[19] *Ibid.,* p. 46.

had contributed to the "bastard vernacular" of communities unable to distinguish it from the speech of the soil.

A short story of this same period also demonstrates James's concern for the development of a civilized harmony and civilized relationships transcending differences of language and nationality. "Collaboration" appeared in 1892,[20] and in the context of the "Conversation" and the essay on Lowell has almost the force of a demonstration by crucial experiment. For if the arts of civilization involve creative activity which takes no account of national animosities or differences of language, what could be more forceful than an example of such collaboration between a Frenchman and a German so short a time after the Franco-Prussian war.

The important characters are Herman Heidenmauer, a German composer whose facility with English frequently causes him to be mistaken for an Englishman, and Felix Vendemer, a Frenchman of modern views who maintains that art is art in any country and that classifications of art as English, French or German are catalogers' and reviewers' names only. Vendemer feels that the very respectability of national prejudices is what makes them so odious. The narrator and observer is a Jamesian representative, like Darcy of the "Conversation", who gives Heidenmauer the book of Vendemer's verses which leads to their collaboration on an opera. The narrator sees that each man pays a personal price for this joint effort of art (the German loses the financial support of his stepbrother; the Frenchman loses his fiancée because of her mother's violent opposition to his working with the German), and that the French and German publics will reprobate the result. But he reflects that the collaboration has ". . . something in it that makes for civilization. In their way they are working for human happiness."[21]

It is apparent that for James questions of language were subsidiary to the problem of civilized relations among the sensitive and perceptive in any society. It was a point he emphasized again when writing the Prefaces to the New York edition between 1905 and 1908 after his last extended American tour. He conceded that the general "international" label might be applied to much of his work, but pointed out that in his later productions, for example *The Wings of the Dove* or *The Golden Bowl,* international contrasts were not their subject; it was not his purpose to exhibit Americans as Americans or English as English, but to show Americans, Englishmen, or Romans as agents or victims "in virtue of an association nowadays so developed, so easily taken for granted as to have created a new scale of relations altogether, a state of things from which *emphasized* internationalism has either quite dropped or is

[20] *English Illustrated Magazine,* September. Reprinted in *Novels and Stories,* Vol. XXVII.

[21] *Novels and Stories,* Vol. XXVII, p. 182.

well on its way to drop."[22] Contrast may serve the end of the novelist, but James maintained that his real subjects could perfectly have been expressed had all the persons been only American or English or Roman. One group of earlier stories depended on the explicit contrast of national traits, and James freely acknowledged the appeal of the contrast to his imagination at a given time. But the latest of the tales included in the volume for which he wrote the Preface containing these remarks was published in 1884. James considered himself well-advised to have gathered his "international" subjects when he might, for by the time he made this comment on them he was far more possessed with the sense of the mixture of manners gradually taking place, "the multiplied symptoms among educated people, from wherever drawn, of a common intelligence and a social fusion tending to abridge old rigours of separation." The imagination in future would be struck, James felt, less by restrictions in relations than by the expansion of opportunity and communication.

> Behind all the small comedies and tragedies of the international, in a word, has exquisitely lurked for me the idea of some eventual sublime consensus of the educated; the exquisite conceivabilities of which . . . constitute stuff for such "situations" as may easily make many of those of a more familiar type turn pale. *There*, if one will—in the dauntless fusions to come—is the personal drama of the future.[23]

The sense of the common intelligence and social fusion made it inevitable that when James delivered "The Question of Our Speech" at Bryn Mawr, or observed the speech habits of immigrants on New York's East Side, or composed his articles on "The Speech of American Women" after his return to England, he should speak not as a linguist or phonologist but as an observer concerned with "tone," and its relation to civilization.

Addressing the Bryn Mawr graduates, James urged them to cherish a "tone-standard," by which he seems to have meant a combination of the accent, intonation, and idiom to which he was accustomed, in a defense of "culture" against the influx of elements threatening the Anglo-Saxon preponderance in America. For he regarded speech as "a virtual consensus of the educated" involving the communication and response which makes the process of imparting culture possible.[24] Language is a living organism, responding to new circumstances and conditions, but the conservative interest should predominate. James exhorted the young ladies to awareness of the problem, together with imitation and emulation of good speakers, and he warned them against "the shouts, shrieks

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[22] *The Art of the Novel*, Critical Prefaces by Henry James, ed. R. P. Blackmur (New York, 1947), p. 199.

[23] *Ibid.*, p. 202 f.

[24] *The Question of Our Speech; The Lesson of Balzac* (Boston, 1905), p. 6.

and yells" of the American press, and against the appropriation of the language by hordes of aliens while the educated neglect it. He was far from the realities of language when he went on to discuss vowels and consonants and made that unfortunate remark about the tooth-grinding *r* which earned Mencken's derision. He voiced a then-popular fallacy when he remarked that "there are . . . sounds of a mysterious intrinsic meanness, and there are sounds of a mysterious intrinsic frankness and sweetness. . . ."[25] But his description of the migration of English to American seemed to Mencken worth approving quotation, and there is a generally disregarded passage in the address which relates his ideas of language, however mistaken in detail, to his great sense that fineness of consciousness promotes fineness of life, and that the "consensus of the educated" may overcome difficulties of relation within "the big Anglo-Saxon total."

> All life . . . comes back to the question of our speech, the medium through which we communicate with each other; for all life comes back to the question of our relations with each other. These relations are made possible, are registered, are verily constituted, by our speech, and are successful . . . in proportion as our speech is worthy of its great human and social function; is developed, delicate, flexible, rich. . . . The more it suggests and expresses, the more we live by it—the more it promotes and enhances life.[26]

Thus its quality, authenticity and security are supremely important to the dignity and integrity of existence, and James, innocent of scientific linguistics then scantly known, could exhort to a conservatism which he hoped would promote the consensus of the educated that was to provide the personal drama of the future.

He experienced misgiving, however, when he visited the cafes of the East Side. Beneath their bedizenment, they appeared to him "torture-rooms of the living idiom," in which the Accent of the Future as heard there was merely a portent to the lacerations to come. He had protested alien influences in his address at Bryn Mawr, but here he conceded possible defeat for the language he had treasured.

> The accent of the very ultimate future, in the States, may be destined to become the most beautiful on the globe and the very music of humanity . . . but whatever we shall know it for, certainly, we shall not know it for English—in any sense for which there is an existing literary measure.[27]

He does not speak of American. As when Darcy referred to American writers having written in English, James in his later years frequently equated the literary language with "English," whoever wrote it. He might have harkened to the accent of the future with

[25] *Ibid.*, p. 29.
[26] *Ibid.*, p. 10.
[27] *The American Scene* (New York, 1907), p. 135.

some composure had he distinguished functional varieties and levels of usage and had he not, with age, become increasingly resentful of Americanisms in speech.[28]

Writing of "The Biglow Papers," James had praised Lowell for using "perfect American," but he was evidently reluctant to regard other dialects as properly American, and absolutely unwilling to use dialect himself. Two considerations were involved: He had stated that the language of "The Biglow Papers" was not English corrupted, but English conserved; other dialects had suffered "the sophistication of schools . . . the smartness of echoes and the taint of slang" and had thus become "the bastard vernacular of communities disinherited of the felt difference between the speech of the soil and the speech of the newspaper, and capable thereby . . . of taking slang for simplicity, the composite for the quaint and the vulgar for the natural." And it seemed to him that all the supposedly "unconventional" American subject matter from which ignorance barred him was marked with "the birthmark of Dialect, general or special—dialect with the literary rein loose on its agitated back and with its shambling power of traction . . . trusted for all such a magic might be worth." He was repelled, and to the raised literary monument to dialect refused to contribute a stone.[29]

James's last considerable word on the subject of language was a series of four papers on "The Speech of American Women" in *Harper's Bazar* from November, 1906, to February, 1907. If the series immediately seems less a discussion of its announced subject than a consideration of manners and the position of women in society, the fact is not surprising when James's earlier discriminations are kept in mind. He has gone on from the Bryn Mawr address to review the position of the American woman, the effects of democracy and freedom upon her, and her lack of an established standard such as guides a European. Speaking only of those who have been schooled, he notes the social pre-eminence of American women "entrenched behind their myriad culture clubs," but concludes that the freedom and the lack of standards have produced only "a tone without form and void, without charm or direction."[30] By "tone" he refers to the idea of "*secure* good manners" which he had commended to the Bryn Mawr ladies. He can announce absurdities such as that New England speech represents "the highest type of utterance implanted among us" despite its want of "distinction" or "the finer charm."[31] But in his conclusion he returns to his sense

[28]John S. Sargent once told Hamlin Garland that James reproved his niece when she said, "Uncle Henry, if you will tell me how you like your tea I will *fix* it for you." James replied: "Pray my dear young lady, what will you *fix* it with and what will you *fix* it to?" Garland, *Afternoon Neighbors* (New York, 1934), p. 43.

[29] *The Art of the Novel,* p. 279.

[30] *Harper's Bazar,* Dec. 1906, p. 1105–6.

[31] *Ibid.,* Jan., 1907, p. 20.

that there is no isolated question of speech, the position which was evident in his earlier statements. "Everything hangs together . . . and there's no isolated question of speech, no isolated application of taste. . . . The interest of tone is the interest of manners, and the interest of manners is the interest of morals, and the interest of morals is the interest of civilization."[32]

James's interest in language is thus ultimately not a matter of linguistics but of non-technical concern for communication among the educated and the intelligent who are capable of participating in the "sublime consensus" of his vision. Whenever he deals with details of language he repeats popular misconceptions of his time. He had a sound sense of the inevitable development which in the United States would produce a distinguishible American language out of transplanted English, however uninformed he may have been of particulars of the change; but advancing years made him fussily impatient with the Americanisms he encountered. His notions of dialect were vague, and he wisely refused to attempt its use, even when, as in his early productive years, he would have had a limited familiarity with New England varieties. James's views on language are primarily interesting as a sidelight on his literary career. He has been regarded as a great worker in the international field, even with productions in which international contrasts have no bearing on his real subject, and his readers should more frequently realize that by the mid-80's he was weary of the whole "international" subject and actively sought to contribute to a consensus from which insistence on differences would largely disappear.

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[32] *Ibid.*, Feb., 1907, p. 115.

FENIMORE COOPER AND SCIENCE

PART II*

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4. Heredity and Environment and the Doctrine of "Gifts"

The question of the respective roles of heredity and environment in conditioning human thought and activitiy is of importance in illustrating how Cooper's thought paralleled scientific ideas. In general, he illustrates how nineteenth-century ethnological ideas were combined with late eighteenth-century environmentalism. As a religious man and as an aristocrat Cooper acknowledged the unchangeable in man, that "this natur' never can be changed in the main, though it may undergo some increase or lessening."[95] But he also recognized the changeable. Men *are* different. This difference could have arose, say, after the dispersion following the Tower of Babel debacle, and become increasingly unpliant under the unremitting influence of heredity. In this sense, Natty Bumppo's constant references in the early books of the Leatherstocking Series to God-given gifts assumes some meanings. But the speculative Cooper did not place complete faith in heredity alone. There was the matter of immediate external influences. He had after all read Charlevoix, Colden, Elliot, Heckewelder, MacKenzie and Major Stephen H. Land and found there a great concern with climate and other conditioning factors. He also knew Buffon. Like Crevecoeur he saw that the American was something unique, despite the fact that the American was descended from European stock. So there were both hereditary gifts and environment-caused gifts, which served either to advance or to restrict the individual. Mediating between the two, Cooper saw that the supposed rigidity of hereditary conduct was not really so, and that actually man's nature was flexible to the extent that environment also went to form the human character.[96]

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* Part I was published in *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters,* volume 48: 179–204. 1959.

[95] *The Deerslayer* (Lovell-Coryell ed., New York), p. 409, Chap. 25.

[96] The various interpretations of Cooper's doctrine of gifts may stem from this dual view of Cooper. Wagenknecht, for instance, stresses the hereditary side in *Cavalcade of the American Novel,* p. 28, when he says that "Confronting the Indian, Cooper [saw] . . . these men were God's children, God had given them their own 'gifts.' But theirs were not the white man's 'gifts.' The Indians' 'gifts' please God—in an Indian—but He will not accept them in a white man. For the future belongs to the white man, with all his sins—to civilization, to Christianity. The Indian is doomed. And the romantic glamor with which Cooper has invested him is the by-product of his doom,

On this topic the key passage is in *Deerslayer* (1892 ed., p. 234): "A natur' is the creatur' itself; its wishes, wants, ideas, and feelin's as all are born in him. This natur' can never be changed in the main though it may undergo some increase or lessening. Now gifts come of sarcumstances. Thus, if you put a man in a town, he will get town gifts; in a settlement, settlement gifts; in a forest, gifts of the forest. A soldier has soldierly gifts, and a missionary preaching gifts. All these increase and strengthen until they get to fortify natur' as it might be, and excuse a thousand acts and ideas. Still the creatur' is the same at the bottom. . . . Herein lies the apology for gifts; seein' that you expect different conduct from one in silks and satins from one in homespun. . . ." In short, with some very minor exceptions, to Cooper nature involves heredity and gifts come of circumstances or the environment.

Cooper's emphasis on man's selfishness and imperfectibility came, in part, from the kind of Episcopalian Christianity he learned from the sermons of his fellow member of the Bread and Cheese Club, Bishop Hobart of New York. But *The Monikins,* in which Brigadier Downright says that selfishness "is incorporated with the very

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for the Indian is not responsible for his tragic fate." Roy H. Pearce, "Civilization and Savagism: The World of the Leatherstocking Tales," *English Institute Essays, 1949* (New York, 1950), pp. 92–116, treats Cooper's Leatherstocking Tales as a cultural history attempting to define and solve the problem of civilizing a new world posed by the contemporary American westward movement. Like Wagenknecht, Pearce defines Cooper's Indians as symbolic of the savage and non-civilized falling before the inexorable movement of civilization rather than as noble primitives, but Pearce's interpretation is in the main environmental. "Cooper defines Leatherstockng's character as one who shares savage ways but is not a savage. His radical inadequacy for civilized life derives from the portion of savagism he shares. So it is that the savage furnishes the primary dimension of meaning in the Tales exactly as he symbolizes at once what Leatherstocking is and is not. Cooper, if we take to the Leatherstocking Tales a knowledge of received ideas of the nature of 'savagism,' is here virtually scientific, certainly explicit. Leatherstocking is forever finding it necessary to explain the savage man to the civilized and the civilized man to the savage. What we must remark is that Leatherstocking's explanations are always in terms of savage life taken in the context of savage environment. In the Tales the explanation most often comes as part of a discussion of Indian and white 'gifts'. . . . This, with its cultural relativism and moral absolutism, is virtually a summary of received understanding of the nature of savage and civilized society; it would come, particularized in this form, only when that theory had been completely worked out and found to apply to the particular conditions of savage and civilized life as they were known to exist." Allan Nevins (*Leatherstocking Saga,* New York, 1954, p. 18), quotes Natty on town, settlement, and forest gifts, and concludes: "Different environments, said the scout, produce special traits." Thus Nevins sees Cooper's and Crevecoeur's positions as similar. One should note too, Cooper's comment (*Pathfinder,* Lovell-Coryell ed., p. 138, Chap. 10), "In truth, while all men act under one common law that is termed nature, the varieties in their dispositions, modes of judging, feeling, and selfishness are infinite." And E. H. Cady, *The Gentleman in America* (Syracuse, 1949), p. 125, uses the environmentalist gift notion to explain one aspect of Cooper's social thought: "The main significance of the 'gift' to the concept of the gentleman is the importance it gives to his rearing, education, and associations. To validate his political ideas, Cooper had to get away from the old notion of hereditary gentility. His 'gift' psychology creates a new basis for exclusiveness which is to be reconciled with democracy only in his own highly technical sense. Only life-long association with members of the class of gentlemen can produce their gifts. And if the perfection of all the qualities which make gentility possible must await the slow acquisiton of such environmental gifts, then the perfect weapon has been forged with which the encroachments of the leveller can be beaten back by gentlemen of good conscience."

monikin nature,"[97] suggestes that this emphasis may well have come also from Cooper's knowledge of the pre-Darwinian struggle for existence so fully shown in this book. Thus *The Monikins,* while seeing hope in our dependence "on the moral interference of the great superior power of creation," stresses the belief that men "are a miserable post set of wretches," who are so debased by nature, so eaten "up by envy, uncharitableness, and all other evil passions, that it is quite impossible they can do any thing that is good of themselves. . . ." (p. 282) Dr. Reasono sums up the state of the animal world prior to the coming of the "monikin" species by noting that "the strong devoured the weak, until the most diminutive was reached, when these turned on their persecutors, and profiting by their insignificance, commenced devouring the strongest." (p. 164) And Downright, when anticipating the moral "eclipse," actually shuddered at the "moral perspective" of selfishness unrestrained by Principle. (p. 402) If the reader imagines that these are the utterances of fictional characters with whom Cooper did not agree, it should be recalled that in the non-fictional *Switzerland, Part Second* (II, 189) Cooper stresses "the indomitable selfishness, in which nine men in ten, or even a much larger proportion, are entrenched." In censuring the concept of free trade in the same book (II, 216) he viewed it as being perilously close to "a state of nature," which he thought was a return to "the condition of the savage." In 1842, in *The Two Admirals* (Lorvell-Coryell ed.) he used biological analogy to reinforce his idea of an inherent selfishness in man's nature: ". . . the physical constitution of man," he wrote, "does not more infallibly tend to decrepitude and imbecility, imperiously requiring a new being, and a new existence, to fulfill the objects of his creation, than the moral constitutions which are the fruits of his action, contain the seeds of abuses and decay, that human selfishness will be as certain to cultivate, as human indulgence is to aid the course of nature, in hastening the approaches of death." (Chapter V, p. 69) Stimson in *The Sea Lions* concludes that living only for worldly interests is "being but better than the brutes."[98] Indeed, *Sea Lions* as a whole emphasizes man's precarious position in the great chain of being between that of angels and brutes and stresses the evils that environment can sometimes cause.[99] Natty's picture in *The Prairie* of life as a ruthless struggle

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[97] *The Monikins* (Townsend-Darley ed., New York, 1859–61), p. 347.

[98] In "No Steamboats—A Vision," *The American Ladies' Magazine,* VII (1834), pp. 71–79, which was a translation of a short story Cooper wrote for the French magazine *Le Livre Des Cent-et-un,* Cooper answered European ideas of inferiority, citing Buffon, Balbi, Basil Hall, Saulnier, Jeffrey, the *British Review* and the *Quarterly Review.* Like other Americans, Cooper defended the American environment as a young one, and consequently not liable to produce the inferior species cited by Buffon.

[99] Even Cooper's Indian Chief asks, "Why hath the Manitou made thy race like hungry wolves?" (Nevins, *Leatherstocking Saga,* 1954, p. 33).

for existence[100] is paralleled when Eve Effingham remarks that the birds and beasts "prey on each other . . . just as the worst of our species prey on their fellows."[101] Thus while Cooper apparently preferred a nature that was serene and providentially organized, he did note that there was the bestial in man as well as the rational, and that this bestial aspect of man was responsible for much of the struggle and suffering in the world.

As Cooper continued writing, his views on race and environment became even more channeled. In general, unchanging aspects of human nature were attributed to race while differences were attributed to the conditioning effects of environment. Natural talents were variously ascribed, sometimes to environment, sometimes to heredity. Thus in describing the protagonist Wilder in *The Red Rover,* Cooper borrows from nineteenth-century ethnological views to explain personality by appearance, that Wilder's projecting brows gave "to the whole of the superior parts of his face that decided intellectual expression which is already becoming so common to American physiognomy."[102] Heredity had so molded Jason Newcome and Guert Ten Eyck that neither could be converted into the other: "All the wildness of Guert's impulses could not altogether destroy his feelings, tone, and tact as a gentleman; while all the soaring, extravagant pretensions of Jason never could have ended in elevating him to that character."[103] With four distinguished generations behind Miles Wallingford, he was eminently fitted, according to Marble, to be captain of the ship: "when natur' means a man for anything partic'lar, she doesn't set him adrift among human beings, as I was set adrift."[104] Miles, in comparing and contrasting Emily Merton and Lucy found "one peculiar charm was common to both" which was peculiar to the "Anglo-Saxon race," that of "feminine purity and feminine tenderness united. . . ."[105] Because Emily had been educated in the niceties of "respectable" society she was in a position to refine the dross of Miles' character and give

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[100] *Prairie* (Illustrated Library ed., New York), p. 235, Chap. 18.

[101] *Home as Found* (1859–61 ed., New York), p. 152, Chap. 9. The same idea is in *Autobiography of a Pocket Handkerchief* (Chapel Hill, 1949), p. 46. In Paris a starving seamstress finds the June landscape is out of keeping with her destitution and despair: "Nature does not stop to lament over any single victim of human society. When misery is the deepest, there is something awful in this perpetual and smiling round of natural movements. It teaches profoundly the insignificance of the atoms of creation."

[102] *The Red Rover* (Lovell-Coryell ed., New York, 16 vols.), p. 18, Chap. 2. Unless otherwise specified, all further references to Cooper's novels which contain chapter listings refer to this edition.

[103] *Satanstoe* 1939 ed., p. 414, Chapter 30.

[104] *Afloat and Ashore,* "Illustrated Library Edition," p. 326, Chap. 19.

[105] *Ibid.,* p. 313, Chap. 18. Cooper speaks of the Anglo-Saxon propensity to believe the worst of one's enemy when Marble thinks the French Captain will leave him destitute. Later, in telling how the boat-folk laugh at a Dutch name, Cooper remarks that "the Anglo-Saxon race" has a "singular aptitude to turn up their noses at everything but their own possessions, and everybody but themselves." (p. 452, Chap. 30).

him "some small portion of the gentler qualities of the salon."[106] On Miles' return to New York from his around the world trip, he is struck by the "beauty of the younger females" who made up, as opposed to "the throng from Ireland and Germany," the "native portion of the population."[107] Cooper himself saw "national characteristics" in *Gleanings Europe: France,* noting that "the races of Saxon root fail in the chin, which wants nobleness and volume" while the profiles of French women "would seem in their proper places on a Roman coin."[108] And describing a young girl and boy on the English Isle of Wight he remarks that such faces are "quite peculiar to the Anglo-Saxon race."[109] It was the fatal position of Aristabolus Bragg that although he was endowed with the good hereditary native endowments of shrewdness, aspiration, intelligence and self-possession he was born in a place out of joint and could not realize the full capabilities of his being: "Had it been his fortune to be thrown earlier into a better sphere, the same natural qualities . . . would have conduced to his improvement. . . ."[110] Both heredity and environment provided grounds for a defense of inequality. Different stock provide different natures, while "habits, education, association, and sometimes chance and caprice, drew distinctions that produced great benefits, as a whole. . . ."[111] In *Notions of the Americans,* Cooper, praising the American respect for hereditary position, claimed, "It is useless to dwell on those secret and deep-rooted feelings by which man, in all ages, and under every circumstance, has been willing to permit this hereditary reflection of character. . . ."[112] And so it went. While Cooper was willing to admit the immediate impress of environment on personality, he went beyond to assert that such personality-conditioning was sometimes passed on to the progeny. This idea in essence was never abandoned. The ability of Miles Wallingford to be correct in gentility was in part "obtained from education, but far more from the inscrutable gifts of nature,"[113] and "Nature had done more toward making Mr. Howel a gentleman than either cultivation or association."[114] And in Cooper's definition of a gentleman the stress he

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[106] *Ibid.,* p. 288, Chap. 20.
[107] *Ibid.,* p. 300, Chap. 21.
[108] *Gleanings in Europe: France* (Spiller ed.), pp. 240–241.
[109] *Ibid.,* p. 26.
[110] *Home as Found* (1892 ed., *Works*), p. 113.
[111] *Afloat and Ashore,* p. 326, Chap. 22. The dashing Dutchman, Guert Ten Eyck was not quite a gentleman although he should have been, for "nature intended Guert Ten Eyck for better things than accident and education, or the want of education, have enabled him to become." (*Satanstoe,* 1892 ed., *Works,* p. 229). Cooper's *Heidenmauer* (1859–61 ed., New York, p. 326), says that conscience is more apparent in "the guileless and untrained child than in the most practised man;" and in *The Deerslayer* (1841 ed., p. 346), he spoke of conscience as the monitor which "receives its more general growth from the training bestowed in the tillage of childhood."
[112] *Notions of the Americans* (1839 ed.), I, p. 156.
[113] *Miles Wallingford* (1892 ed., *Works*), p. 328.
[114] *Home as Found* (1892 ed., *Works*), p. 86.

placed on both race and environments is readily apparent: "The word 'gentleman' has a positive and limited signification. It means one elevated above the mass of society by his birth, manners, attainments, character and social condition. As no civilized society can exist without these social differences, nothing is gained by denying the use of the term."[115]

In *The Water-Witch,* Cooper had claimed it was only necessary for a man to exercise his inherited "natural faculties" to become a "reflecting, and, in some degree, an independent being."[116] When he came to write *Home as Found* he had adopted a semi-Lockian position. "There are limits to the knowledge and tastes, and habits of every man," he wrote, "and as each is regulated by the opportunities of the individual, it follows of necessity that no one can have a standard much above his own experience."[117] No amount of argumentation could have convinced him that men, made by God and inheriting the common heritage left by Adam, could differ in other than accidental characteristics. It was to Mr. Howel's disadvantage that "he had gradually, and unknown to himself, in his moral nature at least, got to be a mere reflection of those opinions" to which he had exposed himself by reading English books and periodicals."[118] And certainly Cooper had little sympathy for Aristabulus Bragg, a transplanted native of Massachusetts and an unprincipled opportunist, who has some good qualities and "much penetration in practical things;" but is "a creature of circumstances" who has taken on too easily the characteristics of his age and environment.[119] Nor could Cooper be much in sympathy with the conditioning action of "exaggerated religious opinions" which the different sects had caused to be imprinted on the American social consciousness.[120] He himself admitted that he was "not a believer in the scheme of raising men very far above their natural propensities,"[121] particularly since men were so patently limited not only by their heritage and surroundings but by their fall from grace.

Clearly current ideas on race led Cooper to see that certain facets of human personality might be interpreted in terms of hereditary causative factors, as when in *The Pioneers* Cooper wrote that the German Frederick Hartmann could be better understood when considered as "an epitome of all the vices and virtues, foibles and excellences, of his race."[122] Environment also played its part in Cooper's fiction, as when he has his sopkesman, the cultured Mid-

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[115] *The American Democrat,* 1838 Ed., p. 120.
[116] *The Water-Witch,* p. 168, Chap. 17.
[117] *Home as Found,* p. 295, Chap. 21.
[118] *Home as Found* (1892 ed., *Works*), p. 86.
[119] *Home as Found,* pp. 15–16. Chap. 1.
[120] *The American Democrat,* p. 74.
[121] *Ibid.,* Introduction, p. 5.
[122] *The Pioneers,* p. 88, Chap. 8.

dleton, ascribe Leather-Stocking's limitations to the fact that he was "a noble shoot from the stock of human nature which never could attain its proper elevation and importance for no other reason than becaause it grew in the forest."[123] This is a key passage and should be kept in mind as explaining why Cooper, proud of being college-bred, should *not* (in the light of environmentalism) be interpreted as regarding the illiterate Leather-Stocking, picturesque as he is, as representing mankind's potential "proper elevation and importance." Judge Temple, for example, recognizes the limitations of the forest environment when he tells Natty that young Oliver Effingham "is made of materials too precious to be wasted in the forest," even if the forest does represent such matters as freedom, purity, and a testing ground for physical courage and manliness. However, in spite of the hereditary factors which differentiated the white man and the black man, it was Cooper's religious belief, as well as Natty's, that both would be on the same footing before a merciful God on Judgment Day.[124] And while Cooper attributed the Indians' habits and "their very existence, as a distinct nation, to the doctrinal character of their ancestors,"[125] in discussing the white man's religion he felt that the "lapse of ages" had "obscured" the pristine doctrine, for a variety of sectarian creeds had sprung up as a result of the environmental influences of education and opportunity as well as the hereditary influences of "the physical and moral conditions of the creature."[126]

When Cooper wrote *The Last of the Mohicans* his views regarding heredity had become more concrete, with the result that references to hereditary conditioning become more numerous. Almost everyone speaks in terms of race. The Indians "believe in the hereditary transmission of virtues annd defects in character,"[127] and Hawkeye, who grew up amongst the Indians and who has adopted many of their ways (thereby unconsciously affirming the environmentalist position), says the Hurons "are a thievish race, nor do I care by whom they are adopted; you can never make anything of them but skulks and vagabonds."[128] Later he says that "A Mingo is a Mingo, and God having made him so, neither the Mohawks nor any other tribe can alter him."[129] Even his "natural turn with a rifle" Natty thinks to be an hereditary gift, having been "handed down from generation to generation, as our holy commandments tell us all good and evil gifts are bestowed. . . ."[130]

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[123] *The Prairie* (1892 ed., *Works*). p. 278.
[124] *The Pioneers,* p. 425, Chap. 41.
[125] *Ibid.,* p. 119, Chap. 11.
[126] *Ibid.,* p. 116, Chap. 11.
[127] *The Last of the Mohicans,* p. 263, Chap. 24.
[128] *Ibid.,* p. 37, Chap. 4.
[129] *Ibid.,* p. 39, Chap. 4.
[130] *Ibid.,* p. 30, Chap. 3.

When Munro meets the French Montcalm to hear the terms of surrender he feels "a distrust, which he derived from a sort of hereditary contempt of his enemy."[131] And an insight into Cooper's own nascent speculations regarding the role of the gentleman is provided when Montcalm (who has been highly praised by Cooper the previous page) says in the surrender interview with Hayward that "all the nobler qualities are hereditary."[132]

Further references to race occur when Hawkeye refuses to kill Magua when the latter stands unarmed at the council meeting because, as Hawkeye says, "the gifts of my color forbid it."[133] The wise old Tamenund calls the "pale-faces . . . a proud and hungry race" who not only claim the earth but who maintain "that the meanest of their color is better than the Sachems of the red man,"[134] and Uncas, standing proudly in the council of the Delewares, proclaims his race to be "the grandfather of nations."[135] The current nineteenth-century notion that the Indians had their origin in Asia and migrated to America across a land bridge in the Bering Sea finds its way into a story via a footnote but is qualified when Cooper admits that "great uncertainty hangs over the whole history of the Indians."[136] Yet at the funeral of Uncas the theory is seemingly accepted when an Indian girl "commenced by modest allusions to the qualities of the deceased warrior, embellishing her expressions with those oriental images that the Indians have probably brought with them from the extremes of the other continent, and which form of themselves a link to connect the ancient histories of the two worlds."[137]

Conditioned behavior, particularly to the Indian, thus means that one standard of judgment for all was not feasible. In the preface to *Wyandotte,* Cooper states that he aimed at "sketching several distinct varieties of the human race, as true to the governing impulse of their educations, habits, modes of thinking and natures. The red

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[131] *Ibid.,* p. 173, Chap. 16.
[132] *Ibid.,* p. 163, Chap. 15.
[133] *Ibid.,* p. 317, Chap. 29.
[134] *Ibid.,* p. 325, Chap. 29.
[135] *Ibid., p.* 329, Chap. 30.
[136] *Ibid.,* p. 29, Chap. 3, n. 2.
[137] *Ibid.,* p. 364, Chap. 33. Considerable light is cast on Cooper's supposed primitivism and the limitation of his doctrines of social justice by his non-fictional statement of his attitudes toward the American government's actual obligations toward and treatment of the Indians. If in his fiction Cooper appears to glorify some Indians such as Uncas as naturally good, in his *Notions of the Americans* (II, pp. 281–285), he finds the Indians "all alike, a stunted, dirty, and degraded race," and he thought that "neither the United States, nor any individual State, has ever taken possession of any land that, by usage or construction, might be decreed the property of the Indians, without a treaty and a purchase." Cooper announced that "a good deal is endeavoured to be done in mitigating the sufferings and in meliorating the conditions of the Indians" through the "office of Indian affairs . . . at the rate of a little more than a million of dollars a year." In fact, according to Cooper, "The Indians have never been slain except in battle, unless by lawless individuals, . . . or in any manner aggrieved, except in the general, and, perhaps, in some degree, justifiable invasion of a territory that they did not want, nor could not use."

man had his morality as much as his white brother."[138] While it is well to note that Cooper's only good Indians are the Delewares, who have been largely Christianized and who have had long contact with the White man, they still had what in the white man's eye were revolting habits—like scalping. To the imperturbable Natty Bumppo such habits were not the occasion for moral obloquy. Cap's curiosity as to what Serpent will do with his scalps in church (Chingachgook has become a pious Moravian) draws this explanation from Natty: "These things are only skin-deep, and all depend on edication and nat'ral gifts."[139] "No, no," he goes on to say, "each colour has its gifts, and its laws, and its traditions; and one is not to condemn another because he does not exactly comprehend it."[140] Such cultural relativism does not of course extend to the after life. Christ died for all colors and "each will be judged according to his deeds, and not according to his skin."[141] There was still the moral law immutably rooted in nature, having, as we have seen, all the permanent features of Newtonian law in the physical universe. In this respect, it is wise to remember that gifts—environment-caused and providing group uniqueness—make no difference before God, and that Cooper still recognizes basic nature, the wishes, wants, ideas and feelings to which a man is born.[142]

The effects of environment are seen again in the case of the spiritual Hetty and her sister the vanity-stricken Judith in *The Deerslayer,* evidenced in the "great differences between those who were nursed at the same breast, slept in the same bed, and dwelt under the same roof."[143] Yet Cooper did not neglect hereditary-racial factors. Robert Hardings in *Afloat and Ashore* is said to resemble his mother, and in *The Chainbearer,* Jason Newcome's descendants "are the legitimate heritors of their ancestor's vulgarity of mind and manners—of his tricks, his dissimulations, and his frauds. This is the way in which Providence 'visits the sins of the fathers upon the children unto the third and fourth generations.' "[144]

In Cooper's anti-rent trilogy, the negro Jaap (who appears in all three novels under various names) is described as having various racial "peculiarities"—such as kinkly hair, white teeth, large and colored lips—which prove him an inferior. His intellect, Cooper comments, had "suffered under . . . (a) blight" since his removal to America.[145] And Cooper regards as "exceptional" the fact that between the negro Jaap and the Indian Sureflint the "known antip-

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[138] Preface to *Wyandotte* (Lovell-Coryell ed.), p. 4.
[139] *The Pathfinder,* p. 398, Chap. 27.
[140] *Idem.*
[141] *The Deerslayer,* p. 49, Chap. 3.
[142] *Ibid.,* see Chap. 26 and 27.
[143] *The Deerslayer* (Paine ed., New York, 1927), I, p. 490, Chap. 17.
[144] *The Chainbearer,* p. 403, Chap. 30.
[145] *The Redskins* (Illustrated Library ed., Boston), p. 472, Chap. 27.

athy" of the two races did not exist.[146] Cooper's most important and admirable negro character, Scipio, in *The Red Rover* is said to owe his superior stature ("animal force") to heredity: "While nature had stamped on his lineaments those distinguishing marks which characterize the race from which he sprang, she had not done it to that revolting degree to which her displeasure against the stricken people is sometimes carried."[147] But even here Cooper goes on to describe Scipio's idly throwing pebbles in the air and catching them as "an amusement which betrayed alike the natural tendency of his mind to seek pleasure in trifles, and the absence of the more elevating feelings which are the fruits of education."[148] When Scipio fights and dies with great bravery, Cooper explains this by saying that natural instinct takes the place of rational process in the case of the negro.[149] In *Afloat and Ashore,* the reactions of the negro Neb are supposed to be conditioned by "tradition or instinct, or some latent Negro quality."[150] And when the ship's cook gives Neb a box on the ear that "would have set a white man reeling" it produces no effect, "falling as it did on the impregnable part of his system."[151] Neb himself was the "oddest mixture of superstitious dread and lion-hearted courage ever met," completely conscious of his inferiority; Cooper petulantly comments that in his own era the "word [inferiority] is proscribed even in the State's Prisons. . . ."[152] And *Miles Wallingford* (N. Y., G. P. Putnam's Sons ed.), p. 9, Chap. I, has Miles speak of Negroes as "a class sealed by nature itself, and doomed to inferiority." For Cooper there was no inconsistency in being a Christian and a slave-holder; in fact, it was really Christian charity of heart to hold slaves, for "the African is, in nearly all respects, better off in servitude in this country, than when living in a state of barbarism at home."[153] Cooper was ready to admit that the institution of slavery was doomed to extinction and he bemoaned the absence in his own day of "the careless, good-natured, affectionate, faithful, hard-working, and yet happy blacks" that had been in practically every family forty years before.[154] While the negro had an "extraordinary aptitude for love,"[155] Cooper imagined that if the negro were freed and given political equality, an "inextinguishable hatred" would arise between

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[146] *The Chainbearer* (Illustrated ed.), p. 225, Chap. 15. Examples of the "natural antipathy" between negro and Indian may be found in *Satanstoe,* pp. 390–399, and 424, Chaps. 23, 24, and 25; and in *Wyandotte* (Illustrated ed.), pp. 228–229, Chap. 13; 370–372, Chap. 23.

[147] *Red Rover* (Illustrated ed.), p. 31, Chap. 2.

[148] *Idem.*

[149] *Ibid.,* pp. 186–189, Chap. 12.

[150] *Afloat and Ashore* (S. A. Maxwell and Co., Chicago), p. 36, Chap. 3.

[151] *Ibid*, p. 52, Chap. 4.

[152] *Ibid.,* p. 309, Chap. 21.

[153] *The American Democrat,* p. 174.

[154] *Afloat and Ashore* (S. A. Maxwell and Co.), p. 438, Chap. 29.

[155] *Ibid.,* p. 417, Chap. 28.

the "two races" living side by side and carrying "on their faces, the respective stamps of their factions."[156] "The evil day may be delayed," he wrote, "but can scarcely be averted."[157]

Since Cooper continually assumed the racial superiority of the white man, it is interesting to note that in the sympathy with which he presents the mulatto Cora Munro he rebukes race-prejudice and shows a bit of liberalism. Major Duncan Heyward, although from the South, treats her with respect, and Hawkeye (who is scornful of white prejudice against the Indians) is willing to give his life for the mulatto. Cora herself is made to rebuke distrust of Indians because of their race. Her first speech voices her liberalism in opposition to her companions' fears about the integrity of their Indian guide: "Should we distrust the man because his manners are not our manners, and that his skin is dark?"[158] Actually, however, this guide does betray them. Later, when the Mohican joins them and Heyward expresses the hope that he may prove "a brave and constant friend," Cora comments "Now Major Heyward speaks as Major Heyward should . . . who that looks at this creature of nature, remembers the shade of his skin."[159] Cora is presented as admirable in her unselfish attitude toward her sister, and in her courage during the forest adventures and during her party's capture by the Hurons. After returning from Montcalm with an invitation to Munro for a parley, Heyward tells Munro that he loves his daughter. Munro, a Scot, supposes Heyward refers to Cora (whereas Heyward actually is asking for the hand of the half-sister, Alice) and tells him that she is part negro, the daughter of a West Indian woman. Munro accepts Heyward's denial of race prejudice and his assertion that such prejudice is in the South "unfortunate." But Cooper himself remarks that Heyward's later inquiry as to whether Alice's mother was white "might have proved dangerous at a moment when the thoughts of Munro were less occupied than at present."[160] Cora's view does not represent Cooper's own overall attitude. It is well to realize that his hero Hawkeye constantly insists on distinctive racial "gifts," and that Tamenund talks of the whites as believing in the master-race concept. The whole tenor of one part of Cooper's introduction to his proposed study entitled *The Towns of Manhattan*[161] indicates that he felt white people supe-

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[156] *The American Democrat,* p. 175.
[157] *Idem.*
[158] *The Last of the Mohicans,* p. 20, Chap. 2.
[159] *Ibid.,* p. 55, Chap. 6.
[160] *Ibid.,* pp. 168–169, Chap. 16.
[161] *New York,* Being an Introduction to an Unpublished Manuscript, by the author, entitled *The Towns of Manhattan,* edited with an Introduction by Dixan Ryan Fox (New York, 1930). With regard to the Indian, it is worth noting that Cooper's views did not wholly coincide with the scientific views of men like Schoolcraft and Catlin. Nevins (*Leatherstocking Saga,* 1954, p. 33), notes that such men "must have regretted that the novelist dealt so unscientifically with the Indian. Theirs was a deeper sym-

rior to the dark. He ridiculed the South for trying to continue the practice of slavery, saying that in terms of economic productivity "a single white man" would be "of more importance to them than that of a dozen negroes." (p. 62) He noted that nearly one-half of the South's property lay in its slave holdings, "a race so different from our own as to render any amalgamation to the last degree improbable, if not impossible." (p. 30) At the same time, however, he had little use for abolitionists, whose actions he called "the machinations of demagogues and the ravings of fanaticism." (p. 33) It must be recalled that Cooper wrote a long article on slavery in which he himself accepts the racial inferiority of the negroes and is scornful about the idea of inter-marriage of negroes and whites. This non-fictional article seems a sure guide to his own views af racism and hence suggests his own accord with the views expressed by Heyward and Hawkeye. This belief in racial differences also accords with Cooper's general political and social conservatism and his lack of exclusive reliance on environmental explanations of character, as well as his Christian paternalism toward those whom he regarded as the less fortunate races. But if Cooper is reactionary in many ways, we should give him credit for being liberal in having created one of the very first[162] mulatto women in American fiction who is made heroic and admirable: she braves the perils of the wilderness and of savage war to guard her sister and to be reunited with her father; and she wins the love of Cooper's most gallant Indian hero, Uncas, and the admiration of Hawkeye. Yet her murder relieves Cooper from dealing with the complications which might have resulted had Cora and Uncas lived and married.[163]

Combined with this hereditary outlook, Cooper realized the fact that the Indians through contact with the whites were rapidly becoming civilized.[164] Birth, he felt, "should produce some advantages, in a social sense," both because the son inherits "a portion of the intelligence, refinement and habits of the father;" and because the

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pathy with the aborigine." And Nevins points out (p. 26), that really Cooper lived too soon to know the "really scientific studies of the ethnologists" like those of Lewis Henry Morgan. See too Gregory L. Paine, "The Indians of the Leatherstocking Tales," *Studies in Philo'ogy,* XXIII (Jan. 1926), pp. 16–39.

[162] See, for orientation, John H. Nelson, *The Negro Character in American Fiction* (Lawrence, Kansas, 1926); Sterling A. Brown, *The Negro in American Fiction* (Washington, 1937); Penelope Bullock, "The Mulatto in American Fiction," *Phylon,* VI (1st Quarter, 1945), pp. 78–82. Also "Fenimore Cooper's Defense of Slave-Owning America," edited by R. E. Spiller, *American Historical Review,* XXXV (April, 1930), pp. 575–582.

[163] Cooper's squeamishness was not wholly shared by his contemporaries. The *United States Literary Gazette* (Vol. IV), May, 1826, p. 90), a Boston publication, in its review of the novel expressed disappointment that Cora and Uncas weren't saved for marriage and in doing so probably expressed the opinion of the majority of the readers. Racism and aversion to miscegenation appear in Cooper's *Wept of the Wish-ton-Wish.* An Indian boy, Conanchet, who has grown up among his white captors, is recaptured by his fellow Indians together with a white girl who becomes his wife. Eventually, however, Conanchet brings the girl back to her mother, since he feels that "The Great Spirit was angry when they grew together."

[164] *Oak Openings,* passim.

surroundings enable the son to participate in the "associations" of the father.[165]

In general, Cooper's ideas on heredity and environment, seemingly ambiguous on the surface, do fall, with some reservation, into a pattern. In his early work the chief emphasis is placed on heredity as explaining human conduct, although isolated instances of a regard for environment crop up. As Cooper continued writing, features of human conduct which bore resemblances to the parent's or which appeared to follow contemporary ethnological ideas were attributed to heredity.[166] Conduct which seemed to depart from precedent was thought to be due to more immediate causative factors in the environment. This was pretty much Cooper's final position. Properly mixed and judiciously used, it allowed Cooper some measure of tolerance without in any manner endangering his own stand in favor of God, moral law, and the paternalistic natural aristocrat.

Leslie Fiedler (in *Love and Death* . . . , 1960, p. 170) claims that Cooper's "primitives resemble more closely than the wild clansmen of Scott the version of the Noble Savage proposed by the rudimentary anthropology of the (French) Encyclopedists, and used by them as controls against which the corruption and effeminancy of the civilized European could be defined." If Cooper derived some of his attitudes toward the Indian tribes such as the Delawares contrasted with the Mingoes from Henry R. Schoolcraft, one should recall that H. R. Hays' *From Ape to Angel* calls Schoolcraft "our first field worker in social anthropology" and "the first applied anthropologist."

5. The Practical Utility of Science

It is important to balance both sides of Cooper's view or science. The theoretical side he deemed important as justifying his own peculiar concept of society, religion, and the cosmos. But he eulogized as well those aspects of applied science which had obvious utility in facilitating such interests as navigation and commerce—in so far as they did not interfere with piety and Episcopal orthodoxy. He distrusted those schools which were "merely schools or metaphysical and useless distinctions."[167] While Cooper disliked

[165] *The American Democrat,* p. 82.

[166] Where human conduct was not concerned, Cooper invariably admitted the impact of environment in changing the organic composition of bodies which could be passed on to the offspring. Thus in *The Chronicles of Cooperstown* (Cooperstown, 1838), p. 97, he wrote that the "salubrity of the climate" appeared "to favor the development of . . . the forms and constitutions" of young women. And in *Notions of the Americans* (1839 ed.), I, p. 137, Cooper noted "that the canvas-back of the Hudson, which in the eyes of M. de Buffon, would be precisely the same bird as that of the Chesapeake, is in truth endowed with another nature," due to the "freshness of the soil" and the "genial influence of the sun."

[167] *The American Democrat,* p. 189.

ostentatious fortunes and a pseudo-aristocracy based on Wall Street speculation and its consequent instability as opposed to inherited landed estates, as a country squire devoted to gracious living he did recognize that if one's income could be augmented in a decent way by applied science, it was not to be neglected.[168]

In his own day he saw the United States as "prospering beyond all precedent, everything is thriving, commerce, manufactures, agriculture. . . ."[169] He thought the "scientific progress" or the young men of West Point was so "admirable" that "no similar institution in the world is superior."[170] In the War of 1812, Cooper thought the United States had been handicapped by its defective "scientific knowledge,"[171] but it had become "formidable" by its scientific improvement of "facilities of intercommunication."[172] Every day was "exhibiting improvements in machinery" and farming.[173] Cooper's *History of the Navy* has many passages showing that as an experienced seaman[174] and a rich man who had investments in commercial vessels he recognized and praised scientific efforts such as the expeditions led by Parry and later by Wilkes to chart safe navigation courses, to locate new islands of commercial value, and to make navigation in general less of a hazardous gamble and more lucrative. Cooper was not hesitant, as many now are, in thinking that the national government was the fit instrument for promoting "scientific discovery" and fitting out expeditions "for the purpose of exploring those seas in which the whale-fisheries, as well as other branches of commercial enterprise, were pursued."[175] For the Wilkes expedition he had the utmost praise, not only because it furthered "the great interests of commerce and navigation" but because it went beyond "to extend the bounds of science, and to promote the acquisition of knowledge."[176] In reviewing a book on Sir William Edward Parry's Northern Expedition in search of a northwest passage, his enthusiasm crossed national boundaries. "Scientific facts," he wrote, "are so intimately blended, that it is

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[168] It should be noted that Cooper felt that caste depended partly on industrialism, that the mechanic was elevated over the day laborer and the slave as a result of "inequalities of condition, of manners, (and) of mental culture." Of course the "man of refinement," with all his superiorities, was on the highest rung of the ladder. See *The American Democrat*, p. 82.

[169] *Correspondence of JFC* (New Haven, 1922), I, p. 320.

[170] *Notions of the Americans* (1839 ed.), I, p. 223.

[171] *Ibid.*, I, p. 232.

[172] *Ibid.*, I, pp. 232–234.

[173] *Ibid.*, I, p. 202, see footnote.

[174] For orientation on Cooper's own connections with the Navy, see Louis H. Bolander, "The Naval Career of James Fenimore Cooper," *U. S. Naval Institute Proceedings*, LXVI (April, 1940), pp. 541–550.

[175] *History of the Navy* (New York, 1854), III, pp. 38–39.

[176] *Ibid.*, III, p. 39. "The scientific corps," wrote Cooper, "were on all occasions diligent and enthusiastic, and their labors are attested by the large collections which they have made, illustrating the natural sciences, and by the observations and examinations on all subjects intrusted to them, which they have patiently accomplished." III, p. 52.

impossible to predict what a flood of light may not burst upon us by the possession of a single fact."[177]

While the Navy was primarily a "military organization," Cooper felt that "its incidental services to science, or to any of the arts that facilitate human intercourse and promote human improvement, are without doubt worthy to be chronicled in its history."[178] The Wilkes expedition especially had done work of a "brilliant character" in helping to promote "the substantial improvement of the condition of mankind."[179] Cooper also had words of praise for the Lynch expedition, which explored the course of the river Jordan and substantiated the findings of Lieutenant Symonds, an English officer who had calculated the difference in levels between the Red and Mediterranean Seas. He similarly praises the expeditions which were surveying and charting the China Seas, the north Pacific and Bering Strait. Such work, in the immediate benefits felt by commerce from this "notable scientific achievement," was meritorious and "augmented" the reputation of the American Navy.

As a naval historian and patriot, Cooper was grateful to science and scientific inventors for improving not only the construction of ships and navigation instruments; he relates science to other problems connected with the sea. "With Bowditch and Vattel," says Captain Truck, "a man might sail round the globe, and little fear of a bad landfall, or a mistake in principles."[180] The plot of *Jack Tier* partly hinges on navigational science, since after the villain, Captain Spike, hides the instruments in his cabin, Rose Budd manages in the Captain's absence to get the sextant (which the first mate Mulford had taught her to use) and to determine their longitude and latitude. Part of the humor of *Jack Tier* centers in confusing the roles of the barometer and chronometer, and Cooper, in orienting his reader to appreciate the fun, provides several long passages explaining their use. Mrs. Budd, always making absurd mistakes, asks Mulford to see how his chronometer agrees with her watch: "Here was a flight in science and nautical language that poor Mulford could not have anticipated," Cooper comments.[181] A chronometer after all was meant to keep the time of a particular meridian; his was set for Greenwich time and hers for New York time, the difference being some five hours. Elsewhere, Cooper wrote of compasses as "faithful but mysterious guides" whose "sources of power" were continually baffling man, but always serving him accurately.[182] In his preface to *The Sea Lions*, Cooper lauded "the recent

[177] J. F. Cooper, *Early Critical Essays: 1820–1822* (Gainesville, Florida, 1955), p. 95.
[178] *History of the Navy* (New York, 1854), III, p. 94.
[179] *Ibid.*, III, p. 51.
[180] *Homeward Bound*, p. 60, Chap. 5.
[181] *Jack Tier*, p. 182, Chap. 7.
[182] *Homeward Bound*, p. 301, Chap. 25.

attempts of science" in rendering the "polar circles much more familiar to this age than to any that has preceded it. . . ."[183] The same book brings together the two uses of science as a tool and as a means of glorifying God when he remarks that if the explorers imprisoned in the Arctic were not found, "their names must be transmitted to posterity as victims to a laudable desire to enlarge the circle of human knowledge, and with it, we trust, to increase the glory due to God."[184] Cooper was interested too in naval weapons of utility in national defence. Thus in *Jack Tier* when a United States revenue steamer shells the treasonable Captain Spikes' ship which has just transferred gun-powder (disguised in barrels of flour) to the Mexicans, Cooper remarks on the improved length of the trajectory. The "monster cannons" bore the name of a "distinguished French engineer," but, says Cooper, the real credit should go to "the ingenious officer who is at the head of our own ordnance, as they came originally from his inventive faculties, though somewhat improved by their European adopter. . . ."[185] Recent improvements, he goes on to say, "have made ships of this nominal force formidable at nearly a league's distance; more especially by means of their Paixhans and their shells."[186] Cooper felt there were many things that a nation could further in times of peace so as to be better prepared in times of war. He advocated the governmental use of a cruiser to ascertain facts about whether or not there is a shoal and a reef near "the tail of the Great Bank" where six ships had apparently floundered and never been heard from again.[187] A "great maritime state" could best protect itself by "expending its money freely, to further the objects of general science, in the way of surveys and other similar precautions. . . ."[188] The superiority of his own knowledge regarding the sea caused him to look with cavalier humor at those who, like Mrs. DeLacey, ostentatiously attempted to show their own knowledge of "naval science" and only succeeded in making themselves look ridiculous.[189]

Another primary concern with Cooper, along with matters naval, was the scientific cultivation and improvement of the soil. He disliked the "trade-talking, dollar-dollar set" in American commercial towns. Born and reared in an aristocratic, agrarian community of feeling, and continuing for the better part of his life to play the part of a gentleman farmer, Cooper would naturally have been interested in anything that promised to improve the quality of his own holdings as well as promising to advance the welfare of the

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[183] Preface to *The Sea Lions* (Lovell-Coryell ed.), p. 5.
[184] *Ibid.*, p. 6.
[185] *Jack Tier*, p. 161, Chap. 6.
[186] *Ibid.*, p. 163, Chap. 6.
[187] *Gleanings in Europe: France* (Spiller ed.), p. 10.
[188] *Lives of Distinguished American Naval Officers* (Phila., 1846), I, pp. 44–45.
[189] *The Red Rover*, p. 46, Chap. 4.

country as a whole.[190] He looked for an advanced, economical manner for improving on nature. Accordingly, soon after his marriage and settling at Fenimore Farm in New York State, he joined the Otsego Agricultural Society and shortly became its secretary and in "joint effort" with his wife designed a flag for the annual fair picturing "a black plough and the words 'West Chester Agricultural Society,' in large black letters on the white ground.. . .[191] Here he studied crop improvement and introduced Merino sheep for the first time to the area.[192] Cooper had the propertied man's interest in the rationalistic exploitation of utilitarian scientific invention. No matter that America had created no worthwhile paintings. They would come with time. But it had more and better ploughs than the whole of Europe, and in "this single fact," he felt, "may be traced the history of the character of the people, and the germ of their future greatness."[193] Here was pictured "the American sanguine, aspiring and confident in his anticipations. He sees that his nation lives centuries in an age, and feels no disposition to consider himself a child, because other people, in their dotage, choose to remember the hour of his birth."[194]

Cooper's friendship with Samuel F. B. Morse prepared him, if indeed preparation was necessary, to hail the invention of the telegraph as contributing to the advancement of the nation in the realms of information, trade, and personal communication.[195] As a man in similar difficulties, Cooper could wholly sympathize with Morse's running feuds with the newspaper press,[196] and with Morse's inability to realize any great financial gain from his invention.[197] And he could sympathize too with Morse's "earnest-

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[190] Sometimes these two interests became inextricably mixed. *Oak Openings,* for instance, with its scene the Kalamazoo Valley, is in part a palpable attempt to stimulate settlement of this area of Michigan and to thus increase the possible profits of the land speculators—of which Cooper at this time (c. 1848) was one.

[191] Susan F. Cooper, "Small Family Memories," *Correspondence,* I, p. 37.

[192] Susan F. Cooper, "A Glance Backward," *Atlantic Monthly,* LIX (Feb., 1887), p. 199.

[193] *Notions of the Americans,* II, p. 115.

[194] *Ibid.,* II, p. 332.

[195] In fact, Cooper's over-zealous anxiousness to defend his friend Morse, once caused the latter to lose the promise of a job. When J. Q. Adams offered his opinion that America had no artist good enough to do some capitol mural paintings, Cooper wrote a letter, published in the *Evening Post,* in rebuttal. Adams thought Morse had written the letter and refused to give him the commission. Cooper had little sympathy for Adams, although Adams was for a policy of internal improvements, but he did write that Adams as President was a "prudent and zealous patriot" whose "intelligence or intentions" there was no reason to distrust. (*Notions of the Americans,* II, p. 219).

[196] Cooper wrote his wife May 10, 1849: "I met Morse just now, looking like a bridegroom, and full of law suits. He groans over the press worse than I ever did, and seems to imagine justice deaf as well as blind. Still he is a great man, and will so stand in history; and so deserves to stand." (*Correspondence,* II, p. 626).

[197] In *Sea Lions,* p. 128, Chap. 10; Cooper takes the occasion of Roswell Gardiner's difficulty in communicating with Deacon Platt to allude to Morse's invention of the telegraph and to use the attempts of his rivals to rob him of its rewards as an illustration of the dangers of democracy. Cooper's dating of the invention was questioned by Morse, was later substantiated as correct, and Cooper's deposition before the New York Commission enabled Morse to successfully prosecute his lawsuit. See *Correspondence of JFC,* II, p. 620; II, pp. 633–638.

ness and single-minded devotion to a laudable purpose"[198] in spending years on experiments to perfect an instrument calculated to advance man's well-being. If Cooper continually saw the problem of man to lie in the perfecting of moral self, he did not hesitate to recognize that man's nature was dual, and that one must consider the material as well as the spiritual.

Cooper's interest in the utilitarian application of science was far-ranging. In *Gleanings in Europe: France,* although he said that of Gothic architecture he "knew nothing except through the prints," he gave a fairly detailed and not uncritical analysis of Westminster Abbey.[199] In the matter of the rapid building up of coral isles in the Pacific, his "theory of geography" led him to speculate that "a railroad may yet run across that portion of our globe connecting America with the old world. . . ."[200] For America he felt no fear of foreign competition in manufacturing: "The exceeding ingenuity and wonderful aptitude of these people will give them the same superiority in the fabrication of a button or of a yard of cloth, as they now possess in the construction of a ship."[201] When speaking of a plan to connect Havre with Paris by a ship-channel as likely to fail, Cooper extolled America as opposed to France by virtue of the fact that "the average practical intellect of the country" sustained well the plannings of "men of science."[202] In general, Cooper saw that such projects were for the benefit of all classes of citizens and that the state's sponsoring of these projects was consequently preferable.[203] He praised the British Isle of Wright roads made by "the practical good sense and perseverance of Mr. McAdam," adding that "there is not, in fact, any very sensible difference between the draft of a really good McAdamized road and of a rail-road."[294] And Cooper's daughter, Susan, tells us that he was "much interested in the great engineering work of Napoleon, which crossed the Simplon with such a fine broad road."[205]

While science could contribute to the prosperity of man, its contributions were welcomed by Cooper. His fear of the tyranny of public opinion was based on the fact that the increased facility of information offered by the printing presses and newspaper manufacturing could pervert the moral character. Inventions injudiciously used could serve no good purpose. Thus Cooper's eternal emphasis on education.[206] In medicine too a code should be used.

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[198] *Sea Lions,* p .128, Chap. 10.
[199] *Gleanings in Europe: France* (Spiller ed.), pp. 45–47.
[200] *Afloat and Ashore,* p. 229, Chap. 16.
[201] *Notions of the Americans* (1839 ed.), II, p. 330.
[202] *Gleanings in Europe: France* (Spiller ed.), p. 69.
[203] *Ibid.,* p. 70.
[204] Cooper would have been prejudiced. Mrs. Cooper's sister, Anne, a "fierce Tory" in England, became in 1827 the second wife of John McAdam, the "Colossus of roads."
[205] Susan F. Cooper, "Small Family Memories," in *Correspondence of JFC,* I, p. 71.
[206] Cooper's distrust of "general systems and comprehensive theories" of education is illustrated in "Imagination" (originally published in 1823, in *Tales for Fifteen* and

Captain Wallingford cannot bring himself to believe that "a physician of Doctor Hosach's eminence and character would speak openly of the diseases of his patients" when gossips claim that Doctor Hosack had told someone that Mrs. Bradford has a cancer; Wallingford is partially mollified when the gossips claim that a friend got the secret out of him "by negations."[207] The sympathetically portrayed physician Dr. Edward McBrain, "a man of very handsome estate, the result of a liberal profession steadily and intelligently pursued,"[208] is not "a man to press a fact . . . without sufficient justification," and is hesitant about identifying the skeletons found in the ash ruins of the Goodwin's house as those of two women.[209] And of course Cooper, being of a strict propriety, could not have sympathized with Dr. Powers of Cooperstown, who was convicted "of mixing tartar emetic with the beverage of a ball given at the 'Red Lion.' "[210]

No moderate in his personal tastes, Cooper so disliked New England, that even Boston biscuits kept him awake at night![211] For him it was no matter for levity; Cooper liked his food—there was a science in its preparation. Bad cooking and hasty eating, he thought, "are the causes of the diseases of the stomach so common in America." Americans had no idea about how to prepare vegetables and meat and still retain their nutriment, a matter of serious concern, for "national character is, in some measure, affected by a knowledge of the art of preparing food, there being as good reason to suppose that man is as much affected by diet as any other animal, and it is certain that the connection between our moral and physical qualities is so intimate as to cause them to react on each other."[212] In both *Notions of the Americans* and *The American Democrat,* Cooper enjoys discussing the implications of what he calls "the science of the table" in a way that would delight a modern dietitian. Of the science of cookery he finds that Americans, as compared to Europeans, are "singularly and unhappily ignorant." The Americans "are the grossest feeders of any civilized nation known," their food being "heavy, coarse, ill prepared and indigestible."[213] The result was certainly not conducive to the formation of an American superman. For Cooper, seldom unpatriotic, the prospect looked forbidding. He did think that "the empire of gastronomy will, sooner or later, be transferred to this spot," but he

later reprinted in *Robert's Semi-Monthly Magazine,* Feb., 1841), where Katherine's mother carefully supervises her daughter's reading and education.

[207] *Afloat and Ashore,* p. 367, Chap. 25.

[208] *Ways of the Hour,* p. 61, Chap. 5.

[209] *Ibid.,* p. 52, Chap. 4.

[210] *The Chronicles of Cooperstown* (Cooperstown, 1838), p. 31.

[211] Cooper's *Journal* for 1848, in *Correspondence,* II, p. 731.

[212] *The American Democrat,* p. 165.

[213] *Ibid.,* p. 164. The Indians were in even worse straits, often obliged to eat raw meat "without any aid from the science of cookery." (*Last of the Mohicans,* p. 105, Chap. 11).

thought that "at present it must be confessed that the science is lamentably defective."[214] In truth, the Americans were too content to depend upon the "bounties of nature." Moral individualism was needed here also, "without which no perfect enjoyment in any branch of human indulgence can exist."[215]

Cooper's interest in utilitarian science, many-faceted, was not always consistent, particularly when humor was at bay. Essentially Cooper favored men like young Wallingford, with their ability at "figures and calculations."[216] He could write very unchivalrously, however, about that "very learned sort of individual, the American antiquarian," who, in exploring an early abandoned mill in "ruinous condition," resembled "the renowned knight of La Mancha tilt(ing) against . . . other windmills. . . ."[217] Yet Susan is our authority that Cooper, laying "no claim to the honor of scholarship in the field of antiquity," was greatly interested in the ancient ruins of Rome,[218] and that he greatly enjoyed riding over the Campagna, occasionally dismounting "to examine more closely a statue or fragment of ancient days."[219] He knew that to wish the steamboat out of existence was contrary to all the principles of political economy, but he was quite certain "that the world is less moral since steamboats were introduced than formerly."[220] The world was too busy to pray. And it pained him to see the "rustic virtues" of the countryside thrust aside by a piping, whistling railroad trailing "a sort of bastard elegance."[221] These inventions, he thought, when misused, coupled "with the gregarious manner of living that has sprung up in the large taverns, (were perhaps) 'doing wonders for the manners of the people'; though . . . the wonder is that they have any left."[222]

Yet it was man who ultimately determined the rightness or wrongness of scientic discoveries, not the discoveries themselves. The "arcana of nature," properly inquired into and properly used, could prove of immense benefit. Dr. Todd, the "man of physic" in *The Pioneers,* who knew eighty Indian remedies and had studied "Denman's Midwifery," was, says Cooper, "on a level with his compeers of the profession."[223] Hawkeye, learned in the secrets of nature, comments that "a little bruised alder will act like a charm" in curing the "deep flesh wound" incurred by the Indian boy in

[214] *Notions of the Americans* (1839 ed.), I, p. 141.
[215] *Idem.*
[216] *Afloat and Ashore,* p. 264, Chap. 18.
[217] *The Red Rover,* p. 39, Chap. 3.
[218] Susan F. Cooper, "A Second Glance Backward," *Atlantic Monthly,* LX (Oct., 1887), p. 481.
[219] *Idem.*
[220] *Homeward Bound,* p. 205, Chap. 18.
[221] *Sea Lions,* p. 11, Chap. 1.
[222] *Afloat and Ashore,* p. 450, Chap. 30.
[223] *The Pioneers,* pp. 64–65, Chap. 6.

recovering Killdeer.[224] Cooper himself deliberated on the "hotly contested" question of whether yellow fever was or was not contagious and came to the conclusion that "a sort of middle course" was to be preferred.[225] And when a rash of small-pox appeared in the Mamaroneck area, Cooper financed the vaccination of a number of people and saw to it that his children were inoculated.[226] Conservation-wise, Cooper appears to have advocated a policy which took cognizance of nature's ways. Richard Jones in *The Pioneers* is satirized for proposing "efficient scientific" means for slaughtering wild ducks and "the wastefulness of the settlers" in clearing the forests is condemned. Cooper's attitude is that of the Judge, who wishes to utilize and conserve our natural resources.

Young America was a nation on the go; science and the products of science were a major desideratum. There was absolutely no reason "why science and all the useful arts should not be cultivated here. . . ."[227] "It is probable," Cooper rejoiced, "that the amount of science in the United States, at this day, compared to what it was even fifteen years ago, and without reference to the increase of the population, is as five to one, or even in a still greater proportion."[228] And so he practiced his animal husbandry, praised the combine as "an instrument of the most singular and elaborate construction,"[229] studied crop development, and forever gave his attention to the practical products of science at the same time that theoretical science gave him a rationale for the worship of an infinitely wise God.

6. Use of Science in the Art of Fiction

Cooper, who was so vitally interested in the role of science in relation to our material and spiritual selves, could hardly have failed to realize its fictional value. Of course, as an artist he consciously worked with materials that had been traditional in the writing craft. Many of his statements regarding science occur at what might be called stop-points in his narrative, where Cooper breaks in with an aside that can only be taken as representing his own view. But there are a surprising number of times that Cooper employed either men of science or some science byplay directly in his writing. And once, in *The Crater,* science provided the entire sub-structure of the plot.

In many ways Cooper's Leatherstocking epic could be related to the vogue of epic painting in the Hudson River School, described

[224] *The Last of the Mohicans,* p. 332, Chap. 31.
[225] *Notions of the Americans* (1839 ed.), I, pp. 114–119.
[226] *Correspondence* (New Haven, 1922), I, p. 28. See Susan F. Cooper's "Small Family Memories."
[227] *Notions,* II, p. 115.
[228] *Notions,* II, p. 217.117.
[229] See Mentor L. Williams, "Cooper, Lyon, and the Moore-Hascall Harvesting Machine," *Michigan History,* XXXI (March, 1947), pp. 26–34.

by Oliver Larkin. Thomas Cole (Cooper's close friend) provided him with his artistic technique in *The Crater.* And Wilson's *Pedestrian Tour to Niagara*[230] (given much contemporary notice), has been pointed out as an influence on Cooper's landscape treatment. But it is well to remember that Cooper was as well a friend of S. F. B. Morse and of Dr. DeKay, and he was familiar with Humboldt's and Gilpin's writings. Morse was a painter before he turned his attention to more scientific and utilitarian pursuits and he contributed his share to the romantic, large canvasses that pictured nature in all its grandeur and largeness. Dr. DeKay's *Anniversary Address on the Progress of the Natural Sciences in the United States,* where he advocated a closer inquiry into nature and its processes, was given in 1826, the same year as Cooper published *The Last of the Mohicans.* In many ways DeKay's interests, as seen in this paper, and Cooper's coincided. Both were interested in geology and associated scientific fields, and both saw the manifestation of God in the phenomena of nature. It perhaps was no coincidence that Cooper speculated about the origin of Uncas and Chingachgook the same year that DeKay pointed out that the history of the Indians was a fit subject for scientific study. Von Humboldt's *Kosmos,* which urged landscape painters to study the topography of large and distant scenes,[231] was not published until 1845, but what was said in the *Kosmos,* Humboldt had adumbrated earlier in different words. No direct connection can be established between Cooper and Humboldt other than a few scattered references which Cooper made, but that Cooper would have agreed with Humboldt and that both were in accord with the main current of theories of art and letters there can be little doubt. Cooper's ideas of landscape treatment as they occur in *The Last of the Mohicans,* for instance, could have been and probably were partially derived from Scott, but for the whole picture it is necessary to achieve a larger perspective.

In *The Last of the Mohicans,* Natty shows a true scientific regard for proper classification when he refuses to answer to the name of La longue Carabine, because the "title is a lie, 'kill-deer' being a grooved barrel and no carabyne."[232] Earlier he had mentioned the gunsmith's art and had observed that "of all we'pons the long-barrelled, true-grooved, soft-metaled rifle is the most dangerous in skillful hands. . . ."[233] In *The Pathfinder* Muir discussed with the hero the "science of gunnery." Rose Budd shows the same esteem

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[230] Suggested by G. H. Orians, "Censure of Fiction in American Romances and Magazines," *PMLA,* LII (Mar., 1937), pp. 195–214. On "Cooper and Thomas Cole: An Analagous Technique," see Donald Ringe's study in *American Literature,* XXX, 26–36 (Mar. 1958).

[231] *Literature of the American People,* edited by A. H. Quinn (New York, 1951), p. 552. See also Albert T. Gerdner, "Scientific Sources of the Full-length Landscape: 1850," *Bulletin of the Metropolitan Museum of Art,* October, 1945.

[232] *The Last of the Mohicans,* p. 315, Chap. 29.

[233] *Ibid.,* p. 73, Chap. 7.

for scientific naval language as does Natty in saying that her wish "is not to parade sea-talk, but to use it correctly when I use it at all."[234] After the pursuing group loses the trail of Magua and the kidnapped sisters and Uncas turns the water out of the brook to reveal Magua's moccasin track, Cooper pictures "Hawkeye regarding the trail with as much admiration as a naturalist would spend on the tusk of a mammoth, or the rib of a mastodon."[235] *The Pathfinder* abounds in similes like pivots, siphons, two negatives repulsing one another, and compasses, all suggestive of elementary science. To raise a sunken schooner "mechanical principles" are utilized: the doors and hatches are sealed and holes bored in the hull to let the water out.[236] In *Afloat and Ashore,* Cooper has a long passage on steamers, which he calls "vast machine[s]," where he states that "Erricson's screw, and Hunter's submerged wheels, [were] rendering steamships, in my poor judgment, the safest craft in the world."[237] And in *Autobiography of a Pocket Handkerchief,* Cooper's sketch of contemporary New York social life contains several references to the then popular subject of mesmerism.[238]

For some reason, Cooper pictured his physicians as men of science carried away with their learning to the point where they aspired to be gods. There are doctors like Battius and Sitgreaves. Dr. Sitgreaves begins by describing himself in depreciating terms as "a poor humble man of letters, a mere Doctor of Medicine, an unworthy graduate of Edinburgh, and a surgeon of dragoons; nothing more, I do assure you."[239] Although an efficient military practitioner, Sitgreaves is made ludicrous by his repeated references to the "lights of science," by his continued attempts to teach the Virginian dragoons to use their sabres "scientifically" in cutting up their victims, and by his repeated desire to attempt the experiment of resuscitating a patient who had his brains dashed out. In conversation with Miss Peyton he attributes polygamy to the ignorance of the ancients which has happily been eradicated by "the increase of science." The crushing rejoinder delivered by Miss Peyton is, "I had thought, Sir, that we were indebted to the Christian religion for our morals on this subject."[240] *Lionel Lincoln* (chapter XVII) has a two page satire on a doctor probing for bullets and so causing his patients to die, and in *The Crater,* only one doctor is brought to the colony because it is better to die under one theory than two. Duncan Heyward is disguised and painted as an Indian physician in *The Last of the Mohicans,* and is warned to be "prepared to per-

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[234] *Jack Tier,* p. 71, Chap. 3.
[235] *The Last of the Mohicans,* p. 229, Chap. 21.
[236] *Jack Tier,* p. 134, Chap. 5.
[237] *Afloat and Ashore,* pp. 373–374, Chap. 25.
[238] *Autobiography of a Pocket Handkerchief* (Chapel Hill, 1949), pp. 101 and 105.
[239] *The Spy,* p. 214, Chap. 20.
[240] *Ibid.,* p. 232, Chap. 22.

form that species of incantation, and those uncouth rites under which the Indian conjurors are accustomed to conceal their ignorance and impotency."[241] If judged by the examples just cited, Cooper apparently thought that the physician as a type to afford comic relief had definite fictional value. Yet this is not to state the whole case. Mark Woolston in *The Crater* is the son of a Philadelphia physician who gave Mark a fairly good education and who was apparently made of sturdy stuff. Dr. McBain in *The Ways of the Hour* represents the sterling qualities of a positive kind which Cooper admired in a physician, and his technical ability is used to unravel the complications of the plot. Young Wallingford, in need of the best physician available for his dying sister Grace, lists in order of preference, the actual contemporary physicians Hosack, Post, Bayley, M'Knight, More, "and even thought of procuring Rush from Philadelphia," but Rush was too far away.[242] The case of Grace points up an interesting anticipation by Cooper of psychosomatic medicine, just as the split-personality theme in *Wyandotte* antedates modern psychology. Grace, her heart broken by Rupert's neglect, is slowly wasting away, prompting Wallingford to comment that though he is unskilled "in the theories of science" he feels his sister's mind is responsible for her condition.[243] "Dr. Post," Wallingford states later, "must know that the mind is at the bottom of the evil. . . .[244] The remedies proposed by Dr. Post serve to indicate that he is fully aware of the delicate relationship between mind and body, for they are meant in the main to divert her from her fixation.

It was in *The Crater*, however, that science may be said to have come into its own and provided the framework for his story. Cooper had before, in *Home as Found* and *Afloat and Ashore,* speculated on how "not only islands, but whole archipelagos are made annually by the sea insects."[245] "The gigantic works completed by these little aquatic animals are well known to navigators, and give us some tolerably accurate notions of the manner in which the face of the globe has been made to undergo some of its alterations."[246] *The Crater* carries this reflection of a "scientific nature" about various geological and botanical phenomena right into the fabric of the tale.[247] Cooper's theme is not scientific. He had an allegorical purpose to serve, but the geological processes—the rise and sinking of the island—serve to keynote the twin theses that God governs all

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[241] *The Last of the Mohicans,* p. 272, Chap. 25.
[242] *Afloat and Ashore,* p. 422, Chap. 28.
[243] *Ibid.,* p. 423, Chap. 28.
[214] *Ibid.,* p. 444, Chap. 29.
[245] *Home as Found,* p. 262, Chap. 19.
[243] *Afloat and Ashore,* p. 214, Chap. 15.
[247] For the following parallels between Lyell's *Principles of Geology* and Cooper's *The Crater* concerning geologic factors, I am indebted to Miss Vivian Hopkins.

and that religion must be prior to politics. For his descriptions of the cataclysmic actions of nature, Cooper looked to what scientific inquiry, particularly the researches of Sir Charles Lyell, had provided, with the result that his story had a probity it otherwise might have lacked.

The volcanic eruption which forces to the surface of the water a large area of land corresponds rather closely with reports that had been carefully brought together by scientists. Lyell records the Chilean earthquake of 1822,[248] in terms not dissimilar to Mark's observation: the wheeling flights of the birds; the "lurid light" of the sunset the night before the eruption; the hissing sounds and the jetting out of fire, smoke and ashes; the feeling of suffocation caused by mephitic vapors.[249] A "new outlet to the pent forces of the inner earth" Mark knew to be somewhere in the area of the eruption, the prodigious pressure of the gasses forcing "open crevices at the bottom of the ocean" and the resulting steam pushing volcanic rock steadily up through the depths.[250] If Cooper's eruption is milder than those described by Lyell, it should be remembered that Mark was stationed on a reef some fifty miles from the point of action.

When Mark's ship is wrecked, he finds himself on a low-lying reef that has a circular mound in its center rising to a height of from sixty to eighty feet, composed of "a soft or friable rock, . . . a stone that is called tufa,"[251] which suggests that the mound is an extinct volcano which had been rendered inactive by the superior activity of its neighbor. This of course is in line with Lyell's belief that if the action of one volcano becomes very great for a century or more, the others assume the appearance of spent volcanos.[252] Actually, the reef upon which Mark is situated has many of the features which in Lyell are associated with coral formation, while his description of the land newly created as "completely altering the whole appearance of the shoal"[253] agrees with Lyell who noted that on a "few occasions the gradual formation of an island by a submarine eruption [could be] observed."[254]

Mark's further invesigations of the island have references to Lyell. When he climbs the Peak to the south of the Reef, he discovers that previous to the eruption about only one-fourth of the

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[248] *Principles of Geology* (London, 1835, Fourth ed.), II, pp. 231–232.
[249] *The Crater* (New York, 1859), pp. 160–162.
[250] *Ibid.*, pp. 163–164. Lyell's accounts are very similar. He speaks of vents in the ocean bottom induced by the tremendous heat which is sufficient to "reduce to a gaseous form a great variety of substances" and which then causes a consequent upheaval of "solid masses to immense heights in the air." See *Principles of Geology* (London, 1835), II, p. 211.
[251] *The Crater* (Illustrated Library ed.), p. 68, Chap. 4.
[252] See Lyell's *Principles of Geology*, II.
[253] *The Crater* (New York, 1859), p. 162.
[254] *Principles of Geology* (London, 1835), II, pp. 198–199.

Peak had been above water, and deduces that since the land to the southward has a greater elevation than that to the north, the eruption had caused the land to project itself "on an inclined plane." "This might account, in a measure," he thinks, "for the altitude of the Peak. . . ."[255] Lyell too had observed such phenomena. He found that strata have, in many situations, originally accumulated on an inclined plane, wherever sand, mud, and gravel are thrown into deep water by rivers and torrents.[256] The process is continually taking place all over the globe, dry land sinking under the ocean to rise again some subsequent day. Throughout Cooper's book what on the surface might be taken as the token of a novelist's imagination is, upon investigation, seen to rest on a strata of scientific fact. In his account of the cause of the eruption, the details accompanying it, the rise of the land, and the "inclined plane" which resulted, Cooper is squarely in agreement with what the geologists of his day had discovered.

This parallel extends even to the denouement, to which many have objected as violating the canon of probability. In the continuous shifting of the earth's surface in the Pacific, islands continually are appearing and disappearing, the despair of lexicographers and the awe of navigators. Cooper's purpose is of course a novelist's purpose; he had no need for the "gradual development" theory ventured by Lyell. Scientific fact was to subserve moralistic allegory, not to replace it. The cataclysm which overtakes the island during Mark's absence is meant to be poetic justice. It is a utilization of science for novelistic ends. Cooper was therefore faithful to his scientific sources in picturing the appearance and disappearance of his island and thus retained that verisimilitude which in the preface to *The Bravo* he had proposed as one of the novelist's main considerations.

Cooper's *The Monikins* also has a great deal to say, in a left-handed way, about science. But we must be careful not to take it too literally, since it is based on the literary conventions of Swift which were generally hostile to science. Just as the satire on the social institutions of the United States constitutes no downright denial of them, so the references to science that one discovers do not mean an absolute dismissal of all that science has contributed to man's physical well-being up to Cooper's time. The book should be taken for what it was meant to be: an indictment of the extravagancies to which man is heir. At the same time it gives us an admirable opportunity to measure the breadth of Cooper's views, his peculiar attitudes, and his considerable acquaintance with the

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[255] *The Crater* (Illustrated Library ed.), p. 197, Chap. 12.
[256] See Lyell's *Principles of Geology,* II.

popular, scientific, and technical thought and controversies prior to 1835.

We have seen that Cooper was acquainted with the great chain of being concept held by his friend and personal physician, Dr. DeKay. In *The Monikins,* Cooper burlesques in the vein of Swift, the current controversies that were going on between those who debated whether species were immutable. It had long been debated in Leaphigh, according to Dr. Reasono, whether all animals belong to the same genus (being subdivided into varieties or species) or whether "they are to be divided into the three great families of the improvables, the unimprovables, and the retrogressives."[257] "They who maintain that we form but one great family, reason by certain conspicuous analogies, that serve as so many links to unite the great chain of the animal world."[258] But, says Dr. Reasono, this was not the most popular thought in Leaphigh at the moment, adding that the great Monikin triumph had been attained when they recognized that "truths, physical as well as moral, undergo their revolutions, the same as all created nature."[259] The division of "animated nature" into improvable, the unimprovable, and the retrogressive, aside from its implicit Manicheanism (the Monikins hold that only when they are purged of material dross do they enjoy the highest state of being), has many surface similarities to the scientific arguments of Jean Baptiste Lamarck, whom Cooper could have known through Lyell's discussion of him in the *Principles of Geology,* and Buffon, with whose work Cooper was personally familiar. To the Monikins, "The improvable embraces all those species which are marching, by slow, progressive, but immutable mutations, toward the perfection of terrestrial life, or to that last, elevated, and sublime condition of morality, in which the material makes its final struggle with the immaterial—mind with matter."[260] In this order the sponge is on the bottom of the evolutionary ladder, with man as intermediate, and the Monikin occupying the top rung, an order which in a sense reverses Buffon, who had held that just as asses were inferior horses, so apes were inferior men. And in fact, Sir John cites Buffon as the authority that Monikin historians were possibly wrong in asserting that monkeys were first men: "no human historian, from Moses down to Buffon, has ever taken such a view of our respective races."[261]

But Dr. Reasono continues to hold that monkeys and men, in the same improvable class, are different in degree of intelligence, that "monkeys . . . were once men, with all their passions, weaknesses,

[257] *The Monikins,* p. 113, Chap. 11.
[258] *Idem.*
[259] *Idem.*
[260] *Ibid.,* p. 114, Chap. 11.
[261] *Ibid.,* p. 117, Chap. 11.

inconsistencies, modes of philosophy, unsound ethics, frailties, incongruities and subserviency to matter; that they passed into the monikin state by degrees, and that large divisions of them are constantly evaporating into the immaterial world . . . final mutations which transfer us to another planet, to enjoy a higher state of being."[262] It was quite impossible for human historians to detect this mass evolutionism, because as yet no man being a Monikin, he could not know the future, and one must therefore depend on Monikin records. And Dr. Reasono points out a human philosopher—who could be either Lord Monboddo or Buffon—who had discovered, "as incontrovertible, that men once had *caudae*," establishing it "by pointing to the stumps."[263] Further references to the environmentalism of Erasmus Darwin and Buffon occur when Dr. Reasono, in his address before the Leaphigh "Palais des Arts et des Sciences," reasons that the monkeys on St. Helena might "have had a common origin with the monikin species." "The vicissitudes of climate, and a great alteration of habits, had certainly wrought some physical changes; but there still remained sufficient scientifi identity to prove they were monikins."[264] He thinks they might be used as menials in Leaphigh. And Lamarck's famous "law of use and disuse" is recalled when a member of the Leaphigh Academy reads a paper on an unknown fluid which had been "rendered subject to the will" and which furthered Monikin happiness.[265]

There are further references to the fossil discoveries of Buffon and the current vogue of phrenology in Cooper's time. The retrogressive class which goes in a "false direction"—animals like whales, elephants, hippopotami, Congo humans and Eskimoes, baboons and common monkeys—become in the course of time, by their downward progress, part of the four Greek elements: "the bones become rocks, the flesh earth, the spirits air, the blood water, the gristle clay, and the ashes of the will are converted into the element of fire."[266] Dr. Reasono, who holds satirically that the "most infallible sign of the triumph of mind over matter, is in the development of the tail,"[267] points to the elephane as a case of downward progress whose trunk is an aberration or abortion, and says that whereas "your geologists and naturalists speak of the remains of animals" (the mastodon, megatherium, iguanodon, plesiosaurus) as significant discoveries, in reality "these fossil remains of which your writers say so much, are merely cases that have met with accidental obstacles to their final decomposition."[268] As to where

[262] *Idem.*
[263] *Ibid.*, p. 121, Chap. 11.
[264] *Ibid.*, p. 186, Chap. 16.
[265] *Ibid.*, pp. 179–180, Chap. 16.
[266] *Ibid.*, p. 115, Chap. 11.
[267] *Ibid.*, p. 116, Chap. 11.
[268] *Ibid.*, p. 120, Chap. 11.

the seat of intelligence is, there is much controversy between Sir John and Dr. Reasono. Sir John as a human being of course holds out for the head: just as sap in a tree brings life-giving fluids to the uppermost branches, so the brains ascend from the tail to the head and not vice-versa. And because the head is the "more honorable member, . . . [men] have made analytical maps of this part of our physical formation, by which it is pretended to know the breadth and length of a moral quality, no less than its boundaries."[269] But to this phrenological notion, Dr. Reasono opposes the Monikin superiority in arts, philosophy, and the "system of caudology" or "tailology" as greater than the human science of phrenology. Nor does Sir John's analogy with the sap of the tree achieve any resounding victory, for, taking a different tack on the same subject, Dr. Reasono points out that the greatest intelligence must necessarily lie in the tail, for just as the sap of a tree receives its nourishment from the roots so the lowest extremity (the tail) must furnish direction to the rest of the body.[270]

Dr. Reasono's discourse on the origins of the earth and the beginnings of life seems to be Cooper's own genial spoofings of the controversies that raged during the early nineteenth century among the geological schools. Thus Dr. Reasono purports to offer "geological proofs" that the earth for many years "was placed in vacuum, stationary, and with its axis perpendicular to the plane of what is now called its orbit. Its only revolution was the diurnal," and there were no changes of the seasons.[271] There was at this time "no other machinist than nature," who used her "own established laws."[272] Eventually, says Dr. Reasono, the friction generated by the earth in its diurnal passage culminated in interior fire, and this in turn, by a "great, salutary, harmonious, and contemplated alteration," resulted in the land of the south pole becoming habitable. By virtue of the diurnal roll, matter was pushed toward the equator, and the thin crust left at the pole allowed the steam from the inside to push out and act like a safety valve, meanwhile producing vegetation.[273] Allowing for Cooper's burlesque, Dr. Reasono's explanations parallel the theory of evolutionary geology propounded by Sir Charles Lyell, who was the leading exponent of the Uniformitarians, followers of the Scottish geologist James Hutton. The essential position is that all natural geological phenomena was the result of the same processes that had acted for all time and which could be observed today.

But tied to the Uniformitarian position is the theory promulgated by Georges Leopold Cuvier, whom Cooper had met at a din-

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[269] *Ibid.*, p. 116, Chap. 11.
[270] *Ibid.*, p. 120, Chap. 11.
[271] *Ibid.*, p. 124, Chap. 12.
[272] *Ibid.*, p. 127, Chap. 12.
[273] *Ibid.*, pp. 124–127, Chap. 12.

ner and of whom he had expressed disapproval. Cuvier was opposed to the Lamarckian school of gradual evolutionary development. Instead, he held that a number of vast cataclysms had interrupted the more steady geological formations, that the earth's strata gave evidence of different forms of animal life which in its progression resulted in man (but Cuvier saw no reason to believe that one species evolved from another), and that geological patterns went to bolster the Biblical account of catalysmic actions such as the Deluge. Cooper parodies this theory by describing an early sect of Monikins possessed of "religious fanaticism and philosophical sophisms" who determined that the safety valve for steam (of uncounted beneficence before) was bad for the Monikins. Gaining power and having acquired "perfection in the mechanic arts," they were enabled to "heremtically seal" the safety-valve. The result was snow, a scarcity of fruits, privation. Finally, the pressure built up under the thin crust at the pole, caused a titanic explosion, and 40,000 square miles of territory flew off to form the "western archipelago," as evidenced by "various geological proofs."[274] The blow also caused a shift in the earth's axis, inclining it 23° 27′ and causing the earth to make its annual revolution, which will continue for all time because "it is proved [by Newton] that all bodies in which the *vis inertia* has been overcome will continue in motion until they come in contact with some power capable of stopping them."[275] The huge steam explosion also caused the land to give way so that the polar region had a sea that was uniformly four fathoms deep, preventing icebergs from reaching there by grounding them.[276] Discoursing on his trip to the outside world before the Leaphigh Academy, Dr. Reasono in the course of "a long scientific talk" on the island of St. Helena finds the Monikin accounts substantiated. "It was reported to be volcanic, by the human *savans,* he said, but a minute examination and a comparison of the geological formation, etc., had satisfied him that their own ancient account, which was contained in the mineralogical works of Leaphigh, was the true one; or, in other words, that this rock was a fragment of the polar world that had been blown away at the great eruption. . . ."[277] And he produces "certain specimens of Rock" to enforce his argument.

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[274] *Ibid.,* pp. 128–133, Chap. 12.

[275] *Ibid.,* p. 134, Chap. 12. The law cited is, of course, popularly known as Newtonian law.

[276] *Ibid.,* p. 159, Chap. 14.

[277] *Ibid.,* p. 185, Chap. 16. Portions of the argument given by Dr. Reasono would seem to be a reflection of the nineteenth century geological controversy between the Plutionists and the Neptunists. The Plutionists, or Vulcanists, were followers of James Hutton, a Scottish geologist who in 1785 published his *Theory of the Earth,* where he held that present day rocks had evolved from rocks which had been deposited under the sea and then subsequently projected upward by intense subterranean heat. Hutton's views, labored and difficult, were considerably popularized by his biographer, John Playfair. This theory that the earth's internal heat was responsible for much

Among other references to science are the Leaplow descriptions of the gyrations of patriots and the odd satirical mixture of astrology and astronomy. Patriotic gyrations are explained in the light of Newtonian principles; they "are much the same as the eccentric movements of the comets, that embellish the solar system without deranging it by their uncertain courses," while the gyrations of the perpendicular and horizontal lines, which denote public opinion, "are quite as imperceptible . . . as are the revolutions of our planet to its inhabitants."[278] And the "great rotary principle" of the most patriotic patriots consists of a "centripetal counterpoise" to their "centrifugal force," and prevents them "from bolting out of the political orbit."[279] As for the astrology-astronomy anomaly, the "moral mathematicians" of Leaplow calculate that a moral eclipse will take place whereby Principle will be obscured by Interest. This "precision" in calculating the "terrible circumstances" awes Sir John and he begins "to perceive the immense difference between living consciously under a moral shadow, and living under it unconsciously."[280]

It is probably safe to say that Cooper's *Monikins* is more permeated with ideas associated with the science he is satirizing than any other novel in the first half or perhaps all of the nineteenth century.

Finally, to conclude this section on Cooper's use of science in the art of fiction attention should be called, on the negative side, to his delight in the fact that many writers even before Scott had "eradicated the sickly sentimentalism of the old school" of novelists. Cooper also disliked (as he said in *The Pilot,* Chapter IX) Gothicism and its "spooks and witchery.") In his long and hostile review of Lockhart's biography of Scott (*Knickerbocker Magazine,* Oct. 1838) Cooper sharply questioned the claim that Scott was first to eradicate sentimentalism. "To say nothing of twenty others, Miss Edgeworth alone supplanted the sentimentalists, before Scott was known, even as a poet. This whole school, which includes Mrs. Opie, Mrs. More, Miss [Jane] Austin (*sic*), and Mrs. Brunton, not to say Madam D'Arblay, was quite as free from sentimentalism as Scott, and because less heroic, perhaps more true to everyday nature." Since Cooper is presently regarded by hostile critics as a sentimentalist in his love stories, his anti-sentimental ideal as here expressed

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[278] *Ibid.,* p. 203, Chap. 17.

present day geological phenomena was strongly opposed by the teachings of Abraham Gottlob Werner. Werner and his followers (the Neptunists), held that the earth's rocks had been formed by chemical precipitation in the ocean. Volcanoes were an essentially modern feature of the earth, they held, and thus were discounted as contributing to the formation of the earth's rocks. For orientation, see C. C. Gillespie, *Genesis and Geology,* Cambridge, 1951.

[279] *Ibid.,* p. 320, Chap. 28.

[280] *Ibid.,* p. 309, Chap. 27.

is significant as paving the way for a partially scientific kind of fiction.

Especially significant, however, is Cooper's acceptance of the aesthetics of the psychology of associationalism then prevalent (cf. Irving and Bryant) and which may be traced back through Wordsworth (from whom he used nearly twenty quotations to adumbrate the action of various chapters) to Hartley and to Newton's *Optics* and his scientific theory of vibrations. See H. C. Warren, *A History of the Association Psychology from Hartley to Lewes,* 1921, and Arthur Beatty, *William Wordsworth* . . . , 1925). The associationalists argued that we find certain places or objects beautiful or appealing, but not others, because historically certain ideas, patriotic or pleasurable or inspiring, have been repeatedly associated with these specific places, the repeated experience providing a "bond" which helps to recall a train of associated ideas. Thus in his essay on Lockhart's *Scott* Cooper said Scott's much-praised "powers of imagination . . . were subordinate rather than inventive, requiring to be quickened by associations, and depending as much on memory (the past) as on any other faculty,"—i.e., depending on "legend and traditions," on the use of historic places "he could see, or read of." In *The Heidenmauer* the long Introduction tells how Cooper recognized that his story showing the Catholic "monk and [Lutheran] baron . . . in collision" took its start from his loitering as a tourist in a German village, Duerckheim, and viewing actual historic sites such as a ruined abbey, a deserted castle, a Roman fortification, and a "Devil's Stone" where he perched and day-dreamed. "At every step," Cooper says, "we felt how intimate is the association between the poetry of nature and that of art; between the hillside with its falling turret, and the moral feeling that lends them interest. Here Caesar had led his legions to the stream and there Napoleon threw his *corps-d'armée* on the hostile bank. Time is wanting to mellow the view of our own historical sites; for sympathy can be accumulated only by the general consent of mankind (cf. Francis Jeffrey on associations focused on universals), and has not yet [in America] clothed them with the indefinable colors of distance and convention."

Yet Cooper in his preface to *Lionel Lincoln* on the American Revolution showed how he tried to make fictional and associational use of American historic places such as Lexington and Bunker's Hill and Prospect Hill, saying that in his researches "no pains were spared in examining all the documents, both English and American, and many private authorities were consulted, with a strong desire to ascertain the truth. The ground was visited and examined. . . ." Occasionally, as in the preface to *The Prairie,* he paid tribute to the theory of associationalism by deploring the difficulties of describing a setting that had so few "poetical associations," a view of "scenic representation" elaborated in Letter XXIII of *Notions.* In Cooper's preface to *The Deerslayer,* commenting on the Leather-Stocking Series as a whole, he says of his hero, "Removed from nearly all the temptations of civilized life, placed in the best associations of that which is deemed savage, and favorably disposed by nature to improve such advantage, it appeared to the writer that his hero was a fit subject to represent the better qualities of both [nature and civilization], without pushing either to extremes. . . . There was no violent stretch of the imagination, perhaps, in supposing one of civilized associations in childhood, retaining many of his earliest lessons amid the scenes of the forest." The boundless virgin wilderness is used to parallel the largeness and magnamity of Leather-Stocking's own spirit, like that of Adam before the Fall. (See *Pathfinder,* Modern Library Edition, pp. 121–23.) But it should be noted that this wilderness was veraciously based on scientific reports including those of Lewis and Clark and of Edwin James' compilation. (See E. S. Muszynska-Wallace, "The Sources of Cooper's *Prairie,*" *American Literature,* XXI, 191–200, May, 1949.) Thus Cooper combined associationalism and the use of scientific reports of actual places, as a means of evoking aesthetic appeal.

7. Conclusion

The key to Cooper's attitude toward science is found in his oscillation between two opposite poles, represented by 1) his attack in *The Prairie* (on Dr. Battius as supposing science can eradicate the evil principle in man); and 2) his defence of science against superstition (in *Mercedes of Castile*) and as advancing utilitarian ends while also confirming the eternal glory of God. In relation to the first pole, one associates his atacks on Deism (in *Precaution and Wing and Wing*), on Voltaire, and on the implications of the rationalistic French Revolution. In relation to the second, one associates his practical interests as a rich and deeply pious man interested in utilitarian matters furthered by science, such as the Erie Canal (advanced by engineers, new scientific methods of hardening cement under water, and labor-saving scientific devices), scientific naval-exploring expeditions such as that by Wilkes and Parry, and his admiration for astronomy as inspiring a religious sense of divine design in *The Crater* and his passages on La Place in *Gleanings in Europe: France.* His attitudes are thus complex and require caution on the part of any interpreter. And however unsatisfactory they may be to logicians enamored of consistency, Cooper's attitudes are significant as being in a large measure representative of the majority of Americans who in the early nineteenth century were reluctant to surrender to science their traditional religious presuppositions, and yet are sympathetic to it in so far as it makes money and saves time and pain and life.

From this it is evident that Cooper's knowledge of ideas associated with science was no idle thing and that it paralleled or reinforced many of his attitudes which gained immense vogue not only in this country but in Europe. From his education at Yale under Silliman,[281] through his years in the Navy, to his friendship with or reading of scientists such as Morse, Lyell, Laplace, etc. etc., Cooper conceived of science as one of the agents of man's material advancement. For himself at any rate he partially succeeded in resolving what to many men were conflicts between religion and the newly-found knowledge, and in this he is akin to the Knickerbockers such as Irving and Bryant who used science as an ally of orthodoxy to inspire reverence and humility. He rejoiced that science helped advance man's health and wealth and that it implemented Christian charity. And he used psychological theories such as associationalism to evoke powerful aesthetic appeals from both European and American historic places and from primaeval forest and sea. Occasionally, like Swift concerned with the virtuosi, Cooper could use the extremists among scientists for comic relief. Like Melville in his concern with the mystery of iniquity, Cooper centered much of his religious thought on "the great struggle of the conflicting egotisms which comprises, in a great degree, the principle of most of the actions of this uneasy world." (*Heidenmauer*, Routledge ed., p. 333). And thus when a fictional scientist such as his Dr. Battius made the extravagant claim that science could eradicate the principle of evil itself from the heart of man, Cooper regarded that as a symptom of sheer arrogance and pride. In his later work, when his religious convictions impelled him to adopt a more or less quietistic position, he saw science still as helping to mitigate much of the evils of man's terrestrial condition, and to this extent contradictions are to be found in his thought. But even here he sees "the hand of God instead of the solution of a problem"; as a man of humble piety he concluded that the ways of God are a mystery, that God effects his purposes through material agents, one of which is science.

[281] The recently published first two volumes of *Letters and Journals of James Fenimore Cooper* (Cambridge, Mass., 1960) show (I, 218) that "Cooper attended his [Silliman's] first course of lectures in 1804 and was, indeed, Silliman's laboratory assistant." See also his long letter to Silliman in II, 94–100. In general these letters up through the early thirties relate more to Cooper's travels and social affairs than to science, although there are references to it of a tangential kind as follows: I, 36–7, 56, 125, 217–18, 221, 199–200, 202, 204, 216, 229–30, 288, 371, 272, 375. Typical of such passing references is that of 1827 (I, 229–30) to the episode of Cooper's receiving from Dr. DeKay a zoological specimen (a "double-breather") which he passed on to the famous Cuvier. It is quite possible, of course, that the many volumes of letters yet to appear will be more illuminating regarding his interest in the various aspects of science, after 1832.

WILLIAM H. LIGHTY, RADIO PIONEER*

ROGER W. AXFORD
University of Wisconsin, Madison

"The thing that I will miss most is WHA," said eighty-three year old Professor William H. Lighty in 1949, after forty-three years in the University community at Madison, Wisconsin.

Studies in wireless telegraph transmission had been in operation before the birth of broadcasting as we know it. Experiments in wireless telegraph transmission were conducted at the University of Wisconsin, and weather reports were sent out regularly by 1915. But 1917 marked the beginning of telephonic transmission from the University of Wisconsin.[1] Thus, Radio Station WHA is reputed to be "the oldest Radio Station in the nation,"[2] in continuous operation.

Lighty's Beginning Interest in Radio

Lighty was aware of radio and its early developments and watched with interest its experimentation in Sterling Hall at the University.[3] His attention had been drawn to the new gadget by his two sons, Russell and Paul. In 1919 during this experimental period Lighty and his sons went to see a set built by a Wisconsin student, Malcolm Hanson, at the University, and questioned him about the wisdom of investing money in a set for the boys to use and study.[4] Lighty noted that through radio building the boys had a chance to learn something about science and physics, as well as about the communicating of ideas. The boys got their set and became active in the American Radio Relay League, which was composed of "ham" operators. They and their friends communicated with people in almost all parts of the world. Later, because of Pro-

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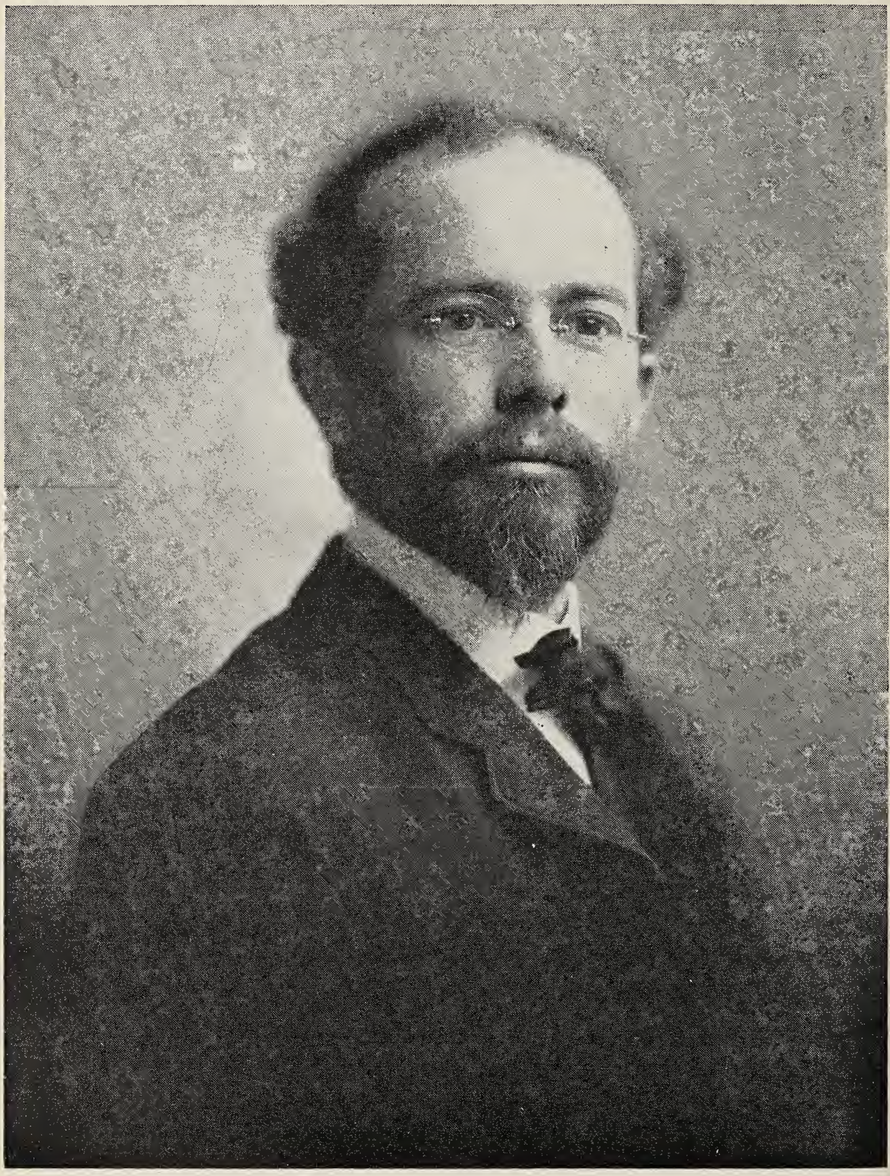
* Paper read at the 90th annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

[1] Harold B. McCarty, "WHA, Wisconsin's Radio Pioneer," *Wisconsin Blue Book* (Madison, Wisconsin: Published by the State of Wisconsin, 1937), p. 195.

[2] McCarty, *ibid.*, p. 197.

[3] Lighty Interview, Lafayette, New Jersey, December 6, 1958.

[4] "The student whom we visited was undoubtedly Malcolm Hanson. I think that we regarded him with awe, and accorded him the appropriate hero worship. He was not only the master of a most noisy and fearsome four kilowatt rotary spark gap transmitter, but through the mysterious black art of a set of vacuum tubes, made by the Physics Department glass blower, J. B. Davis, was able to project his voice over the air waves. More as a hobby, and an excuse to operate the apparatus, Malcolm got hold of the daily weather and market reports, which he broadcast on a fairly regular schedule, every noon." (Paul Lighty to R. Axford, July 13, 1959). The set owned by the Lighty boys and their father is now a part of the permanent collection of the Communications Center of the Wisconsin State Historical Society, Madison, Wisconsin.



William H. Lighty
1866–1959
Photograph provided by The State Historical
Society of Wisconsin.

fessor Lighty's interest and help to the League, he was made an honorary member of the Wisconsin American Radio Relay League in 1925.

Of this early beginning in radio Lighty said, "I felt then that radio communication would some day be one of the great factors in human communication and progress."[5]

The Early Days of Radio at the University of Wisconsin

Professor Earle M. Terry, physicist, is credited with the earliest experimentation with radio at the University of Wisconsin. It was Terry who first made a transmitter available. He designed equipment, constructed tubes, and built apparatus. Since tubes and equipment could not be bought commercially, Terry and his assistants fashioned their own. In 1915 a government license was issued for the University transmitter and the call 9XM was assigned.[6] It was not until 1922 that the University received the call letters WHA.

It was because of the need for materials for broadcasting that Lighty became active in radio, according to Professor Edgar B. Gordon of the Music Department of the University. He recalls that Terry needed educational material and entertainment, and, therefore, asked Lighty to do the programming.[7]

Another person with whom Lighty worked very closely was physicist Malcolm Hanson, a student of the above-mentioned Terry. Hanson was obsessed with the new gadget of radio, and would work far into the night on experiments.[8] It was Hanson who in 1919 had first reported hearing several telephonic broadcasts from the University of Wisconsin while on duty at the Great Lakes Training Post. Following his naval training, Hanson came to the University and devoted himself to radio experimentation. Hanson became WHA's first radio operator. While Hanson worked with the mechanical difficulties, Lighty worked with the programming problems. Each of the men seemed to have seen the social possibilities of radio, though this was Lighty's primary consideration. Lighty and Hanson were close friends, as is evidenced by their letters. Lighty wrote Hanson recalling those early days:

> I shall always have the ineradicable image of a square set young man in a dark suit with thin light stripes in it, in the midst of all sorts of strange wires, coils, switches, bulbs, etc., in the basement of the physics building, where I first saw you. You were the inspiration of a group of

[5] Lighty Interview, Lafayette, New Jersey, December 7, 1958.
[6] McCarty, *op. cit.* pp. 195–6.
[7] Interview with Professor Emeritus Edgar B. Gordon, Music Department, University of Wisconsin, July 28, 1958, Madison, Wisconsin.
[8] This is the same Malcolm Hanson of later fame with Admiral Byrd's Expedition on which Hanson was a radio operator. Hanson Papers, Wisconsin State Historical Society.

> young boys, among whom was one of mine—Russell. He was interested and knew a little about it. I too was interested, but knew nothing about it technically. I don't now. But my interest in its beneficent possibilities has constantly increased, as my participation has lessened.
>
> You and Terry, who approached the problems basically from the technical side, also, had the uncommon insight into its social potentialities.[9]

In his short history of Station WHA, Director Harold B. McCarty points out, "With his foresight and eagerness for university extension it was natural that Professor Lighty should become the station's first program director."[10] Although Lighty had been serving in this capacity, President E. A. Birge officially appointed him "program director" and gave him a committee of twelve faculty members. Some of Lighty's associates and supporters felt that he was spending too much time on this experiment of radio, but no doubt the president's appointment gave him official sanction, encouragement, and the backing of the University administration.[11]

Radio as the Wings for Education

Lighty saw the possibilities for radio to take education not only to the boundaries of the state, but as far as the ether would carry it. But, although Lighty had the vision, educational broadcasting at the University of Wisconsin had its inevitable growing pains.

As might be expected, there were mechanical difficulties encountered. On one occasion Hanson had to erect a patchwork-quilt tent for the speaker in order to deaden the echoes in the concrete walled room in the Physics Building, which was then the studio.[12] Unfortunately for the historian, the record of the mechanical problems are very limited, for the papers of Professor Terry were destroyed. Once WHA tried to rebroadcast Clemenceau's address given at the University of Chicago, but very little could be heard. At another time, the technician, Malcolm Hanson, had to pretend that a broadcast was an experiment when a cello player who was appearing at a concert, when he observed the microphone, suddenly moved to the other side of the stage so that he could not be heard. It seems that without informing the station, the musicians had formed a union, and it was against their rules to broadcast without extra compensation.

Besides the mechanical difficulties of the early broadcasts, there was the problem of engaging the necessary persons from the faculty to participate. Lighty was responsible for getting the faculty

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[9] *The Story of Malcolm Hanson* (privately printed, 1946), on file in the State Historical Society of Wisconsin, Madison, Wisconsin.

[10] McCarty, *op. cit.*, p. 199.

[11] Interview with Professor Henry L. Ewbank, Speech Department, Chairman, Radio Committee 1928–. at Madison, Wisconsin. June 4, 1958.

[12] "Extension Division Professor Recalls Early Days of WHA," *Daily Cardinal*, Madison, Wisconsin, January 9, 1934, p. 8.

to take part in the broadcasts. He gave first consideration to making the radio broadcasts represent the many departments of the University. But, not a few faculty members thought radio was a gadget, a fad, an activity below their professional dignity. Still Lighty persisted until he got faculty participation.

Many of the professors remember Lighty as the person who "wheedled out of them" their services to radio. Sprightly Miss Lelia Bascom, whose career in the Extension English Department paralleled Lighty's, tells of his tenacious leadership in radio:

> He worked with it consistently, and he got people to talk over the radio. For example, that's where I come in. He would say to me, "Now, Miss Bascom, will you go to Miss so and so and ask her to give a series of eight lectures on history." She immediately said, "I can't."
>
> I said, "We must hang on to our wavelength; we have only two or three hours a day. We need this, because we need to expand. The thing won't go over unless we do. We want to reach all the state. Mr. Lighty finds it worthwhile, and always pushes it hard."
>
> So I would entreat Miss so and so, and finally she would agree to do it. She kicked about it, but she did it just the same. When Mr. Lighty was not present at a committee meeting I often went down to represent him. So I heard something about the inner-workings, which were daily difficulties in getting the government to give us a longer wavelength, to get us longer hours, etc. Mr. Lighty and Mr. Hanson worked together on these problems, but Lighty's particular field was in getting people to talk over the radio and do their fair share.[13]

By 1924 the difficulty of getting faculty to broadcast must have lessened, for we find Lighty writing F. B. Swingle, of the *Wisconsin Agriculturist,* that "about three hundred faculty members have participated in the University broadcast programs."[14]

Miss Bascom related that one year President Frank would not appropriate any money for the radio programming. As a result, Mr. Carl Hills, head of the Agriculture Commission, made the money available to run the Extension radio service.

Lighty's Purposes in Radio

Lighty's interest in radio was from the standpoint of university service. Miss Bascom emphasized Lighty's social service approach in contrast to the interest of the engineering department which was primarily in the physical aspects of early radio. She said that Lighty was interested in bringing cultural programs to the people of the state, "for example, good music, not jazz; talks on political questions; lectures and university events."[15] She pointed out that the Extension Division began the radio service, an undertaking of which other departments were wary.

[13] Interview, Miss Lelia Bascom, June 21, 1958, Madison, Wisconsin.
[14] Lighty to F. B. Swingle, November 21, 1924 (Lighty Papers).
[15] Lelia Bascom, *op. cit.*

Lighty wanted to reach as many persons as possible with educational programs. Therefore, to assist in program planning, Lighty wanted to know more about the number of receiving sets in each community, and whether they were being used. In a letter to Terry he suggested a technique of which he was fond, the inclusion of a questionnaire from time to time in letters sent to students in radio. It would include questions pertaining to the instruction in Code, and also questions regarding the number of homes in each community in which there were receiving sets. In this way Lighty learned a little more about the listening constituency of the station.[16]

Lighty wanted to let the people of the state know about the services of the University, the public schools, and state government. He made radio time available to various University and state departments. Debating societies and musical groups from schools outside the city broadcast from the University station. In 1921 basketball games and musical concerts were broadcast directly from the University Armory. Special programs, such as the Farm and Home Week, and lectures by visiting dignitaries, were broadcast directly from their points of origin.[17]

Agricultural facts and the latest discoveries of the experiment stations were broadcast each noon on the farm half-hour, the oldest farm program in America. This was developed under the leadership of Professor Andrew W. Hopkins to meet the needs and interests of the Wisconsin farmers. Radio made possible first-hand information from the College of Agriculture for farmers living in remote areas. Hopkins was on Lighty's Radio Committee, and was Chairman of the radio committee for the influential College of Agriculture. Of Lighty's purposes in radio, Hopkins had the following to say:

> I was always impressed that he had a great vision of the possibilities of adult education. He was enthusiastic about people, and he had a great belief in people. He believed that tremendous things could come out of education, and of course we found Lighty a most enthusiastic supporter of the use of radio in education. He was interested in any means of promoting education.[18]

Lighty saw in radio an instrument for furthering the idea of university extension as set forth by President Van Hise, who said, "I shall never rest content until the beneficent influences of the University of Wisconsin are made available in every home of the state."[19]

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[16] Lighty to Terry, October 21, 1924 (Lighty Papers).
[17] McCarty, *op. cit.*, pp. 200–1.
[18] Interview, Andrew Hopkins, Professor Emeritus, Agricultural Journalism, University of Wisconsin, June 10, 1958, Madison, Wisconsin.
[19] Lighty, WHA-FM Inaugural Broadcast (Tape), March 30, 1947.

Wisconsin School of the Air

Lighty helped to start what is today the "Wisconsin School of the Air." Professor Gordon, with the encouragement and assistance of Lighty, organized in 1922 what McCarty says is "without doubt the first music appreciation course ever to be heard on the air." People listened with earphones, in those early days, and Gordon reports that he encouraged listeners to sing along with him while listening to the program.[20] Today through the "Wisconsin School of the Air" thousands of school children still sing, and once each year busloads of children come to the University to participate in the traditional Radio Music Festival.

In a letter to the high schools of the state in 1924 Lighty brought to the attention of the school administrators that "already a number of high schools in Wisconsin have radio telephone receiving equipment," and Lighty mentions that other schools were contemplating installations. He told the school men about a course, "Appreciation of Music," directed by Professor D. D. Gordon. This course which Lighty mentioned brought Professor Gordon national recognition for more than a quarter of a century. Through it children in country schools and grade schools all over the state were taught to appreciate good music. Lighty stated that the purpose of his letter was to inquire of the high schools about what equipment they now had, and whether they were interested in receiving such broadcasts for the school and the community. "It is contemplated," wrote Lighty, "that the radio broadcasting shall serve the state in much the same way as the circulating motion picture films and lantern slides of the Visual Instruction Bureau,"[21] and he urged school men to express their opinions and make use of the service.

The Nature of the Early Programming

Although space does not permit a detailed listing of the many programs that were produced in the early broadcasting, it is interesting to note the variety offered during a week as a sample. The *Daily Cardinal,* July 30, 1923, carries the following: July 30, "Elections and Voting" by Miss Sophie Hall, Librarian, Municipal Information Bureau, University Extension Division; August 1, "Summer Dresses and Health" by Miss H. T. Parsons, Assistant Professor Home Economics; August 3, "Reading from Literature" by Mrs. Elizabeth Parker Hunt, Wellesley College, Lecturer in Speech

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[20] Letter from Theodore H. Schaefer, Slinger, Wisconsin, to Professor Edgar D. Gordon, July 5, 1922 (Lighty Papers). "Put me down as one of the participants in the 'Radio Chorus' singing 'America' last night. As I was alone in the house at the time my intention at first was to merely listen in, however, after it got underway I could not resist rising on my feet and singing."

[21] Lighty to Wisconsin High School Principals, May 1924 (Lighty Papers).

at University Summer Sessions. The variety in offerings was no doubt an attempt by Lighty to make the programming representative of the total University.

It was fortunate for the historian that Lighty was concerned about the content of the lectures going out over the air, for many have been preserved.[22] No doubt, being responsible for the programs, he had the usual fear that the comments of the speakers might not represent the official views of the University. Therefore, Lighty asked that manuscripts be submitted a week in advance and that the speeches be kept on file, "just in case."

> Our uniform rule in broadcasting from the University radio station is to broadcast from previously prepared manuscripts so that the record of the exact broadcast may be filed in the President's office for the purpose of comparison should anyone at any time question any statement made or make exception to any statement.[23]

Federal Regulation of Radio and N.U.E.A.

As the airlanes have become regulated by the federal government for airplanes, so in the early years of radio the ether gradually came under the control of the federal government. Lighty took a vital interest in regulations put on radio and corresponded with Herbert Hoover, then Secretary of Commerce, regarding this.

The first well planned regulations of radio were not enacted through passage of laws, but by a series of conferences called by Mr. Hoover. Up until the creation of the Federal Radio Commission on February 23, 1927,[24] regulation was maintained through such conferences.

When writing Mr. Hoover, Lighty reminded him of the educational and social role of radio. He expressed appreciation for the inclusion of C. M. Jansky, of the University of Minnesota, as a representative of the National University Extension Association. The inclusion of Jansky did not happen by chance. Lighty had written the directors of the extension divisions throughout the country urging them to support the appointment of Jansky to the conference in 1925. Jansky, a close friend of Lighty, had entered the University of Wisconsin in 1913 and had built the first radio set there for sending code. Always interested in the public service aspect of radio, Lighty told Hoover that "the association feels peculiarly grateful for the broad and farseeing policies which have laid the foundations for safeguarding and conserving public utility rights in the ether."[25] Jansky had given an address entitled "The

[22] Birge Papers, President's Files, University of Wisconsin Memorial Library Archives, Madison, Wisconsin, Boxes 128–29, 1923.

[23] Letter from Lghty to Miss Emily R. Kneubuhl, of Minneapolis, Minnesota, July 14, 1923.

[24] U. S. Government Organization Manual, 1957–58, p. 638.

[25] Lighty to Herbert Hoover, Secretary, Department of Commerce, Washington, D. C., May 13, 1925.

Future of Radio" at the Third National Conference. Jansky wrote Lighty in April of 1925 when he was attending the National University Extension Association meeting at the University of Virginia, urging a consideration by the universities of their educational role in radio. Pointing up the rich resources of the universities for programming, Jansky wrote: "In view of the increasing interest of educational institutions in radio broadcasting I believe that a careful consideration of all phases of the subject at your conference would be highly desirable." He recommended that it would be highly useful if representatives of all educational institutions could get together at a conference for the exchange of ideas to answer collectively the question, "What should be the relationship of educational institutions to the broadcasting field and what consideration should be given these institutions by those vested with the authority of regulating radio communication?"[26]

At the Seventh Session of the N.U.E.A. Conference at the University of Virginia, on Lighty's recommendation, Mr. W. D. Henderson, Director of the University Extension Division of the University of Michigan, moved that Professor C. M. Jansky be requested to act as the official representative of the N.U.E.A. in connection with the Fourth National Radio Conference which was to be held in September 1925 in Washington, D. C. The resolution was unanimously adopted and sent to Herbert Hoover. Mr. J. W. Scoggs, Director of University Extension of the University of Oklahoma, moved that W. H. Lighty be appointed as chairman of a committee of three named by the N.U.E.A. president "to represent this Association in all matters pertaining to radio-casting during the next year." This was passed, and Lighty became the moving spirit for educational radio broadcasting for the Association for many years to come.[27]

Lighty Helped Other Stations Begin

During the early years in the development of radio other educational institutions contemplating beginning a station looked to the University of Wisconsin for help in getting started.

B. C. Riley, Director of Extension, became interested in radio at the University of Florida, and wrote Lighty inquiring as to what state colleges and universities were using radio regularly, how many were using radio for extension instruction, and how many are under the control of extension divisions.[28] Lighty wrote out the names of colleges and universities where stations were established, and the names of the persons who directed the programs. Lighty kept an active file on this for N.U.E.A. Riley's response to Lighty's

[26] C. M. Jansky, Jr., to Lighty, April 28, 1925.
[27] *N.U.E.A. Proceedings,* April 30–May 2, 1925, Charlottesville, Virginia, p. 128.
[28] B. C. Riley to Lighty, October 28, 1924 (Lighty Papers).

answers was, "It is always a pleasure for me to ask a Wisconsin man for information when I really need it, because I know that I will get a reply 'plus.' "[29]

Maurice H. Wessen, of the University of Nebraska, heard about Lighty's survey of the use of radio in schools, and inquired about access to his findings and conclusions.[30] Lighty took great pains to give him the details of his findings, as he did in answer to all such inquiries.

Another inquiry came from Professor H. F. Mallory, Secretary of the Home Study Department of the University of Chicago. Of the Wisconsin experiment in radio Lighty warned, "Our work here has been so much a matter of gradual evolution that it would be impracticable for a new enterprise at the present time to go through the same procedures." He suggested that Chicago follow the pattern of others that were operating state stations, including Missouri and the University of Iowa.[31]

Lighty Retires as Radio Committee Chairman At the University of Wisconsin

Although Lighty worked on the national level for educational radio through the N.U.E.A., his interest continued on the local level at the University of Wisconsin. He retained his interest in radio programming even after the chairmanship of the Radio Committee was taken over by Professor H. L. Ewbank of the Department of Speech at the University in 1928. At this time President Glenn Frank appointed a smaller group to investigate the problems and further possibilities for university broadcasting services. After 1929 when Professor Terry died, Professor Edward Bennett, chairman of the Department of Electrical Engineering took Terry's place on the committee.

In February 1931 the committee chose H. B. McCarty, instructor in speech, as WHA program director on a part-time arrangement. McCarty had been the announcer for the station since September 1929, and was well acquainted with its needs. At that time the station was broadcasting less than two hours per day. If the station license was to be retained they were informed that more of the available time must be used. Immediately the programming was expanded and by March 1931 the total weekly broadcasts increased from nine and one-half to seventeen. In 1932 it increased to twenty-seven, and later doubled to fifty-four.[32] McCarty continued to serve as program director and does to this day. He was a close friend of Lighty's and conferred with him often.

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[29] B. C. Riley to Lighty, November 12, 1924 (Lighty Papers).
[30] Maurice H. Wessen to Lighty, November 18, 1924 (Lighty Papers).
[31] Lighty to H. F. Mallory, December 17, 1924 (Lighty Papers).
[32] McCarty, *op. cit.,* p. 202.

Education Vs. Propaganda

An account of Lighty's career in radio would not be complete without mention of his continuing interest in the use of radio for education, as opposed to radio for profit and propaganda. Even though no longer actively engaged in radio work, as late as 1936 Lighty was still hammering away at the important responsibility of those in the communications field. He felt that educators hold a trusteeship for social enlightenment. Even after his retirement in 1937 Lighty continued his interest in radio. He saw financial support as the basic problem for educational radio if it were not to be crowded out by commercial radio.[33]

Lighty was very critical of commercial broadcasting, and continually pressed for the special role of educational radio.[34] Lighty wrote a memorandum just shortly before his retirement castigating Mr. John W. Studebaker, then United States Commissioner of Education. This memo was no doubt for the benefit of the University of Wisconsin committee on radio, and the N.U.E.A. radio committee, although the manuscript does not say. Lighty referred to a speech which Studebaker had made in St. Louis, to the N.E.A. in which Studebaker equates the "broadcaster" with teaching. Lighty emphasizes that "the broadcaster, as Studebaker uses the term, has little to pool with the trained teacher or educator," and that "it is not true that the job of educating over the air in terms of effectiveness is comparable to the broadcasters job of entertaining. Education is *not* business. Education must be free so long as it is education. When not free, it is propaganda."[35]

WHA Begins FM

Lighty had the pleasure of seeing another milestone in the success of WHA. He participated in the inauguration of WHA-FM broadcasting from the University station on March 30, 1947. Lighty, the octogenarian, saw in frequency modulation great potentials for adult education. On this occasion he said, "Just imagine what can be done for that whole new audience—the things that they can be given for a better life—the way in which they can be helped to grow and appreciate what is good and worthwhile!"[36]

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[33] W. H. Lighty, "Educational Radio Communication," *Education by Radio,* Vol. VI, No. 6 (June, 1939), p. 17.

[34] Lighty to McCarty, April 24, 1936 (Lighty Papers). Writing thanking McCarty for letting him read a paper by a Dr. Crane, Lighty says: "It seems to me Dr. Crane misses his chance when he only praises the meritorious programs and wholesome influences and gives so small consideration to the shameful, the vulgar, and the near vicious lying and misrepresentation which commercialism forces upon us unless we stand continuously at the 'valve' to shut out this spot blah, blah, until we get the next newer program we wish to listen to."

[35] "Studebaker Memorandum," December 10, 1936, pp. 1–2 (Lighty Papers).

[36] "Lighty, WHA Go Pioneering Again," *Wisconsin State Journal,* March 23, 1947.

Lighty Recognized as Radio Pioneer

Unlike many other pioneers, Professor Lighty was recognized and honored during his lifetime for his leadership and service in radio. At a WHA dinner, attended by one hundred and fifty persons, held on May 24, 1956, in Madison, he received a special citation inscribed as follows:

> Radio's pioneer program planner, whose vision and leadership gave impetus, high purpose and direction to the development of the Wisconsin State Broadcasting Services.

In an account of the recognition the press records that "looking back, Professor Lighty thinks of the extension courses and the radio station as his greatest landmarks, and the things he is proudest of having been associated with."[37]

Lighty saw radio as a medium for further social enlightenment and enrichment, and seeing the vision he "etherized" education to make it available to the greatest number of people. Perhaps Lighty will be remembered best as a trail-blazer in educational radio, the man who "broadcast a university," and the first program director of WHA, "the oldest station in the nation."[38]

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[37] "Friends Hail Professor Lighty, Extension and WHA Pioneer," Madison, Wisconsin, *Capital Times,* June 7, 1956.

[38] W. H. Lighty passed away on May 19, 1959, at the home of his son Paul, Lafayette, New Jersey, at the age of 93.

DANIEL H. BURNHAM AND THE "RENAISSANCE" IN AMERICAN ARCHITECTURE*

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Say not, "Greece is no more."
Through the clear morn
On light wings borne
Her white-winged soul sinks
  on the New World's breast.
Ah! happy West—
Greece flowers anew,
  and all her temples soar!

In these florid verses, with more fervor than accuracy, Richard Watson Gilder celebrated the opening (May 1, 1893) of the World's Columbian Exposition at Chicago.[1] Other commentators were no less enthusiastic. W. H. Gibson of *Scribner's* rejoiced that a "Heavenly City," a "New Jerusalem," had settled upon the shores of Lake Michigan.[2] "The fair! The fair!" cried Candace Wheeler of *Harper's:* "Never had the name such significance before. Fairest of all the world's present sights it is."[3] "All the descriptions in the world and the most faithful illustrations will give no idea of the great beauty and the grand proportions of the buildings, and the charm of the surroundings," added Francis D. Millet, a spokesman of the vested interest (he served as Director of Painters for the Exposition).[4] In the popular journals everybody, it seemed, was singing the praises of the Fair, urging the public to proceed posthaste to Chicago.

To see what? In part, at least, to see the impressive "White City" which a corps of architects, sculptors, and painters had erected in the reclaimed bog, Jackson Park. Under the general supervision of that master organizer and dynamic administrator, Daniel Hudson Burnham, sand and marsh had been transformed by Frederick Law Olmsted and his assistants into reflecting basin and quiet lagoon, and the nation's most illustrious architects had run up the necessary buildings. And such buildings! Monumental structures of self-assured majesty in the Renaissance and Baroque modes, arcaded

* Paper read at the 90th annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

[1] *Century,* XLVI, 22 (May, 1893).
[2] *Scribner's Magazine,* XIV, 29 (July, 1893).
[3] *Harper's Magazine,* LXXXVI, 833 (May, 1893).
[4] *Ibid.,* LXXXV, 875 (November, 1892).

facades gleaming white by day and by night under summer sun and batteries of electric lights. Here was bodied forth in plaster, fibre, and paint a vision—a vision which seems first to have existed in the imagination of Burnham only. It was that of the City Beautiful, and it was to have an influence on American architecture far out of proportion to its brief life span or its inherent aesthetic merit.

From the beginning Burnham ran the show. He was Director of Works, he selected the artists who designed and decorated the buildings, and after consultation with his Board of Architects he made decisions such as those which established a "classic style" for the principal structures, set the cornice lines at a uniform height of sixty feet, and proclaimed white as the dominant color-theme. Because his partner, John Root, died of pneumonia before the work was far advanced, it may be assumed that the form which the Exposition grounds and buildings finally took represents largely his own ideal.[5] To be sure, artists such as Henry S. Codman, Olmsted's Paris-trained assistant, Richard M. Hunt, dean of American architects, and Charles F. McKim, leading light of the most successful firm in the East, made their presence felt. Toward these men, conservatives who approved the "wisdom of the Classic policy,"[6] the Director showed great deference (Louis Sullivan charged that he toadied to them outrageously), and they and other Eastern architects such as Post, Peabody, and Stearns were awarded the architectural plums—the buildings comprising the Court of Honor. To Hunt went the Administration Building, a pretentious structure with massive dome surmounting a colonnaded drum, which formed the western terminus of the east-west axis. From its steps one looked down the length of the basin, past the Columbian fountain of MacMonnies to the colossal Bartholdi-like *Republic* of Daniel French, standing imperiously in golden draperies upon a high pedestal set in the water near the eastern (lake-front) terminus. To the right lay the spired and domed Machinery Building designed by the Boston partners, Peabody and Stearns; beyond, McKim's pedimented Agricultural pavilion postured proudly, the *Diana* of St. Gaudens (borrowed from Madison Square Garden) astride its Pantheon-dome. Opposite, in west to east course, stood the Electricity Building of Henry Van Brunt, a New Englander with offices in Kansas City, and George B. Post's Manufactures and Liberal

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[5] Root apparently envisioned a colorful and sumptuous ensemble, with classicism subordinated to Romanesque, Moorish, Asian, and other motifs. See Harriet Monroe, *John Wellborn Root* (Boston, 1896), pp. 242–47.

[6] McKim to Hunt, March 3, 1893, quoted in Charles Moore, *Life and Times of Charles Follen McKim* (Boston, 1929), p. 122. Although Sullivan, Wright, and many subsequent critics have assailed this use of classic, one could argue that the Burnham scheme was defensible in view of the magnitude of the project and the limited time (about two years) in which to complete it.

Arts Building, with its parade of white bays marching decorously to the end of the vista. A tall quadriga-crowned peristyle, with a triumphal arch in the center, closed the composition at lake's edge.[7]

From the Administration plaza northward ran a bisecting axis, its spine a lagoon extending from an obelisk at the south to the Fine Arts Palace at the north. The latter structure, a blatant bit of pseudo-classicism, was the handiwork of Charles B. Atwood of New York, an accomplished adapter of other men's ideas who had been selected by Burnham to assume the mantle of Root. During the months in which the Exposition buildings took shape, Atwood was much in evidence as administrative assistant to the Director, and it was he who was chiefly responsible for the sixty-odd subsidiary buildings put up by the Burnham office. It was he who did the triumphal arch and peristyle for the Court of Honor. It was he more than anyone who strove to bring to fruition the ideal propounded by the Director in the early days of preparation: "Make no little plans; they have no magic to stir men's blood, and probably themselves will not be realized. Make big plans; aim high in hope and work, remembering that a noble, logical diagram once recorded will never die. . . Let your watchword be order and your beacon, beauty."[8]

Burnham and Atwood's notion of beauty was not quite that of Louis Sullivan, the Chicago "radical" whose Transportation Building stood to the north of the Administration Building on the west side of the lagoon. Sullivan had scant opportunity to follow his own bent, however, and his building—one of the largest in the Fair, with four great train-sheds and a front block covering five and a half acres—displayed the required sixty-foot-high cornices, the Roman arcades, and the classical detail. He expressed such independence as he could, simplifying entablatures and arches, eliminating keystones, and coloring soffits. His triumph was the celebrated Golden Door—a large flat panel of gold leaf and warm colors within which five receding orders spanned the main entry. Large form and intricate detail were combined with a Richardsonian finesse, and the effect, if somewhat unrelated to the general scheme, seems to have been majestic. The French Union Centrale des Arts Decoratifs, adjudging Sullivan's achievement the finest decoration of the Fair, awarded him three medals.[9] Interestingly, American critics, who outdid one another in glorifying the work of Burnham and his cohorts, were mostly noncommittal on the Transportation

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[7] The fullest pictorial record of the Exposition is *The Art of the World: Painting, Sculpture and Architecture at the World's Fair,* ed. R. Hitchcock. 2 vols. (Chicago, 1896).

[8] Quoted by Thomas E. Tallmadge, *The Story of Architecture in America.* Rev. ed. (New York, 1936), p. 290.

[9] Hugh Morrison, *Louis Sullivan* (New York, 1935), pp. 134–37. Sullivan was the only architect to receive a foreign testimonial.

Building. Only Montgomery Schuyler, writing for the *Architectural Record* in 1894, praised Sullivan's work without serious reservation (he admired the "honesty" of the construction and was much impressed by the Golden Door), and he rapped the knuckles of his peers for failing to acknowledge its merit.[10] Other Western architects, W. L. B. Jenney (Horticultural Building), S. S. Beman (Mines and Mining Building), and Henry Ives Cobb (Fisheries Building), whose buildings were relegated to the north lagoon, were also given short shrift, and perhaps that was as it should be. Their work was in the prescribed mode, completely perfunctory, though Cobb in the Fisheries Building enlivened the inert formalism with a Romanesque enrichment, including molded decorations in the shape of fish, sea horses, lobsters, and other marine life.

The lagoon, of course, was a concession to the devotees of the "picturesque," but its informality was so slight as to reinforce by mild contrast the "sublimity" of the Court of Honor. That was the intention, and it worked perfectly. The one feature of note was an artificial "Wooded Island" which rose from the water near the Sullivan Building, and which Burnham wisely designated as the setting for the Japanese pavilion. Here it was that the young Frank Lloyd Wright, fresh from work on the Transportation Building, learned at first hand of Japanese design and principles of building. Other men were struck by other things, though recorded observations leave no doubt that the pavilions of Japan and other countries, as well as those of the several States—consigned as they were to the perimeter of the White City—made little impression amidst the incandescent glitter of the central court. As a matter of fact, these structures, thrown up independently of the rules established for the principal buildings, were for the most part a "higgledy-piggledy," as Schuyler called them, with Greek temples rubbing elbows with Tudor mansions, Italian villas with German castles, French chateaux with California Spanish missions, and so on.[11]

Small wonder that the Court of Honor, with its monumental scale, its adroitly calculated disposition of parts, its reflecting pools, its symbolic statuary and mural paintings, and its exploitation of the new electric lighting, beguiled most visitors. Even that Worldly Wise Man, Henry Adams, was impressed ("As a scenic display, Paris had never approached it"), though he recognized it for what it was, a "product of the Beaux Arts artistically induced to pass the summer on the shore of Lake Michigan." The question which occurred to him—it was precisely that which Sullivan and his associates hammered at—was whether it could be made to seem at home there. "That the Exposition should be a natural growth and

[10] "Last Words About the World's Fair," *Architectural Record,* III, 291–301 (January–March, 1894).

[11] *Ibid.,* III, 56 (July–September, 1893).

product of the Northwest offered a step in evolution to startle Darwin. . . ."[22] Yet Americans came by the thousands, like pilgrims to a new shrine, and to the surprise of Adams gave the illusion of having passed their lives among planned landscapes and imperial buildings. If some of them (like the parents of Hamlin Garland) were overwhelmed by the sumptuousness of it all, they evidently went away converts to the Grand Manner.[13] Louis Sullivan, in bitter retrospect, said that they went away

> carriers of contagion, unaware that what they had beheld and believed to be truth was to prove, in historic fact, an appalling calamity. For what they saw was not at all what they believed they saw, but an imposition of the spurious upon their eyesight, a naked exhibitionism of charlatanry in the higher feudal and domineering culture, conjoined with expert salesmanship of the materials of decay.[14]

In sum, averred Sullivan, Burnham and his accomplices from the East had sold the country on "bogus antique." Why? Chiefly for pecuniary gain. How? By means of "skillful publicity and propaganda."

Probably there is a modicum of truth in this charge, though Sullivan characteristically overstates his case. Granted that Burnham, the chief offender, was possessed of but a modest talent, there is little reason to abuse his motives or impugn his character. Doubtless he was a better organizer and administrator than architect (Wright said with some truth that he would have been "equally great in the hat, cap or shoe business"), and the Fair gave him an unexampled opportunity to show what he could do. He labored tirelessly to get the buildings and grounds ready for the opening, trying (successfully) to avoid the experience of Philadelphia in 1876.[15] He supervised the work of architects, painters, and sculptors with zestful inspiration, praising, prodding, and cajoling. Regarding the Exposition as a showpiece, a salute to four hundred years of American progress, he had favored the use of traditional modes because they were readily accessible to the artist and easily intelligible to the layman, and because he sincerely believed them to be aesthetically legitimate and pleasing. In 1890, when Modern architecture still was gestating, such an attitude was acceptable and defensible.

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[12] *The Education of Henry Adams* (Boston, 1918), pp. 339–40.

[13] ". . . I observed," says Garland, "that the farther they [his parents] got from the Fair the keener their enjoyment of it became! . . . Scenes which had worried as well as amazed them were now recalled with growing enthusiasm, as our train, filled with other returning sight-seers of like condition, rushed steadily northward . . ." (*A Son of the Middle Border*, New York, 1923, p. 461).

[14] *The Autobiography of An Idea* (New York, 1924), pp. 321–22.

[15] William Dean Howells visited the Centennial Exposition a week after it had opened and was struck by the apparent chaos: "the first impression was certainly that of disorder and incompleteness." "The paths were broken and unfinished, and the tough, red mud of the roads was tracked over the soft asphalt into all the buildings. . . . At many points laborers were digging over the slopes of the grounds . . . and ironical signboards in all directions ordered you to keep off the grass. . ." See "A Sennight of the Centennial," *Atlantic Monthly*, XXXVIII, 92–107 (July, 1876).

Before the Fair he had worked chiefly in Richardsonian Romanesque, but the experience of the White City converted him to classic, particularly as it was associated with formal treatment of environs. He railed at what he termed the "disgusting and disorderly" in contemporary work, and proclaimed that only the "logical" is beautiful. "The monuments of Pericles, reared in the zenith of Attic supremacy, are logical. The pilgrims of twenty-four centuries say that they are also beautiful."[16]

There were no Periclean monuments at Chicago in 1893, though the comments of some critics would lead one to believe that there were. Nearly everyone agreed, however, that the Fair was considerably more than the "cattle-show on the shore of Lake Michigan" which one Eastern newspaper had smugly predicted.[17] The growling of Sullivan was lost in a swelling chorus of praise. Even Montgomery Schuyler, who in orientation was closer to Sullivan than to Burnham, commended the "unity" and "majesty" of the Court of Honor while expressing the hope that it would have no impact upon subsequent American architecture.[18] The *Encyclopaedia Britannica* gave the imprimatur of authority to the opinions of popularizers by adjudging the White City "an artistic and educational triumph of the first order."[19] Burnham himself could not have put it more agreeably. When one enthusiastic observer wrote, at the closing of the Fair, that "Here were made visible our [American] beginnings, our achievements, our hopes, our dreams," the Director undoubtedly would have agreed. And when the same writer added that here "The nation became conscious of itself, and was strong, beautiful, proud," he would have urged that such, precisely, was the sentiment which the White City was intended to convey.[20] For America at the end of the nineteenth century had come of age, or so she believed. Vigorous in her young strength, rich in material things, she had begun to move upon the world stage, and to play the exciting game of empire. In the eyes of men like Henry and Brooks Adams she was fast becoming a new Rome, and as such she needed an architecture commensurate with her station—an imperial architecture. That is what the artists at Chicago attempted to produce: the White City was a little Rome, though Rome, to be sure, by way of the Italy of the Renaissance and the France of Louis XIV–XVI and Napoleon III.

America loved it. If the country was "sold" on "bogus antique," as Sullivan charged, the architects of the Fair were not alone cul-

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[16] *Century,* LXIII, 620 (February, 1902).
[17] Quoted by Harriet Monroe, *John Wellborn Root,* p. 218. See also Will H. Low, "The Art of the White City," *Scribner's,* XIV, 504–12 (October, 1893) and Alice F. Palmer, "Some Lasting Results of the World's Fair," *Forum,* XVI, 517–23 (December, 1893).
[18] *Architectural Record,* III, 55 (July–September, 1893), 301 (January–March, 1894).
[19] *Encyclopaedia Britannica,* 11th ed., VI, 125.
[20] *Forum,* XVI, 519 (December, 1893).

pable; the public were willing victims. Burnham was shrewd enough to recognize a good thing when he saw it, and he threw his weight behind a rolling snowball which gained size and momentum at an astonishing rate. He was quoted widely in the press, he was wined and dined in New York, Boston, and other Eastern cities, he was awarded honorary degrees by Harvard and Yale, and in the end he was called to Washington to assist in the renovating of the capital city. Wherever he went he disseminated the gospel of classicism: American architects should "abandon their incoherent originalities and study the ancient masters of building. . . . It will be unavailing hereafter to say that great classic forms are undesirable. The people have the vision [of the White City] before them . . . and words cannot efface it."[21]

Publicists such as Mariana G. van Rensselaer took up the cry. Mrs. van Rensselaer, first biographer of Henry Hobson Richardson, approved the turn from Romanesque to Renaissance, discovering in the latter a "practical as well as aesthetic plasticity," an "essential dignity," and a "truly modern spirit." The buildings of the Exposition, she told the readers of *Forum*, "ought to prove that Renaissance forms of art are the best for current use."[22] A good many architects seem to have agreed with her, and to have heeded Burnham's advice. McKim, Mead, and White, those masters of the art of refined quotation who had been using classical motifs for nearly fifteen years, continued designing in the recommended manner, and dispatched from their office a battalion of carefully indoctrinated disciples, among them Thomas Hastings, John M. Carrère, and Henry Bacon. The New England firm of Shepley, Rutan, and Coolidge, the successors to Richardson who before Chicago had worked mostly in the rough-textured, asymmetrical, picturesque manner of their master, put on formal dress to turn out pretentious Italianate palazzos. And there were others—men like George B. Post of New York, who designed the pedimented Stock Exchange in Wall Street, the baroque Cook County Court House in Chicago, and the grandiose pile which serves as a capitol building for the State of Wisconsin. Most of them were cosmopolites ("too-well-educated," in Wright's opinion) who knew the monuments of Europe at first hand and had no qualms about appropriating from them whatever they pleased for their own designs.

Stanford White defended this practice by contending that Rome had plundered Greece, that every renaissance had its beginnings in the past, that America had its roots in Europe and therefore was entitled to draw upon the cultures of Greece and Italy, Egypt,

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[21] Burnham, quoted by Montgomery Schuyler from a Chicago newspaper, *Architectural Record*, III, 292 (January–March, 1894).
[22] *Forum*, XIV, 531–32 (December, 1892).

Spain, and France.[23] All of which may be true, but it was completely beside the point to a man like Wright. Rail as he would, however, the plundering of Europe continued, as the proliferating constructions of McKim, Mead, and White (to look no further) demonstrated. The Boston Public Library (1887–95), for example, seems to have been derived principally from Labrouste's Bibliotheque Ste. Genevieve, the Columbia University Library (1893) from the Pantheon, the Herald Building in New York (1894) from the Palazzo Consiglio in Verona, the Tiffany Building (1906) from the Vendramini Palace in Venice, the Pennsylvania Station (1906–09) from the Baths of Caracalla, and so on. The less pretentious domestic work of the day also came from Europe, as it had always done, but Europe at one remove—the American colonies of the seventeenth and eighteenth centuries. Here, too, McKim, Mead, and White led the way. In 1877 the three of them, accompanied by their early associate, William B. Bigelow, made their celebrated trip up the Atlantic Coast to examine houses at Salem, Newburyport, Portsmouth, and other towns. On their return to New York they launched a Colonial revival, using native materials such as Harvard brick or Pennsylvania ledgestone which they embellished with classical detail.[24] Perhaps the Colonial style, with its quasi-indigenous flavor, gratified the burgeoning nationalist impulse which the Expositions of 1876 and 1893 did much to stimulate;[25] perhaps it seemed an easy and coherent corrective to the excesses of nineteenth century eclecticism; at all events, after the Chicago Fair it became—in a spic-and-span white version—the favorite domestic style of the time.[26]

Wright had only contempt for these houses ("Colonial wedding cakes," as he called them), choosing to create his own style in his own way. His strength of purpose was immediately put to a severe test when Burnham, perceiving the merit of his early work such as the Winslow House in River Forest, proposed most insistently (in 1893) to subsidize the struggling young architect in elaborate study abroad: "he would take care of my wife and children if I would go to Paris, four years of the Beaux Arts. Then Rome—two

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[23] Charles C. Baldwin, *Stanford White* (New York, 1931), p. 2.

[24] Tallmadge, *Story of Architecture in America,* p. 251; Moore, *Life and Times of McKim,* pp. 41–42.

[25] Cf. Howard C. Butler, "An American Style of Architecture," *The Critic,* n.s. XX, 203 (September 30, 1893). Butler makes an ardent plea for Colonial because it is "all our own." See also "The Contemporary Suburban Residence," *Architectural Record,* XI, 69–81 (January, 1902).

[26] McKim, Mead, and White were of course architects to the wealthy. On the more plebeian level the Colonial style was promoted by men like Eugene Clarence Gardner, one of the last major "pattern book" authors. See Gardner's "Colonial Architecture," *New England Magazine,* n.s. XIX, 499–514 (December, 1898), where he takes pains to demonstrate that "there was much true and simple architecture in the early [i.e., Colonial] time, much refined and noble work to which we may well turn today for profitable lessons" (p. 514).

years. Expenses all paid. A job with him when I came back."[27] It was not easy for a neophyte to resist the importunings of a man whose genius was at that moment being loudly acclaimed, but Wright had courage and a vision, and he declined the proposition. Burnham, vexed, warned him that Sullivan (whose independent questing the young man desired to emulate) was a good decorator on a bad tack, that eventually "all America" would be "constructed along the lines of the Fair."[28]

He knew whereof he spoke, and before many months had passed, budding architects who lacked Wright's fortitude and self-assurance, or his genius, found themselves pushed willy-nilly into classicism. Russell Sturgis, a perceptive architect-turned-critic who watched this development with growing displeasure, recorded at the end of the century that one would "have to be among the younger architects and head draughtsmen to realize how strong this [classical] tendency is." He placed the blame more upon McKim, Mead, and White than upon Burnham, and in a long letter to Peter B. Wight (1897) he assailed their philosophy of building.

> That firm is deliberately working—and has been for three years—in the direction of square, bare, blank, unvaried, unmodified boxes, with holes cut in for light and air, except where a Roman colonnade is introduced. They seem to choose deliberately the no-style which consists in following the least interesting Italian work of the seventeenth century, merely reducing it to a still blanker and barer monotony. . . This style they would be wholly unable to recommend and foist upon their clients but for that good taste which is the unquestionable gift of the designers of the firm. I cannot but suppose that McKim, Mead and White resort to this style because it is easy to work in. However that may be, it is most depressing to see the willingness with which millions are given to such fatuous designing.[29]

Henry Van Brunt, an important if less forceful commentator than the other anti-traditionalists, also declared himself in opposition to such "conventional quotations from the classics." As befits the translator of Viollet-le-Duc's *Discourses on Architecture*—that treatise so highly esteemed by Wright and other progenitors of Modern—he questioned the virtue of setting up old forms in new places and demanded an architecture "belonging to our times and to our people."[30] He didn't get it. Like most of his fellows he was inundated by the tidal wave of classicism which swept over the country after 1893.

To be sure, Burnham, McKim, Post, and like-minded men did not regard the use of classical motifs as a "senseless reversion," as

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[27] Wright, *An Autobiography* (New York, 1932), p. 123.

[28] Quoted by Wright, *ibid.*, p. 124.

[29] Quoted by Baldwin, *Stanford White*, pp. 354–55.

[30] *Greek Lines and Other Architectural Essays* (Boston, 1893), pp. 62, 70, 89. Van Brunt's partner, William Robert Ware, sometime professor of architecture, had been Sullivan's teacher at M.I.T. in the 1870's.

Wright called it. They believed, or professed to believe, that it was the essence of modernity. Thomas Hastings spoke for them when he wrote in 1894 that America was perpetuating the renaissance in art and life which had begun in Italy five centuries earlier, and that the architectural style which had prevailed at that time was precisely that which should be used today. By some sleight of hand logic he deduced that "whatever we now build, whether church or dwelling, the law of historic development requires that it be Renaissance."[31] Wright, while he believed that the "law of historic development" worked in quite another direction, shared the conviction that America of the 1890's was involved in an aesthetic renaissance —at least he did until events seemed to him to demonstrate that the renaissance was merely a "rebirth by a special kind of abortion."[32] But his disillusionment, like that of his Lieber Meister, seems to have been exceptional. The painter Abbott Thayer, for instance, pretended to see in turn-of-the-century America a reincarnation of fifteenth century Italy. "You and I," said Thayer to Royal Cortissoz in a droll moment, "are Mantegnas and Gozzolis, not Yankees."[33]

Augustus Saint-Gaudens, whom Henry Adams described as "a child of Benvenuto Cellini, smothered in an American cradle," spoke to the same purpose, and it was he who brightened a meeting (February 24, 1891) of the Board of Architects and the Grounds and Building Committee of the Columbian Exposition by exclaiming that "this is the greatest meeting of artists since the fifteenth century."[34] In view of Saint-Gaudens's innate good taste and modesty, it is probable that the statement was inspired not so much by smugness (as charged by some anti-"Renaissance" critics) as by pleased surprise and satisfaction in achievement, and one is likely to be disposed to charity if he reflects that those present included Hunt, McKim, Jenney, Burnham, Olmsted, Beman, Schwab, Van Brunt, Codman, Whitehouse, Saint-Gaudens, Post, Gage, Cobb, Peabody, Adler, and Sullivan. In hammering out solutions to major problems of design and construction, these men seem to have been struck anew by the advantages of close cooperation among all artists—architects, painters, sculptors, and landscape-designers—and in major projects undertaken later many of them tended to exploit the collaborative effort. Public buildings such as those erected in Washington, D. C. after the turn of the century by Burn-

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[31] "The Relations of Life to Style in Architecture," *Harper's Magazine*, LXXXVIII, 957–62 (May, 1894). For a brief account of the factors underlying the concept of an American Renaissance, see Oliver Larkin, *Art and Life in America* (New York, 1949), pp. 294–96.

[32] *A Testament* (New York, 1957), p. 33; *Genius and the Mobocracy* (New York, 1949), p. xii.

[33] Quoted by Larkin, *Art and Life in America*, p. 296.

[34] *The Education of Henry Adams*, p. 387; Larkin, *Art and Life in America*, p. 311.

ham and Company or by Carrère and Hastings or by other firms of like persuasion are illustrations in point. The Boston Public Library (begun before the Fair but not completed until 1895) represented in its finished form the work of McKim, Mead, and White (the building proper), Puvis de Chavannes, John Singer Sargent, and E. A. Abbey (murals), Augustus Saint-Gaudens (medallions over entry) and his brother Louis (two lions for main staircase), Daniel Chester French (bronze doors), and Frederick MacMonnies (fronting statuary). Richardson had demonstrated the usefulness of such pooling of talent in his great Trinity Church project of the 1870's, but the men of classical predisposition who flourished after 1893 looked not to him but to the example of sixteenth-century Rome or nineteenth-century Paris.[35] Indeed, F. D. Millet, the unctuous apologist for the art of the Fair, looked no further than Chicago: "There first in this country, on a reasonably large scale at least, have the allied arts worked together and in harmonious proportions. The immediate fruits of this union, even if it be but temporary, are incalculable; of the final result there can be no doubt. It means the dawn of a real art in this country."[36]

To assist in the birth of this "real" art, Burnham and McKim stood by as eager midwives. The Fair would do much to turn the country to classicism, and there would be great demand for young artists adequately schooled in the correct way of working. Burnham might offer to finance the preparation of a Wright, but many proselytes would be needed, and a European training seemed desirable. During evenings before the fire in the Director's office on the Fair grounds, the two men discussed the matter and decided to set up in Rome a counterpart to the long-established French school. In 1894, after much difficulty, the American Academy at Rome came into being, and in January, 1895, instruction began. Wealthy entrepreneurs were asked to underwrite the cost, Burnham securing subscriptions from Chicagoans such as C. H. McCormick, Marshall Field, G. M. Pullman, J. J. Glessner, and Franklin MacVeagh, and McKim inducing J. P. Morgan and Henry Walters to provide generous endowments.[37] Within a decade the Academy was flourishing, and at its commodious quarters in the Villa Mirafiori bright-eyed young men submitted gladly to the regimen that Wright had spurned, savoring the glory that was Greece and the grandeur that was Rome, and learning to design by recipe. At Washington, Chicago, Cleveland, and many other American cities, the twentieth century would have work for them to do.

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[35] Cf. Hastings, *Harper's Magazine,* LXXXVIII, 957–62 (May, 1894) and E. H. Blashfield, *Mural Painting in America* (New York, 1913), pp. 311–12.

[36] "The Designers of the Fair," *Harper's Magazine,* LXXXV, 883 (November, 1892).

[37] For details see Moore, *Life and Times of McKim,* pp. 128–81.

For the masters, McKim and Burnham, the job lay at hand. It was to renovate the nation's capital. As the Centennial year approached (i.e., 1900, commemorating the removal of the capital to Washington in 1800), members of Congress and sundry private citizens began to advocate "the improvement of the District of Columbia in a manner and to an extent commensurate with the dignity and the resources of the American nation."[38] Commentators such as George B. Post expressed revulsion at the "disgraceful character of the architecture of the Government" (usually they excepted the White House, the Capitol, and the Treasury Building).[39] The White City, after all, was still fresh in mind, and the example of this "dream of Ionian seas" seemed to foster dissatisfaction with the eclectic potpourri which was nineteenth century Washington.[40] The call went out not merely for monumentality but for order, unity, harmony, homogeneity—in short, for plan. There had once been a plan—that of L'Enfant—and the articulate men of the American "Renaissance" would have it dusted off and dressed up for contemporary use. The American Institute of Architects, which devoted its annual meeting of 1900 wholly to the subject of "The Improvement of the City of Washington," strongly favored this course of action.[41] Chicago had produced a new L'Enfant, an American Haussmann, and the Institute (dominated at this time by classicists such as Peabody, Post, and McKim) recommended to the Senate that Burnham be invited to direct the improvement project. The Senate acceded, and in March, 1901, Burnham rode into Washington in triumph. His appointment to the new Park Commission seemed to him complete vindication of the course which he had pursued for a decade. The people had spoken, he said, and they had decreed that the national capital should demonstrate the "sense and soul of landscape art, so magnificent that the capitals of Europe shall confess it; so simple that the rawest county-seat in the newest State, having seen the vision of the World's Fair, shall grasp and apply."[42]

The Park Commission as finally established was composed of Burnham, McKim, Saint-Gaudens, and Frederick Law Olmsted, Jr., with Charles Moore, Clerk of the Senate Committee on the District of Columbia, acting as secretary. These men actually served in a

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[38] *Senate Reports*, 57th Cong., 1st Ses., 1901–1902, vol. 3, no. 166, p. 8.

[39] "Federal Architecture," *The Critic*, n.s., XXIII, 205 (March 16, 1895).

[40] *Senate Documents*, vol. 21, 60th Cong., 2d Ses., 1908–1909, doc. 665. The quotation is from an address by Secretary of State Elihu Root at the annual dinner of the American Institute of Architects, January 11, 1905. Root voiced a common sentiment in official circles when he declared that "It was reserved for the great city of the Middle West, by the example of that fair White City by the lake, which remains with us a dream of Ionian seas, to lead our people out of the wilderness of the commonplace to new ideas of architectural beauty and nobility" (p. 32).

[41] The papers read at the 1900 meeting are printed in *Senate Documents*, vol. 5, 56th Cong., 2d Ses., 1900–1901.

[42] "White City and Capital City," *Century*, LXIII, 620 (February, 1902).

quasi-official or advisory capacity, making their recommendations to Congress through the District Subcommittee headed by Sen. James McMillan (R, Mich.), but the proposals which they submitted after nearly a year of study were pretty largely honored. It is characteristic of their orientation that their first step was to go to Europe. Saint-Gaudens did not make the trip, but the others, with their cameras and sketching pads, traversed the Continent in the summer of 1901, visiting Paris, Rome, Venice, Vienna, Budapest, Munich, London, and other cities. A good deal of time was spent examining parks and formal gardens, and at Olmsted's insistence they searched out all the work of André Le Nôtre which lay within reach. Their purpose was to gain some clue as to how best to treat the Mall, that long plot extending west of the capitol which had been the *pièce de résistance* of L'Enfant's scheme, but which Downing at mid-century had converted into a picturesque park, with winding roads and trees now grown tall. According to Moore, it was chiefly Paris which provided the solution. Standing on a terrace overlooking the Place de la Concorde, exulting in the "glories of a city designed as a work of art," the Commission conjured up certain American equivalents—

> the Palace of the Tuileries as the Capitol, the Tuileries Gardens as the Mall, the Obelisk in the crossing of two Paris axes as the Washington Monument . . . and then a Lincoln Memorial as a national monument in location at the termination of the composition, and also as a center of distribution comparable to the Arc de Triomphe de l'Etoile.[43]

Thus the solution, like the form of the public buildings subsequently erected on the perimeter of the Mall, came straight out of Europe, a fact which much irritated the highly vocal Sullivan-Wright wing of American designers.

Though the Lincoln Memorial was still a dream (construction did not begin until 1914), its Grecian peripteral form and its placement at the western terminus of the Mall followed the recommendation laid down in the Commission report long before Henry Bacon set up his first Doric column beside the Potomac.[44] As envisioned, it serves as a distribution point for vehicles in the Potomac Park area and for those moving to and from Arlington across McKim, Mead, and White's Memorial Bridge. As a southern terminus to the White House-Washington Monument cross-axis, the Commission proposed a monument to the Founding Fathers; but this, after

[43] *Life and Times of McKim,* p. 198. The fullest discussion of the renovation of Washington is to be found in Moore's *Daniel H. Burnham,* 2 vols. (Boston, 1921), I, ch. 10, 11, 15. Notice that Moore's own modest reputation as a monitor of public taste dates from this service with the Park Commission (he had no training in the fine arts). Later he served as chairman of the Fine Arts Commission for many years and wrote the standard biographies of Burnham and McKim.

[44] The report (with drawings, photographs, and maps) which the Burnham Commission submitted in 1902 is printed in *Senate Reports,* 57th Cong., 1st Ses., 1901–1902, vol. 3, no. 166.

many years of delay, gave way in the 1930's to a memorial to Jefferson alone—a diminutive Pantheon which had a certain aptness because of Jefferson's great admiration for its prototype. Designer was John Russell Pope, a product of the American Academy at Rome who also assisted with the designs of the temple-fronted National Archives Building and the saucer-domed National Gallery of Art on the north side of the Mall. At the Capitol-end of the long axis the Burnham group hoped to sustain the Roman flavor of the architecture by working the west face of Capitol hill into a series of fountain-bedecked terraces descending to the level of the Mall. This scheme, however, was subsequently dropped in favor of a more modest embellishment of plantings in semi-formal disposition.

The greatest challenge was the Mall itself. The Commission's proposal to supplant the picturesque with the formal aroused the ire of a number of Congressmen, most notably the cantankerous Speaker of the House, "Uncle Joe" Cannon of Illinois, who was not easily placated. The local press rushed to the defense of the trees which Burnham and McKim avowedly intended to "butcher." Worst of all, the railroads had to be reckoned with, for in the years following the Civil War, Congress had permitted the Pennsylvania and the Baltimore and Ohio lines to lay tracks across the Mall and to locate a depot (Potomac Station) squarely between the Washington Monument and the Capitol. But the indefatigable Burnham was equal to the challenge, shouldering aside all opposition and persuading the leader of the railroad interests, Alexander Cassatt (Mary's brother), to vacate the Mall. He capped his triumph by obtaining the commission to do the new Union Station, which after 1907 was to flaunt its arcaded Roman facade upon the broad plaza north of Carrère and Hasting's Senate Office Building.[45]

And so classicism returned to Washington on a grand scale, settling comfortably about the Mall in anticipation of long tenancy, with only the red sandstone eccentricities of James Renwick's Smithsonian Institution to ruffle the calm. The Senate Park Commission died after reporting in 1902, but interested groups such as the American Institute of Architects and the "Committee of One Hundred" (Washington residents concerned about the development of the capital) kept pressure upon Congress until a permanent Fine Arts Commission was established by law in 1910. The first chairman of the new group was (need one say?) Daniel Hudson Burnham. Members included such traditionalists as Henry Bacon, John Russell Pope, John Mead Howells, Daniel Chester French, Herbert Adams, Lorado Taft, J. Alden Weir, Francis D. Millet, E. H. Blashfield, and F. L. Olmsted, Jr. (Saint-Gaudens, McKim, and White

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[45] Fiske Kimball, *American Architecture* (Indianapolis, 1928), pp. 171–87; Carroll L. V. Meeks, *The Railroad Station* (New Haven, 1956), p. 129.

were dead by 1910.) Charles Moore assumed the chairmanship in 1915, and for twenty-two years perpetuated the cause of the American "Renaissance."[46] From White City to Capital City to all America went the gospel of the City Beautiful, as Burnham had predicted.[47] A Thorstein Veblen might shudder at "conspicuous waste," a disillusioned Louis Sullivan might find solace in the bottle, but most Americans evidently liked "Renaissance" architecture, especially if harmoniously integrated with formal environs. For whatever reason, it embodied their notion of the ideal in public building: it was monumental, dignified, handsome, perdurable.

To Wright it was none of these things, and by the 1950's he professed to have evidence that discriminating Americans were beginning to share his opinion, were beginning to recognize that these quasi-classic agglomerations were not only deadly but dead. The fact is, he added, they were "killed for us by cold steel" long ago. "And though millions of classic corpses yet encumber American ground unburied, they are ready now for burial."[48] Possibly Wright was right; he was always an optimist. Through a long career he remained true to his ideals, damning the "Renaissance" at every opportunity. But countless structures presently going up—city halls, court houses, banks, libraries, public buildings of every sort—offer evidence that there remains much life in the "corpses." They have been "disinfected," to be sure, stripped of pediments, columns, coffered vaults, domes, and other Graeco-Roman encumbrances, but they are "classical" in their solemn strength, their cubic regularity and symmetry, their monumental repose. In the field of domestic architecture Wright has not fought in vain, but in the realm of public building the spirit of Burnham marches on. The message of the White City rings less stridently than once it did, but it still sounds across the land.

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[46] See *Forty Years of Achievement, National Commission of Fine Arts 1910–1950*, Senate Document 128, 81st Cong., 2d Ses. (Washington, 1950).

[47] For details as to ways and means, consult Maurice Neufeld, "The White City: The Beginnings of a Planned Civilization in America," *Journal of the Illinois State Historical Society*, XXVII, 71–93 (April, 1934), and Larkin, *Art and Life in America*, p. 337.

[48] *The Natural House* (New York, 1954), p. 55.

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OF

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VOL. L

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MADISON, WISCONSIN
1961

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PRESIDENTIAL ADDRESS

AN ACADEMY . . . OF ARTS AND LETTERS

MERRITT Y. HUGHES
President, Wisconsin Academy of Sciences, Arts, and Letters, May 7, 1960 to May 6, 1961

Our name declares a triple faith which we share with only one other academy in this country, the Michigan Academy of Sciences, Arts, and Letters. In our early *Transactions* little space may have been given to Arts and Letters, and in that space there may have been much candid doubt about the purpose and even about the meaning of the words themselves. Though like other state academies, ours owed its birth to its founders' confidence in Science as the servant, if not the saviour, of the commonwealth, its founders gave it a name which implies that man does not live by bread alone.

Were the founders trying to save our young economy from ever needing the warning which those words carry in the title of a recent Russian novel? It would be pleasant to think of them as trying to forestall the cultural "imbalance" which is now puzzling our efforts to overtake the Russians in scientific education. In the early *Transactions* there are indications of such foresight. Though they may not indicate much anxiety about the future, they do suggest wisdom in interpreting the past. Our founders may have regretted the growing imbalance in the Anglo-American tradition—the attitude towards science for which Bacon's *Advancement of Learning* has been principally blamed. Our founders seem to have shared Bacon's understanding of the importance of the imagination in both science and literature. They were not deceived by his narrowly utilitarian interpreters.

Perhaps the founders remembered that when the Royal Society was chartered by Charles II in 1662, although the "glory of God" was one of its avowed objects, the humanities were ignored in the charter. Its purpose was starkly declared to be to "promote by the authority of experiments the sciences of natural things, and of useful arts." Of course it is a mistake to regard the founders of the Royal Society as enemies of the fine arts or of literature. With a dramatist like the Duke of Buckingham, a scientific romancer like John Wilkins (later bishop of Chester), an architect like Sir Christopher Wren, an antiquarian and essayist like John Evelyn, and an astronomically-minded Christian apologist like Bishop Seth Ward among them, the founders might assume that they themselves were

* Address of the retiring president, delivered at the 91st annual meeting of the Academy, May 6, 1961.

the great white hope of English literature. In their routine reports they expected to set that literature an example that would firmly correct its faults of style.[1] But of its patronage they washed their hands. When a visiting member of the *Académie Française* hinted to the first historian of the Royal Society that it had a poor library, he was ready with the reply that "With Books they meddle not . . . ; their Revenue they designe for Operators and not for Lecturers."[2] And when later their historian proposed that they might set up a literary academy something like the *Académie Française,* they turned him down. Being both more modest and more ambitious than those confident Englishmen, our founders proposed to meddle with books and to make Arts and Letters a part of their business.

With the Arts it must be confessed that they meddled very little, so little indeed as to make it a question whether our Academy has ever taken the Fine Arts seriously or ever clearly discriminated between the Useful Arts and Applied Science. From the beginning there has never been any doubt of our passionate interest in the sciences, or that we have tried hard to be interested in Letters. But in our history the record of the Arts—aside from Letters, which is an art both useful and fine—has hardly corresponded with the honor that we do them by electing a vice-president to represent them. In our original "Plan of Operations"[3] Departments of the Fine and Useful Arts were projected, but the former was abandoned to a patron who could hardly be expected to take any but the most pragmatic interest in them. The "Plan" expressed[4] the pious hope "that such relations may be established with the State Agricultural Society as, without changing . . . the independence of that organization, will constitute said Society the proposed Department of the Useful Arts: leaving the field of the Fine Arts to be filled by a newly-created Department of the Fine Arts, which it is thought may be formed very soon.

The pious hope bore withered fruit. The report of our first President to Governor Washburn[5] easily demonstrated the living interest

[1] Enough has been written about the determination of the founders of the Royal Society to chasten English writing on all its levels, including those of syntax and metaphor, and to "beat the mythologists out of the republic of letters." The matter is well summed up by Jackson I. Cope and Harold Whitmore Jones in their Introduction (p. xxv) to their edition of *The History of the Royal Society,* by Thomas Sprat. (St. Louis, Missouri: Washington University Studies, 1958.) If the founders could rise to read *The Origin of Species,* they would be delighted to find Darwin ranked by Sir Arthur Keith (in his new Introduction to its sixth Everyman edition [1928], p. xix) "with that small select group of great Englishmen which holds Shakespeare."

[2] This reply of Sprat to Samuel Sorbière is quoted by Dorothy Stimson in *Scientists and Amateurs: A History of the Royal Society* (New York: Henry Schuman, 1948), p. 75.

[3] *Bulletin of the Wisconsin Academy of Sciences, Arts, and Letters,* No. 1 (1870),
[4] *Ibid.,* p. 25.
p. 20.

[5] *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters,* Vol. I (1872). President Hoyt's Report contained a list of 141 articles on scientific subjects by residents of the state which were known to be in print in 1870 (pp. 17–25).

of our founders in the natural sciences, but nothing was said about any response by the Agricultural Society to its appointment as patron of the Useful Arts. The best that President Hoyt could say about them[6] was that in the past they had generally been "cultivated with considerable success." Of the Fine Arts he confessed that "they had made little impression upon the life and character of the people. Architecture," he mourned, "both in the construction of private dwellings and buildings for public use, gave here, as elsewhere in our country, painful proof of a prevailing ignorance of the principles of the art."

Though a "Department of the Arts" figured in the *Transactions* of our first decade, it never contained more than three articles as against a score or more on the natural or social sciences. Peaks of three articles pretending to deal with the Arts, either Useful or Fine, were achieved in 1872 with the help of history and ethnography, and in 1873 entirely with the help of engineering. The first of the three titles under "Arts" in 1872 headed a two-page article on "The Production of Sulphide of Mercury by a New Process and its Use in Photography." It was followed by two papers totalling seventeen pages on "The Rural Population of England as Classified in Domesday Book" and "On the Place of the Indian Languages in the Study of Ethnology." In 1873 the now uncompromisingly useful "Department of the Arts" consisted of speculations "On Wisconsin River Improvement," "On the Strength of Materials as Applied to Engineering," and on "Railway Gauges."

In spite of an attempt[7] to draw the attention of the annual meeting of 1876 away from "the mechanic arts, admirable as are their results," to "those arts which are called *par eminence* Fine Arts, or more commonly 'Art,' " the Academy could not be interested either in the Fine Arts as a part of education or in the "Mechanic Arts" from any point of view except their utility. Thirty-four years later, when President Davis[8] analyzed the distribution of articles among what seemed to him to be the distinct fields of interest in the first thirty-six years of the *Transactions*, only .07% of the titles belonged under "Art." Unless we except Letters, which seem always to have been regarded by our founders as outside the "Department of the Arts," by 1907 it was submerged and forgotten. Wisely perhaps, we have resigned painting and sculpture to strong, local groups like the Madison Art Association (now over sixty years old) and the Milwaukee Friends of Art. In the years while we have been diligently developing the Junior Academy of Science under the direction of Professor John Thomson—and now under that of Pro-

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[6] *Ibid.*, pp. 25–26.

[7] By Alford Payne, S.T.D., in a paper on "Art as Education" (*Transactions*, IV, 32).

[8] J. J. Davis in "The Academy, its Past and Future," *Transactions*, XV, ii (1907), 891.

fessor Jack Arndt—the mysteriously named and brilliantly successful "music clinics" have grown up independently of us on the University campus in Madison. Without serious help from us parallel services to artistic high school students have been emerging on the Madison campus and at many of the State Colleges.

Perhaps it is too late for the Academy to think of justifying its profession of interest in the Fine Arts by trying to set up organizations on the levels of the municipal art associations or of the "clinics" for students on the Madison campus. It may be too late for us to think of any over-all service to the arts throughout the state such as is being rendered by the Wisconsin Arts Foundation and Council from its offices in Milwaukee and Madison.

The time for leadership in the arts by the Academy may indeed be past. Independent action on our part now might well seem to be—and actually be—intrusion upon the work of the Wisconsin Arts Foundation and several other organizations. Perhaps in a society where local choruses, local semi-professional theatres, and local private exhibitions of painting, photography, and sculpture are widespread spontaneous growths, central support and leadership in the arts may be less and less needed. It is hard to imagine anything that the Academy could do to improve the symphonic technique or the morale of the orchestra which is one of our hosts here in Waukesha. And yet as long as there is no truly professional symphony orchestra anywhere in Wisconsin, and as long as almost all our cities lack even the meanest public art displays, the Academy can hardly be at ease with its record of indifference to the Fine Arts.

II

On the junior level in the field of Letters it may also be true that there is now no room for service of any kind by the Academy. In all the eighteen years of the life of the Junior Academy of Science no one seems to have dreamed of a Junior Academy of Letters. If by a miracle we were to receive an endowment fully sufficient to finance such a Junior Academy—headed by a member of the Department of English or of Speech at one of the private or State Colleges or at the University—could a leader be found to try to build up interests in reading and writing among adolescents in numbers justifying regional meetings rivalling the seven established regional meetings of the Junior Academy of Science? Could such a leader possibly contrive programs excelling or supplementing the existing pyramid of regional and state-wide forensic meets which are sponsored by the Department of Speech in the University Extension? With no broader base than the Academy affords, will it ever be possible to challenge or even in a modest way to supplement such developments in the field of "Letters" as the Speech Institute and the Summer High School Journalism Workshop which are to be launched in a few weeks on the Madison campus? In the neglected center of the field of "Letters" should the Academy attempt any initiative apart from the now vigorous Wisconsin Council of Teachers of English? On the level of a Junior Academy of Letters it is hard to imagine any work being done which is not already being better done by specialists. This is most obviously true in History, for our Academy itself is younger than the State Historical Society.[9] In numbers our Junior Academy of Science falls far short of the nearly twenty-two thousand Young Historians who subscribe to *The Thirtieth Star* and are challenged to compete in regional essay contests that culminate in the award, at the annual banquet, of prizes really commensurate with the hard work of both the contestants and the judges.

Policy and decency alike forbid the Academy to trespass in regions which belong to the established educational agencies in a state whose boundaries were long ago declared by the President of its University to be no wider than those of the campus. If the University were to propose a literary partnership with us on the lines of the Junior Academy of Science, we might not decline; but no such initiative seems probable on either side. Partnership on that level with institutions like the Historical Society and other Wisconsin organizations awarding prizes for compositions of various kinds in English or other languages is also hardly likely. Perhaps it might take the form of recognition in some way by us of a few of their top contestants. Something of that kind flanking the awards of our Junior Science Academy at our annual meetings might help to redress an imbalance which many of our scientific members have long been chivalrously regretting.

III

If then we are to become in any effective way an Academy of Letters, it must be on an adult level and in ways distinct from the adult education which is being constantly broadened by the University Extension and many other agencies, private as well as public. It must be done—I believe—on a basis of three principles. One of them is the principle that, at least in modern times, the main

[9] The senior position of the Historical Society was recognized in the Academy's original *Plan of Operations*, pp. 20–21, by a suggestion that, "with mutual advantage," the Academy's Department of Letters might "be formed about the State Historical Society, should that useful and prosperous institution favor the establishment of a relation of that sort; said Society maintaining its . . . independent existence and yet fulfilling the office of the proposed Department by an enlargement of its scope, so as to embrace investigations in the branches properly included, and by concentrating in its library all the works that may be accumulated by the Academy in whatever Department."

function of literary academies is the recognition of literary achievement. Another emerges from the fact that in the *Transactions* we have a small but sound inheritance of literary scholarship. The third emerges from the need in Wisconsin—as everywhere else—to create a working alliance between Science and Literature. The extraordinary thing about the three principles is that they can be put into effect without any addition to our budget or any change in our organization. They need only to be kept firmly in mind by the editors of the *Transactions* and the *Review*, and to be worked more and more effectively into the programs of our meetings and into the imagination of many people who ought to be interested in the Academy and perhaps have not even heard of it.

Recognition of literary achievement by prizes is beyond our resources and would hardly be possible even if we had an endowment equal to the Nobel funds in Stockholm. It would, of course, be a great pleasure if we could help serious young writers by "crowning" their really outstanding work as the *Académie Française* does in about a score of cases year by year. To undertake anything of the kind would require both a formidable tradition like that which is maintained by the French Academy and a force of technical assistants costing much more than the value of the awards that would be made. To be of any real importance the awards would have to be absolutely distinct from the scholarships which are made in ever increasing numbers by schools and Foundations to encourage young writers of "promise." Even if awards were restricted to authors having some vital connection with Wisconsin, the standard would have to approximate that of a national literary Hall of Fame. Whether we liked it or not, in awarding them we should be setting ourselves up as a kind of literary tribunal dedicated—as Matthew Arnold said in "The Literary Influence of Academies"[10]—to maintaining standards giving "the law, the tone to literature, and that tone a high one."

The responsibilities and pretensions of a literary tribunal may be unavoidable by any official organization calling itself an Academy of Letters. Certainly we ought not to try to avoid them. Yet we are in no position to assume them with an authority even remotely resembling that of the French Academy, of the Royal Society of Literature, or of the Royal Society of Canada. If ever we are in such a position, it can only be by some almost unimaginable change in the level of culture throughout the state. But at our annual meetings it is easily within our power *as we are* to add to the critical reputation of writers of real worth, minor as well as major, living as well as dead. It is strange that August Derleth's *Still Small Voice*

[10] *Essays Literary and Critical* by Matthew Arnold. (London and Toronto: J. M. Dent & Sons, 1906; reprinted 1914), p. 28.

was not anticipated by any criticism of Zona Gale in our *Transactions*. Stranger still is the silence there about the Son of the Middle Border, though it may be no stranger than the facts that his manuscripts are in the Doheny Library at the University of Southern California, and that our two biographies[11] of Hamlin Garland should both have been published by University Presses outside of Wisconsin. Yet in the *Transactions* we have had analyses of some minor Wisconsin writers, such as the study of Margaret Ashmun by Julia Grace Wales.[12]

IV

In a multi-national world any limitation of interest to the literature of an area no larger than our state is impossible for a publication of world-wide exchange like that of our *Transactions*. And in a society with as much interest as ours has had, and with changing motives still has, in the literature of the past and its interpretation, an Academy of Letters is naturally concerned—perhaps too much concerned—with antiquity. At the outset the "Department of Letters" in the *Transactions* typically consisted of only one or two "Studies in Comparative Grammar" like the short paper on "Some Weak Verbs in the Germanic Dialects"[13] which alone represented it in Volume II. That little investigation of the development of a few Gothic strong verbs into weak ones did well if it got as large an audience as presumably listened to the most specialized of the twenty-three scientific papers in that Volume, Dr. P. R. Hoy's description of the water puppy.[14] Over-specialized and remote from the larger issues of life though the little study in comparative grammar may have been, it represented a valid curiosity about language which incidentally linked the author to philologists in all the great universities of the world. For him and for them it had a beauty no less lovely than Dr. Hoy saw in his water puppy—"a most beautiful object, as it appears in its favorite surroundings, with the long scarlet plumose gills, continually waving backwards and forwards."

The slow relaxation of the grip of historical philology upon the "Department of Letters" in our *Transactions* betrays its dependence upon the men teaching languages in the University and upon the fashions of scholarship in the late nineteenth century. Misguided though the fashions may seem to us now, they helped to keep the Academy aware of widening horizons in literary history.

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[11] Donald Pizer's *Early Life of Hamlin Garland* (Los Angeles: University of California Press, 1961) and Jean Holloway's *Hamlin Garland: A Biography* (Austin: University of Texas Press, 1960).

[12] *Transactions*, XXXIV (1942), 221–30.

[13] By J. B. Fueling, Professor of Comparative Philology, in the University of Wisconsin.

[14] "Water Puppy (Menobranchus lateralis say)." By P. R. Hoy, M.D. Pp. 248–50.

The progress is hard to chart because the papers published in that "Department" were either very few, or—with increasing numbers—they became miscellaneous and remote from any literary or philological interest. The few with a fair claim to be printed there λεγόμενα of Shakespeare"[15] and, in an article on "The Vocabulary of show philology chaperoning literature in studies like "The Ἅπαξ Shakespeare"[16] by the same writer twenty-five years later, being lured within distant sight of modern esthetic studies of the vocabularies of the poets.

Still moving in traditional channels of academic literary scholarship in the first quarter of the twentieth century, and still almost monopolized by men from the modern language departments at the University, the little current of literary studies became less specialized as it slowly broadened on its way through the sea of increasingly specialized scientific articles in the *Transactions*. In many of our papers in all fields over-specialization may have been a vice. But charges of that kind are most readily made by audiences whose interests are themselves too narrow. A glance back at the series of medieval and Chaucerian studies which Karl Young contributed to the *Transactions* before his translation from our University to Yale shows not merely a national scholarly reputation in the making but also a foundation being laid for our most recent illuminations of Chaucer's poetry against its whole literary and cultural background.

On the basis of Karl Young's papers it would be absurd to boast that in the twenties the *Transactions* made a major contribution to American scholarship. So on the basis of Ruth Wallerstein's study of "Cowley as a Man of Letters"[17] it would be absurd to think that in the thirties the Academy took a leading part in the extension of interest in the "Metaphysical Poets" to their heir who narrowly missed being elected a Fellow of the Royal Society. The important thing for the Academy is the fact that its programs have often included literary studies which were scholarly by the strictest academic standards and at the same time had an obvious bearing on the main developments in the literature of the past.

The literature of the past has had at least its full share of attention from the Academy. For this the influence of the universities has been partly responsible, but to that same influence our recent programs owe dissections of the plays of two prominent American dramatists, Arthur Miller and Tennessee Williams,[18] essays on con-

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[15] By Professor J. D. Butler, LL.D., of Madison. *Transactions,* V (1877–1881), 161–76.
[16] *Transactions,* XIV. i (1902), 40–55.
[17] *Transactions,* XVI (1932), 127–140.
[18] "Memory and Desire and Tennessee Williams' Plays," by John J. Enck, in *Transactions,* XLII (1953), 249–56, and "Arthur Miller: An Attempt at Modern Tragedy," by Alvin Whitley, in *Transactions,* XLII, 257–62.

temporaries like Camus,[19] Valèry Larbaud and Samuel Becket,[20] and at least one discussion of a debatable aspect of modern poetry.[21] In recent volumes of the *Transactions* the increasing majority of studies of contemporary writers seems to show that our liveliest interest is in the literature of the present.

The only literature that we neglect is that of the future, which in the past it has been the professed purpose of the great literary academies to foster and mould. That task the Academy has never seriously considered. On the level of help to writers young or old by prizes or scholarships the way is not open. On that of guidance for amateur writers we can only leave the responsibility to the creative writing seminars. In their encouragement we cannot compete with the poetry societies or offer a medium of publication that could possibly serve them as well as do the better poetry magazines, one of the best of which is published no further away than Beloit.

The best service within our power to the literature of both the present and the future lies most surely in more criticism of contemporary writers like that which has been slowly emerging in the *Transactions*. More and more of it is likely to seek us out. Three or four newspapers in the state are extending the audience for such criticism and helping to raise its standards. Rising enrolments in the University and State Colleges are fast increasing the staffs of modern language teachers eager to write such criticism. With the multiplication of advanced courses in literature in the hands of young men in the State Colleges in ranks often superior to those of men of comparable training in the University, critical scholarship of the best kind in many fields should be increasingly offered to us from all over the state. The amount may force us to find a literary assistant for the Editor of the *Transactions*. If the final results are not good, we shall have only ourselves to blame.

V

The great problem, of course, is to redress the imbalance between our interests in Science and Letters. It has always existed—less because the planners of our programs have been partial than because for many years practically no papers were offered for the "Department of Letters." Only by extension to offerings from sociology, anthropology, political science, and ethics could the caption be justified, and before the turn of the century it was dropped. In his analysis[22] of everything which had been published in the *Trans-*

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[19] Robert F. Roeming, "Camus Speaks of Man in Prison," in *Transactions*, XLIX (1960), 213–218.

[20] Melvin J. Friedman, "Valèry Larbaud and Samuel Becket," *Transactions*, XLIX (1960), 219–28.

[21] Haskell M. Block, "*Furor Poeticus* and Modern Poetry," *Transactions*, XLV (1956), 77–90.

[22] By J. J. Davis in *Transactions*, XV, ii (1907), 891.

actions down to 1906 President Davis found that only 13% could be classed under "Letters." By including papers in "Social and Political Science" the percentage rose to 33%. It became customary to lump those sciences with Letters under the term "Humanities." Some hardly humane wars were fought between partisans of the remote antiquity and the almost immediate contemporaneity of the Indian mounds. Some strange appeals to physiology and chivalry were made by both sides in the battle over women's rights. The problems of control of the railways and the "trusts" were solved more by faith than by knowledge of law or economics, and the state's obligations to its schools, its criminals, and the insane were treated with a speculative assurance that seems sadly unscientific today.

In spite of the embarrassing rhetoric and confused thinking on some of the pages dealing with what President Davis called "Social and Political Science," there were some solid papers on ethics. From an early discussion[23] of the mind's constraints upon its own liberty by the President of the University to Professor Frank Sharp's analysis[24] of "The Personal Equation in Ethics" the approach was psychologically realistic. On the level of public morals it often was learnedly and earnesty realistic in articles like Charles N. Gregory's on "Political Corruption and English and American Laws for its Prevention."[25]

In the studies which President Davis roughly described as "humanistic" a kind of true civic humanism was being worked out. Its effect upon our programs was felt first in the matter of forest conservation but—as President Davis sadly remarked—with no visible effect upon public policy. Some of its features were to emerge later in the noble but vague "Wisconsin Idea." In the *Transactions* it sometimes had Utopian overtones, but it was chastened by the standards of the scientific articles. Even in the wishful realm of geology those standards never fell, though a geologic survey of the state was the Academy's first enterprise. They stood firm from our earliest, unhopeful reports of precious metals to the grimly humorous treatment of the record of die-hard faith in them by our lately lost State Geologist, Ernest F. Bean. In the philosophy of our civic humanism the natural sciences have been a discipline quite as much as they have been a Baconian genie promising that by hitching our wagons to stars we can squeeze unlimited wealth out of nature.

If in reading old volumes of the *Transactions* we are sometimes puzzled by the confused roles of Sciences and Letters, there may be

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[23] "Freedom of Will Empirically Considered" in *Transactions*, VI (1885), 2–20.
[24] *Transactions*, X (1894), 310–326.
[25] *Transactions*, X (1894), 262–297.

comfort for us in looking back for a moment at their confusion by the ancestor of all modern academies, the French Academy which flourished in the reign of Henri III under the leadership of the poet Jean-Antoine de Baïf, nearly a century before the founding of the Royal Society. Its philosophy was Platonic and owed much to the Neo-Platonic academic tradition in Italy. Its doctrine was the belief that poetry, the queen of all sciences and arts, could be cultivated only by men of universal knowledge. One of its manifestoes[26] describes a symbolic Temple of the Arts where Aristotle displays them all to the patroness of the Academy, Marguerite of Savoy. Though Poetry is their queen, the seven arts are led by Military Science. Rhetoric comes third and Grammar only fifth. Between them march Medicine and Architecture. The last is Agriculture. Though in this strange hierarchy the sciences do not seem to rank high, the interest in them was great. In the correspondence of some of the leaders—all of them poets—scientific interests constantly emerge. Their great concern was with cosmography or astronomy, and the main weight of evidence[27] shows pretty clearly that they were on the side of Copernicus in the debate in which so many Englishmen—including Francis Bacon—were against him.

In naming their Academy of Sciences, Arts, and Letters, our founders preserved more than a trace of the belief of Henri III's academicians that the disciplines are mutually indispensable. That faith forever needs reaffirmation. In a specialized world where scientists in different subdivisions of their fields cannot always understand one another, the reaffirmation of that faith is more and more necessary. James Bryant Conant's book *On Understanding Science*[28] might well be prescribed reading for scientists as well as for humanists. The response of the humanities to science in poetry and fiction might also be the basis of some widely prescribed reading of primary and secondary material. Of the latter Marjorie Hope Nicolson's *The Breaking of the Circle*[29] might be suggested for scientists. An example in our *Transactions* is Harry H. Clark's "The Role of Science in the Thought of W. D. Howells."[30] The situation is not helped by the revolt against the scientists and their "myths" by several only too representative living poets who have suffered con-

[26] *Civitas veri sive morum Bartholmei Delbene Patricii Florentini Ad Christianissimum Henricum III Francorum et Poloniae Regem Aristotelis de Moribus doctrinam, carmine et picturis complexa et illustrata Commentariis Theodori Marcilii, Professoris Eloquentiae Regii,* Paris, 1609. The grand pictorial plan of the City of Truth is reproduced by Frances A. Yates in *The French Academies of the Sixteenth Century* (London: The Warburg Institute, 1947), opposite page 112.

[27] As presented by John C. Lapp in his Introduction to his edition of *The Universe of Pontus de Tyard* (Ithaca: Cornell University Press, 1950), pp. xliii–xlvi.

[28] New Haven: Yale University Press, 1947.

[29] Evanston: Northwestern University Press, 1950.

[30] Volume XLII (1953), pp. 263–304.

dign punishment in Joseph Warren Beach's *Obsessive Images*.[31] What is needed is an initiation for all of us in both Science and Letters. To that good end the programs of our annual meetings can help in a small way—but only if we succeed much better than our founders and leaders have yet done in trying to make the Academy justify its name.

[31] Minneapolis: University of Minnesota Press, 1960; pp. 286–93.

SCIENCES

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN NO. 44 CRUCIFERAE—MUSTARD FAMILY*

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There are few families in the Wisconsin flora that are as easy to recognize as the Cruciferae. In the course of its evolution an ancestral type hit upon a "streamlined" flower model, characterized by 4 sepals, 4 petals, and 6 stamens, of which two are shorter than the rest. The great success of this flower is attested by the large number of species and individuals in the family, and by the uniformity of floral structure. From genus to genus flower differences in the Cruciferae are often as small as the distinctions generally found in other families between species of the same genus. Thus, while it is easy to recognize a plant as belonging to the Cruciferae, the genera and species are often very difficult to tell apart. Fortunately for the taxonomist, however, natural selection did produce a highly varied assemblage of fruits of many shapes and types of dehiscence.

Our interest in the Cruciferae also stems from economic considerations, for aside from its many useful members such as cabbage, kale, brusselsprouts, cauliflower, radish, mustards and horse-radish, the family in Wisconsin contains many introduced garden plants as well as farm weeds, some of which, like the Yellow Rocket and Hoary Alyssum, are serious agricultural pests. And yet even the weeds, with their many bright flowers and large populations of individuals so characteristic of the group, help to give this family its special charm.

This treatment of the Cruciferae of Wisconsin is based on specimens in the herbaria of the University of Wisconsin, Madison, (WIS), University of Wisconsin–Milwaukee, Milwaukee Public Museum (MIL), the University of Minnesota (MINN), Northland College, Ashland, Eau Claire State Teachers' College, and Beloit College.

Dots on the maps represent specific locations, triangles county reports only. Numbers in the enclosures on the maps indicate the number of specimens in flower and fruit. Specimens in a vegetative condition are not included. These numbers indicate when the species is likely to flower and fruit in Wisconsin, and give a rough, though low, estimate of the amount of material that was available for this study.

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The order of the genera is according to *Gray's Manual of Botany, ed. 8* (Fernald, 1950). In the general descriptions, liberal use was made of the above work, as well as of the *New Britton and Brown Illustrated Flora* (Gleason, 1952), and the *Flora of the British Isles* (Clapham, Tutin, and Warburg, 1952.)

Grateful thanks and acknowledgment for the loan of their Wisconsin Cruciferae are due to Drs. G. B. Ownbey, University of Minnesota, A. M. Fuller, Milwaukee Public Museum, A. L. Throne, University of Wisconsin, Milwaukee, F. C. Lane, Northland College, H. C. Greene, curator of the Cryptogamic Herbarium, University of Wisconsin, and Tom Hartley, Iowa State University, Iowa City.

We also wish to thank Drs. J .W. Thomson and J. D. Sauer for their constructive criticism, Mrs. Katharine S. Snell for her encouragement and invaluable assistance in the preparation of the manuscript, and Mr. J. E. Dallman for the execution of the *Cakile* drawings.

This project, both in the laboratory and in the field, was supported during 1958–1960 by the Research Committee of the University of Wisconsin on funds from the Wisconsin Alumni Research Foundation.

CRUCIFERAE OF WISCONSIN

Annual, biennial or perennial herbs, with alternate or opposite, estipulate, simple, often lobed, or compound leaves. Flowers generally in various types of ebracteate racemes, regular, perfect, hypogynous; sepals and petals 4 (or rarely the latter lacking); stamens 6, with the two outer shorter than the 4 inner, all usually with nectariferous glands at their bases; pistil 2-carpellate, the ovary usually 2-celled by a thin partition, the *septum*, with many to as few as 1 ovule in each cell, or sometimes only one-celled with a single ovule. Fruit basically a capsule, though very variable, if elongate called a *silique*, if short a *silicle*, usually dehiscent with the 2 *valves* (ovary wall) deciduous, leaving the placenta *(replum)* and the intervening septum attached to the pedicel, or less commonly transversally septate with indehiscent segments *(Cakile, Raphanus, Erucastrum,* or *Brassica)* or completely indehiscent *(Neslia)*.

ARTIFICIAL KEY TO GENERA

1. Cauline leaves compound or pinnately dissected more than half-way to the midrib, or at least the upper- or lowermost leaves pinnatifid -- 2

2. Plants aquatic, with finely dissected, submerged leaves; fruit a silicle; flowers white ____________________ 23. ARMORACIA.
2. Plants terrestial or semi-aquatic, the leaves not finely dissected; fruit usually a linear silique, more than three times as long as broad, shorter in the yellow-flowered *Rorippa* ________ 3
  3. Leaves few (2–3), palmately compound, the leaflets three or appearing as five or seven, the margins serrate or laciniate; flowers white to pink or pale purple ______ 25. DENTARIA.
  3. Leaves generally numerous, pinnately dissected ________ 4
    4. Fruits indehiscent, with a stout beak, often corky inside, (3–) 4–10 mm broad; leaves coarse with simple hairs, rough to the touch; petals 13–20 mm long, white, pink-purple or pale yellow __________________________ 11. RAPHANUS.
    4. Fruits usually dehiscent (indehiscent in *Diplotaxis)*, non-corky, up to 4 mm broad ______________________________ 5
      5. Leaves, especially of the basal rosette, lyrate-pinnatifid, the margins entire; petals white, 5–8 mm long; siliques 2–4 cm long; plants small, slender, much branched ____________________________ 27. ARABIS *(A. lyrata)*.
      5. Leaves pinnate or pinnatifid ______________________ 6
        6. Seeds of ripe fruits arranged in *two* (often irregular) *columns in each locule* _________________________ 7
          7. Plants free-floating or creeping aquatics; petals white; leaves pinnate with rounded or elliptic leaflets ____________________________ 22. NASTURTIUM.
          7. Plants erect; petals yellow; leaves pinnatifid, not bearing distinct leaflets _________________________ 8
            8. Fruits linear, 2–5 cm long, with a prominent midnerve, indehiscent; leaves mostly at the base of the stem ___________________ 14. DIPLOTAXIS.
            8. Fruits globose to oblong, plump, to 2 cm long, but mostly less than 1 cm, nerveless, dehiscent; stem leafy throughout __________ 21. RORIPPA.
        6. Ripe seeds (through elongation of their seed stalks) arranged *in a single column in each locule* __________ 9
          9. Leaves two or three times pinnate, sometimes once-pinnate; plants canescent or with glandular hairs ______________________ 18. DESCURAINIA.
          9. Leaves once pinnate or pinnatifid; plants neither canescent nor with glandular hairs _____________ 10
            10. Petals white; leaves normally thin, pinnately divided with equal, linear, rounded or elliptical segments, the margins entire or wavy ___________________________ 26. CARDAMINE.

10. Petals yellow; leaves often coarse, pinnatifid with segments of unequal size, the margins serrate or cleft ---------------------------------- 11

11. Uppermost leaves strongly clasping; stem and leaves glabrous above ---------------- 12

12. Uppermost leaves usually coarsely dentate, sometimes palmately lobed, broadly obovate to rounded ---------------- 24. BARBAREA.

12. Uppermost leaves entire or dentate, lanceolate to oblong ------------- 12. BRASSICA.

11. Uppermost leaves petioled or sessile; plants hispid throughout or at least at the base (except *Brassica juncea,* which is glabrous) -------- 13

13. Petals up to 4 mm long; fruit strictly appressed, sharp-pointed--- 17. SISYMBRIUM.

13. Petals 5–13 mm long --------------- 14

14. Cauline leaves pinnatifid with long linear segments, the uppermost feathery ----- -------------------- 17. SISYMBRIUM.

14. Cauline leaves pinnatifid, not feathery 15

15. All but the uppermost fruits leafy-bracted at the base, 4-angled ------------ ----------------- 13. ERUCASTRUM.

15. Fruits not leafy bracted, round in cross-section or nearly so -------------- --------------------- 12. BRASSICA

1. Cauline leaves simple, not cleft or pinnatifid (or if pinnatifid below, then perfoliate and simple above) ------------------- 16

16. *Fruit a linear silique,* more than three times as long as broad --- 17

17. Plants with a basal rosette, or bearing numerous distinct basal leaves; flowers white to pink or purplish, rarely pale yellow --- 18

18. Fruits oblong or oval, inflated or flattened and twisted, to 1.5 cm long ---------------------------- 1. DRABA.

18. Fruits linear, 1.5–12.0 cm long ----------------- 19

19. Plants arising from a knobby tuberous base; pubescence of simple hairs or plants glabrous 26. CARDAMINE.

19. Roots non-tuberous, pubescence of simple, forked, or stellate hairs often only at base of stem, or plants glabrous ------------------------------------ 27. ARABIS.

17. Plants without a basal rosette or distinct basal leaves 20

20. Flowers white, pink, or purple ----------------- 21

21. Leaves obovate to oblanceolate, the margins sinuate toothed; petals 6–8 mm long; siliques indehiscent and transversely jointed; succulent beach plants of the Lake Michigan strand ---------------------- 10. CAKILE.

21. Leaves lanceolate or deltoid-ovate, not fleshy, the margins dentate or minutely toothed ----------------- 22

22. Petals white, about 4 mm long-- 16. ALLIARIA.

22. Petals pink or purple, rarely white, 10–20 mm long, showy --------------------------- 19. HESPERIS.

20. Flowers yellow ---------------------------------- 23

23. Plants glabrous; leaves elliptic, auriculate-clasping -------------------------------- 15. CONRINGIA.

16. *Fruit a silicle,* less than three times as long as broad, triangular, oblongoid, or rounded -------------------------- 24

24. Fruits strongly flattened at least in the upper half, notched at the summit -- 25

25. Pods triangular-obcordate; flowers white 7. CAPSELLA.

25. Fruits circular or elliptic, when viewed from the flat side, strongly flattened; flowers white or greenish ----- 26

26. Seeds one per locule; fruits 2–4 mm broad ------------------------------------- 5. LEPIDIUM.

26. Seeds on per locule; fruits 8–15 mm broad ---------- ------------------------------------ 4. THLASPI.

24. Fruits various, flattened or not, often inflated or with a winged margin, not notched at summit ----------------- 27

27. Pods pear-shaped, tapering to the base ----------- 28

28. Flowers white or purple; fruits 3–4 mm long; plants low, bushy perennials ----- LOBULARIA (see genus 3.).

28. Flowers yellow; fruits 5–12 mm long; plants stiffly erect annuals ---------------------- 8. CAMELINA.

27. Pods nearly globose or ellipsoid, rounded or cordate at the base; *petals white* ------------------------------ 29

29. Margins of cauline leaves wavy to entire; plants annual --------------------------------------- 30

30. Fruits 5–8 mm long, elliptic, closely appressed to the stem; petals deeply 2-parted; plants densely white-hoary --------------------------- 2. BERTEROA.

30. Fruits to 3 mm long, circular, on divergent pedicels -- 31

31. Fruit dehiscent, with a narrow winged margin; seeds generally 4 per pod; low annual 3. ALYSSUM.

31. Fruit indehiscent, globose, not winged, the surface wrinkled; seeds one or two per pod; erect, strict annual ---------------------------- 9. NESLIA.

29. Margins of cauline leaves serrate or crenate; plants perennial from a deep taproot ______________________ 32
 32. Petals 5–7 mm long; silicles to 3 mm long, dehiscent though seeds never maturing; large-leaved, robust herb from a thick tap root ____________ 23. ARMORACIA.
 32. Petals about 2 mm long; silicles 2–3 mm long, indehiscent, with 1 seed in each half; leaves small, auriculate-clasping; slender weeds ________ 6. CARDARIA.

1. DRABA L.

[Hitchcock, C. L. 1941. *A Revision of the Drabas of Western North America.* University of Washington Publ. in Biology 11.]

Low slender annuals or perennial from a basal rosette, often stellate-pubescent throughout. Leaves small, simple, entire to dentate. Petals white or rarely pale yellow, the sepals ascending. Siliques flattened, often twisted; seeds numerous, red-brown, in two columns in each locule.

Key to Species

1. Fruits twisted, lanceolate, acuminate, the style elongate; plants perennial ____ 2
 2. Pedicels and siliques glabrous or with a few simple hairs; seeds 1.0–1.7 mm long ______________________ 1. *D. arabisans.*
 2. Pedicels and siliques heavily stellate-pubescent; seeds 0.8–1.0 mm long _________________________________ 2. *D. lanceolata.*
1. Fruits straight and flat, narrowly oblong, rounded at the apex; style lacking; plants annual or winter-annual ________________ 3
 3. Plants 4–8 (–15) cm tall; leaves mainly basal, the cauline leaves few or lacking; raceme corymbiform, few-flowered; pedicels equalling or shorter than the fruits ________ 3. *D. reptans.*
 3. Plants (5–) 8–30 cm tall; cauline leaves present; inflorescence a loose raceme; pedicels longer than the fruit__ 4. *D. nemorosa.*

1. DRABA ARABISANS Michx. Map 1.

Erect perennial, sparingly branched above, to 5 dm tall. Basal leaves oblanceolate, tapering to the base; cauline leaves oblanceolate to obovate, 5–45 mm long, broadly serrate, evenly but not heavily stellate-pubescent. Petals white, 3–4 mm long. Siliques lanceolate, acuminate, flattened and much twisted, glabrous or with very few simple hairs. Seeds oval, 1.0–1.7 mm long.

Rare, on shaded cliffs of Niagara Dolomite, in Door and Fond du Lac Counties. Flowering from mid-June through early July and fruiting from late June through July.

2. Draba lanceolata Royle Map 1.

Similar to *D. arabisans.* Stellate throughout. Basal leaves oblanceolate to spatulate, 7–30 mm long; cauline leaves lancelate to ovate. Petals white, 3–5 mm long; racemes leafy-bracted at base. Pods 4–14 mm long, densely and evenly stellate-pubescent. Seeds very small, ovoid, 0.8–1.0 mm long.

One collection, Door Co.: from summit of limestone cliff, Fish Creek, June 14 [in fruit], *Fassett 16216* (WIS), *16217* (MIL).

3. Draba reptans (Lam.) Fern. Map 2.
Draba caroliniana Walt.

3a. Draba reptans forma reptans

Minute annuals, 4–15 cm tall, branching from the basal rosette or slightly above. Stem sparingly pubescent with stellate and forked hairs. Basal leaves ovate, entire or nearly so, *densely stellate-pubescent;* cauline leaves few or lacking, usually entire. Inflorescence corymbiform, few-flowered; petals white, 4–5 mm long. *Siliques glabrous,* narrowly oblongoid, 0.8–1.3 cm long, slightly flattened. Seeds rounded, about 0.5 mm broad.

Frequent in sandy or gravelly places, especially in southern Wisconsin, on sandstone (sometimes limestone) cliffs, rocky hillsides, in sandy prairies, open sandy river terraces, often along sandy roadsides, gravel pits, cultivated fields and pastures. Flowering from mid-April through late May, being among our earliest flowering species, and fruiting from early May through early July.

3b. Draba reptans forma micrantha (Nutt.) Hitchc.

Siliques hispidulous; upper surface of leaves with *mostly simple hairs;* otherwise as f. *reptans.*

Dane Co.: crumbling sandstone, *Fassett 9884* (WIS); Dodge Co.: prairie relic along R.R., *Shinners 4252* (WIS).

4. Draba nemorosa L. var. lejocarpa Lindbl. Map 1.

Widely branched slender annual, (5–) 8–30 cm tall, pubescent throughout with forked and stellate hairs. Basal leaves obtuse; cauline leaves oblong to ovate, acute. Petals pale yellow to white, about 2 mm long. Mature racemes very long with fruits nearly to the base of the plant. Siliques elliptic, 3–13 mm long, glabrous, the pedicels longer, slender, divergent.

Rare in Wisconsin, and doubtfully native, the two collections seemingly weedy: Marinette Co.: Marinette, June 25, 1916 [in fruit], *Goessl 4197* (MIL), *s.n.* (WIS); La Crosse Co.: dry sandy plain, Upper French Island (in Mississippi River), June 7, 1956 [in fruit], *Hartley 342* (WIS).

2. BERTEROA DC.

1. BERTEROA INCANA (L.) DC. Hoary Alyssum Map 3.

Erect, often much branched, to 1 m tall, *gray-green throughout* with dense, stellate pubescence. Leaves entire, lanceolate. *Petals white, deeply cleft,* 4–6 mm long. Silicles 5–8 mm long, inflated, ellipsoid, the style persistent. Seeds dark brown, 4 per locule.

A very common weed throughout the state, mostly on sandy or gravelly soil, along roadsides, railroads, in cultivated fields, pastures, sandy prairies, open woods and waste ground. Naturalized from Europe. Flowering from late May through early October and fruiting from mid-June through late October.

3. ALYSSUM L.

1. ALYSSUM ALYSSOIDES L. Small Alyssum Map 4.

Small annuals 7–25 cm tall, simple or branched from the base with several arched-ascending stems, whitish stellate-pubescent throughout. Leaves linear-spatulate, 8–15 mm long. Petals white or pale yellow; sepals persistent. Silicles round, lens-shaped with a winged margin, 2.5–3.5 mm in diameter, the valves smooth and nerveless, the style persistent. Seeds red-brown, generally 4 per fruit.

Locally abundant in sandy places, in prairies, sand dunes, beaches, along roadsides, and most often along railroads. Naturalized from Europe. Flowering from late May through early June and fruiting from early June through mid-July.

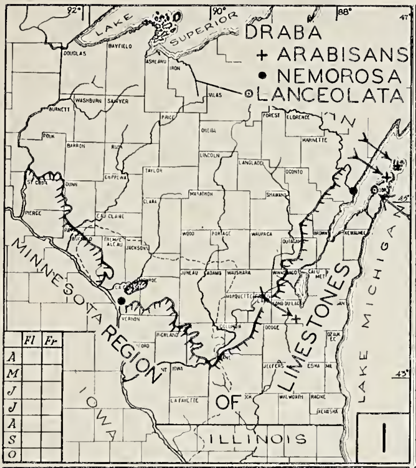
LOBULARIA MARITIMA (L.) Desv., "Sweet Alyssum", a low perennial with narrow leaves and white or purple petals, resembles *Alyssum,* though differing in having pyriform silicles. Introduced from Europe. Commonly cultivated as an ornamental and occasionally escaping: Ozaukee Co.: strand of Lake Michigan, probably escaped, *Iltis 8292;* Dane Co.: along highway, 1958, *Pirone, s.n.;* waste field, 1958, *Klisiewig* (all WIS).

4. THLASPI L.

1. THLASPI ARVENSE L. Penny Cress Map 5.

Erect glabrous annual, 1–5 (–8) dm tall. Leaves oblong to obovate, the upper sagittate-clasping, entire or with few teeth. Petals white, 2.5–4.0 mm long. Silicles much flattened, oblong to circular, broadly winged, 10–15 mm long, notched at the apex to about 3 mm.

Common weed of open, waste places, along railroads and roadsides, in cultivated fields, moist ground in pastures, and near marshes or streams. Naturalized from Europe. Flowering from late April through July and fruiting from late May through September (November).


DRABA
+ ARABISANS
• NEMOROSA
⊙ LANCEOLATA
LAKE SUPERIOR
MINNESOTA
REGION OF LIMESTONES
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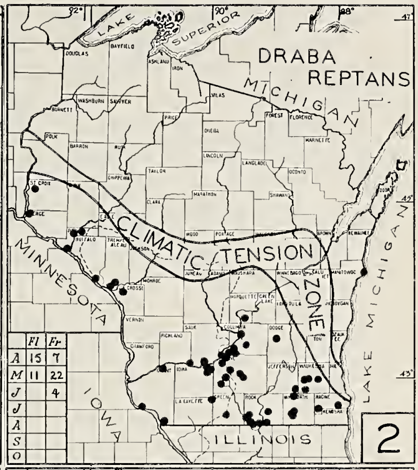
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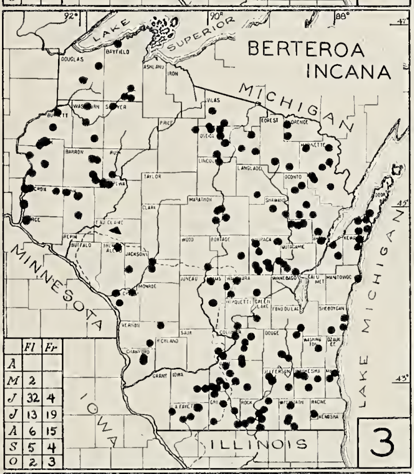
J – 4
J
A
S
O
2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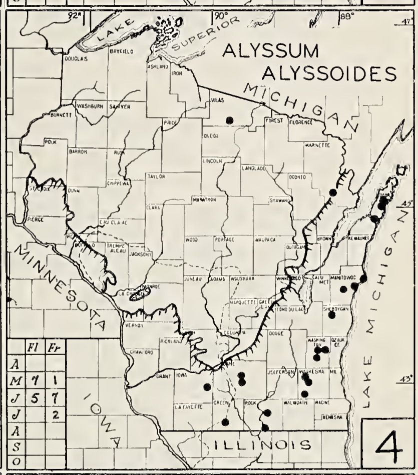
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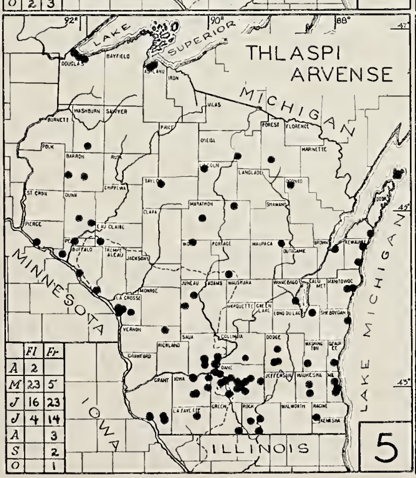
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S – 2
O – 1
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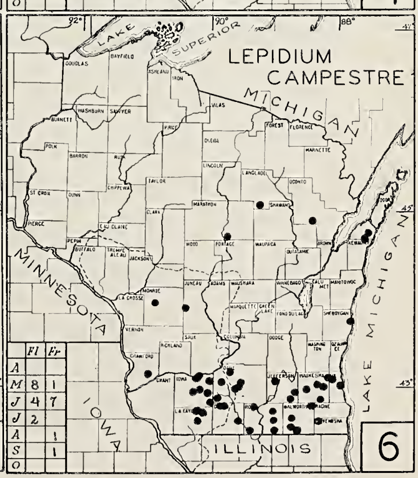
LEPIDIUM
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LAKE SUPERIOR
MICHIGAN
MINNESOTA
LAKE MICHIGAN
IOWA
ILLINOIS
Fl Fr
A
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J 4 7
J 2
A – 1
S – 1
O
6

5. LEPIDIUM L. PEPPERGRASS

[Hitchcock, C. L. 1936. The genus *Lepidium* in the *U. S. Madroño* 3:265–320.]

Petals small, white or greenish, or lacking. Racemes slender, elongate; pedicels divergent. Silicles small, dehiscent, rounded or obovate, usually much flattened contrary to the partition, notched at the apex, with one seed per locule.

KEY TO SPECIES

1. Upper leaves perfoliate and entire, the lower dissected; fruits 3.5–4.2 mm long; rare in Wisconsin ---------- 1. *L. perfoliatum.*
1. Leaves similar throughout, not perfoliate; fruits 2–6 mm long 2
  2. Fruits inflated, 4–6 mm long, broadly winged in their upper half; leaves auriculate-clasping, often closely appressed, imbricate ------------------------------------ 2. *L. campestre.*
  2. Fruits flattened, 2–4 mm long; leaves sessile and attenuate at base, spreading and not imbricate ---------------------- 3
    3. Petals present, exceeding sepals; silicles orbicular or nearly so, 2.5–3.3 mm long; cotyledons within the seed acumbent ---- ------------------------------------ 3. *L. virginicum.*
    3. Petals absent, if present minute and narrower and shorter than the sepals; siliques mostly elliptic or obovate, 1.8–3.0 mm long; cotyledons within the seed incumbent_4. *L. densiflorum.*

1. LEPIDIUM PERFOLIATUM L.

Erect, 1–7 dm tall, branching above. *Upper leaves rounded, perfoliate,* the middle leaves strongly cordate, acute at the apex, *the lower leaves dissected.* Petals white, to 1 mm long, slightly exceeding the sepals. Silicle rhombic-ovate, 3.5–4.2 mm long.

A weed of railroad stations and rights-of-way, naturalized from Europe. Walworth Co.: Delavan, June 9, 1934 [in fruit], *Wadmond 10334* (WIS); May 30, 1936 [in flower and fruit], *Wadmond s.n.* (WIS); Sheboygan Co.: July 1933 [in fruit], *Goessl s.n.* (WIS).

2. LEPIDIUM CAMPESTRE (L.) R. Br. Field Peppergrass Map 6.

Simple or branched, 1–6 dm tall. Stem densely pubescent with simple hairs. Leaves numerous, *imbricate,* lance-ovate, *auriculate-clasping,* entire to irregularly serrate; lower leaves with rounded apices, the upper ones acute. Petals white, 1.8–2.5 mm long, slightly exceeding the sepals. Silicles oblong-ovate, 4.0–6.5 mm long, papillose, swollen at base, the *apex with a broad flat wing.*

Frequent in southern Wisconsin in disturbed sandy places, cultivated fields, roadsides, railroads, waste places, grazed hillsides, and pastures. Naturalized from Europe. Flowering from mid-May through mid-July and fruiting from early June through August.

3. LEPIDIUM VIRGINICUM L. Peppergrass Map 7.

Stems erect, glabrous to minutely pubescent, usually much branched, 2–9 dm tall. Basal leaves dissected or pinnatifid. Cauline leaves linear to lanceolate, incised to entire. *Petals white, about 1 mm long and exceeding the sepals.* Silicles much flattened, nearly orbicular, 2.5–3.3 mm long; cotyledons acumbent (see drawing on map 7).

Common and weedy, mainly in southern Wisconsin, in dry places, along railroads, city streets, waste places, quarries, roadsides, open fields, pastures, open sand bars along streams and borders of open oak woods. Flowering from mid-May through mid-July and fruiting from mid-July through late November.

Easily confused with *L. densiflorum,* but distinguished by the white petals and acumbent cotyledons.

4. LEPIDIUM DENSIFLORUM Schrad. Peppergrass Map 8.

Lepidium apetalum of Auth., not Willd.

Stem erect, much branched. Sepals with thin white margins; *petals lacking or minute* and smaller than the sepals. Silicles 1.8–3.0 mm long, mostly elliptic to obovate, though sometimes nearly orbicular and broadly rounded at apex much as in *L. virginicum.* Cotyledons *incumbent;* when fruits are mature this is a most reliable character (see drawing with map 8).

Very common throughout the state, particularly in dry sandy places, roadsides, railroad embankments, city streets, waste places, fields, pastures, and common in native communities such as sandy prairies, borders of Jack Pine or Oak woods and on beaches and riversides. Flowering from early May to mid-July and fruiting from early June through October.

While this paper was in galley proof, the following notes were added as a result of Dr. G. A. Mulligan's studies of our *Lepidium* collections (cf. The genus *Lepidium* in Canada. Madroño 16:77–90. 1961). To Dr. Mulligan, of the Plant Research Institute, Canada Department of Agriculture, Ottawa, we extend our sincere thanks.

3a. LEPIDIUM DENSIFLORUM var. DENSIFLORUM. Nearly all of our collections fall into this variety. Mulligan *(loc. cit.)* states that it is an annual or winter annual with fruits averaging 2.5 mm long and 2 mm wide.

3b. Lepidium densiflorum var. macrocarpum Mulligan *(loc. cit.* 16:86. 1961).

Lepidium densiflorum var. *bourgeauanum sensu* Hitchcock 1936, not *Lepidium bourgeauanum* Thellung.

Eight Wisconsin specimens have been assigned by Mulligan to this variety, who states in the original description that var. *macrocarpum* is a biennial distinguished by larger capsules (3.0–3.5 mm long and 2.0–2.5 mm wide) occurring naturally in Alberta, British Colombia and Saskatchewan. The Wisconsin records, from Adams, Barron, Dane, Marinette, Marquette, Polk, and Portage Counties, extend the known range of this variety from SW Saskatchewan to Southern Wisconsin. The introduction must have been very recent, for all but the 1928 Polk County and 1956 Dane County collections have been made since 1957.

Lepidium densiflorum var. densiflorum X Lepidium virginicum Hybrids

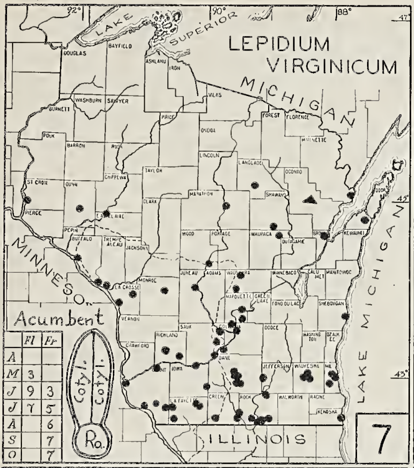
A score or more of either of these two species have been annotated by Mulligan as containing genes of the opposite species, while a few populations were shown by Mulligan to represent hybrid swarms, consisting of both parents and intermediates. Judging from this, as well as their frequent joint occurrence, hybridity between these two species appears to be quite common in Wisconsin.

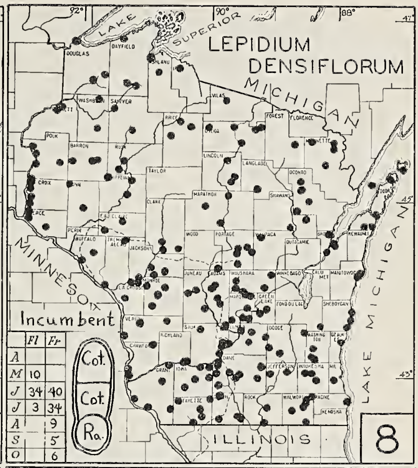
Lepidium bourgeauanum Thellung

Lepidium fletcheri Rydb.

The one specimen of this mainly western Canadian species so named by Mulligan was collected in "Sheboygan, common, Sept. 1918" by Chas. Goessl, a retired railroad man, whose collections are generally considered by us with suspicion, for he seemed to have been very careless in labelling his specimens. It is likely that this collection was not made in Wisconsin. The species is slenderer than *L. densiflorum,* and resembles *L. ruderale,* except that the leaves are only incised, and the sepals more robust and hairy. According to Mulligan, the species is supposed to have short petals, which are *not* evident in the *Goessel* specimen.

Lepidium ruderale L. is very similar to *L. virginicum,* differing by the silicles gradually narrowed to the apical teeth, and by the bipinnatifid lower leaves. Milwaukee Co.: Railroad tracks, Gordon Park, Milwaukee, 1940, *Shinners 2176* (WIS); vacant lot, Fairmont Ave. on Green Bay Road, Milwaukee, 1938, *Shinners s.n.* (WIS).


LEPIDIUM
VIRGINICUM
LAKE SUPERIOR
MICHIGAN
MINNESOTA
LAKE MICHIGAN
ILLINOIS
Acumbent
Cotyl.
Cotyl.
Ra.
7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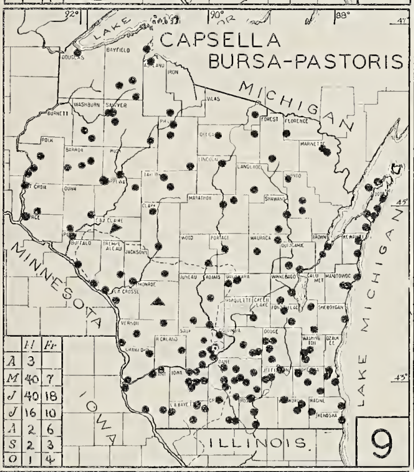
DENSIFLORUM
LAKE SUPERIOR
MICHIGAN
MINNESOTA
LAKE MICHIGAN
ILLINOIS
Incumbent
Cot.
Cot.
Ra.
8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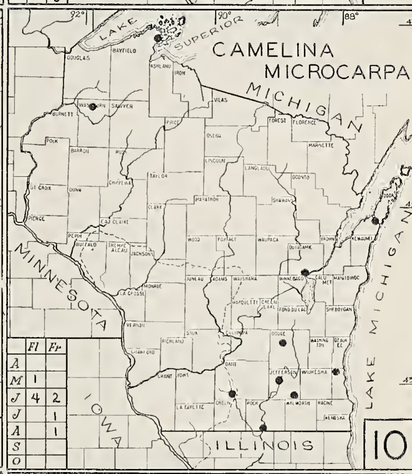
LAKE
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
ILLINOIS
9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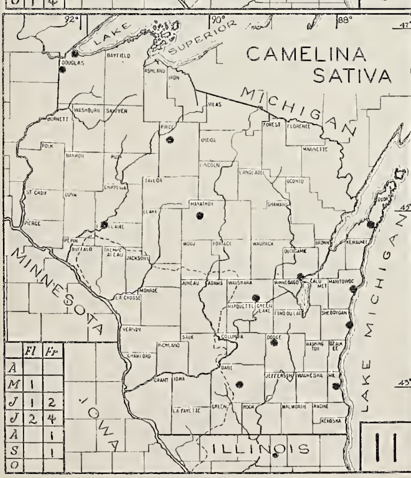
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
ILLINOIS
10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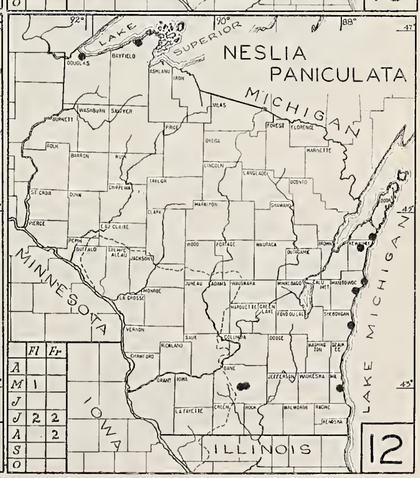
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
ILLINOIS
11


NESLIA
PANICULATA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
ILLINOIS
12

6. CARDARIA Desv.

[Rollins, R. C. 1940. On two weedy crucifers. *Rhodora* 42:302–326.]

Perennials similar in appearance to *Lepidium*. Cauline leaves serrate-dentate, sessile or clasping. Flowers small, white. Silicles ovoid to cordate, *somewhat inflated, indehiscent,* the style and pedicel slender.

1. Cardaria draba (L.) Desv. Hoary Cress

Silicles glabrous, broader than long, cordate and notched at the base.

One collection: Waukesha Co.: E. Millers farm, Big Bend [flower and young fruit] June 3, 1931, *Fuller 4033B* (MIL). Adventive from Europe; a troublesome weed in the western U.S.

2. Cardaria pubescens (C. A. Mey.) Whitetop

Silicles pubescent, longer than broad, more or less globose, not notched at the base.

One collection: Walworth Co.: on sandy soil at edge of field, Crane Farms, Williams Bay, July 1, 1941 [flower and young fruit] *Thomson s.n.* (WIS). Adventive from Europe.

7. CAPSELLA Medic.

1. Capsella bursa-pastoris (L.) Medic. Shepherd's Purse Map 9.

Erect annual, often much branched, to 4 dm tall, glabrous to somewhat hirsute. Rosette leaves highly variable, serrate or cleft to deeply pinnatifid. Cauline leaves sagittate-clasping, entire to serrate. Petals white, 2–4 mm long. *Silicles obcordate-triangular,* flattened contrary to the partition.

Very common and exceptionally weedy throughout the state, along roadsides, waste places, city streets, cultivated fields, open woods, pastures, etc. Naturalized from Europe. Flowering from late April through July, occasionally into October, and fruiting from mid-May through October.

8. CAMELINA Crantz. False Flax

Slender erect annuals, with simple stellate pubescence. Leaves linear to lanceolate, sagittate-clasping. Petals small, yellow; sepals erect. Silicles *obovoid* to pyriform, pointed, one-nerved, keeled at the sutures. Seeds numerous, small, elliptic to oblong.

Key to Species

1. Base of stem densely pubescent, the simple hairs projecting beyond the stellate hairs; silicles 5–7 (–8) mm long, about twice the length of the style ------------------------ 1. *C. microcarpa.*

1. Pubescence at the base of the stem appressed or lacking, or with few long simple hairs; silicles 7–12 mm long, about 3–4 times as long as the style ---------------------------------- 2. *C. sativa.*

1. CAMELINA MICROCARPA Andrz. False Flax Map 10.

Erect, simple or branching above, to 7 dm tall, rough-pubescent throughout with both simple and stellate hairs, the base of the stem with long simple hairs projecting beyond the stellate ones. Fruits about twice as long as the slender style, 5–7 (–8) mm long, 4–5 mm broad. Seeds brown, less than 1 mm long.

Occasional in waste places and along railroad embankments. Adventive from Europe. Flowering from mid-May through mid-June and fruiting from late June through mid-August.

Very similar to the following species, but separated by the smaller fruit size and the dense simple pubescence at the base of the stem. *C. sativa* may have a few simple hairs at the base, but these are neither dense nor spreading.

2. CAMELINA SATIVA (L.) Crantz Gold-of-Pleasure Map 11.

Stems to 9 dm tall, glabrous or with appressed stellate pubescence, occasionally with a few long simple hairs at the base. Silicles about 3–4 times as long as the style, 7–12 mm long, 5–7 mm broad. Seeds yellow-brown, 0.9–1.5 mm long.

Occasional in waste places and along railroads. Adventive from Europe. Flowering from mid-May through mid-July and fruiting from mid-June through early September.

BUNIAS ORIENTALIS L. is a tall, robust biennial, with simple upper leaves and lyrate-pinnatifid lower leaves, bright yellow flowers in slender glandular racemes, and ovoid, beaked, indehiscent silicles. One collection: Green Co.: In field along highway M, 1959, *Richards s.n.* (WIS). Adventive from Europe.

9. NESLIA Desv.

1. NESLIA PANICULATA (L.) Desv. Ball Mustard Map 12.

Slender erect annuals or biennials, to 6 dm tall. Leaves oblong to lanceolate, sagittate-clasping, the margins entire, wavy, or remotely serrate. Flowers pale yellow, in long racemes; petals 2–3 mm long. Silicles indehiscent, globose, very slighty flattened, 2–3 mm in diam.; style slender, 1 mm long; pedicels slender, divergent, 4–13 mm long. Seeds 1–2 per pod, nearly round.

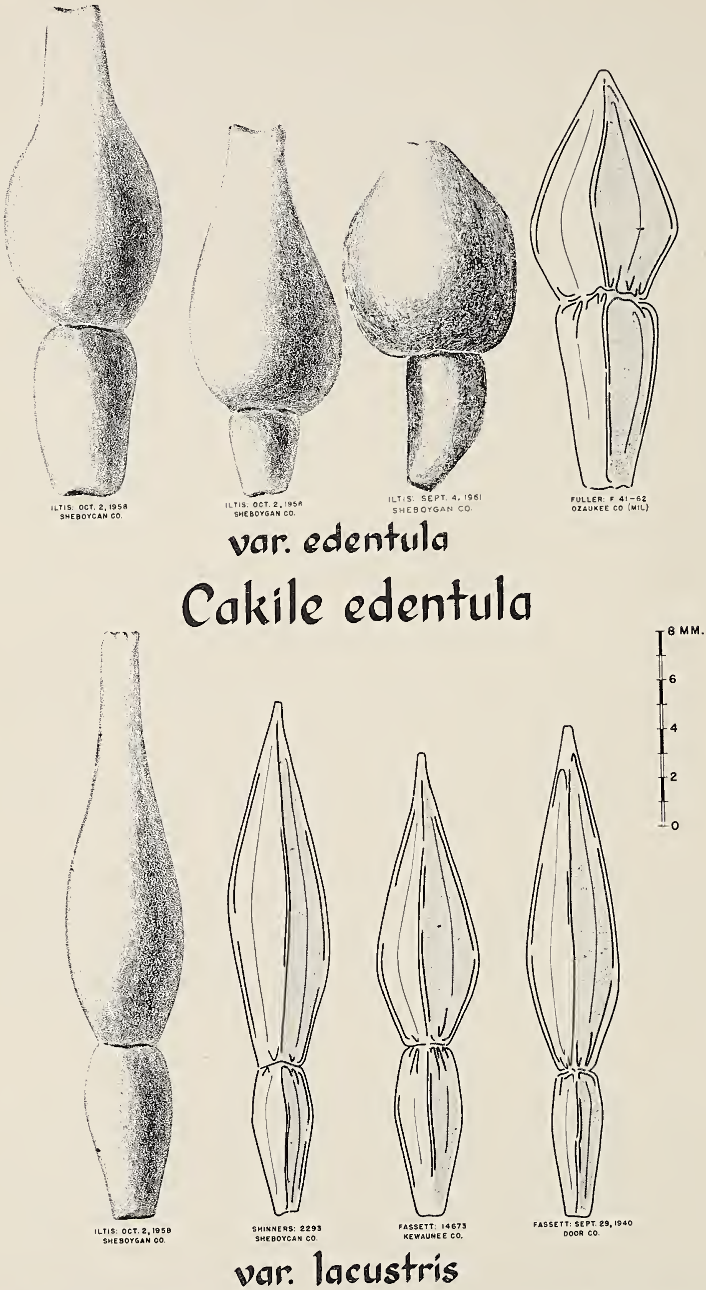


Figure 1. Fruits of Cakile: shaded drawings of fresh, line drawings of dried specimens.

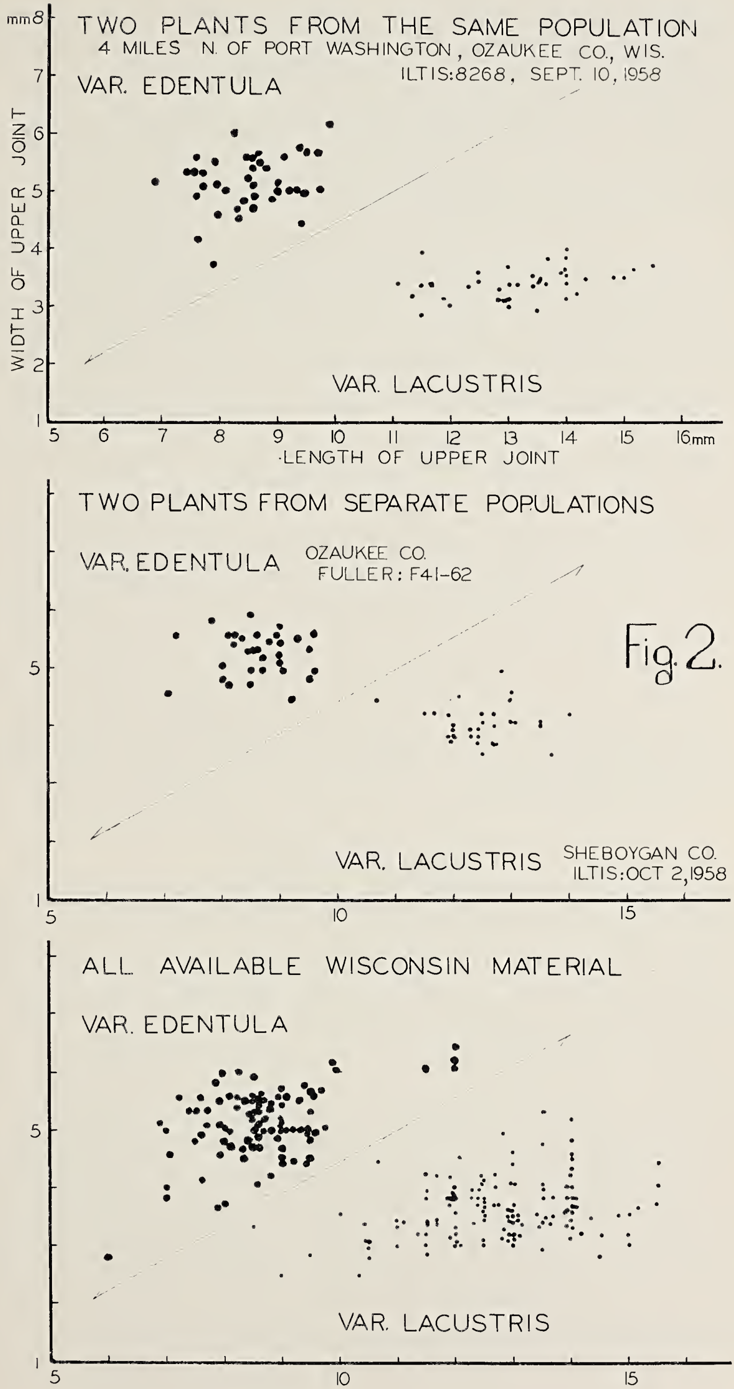

TWO PLANTS FROM THE SAME POPULATION
4 MILES N. OF PORT WASHINGTON, OZAUKEE CO., WIS.
ILTIS:8268, SEPT. 10, 1958
VAR. EDENTULA
VAR. LACUSTRIS
WIDTH OF UPPER JOINT
mm
LENGTH OF UPPER JOINT
TWO PLANTS FROM SEPARATE POPULATIONS
VAR. EDENTULA
OZAUKEE CO.
FULLER: F41-62
VAR. LACUSTRIS
SHEBOYGAN CO.
ILTIS:OCT 2,1958
ALL AVAILABLE WISCONSIN MATERIAL
VAR. EDENTULA
VAR. LACUSTRIS

Fig. 2.

Occasional in Wisconsin from waste places in cities. Adventive from Europe. Flowering from late May through early July and fruiting from late June through early August.

10. CAKILE Hill Sea Rocket

1. Cakile edentula (Bigel.) Hook. Sea Rocket
Map 13; figs. 1 & 2.

Erect, *glabrous* annuals, simple or much branched above, 5–60 cm tall. *Leaves fleshy,* obovate or oblanceolate, wavy-toothed and quite variable. Petals pale purple to nearly white, 6–8 mm long. Fruit a jointed, fleshy indehiscent transversally septate silique, the upper portion 6–15 mm long, 3–8 mm wide, often beaked, ovoid to lanceolate, the lower portion 2–8 mm long, 2–6 mm wide, often sterile and very small. Seeds elongate, red-brown, usually only one per joint.

A characteristic species of the Lake Michigan strand, especially on the upper sandy or gravelly beach (stormbeach), occasionally on dunes, often associated with the annual Chenopodiaceae *Salsola, Coriospermum,* and *Cycloloma,* as well as with *Potentilla anserina, Euphorbia polygonifolia,* etc., and at the base of dunes with *Ammophila, Calamovilfa, Agropyron,* and *Lathyrus maritimus.* A pioneer on the lower beaches, this is often the only species able to withstand the frequent disturbances due to rough waters. Flowering from early July through early September and fruiting from mid-July through late September.

Key to Varieties

1. Upper portion of silique broad, lance-ovoid to ovoid or subspherical, 7–10 (–12) mm long, 4–8 mm wide; pedicels 2–3 (–4) mm long ---------------------------------- 9a. var. *edentula.*

1. Upper portion of silique narrowly lanceolate, 9–16 mm long, (3–) 4–5 mm wide; pedicels (4–) 5–7 (–8) mm long ------------ -- 9b. var. *lacustris.*

The Great Lakes population was segregated from the typical East Coast variety by Fernald (cf. 1950) as var. *lacustris* Fern., "by the upper joint of the silicle ovoid-lanceolate, long beaked, its articulating surface with 2 deep and 4 shallow pits; articulating summit of lower joint with 2 long and 4 short subulate processes". The differences in the articulating surface appear to be very slightly if at all developed, and seem to be of next to no value in distinguishing the two varieties. Furthermore, contrary to Deam, and others, both varieties occur in Wisconsin, occasionally growing together (see insert, map 13), yet remaining very distinct morphologically (cf. fig. 2, graph 1).

Var. EDENTULA, the rarer of the two varieties in Wisconsin, has short, lance-ovoid to ovoid or even subspherical (!) siliques, while var. LACUSTRIS has elongate lanceolate fruits (fig. 1). When length and width of the upper silique joint are plotted on a graph (fig. 2), Lake Michigan plants show a *clear morphological separation into two taxa, which in Wisconsin at least seem to behave as two good species.* The taxa look different in the field, not only because of their distinctive fruits, but also because of inflorescence differences, var. *edentula* having fruits on shorter pedicels arranged in more congested racemes. The flowers and leaves seem identical. However, exploratory study has shown that when fruits of collections from along the St. Lawrence River and the East Coast are plotted on a graph, the position of the symbols falls approximately intermediate between those of the two Wisconsin varieties, these plants thus not separable into two clear-cut groups. The Cakile problem, currently under consideration, is certainly a fascinating one, whose solution will shed some light on the post-glacial migrations of vegetation from the eastern seabord to the Great Lakes.

11. RAPHANUS L. Radish

Coarse herbs with simple pubescence, the lower leaves pinnatifid. Petals large, broadly obovate. Silique cylindric, long-beaked, indehiscent, the stigma broad. Seeds spherical, in a single row.

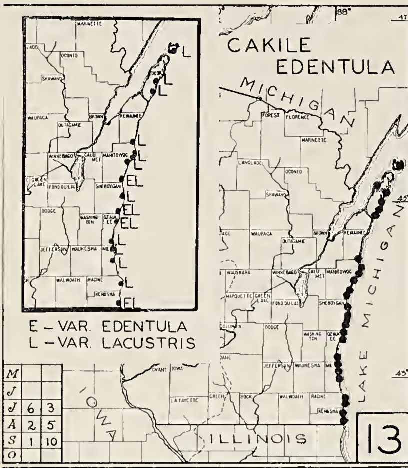
Key to Species

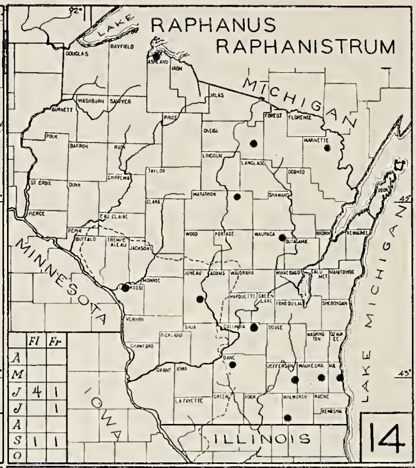
1. Silique linear, 4–5 mm broad, constricted around the seeds at maturity .... 1. *R. raphanistrum.*
1. Silique lance-oblong, 6–10 mm broad, not constricted around the seeds .... 2. *R. sativus.*

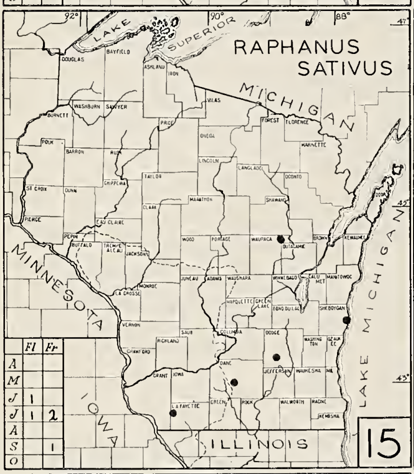
1. RAPHANUS RAPHANISTRUM L. Jointed Charlock; Wild Radish Map 14.

Erect annual, often much branched above, to 10 dm tall. Stem somewhat pubescent, rough at base, from a non-tuberous tap root. Leaves pinnatifid, variable, rough to the touch. Petals white or pale lemon yellow,[1] often dark veined, to about 2 cm long. Siliques to 5 cm long, strongly constricted around the seeds *at maturity.* Seeds oval, red-brown.

[1] Both colors may occur in the same population (*fide R. Schlising 1518* [WIS]). Contrary to Gleason (1952), the color differences in some populations appear to be genetic, and not due to fading with age.


CAKILE
EDENTULA
E – VAR. EDENTULA
L – VAR. LACUSTRIS
M
J
J 6 3
A 2 5
S 1 10
O
MICHIGAN
LAKE MICHIGAN
IOWA
ILLINOIS
13


RAPHANUS
RAPHANISTRUM
Fl Fr
A
M
J 4 1
J 1
A
S 1 1
O
MICHIGAN
MINNESOTA
LAKE MICHIGAN
IOWA
ILLINOIS
14


RAPHANUS
SATIVUS
Fl Fr
A
M
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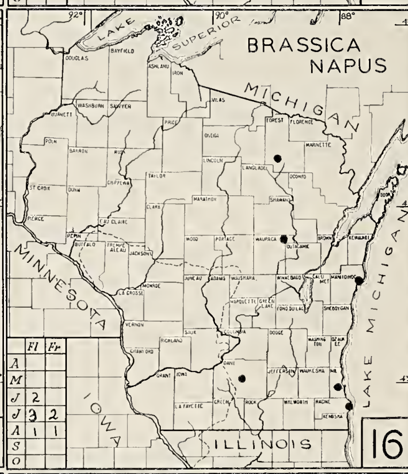
J 1 2
A
S 1
O
LAKE SUPERIOR
MICHIGAN
MINNESOTA
LAKE MICHIGAN
IOWA
ILLINOIS
15


BRASSICA
NAPUS
Fl Fr
A
M
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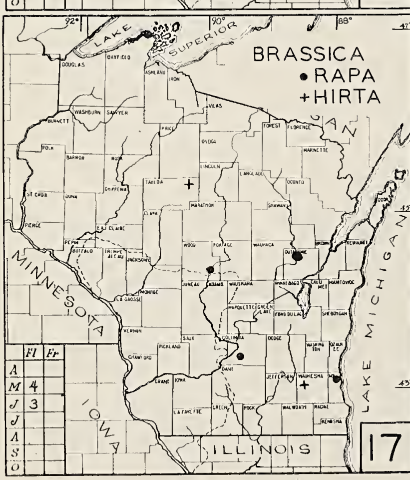
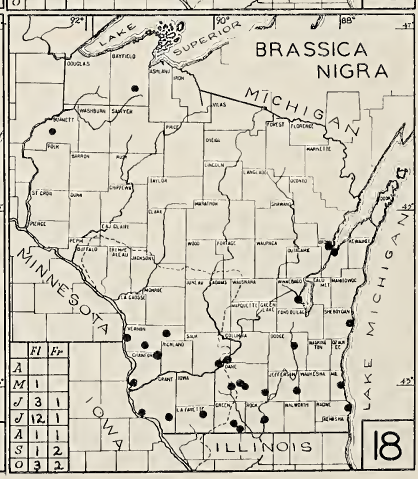
S
O
LAKE SUPERIOR
MICHIGAN
MINNESOTA
LAKE MICHIGAN
IOWA
ILLINOIS
16


BRASSICA
• RAPA
+ HIRTA
Fl Fr
A
M 4
J 3
J
A
S
O
LAKE SUPERIOR
MINNESOTA
LAKE MICHIGAN
IOWA
ILLINOIS
17


BRASSICA
NIGRA
Fl Fr
A
M 1
J 3 1
J 12 1
A 1 1
S 1 2
O 3 2
LAKE SUPERIOR
MICHIGAN
MINNESOTA
LAKE MICHIGAN
IOWA
ILLINOIS
18

Occasional along roadsides, railroads, cultivated fields and waste places, in sandy or gravelly soil. Naturalized from Europe. Flowering from mid-June on, and fruiting from late June through September.

2. RAPHANUS SATIVUS L. Radish Map 15.

Erect, much branched above, from a tuberous tap root. Leaves pinnatifid, the basal ones long-petioled. Petals white to pink-purple, not dark veined, to 13 mm long. Silique lance-oblong, spongy within, not constricted around the seeds.

Occasionally escaping from cultivation, along roadsides and in waste places. Native of Europe. Flowering from late June through late July and fruiting from late July.

RAPHISTRUM RUGOSUM (L.) All. is a slender annual or biennial weed with the siliques transversely two-jointed, their upper portion 8-ribbed, globose, and with a slender beak. One collection: Milwaukee Co.: Milwaukee, Courthouse Square, Sept. 5, 1939 [in flower and fruit], *Shinners 1478* (WIS). Adventive from Europe.

12. BRASSICA L. CABBAGE; MUSTARD; TURNIP

Erect annuals, the lower leaves often incised, pinnatifid or lyrate. Petals yellow, spatulate, 6–15 mm long. Siliques round to four-sided, with a stout, seedless or one-seeded, indehiscent beak, the valves 1- to 5-nerved. Seeds usually globose, in a single row in each locule. Including *Sinapis* L. All species are highly variable due to their long history in cultivation and as weeds.

KEY TO SPECIES

1. Leaves all clasping; stems of mature plants glabrous ________ 2
    2. Root thick and fleshy; young buds slightly overtopping the open flowers; petals generally bright yellow, 6–11 mm long ______________________________ 1. *B. napus.*
    2. Root slender; young buds below the open flowers; petals pale yellow, 12–15 mm long ______________________________ 2. *B. rapa.*
1. Lower leaves petioled, the upper sessile to somewhat clasping; stems glabrous to hispid throughout ______________________________ 3
    3. Uppermost leaves entire or occasionally serrulate, oblong to lance-linear; beak of silique slender, 4-angled to round in cross-section, not 2-edged, 1-nerved or nerveless on each side, seedless_4
        4. Fruits, 8–22 mm long, appressed to the stem; plants more or less hirsute, green ______________________________ 3. *B. nigra.*
        4. Fruits 30–50 mm long, the pedicels ascending-divergent; plants mainly glabrous and glaucous __________ 4. *B. juncea.*

3. Uppermost leaves pinnatifid or toothed, often ovate to lanceolate; the beak of the silique stout, flattened and 2-edged, 3-nerved, often with one seed in the indehiscent locule ________________ 5
   5. All leaves strongly pinnatifid; fruits not ridged, constricted around the seeds the very long flat beak longer than the densely bristly body of the silique; rare in Wisconsin ____ 5. *B. hirta.*
   5. Only lower leaves pinnatifid or all the leaves toothed; fruits with longitudinal ridges, not strongly constricted around the seeds, the short 4-angled flattened beak about half as long as the glabrous or slightly hairy body of the silique; very common in Wisconsin ________________________________ 6. *B. kaber.*

1. BRASSICA NAPUS L. Turnip Map 16.

Brassica rapa L. of Gleason (1952), Bailey (1949), and other authors.

Erect, robust, often branching above; stems glabrous, arising from a thickened tuber-like base. *Leaves clasping,* entire to remotely toothed. Petals generally bright yellow, 6–11 mm long. Young buds above the open flowers, the inflorescence convex in outline. Siliques 4–8 (–10 ?) cm long, on widely divergent pedicels.

A rare weed of waste places, occasionally persistent after cultivation. Adventive from Europe. Flowering from earliest June through mid-August and fruiting from late June through September.

2. BRASSICA RAPA L. Field Mustard; Navette; Rape Map 17.

Brassica campestris L. of Gleason (1952), and other authors.
Brassica campestris L. var. *rapa* of authors.

Very similar to and easily confused with *B. napus.* Young stems with scattered hairs; roots neither swollen nor fleshy. Petals pale yellow, 12–15 mm long, about twice the length of the sepals. Young buds below the open flowers, the inflorescence thus concave in outline.

A rare weed of fields and waste places. Adventive from Europe. Flowering from late April through June.

3. BRASSICA NIGRA (L.) Koch Black Mustard Map 18.

Erect, widely branching, to 15 dm tall. Stems hirsute, especially below, often glaucous above. Lower leaves with a large terminal lobe and several smaller ones, the upper leaves lance-linear, entire or minutely serrulate; all leaves petioled. Petals yellow 6–8 mm long, with well-marked strong veins. *Siliques 8–22 mm long,* square in cross section, *closely appressed to the stem,* often somewhat overlapping; *pedicels short.* Seeds globose, dark brown.

A weed of waste ground, roadsides, cultivated fields, railroad embankments, farm yards, often in moist soil near disturbed streams. Naturalized from Europe. Flowering from late May through mid-October and fruiting from early June through October.

This species, in young fruit, is easily confused with *B. kaber,* from which it may be separated by the linear, entire upper leaves; and with *B. juncea,* which is nearly glabrous and which has long, divergent pedicels when in fruit.

4a. BRASSICA JUNCEA (L.) Coss. var. JUNCEA
Leaf Mustard; Brown Mustard; Indian Mustard. Map 19.

Erect, simple or branched above, to 12 dm tall. *Stems glabrous to somewhat hispid below, often glaucous above.* Lower leaves lyrate-pinnatifid, petioled, irregularly toothed or serrate, the upper leaves oblong to linear, entire. Petals pale to deep yellow, 5–10 mm long. *Siliques 3–5 cm long, 4-angled at maturity,* the valve midrib prominent, the valves somewhat constricted around the seeds, the beak slender. Seeds globose, red-brown, somewhat ridged.

An occasional weed of waste ground, fields, and railroad embankments. Adventive from Europe. Flowering from mid-June through mid-September and fruiting from late June through September.

4b. BRASSICA JUNCEA var. CRISPIFOLIA Bailey Curled Mustard.

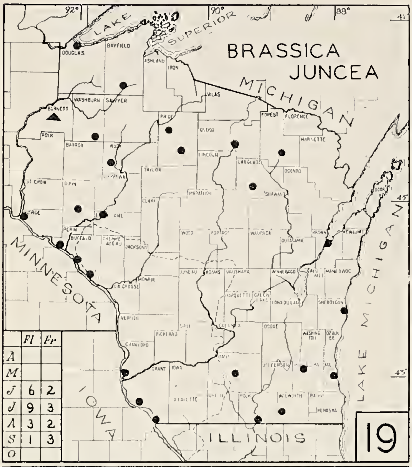
Leaves deeply laciniate and curled. This variety is occasionally cultivated for greens.

Sauk Co.: Prairie du Sac, *Smith 53871* (MIL). Milwaukee Co.: Milwaukee, 1941, *Goessl s.n.* (WIS); Milwaukee, cultivated, 1842, *Coll. unknown* (WIS). Introduced from Europe.

5. BRASSICA HIRTA (L.) Moench. White Mustard Map 17.
Brassica alba Gray

Widely branching, to 9 dm tall. Stems ridged, lightly pubescent with simple hairs. Leaves lyrate-pinnatified, pubescent along the veins. Petals generally pale yellow, about 1 cm long. Fruits 25–35 mm long, the valves constricted around the seeds at maturity, the *body heavily pubescent with long stiff white hairs,* about half as long as the *very long flattened beak; pedicels horizontally divergent.* Seeds pale brown.

A rare weed of waste places. Adventive from Europe. Taylor Co.: Rib Lake, waste ground, Sept. 27, 1915 [in flower with immature fruits]. *Goessl 37669* (MIL). Waukesha Co.: along R.R. between Hartland and Pewaukee, July 4, 1947 [in fruit], *Cull 892* (WIS).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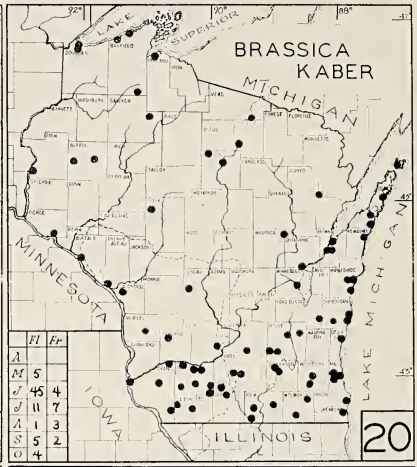
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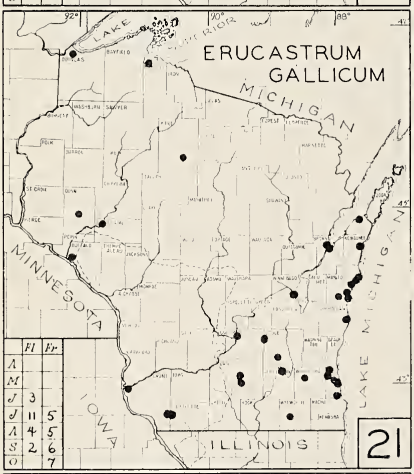
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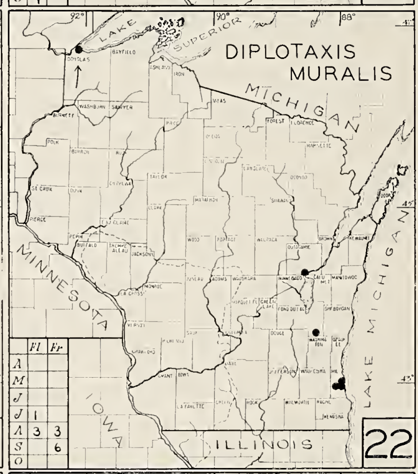
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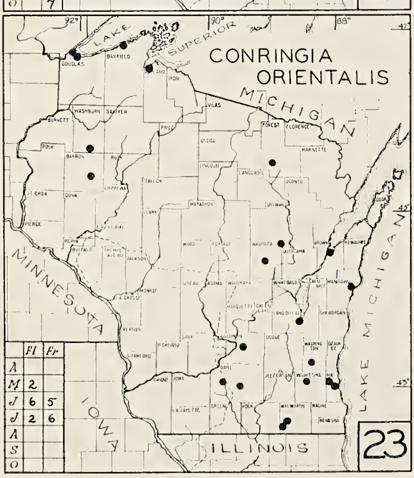
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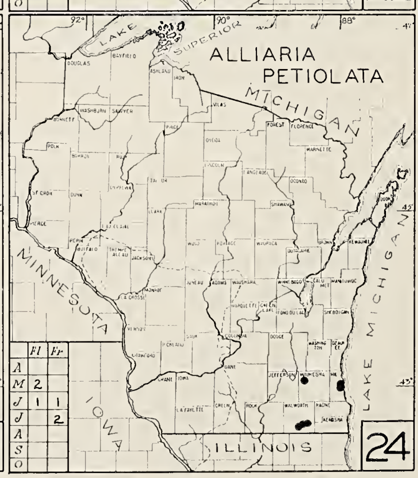
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24

6. Brassica kaber (DC.) Wheeler var. pinnatifida (Stokes) Wheeler Crunch Weed; Charlock Map 20.

Sinapis arvensis L.
Brassica arvensis (L.) Rabenh., not L.

Erect, simple to somewhat branched, to 9 dm tall, *coarse, the lower stem heavily pubescent with stiff white hairs.* Lower leaves obovate, lyrate-pinnatifid, or more often with margins only irregularly serrate to dentate; upper leaves oblong to ovate or rhombic, nearly sessile. Petals yellow, 9–12 mm long. *Fruiting pedicels thick, 2–5 (–6) mm long.* Mature fruits 2–4 cm long, with strong longitudinal ribs, not much constricted around the seeds, the short 4-angled beak flattened, 3-nerved, about half as long as the glabrous or slightly bristly body of the silique. Seeds red-brown.

A common weed of cultivated fields, pastures and waste places. Naturalized from Europe. Flowering from mid-May through mid-October and fruiting from mid-June through October.

At any given locality, *Barbarea vulgaris* flowers earlier, coloring the fields golden yellow. Later in the season, from late spring to the middle of the summer, the same fields may still be yellow, but then with *Brassica juncea*, or, more commonly, *B. kaber.*

13. ERUCASTRUM Presl

1. Erucastrum gallicum (Willd.) O. E. Schulz Map 21.

Erect, simple or branching annual or biennial, to 8 dm tall. Stems pubescent with simple hairs. Leaves rough-textured, oblong, pinnatifid with deep, rounded sinuses. Petals pale yellow, 7–8 mm long, the sepals about 5 mm long. Siliques 2–3 cm long, 1–2 mm broad, ascending on widely divergent pedicels. Seeds ellipsoid, red-brown, less than 1 mm long.

Scattered, though locally abundant especially in SE Wisconsin, in waste places, railroad yards, along roadsides, and on sandy beaches, especially of Lake Michigan. Naturalized from Europe. Flowering from late June through early September, and fruiting from early July through late October.

14. DIPLOTAXIS DC.

1. Diplotaxis muralis (L.) DC. Map 22.

Erect annual, branching from the base, 1–5 dm tall, hispid below. Leaves near the base only, toothed to pinnatifid, 3–8 cm long. Petals pale yellow, 5–6 mm long, about twice the length of the acute, green sepals. Siliques 2–4 cm long, 2–4 mm broad; pedicels divergent, 1–2 cm long; stigma broad. Seeds rounded, red-brown, in a double column in each locule.

A rather rare weed of railroad yards and city streets. Naturalized from Europe. Flowering from early July though August and fruiting from early August through September.

15. CONRINGIA Link

1. Conringia orientalis (L.) Dumort. Hare's-ear Mustard Map 23.

Erect annuals, to 6 dm tall, *glabrous* and glaucous, sometimes branched above. Leaves elliptical, *strongly auriculate-clasping,* simple, entire to slightly wavy. Petals cream or pale yellow, 6–10 mm long, the sepals 4–6 mm long. Siliques 4–11 cm long, four-angled, erect, on divergent pedicels 5–20 mm long. Seeds elliptic, deep brown.

Occasional in waste places, along railroads, on borders of cultivated fields, and on beaches of Lake Michigan. Naturalized from Europe. Flowering from mid-May through mid-July and fruiting from early June through July.

This species has been confused with *Brassica rapa* and *B. napus,* but may be separated by the oblong, broadly rounded, entire leaves, and the absence of basal rosettes.

16. ALLIARIA B. Ehrh.

1. Alliaria petiolata Cav. & Grande Garlic Mustard Map 24.
Alliaria officinalis Andrz.

Erect, simple branched, robust annuals to 12 dm tall, glabrous or with simple pubescence at the base. Leaves cordate, deltoid-ovate, with regularly dentate margins. Petals white, 3–4 mm long. Siliques 3–5 cm long, spreading; pedicels short, thick. Seeds brown, elongate, 10–18 in a single row.

Occasional in southeastern Wisconsin, in sand or gravel, at the base of bluffs, along roadsides, or on sandy beaches. Naturalized from Europe. Flowering from mid-May through early June and fruiting from late May through mid-July.

17. SISYMBRIUM L.

Erect annuals, glabrous or with simple hairs; leaves pinnatifid. Petals yellow, small. Siliques linear, cylindric or long-subulate; valves nerved; stigma 2-lobed. Seeds oblong, in one row in each locule, smooth.

Key to Species

1. Leaflets of upper leaves linear, rarely more than 2 mm broad; fruits widely divergent, 6–10 cm long; petals pale yellow -- 1. *S. altissimum.*
1. Leaflets of upper leaves angularly toothed, the terminal segment ovate or elliptic; fruits closely appressed to the stem, 1–2 cm long; petals deep yellow ---------------------------- 2. *S. officinale.*

1. Sisymbrium altissimum L. Tumble-Mustard Map 25.

Loosely branching, to 10 dm tall. Leaves pinnatifid with long linear segments. Petals 5–8 mm long, pale lemon yellow; sepals 3–5 mm long. Fruits widely divergent, 6–10 cm long.

Common throughout the state, along roadsides, waste places, in cinders along railroads, borders of and in cultivated fields and in sandy prairies. Naturalized from Europe. Flowering from mid-May through early September and fruiting from late June through late September.

2. Sisymbrium officinale (L.) Scop. Hedge-Mustard

Erect from a taproot, loosely branched above, to 12 dm tall. Stem pubescent with simple hairs. Leaves pinnatifid, the terminal segment ovate or elliptic and toothed. Petals to 4 mm long, deep yellow; sepals less than one-third the length of the petals. Fruit 10–17 mm long, closely appressed to the stem; pedicels 2–3 mm long.

2a. Sisymbrium officinale var. officinale Map 26.

Racemes, pedicels and fruits with *dense, soft pubescence.*

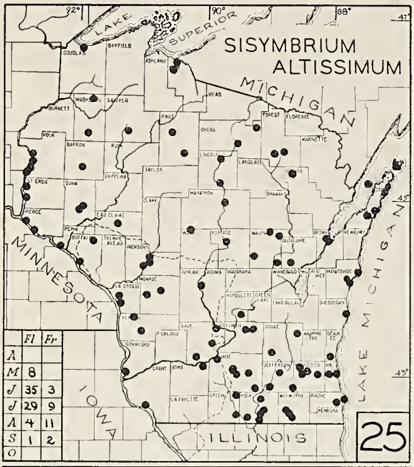
Less common than the following variety, mainly in southern Wisconsin. A weed of waste places and pastures. Introduced from Europe. Flowering from early July through mid-August and fruiting from early July through August.

2b. Sisymbrium officinale var. leiocarpum DC. Map 27.

Racemes, pedicels and fruits *glabrous or with few scattered hairs;* plants somewhat greener.

A common weed throughout Wisconsin in waste places, along railroads, roadsides, and in pastures and borders of cultivated fields. Naturalized from Europe. Flowering from late May through mid-September and fruiting from early June through late October.

Sisymbrium loeselii L., a to 1 m tall, often robust herb with pilose-hirsute stems, deeply lyrate-pinnatifid essentially glabrous leaves, greatly elongating inflorescences with yellow petals about 6 mm long, and narrowly *linear widely divergent siliques 17–28 mm long and about 2 or 3 times as thick as the pedicels* (and thickest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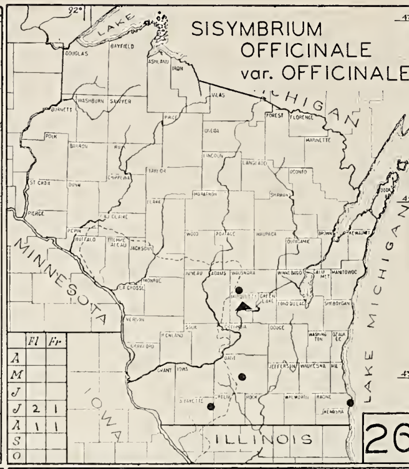
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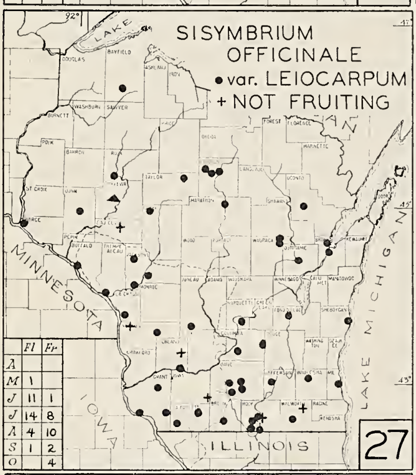
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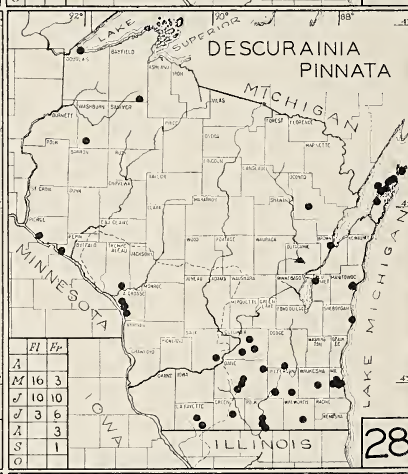
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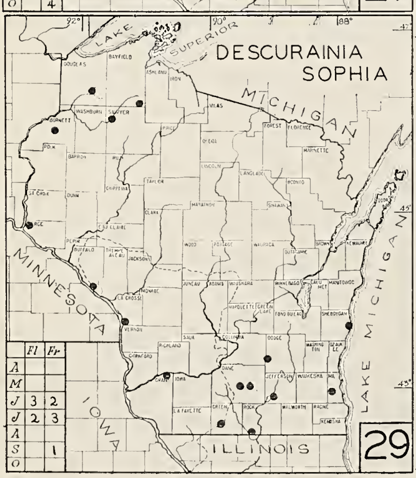
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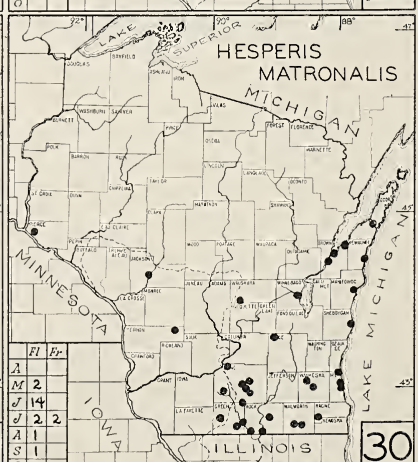
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near the base), has been collected once as a weed in cold frames behind the Horticulture Greenhouses, University of Wisconsin, Madison, August 6 [fl. & fr.], 1961, *Iltis s.n.* (WIS). This Eurasian weed, common in Canada and the western U.S. and occasionally in the NE U.S., can be expected to spread in Wisconsin.

18. DESCURAINIA Webb. & Berthelot Tansy Mustard

[Detling, L. E. 1939. A revision of the North American species of *Descurainia*. *Am. Midl. Nat.* 22:481–520.]

Erect annuals, the stems canescent or with distinct glandular hairs. Leaves uni-, bi-, or tri-pinnate. Petals yellow, about 2 mm long. Fruit a straight or clavate silique, the valves faintly one-nerved. Seeds elliptic or oblong, in one or two rows in each locule.

Key to Species

1. Stems pubescent and glandular; siliques 6–10 mm long, club shaped; leaves once or twice pinnate ______________________________ 1. *D. pinnata* var. *brachycarpa*.

1. Stems lightly appressed pubescent to canescent, but never glandular; siliques linear, 12–21 mm long; leaves twice or three times pinnate ______________________________________ 2. *D. sophia*.

1. Descurainia pinnata (Walt.) Britt. var. brachycarpa (Richards) Fern. Tansy Mustard Map 28.

Sisymbrium canescens Nutt. var. *brachycarpa* (Richards) Fern.

Erect, to 7 dm tall, often branched above; stems glandular throughout, often also appressed pubescent. Leaves pinnate or bipinnate. Petals pale yellow. Siliques 6–10 mm long, narrowly clavate; pedicels slender, divergent. Seeds small, red-brown, ovoid, in two rows in each locule.

Frequent, mainly in southern Wisconsin, in sandy places, along beaches and waste places, most commonly along railroad embankments. Flowering from early May through early July and fruiting from mid-May through September.

2. Descurainia sophia (L.) Webb. Herb Sophia Map 29.

Similar to *D. pinnata;* stems lightly appressed pubescent to canescent. Leaves twice to three times pinnate. Siliques 12–21 mm long, 1 mm wide, linear. Seeds in one row.

Occasional as a weed of farmyards, railroad embankments and roadsides. Naturalized from Europe. Flowering from mid-June to mid-July and fruiting from late June through early September.

19. HESPERIS L.

1. Hesperis matronalis L. Dame's Violet; Dame's Rocket; Mother-of-the-Evening Map 30.

Erect perennials or biennials, pubescent throughout, generally rough to the touch, leaves simple, lanceolate, sessile or short-petiolate, the margins nearly entire or minutely toothed. Petals purple to pink, sometimes white, showy, to 2 cm long; sepals elliptic with watery margins. Silliques to 14 cm long, constricted between the elliptic dark brown to black seeds.

Frequently cultivated for its showy flowers and evening fragrance, and escaping along roadsides, railroads, fields and city streets, and occasionally in woods. Introduced from Europe. Flowering from late May through mid-July (one specimen September 20), and fruiting from mid-June to August.

Malcolmia maritima R. Br., the "Virginia Stock", is a low annual, to about 2 dm tall, pubescent throughout with appressed forked and stellate hairs, with petiolate leaves and white or purple flowers. It is occasionally cultivated as an ornamental and has escaped in Dane Co.: roadside, *Steinhoff 50* (WIS); streambank, Manitou Way, Madison, 1958, *Stromberg s.n.* (WIS).

Iodanthus pinnatifidus (Michx.) Steud. is a tall, robust, glabrous annual with auricled, serrate cauline leaves and purplish flowers. There is one, doubtfully native, collection from Wisconsin: Waukesha Co.: Hunters Lake, vicinity of Dousman [in flower and young fruit], 1942, *Schenk s.n.* (WIS). This may have been introduced from Illinois where it is frequent, from the central part southward, along river banks and in alluvial soils.

20. ERYSIMUM L. Treacle Mustard

Erect weedy annuals or perennials, simple to much branched, pubescent with closely appressed, stellate or two-parted hairs. Leaves simple, linear to lanceolate, entire or nearly so. Petals yellow or orange; ovary pubescent, the style short. Fruits linear, four-angled, with a strong midvein. Seeds numerous, oblong, in a single row in each locule.

Key to Species

1. Petals 15–23 mm long, bright yellow or orange; fruits 4–10 cm long; rare -- 1. *E. asperum.*
1. Petals 3–8 mm long; fruits 1–4 cm long ------------------ 2
   2. Pedicels slender, widely diverging; petals bright yellow to orange; leaves lance-linear to broadly lanceolate, green, minutely stellate-pubescent ---------------------- 2. *E. cheiranthoides.*

2. Pedicels, when mature, stout and stiff and nearly as broad as the fruit, strongly ascending; petals lemon-yellow; leaves linear, gray-green with appressed, mostly two parted hairs ---------- -- 3. *E. inconspicuum.*

1. ERYSIMUM ASPERUM (Nutt.) D.C. Western Wallflower Map 31.

Erect, 2–4 dm tall, appressed-pubescent nearly throughout. Cauline leaves linear to lance-linear, entire to repand toothed. *Petals bright yellow to orange, 15–23 mm long;* pedicels 5–7 mm long. Siliques linear, strongly keeled and 4-angled.

Rarely introduced in Wisconsin from the western U.S. Bayfield Co.: headwaters of the Marengo River, *Knowlton 72197* (MIL). Grant Co.: along railroad embankment, Wyalusing, 1958, *Hartley 4479* (WIS). Waupaca Co.: Marion, along railroad, *Goessl s.n.*, 1915 (WIS). Flowering in early June and fruiting in mid-July.

2. ERYSIMUM CHEIRANTHOIDES L. Wormseed Mustard Map 32.

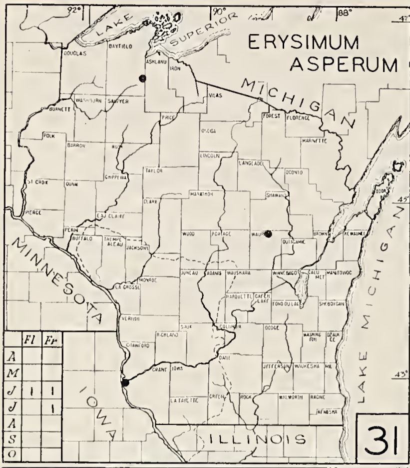
Erect annual or winter annual, simple to much branched above, to 10 dm tall; stems appressed-pubescent. Leaves lance-linear to broadly lanceolate, entire to repand-toothed, minutely stellate-pubescent. *Petals bright yellow to orange, 3–5 mm long;* pedicels slender, widely diverging, 5–13 mm long. Siliques linear, 1–2 (–3) cm long; stigma only slightly notched.

Very common throughout the state, mainly in sandy places, along shores of lakes and rivers, on sand bars and islands, often in prairies, less commonly on sandstone or limestone cliffs, wooded slopes, marshes, often weedy along roadsides, railroads, waste places, farmyards, pastures, and in cultivated fields. Adventive from Eurasia. Flowering from early May through mid-October and fruiting from early June through early November.

3. ERYSIMUM INCONSPICUUM (Wats.) MacMillan Map 33.

Erect, appressed-pubescent perennial, often branched above, to 6 dm tall. Leaves linear, mostly entire. *Petals lemon-yellow, 5–7 mm long,* the sepals about 4 mm long, stiffly erect. Siliques 2–4 cm long, heavily appressed-pubescent; stigma conspicuously capitate, two-parted; pedicels nearly as broad as the fruits, about 4–6 (–8) mm long.

Frequent in dry open places, often on cinders and ballast along railroad embankments, occasionally on bluffs and in waste places. Flowering from early June through mid-July and fruiting from mid-June until early August.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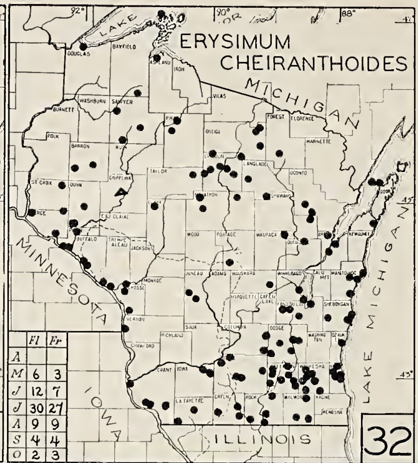
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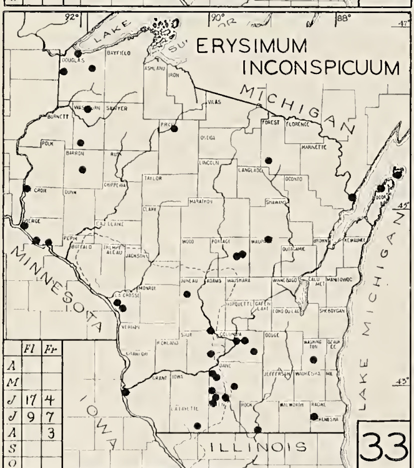
M 6 3
J 12 7
J 30 27
A 9 9
S 4 4
O 2 3
32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LAKE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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M
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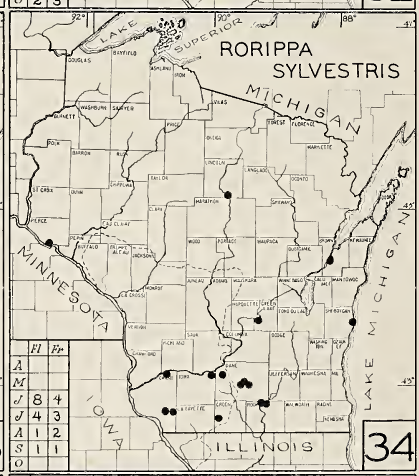
J 9 7
A 3
S
O
33


RORIPPA SYLVESTRIS
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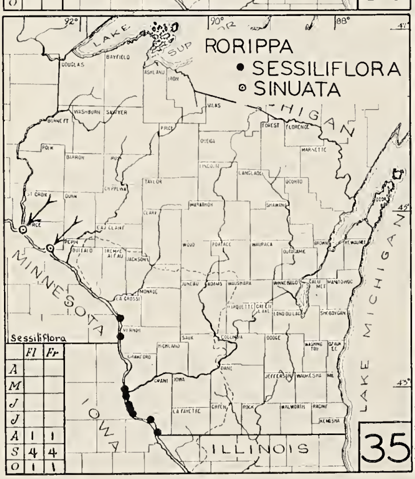
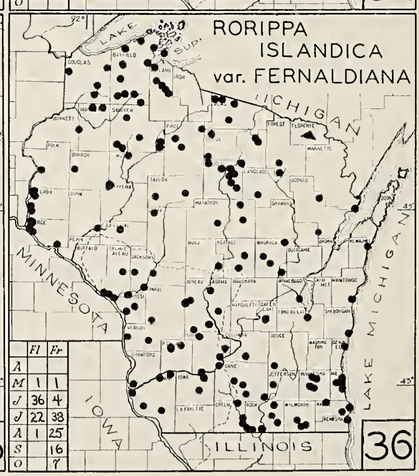
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 8 4
J 4 3
A 1 2
S 1 1
O
34


RORIPPA
• SESSILIFLORA
⊙ SINUATA
LAKE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Sessiliflora
Fl Fr
A
M
J
J
A 1 1
S 4 4
O 1 1
35


RORIPPA ISLANDICA var. FERNALDIANA
LAKE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M 1 1
J 36 4
J 22 38
A 1 25
S 16
O 7
36

21. RORIPPA Scop. Yellow Cress, Yellow Watercress

Annuals or perennials. Leaves pinnate or pinnatifid. *Petals yellow, small;* pedicels divergent, generally short and slender. Fruit a short silique or *silicle, terete* or nearly so. Seeds numerous, small, wingless, in two rows in each locule; *Radicula* Hill; *Nasturtium* of many authors, not R. Br.

Key to Species[1]

1. Petals 4–6 mm long, exceeding sepals ____________________ 2
   2. Plants much branched, 1–2 (–3) dm tall; stem with oblongoid to subspheroid hairs; all leaves with rounded sinuses, none cleft to the rachis (rare) _________________________ 1. *R. sinuata.*
   2. Plants often simple, slender, 2–5 (–6) dm tall; stem with slender or only slightly inflated hairs; leaves deeply pinnatifid, often to the rachis, the lateral leaflets of upper leaves linear _____________________________________ 2. *R. sylvestris.*
1. Petals 1–2 (–3) mm long, equalling or shorter than the sepals 3
   3. Pods, except the lowermost, sessile or nearly so; style short, knobby; leaves mostly oblong-ovate; stem glabrous; only along Mississippi River _________________________ 3. *R. sessiliflora.*
   3. Pods on filamentous and divergent pedicels; style slender; leaves mostly lance-ovate ____________________ 4. *R. islandica.*

1. Rorippa sinuata (Nutt.) Hitchcock Map 35.

Perennial with underground rhizomes, much branched and spreading ascending, 1–3 dm tall. Stem pubescent with oblongoid to subspheroid hairs. Leaves oblong or elliptic-lanceolate, 2–5 cm long, with regularly sinuate margins like an oak leaf. Petals pale yellow, 4–6 mm long, exceeding the sepals. Fruit cylindric to lanceolate, curved at maturity, 7–15 mm long, the style and pedicels both quite slender.

Only two collections (MIL) from Wisconsin from near the Mississippi River in Pierce County. Introduced from the western U.S., where it is widespread in bottomlands, roadsides, fields, and along sandy or rocky shores. Flowering and fruiting in July and August.

2. Rorippa sylvestris (L.) Besser Creeping Yellow Water Cress Map 34.

Perennial with underground rhizomes. Stems erect, slender, often weak and branched, to 5 (–6) dm tall, with scattered short stiff hairs mostly near the base. Leaves oblong-elliptic, pinnatifid to the rachis; leaflets generally toothed or serrate, the lateral ones of the

[1] Rorippa austriaca (Crantz) Besser is reported from Wisconsin by Fernald (1950), Gleason (1952), and C. L. Wilson (1927). There are no voucher specimens for these reports, and this species apparently does not occur in Wisconsin.

upper leaves mostly linear. Petals yellow, 4–5 mm long, exceeding the sepals. Pedicels slender, divergent, 5–10 mm long. Fruits linear, 5–13 mm long.

Occasional, in moist places in the southern part of the state, along sandy or gravelly shores of lakes or rivers, often weedy in ditches, low fields and waste places. Introduced from Europe. Flowering from mid-June, fruiting from July through September.

3. RORIPPA SESSILIFLORA (Nutt.) Hitchcock
Sessile-Flowered Watercress Map 35.

Annual or biennial, glabrous, often much branched from the base, 10–35 cm tall. Leaves oblong-ovate, crenate to pinnatifid, but rarely cleft to the rachis. Petals pale yellow, to 1 mm long, shorter than sepals. *Fruits plump,* 5–12 mm long, 1–3 mm broad, *sessile* except for the lowest; style capitate; seeds minute, ca. 200 per fruit, red brown.

Mud flats of the Mississippi River, from Grant to La Crosse Counties. Flowering and fruiting from mid-August to mid-October.

This species is here at the northern limit of its range. In Grant County it is fairly common, occurring continuously to the Illinois state line. There seems every reason to believe that the lack of specimens from northern Illinois, which results in a 100 mile disjunction (cf. Jones and Fuller, 1955), is due to lack of collecting, and not due to some "historical factor" related to glaciation and the unglaciated "Driftless Area."

4. RORIPPA ISLANDICA (Oeder) Borbas Marsh Cress, Yellow Watercress Maps 36, 37
Rorippa palustris (L.) Bess.

Annual or biennial, simple or widely branching, to 10 dm tall. Leaves quite variable, mostly lance-ovate, pinnate or pinnatifid, variously toothed. Petals yellow, 1–2 mm long, shorter than the sepals. Fruits ellipsoid to sub-globose, inflated, 2–5 (–7) mm long, on slender divergent pedicels; seeds ca 40–60, small.

KEY TO VARIETIES

1. Stem glabrous or occasionally hispid below
______________________________ 4a. *R. islandica* var. *fernaldiana.*
1. Stem hispid nearly throughout with stiff spreading hairs
_________________________________ 4b. *R. islandica* var. *hispida.*

4a. RORIPPA ISLANDICA var. FERNALDIANA Butters & Abbe Map 36.
Rorippa hispida (Desv.) Britt. var. *glabrata sensu* Fernald (1928), not Lunell (1908).

Stems glabrous throughout or somewhat hispid below only. Fruits slightly larger than in var. *hispida,* 3.0–6.4 mm long, averaging 4.3 mm long *(fide* Butters & Abbe, 1940).

Common throughout the state in moist or wet places, on sandy, rocky, or muddy river and lake shores, in mucky sloughs, sedge meadows, wet prairies, marshes with *Sagittaria* and *Typha,* often weedy along wet roadsides, railroads, old fields and in waste places. Flowering in the southern part of the state in late May, northward from mid-June through July and fruiting in late May in the south, mostly from mid-June to October in the north.

4b. RORIPPA ISLANDICA var. HISPIDA (Desv.) Butters & Abbe
Rorippa hispida (Desv.) Britt. Map 37.

Stem hispid throughout with simple, stiff white hairs. Fruits 2.2–4.6 mm long, averaging 3.4 mm long (*fide* Butters & Abbe, 1940).

Infrequent but widespread throughout the state, in open, sandy or mucky, wet soil, particularly in sedge meadows, borders of bogs, wet marshy places, often along the muddy shores of lakes and rivers. Flowering from mid-June through August and fruiting from early July into October.

22. NASTURTIUM R.BR. WATER CRESS

1. NASTURTIUM OFFICINALE B.Br. Water Cress Map 38.

Free-floating or creeping emergent aquatic, glabrous to sparingly pubescent with simple hairs. Leaves pinnate, the leaflets narrowly elliptic to rounded. *Petals white,* 3–5 mm long. Pedicels widely divergent, to 25 mm long; fruits ascending 10–27 mm long, linear, plump, often curving. Seeds in a double row in each locule.

Mainly in southern Wisconsin, most frequent in or along springs, and shallow, clear running streams, in roadside and drainage ditches, cattail marshes, sloughs, and less commonly along lake shores, often forming extensive and pure colonies. Flowering from late May through mid-October and fruiting from earliest July through mid-October.

23. ARMORACIA GAERTN.

Perennials with deep tap roots or with rhizomes. Flowers white. Silicles subglobose, obovoid or ellipsoid, the valves nerveless. Seeds wingless, in two rows in each locule.

KEY TO SPECIES

1. Plants aquatic; submerged leaves finely dissected
-- 1. *A. aquatica.*
1. Plants terrestial; basal leaves oblong-ovate, long-petiolate
-- 2. *A. rusticana.*

1. ARMORACIA AQUATICA (A. Eaton) Wieg. Lake Cress Map 39.

Neobeckia aquatica (A. Eaton) Greene
Radicula aquatica (A. Eaton) Robinson

Aquatic with the appearance of *Proserpinaca* or *Myriophyllum*. *Submerged leaves finely pinnately divided into linear or filiform segments;* upper leaves lanceolate, the margins serrate. Petals white, 5–7 mm long; sepals 5 mm long. Silicles somewhat flattened, to 1 cm long, 3–4 mm broad; beak slender; pedicels slender, divergent.

Only three specimens from Wisconsin: Brown Co.: Green Bay, 1891, *Schuette 38887* (WIS). Green Lake Co.: in 15 ft. of water, Green Lake, 1921, *Rickett s.n.* (WIS). Lincoln Co.: submersed in quiet water, Tomahawk, 1915, *Goessl 2651* (MIL); to be expected elsewhere, since its rarity may be due to the difficulty with which this species is collected.

2. ARMORACIA RUSTICANA Gaertn. Horse-Radish Map 39.

Erect robust annual, 5–10 dm tall, from a thickened and deep tap root. Stems glabrous or hispid below. Basal leaves to 3 dm long; cauline leaves numerous, with crenate margins. Petals white, 5–7 mm long. Silicles elliptic, 3–4 mm long, with swollen bases; pedicels slender, spreading, 5–8 mm long.

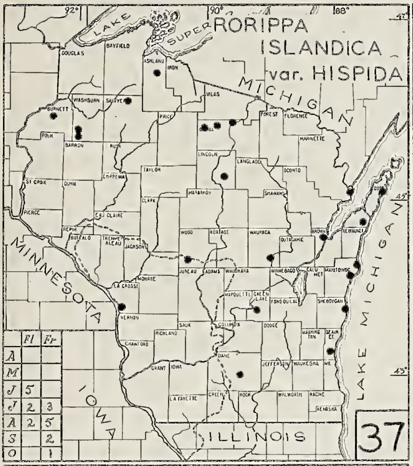
A weed of waste places, often in moist ground in dumps and along railroads, escaped from cultivation. Native of Europe. Flowering from late May through late June and fruiting from mid-June through early July.

24. BARBAREA R.BR. YELLOW ROCKET

1. BARBAREA VULGARIS R.Br. Yellow Rocket; Winter Cress
Maps 40, 41.

Erect, often robust biennials or perennials, simple to much branched, 3–9 dm tall. Basal leaves deeply pinnatifid with a large elliptic to nearly orbicular, often cordate terminal lobe, the lower cauline leaves pinnatifid to lyrate, the upper rounded or obovate to elliptic, coarsely dentate to palmately dissected, the base sessile or clasping. Petals pale to bright yellow or yellow-orange, 4–8 mm long. Fruits appressed or ascending to arched-ascending on horizontally divergent pedicels, 18–40 mm long; style 0.5–3.0 mm long.

Common, especially in southern Wisconsin, in moist places, along the banks of streams rivers and lakes, borders of woods, in disturbed places in oak and maple woods, in low prairies and sedge meadows; and very frequent in waste places, along railroads, road-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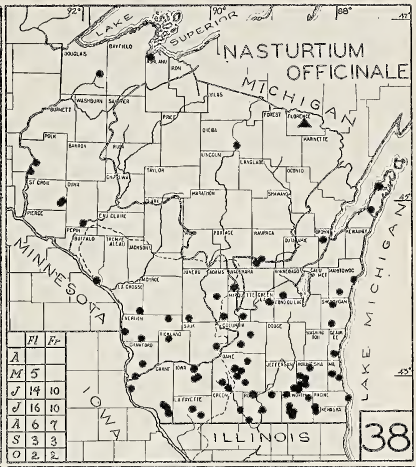
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 5
J 2 3
A 2 5
S 2
O 1
37


NASTURTIUM OFFICINALE
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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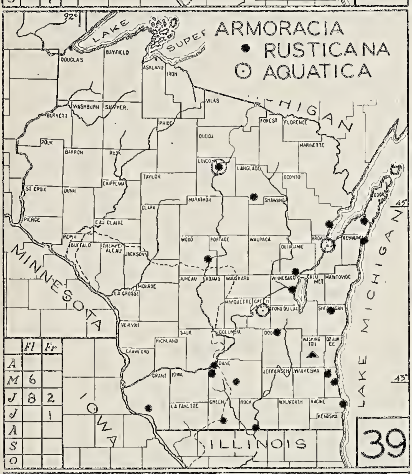
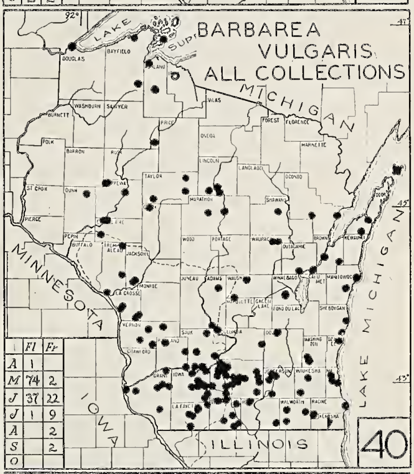
J 14 10
J 16 10
A 6 7
S 3 3
O 2 2
38


ARMORACIA
• RUSTICANA
⊙ AQUATICA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M 6
J 8 2
J 1
A
S
O
39


BARBAREA VULGARIS ALL COLLECTIONS
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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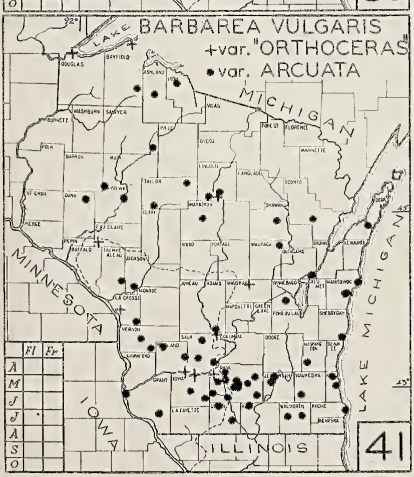
M 74 2
J 37 22
J 1 9
A 2
S 2
O
40


BARBAREA VULGARIS
+var. "ORTHOCERAS"
•var. ARCUATA
LAKE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
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Fl Fr
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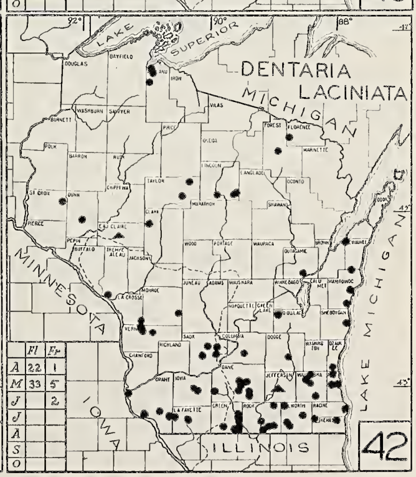
J
A
S
O
41


DENTARIA LACINIATA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A 22 1
M 33 5
J 2
J
A
S
O
42

sides, and often a pernicious weed in cultivated fields and pastures. Flowering from earliest May through mid-July and fruiting from mid-May through September.

Several of the Wisconsin specimens (Map 41) have short thick styles, small pale flowers, rather strict fruits and somewhat dissected cauline leaves. These plants, using the petal and style length as criteria, would "key" to *B. orthoceras* Ledebour in both Fernald (1950) and Gleason (1952). Very similar, but with somewhat longer petals and styles, are a small number of specimens which may belong to *B. vulgaris* var. *vulgaris*. However, *Barbarea stricta* Andrz. *(=B. orthoceras)*, according to Clapham, *et al.* (1952), has "hairy buds." Pubescence is not present on the buds of any of the Wisconsin specimens. In the European and Alaska material of the University of Wisconsin Herbarium, curved bristles are present on the *sepal margins,* and are especially visible in the bud stage. On the basis of this and other more minor characters, it seems to us that the true *B. orthoceras* does not occur in Wisconsin despite the report of Fernald (1950:717). Incidentally, neither Fernald (1950) nor Gleason (1952) mention this "hairy bud" character.

The greater percentage of our specimens have large, deep yellow flowers, *arched-ascending fruits on slender pedicels, and long slender styles,* and have been called var. *arcuata* (Opiz) Fries. Only those with mature and clearly arcuate-ascending siliques are included on Map 41. When in flower or even young fruit, the varieties of *B. vulgaris* are nearly indistinguishable.

25. DENTARIA L. Toothwort

[Montgomery, F. H. 1955. Preliminary studies in the genus *Dentaria* in eastern North America. *Rhodora* 57:161–173.]

Slender, glabrous, erect, spring-flowering woodland perennials from horizontal rhizomes. Leaves palmately or compound dissected. Petals white to pale pink or pale purple. Siliques linear-lanceolate, erect or nearly so, the seeds wingless, flattened, in a single row in each locule.

Sexual sterility is very common in *Dentaria* in Wisconsin, as elsewhere, and plants with fruits are rarely found. This condition is no doubt related to the remarkable high polyploid levels within the genus, the 2n numbers for our species reported by Montgomery (1955) as ±240 for *D. diphylla,* ±208 for *D. maxima,* and 96 for *D. laciniata.*

Key to Species

1. Leaves divided into 4–7 linear to lanceolate segments; rhizome of fusiform, easily separable segments ____________ 1. *D. laciniata.*
1. Leaves divided into 3 ovate segments; rhizome continuous and toothed ____ 2

2. Hairs on the leaflet margin 0.1 mm long, appressed; diameter of the rhizome uniform; leaves usually 2; Eastern Wisconsin -- 2. *D. diphylla.*

2. Hairs on the leaflet margin 0.2–0.3 mm long, spreading; diameter of rhizomes reduced at regular intervals; leaves usually 3; very rare, Northern Wisconsin (Ashland County) 3. *D. maxima.*

1. DENTARIA LACINIATA Muhl. Cut Toothwort Map 42.

Rhizome constricted, the segments 15–30 mm long. Stems 1–3 dm tall. Leaves palmately divided into 4–7 linear to lanceolate segments, these entire to sharply toothed or laciniate. Petals pale pink to pale purplish, 10–15 mm long; sepals 4–8 mm long. Siliques linear-lanceolate, 30–45 mm long with a long and slender style, not commonly collected in fruit in Wisconsin and then when the leaves are nearly withered, the elastically rapidly coiling valves like those of *Impatiens,* the Jewel-weed.

Widespread throughout the state, mainly in the southern mesic deciduous forests (Curtis, 1959), in rich Sugar Maple, Maple-Basswood, Oak-Hickory and bottomland forests, often with *Trillium, Podophyllum, Claytonia, Uvularia,* etc. Flowering from early April to the end of May, and fruiting from late May through June. Plants soon withering.

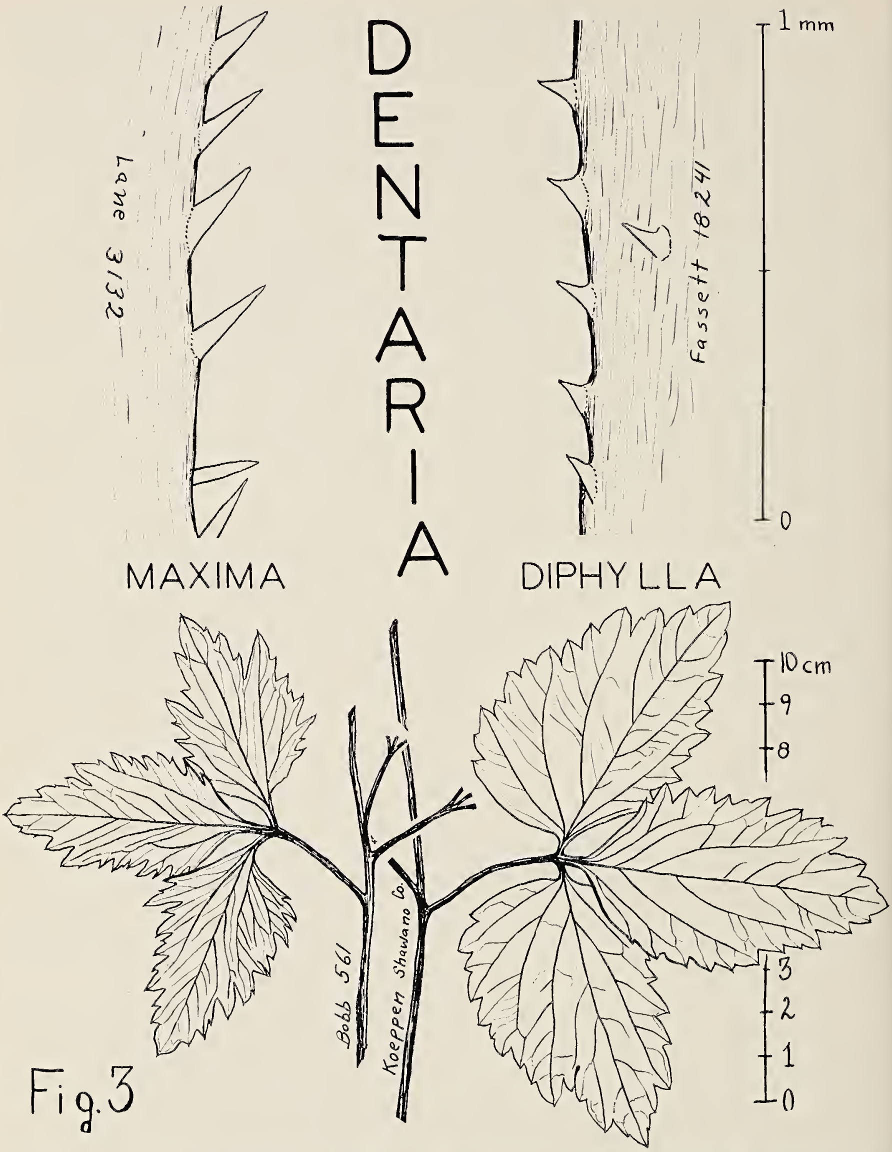
2. DENTARIA DIPHYLLA Michx. Toothwort; Crinkleroot Map 43.

Rhizome continuous, with uniform diameter, as much as 40 cm or more long; stems to 35 cm tall. Leaves two, occasionally three, opposite or nearly so, the 3 leaflets ovate and toothed, the terminal leaflet broader than the lateral ones, the hairs along the leaflet margins 0.1 mm long, appressed (fig. 3). Petals white, 8–14 mm long; sepals 4–6 mm long. Siliques straight, lanceolate, rarely maturing in Wisconsin.

Eastern Wisconsin, in deep humus of rich Maple-Beech or Maple-Basswood forests, one collection from a White Cedar bog *(Fassett 18241* [WIS]), in Florence Co. on steep, wooded slopes with *Tsuga,* Maple and Basswood, at nearby Lost Lake very abundant in a Sugar Maple-Basswood forest with a rich herb layer of *Caulophyllum, Viola canadensis, Adiantum pedatum, Trillium grandiflorum, Sanguinaria,* etc. Flowering from mid-May through early June, the fruits appearing in late May, rarely maturing.

3. DENTARIA MAXIMA Nutt. Toothwort Map 43; Fig. 3.

Very similar to *D. diphylla;* rhizome interrupted by abrupt constrictions. Leaves commonly 3, alternate, the 3 leaflets more sharply,



deeply, and irregularly toothed than those of *D. diphylla;* hairs on the leaflet margin 0.2–0.3 mm long, spreading (fig. 3).

The only Wisconsin station is in Ashland Co.: river bottom forests, about 3.5 mi. south of Ashland along Wis. 13, near crossing of White River, April 22, 1958, *Lane 3132* (WIS); White River Bottoms, May 16, 1931, *Bobb 561* (WIS), May 28, 1931, *122* (WIS), *Rowland* and *Arnson,* May 28, 1930 (Northland College Herb.).

Dr. F. C. Lane of Northland College writes that in this mesic river bottom elm forest *D. maxima* is very abundant, forming large clones, and is associated with *Erythronium americanum,* and *Viola* spp.

26. CARDAMINE L. Bitter Cress

Slender perennial herbs; petals white to pink or pale purplish. Siliques linear, usually flattened, tipped with a persistent style, the valves nerveless; pedicels divergent. Seeds flattened, wingless, in a single row in each locule.

Key to Species

1. Stem leaves simple -- 2
   2. Flowers usually pink to purplish, rarely white, nodding; stem often minutely hirsute with slender straight hairs throughout, rarely glabrous throughout; stem leaves 2–4 (–5); plants 1–2 (–3) dm tall -------------------------------- 1. *C. douglassii.*
   2. Flowers white, erect or ascending; stems densely puberulent with small incurved hairs *on lower* ⅓ *of stem,* glabrous above (very rarely glabrous throughout); stem leaves (4–) 5–12; plants 2–5 (–6) dm tall ---------------------------- 2. *C. bulbosa.*
1. Stem leaves pinnately divided ------------------------------ 3
   3. Petals 7–14 mm long; leaflets of the basal leaves nearly circular; cauline leaves 2–5 (–6); stems simple ----- 3. *C. pratensis.*
   3. Petals 2–4 mm long; leaflets of the basal leaves irregular, not circular; cauline leaves few to numerous; stems generally branching -- 4
      4. Lateral leaflets of the cauline leaves oval or oblong, decurrent on the rachis; plants 1–7 dm tall; stems often hirsute; mature siliques with style 0.5–2.0 mm long 4. *C. pensylvanica.*
      4. Lateral leaflets of the cauline leaves linear, not decurrent on the rachis; plants 1–3 dm tall; stems glabrous; mature siliques with style 0.2–0.9 mm long ---------------- 5. *C. parviflora.*

1. Cardamine douglassii (Torr.) Britt. Pink Spring Cress; Pink Bitter Cress Map 44.

Cardamine bulbosa (Schreb.) B.S.P. var. *purpurea* (Torr.) B.S.P.

Similar to *C. bulbosa,* but only 1–2 (–3) dm tall. Stems usually minutely or sparsely hirsute throughout, the hairs longer than in *C. bulbosa* and divergent, if sparsely pubescent or glabrous above, then glabrous also to the very base. Cauline leaves 2–4 (–5), the lower one or two often deeply cordate and with petioles, the upper often coarsely toothed. Sepals purple-tinged; petals pink-purple to white or nearly so (in forma *albidula* Farw.), 10–20 mm long, the flowers generally nodding. Siliques rarely maturing in Wisconsin, linear, 22–35 mm long (including the filiform style).

Occasional, though locally abundant, in low or moist, rich woods in the southern mesic forests (Curtis, 1959) and in wooded boggy places underlain by dolomites, mainly in eastern Wisconsin. Flowering from mid-April until early June and fruiting from mid-May on, about 2 to 3 weeks earlier than *C. bulbosa.*

Field observations on this species were made in the spring of 1960, in a White Cedar *(Thuja)* and Yellow and Paper Birch *(Betula lutea, B. papyrifera)* woods, about 100 yards from the strand of Lake Michigan, 1 mile SE of Lake Church, Ozaukee County. Here the soil varied from sandy loam on higher ground to black wet humus in the depressions, and was only a few feet above the bedrock of the Niagara Dolomite. The rich herb layer included Skunk Cabbage *(Symplocarpus foetidus)*, Marsh Marigold *(Caltha palustris)*, Small Ginseng *(Panax trifolia)*, Trillium *(Trillium grandiflorum* and *T. cernuum macranthum)*, Yellow Dogtooth Violet *(Erythronium americanum)*, and many shrubs of several species of Gooseberries *(Ribes triste, R. americanum, R. cynosbati)*, all growing with *Cardamine douglassi,* which, in full bloom on May 15th, was particularly common in the moister area. Its showy petals ranged from an occasional white[1] to the more common pale lilac-purple. Several of the plants examined, perhaps 10%, were either glabrous throughout (!) or with only 2 or 3 slender hairs on the whole plant. They were in every respect typical for the species, however: small, few-leaved, and with colored, nodding flowers. The remaining specimens showed the characteristic pubescence all the way to the inflorescence.

The isolated collection in Vernon County (cf. Map 44) is from a mature and wonderfully preserved Red Oak-Sugar Maple forest in the Champion Valley area, to which the second author was taken by Drs. J. T. Curtis and G. Cottam. Here a densely forested ravine is banked by steep slopes, where spring seepage produces some local wet areas. *Cardamine douglassii* is abundant here, with *Galium aparine, Floerkia proserpinacoides, Poa alsodes,* and other interesting species. These Cardamine plants were more robust than the ones from Lake Michigan and had very large, deeply cordate, basal leaves. By May 20, all plants were past flowering. The Sauk County collection is from a Sugar Maple forest with seepage similar to the above.

[1] The white petals changed to a pale purple on drying!

2. CARDAMINE BULBOSA (Schreb.) B.S.P. Spring Cress; Bitter-cress Map 45.

Stems erect from a short tuber, 2–6 dm tall, glabrous above, usually with very short, *dense, fine appressed puberulence on the lower* ⅓. Leaves (4–) 5–12, simple, the 2 to 5 lowest ones petioled, cordate-ovate or reniform to obovate, the upper sessile, entire to remotely dentate, rarely coarsely toothed. Sepals green with white margins; petals white, 7–15 mm long, smaller than in *C. douglassii*, the flowers generally erect. Siliques linear lanceolate, rarely reaching maturity in Wisconsin, 18–24 mm long.

Frequent, mainly in the southern part of the state, in open, moist or wet places, especially in marshes with *Iris, Caltha,* etc., wet sedge meadows, damp prairies, swales, sloughs, along muddy shores of lakes and streams, dense thickets near water, *Thuja* or Tamarack *(Larix)* bogs with *Rhus vernix* and *Salix,* bottomland forests, damp spots in Maple-Basswood forests, rarely in sandy places, moist talus slopes, dripping wet limestone cliffs (Grant Co.), and in pastures or along railroad embankments. Flowering from early May through mid-June, the fruits, which appear in mid-May, rarely maturing in Wisconsin in June and July.

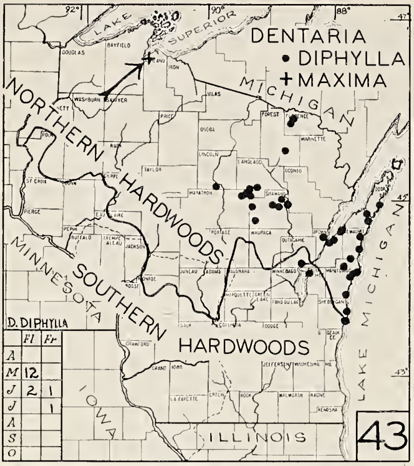
Sometimes confused with the earlier flowering *C. douglassii,* but may be differentiated by the glabrous upper stems and minute incurved puberulence on the lower stem, more numerous, less coarsely toothed stem leaves, and smaller, generally erect (not nodding) white flowers, as well as by the rather different ecology and later flowering period.

3. CARDAMINE PRATENSIS L. var. PALUSTRIS Wimm. & Grab. Cuckoo Flower Map 46.

Stem erect, glabrous, simple, arising from a short rhizome. Leaflets of basal leaves nearly orbicular; cauline leaves 2–6, the leaflets elliptic to linear. Petals white to pinkish, 7–14 mm long, about three times the length of the sepals. Fruits rare, often aborted, when present 1–3 cm long; style short.

Occasional, mostly in the eastern part of the state, in wet open places, marshes, swampy areas, along lakes, springs, wet sedge meadows, rarely in quaking or Alder bogs, and open White Cedar *(Thuja)* hardwoods. Flowering from late May through mid-June, the fruits first appearing in late May.

The isolated station in Polk County is from Cedar Lake *(Moyle 2688* [MINN]).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+ MAXIMA
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NORTHERN HARDWOODS
SOUTHERN HARDWOODS
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IOWA
ILLINOIS
LAKE MICHIGAN
D. DIPHYLLA
Fl Fr
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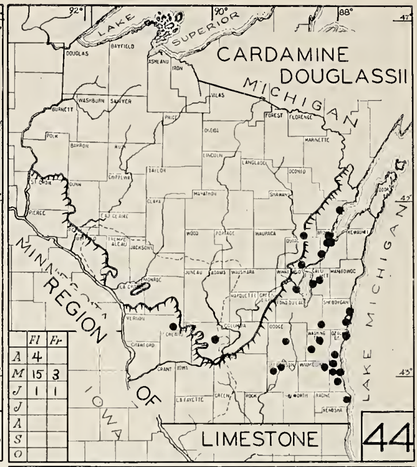
J 2 1
J 1
A
S
O
43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REGION OF LIMESTONE
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LAKE MICHIGAN
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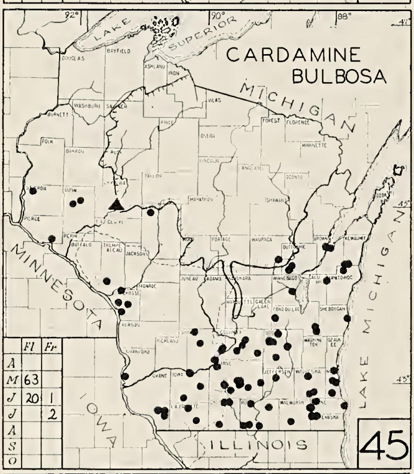
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MINNESOTA
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J 2
A
S
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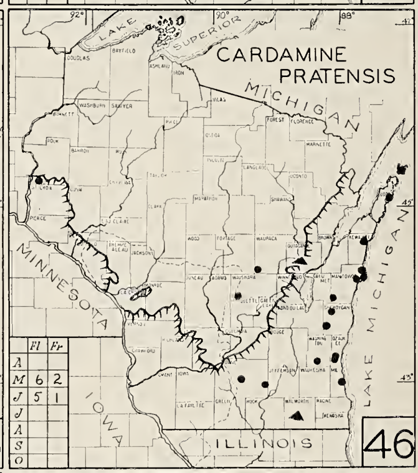
45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MICHIGAN
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ILLINOIS
LAKE MICHIGAN
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J
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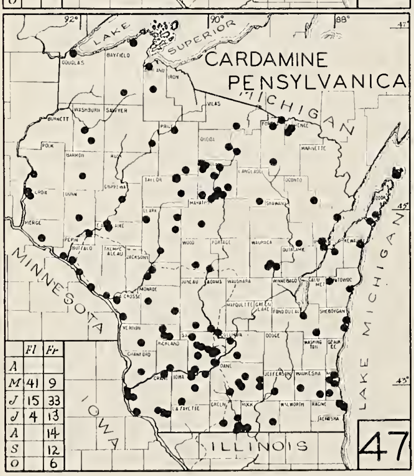
46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LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
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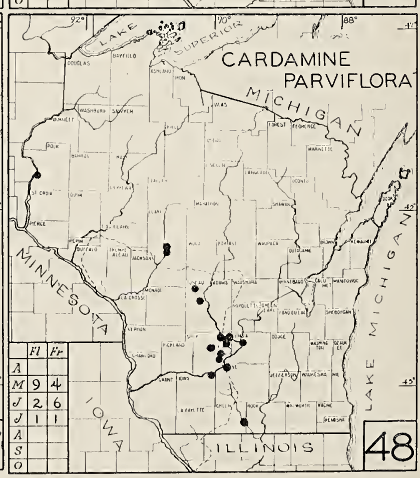
A 14
S 12
O 6
47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PARVIFLORA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M 9 4
J 2 6
J 1 1
A
S
O
48

4. CARDAMINE PENSYLVANICA Muhl. Pennsylvania Bittercress Map 47.

Cardamine hirsuta L. var. *pensylvanica* Muhl. ex Willd.

Stems hispidulous at least at the base, often throughout, except when submerged or decumbent, then often glabrous, simple to much branched, to 1–5 (–7) dm tall. Leaves pinnate; lateral leaflets of cauline leaves linear to obovate, the terminal leaflets (except of uppermost leaves) broader than the lateral leaflets, their bases decurrent on the rachis. Petals white, 2–4 mm long, more than half the length of the sepals. Siliques 10–27 mm long; style 0.5–2.0 mm long.

Common throughout Wisconsin, mostly in moist or wet places: bottomland forests and rich wet woods, moist ravines, along the shores of lakes, rivers and streams, on open sand flats, in springs, marshes, wet meadows, and occasionally weedy in cultivated fields and along roadsides. Flowering from early May through July and fruiting from late May through October.

5. CARDAMINE PARVIFLORA L. var. ARENICOLA (Britt.) Schulz

Cardamine arenicola Britt. Map 48.

Stems simple to much branched, *glabrous,* to 3 dm tall. Leaves all pinnate; leaflets of basal rosettes ovate to suborbicular, the terminal leaflets of cauline leaves only slightly broader than the *linear lateral leaflets,* these *not decurrent on the rachis.* Petals white, 2.5–4.0 mm long, the sepals about half as long. Siliques linear, 1–3 cm long; style 0.2–0.9 mm long; fruiting pedicels 6–10 mm long.

Occasional, especially in central Wisconsin, in dry or damp rocky woods, sandstone or quartzite bluffs or hillsides, and in moist sand, sandy muck, willow thickets along rivers, or roadsides. Flowering from early May through June (one specimen July 22), and fruiting from late May through July.

Very easily confused with *C. pensylvanica,* but separated by *the total absence of stem pubescence,* by the narrower leaflets, smaller size, shorter styles, and by the generally drier habitats in which it occurs. Xeromorphic extremes of *C. pensylvanica,* however, are (nearly?) indistinguishable from this species.

27. ARABIS L. ROCK CRESS[1]

[Hopkins, M., 1937. *Arabis* in eastern and central North America. *Rhodora* 39:63–98; 106–148; 155–186. Rollins, R. C. 1941. Monographic study of *Arabis* in western North America. *Rhodora* 43:289–325; 348–411; 425–481.]

Perennials or less often biennials from a basal rosette, the leaves simple, mostly entire. Petals white to yellowish or pale purplish.

[1] We are very grateful to Dr. Reed C. Rollins, of the Harvard University Herbarium, Cambridge, Mass., for checking the identification of most of the specimens of this difficult genus on which the following treatment is based.

Siliques linear, flattened or terete, with several to many seeds in each cell, the valves usually one-nerved. Seeds flattened, often winged at the margin.

A. Key to Flowering Material

1. Stem leaves attenuate to a narrow base, not clasping or auriculate ---------- 2
  2. Plants 1–3 (–4) dm tall, often with many slender branches; stem leaves mostly linear, 1–5 mm wide; petals 5–8 mm long ---------- 1. *A. lyrata.*
  2. Plants (3–) 4–11 dm tall, erect and strict, generally unbranched; stem leaves oblanceolate to narrowly elliptic, 6–50 mm wide; petals 3–5 mm long ---------- 8. *A. canadensis.*
1. Stem leaves, at least the lowermost, strongly clasping or auriculate ---------- 3
  3. Pedicels 1–4 mm long; petals 2–4 mm long; plants 2–5 (–6) dm tall, weak-stemmed and much branched from the base, usually stellate-pubescent throughout; leaves oblanceolate to oblong-ovate ---------- 9. *A. shortii.*
  3. Pedicels (5–) 6–15 mm long; petals (4–) 5–10 mm long; plants simple, erect and strict, generally unbranched, glabrous or pubescent ---------- 4
    4. Plants glabrous throughout (the basal rosette leaves rarely pubescent in No. 4) ---------- 5
      5. Basal rosette leaves normally lacking at anthesis; largest stem leaves (except in depauperate plants) (5–) 8–20 cm long; pedicels divergent; sepals nearly equalling the length of the petals ---------- 7. *A. laevigata.*
      5. Basal rosette leaves lanceolate, usually ascending, entire to shallowly serrate; largest stem leaves 2–5 (–9, rare) cm long; pedicels generally appressed to subappressed; sepals about half the length of the petals ---------- 4. *A. drummondi.*
    4. Plants pubescent, *at least at the very base of the stem,* the stem leaves and upper stem often glabrous ---------- 6
      6. Leaves of basal rosette often lyrate-pinnatifid, glabrous except for few, simple, stiff hairs on the margin (these often only at the tip of each tooth or laciniation) ---------- 6. *A. missouriensis.*
      6. Leaves of basal rosette entire or serrate, stellate-pubescent on both surfaces ---------- 7
        7. Pubescence at base of stem spreading, mostly of simple, hirsute hairs ---------- 8
          8. Plants robust, glaucous above, the stems hirsute only at the base; stem leaves 2–12 cm long, strongly sagittate-clasping ---------- 2. *A. glabra.*

8. Plants often slender, not glaucous, the stems hirsute to above the middle;[1] stem leaves 1–4 cm long, sessile to slightly auriculate ____ 3a. *A. hirsuta* var. *pycnocarpa.*

7. Pubescence at the base[2] of the stem mostly of appressed stellate or forked hairs ____________________________ 9

9. Petals white, 3–6 mm long; fruits *at maturity* erect; seeds of young fruits in a single row; stems sparsely to densely pubescent on at least the lower third, often throughout (only rarely the stem nearly glabrous throughout) _______ 3b. *A. hirsuta* var. *adpressipilis.*

9. Petals whitish-pink to purple, 5–8 mm long; fruits *at maturity* widely spreading; seeds of young fruits in a double row; stems glabrous except for the lowermost 5 cm's _________________________ 5. *A. divaricarpa.*

B. Key to Mature Fruiting Material

1. Fruiting pedicels erect or strongly ascending; *fruits* not curved, straight or nearly so, erect and *closely appressed to the stem*____ 2

2. Fruits somewhat quadrangular to terete at maturity; base of stem hirsute with stiff, spreading hairs; style rather broad, often somewhat capitate; plant glaucous, often robust__ 2. *A. glabra.*

2. Fruits flattened; hairs at the base of the stem, if present, spreading or appressed; style much narrower than the fruit__ 3

3. Fruits 0.7–1.1 mm broad; seeds broadly winged, in a single row in each locule; stem often pubescent throughout, or at least the lower ⅓ (rarely glabrous, except at very base); plants generally slender ____________________ 3. *A. hirsuta.*

3. Fruits 1.2–2.1 mm broad; seeds not winged, in a double row in each locule; stem glabrous (or rarely with a few scattered hairs at the base only); plants generally robust ________ ____________________________________ 4. *A. drummondi.*

1. Fruiting pedicels ascending to diverging; *fruits* straight to strongly arched, erect to divergent or recurved, *not closely appressed to the stem* ____ 4

4. Fruits strongly curved and much flattened 1.2–3.3 mm wide 5

5. Fruits pendulous, 2.5–3.3 mm broad; seeds broadly winged; leaves with a narrow base, often slightly petiolate, *never clasping* ___________________________________ 8. *A. canadensis.*

5. Fruits recurving, 1.5–2.0 mm broad; seeds narrowly winged; leaves sagittate- or auriculate-clasping ___________ 6

6. Largest cauline leaves 1–5 (–7) cm long; stems with 19–50 nodes (leaves) to the lowest fruiting pedicel; base of stem

[1] Collections of *Arabis hirsuta* var. *adpressipilis* may be hirsute, but then only at the *very base,* the remainder of the stem clothed with more or less appressed, *forked* hairs.

[2] Often only at the *very* base.

pubescent with short simple hairs; rosette leaves often lyrate-pinnatifid, glabrous, except for a few stiff hairs on the margin ________________________ 6. *A. missouriensis.*

6. Largest cauline leaves 8–20 cm long; stems with 8–16 (–19) nodes to the lowest fruiting pedicel; plants glabrous even at base; rosette leaves serrulate _____ 7. *A. laevigata.*

4. Fruits straight or nearly so, terete to flattened, 1–2 mm broad ____ 7

7. Cauline leaves auriculate-clasping at the base; fruits diverging or ascending _____________________________________ 8

8. Plants usually unbranched and strict, robust, glabrous except at the base; pedicels 5–13 mm long; basal leaves oblanceolate to spatulate, stellate-pubescent on both surfaces __________________________________ 5. *A. divaricarpa.*

8. Plants much branched from the base, slender and weak-stemmed, stellate-pubescent throughout; pedicels 1–4 mm long; basal leaves long-petiolate, spatulate ___ 9. *A. shortii.*

7. Cauline leaves sessile, spatulate to linear, or the lowest lyrate-pinnatifid; fruits ascending to erect; plants slender, much branched, 1–4 (–5) dm tall ___________ 1. *A. lyrata.*

1. ARABIS LYRATA L. Lyreleaf Rock Cress Map 49.

Slender and much branched, 1–4 dm tall. Stem usually pubescent at the base. Rosette leaves 2–4 cm long, lyrate-pinnatifid to dentate. Cauline leaves spatulate to linear, mostly entire. Petals showy, white (rarely cream or pale pink), 5–8 mm long. Siliques erect or ascending, on divergent pedicels, 20–45 mm long, 1 mm or less wide. This species is quite variable, reflecting the diversity of habitats in which it occurs.

Very common, particularly in the "Driftless Area", in a large number of communities (Curtis 1959), most abundant in open, very sandy and sunny places, on beaches and dunes, sand flats, sandy, gravelly, or rocky dry prairies, in open, dry Pine or Oak woods, on sandstone cliffs and rocky slopes, less commonly on limestone cliffs and quartzite outcrops, frequently weedy in pastures, gravel pits, railroad embankments and roadsides, essentially lacking from the eastern Wisconsin Niagara Dolomite formation, and from the Northern Highlands except along roadsides, railroads and lake shores. Flowering from late April through September and fruiting from mid-May through September.

2. ARABIS GLABRA (L.) Bernh. Tower Mustard Map 50.

Stiffly erect, to 9 dm tall. *Stem with stiff, spreading, simple hairs at the base,* glabrous and often glaucous above. Leaves lanceolate, strongly sagittate-clasping, strictly appressed, only the basal ones hirsute. Petals white to yellowish, mostly 4 (–5) mm long, slightly longer than the sepals. Siliques sub-terete, (5–) 8 (–11) cm long, 1.0–1.5 mm broad, strictly appressed; stigma broad, often somewhat capitate. Seeds in one or two rows in each locule, very narrowly or not at all winged.

Widespread throughout the state in dry, well-drained, often open places, especially common in sandy fields, prairies and "bracken grassland" (Curtis 1959), in open, sandy Jack Pine or Aspen woods with Bracken Fern, *Comptonia* (Sweet-fern) and Blueberry understory, less common on sand dunes or beaches, gravelly or rocky places as streambeds, railroad embankments, gravel pits, etc., frequently weedy along roadsides or in pastures, and rarely on sandstone (Richland Co.) or limestone cliffs [Racine Co., *Wadmond 2145* (WIS)]. Flowering from late May through mid-July, and fruiting from mid-June to late September.

This species is often confused with the more slender *A. hirsuta,* which has winged seeds, and when in young fruit with *A. drummondi,* which lacks the distinctive hirsute pubescence at the stem base.

3. ARABIS HIRSUTA (L.) Scop. Hairy Rockcress Maps 51, 52.

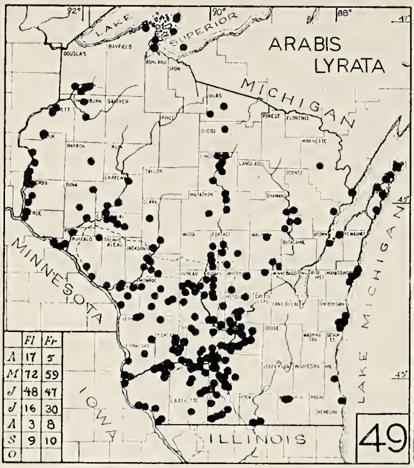
Slender, erect, sometimes slenderly branching above, 6–60 (90) cm tall, pubescent at least at the very base. Rosette leaves stellate-pubescent on both surfaces. Cauline leaves 1–5 (–7) cm long, auriculate-clasping. Petals white, 3–6 mm long. Flowering pedicels diverging, becoming ascending or appressed. Siliques ascending and more or less appressed to the stem, flattened, 3.0–6.5 cm long, 0.7–1.1 mm broad. Seeds rectangular, broadly winged, in a single row in each locule.

KEY TO VARIETIES

1. Stem pubescence mostly of simple, spreading, hirsute hairs; cauline leaves often heavily pubescent .... 3a. var. *pycnocarpa.*
1. Stem pubescence (except sometimes at the very base) mostly of appressed forked hairs; cauline leaves often glabrous or nearly so .... 3b. var. *adpressipilis.*

3a. ARABIS HIRSUTA var. PYCNOCARPA (Hopkins) Rollins Map 51.

In the western, southern, and eastern parts of the state, almost exclusively on ridges or in crevices of vertical, dry to moist or rarely wet *limestone or dolomite cliffs* (these usually in the open, sometimes in Maple-Basswood forests), rocky limestone shores of lakes, and rarely on dunes (see notes after var. *adpressipilis).* Flowering from mid-May to early July and fruiting from late May until September.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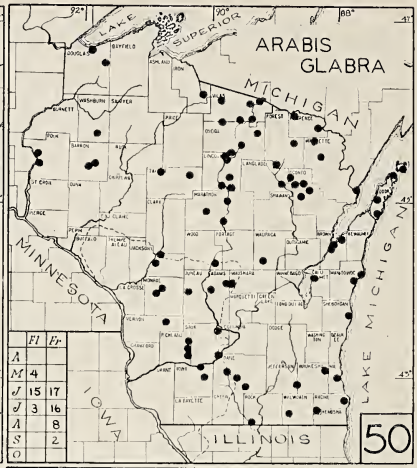
49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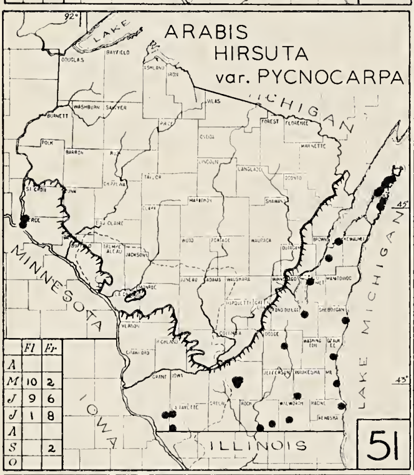
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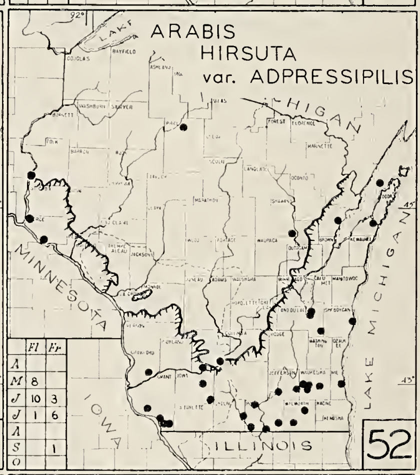
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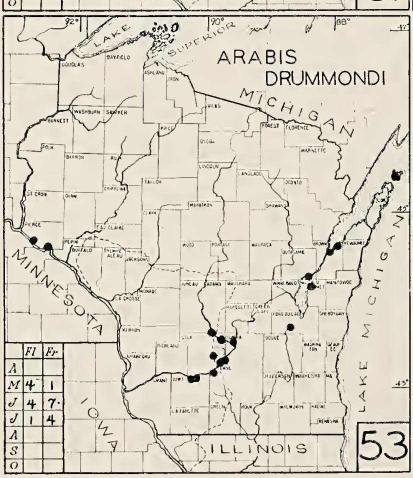
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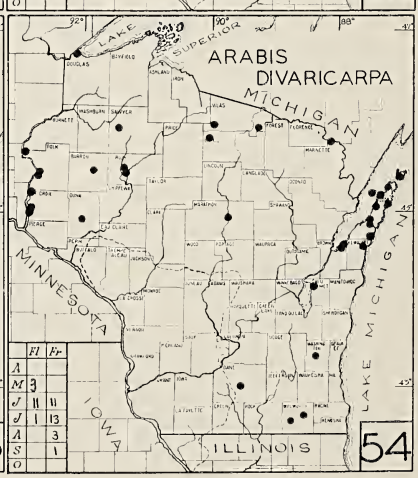
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3b. ARABIS HIRSUTA var. ADPRESSIPILIS (Hopkins) Rollins Map 52.

Slightly wider-ranging than var. *pycnocarpa* and occasionally tending to be weedy, in rich, rocky, dry woods (Oak-Hickory, Waukesha Co.), on wooded, pastured hillsides, occasionally on moist or dry, open or shaded limestone cliffs, along railroad embankments, and in sandy or gravelly fields and shores, with one specimen from "Muckwonago Swamp" [*Fassett 20627* (WIS)]. Flowering from about May 20 through early July, and fruiting from mid-June through September.

Hopkins (1937:116) cites *Fassett 13457* and *13369*, (both WIS), both from damp cliffs in Grant Co., as *A. pycnocarpa* var. *glabrata.* Rollins (1941) restricts the name var. *glabrata* only to the "large flowered plants with diverging pedicels and somewhat saccate outer sepals from the northwestern U. S. and adjacent Canada," and states that this variety does not occur in Wisconsin. While these two plants, which both fall within var. *adpressipilis*, are perhaps somewhat more glabrous than usual, the fact that they were collected in the "Driftless Area" very possibly influenced Hopkins' taxonomic judgment, who, as a student of Fernald in the early 1930's, must have been strongly exposed to the "Nunatack Hypothesis" of his teacher [See Iltis & Shaughnessy (1960:118–119) for a nearly identical error due to "Phytogeographic Suggestion," in this case in *Dodecatheon*, Primulaceae].

The two varieties may grow very close together. Thus, along the Kinnickinnic River in Pierce County (E and NE of the County Trunk F bridge), we find var. *adpressipilis* in crevices of limestone boulders on a sunny, steep south-facing dry prairie, growing with *Campanula rotundifolia, Pellaea-glabella, Aquilegia canadensis,* and *Muhlenbergia cuspidata.* Looking south across the valley, we see a very high, vertical, N-facing limestone cliff. At its base, on the moist open ledges and cliffs right above the river, there is abundant var. *pycnocarpa*, in association with *Erigeron philadelphicus, Veronicastrum virginicum, Cystopteris bulbifera, C. fragilis, Aquilegia canadensis, Lycopus americanus, L. uniflorus, Mitella diphylla, Arabis lyrata,* and *Besseya Bullii.* Between Hager City and Bay City, in the same county, var. *pycnocarpa* grows in a nearly pure *Juniperus virginiana* stand on a steep south-facing talus slope beneath a dolomite bluff. Within a few yards grow *Artemisia frigida, Chrysopsis Ballardii,* and *Symphoricarpus occidentalis,* attesting to the xeric nature of this woods. In contrast, on the massive, vertical, NW-facing St. Croix River bluffs just below Osceola in Polk County, var. *pycnocarpa* grows in moss cushions on shaded sandstone rocks densely covered with deciduous mesophytic forest vegetation, sharing this niche with *Cryptogramma stelleri* and other ferns, with *Taxus canadensis* and *Acer spicatum* in the immediate vicinity.

4. ARABIS DRUMMONDI Gray Drummond Rockcress Map 53.

Erect, unbranched, glabrous, to 10 dm tall. Leaves of the basal rosette narrowly oblanceolate, glabrous (rarely with a few hairs, especially at their very base), generally ascending, the cauline leaves auriculate-clasping. Petals white to pale purple, 5–10 mm long, exceeding the sepals. Siliques erect and appressed, (6–) 7–12 cm long, 1.2–2.2 mm broad, the valves with a strong midvein. Seeds in a double row in each locule, 1.1–1.5 mm long, 0.8–1.1 mm broad, narrowly winged.

Locally abundant, in a Juniper woods on dolomite talus in Pierce Co.; at Devil's Lake on rocky east-facing cliffs; along the Wisconsin River in sandy, open flood plain woods, sand bars, and pastures; and on bluffs and talus slopes following the western border of the Niagara Dolomite, from lower Fond du Lac Co. to Washington Island, Door Co. Flowering from early May to mid-June and fruiting in June and July.

This species in young fruit may be confused with *A. divaricarpa* or *A. glabra,* but can be separated by the lack of pubescence at the very base of the stem. In some collections *(Zimmerman 1180,* Devil's Lake, Sauk Co.; *Fassett 16225,* High Cliff, Calumet Co.—both WIS), the basal rosette leaves are slightly pubescent on the margins and under surfaces.

5. ARABIS DIVARICARPA A. Nelson Map 54.

Arabis brachycarpa (T.&G.) Britton

Erect, often somewhat branched from the base, to 9 dm tall. Stems with stellate pubescence at the base. Basal leaves oblanceolate to spatulate, stellate-pubescent on both surfaces. Cauline leaves glabrous, oblong to linear lanceolate, auriculate or sagittate-clasping at the base, entire. Petals pale pink-purple or nearly white, 5–8 mm long. Siliques straight, 2.5–8.0 cm long, 1.2–2.0 mm broad, on widely diverging pedicels. Seeds narrowly winged at the top, 1 mm in diameter, in two rows in each locule in young fruit, becoming somewhat uniseriate.

In dry, well-drained, rather open wooded places, in rocky or sandy soil, frequently on limestone or dolomite cliffs, outcrops, bluffs, and talus slopes, rarely on granite outcrops (basic lava flows), on the inner strand and on dunes of the Great Lakes, and occasionally along railroad embankments and roadsides. Flowering from late May to mid-June (rarely in early July) and fruiting from mid-June through August.

6. ARABIS MISSOURIENSIS Greene, var. DEAMII (Hopkins) Hopkins
Arabis viridis Harger, var. *Deamii* Hopkins Map 55.

Erect, with one main stem, to 6 dm tall; stem slightly hispid at the base, glabrous above, *with 19–50 nodes to the first flower* or branch. *Basal leaves* lanceolate to oblanceolate, serrulate to *lyrate-pinnatifid, glabrous except for a few marginal hairs, these singly at the tip of each tooth or laciniation.* Cauline leaves sagittate-clasping, imbricated, the upper narrowly lanceolate and entire, the lower broadly lanceolate, and serrulate to laciniate. Petals white to cream, 6–8 mm long, about twice the length of the sepals. Siliques flattened, at first erect, becoming arched and recurved, 6–9 cm long, 1.5–2.0 mm broad. Seeds in a single row, 1.4–1.8 mm long, 1 mm wide.

Occasional, mainly in the northern half of Wisconsin, usually in dry, sunny, sandy, gravelly or rocky (acidic?) places, often on the border of rocky, open oak woods, with six of the central and northern Wisconsin specimens on Pre-Cambrian granite or quartzite outcrops. Flowering from earliest June to earliest July and fruiting from late June through August.

When in fruit, this species is very similar to *A. laevigata,* but is easily separated by the much larger number of nodes to the first flower, and by the distinctive basal rosettes.

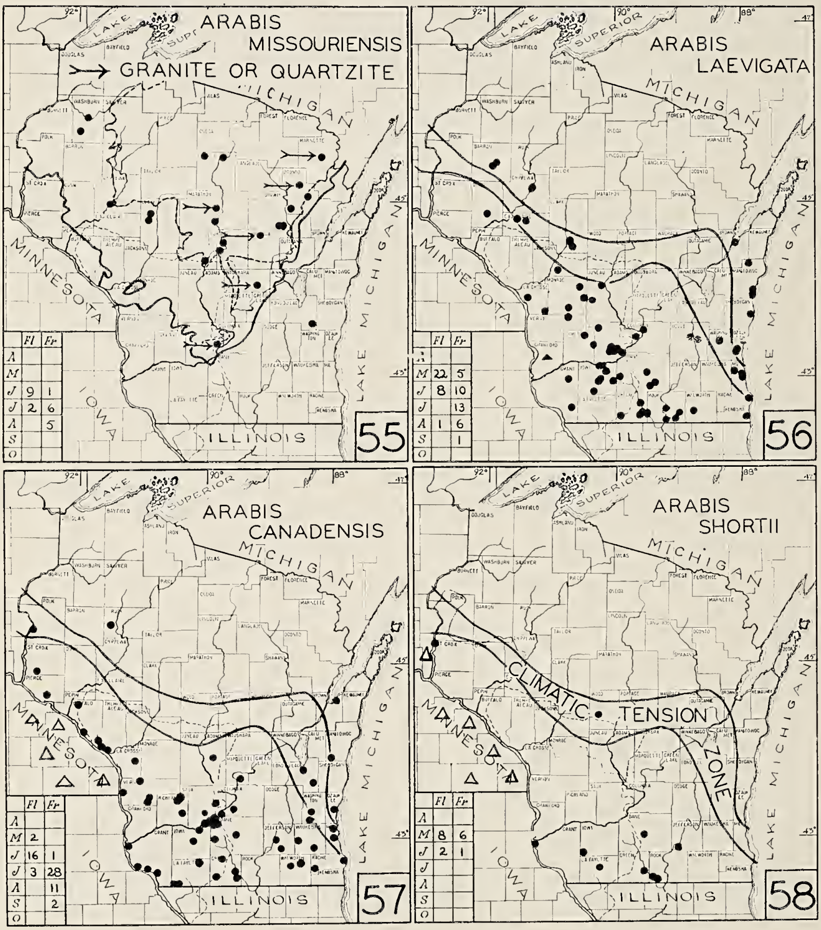
Hopkins (1938) cites, in error, a Wisconsin collection of this species *(Hermann 8760,* Sauk Co. (WIS)) as typical *A. viridis.* This plant was found on "mossy granitic boulders, in a wooded ravine at Parfrey's Glen". It is perhaps significant that this, the southernmost station in Wisconsin and a rather isolated one, is in one of the most unusual habitats in the state—a deep, cool, dark gorge which harbors many rare plants (e.g. *Aconitum noveboracense).*

7. ARABIS LAEVIGATA (Muhl.) Poir. Smooth Rockcress Map 56.

Stem glabrous throughout, even at the very base, to 10 dm tall, *with only 8–16 nodes (leaves) to the first flower or branch.* Cauline leaves clasping, linear to oblong-lanceolate, not imbricated, to 2 dm long. Lower leaves serrate-dentate, the upper entire. Petals equalling or only slightly exceeding the sepals. Fruits similar to those of *A. missouriensis.*

Frequent in the southern part of the state, north to the "tension zone", in moderately damp or moist wooded places, mostly on or at the base of more or less wooded sandstone cliffs, and, in eastern Wisconsin, on wooded limestone cliffs and ledges, often in sandy or gravelly, mesic, generally rocky and steep Oak or Sugar Maple-Basswood woods (on very rocky, wet talus, with understory of

Taxus—Grant Co.), on pine relics on sandstone bluffs in southern Wisconsin, on damp, rocky cliffs in Northern Hardwoods of *Tsuga*—White Pine, Yellow Birch, *Circaea alpina, Streptopus roseus,* (Vernon Co.) and occasionally on sand flats (with *Hypoxis, Sisyrinchium, Castilleja coccinea, Pedicularis canadensis*—Juneau Co.) and stream or river banks. Flowering from May through June (occasionally in August) and fruiting from June through September.



8. Arabis canadensis L. Sickle-Pod Map 57.

Erect biennial, often unbranched, hispid at base, glabrous above, 4–9 (–13) dm tall. Cauline leaves oblong-lanceolate, 3–13 cm long and 0.5–4.0 cm broad, entire or with small remote serrations, the pubescence mostly of simple hairs. Petals white to yellowish-green, 3–5 mm long, less than twice the length of the sepals, the racemes long and loose. Siliques much flattened, slightly curved, 2.5–4.0 mm broad, 6–10 cm long, divergent to deflexed,[1] the valves with a conspicuous midvein. Seeds broadly winged, 3 mm long, red-brown, in a single row in each locule.

Frequent in the southern part of the state, mainly in dry oak forests (Curtis, 1959), mostly Oak-Hickory, Bur Oak-Black Oak, sometimes in mesic woods, with Maple, Basswood, and Ash, on rocky or gravelly, wooded, north-facing sandstone hillsides, on rocky bluffs, talus slopes, wooded borders of xeric prairies and occasionally on them, often on the wooded banks of streams or rivers, with one collection on limestone [*Fassett 15250,* Fond du Lac Co. (WIS)]. Flowering from late May into early July and fruiting in July through August.

9. ARABIS SHORTII (Fern.) Gl. Shorts Rockcress Map 58.

Arabis perstellata E.L.Br. var. *shortii* Fern.
Arabis dentata T.&G.

Slender and weak-stemmed, much branched from the base, to 5 dm tall, stellate-pubescent throughout. Rosette leaves long-petioled and spatulate (a good character for vegetative recognition). Cauline leaves oblanceolate to oblong-ovate, clasping, wavy to dentate, 2–7 cm long, with simple hairs above and stellate only along the midrib, densely stellate-pubescent below. Petals white to pale pink, 2–4 mm long, rarely exceeding the sepals. Pedicels 1–3 (–4) mm long, divergent. Siliques linear, widely spreading 1.5–3.0 cm long, 1 mm broad.

On sandy alluvial soil in southern Wisconsin; rare, but locally abundant in river bottom forests or rich, damp, deciduous woods near streams or lakes, occasionally weedy (Park Hq., Wyalusing St. Pk.); in the "Avon Bottoms" in the Sugar River Valley abundant in stands of Silver Maple, Elm *(Ulmus americana)*, Swamp White Oak *(Quercus bicolor)*, Hackberry *(Celtis occidentalis)*, Sycamore *(Platanus occidentalis)*, Basswood, *Diarrhena americana, Arisaema dracontium, Cephalanthus occidentalis, Chaerophyllum procumbens* and *Euonymous atropurpureus;* formerly in the woods at Picnic Point, Lake Mendota, Madison; the isolated Wood Co. collection *(Fassett 14124)* from near Little Bull Falls of the Yellow River; along the St. Croix R., often in extensive colonies, sometimes the only species growing in bare leaf mulch, or with *Galium aparine, Ranunculus abortivus, Menispermum, Phlox divaricata* etc., in *Acer saccharinum-Ulmus-Fraxinus* flood plain forest. Flowering from early to late May and fruiting in late May and June.

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[1] Plants projecting horizontally from steep banks have fruits at right angles to the peduncle, but in relation to the horizon *fruits are always vertical.*

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ERRATA

PRELIMINARY REPORT ON THE FLORA OF WISCONSIN
No. 43—*Primulaceae*

Transactions of the Wisconsin Academy of Sciences, Arts and Letters 49:113–135, 1960

The following errata all involve change in numbers, both of genera and species, in two of the main keys.

page 115. The numbers with the last four genera in generic key should read:

________ 5. ANAGALLIS
________ 4. LYSIMACHIA
________ 7. TRIENTALIS
________ 6. SAMOLUS

page 123. generic heading, middle of page, should read:

4. LYSIMACHIA, etc.

10th line from bottom: ________________________ 4. *L. nummularia*
page 124. 5th line from top: ____________________________ 5. *L. quadrifolia.*
page 125. 3rd line from top. ____________________________ 6. X *L. producta.*
7th line from top: ___________________________ 7. *L. terrestris.*
9th line from top: ___________________________ 3. *L. clethroides.*

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. NO. 45. AMARANTHACEAE—AMARANTH FAMILY[1]

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Distribution maps are based on specimens in the herbaria of the University of Minnesota (MINN), the Milwaukee Public Museum (MIL), and the University of Wisconsin, including hosts of fungi in the cryptogamic collection (WIS). Type material discussed for some of the species was examined in the British Museum of Natural History (BM), the Linnaean Society of London (LINN), and the Museum Nationale d'Histoire Naturelle in Paris (P). We are indebted to the curators for making this material available for study.

AMARANTHACEAE OF WISCONSIN

Annual herbs, with simple, entire, estipulate leaves cuneate or attenuate at the base and decurrent on the petioles. Flowers very small, subtended by scarious, acuminate bracts, crowded in axillary or terminal inflorescences. Perianth uniseriate, the petals and sepals alike and designated as *tepals*. Stamens 3–5. Ovary superior, 1-celled, ripening into a membranaceous circumscissile or indehiscent utricle containing a single seed.

All the species begin flowering in summer and continue until frost. Flowering and fruiting specimens are not distinguished on the tables accompanying the maps, because all stages from new flower buds to ripe fruits are present on each plant after the first weeks of the season.

All members of the family found growing spontaneously in Wisconsin belong to the two genera treated below. Three common garden ornamentals belonging to other genera are often planted within the state: *Gomphrena globosa* (globe-amaranth), *Iresine Herbstii* (blood-leaf) and *Celosia cristata* (cockscomb).

KEY TO GENERA

A. Leaves alternate, green or reddish, glabrous or slightly pubescent. Flowers unisexual. Tepals free, neither lanate nor winged. Stamens free .... 1. AMARANTHUS.

AA. Leaves opposite, grayish-green, conspicuously pubescent. Flowers perfect. Perianth tube lanate, with longitudinal spiny wings. Stamens united into a tube .... 2. FROELICHIA.

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

1. AMARANTHUS L. Pigweed, Amaranth

Prostrate or erect annual herbs, with simple, alternate, entire, long-petioled leaves. Plants generally tinged with reddish anthocyanin pigment, some cultivated forms intensely colored. Flowers unisexual, monoecious or dioecious, in dense, cymose clusters located in leaf axils and, in some species, in dense leafless, terminal thyrses; each dichasium (group of 3 flowers) subtended by a spiny-tipped, persistent bract. Tepals free, 3–5 in staminate flowers, 0–5 in pistillate flowers. Stamens free, 3–5. Style-branches 3, plumose. Utricle circumscissile or indehiscent. Seed lenticular, dark brown or white, the embryo coiled around a starchy "endosperm".

Key to Species

A. Plants diffusely branched. Inflorescences wholly axillary. Leaves small, more or less spatulate. Stamens 3.
- B. Prostrate carpet-plants. Bracts and tepals approximately equal in length. Tepals 4–5, with conspicuous, branching venation. Seed about 1.5 mm in diameter ___ 1. *A. blitoides.*
- BB. Bushy tumbleweeds. Bracts much exceeding tepals. Tepals 3, with simple midveins. Seed less than 1 mm in diameter ____ 2. *A. albus.*

AA. Plants normally with a dominant erect main stem. Terminal, spike-like or panicle-like thyrses present. Leaves generally medium to large, ovate to lanceolate or elliptic to oblong. Stamens generally 5 (3–5 in No. 8).
- C. Plants dioecious. Tepals generally 0–2, if more, then with conspicuous, branched midveins.
  - D. Bracts about 1 mm long, with very slender midribs. Pistillate tepals absent or rudimentary, lacking midveins. Utricle indehiscent ________ 3. *A. tuberculatus.*
  - DD. Bracts about 2 mm long, with stout midribs. Pistillate tepals present. Utricle circumscissile.
    - E. Pistillate tepals 1–2, lanceolate, with simple midveins. Outer staminate tepals much long and more acute than inner ___________ 4. *A. tamariscinus.*
    - EE. Pistillate tepals 5, spatulate, with branched midveins. Staminate tepals approximately equal, obtuse ________________________ 5. *A. arenicola.*
- CC. Plants monoecious. Tepals 3–5, with simple midveins.
  - F. Upper cymes staminate, lower cymes pistillate. Rigid needle-like axillary spines present ___ 6. *A. spinosus.*
  - FF. Initial flower of each cyme staminate, the others pistillate. Spines absent.

G. Utricle exceeded by bract and longer tepals. Coarse, weedy plants, generally dull green with slight red pigmentation.

H. Tepals reflexed, obtuse or emarginate ______________________________ 7. *A. retroflexus.*

HH. Tepals straight, acute.

I. Terminal inflorescence stiff, simple or with a few widely spaced, long, lateral branches. Bracts very large, the lamina equalling utricle and with a very thick, excurrent midrib. Tepals and stamens 3–5. Style-branches spreading from base ______________________ 8. *A. Powellii.*

II. Terminal inflorescence lax, with many crowded, short, lateral branches. Bracts moderately large, the lamina shorter than utricle, and with a moderately thick and excurrent midrib. Tepals and stamens 5. Style-branches erect ______________________________ 9. *A. hybridus.*

GG. Utricle equalling or exceeding bract and tepals. Ornamental, domesticated plants, often brightly colored.

J. Shorter tepals less than 2 mm long, about ½ as long as utricle. Style-branches erect ______________________________ 10. *A. cruentus.*

JJ. Tepals all over 2 mm long, nearly equalling utricle. Style-branches spreading from base.

K. Tepals all lanceolate, acute. Inflorescence stiff _________ 11. *A. hypochondriacus.*

KK. Inner tepals spatulate, emarginate. Inflorescence lax _____ 12. *A. caudatus.*

1. AMARANTHUS BLITOIDES S. Wats. Map 1.

Prostrate, slightly succulent herbs, much branched, the fully developed leaves often crowded near tips of branches. Leaves usually very small, seldom over 4 cm long, spatulate, obtuse with shortly mucronate tips. Flowers monoecious, in axillary clusters. Bracts scarcely exceeding longer tepals, with slender, shortly excurrent midribs. Tepals 4–5, those of pistillate flowers variable, the larger almost as long as the utricle and with conspicuous, branching, green veins, acuminate, not recurved. Stamens 3. Style-branches short, recurved. Utricle smooth, circumscissile. Seed ca. 1.5 mm in diameter, black, rather glossy.

The species presumably originated in western North America as a pioneer of streambanks, talus, and other naturally disturbed habitats. A few Wisconsin collections are from such places, including the earliest, from Green Bay [Fox River banks at Fort Howard, 1881, *Schuette s.n.* (WIS).]. Conceivably, the species was a rare member of the aboriginal pioneer flora of this area. However, the bulk of its present populations in Wisconsin and in eastern North America in general are growing in artificially disturbed places. It is most abundant in trampled yards, along pathways, roads, and railroad tracks.

This species is named *A. graecizans* L. in the 8th edition of Gray's Manual and in some other floristic works, following Fernald's conclusion that it matches the type of a Gronovian name, cited by Linnaeus as a synonym of *A. graecizans* (Fernald 1954, pp. 139–140). Fernald identified Gronovius' specimen from a photograph on which the critical flower characters are not discernible. Examination of the actual specimen (BM!) together with another Linnaean specimen of *A. graecizans* (1117.3 LINN!) indicates that Fernald was mistaken and supports the contrary conclusion of Thellung (1914, pp. 285–286, 307) and Dandy and Melderis (Fernandes 1957). They found that Linnaeus' material of *A. graecizans* is different from material of *A. blitoides* and that the name *A. graecizans* properly belongs to an Old World species otherwise known as *A. angustifolius*. Thellung, however, believed that *A. graecizans* should be rejected as a *nomen confusum*.

An apparent hybrid with the next species is noted below.

2. AMARANTHUS ALBUS L. Map 2.

Low, stiff, bushy herbs, much branched, with fully developed leaves mainly towards the bases of the branches. Leaves usually very small, seldom over 5 cm long, narrowly spatulate, obtuse, with conspicuously mucronate tips. Flowers monoecious, in axillary clusters. Bracts more than twice as long as tepals, with very narrow laminas and stout, long excurrent midribs. Tepals 3, those of pistillate flowers shorter than the utricle, with simple midveins, acutish, not recurved. Stamens 3. Style-branches very short, erect. Utricle rugose, circumscissile. Seed 1 mm or less in diameter, dark brown, shiny.

The species is a native North American tumbleweed, widely distributed as a pioneer of naturally and artificially disturbed habitats. It was reported as a common weed in Wisconsin on the earliest collections, made in the early 1860's [Madison, Racine, Lead Mines, without dates, *T. J. Hale s.n.*, (all WIS)]. Most Wisconsin collections are from fields, gardens, roadsides, and railroad tracks, but a few are from natural habitats: sandy lakeshores, streambanks, and talus slopes.

Like the preceding, this species has been erroneously identified with *A. graecizans* L. in many floristic works. It agrees well with Linnaeus' specimens of *A. albus* (1117.1 LINN!).

Occasional individuals are known that appear to be hybrids between this and the preceding species, including one from Wisconsin [Waukesha Co.: along railroad near Waukesha, 12 Aug. 1939, *Oppel & Shinners 1337* (WIS)].

3. AMARANTHUS TUBERCULATUS (Moq.) Sauer. Map 3.

Acnida tuberculata Moq.

Acnida altissima (Riddell) Moq. ex Standl.

Prostrate, ascending, or erect annual herbs. Smaller leaves oblong to spatulate, obtuse; larger leaves ovate-lanceolate, acute. Flowers dioecious, in lax, terminal, spike-like or raceme-like thyrses. Bracts about half as long as utricles or staminate tepals, with slender, long-excurrent midribs. Pistillate tepals lacking or rudimentary; staminate tepals 5, nearly equal, midveins not excurrent. Stamens 5. Style-branches short, erect. Utricle smooth or rugose, indehiscent. Seed 1 mm or less in diameter, dark brown, shiny.

The species is native to lakeshores, stream banks, and marshy places in a wide region of the Great Lakes and Upper Mississippi; collected widely in Wisconsin since the mid 19th Century. Most of the collections from Wisconsin, as from the rest of the range, are from natural habitats. However, the species has become locally abundant as a weed, especially along wet ditches and in lowland fields.

Populations often grow where falling water levels expose a strip of bare sand or mud along a stream or lake. Such places offer highly variable lengths of the vegetative period, between germination and onset of the critical photoperiod for flower initiation. Consequently the species appears very heterogeneous vegetatively, although the taxonomically critical flower characters are quite constant. The Wisconsin specimens agree well with Moquin-Tandon's original material (Hort. Genev., Oct. 1847–P!).

Mixed populations of *A. tuberculatus* and weedy monoecious amaranths are common, yielding occasional sterile hybrids. In Wisconsin, the monoecious parent is usually *A. retroflexus* [Brown Co.: river banks below shanty town, Green Bay, 27 Sept. 1881, *Schuette s.n.*. Dane Co.: Madison, 14 Aug. 1890, *Cheney s.n.*. Sheboygan Co.: Sheboygan, 2 Aug. 1922, *Goessl s.n.*. Iowa Co.: Arena, 3 Oct. 1925, *Fassett 2633*. Pierce Co.: sandy river shore, Prescott, 30 Aug. 1927, *Fassett 5314* (all WIS)]. Recently *A. Powellii* has also begun hybridizing with *A. tuberculatus* [Dane Co.: lowland cornfield by University Bay, Madison, 27 Sept. 1951, *Sauer 1592* (WIS)]

4. AMARANTHUS TAMARISCINUS Nutt. *(See note below No. 6)*
Acnida tamariscina (Nutt.) Wood.

5. AMARANTHUS ARENICOLA I. M. Johnston. *(See note below No. 6)*

6. AMARANTHUS SPINOSUS L.

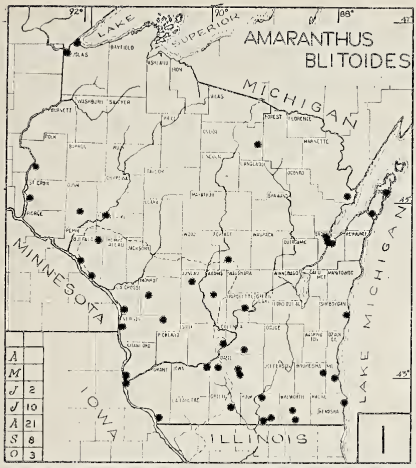
These three species are not treated in detail here, as they have not established themselves within the state, although they may be expected occasionally as ephemeral, adventive waifs. The first two are common riverbank pioneers and weeds in a wide belt between the Mississippi River and the Rockies. *Amaranthus spinosus* is a world-wide weed of tropical and warm temperate regions. *Amaranthus tamariscinus* has been found in two areas in Wisconsin [Milwaukee Co.: Milwaukee, no date, *Sartwell s.n.* (GH). Sheboygan Co.: railroad yards, Sheboygan 28 Aug. 1903, 9 Sept. 1914, one perhaps a hybrid with *A. tuberculatus, Goessl s.n.* (both WIS)]. A single plant of *A. arenicola* was found [Rock Co.: along railroad, Beloit, 16 Aug. 1942, *Shinners 4647* (WIS)] and the collector of *A. spinosus* noted only three plants present [Jefferson Co.: along railroad near Fort Atkinson, 31 Aug. 1949, *Anthes s.n.* (WIS].

7. AMARANTHUS RETROFLEXUS L. Rough Pigweed. Map 4.

Erect coarse herbs, sometimes much branched. Leaves medium sized, generally at least 15 cm long when mature, ovate, rhombic-oval, or lanceolate, usually obtuse. Flowers monoecious, in thick, stiff, panicle-like terminal thyrses, with many short, crowded lateral branches. Bracts far exceeding tepals and utricles, with thick, shortly-excurrent midribs. Tepals 5, those of pistillate flowers exceeding the utricle, with simple midveins, obtuse or emarginate, recurved. Stamens 5. Style-branches medium long, erect or slightly recurved. Utricle slightly rugose, circumscissile. Seed 1 mm in diameter, dark brown, shiny.

One of the commonest temperate-zone pigweeds, now spread around the world but probably originally native to eastern North America. It was already widespread in Wisconsin during the last half of the 19th Century. A small part of the Wisconsin populations occupy natural habitats, especially sandy lakeshores, but the species is usually found as a weed in gardens, fields, dumps, and roadsides. The Wisconsin specimens agree well with Linnaeus' original material (1117.22 LINN!).

Hybrids with *A. tuberculatus* occur, as noted above. Recently, *A. Powellii* has begun mixing with *A. retroflexus,* and some sterile hybrids have resulted (map 5). All of these were collected since 1922 in artificially disturbed sites.


AMARANTHUS BLITOIDES
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
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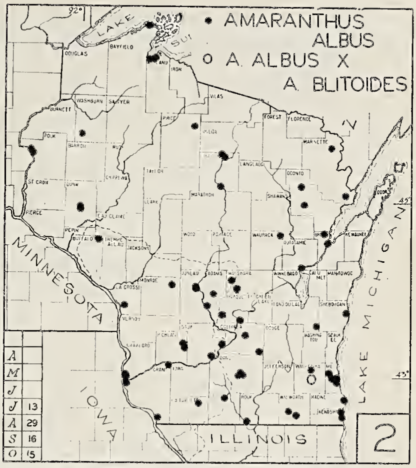
O 3
1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o A. ALBUS X A. BLITOIDES
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IOWA
ILLINOIS
LAKE MICHIGAN
A
M
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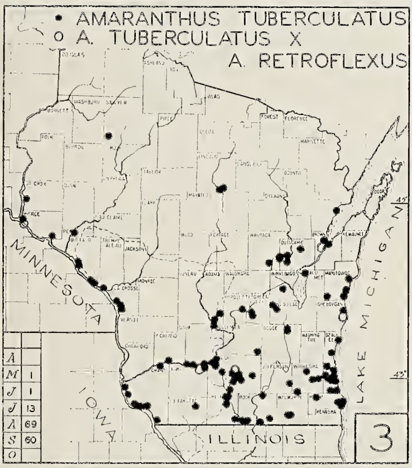
A 29
S 16
O 15
2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o A. TUBERCULATUS X A. RETROFLEXUS
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
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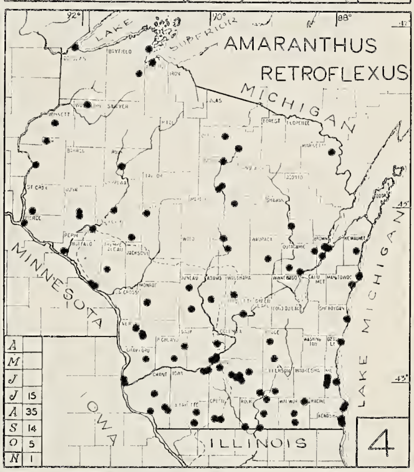
A 69
S 60
O
3


AMARANTHUS RETROFLEXUS
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
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A 35
S 14
O 5
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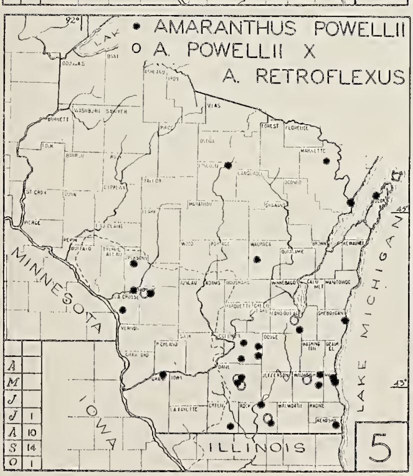
• AMARANTHUS POWELLII
o A. POWELLII X A. RETROFLEXUS
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
A
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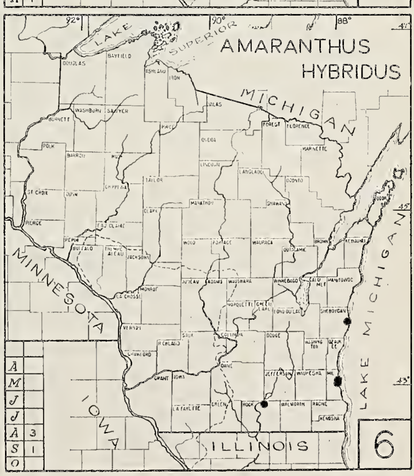
J
J 1
A 10
S 14
O 1
5


AMARANTHUS HYBRIDUS
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
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8. AMARANTHUS POWELLII S. Wats. Map 5.

Erect, coarse, much branched herbs. Leaves rather small, generally under 10 cm long, ovate, rhombic-oval, or lanceolate, usually obtuse. Flowers monoecious, in long, thick, stiff, spike-like, terminal thyrses, some with a few, long, widely-spaced lateral branches. Bracts far exceeding tepals and utricles, with thick, moderately excurrent midribs. Tepals 3–5, the longer ones of pistillate flowers exceeding the utricle, with simple midveins, acute, nearly straight. Stamens 3–5. Style-branches long, recurved from base. Utricle slighly rugose, circumscissile. Seed about 1¼ mm in diameter, dark brown, shiny.

The species is apparently native to desert washes, mountain canyons, and other open habitats in western North America and the Cordillera of Central and South America. It has long been a common weed in the western U. S., particularly in irrigated land, and has recently been migrating eastward along roadsides and in cultivated ground. There were a few isolated collections of the plant from Wisconsin before 1939: Sheboygan Co.: Sheboygan, 28 July, 1903, perhaps cultivated, *Goessl s.n.* Grant Co.: Blue River, 24 Aug. 1927, *Davis, s.n.* (both WIS). The species has been found with increasing frequency since 1939, over two-thirds of the present collections dating from after 1955. It is now abundant in many localities and as mentioned above, is hybridizing with two older residents, *A. tuberculatus* and *A. retroflexus.*

9. AMARANTHUS HYBRIDUS L. Map 6.

Erect, coarse herbs, sometimes much branched. Leaves medium sized, generally at least 15 cm long when mature, ovate, rhombic-oval, or lanceolate, usually acute. Flowers monoecious, in slender, lax, terminal, panicle-like thyrses, with many short, crowded, lateral branches. Bracts slightly exceeding tepals and utricles, with medium thick, long-excurrent midribs. Tepals 5. those of pistillate flowers about equalling utricle, with simple midveins, acute, straight. Stamens 5. Style-branches rather short, erect. Utricle rugose, circumscissile. Seed about 1 mm in diameter, dark brown, shiny.

Aboriginally, this species was presumably a river-bank pioneer in tropical America and the warmer parts of eastern North America. As a weed of artificial habitats, it has migrated around the world and become one of the commonest amaranths. It is a conspicuous weed of cornfields and soybean fields through most of Illinois and established populations extend barely across the border into Wisconsin [Rock Co.: cornfield near Edgerton, 5 Sept. 1952, *Sauer 1597* (WIS)]. Occurrences farther north in Wisconsin may represent only ephemeral adventives [Sheboygan Co.: Sheboygan, 5 Aug. 1914, *Goessl s.n.* (WIS); Milwaukee Co.: heaps of top soil brought in for grading, waste ground, Milwaukee, 15–20 Aug. 1939, *Shinners, 983, 985* (MIL)].

10. AMARANTHUS CRUENTUS L. *(See note below No. 12)*
A. paniculatus L.

11. AMARANTHUS HYPOCHONDRIACUS L. Prince's Feather. *(See note below No. 12)*
A. flavus L.
A. leucocarpus S. Wats.

12. AMARANTHUS CAUDATUS L. Love-lies-bleeding.
A. sanguineus L.

These three species are not treated in detail here, because they have not established themselves within the state. All three are ancient cultigens, domesticated as grain crops in the highlands of Central America, Mexico, and South America, respectively. Each species has both dark and light seed color forms and a variety of plant leaf color forms, some of which have been given Latin names, although they are simple Mendelian variations that segregate within progenies. These species are now grown as ornamentals around the world and often sold in commercial flower seed packets. All three have undoubtedly been repeatedly planted and occasionally escaped in Wisconsin, although rarely collected. There is only one known collection of A. CRUENTUS [Dane Co.: along railroad track, Madison, Oct. 1938, *Shinners s.n.* (WIS)]. AMARANTHUS HYPOCHONDRIACUS has been collected 10 times, beginning late in the 19th century, always in urban areas in the southeastern part of the state; only one of these specimens is known to have been a volunteer [Dane Co.: dump near Madison, 22 Aug. 1945, *Hale & McCabe s.n.* (WIS)]. There is only one known collection of A. CAUDATUS [Dane Co.: Madison, Oct. 1924, *Davis s.n.* (WIS)].

The Wisconsin material agrees well with Linnaeus' specimens (*A. cruentus:* 117.24; *A. paniculatus:* 117.20; *A. hypochondriacus:* 117.24; *A. flavus:* 117.23; *A. caudatus:* 117.26; *A. sanguineus:* 117.21—all LINN!).

2. FROELICHIA Moench Cottonweed

Erect to procumbent, hairy annual herbs with simple, opposite, entire, sessile or petiolate, apiculate leaves from often swollen nodes, the stems sometimes squarish. Flowers perfect, each subtended by two deciduous scarious bracteoles and one persistent scarious bract, densely spiral in spicate, paniculate inflorescences. Perianth tube woolly, apically 5-lobed, in age becoming strongly indurate and bearing two longitudinal irregularly toothed wings as well as (usually) a single tubercle on one face and a pair of tubercles on the other. Staminal tube membranaceous, the 5 oblong 1-locular anthers alternating with the 5-ligulate lobes. Pistil ovoid; style elongate; stigma capitate. Utricle membranaceous, indehiscent. Seeds smooth, tan to dark red-brown, ovoid, with annular embryo and farinaceous endosperm, usually germinating while still encased within the mature perianth.

KEY TO SPECIES

A. Mature fruiting perianths 5.0–5.5 mm (rarely less) high, flask-shaped, the neck rising more or less straight above the basal portion (Fig. 1). The larger of the 2 bracteoles generally 3 mm or more long. Flowers arranged in a 5-rowed spiral (twist until 5 rows come into line). Seeds mostly over 1.5 mm high, dark reddish-brown; larger leaves mostly 10–30 mm wide ---------------------------------- 1. *F. floridana.*

AA. Mature fruiting perianths rarely over 4 mm high, conic, the neck portion usually rising in a more or less asymmetrical "lop-sided" fashion above the basal portion (Fig. 1). The larger of the two bracteoles rarely more than 2 mm long. Flowers arranged in a 3-rowed spiral (twist until 3 rows come into line). Seeds mostly under 1.5 mm, tannish; larger leaves mostly 5–10 mm wide --------------------- 2. *F. gracilis.*

The species appear to be distinct with no known evidence of hybridization or other taxonomic complexity. Confusion in their identity usually is a result of over-reliance on unstable characters, especially the nature of the mature perianth wings, whose expression depends primarily upon relative maturation. Differences in habit (mentioned below) are relatively constant except in the case of young plants which, apparently under the primary influence of short photoperiods, may commence flowering while vegetatively quite different from normal.

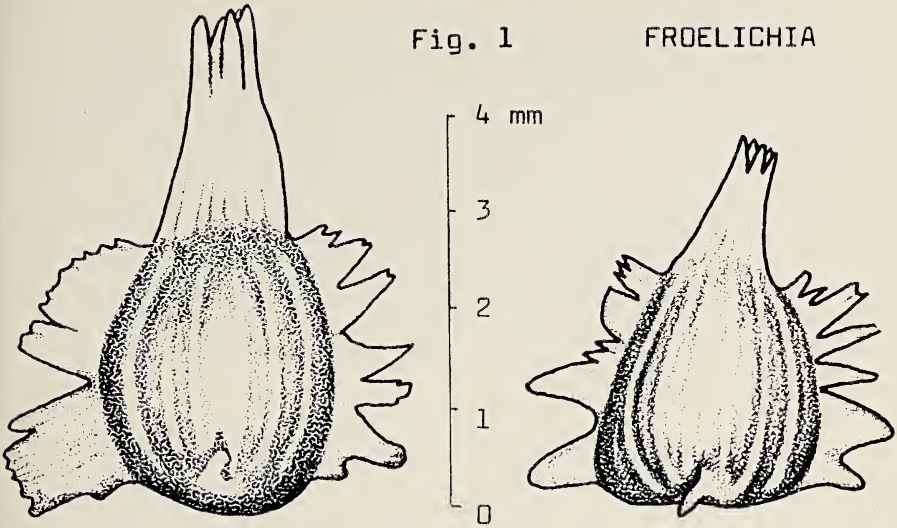
1. FROELICHIA FLORIDANA (Nutt.) Moq. Cottonweed

Map 7; fig. 1.

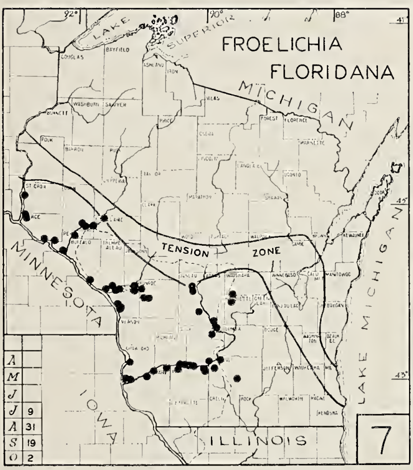
Erect or ascending tomentulose herbs with usually stout, mostly quadrangulate stems, simple to sparingly branched at base, (3–) 4–8 dm tall. Leaves thickish, papillose-puberulent above, sericeous-tomentose beneath, the larger mostly 10–27 mm wide, short-petiolate, typically *elliptic-oblanceolate* with obtuse apices and tapering bases, the uppermost reduced, subsessile and linear- to elliptic-oblong. Flowers 5-ranked (which may be seen by twisting inflorescence until 5 straight rows come into line), the mature spikes 11 (8–12)[1] mm in diameter, averaging 17 flowers/cm. Bracts acumi-

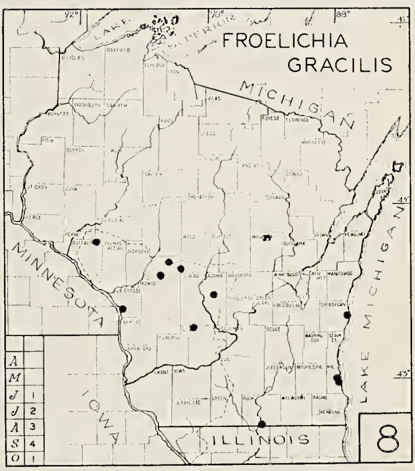
[1] The first number indicates the mean, the parenthetical numbers the size range in Wisconsin.

Fig. 1 FROELICHIA



FLORIDANA GRACILIS





nate, stramineous to blackish-brown. Bracteoles slightly unequal, the larger 3.4 (3.0–3.7) mm high. Mature perianth indurate, 5 (4.0–5.6) mm high, cottony, the neck symmetrically erect. Lobes of the staminal tube 1.0 (0.7–1.5) mm long. Anthers 0.8 (0.6–09) mm long. Seeds 1.6–1.8 mm high, dark reddish-brown and rather glossy.

Though the variational patterns within this range are not yet clearly defined, the range of the species usually is considered to extend from Delaware to Colorado, southeastward to Texas and Florida. The Wisconsin plants may be designated as var. *campestris*

(Small) Fern. with probable validity, inasmuch as they do vary considerably from the more southern typical variety. It is known (Davidson, unpublished) that these differences (mostly size distinctions) are maintained under greenhouse conditions. The species throughout its range seems restricted to sandy soil conditions and is often a prevalent pioneer in disturbed areas, in SW Wisconsin, south of the Tension Zone, in dunes, sandy prairie remnants, fields, and sand terraces along major rivers and in the central Wisconsin sand plains; near Arena, Iowa Co., or in SW Jackson Co., in "sand-blows" with *Polygonella articulata, Oenothera rhombipetala, Aristida tuberculosa,* and *Hudsonia tomentosa,* with *Pinus banksiana* nearby. Flowering and fruiting from mid-July to mid-September (October).

2. FROELICHIA GRACILIS (Hook.) Moq. Slender Cottonweed. Map 8; fig. 1.

Slender, erect to procumbent annual tomentulose herbs with stems usually terete and divergently branching at base, 2–4 dm tall. Leaves thickish, mostly papillose-puberulent above, sericeous-tomentose beneath, *linear* to *lanceolate* or *lance-elliptic,* the largest with mostly acute apices, 5–10 mm wide, the uppermost reduced. Flowers 3-ranked (which may be seen by twisting inflorescence until 3 straight rows come into line), the mature spikes 8 (6–9) mm in diameter, averaging 8 flowers/cm. Bracts acuminate, stramineous to blackish-brown. Bracteoles slightly unequal, the larger 2 (1.1–2.3) mm high. Mature perianth indurate, 4 (3.4–4.3) mm high, silvery sericeous, the neck oblique. Lobes of the staminal tube 0.5 (0.4–0.6) mm long. Anthers 0.5 (0.4–0.6) mm long. Seeds 1.2–1.4 mm high, tan to yellowish brown, rather dull.

This species usually is considered indigenous west of the Mississippi River from Iowa or Nebraska to Colorado, southward to Texas, Arizona and Chihuahua. Its range has expanded eastward in recent years, having been reported since 1924 as adventive in Illinois, Indiana, Ohio, Pennsylvania, Maryland, New Jersey, New York and Virginia (Blake, 1956). Although *F. floridana* has been known in Wisconsin since at least 1861 [Pepin Co.: Pepin, 1861, *Hale s.n.* (MINN, WIS)] and was collected several times during the late 19th century, *F. gracilis* apparently was not known in Wisconsin until 1927 [Sheboygan Co.: coal yard, Sheboygan, Aug. 1927, *Goessl s.n.* (WIS)]. In this state, as in others east of the Mississippi River, the species occurs in sandy, gravelly, or cindery soil, mostly along railroads, less frequently along roads, and in adjacent waste places. Flowering and fruiting from late June to early September (October).

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PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN NO. 46. CARYOPHYLLACEAE—PINK FAMILY[1]

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This treatment of the Caryophyllaceae of Wisconsin is based on specimens in the following herbaria: University of Wisconsin, Madison (WIS); Milwaukee Public Museum (MIL); University of Minnesota, Minneapolis (MINN); Chicago Natural History Museum (F); Northland College, Ashland; University of Wisconsin—Milwaukee; Iowa State College, Ames, Iowa; Eau Claire State Teachers College; Platteville State Teachers College; and Saint Norbert's College, De Pere.

Dots on the maps represent specific locations of collections, and triangles represent county records. The numbers in the map corner insets list the amount of flowering and fruiting material studied, and indicate approximate flowering and fruiting seasons for the species. The manuscript text is based in part on *The New Britton and Brown Illustrated Flora* (Gleason, 1952), and on *Gray's Manual of Botany*, Ed. 8 (Fernald, 1950). County records for Illinois, where given, are based mostly on the maps of Jones and Fuller (1955) and Winterringer and Evers (1960), those for Minnesota on preliminary maps prepared by Dr. Max Partch (St. Cloud, Minn.), to whom we extend our thanks.

Thanks and acknowledgment for loans of Wisconsin Caryophyllaceae are due Drs. Henry C. Greene, Curator of the Cryptogamic Herbarium, University of Wisconsin; M. J. Fay, Eau Claire State Teachers College; Eugene Hsi, Northland College; Emil P. Kruschke, Milwaukee Public Museum; John R. Millar, Chicago Natural History Museum, Gerald B. Ownbey, University of Minnesota; Richard W. Pohl, Iowa State College; Alvin L. Throne, University of Wisconsin—Milwaukee; and Russell D. Wagner, Platteville State Teachers College. Thanks are also due Dr. Carroll E. Wood, Jr., Harvard University, Cambridge, for information on Wisconsin *Herniaria;* Mr. Max A. Gratzl, for the excellent photographs of *Scleranthus;* Mr. Donald Ugent, for critically reading parts of the manuscript; Mrs. Russell Rill, for use of her excellent private herbarium of the Waupaca region; Mrs. Katherine S. Snell, Herbarium Assistant, for ready, cheerful assistance in the course of this study; and Miss Kathryn L. Wollangk and Mr. Stephen W. Gilson, for aid in the preparation of the maps.

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CARYOPHYLLACEAE OF WISCONSIN

Annual to perennial herbs, with *stems often swollen at the nodes. Leaves simple, entire, opposite* or rarely whorled, often narrow and small. Inflorescence of bracteate cymes. Flowers mostly perfect, hypogynous or rarely perigynous, regular, (4–) 5-merous. Sepals free, or fused and forming a tube, persistent in fruit. Petals free, usually 5, (or cleft to the base and appearing as 10), or rarely lacking. Stamens usually twice the number of petals. Styles 2–5 (rarely 1, 2-parted). Ovary 1–3-celled (or 5-celled in *Lychnis alba)*, with 1 to many ovules on basal or free-central placentae. Fruit a 1-seeded utricle or a few- to many-seeded capsule. Seeds usually with curved embryo surrounding a mealy albumen (perisperm).

The Wisconsin Caryophyllaceae, or Pinks, are predominantly a group of weedy species of open and disturbed places. Fewer than half of the species of Wisconsin Caryophs are native to the state and occur mostly as members of distinct plant communities with only several in weedy habitats. The majority of the Caryophs in Wisconsin are not native to the state or to North America, but are introduced and naturalized from Europe and Asia. Included here are many pestiferous weeds, which may have been inadvertently introduced, such as the "chickweeds" and Cockle or White Campion, as well as a number of showy garden species brought from the Old World, such as Maiden and Cottage Pinks, Carnations, and Catchflys. Some of these have escaped from cultivation and have become established locally as members of the Wisconsin flora, including Baby's Breath *(Gypsophila)* and Sweet William. All species of Caryophyllaceae known to be growing without cultivation in Wisconsin have been listed in this treatment of the family, one of which *(Scleranthus perennis)* is here reported for the first time for North America.

KEY TO GENERA

A. Sepals free from each other the entire length (in genera 1 and 2 only slightly fused at base or forming a perigynous calyx-tube around the ovary, with stamens inserted on the tube and with the free calyx-teeth longer than the calyx-tube); flowers generally less than 1 cm long.
   B. Fruit an indehiscent 1-seeded utricle; petals lacking; styles 1 or 2.

C. Leaves with scarious stipules; sepals free their whole length to slightly fused at base; style 1, at tip 2-parted (PARONYCHIEAE) ________________ 1. PARONYCHIA.

CC. Leaves without stipules; sepals fused into a perigynous calyx-tube at base; styles 2 (SCLERANTHEAE) ____ 2. SCLERANTHUS.

BB. Fruit a several- to many-seeded capsule, opening by valves or teeth; petals 4 or 5, rarely 1–3 or lacking; styles 3–5; mostly weak-stemmed or small herbs (ALSINOIDEAE).

D. Styles 5; capsule with 5 or 10 valves or teeth.

E. Leaves filiform, appearing whorled, with minute scarious stipules; petals entire, shorter than the sepals or slightly longer _______ 3. SPERGULA.

EE. Leaves with flat blades, opposite, without stipules; petals notched at tip or cleft nearly to base (thus sometimes appearing as 10), equalling to longer than the sepals.

F. Capsule ovoid, with 5 often bifid valves; leaves ovate, the larger 3–6 cm long and 2–3 cm wide __________________________ 4. MYOSOTON.

FF. Capsule cylindrical, often curved at end, with 10, often twisted teeth; largest leaves smaller, if ovate 1.5 cm or less wide 5. CERASTIUM.

DD. Styles 3 or 4 (rarely 5); capsule with 3, 4, or 6 (rarely 8) valves or teeth.

G. Leaves filiform, appearing whorled, with scarious stipules; petals pale rose; rare weed _______________________________________ 6. SPERGULARIA.

GG. Leaves filiform to ovate, oblong, or elliptic, opposite, without stipules; petals white.

H. Sepals usually 4 (sometimes 5); styles as many as, and alternate with the sepals; capsule with 4 teeth; small, tufted plant, with linear, mucronate leaves; northern Wisconsin; very rare weed _______________ 7. SAGINA.

HH. Sepals 5; styles 3, rarely 4; capsule with 3 or 6 (rarely 4 or 8) valves or teeth.

I. Petals 5, entire or rarely emarginate; styles 3 ______________________ 8. ARENARIA.

II. Petals 5, but deeply cleft (often almost to the base) and sometimes appearing as 10; styles 3 or 4 ___________ 9. STELLARIA.

AA. Sepals fused into a definite calyx-tube, the 5 free calyx-teeth less than half as long as the tube, or, if longer than the tube, over 1 cm long; flowers usually over 1 cm long, showy; small or large herbs (SILENOIDEAE).

J. Flowers subtended at base or on pedicel by 2–6 appressed bracts lying flat against the calyx.

K. Calyx many-nerved; petals dentate or lacerate; flowers over 1 cm long; leaves linear to ovate _ 10. DIANTHUS.

KK. Calyx with 5 major ribs ending in teeth; petals with a shallow notch; flowers under 1 cm long; leaves linear-filiform; small, wiry herb ____________ 11. TUNICA.

JJ. Flowers on naked pedicels, or the bracts *not* immediately below the calyx and not appressed.

L. Capsule 4-toothed; styles 2; calyx strongly 5-ribbed or only obscurely many-nerved.

M. Calyx strongly 5-angled, with green, winged ribs ________________________________ 12. VACCARIA.

MM. Calyx tubular or broad-campanulate, obscurely nerved.

N. Calyx over 1.5 cm long, 2-lipped, 5-toothed; leaves ovate to ovate-lanceolate or elliptic _______________________________ 13. SAPONARIA.

NN. Calyx under 1 cm long, not lipped, but with 5 prominent teeth; leaves mostly linear ___________________________________ 14. GYPSOPHILA.

LL. Capsule with 5 or more teeth; styles 3 or more; calyx 10- or 20-nerved or ribbed (this often most noticeable near the *base* of the calyx).

O. Calyx teeth 1.5–5 cm long, longer than the petals; flowers magenta purple _____ 15. AGROSTEMMA.

OO. Calyx teeth to 10 mm long, shorter than, or rarely equalling the petals.

P. Capsule normally with 5 or 10 teeth; styles (of female flowers) normally 5 (3–9); *flowers red or magenta-purple and perfect, or white and imperfect* (if white-flowered, plants never with styles or capsules as well as stamens visible on the same plant) ______________ 16. LYCHNIS.

PP. Capsule with 6 teeth; styles 3; *flowers pink or white, all perfect* (if white-flowered, plants sometimes with styles or capsules as well as stamens visible on the same plant) _17. SILENE.

1. PARONYCHIA Mill. Whitlow-wort.

[Core, E. L. The North American species of *Paronychia*. Amer. Midl. Nat. 26:369–397. 1941.]

Erect slender annuals, dichotomously branching, the minute flowers in the axils of branches or in cymes. Leaves opposite, often white- or black-dotted; stipules scarious, subtending the leaves and the bracts of flowers. Sepals 5, often fused slightly at base, when mature with cucullate, mucronate tip. Petals lacking. Stamens 2–5. Styles 1, 2-parted at the apex. Fruit a globose utricle containing a single, dark, shiny, round seed.

KEY TO SPECIES

A. Upper branches of inflorescence puberulent; at least some upper leaves minutely ciliate with short, antrorse hairs; sepals usually with 2 or 3 longitudinal ridges, and with obsolete or very narrow white margins ______________ 1. *P. fastigiata.*

AA. Upper branches of inflorescence glabrous; leaf margins smooth; sepals smooth or with one central ridge (this rarely with lateral ridges), and with well-defined, whitish, papery margins ________________________________ 2. *P. canadensis.*

1. PARONYCHIA FASTIGIATA (Raf.) Fern. Forked Chickweed; Whitlow-wort. Map 1.

Anychia polygonoides Raf.

Stems 5–28 cm tall, erect or reclining, always *puberulent on the upper branches,* often throughout. Main stem-leaves oblanceolate or narrowly elliptic, mostly acute, 10–23 mm long, 2–5 mm wide; bracts always, and lower and middle stem leaves often very minutely antrorsely ciliate. Stipules lanceolate, papery, those of the bracts shorter than to several mm longer than the sepals. *Sepals linear-lanceolate,* 1.1–1.4 mm long, *with 2 or 3 prominent longitudinal ridges* (10X). Utricle shorter than the sepals.

Native, but rather rare and sporadic in Wisconsin, mainly in the "Driftless Area" in the Black, Chippewa, Wisconsin, and Mississippi River valleys, on sandstone ledges, bluffs, and in thinly wooded to open, sandy places, such as lake shores and roadsides; on top of sandstone bluffs on sterile sand under scattered *Pinus resinosa,* Long Bluff, Camp Douglas (Juneau Co.); dry sandstone ledge, upland woods on Trempealeau Mountain, Perrot State Park (Trempealeau Co.); sand bar, Dells of the Wisconsin River (Sauk Co.); and moist sandy beach, Eau Claire Lake (Eau Claire Co.). Flowering and fruiting from July to late September (October).

KEY TO VARIETIES

A. Upper stipular bracts lanceolate, equalling or shorter than the calyx; flowers much crowded on the ultimate branches; plants usually reddish or brownish when mature _________________ ___________________________ 1a. *P. fastigiata* var. *fastigiata.*

AA. Upper stipular bracts lanceolate-attenuate, equalling or longer than the calyx; flowers generally not crowded on the ultimate branches; plants usually greenish when mature ____ 1b. *P. fastigiata* var. *paleacea.*

Although var. *paleacea* Fern. is distinguished by Fernald (1936, 1950) from var. *fastigiata* solely on the stipular bract character, the other differences listed in the key have been noted in Indiana by Deam (1940) and generally apply to the Wisconsin specimens as well. Deam also noted that in Indiana var. *paleacea* has an earlier flowering season. This is true in Wisconsin as well, where most of the collections were made from early July to mid-August, while collections of var. *fastigiata* were made from late August to October. One collection (*Peterson 152,* 25 September, Onalaska, La Crosse Co. [WIS]) contains one reddish plant of var. *fastigiata* and two greenish plants of var. *paleacea,* which were apparently growing together at the same station. On the other hand, 50 individuals from the same population, collected on a sand bar at Tower Hill State Park, Iowa Co., were all var. *fastigiata.* Although these varieties are usually distinct, several of the collections (*e.g., Schlising & Musolf 1795, Grether 6641,* and *Peterson 710*) seem to be intermediate in stipular bract length.

Paronychia fastigiata var. *paleacea* often somewhat resembles *P. canadensis* in its greener aspect and less densely-flowered branches.

2. PARONYCHIA CANADENSIS (L.) Wood. Forked Chickweed; Whitlow-wort. Map 2.

Anychia canadensis (L.) Ell.

Similar to *P. fastigiata* in size and branching, but with upper branches more delicate, leaves less acute and broader, and the inflorescence more open. *Glabrous throughout.* Main leaves obovate, oblanceolate, or elliptic, 10–21 mm long, 3–9 mm wide, entire, eciliate. Stipules of inflorescence ovate-lanceolate, shorter than the sepals. *Sepals oblong-ovate,* 0.8–1.3 mm long, with *prominent, white, scarious margins,* often with a central rib (rarely with 2 lateral ones). Utricle longer than the sepals.

Native, mainly in the "Driftless Area" of southern Wisconsin, here reaching its northern limit; in dry, bare and sterile soil, on slopes and cliffs, especially common on sandstone ledges, occasionally on limestone; in Red Oak-White Oak woods and on wooded dry sandstone ledges, top of Trempealeau Mountain (Trempealeau Co.); soil pocket on Niagara Dolomite boulders, Blue Mounds State Park (Iowa Co.); and rarely on xeric prairie. Flowering and fruiting from the first of July through September.

HERNIARIA CINERIA DC., Rupture-wort, a native of Europe somewhat resembling *Paronychia* or a creeping *Euphorbia,* is a spreading, grayish, short-hispid annual with tiny, ciliate stipules and opposite, oblong leaves, the 5-parted calyx enclosing the 1-seeded, indehiscent nutlet. The sole specimen, annotated by L. C. Wheeler in 1937, is labelled: "Green Bay, 1870, recd. May, 1871, Dr. J. M. Antoine, Brussels, Door County," and is in the Gray Herbarium, Harvard University. The collector, a Belgian botanist, wrote to Asa Gray in an undated letter (*ca.* 1871) that he collected the species in sandy terrain in the vicinity of Green Bay, and points out that the species was not included in Gray's Manual. *Herniaria* has not been recollected here, and Antoine himself (1871) did not include it in his note on the flora of Wisconsin. (Information courtesy of Carroll E. Wood).

2. SCLERANTHUS L. KNAWEL

Low herbs with forked, pubescent, wiry stems and numerous minute greenish flowers in tight cymes. Leaves minute, estipulate. Sepals fused at base to form a perigynous calyx tube, becoming thick and hard in fruit. Petals lacking. Stamens (1–) 10, inserted on calyx tube below the calyx teeth. Styles 2, distinct. Fruit a hard, one-seeded utricle, persistently enclosed by the calyx. Old World.

KEY TO SPECIES

A. Calyx teeth acute, with a narrow scarious border at the tip; subtending bracts usually equalling or longer than the flowers; annual (Fig. 1–3.) ________________________ 1. *S. annuus.*

AA. Calyx teeth elliptic, blunt or rounded, and with a conspicuous white scarious border at the tip; subtending bracts shorter than the flowers; perennial (Fig. 1–3.) ______ 2. *S. perennis.*

1. SCLERANTHUS ANNUUS L. Annual Knawel. Map 3; Figs. 1–3.

Small annual or biennial, much branched from the base, with branches ascending or reclining, 3–14 cm long. Leaves linear-subulate, the larger 5–25 mm long, the connate bases ciliate. *Inflorescence bracts usually equalling or longer than the flowers.* Calyx mostly 2.4–4 mm long, the *teeth acute,* bordered at the tip with a narrow scarious margin. *Calyx teeth in fruit erect or slightly spreading,* free from each other most to all of their length. Stamens half as long as the calyx teeth or shorter.

Naturalized from Europe. A rare weed in Wisconsin: Manitowoc Co.: roadsides, sandy soil, Cleveland, 1907, *Goessl s.n.* (WIS). Sheboygan Co.: sand dunes, 3 miles south of Sheboygan on Lake Michigan, 1927, *Wadmond s.n.* (MINN, WIS). Barron Co.: sand delta, Prairie Lake, Cameron, 1938, *Fassett 19927* (WIS). Douglas Co.: firelane road near Stone's Bridge, 1942, *Thomson 5094* (WIS). Lincoln Co.: sandy roadside, 1950, *Seymour 11650* (WIS); and sandy shore of Lake Nokomis, 1950, *Seymour 12406* (MIL, WIS). Flowering and fruiting from July to September.

2. SCLERANTHUS PERENNIS L. Perennial Knawel.
Map 4; Figs. 1–3.

Small perennial, 3–10 cm tall, often with dead leaves at the base. Similar to *S. annuus,* but stems usually more ascending and less branched at base, with numerous, short internodes below the major branching. Larger leaves 5–12 mm long. *Bracts of inflorescence shorter than the flowers.* Calyx mostly 2.5–4 mm long, with *blunt or rounded elliptic teeth,* with wide, white, scarious border at the tip. *Calyx teeth usually bending together in fruit,* over-lapping one another and in contact for much of their length. Stamens nearly as long as the calyx teeth.

A Eurasian weed, occurring from Europe to Asia Minor, the Caucasus, Armenia, and Siberia (Hegi, 1908), established in south-

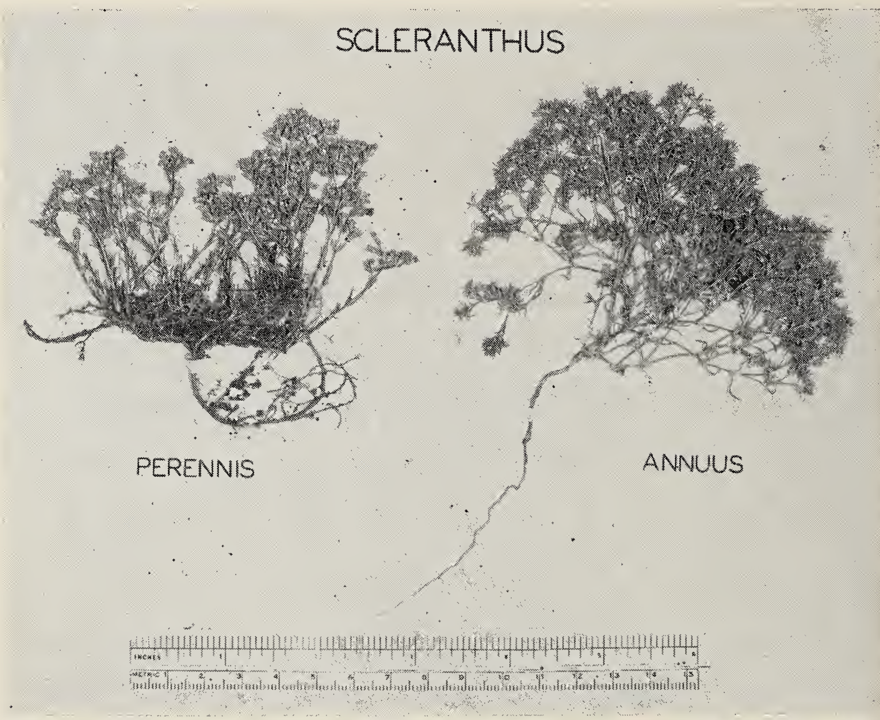


FIGURE 1. *Scleranthus perennis (Fassett 21635), S. annuus (Fassett 19927).*

FIGURE 2. *Scleranthus annuus* (top), *S. perennis* (bottom). Same plants as in Figure 1. Scale on left in mm.

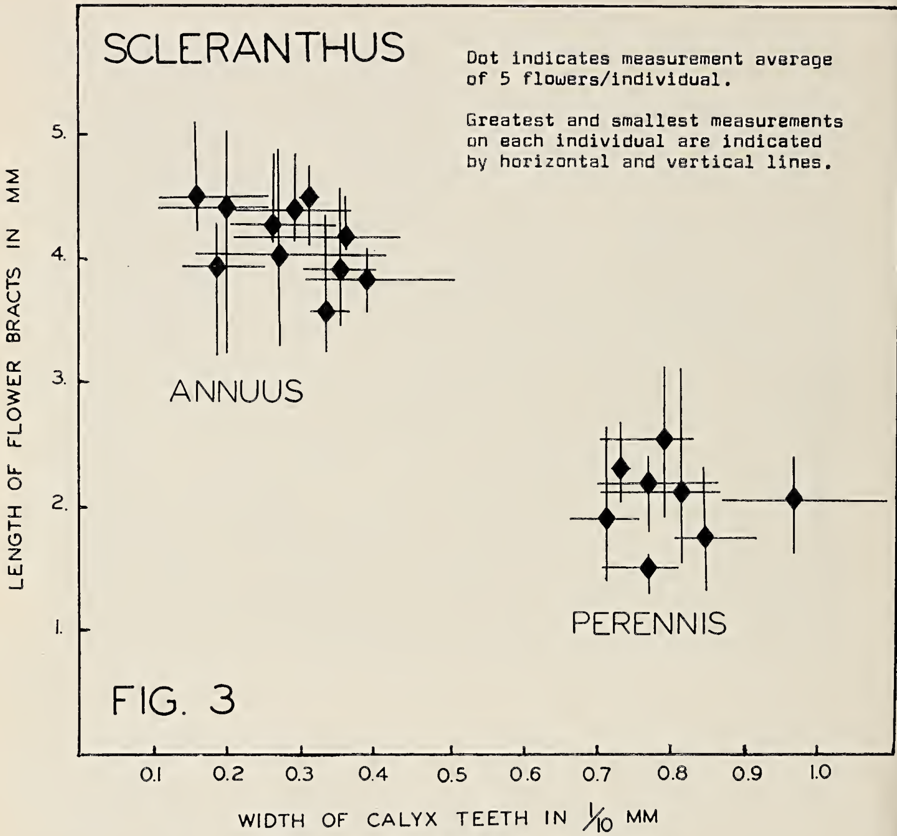


FIGURE 3.

central Wisconsin in sandy, disturbed areas: Juneau Co.: Camp Douglas, 1928, *Davis s.n.* (WIS); prairie along county trunk H, Camp Douglas, *Wills s.n.* (WIS); abundant mat-forming weed in sandy lawn, Mauston, 1958, *Curtis & Greene s.n.* (WIS). Marquette Co.: sandy pasture, Montello, 1937, *Fassett 20418* (WIS); sandy roadside, abundant in pastures, Montello, 1942, *Fassett 21635* (MIL, MINN, WIS). Sauk Co.: Lake Delton, 1941, *Schorta s.n.* (WIS). Columbia Co.: sand dunes near Fox River, Fort Winnebago, 1948, *Seymour 10313* (WIS). Flowering and fruiting from late June to September.

Scleranthus perennis is listed here for the first time as occurring in Wisconsin, and it appears, for the first time in North America as well.

All fourteen collections of Wisconsin *Scleranthus* studied were labelled *S. annuus*. Since taxonomic manuals and floras all list *S. annuus* as having very narrowly bordered calyx teeth, the broad, white, scarious borders of the calyx teeth in part of the Wisconsin collections readily indicated an unusual variant. It was not difficult to demonstrate that not only *S. annuus,* but also the Eurasian *S. perennis* listed in European floras (Hegi, 1908; Karsten, 1895; Clapham, Tutin, and Warburg, 1952) does occur in Wisconsin. Measurements were taken of 19 plants from the 14 Wisconsin collections labelled *S. annuus.* Width of calyx teeth (0.5 mm from tip of the tooth) was plotted on the horizontal axis of a scatter diagram, and length of bracts subtending upper flowers on the vertical axis. The resulting Figure 3, where averages as well as extremes of measurements for any one individual are indicated, *shows two clearly separated groupings of individuals.* The wider-toothed, shorter-bracted individuals do have all the characters listed in European floras for *S. perennis,* and compare very well with European collections such as *Mattisson 3751* from Skåne (Sweden), or *Klástersky s.n.,* 1938, from Bohemia (both WIS), except that the Wisconsin collections seem smaller. The other group on the scatter diagram contains individuals bearing all the characters listed for *S. annuus.*

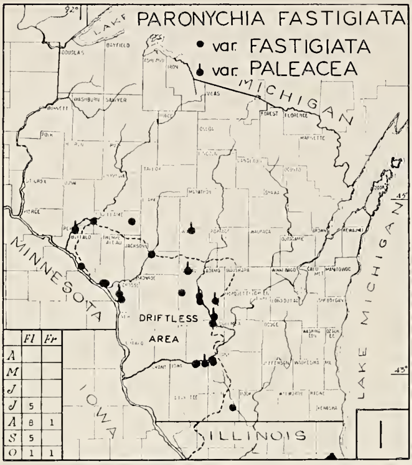
The Wisconsin collections of *S. perennis,* although made over a thirty-year period (with the first collection in 1928), all came from a comparatively small area in the central Wisconsin "sand counties." All the plants here may very probably be the progeny of one original introduction of *S. perennis.*

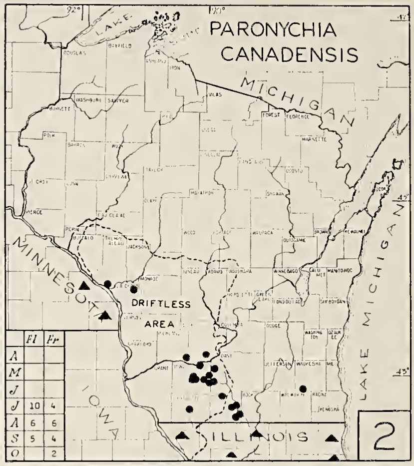
3. SPERGULA L. Spurrey

1. Spergula arvensis L. Spurrey; Corn Spurrey. Map 5.

Annual with flowering stems 1–6 dm long, simple or with 2–18 weak ascending branches from the base, nearly glabrous below to glandular-hairy in the inflorescence. *Leaves filiform, in opposite clusters at the nodes,* often glandular-hairy, mainly 1–5 cm long, with tiny *scarious stipules.* Inflorescence cymose, dichotomous. Sepals 5, ovate, blunt, scarious or scarious-margined, 1.5–4 mm long, often glandular-hairy. Petals 5, white, entire, to sometimes longer than the sepals. Stamens 10 or 5. Styles 5. Capsule 5-valved, longer than the sepals. Seeds 1–1.5 mm wide, black with white papillae and with a very narrow white concentric wing-margin.

Naturalized from Europe, a weed of sandy areas in northern and central Wisconsin, mainly in cultivated or neglected fields, roadsides, and lake shores, locally abundant in Marathon County in pea and potato fields, the one collection from southern Wisconsin from a strawberry patch in Dane County, 1953, where in subsequent years it did not persist *(Thomson s.n.* [WIS]); in dry, sandy field with *Comptonia peregrina, Hieracium aurantiacum* and *Robinia*


PARONYCHIA FASTIGIATA
• var. FASTIGIATA
var. PALEACEA
LAKE
MICHIGAN
MINNESOTA
DRIFTLESS AREA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 5
A 8 1
S 5
O 1 1
1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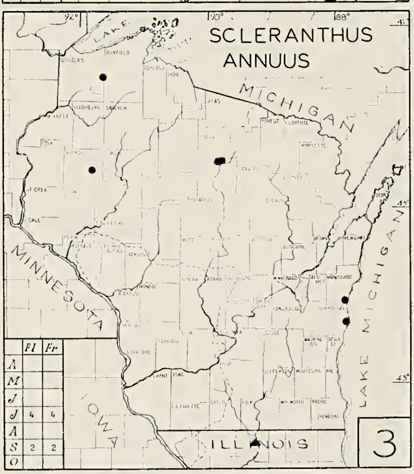
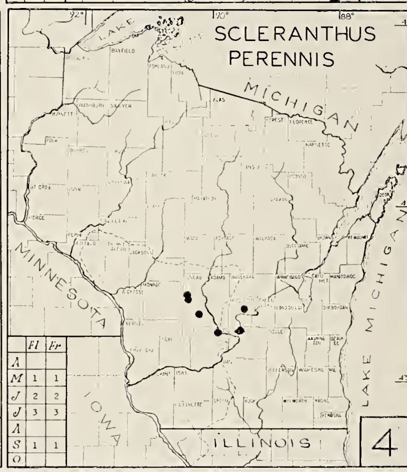
LAKE
MICHIGAN
MINNESOTA
DRIFTLESS AREA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 10 4
A 6 6
S 5 4
O 2
2


SCLERANTHUS ANNUUS
LAKE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 4 4
A
S 2 2
O
3


SCLERANTHUS PERENNIS
LAKE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M 1 1
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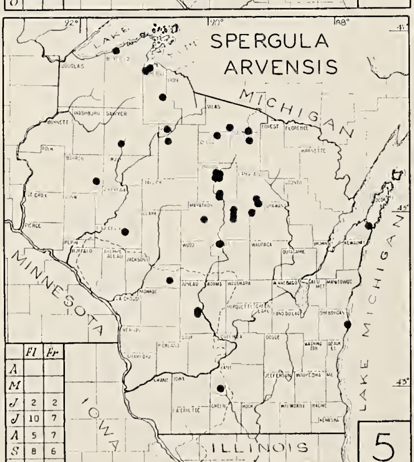
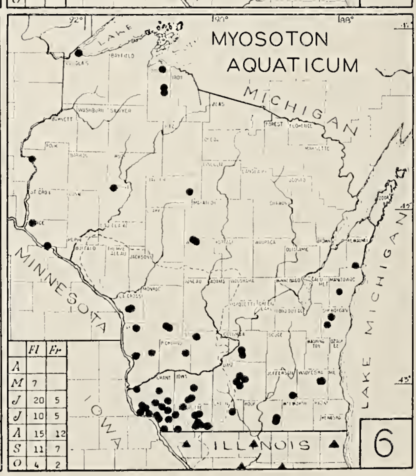
A
S 1 1
O
4


SPERGULA ARVENSIS
LAKE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 2 2
J 10 7
A 5 7
S 8 6
O
5


MYOSOTON AQUATICUM
LAKE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M 7
J 20 5
J 10 5
A 15 12
S 11 7
O 4 2
6

pseudo-acacia (Lincoln Co.); in sandy roadside with *Linaria canadensis* and *Paronychia fastigiata* (Juneau Co.); and in a cranberry marsh (Jackson Co.). Flowering and fruiting from mid-June until mid-September.

4. MYOSOTON Moench. Giant Chickweed

1. Myosoton aquaticum (L.) Moench. Giant Chickweed.
Stellaria aquatica (L.) Scop. Map 6.

Reclining or upright perennial, glabrous at base to densely glandular-hairy above. Flowering stems weak, from 1–6 (–10) dm long, often much branched in the cymose inflorescence. *Larger leaves narrowly to broadly ovate or elliptic, 3–7 cm long, 1.5–3.5 cm wide,* often cordate at base, *sessile,* the lower sometimes petioled. Flowers long-pediceled, in the axils of reduced foliage leaves. Sepals ovate-lanceolate, 5–9 mm long. *Petals 5, white, deeply notched, longer than the sepals.* Stamens 10. *Styles 5.* Valves of capsule 5, often bifid. Seeds orbicular-reniform, brown, rough-acute-warty, 0.8–0.9 mm wide.

Naturalized from temperate to arctic Eurasia, occurring mainly in southwest Wisconsin but also scattered in other areas, usually in moist situations, especially on rocky, gravelly and shady streamsides, in roadside ditches, pastures, abandoned old fields, seepage bogs, alder thickets, sedge meadows, and shady wood borders, or in oak or maple woods; on damp or wet sandstone cliffs along and above streams in open sun, with *Sullivantia* and *Mimulus glabratus* (Grant Co.); in moist, lowland floodplain forest of *Acer nigrum, Quercus bicolor, Ulmus,* and *Tilia* (Vernon Co.); on steep, damp, densely wooded limestone slope with maple, basswood, and oaks (Lafayette Co.); first collected in the state in 1910, with most of the early collections from weedy habitats, since then often collected, especially in southwest Wisconsin, in native communities, where often it seems very much at home. Flowering from the last week of May to the first week of October, and fruiting from mid-June to early October.

Extreme variation occurs in this species, and small or depauperate specimens are sometimes confused with *Stellaria media.* They may be distinguished as follows:

Myosoton aquaticum	Stellaria media
1. Upper stem pubescent with scattered hairs.	1. Upper stem pubescent in lines.
2. Petals longer than sepals.	2. Petals shorter than sepals or none.
3. Styles 5.	3. Styles 3.
4. Mature capsule 5-valved.	4. Mature capsule 6-valved.

5. CERASTIUM L. Mouse-ear Chickweed

[Fernald, M. L., and K. M. Wiegand. Studies of some boreal American Cerastiums of the section Orthodon. Rhodora 22:169–179. 1920.]

Low, generally pubescent herbs with opposite, estipulate leaves. Sepals 5, scarious-margined. Petals 5, white or pale pink, the apex notched or cleft to the middle. Stamens 10 or 5. Styles 5. Mature capsule cylindrical, usually upward-curved at the end and exceeding calyx, scarious, with 10, often twisted teeth.

Key to Species

A. Inflorescence bracts subtending pedicels green and leaflike throughout, not scarious on the margin, ciliate; teeth of opened (mature) capsule 0.5–0.9 mm long; viscid annual, often with very weak stems ________________ 1. *C. nutans.*

AA. Inflorescence bracts subtending pedicels scarious, or green with scarious margin especially near the apex (the lowermost bracts often leaflike), ciliate or eciliate; teeth of opened (mature) capsule 0.9–1.6 mm long; perennials generally with upright habit, but often with stems decumbent at the base.

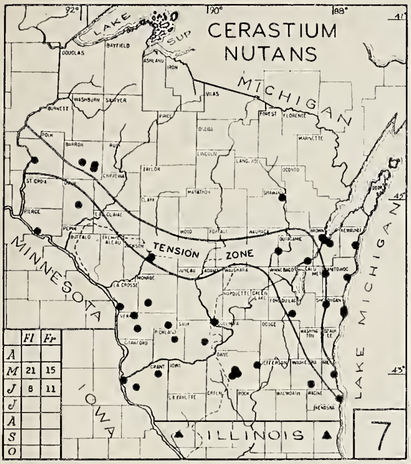
  B. Petals showy, 8–12 mm long, 3–7 mm longer than the sepals; axils of stem leaves with sterile leafy short-shoots, the plants therefore very leafy; plants of sandy areas ____________________________________ 2. *C. arvense.*

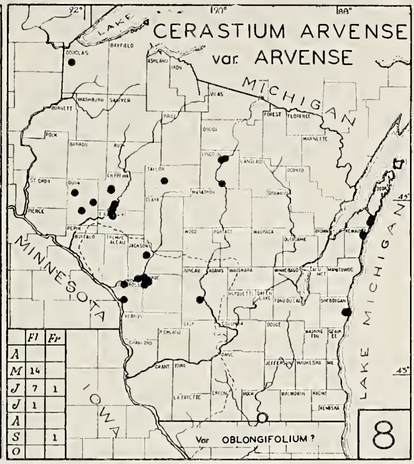
  BB. Petals 3–8 mm long, shorter than to rarely longer than the sepals; sterile shoots rarely present in the leaf axils; ubiquitous weed ______________________ 3. *C. vulgatum.*

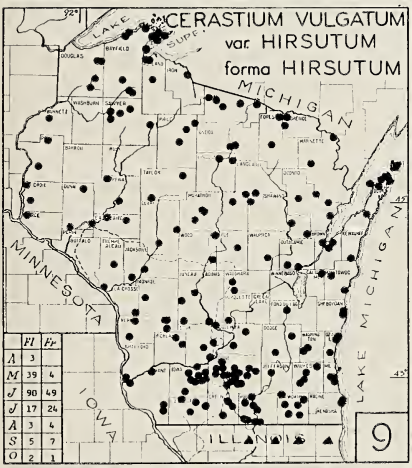
1. Cerastium nutans Raf. Nodding Chickweed. Map 7.

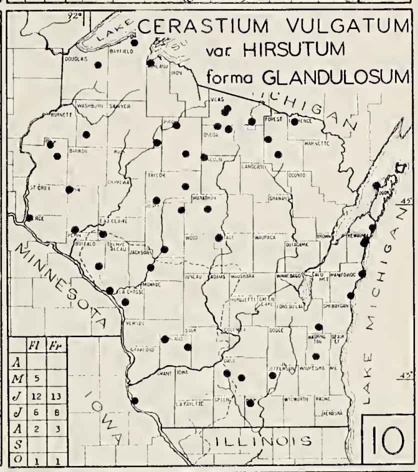
Rather weak annual, 1–4 dm tall, often viscid with glandular hairs. Main stem leaves acute, 1.4–5.4 cm long, 0.3–1.3 cm wide, ovate to lanceolate or oblanceolate, nearly glabrous to heavily viscid-pubescent on both surfaces. *Bracts of inflorescence herbaceous, without translucent margins.* Sepals 4–6 mm long, shorter than the 5–7 mm long white petals. Capsule curved, 6–12 mm long, with teeth 0.5–0.9 mm long. Pedicels in fruit typically 1–5 cm long, usually curved downward at the tip.

Native, mostly south of the Tension Zone, occasional, most often in dry or mesic oak or maple woods, in moist areas of sand or gravel such as creek beds and tops or bases of limestone or sandstone bluffs, and sometimes weedy along railroads and roadsides. Flowering from about the second week of May through the first third of June.


CERASTIUM NUTANS
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
M 21 15
J 8 11
7


CERASTIUM ARVENSE var. ARVENSE
MINNESOTA
IOWA
LAKE MICHIGAN
Var. OBLONGIFOLIUM ?
Fl Fr
M 14
J 7 1
J 1
S 1
8


CERASTIUM VULGATUM var. HIRSUTUM forma HIRSUTUM
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A 3
M 39 4
J 90 49
J 17 24
A 3 4
S 5 7
O 2 1
9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IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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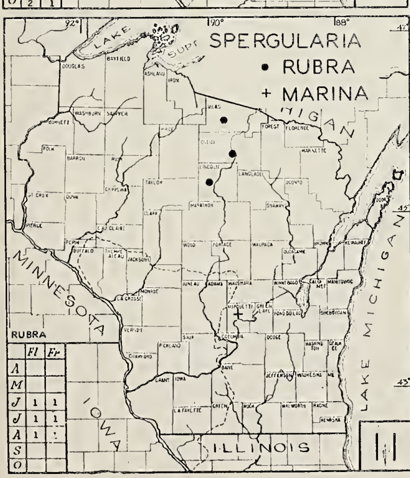
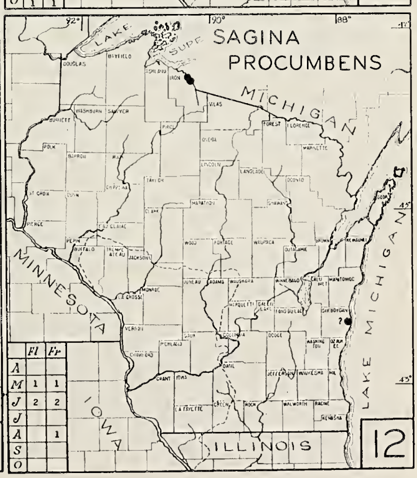
J 6 8
A 2 3
O 1 1
10


SPERGULARIA
• RUBRA
+ MARINA
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
RUBRA
Fl Fr
J 1 1
J 1 1
A 1
11


SAGINA PROCUMBENS
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
M 1 1
J 2 2
A 1
12

2. CERASTIUM ARVENSE L. var. ARVENSE. Field Chickweed. Map 8.

Matted perennial with tufts of leaves (short-shoots) in axils of most stem leaves, giving plants a bushy appearance, the branch bases decumbent. Stems pubescent, 10–26 cm tall. Leaves linear to narrow-lanceolate or oblanceolate, acute, 10–33 mm long and 1–5 mm wide, sparingly to densely pubescent, sometimes glandular. Inflorescence rather stiff and erect, pubescent throughout, the *bracts* and sepals *scarious-margined,* the sepals acute, 5–7 mm long, pubescent, sometimes glandular. *Petals 8–12 mm long, white and rather showy,* with a 2–3 mm deep cleft. Capsule 6–9 mm long, 2–2.5 mm wide, the elongate teeth about 1.5 mm long.

Native, mainly in west-central Wisconsin and along the Lake Michigan shore, in dry, open, usually sandy places such as river banks, sand dunes, and open woods; sandy prairies at edge of scrubby *Pinus banksiana-Quercus velutina* woods, with *Tradescantia ohiensis, Lithospermum croceum,* and *Selaginella rupestris* (NW Monroe Co.); and rarely weedy in old fields and roadsides. Flowering from early May through mid-June, and fruiting from June to September.

All Wisconsin individuals are densely leafy, and belong to var. *arvense.* However, two old and somewhat incomplete collections from Beloit are more loosely branched, have larger leaves somewhat farther upward on the stems, and are probably referable to Var. OBLONGIFOLIUM (Torr.) Holl. & Britt.: Rock Co.: Beloit, May 22, 1875, *Swezey s.n.* (WIS), May 29, 1895, *G. B. Olds s.n.* (WIS).

3. CERASTIUM VULGATUM L. var. HIRSUTUM Fries. Common Mouse-ear Chickweed. Maps 9 & 10.

Hirsute perennial of extremely varied habit and appearance. Leafy shoots often present at the base. Stems 4–45 cm tall. Leaves 5–30 mm long, 2–12 mm wide, ovate or lance-ovate to oval or oblong, the lower often spatulate, *hirsute on both surfaces.* Inflorescence forking, with *scarious-margined bracts,* only the lowermost herbaceous. Sepals scarious-margined, 4–7 mm long, usually hirsute, sometimes glandular. *Petals slightly shorter than to rarely longer than the sepals.* Pedicels mostly 5–13 mm long in fruit, bearing *curved capsules* 7–11 mm long, 2–3 mm wide.

Naturalized from Eurasia, very abundant throughout Wisconsin in a great variety of disturbed or open habitats, such as sandy roadsides, lawns, gardens, pastures, cultivated fields, waste places, and along railroads, frequent on sandy lake shores and stream banks, the Lake Michigan sand dunes, and on bluffs; occasionally in a number of forest types: aspen-spruce-fir, oak-basswood-cherry, oak-hickory, basswood-elm-maple, and mature hemlock-sugar maple. Flowering from latest April through the first third of July (October), with a flowering peak in mid-June. Fruiting from late May through July (October).

Key to Forms

A. Upper branches of the inflorescence hirsute, with none of the hairs bearing glands ____ 3a. *C. vulgatum* var. *hirsutum* forma *hirsutum.*

AA. Upper branches of the inflorescence hirsute, with all of the hairs bearing glands ________ 3b. *C. vulgatum* var. *hirsutum* forma *glandulosum.*

The non-glandular forma HIRSUTUM (Map 9) is more common in Wisconsin than the glandular forma GLANDULOSUM (Boenn.) Druce (Map 10), which, though widely distributed in the state, is most common in the north. Both glandular and completely non-glandular plants have been observed in the same population.

CERASTIUM VISCOSUM L., reported for Wisconsin by Fassett (1957), is a more southern species with smaller flowers. No collections have been seen from the state.

CERASTIUM TOMENTOSUM L., Snow-in-Summer, a white-tomentose, mat-forming perennial to 40 cm tall, with leaves 3–5 cm long, is frequently grown in gardens in Wisconsin, the two collections evidently representing escapes: Milwaukee Co.: spreading from garden, lake shore south of Atwater Beach, Shorewood, *Shinners s.n.* (WIS). Kewaunee Co.: weedy open sandy places, dump along Lake Michigan, *Iltis & Buckmann 10826* (WIS).

6. SPERGULARIA J. & C. Presl. Sand Spurrey

[Rossbach, R. P. *Spergularia* in North and South America. Rhodora 42:57–70, 105–143. 1940.]

Small annuals with decumbent or erect stems, to 15 cm long. Leaves filiform, opposite, the secondary shoots at the nodes making leaves appear whorled. Stipules scarious, prominent, 1.5–4 mm long. Flowers small. Sepals 5, ovate, blunt, scarious-margined, longer than the 5 dull pink, entire petals. Stamens 2–10. Styles and valves of capsule 3. Seeds minutely papillate.

Key to Species

A. Stipules triangular-acuminate, markedly longer than broad; capsule about as long as calyx; stamens 6–10 ___ 1. *S. rubra.*

AA. Stipules triangular, almost as broad as long; capsule longer than calyx; stamens 2–5 _____________________ 2. *S. marina.*

1. SPERGULARIA RUBRA (L.) J. & C. Presl. Red Sand Spurrey. Map 11.

Tissa rubra (L.) Brandegee.

Stems several to many times branched at base, decumbent. Plants nearly glabrous to densely glandular-hairy, especially in the inflorescence. Main leaves 0.6–2 cm long, 0.4–1 mm wide, mucronate. *Stipules conspicuous, triangular-acuminate, 1.5–4 mm long. Sepals* 2.5–4 mm long, longer than the petals and *about as long as the capsule.* Stamens 6 (–10). Seeds about 0.5 mm long.

Naturalized from Eurasia, in Wisconsin a rare weed of sandy areas, with only three collections (all WIS): Oneida Co.: Hugo Sauer Nursery near Rhinelander, 1958, *Weber 69.* Vilas Co.: Trout Lake State Forest Nursery, in seed bed and lawn, 1959, *Iltis 13074* (persisting and abundant in 1961!). Lincoln Co.: sand of fire lane, Town of Harding, 1952, *Seymour & Schlising 14424.* Flowering all summer.

2. SPERGULARIA MARINA (L.) Griseb. Salt-marsh Sand Spurrey Map 11.

Tissa marina (L.) Britton.

Stems simple or with 2–6 branches from base. Plants glabrous, especially in the lower portions, to densely glandular-hairy in inflorescence. Leaves mostly 1.5–3.5 cm long, about 1 mm wide, often slightly mucronate. *Stipules deltoid, mostly 2–3 mm long, clasping (sometimes encircling) node. Sepals* 2.8–3.5 mm long, *shorter than the capsule.* Stamens (2–) 3 (–5). Seeds 0.6–0.7 mm long.

Native of Europe, probably introduced in America; collected in only one locality in Wisconsin, at abandoned Soo Line Railroad station in Westfield, Marquette Co.: sand and cinders, 1941, *Shinners 4006* (WIS), and sandy roadsides and edges of vacant lots, 1960, *Schlising & Musolf 1771* (WIS).

7. SAGINA L. PEARLWORT

1. SAGINA PROCUMBENS. L. Pearlwort; Birdseye. Map 12.

Tiny matted or tufted perennial (somewhat resembling *Arenaria stricta),* to 10 cm tall, *glabrous throughout. Leaves linear, mucronate, 3–18 mm long,* often with short-shoots in their axils, estipulate. Pedicels capillary, often hooked or recurved at the summit. Sepals normally 4, sometimes 5, oval or oblong, with rounded apex, 1.8–2.5 mm long. Petals the same number as sepals, entire, shorter than sepals, or sometimes absent. Stamens 4 or 5. Styles 4 or 5, alternate with the sepals. Capsule 4-valved, equalling or longer than the sepals.

A circum-boreal species, possibly native to northern Wisconsin, but here mainly from weedy habitats, with all but one collection made in 1929 and 1930 from near Hurley, Iron County: woods and pasture, *Bobb 225* (WIS, NORTHLAND), roadside ditch, *Fassett 9541* (WIS), roadside, base of bluff near Lake Lavina, *Fassett 10761* (WIS), and 2 miles west of Hurley, *Knowlton s.n.* (WIS). *Goessl s.n.* (WIS), from "Lawn city park," *sine. loc.,* probably came from Sheboygan.

8. ARENARIA L. Sandwort

[Maguire, B. Studies in the Caryophyllaceae V. *Arenaria* in America North of Mexico. Amer. Midl. Nat. 46:493–511. 1951]

Delicate small herbs with sessile estipulate leaves. Inflorescence 1 to many-flowered. Sepals 5. *Petals 5, white, entire* (rarely emarginate). Stamens normally 10. *Styles 3.* Capsule ovoid or conic, splitting into 3 valves, in some species each valve 2-cleft and splitting nearly to base.

Key to Species

A. Leaves with expanded, ovate to lanceolate blades; capsule with 6 teeth; plants pubescent and leaves ciliate (pubescence reduced to minute knobs and ciliation essentially lacking in No. 3).
- B. Leaves broadly ovate, not over 6 mm long; sepals usually with minute, white, stalked glands; petals shorter than sepals; plants creeping; eastern Wisconsin -- 1. *A. serpyllifolia.*
- BB. Leaves oblong or elliptic to lance-ovate or lanceolate, over 6 mm long; sepals without glands, glabrous, pustulate, or sparsely pubescent; petals longer than or (rarely) shorter than sepals.
  - C. Leaves oblong to elliptic or lance-ovate; usually blunt, ciliate, the midrib pubescent beneath; sepals obtuse, shorter than the petals; common, southern Wisconsin-------------------------------------- 2. *A. lateriflora.*
  - CC. Leaves lanceolate or lance-ovate, acute, nearly eciliate, the midrib glabrous beneath; sepals acuminate, longer than the petals; rare, northern Wisconsin -- 3. *A. macrophylla.*

AA. Leaf blades linear or linear-subulate, entire; capsule with 3 teeth; plants glabrous, mat-forming ---------- 4. *A. stricta.*

1. Arenaria serpyllifolia L. Thyme-leaved Sandwort. Map 13.

Pubescent annual with weak, often decumbent stems, simple or much branched, sometimes to 30 cm tall. *Leaves ovate, ciliate,* the larger 3–6 mm long, often pustulate. *Sepals with whitish pubescence (hairs usually bearing minute whitish glands)*, in fruit 2.4–3.6 mm long, longer than the petals. Capsule elongate-ovoid, with 6 teeth. Seeds black, about 0.5 mm long, tuberculate.

Naturalized from Europe, in eastern Wisconsin west to Dane County, in disturbed, rocky, sandy, mostly calcareous places, such as roadways, ridges, pastures, quarries, gravel pits, on calcareous cliffs, shores and beaches, and in thin soil pockets on Niagara Dolomite.

Some of the specimens studied *(e.g., Rogers s.n.,* from Ephraim, Door Co., [WIS]) have long internodes and a diffuse, spreading habit, and suggest the variety *tenuior* Mert. & Koch as described in Gleason (1952) and Fernald (1950). However, these plants seem more like shade forms hardly warranting varietal distinction.

2. Arenaria lateriflora L. Grove Sandwort; Side-flowering Sandwort. Map 14.

Perennial from slender creeping rhizomes, with upright, simple or branched, retrorsely puberulent stems 10–25 cm tall. *Leaves oblong or elliptic to lance-ovate or lanceolate,* mostly 1.5–3 (3.8) cm long, 0.4–1.5 cm wide, narrowed at the base, acute to obtuse or sometimes rounded at the apex, *ciliate, the midrib pubescent,* often puberulent or pustulate throughout. *Inflorescence (1–) 2–3 (–5) flowered, on long and slender terminal pedicels or from the leaf axils. Sepals* blunt, entire, glabrous, or with few hairs in lines, 2–4 mm long, *shorter than the petals.* Capsule with 3 deeply cleft valves, longer than the sepals. Seeds with an appendage (strophiole) at the hilum.

Native and common in southern, and occasional in western and central Wisconsin, in densely wooded to open, mesic to damp situations, most common in southern floodplain forest, oak, oak-hickory, oak-maple and other deciduous woods, on limestone, sandstone, loam, and sand, as well as on low moist prairies, pastures, river banks, sand bars, thickets, and roadside ditches. Flowering from the second week of May through mid-June (September).

Although *Arenaria lateriflora* is generally thought of as an arctic and boreal species, in Wisconsin it occurs mostly south of the Tension Zone, being absent from a broad region in northern Wisconsin, and from there north to Hudson Bay (Raup, 1947: plate 23)! In Wisconsin it seems to behave more like a southern than a northern species, and one wonders if not two taxa might be involved here.

3. Arenaria macrophylla Hook. Map 14.

Similar to *A. lateriflora* but much less pubescent, the stem hairs minute and barely noticeable with a 10X lens. *Leaves* larger, *lanceo-*

late or lanceolate-elliptic, generally sharply acute and more pointed than those of *A. lateriflora; margins and midrib smooth. Sepals acuminate, longer than the petals* and longer than the 6-toothed capsule.

Native, but very rare in Wisconsin, on cliffs of the igneous Penokee Range (outlined on Map 14), with only two collections known: Ashland Co.: Mossy crevices in bluff, Voght Knob, Foster Junction, *Fassett 5794* (WIS). Iron Co.: basalt cliff west of Hurley, *Fassett 9454* (WIS).

Arenaria macrophylla is a widely disjunct species (Fernald, 1925: Map 31.) with a main range in the northwestern United States, and with localized colonies around Lake Superior, the Gulf of St. Lawrence and in Labrador.

4. ARENARIA STRICTA Michx. Rock Sandwort. Map 15.

Glabrous perennial, often much branched from basal prostrate stems, growing in *dense tufts or mats 3 or 4 cm high,* the basal shoots persistent. *Main stem leaves linear-subulate, stiff and with sharp tips, the lower mostly, bearing dense, leafy short-shoots in their axils.* Upright branches (10–) 15–20 (–30) cm tall, bearing much-forked, slender cymes of delicate white flowers.

A native species of Wisconsin, represented here by two subspecies, one a common plant of dry habitats in the southern and eastern parts, and a second, similar one, rare on a few bluffs in the western and central parts of Wisconsin.

KEY TO SUBSPECIES

A. *Petals longer than sepals,* usually from 1 mm longer to two times the length of sepals; *sepals sharply lance-ovate or acuminate,* with 3 ribs of about equal prominence; capsules mostly shorter than sepals; southern and eastern Wisconsin, common ---------------------------------- 4a. *A. stricta* ssp. *stricta.*

AA. *Petals shorter than to equalling sepals; sepals blunt or acute,* but not long-acuminate, the two lateral ribs usually not as prominent as the midrib; capsules about equalling sepals or longer; western and central Wisconsin, rare -------------------------- 4b. *A. stricta* ssp. *dawsonensis.*

4a. ARENARIA STRICTA spp. STRICTA. Rock Sandwort. Map 15.

Sepals lance-acuminate or sharply lance-ovate, 3.4–5.5 mm long, *strongly 3-ribbed. Petals at least 1 mm longer, to sometimes twice as long as the sepals. Capsule about equalling or shorter than sepals,* with 3 entire valves.

Eastern and southern Wisconsin within the "Region of Limestones," mostly in dry, open, rocky or sandy places, such as tops of calcareous sandstone *(i.e.,* sandstones overlain by dolomites) or (less often) limestone bluffs, as well as on rock outcrops in the very steep, very dry prairies beneath them, on sandy and gravelly hillsides, sand prairies or open woods, sand dunes along Lake Michigan, rarely on rock outcrops in woods or in woods recently converted from prairie. Flowering and fruiting mainly from the last third of May through June (July).

4b. ARENARIA STRICTA ssp. DAWSONENSIS (Britton) Maguire
Northern Rock Sandwort. Map 15.

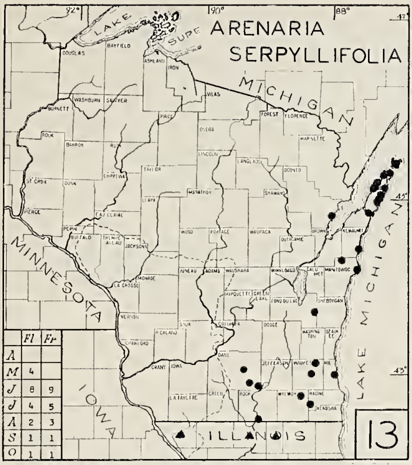
Arenaria dawsonensis Britton.

Similar to ssp. *stricta,* but somewhat smaller, with the leafy short-shoots somewhat more in the leaf axils of the lower half of the plant. *Sepals blunt to acute, but not long-acuminate,* 2.3–4.0 mm long, *the midrib often much more prominent than the lateral ribs. Petals shorter than to equalling sepals. Capsule usually longer than the sepals.*

Collected in only four localities: La Crosse Co.: cliff top, Timber Coulee, 1958, *Peterson 608* (WIS). Vernon Co.: rich "goat" prairie, Coon Valley, 1939, *Marks s.n.* (WIS). St. Croix Co.: top edge of enormous sandstone cliff along the St. Croix River, Boy Scout Camp north of Houlton, 1929, *Fassett 16929* (WIS), and 1960, *Schlising & Musolf 1835* (WIS). Waupaca Co.: dry, rocky bluff south of New London, 1961, *Rill s.n.* (WIS, Private Herbarium K. Rill). A small specimen collected late in the season, apparently from the last locality *(Seymour & Rogers 10397* [WIS]), probably belongs to this subspecies.

In the second St. Croix County collection, some sepals have lateral ribs as prominent as the midrib and are acuminate rather than obtuse; the capsule length is variable, with some capsules longer than the sepals and some shorter. However, the petals are all shorter than the sepals. The 1929 collection from the same locality more completely meets the key characters of ssp. *dawsonensis.* The La Crosse, Vernon, and Waupaca County collections are more clearly distinguishable from ssp. *stricta* on the basis of the key characters than are either of the St. Croix collections.

These four localities of ssp. *dawsonensis* are among the most southern stations of this taxon, the range extending far into the Arctic. Maguire (1951) does not list ssp. *dawsonensis* as occurring in Wisconsin. Fernald (1950) gives the range as from southern Labrador to Yukon, and south to Newfoundland, eastern Quebec, Ungava, western Ontario, Minnesota, South Dakota, and Alberta.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SERPYLLIFOLIA
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MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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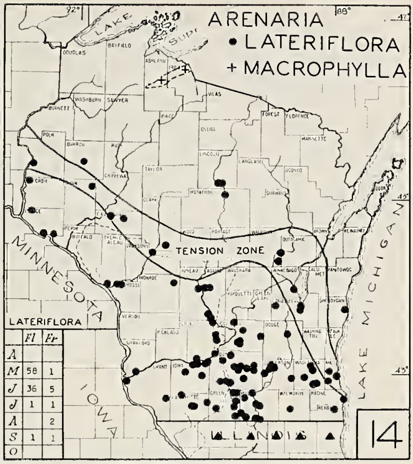
M 4
J 8 9
J 4 5
A 2 3
S 1 1
O 1 1
13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+ MACROPHYLLA
TENSION ZONE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
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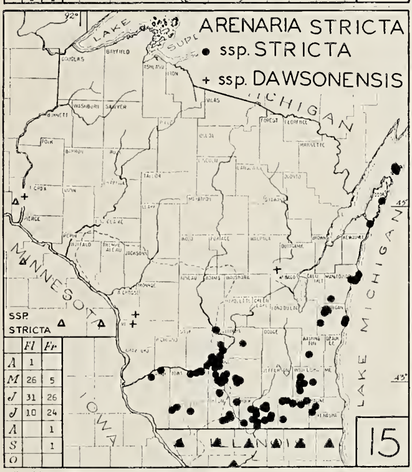
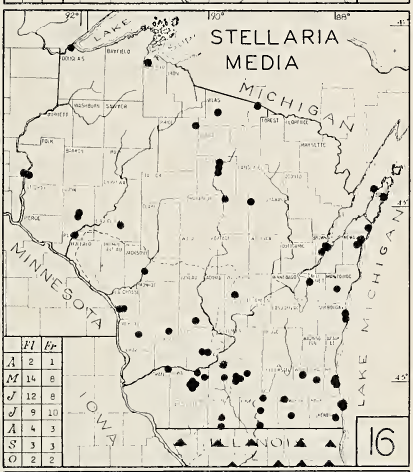
A 2
S 1 1
O
14


ARENARIA STRICTA
• ssp. STRICTA
+ ssp. DAWSONENSIS
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
SSP. STRICTA
Fl Fr
A 1
M 26 5
J 31 26
J 10 24
A 1
S 1
O
15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MEDIA
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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J 12 8
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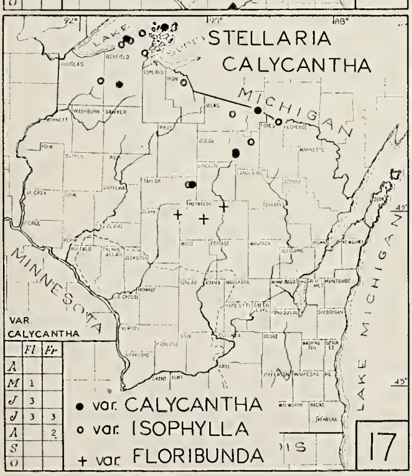
S 3 3
O 2 2
16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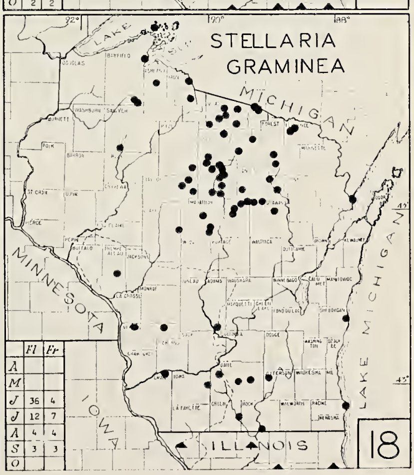
CALYCANTHA
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
VAR CALYCANTHA
Fl Fr
A
M 1
J 3
J 3 3
A 2
S
O
• var. CALYCANTHA
o var. ISOPHYLLA
+ var. FLORIBUNDA
17


STELLARIA
GRAMINEA
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 36 4
J 12 7
A 4 4
S 3 3
O
18

9. STELLARIA L. Starwort; Chickweed

Usually glabrous, delicate herbs, with frequently weak and reclining stems and with estipulate leaves. Sepals (4–) 5. Petals white, usually 5, sometimes 1–4 or lacking, deeply cleft, often nearly to base, the flowers therefore appearing as if 10-petaled. Stamens 10, 8, or fewer. Styles 3 or 4. Capsule ovoid to globose, opening with as many or twice as many valves as styles.

A difficult genus, its great variability in habit often depending on season and habitat. Specimens bearing plentiful flowers or fruit are needed for determination.

Key to Species

A. Flowers solitary or in few-flowered terminal cymes, in the axils of foliage leaves or leaflike bracts; petals shorter than the sepals or lacking.

B. Stems pubescent in lines; middle stem leaves with distinct petioles; sepals pilose at base; seeds tuberculate; common weed ---------------------------------- 1. *S. media.*

BB. Stems glabrous; middle stem leaves sessile or tapered to base, without distinct petioles; sepals glabrous at base; seeds essentially smooth; uncommon, northern Wisconsin ---------------------------------- 2. *S. calycantha.*

AA. Flowers few to many in cymose inflorescences, with scarious bracts subtending the pedicels; petals mostly longer than the sepals.

C. Middle leaves lanceolate to lance-linear or oblanceolate (mostly at least 3 mm wide or wider at widest point), sessile, or narrowly elliptic and attenuated to base; inflorescence clearly terminal and much exceeding the lateral leafy shoots (if any) at its base.

D. Petals shorter than sepals or lacking; sepals 1.5–3.5 mm long; capsule straw-colored or brown to purple-black; uncommon ---------------- 2. *S. calycantha.*

DD. Petals exceeding (equalling) sepals; sepals mostly over 4 mm long.

E. Sepals acute, usually ciliate and strongly 3-ribbed; inflorescence many-flowered; capsule pale brown to straw colored; common ---------- 3. *S. graminea.*

EE. Sepals blunt or subacute, eciliate, without prominent ribs; inflorescence few-flowered or flowers solitary; capsule dark brown to black; rare, northern Wisconsin ---------------------------- 4. *S. longipes.*

CC. Middle stem leaves linear (0.4–) 1–3 (–4) mm wide, often slightly tapered at both ends; inflorescence (especially with age) often appearing lateral, and shorter than to only slightly longer than the prominent leafy shoots at its base, or (in No. 5) inflorescences terminal or on few-flowered lateral branches.

F. Sepals (3.2–) 4.0–6.1 mm long, eciliate; petals usually much exceeding sepals; leaves 0.4–1.2 (–2) mm wide; slender plants, uncommon in central and western Wisconsin ______________________________ 5. *S. palustris.*

FF. Sepals 2.3–4 (–4.4) mm long, eciliate or ciliate; petals equalling or slightly longer than the sepals; leaves 1–4 (–5) mm wide; slender or much-branched, reclining or upright plants common throughout Wisconsin _______ ______________________________________ 6. *S. longifolia.*

1. STELLARIA MEDIA (L.) Cyrillo. Common Chickweed. Map 16.

Upright, reclining, or creeping annual or perennial, very variable, with weak *stems* 5–33 cm long, *pubescent in lines. Leaves broadly ovate to obovate or elliptic,* the *lower long-petioled,* the upper sessile, the blades 5–25 (–35) mm long, 4–20 mm wide, bearing small white blisters (pustules) on surfaces. *Flowers solitary in axils of foliage leaves or in few-flowered cymes,* the bracts leaf-like. Sepals pilose, at least at base, longer than the watery-white petals. Capsule 4.5–6.3 mm long, the 6 straw-colored valves separating to the base. *Seeds* orbicular or squarish, *tuberculate,* 0.9–1.3 mm long.

Naturalized from Eurasia, common in southern Wisconsin, but apparently occurring throughout the state, especially as a weed of lawns and gardens, railroad yards, roadsides and other open or shady disturbed areas as well as in open areas in moist, low woods and on stream banks, occasionally in oak-mixed hardwood forests, on rock outcrops, limestone cliffs, clay, or black loam. Flowering and fruiting from early May through August (October). Specimens bearing flowers are on hand from 31 January and 1 February, 1890, from Madison!

2. STELLARIA CALYCANTHA (Ledeb.) Bong. Northern Starwort.
Stellaria borealis Bigel. Map 17.

Perennial from slender rhizomes, the stems branched, upright to weak and reclining, 5–35 cm long, glabrous. *Leaves* narrowly ovate to elliptic, lanceolate or oblanceolate, or lance-linear, acute, *often slightly ciliate,* 1–5 cm long. *Flowers very small,* solitary in the leaf axils or in branched cymes, subtended by reduced foliage leaves or by minute, scarious bracts. *Sepals 1.6–3.2 mm long,* ovate or lance-ovate, blunt or acute, scarious-margined, weakly veined. *Petals 1–5, shorter than the sepals, or lacking.* Styles 3 or 4. *Capsule straw-*

colored or dark brown to purplish-black, to 5.2 mm long. *Seeds essentially smooth.*

A polymorphic and difficult, rather rare species, native of northern Wisconsin. Flowering from late May through July, and fruiting in July and August.

Three weakly defined varieties, which grade into one another, differing primarily in leaf characters, have been recognized by Fernald (key modified from Fernald, 1950). They are listed here without real understanding of whether genetic or environmental factors are primarily responsible for their slight morphological distinctions.

Key to Varieties

A. Leaves ovate, ovate-lanceolate, or elliptic-lanceolate, the primary ones 0.7–2.5 cm long; flowers often solitary, or in few-flowered cymes ---------- 2a. *S. calycantha* var. *calycantha.*

AA. Leaves lanceolate to lance-linear, the primary ones (2–) 2.5–5 cm long; flowers mostly in several- to many-flowered cymes.

B. *Upper bracteal leaves* reduced, but *herbaceous throughout;* flowers few to many, terminal and axillary ------------- ---------------------- 2b. *S. calycantha* var. *isophylla.*

BB. *Upper bracteal leaves* much reduced to *minute scarious-margined bracts;* flowers numerous in terminal cymes ---- --------------------- 2c. *S. calycantha* var. *floribunda.*

2a. Stellaria calycantha var. calycantha. Map 17.

Leaves narrowly ovate to elliptic or oblanceolate, the largest *to 2.5 cm long. Flowers usually solitary in leaf axils,* sometimes in 2- to 5-flowered cymes.

Rare; in fir-white birch-aspen woods, Apostle Islands (Ashland Co.); north-facing clay bank (in shade), edge of fir-spruce-yellow birch forest, shore of Lake Superior (Bayfield Co.); shore of Lake Bellvue, Delta (Bayfield Co.); and woods, Mosinee Hills, Wausau (Marathon Co.).

Some plants keying out to var. *calycantha (e.g., Lane 2184,* North Twin Island, Ashland Co. [NORTHLAND]), could conceivably be young stages of the next two varieties.

2b. Stellaria calycantha var. isophylla Fern. Map 17.

Leaves lanceolate or lance-linear, the larger 2.5–5 cm long. Flowers few to many, in cymes, in axils of reduced leaves or subtended by *leaflike non-scarious bracts.*

Uncommon; *Thuja-Abies-Betula lutea* deer yard lowland (northeast Forest Co.); basalt cliff west of Hurley (Iron Co.); on mud and debris of abandoned beaver dam, in full sun, Siphon Creek

(Vilas Co.) ; wet *Mnium* moss cushions, with *Mitella nuda,* in open *Thuja-Sphagnum-Ledum* bog (Vilas Co.).

Duplicate collections of *Schlising & Schlising 1950* (Siphon Creek, Vilas Co. [WIS]), all from one colony of plants, contain individuals with small leaves and young, unbranched inflorescences that easily key out to var. *calycantha,* while other, older plants from the same collection, with leaves over 2.5 cm long and branched inflorescences, key to var. *isophylla.* It seems, then, that young plants of this variety (as well as of the next) may easly pass for var. *calycantha* on the basis of the listed varietal differences.

2c. STELLARIA CALYCANTHA var. FLORIBUNDA Fern. Map 17.

Leaves lanceolate or lance-linear, the larger 2.5–3.5 cm long. Flowers numerous, in cymes, subtended by minute scarious bracts.

Rare, with three collections: Clark Co.: wet places, Abbotsford, 1890, *Sandberg s.n.* (F, MINN). Marathon Co.: Granite Heights, 1894, *Cheney s.n.* (WIS) ; Edgar, 1915, *Goessl s.n.* (WIS).

A young individual of this variety cannot be told from var. *isophyllia* or var. *calycantha,* for the *lowermost* flowers are in the axils of foliage leaves. A mature specimen, with many-flowered inflorescences can be readily distinguished from the other varieties on leaf and bract characters, and from *S. longifolia* or from *S. graminea* by leaf, sepal, petal, and seed characters.

3. STELLARIA GRAMINEA L. Grass or Common Stitchwort. Map 18.

Perennial with a weak slender, glabrous, four-angled stem, commonly 2–4 (–6) dm tall. *Leaves narrowly lanceolate or linear-lanceolate, usually broadest a little above the base,* or sometimes (especially late in the season) narrowly elliptical or ovate and petioled. *Inflorescence large* and sometimes half the length of the plant, *terminal,* mostly *without leafy lateral branches from its base, many-flowered,* the bracts scarious, ciliate, and small. *Sepals* scarious-margined, lanceolate, acute, or acuminate, (2.5–) 4.0–6.2 mm long, often ciliate, *usually with three distinctly raised ribs. Petals longer than sepals,* the flowers rather showy. Capsule pale brown or straw-colored, exserted, its valves splitting to the base. *Seeds rugose-tuberculate with fine, sharp ridges,* orbicular-subreniform, 0.8–1.2 mm long.

Naturalized from Europe, most common in the "Northern Highlands" and occasional in southern Wisconsin, in grassy areas, such as moist fields, meadows, pastures, and roadsides, and, less commonly, in tall herbs along streams, gravelly shores of lakes, in sedge meadows, and in mesic to moist, rich Northern Hardwoods. Flowering from early June through July (September), with a flowering peak in the last third of June. Fruiting from mid-June to September.

Late specimens (*e.g., Fassett, Uhler, & McLaughlin 9638* [WIS], Dells of the Wisconsin River, Adams Co.; *Peroutky & Seymour 12971* [WIS], town of Corning, Lincoln Co.) mimic *S. calycantha* in habit and leaves, but may be distinguished by the sepal, petal and seed characters.

4. STELLARIA LONGIPES Goldie. Map 19.

Glabrous perennial from slender rhizomes, with stems (0.5–) 1.5–2 (–3) dm tall. *Leaves* narrowly lanceolate-acuminate, sessile and rounded at base, *stiff and ascending,* 15–20 (–30) mm long, 2–3 mm wide. *Inflorescence terminal,* (1–) 3–9 flowered, with scarious bracts. Sepals ovate to elliptic, acute, or sometimes blunt, eciliate, 3.5–4.5 (–5) mm long, usually weakly 3-nerved. *Petals longer than sepals. Capsule exserted, black.* Seeds oblong to oval, 0.8–1.0 mm long.

A circum-boreal species, *very rare in Wisconsin,* the two specimens from Oneida Co.: one colony, moist, gravelly bank, Rhinelander, 19 June, 1915, *Goessl 532* (MIL); east N. Log. RR, Rhinelander, 16 June, 1915, *Goessl s.n.* (WIS) [possibly the same station].

STELLARIA HOLOSTEA L., Easter-bells or Greater Stitchwort, is a cultivated Eurasian perennial with ciliate, narrowly lanceolate leaves tapered to base, and large white flowers 1.5–2 cm across, the one collection from Milwaukee County: a weed about gardens, Milwaukee, in flower March 16, 1854, *Lapham s.n.* (WIS).

S. STELLARIA PALUSTRIS Retz. Marsh Stitchwort. Map 19.
Stellaria glauca With.

Slender glabrous perennial, 2–4 dm tall, very similar to *S. longifolia,* but usually less branched. *Leaves very narrowly linear,* 1.5–3.5 cm long, *0.4–1.2 (–2) mm wide.* Inflorescences terminal and axillary (only infrequently overtopped by lateral shoots from their bases), the bracts scarious and eciliate. *Sepals lanceolate, acuminate, (3.2–) 4.0–6.1 mm long. Petals conspicuously exceeding sepals,* 5.2–8.5 mm long. Capsule pale. Seeds brownish, with low papillae.

Native to cold-temperate Europe and Asia, locally established in south-central and northwestern Wisconsin in wet places: Marquette Co.: drainage ditch in tamarack bog, Endeavor, *Iltis & Buckmann 11285* (WIS); wet *Carex-Glyceria* meadow (once a *Larix-Rhus vernix* bog), black muck soil, southwest shore of Ennis Lake, *Iltis et al. 6305* (WIS); *Cornus stolonifera* river sand flat, *White 792*

(WIS); sedge meadow, with *Campanula aparinoides, Porter, Anderson, & Post, s.n.* (WIS). Burnett Co.: Searles Cranberry Marsh, Lake Pokegama, Hertel, *Dana s.n.* (WIS). Dane Co.: *Carex filiformis* society, University Bay, Madison, *Heddle 2T177* (WIS). Flowering from mid-June through July.

This taxon is tentatively listed as *S. palustris,* to which it keys out in Gleason (1952) and Fernald (1950) mainly because of its large petals and sepals. However, the several collections of European *S. palustris* in the University of Wisconsin Herbarium generally have larger flowers, as well as wider and more lanceolate leaves than do the Wisconsin collections. Extremely variable in the Old World, Ascherson and Graebner (1929) list no fewer than 14 subspecific taxa within *S. palustris.* In contrast, the Wisconsin specimens are remarkably uniform in their slender habit and *very narrow leaves* and may perhaps belong to forma *angustifolia* Marsson.

Wisconsin *S. palustris* differs from *S. graminea* mainly in the very narrowly-linear leaves, as well as generally more weakly-nerved and eciliate sepals and smaller inflorescences. *Stellaria palustris* differs from *S. longifolia* in Wisconsin by having larger flowers, with petals exceeding the sepals by several mm, narrower leaves, and fewer-flowered inflorescences.

6. STELLARIA LONGIFOLIA Muhl. Long-leaved Starwort.
Maps 20 & 21.

Perennial with weak, usually ascending, 4-angled, glabrous stems, (1–) 1.6–4 (–5.5) dm tall, the angles sometimes scabrous. Leaves linear or narrowly lance-linear to elliptic, often acute at both ends, mostly 1.5–5 cm long, 1–4 (–5) mm wide, sometimes ciliate at the base. Inflorescence few- to many-flowered, usually with leafy lateral branches from its base, these nearly equalling or overtopping it. Bracts scarious, eciliate. Sepals lanceolate, acute, scarious-margined, mostly eciliate, 2.3–4 (–4.4) mm long, often weakly 3-nerved, rarely 3-ribbed. Petals equalling or longer than the sepals. Capsule straw-colored to dark brown or black, well exserted. Seeds oblong, 0.7–1 mm long, essentially smooth.

A native circumboreal species, fairly common in Wisconsin, where strikingly variable and seemingly consisting of two entities, one found throughout the state but most common in the southern part, and the second essentially north of the Tension Zone. These, here listed as varieties, seem to have frequent intermediates which are difficult or impossible to distinguish. Further study of this taxon is certainly needed, the present treatment of this "species" to be considered tentative. It is likely that with better material and more field study the varieties will be recognized as species or geographic subspecies. When a combination of characters is used, as in the following key, most specimens, especially the mature ones, can be assigned to a variety.

Key to Varieties

A. (1) Mature capsule straw-colored to brownish; (2) plants with leaves mostly over 1.5 mm wide; (3) plants mostly dark green; (4) middle nodes frequently as long as or longer than the leaves; (5) inflorescence few- to many-flowered, but often with comparatively few flowers on long pedicels; (6) plants upright, but often frail and reclining on surrounding vegetation; (7) throughout the state, more common in southern Wisconsin ____________________ 6a. *S. longifolia* var. *longifolia.*

AA. (1) Mature capsule dark pigmented, purple brown to brownish-black; (2) leaves generally smaller and more narrow, mostly 1.5 mm wide or less; (3) plants usually yellowish-green or light green; (4) middle nodes frequently mostly shorter than the leaves; (5) inflorescence few- to many-flowered but frequently many-flowered, with flowers on short pedicels; (6) plants upright, most often rather stiff and not decidedly sprawling or reclining; (7) mostly north of the Tension Zone ________________________ 6b. *S. longifolia* var. *atrata.*

6a. Stellaria longifolia var. longifolia. Map 21; Fig. 4.

This variety has been rarely collected with mature fruit, so few of the Wisconsin specimens have the pale capsules. However, it is recognized by the larger leaves and the often spreading reclining habit. On Map 21, the hollow circles represent this variety, those with short, horizontal lines being collections with pale capsules, while those without representing collections placed here on the basis of vegetative characters.

Variety *longifolia* occurs throughout the state, though most common in southern Wisconsin, in moist places such as low woods, marshes, sedge meadows, swamps, bogs, lake shores, and roadside ditches; *e.g.*, marsh on Hwy E, with *Cicuta maculata, Anemone canadensis, Thalictrum dasycarpum* (Trempealeau Co., *Schlising 1572* [WIS]); wet sand along Hwy 12–16, Lyndon Station, with *Drosera, Xyris, Spiraea tomentosa, Eleocharis, Juncus, Aletris, Viola lanceolata* (Juneau Co., *Zimmerman 3135* [WIS]; damp, grazed low prairie in valley along stream, Governor Dodge State Park, with *Lilium michiganense, Cacalia tuberosa, Crataegus,* and *Lobelia* spp. (Iowa Co., *Iltis 9691* [WIS]); open, wet sedge meadow, edge of West Salem *Larix* bog (La Crosse Co., *Iltis 5823* [WIS]); and densely wooded seepage at base of Black River bluff in bottomland forest (La Crosse Co., *Iltis 5998* [WIS]). Flowering from mid-May through July, with a flowering peak in mid-June. Fruiting from mid-June to September.

6b. STELLARIA LONGIFOLIA var. ATRATA Moore. Map 21; Fig. 4.
Stellaria atrata (Moore) Boivin.

This variety is usually more yellow-green than var. *longifolia*, more delicately branched, shorter-leaved and more upright. A

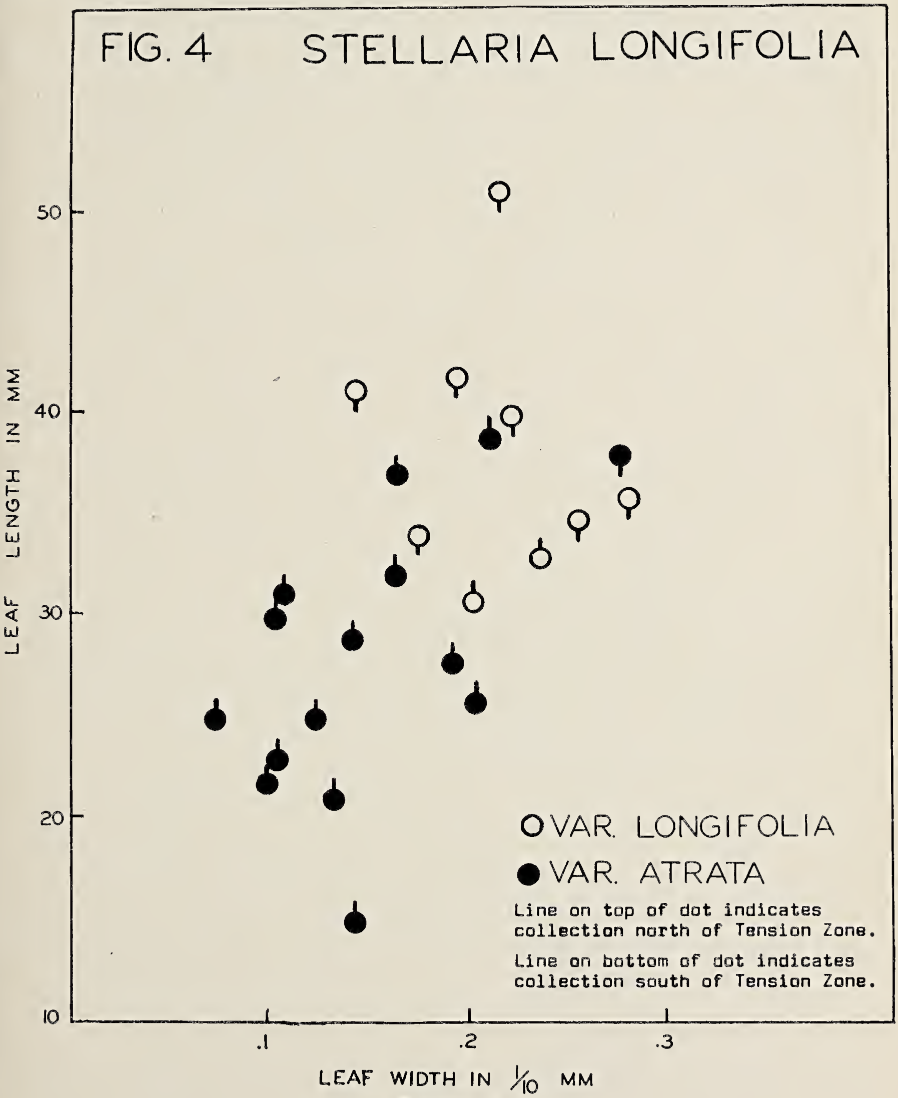
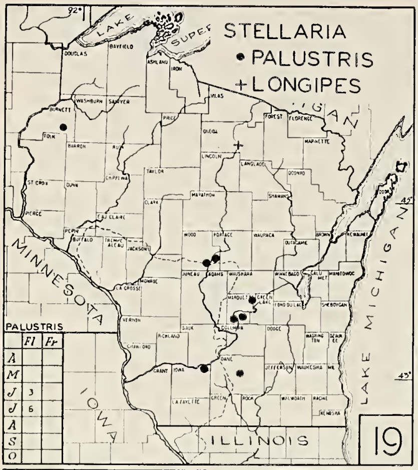


FIGURE 4.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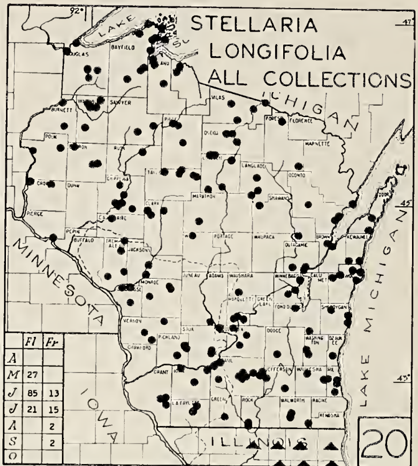
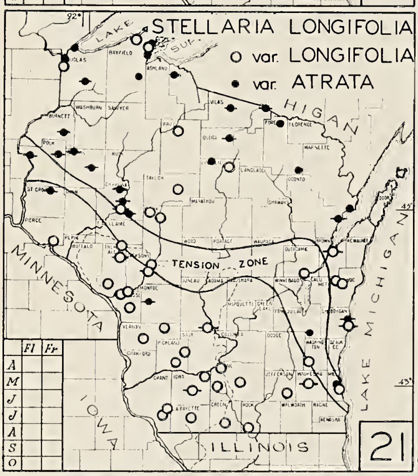
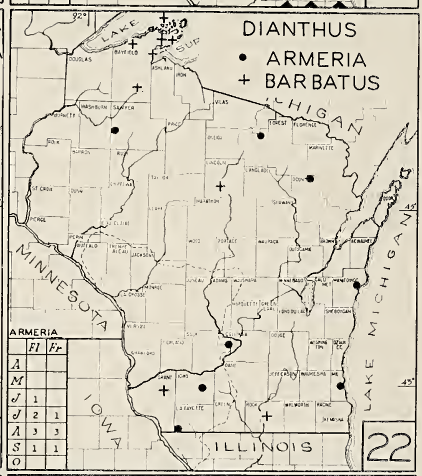
+ LONGIPES
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
PALUSTRIS
Fl Fr
A
M
J 3
J 6
A
S
O
19


STELLARIA
LONGIFOLIA
ALL COLLECTIONS
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M 27
J 85 13
J 21 15
A 2
S 2
O
20


STELLARIA LONGIFOLIA
o var. LONGIFOLIA
• var. ATRATA
TENSION ZONE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J
A
S
O
21


DIANTHUS
• ARMERIA
+ BARBATUS
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
ARMERIA
Fl Fr
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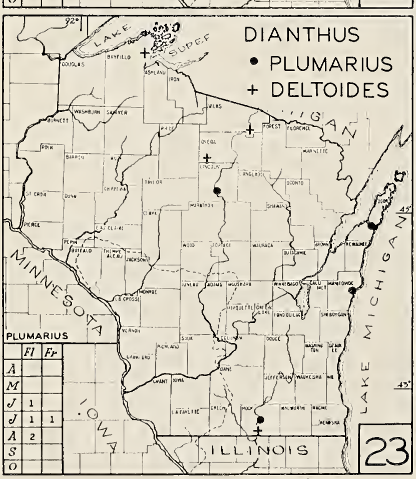
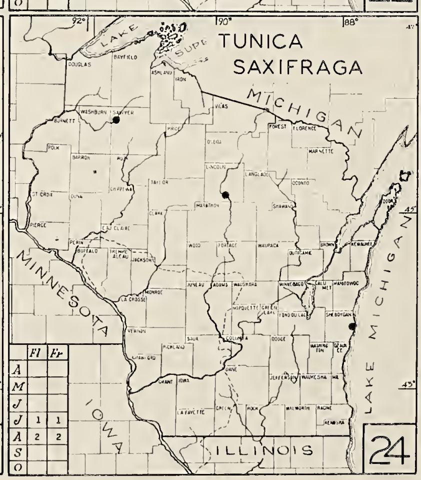
A 3 3
S 1 1
O
22


DIANTHUS
• PLUMARIUS
+ DELTOIDES
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
PLUMARIUS
Fl Fr
A
M
J 1
J 1 1
A 2
S
O
23


TUNICA
SAXIFRAGA
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
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J 1 1
A 2 2
S
O
24

greater proportion of the collections of this variety have dark capsules. On Map 21 dark circles with short horizontal lines represent collections bearing dark capsules, while dark circles without lines are collections without capsules. In Wisconsin, this variety seems to come south only as far as the Tension Zone.

The habitats for var. *atrata* seem to be similar to those of var. *longifolia,* occurring mainly in moist places, though perhaps more commonly in Sphagnum bogs; e.g. roadsides in open sedge marsh southwest of Oconto (Oconto Co., *Iltis & Buckmann 10984* [WIS]); wet cedar bog, with birch and alder, southeast Forest County, *(Patman, Noller, Christensen s.n.* [WIS]); moist, shady hummocks, High Lake Bog (Vilas Co., *Potzger 8629a* [WIS]); wet sedge meadow on La Crosse River, Sparta (Monroe Co., *Iltis & Neess 8951* [WIS]); and sandy, grassy roadside near Lake Evelyn (Polk Co., *Schlising & Musolf 1630* [WIS]). Flowering and fruiting seasons are similar to those of var. *longifolia.*

The dark capsuled, northern plants *(atrata)* were first recognized as a variety by Moore (1950) and later elevated to the species level by Boivin (1953). However, most characters that Boivin lists to distinguish *S. longifolia* from *S. atrata* are practically useless when applied to the Wisconsin specimens. Boivin *(loc. cit.)* furthermore distinguished two varieties: var. *atrata,* with ciliate sepals, and var. *eciliata,* with eciliate sepals. In Wisconsin, however, while both the northern *atrata* and southern *longifolia sensu stricto* usually *do have eciliate sepals,* there are a good many plants of *both taxa* that have ciliate sepals! Boivin's varieties do not seem tenable here.

All collections of *S. longifolia* are included on Map 20, those that could be assigned to varieties on Map 21. The dots on Map 21 with horizontal lines represent the fruiting specimens plotted on the scatter diagram in Figure 4. The horizontal axis gives the leaf width (in 1/10 mm) of the largest stem leaf of the 2nd or 3rd node below the inflorescence, while the vertical axis plots the measurement of the same leaf's length. Solid circles represent plants bearing dark-colored capsules, and hollow circles, plants with straw-colored capsules. A short vertical line on the top of the dot indicates a collection from north of the Tension Zone, and a vertical line on the lower side of the dot indicates a collection from south of the Tension Zone. While the diagram does separate the varieties, the overlap is considerable. Immature specimens, in most instances, can not be assigned to a variety.

10. DIANTHUS L. Pink; Carnation

Showy Old World herbs. Calyx cylindrical, 5-toothed, many-nerved, subtended by 2–6 appressed bracts. Petals dentate to lacerate, longer than the calyx. Stamens 10. Styles 2. Capsule dehiscent by 4 teeth. A very large genus with many cultivated species, including *D. caryophyllus,* the Carnation, and *D. chinense,* the Rainbow Pink.

Key to Species

A. Bracts at base of calyx lanceolate, over half as long as to exceeding calyx; flowers solitary and short-pedicelled or sessile and in clusters.
 B. Bracts and calyx pubescent throughout; leaves linear to lance-linear ---------------------------- 1. *D. armeria.*
 BB. Bracts and calyx glabrous, with ciliate margins; leaves ovate to lanceolate or oblanceolate ------- 2. *D. barbatus.*
AA. Bracts at base of calyx ovate, less than half as long as calyx; flowers usually solitary and long-stalked.
 C. Main leaves 3–9 cm long; bracts abruptly acuminate, ¼–⅓ as long as calyx ---------------------- 3. *D. plumarius.*
 CC. Main leaves 1.5–2.5 cm long; bracts long-tipped, about half as long as calyx ---------------------- 4. *D. deltoides.*

1. Dianthus armeria L. Deptford Pink. Map 22.

Simple-stemmed or branched biennial, 3–5 (–8) dm tall, pubescent in the inflorescence. *Leaves linear to lance-linear, 3–10 cm long. Flowers sessile,* borne *in tight clusters* of 2–10, *or* the lower ones solitary. *Bracts subtending calyx lanceolate, pilose, over half as long as calyx. Calyx* 12–20 cm long, *pilose.* Petals purple-red, white-dotted, dentate, exceeding calyx by 2–5 mm, the flowers about 1 cm in diameter. Capsule about equalling calyx.

Naturalized from Europe, sporadic in Wisconsin, mainly along roadsides, with one collection each from the edge of a cranberry marsh and a woods, with all the collections made since 1951, excepting those from Manitowoc of 1913 and 1916 (these cultivated in a garden?), more common south and southeastward of Wisconsin. Flowering from late June to earliest September.

2. Dianthus barbatus L. Sweet William. Map 22.

Perennial with unbranched, essentially *glabrous stems* 3–7 dm tall. *Leaves ovate to lanceolate,* those at base sometimes oblanceolate, 4–10 cm long. *Inflorescence a dense, terminal cyme of short-stalked or sessile flowers. Bracts lanceolate, ciliate,* with scarious margins at base, usually *exceeding calyx.* Calyx 15–20 mm long. Petals very showy, red, pink, or white, dentate, longer than the calyx, the flowers 2–3 cm in diameter. Capsule included.

Introduced from southern Europe. Commonly cultivated and occasionally escaped from gardens, becoming established, especially in the Apostle Islands and vicinity, in old logging roads and clearings in woods (Ashland Co.), on conglomerate ledges (Bayfield Co.), and along a railroad (Grant Co.). Flowering from mid-June through August.

3. DIANTHUS PLUMARIUS L. Grass, Garden, or Cottage Pink. Map 23.

Perennial forming large loose mats, with *linear* glaucous *leaves 3–9 cm long. Flowers single or in groups up to 5,* the pedicel about 1 cm long or longer. Calyx about 2 cm long, subtended by scarious-margined *abruptly pointed bracts up to ⅓ as long as the calyx.* Petals fringed, very showy, red, pink, or white, often with darker transverse bands, longer than the calyx, the flowers 3–4 cm across. Capsule exserted.

A garden flower from southeast Europe, often grown in rock gardens, adventive in vacant lots and roadsides in Door, Lincoln, and Rock counties. Flowering from late June to August.

4. DIANTHUS DELTOIDES L. Maiden Pink. Map 23.

Perennial with basal leafy shoots forming low mats. Similar to *D. plumarius,* but with stem *leaves less than 2.3 cm long,* the smaller flowers 1–1.5 cm across. Calyx about 1.5 cm long, with *acuminate bracts to ½ as long.* Petals dentate, purple-red, lavender, or rarely white.

A European rock garden flower, escaped in Bayfield, Oneida, Rock, and Vilas Counties. Flowering from June to October.

11. TUNICA Scop.

1. TUNICA SAXIFRAGA (L.) Scop. Tunic Flower; Coat Flower. Map 24.

Much-branched, loosely *mat-forming low perennial,* with narrowly lance-linear, connate leaves. Flowers borne singly or in diffuse, open cymes. *Calyx 5-ribbed and 5-toothed, 4–5 mm long, subtended by 4–6 scarious-margined bracts.* Petals pink, 1 or 2 mm longer than the calyx. Stamens 10. Styles 2. Capsule longer than the calyx and dehiscent by 4 teeth.

Introduced as a garden plant from Europe, commonly cultivated, and occasionally escaped: Sheboygan Co.: roadside, Sheboygan, 1912, *Goessl s.n.* (WIS). Sawyer Co.: Hayward, 1924, *Davis s.n.* (WIS). Lincoln Co.: roadside, Hwy. 107, along Wisconsin River, 1954, *Seymour 15811* (WIS). Flowering in July and August.

12. VACCARIA Medic. Cow-herb

1. Vaccaria segetalis (L.) Garcke. Cow-Herb; Cow-cockle.
Saponaria vaccaria L. Map 25.

Glabrous annual 2–7 dm tall. Stem simple to a much-forked cymose inflorescence. *Leaves lance-ovate, clasping* at base, the larger ones 4–8 (–12) cm long, reduced upwards in the inflorescence. *Calyx inflated, 1–1.6 cm long, with 5 prominent, usually green, winged ribs.* Petals showy, rose, 1.8–2.5 cm long and exceeding calyx, the flower 1.5–2 cm across. Stamens 10. Styles 2. Capsule included in the inflated calyx, dehiscent by 4 teeth.

A native of southern Europe and Asia, apparently once a common weed of dry, sandy waste places, railroad embankments and grain fields in scattered locations in Wisconsin, now rare or absent, the last collection in 1947, and all others either from the 1880's or 1890's or from 1907 to 1922. Flowering and fruiting from late June to early September.

13. SAPONARIA L. Bouncing Bet; Soapwort

1. Saponaria officinalis L. Bouncing Bet; Soapwort. Map 26.

Showy perennial, with simple, upright stems from rhizomes, to 9 cm long, glabrous or minutely pubescent above. *Leaves* 5–9 cm long, *ovate to ovate-lanceolate or elliptic,* tapered to base, prominently 3-veined, often brown-spotted, bearing axillary shoots. Flowers in tight cymes or in open cymose clusters. *Calyx cylindrical,* weakly 20-nerved, 1.6–2.4 cm long, *5-toothed and 2-lipped. Petals pale rose to pink or whitish,* with definite claw and blade, the flowers 2–3 cm across (sometimes double in var. caucasica Hort.). Stamens 10, exserted. Styles 2. Capsule 4-toothed, about length of calyx or shorter.

Naturalized from Eurasia and found throughout Wisconsin, especially common in the southern part in open disturbed habitats, such as sandy roadsides, stream banks, beaches, railroad embankments, and waste places. Flowering from the last week of June to mid-October, and fruiting from mid-July through October.

14. GYPSOPHILA L.

Glabrous and glaucous much-branched herbs with numerous minute flowers on filiform pedicels in cymose inflorescences. Calyx 5-toothed, weakly nerved. Stamens 10. Styles 2 .Capsule 4-toothed, longer than sepals.

KEY TO SPECIES

A. Annual, much branched from base, about 2 dm or less tall; stem-leaves linear-filiform, under 3 mm wide__ 1. *G. muralis.*

AA. Perennial, with stout base and tall stems; stem leaves linear-lanceolate, tapered at both base and apex, at least some 3–10 mm wide ________________________________ 2. *G. paniculata.*

1. GYPSOPHILA MURALIS L. Map 27.

Frail, finely and diffusely branched annuals to 2 dm tall. *Leaves linear-filiform,* 1–2 cm long. Sepals mostly 2–3 mm long, shorter than the pink-purple petals.

A garden plant naturalized from Europe, adventive in two locations in Wisconsin, in one evidently persisting for the past 11 years: Marathon Co.: sandy soil on top of a bank along Wisconsin River, edge of Country Club grounds, in Schofield 1949, *Wilson s.n.* (WIS), and Schofield, 1960, *Kennedy s.n.* (WIS). Sheboygan Co.: old house site, 1903, *Goessl s.n.* (WIS). Flowering from June to earliest Oct.

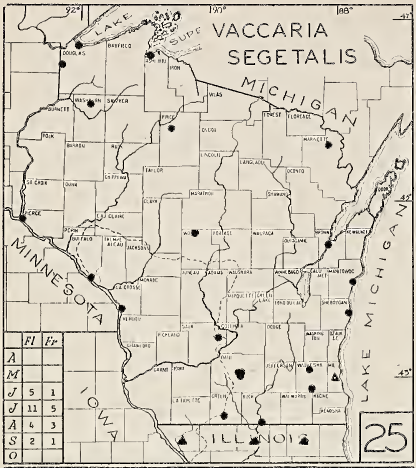
2. GYPSOPHILA PANICULATA L. Baby's Breath. Map 27.

Robust perennial to 1 m tall, *abundantly and finely branched* from a stout central stem, commonly forming dense "bushes," with showy many-flowered, beautifully cymose inflorescences; *leaves linear-lanceolate. Sepals* mostly 1.5–2 mm long, *with prominent white margins.* Petals white, about 4 mm long, longer than the sepals.

Native of arid Eurasia, much planted in gardens, recently becoming naturalized in a few places, where now well established and locally very abundant; Adams Co.: with prairie species, abundant for 500 yards in fields, pastures, and roadsides, 1959, *Iltis 13355* (WIS). Marinette Co.: large colonies in sand along Hwy 141 and in sandy, grassy fields with goldenrods, 1960, *Schlising 1690* (WIS). Sauk Co.: rocky exposed situations, Devil's Lake, 1944, *Swink s.n.* (F). Waupaca Co.: observed 2 miles SSW of Rural, abundant on roadsides and in fields *(fide Iltis,* 1960). Flowering from early July and probably throughout the summer.

GYPSOPHILA ACUTIFOLIA Fisch., resembling *G. paniculata,* but with broader leaves, longer sepals, and glandular-pubescent pedicels, was collected in 1941 along the C & NW railroad tracks, at North Fond du Lac (Fond du Lac Co., *Shinners 3778* [WIS, MINN]). This garden escape is native to the Caucasus.

GYPSOPHILA ELEGANS Bieb., a glaucous flower-garden annual from the Caucasus, has open corymbiform panicles, the longer pedicels 1.2–3.5 cm long, and showy petals twice to thrice as long as the calyx. The one collection was made in 1915 in a vacant lot in Rhinelander (Oneida Co., *Goessl s.n.* [WIS]).


VACCARIA SEGETALIS
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
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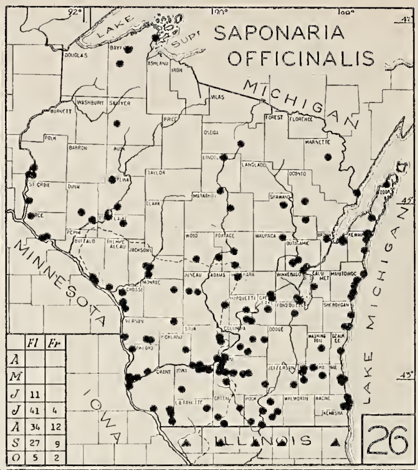
J 11 5
A 4 3
S 2 1
O
25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LAKE MICHIGAN
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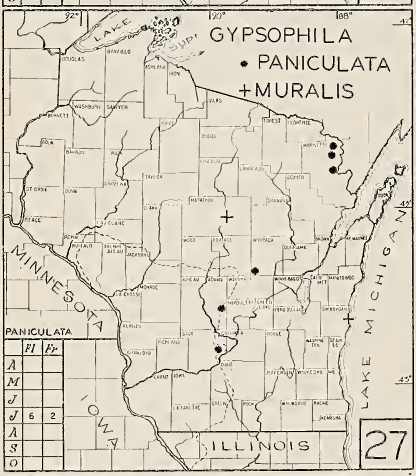
S 27 9
O 5 2
26


GYPSOPHILA
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+ MURALIS
LAKE SUPERIOR
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J 6 2
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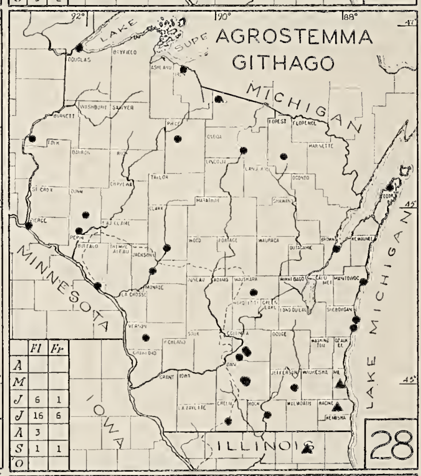
S
O
27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MINNESOTA
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ILLINOIS
LAKE MICHIGAN
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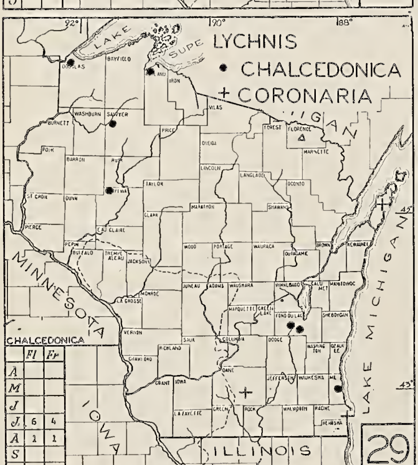
A 3
S 1 1
O
28


LYCHNIS
• CHALCEDONICA
+ CORONARIA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
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A 1 1
S
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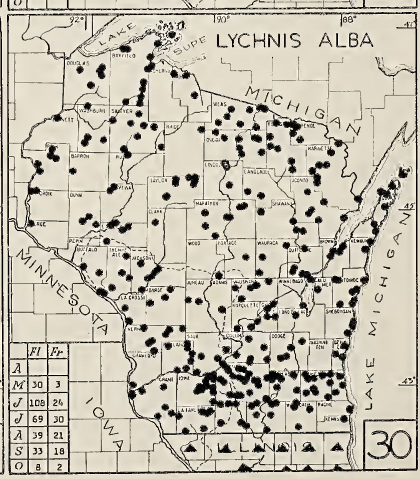
29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MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
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M 30 3
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J 69 30
A 39 21
S 33 18
O 8 2
30

15. AGROSTEMMA L. Corn Cockle

1. Agrostemma githago L. Corn Cockle; Purple Cockle.
Map 28.

Pilose, few-branched, strictly erect annual, to 8 dm tall. Leaves linear or lanceolate, 8–12 cm long, 1 cm wide. Flowers showy, single on simple stems, or to 11 in branched plants. *Calyx-tube 10-ribbed, with linear-lanceolate teeth 1.5–5 cm long, surpassing the showy, red-purple, oblanceolate, emarginate petals.* Stamens 10. Styles 5. Capsule 5-toothed.

Naturalized from Europe, now very rare, or perhaps absent from Wisconsin, though once common in disturbed or waste places, fields, roadsides, and railroad embankments; Superior dock (Douglas Co.); Menominee tramway (Dunn Co.); in a wheatfield (Vernon Co.); in a grainfield, Ephraim (Door Co.); and at Lake Mendota marshes (Dane Co.). Flowering mainly from the middle of June through July (September) and fruiting from early July to early September.

This species has been collected in scattered localities over most of Wisconsin, but most collections are from the southern half of the state. The earliest collections date from 1885, at Madison (Dane Co.) and Two Rivers (Manitowoc Co.), while the last date from 1929 and 1944, with 26 additional collections between 1885 and 1929. It has been suggested that this species was associated as a weed with agricultural rye, for the acreage of rye grown in Wisconsin was greatly increased and expanded in the period 1880–1924, and much decreased by the 1940's (Packard, 1958), the rye acreage roughly corresponding with the occurrence, or at least the collections, of corn cockle. Hegi (1908) lists this species as a weed of grain fields in Europe.

16. LYCHNIS L. Campion

Robust herbs with slightly to strongly clasping, entire leaves. Inflorescence cymose, forking or densely compacted. Flowers showy, perfect or unisexual. Calyx-tube hairy, well-ribbed. Petals exceeding calyx, with claw and blade, and usually with auricles and with appendages at base of blade. Stamens 10. Styles normally 5, less often 3–9.

Key to Species

A. Plants densely white-wooly; petals magenta-purple -- 1. *L. coronaria.*

AA. Plants green, glandular-pubescent to hirsute or pilose, not white-wooly; petals white or red.

B. Flowers white, unisexual, solitary in a forking inflorescence; calyx tubular, cylindrical, or ovoid, inflated; very common weed ________________________________ 2. *L. alba.*

BB. Flowers red, perfect; densely aggregated in a terminal inflorescence; calyx clavate (especially in fruit), not inflated; rare escape ___________________________ 3. *L. chalcedonica.*

1. LYCHNIS CORONARIA (L.) Desr. Map 29.
Rose Campion; Mullein Pink; Dusty Miller.

Tall, *densely white-wooly* perennial, with stiffly forked inflorescence bearing large, *showy, magenta-purple, perfect flowers.*

A native of southern Europe, this commonly-grown garden flower has escaped from cultivation in Dane, Door, and Racine Counties.

2. LYCHNIS ALBA Mill. White Campion; White Cockle; Evening Lychnis. Map 30.

Melandrium album (Mill.) Garcke.

Dioecious pubescent biennial or perennial 2–11 dm tall. Leaves oblanceolate or lanceolate to oval or elliptic, 5–12 (–14) cm long, acute, narrowed at base, the lower petioled, the upper sessile. Inflorescence forking, usually glandular-pubescent. *Flowers unisexual,* opening in the evening, bracteate. *Calyx 1.5–2.6 cm long, cylindrical, inflated,* especially in fruit, *the narrowly-lanceolate teeth 2–6 mm long,* pilose and usually with some glandular hairs, 20-nerved in pistillate flowers, 10-nerved in staminate, the nerves often purple (especially in the staminate flowers). *Petals showy, white,* bilobed, 1.5–3 cm across. Styles usually 5, often 3–9, or even 0–13 (see discussion below). Capsule ovoid, about length of calyx. When flower has 5 styles, capsule opening with 10 (sometimes with only 5) erect or slightly spreading teeth. (Easily confused with the rarer *Silene noctiflora* [which see], which has 3 styles, 6 capsule teeth and *perfect flowers.)*

Naturalized from Eurasia and exceedingly abundant through Wisconsin in any disturbed or open habitat, one of the most pernicious weeds of cultivated fields, pastures, and gardens, less often in woods (especially at the edges, and in portions grazed by cattle or deer), in prairies, meadows, swamps, marshes, and at edges of bogs. Flowering from (early) late May through early October, with a flowering peak the last week of June. Fruiting from late May through October.

Variations in style number has been studied in Iowa and Minnesota plants (Dean, 1959). Of 21,669 *Lychnis alba* flowers studied, Dean found 66.9% bearing the typical 5 styles and 33.1% bearing from 0 to 4 or from 6 to 10 styles. Dean (personal communication,

1961) has since found flowers bearing as many as 13 styles. He indicates that he believes some of these style variations perhaps are "not as abnormal as some regard them but may be actually typical."

Although hermaphrodite (bisexual) flowers do rarely occur, *Lychnis alba,* as well as the red-flowered *L. dioica* of gardens, is noted for its strict separation of the sexes. Both are diploid, with 2N—24. Male plants have 22 autosomes and X and Y sex chromosomes, while female plants have 22 autosomes and XX sex chromosomes (a mechanism similar to that found in man).

3. LYCHNIS CHALCEDONICA L. Map 29.
Scarlet Lychnis; Maltese Cross; London Pride.

Perennial with erect *pilose stems* to 8 dm tall. Leaves ovate or lance-ovate, acute, the larger 6–9 cm long. *Inflorescence terminal, compact, and many-flowered. Flowers perfect. Calyx clavate,* 11–18 mm long, with 10 pilose ribs, and 5 acute teeth about 3 mm long. *Petals brick-red,* bilobed. Capsule 5-toothed, included in calyx.

Native to Russia and Siberia, commonly cultivated in Wisconsin, and rarely escaped, mainly in sandy roadsides, along streams, and in fields. Flowering and fruiting from early July to early August.

17. SILENE L. CATCHFLY; CAMPION

[Hitchcock, C. L., and Bassett Maguire. A revision of the North American species of *Silene*. Univ. Wash. Pub. Biol. 13:1–73. 1947.]

Annuals to perennials with opposite or whorled leaves. Flowers perfect. Petals with narrow claw, expanded blade, auricles, and a pair of appendages at the junction of claw and blade, longer than (or rarely equalling) the calyx, emarginate to bilobed or fringed. Stamens 10. Styles 3. Ovary usually stipitate (with a stalk between its base and base of the calyx). Capsule dehiscent by 6 teeth.

KEY TO SPECIES

A. Middle cauline leaves in whorls of 4; petals fringed with several deep cuts; prairies and woods, southeast and western Wisconsin ---------------------------------- 1. *S. stellata.*

AA. Middle cauline leaves opposite; petals once cut, bilobed, or emarginate.

B. Flowers in very leafy cymes, *i.e.,* solitary in the axils of large leaves; native of woodlands and thickets, southern Wisconsin -------------------------------- 2. *S. nivea.*

BB. Inflorescences bracteate, cymose or racemose, few- to many-flowered, congested to open; garden escapes and weeds, disturbed habitats throughout Wisconsin.

C. Stems hairy throughout; calyx hairy, at least on the nerves.

D. Calyx with glandless hairs; inflorescence a one-sided raceme; flowers sessile or short stalked, each subtended by two bracts ---------- 3. *S. dichotoma.*

DD. Calyx with glandular hairs; inflorescence not one-sided; flowers pedicelled, in forking cymes (uncommon. See also *Lychnis alba.)* ----- 4. *S. noctiflora.*

CC. Stems, or at least branches of inflorescence, glabrous; calyx glabrous (sometimes calyx teeth pubescent).

E. Calyx with 10 prominent nerves; petals emarginate, pink or lavender, or petals lacking; annuals or biennials, often with glutinous bands on the upper internodes.

F. Calyx ovoid, green-nerved, often with purple teeth; stalk of capsule (within calyx) about 1 mm long; petals minute and inconspicuous, rose or pink, or lacking ---------- 5. *S. antirrhina.*

FF. Calyx strongly clavate, often purplish; stalk of capsule (within calyx) 6–8 mm long; petals showy, lavender-purple, the flowers about 1 cm in diameter ---------------- 6. *S. armeria.*

EE. Calyx with 10 or 20 nerves, branching or inconspicuous; petals deeply notched, white; perennials, without glutinous bands on the internodes.

G. Calyx subspherical to ovoid (in pressed specimens campanulate, widest at the summit), rounded or umbilicate (invaginate) at base, in fruit papery and inflated, not appressed to the included capsule; uppermost bracts of inflorescence usually entire ---------- 7. *S. cucubalus.*

GG. Calyx oblong-ovoid or ellipsoid, widest at or near the middle, narrowed to the base or attenuate to the pedicel (not umbilicate), in fruit firm and appressed to the slightly exserted capsule; uppermost bracts of inflorescence minutely ciliate ------------------------------ 8. *S. cserei.*

1. SILENE STELLATA (L.) Ait. f. var. SCABRELLA (Nieuw.) Palm. & Stey. Starry Campion; Widow's-frill. Map 31.

Puberulent perennial with several *stiff stems 6–13 dm tall. Leaves* lanceolate or lance-ovate, *long acuminate,* the major ones 4–10 cm long and *in whorls of 4.* Inflorescence a stiff paniculate cyme, with branches and pedicels puberulent. Calyx campanulate, inflated, 9–14 mm long, at summit often about as wide as long, with triangular teeth, 2–5 mm long. *Petals white, prominently fringed.* Capsule shorter than the calyx. All our plants are of the pubescent more western variety.

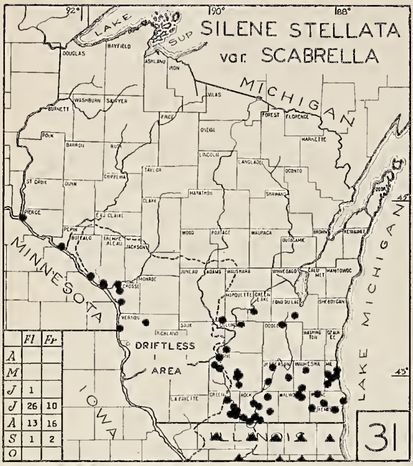
Native, locally frequent in southeastern Wisconsin and occasional in western Wisconsin, but essentially lacking from the "Driftless Area" except in the river valleys of the western part, in open upland oak woods, mesophytic or sandy woods, and wood borders, river banks and sand terraces (Pepin Co.), occasionally along roadsides and railroads, fence rows, grassy ditches and moist meadows; prairie borders and deep-soil prairies, *e.g.*, near Albany and Brodhead (Green Co.), with *Liatris pycnostacha, Cacalia tuberosa, Eryngium yuccaefolium, Silphium, Helianthus, Solidago* and *Aster* spp., *Dodecatheon meadia, Sporobolus heterolepis, Amorpha canescens,* and *Carex* spp. Flowering and fruiting from (June 8?) early July to mid-August (September).

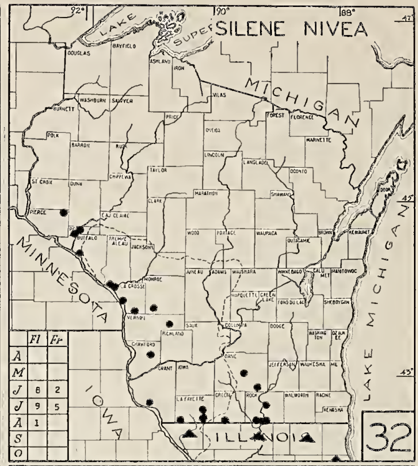
2. SILENE NIVEA (Nutt.) Otth. Snowy Campion; White Campion. Map 32.

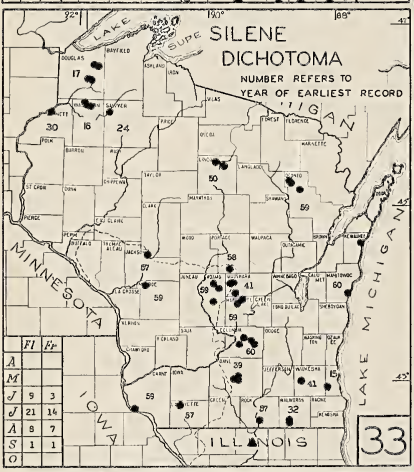
Tall perennial with glabrous or pubescent, simple or sparingly branched stems from 6–9 dm tall. Leaves opposite throughout, lanceolate to lance-elliptic, densely puberulent to glabrous, 4–11 (–13) cm long, and mostly 1–2 (–2.5) cm wide. *Flowers in very leafy cymes, appearing axillary, or sometimes solitary.* Calyx tubular, somewhat inflated, weakly green-nerved, glabrous to densely hirsute, 12–18 mm long. Petals white, notched. Capsule about length of calyx.

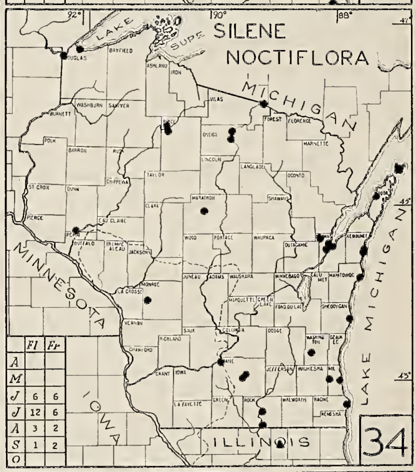
Occasional in southwestern Wisconsin, from Rock to Pierce Counties, typically a woodland species, in Wisconsin collected in alluvial woods ("Southern Floodplain Forest"), roadside thickets, grassy places along roadsides and rivers, sedge meadows, and rarely on wet cliffs, *e.g.*, on sunny, very steep seepage slope on Grant River with *Sullivantia renifolia* and *Mimulus glabratus* (Grant Co.). Flowering and fruiting the last third of June through July (August).

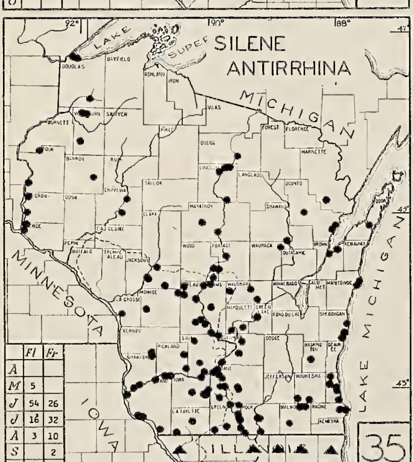
SILENE VIRGINICA L., the Fire Pink, a perennial with large, crimson-red flowers, is shown by Hitchcock and Maguire (1947; Plate 1, Map 2) to occur in southern Wisconsin (Madison?). However, the species is unknown here, no specimen of it has been seen, and the collection upon which the report was based has not been relocated (*fide* Hitchcock, personal communication, 1961–WIS). This species does come to within about 80 miles of Wis. in NE Illinois (Jones & Fuller, 1955).

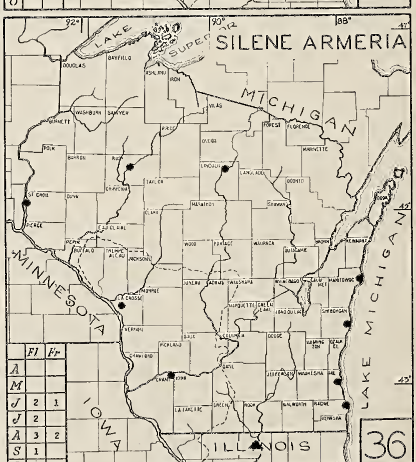

SILENE STELLATA var. SCABRELLA
DRIFTLESS AREA
Fl Fr
J 1
J 26 10
A 13 16
S 1 2
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
31


SILENE NIVEA
Fl Fr
J 8 2
J 9 5
A 1
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
32


SILENE DICHOTOMA
NUMBER REFERS TO YEAR OF EARLIEST RECORD
Fl Fr
J 9 3
J 21 14
A 8 7
S 1 1
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
33


SILENE NOCTIFLORA
Fl Fr
J 6 6
J 12 6
A 3 2
S 1 2
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
34


SILENE ANTIRRHINA
Fl Fr
M 5
J 54 26
J 16 32
A 3 10
S 2
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
35


SILENE ARMERIA
Fl Fr
J 2 1
J 2
A 3 2
S 1
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
36

3. Silene dichotoma Ehrh. Forking Catchfly. Map 33.

Hirsute, often *robust biennial,* 3–10 dm tall. Leaves oblanceolate to elliptic or lanceolate, the lower petioled, the upper sessile, 3–11 (–13) cm long. Inflorescence dichotomously forked, with one to several *elongate, one-sided, strict racemes of sessile or short-stalked white flowers, each flower subtended by two narrow bracts.* Calyx oblongoid, 10–15 mm long, thin and slightly inflated, with 10 prominent rib-like, hirsute nerves. Petals deeply bilobed. Capsule about 9–11 mm long, 4–5 mm thick.

Naturalized from Europe, in Wisconsin locally abundant in sandy, open situations such as roadsides (where collected with *Comandra richardsiana, Lychnis alba, Melilotus* and *Trifolium* spp.), road cuts, railroads, in old fields, and as a weed in fields of sweet and red clover. Flowering from the last week of June (occasionally earlier) to about mid-August (earliest September), with the flowering peak in mid-July. Fruiting from late June through September.

It seems that this species is becoming more common in Wisconsin. The first collection was made in 1915, along a railroad track, town of Greenfield, Milwaukee County, *Heddle 32586* (MIL). Subsequently several collections were made between 1916 and 1930, all in the four northwesternmost Wisconsin counties, where the species still seems to persist. In southern Wisconsin this species did not become well established until the 1940's and 1950's.

Silene gallica L., an adventive from Europe and very similar to *S. dichotoma,* has smaller leaves, glandular hairs on upper portions of the plant and on the smaller, 8 mm long calyces, and reddish petals. The one collection, *Goessl s.n.,* August, 1919, Sheboygan (WIS), could well represent a cultivated plant.

4. Silene noctiflora L. Night-flowering Catchfly; Sticky Cockle.
Melandrium noctiflorum (L.) Fr. Map 34.

Somewhat viscid annual, 2–8 dm tall. Stems villous-pubescent, at least the upper portions glandular. Lower leaves spatulate, obovate, or broadly oblanceolate, 4–10 cm long, pubescent on both surfaces, pustulate, the upper elliptic, ovate, lanceolate or lance-linear. Inflorescence cymose, forking, usually few-flowered. *Calyx* 19–26 mm long, *ellipsoid-tubular, narrowed at base and apex, with 10 green, clearly-defined, villous and glandular-hairy nerves,* 5 thick and prominent ones alternating with the 5 thinner ones, these anastomosing up near the apex. *Calyx teeth 5–10 mm long, lance-linear or linear, up to about 1 mm wide in the middle.* Petals white, bilobed, the *flowers perfect,* opening in the evening. *Capsule with 6 strongly recurved teeth,* shorter than calyx.

Naturalized from Europe, occasional in Wisconsin in weedy habitats, as in yards, fields, gardens, along roads and railroads, and in other disturbed areas, including edges of woods, *e.g.*, near Fifield (Price Co.), in disturbed *Pinus strobus-Picea-Acer spicatum* grove with *Aster macrophyllus* and *Oryzopsis asperifolia.* Flowering and fruiting from about the last third of June through early September, and fruiting to late September.

Silene noctiflora, now rare in Wisconsin, with only 7 of the 31 Wisconsin specimens collected since 1919, was formerly common as a weed, mainly in grainfields, especially in eastern Wisconsin (Wadmond, 1909; Russell, 1907). It is a species easily confused with the ubiquitous *Lychnis alba.* The following key will help separate the two species:

A. Flowers perfect (rarely unisexual); styles usually 3; calyx with 10 prominent, green nerves and 10 prominent white interstices; calyx ellipsoid, pointed at both ends, widest in the middle, only slightly inflated in fruit, the calyx teeth lance-linear, 5–10 mm long, less than 1 mm wide at the middle; capsule with 6 strongly recurved teeth ---- *Silene noctiflora.*

AA. Flowers unisexual; styles usually 5 (3–9); calyx irregularly 10-nerved in staminate flowers, irregularly 20-nerved in pistillate; calyx widest at or near base, ovoid in the female flower, tubular in the male, inflated in fruit (female flowers), with narrow triangular-lanceolate calyx teeth 2–6 mm wide or wider at the middle; capsule with (usually) 5 or 10 erect or slightly spreading teeth -------------------- *Lychnis alba.*

5. SILENE ANTIRRHINA L. Sleepy Catchfly; Sticky Catchfly. Map 35.

Annual or biennial (1–) 2–8 dm tall, polymorphic, the plants simple-stemmed and upright, or with numerous stiffly-ascending branches from the base, or lax and divaricately branched, puberulent below to scabrous or glabrous above. *Upper internodes often with dark,* glutinous bands. Leaves linear or lanceolate to oblanceolate, 2–8 cm long, ciliate-margined near base, often with tufts of smaller leaves in their axils. Inflorescence usually paniculately branched and many flowered. *Calyx 4–9 mm long, ribbed with green nerves,* the often *purple-tipped triangular teeth about 1 mm long. Petals pink or rosy, inconspicuous,* equalling to barely exceeding calyx, or petals lacking. Capsule 4–9 mm long, 2–5 mm thick.

Native, though somewhat weedy, occurring over most of the state, especially in southern Wisconsin and the central sand plains, and along rivers and the Lake Michigan shore, generally in open, sandy or gravelly habitats, such as fields, roadsides, railroads, sandstone and limestone cliffs, on Lake Michigan sand dunes, and in dry prairies; in dry, steep shallow-soil prairie near Cassville (Grant Co.), with *Bouteloua curtipendula, B. hirsuta, Silphium laciniatum, Scutellaria leonardii, Andropogon gerardi* and *Castilleja sessiliflora;* dry prairie on railroad near Black River Falls (Jackson Co.), with *Tradescantia ohiensis, Rhus radicans, Coreopsis palmata,* and *Asclepias tuberosa;* and thin soil on granite near Grantsburg (Burnett Co.) with *Campanula rotundifolia, Opuntia fragilis, Rhus radicans, Xanthoxylum,* and *Selaginella rupestris.* Flowering from latest May through July (August) and fruiting from the third week of June to September.

This species seems to respond readily in its growth habit to environmental differences. Thus many of the most robust individuals come from open, sandy situations, while those from cliffs are very lax and frail, with smaller leaves and capsules.

Three minor forms have been reported from Wisconsin. Since some of their characters are ephemeral, their occurrence is based on information supplied by the collector:

SILENE ANTIRRHINA forma DEANEANA Fern. has no glutinous bands on the internodal areas *(e.g.,* Lafayette Co., Red Rock Quarry, Darlington, *Nelson s.n.* [WIS]). In the specimens studied the prominence of the glutinous bands on the upper internodes varies greatly. The bands range from dark, viscid areas around the stem that are several cm long to barely noticeable areas a few mm long, or, in the form, are completely lacking. Blowing debris and seeds from the plants' own capsules are often found adhering to the sticky bands.

SILENE ANTIRRHINA forma BICOLOR Farw. has petals ventrally white and dorsally pink. It has been collected in Waupaca County near Clintonville *(Rill s.n.* [WIS]).

SILENE ANTIRRHINA forma APETALA Farw. has the petals lacking. It has been collected in Lincoln County on a river bluff in the town of Pine River *(Seymour 15955* [WIS]).

6. SILENE ARMERIA L. Garden- or Sweet William-catchfly; None-so pretty. Map 36.

Annual with *glabrous stems,* simple or branched above, with or without glutinous internodal bands, 6–45 cm tall. Leaves oblong, ovate or obovate, glabrous, 1–8 cm long, (0.3–) 1–2 (–4) cm wide, clasping. *Flowers solitary* on small plants or *2–20 or more in congested cymes. Calyx slender, cylindrical-clavate, purplish,* 12–16 mm long, 2–4 mm wide, the teeth minute. *Flowers pink or purple,* 9–13 mm in diameter, the *petals* with wavy margin or emarginate, *with 2 linear appendages at base of blade.* Capsule on a 6–8 mm stalk (carpophore), the two about length of calyx.

Introduced from Eurasia, common in cultivation, and perhaps locally established in Wisconsin; driveway, Point Beach State Forest (Manitowoc Co.); vacant lot, Milwaukee, with *Datura, Kochia* (Milwaukee Co.) spontaneous in a lawn, Tomahawk (Lincoln Co.); the earliest collections dated 1861 from Milwaukee and St. Croix (both *Hale, s.n.* [F, WIS]). Flowering the last week of June through mid-September.

7. SILENE CUCUBALUS Wibel. Bladder Campion; Maiden's Tears.
Silent latifolia (Mill.) Britt. & Rendle. Map 37.

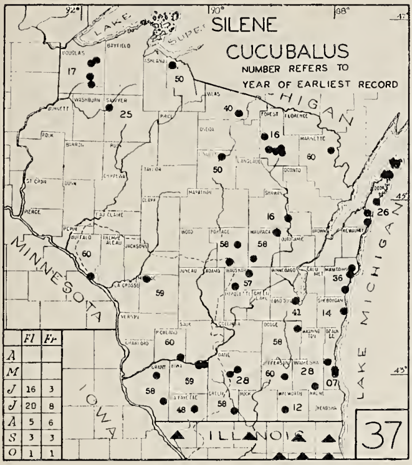
Glabrous and glaucous weedy perennial similar to *S. cserei* (which see) 3–8 (–10) dm tall. Leaves usually lanceolate to ovate or elliptic, sometimes oblong or oblanceolate, acute, mostly 3–8 cm long. *Cymes loose and paniculate;* uppermost inflorescence bracts scarious, usually glabrous. *Calyx subspherical to ovoid, rounded to umbilicate (invaginate) at base,* 9–17 mm long, with branching and anastomosing nerves, *greenish, or often purplish, in fruit papery and much inflated, not appressed to the much smaller capsule.* (Calyx, *when pressed,* often campanulate, with wide open apex.) Petals white, deeply bilobed.

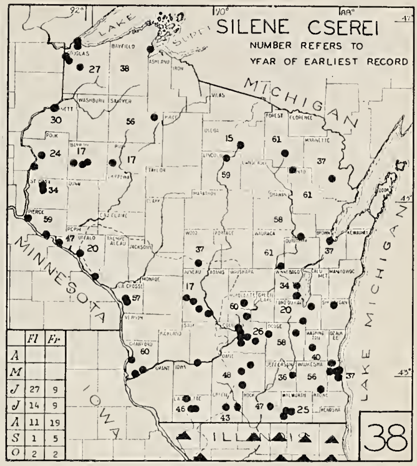
Naturalized from Eurasia, locally common, but largely missing from western and central Wisconsin, in disturbed, open habitats, mainly on roadsides, roadcuts, old fields, waste places, and along railroads; near Cleveland (Manitowoc Co.) in a grassy field with *Chrysanthemum leucanthemum,* and *Linaria vulgaris;* near Custer (Portage Co.) weedy along roadside and in thickets of *Prunus* and *Quercus macrocarpa.* Flowering from mid-June through August (mid-October) and fruiting from late June through mid-September (October).

It seems that this species is becoming more common in Wisconsin. The first published record (as *S. vulgaris*) is from Milwaukee County (Russell, 1907), while the first collection was made in 1912 in Delavan, Walworth County (*Wadmond s.n.* [MINN]). Only sporadic collections were made through the 1940's, with more collections since 1949 than during all the years before. The great increase in the number of herbarium specimens of *Silene cucubalus* in the past decade, while no doubt partly due to the more intensive collecting activity, may be best explained by an increase in abundance and range of this weedy species.

8. SILENE CSEREI Baumg. Bladder Campion. Map 38.

Very similar to *Silene cucubalus,* but commonly taller (to 1 meter tall), and often with larger leaves (to 11.5 cm long). *Cymes* more





narrow and racemose, with the uppermost inflorescence bracts minutely ciliate. *Calyx narrowly ovoid-oblong to ellipsoid, constricted at summit, often narrowed at base and attenuate to the pedicel* (not umbilicate), 8–13 mm long, with nerves not evidently anastomosing, *glaucous, greenish,* slightly inflated and papery in flower, becoming firmer *in fruit* and *appressed to capsule. Capsule ovoid, slightly exserted,* longer than in *S. cucubalus* (the calyx however, smaller). Petals white.

Naturalized from the Balkans and Asia Minor and found throughout most of Wisconsin, though not as common in central and northern parts, in disturbed habitats, mainly on roadsides and roadcuts, in ballast, cinders, sand, or gravel of railroad tracks; in Shorewood (Milwaukee Co.), in cinders and gravel along railroad tracks, with *Plantago major, P. indica, Chaenorrhinum minus, Oenothera biennis, Saponaria,* and *Linaria;* west of Doylestown (Columbia Co.) on grassy banks and in gravel along railroad tracks, with *Lychhis alba, Mirabilis nyctaginea, Descurainia pinnata,* and *Erysimum inconspicuum.*

Silene cserei, like *S. cucubalus* with which it may grow, seems to be increasing its range in Wisconsin. Infrequent collections were made following 1915, the year the first collection was made (Rhinelander, Oneida Co., *Goessl 2497* [MIL]). More frequent collections have been made in the 1930's and 1940's, and over 40% of the total number of specimens date from after 1955. Spreading very freely along railroad tracks, large colonies of *S. cserei*—often extending for miles—can be found in many places in Wisconsin. Apparently *S. cserei* is much more "at home" on railroad ballast than *S. cucubalus,* the latter preferring roadsides and fields.

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NOTES ON WISCONSIN PARASITIC FUNGI. XXVII

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The collections referred to in this series of notes were, unless indicated otherwise, made during the season of 1960.

Undetermined powdery mildews in the OIDIUM stage have been collected on 1) *Cornus rugosa.* Columbia Co., Gibraltar Rock County Park, June 20; 2) on the inflorescence of *Cornus femina,* with various collections in the Madison area from 1946 to the present, a very striking early season manifestation which it seems quite certain cannot be *Phyllactinia corylea* (Pers.) Karst., the only determined species reported on this host from Wisconsin; 3) on *Valeriana edulis.* Jefferson Co., near Waterloo, July 28; 4) on *Aronia melanocarpa* and 5) on *Amelanchier laevis.* Sauk Co., Devils Lake State Park, September 15; and 6) on *Chrysanthemum coccineum* (cult.), Dane Co., near Cross Plains, August 26. In general, the development of powdery mildews was very limited in southern Wisconsin in 1960.

PERISPORIUM WRIGHTII B. & C. collected on *Opuntia macrorhiza* near Pine Bluff, Dane Co., by D. Ugent, July 17, is immature, as are most specimens I have seen of this fungus, but the perithecia here contain large numbers of hyaline, rod-shaped microconidia.

LEPTOSPHAERIA sp., on the dead tips of otherwise green and vigorously growing leaves of *Carex vulpinoidea,* was collected at Madison, July 6. The falcate, olivaceous, triseptate ascospores, 22–25 x 5–6 μ, have, as is often the case in this genus, one of the central cells slightly enlarged. This would seem close *L. caricicola* Fautr. (ascospores triseptate, 18–21 x 4 μ) or to *L. caricina* Schroet. (ascospores triseptate, 20 x 5 μ) which for their part would seem to be probably identical.

LEPTOSPHAERULINA sp. appears parasitic on dark brown lesions on leaves of *Lactuca biennis,* collected at Madison, June 28. The thin-walled, pale brown perithecia are gregarious, subglobose, about 150 μ diam. The asci are broadly ovoid to almost subglobose, approx. 40–45 x 50 μ. There is no evidence of paraphyses or paraphysoids. Ascospores are subhyaline to yellowish, broadly clavate, 28–30 x 9.5–11 μ, indistinctly muriform, perhaps slightly immature. This might almost as well be referred to the hyaline-spored *Pleosphaerulina* Pass. which, according to v. Hoehnel, should be replaced by *Pringsheimia* Schulzer.

ASTERINA RUBICOLA Ell. & Ev. is fairly common on leaves of *Rubus strigosus* in the fall in southern Wisconsin. As a general thing, the small shining-black ascomata, usually clustered in groups on small but well-defined spots, contain no spores of any sort at this season, but in a collection made near Verona, Dane Co., September 28, a small percentage of the fruiting bodies contain numerous *Coniothyrium*-type conidia which are brownish-olivaceous, globoid, subgloboid, or broadly ellipsoid, 2–3 x 2.5–3.5 μ. The ascomata with the spores differ in no external respect from their sterile neighbors, so their detection is a hit or miss affair.

PHYLLACHORA GRAMINIS (P.) Fckl. fruiting bodies (presumptive) on *Elymus canadensis*, collected at Madison, October 12, contain very large numbers of laxly curved, slender, hyaline scolecospores, about 12–17 x .8–1 μ. There is some evidence of an accompanying incipient ascigerous stage.

CHRYSOMYXA PIROLATA *Wint. (C. pyrolae* (DC.) Rostr.) is represented by a number of uredial specimens in the University of Wisconsin Herbarium, but telia have been unreported until now. Re-examination of duplicate material of a specimen on *Pyrola elliptica,* collected near Verona, Dane Co., May 3, 1948, shows germinated telia in some abundance, which were, inexplicably, overlooked at the time.

MELAMPSORA ABIETIS-CANADENSIS (Farl.) Ludw. I on *Tsuga canadensis,* so far as Wisconsin material is concerned, has been represented up to now by three scanty specimens on leaves, all from the far northern part of the state. In June at a station near LaValle, Sauk Co., there was observed a massive infection of large, old trees with the rust strictly confined to the cones, so far as noted. Perhaps as many as a fifth of the large crop of young cones were a bright orange-yellow hue from the exposed caeomoid spore masses, a most striking sight.

UROMYCES sp., on a phanerogamic specimen of *Carex richardsoni* in the University of Wisconsin Herbarium, was submitted to G. B. Cummins who states that he is unable to identify it and that it is not the usual sort of rust encountered on North American Carices. Since the specimen was collected in 1879 in the environs of Green Bay, Wis. it seems quite certain the habitat has long since been destroyed. The urediospores are light cinnamon-brown, globoid, broadly ellipsoid, or obovoid, with wall about 1.5–2 μ thick, finely echinulate, pores 2–3(–4), approx. equatorial. (15–)18–20(–23) x 22–25(–28) μ. The pallid olivaceous teliospores are ellipsoid to broadly ellipsoid, with wall about 3–5 μ thick above by 1.5 μ at sides, 17–20 x 22–26(–30) μ, pedicel very short. Many of the teliospores had germinated and Cummins thinks it probable that they are of the current season and thus germinated without dormancy.

PHYLLOSTICTA MINUTISSIMA Ell. & Ev., common on leaves of *Acer saccharum* in Wisconsin, is not ordinarily very destructive, being prominent usually only toward season's end. However, in early August, sizeable planted specimens of sugar maple in the University of Wisconsin Arboretum at Madison suffered near total defoliation, following a massive infection with *P. minutissima*. The attack proceeded from the leaf tips inward, causing reddish discoloration, drying, and very strong curling.

PHYLLOSTICA APOCYNI Trel. on *Apocynum androsaemifolium*, collected at Parfrey's Glen, Sauk Co., September 16, 1959, has some pycnidia, associated with the normal *Phyllostica*-type and macroscopically indistinguishable, which contain very large numbers of hyaline microspores, approx. 3–4 x 1–1.5 μ.

PHLLOSTICAE of uncertain affinities, and sometimes of questionable parasitism, are found in the course of every collecting season. It seems worthwhile to continue recording descriptive notes of these and to file them in the Wisconsin Cryptogamic Herbarium, in the hope that some if not all may eventually be identified. (In the past certain small and inadequate collections have ultimately served to supplement later large specimens on which descriptions of new species of *Phyllosticta* have been based.) Ten undetermined *Phyllostictae* are listed here:

1) On *Carex sartwellii* at Madison, October 10. Lesions are small, angled, and reddish-brown, the pycnidia blackish, small and flattened, about 75–100 μ diam. The conidia are slender, rod-shaped microspores. Associated with and perhaps connected with *Cercospora caricis* Oud.

2) On *Carex blanda* at Gov. Dodge State Park, Iowa Co., June 24. This appears parasitic on indeterminate brownish areas on the leafy bracts of the inflorescence. The small, blackish, thick-walled, sublenticular pycnidia are hypophyllous, multiseriate and substomatal, mostly about 35–40 μ in short diameter, but up to 50 μ or a little more. They are rather widely open, tending to conform with the stomatal aperture, and verge upon the melanconiaceous. The hyaline conidia are of the microtype, about 4–5 x 1–1.3 μ.

3) On *Carya ovata* at Perrot State Park, Trempealeau Co., June 17, 1959. The lesions are broadly subfusoid or suborbicular, medium brown with a narrow darker border, about .3–.5 cm. diam., and usually oriented along the principal lateral veins of the leaflet. The epiphyllous pycnidia are sooty brown, gregarious to clustered

centrally on the spot, subglobose, imperfectly developed apically, about 50–80 μ diam. The hyaline conidia appear to fall into two classes, 1) 2.5–3 x .7–1 μ, short rod-shaped, and frequently biguttulate, very numerous, and 2) 5–6 x 1.5–1.7(–2) μ, subfusoid, and comparatively few. The larger conidia are quite similar to those of *Phyllosticta caryae* Peck, as represented in a specimen collected by Peck at Piffard, N. Y. and labeled "ex type". *P. caryae* has been reported from Wisconsin, but there is no verifying specimen at present in the Wisconsin Herbarium.

4) On *Rubus occidentalis* at Madison, August 1. The conspicuous lesions are dull brown with yellowish halo, orbicular to variously elongate. The pallid-brownish pycnidia are scattered, subglobose, approx. 125–140 μ diam.; conidia hyaline, cylindric, faintly biguttulate, (5–)7–10 x (2–)2.5–3 μ. These conidia are longer and larger than those of other species I find reported on *Rubus*. They appear well matured and show no evidence of incipient septation.

5) On *Cornus obliqua* near Jefferson, Jefferson Co., July 28. The hyaline, broadly ellipsoid conidia, 5–7 x 2.5–3 μ, are somewhat smaller than those of *Phyllosticta cornicola* (DC.) Rabh., and the subglobose, blackish pycnidia, approx. 60–75 μ diam., much smaller.

6) On *Asclepias phytolaccoides* near Verona, Dane Co., September 28. The spots are greenish-black and angled, approx. 2–7 mm. diam. The pycnidia are scattered to gregarious, globose, black, appearing non-ostiolate, small, about 50–65 μ diam. Hyaline microconidia, 3–4 x 1–1.3 μ are present in some profusion.

7) On *Solidago gigantea* in close association with *Ramularia serotina* Ell. & Ev., Gov. Dodge State Park, Iowa Co., July 21, 1959. The epiphyllous pycnidia occur usually near the margins of the small, rounded, brownish-ashen spots, which are assumed to have been produced primarily by action of the *Ramularia*. Pycnidia are dark grayish, subglobose, approx. 100–150 μ diam., while the conidia are hyaline, short-cylindric to broadly ellipsoid, or occasionally subfusoid, 4–6(–7) x 2–2.5 μ. The conidia are of about the same dimensions as those of *Phyllosticta madisonensis,* described on this host from Wisconsin, but the fungus does not seem similar in other respects.

8) On *Aster macrophyllus* at Wildcat Mt. State park, Vernon Co., September 9, 1959. Held out-of-doors in a wire cage at Madison until early May 1960. At the time of collection the pycnidia were scattered or clustered on large, conspicuous purple-brown spots. They were black, composed of dark, thick-walled pseudoparenchymatous cells, globose and somewhat erumpent, approx. 200–250 μ diam., with contents undifferentiated. Following the caging, and

produced presumably after overwintering, numerous hyaline, rod-shaped conidia, 4–7 x 1.5–2 μ, were observed in the pycnidia. It seems possible that, in some instances, the caging of leaves may have influence in favoring the production of an imperfect as over a perfect stage, since the latter may sometimes depend on a very delicate balance of conditions, not realized in a cage, where the leaves tend to become appressed to one another.

9) On *Aster pilosus* at Madison, August 21. The pycnidia are closely clustered on dead upper stem leaves, or scattered singly on the adjacent stem. They are clear brown, subglobose, uniformly about 100 μ diam. The conidia are hyaline, ellipsoid, 4–5 x 2–2.5 μ.

10) On *Inula helenium,* Gov. Dodge State Park, Iowa Co., July 21, 1959. The lesions are brownish, orbicular, about 1 cm. diam. Pycnidia globose, thin-walled, brownish, about 75–100 μ diam., the conidia hyaline, broadly ellipsoid, frequently biguttulate, (2–)2.5–3 x 4–6.5 μ. This may be identical with *Phyllosticta Inulae* Allesch., which has conidia of the same dimensions, but material for comparison is not available.

CONIOTHYRIUM (?) sp. parasitized thalli of the lichen *Dermatocarpon miniatum* (L.) Mann, collected by J. Looman at Nelson Dewey Memorial Park at Cassville, Grant Co., July 21, 1959. The brownish elevated mass of the parasite is deeply imbedded in the host medulla, and the algal layer has been forced aside, as is shown in sections. The imbedded, subrostrate, dark brown pycnidia are scattered in the uppermost layer of the elevated mycelial mass, but they are easily seen under a hand lens. They are subglobose, or somewhat flattened below and irregular in outline, approx. 60–75 μ diam. The conidia are clear greenish-olivaceous, thin-walled, broadly ellipsoid, 3–4.3 x 2.5–3.5 μ. Keissler's "Die Flechtenparasiten" was consulted, but no certain conclusion as to identity could be reached.

CONIOTHYRIUM sp. is epiphyllous on rounded ashen spots, approx. 2–4 mm. diam., on leaves of *Ribes missouriense,* collected in the New Glarus Woods Roadside Park, Green Co., September 21, 1959. The gregarious black pycnidia are subglobose to globose, approx. 150–175 μ diam., the conidia smoky gray, ellipsoid or subfusoid, 4.5–6 x 2.5–3 μ. Questionably parasitic.

CONIOTHYRIUM sp. occurs on leaves of two specimens *Ribes missouriense,* and on one of what appears to be *Ribes cynosbati,* the former from Cross Plains and Madison, Dane Co., respectively, collected in June and July, the latter from Ferry Bluff, Sauk Co., in June. The small, but conspicuous, ashen spots are rounded to elongate, mostly very irregular in outline. The pycnidia are epiphyllous, scattered to gregarious, blackish, subglobose, about 115–140 μ diam. The numerous conidia are of a clear grayish shade, thin-walled, broadly ellipsoid or short-cylindric, approx. 4–6 x 2–3 μ. There is no evidence of insect action in connection with the spotting and it seems quite likely the fungus is parasitic. So far as appearance of spots is concerned, as well as in size of pycnidia, these specimens appear quite different from the 1959 collection on *R. missouriense* mentioned in the preceding note. Except for one obscure report which I have been unable to check adequately, all mention of *Coniothyrium* on *Ribes* appears to be based on specimens on stems and branches.

DARLUCA FILUM (Biv.) Cast. occurs on telia of *Puccinia asteris* Duby on *Aster pilosus*, collected at Madison, October 10. Development of this hyperparasite on a microcyclic rust is rare, although one earlier Wisconsin specimen on *P. asteris* is in the Wisconsin Herbarium.

STAGONOSPORA ATRIPLICIS (West.) Lind. on *Chenopodium album* from Madison, July 4, has some pycnidia which contain small, rod-shaped microconidia instead of the characteristic phragmospores.

STAGONOSPORA sp. is present in profusion on the leaves of a phanerogamic specimen of *Carex leptonervia* Fern., collected by J. J. Jones, August 16, 1954, near Winegar, Vilas Co. The blackish subglobose pycnidia are about 150 μ diam. The subhyaline spores are cylindric to subcylindric, or subfusoid, straight or slightly curved, (25–)30–35(–40) x (4–)5–6 μ, 4–6 septate, often with slight constrictions at the septa.

STAGONOSPORA sp. heavily infected *Carex pennsylvanica* near Cross Plains, Dane Co., September 7. The elongate, indeterminate spots are yellowish- to reddish-brown, usually involving the narrow leaves from margin to margin. The affected areas are not necessarily distal, but often occur within the still green areas of the leaves. The pycnidia are scattered, mostly pallid brownish, occasionally somewhat darker, rather thin-walled and translucent, subglobose, approx. 90–150 μ diam. The conidia are hyaline, often guttulate or granulose, obtuse and cylindric, straight or slightly curved, 2–3 septate, 23–30(–33) x 7–8(8.5) μ. Where 3 septate, it sometimes appears as though division had occurred in a terminal cell without accompanying divisions in the other two. This fungus appears truly parasitic, in contrast to the sometimes doubtful specimens where pycnidia are confined to dead leaf tips.

STAGONOSPORA sp. occurs on tiny, white, translucent spots about 1 mm. diam. on *Circaea latifolia,* collected June 27 near Pine Bluff, Dane Co. The thin-walled, pale brown, subglobose pycnidia are epiphyllous, two or three per spot, approx. 75 μ diam. The spores are cylindric or subfusoid, straight or slightly curved, 13–18 x 2.5–3.5 μ, 1–3 septate. There seem to be no reports of any Sphaeropsidales on *Circaea*, other than an undetermined species of *Septoria* mentioned in my Notes XXVI.

STAGONOSPORA sp. collected on *Fraxinus pennsylvanica* var. *lanceolata* at Gov. Dodge State Park, Iowa Co., June 24, seems distinct from any other sphaeropsidaceous species with phragmospores or scolecospores reported on *Fraxinus* from Wisconsin. The conspicuous spots are tan colored, one or two per infected leaflet, suborbicular, with narrow, irregular, darker margins, about .5–1 cm. diam. The pycnidia are epiphyllous, light brown, subglobose, tending to collapse, deeply seated in the host tissue, approx. 75–125 μ diam., scattered to gregarious. The conidia are hyaline, straight to lax, or slightly sinuous, often more obtuse at one end than at the other, 23–32 x 3–3.5 μ, (2–)3 septate. Admittedly, this might be classed as a *Septoria*, various species of which have been reported on *Fraxinus*, but it is certainly not *S. besseyi* Peck, of which there are numerous specimens in the Wisconsin Herbarium.

SEPTORIA sp. on dead leaves of *Agrostis alba* at Devils Lake State Park, Sauk Co., September 15, has spores which in their dimensions seem to correspond fairly closely to the macrospores of *S. passerinii* Sacc., as described and figured by Sprague. This species, however, has been reported only on Hordeae. In the specimen on *A. alba* the scattered brown pycnidia are somewhat flattened, thin-walled and translucent, mostly about 125 μ diam. The spores are from almost straight to lax or strongly curved, approx. 23–28 x 2–2.5 μ, appearing obscurely 2 septate.

SEPTORIA sp. on dead areas on leaves of *Calamagrostis canadensis*, collected at Gibraltar Rock County Park, Columbia Co., June 20, in microscopic characters corresponds quite closely with *Septoria secalis* Prill & Delacr., as described and figured by Sprague in his "Diseases of Cereals and Grasses in North America", p. 253. For conclusive determination, however, more and better material would be desirable.

SEPTORIA sp. (or RHABDOSPORA?) occurs on flowering stems of *Zigadenus elegans*, collected near Eagle, Waukesha Co., July 22, 1959. The black, globose pycnidia are approx. 65–100 μ diam., scattered on elongate, light-colored areas on the stem. The conidia are hyaline, flexuous, tapering at one, or sometimes both apices, rather obscurely 1–3 septate, 20–33 x 1–1.5 μ. A *Septoria* was collected on leaves of this host at the same station in 1951, and reported on in my Notes XVII. It had continuous spores which were definitely thicker in relation to length, and pycnidia which averaged about 100 μ diam.

SEPTORIA sp. developed on leaves of *Viburnum acerifolium*, collected at Devils Lake State Park, Sauk Co., October 10, 1959, and held out-of-doors over winter in a wire cage at Madison until May 1960. The freshly collected leaves were still green, with conspicuous, angled, sordid-brownish spots. The pycnidia were inconspicuous, scattered to gregarious, deeply sunk in the host tissue, but with rather thin, translucent walls and with contents undifferentiated. The overwintered pycnidia showed a surprising further development of the wall which had become black and is composed of dark, thick-walled mostly isodiametric cells. These mature pycnidia are subglobose, approx. 125–160 μ diam., with a prominent ostiole, and with spores which are hyaline, slender and acicular, straight or slightly curved, 23–38 x 1–1.3 μ, appearing continuous. This is not *Septoria viburni* West., reported on *Viburnum opulus* (cult.) in Wisconsin, as that species has cylindric guttulate spores. I have found no record of other *Septorias* on *Viburnum*. It seems possible that the October collection constituted an overwintering stage of a *Septoria* which had developed normally earlier in the season.

SEPTORIA sp. occurs on dead tips of leaves of *Chrysanthemum coccineum* (cult.), collected near Cross Plains, Dane Co., August 28. The tiny pycnidia, approx. 60–75 μ diam., are thin-walled and fragile and closely crowded. The hyaline spores appear continuous, are slightly curved, and are about 15–20 x 1.2–1.7 μ. Most of the species reported on *Chrysanthemum* and allied hosts have spores which are much longer than these.

LEPTOTHYRIUM (?) sp. occurs on leaves of *Viburnum acerifolium* (cult.), collected at Madison, September 26. The fruiting structures are subcuticular in origin, lifting the cuticle as they develop under it. The spots are orbicular, reddish-brown with narrow purplish borders, approx. .5–1 cm. diam. The fruiting bodies are convex above and flattened below, non-ostiolate, black, approx. 100–125 μ diam., and scattered on the spots. Conidiophores are hyaline, basal and rudimentary, about 6–7 x 2 μ, the conidia pallid greenish, broadly ellipsoid, 5–6 x 3–3.5 μ. Perhaps parasitic.

GLOEOSPORIUM CANADENSE Ell. & Ev. *(Discula quercina* (West.) v. Arx) is common on *Quercus alba* and *Q. macrocarpa* in Wisconsin, and has spores about as described by Ellis and Everhart, 10–14 x 3.5–4.5 μ, narrowly ellipsoid or fusoid. In a specimen on *Q. macrocarpa*, collected August 26 near Cross Plains, Dane Co., the conidia are 12–14 x 7–8.5 μ, broadly oval in outline. Fruiting is essentially hypophyllous and is confined to segments of the principal veins, producing yellowing on the upper leaf surface along the infected veins, but without the reddish-brown and extensive dead areas commonly seen in *G. canadense* infections. At the time of collection the leaves affected were being prematurely shed. It seems doubtful that the Cross Plains specimen represents merely a variant manifestation in view of the much greater spore width and the quite different lesions produced.

DISCULA sp. (following the treatment of von Arx in his revision of *Gloeosporium)* is present in small amount on leaves of *Quercus bicolor,* collected near Avon, Rock Co., September 3, 1959. The lesions are pale reddish, rounded, about .5 cm. diam. The acervuli are gregarious, subepidermal, epiphyllous but deeply sunken to a point about midway between upper and lower epidermis, and hemispherical in outline, approx. 100–125 μ diam. Conidiophores are subcylindric, appearing somewhat grayish in mass, very closely ranked over the entire surface of the acervulus, 10–12 μ long. The conidia are hyaline, continuous, fusoid or occasionally narrowly subcylindric, 5–8 x (1–)1.5(–2) μ. Quite similar to *Discula quercina* (West.) v. Arx *(Gloeosporium quercinum* West.) in general characteristics. The latter, however, is hypophyllous and has conidia which are longer and somewhat wider than those of the specimen under consideration.

DISCULA sp. occurred on reddish-brown, wedge-shaped apical portions of leaves of *Ribes diacantha* (cult.) at Madison, August 22. The fruiting body superficially resembles a pycnidium, but in section is seen to be a somewhat elevated acervulus, approx. 150 μ wide by 60 μ high, subepidermal with a well-developed blackish mycelial covering above, but with a wide central aperture. The base and sides of the acervulus are lined with closely ranked, slender, hyaline conidiophores about 12–15 x 2 μ, while the conidia are hyaline, broadly ellipsoid, subfusoid, or fusoid, about 5–7 x 2–3 μ.

PHLYCTAENA (?) sp. occurs on leaves of *Desmodium nudiflorum,* collected near Browntown, Green Co., July 19. The acervuli appear subepidermal in origin and in fact verge upon a pycnidial structure. The conspicuous, orbicular, dull reddish-brown spots are mostly about .5 cm. diam. In accommodation to the very thin leaf the acervuli are noticeably flattened, and are mostly about 60–75 μ in broad diameter, pallid brownish, very inconspicuous and few and scattered on the spots. The conidiophores are more or less bottle-shaped, approx. 9–12 x 2 μ, rather loosely ranked. The conidia are hyaline, from almost straight to mostly curved and falcate, usually broadest in the middle and tapering toward the ends, appearing continuous, 22–25 x 1.5–2 μ. Certainly not far from *Septoria.* The tentative assignment to *Phlyctaena* attempts to follow the treatment of von Arx in his revision of *Gloeosporium.*

PHLEOSPORA ANEMONES Ell. & Kell. has been found several times on *Anemone cylindrica* in Wisconsin. That the large, black, closely grouped fruiting structures are close to *Septoria* cannot be denied and the fungus has in fact been so designated by some workers. In the fall host plants are sometimes found bearing black fruiting structures which externally correspond closely to those of *Phleospora anemones,* but whose contents are not differentiated and do not become so prior to the onset of winter. Host leaves bearing these structures were collected near Cross Plains, Dane Co., in September 1959, placed in a wire cage, and overwintered out-of-doors at Madison until early May 1960. It had been thought that a perfect stage might develop, but examination showed profuse production of typical *Phleospora* spores, indicating that this fungus, like a number of others observed by the writer, may live from year to year without production of a perfect stage.

INULA HELENIUM, collected at Gov. Dodge State Park, Iowa Co., July 21, 1959, bears an unidentified monilaceous fungus which seems perhaps to fall within the range of what has been called *Ovularia.* The tufted fascicles are epiphyllous on more or less extensive, sordid brownish areas. The hyaline, clustered conidiophores, more or less widely divergent from a small, brownish, elevated stroma, are approx. 15–20 x 2.5–3 μ, simple, with a single scar at the narrowed tip, or subgeniculate and denticulate at the tip. The conidia appear to have been catenulate and are hyaline, fusoid, or sometimes narrowly subcylindric in the longer conidia, which may be narrowed at one end and irregularly obtuse at the other, 8–22 x 2–3 μ and continuous so far as observed.

BOTRYTIS sp. appears parasitic on upper portions of leaves—not necessarily the tips—of *Hemerocallis fulva,* the common day-lily, collected at Madison, July 6. The fungus is amphigenous, the conidia smooth, thin-walled, subhyaline, broadly oval, 12–16 x 9–10 μ, produced in clusters from very short, stubby branches in the apical region of the medium-long, sparingly septate, grayish-olivaceous conidiophores. The hardy host plant is extensively naturalized in Wisconsin, but the present instance is the first in many years of collecting where an apparent parasite has been noted on it. There seem to be no literature references recording *Botrytis* on *Hemerocallis.*

CLADOSPORIUM sp., possibly parasitic, occurs in minute gregarious tufts on long, narrow, brownish lesions on the adaxial sides of leaves of *Bromus purgans*, collected at the New Glarus Woods Roadside Park, Green Co., October 4. The conidiophores are closely fascicled in small groups, clear brown, multiseptate, sparingly geniculate and somewhat paler toward tip, approx. 60–75 x 3–3.5 μ. The few conidia observed ran about 10–12 x 4.5–5 μ, short-cylindric, rather deep brown with wall minutely roughened. The leaves also bear *Puccinia recondita* Rob. ex Desm.

CERCOSPORELLA (?) sp. occurs on leaves of *Dioscorea villosa,* collected at Gov. Dodge State Park, Iowa Co., July 21, 1959. The fungus is amphigenous on small, translucent, orbicular or angled, brownish, darker bordered spots approx. 1–3 mm. diam. The hyaline, multigeniculate conidiophores are scattered, mostly singly or in pairs, on the spots, but many of them appear to be compound, being considerably enlarged and somewhat amorphous in aspect basally. They are about 3 μ wide in the narrower upper portion and approx. 15–40 μ long, very inconspicuous and revealed only in sections. The conidia are hyaline, subacicular, straight or slightly curved, base narrowly obconic, 2–3 septate, approx. 30–45 x (1.5–) 2–2.5 μ.

CERCOSPORELLA CELTIDIS (E. & K.) J. J. Davis *(Ramularia celtidis* Ell. & Kell.) was collected on *Celtis occidentalis* by Davis in Crawford Co., Wis. in 1921. In his specimen most of the spores are lax and filiform, about 50 x 2.5 μ, or longer, but there are a considerable number which are not more than 20–25 x 2.5 μ. At a station near Cross Plains, Dane Co., October 7, on leaves of the same host, a fungus was found which it seems likely may be a reduced late-season development of *Cercosporella celtidis.* The spots are grayish and less sharply defined than in the 1921 specimen. The conidia are hyaline, slender-cylindric, about 12–14 x 2.5 μ, and there is considerable production of superficial, creeping, slender thread-like mycelium on the surface of the spots.

CERCOSPORA FILIFORMIS (Davis) Chupp is fairly common on *Anemone patens* var. *wolfgangiana* in Wisconsin. After the *Cercospora* has passed its peak, small pycnidium-like bodies are regularly produced on the old lesions. In past years these have been examined from time to time, but no spores have been found in them. In a collection made near Cross Plains, Dane Co., July 14, however, these structures are filled with hyaline, rod-shaped microconidia, possibly indicative of a perfect stage to be developed, although when similar leaves were overwintered out-of-doors in 1954–55, the "pycnidia" produced only *Cercospora* conidia from their surfaces and no perfect stage ensued.

CERCOSPORA sp. is hypophyllous on sordid brownish areas on leaves of *Callistephus chinensis* (cult.), collected September 7 near Cross Plains, Dane Co. The conidiophores are from almost straight to slightly curved or angled, widely and loosely 1–3 geniculate, clear pale brown below, pallid and slightly wider at the truncate tips, basally 2–3 septate, approx. 125–135 x 4.5–6 μ, fascicled from a more or less well-developed blackish stroma. The conidia are hyaline, slightly curved, narrowly obclavate, multiseptate, truncate at base, approx. 100–140 x 3.5–4.5 μ. Chupp, in his monograph, does not list any species of *Cercospora* on *Callistephus.*

Cercospora sp. on *Centaurea macrocephala* (cult.), collected near Cross Plains, Dane Co., September 7, does not correspond to *Cercospora centaureae* Died., the only species mentioned by Chupp as on *Centaurea.* In the Wisconsin specimen the spots are small, rounded, and sharply defined, about 2–5 mm. diam., with wide dark brown borders and cinereous centers. The conidiophores are epiphyllous, clear gray brown, multiseptate, mildly geniculate, with widely spaced but nevertheless rather prominent geniculations, obtuse and truncate at tip, with prominent scar, approx. 225–275 x 4–6 μ in small, loose fascicles of about 3–10 phores, from a small stroma. The conidia are hyaline, obscurely multiseptate, more or less curved, essentially acicular, truncate at base, with prominent scar, approx. 90–120 x 3–3.5(–4) μ.

Sclerotiomyces colchicus Woronichin occurs on leaves of *Acer saccharinum,* collected September 9, 1959 and of *Zanthoxylum americanum,* September 13, 1960, both at Wildcat Mt. State Park, Vernon Co. Epiphyllous, as in the case of all other specimens of this photosynthesis-reducing fungus collected so far in Wisconsin. This seems not to be a typical "honey-dew" organism, since there is, so far as I have observed, no evidence that it develops on insect excretions.

Additional Hosts

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

Synchytrium fulgens Schroet. on *Oenothera rhombipetala.* Sauk Co., near Spring Green, September 11, 1959. Karling (Mycologia 50:373. 1958) discusses American collections of this species.

Albugo candida (Pers.) O. Ktze. on *Erysimum cheiranthoides.* Dodge Co., near Horicon, July 12.

Albugo tragopogonis (Pers.) S. F. Gray on *Antennaria plantaginifolia.* Iowa Co., Blue Mounds State Park, August 11.

Plasmopara halstedii (Farl.) Berl. & DeToni on *Silphium terebinthinaceum* x *laciniatum.* Dane Co., Madison, September 20. In my notes XXII I stated that *P. halstedii* had not been found on *Silphium laciniatum* in Wisconsin, which remains true, but I speculated that, since at that time the fungus had not yet been found on the hybrid either, the hybrid might have resistance imparted by *S. laciniatum,* which is evidently not the case.

CRYTOSPORELLA ANOMALA (Peck) Sacc. on *Corylus americana* x *avellana*. Pierce Co., River Falls, November 12, 1959. Coll. & det. A. H. Epstein. This species, only very occasionally seen on native hazelnut, was causing serious and extensive damage in a commercial plantation of the European filbert crossed with the American species. It is reported as occurring on filbert in Europe, along with two other species of *Cryptosporella*.

VENTURIA INAEQUALIS Wint. *Fusicladium dendriticum* stage on leaves and young fruit of *Pyrus arnoldiana* (cult.). Dane Co., Madison, June 6.

TICHOTHECIUM sp. occurred as an obvious parasite on the lichen *Caloplaca flavovirescens*, collected by K. G. Foote near Ridgeway, Iowa Co., April 19. The many-spored asci of the parasite are broadly clavate, about 35 x 12 μ, the uniseptate, dark brown, broadly spindle-shaped ascospores are approx. 5–7 x 3–3.5 μ. These spore dimensions do not fit those of either of the two species listed by Keissler in his monograph on lichen parasites, although they are not far from those of *Tichothecium nanellum* Arn.

OPHIODOTHIS HAYDENI (B. & C.) Sacc. on *Aster pilosus*. Dane Co., Madison, August 21. This growth, although usually sterile in my experience, is characteristic and obviously parasitic, causing much distortion of the host.

ELSINOE VENETA (Burkh.) Jenkins. *Sphaceloma* stage on *Rubus parviflorus* (cult.). Dane Co., Madison, July 20.

MELAMPSORA ABIETI-CAPREARUM Tub. ii, III on *Salix glaucophylloides* Fern. Columbia Co., near Swan Lake, Pacific Twp., September 18, 1959.

PUCCINIA DIOICAE P. Magn. II, III on *Carex normalis*. Dane Co., near Verona, June 29. On *C. brevior*. Dane Co., near Pine Bluff, August 4.

PUCCINIA DIOICAE P. Magn. on *Carex concinna*. Door Co., Ridges Sanctuary at Bailey's Harbor, June 12, 1954. Coll. J. H. Zimmerman. On *C. disperma*. Winnebago Co., Menasha, May 18, 1889. Collector unknown. On *C. foenea*. Dane Co., Madison, June 23, 1950. Coll. J. H. Zimmerman. On *C. houghtonii*. Ashland Co., Ironwood Island, June 27, 1956. Coll. F. C. Lane (2682). On *C. pauciflora*. Oneida Co., near Minocqua, August 11, 1953. Coll. J. J. Jones. On *C. projecta*, Green Co., near Albany, August 3, 1956. Coll. H. H. Iltis (6726). On *C. sterilis*. Dane Co., Madison, June 14, 1950. Coll. J. H. Zimmerman. These were all noted on phanerogamic specimens in the University of Wisconsin Herbarium.

PUCCINIA CARICINA DC. on *Carex atherodes*. Sauk Co., Devils Lake State Park, July 24, 1947. Coll. J. H. Zimmerman. On *C. pedunculata*. Sauk Co., Parfrey's Glen, June 14, 1937. Coll. F. J. Hermann (8764). On *C. pseudocyperus*. Lincoln Co., Tomahawk, September 16, 1952. Coll. F. C. Seymour. All on phanerogamic specimens in the University of Wisconsin Herbarium.

PUCCINIA CARICINA DC. var. LIMOSAE (Magn.) Jorstad II, III on *Carex limosa*. Vilas Co., Sayner, July 27, 1902. Coll. S. C. Wadmond. On a phanerogamic specimen in the University of Wisconsin Herbarium. The urediospore pores are scattered, which would seem to throw the specimen into what was formerly designated *Puccinia karelica* Tranz., rather than into *P. limosae* Magn., both of which are placed by Jorstad in *P. caricina* var. *limosae*.

PUCCINIA ASTERIS Duby on *Aster pilosus*. Dane Co., Madison, October 10.

GYMNOSPORANGIUM GLOBOSUM Farl. I on *Sorbus americana* (cult.). Dane Co., Madison, August 13.

GYMNOSPORANGIUM JUVENESCENS Kern I on *Amelanchier interior* Nielsen. Columbia Co., Gibraltar Rock County Park, June 20.

SCHIZONELLA MELANOGRAMMA (DC.) Schroet. on *Carex blanda*. Sauk Co., Devils Lake State Park, June 20, 1946. Coll. J. H. Zimmerman. On a phanerogamic specimen in the University of Wisconsin Herbarium. This is the first broad-leaved species of *Carex* on which this smut has been noted in Wisconsin.

ENTYLOMA COMPOSITARUM Farl. on *Aster pilosus*. Dane Co., Madison, October 10.

CERATOBASIDIUM ANCEPS (Bres. & Syd.) Jacks. (*Sclerotium deciduum* J. J. Davis) appears strongly parasitic, but not at all specific, as one observes it on various hosts in the field. At a single station in Wildcat Mt. State Park, Vernon Co., June 9, this fungus was collected on eight hosts not previously recorded for Wisconsin, as follows: *Cryptotaenia canadensis, Monarda fistulosa, Veronicastrum virginicum, Triosteum perfoliatum, Aster paniculatus, Aster prenanthoides, Rudbeckia laciniata*, and *Senecio aureus*. In addition, it occurred on *Sanguinaria canadensis, Verbena urticifolia*, and *Solidago gigantea*, previously reported as hosts. Near LaValle, Sauk Co., June 15, the fungus was collected on *Urtica dioica*, and on young shoots of *Rumex* (probably *R. britannica*).

PELLICULARIA FILAMENTOSA (Pat.) Rogers on *Plantago lanceolata*. Dane Co., Madison, July 20.

PHYLLOSTICTA DEARNESSII Sacc. on *Rubus* sp. (dewberry). Dane Co., near Pine Bluff, August 30. Although it is scarcely possible to state the host species, it is obviously neither *R. strigosus* nor *R. parviflorus,* the only previously reported hosts for this fungus in Wisconsin.

PHYLLOSTICTA FRAGARICOLA Desm. & Rob. on *Potentilla norvegica* var. *hirsuta.* Jefferson Co., near Waterloo, July 28. This specimen corresponds closely to like-named collections on *Potentilla arguta* and *P. recta.*

PHYLLOSTICTA ANTENNARIAE Ell. & Ev. on *Antennaria plantaginifolia.* Iowa Co., Blue Mounds State Park, August 11. The conidia are slightly longer, up to 10 μ, than in other specimens on *Antennaria fallax,* but are of the same general type.

NEOTTIOSPORA ARENARIA Syd. on *Carex grayii.* Outagamie Co., near Stephensville, June 19, 1951. Coll. R. T. Brown and R. Bray. On *C. scoparia.* Burnett Co., near Webster, September 6, 1929. Coll. W. T. McLaughlin (1846). On phanerogamic specimens in the University of Wisconsin Herbarium.

ASCOCHYTA GRAMINICOLA Sacc. on *Oryzopsis asperifolia.* Price Co., Camp Merrill near Phillips, September 13, 1911. Coll. J. J. Davis. On a leaf bearing *Puccinia pygmaea* Erikss., for which the specimen was originally collected. On *Muhlenbergia racemosa.* Sauk Co., Ferry Bluff, Town of Prairie du Sac, June 24.

ASCOCHYTA AQUILEGIAE (Rabh.) Hoehn. on *Aquilegia buergeriana* Sieb. & Zucc. (cult.). Dane Co., Madison, July 4, 1959.

ASCOCHYTA PISI Lib. on *Lathyrus ochroleucus.* Iowa Co., Blue Mounds State Park, August 11.

ASCOCHYTA CUCUMIS Fautr. & Roum. on *Cucurbita maxima* (cult.). Dane Co., Madison, September 26.

ASCOCHYTA COMPOSITARUM J. J. Davis on *Senecio aureus.* Vernon Co., Wildcat Mt. State Park, June 9. This is the small-spored variety, originally designated by Davis as var. *parva,* but later considered as better included with the species. In the present specimen most of the spores are about 8–10 x 3 μ, and are possibly somewhat immature, as only a minority show a septum.

DARLUCA FILUM (Biv.) Cast. on *Pucciniastrum pyrolae* (Pers.) Schroet. II on *Pyrola elliptica.* Dane Co., near Verona, September 28. The first Wisconsin collection on a species of *Pucciniastrum.* On *Melampsora abietis-canadensis* (Farl.) Ludw. II on *Populus grandidentata.* Vernon Co., Wildcat Mt. State Park, September 13. On *Tranzschelia pruni-spinosae* (Pers.) Diet. III on *Prunus nigra.* Chippewa Co., near Cadott, September 20, 1922. Coll. J. J. Davis. The first Wisconsin report of *Darluca* on *Tranzschelia.* On *Puccinia* *puritanica* Cumm. II on *Carex pennsylvanica.* Dane Co., near Cross Plains, August 17.

STAGONOSPORA ARENARIA Sacc. on *Lolium multiflorum.* Dane Co., Madison, October 12. The straight to laxly curved spores are mostly about 35–40 x 3–3.5(–4) μ and mostly 3, but occasionally 4 septate.

STAGONOSPORA CARICINELLA Brun. on *Carex normalis.* Dane Co., near Cross Plains, July 14. On *C. brevior.* Dane Co., Madison, July 6.

STAGONOSPORA ALBESCENS J. J. Davis on *Carex conoidea.* Dane Co., Madison, June 20. Mostly on the upper leaves (or bracts) subtending the pistillate spikes, but also on the scales of the staminate inflorescence.

STAGONOSPORA CYPERICOLA H. C. Greene on *Cyperus schweinitzii.* Iowa Co., near Arena, August 11. The spores in this specimen are mostly about 22–25 x 5–6.5 μ, slightly smaller than in the type. The leaves also bear *Puccinia cyperi* Arth.

SEPTORIA NODORUM Berk. on *Alopecurus aequalis.* Waukesha Co., Big Bend, June 26, 1930. Coll. J. J. Davis. Associated with *Uromyces dactylidis* Otth *(U. alopecuri* Seym.).

SEPTORIA RIBIS Desm. on *Ribes alpinum* (cult.). Jefferson Co., McKay Nursery at Waterloo, October 10. Comm. E. K. Wade.

SEPTORIA CORNICOLA Desm. var. AMPLA H. C. Greene on *Cornus obliqua.* Dane Co., Madison, September 26.

SEPTORIA ASTERICOLA Ell. & Ev. on *Aster sericeus.* Sauk Co., near Spring Green, May 26. That *S. astericola* and *Septoria fumosa* Peck, the latter commonly reported on species of *Solidago,* are really distinct may be doubted.

SEPTORIA ATROPURPUREA Peck on *Aster junciformis.* Dane Co., near Deerfield, July 28.

SEPTORIA LANARIA Fairman on *Antennaria petaloidea* Fern. (host det. E. W. Beals). St. Croix Co., near New Richmond, May 29. Coll. H. H. Iltis. Although the fungus is on the previous year's leaves it seems certain it was parasitic.

HAINESIA LYTHRI (Desm.) Hoehn. on *Rubus allegheniensis.* Vernon Co., Wildcat Mt. State Park, September 13. The *Sclerotiopsis* stage is also present in this specimen. At the same station, September 9, 1959, a specimen with *Sclerotiopsis* only was collected on *Carya cordiformis.* Both are stages of *Pezizella lythri* (Desm.) Shear & Dodge.

LEPTOTHYRIUM SIMILISPORUM (Ell. & Davis) Davis on *Aster macrophyllus*. Sauk Co., Devil's Lake State Park, September 15. All previous collections in Wisconsin have been on species of *Solidago*.

MELASMIA ULMICOLA B. & C. on *Zelkova carpinifolia* (cult.). Dane Co., Madison, August 6. Referred here with some doubt. There are many slender rod-shaped or slender-ellipsoid conidia, about 5 x 1.5 μ, which are very similar to those on specimens on *Ulmus* but there is also a second class of subfusoid conidia, about 7 x 2.5–3 μ, which seem to be a constant feature.

COLLETOTRICHUM GRAMINICOLA (Ces.) Wils. on *Avena sativa* (var State Pride). Dane Co., Madison, June 11, 1958. Coll. D. C. Arny. Also on *Poa annua* at Madison, August 14.

ELLISIELLA CAUDATA (Peck) Sacc. on *Koeleria cristata*. Dane Co., Madison, July 17, 1959.

CYLINDROSPORUM BETULAE J. J. Davis on *Betula populifolia* (cult.). Dane Co., Madison, October 12. The lesions, although entirely characteristic, are somewhat old and only a few typical *Cylindrosporium* conidia were observed. There are present, however, many hyaline, bacilliform microspores, approx. 4–6 x 1 μ.

CYLINDROSPORIUM FILIPENDULAE Thum. on *Spiraea "rosebella"* (cult. and said to be a hybrid of *S. alba* DuRoi and *S. salicifolia* L.). Dane Co., Madison, August 22.

CERCOSPORELLA DEARNESSII Bub. & Sacc. on *Solidago hispida*. Vilas Co., Trout Lake, September 7, 1959. Coll. J. D. Sauer. The conidiophores are from 60–85 μ long in this specimen.

CERCOSPORA FUSIMACULANS Atk. on *Panicum wilcoxianum*. Dane Co., near Cross Plains, September 1, 1959.

CERCOSPORA CARICIS Oud. on *Carex normalis*. Dane Co., near Verona, June 29, and near Cross Plains, July 14.

ADDITIONAL SPECIES

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

SYNCHYTRIUM DAVISII Karling on *Rubus hispidus* and *R. triflorus (R. pubescens)*. Jackson Co., near Millston, September 26, 1912. Davis originally labeled these collections (and others) as *Synchytrium aureum* Schroet., but Karling (Mycologia 49:744. 1957), after critical study, has erected this species, with the specimen on *R. hispidus* designated as the type. Certain other Wisconsin specimens on these hosts remain under *S. aureum*.

PSEUDOPERONOSPORA CELTIDIS (Waite) G. W. Wils. on *Celtis occidentalis*. Vernon Co., Wildcat Mt. State Park, September 13. On the basis of inoculation experiments, it has been suggested that this species may be identical with *Pseudoperonospora humuli* (Miyabe & Takah.) Wils.

CERATOSTOMA PARASITICUM Ell. & Ev. on *Fomes applanatus*. Dane Co., Madison, June 15. Coll. & det. D. J. Rossouw.

OPHIOBOLUS GNAPHALII (Sacc. & Br.) Fairm. var. *lanaria* Fairm. on *Antennaria petaloides* Fern. (host det. E. W. Beals). St. Croix Co., near New Richmond, May 29. Coll. H. H. Iltis. This very interesting fungus, developing on the hairy under surface of the previous year's more or less evergreen leaves, seems possibly, although not certainly parasitic. Described by Fairman (Ann. Mycol. 9:149. 1911) on *Antennaria plantaginifolia* from Lyndonville, New York.

SCUTULA TUBERCULOSA Rehm on *Peltigera canina* var. *spuria*. Marinette Co., Dunbar, April 27, 1945. Coll. J. W. Thomson. On a specimen in the University of Wisconsin Herbarium.

PUCCINIA POLYSORA Underw. II, III on *Zea mays* (cult.). Dane Co., near Madison, September 1959. Coll. & det. M. S. Pavgi. It is believed that this rust, although undetected until recently, has long been present in Wisconsin and neighboring states.

PUCCINIA PURITANICA Cummins II, III on *Carex pennsylvanica*. Dane Co., near Cross Plains, August 17. Det. G. B. Cummins. The second collection of this species. The type was collected on the same host at Waltham, Mass. in 1910. The teliospores are pallid-olivaceous and germinate in the current season without dormancy.

PHYLLOSTICTA CELTIDIS Ell. & Kell. on *Celtis occidentalis*. Grant Co., Wyalusing State Park, September 24, 1959.

PHYLLOSTICTA ARMERIAE Allesch. on *Limonium* sp. (cult.). Outagamie Co., Kaukauna, July 18. Coll. N. Esler. Comm. E. K. Wade.

Phyllosticta heliopsidis sp. nov.

Maculis orbicularibus, centris albidis, marginibus fusco-purpureis, 2–5 mm. diam.; pycnidiis epiphyllis, paucis et sparsis, fumoso-olivaceis, subglobosis, ca. 150–200 μ diam., ostiolis prominentibus cum marginibus nigris; conidiis numerosis, hyalinis, rectis, tenuo-cylindraceis vel raro curvis leniter et subfusoideis, 5–7.5 x 1.5–2 μ.

Spots orbicular with whitish centers and rather wide dark purplish margins, 2–5 mm. diam.; pycnidia epiphyllous, few and scattered, smoky-olivaceous, subglobose, approx. 150–200 μ diam., ostiole outlined by prominent band of blackish cells; conidia numerous, hyaline, straight, slender-cylindric, or rarely slightly curved and subfusoid, 5–7.5 x 1.5–2 μ.

On living leaves of *Heliopsis helianthoides* (L.) Sweet, along the Milwaukee Railroad right-of-way, Iowa County, 1½ miles east of

Arena, Wisconsin, U. S. A., September 9, 1959. The host has often been referred to previously as *Heliopsis scabra* Dunal.

Many of the spots have only a single pycnidium, and most not more than two or three, scattered and more or less remote from one another.

PHOMA POLYGRAMMA (Fr.) Sacc. var. PLANTAGINIS Sacc. on scapes of *Plantago lanceolata*. Dane Co., Madison, August 22. There is reason to believe that this is really a species of *Phomopsis*. A specimen in the University of Wisconsin Herbarium collected by L. R. Jones in 1920 at Winchester, Va. has both alpha and beta type spores in abundance, but other specimens from Maryland, New Jersey, New York and Wisconsin have only the fusoid *Phoma*-type conidia. However, the development and general appearance of the fungus also suggests *Phomopsis* as I have seen it in other representatives of the genus.

Ascochyta lonicerae-canadensis sp. nov.

Maculis conspicuis, orbicularibus vel irregularibus, sordido-brunneis, marginibus obscuro-purpureis, angustis, ca. (1–)1.5–2 (–2.5) cm. diam.; pycnidiis epiphyllis, sparsis, flavido-brunneis, subglobosis, ca. 100–125 μ diam.; conidiis hyalinis, cylindraceis vel late subfusoideis, granulosis aliquanto, septis mediis, (13–)15–17 (–18) x 6–7.5 μ.

Lesions conspicuous, orbicular or irregular, sordid brownish with narrow dull purplish border, approx. (1–)1.5–2(–2.5) cm. diam.; pycnidia epiphyllous, scattered, yellowish-brown, subglobose, approx. 100–125 μ diam.; conidia hyaline, cylindric or broadly subfusoid, contents somewhat granular, septa median, (13–)15–17(–18) x 6–7.5 μ.

On living leaves of *Lonicera canadensis*. University of Wisconsin Arboretum, Madison, Dane County, Wisconsin, U. S. A., August 13, 1960. The host plant was transpanted from Bayfield Co., Wis. in 1958, so it seems possible the parasite was brought along with it.

The conidia here are decidedly wider than those of other species of *Ascochyta* which are reported as occurring on Caprifoliaceae. There is occasionally slight constriction at the septum, but usually none.

DIPLODINA CHENOPODII Karst. on *Coriospermum hyssopifolium*. Ozaukee Co., Lake Michigan beach 5 miles north of Port Washington, October 15. Coll. J. D. Sauer. This corresponds quite closely to Petrak's Fl. Bohem. et Morav. Exsicc. Ser. II, No. 1132, distributed as this species on *Chenopodium glaucum*. Hollos described *Diplodina coriospermi*, but the principal difference seems to be in slightly wider spores, so it seems likely that *D. coriospermi* is synonymous with *D. chenopodii*, although Petrak (Ann. Mycol. 23:57. 1925) states *D. coriospermi* should be referred to *Ascochytella,* a genus most authorities seem to regard as of dubious standing.

Stagonospora biseptata sp. nov.

Maculis variabilis, pallido-brunneis, in bracteis foliatis; pycnidiis amphigenis, nigro-fuscis, sparsis, subglobose, ca. 100–125 μ diam.; conidiis hyalinis, cylindraceis, subcylindraceis, vel subfusoideis, rectis vel curvis leniter, granulosis et guttulatis, biseptatis, (8–) 10–11(–13) x (35–)40–50(–55) μ.

Spots variable, brownish straw-colored with mottled darker areas, mostly on the leafy bracts subtending the inflorescence, and often, but not always, involving the entire bract; pycnidia amphigenous, blackish, scattered, subglobose, approx. 100–125 μ diam.; conidia hyaline, cylindric, subcylindric, or subfusoid, straight or slightly curved, granular and guttulate, biseptate, (2–)10–11(–13) x (35–)40–50(–55) μ.

On *Carex lanuginosa.* University of Wisconsin Arboretum, Madison, Dane County, Wisconsin, U. S. A., July 6, 1960.

In 1952 in the same general area a small specimen of this fungus was collected and commented on in my Notes XVIII.

Stagonosporia astericola (Davis) H. C. Greene comb. nov.

(Davis, J. J.—Trans. Wis. Acad. Sci. Arts Lett. 21:281. 1924)

Davis described *Asteromella astericola* as occurring on *Aster lateriflorus* in Wisconsin and I have since found the same organism on *Aster ericoides* on several occasions. The elongate, subcylindric spores, including those in Davis' specimen, often have a median septum, and in a specimen on *A. ericoides,* collected June 18, 1959 in Perrot State Park, Trempealeau Co., the spores are frequently 2 septate.

Septoria quercicola Sacc. on *Quercus macrocarpa.* Trempealeau Co., Whitehall, August 19. Coll. E. P. Jensen. The pycnidia occur individually, or only two or three together, on tiny, rounded, reddish-tan spots which are very numerous on the infected leaves. The spores are strongly curved, 3 septate, not constricted at the septa, hyaline and obtuse at both ends, mostly about 35–40 x 3.5–4.5 μ. Said to have been very prevalent on bur oak in Trempealeau Co. in 1960.

Chaetosticta perforata (Ell. & Ev.) Petr. & Syd. on *Cirsium discolor.* Dane Co., Madison, August 13, 1959. Det. S. J. Hughes. This fungus simulates *Acanthostigma occidentale* (Ell. & Ev.) Sacc. in macroscopic appearance, but is an imperfect form producing hyaline phragmospores. Also on *Cirsium muticum,* collected at Madison, September 3, 1951, and discussed in my Notes XVII, but without a determination at that time.

GLOEOSPORIDIELLA VARIABILE (Laub.) v. Arx (*Gloeosporium variabile* Laub.) on *Ribes alpinum* (cult.). Barron Co., Rice Lake, August 6. Coll. Mrs. J. Brecka. Comm. E. K. Wade. This seems quite distinct from *Gloeosporium ribis,* common on native currants in Wisconsin, as the conidia of *G. variabile* are narrower, longer, and mostly strongly curved than those of *G. ribis.*

Leptothyrium salicicola sp. nov.

Maculis orbicularibus, 2–8 mm. diam., saepe confluentibus, brunneis, zonatis plus minusve, marginibus angustis, fuscis; fructificationibus epiphyllis, sparsis, nigris, pseudoparenchymaticis, rotundatis supra, applanatis infra, fissilibis stellatis supra, subepidermidibus, erumpentibus, ca. 135–175 μ latis; conidiophoris subhyalinis, tenuibus, inconspicuis, basiliaribus plerumque; conidiis hyalinis, subfusoideis vel fusoideis, subcylindraceis interdum, (9–)12–14(–17) x 3.5–4.5 μ.

Lesions orbicular, 2–8 mm. diam., often confluent, grayish-brown, more or less zonate with narrow darker margin; fruiting bodies epiphyllous, scattered, black, pseudoparenchymatous, rounded above, flattened below, the upper covering tending to split stellately, subepidermal in origin, but strongly erumpent, approx. 135–175 μ wide; conidiophores subhyaline, slender, inconspicuous, mostly basal; conidia hyaline, subfusoid to fusoid, or occasionally subcylindric, (9–)12–14(–17) x 3.5–4.5 μ.

On living leaves of *Salix petiolaris.* University of Wisconsin Arboretum, Madison, Dane County, Wisconsin, U. S. A., October 3, 1960.

The rounded fruiting bodies are about half as high as wide and not numerous, usually only one or two per lesion.

PIROSTOMA CIRCINANS Fr. on *Sorghastrum nutans.* Dane Co., Madison, September 28. Vast numbers of the shining-black, flattened, punctate, fruiting bodies, approx. 25–50 μ diam. are crowded on the abaxial surfaces of the still green basal leaves. Despite the crowding, the circinate nature of the arrangement is plainly to be seen. Sections show the fungus to be evidently parasitic within the epidermis, with some of the larger bodies appearing even more deeply seated. Although no conidia were observed, the fungus is identical in aspect with exsiccati specimens on *Phragmites communis* and is so characteristic and well-marked that a report seems fully justified. An undetermined fungus on *Danthonia spicata,* mentioned in my Notes XXIV (Trans. Wis. Acad. Sci. Arts Lett. 47: 108. 1958) obviously also is referable to *P. circinans.*

DIPLOCLADIUM MINUS Bon. on *Polyporus gilvus.* Dane Co., Madison, October 18. Coll. & det. D. J. Rossouw.

A FIVE-YEAR SURVEY OF OAT SEED QUALITY IN WISCONSIN

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In 1959 there were 2,562,000 acres of oats grown in Wisconsin (1) making this the most important small grain, and second only to field corn among cereals in general. Oats are planted in the spring on Wisconsin farms as a companion or nurse crop when seeding a hay crop. The oat crop furnishes grain for feeding and straw for bedding livestock. Seed oats is also an important cash crop in the state for some specialized seed producers.

There are many people interested in the production of seed oats besides the farmers of the state. The Wisconsin Agricultural Experiment Station carries on an oat breeding program to furnish improved varieties for the state's agriculture. The Wisconsin Crop Improvement Association, an organization of seed producers, promotes the use of improved varieties by providing the organization for certifying the trueness of varieties which involves maintaining necessary records and seed testing facilities and making field inspections. The State Seed Laboratory of the Wisconsin Department of Agriculture has been interested in the use of high quality seed on Wisconsin farms.

In order to obtain information on the quality of seed oats being used in the state, a series of surveys was conducted in five areas from 1955 through 1959 by the State Seed Laboratory. It is hoped that this information will stimulate the use of better quality seed, promote seed testing and further better weed control.

Methods and Materials

The samples of oat seed used in these surveys were obtained through the cooperation of county agricultural agents and vocational agricultural teachers in the counties being surveyed (Figure 1). The teachers had their students bring in samples of the oats which were to be used for seed on their families' farms. The 1959 survey was an exception in that the samples were collected by the 4-H clubs of Walworth County as part of a county-wide project on weeds and weed control. The State Seed Laboratory supplied paper bags for the samples, directions for drawing the samples, and a questionnaire to accompany each sample giving the sender's name, address and school and pertinent information on the sample submitted. The samples received were from three sources (Table

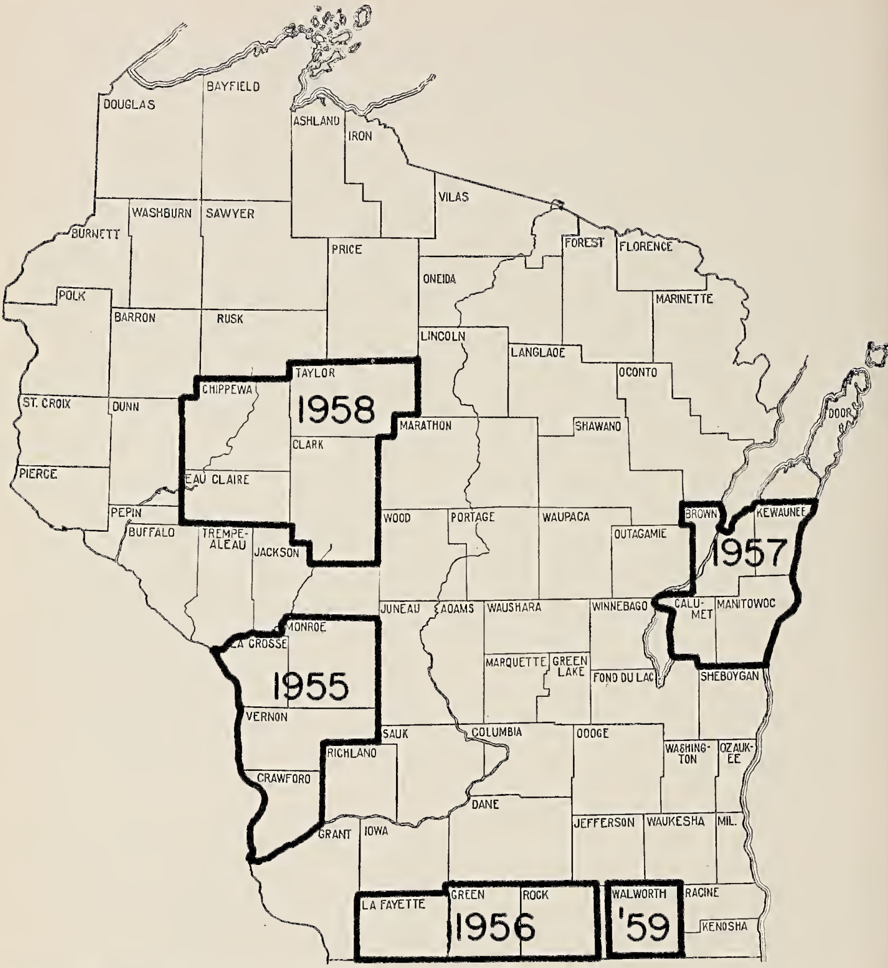

FIGURE 1. Five survey areas and year each was surveyed.

1): home-grown, purchased from neighbors, or purchased from seed dealers. During the five years samples were submitted by 954 persons from 54 schools and 15 clubs.

The samples were assembled and delivered to the State Seed Laboratory at Madison where they were tested during the summer as time permitted. Each sample was tested for purity, germination and noxious weed seed content according to standard seed testing procedures with the exception that the amount of seed tested was half of that specified in the "Rules for Testing Seed, adopted by the Association of Official Seed Analysts" (2). This reduction in sample size appeared justified because the number of samples was large for the number of analysts available and because the results would not be used for labeling purposes.

The information on the samples after testing was summarized and reported to the cooperating vocational agricultural teachers and county agricultural agents.

TABLE 1. SAMPLES OF OAT SEED RECEIVED EACH YEAR AND SOURCES ACCORDING TO INFORMATION SUPPLIED BY INDIVIDUALS SUBMITTING SAMPLES

YEAR	NUMBER OF SAMPLES	PERCENTAGE OF SAMPLES FROM EACH SOURCE		
		Home-grown	Purchased	
			Neighbor	Seed dealer
1955	248	78	....	..
1956	103	56	11	33
1957	382	62	19	19
1958	300	75	15	10
1959	87	61	17	22
Total	1120			
Average		63*	16	21

*1955 excluded from average.

RESULTS AND DISCUSSION

Oat Varieties

There were 42 variety names given for the samples submitted (Table 2). The four varieties—Beedee, Branch, Fayette and Sauk—which were bred and developed by the Wisconsin Agricultural Experiment Station and released after 1950, accounted for 36.3 per cent of the samples. Fourteen varieties in the survey were on the approved list for certification by the Wisconsin Crop Improvement Association during the years of the surveys, and accounted for 74.5 per cent of the samples. However, only one-fifth of all the samples were declared to be certified.

There were 28 additional varieties for which one or more samples were obtained, accounting for 20.1 per cent of the samples. These were mainly older varieties which had been superseded by newer ones. No variety names were given for 5.4 per cent of the samples.

The examination of all samples showed that 10.6 per cent had in excess of four per cent contamination with other varieties. The variety names on 1.6 per cent of the samples were totally incorrect. These determinations of the correctness of variety names were made by visual examination of the color of the oat kernels. Many varieties cannot be separated on color, so that the varietal contamination in all of the samples might be higher than the above figures indicate.

Those samples which were from home-grown seed showed the most varietal contamination with 12.9 per cent of the samples having over four per cent other varieties present, while 8.4 per cent of the samples from seed purchased from neighbors and 5.1 per cent from seed dealers showed a similar rate of contamination.

TABLE 2. NUMBER OF SAMPLES OF EACH OAT VARIETY RECEIVED DURING 1955 TO 1959

Varieties	No. of Samples	Varieties	No. of Samples
Abegweit	1	Kherson	1
Ajax**	181	Larain	2
American Beauty	1	Mindo**	2
Andrew	2	Minhafer**	4
Beaver	8	Missouri 0-205	12
Beedee*	54	Mohawk	2
Benton	1	Nemaha	72
Bonda**	58	Newton	3
Bonham	18	Rodney	47
Branch*	168	Sauk*	166
Cherokee	16	Shelby**	1
Clarion	4	Silver King	1
Clintafe**	1	Simcoe	7
Clintland**	96	Sioux	1
Clinton**	64	Swedish White	1
Craig	1	Valor	1
Exeter	1	Vanguard	4
Fayette*	14	Vicland**	2
Garry**	22	White Cross	1
Gopher	6	White Kherson	1
Iogold	1	Yellow Kherson	4

*Varieties developed by the Wisconsin Agricultural Experiment Station and released after 1950.

**Additional varieties approved for certification by the Wisconsin Crop Improvement Association during one or more of the five years of the survey.

Farmers generally are eager to accept new varieties of oats and do a very commendable job of maintaining the purity of these varieties for seed purposes. Fifty years ago the farmers of the state had difficulty maintaining pure varieties. New varieties of grain produced by the Wisconsin Agricultural Experiment Station were contaminated with other varieties within several years after being released to farmers. This prompted members of the Agronomy Department of the Wisconsin College of Agriculture at Madison to establish a seed inspection program (3), later to become the seed certification program, as a means for training farmers to protect seed from contamination. The results of these surveys indicate that the farmers of Wisconsin learned this lesson and are putting it into practice.

Germination

A satisfactory germination of seed oats is usually considered to be 90 per cent. During the five years of these surveys 83.3 per cent of all the samples were equal to or better than this standard (Table 3). Eighty samples, or 7.1 per cent, had germinations less than 80 per cent. The results of these surveys correspond to the results of germination tests on oat samples submitted to the State Seed Laboratory by farmers and seed dealers. In a year when there is no particular problem with germination, it is customary to expect that at least 5 per cent of the samples will germinate less than 80 per cent. The results of these surveys from 1955 to 1959 indicate that the persons preparing these lots for seed did not have many of the samples tested for germination.

The samples from home-grown seed contained 7.7 per cent which germinated less than 80 per cent while the samples purchased from

TABLE 3. VARIATION IN GERMINATION PERCENTAGES OF OAT SAMPLES FROM 1955 TO 1959

YEAR	PERCENTAGE OF SAMPLES IN GERMINATION CLASSES				
	100–95	94–90	89–60	79–50	49–0
1955	65.7	20.2	8.9	4.4	.8
1956	81.5	10.7	2.9	2.9	2.0
1957	50.2	24.6	13.6	7.4	4.2
1958	69.6	17.3	7.7	4.3	1.0
1959	74.7	16.1	6.9	2.3	0.0
Average	63.6	19.7	9.6	5.1	2.0

neighbors showed 5.6 per cent and from seed dealers 5.1 per cent. Although seed which was purchased has a slightly better record than home-grown seed, it appears that some farmers were paying for seed which would not produce plants in the field.

Purity

Impurities in seed consist of (a) other crop seeds; (b) weed seeds and (c) inert matter, such as, chaff, dirt or broken and damaged seeds half the original size or less. There were many samples in these surveys with considerable quantities of the above impurities (Table 4). Seed oats submitted to the Wisconsin Seed Certification Service must have a minimum pure seed content of 99.56 per cent. The average pure seed content of those samples drawn by the seed inspectors of the Wisconsin Department of Agriculture from seed oats offered for sale by retail seed dealers in the spring of 1959 was 99.87 per cent. A comparison of the quality of seed oats being offered for sale in the state and the quality of the oats found in these surveys would point to the conclusion that farmers should pay more attention to the pure seed content of the seed they intend to plant.

Weed Seeds

There were 54 different kinds of weed seeds (4) found in the oat samples in these surveys (Table 5). Eight weed seeds were found in the five survey areas indicating that they are generally found in oat fields throughout the state.

There are other weed seeds which occurred predominantly in one area, such as wild oats, night flowering catchfly and common ragweed in 1957 in the northeast area, and hempnettle, wild radish, Pennsylvania smartweed and water smartweed in 1958 in the northwest area.

TABLE 4. VARIATION IN PURE SEED PERCENTAGES OF OAT SAMPLES FROM 1955 TO 1959

YEAR	PERCENTAGE OF SAMPLES IN PURE SEED CLASSES				
	100.00 99.50	99.49 99.00	98.99 98.00	97.99 97.00	96.99 below
1955	51.7	19.3	19.3	6.5	3.2
1956	68.0	12.6	8.7	3.9	6.8
1957	42.5	19.6	19.1	8.1	10.7
1958	60.3	19.3	15.0	2.7	2.7
1959	59.7	23.0	9.2	3.5	4.6
Average	53.0	19.1	16.3	5.5	6.1

A few weed seeds are not only common but are difficult to remove from oat seed because they are nearly the same size as the oat kernels. Examples of such weed seeds are wild buckwheat, quackgrass, yellow foxtail, and wild mustard. Extra care must be taken in seed cleaning to remove them from the oats.

A number of very small weed seeds, such as, white cockle, Virginia peppergrass, wormseed mustard and red sorrel, were present in some samples. With a minimum of care in cleaning these weed seeds should have been removed.

TABLE 5. WEED SEEDS CONTAMINATING OAT SAMPLES FROM 1955 TO 1959. (BASED ON 50 GRAMS OF OATS.)

COMMON AND BOTANICAL NAMES	OCCURRENCE	
	No. of Samples	Years
Wild buckwheat, *Polygonum convolvulus*	713	5
Quackgrass, *Agropyron repens*	554	5*
Yellow foxtail, *Setaria glauca*	244	4
Ladysthumb, *Polygonum persicaria*	145	5
Lambsquarters, *Chenopodium album*	131	5
Green foxtail, *Setaria viridis*	89	5
Curly dock, *Rumex crispus*	75	5
Pennsylvania smartweed, *Polygonum pensylvanicum*	51	4
Water smartweed, *Polygunum hydropiper*	50	3
Barnyard grass, *Echinochloa crus-galli*	42	3
Wild mustard, *Brassica kaber*	39	3**
Hempnettle, *Galeopsis tetrahit*	36	2
White cockle, *Lychnis alba*	26	5
Wild radish, *Raphinus raphanistrum*	25	4**
Canada thistle, *Cirsium arvense*	23	4*
Night flowering catchfly, *Silene noctiflora*	23	2
Wild oats, *Avena fatua*	22	3
Common ragweed, *Ambrosia artemisiifolia*	19	2
Virginia peppergrass, *Lepidium virginicum*	17	3
Wormseed mustard, *Erysimum cheiranthoides*	10	4
Red sorrel, *Rumex acetosella*	9	3
Broadleaf plantain, *Plantago major*	7	2
Blackseed plantain, *Plantago rugelii*	6	2
Corn spurry, *Spergula arvensis*	6	2
Vetch, *Vicia spp.*	5	2
Perennial sowthistle, *Sonchus arvensis*	5	1**
Redroot pigweed, *Amaranthus retroflexus*	4	4
Marsh cress, *Rorippa islandica*	4	3
Velvetleaf, *Abutilon theophrasti*	4	2
Field pennycress, *Thlaspi arvense*	4	3
Common mallow, *Malva neglecta*	4	2
Ball mustard, *Neslia paniculata*	4	1
Hoary alyssum, *Berteroa incana*	3	2
Smallseed falseflax, *Camelina microcarpa*	3	1
Spiny sowthistle, *Sonchus asper*	3	1
Hedge mustard, *Sisymbrium officinale*	3	1
Chicory, *Cichorium intybus*	2	1
Prickly sida, *Sida spinosa*	2	1
Mayweed, *Anthemis cotula*	2	2
Indian mustard, *Brassica juncea*	1	1**
Field pepperweed, *Lepidium campestre*	1	1
Hairy catchfly, *Silene dichotoma*	1	1
Flowering spurge, *Euphorbia corollata*	1	1
Field sandbur, *Cenchrus pauciflorus*	1	1
Sulphur cinquefoil, *Potentilla recta*	1	1
Yellow rocket, *Barbarea vulgaris*	1	1**
Meadow salsify, *Tragopogon pratensis*	1	1
Cinquefoil, *Potentilla sp.*	1	1
Russian pigweed, *Axyris amaranthoides*	1	1
Prostrate knotweed, *Polygonum aviculare*	1	1
Giant ragweed, *Ambrosia trifida*	1	1
Haresear mustard, *Conringia orientalis*	1	1
Foxtail barley, *Hordeum jubatum*	1	1
Houndstongue, *Cynoglossum officinale*	1	1

*Primary noxious weed seeds.
**Secondary noxious weed seeds.

Approximately one sample in every ten contained more than 0.5 per cent weed seeds (Table 6). The samples of home-grown seed contained slightly more than the average with 12.2 per cent and the seed purchased from neighbors, 11.3 per cent, and seed purchased from seed dealers, 4.5 per cent.

Along with the evidence of considerable weed seed contamination of the samples in these surveys, there is equally good evidence that weed seeds are not a necessary evil. There were 230 samples in the five years, or 20 per cent, which were found to be free of weed seeds (Table 6). Weed free seed is not obtained by chance, but through careful seed production methods which require, among other things, careful cleaning based on a knowledge of the weed seeds which are present in the seed. Seed testing is a means of obtaining such information.

Noxious Weed Seeds

There are 12 weed seeds which are listed as noxious in the Wisconsin State Seed Law. The seven noxious weed seeds found in the samples during this series of surveys were determined along with the other weed seeds in the separation of the 50 grams of oats for the purity analysis (Table 5). A larger quantity of oats consisting of 250 grams from each sample was examined expressly for noxious weed seeds. By examination of the larger quantity of seed, a larger number of samples were found to be contaminated with noxious weed seeds (Table 7), and Canada thistle and wild radish seeds were found to be present in all five years.

TABLE 6. OAT SAMPLES CONTAINING OVER 0.5 PER CENT WEED SEEDS BY WEIGHT AND NO WEED SEEDS IN 50 GRAM SAMPLES, AND NO NOXIOUS WEED SEEDS IN 250 GRAM SAMPLES FROM 1955 TO 1959

Years	Samples Containing					
	Over 0.5% Weed Seeds		No Weed Seeds		No Noxious Weed Seeds	
	No.	%	No.	%	No.	%
1955	11	4.4	82	33.1	48	19.3
1956	2	1.9	40	38.8	47	45.6
1957	83	21.7	58	15.2	167	43.7
1958	18	6.0	30	10.0	68	22.7
1959	3	3.4	20	23.0	54	62.1
Totals	111		230		384	
5-year average		9.9		20.5		34.4

There were considerably more noxious weed seeds in seed that was home-grown than in seed that was purchased. The percentage of the samples from the three sources which contained noxious weed seeds was as follows: home-grown, 55.4 per cent; purchased from neighbor, 8.1 per cent; and purchased from seed dealer, 4.2 per cent.

There were 34.4 per cent of the samples which contained no noxious weed seeds in the 250 gram sample examined (Table 6) indicating that the presence of noxious weed seeds contributed more to lowering the quality of seed oats than varietal purity, germination, pure seed or weed seeds.

Noxious weed seeds are so designated because the plants increase the difficulties and cost of agricultural production in a number of ways. One of these is through the difficulty of removing them from crop seed in the cleaning process.

Samples Satisfactory for Seed

The value of these samples as seed can now be judged on the basis of all five factors which have been discussed previously. The following criteria have been used: varietal purity, four per cent other varieties, maximum; germination, 80 per cent, minimum; pure seed, 99 per cent, minimum; weed seed, 0.5 per cent, maximum; and noxious weed seed, none. The percentage of samples found to be

TABLE 7. NUMBER AND PER CENT OF SAMPLES CONTAINING EACH OF SEVEN NOXIOUS WEED SEEDS AND THE NUMBER OF SURVEY YEARS PRESENT. (BASED ON 50 GRAMS OF OATS.)

Kinds of Noxious Weed Seeds	Samples		Years
	Number	Per Cent	
Primary			
Quackgrass	714	64	5
Canada thistle	35	3	5
Secondary			
Wild mustard	59	5	5
Wild radish	34	3	5
Perennial sowthistle	11	1	1
Indian mustard	1	....	1
Yellow rocket	1	....	1

satisfactory for seeding purposes was 25.8 per cent for the five years (Figure 2). The samples complying with the above standards for each of the qualify factors were: germination, 92.9 per cent; weed seed, 90.1 per cent; varietal purity, 89.4 per cent; pure seed, 72.1 per cent; and noxious weed seeds, 34.4 per cent.

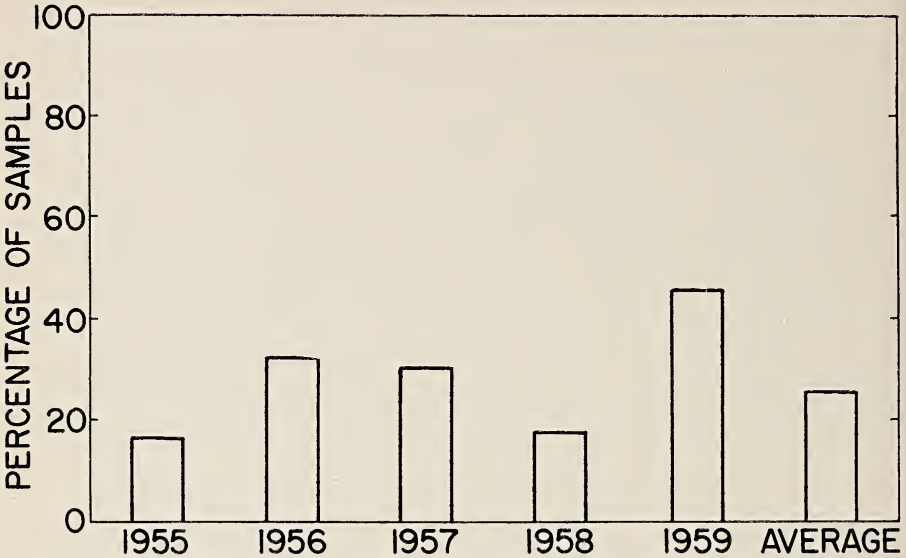

FIGURE 2. Percentage of samples satisfactory for seeding purposes based on varietal purity, germination, pure seed, weed seed, and noxious weed seeds from 1955 to 1959.

Some farmers would object to these standards, since they would not fill their needs. For instance, the farmer who wanted to produce seed oats for sale commercially would not be satisfied to have any mixture of varieties or as much as 0.5 per cent weed seeds because this might lower the quality and value of his crop. Another farmer might be willing to accept oats which germinated 75 per cent, if he wanted a variety in short supply. He would justify the purchase of such oats by increasing the seeding rate. The proposed standards are suggested for use in this survey, as standards which would meet the needs of the average farmer who is growing oats for grain.

Surveys of seed quality have been made in a number of states during the past ten years with similar results in general (5). Agricultural leaders in Wisconsin have been recommending the testing of seed since the first seed testing laboratory was established in the College of Agriculture in 1907. It is obvious from the records of these surveys that many farmers still plant seed oats without testing.

Seed Cleaning

The persons submitting the oat samples were asked whether or not the seed had been cleaned. There were 965 samples, or 86.0 per cent, which were declared to be cleaned. On examination of the records of these samples, it was evident that some had not been cleaned, or, if they had been, the cleaning job was woefully inadequate in removing the contamination. As a result, standards were adopted for those quality factors which can adversely affect seeding value and which can be improved by cleaning. These factors and their respective standards were: pure seed, 99 per cent minimum; weed seed, 0.5 per cent maximum; noxious weed seeds, none; and inert matter, 1 per cent maximum.

The cleaning was satisfactory in a small percentage of the samples (Table 8). A great deal of significance should not be attached to the differences between the years, because of the lack of uniformity in the method of obtaining the samples. The general conclusion that there is still ample room for improvement in the cleaning of seed oats is well illustrated, however.

TABLE 8. COMPARISON BY SOURCE OF THE EFFECTIVENESS OF CLEANING OAT SEED FROM 1955 TO 1959

YEAR	PERCENTAGE OF SAMPLES CLAIMED (C) AND FOUND* (F) TO BE CLEANED							
	Home-grown		Purchased				Average, All Samples	
			Neighbor		Seed Dealer			
	C	F	C	F	C	F	C	F
1955....	79.3	8.8	98.0**	63.0	....	....	83.4	20.3
1956....	77.5	27.2	91.0	63.6	97.0	79.4	86.5	48.5
1957....	81.8	30.0	93.0	40.3	93.3	77.0	86.2	40.6
1958....	89.5	19.5	88.5	15.5	96.6	43.3	90.0	21.3
1959....	73.6	43.4	100.0	66.7	89.5	84.1	81.5	56.3
Average	82.5	22.3	92.3	37.3	94.4	72.8	86.0	32.1

*Standards used: pure seed, 99 per cent minimum; weed seed, 0.5 per cent min.; noxious weed seeds, none; and inert matter, 1 per cent max.

**Samples listed as "purchased" in 1955, and omitted from average of columns under "purchased".

The fact that many samples had been treated with fungicide material bears out the claims of the individuals submitting the samples that the seed had been cleaned. In 1955 it was found that among those samples of home-grown seed which were claimed to be cleaned, 138 were poorly cleaned. Of these there were 81, or 59 per cent, which had been treated. The fungicides used on the oats generally contained mercury which is highly poisonous, making the grain unfit for any use other than for seeding purposes. From this information we can assume that the farmers must have thought their seed was cleaned and in shape for seeding or they would not have gone to the expense of treating it.

The chances of getting properly cleaned seed are best when purchasing seed oats from seed dealers (Table 8), and seed oats purchased from neighbors are likely to be more adequately cleaned than when home-grown oats are used for seed.

Summary

A series of surveys of seed oat quality was conducted in five areas of Wisconsin from 1955 to 1959 by obtaining samples through the cooperation of the high school vocational agricultural teachers. The samples were tested for purity, germination and noxious weed seed content.

There were five quality factors reported on as being the ones influencing the seeding value of oats. These were noxious weed seeds, pure seed, varietal purity, weed seeds, and germination arranged in order of decreasing influence. During the five years, 25.8 per cent of the samples were found to be satisfactory for seed.

The results show that seed oats are not being cleaned adequately and that the seed is not being tested to determine its suitability for seeding purposes.

The seed oats were from three sources—home-grown, purchased from neighbors or purchased from seed dealers. That purchased from seed dealers proved to be best on all counts, while home-grown seed was the poorest.

Acknowledgment

The writer is indebted to Howard T. Richards, who organized the collection of samples and the reporting of results to participants, and to the seed analysts at the State Seed Laboratory who made the surveys possible.

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HEMLOCK REPRODUCTION AND SURVIVAL ON ITS BORDER IN WISCONSIN

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Eastern hemlock *(Tsuga canadensis)* grows throughout the greater part of eastern United States and extends into Wisconsin where the border abruptly stops in the western part of the state (Fig. 1). Within the range of hemlock in Wisconsin phytosociologi-

FIGURE 1. *Tsuga canadensis* border as drawn from location of present day stands and state political divisions (in part).

cal aspects under which the species reproduces and survives were recorded for this paper from 34 southern and western stands without severe disturbances.

Using the quarter method (Cottam and Curtis, 1956)[1] the location of germinated seedlings (current year's reproduction), seedlings (less than 1 year old and less than 1 foot tall), saplings (less 12dbh)[2], and trees were checked on a form sheet according to their location (logs, stumps, mounds, intervening area between mounds, and pits) to determine which sites were most favorable for germination and successful survival. One hundred and forty-eight quadrants were studied in each stand. Fallen coniferous logs and stumps were examined and measured as reproductive sites. Measurements included area, zone of decay, and circumference of solid core. An estimated per cent moss cover and residual bark was recorded along with a general description of each log and stump.

To determine the substratum necessary for successful germination and survival, Indices of Decay Classes based upon the characteristics of 61 hemlock logs and 37 stumps were constructed. Five stages of decay were designated for both logs and stumps with particular emphasis given to the part logs play in the reproduction and survival of hemlock.

Index for Logs:

D1. Fallen tree with needles, cones, and twigs present; branches and bark intact.

D2. Fallen tree with no needles, cones, or twigs present; distal ends of large branches present; bark intact without evidence of sloughing.

D3. Fallen tree with proximal end of large branches present; bark sloughing but intact patches present; decay of wood may be initiated.

D4. Fallen tree with proximal ends of large branches present; presence *or* absence of patches of bark; decay of wood well advanced; solid core present inside rotten shell; wood moist to touch, fracturing into small pieces.

D5. Fallen tree incompletely outlined in ground humus; no indication of branch positions, decay of wood complete; no solid core present; wood residue dry and crumbly.

Index for Stumps:

D1. Stump with freshly exposed surface; bark intact.

D2. Stump with more than 50 per cent bark present; outer core of wood solid on exposed surface.

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[1] Cottam, G. & Curtis, J., 1956. The use of distance measures in phytosociological sampling. Ecology 37:451.

[2] dbh: diameter breast height.

D3. Stump with more than 50 per cent bark present; outer core of wood not solid on exposed surface.
D4. Stump with less than 50 per cent bark present; outer core of wood solid on exposed surface.
D5. Stump with less than 50 per cent bark present; outer core of wood not solid on exposed surface.

The density of *Tsuga* seedlings on logs parallels the per cent moss cover through Decay Class 4 in which maximum germination occurs. On stumps, the density of seedlings is highest in Class 5. Decay Classes 3, 4 and 5 exhibit increasing decay and exposure of greater surface area for germination in both logs and stumps.

Mosses are rarely present in Decay Class 1. The number of moss species reaches a maximum of 13 in D4 and diminishes to six in Class 5. Decay Class 4 represents the highest hydrophytic environment (Figs. 2 and 3) in both logs and stumps.

Herbacious plants were not found on logs in Decay Classes 1, 2 or 3. Those noted as the most abundant species in Class 4 were *Mianthemum canadensis, Trientalis borealis, Coptis trifolia, Cornus canadensis, Clintonia borealis,* and *Oxalis montana.*

The degree of wood decay varies according to species and location in relation to ground surface. It is not uncommon for yellow birch *(Betula lutea)* to remain standing long after death. Once such a tree falls, it takes only a short period for the wood residue to disappear leaving the desiccated shell of xeric bark. Hemlock seldom decays in a standing position, but starts to decompose only after it has remained on the ground for a long period of time. Once decomposition by weathering and fungal action is initiated, the length of time for a log to be transformed from one decay class to another is greatly shortened.

Germination cannot occur on decaying logs unless there is a moist depression in the bark in which seed and humus can lodge. Germination percentage is low on the relatively smooth bark of birch but high in fissures and exposed wood commonly located at the butt end of the fallen tree. The fractured bark of hemlock presents a greater area for retention and subsequent germination of seeds.

In considering logs and stumps as favorable germination habitats, density of germinated seedlings varies according to the different micro-areas on these substrata. In descending order the most favored are: (1) mats of moss, (2) moist exposed wood, and (3) bark free of moss. Moss growth is indicative of a mesic microenvironment. Wood, which has a high water holding capacity, benefits germination. Residual bark, which has a lower water holding capacity is least favorable.

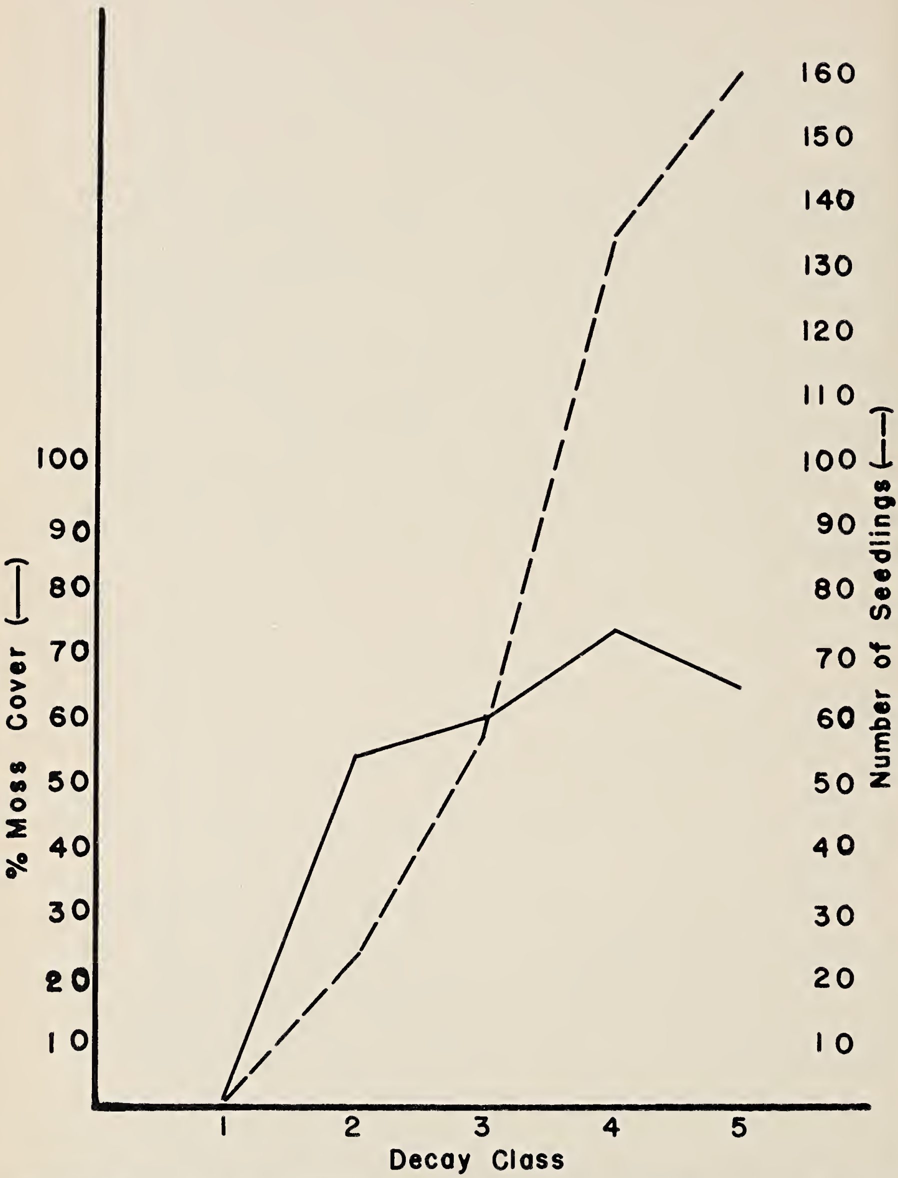

FIGURE 2. Mean Number of germinated *Tsuga canadensis* seedlings in each Decay Class per 21 feet of stump area and mean per cent moss cover.

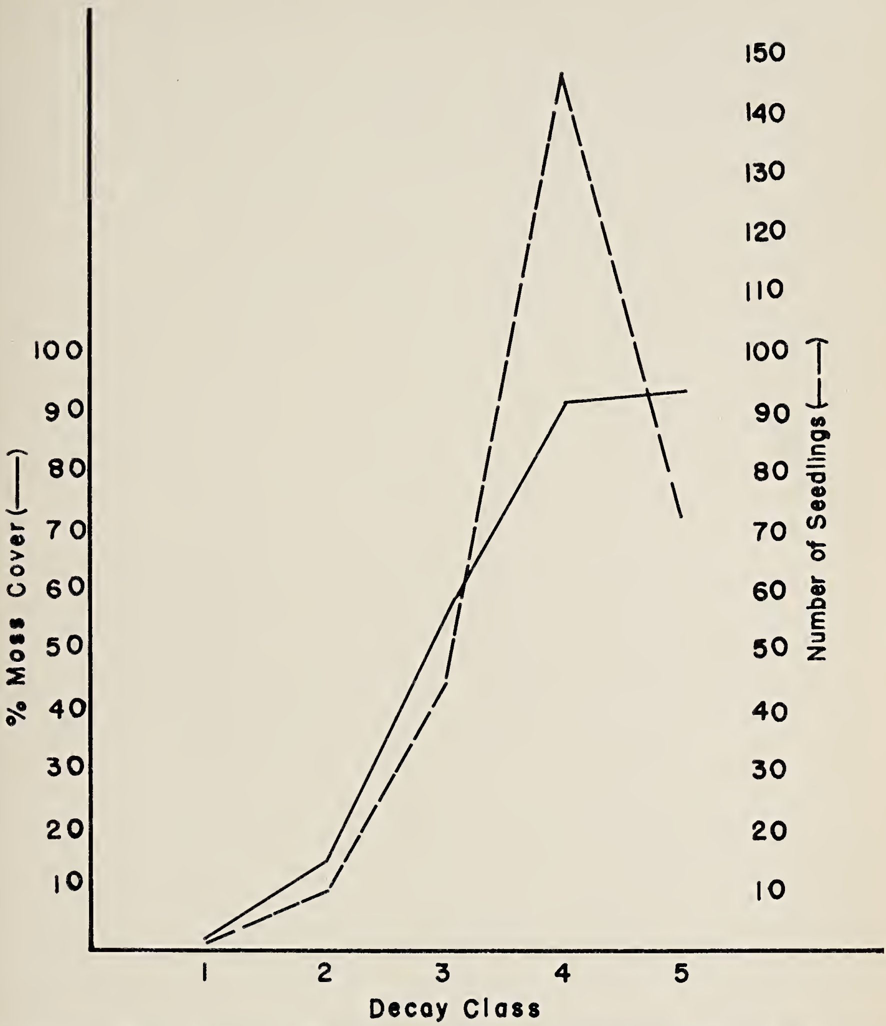

FIGURE 3. Mean Number of germinated *Tsuga canadensis* seedlings in each Decay Class per 50 feet of fallen tree trunk and mean per cent moss cover.

Infrequently, large areas of hemlock are windthrown to create favorable germination habitats, but more commonly only a few trees in a stand are windthrown each year. In the blowdown of a shallow rooted hemlock the extent of the root system determines the amount of earth upturned. A pit is formed by the extraction of roots and adhering soil and rocks. Decay of roots and weathering loosens the clinging upturned soil which falls to form a mound on the side of the pit toward which the tree fell. Because of the over-turn of soil the upper layers of the mound contain more nutrients than the underlying layers.

Various names have been given to these mounds which contribute to the micro-relief of a forest: Indian-graves, clay-mounds and tip-ups. In any stand there are mounds of all ages and heights. Mounds which have a high content of rock material resist erosion for longer periods than mounds composed of finer soil so that mound height does not necessarily indicate mound age.

Lesser numbers of germinated seedlings were recorded from the pits and intervening areas than from other germination habitats. Etiolated Tsuga seedlings were observed between layers of deciduous leaf mold which accumulates in pits. The deeper organic layers of leaf mold are meshed with mycelia of saprophytic fungi. Apparently these fungi also limit the life of a seedling in the duff.

In addition to providing an effective barrier of litter and fungi the pits often act as a water reservoir for the duration of the germination period.

Like the pits, litter also accumulates in the intervening areas. The depth of the organic matter would limit Tsuga germination and successful survival in these areas.

Mounds, which are exposed to ground winds because of their height, have a thinner organic layer enabling seeds to germinate more readily. Nutrients brought to the surface in the upheaval of soil in the formation of the mound contribute to successful establishment.

Although many thousands of seedlings germinate on the available substrata in the forest, few germinate on a substrata where successful establishment occurs. Hemlock seeds which germinate on mounds, logs or stumps are those most likely to survive (Table 1). Rarely are trees, saplings or seedlings found in the pit region. From 83.6 to 100 per cent of the seed bearing trees occur on mounds. Even though seed germination is high in intervening areas successful survival does not occur regularly as indicated in the seedling column of Table 1. It can be inferred from the tree data that conditions of the substrata were favorable for successful establishment in the intervening areas of several stands. Germination probably took place on small mounds which have since eroded or on logs which have completely disintegrated.

Unless a drastic environmental change occurs, it appears that Tsuga canadensis will perpetuate itself by continuing to create its own reproductive environment. The species has the reproductive capacity to remain a component of the northern hardwood forest with slight fluctuations in the geographical location of the border if not disturbed.

TABLE 1. TABULATION OF SUCCESSFUL GERMINATION PER CENT OF *Tsuga canadensis* ACCORDING TO MOUND, PIT, INTERVENING LOG OR STUMP AREA

Stand Number	Trees					Saplings					Seedlings				
	M	P	I	L	S*	M	P	I	L	S	M	P	I	L	S
7	94.0	0.0	2.0	4.0	0.0	57.4	0 0	5.7	13.2	23.7	29.0	0.0	0.0	39.5	30.6
11	83.6	0.7	9.8	0.0	5.9	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	90.9	0.0	3.9	3.9	1.3	85.1	0.0	0.0	14.9	0.0	0.0	0.0	0.0	0.0	0.0
13	97.1	0.0	2.9	0.0	0.0	99.6	0.0	0.0	0.0	0.4	100.0	0.0	0.0	0.0	0.0
14	100.0	0.0	0.0	0.0	0.0	98.4	0.4	0.0	0.0	1.2	98.4	0.0	0.0	0.0	0.0
23	96.0	0.0	0.0	4.0	0.0	88.7	0.0	0.0	7.0	10.6	56.2	0.0	0.0	12.5	31.3
25	100.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	93.0	0.0	3.0	4.0	0.0	100.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.6	97.6

*M = Mound.
P = Pit.
I = Intervening.
L = Log.
S = Stump.

CHARACTERISTICS AND GENESIS OF A PODZOL SOIL IN FLORENCE COUNTY, WISCONSIN*

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A classic Podzol soil, called the Au Train loamy sand, was studied, both under forest cover and in an adjacent field, in Florence County, in northeastern Wisconsin, about 3 miles from the Michigan state line and 8 miles southwest of Iron Mountain, Michigan. The study was part of the soil survey of Florence County by the Soil Survey Division, Wisconsin Geological and Natural History Survey, in cooperation with the U. S. Soil Conservation Service and the Soils Department, College of Agriculture, University of Wisconsin (Gaikawad, 1961).

Processes of soil formation since the continental glacier disappeared from the county, possibly about 14,000 years ago, have produced: 1) on the forest floor an organic layer 2.25 inches (5.6 cm.) thick, 2) an underlying bleached sandy layer of "A_2 horizon" 8.75 inches (22 cm.) thick, and 3) a rock-like, cemented, dark-brown subsoil layer called the iron-humus Ortstein or hardpan (B_{irh_2}). Under cultivation by man over a period of about 65 years the organic layer of the forest floor has been removed, lime and organic matter have been added to the second layer, which has been compacted, and the third layer, the "Ortstein" hardpan, has apparently been somewhat weakened.

In the upper left-hand corner of Figure 1 is a diagram of the site. To the right of this diagram is a sketch of "cradle-knoll" or tree-throw micro-relief, characteristic of the soil under forest cover. Although the soil layers or horizons are irregular in thickness and exhibit lateral discontinuities, as shown in Figure 1, average depths to top and bottom of each horizon are given in the table. The "H" or humus layer, one-fourth inch thick on top of the bleached "A_2 horizon" in the forest soil, contained 11 grams of oven-dry roots in one square foot (not reported in column 4 of the figure).

Soil profile descriptions follow:

1. Au Train loamy medium sand

N.W. Corner Sec. 17, T.38 N., R.19 E., Florence Co., Wis.

(Soil profile under forest of balsam fir, white pine, white cedar, hard maple, yellow birch, aspen)

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* Paper read at the 91st annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

2.25″–1.25″	L	Dark reddish-brown (5YR 3/2, moist Munsell color notation) needles and leaves; pH 5.2, by Truog field test; very few roots; abrupt, smooth lower boundary.
1.25″–0.25″	F	Dark reddish-brown (5YR 3/2–3/1) somewhat decomposed needles and leaves; pH 5.0; very few roots; abrupt, smooth lower boundary.
0.25″–0″	H	Black (5YR 2/1) humus with small fragments of charcoal; pH 5.1; many roots; abrupt, smooth lower boundary.
0″ –1.25″	A_{21}	Very dark gray (5YR 3/1–4/1) loamy medium sand; very weak medium granular to single grain; loose; pH 4.1; some charcoal present; very many roots; gradual, irregular boundary.
1.25″–8″	A_{22}	Reddish-gray (5YR 5/2) medium sand; single grain; loose; many roots; pH 5.2; gradual, irregular boundary.
8″ –8.75″	A_{23}	Dark reddish-gray (5YR 4/2–5/2) medium sand; single grain; loose; many roots; pH 5.1; abrupt, irregular boundary.
8.75″–12″	B_{irh_1}	Dusky red (2.5YR 3/2–2/2) loamy medium sand; massive to weak angular fine blocky; soft to very friable "Orterde"; pH 5.3; many roots; abrupt, irregular boundary.
12″ –21″	B_{irh_2}	Dark reddish-brown (2.5YR 2/4) loamy medium sand; massive; cemented "Ortstein"; crushes to irregular fragments; clear, irregular boundary; very few roots, confined to surfaces of fractures in this "pan"; pH 5.5; abrupt, irregular boundary.
21″ –25″	B_{irh_3}	Reddish-brown (5YR–2.5YR 4/3) loamy medium sand; massive; soft and loose to somewhat cemented; very few roots; pH 5.4; clear, irregular boundary.
25″ –46″	B_f	Reddish-brown (5YR 4/3) with some irregular banding (4/2–4/4) loamy medium sand; single grain; slightly cemented "incipient fragipan", which shatters under pressure between the fingers; very few roots; pH 5.6; gradual, irregular boundary.

46″ –78″	C_1	Brown (7.5YR 5/4) medium sand glacial drift; single grain; loose to slightly cemented; roots rare; pH 5.4 at the top to 4.8 at the bottom; sampled with hollow auger below bottom of pit.
78″ –108″	C_{2g}	Similar material, saturated with water on June 8, 1960.

2. Au Train loamy medium sand

(Soil profile in newly planted corn field, about 300 feet west of the profile described above)

0″– 8″	A_p	Dark gray (5YR 4/1–3/1) loamy sand with scattered stones; plow layer; granular; loose; pH 6.2; roots abundant; abrupt, smooth boundary.
8″– 14″	A_2	Reddish-gray (5YR 5/1–5/2) medium sand; single grain; loose; pH 6.2; few roots; abrupt, irregular boundary.
14″– 23″	B_{irh_1}	Dark reddish-gray (5YR 3/2–4/2) medium sand; massive to angular medium blocky; soft to loose "Orterde"; pH 5.2; few roots; irregular, abrupt boundary.
23″– 30″	B_{irh_2}	Dusky red (2.5YR 3/2) loamy medium sand; cemented "Ortstein"; hard; pH 5.1; few roots, largely confined to surfaces of cracks; abrupt, irregular boundary.
30″– 40″	B_{irh_3}	Reddish-brown (5YR 4/4–4/6) loamy medium sand; massive; loose; pH 4.8; clear, irregular boundary.
40″– 46″	B_f	Reddish-brown (5YR 4/3) loamy medium sand; massive; somewhat cemented; pH 5.1; irregular, clear boundary.
46″– 98″	C_1	Light brown (7.5YR 6/4), above, to reddish-brown (5YR 5/3–4/3), below, medium fine sand with some gravel and bands of very fine sandy loam; massive to single grain; slightly cemented to loose.
98″–108″	C_2	Brown (7.5YR 5/4) mottled yellowish-red (5YR 4/8) medium sand; reddish black (10R 3/1–2/1) iron-rich concretions ⅛ inch in diameter; single grain; loose glacial drift.

Definitions of Kinds of Data Reported in Figure 1 and Report on Methods and Procedures

This information will be reported by column numbers, as given at the heads of columns in Figure 1. Analyses were made of soil passed through a 2 mm sieve.

pH or Soil Reaction (Column 1): Measurements were made by means of the Beckman pH meter. The pH of the organic layers (L, F, H) on top of the mineral soil in the forest was 5.0, by the Hellige-Truog quick test used in the field. The upper 1¼ inches of the A_2 horizon had a pH of 4.1 as measured by Beckman pH meter.

Bulk Density (B. D., Column 2) was determined by driving a steel cylinder into each soil horizon in such a way as to take a 200 cc sample. The oven dry weight of the soil in grams was divided by the volume of the soil to obtain bulk density. Careful estimates yielded the average figure of 0.14 gm per cu cm of the organic layer (L, F, H).

Organic Matter (O. M., Column 3): The Walkley-Black method (Jackson, 1958) was used.

Dry Weight of Roots (Column 4): A 1-foot-square steel box, with lower cutting edge, was driven through each horizon; and roots were carefully removed from the soil in the field, and were gently washed in the laboratory before drying and weighing. Weight of roots from the humus horizon (H) is given above.

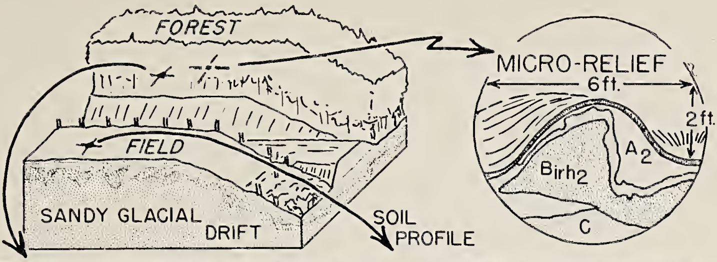
Carbon-nitrogen Ratio (Column 5): Percent carbon by the Walkley-Black method and percent nitrogen by the Kjeldahl method (Jackson, 1958) were used in obtaining this ratio for each horizon.

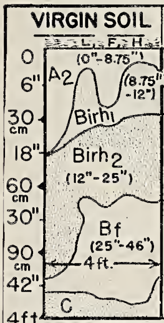
Clay, silt, and sand contents (Columns 6, 7, 8): Clay (mineral particles less than .002 mm in dia.), silt (.05–.002 mm in dia.), and sand (2.00–.05 mm in dia.) contents were determined by a hydrometer method described by Day (1956).

Available phosphorus in pounds per acre (Column 9) was determined by a Wisconsin State Soil Testing Laboratory procedure, using 4 cc of soil, 15 ml of 0.3 N HCl, with activated charcoal to remove soluble organic matter. To 3 ml of colorless extract, 3 ml vanadate solution were added, and calculations made on the basis of light transmission readings on a B. and L. spectrometer.

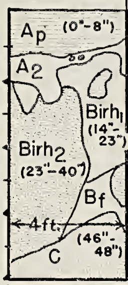
Available potassium, in pounds per acre (Column 10): The separate determinations for available K in soil moist from the field, and in oven-dried soil were made by flame photometer procedures of the Wisconsin State Soil Testing Laboratory (Jackson, 1958).

Cation exchange capacity in millequivalents per 100 g of soil (Column 11) was determined by the E.D.T.A. titration method, using Mg^{++} as the saturating cation and Na^{+} as the displacing cation, and titrating Mg^{++} in the displaced solution with E.D.T.A. standard solution.





VIRGIN SOIL	1 pH	2 B.D.	3 O.M.	4 Roots	5 C/N
A2 (0"-8.75")	5.2	1.27	0.9	38.3	19
(8.75"-12")	5.3	1.23	2.1	6.6	20
Birh1 / Birh2 (12"-25")	5.5	1.51	1.6 / 0.7	2.2 / —	25 / 22
Bf (25"-46")	5.6	1.57	0.3	—	17
C	5.4	1.56	0.3	—	16



CULT'D SOIL	1 pH	2 B.D.	3 O.M.	4 Roots	5 C/N
Ap (0"-8")	6.2	1.37	1.8	31.2	15
A2	6.2	1.51	0.2	0.2	12
Birh1 (14"-23") / Birh2 (23"-40")	5.2	1.29	1.7	1.4 / —	21
Bf	5.0	1.43	1.4	—	23
(46"-48")	5.1	1.44	0.4	—	19
C	5.3	1.38	0.2	—	15

	Depth	6 Clay %	7 Silt %	8 Sd. %	9 Avl.P # a.	10 Avl. K "wet"	10 Avl. K "dry"	Depth	6 Clay %	7 Silt %	8 Sd. %	9 Avl.P # a.	10 Avl. K "wet"	10 Avl. K "dry"
Ap	—	—	—	—	—	—	—	0"-8"	6	7	87	8.5	382	126
A2	0"-8¾"	5	10	85	0.7	34	27	8"-14"	3	4	93	2.0	75	24
Birh1	8¾"-12"	12	10	78	1.5	48	54	14"-23"	8	3	89	2.5	52	54
Birh2	12"-25"	8	6	86	19.1	26	26	23"-40"	6	4	90	7.0	23	20
Bf	25"-46"	5	4	91	24.0	15	15	40"-46"	3	2	95	52.5	12	15
C	46"-48"	3	1	96	82.0	16	18	46"-48"	1	1	98	69.0	16	12

	Depth	11 C.E.C.	12 Ba.St.	13 Ca^{+},X	14 Na^{+},X	15 ca/mg	16 Fe	Depth	11 C.E.C.	12 Ba.St.	13 Ca^{+},X	14 Na^{+},X	15 ca/mg	16 Fe
Ap	—	—	—	—	—	—	—	0"-8"	4.5	69.8	2.4	0.03	6.4	**0.2**
A2	0"-8¾"	4.4	24.1	0.8	0.01	7.1	**0.1**	8"-14"	1.5	52.0	0.5	0.01	3.4	**0.1**
Birh1	8¾"-12	12.2	27.5	2.9	0.03	13.5	**0.6**	14"-23"	8.0	20.2	1.1	0.04	4.4	**0.6**
Birh2	12"-25"	6.7	14.2	0.8	0.05	19.2	**0.5**	23"-40"	6.9	12.5	0.5	0.02	6.8	**0.3**
Bf	25"-46"	2.3	31.7	0.7	0.01	32.5	**0.2**	40"-46"	2.4	13.4	0.2	0.08	12.1	**0.1**
C	46"-48"	2.1	36.6	0.7	0.01	20.4	**0.1**	46"-48"	1.2	29.6	0.2	0.08	8.0	**0.1**

FIGURE 1. Some field and laboratory data for a virgin profile and a cultivated profile of the maximal Podzol soil, Au Train loamy sand, near the N.W. corner of Sec. 17 and the N.E. corner of Sec. 18, T.38 N., R.19 E., Florence County, Wisconsin, respectively. Note that the horizontal scale is compressed in the soil profile diagrams, which represent four feet in width, as well as in depth, for each of the two rectilinear soil sections. A key to the abbreviations in the figure is as follows:

Abbreviations in the diagrams: A_p, plowed dark surface soil in the field; A_2, reddish-gray light colored soil layer or horizon; B_{irh} , soft upper subsoil layer or "B" horizon containing iron (ir) and humus (h) deposits; B_{irh} , cemented lower subsoil layers containing iron and humus deposits; B_f, weakly developed, pale, coherent subsoil layer or horizon, called "incipient fragipan"; C, loose sand or "parent material" of the soil; L, surficial litter layer of recently fallen leaves, needles and wood on the forest floor; F, fermented or partially decomposed organic material lying beneath the L layer; H, humus layer or well decomposed organic material forming the bottom part of the natural organic blanket on the forest floor.

Abbreviations at the heads of columns in the tables: 1—pH, measure of soil reaction; 2—B.D., bulk density in gm/cm^3; 3—O.M., organic matter in per cent; 4—Roots, dry weight in gm of plant roots found in a column of soil 1 ft^2 in horizontal cross-section; 5—C/N, carbon/nitrogen ratio; 6—Clay, content on an oven-dry weight basis of mineral particles less than .002 mm in dia.; 7—Silt, content of mineral particles .002 to .05 mm in dia.; 8—Sand, content of mineral particles .05 to 2.0 mm in dia.; 9—Avl.P, pounds per acre of phosphorus "available to plants"; 10—Avl.K, pounds per acre of "available" potassium in undried soil as taken in the field ("wet"), and in oven-dried soil ("dry"); 11—C.E.C., cation exchange capacity in meq per 100 g of soil; 12—Ba.St., percent base saturation; 13—$Ca^{++}X$, meq exchangeable calcium per 100 g of soil; 14—$Na^{+}X$, exchangeable sodium; 15—Ca/Mg, ratio between exchangeable calcium and exchangeable magnesium; 16—Fe, percent reductant-soluble or "free" iron on a dry wt. basis.

Percent base saturation (Column 12) was calculated on the basis of exchangeable cation determinations and cation exchange capacity determinations.

Exchangeable cations (Columns 13, 14, 15) were determined by extractions with 1 *N* NH_4OAC solution at pH 7, and by flame photometry. Data are reported in millequivalents per 100 g of soil.

Reductant soluble iron content (Column 16) was determined by the dithionite-citrate-bicarbonate method (Jackson, 1956).

Discussion

During an undetermined portion of the period of approximately 14,000 years since the Cary (middle Wisconsin) glaciation in Florence County, an organic mat on the forest floor has been maintained at a steady state on the Au Train loamy sand. Bits of charcoal in the humus (H) horizon of the organic mat attest to interruptions of this steady state by forest fires. The presence of large white pine trees indicates, however, that the forest at the study site was not clear-cut and destroyed during lumbering operations of 1850–1920. Tree-fall has caused disturbance of the soil horizons, as indicated in Figure 1. However, the virgin soil was sampled as far away as possible from "cradle-knolls" or tree-tip mounds. This soil is a well developed or "maximal" Podzol and the study site is situated in a well drained position fairly close to the water table (78 inches in June, 1960). The proximity to the water table may account for the extreme cementation of the iron-humus subsoil (B_{irh}), because a relatively high water table favors tree growth (Wilde, 1958). The latter provides for the volumes of organic matter necessary for podzolization (Stobbe and Wright, 1959) which involves the translocation of iron and organic matter through leached sandy parent material from the surface soil (A_2 horizon) to the subsoil (B_{irh}).

Tree roots are most abundant in the humus horizon, in the A_2 and upper B_{irh} horizons, to a depth of a foot below the surface of the mineral soil. In this zone a notable depletion of available phosphorus has occurred, presumably by plant root feeding. Weathering of the relatively small amount of weatherable minerals in the upper 2 feet of soil, and base cycling by trees and deposition of small amounts of aeolian silt would explain the relative accumulation of available potassium in upper horizons of the soil. The fixation of available potassium by drying of the soil may be explained as the action of a small amount of vermiculite clay. Iron and organic matter have accumulated in the subsoil (B_{irh}), particularly in the upper portion, the dark reddish-brown to dusky red soft "Orterde". The latter overlies the cemented portion, the dark reddish-brown "Ortstein" hardpan. Apparently considerable clay has been translocated from the pale (reddish-gray) A_2 horizon into the B_{irh} horizon, presumably independently of iron and organic matter (Flach, 1960). The carbon/nitrogen ratio is high in this soil, and base saturation is low, as is the case in many Podzol soils (Soil Survey Staff, U.S.D.A., 1960; Hole and Schmude, 1959). The exchangeable Ca/Mg ratio is high and increases with depth.

Clearing of the forest from this soil 65 years ago, and ensuing cultivation in the field across the road from the forest site has apparently made the following changes in the Au Train loamy sand:

1) The cradle-knoll micro-relief of the forest soil has been erased.
2) Mixing by plow and other agricultural tools has replaced the organic mat and upper A_2 horizon with a plow layer (A_p).
3) Some disturbance of the soil profile was very possibly produced by stump pulling and burning during land clearing.
4) The A_p and A_2 horizons have been compacted, particularly just below the plow layer (A_p), by loss of organic matter and pressure from farm machinery.
5) Despite additions of manure and crop residues by the farmer, organic matter has been lost, presumably as a result of increased aeration and summer temperatures in the A_p horizon as compared to the upper soil horizons in the forest, as a result of excess of translocation of organic matter from the B horizon over additions to it, and as a result of artificial increase in pH which favors microbial activity.
6) Slight reduction in contents of N, exchangeable calcium (except in the plow layer), cation exchange capacity, and

reductant soluble iron may be the results of removal of plant nutrients by crops in excess of additions by the farmer, and the results of accelerated leaching.

7) The upper 14 inches of soil have higher pH, contents of exchangeable calcium and magnesium, and base saturation values, as a result of liming and fertilization by the farmer.
8) The C/N ratio of organic matter in the upper 14 inches of soil has been lowered, presumably by loss of carbon as CO_2 to the air, with accelerated microbial activity and aeration.
9) The average specific gravity of plant roots has dropped from 0.3 to 0.2, with the replacement of forest by crop and pasture plants.

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THE GEOLOGIC MATERIAL: ITS IMPACT ON SOIL PROFILE CHARACTERISTICS IN WEST CENTRAL WISCONSIN

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For several years, soil investigations in West Central Wisconsin have included, among other things, an attempt to correlate more closely soil profile characteristics with the geologic material in which they develop. The following is but a brief summary of some of the knowledge gained during that period. The theories proposed and the ensuing conclusions are those of the author only, and not necessarily reflecting those of the many people involved in the gathering of the information.

The author is especially indebted to Mr. Paul Carroll[1] for permission to reproduce substantial parts of the field data gathered by him, and to Dr. Francis D. Hole of the Wisconsin Geological and Natural History Survey, University of Wisconsin, for encouraging preparation of the article.

The exposed part of the lithosphere and included portions of the biosphere reflect the interaction of local factors such as underlying material,[2] topography, climate, and organic agencies (flora, fauna, man). Soil scientists regard the "soil environment" as a product of the interaction of these four factors acting through time (3), which is considered to be a fifth factor of soil formation. This approach enables the researcher to understand the mode of formation of the various kinds of soil and helps in predicting soil-type distributions. In short, measuring the environment (qualitative and quantitative), is a major step toward understanding why particular soils occur in specific localities.

Bear (1) and Jenny (3) in their respective treatises on soil chemistry and soil formation give an excellent bibliography of the extent to which soil characteristics can be attributed to the initial geologic materials. In many instances, the extent to which parent material properties influence soil characteristics is controversial, and a generalization may often be misleading.

West Central Wisconsin, with its combination of glaciated and driftless areas, offers many opportunities to study the relationships between soil characteristics and associated geologic materials. The area in which observations were made and from which samples were collected includes the following counties: Pierce, St. Croix, Pepin, Dunn, Eau Claire, Chippewa, and Taylor.

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[1] Soil investigator, Soil Conservation Service, River Falls, Wis.

[2] Term used to denote both consolidated and unconsolidated material, often referred to by soil-scientists as "parent-material".

Methods

Field examination of soils in selected areas were initiated in 1956 by Mr. Paul Carroll, as a part of the coöperative soil-survey program of the U. S. Soil Conservation Service and the University of Wisconsin. Each observation included a detailed description of the soil profile to a minimum depth of 5 feet and often deeper so as to reveal the various types of strata underlying the soil solum. Bulk samples of the soil horizons, including one or more of the underlying geologic materials, were collected for further laboratory studies. Samples were taken to the laboratory, air dried and sieved to pass a 2 mm. screen. Duplicate 50 gm. samples were treated with hydrogen-peroxide to destroy organic matter, and dispersed in Na-hexametaphosphate. Particle size distribution was determined by hydrometer, except in the case of silt fractionation, where a pipette was used to determine coarse and fine fractions. Chemical analyses on the 2 mm. material included a pH measurement using a glass electrode and a 1:1 soil: water mixture; cation exchange capacity with buffered (pH 7.0) NH_4-acetate; free iron-oxide using Na-hydrosulfite as extracting agent, Coleman Junior spectrophotometer and orthophenanthroline.

Results and Discussions

In areas where different geologic materials, e.g. limestone, sandstone, glacial till and loess, occur in a single stratigraphic column or form a continuous surface on level or sloping land, an assemblage of different soils usually results. In West Central Wisconsin, a common landscape association consists of plateau-like remnants (mesas) with gently sloping to level intervening lowlands. The presence of the tabular highland remnants is due mostly to the protective capping of the dolomitic limestone. This dolomitic layer is one unit in the sequence of sandstones and limestones (usually dolomitic) which make up the stratigraphic column in this part of the state. Often a thin shale layer can be found interbedded or separating the two main types of material making up the stratigraphic section. The fluvial dissection in conjunction with the general dip of the beds determines the age and type of bedrock exposed. More often than not, a variable thickness of wind deposited silty (loess) material overlies the bedrock. In the northern part of the area, glacial till of Wisconsin age overlies the bedrock the till being in turn capped by a variable thickness of eolian material. The following are selected instances which clearly illustrate the relationship between soil profiles and their respective underlying geologic materials.

A. *Stratigraphy, a factor in soil profile characteristics.*

The "Colluvial Hixton"[3] soils of St. Croix County are found most frequently on valley slopes below limestone-capped ridges underlain by sandstone. During the process of geologic and accelerated erosion, movement down the slopes created a heterogenous mixture of limestone slabs and loess, which together with the sand became the parent material for the Hixton like soils of the county. In selective places, the great quantities of weathering limestone fragments provide clay size material in quantities large enough to impart a sandy clay loam to clay loam texture to the middle and lower solum (see description below).

In one area where the limestone capping was missing completely a sandy Gray-Brown Podzolic Boone soil developed on the slope. However, at a depth of five feet a loamy material was located. This finer textured material remained as evidence of earlier colluvial movement, when a limestone capping was still in existence. The following are a few examples of the types of soil profile encountered on the slopes of the mesas.

B. *Soil development in coarse silt dominated loess,*[7] (Pepin and Dunn Counties).

Loess of variable thickness overlies bedrock and glacial deposits in relatively extensive areas of Dunn, Pepin, and other counties in western and southwestern Wisconsin. The larger body of loess extends well into Minnesota, Iowa, Illinois, and Missouri. Loess of this larger area is characteristically thickest on the bluffs adjoining the Mississippi River and other glacial drainage channels, thinning away from the river valleys. Usually the loess in Dunn and Pepin counties is from one to six feet thick and is found primarily on the uplands, upland valley slopes and occasionally in the valley bottoms. Much thicker loess deposits, however, may be found further to the west and south nearer the Mississippi River.

Within this loess belt, are found significant areas of coarse-textured loess.[8] In parts of these two counties the loess is underlain by till.

Mechanical analysis of soils from the four selected sites indicated a very high percentage of total silts (table 1). The amount ranges from approximately 76 percent in the surface horizons to approximately 70 percent in the B_2 horizons, and from 72 to 75 percent in the parent material. The ratio of coarse silt to fine silt

[3] Quotation marks used to distinguish these soils from central concept of the series.

[7] Loess is a geological deposit of relatively uniform calcareous silt with some very fine sand and clay, presumably transported by wind from alluvium or disintegrated siltstone during periods of aridity.

[8] Wind-blown materials consisting primarily of coarse silts e.g. 50 to 20 microns in diameter.

I. MINIMAL-PODZOL DEVELOPED IN ST. PETER SANDSTONE, ORDOVICIAN SYSTEM (BOONE FINE SAND)

HORIZON	DEPTH	COLOR (MOIST)[4]	TEXTURE	REACTION (pH)[5]
Ap	0–2″	10YR 3/1(1)	Organic Matter	4.5
A_{21}	2–10″	10YR 5/1	Fine sand	4.5
A_{22}	10–15″	10YR 7/1	Fine sand	4.5
Birh	15–42″	10YR 5/4	Fine sand	4.5
C	42–60″	10YR 6/4	Fine sand	6.0

II. "COLLUVIAL HIXTON", A GRAY-BROWN PODZOLIC DEVELOPED FROM MIXED SANDSTONE, LIMESTONE, AND CALCAREOUS SANDSTONE

Profile II-a

HORIZON	DEPTH	COLOR (MOIST)	TEXTURE	REACTION (pH)
A_1	0–4″	10YR 3/1	Fine sandy loam[6]	7.0
AB	4–13″	10YR 4/2–4/3	Fine sandy loam[6]	6.5
B_1	13–20″	10YR 4/3	Loam	6.5
B_{21}	20–26″	7.5YR 3/4	Loam	6.5
B_{22}	26–33″	7.5YR 4/4	Loam	6.5
B_3	33–40″	10YR 4/4	Loam	6.5
Dr	40–60″	10YR 8/4	Sandstone	6.0

Profile II-b

HORIZON	DEPTH	COLOR (MOIST)	TEXTURE	REACTION (pH)
A_1	0–2″	10YR 2/2	Sandy loam	6.6
A_2	2–6″	10YR 4/3	Sandy loam	6.0
B_1	6–14″	7.5YR 4/4	Sandy loam	6.0

[4]Moist, Munsell Color Notations.
[5]By Truog–Hellige field kit.
[6]Possible loess influence here.

III. "COLLUVIAL HIXTON", PROFILE II-B CONTINUED

HORIZON	DEPTH	COLOR (MOIST)	TEXTURE	REACTION (pH)
B_{21}	14–20″	7.5YR 4/4	Loam	5.5
B_{22}	20–30″	7.5YR 4/4	Sandy clay loam	4.7
B_{23}	30–42″	5YR 3/4	Clay loam	5.0
B_3	42–48″	7.5 4/4	Clay loam	5.5
C	48–58″	7.5 4/4	Loam	6.0
Dr	58+″	10YR 7/4–5/8	Sandstone	6.0

ranges from 1.83 to 2.97. The clay percentages in the B horizon varied quite widely.

A structural characteristic of these soils is the general macroplatiness of the profile, which is quite distinct in the parent loess and weakly to moderately expressed in the solum. Compound structural forms of subangular blocky and platy were observed in the B horizon of all sampling sites. The macroplaty characteristics of these soils is probably "inherited" from the parent loess. Alternating light (10YR 5/3) and darker-colored (10YR 4/3) horizontal silty bands extend deep into the parent loess. These layerings in the parent loess result in abrupt and smooth boundaries and provide lateral lines of weakness in an otherwise massive structural form. A combination of vertical zonation induced by roots and freezing and thawing, coupled with an "inherited" horizontal layering result in the observable macroplatiness of the soil solum.

C. *Soil development in Glauconitic sandstone*

During 1958, while a detailed soil survey of Pepin County was in progress, a series of field observations were made on the Norden and other associated series developing, at least in part, in glauconitic sandstone (Franconia formation, Cambrian system), described in detail by Berg (2) and Nelson (4). The interest was primarily in the weathering sequence of the glauconitic parent rock. For this reason, the red variant of the Norden series was selected for study. The red variant is a highly ferruginous soil of very limited extent in Wisconsin, but one of significance because of the advanced glauconite weathering in it. Generally, the red variant of the Norden has been defined as a Gray-Brown Podzolic soil. However, because of high iron content in the upper part of the solum (table 2), it may be more properly regarded as a Gray-Brown Podzolic soil intergrading to Podzol. All profiles exhibited moderate to strong brown colors in the solum with additional brown "earthy" streaks extending horizontally and vertically through the lower part of the soil profile. Clay skins were observed along the cleavage planes of the disintegrated sandstone in the lower profile, the skins becoming thicker and more continuous with increased depth.

The Franconia sandstone formation often consists of alternating bands of white and green (glauconitic) material. The brown streaks usually develop in the originally green glauconitic material. Table 2 shows the extremely high iron content of the upper part of the solum. Lower horizons showed a marked decrease in that particular constituent. Although omitted from table 1, mechanical analysis of the profile indicated the presence of two clay-enriched layers. These layers may have formed by a differential weathering in certain parts of the soil profile due to the presence of a series of

TABLE 1. PARTICLE SIZE DISTRIBUTION OF SELECTED SOIL HORIZONS DEVELOPING IN RESPECTIVE GEOLOGIC MATERIALS

Soil Type	Horizon	Geologic Materials	Total Sand 2–0.05mm %	Total Silt 0.05–0.002mm %	Total Clay 0.002mm %	Coarse Silt / Fine Silt (0.05–0.02 mm / 0.02–0.002mm)
Norden sandy loam	Ap	Glauconitic s.s.	62	24	14	....
Norden sandy loam	B_{22}	Glauconitic s.s.	51	17	32	....
Norden sandy loam	Dr	Glauconitic s.s.	90	3	7	....
El Paso, shallow variant	Ap	Acid shale	11	47	42	....
El Paso, shallow variant	B_{22}	Acid shale	20	21	59	0.3
El Paso, shallow variant	Dr	Acid shale	15	16	71	....
El Paso silt loam*	Ap**	Silt loam loess	14	67	19	1.1
El Paso silt loam*	B_{22}**	Silt loam loess	18	50	32	1.8
El Paso silt loam*	Dr	Acid shale	12	18	70	0.1
Brill silt loam	Ap	Silt loam loess	11	69	20	0.87
Brill silt loam	B_{22}	Silt loam loess	11	56	33	1.33
Brill silt loam	C	Silt loam loess	17	57	26	1.38
Seaton silt loam***	Ap	Silt loam loess	12	77	11	1.59
Seaton silt loam***	B_2	Silt loam loess	10	72	18	2.46
Seaton silt loam***	C	Silt loam loess	13	72	15	2.44
Milaca silt loam	A_1****	Silt loam loess	16	73	11	....
Milaca silt loam	B_2	Red till	52.2	29	19	....
Milaca silt loam	C_2	Red till	69	21	10	....

*Tentative series name.

**Developed in overlying silt.

***"Fayette", an average of 6 profiles, three analyzed locally and three from data of the soil survey laboratories, S.C.S., Lincoln, Nebraska.

****This horizon is formed in the thin loess cover overlying the till, and characteristic of this particular series.

Table 2. Chemical Properties of Selected Soil Horizons Developing in Respective Geologic Materials

Soil Type	Horizon	Geologic Material	pH	Cation Exchange Capacity m.e./100 gm.	Free Iron Oxide Fe_2O_3 %
Norden sandy loam	A_1	Glauconitic s.s.	5.5	...	50.0
Norden sandy loam	B_{22}	Glauconitic s.s.	5.2	...	11.4
Norden sandy loam	Dr	Glauconitic s.s.	...	...	1.0
El Paso silty clay	Ap	Acid shale	6.5	7.7	0.9
El Paso silty clay	B_{22}	Acid shale	4.6	16.0	2.0
El Paso silty clay	Dr	Acid shale	3.7	16.4	4.3
El Paso silt loam	Ap*	Silt loam loess	6.0	6.5	0.9
El Paso silt loam	B_{22}*	Silt loam loess	4.3	13.3	1.4
El Paso silt loam	Dr	Acid shale	3.7	15.8	2.7
Brill silt loam	Ap	Silt loam loess	5.5	5.1	0.9
Brill silt loam	B_{22}	Silt loam loess	5.0	17.1	1.5
Brill silt loam	C	Silt loam loess	6.0	14.8	1.3
Milaca silt loam	A_1*	Silt loam loess	5.2	...	...
Milaca silt loam	B_2	Red till	4.7	25.5	...
Milaca silt loam	C_2	Red till	5.3	15.3	...

*See table 1 for notation on this horizon.

perched water tables, in addition to the movement of clay size material from overlying horizons as evidenced by vertical clay skins. Perched water tables have been observed in road cuts, and when exposed to atmospheric conditions, form red, weathered streaks, parallel to the bedding planes. The two major changes taking place during the development of a soil profile from glauconitic sandstone therefore are: (a) the formation of a highly-

FIGURE 1. Road cut showing acid shale with overlying siltstone and capped by eolian material. (Pierce County, Wisconsin)

ferruginous upper solum and (b) the development of one or more textural layers in the subsoil.

D. *Soil development in acid shale*

The particular area investigated occupies a nine-square-mile valley in the southwest quarter of Rock Elm Township, Pierce County, Wisconsin. The valley is formed at the confluence of two first order streams[9] and has been eroded in its deepest part to a level about 140 feet below the surrounding landscape. Geologic erosion has cut through a stratum of St. Peter sandstone, including an underlying thin layer of basal siltstone and shale.

The valley consists of undulating to rolling uplands, gently to strongly-sloping upland valley slopes, where only a relatively thin

[9] Unbroken, fingertip streams in the headwaters of the drainage basin.

silt mantle exists, and where, most or all of the B horizon of the soil profile is developing in the underlying shale. On gentler gradients, however, the soils are considerably deeper, with only the lower part of the B horizon extending into the underlying shale. The deep silt mantles are derived either from wind deposited silts or from siltstone that outcrops in the higher surrounding areas.

Table 1 shows the influence of the parent rock on the relative amounts of silt and clay in the two respective profiles. The El Paso silt loam[10] has its solum developing in silty material underlain by a clayey shale. The coarse silt/fine silt ratios reaffirm the sharp break in the geologic materials between the solum (20 inches in this case) and the underlying material. The El Paso, shallow variant, almost totally developed in the shale, has a solum which reflects the clayey nature of this material. In both soils those layers developing in the shale exhibited a stronger compound structure of large plates in turn subdivided into smaller subangular to angular blocks. A short description is given herewith for purposes of illustration:

El Paso Silt Loam Profile (Showing Horizons From the Lower Part of the Solum and Directly Underlying Shaley Material)

Horizon	*Depth*	*Description*
B_{22}	14–17″	Dark brown (10YR 4/3, moist) silty clay loam with compound structure of strong fine to medium angular blocky and weak to moderate medium macroplaty; many thick, patchy, high-contrast clay skins (10YR 3/2, moist) and light silt coats on vertical and some horizontal faces of structural peds; very firm; pH 4.3; gradual and wavy lower horizon boundary. 3 to 4″ thick.
B_{23}	17–20″	Dark brown (10YR 4/3, moist) silty clay loam with compound structure of moderate medium angular blocky (having stronger vertical than horizontal cleavage planes) and moderate medium platy; continuous, thick high-contrast clay skins on vertical faces of structural peds; very firm; very few fine prominent mottles (5YR 4/5, moist) in the lower part of the horizon, pH 4.2; diffuse and irregular lower horizon boundary. 3 to 5″ thick.
D	20–27″	Olive gray (5Y 5/2, moist) clay with moderate fine to very fine platy structure. Has occasional but weak vertical cleavage planes; very firm; very few fine prominent mottles (10YR 5/8, moist); pH 3.9; diffuse and smooth lower horizon boundary. 7 to 36″ thick.
Dr	27+″	Olive gray to light olive gray (5Y 5/2 to 6/2, moist) shale having very thinly-laminated, rather loosely-bedded structure; many iron-oxide streaks (10YR 5/8, moist) on the horizontal structural planes; individual shale flakes are very firm when moist and very hard to extremely hard when dry; pH 3.7. Many feet thick.

[10] Tentative series name.

Field examination of the acid shale revealed the presence of pyritized fossils. The pyrite crystals present were in various stages of decomposition i.e. ranging from fresh yellow perfect cubes to a dark gray powder. Chemical analysis of the powder showed it to be mostly $FeSO_4$. The decomposition of the pyrite crystals may be taking place in the following manner:

$$2FeS_2 + 7O_2 + 2H_2O \longrightarrow 2FeSO_4 + 2H_2SO_4$$

Such a reaction would lead to extreme acid conditions. Table 2 shows the very low pH (high acidity) in the underlying shale as well as the possible influence this acidity has on overlying materials. The siltstone overlying the shale, inherently, has a much lower acidity (higher pH).

The above study illustrates the impact a geologic material can have on soil properties even if only as an "underlying layer". The extent of that influence depends on the make up of the geologic material, especially those constituents which exhibit a "dynamic-aspect" i.e. active-acidity produced continuously by a mineral or chemical compound present in it.

E. *Soils of Taylor County: a preliminary study of "Acid Gray-Wooded" soils in Central Wisconsin*

Taylor County is covered by reddish-brown, acid till and glaciofluvium of late Wisconsin age and Patrician source (Part of the Chippewa Lobe of the continental glacier). With the possible exception of the terminal moraine that extends across the county from north-east to south-west, the drift is overlain by a deep to moderately deep blanket of loess. The loess, in many depressed sites, has assumed the characteristics of lacustrine silts.

The silt mantled zonal soils of Taylor County represent varying stages of "Gray-Wooded" solum development, under varying drainage and microclimatic conditions. Most, if not all of the "Acid Gray-Wooded" soils in Taylor and the adjacent counties developed in deep to moderately deep silts on level to gently rolling topography. Unlike the true Gray-Wooded soils of Canada that have calcareous parent materials, the soils of Taylor County developed in acid silts and underlain by slightly to moderately acid deposits of sandy clay loam to clay loam glacial till, sandy gravelly outwash or lacustrine silts and clays. The following abbreviated descriptions illustrate the range of soil profile characteristics found in the area.

Laboratory analysis showed a two-fold increase in clay content from A_2 to B_{21} horizon (15 vs. 29 percent respectively). Abundance of clay skins in the lower B horizon and many continuous silt coatings on ped surfaces in the upper B point to a clay movement along vertical surfaces resulting in a methodic degradation of the upper B horizon.

BRILL SILT LOAM (A MONOSEQUAL "ACID GRAY-WOODED" SOIL)

HORIZON	DEPTH	COLOR (MOIST)	TEXTURE	pH
Ap	0–4″	10YR 4/2	Silt loam	5.5
A_2	4–13″	10YR 5/2	Silt loam	5.0
B&A	13–15″	7.5YR 4/4	Silty clay loam	5.0
B_{22}	15–21″	7.5YR 4/4	Silty clay loam	5.0
B_{23}	21–27″	10YR 4/3	Silty clay loam	5.0
B_3	27–30″	10YR 4/3	Silty clay loam	5.3
C	30–40″	10YR 4/3	Silt loam	6.0
D	40+″	....	Sand and gravel	6.0

NOTE: Although initially described as a Gray-Brown Podzolic, this soil shows strong evidence of an "Acid Gray-Wooded" type of profile e.g. deep tonguing, degradation (destruction) of the B horizon (B&A or A&B layers), absence of A_3 or B_1 horizons, thickness and whitish color of A_2 horizon.

STAMBAUGH SILT LOAM (PODZOL SOIL)

HORIZON	DEPTH	COLOR (MOIST)	TEXTURE	pH
Ao	1–0″	10YR 2/2–2/1	Organic matter	6.0
A_2	0–4″	10YR 5/2	Silt loam	5.5
Bir	4–10″	7.5YR 4/4	Silt loam	5.3
Bm_1	10–18″	10YR 4/3	Silt loam	5.5
Bm_2	18–28″	10YR 6/2	Very fine sandy loam	5.0
Dm	28–29″	7.5YR 4/4	Sand and gravel	5.5
D	29+″	7.5YR 4/4	Sand and gravel	6.0

NOTE: The profile shows a relatively thin A_2 with little tonguing and an iron-enriched layer (Bir) underlain by a series of strongly cemented horizons (Bm_1, Bm_2, Dm). Note the complete absence of a "degraded-layer" (B&A) in the upper B.

BOHEMIAN SILT LOAM (ACID VARIANT), A BISEQUAL "ACID GRAY-WOODED SOIL"

HORIZON	DEPTH	COLOR (MOIST)	TEXTURE	pH
Ap	0–6″	10YR 4/2	Silt loam	6.0
Bir	6–9″	10YR 4/4	Silt loam	5.5
A_2	9–12″	10YR 6/2	Silt loam	5.3
A&B	12–15″	5YR 4/3	Silt loam	4.8
B_{22}	15–27″	5YR 4/4	Silty clay loam	4.5
B_3	27–37″	5YR 4/4	Silt loam	4.8
C	37+″	5YR 4/4–4/6	Silt/very fine sand	5.2

NOTE: This soil has a bisequal profile i.e. a repeated succession of eluvial (leached)—illuvial (accumulation) horizons, the upper sequence usually being an A_2–Bir (iron and/or organic matter enriched layer) combination, underlain by an A_2–B_2 (textural layer) sequence.

The textures in the various horizons reflected the silty nature of the parent loess and/or lacustrine silt. The A_1 and A_2 horizons generally are silt loam. The transitional (A&B or B&A) zone of degradation and the underlying B_2 are a heavy silt loam to silty clay loam. In some few instances the A_2 appears to grade abruptly into a clayey B. In no instance did an "Acid Gray-Wooded" profile display either A_3 or B_1. Both were entirely lacking or were replaced by an A&B (or B&A) horizon.

A fragipan-type cementation was found in several of the observed "Acid Gray-Wooded" soils. Among the monosequal "Acid Gray-Wooded" soils (lacking the A_2-Bir or A_2-Bhir sequence), fragipans are most prominently expressed in the B_3 and upper C horizons. The structure of the B horizon in the "Acid Gray-Wooded" soils usually is compound; moderate, medium to coarse prisms that break under pressure to moderate medium subangular to angular blocky peds. A general macro- to microplatiness is also evident. The prismatic structural form is obvious even more in the undisturbed profile, where tongues of A_2 and prominent silt coats extend along the prisms' vertical faces. Toward the lower B, the prismatic structural form becomes weaker and, generally coarser. The subangular to angular blocky structural form is most strongly developed in the middle B and becomes weaker and coarser in the lower parts of the solum.

Conclusions

In the preceding pages selected instances are cited which establish a definite relationship between soil profile characteristics and the type of geologic material in which the profile develops. An attempt was made to describe as fully as possible those properties observable in the field, and in addition, conduct specific laboratory analyses.

The extent to which a soil profile displays inherent geologic characteristics depends on: (a) the degree of uniformity ("stratification") of the parent-material, its texture and mineralogy, (b) position of the soil in the landscape, especially relative to other types of rock materials, (c) the intensity and duration of surface exposure.

The degree of certainty with which a particular soil profile characteristic can be attributed to the geologic substructure rather than to climate, organisms and/or time, will depend on accuracy and extent of field observation and of course on laboratory analyses. Each case has to be judged on an individual basis and generalizations avoided unless enough data, field and laboratory, are available.

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THE BASE OF THE ST. PETER SANDSTONE IN SOUTHWESTERN WISCONSIN*

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The problem of the base of the St. Peter sandstone formation in southwestern Wisconsin has been debated for many years. The paucity of exposures of this contact hampered investigation greatly and it awaited the collection of logs of wells based on samples of the cuttings to understand much of the phenomena. From this data the existence of considerable amounts of chert pebble conglomerate, chert rubble, sandstone, in part quartzitic, and non-calcareous shale together with some dolomite or dolomite conglomerate was established. These strata are here termed the "basal beds" and are very little exposed in either natural or artificial exposures. Problems which arise consist of: (1) whether or not the basal beds are part of the original St. Peter sandstone formation or belong in the older Prairie du Chien group, (2) whether an unconformity is present at the top of these beds or at their bottom, and (3) determination of the true bottom of the basal beds, for there may be some non-dolomitic shale layers in the Prairie du Chien strata. The nature of the basal beds which strongly indicate reworked weathered material and the fact that they rest upon various older formations down to the Cambrian Franconia sandstone, as well as their difference from known Prairie du Chien strata convince the writer that there is a pronounced unconformity at the bottom of this downward extension of the St. Peter sandstone. It is possible, however, that there are some non-calcareous shales in the Prairie du Chien group. A. E. Flint (1956) deals almost entirely with the upper contact of the basal beds although he discusses some exploration drill holes which penetrated the basal strata. The present paper is confined to the same area that was discussed by Flint.

Previous Investigations. Although study of the problem of the base of the St. Peter has been carried on for many years (Heller 1956, Powers 1935, Trowbridge and Atwater 1934), few geologists have had access to subsurface information derived from sample-controlled logs of water wells. Such information is vital to a correct interpretation of the evidence which bears on this problem. Flint (1956) reviewed the opinions of almost all of the students of the

* Paper read at the 90th annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters. Mr. Thwaites died June 7, 1961.

area so thoroughly that little can be added. He omits, however, a paper by Twenhofel and Thwaites (1919) which was based on a report on the Sparta and Tomah quadrangles, Wisconsin, which was refused publication by the U. S. Geological Survey. In this paper a surface exposure of St. Peter sandstone where it lies on Cambrian strata was discussed.

Nature of Subsurface Data. The following factors must be evaluated in order to use subsurface data from cable tool cuttings. In surface exposures all the strata above a given outcrop are either covered or removed by erosion, and everything below the base of the exposure is concealed. Lateral relations between exposures is confused by both dip of the strata and lenticular deposition. The great advantage of drill records is that they are vertical, or near vertical, sections which are subject only to the hazards of obtaining good cuttings or cores if a core drill is used. The basal beds at the base of the outcrops of St.Peter sandstone are concealed because the outcrops are so friable that sand weathered from them conceals the outcrop of the less resistant basal beds. Cable tool drilling through the basal beds is generally accomplished with considerable difficulty from caving particularly of the shales. With core tools recovery is poor. In many wells the initial drilling is not too difficult, but safe completion demands casing. In some wells this casing must be under-reamed. The caved fragments are normally much larger than are actual cuttings, but some are broken up by the drill and others are rounded by mixture with drill cuttings which are agitated by the action of the tools. This process of admixture may give a false color to some of the cuttings. It is very difficult to distinguish thin layers of interbedded shale in sandstone and to separate cemented conglomerate of broken dolomite from true solid dolomite. Correlation of the material is very difficult unless the hole is carried down into recognizable formations below. This applies particularly to the exploratory holes of the U. S. Geological Survey, many of which were not drilled enough to identify the formation at the bottom. Although some of the difficulties described above make interpretations of cable tool cuttings somewhat difficult, it is clear the attitude of many old-time geologists that cable tool cuttings are valueless is not just. It may be remarked that had caving been so bad as they claimed, it would have been almost impossible to complete a hole. When a record of casing is available, the order in which each string of pipe was installed can generally be found which is a great advantage in interpreting cuttings. Another source of data is from fresh highway cuts. An enormous amount of information was lost because the geologists of the Wisconsin Survey were not encouraged to examine highway grading while it was fresh. At the present time this involves walking over the project, for cuts even in firm bedrock are slanted back, covered with black earth, and seeded so that by the time the road is opened to traffic nothing whatever can be seen.

Underlying Formations. In the normal stratigraphic succession the St. Peter sandstone is underlain by the dolomites of the Prairie du Chien group (Powers 1956, Heller 1935, Trowbridge and Atwater 1934). If localities where the basal beds are thick are considered, it is found that the next underlying formation ranges down to the Franconia sandstone of Cambrian age. Such localities where there is no recognizable Prairie du Chien are not as common in southwestern Wisconsin as farther to the east. In some places the converse is true and there is no St. Peter sandstone between Prairie du Chien dolomite and basal Platteville strata. This discrimination is rendered difficult by reason of the sandy Glenwood member of the Platteville and sandstone which is properly included in the Prairie du Chien. In many well records, particularly drillers logs, the sandstones of the Prairie du Chien have been erroneously correlated as St. Peter. Although the official usage of the U. S. and some other geological surveys is to subdivide the Prairie du Chien group into three distinct formations, the writer is far from convinced that this procedure is practicable in Wisconsin. The formations in descending order are: Shakopee (Willow River) dolomite, New Richmond (Root Valley) sandstone, and Oneota dolomite. The relative stratigraphic positions of some of the type localities of these formations is not clear. The well logs examined by the writer show definitely that instead of a single New Richmond sandstone, there are in some places several sandstone beds interbedded with dolomite and in other places no sandstone at all. It seems probable that the sandstone beds within the Prairie du Chien are lenticular. The mixture of sandstone and dolomite strongly suggests conditions like the east coast of Florida where sand brought by waves and currents from the north is interbedded with local calcareous deposits. The writer has never been able to make any definite subdivision of the entire group of dolomites in Wisconsin and decidedly prefers to use the name Prairie du Chien as a formation rather than as a group; in fact until recently Owen's ancient name "Lower Magnesian" was still used by the Wisconsin Geological Survey. In many sections it is difficult to determine the exact top of the Prairie du Chien. The writer has fixed it by presence of non-dolomitic shale and chert conglomerate in the overlying beds but some noncalcareous green-gray shale is present throughout the entire Prairie du Chien sequence for the most part as mere thin laminae or small specks. Just how this noncalcareous nature is reconciled with the adjacent dolomite has not been determined. A confusing feature of the contact with the basal beds is the presence of organic reefs or bioherms throughout the Prairie du Chien dolomite. Although oolitic chert and dolomite are most abundant in the recognized Prairie du Chien, it is by no means certain that either is entirely confined to it. Fragmental oolitic chert is certainly present in the overlying basal St. Peter beds and it may be indigenous to the dolomite layers of those strata although this has not been definitely proved. The supposed dolomites of the basal beds may possibly be cemented conglomerate or cemented talus. Attempts to subdivide the Prairie du Chien by use of insoluble residues were not successful. The arithmetical average of insoluble material in 55 analyses collected by Steidtmann (Steitdmann, 1924, pp. 185–187) is 8.5% but the range is from 1.37% to 26.26% which is too much of a scatter to permit an accurate average. The clays formed from weathering of the Prairie du Chien under modern climatic conditions are decidedly more brown than are the clays of the basal shales, some of which are very pale pink. It is impossible to make an isopach map of the Prairie du Chien because not only of the uncertainty of its top but chiefly because of rapid changes of thickness whose distribution is at present entirely unpredictable. It is found, however, that a map can be made of the combined St. Peter-Prairie du Chien thickness. This ranges from 300 feet along the Mississippi River to less than 100 feet west of Milwaukee. No Prairie du Chien is reported in any well within a considerable area in southeastern Wisconsin although it has been recognized in some well logs in the southern part of Michigan.

Basal St. Peter Beds Below the Original St. Peter Sandstone. When the St. Peter was named by Owen (Wilmarth, 1938, pp. 1884–1885) over a century ago, the term applied only to the "soft white sandstone" which is exposed along what is now called Minnesota River. Since exposures of the basal contact are naturally confined to localities where the formation is abnormally thin, nothing was known of the strata which are confined to areas where the entire St. Peter is abnormally thick. In preparing geological maps it was presumed that the underlying Prairie du Chien dolomite was present in many areas where subsequent drilling failed to demonstrate this fact. These localities of thick St. Peter naturally offer few outcrops, for the lower strata are covered by sand from the disintegration of the higher beds. Only one outcrop has been described where the St. Peter rests upon Cambrian strata. Twenhofel and Thwaites (1919, p. 638) describe the outcrop at Middle Ridge in the Sparta quadrangle of western Wisconsin, where St. Peter sandstone rests "on a residuum of red clay and chert which is altogether without stratification." They concluded: "This residuum was derived from 'the weathering of' older formations." The underlying formation at this locality is the Jordan member of the Trempealeau formation of the Upper Cambrian. In 1914 the writer visited several exposures in the Sugar River Valley near Albany, Wisconsin which displayed at that time the lower beds of the St. Peter without any of the underlying formation. At that time there were large pits in the chert rubble, for it was used to surface sandy roads in that vicinity. Since then its unsuitability with automobile tires has caused these pits to be abandoned and it is very unlikely that any are now worked. Similar material is often encountered in drilling and does not appear to cave extensivly. It was called "cotton rock" in some of the exploration drill holes of southwestern Wisconsin. Field notes on and photographs of these exposures are still extant in the office of the Wisconsin Geological Survey. The following quotations are from the writer's notes of 1914.

> "Center sec. 8, T. 3 N., R. 10 E. Gully west of school house on south side of Allen Creek shows poor exposure of ordinary yellowish to very ferruginous St. Peter. Bedding locally steeply tilted and is interbedded with red sandy to clay shale and oolitic chert. At one point near the north end is a bed of broken weathered chert passing into chert sandstone conglomerate with small rounded cherts about ⅛th inch diameter. Above this is usual St. Peter sandstone. Chert bed is clearly regolith and not reworked much.
>
> "NE. ¼ SE. ¼ sec. 16, T. 3 N., R. 9 E. West of here visited several chert pits. The largest was about 1½ miles north of Albany. This is a large excavation in irregularly broken white to yellowish-red chert which varies from very hard to chalky and is extensively used on roads in the vicinity. In the chert there is occasional bedding but most is loose or without bedding. There are also layers of yellowish-brown sandstone and chert-sandstone conglomerate. At the very bottom of pit was found very fine-grained calcareous buff and red streaked sandstone and red shale much like that seen in gully to east. At top of pit main part of sandstone is like usual St. Peter but shows layers of red shale."

Fig. 1 is a photograph of this pit by W. O. Hotchkiss.

Alden (1918, pp. 81–82) briefly described some of the above exposures saying:

> "In a street cut just north of the Schoolhouse at Albany, 3 to 5 feet of this loose chert was seen overlying a rounded and weathered surface of the limestone (dolomite) and underlying the undulating basal layers of sandstone, in whose lowest layer fragments of chert are included."

Alden mentions the red to white shale but concludes that most of the exposures were so poor that the true relations could not be found. A section is given of a cut on the Illinois Central Railroad (NW. ¼ sec. 29, T. 4 N., R. 8 E.) where he describes thin layers of white sandstone, in part shaly, which grade laterally into partly brecciated dolomite. Alden suggested that the dolomite was a reef

FIGURE 1. Exposure of chert rubble near Albany, Wisconsin.

formed at the same time as the adjacent sandstone. It is probably part of the basal beds and hence none of the true Prairie du Chien was exposed. Alden also described quartzitized sandstone in these beds.

A road cut on U. S. 14 about 5.4 miles west of Readstown was not visited by the writer until several years after its completion. The location is NW. ¼ NW. ¼ sec. 22, T. 12 N., R. 4 W. One end of the cut is in dolomite which overhangs for a few feet above red shale beneath and is overlain by normal St. Peter sandstone. In the present condition of the cut, it is difficult to determine if the overhanging contact is erosional or due to folding of the strata while still soft. It is possible that the dolomite is really a part of the basal St. Peter beds. No exposure is known to the writer in which the bedding of the Prairie du Chien is demonstrably truncated by either the upper St. Peter or these basal beds. Several localities have been observed in which St. Peter sandstone appears to fill narrow channels in the older dolomite. Fig. 2 shows one of these which was discovered in the Steil exploration of the U. S. Geological Survey near Highland, Wisconsin. The shale just above the dolomite appears to follow the irregular contact. Another exposure in the abandoned railroad cut at Dill, west of Monroe, was visited by the writer in 1907 while working as assistant to Alden. The cut was undoubtedly much fresher at that time than when it was visited by Flint more than 40 years later. Flint described this as a filling of a depression between two adjacent domes of dolomite, but there was no suggestion of such a structure at the time it was visited by the writer.

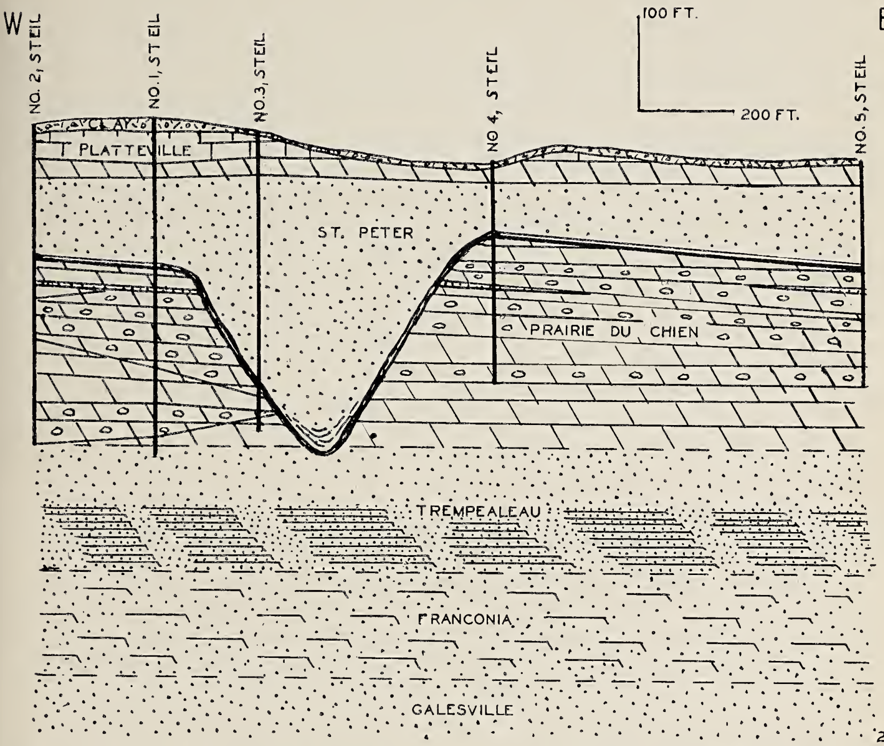

FIGURE 2. Cross section of Steil exploration drill holes, near Highland, Wisconsin, redrawn by the writer. It is suggested that the St. Peter sandstone fills an erosion valley in the top of the Prairie du Chien dolomite instead of a depression between organic reefs. A layer of deoxidized shale follows the contact. Old formations added from records of nearby water wells.

Another similar occurrence was visited by the writer while he was a student at the University of Wisconsin. At that time our instructor, C. K. Leith, accounted for the narrow wedge of sandstone in the dolomite as a graben. When visited years later weathering had destroyed the entire exposure.

Well Records. The following well records are all located in or near southwestern Wisconsin and are based on samples of the cuttings which were examined by the writer. The strata extend downward from the highest St. Peter sandstone, excluding the sandy base of the Platteville, to the highest recognizable Cambrian strata. They give a much better knowledge of the basal beds than can be obtained from outcrops.

PARTIAL LOG OF VILLAGE WELL, NO. 2, LINDEN, WISCONSIN

	Thickness feet	Depth feet
Sandstone, medium to fine-grained, light gray to white	90	300
Sandstone, medium to fine-grained, coarse-grained to silty	10	310
Shale, gray, red, and green-gray	35	345
Dolomite, slightly sandy, light gray	40	385
Dolomite, light gray; shale, red and green-gray	10	395
Shale, red and green-gray	30	425
Sandstone, medium to fine-grained, light gray, dolomitic	5	430
Dolomite, light gray; sandstone, fine-grained, gray, dolomitic	15	445
Sandstone, fine to medium-grained, light gray; no sample 450–455	25	470
Shale, red and green-gray; chert, white	10	480
Conglomerate, chert pebbles, white, in sandstone, coarse to fine-grained; shale, red caved(?)	25	505
Shale, red and green-gray	10	515
Sandstone, medium to fine-grained, pink; shale, red, probably caved	20	535
Shale, dark red, mottled with green-gray	60	595
Total St. Peter 385 feet		
Shale, very sandy, pink, very dolomitic, glauconitic. This is part of Cambrian Franconia formation		

Casing was inserted from 284 to 351 before drilling deeper. It was then thought that Prairie du Chien dolomite had been reached. Later pipe was set from 342 to 434. After drilling to 776 pipe was hung from the top of the last pipe to depth 638. The cuttings from 434 to 776 may have been contaminated by cavings.

PARTIAL LOG OF VILLAGE WELL NO. 2, HAZEL GREEN, WISCONSIN

	Thickness feet	Depth feet
Sandstone, coarse to fine-grained, light gray to pink	115	475
Shale, medium-gray and pale red; sandstone, pink-gray	5	480
Sandstone, medium to fine-grained, pale pink-gray	50	530
Shale, pale red, some green-gray, base dolomitic	15	545
Dolomite, oolitic at base, light gray and pink; shale red, green-gray, some sand	35	580
Shale, red, green-gray; chert and dolomite oolites	10	590
Sandstone, medium to fine-grained; shale, red and green-gray	10	600
Shale, red and green-gray; some sand, mica and oolitic chert	35	635
Chert rubble, light gray, not caving; some shale like above; some sandstone, light gray quartzitic	50	685
Sandstone, medium to coarse-grained, light gray to pink; much chert and red shale; no samples 690–695, 700–705	40	725
Shale, sandy, red	5	730
Total St. Peter 379 feet		
Dolomite of Trempealeau formation		

The well was cased to 554.5 feet before drilling deeper. At 760 caving became so bad that progress was stopped until casing was installed from 711 to 760. Samples below 760 examined by J. B. Steuerwald.

PARTIAL LOG OF CITY WELL NO. 1, SHULLSBURG, WISCONSIN

	Thickness feet	Depth feet
Sandstone, medium to coarse-grained, light gray and light pink	202	395
Sandstone, coarse-grained, red; shale, red	2	397
Shale, dark red mottled with green-gray; pebbles white chert	38	435
Chert rubble, white; shale, red	18	453
Shale, dark red; chert, white	9	462
Shale, red and green-gray; sandstone and chert caved	20	482
Sandstone, fine-grained, gray, very dolomitic	20	502
Sandstone, fine-grained, gray, pink and green-gray; some shale and chert, caved(?)	18	520
Total St. Peter 327 feet		
Dolomite of Trempealeau formation		

The well was drilled to 444. Strata below caved so badly that a liner was inserted to 520. This well is shown in Fig. 3.

PARTIAL LOG OF CITY WELL NO. 3, DE WITT, IOWA

	Thickness feet	Depth feet
Sandstone, medium to fine-grained, light gray to white	215	1065
Sandstone, fine to medium-grained, light pink to yellow-gray, pebbles of chert and dolomite	15	1080
Shale, dark purple-red, some green-gray; pebbles of chert up to 1 cm. diameter	55	1135
Dolomite, gray, may be conglomerate; shale and chert, caved	26	1161
Shale, light green-gray, some sand and chert	12	1173
Chert, white and gray, part oolitic; some sand; some shale; some dolomite	87	1260
Sandstone, fine to medium-grained, light gray to white; some chert, dolomite and shale, caved(?)	40	1300
Dolomite, light purple, possibly conglomerate; some sandstone	10	1310
Sandstone, fine-grained, light gray, dolomite, pyritic	10	1320
Dolomite, sandy, light purple, possibly conglomerate	40	1360
Total St. Peter 510 feet		
Dolomite of Trempealeau formation		

Samples were also examined by W. H. Norton, Iowa Geological Survey. Casing was underreamed from 1100 feet to 1256.

Interpretation of the Basal Beds. The presence of these basal beds below the original St. Peter sandstone raises several questions. Are they conformable below the sandstone of outcrops? Are they unconformable on older formations? Are they a downward continuation of the St. Peter? Should they be made a separate formation not previously recognized? Are they a part of the underlying Shakopee formation of the Prairie du Chien group? Norton (pp. 37–42) desired to make them a separate formation although he regarded them as a downward continuation of the St. Peter. He knew of no surface exposure from which to obtain a formational name so suggested a type locality in a well. The writer advised against this and the project was dropped. The chief difficulty in interpretation is the apparent presence of dolomite which seems inconsistent with the non-dolomitic nature of all of the shale. It has been suggested that these beds are not true dolomite but a conglomerate of cemented dolomite pebbles. Alden noted a brecciated structure in one outcrop. Some of the sandstone layers are dolo-

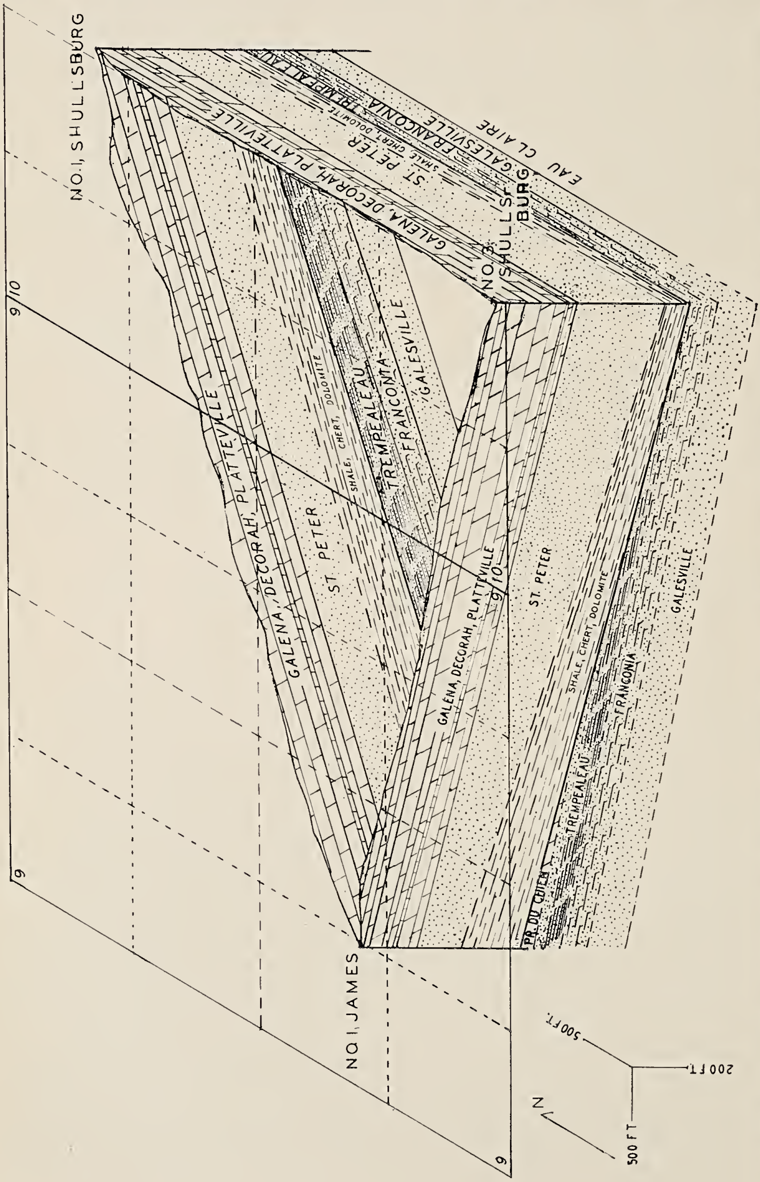

FIGURE 3. Fence diagram of subsurface geology at Shullsburg, Wisconsin. No. 1 James was an exploration drill hole of the U. S. Geological Survey. The other holes are water wells of which only No. 1 penetrates the Cambrian formations. A slight bevel of pre-St. Peter formations is shown.

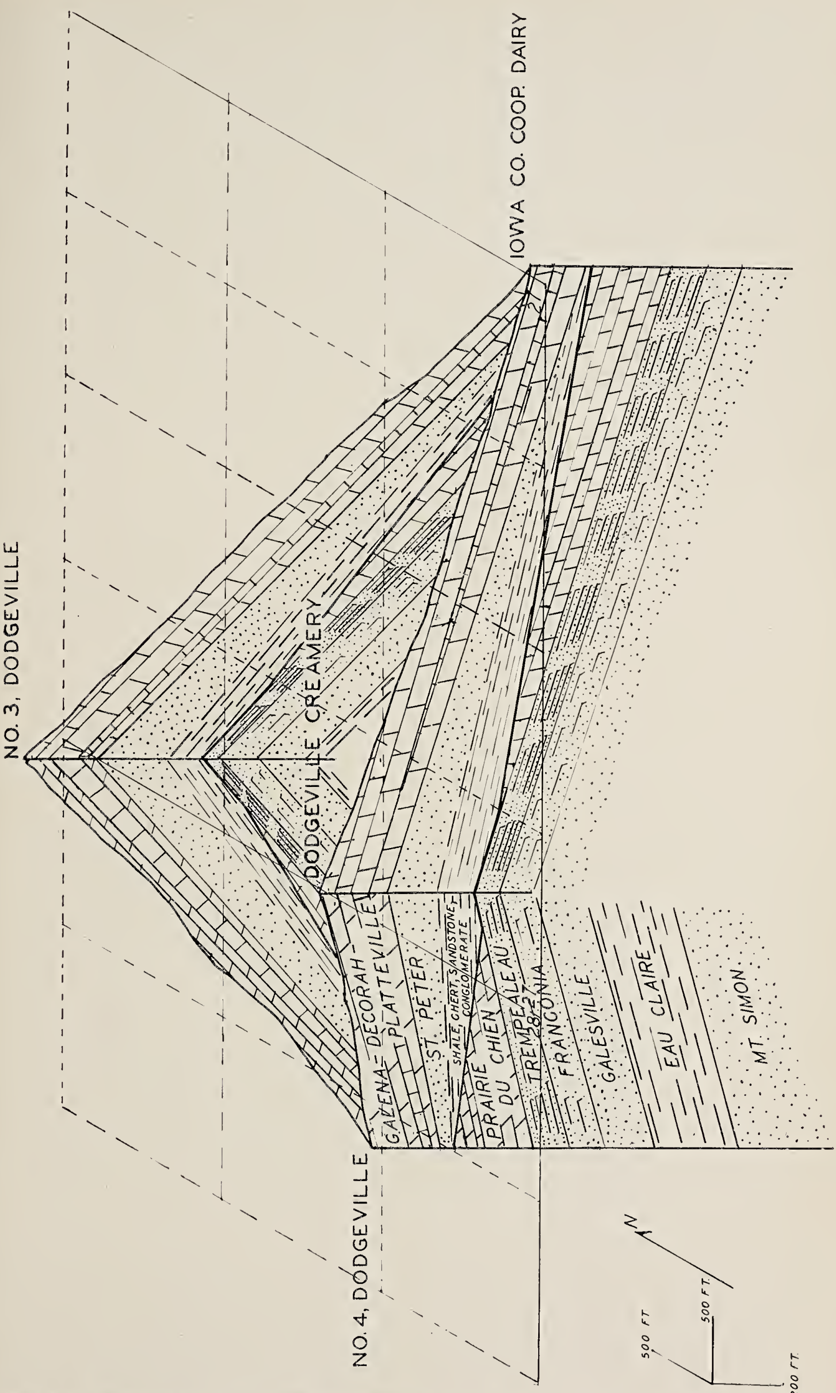

FIGURE 4. Fence diagram of subsurface geology at Dodgeville, Wisconsin.

mitic. Some of the sandstone is quartzitic and breaks into chips under the drill. The red and pink colors of some sandstone layers may be due to drilling up of caved fragments of red shale. The mottling of green-gray color in the red is explicable by deoxidation from organic matter. The red color of the shale does not agree with the color of modern residual clays from the Prairie du Chien dolomite but might have been formed under a different climate. The chert rubble (Fig. 1) is too free of clay to be regarded as a residual soil but is explicable as a reworked deposit. The chert pebbles are not well rounded, but many seem to display the results of weathering prior to deposition. Some sand layers were laid down in the rubble. It is possible that the supposed dolomite layers are cemented conglomerate or talus from dolomite hills not far distant. It is far from clear that any oolitic dolomite or oolitic chert is present in primary dolomite of these beds. All such occurrences are probably

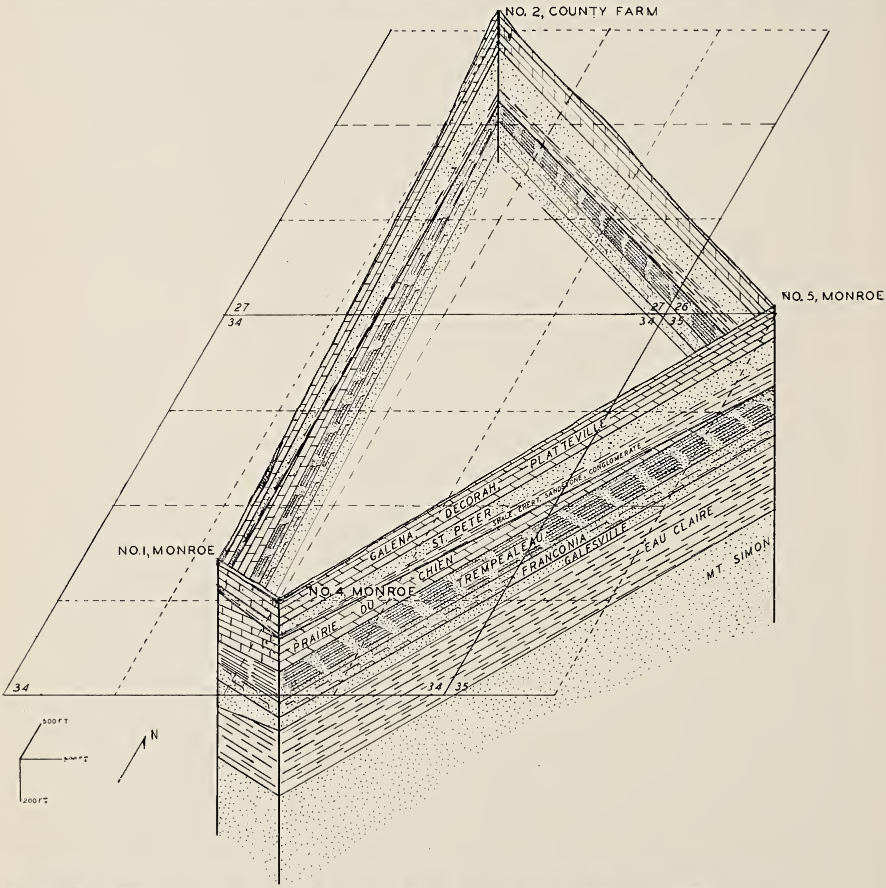

FIGURE 5. Fence diagram of subsurface geology at Monroe, Wisconsin.

fragmental. The chert-sandstone conglomerate positively indicates reworking of a chert residuum. It is possible that dolomite accumulated in sheltered localities within the hills of Prairie du Chien dolomite without adding enough to the adjacent shales to make them effervesce with acid. The very irregular sequence of the basal beds where it is almost, if not quite, impossible to correlate beds between adjacent holes is a natural result of waves and currents of an advancing sea which was interspersed by many islands. The main evidence that the basal beds are conformable with the overlying St. Peter sandstone is the occurrence of many layers of sandstone clear down to their base. Furthermore Figs. 3, 4, 5, 6, and 7 indicate clearly that the base of the basal beds truncates older formations down to the Cambrian Franconia formation. None of the basal beds, with the possible exception of the green-gray shale layers, is at all like any known Shakopee strata which has ever been observed in outcrop (Powers, Trowbridge, and Atwater). The basal beds served to level up the irregular surface of positively known Prairie du Chien strata. The irregularity of the Prairie du Chien surface is due in part to reefs or bioherms of organic origin. Their presence is no indication that there is conformity, for such accumu-

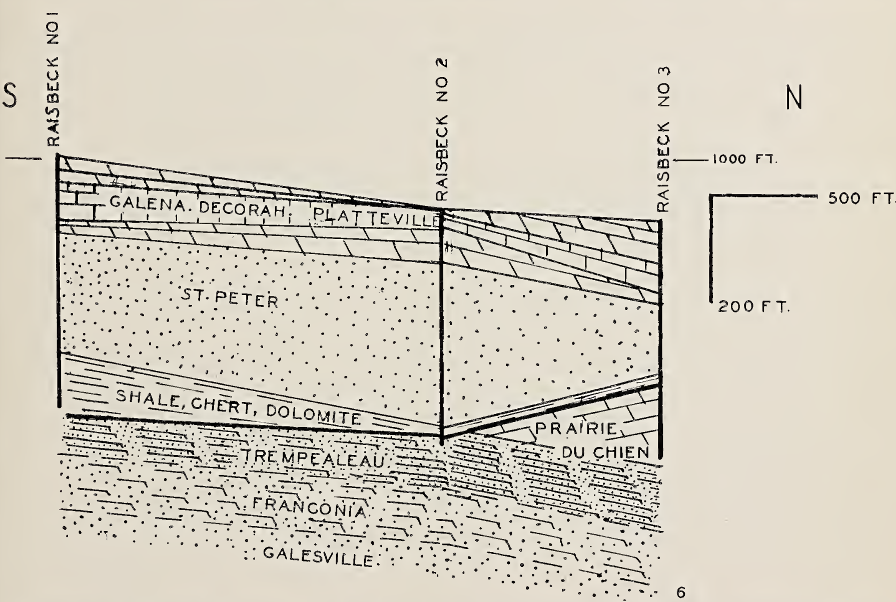

FIGURE 6. Geologic section of Raisbeck exploration of U. S. Geological Survey near Meekers Grove, Wisconsin. Although the abrupt border of the Prairie du Chien dolomite might be accounted for by original deposition the relation of the basal St. Peter beds strongly suggests an unconformity. The older formations were added from records of nearby water wells.

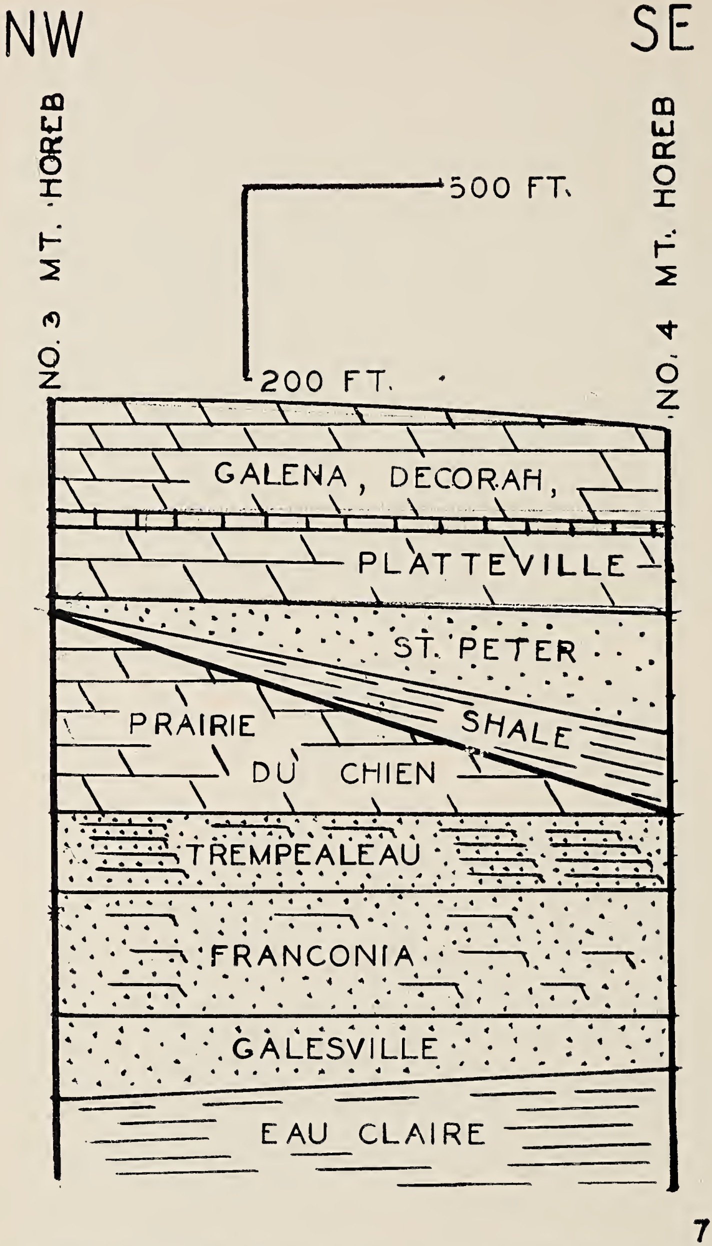

FIGURE 7. Cross section between two water wells in Mt. Horeb, Wisconsin. The non-dolomitic nature of the shale, which is present in one well and not in the other suggests an unconformity with reworking of residual clays.

lations in the Silurian dolomite of northeastern Wisconsin form hills on the present erosion surface (Thwaites and Bertrand, 1957, pp. 836–838). That the bedding in the bedrock is parallel to the slope of these hills is no indication that the Pleistocene is conformable on the Silurian. Much more important evidence is that shown in Fig. 8, the fact that the basal beds locally rest on formations

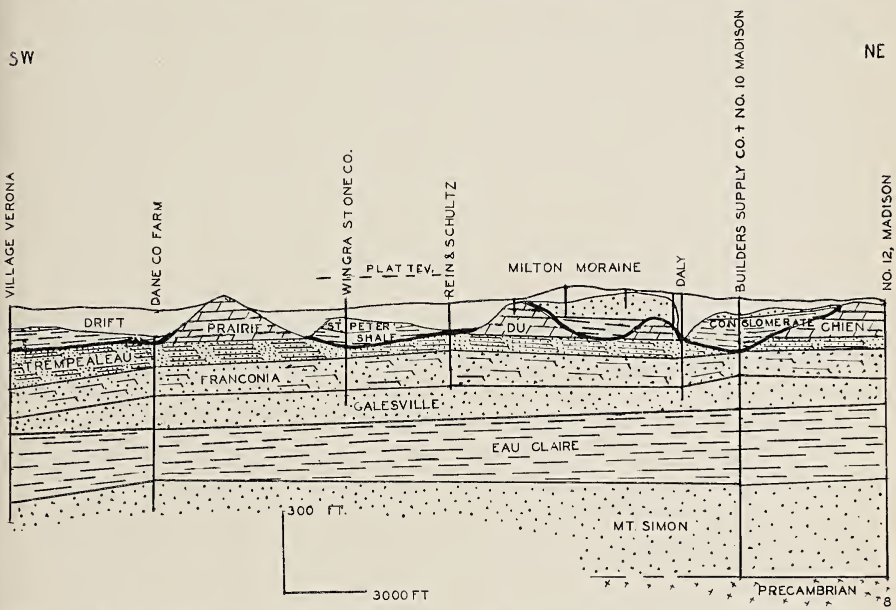

FIGURE 8. Geologic section from Verona to Madison, Wisconsin. Some well logs reported by W. C. Alden were included. Other records were based on examination of samples. A striking unconformity is indicated at the base of the St. Peter.

as old as the Cambrian Franconia sandstone. This fact makes it very difficult to regard them as a lateral replacement of the adjacent Prairie du Chien dolomite. The unconformity is at their base, not at their top next to the sandstone of the outcrops. Flint did not seem to be familiar with the basal beds, for he states:

> ". . . separating the impure dolomite and dolomitic limestone from the overlying St. Peter is a contact zone, which in places is more than 10 feet thick and consists of intercalated shale, sandstone, and admixtures of these locally cemented by dolomitic material. This interval is considered by some geologists as a basal phase of the St. Peter sandstone, but others have interpreted it as a weathered residuum on the upper Shakopee surface."

The writer concludes that these basal beds are not strictly residuum but reworked weathered material. It is possible that in some wells layers of sandstone within the Prairie du Chien have been confused with these basal St. Peter beds just as the sandstone at the base of the overlying Platteville is often mistakenly included in the St. Peter. Such an error would be minor, for such sandstones are rarely more than a few feet thick in Wisconsin.

Hypothesis of Subsurface Solution and Slump. The basal beds below the St. Peter sandstone proper show much evidence of slump and sliding. There are minor folds and faults, the surfaces of which are marked by slickensides. Samples of such slickensided surfaces are often recovered from caved fragments in cable tool holes. The writer was shown a core from a diamond drill hole in southwestern Wisconsin which displayed a joint in dolomite filled with red shale. Intrusion into broken dolomite is strongly suggested but whether the dolomite belongs to the Prairie du Chien or to the basal beds is not clear. The overhang of dolomite above shale which is exposed on U. S. Highway 14 may not be erosional but instead due to sliding of the strata while still soft. Such sliding would be expected on the irregular surface of the underlying Prairie du Chien regardless of the origin of the slope at that place. An overhang is not a normal erosional feature but could have been due either to wave erosion or lateral stream erosion. A possible origin through solution has also been suggested, but its association with the top of a shale bed strongly suggests sliding as the most probable origin. Flint suggests subsurface solution as the cause of some of these phenomena, but it seems unlikely that it is the same as that which caused, or was associated with, the sulphide mineralization of younger strata in southwestern Wisconsin. The features of sliding with minor faulting extend far outside the mineralized district and are not associated with any substantial amount of sulphide deposition. Solution due to normal ground waters seems unlikely, if not impossible, because the waters of the St. Peter almost wholly entered that formation through the overlying dolomites and limestones and thus became saturated with carbonate. It seems very improbable that solution was due to escaping ground water. The solution and slump phenomena extend far from the outcrop of this contact as shown in the figures here included.

Conclusions

(1) Flint (1956) is correct in concluding that the horizon which he considered the base of the St. Peter is conformable on underlying beds of shale which are here ascribed to the basal beds. (2) The basal beds below the normal St. Peter sandstone of outcrops vary greatly in thickness and level up the irregular top of the Prairie du Chien dolomite. (3) The shale is all non-calcareous and is associated with chert rubble, chert-pebble conglomerate, and quartzitized sandstone which are best accounted for as reworked residuum of the weathering of the Prairie du Chien. (4) No unaltered pre-St. Peter

soil profiles are known, for the waters of the St. Peter sea advanced through many narrow channels between islands and ridges of dolomite. (5) The basal beds almost certainly contain local patches of dolomite although there is a possibility that these could be cemented conglomerate or cemented talus formed from the older Prairie du Chien. (6) The shales of the basal beds are the probable cause of sliding with associated minor faulting and folding because they lie on sloping surfaces of dolomite. (7) The origin of the sloping surfaces varies and although no clear-cut examples of truncation of the Prairie du Chien strata have been discovered, subsurface exploration strongly suggests that such must occur. (8) Hills due to reef structure are common in the present day erosion surface of parts of Wisconsin and are abundant in the top of the Prairie du Chien. (9) The disturbances of the basal St. Peter beds clearly antedate the deposition of the overlying St. Peter sandstone. (10) The basal beds show no evidence of unconformity at the top but their base cuts across older strata down to the Cambrian Franconia formation in a way which cannot be explained by non-deposition of the Prairie du Chien but only by an erosion interval at its top.

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WATER TEMPERATURES IN A WELL NEAR WILD ROSE, WISCONSIN*

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Temperature measurements made in a well near Wild Rose, Wis., show that ground-water temperatures, which are generally assumed to be almost constant, fluctuate seasonally, and vary with depth. The measurements, made by the U. S. Geological Survey in cooperation with the Wisconsin Geological and Natural History Survey, are discussed because an understanding of ground-water temperatures is becoming increasingly important in Wisconsin. Many industries in the State depend upon the relatively uniform temperature of water from wells, and the attraction of Wisconsin's streams to thousands of sportsmen is the direct result of ground water discharging at temperatures favorable for cold-water game fish, especially trout. Moreover, the movement (Wenzel, 1942, p. 7) and the chemical character of ground water (Hem, 1959, p. 4) are related to its temperature. The knowledge gained by a study of ground-water temperatures in Wisconsin can aid in the development and conservation of the State's ground-water resources.

The temperature of ground water is usually determined by measuring the temperature of the water as it is pumped from a well or as it flows from a well or spring. Sometimes the temperature is measured by lowering a thermometer or other device directly into a well and measuring the temperature of the water at various depths in the well. In Wisconsin experience indicates that temperatures obtained in these ways usually cannot be used to describe the manner in which temperatures are distributed within the aquifer, because, in practice, the observed temperatures are related to the geology and the hydrology of the aquifer plus such other factors as well construction, discharge rate, and housing that are unrelated to the distribution of temperature in the aquifer. For reasons which will be discussed in detail in the ensuing pages, the temperatures observed in the well near Wild Rose are assumed to approximate closely the temperature of the ground water at various depths in the aquifer, and, as such, they are used to interpret the movement of heat within the aquifer and to illustrate the role of ground-water movement in the thermal regimen of the area.

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Ground-water temperatures have been measured since 1869 when Lord Kelvin first began making systematic observations of the earth's temperature (Darton, 1920). Particular attention has been given to "thermal" areas, geothermal gradients, heat flow, hot springs, and geysers (Jakowsky, 1950, p. 966–986). The occurrence of ground water in areas of extreme cold or permafrost also has been studied (Cederstrom and others, 1953; and Hopkins and others, 1955). Temperatures of soil also have received considerable attention (Chang, 1958). By contrast, little attention has been given to the causes and variations of ground-water temperatures in "nonthermal" areas. However, the temperature of discharging ground water is nearly always measured as part of a ground-water study. For example, in Wisconsin, Foley and others (1953, p. 88) measured the temperature of ground water sampled for chemical analyses from the "dolomite" and "sandstone" aquifers of the Milwaukee-Waukesha area. Other investigators have considered: (1) The temperature of water pumped from wells (Harder, 1960, p. 24–25, Rasmussen and Andreasen, 1959, p. 54–56) ; (2) the areal distribution of temperature in an aquifer (Darton, 1898; and Suter and others, 1959, p. 74–75) ; (3) the temperature of ground water in the United States at depths of 30 to 60 feet (Collins, 1925, p. 97–98) ; (4) the effect of artificial recharge on ground-water temperature (Leggette and Brashears, 1938, p. 414–418; Brashears, 1941, and 1946, p. 504, 511, 513–515; and Jennings, 1950) ; and (5) the effect of infiltration of water from a nearby stream on ground-water temperature (Kazman, 1948, p. 840–844; Rorabough, 1951, p. 169, and 1956, p. 162–164; and Simpson, 1952, p. 68–72).

Methods

All the temperatures presented in this paper were measured by the U. S. Geological Survey with a single underwater thermometer. The thermometer consists of a thermister or temperature sensitive element, a constant-resistance insulated cable, a power supply, a Wheatstone bridge, and a microammeter. The water temperatures were measured by lowering the thermister into the well, stationing it at progressively greater depths, and reading the meter, which is calibrated in degrees Fahrenheit. The temperatures were read to 0.1 degree.

Although ground-water temperature at depths of 70 feet or more probably did not vary during this study, temperature measured at these depths at different times varied as much as 0.4°F. These differences are attributed to errors in calibration of the instrument. However, for a given set of measurements the deviation from the true temperature is constant.

Other sources of error have been recognized. These include: mixing of water from different depths by the cable; temperature changes due to heat exchange between the cable and the water in the well; and variations in the techniques of the different operators. In general, the quality of the measurements improved as the operators gained experience.

Acknowledgments

The underwater thermometer is the property of the Division of Well Drilling, Wisconsin State Board of Health, and thanks are given for its use. The Wisconsin Conservation Department owns the well in which the measurements were made and the use of this well is gratefully acknowledged.

Location of the Well

The well in which the measurements were made is in central Wisconsin, in Waushara County, about 90 miles north of Madison. It is in the SE¼ sec. 24, T. 20 N., R. 10 E., about 0.5 mile north of the village of Wild Rose at the trout hatchery of the Wisconsin Conservation Department. Specifically, it is 300 feet west of Wisconsin State Highway 22, 50 feet north of the north raceway of the hatchery and 5 feet west of the rearing shed.

Geologic Setting

Glacial deposits of Cary age (Thwaites, 1943), more than 200 feet thick, conceal an irregular bedrock surface in the Wild Rose area. The glacial drift consists of a mixture of sand and gravel, some silt, and very little clay (Whitson and others, 1913). At the well the deposits include poorly sorted silty sand, silty clay, and sandy gravel. A log of a well about 200 feet north of the well in which the temperatures were measured is given in table 1.

Less than 50 feet of sandstone of Cambrian age underlie the glacial drift at the well site. Both the glacial drift and sandstone are permeable, porous, and water-bearing. The total saturated thickness of the glacial drift and sandstone is estimated to be 250 feet.

Granite of Precambrian age underlies the sandstone. The granite is, for practical purposes, impermeable.

Hydrologic Setting[3]

The water table in the Wild Rose area slopes eastward about 30 feet per mile, except near streams where the slope is greater and toward the streams. The streams flow to the east. Recharge of the

[3] The ground-water hydrology of Portage, Waupaca, and Waushara Counties was studied by the U. S. Geological Survey in cooperation with the Wisconsin Geological and Natural History Survey. Results of these studies are being prepared for publication.

TABLE 1. LOG OF A WELL AT THE FISH HATCHERY, WILD ROSE, WIS. (PREPARED BY THE WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY FROM EXAMINATION OF SAMPLES)

DESCRIPTION	THICKNESS (FEET)	DEPTH (FEET)
No samples	10	10
Sand, very fine, light-pink-gray, dolomitic, silty	15	25
Clay, light-pink, dolomitic, silty	20	45
Sand, very fine, light-pink-gray, silty	40	85
Sand, fine to very fine, light-yellow-gray	10	95
Sand, fine, light-gray, silty	25	120
Sand, fine to very fine, pink-gray, silty	10	130
Sand, very fine, pebbly, pink-gray, silty	5	135
Sand, very fine to medium, light-gray, silty	40	175
Sand, medium to coarse, light-gray	5	180
Gravel, sandy	3	183

ground-water reservoir results when precipitation in the area percolates to the water table, and discharge occurs when the water in the reservoir moves into a local stream, is used by vegetation, or is pumped from wells.

At the well site, the ground water moves toward and discharges into the hatcher's raceways. The water flows from the raceways into the Pine River. Ground water also is discharged by springs and wells on the hatchery grounds and conducted into the raceways. The total discharge through the raceways was 2,200 gpm (gallons per minute) on September 1, 1956, and averaged about 2,200 gpm during 1957 (John Ockerman, Wisconsin Conservation Department, personal communication).

The water table in the shallower part of the aquifer at the well stays at an almost constant level about 3 feet below the land surface because the water level in the nearby raceway is artificially maintained. The well taps the deeper part of the aquifer, however, and water rises about 8 feet above the land surface, because permeability differences within the glacial drift create artesian conditions at depths below 10 feet.

The total depth of the well is 187 feet, but, during the period when the temperature measurements were made, it was filled with gravel to a depth of 141 feet. The 4-inch diameter steel casing extended from 0.4 foot above the land surface to the bottom of the well, so that all the water entered the well through an area of about 13 square inches at the bottom. Because the well was partly plugged, the flow during the period of the temperature measurements was about 4 gallons per hour. Differences in water levels and flow rates in the well were not measured.

THE OBSERVED TEMPERATURES

Temperatures were measured on six occasions during the period February 1957 to February 1958. The temperature measured in May, August, October, and November 1957 and February 1958 were plotted against depth (fig. 1). Although only a few measurements

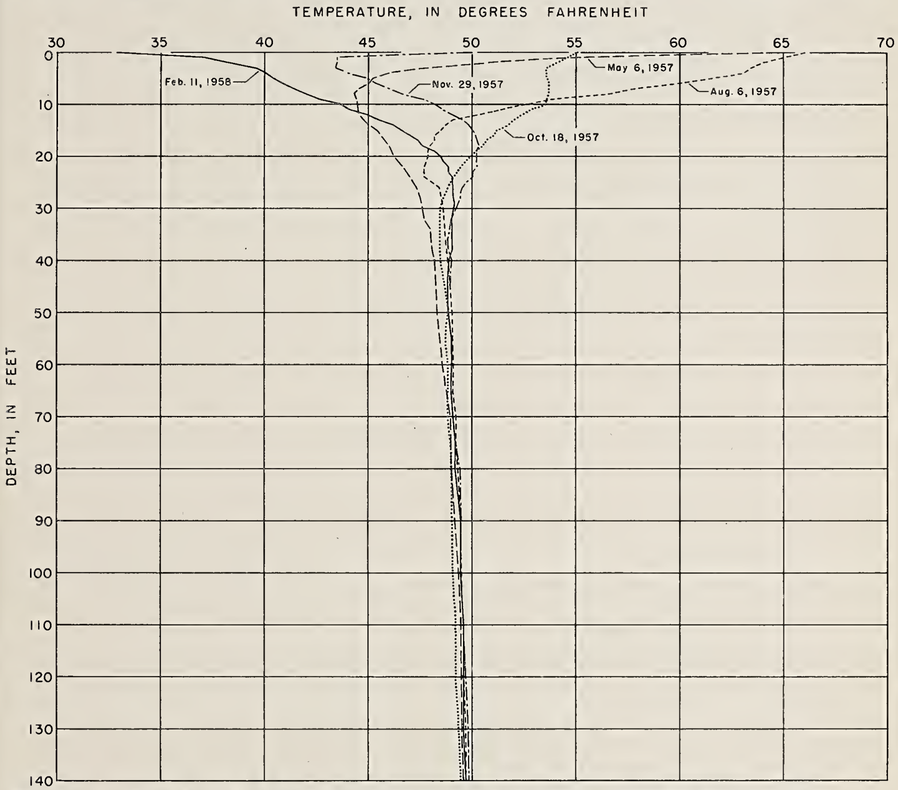

FIGURE 1. Graphs of water temperature in a well near Wild Rose, Wis.

were made in February 1957, the data are sufficient to show that the temperatures were probably identical with the temperatures measured in February 1958. Figure 1 shows that from the land surface to a depth of about 60 feet the temperatures fluctuated with time, the magnitude of the fluctuation decreasing with depth.

The maximum observed range of water temperature at different depths, determined by subtracting the observed minimum from the observed maximum, was plotted against depth in figure 2. At a depth of 1 foot, the temperature range was 30.5°F, at 10 feet it was 9.9°F, and at 36 feet it was less than 1°F. For depths below 60 feet the temperature increased uniformly with depth (fig. 1) and did not fluctuate significantly with time (fig. 2).

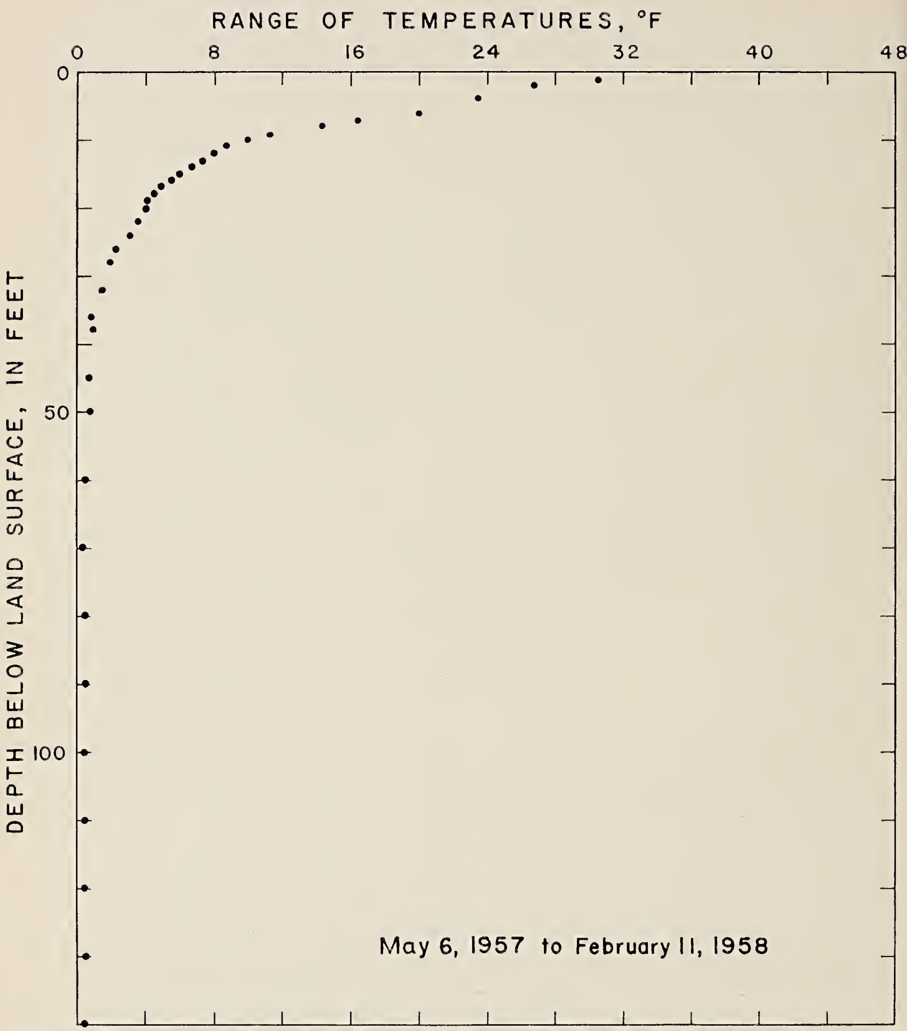

FIGURE 2. Maximum observed range of water temperatures in a well near Wild Rose, Wis.

Relation of the Observed Temperatures to Aquifer Temperatures

The relation of the observed temperature of water in the well to the temperature of ground water in the aquifer may be derived from the following argument. First, consider the effect of water flowing through a well cased in unsaturated rock. Boldizsar (1958) has shown that for large flows of water, heat is exchanged between the water in the well and the rock penetrated by the well if a temperature difference exists, and usually the rock becomes warmer.

He points out that for small flows, from depths of less than 100 meters, the exchange of heat is negligible, and the temperature of the rock does not change. Therefore, at the well near Wild Rose, the temperature of the rock of the ground-water reservoir probably would not be measurably affected by the heat in the small volume of water flowing through the well.

Next, consider the effect of the heat in the water flowing through a well cased in a ground-water reservoir. For large flows, heat will be exchanged if a temperature difference exists between the aquifer and the water in the well. The warming or cooling of the aquifer will be less than if the rock were unsaturated, because more heat is required to warm saturated rock than is required to warm unsaturated rock, and some of the heat is carried away by the ground water moving past the well. Obviously, as the flow of water in the well approach zero, the exchange of heat between the well and the ground-water reservoir becomes more complete, and the difference in temperature between the water in the well and th ground-water reservoir approaches zero. Therefore, the temperature in the subject well and the temperature of the ground-water reservoir should be nearly identical, because the water in the well is flowing very slowly to the surface.

From the preceding discussion a condition of zero flow would appear to be ideal. This, however, is not always true, because other factors operate to disturb the temperature in a nonflowing well. These factors include convection within the well (Van der Merme, 1951), circulation from one part of the aquifer to another or from one aquifer to another through the well (Foley and others, 1953, p. 75), and external sources of heat.

External sources of heat are those that affect the water in the well but not those in the aquifer. In Wisconsin common external sources of heat are solar radiation and heated pump houses. Convection of air within the well causes warm or cold air to be brought in contact with the water, and as a result the temperature of the water standing in the well is not necessarily representative of the temperature of the water in the aquifer. During periods when the ground was frozen, the temperatures observed in the subject well were probably somewhat higher than those near the top of the aquifer.

The effect of the casing upon water temperature in a well may be significant also. For example, steel casing is an excellent conductor of heat so that the transfer of heat between the well and the atmosphere, or between the water in the well and the aquifer immediately outside the well, may be facilitated.

SIGNIFICANCE OF THE OBSERVED TEMPERATURES

If the observed temperatures (fig. 1) are representative of the aquifer, they are significant. They show the distribution of temperatures in the aquifer with depth and time, and the movement of heat in the aquifer can be inferred. In the following discussion, the observed temperatures are assumed to be representative of the aquifer at the site of the well, so that the fact that the temperatures were measured in a well becomes immaterial to the argument.

Seasonal fluctuations. The temperature of the ground water at shallow depths responded to seasonal changes in air temperature. Similar responses in earth or soil temperatures to depths of as much as 100 feet have been observed and reported by many investigators (Carslaw and Jaeger, 1947, p. 62). The effect of seasonal air temperature of the ground water is reflected in the data of figure 1. As the air temperature changed, the temperature of ground water to a depth of about 60 feet changed with a lag in time. The temperature fluctuations of ground-water decreased with depth (fig. 2), and the time required for the air temperature to affect the ground-water temperature increased with depth (fig. 3). Thus, the maxi-

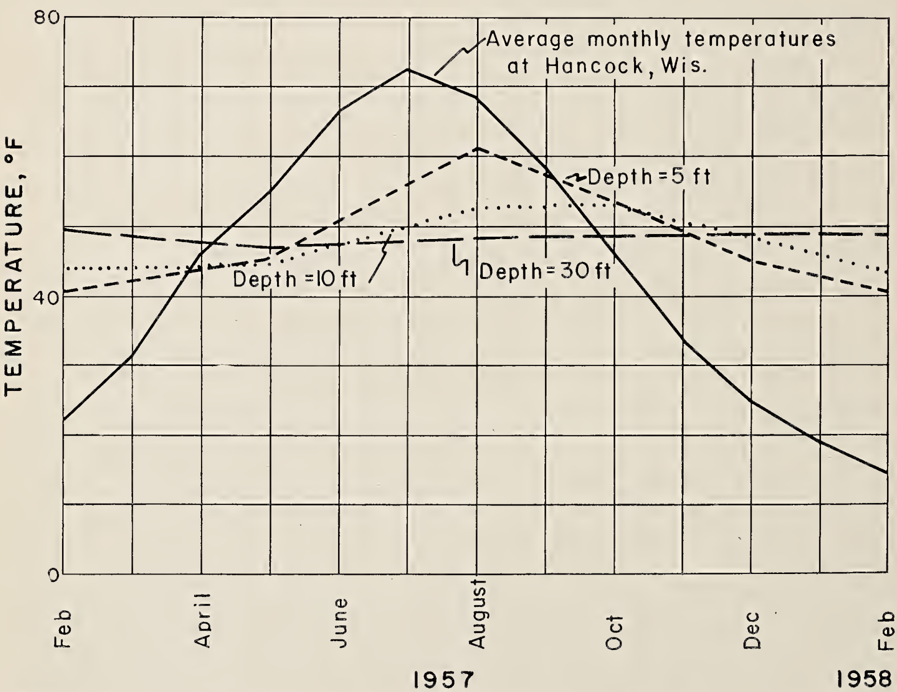

FIGURE 3. Average monthly air temperature at Hancock, Wis., and water temperatures at depths of 5, 10, and 30 feet in a well near Wild Rose, Wis.

mum temperature difference below 36 feet is less than 1°F, and the water temperature reaches a maximum after air temperature.

Temperatures below 60 feet. Below a depth of about 60 feet, the water temperature increased gradually with depth (fig. 1). From 60 to 140 feet, the average rate of increase is about 0.9°F per 100 feet. In addition to the observations in the subject well, temperatures were measured in four other wells in central Wisconsin. In these wells, which ranged in depth from 184 to 349 feet, the temperature increase with depth below 60 feet was less than 1°F per 100 feet.

Movement of heat in the ground-water reservoir. Heat moves through the ground-water reservoir by conduction and convection (R. W. Stallman, written communication, January 1960). The movement of heat by conduction is governed by the thermal conductivity of the media (k) and the temperature gradient (T/Z). The movement is along a path of diminishing temperature and is expressed quantitatively by the expression $Q = KT/Z$, where (Q) is the heat flux through a unit area in unit time (Chang, 1958, p. 28). The movement of heat by convection is controlled by the properties of the water—specific heat, density, temperature, and velocity (R. W. Stallman, written communication, January 1960, p. 7). In general, the lateral movement of heat in an aquifer is by convection, whereas the vertical movement of heat is by conduction. The data shown on figure 1 are sufficient to determine a thermal gradient (T/Z) and, therefore, to show whether heat is being conducted upward or downward and to measure relative differences in the amount of heat moving through a vertical column of rock in the area. Two generalizations about the conduction of heat may be made immediately from inspection. First, heat is moving steadily through the aquifer from below; and, second, heat moves into and from the aquifer seasonally.[4]

Heat moves laterally by convection, and, although measurements were made in only one well, the effect of convection also can be inferred from the observed temperature gradients. Earth temperatures usually increase steadily with depth below the zone of seasonal variation, because heat is flowing to the surface from the interior of the earth (Evans and others, 1942, p. 268–269). The average increase in temperature below a depth of 100 feet at eight sites in Michigan, Illinois, and Iowa is about 1.3°F per 100 feet (Spicer, 1942, p. 280–282). The temperature gradient in a well drilled more than 300 feet into crystalline rock of Precambrian age near Sextonville, Wis., about 80 miles southwest of Wild Rose,

[4] The exchange of heat between the well and the aquifer is negligible and is not considered here.

is 1.1°F per 100 feet. Therefore, the temperature gradient in the granite of the Wild Rose area also might be about 1.1°F per 100 feet. At the subject site, the average observed temperature gradient for the interval between 60 and 140 feet is about 0.9°F per 100 feet. Inasmuch as the thermal conductivity of granitic rocks is usually greater than the thermal conductivity of saturated sand and clay (Birch, 1942, p. 251–252 and 259; Ingersoll and others, 1948, p. 244; Chang, 1958, p. 30–32), and the temperature gradient in the granite is greater than that measured in the subject well, more heat is moving through the granite than is being conducted through the ground-water reservoir. Convection of heat can account for this difference. As the water moves through the aquifer, some of the heat received from the granite is convected by the moving ground water and is released from the aquifer, as the ground water is discharged.

In addition to the heat moving upward through the ground-water reservoir from below, heat is added from above to the ground-water reservoir in the summer and removed in the winter due to variations in solar radiation.[5] Thus, on February 11, 1958, the temperature [of ground water in the subject well] increased with depth from the surface to 30 feet (fig. 1), indicating that in this zone heat was moving toward the surface. Between 30 and 50 feet the temperature decreased slightly, showing that heat was moving downward. Heat from a depth of 30 feet was either being conducted upward to be radiated at the surface or was being conducted downward to warm the water in the interval between 30 and 50 feet.

By a similar analysis, the data of May 6, 1957, show that although heat was flowing into the aquifer from the land surface and warming of the water had begun, not enough heat had moved into the aquifer to warm the water below a depth of 8 feet. Warming of the water continued as heat flowed downward from the surface, and by August 6, 1957, all the water to a depth of 60 feet had received some heat. By October 18, 1957, heat had ceased to flow into the aquifer from the surface, and the water in the top 10 feet had begun to cool. However, the water between 30 and 40 feet was still receiving heat. On November 29, 1957, heat was flowing toward the surface from a depth of about 18 feet, and the water in this interval was cooling. The water between 18 and 35 feet was still receiving heat.

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[5] On a smaller scale, heat is added to and taken from the soil as a result of diurnal and day-to-day air-temperature variations (Langbein, 1949, p. 543). Each of the curves of figure 1 have the effect of small short-term air-temperature variations "built in". This effect is most obvious in the curves of August 6, and October 18, 1957. In the following discussion, the effect of these short-term variations have been disregarded.

Conclusions

Several generalizations have been drawn from the data obtained: (1) The temperature measured in the well closely approximates the actual temperature of the water at various depths in the aquifer; (2) in the Wild Rose area, Wisconsin, the temperature of water in the zone of saturation increases about 0.9°F per 100 feet below a depth of 60 feet, and, therefore, heat is flowing upward through the ground-water reservoir from a greater depth; (3) some of the heat that moves through the aquifer is released at the land surface as latent heat in discharging ground water; (4) water in the interval from a depth of 60 feet to the surface is subject to seasonal temperature fluctuations that are related to seasonal variation in air temperature.

If these generalizations are valid, then the temperature of ground water in the Wild Rose area is due primarily to two factors (1) the temperature of the water as it recharges the aquifer and (2) the change in temperature due to the gain or loss of heat as the water moves through the aquifer. The amount of heat gained or lost by the water (hence, the temperature of the ground water) is dependent upon the length of time the water is in the aquifer and the path the water takes as it passes through the zone of saturation from the point of recharge to the point of discharge.

Temperature relations similar to those described for the Wild Rose area probably occur in other areas where the hydrologic conditions are similar.

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NITIDULIDAE COLLECTED FROM BANANA BAIT TRAPS IN WISCONSIN[1]

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During the summer of 1954 a series of four bait traps were placed in three locations in Wisconsin to study the occurrence and seasonal incidence of Nitidulidae associated with the mycelial mats of the oak wilt fungus *(Ceratocystis fagacearum* (Bretz) Hunt). Preliminary work had shown that many of these species associated with the fungus were also found in banana bait traps.

Each trap consisted of: a tin can 5 inches high by 4 inches in diameter; a cylinder of 4-mesh screen, 7 inches high and slightly less than 4 inches in diameter, closed at one end by screen; a metal cone; soil; leaves; and one half of a banana. The can was placed to its own depth in soil and filled approximately 7/8 full with soil. The soil was covered with a small layer of leaves and the half banana was squashed down on top of the leaves. The screen cylinder, which prevented rodents from removing the bait, was fitted just inside the top of the can and finally the cone was placed on top of the screen.

At the time of each collection the remains of the banana, the leaves and about one quarter of the soil were transferred to pint bottles and examined in the laboratory. The remainder of the soil was examined in the field and returned to the traps before replenishing them with fresh soil, leaves and banana.

Four traps were placed in each of three locations, namely: on the University of Wisconsin Campus in Dane County, near Griffith State Nursery in Wood County, and in Rib Mountain State Park in Marathon County. The traps were set out in late April or early May and were examined at weekly intervals thereafter until early November.

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Many insects, including several families of Diptera, Staphylinidae, Histeridae, Scarabaeidae and Nitidulidae were taken in the traps. Records were kept of the Nitidulids collected. Those species that were known to the authors were recorded and discarded at the time of examination. Unknown species were pinned and coded for later identification. When the numbers of a species taken were so great as to make pinning impractical, a small series of ten to twenty specimens was prepared. If a coded series contained more than one species when identified, as was often the case, particularly with the genus *Epuraea,* the ratio obtained from the prepared specimens was applied to the whole series.

The seasonal abundance of the fourteen most common species is indicated in the graphs in Figures 1 and 2. The graphs represent the totals for all twelve traps. For certain species there were considerable differences between the three locations in the numbers collected. These differences are indicated in Table 1 which also lists those species taken in small numbers.

The graphs indicate peaks of abundance which presumably are associated with the life history of the insects and represent the period of the adult stage. Many of the species exhibited a relatively high population in May and another in September or October. These species probably overwinter as adults. *Epuraea* and *Stelidota* spp. appeared later in the year, late May or June, *(E. alternata* in July) and again in August, although *S. geminata* was relatively common in late September. There was no indication of a second peak for *S. strigosa. C. adustus* exhibited two peaks, one in late June and early July and the other in late September. *Glischrochilus* spp. tended to show a third period of abundance in midsummer, indicating, perhaps, two generations.

Different environmental conditions possibly explain the differences in the numbers of individual species collected in the three locations. If this is so, it points out differences in closely related species. For example, the largest numbers of *Stelidota strigosa, S. geminata,* and *S. octomaculata* were taken in Wood, Dane, and Marathon Counties, respectively. A similar situation occurred in respect to the three common species of *Glischrochilus.*

In conclusion, the authors wish to draw attention to the fact that, although the collections described here indicate certain trends, the causes of the differences are not known, nor is the reliability of the trapping method as an indicator of absolute populations known. The response of insects to an attractant may be influenced by other materials in the neighborhood. For example, although no specimens of *Colopterus truncatus* were taken in the traps between the first week of June and the first week of September in Wood

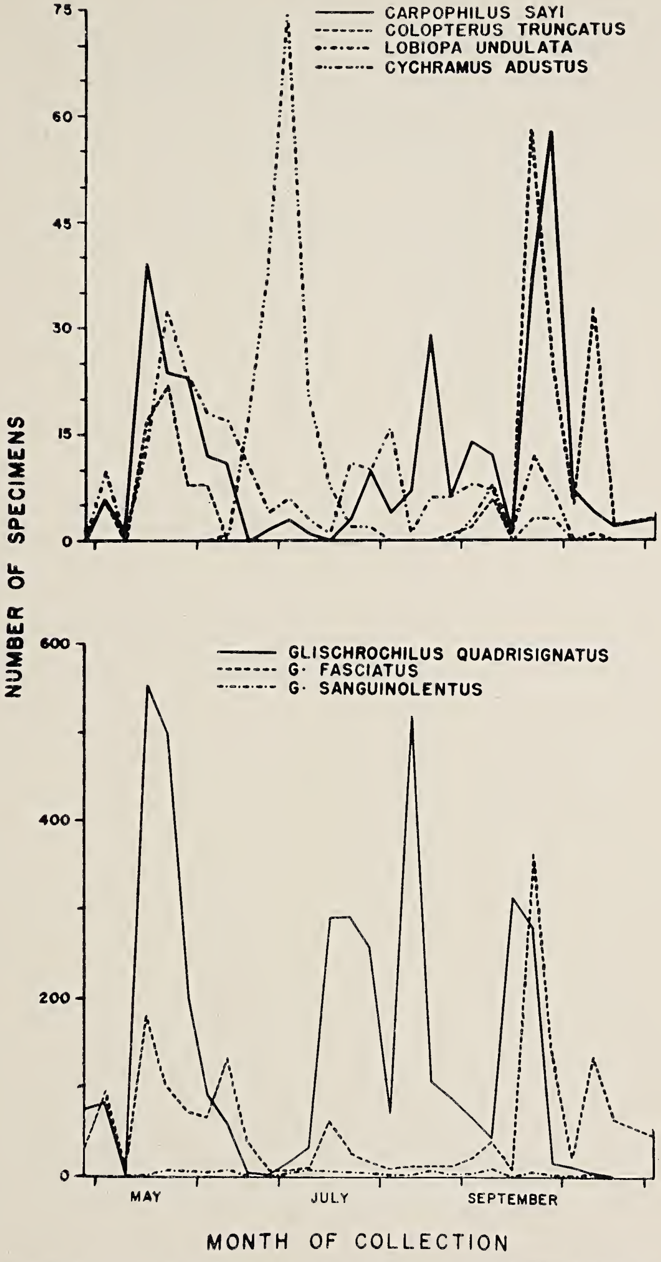

FIGURE 1. Seasonal trends in population of Nitidulidae as determined by collections from banana bait traps.

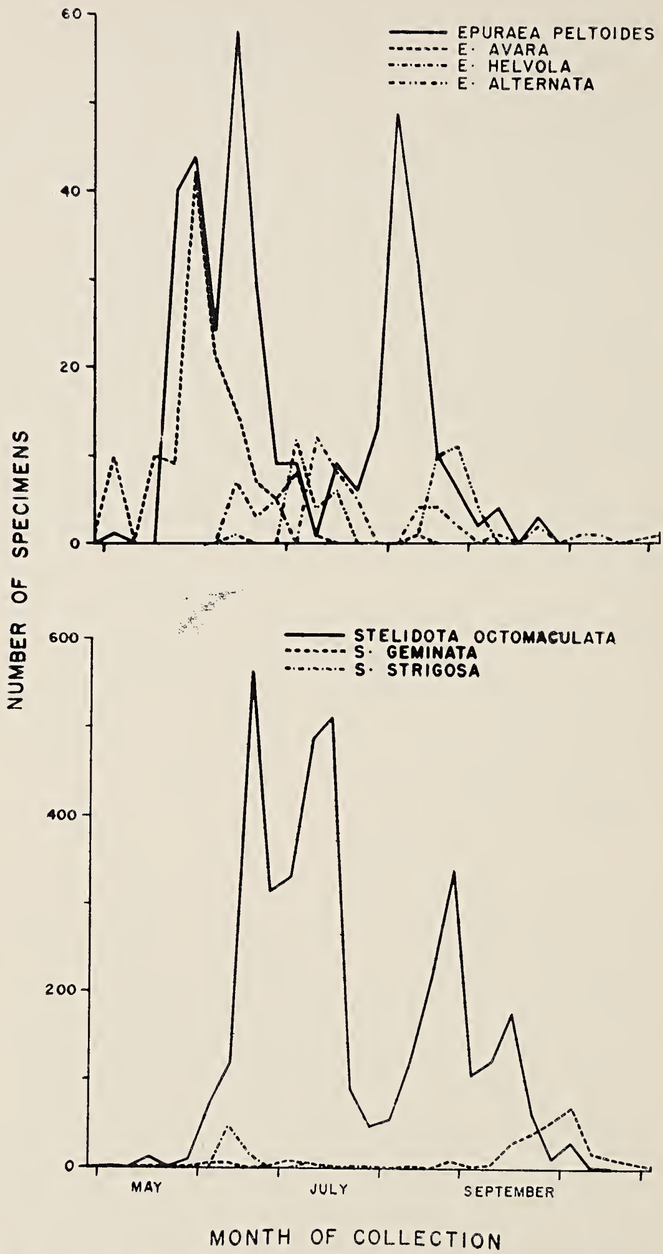

FIGURE 2. Seasonal trends in population of Nitidulidae as determined by collections from banana bait traps.

County, they were found nearby in relatively large numbers in hatchet wounds on *Quercus ellipsoidalis* Hill throughout June and July (McMullen *et al,* 1960). However, the work does show that adults of many species are abundant in May and June and again in September, the time of year at which mycelial mats of the oak wilt fungus are most abundant in Wisconsin.

TABLE 1. LIST OF NITIDULIDAE COLLECTED IN BANANA BAIT TRAPS WITH NUMBERS TAKEN AT THREE LOCATIONS, WISCONSIN, 1954

Species	County		
	Dane	Wood	Marathon
Colopterus truncatus (Rand.)	15	171	14
C. maculatus (Erichs.)	0	5	0
Carpophilus hemipterus (Linn.)	14	1	0
C. sayi Parsons	229	18	45
Epuraea helvola Erichs.	3	41	12
E. rufa (Say)	10	0	0
E. corticina Reitter	0	0	2
E. avara (Rand.)	0	65	67
E. peltoides Horn	7	304	51
E. labilis Erichs.	0	2	0
E. alternata Parsons	47	0	2
E. planulata Erichs.	0	1	0
Stelidota strigosa (Gyll.)	0	73	3
S. geminata (Say)	271	1	0
S. octomaculata (Say)	5	25	3816
Omosita colon (Linn.)	16	12	0
Lobiopa undulata (Say)	79	127	5
Phenolia grossa (Fab.)	0	0	6
Cychramus adustus Erichs.	2	43	152
Oxycnemus histrina (Lec.)	0	7	1
Cryptarcha ampla Erichs.	6	16	4
C. concinna Melsh.	0	5	0
Glischrochilus obtusus (Say)	0	2	0
G. sanguinolentus (Oliv.)	0	33	57
G. fasciatus (Oliv.)	185	332	1286
G. quadrisignatus (Say)	3320	115	393
Totals	4209	1399	5917

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FADING FINS*

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Beneath the surface of the gray-yellow water flowing past the homes and factories of Everywhere, U.S.A., gyrates a phantom of Death. The principal character of this danse macabre flips to one side, then to the other, twists in futile loops and wrenches in jerks. Splayed fins extend awkwardly and stiffly from its sides. Its white belly arches agonizingly, curving and recurving. A hot noonday sun can scarcely illuminate the floor of this murky arena. Here the fish struggles from corner to corner. Warm sticky tongues of silt grasp at his fins, clays entwine themselves about his lips and gills, and organic wastes enfeeble his heart and disorient muscles and nerves. Wildly our dancer lunges to escape from the altar but the river gathers the sacrifice in her lap and carries it away. The last of his kind, *Piscis perdidus* is lost forever, a statistic in the logbook of time.

This drama is nothing new. Yearly it is being enacted from one end of our country to the other. If man's hand has fallen heavily upon the face of the land, even more devastating is his impact on our waters. Man often cannot evaluate this change with eye, nose, or ear. He must rely upon laboratory refinements to make such measurements. Changes, however, have occurred—enough to strike off species after species. Ranges have shrunk in many instances to individual streams, frequently widely separated by hundreds of miles from the next body of water harboring another remnant of the same form.

Nor is this entirely a mystery. Fish biologists are quite aware of the fact that the distribution of our fishes varies yearly, that species which are taken in a particular water today may diminish in number or disappear before the same time next year. In every state the number of species apparently is on the decline. Still state lists include fish which have not been collected since the turn of the century. Why? First, extensive collections were seldom made, and even today little collecting is done. Many important streams and lakes have not been sampled at all because of lack of equipment, money and personnel. Ignorance clouds our knowledge. Moreover there is but rarely an attempt anywhere to assess, synthesize, evaluate and study critically fish species other than those which are

* I wish to thank my colleagues Profs. J. W. Barnes and R. E. Simpson, and Prof. Milton Trautman of Ohio State University for their suggestions and critical reading of the manuscript.

of sporting or commercial value, or which, due to parasitic or competitive habits, interfere with the well-being of those fish man considers of value. For instance, although 150 species exist within the state of Wisconsin, only two dozen appeal in some way to the tastes of fishermen and fisheries. Many of the forgotten are in serious trouble—some are hanging on the brink of extinction.

We must keep in mind that all species of fish were not found in unlimited numbers even under primeval conditions. Many species have held their existence by a thin thread, tolerated as neighbors by the common forms, but never allowed to burgeon. The subtle changes wrought by man have in a few cases provided a boon, and some dimly-regarded members have catapulted into respectable standing in the piscine community. More frequently the pendulum has swung the other way, with species being cut down one by one.

In my study of several Central Wisconsin rivers in recent years, I found no traces of at least seven species of fish which had been recovered in the very same waters three decades previously. Repeated careful samplings with improved techniques over those used by Greene thirty years before failed to "restore" these forms. Moreover, several species which I was able to report gained their inclusion on the presence list by a handful of individuals despite the fact that over 17,000 fish were captured and examined. The lawyer *(Lota maculosa)* appeared on the basis of one individual; the least darter *(Etheostoma microperca)*, on the basis of two individuals; the northern mimic shiner *(Notropis v. volucellus)*, seven individuals. It was significant that relatively few species made up the bulk of fish found within a given body of water. In the 1958 survey the ten most common species on each of the streams surveyed represented 80 to 90 percent of the total number of fish captured; the 43 remaining species comprised only 10 to 20 percent of the catch.

The following factors have had a profound impact on fish distribution over the nation: impoundments, canals, dredging operations, sewage and industrial wastes (e.g., coal mines, canneries, creameries, paper mills), irrigation, highway construction, insecticides, and agricultural practices under which can be enumerated grazing, siltation, deforestation, fertilizers. Frequently life-giving springs have gone dry and water tables have dropped. Many communities have felt the pinch when the well runs dry. The fish is among the first to perish with the impact of the drought.

Unfortunately the fish is a victim of his surroundings. Should conditions change within the stream, he either becomes accustomed to these changes or those mutants capable of enduring such changes assume the responsibility of perpetuating that species. If neither physiological ability nor genetic variability exist, he can move either downstream or upstream until he meets conditions which satisfy his needs. However, the answer isn't as simple as all this. Although fish can move freely, many species are shackled by rather narrow ecological requirements. Critical water temperatures, bottom siltation, turbidity, fish associates, vegetation, nature of the bottom, and rate of water flow are just some of the factors which must be met, not singly nor generally, but often in toto. A particular species like the pugnose shiner *(Notropis anogenus)* can't afford to move, let us say, either upstream or downstream because one, two, or more factors necessary for its continued existence cannot be met. Therefore the pugnose shiner, unable to stand up against a changing environment, has sacrificed range and number within the past quarter century. The spotty map of old collection records looks like a forgotten graveyard.

Dams of concrete and steel have provided an impasse for certain fish species. The river herring or "golden shad" *(Alosa chrysochloris)*, one of the most beautiful and lively fishes of the Mississippi basin, ran into trouble with the dam breeching the river at Keokuk, Iowa. Just after the structure was placed in 1913, enormous numbers of herring gathered below it with the approach of spawning. During the first few years after the construction of the dam, the herring in the upper part of the river rapidly declined in abundance until a relatively low point was reached. Evidence points to the fact that the dam was primarily responsible for this decrease. Also the American eel *(Anguilla rostrata)*, a highly prized delicacy in some parts of the country, is stopped in its upward migration from the sea by dams at Keokuk and other places and has virtually disappeared from Minnesota and Wisconsin waters. Aside from the fact that dams pose an obstacle to spawning migration, changes are wrought on the streambed and in rate of flow. These factors combined or singly have contributed to the decrease of the following species on the Ohio River: blue catfish *(Ictalurus furcatus)*, white bass *(Roccus chrysops)*, rock bass *(Amboplites rupestris)*, smallmouth bass *(Micropterus dolomieu)*, yellow walleye *(Stizostedion vitreum)*, and Ohio logperch *(Percina caprodes)*.

Turbidity reigns as the most influential reaper of all. Virtually all of man's activity converts crystal-clear waters to colloidal films of varying intensities. Milk pollution, lignin wastes, coal and iron ore wastes, raw sewage, errant topsoil, bovine hooves biting away at helpless river banks, all contribute to the load suspended in ocean-bound waters. The blue or Missouri sucker *(Cycleptus elongatus)*, esteemed by many as a valuable food fish, is rarely found in such highly turbid streams as the Missouri River and is more frequently taken in the clearer, cleaner sections of the Ohio and Mississippi Rivers. Even in these rivers it has decreased to only a fraction of its former numbers, is considered very rare in Minnesota and Wisconsin waters of the Mississippi and in precarious numbers for that section of the Mississippi bounding the states of Illinois and Iowa. Sharp reductions in abundance in the Illinois River and in the Ohio further suggest its intolerance to turbidity and other pollutants.

Unfortunately many species of fish which are wedded ecologically to large bodies of water tolerate turbidity with difficulty. An important corollary declares: the larger the stream, the greater the turbidity. The silver chub *(Hybopsis storeriana)* requires waters with plenty of fin room and waters that are clear. In Iowa it was found that the population diminishes after years when successive floods cause the water to remain turbid over considerable periods of time. A close relative, the gravel chub *(Hybopsis x-punctata)* which only recently gained specific status, is so intolerant of high turbidity, that it is fast disappearing over its rather restricted range in Central United States. Another species, the harelip sucker *(Lagochila lacera)* which ranged from Ohio to Arkansas to Georgia, has not been taken anywhere in the last 50 years and is believed extinct. It possessed a small, specialized mouth and closely-bound gill covers. This, coupled with conversion of the typical clear-water prairie stream type into muddy streams of the western-plains type probably caused its disappearance. The harelip must have been particularly susceptible to asphyxiation through impacting of colloidal clay about the gills.

No fish illustrates intolerance to turbidity better than the bigeye shiner *(Notropis boops)*, found in a narrow belt lying along the southern edge of the North Central States. This minnow originally was well distributed over the entire western half of the state of Ohio. As early as 1897 it had become uncommon in Central Ohio. The more than 2000 collections made since 1925 in Ohio show that between 1930–41 a relict population was still present in the Auglaize River, but that since 1941 none have been found there, or elsewhere, in Western Ohio. Today it remains only in a few tributaries of the Scioto River in a tiny area of southcentral Ohio. According to Trautman (1957) :

> The Bigeye was present in streams as long as these were essentially of the clear-water type, disappearing when the waters became silt-laden and the stream bottoms became covered with silt. As an example: In 1928, Morgan's Fork, in Pike County, contained a large population of Bigeye Shiners. One of its tributaries became turbid because of silt which entered from a newly made hill cornfield. Before the tributary became turbid it contained a large population of shiners; these disappeared as soon as the stream became turbid. A few years later erosion was stopped, after the cornfield had been allowed to revert to a brush field, whereupon the waters became clear, the gravel of the stream bottom became free of silt, and the Bigeye again became abundant."

No state in the country has had a more thorough evaluation of its fish life than has the state of Ohio. We know best the history of fish and fishing from the intensive yearly collections made in all corners of that state from 1920 to 1950. Collections prior to that time, although not extensive, have furnished a valuable springboard for comparison. Species incapable of withstanding turbidity and culled to extinction since the turn of the century are many. Between 1900 and 1930 the blackchin shiner *(Notropis heterodon)* was numerous in East, Middle, and West Harbors, at the mouth of the Portage River, about South and Middle Bass Islands and in some of the Portage Lakes. After 1930 the blackchin decreased rapidly in abundance. Since 1940 none have been taken in Ohio waters although many attempts were made to capture it. Trautman reports that it disappeared almost immediately when waters became turbid, the bottoms silt-covered, and the aquatic vegetation vanished. Other extinct species and possible dates of their extinction are: gilt darter *(Percina evides)* and Western silvery minnow *(Hybognathus nuchalis)*, before 1900; pugnose shiner *(Notropis anogenus)*, 1931; crystal darter *(Ammocrypta asprella)*, 1925.

Turbidity and siltation are blamed for the decrease of a large percentage of the 160 species and 12 subspecies of fishes in Ohio and a listing of these reads like the "Who's Who in Ohio Fishes". Some of the families represented in this decrease in abundance and distribution are: fresh-water lamprey, paddlefish, sturgeon, gar, bowfin, mooneye, herring, whitefish, trout, sucker, minnow, North American catfish, mudminnow, pike, eel, killifish, pirate-perch, perch, darter, sunfish and silverside. This leaves a weak minority of families whose members have retained the status quo or increased in abundance.

This does not mean that the families listed above are entirely decimated, nor that there was no increase in certain species of these families. The carp *(Cyprinus carpio)*, a minnow, has proved that it can establish itself under a wide variety of conditions. No species of fish in the past century can match its extension in range and numbers. The fathead minnow *(Pimephales promelas)* and suckermouth minnow *(Phenacobius mirabilis)* have filled the niches vacated by the withdrawal of other minnow species. Amazing hordes of sea lamprey *(Petromyzon marinus)*, alewife *(Pomolobus pseudoharengus)*, and smelt *(Osmerus mordax)* have moved into waters of the Great Lakes. Extensions of range and abundance in Ohio are demonstrated by the goldeneye *(Hiodon alosoides)*, the black bullhead *(Ameiurus melas)*, white crappie *(Pomoxis nigromaculatus)*, warmouth *(Chaenobryttus gulosus)*, green sunfish *(Lepomis cyanellus)*, and orangespotted sunfish *(Lepomis humilis)*.

Some of these fill a welcome spot in a fisherman's minnow bucket and creel. Still, for every species showing an increase, at least five show a corresponding decrease.

Would the species composition have remained unchanged had man's destiny kept him from this continent? The answer, of course, is no. Change inevitably takes place under the press of natural phenomena. There are the cyclic weather patterns measured in centuries and millenia, the successful hatches of predatory or competitive species, the evolution of new species due to isolation. It may well have been that the pugnose shiner was going to extinction before man tampered with land and water. Now, however, it will take only a nudge or two to push it over the brink. The harelip sucker was never abundant anywhere and as pointed out above may now in all probability be extinct. The pallid sturgeon *(Scaphirhynchus album)* has had such a tenuous history that practically nothing is known about its habits. Rarely has one been found containing visible eggs. Here is a species which has persisted at extremely low levels for as long as man has known it.

Another species which apparently is on its way out due to factors beyond man's control is the redside dace *(Clinostomus elongatus)*. Populations have persisted in isolated, widely separated streams. It has disappeared from Iowa waters and is exceedingly rare in the extreme southeastern corner of Michigan's southern peninsula and in the southeastern part of Minnesota. In Ohio many redside populations decreased drastically in abundance with wastes from coal mines and heavy siltation. In Wisconsin hybridization has been found between this species, the abundant northern creek chub *(Semotilus atromaculatus)* and the northern common shiner *(Notropis cornutus frontalis)*. Hybridization, it is felt, often results when a species is in trouble and is a last-ditch mechanism for perpetuation of that species. I have noted one instance in a Central Wisconsin stream where the redside has been able to endure heavy siltation. Such evolution of a strain resistant to previously unfavorable conditions may assist in the continuance of this species in certain areas.

During the past summer I made several trips within the state of Wisconsin with the express purpose of capturing the finescale dace *(Chrosomus neogaeus)*, a beautiful golden-bronze minnow found only in the uppermost reaches of quiet, bog streams. In one trip after the other in streams where it had been taken only a quarter century ago we drew a blank—*with one exception!* After three hours of intensive shocking in the headwaters of the Tomorrow River, we finally captured a single individual. The prize was hard-won and greatly appreciated. It brings the number of individuals in our school collection to a grand total of five. There are streams in the state, I'm sure, where more could be found. But the fact remains that no published data less than thirty years old is available and financial assistance to workers for current studies is scarce. Emphasis has been placed too strongly on those fish of sporting and commercial interest and it is difficult to bend thinking in another direction.

Lists of priorities in many conservation departments do not include surveys embracing all the fishes found within their boundaries. Such surveys, if done at all, are frequently the work of one or two individuals who devote time and energy in a labor of love. Due to lack of personnel and funds, the coverage has often been scanty.

The blame should not be directed against the fish biologist and his superiors alone since they are responsive to the plaintive wails of the taxed public. One would expect that the academic ichthyologist, freed from the same squeeze, would even out the balance. But here too the survey type of research appears to have fallen into disrepute. Noses among the piscine hierarchy are thumbed at collecting studies since it is felt that anyone, even the man-with-the-shovel, can do this "simple" kind of work. On the other hand they gloat over high-powered research techniques shrouded in statistics, refined laboratory equipment, unusual chemical compounds, off-beat fish with crooked spines and the effect of predation on such anomalies. Many ichthyologists condemn any research that smacks of immediate utility. "Science for science's sake" has been thrown around until many have lost sight of the fish for all the water.

I have no quarrel with this viewpoint. There is no question that such knowledge too is important, and each pearl, however unusual it may be, contributes to the necklace of integrated knowledge. At the same time the fact remains that basic life history material is utterly lacking for altogether too many species, that the salvation of many species is entirely dependent upon our knowledge of their spawning and mating requirements, that our knowledge of these requirements and of fish movements is sketchy to say the least. There is little doubt that the greatest overall contributions to our knowledge of life histories has come from the pens of survey men whose well-conceived, year-around collections of all species piece in what little we now know. We have barely scratched the surface. Some species have only recently acquired a name and already dangle on the thread of extinction. So reduced are they in numbers that a study in their behalf may well function in opposite fashion and rub out the last of their kind in the final effort to save.

The question arises: Who is to be blamed for this loss? Should condemnation fall upon the sewage system, outmoded and outdated before its time in the face of a mushrooming population? Should industry which feeds, clothes, and houses this population suffer ignominy because its effluent has changed the character of the fish and fishing downstream? Must the farmer grovel under the foot of society because, in his effort to earn a fair share, his cattle and agricultural practices changed the trout brook into a haven for suckers and chubs? Must the public service commission with its control over water rights be held responsible because it trades a trout stream for a dam in a destitute corner of the state which can then show more meat and butter on the tables, warm clothes on the backs of its men and women and better schools and homes for all?

Must the sportsmen's organizations, sacrificing time and money to erect fences and seal down banks with ripprap, deflectors and the like, endure censure because their interest channels in the salvation and perpetuation of only a special segment of fish life? Must we criticize the fish biologist who under the thumb of an expanding fishing fraternity struggles year after year to reduce mortality and produce more from a select list of fish? Should we complain about the conservation department that enters into a watershed purchase program so that good trout streams may still be with us for the next two centuries or more? Can we grumble at the pure scientist whose esoteric research today may be the atomic salvation of fish tomorrow? Should we condemn the trapper whose nets and traps provide millions of minnows for fishermen's buckets? Should we condemn the fisherman for disseminating the seeds of competitive forms in new waters, for catching more than he can eat or give away, for returning stunted fish to waters already overpopulated, when this same fisherman spends millions of dollars yearly, dollars to be shared by many segments of our economy?

What complaints should we level against the manufacturers of fishing equipment, gadgets and lures which are sportier, catch more, catch bigger, make-it-easier? Must the conservation ethic perish in the welter of economic reasons without end? Is not the *raison d'etre* enough to justify at least a few fist-shakings and another few dollars to abet a program of salvation? Did we have to erect our mute monuments to the passenger pigeon after its death or could we have provided a living monument for eternity?

These questions, perplexing as they are, fall squarely on the shoulders of man in whose care rest the creatures of the world. The obligation, therefore, is everyone's, nor are we unaware of this. The last few whooping cranes winging between Arkansas, Texas, and Canada have received the love and attention which only a doting public can give. In Wisconsin thousands of dollars, contributed by foundations and private individuals, are being thrown into the purchase of marshes so that the remaining scatterings of prairie chickens may persist in perpetuity. Even the fading timber wolf has evoked at least lip service in his behalf. Are the paddlefish, pallid sturgeon, blue sucker, gravel chub, and silver shiner any less valuable than those? Need the appreciation of these forms rest with what we can see, smell, or taste? For it stands to reason that the great American public will seldom see a whooping crane, smell the scent tree of a wolf or taste the breast of a prairie chicken, but the knowledge of a wild animal still with us raises within our souls the primeval joy of survival against all odds. So too will we be richer in the knowledge that rare aquatic forms have been preserved in suitable waters as living models for coming generations.

Speckling the eastern states like errant ink spots are species like the Ohio spotted chub *(Hybopsis dissimilis)*, western tonguetied chub *(Parexoglossum laurae hubbsi)*, variegated darter *(Etheostoma variatum)*, spotted darter *(E. maculatum)*, bluebreast darter *(E. camurum)*, Tippecanoe darter *(E. tippecanoe)*. Though not rare, yet because of their very restricted ranges, these species share the threat of extinction. What preparations are we making for their preservation? Has a stream, out of the score or so in which it is still found, been set aside as a preserve for the Tippecanoe darter, even as we have set aside a remnant marsh in the state of Wisconsin, as a living laboratory for unborn generations of prairie chickens?

Recently one of my students showed me fish which he was clearing for skeletal staining. They were mostly minnows obtained from a local bait station. Near the top of the jar I spotted a redside dace, one of the rarest minnows in the state. We can only conjecture as to how many of these had been seined in the past, perished in minnow buckets or succumbed on a fisherman's hook. Could this single specimen have been the last of its kind from some unknown stream? We tried to get the necessary data on this unusual fish, a beautiful male with typical red slashes on the sides. We met with little success because the dealer feared that we and others would seine in the same stream, and, as he put it, "Minnows are hard to find in winter."

The upshot is that seining of all minnow species is permitted anywhere in all but trout waters, and even here they may be taken in glass and wire traps. Not a single regulation in the Wisconsin statutes provides for these failing forms. The redside dace, exploited to the end, appears to be doomed unless proper authorities and a sympathetic public can be brought into a compromising attitude. We are already too late to do much about some species. But with vigilance some rare forms may continue finning crystal waters under deep-rooted banks, tomorrow, next year, throughout this century and onward.

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ARTS AND LETTERS

HAWTHORNE'S LITERARY AND AESTHETIC DOCTRINES AS EMBODIED IN HIS TALES†

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In discussing Shelley (in "P's Correspondence," 1845) Hawthorne emphasized the importance of the genetic or chronological approach to an author's work. In viewing all Shelley's "successive productions," the reader should be conscious, Hawthorne says, that, seen as a whole "there is a harmony, an order, a regular procession. . . . They are like the successive steps of a staircase. . . as Shelley really climbed, as it seems he has, from a lower region to a loftier one," developing from the early "faults into which a too exclusive use of fancy and [a cold] intellect are wont to betray him" toward his later works which are "warmer with human love" (Standard Library Edition of Hawthorne's *Works*, 1883, II, 419–20. Unless otherwise noted, citations to follow are from this edition.) Following Hawthorne's own advocacy of the genetic approach, let us then try to summarize his own successive stories chronologically as they embody or relate to writers or artists.

Some of the more interesting particular ideas we should watch for are the following. Since in his third-person preface to "Rappacinni's Daughter" (1844) Hawthorne said "he seems to occupy an unfortunate position between the Transcendentalists (who, under one name or another have their share in all the current literature of the world) and the great body of pen-and-ink men who address the intellect and sympathies of the multitude,"* what was Hawthorne's position as regards Platonic archetypes or idealizations versus earthy imagery? Partly a moralist who also resented his era's obsession with utility as opposed to beauty, precisely what did beauty and the artist's concern with it mean to Hawthorne? Is aesthetics in the main subordinated to religion in the broad sense? If Hawthorne was intensely democratic and generally of the opinion that the individual's effort gains significance only when it is in accord with the "uninstructed multitude" and in sympathy with

† Grateful acknowledgement is made of the fact that I have been aided in getting this study into its present form by Miss Mary Pitlick, a Research Assistant employed for this purpose by the Graduate School of the University of Wisconsin.

* He goes on to say of himself, "If not too refined, at all events too remote, too shadowy, and unsubstantial in his modes of development to suit the taste of the latter class (the multitude), and yet too popular to satisfy the spiritual or metaphysical requisitions of the former (the transcendentalists), he must necessarily find himself without an audience, except here and there an individual" who, not repulsed by the lack of "human warmth" in allegory, can appreciate his "fancy and originality." (II, 107).

their welfare, how does he fit this over-arching view in with his frequent defence of the artist as a gifted individual out of accord with the utilitarian populace? He had an unusual fear of invading the privacy of others, yet how did he justify the artist's omniscient probing into the secret motives and thoughts of his individual subjects in his quest of "psychological romance"? Precisely what did Hawthorne have to say of the technical or pictorial questions of the craft of fiction, such as Poe concerned himself with, and precisely where did he stand on the much disputed question of the mechanical versus the organic? What is his view of imagination and its relation to a truthful view of realities, to what one might call kodak literalism? Let us now explicate his successive stories and sketches relevant to artists.

Hawthorne satirizes the poet in "The Canterbury Pilgrims" (1833) as "the chief spokesman"[1] of a small group seeking the "cold and passionless security" (N.P., p. 1203) of a celibate Shaker village in retreat from worldly disappointment. After the frustrated poet rails against an unappreciative public, Hawthorne comments, "During this harangue, the speaker gesticulated with great energy, and as poetry is the natural language of passion, there appeared reason to apprehend his final explosion into an ode extempore" (N.P., p. 1199).

In response to the young Shaker man who refers to the poet in utilitarian terms as a "varse-maker" (N.P., p. 1198), the poet explains the infusion of ideal insight into poetic form: " 'True, I am a verse-maker,' he resumed, 'but my verse is no more than the material body into which I breathe the celestial soul of thought' " (N.P., p. 1199).

As he abstracts himself after his harangue, the poet is inspired to creation by nature which inspires "reverie, which he called thought" (N.P., pp. 1199–1200). The poet in his harangue points out the opposition (satirized by Hawthorne) between an unappreciative society and himself as artist who confuses an escapist's reverie with thought:

> "Alas! how many a pang has it cost me, this same insensibility to the ethereal essence of poetry, with which you have here tortured me again, at the moment when I am to relinquish my profession forever! O Fate! why hast thou warred with Nature, turning all her higher and more perfect gifts to the ruin of me, their possessor? What is the voice of song, when the world lacks the ear of taste? How can I rejoice in my strength and delicacy of feeling, when they have but made great sorrows out of little ones? Have I dreaded scorn like death, and yearned for fame as

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[1] Nathaniel Hawthorne, *The Complete Novels and Selected Tales of Nathaniel Hawthorne*, ed. Norman Holmes Pearson (New York, 1937), p. 1198. Subsequent references to this text will be indicated by the initials N.P. Other text references are indicated by "H.H.," *The Complete Short Stories of Nathaniel Hawthorne* (Garden City, New York: Hanover House, 1959).

> others pant for vital air, only to find myself in a middle state between obscurity and infamy? But I have my revenge! I could have given existence to a thousand bright creations. I crush them into my heart, and there let them putrefy! I shake off the dust of my feet against my countrymen! But posterity, tracing my footsteps up this weary hill, will cry shame upon the unworthy age that drove one of the fathers of American song to end his days in a Shaker village!" (N.P., p. 1199).

The qualitative difference between the poet possessing imaginative insight and the common man without this gift is pointed up elsewhere in the story. For example, Hawthorne says, "The reader must understand that, for all these bitter words, he was a kind, gentle, harmless, poor fellow enough, whom Nature, tossing her ingredients together without looking at her recipe, had sent into the world with too much of one sort of brain, and hardly any of another" (N.P., p. 1199). Again, in commenting on the disillusioned, bankrupt merchant in the retreating group, Hawthorne refers to him as "one so different from the poet that the delicate fancy of the latter could hardly have conceived of him . . ." (N.P., p. 1200). While Hawthorne was elsewhere tender toward the artist victimized by society's indifference, this particular poet is satirized because of his attire, which showed "a peculiar sort of foppery, unworthy of a mature man," contrasted with the "plain good sense and unworldly feelings" (N.P., pp. 1198, 1202) of the people, especially the young Shaker couple, strengthened by mutual love, who are turning toward the world "to mingle in an untried life" (N.P., p. 1203).

"The Village Uncle" (1835) expresses the same Hawthornian preference for the humble reality of the folk artist-craftsman over the unreality resulting when "fancy [frequently referred to by Hawthorne as the creative imaginative faculty] can create so bright a dream of happiness . . ." (HH, p. 160). Like the preceding artist aroused to imaginative creativity by moonlight, the old man, who is the first-person narrator of "The Village Uncle," kindles his imagination with firelight: "And now, come, Susan, come my children, draw your chairs around me, all of you. There is a dimness over your figures! You sit quivering indistinctly with each motion of the blaze, which eddies about you like a flood, so that you all have the look of visions, or people that dwell only in the firelight, and will vanish from existence as completely as your own shadows when the flame shall sink among the embers" (HH., p. 154).

The narrator reminisces back to his bachelor days when he was an artist, a writer whom he pictures in his study as a "solitary figure in a looking-glass." Comparing the isolation of this life with his happy participation in family life, the narrator thinks, "Oh, I should be loath to lose my treasure of past happiness, and become once more what I was then; a hermit in the depths of my own mind; sometimes yawning over drowsy volumes, and anon a scribbler of wearier trash than what I read; a man who had wandered out of the real world and got into its shadow, where his troubles, joys, and vicissitudes were of such slight stuff that he hardly knew whether he lived, or only dreamed of living. Thank Heaven, I am an old man now, and have done with all such vanities" (H.H., p. 154).

Through the catalystic agency of his "frank, simple, kind-hearted, sensible, and mirthful" (H.H., p. 157) wife, the narrator rejected art for domestic bliss with Susan, for the humble community-service occupation of fisherman, and for the role of folk-artist or "spinner of long yarns" (H.H., p. 158). During his courtship of Susan, art to the narrator was not the shadowy world of the Platonic ideal but was associated with nature's myriad forms by the seashore where he saw Susan's "own slender beauty in so stern a scene . . . all combined into a strain of poetry" (H.H., p. 157). After his marriage, the literary tastes of the writer-turned-fisherman became anti-intellectual and almost primitive: "All that I heard of books was when an Indian history, or tale of shipwreck, was sold by a pedlar or wandering subscription man, to some one in the village, and read through its owner's nose to a slumberous auditory." When his children were growing up, he "feared to trust them even with the alphabet; it was the key to a fatal treasure" (H.H., pp. 157–158).

As the reminiscence continues, the narrator speaks tenderly of his present venerable position of folk artist, "the patriarch, the Uncle of the village." He is "a spinner of long yarns"

> . . . seated on the gunwale of a dory, or on the sunny side of a boat-house. . . . Such, Heaven be praised! is the vigor of my faculties, that many a forgotten usage, and traditions ancient in my youth, and early adventures of myself or others, hitherto effaced by things more recent, acquire new distinctness in my memory. I remember the happy days when the haddock were more numerous on all the fishing grounds than sculpins in the surf; when the deep-water cod swam close in shore, and the dog-fish, with his poisonous horn, had not learned to take the hook. I can number every equinoctial storm in which the sea has overwhelmed the street, flooded the cellars of the village, and hissed upon our kitchen hearth. I give the history of the great whale that was landed on Whale Beach, and whose jaws, being now my gateway, will last for ages after my coffin shall have passed beneath them.
>
> If melancholy accidents be the theme of conversation, I tell how a friend of mine was taken out of his boat by an enormous shark; and the sad, true tale of a young man on the eve of marriage, who had been nine days missing, when his drowned body floated into the very pathway, on Marblehead Neck, that had often led him to the dwelling of his bride,—as if the dripping corpse would have come where the mourner was. With such awful fidelity did that lover return to fulfil his vows! Another favorite story is of a crazy maiden who conversed with angels and had

> the gift of prophecy. . . . I speak of pilots who knew the wind by its scent and the wave by its taste, and could have steered blindfold to any port between Boston and Mount Desert, guided only by the rote of the shore,—the peculiar sound of the surf on each island, beach, and line of rocks, along the coast. Thus do I talk, and all my auditors grow wise while they deem it pastime (H.H., pp. 158–159).

The Village Uncle concludes his story with an Hawthornian moral which by implication appears to deprecate serious art because of its non-utilitarianism: "In chaste and warm affections, humble wishes, and honest toil for some useful end, there is health for the mind, and quiet for the heart, the prospect of a happy life, and the fairest hope of heaven" (H.H., p. 160).

In "Passages From a Relinquished Work" (1834) the first-person narrator of the story, who as a wandering story-teller is a folk-artist like the Village Uncle, illustrates the animosity even to folk-art of a puritan, utilitarian, New England culture, represented by Parson Thumpcushion. Abandoning his foster home and his guardian (Parson Thumpcushion) for his vagabond-folk-artist existence, the narrator says, ". . . my chief motives were, discontent with home and a bitter grudge against Parson Thumpcushion, who would rather have laid me in my father's tomb than seen me either a novelist or an actor, two characters which I thus hit upon a method of uniting. After all it was not half so foolish as if I had written romances instead of reciting them" (H.H., p. 414). Hawthorne emphasizes the "grossness" of the antipathy of New Englanders to non-utilitarian pursuits (H.H., pp. 413–414).

Even the story-teller seems partially imbued with this negative attitude toward his occupation, directing at himself humorous satire. He half-facetiously compares his obscure person with Goldsmith, Childe Harold, and Don Quixote; he remembers being made an "absurdity" by a practical joker (H.H., p. 420). However, the story-teller's attitude at the end is extreme enough, like the attitude of his countrymen, for the reader to consider his literary occupation as one of "guilt and madness" (H.H., p. 421), unless this, too, is tongue-in-cheek satire. That this story is autobiographically-directed satire is reinforced by the inclusion in the story-teller's repertoire of "Mr. Higginbotham's Catastrophe," another Hawthorne tale.

Although the emphasis of the story is on the cleavage between the artist and a practical society, there is one situation which explores rapport between the artist and society and by implication reveals Hawthorne's democratic egalitarianism. The story-teller speaks of the creation of his tales: "Besides the occasions when I sought a pecuniary reward, I was accustomed to exercise my narrative faculty wherever chance had collected a little audience idle enough to listen. These rehearsals were useful in testing the strong points of my stories; and, indeed, the flow of fancy soon came upon me so abundantly that its indulgence was its own reward, though the hope of praise also became a powerful incitement" (H.H., p. 414).

"The Devil in Manuscript" (1835) is significant in having the narrator agree with Oberon in his aversion to the kind of topic or framework Hawthorne was to deal with in stories of witchcraft such as "Young Goodman Brown." Oberon finally burns the manuscript of all his rejected stories in which, he says, " '. . . I endeavored to embody the character of a fiend as represented in our traditions and written records of witchcraft. Oh, I have a horror of what was created in my own brain, and shudder at the manuscripts in which I gave that dark idea a sort of material existence!' " (III, 575). Oberon admits, " 'I am surrounding myself with shadows, which bewilder me, by aping the realities of life. They have drawn me aside from the beaten path of the world." (p. 576). As an author, Oberon has "recollections" of his throes of creativity—of how he used various scenes and dreams, and became " 'feverish, the victim of my own enchantments . . . !' but he concludes that the different moods in which he created the tales resulted in no 'corresponding difference' in the 'worthless' finished product. (pp. 578–579.

Another theme in this story (which accords with Hawthorne's view in the preface of the 1851 edition of *Twice-Told Tales)* is that of the indifference of the American reading public to authors and to literature. Seventeen booksellers had rejected Oberon's manuscripts and he wants to escape being a "damned author," to avoid having " 'to undergo sneers, taunts, abuse, and cold neglect, and faint praise, bestowed for pity's sake, against the giver's conscience!' " (p. 580). In contrast to this "cold neglect," the author cries, "my brain has set the town on fire," as he burns his manuscripts in a windstorm.

The painter in "The Prophetic Pictures"[2] *(Token,* 1837) illustrates how the true artist " 'must look beneath the exterior" ' to " 'see the inmost soul' " of his subjects.[3] However, the story is essentially a warning against the artist who allows himself in his *pride* to be "insulated from the mass of human kind" and to have "no sympathies" beyond his art (AWS, pp. 259–260). In this story, the "proud" painter "failed to see the disorder" of his own character; and in painting the portraits of Walter and Elinor, a young couple about to be married, portraits which prophesied that Walter as a

[2] Hawthorne, *Works* I, Lathrop Edition, 192. "This story was suggested by an anecdote of Stuart, related in Dunlap's *History of the Arts of Design*—a most entertaining book to the general reader, and a deeply interesting one, we should think, to the artist."

[3] Hawthorne in the American Writers Series, p. 257, hereafter referred to as AWS.

husband would become dangerously insane, the proud painter regarded Walter and Elinor virtually "as creations of his own," rivaling the work of the Creator. Eventually, repenting of his pride in his prophetic art, the painter returns just in time to prevent the husband from stabbing his sorrowful wife, a rescue which shows that a prophetic "Fate [can] impede its own decree" (AWS, p. 262), that the artist *has* a free-willed responsibility.

In "The Great Carbuncle" (1837), as in other tales and stories, Hawthorne criticizes the serious artist for his obsession with fame. Here, a poet and five other self-centered people are goaded by "selfish and solitary longing for this wondrous gem" (N.P., p. 927), the Great Carbuncle. Hawthorne laughs at this artist just as much as at Oberon in "The Devil in Manuscript": "The fifth adventurer likewise lacked a name, which was the greater pity, as he appeared to be a poet. He was a bright-eyed man, but woefully pined away, which was no more than natural, if, as some people affirmed, his ordinary diet was fog, morning mist, and a slice of the densest cloud within his reach, sauced with moonshine, whenever he could get it. Certain it is, that the poetry which flowed from him had a smack of all these dainties" (N.P., p. 928). Here, the moonlight used elsewhere as the atmosphere for serious artistic creation is used for satiric purposes.

The poet's egocentricity makes him vulnerable to the thrust of Hawthorne's satire, as in the following passage where the Great Carbuncle facetiously represents the world of ideality which the serious artist perceives through his imagination:

> "For myself, hiding the jewel under my cloak, I shall hie me back to my attic chamber, in one of the darksome alleys of London. There, night and day, will I gaze upon it; my soul shall drink its radiance; it shall be diffused throughout my intellectual powers, and gleam brightly in every line of poesy that I indite. Thus, long ages after I am gone, the splendor of the Great Carbuncle will blaze around my name!"
>
> "Well said, Master Poet!" cried he of the spectacles. "Hide it under thy cloak, sayest thou? Why, it will gleam through the holes, and make thee look like a jack-o'-lantern!" (N.P., p. 931).

But the poet settles willingly for a substitute, "a great piece of ice." And Hawthorne chuckles: "The critics say, that, if his poetry lacked the splendor of the gem, it retained all the coldness of the ice" (N.P., p. 936). Selfishness, then, is incompatible with serious artistic creation. And Hawthorne's sympathies lie again with the simple, the young couple Hannah and Matthew, who find the gem but have the wisdom to reject it and return to the humble cottage which they had hoped to light with the gleam from the Great Carbuncle.

In "Edward Randolph's Portrait" *(Democratic Review,* 1838) Hawthorne returned to vary the theme of "The Prophetic Pictures," suggesting that when the artist's slanting (in this case adaptation) is done in a defensible cause (in this case to try to dissuade a political tyrant from a sin against colonial liberties), then the artist's slanting is justifiable. Alice Vane, the "favorite niece" of Lieutenant-Governor Hutchinson who has to decide whether to quarter a British fleet at Boston's Castle William, uses her artistry gained by study in Italy, to alter the fading portrait of Edward Randolph so as to make it symbolic of the agony of an earlier colonial ruler who opposed liberty and therefore "the inward misery of that curse worked itself outward, and was visible on the wretched man's countenance, making it too horrible to be looked upon." (N.P., p. 966) As Alice says to her uncle about to profane American liberties, ". . . if ever mortal man received a warning from a tormented soul, your Honor is that man." (p. 969) Hutchinson was not deterred by the portentous portrait, however, and years later when he died, he resembled Randolph.

"Sylph Etherege" *(Token,* 1838) belongs to the group of stories involving beauty and art because of the fact that the story hinges upon the role of a "miniature" picture purportedly of Sylph's betrothed, Edgar Vaughan, whom she had never seen, a picture which nourishes her romantic wishful thinking. Actually, the picture is a fabricated one, given her by Edgar, posing as Edward Hamilton, Edgar being actually of "ill-omened shape," "the reverse of attractive," (III, 511) and motivated by "wounded vanity" (p. 515) and "mockery and malice." Hamilton, with his "evil smile," appears and tells the romantic Sylph he is Vaughan. When she dropped the misleading miniature he "set his foot upon it, and crushed the ivory counterfeit to fragments." " 'There, my sweet Sylph,' he exclaimed. 'It was I that created your phantom-lover, and now I annihilate him! Your dream is rudely broken. Awake, Sylph Etherege, awake to truth!' " Such was his unfeeling way of "curing Sylvia of romantic notions, and reconciling her to truths and realities of life." (p. 515) Although her patroness, Mrs. Grosvenor, thinks that if Vaughan succeeds in winning her love, "she will be the better, her whole life long, for the lesson we have given her," the "fragile Sylph," made vulnerable by her imagination unbalanced by understanding or the acceptance of the fact that "the beauty of the pictured countenance was almost too perfect to represent a human creature, that had been born of a fallen and world-worn race," (p. 512) dies, seeming to "fade into the moonlight." The story may be briefly summarized as meaning that, while a person such as Sylph may need curing of the "fantastic nonsense" (p. 508) of mistaking the "fanciful" for the imperfections of the real and the true, of mistaking illusions for reality, if the cure is motivated by "wounded vanity" or other evil impulses (the union of the young people had in this case been greedily arranged as a means of "uniting two rich estates") (p. 509) and the transition is too abrupt, it may cause death. Quick disillusionment kills, and "counterfeit" art is thus very dangerous. The broad implications of this story are especially interesting, considering that Hawthorne has often been regarded as the crusader for romance and the idealizing function of the imagination. Misled by the "counterfeit" picture, Sylph "had communed with a creature of imagination, till her own loveliness seemed but the creation of a delicate and dreamy fancy." (p. 514) This "picture was but the masculine counterpart of Sylph Etherege's sylph-like beauty. There was that resemblance between her own face and the miniature which is said often to exist between lovers whom Heaven has destined for each other, and which, in this instance, might be owing to the kindred blood of the two parties," since they were cousins. Sylph fancied that "in some of her daydreams, imagination had conjured up the true similitude of her distant and unseen lover." (p. 512) Thus Sylph had lived as in a "moonlight garden" nourished by "blissful fantasies" and "disquieted if reality threw a momentary cloud" between herself and her imaginary lover (p. 513). "She had been left to seek associates and friends for herself in the haunts of imagination, and to converse with them, sometimes in the language of dead poets, oftener in the poetry of her own mind," tinting with "stronger hues" the "fancy-picture" of her idealized lover (p. 510).

In broad terms, this story of the tragic fate of the over-imaginative Sylph Etherege is in accord with Hawthorne's favorite, Dr. Johnson, who also warned his readers against the "dangerous tendencies of the imagination" when unbalanced by understanding of the realities of life. Hawthorne's ability on occasion to see life realistically is evident in stories such as "Mrs. Bullfrog" and in *Our Old Home* and in his shrewd conduct in his three political posts. If Hawthorne was at times a romancer, this story shows that he understood the harm which could be done by a "villain" who deliberately by artistic creations (the "miniature") plays upon the weakness of viewers who are addicted to wishful thinking, illusions, "blissful fantasies," and a life of imagination unbalanced by a vigilant regard for "realities." (Sylph's illusions remind one of James' Isabel Archer's illusions which Henrietta Stackpole says caused her unhappiness.) From another angle, "Sylph Etherege" (enamoured of a countenance "too perfect" to belong to our "fallen and world-worn race") reminds one of the conclusion of "The Birthmark" where Hawthorne says the idealist Aylmer's tragedy in causing the death of his bride could have been avoided if he had learned humbly to live with earthly imperfections. The creative imagination can be dangerous, especially when its counterfeit creations are made plausible by flattering the credulous and the vain. Thus the "villain" says that in creating the counterfeit picture "I did but look into this delicate creature's [Sylph's] heart; and with the pure fantasies I found there I made what seemed a man,—and the delusive shadow has wiled her away to Shadow-land, and vanished there! It is no new tale. Many a sweet maid has shared the lot of poor Sylph Etherege!" (p. 516). Hawthorne's 1851 preface to *The Snow Image and Other Twice-Told Tales* in which this tale is collected speaks of his concern with burrowing "into the depths of our common nature, for the purposes of psychological romance" as contrasted with Cooper's kind of extrovert romance, and hence this tale forms a bridge to the psychological James, who began publishing about fourteen years later.

Hawthorne's "Chippings with a Chisel" *(Democratic Review,* 1838) centers on the advantages of the naturally heart-felt vs. traditionally universalized utterances (as eulogies), and on the extent to which visible symbols are needed. The fable involves the narrator's acquaintance with "a carver of tombstones" at Edgartown on the island of Martha's Vineyard, and his reactions to "interviews" with eight or nine of his typical customers as they choose inscriptions and designs to commemorate the dead. Hawthorne insists that this "sculptor . . . may share that title with Greenough, since the dauber of signs (cf. "Drowne's Wooden Image") is a painter as well as Raphael" (I, 456, *TTT)*. When a girl chooses an epitaph for her deceased sister which had already been "inscribed upon innumerable tombstones," Hawthorne remarks that "when we ridicule the triteness of monumental verses, we forget that [individualized and sincere] Sorrow reads far deeper in them than we can, and finds a profound and individual purport in what seems so vague and inexpressive, unless interpreted by her. She [Sorrow] makes the epitaph anew, though the self-same words may have served for a thousand graves" (p. 462–3). And the sculptor, with his keen "pride of art," expresses a preference for the "comfort to be gathered from these old scraps of poetry" rather thon from "any new fangled ones." (p. 465) In another contexture, however, Hawthorne in commenting on artificial gravestones "of Gothic taste," "carved in London" and imported to Martha's Vineyard, says that the gravestones "far the most impressive both to my taste and feelings" were those "roughly hewn from the gray rocks of the island, evidently by the unskilled hands of surviving friends and relatives" (p. 456). "It is an old theme of satire, the falsehood and vanity of monumental eulogies; but when affection and sorrow grave the letters with their own painful labor, then may we be sure that they copy from the record on their hearts." (p. 456) And this preference for the natural simplicity of individualized grief is again shown in Hawthorne's mentioning that in contrast to the triteness of verses already used on innumerable tombstones " 'I was struck by at least a dozen simple and natural expressions from the lips' " of the bereaved who were choosing epitaphs, and that one of these "simple and natural expressions" would "have formed an inscription equally original and appropriate" (463). Notice here he refrains from saying "more appropriate."

The second artistic theme developed in the story involves the extent of the need for symbols. Hawthorne claims that wives are more reluctant than husbands to erect tombstones to their departed mates, not because of the wives' lack of constancy but because women "are conscious that a portion of their being has gone with the departed. . . . Soul clings to soul; the living dust has a sympathy with the dust of the grave; and, by the very strength of that sympathy, the wife of the dead shrinks the more sensitively from reminding the world of its existence. The link is already strong enough; it needs no visible symbol (p. 461). Yet Hawthorne praises some "emblematical" designs on tombstones, such as the "chiselling an open book upon a marble headstone" to symbolize "the scriptural knowledge of an old woman who had never read anything but her Bible" (p. 465). Finally, when the sculptor asks Hawthorne's own choice of a tombstone, he expresses himself as questioning the propriety of erecting monuments at all, since for him they suggest imprisonment "instead of the freedom of the skies" whither one would "soar upward with the butterfly." He would forget what the dead have "cast off," "forget the Grave," for "Every gravestone that you ever made is the visible symbol of a mistaken system." (p. 467) In this story it is possible that the apparent rejection of symbols is limited to those of the grave and that this was influenced in part by Hawthorne's semi-Unitarian rearing and the revolt of the Unitarians from earlier mortuary symbols. Elsewhere, of course, Hawthorne shows he was dedicated to the use of symbols in the interest of artistically presenting general truths, which he wished to flesh out in vivid sensuous form.

"The Birthmark" *(Pioneer Magazine,* 1843) does not center directly on an artist but rather on a scientist, Aylmer, one who in his pride devotes his scientific artistry to trying to remove the tiny birthmark from the cheek of his bride Georgiana, a birthmark which is the only thing which detracts from her complete loveliness. (The scientist, and also the humanitarian [Cf. Hollingsworth] and the artist, in Hawthorne's general view, were especially vulnerable to a pride which deprived them of the sympathy for others which he regarded as all-important.) In this story Hawthorne has the scientist-lover create a boudoir setting whose fabulous loveliness matches that of the bride who dies through her husband's attempt to make her beauty completely perfect. Recalling "antique naturalists" (Albertus Magnus, Agrippa, and Paracelsus), Aylmer is like them in that they "imagined themselves to have acquired from the investigation of Nature a power above Nature, and from physics a sway over the spiritual world" (II, 61). At the end, the birthmark being "the bond by which an angelic spirit kept itself in union with a mortal [imperfect] frame," as the birthmark fades, Georgiana's "soul took its heavenward flight." Hawthorne adds that "had Aylmer reached a profounder wisdom, he need not have flung away the happiness which would have woven his mortal life of the self-same texture with the celestial," since things of earth in their imperfect loveliness represent a "dim sphere of half development" to be made perfect hereafter in "a higher state" (II, 69).

"The Hall of Fantasy" *(Pioneer Magazine,* 1843)[4] is interesting as showing Hawthorne's mid-way position between the transcendentalists and the practical multitude. In over-all plan, the story involves the author's visit with a friend to a large edifice " 'which occupies in the world of fancy the same position which the Bourse, the Rialto, and the Exchange do in the commercial world,' " (II, 197) which admits "the light of heaven only through stained and pictured glass" which gave one the effect of a "visionary atmosphere" and "the fantasies of poetic minds." He surveys four groups—the writers, "the inventors of fantastic machines," the "noted reformers of the day," and Father Miller and his followers whose theories about the approaching end of the world "scatters all their dreams like so many withered leaves." And Hawthorne ends with an anti-Platonic panegyric "like the very spirit of earth, imbued with a scent of freshly turned soil." He had sympathized with the aspirations of those devoted to the various fantasies, and "*almost* desired that the whole of life might be spent in that visionary scene," but he concludes as a practical person that we should be "content" with "merely an *occasional* visit, for the sake of spiritualizing the grossness of this actual life" (p. 201, 207, 211). In the section on writers, Hawthorne indicates his personal choice of the world's masters.

> In niches and on pedestals around the hall stood the statues or busts of men who in every age have been rulers and demigods in the realms of imagination and its kindred regions. The grand old countenance of Homer;

[4] H. P. Miller, ("Hawthorne Surveys his Contemporaries," *American Literature,* 12: (May, 1940), 228–235) discusses the way in which the first version of Hawthorne's "The Hall of Fantasy" first published in *Pioneer* in February 1843 contains "the fullest notice and characterization of his contemporaries which he ever wrote for publication." This was drastically revised three years later when the story was included in *Mosses from an Old Manse.* Miller cites the original passages on Alcott and Emerson (as strong influences on others), and on Poe who "had gained ready admission for the sake of his imagination, but was threatened with ejectment as belonging to the obnoxious class of critics." This passage omitted in the 1846 version is Hawthorne's only published comment on Poe.

> the shrunken and decrepit form but vivid face of Aesop; the dark presence of Dante; the wild Ariosto, Rabelais' smile of deep-wrought mirth; the profound, pathetic humor of Cervantes; the all-glorious Shakespeare; Spenser, meet guest for an allegoric structure; the severe dignity of Milton; and Bunyan, moulded of homeliest clay, but instinct with celestial fire,—were those that chiefly attracted my eye. Fielding, Richardson, and Scott occupied conspicuous pedestals. In an obscure and shadowy niche was deposited the bust of our countryman, the author of Arthur Mervyn." Hawthorne adds, interestingly, since he omits Coleridge to whose theory of imagination he is sometimes supposed to have been mainly indebted, that Goethe will never be the victim of oblivion, and that "next" to his statue is that of Emanuel Swedenborg. Goethe and Swedenborg, the first admired by Margaret Fuller and the second by Emerson, were to Hawthorne "two men of transcendent imagination" (II, 197–8).

If one compares this list with that in "Earth's Holocaust" it will be noted that he omits Shelley; the Bible, also imperishable in the Holocaust, did not lend itself to a personalized statue. The statues of these "men who in every age have been rulers and demigods in the realms of imagination" front an "ornamental fountain of water . . . with its endless transformation, in which the imaginative beholder may discern what form he will," the water of which is extolled as "uniting the virtues of the Fountain of Youth with those of many other enchanted wells long celebrated in tale and song" (p. 198). Those who in their "poetic absorption" view these statues admiringly have "thoughtful, inward eyes"; and Hawthorne "felt an inward attraction towards these men, as if the sympathy of feeling, if not of genius, had united me to their order." In the light of other stories in which Hawthorne seems to suggest that great writers are necessarily above or estranged from society, it is noteworthy that he says here that "so far as my experience goes [in 1843] men of [literary] genius are fairly gifted with the social qualities; and in this age there appears to be a fellow-feeling among them which had not heretofore been developed. As men, [unlike Owen Warland] they ask nothing better than to be on equal terms with their fellowmen; and as authors, they . . . acknowledge a generous brotherhood" (p. 200). Occasionally, however, some of the literary admirers of their imaginative earlier "rulers" are "dreamers" whose "madness is contagious," although the true "poet knows his whereabout, and is less likely to make a fool of himself in real life" (p. 201).

In the main, Hawthorne's personal evaluation in this story seems to be one of mediation and balance. He would "thank God that there is such a place of refuge" from "actual life," and he concludes "in truth, that there is but half a life—the meaner and earthlier half—for those who never find their way into the hall" of fantasy or imagination (p. 203). Seemingly wild and impracticable as may be some of the inventors of machines and the "self-styled reformers" who have seen only one isolated "fragment of truth" (cf. Hollingsworth) Hawthorne recognizes that these three types [writer, inventors and reformers] are basically united in their quest of a better life through the use of the imagination. "The fantasies of one day are the deepest realities of a future one," but "the white sunshine of actual life is necessary in order to *test* them" (p. 204). (Compare "Slyph Etherege" on the great dangers of unbalanced and untested imagination.) "Be the individual theory as wild as fancy could make it, still the wiser spirit would recognize the struggle of the race after a better and purer life than had yet been recognized on earth" (p. 205). As contrasted with Platonic or transcendental abstractions, it will not satisfy Hawthorne to have "our mother earth . . . exist merely in Idea. I want her great, round, solid self to endure interminably, and still to be peopled with the kindly race of man . . ." (p. 210).

In "The Procession of Life" (1843), a paean to American democracy, the hostility toward an artistically unsympathetic populace, frequently evident in Hawthorne, is muted almost to praise as he denounces social stratification according to wealth. Before he concludes the story with death leveling all, Hawthorne suggests that artists with their "electric sympathy" help to make all men brothers:

> Were Byron now alive, and Burns, the first would come from his ancestral abbey, flinging aside, although unwillingly, the inherited honors of a thousand years, to take the arm of the mighty peasant who grew immortal while he stooped behind his plough. These are gone; but the hall, the farmer's fireside, the hut, perhaps the palace, the counting room, the workshop, the village, the city, life's high places and low ones, may all produce their poets, whom a common temperament pervades like an electric sympathy. Peer or ploughman, we will muster them pair by pair and shoulder to shoulder. Even society, in its most artificial state, consents to this arrangement (N.P., pp. 1084–1085).

Then Hawthorne quickly disdains for a quantitative distinction the qualitative distinction between the artist and the populace, an attitude which partially counterbalances the opposite attitude in "The Artist of the Beautiful":

> Yet the longer I reflect the less am I satisfied with the idea of forming a separate class of mankind on the basis of high intellectual power. At best it is but a higher development of innate gifts common to all. Perhaps, moreover, he whose genius appears deepest and truest excels his fellows in nothing save the knack of expression; he throws out occasionally a lucky hint at truths of which every human soul is profoundly, though unutterably, conscious (N.P., p. 1085).

"A Select Party" (1844) emphasizes the view that the world of ideality, which the creative imagination of the artist perceives, is more real than the material world. To his castle in the air, representing ideality, a Man of Fancy (again the creative faculty) invites guests to a select party. To the people of the lower world looking upward, the castle seemed "unreal, because they lacked the imaginative faith [possessed by the artist and other selfless persons]. Had they been worthy to pass within its portal, they would have recognized the truth, that the dominions which the spirit conquers for itself, among unrealities become a thousand times more real than the earth whereon they stamp their feet saying, 'This is solid and substantial; this may be called a fact' " (H.H., p. 238). Represented by "the wise and witty," "generous and heroic friends," and "the beautiful dream woman" of the host's youth, the material world is discovered by the Man of Fancy to be far more insubstantial than "a number of guests whom incredulous readers may be inclined to rank equally among creatures of imagination. The most noteworthy were an incorruptible Patriot; a Scholar without Pedantry; a Priest without worldly ambition; and a Beautiful woman without pride or coquetry; a Married Pair whose life had never been disturbed by incongruity of feeling; a Reformer untrammelled by his theory; and a Poet who felt no jealousy towards other votaries of the lyre" (H.H., p. 242).

The selfless artist is the future Great American Poet. He is of

> . . . poor attire, with no insignia of rank . . . [with] a high, white forehead, beneath which a pair of deepset eyes were glowing with warm light. It was such a light as never illuminates the earth save when a great heart burns at the household fire of a grand intellect. And who was he?—who but the Master Genius for whom our country is looking anxiously into the mist of Time, as destined to fulfil the great mission of creating an American literature, hewing it, as it were, out of the unwrought granite of our intellectual quarries? From him, whether moulded in the form of an epic poem or assuming a guise altogether new as the spirit itself may determine, we are to receive our first great original work, which shall do all that remains to be achieved for our glory among the nations.

This literary genius, to whom is given the chair of honor at the banquet, is not snobbish or aloof but

> passes daily amid the throng of people toiling and troubling themselves about the trifles of a moment, and none pay reverence to the worker of immortality. Nor does it matter much to him, in his triumph over all the ages, though a generation or two of his own times shall do themselves the wrong to disregard him (H.H., pp. 242–243).

The ideality perceived by the artist's imagination is concretized by a room illuminated by moonlight (Hawthorne's usual creative atmosphere):

> Along the walls, illuminated by the mild intensity of the moonshine, stood a multitude of ideal statues, the original conceptions of the great works of ancient or modern art, which the sculptors did but imperfectly succeed in putting into marble; for it is not to be supposed that the pure idea of an immortal creation ceases to exist; it is only necessary to know where

> they are deposited in order to obtain possession of them. In the alcoves of another vast apartment was arranged a splendid library, the volumes of which were inestimable, because they consisted not of actual performances, but of the works which the authors only planned, without ever finding the happy season to achieve them. To take familiar instances, here were the untold tales of Chaucer's Canterbury Pilgrims; the unwritten cantos of the Fairy Queen; the conclusion of Coleridge's Christabel; and the whole of Dryden's projected epic on the subject of King Arthur. The shelves were crowded; for it would not be too much to affirm that every author has imagined and shaped out in his thought more and far better works than those which actually proceeded from his pen (HH., pp. 244–245).

"Drowne's Wooden Image" *(Godey's Magazine,* June, 1844) centers on the quickening effect of love (even if unilateral) on an artist's creativity, on the organic vs. obedience to mechanical rules, with allusion to the problem of literalism (in the Kodak sense) vs. idealisation. Briefly, the fable involves the supposedly stolid Drowne, a carver of wooden images to be used as figure-heads for ships, who is rapt out of his prosaic routine by his admiration for a very lovely Portuguese young lady. The setting is the port of Boston, evidently in the late eighteenth century, since the actual painter Copley visits Drowne's workshop and acts as a kind of Chorus, pointing the moral. Evidently the lady sits as the artist's model and then leaves the port on the arm of her escort, Captain Hunnewell; and Drowne, disillusioned, loses his temporary artistic inspiration. Broadly speaking, Drowne's turn from utilitarian and prosaic "carving ornamental pump heads, and wooden urns for gate posts" to his matchless figurehead followed by defeatism, resembles Owen Warland's early concern with prosaic clocks, his hope that Annie could respond to his love which in part inspired his attempt to spiritualize machinery (the artificial butterfly) and the fact that if she had responded he could have risen to an art that was "worthier." This "first American" pioneer in sculpture, "that art in which we can now reckon so many names already distinguished" (II, 348), is set in the environment where the embryo artist was functional in providing decoration for American ships, on which our "specimens of native sculpture had crossed the sea in all directions, and had been not ignobly noticed among the crowded shipping of the Thames" and other foreign ports. (II, 349). Such utilitarian and mechanistic sculpture had no deficiency, Hawthorne remarks, "*except* that deep quality, be it of soul or intellect, which bestows life upon the lifeless and warmth upon the cold, and which, had it been present, would have made Drowne's wooden image instinct with spirit" (II, 350).

After the young lady arrives and Drowne is known to be carving a new figurehead, Copley, "the celebrated painter," who had noted that hitherto none of Drowne's art-works embodied "the ethereal essence of humanity," (II, 351) noted in his unfinished sculpture "the divine, the life-giving touch," and he eagerly inquired, "What inspired hand is beckoning this wood to arise and live?" (II, 353). "Day by day, however, the work assumed greater precision, and settled its irregular and misty outline into distincter grace and beauty. . . . Gradually, by a magic touch, intelligence and sensibility brightened through the features, with all the effect of light gleaming forth from within the solid oak" (II, 353–4). It will be noted that Hawthorne here stresses a dual kind of inwardness associated with organic art—the irradiation of light from within the artist's materials, and (as Drowne's puts it), "A well-spring of inward wisdom gushed within me as I wrought upon the oak with my whole strength, and soul, and faith" in creating "this creature of my heart" (II, 355). Drowne tells Copley he knows nothing of the sculptor's *rules* of art (Copley repeatedly attacks the rules"), and Copley recognizes in Drowne "that expression of human love which, in a spiritual sense, as the artist could not help imagining, was the secret of the life that had been breathed into this block of wood" (II, 355). In the statue's "dark eyes, and around the voluptuous mouth, there played a look made up of pride, coquetry, and a gleam of mirthfulness." (II, 356). The townspeople claimed Drowne had been seen "kneeling at the feet of the oaken lady, and gazing with a passionate ardor into the face that his own hands had created" as "a modern Pygmalion" (II, 357, 353). Copley, who admired the lady, remarked that it was "No wonder that she inspired a genius in you, and first created the artist who afterwards created her image" (II, 361). (One is reminded of Milton's saying that before the poet can create a true poem, he must have made his own life a true poem.)

But when the unresponsive lady departs from the tearful Drowne, "the light of imagination and sensibility, so recently illuminating it [his face], had departed," and during the remainder of his life he returned to creating merely wooden images, (II, 361), during this brief period having wrought his art "in a kind of dream." (II, 361). Hawthorne's conclusion is that "in every human spirit there is imagination, sensibility, creative power, genius, which, according to circumstances [especially whether or not one is capable of love], may either be developed in this world, or shrouded in a mask of dulness until another state of being. To our friend Drowne there came a brief season of excitement, kindled by love. It rendered him a genius for that one occasion, but, quenched in disappointment, left him again the mechanical carver . . ." (II, 362). While Copley says the statue "is as ideal as an antique statue" (II, 354), yet this idealization was also a *literal* reproduction in all minute details.

In her appearance the actual lady "was exactly and minutely the shape, the garb, and the face which the towns-people had so recently thronged to see and admire [in the statue]. Not a rich flower upon her head, not a single leaf, but had its protype in Drowne's wooden workmanship, although now their fragile grace had become flexible, and was shaken by every footstep that the wearer made. The broad gold chain upon the neck was identical with the one represented on the image . . ." (II, 358). Obviously Hawthorne held that the artist had to begin with actuality or nature, and love was to him the alchemy which enabled the artist to interfuse the actual and the ideal, the particular and the universal.

"Earth's Holocaust" *(Graham's Magazine,* March, 1844) in broad terms is a comprehensive satire of those who imagine that progress can be insured by merely destroying (burning in the context of this story) all the "wornout trumpery" of the past as embodied in external things, such as "the blazonry of coat armor, the crests and devices of illustrious families, pedigrees that extended back . . . into the dark ages" as symbols of caste or inequalities. As regards our immediate topic of literature, the story tests the immortality of various writers and books by indicating which ones cannot be destroyed by fire. The setting of the test-by-fire is a site on "one of the broadest prairies of the West.'" II, 430–1.

Hawthorne has the case for the literary opposition, for traditional patronage, stated by "a grayhaired man, of stately presence, wearing a coat" with a "badge of rank." This man protests that "this fire is consuming all that marked your advance from barbarism, or that could have prevented your relapse thither. We, the men of the privileged orders (note the title of a pamphlet by Joel Barlow whose verses Hawthorne elsewhere called "leaden"), were those who kept alive from age to age the old chivalrous spirit; the gentle and generous thought; the higher, the purer, the more refined and delicate life. With the nobles, too, you cast off the poet, the painter, the sculptor—all the beautiful arts; for we were their patrons (cf. Hawthorne's praise of Dr. Johnson, the conservative who revolted from Lord Chesterfield's offer of patronage), and created the atmosphere in which they flourish" as they are nourished by "the gorgeous past." (II, 432–34; 431). After the reformers burn everything associated with the "robes of royalty," liquors, "all the boxes of tea and bags of coffee in the world," tobacco, purses and banknotes, physicians' equipment involving homoeopathy, gunpowder, instruments of prisons and torture, and even "marriage certificates," and "title deeds of landed property," the reformers being convinced that "Reason and Philanthropy combined will constitute just such a tribunal as is requisite" for the "millenium," (p. 441), these iconoclasts attempt to "get rid of the weight of dead men's thoughts" embodied in "books and pamphlets." The volumes of Voltaire "threw an infernal light over the visages of the spectators," and German stories "emitted a scent of brimstone." (Cf. Hawthorne's "Celestial Railroad" and its attack on German works which nourished "Giant Transcendentalist" as like "smoke, mist, moonshine, raw potatoes, and sawdust" (II, 224). Byron's works produced "lurid gleams and gushes of black vapor," and Tom Moore's "diffused an odor like a burning pastil," but among American writings, the poems of Ellery Channing showed an "excellent inflammability," while Hawthorne's own works "were changed to vapor by the first action of the heat." He pays conventional tribute to the "powerful blaze" of Milton's works as promising "to endure longer than almost any other material of the pile," and mentions that "from Shakespeare there gushed a flame of such marvellous splendor that men shaded their eyes." As regards literary values, the two surprises in this story are Hawthorne's tribute to Shelley and (considering his coolness to the churches and theology) to the Bible. "Shelley's[5] poetry emitted a purer light than almost any other productions of his day. . . ." And the Bible, the "head" of all "human literature," and representing "the main pillars which supported the whole edifice of our moral and spiritual state," instead of "being blackened into tinder, only assumed a more dazzling whiteness as the finger marks of human imperfection were purified away . . . without detriment to the smallest syllable that had flamed from the pen of inspiration" (444–53). The "titan of innovation," represented by the reforming mob, was awed as the attempt to destroy the Bible aroused "a mighty wind . . . roaring across the plain with a desolate howl, as if it were the angry lamentation of the earth for the loss of heaven's sunshine . . ." (452). When the narrator asks whether anything will be left for humanity to build on, his wise friend replies that "you will find among the ashes everything really valuable"—i.e., The Bible, Shakespeare, Milton, and Shelley. "Not a truth is destroyed nor buried so deep among the ashes but it will be raked up at last" (p. 453). The frantic "bookworm" who sees everything as lost is characterized as having "no *inward* fountain of ideas," mere traditionalists being thus seen as comparable to

[5] In "P's Correspondence" (1845) Hawthorne says Shelley eventually in his latest period approached "the threshold of heaven." High praise indeed, from Hawthorne! "Shelley has really climbed . . . from a lower region (of Godwin) to a loftier one (of Platonism and love). His later works such as *Prometheus Unbound* "are warmer with human love, which has served as an interpreter between his mind and the multitude, [i.e., he has used the vicarious imagination and is in accord with Hawthorne's own ideal of the Jacksonians of the Young America party]. The author has learned to dip his pen oftener into his heart, and has thereby avoided the faults into which a too exclusive use of fancy (as opposed to the vicarious imagination) and (Godwinian) intellect are wont (in his earlier period) to betray him . . . Now you . . . are conscious of a heart warmth responsive to your own. In his private character Shelley can hardly have grown more gentle, kind, and affectionate, than his friends always represented him to be. . ." (II, 420).

the short-sighted reformers who commit the fatal "error at the very root of the matter," the need to "Purify that inward sphere" of the individual's own heart. Hawthorne asks, "Is not Nature better than a book? Is not the human heart deeper than any system of philosophy? Is not life replete with more instruction than past observers have found it possible to write down in maxims? Be of good cheer. The great book of Time is still spread wide open before us; and, if we read it aright, it will be to us a volume of eternal truth." (p. 449)

Hawthorne's "Artist of the Beautiful" *(Democratic Review,* June, 1844) in which art is objectified in a mechanical butterfly, is sometimes erroneously said to present beauty as completely disassociated from religion. The general framework of the story and the contexture of the beautiful involves a revolt from the "utilitarian"—here represented by the blacksmith and the practical clock-maker. As a boy the artist, Owen, "was attempting to imitate the beautiful movements of Nature as exemplified in the flight of birds or the activity of little animals," (p. 249) his interest at first being in externals rather than in introspection. Hawthorne himself, after speaking of Owen's "chasing butterflies" as mere "playthings," remarks, "Alas that the artist, whether in poetry, or whatever other material, may not content himself with inward enjoyment of the beautiful. . . ." As long as this artist subordinates his art to drink and riotous living (i.e., is unethical) he is unable to create even mechanical art. One aspect of moralism, at least as associated with the social solidarity of Dr. Johnson's eighteenth century neo-classicism, is involved in the fact that Hawthorne says that the artist's "morbid sensibility" and "creative eccentricity," which made the townspeople of "unimaginative sagacity" think the artist mad, were aggravated by the artist's lack of social conformity. "The lack of sympathy—that contrast between himself and his neighbors which took away the restraint of example—was enough to make him" seem mad. One may also find some spiritual implication in Annie's early interpretation of the artist's aim as involving "the spiritualization of matter"; but it should be noted that the artist himself calls this "a strange idea," and he expresses a "strange distaste at the stiff and regular processes of ordinary machinery." "In his idle and dreamy days he had considered it possible, in a certain sense, to spiritualize machinery, and to combine with the new species of life and motion thus produced a beauty that should attain to the ideal which Nature has proposed to herself in all creatures, but never has taken pains to realize." To be completely successful this artist needs the intuitive sympathy of Annie, he needs to be "enlightened by the deep intelligence of love" (Cf. "Drowne's Wooden Image") which would, Owen says, "give firmness to my heart and hand." But actually Annie "had shown herself incapable of any deep response" or any "spiritual power that he worshipped," since this capacity had existed only "within the artist's imagination," and he "had deceived himself." Hawthorne adds, had the artist "found Annie what he fancied, his lot would have been so rich in beauty that out of its mere redundancy he might have wrought the beautiful into many a worthier type than he had toiled for," i.e., worthier than the merely mechanical butterfly. Viewed from this angle, the story deals with the way in which an artist's failure to find fulfillment in genuine love truncates his art which emerges in unworthy forms. In this case, the child of Owen's beloved, fathered by another, destroys even the artist's unworthy art. When Owen temporarily thinks he has "thrown . . . aside" his artist's dream and turned to "common sense" alone, after he recovers from "the calamity of men whose spiritual part dies out of them," he is led to "thank Heaven for rendering him again the being of thought, imagination, and keenest sensibility that he had long ceased to be." In other words, for Hawthorne the artist with spiritual orientation needs the harmonious balance of "thought, imagination, and keenest sensibility" rather than the extremist's[6] espousal of any one of these alone viewed as completely apart from the practical clock-maker's cold, "unimaginative sagacity" (cf. 514–5 Locke's Understanding without Reason), and apart from "the hard, cold world." (The quotations, in order, in the last paragraph will be found in II, 507, 515, 514, 521, 507, 524, 519, 523, 525, 514–5.)

In this story the antithesis of time and eternity (cf. Melville on man's-time and God's-time in *Pierre)* and the antithesis of the mechanistic and the organic, appear to involve a hierarchical progression of values in which art tends to be associated at its best with the universalized timeless and the organic. Is the very fact that the butterfly *is* mechanical a major explanation for its inability to survive? Is Hawthorne suggesting that art cannot have sufficient organic vitality to endure, to be timeless (transcending me-

[6] In connection with this recognition that a "worthier" art than that represented by the mechanized butterfly was desirable, it is interesting to recall that in Hawthorne's preface to *The House of Seven Gables* he had used the image of the butterfly associated with mechanical things in a satiric or disparaging way. "The author has considered it hardly worth his while, therefore, relentlessly to impale the story with its moral as with an iron rod,—or, rather, as by sticking a pin through a butterfly,—thus depriving it of life, and causing it to stiffen in an ungainly and unnatural attitude." It is noteworthy that in the "germ" for "The Artist of the Beautiful" in *American Note-Books* Hawthorne had cited as the artist's product various things which he called trivially mechanical; this original conception would appear to support the present interpretation of the mechanical butterfly as being *not* the "worthier type" of art he strove for. It will be recalled that in *The House of Seven Gables* Hawthorne thought the artistic Clifford, had his normal development not been stunted by imprisonment, might have developed into a "Sybarite." "The Procession of Life" has already been cited as counterbalancing "The Artist of the Beautiful" in its view that the true artist is not at the opposite pole from the populace and warm human sympathies.

chanical clockmakers) unless it is vitalized by the quickening and redemptive love of a woman endowed by sympathy and spiritual understanding? After the butterfly is destroyed, the artist, rather than being frantic, "looked placidly at what seemed the ruin of his life's labour," for, Hawthorne moralizes, "when the artist rose high enough to achieve the beautiful, the symbol [the mechanical] by which he made it perceptible to mortal senses became of little value in his eyes while his *spirit* possessed itself in the enjoyment of the reality." Finally, Hawthorne says in this story that when artistic ideas "grow up within the imagination" and appear to "be shattered and annihilated by contact with the practical" world, the artist "must stand up *against mankind* and be his own sole disciple, both as respects his genius and the objects to which it is directed." This doctrine, again, would seem to be out of accord with Hawthorne's more frequent view as a Jacksonian democrat that the artist gains power by expressing himself in harmony with the sentiment of the "uninstructed multitude." (II, 535–6; 512).

In Hawthorne's "The Great Stone Face," *(National Era,* Jan., 1850) in which the poet loses (along with the merchant [Gathergold], with the warrior [Old Blood-and-Thunder] and the politician [Old Stony Phiz]), in the contest as to who will most resemble the magnaminity and "divine sympathy" of the Stone Face, the author makes three points relating to aesthetics and the quest of greatness. First, the poet's literary "genius" includes the art of idealizing. "If he sang of a mountain, the eyes of all mankind beheld a mightier grandeur reposing on its breast, or soaring to its summit, than had before been seen there. If his theme were a lowly lake, a celestial smile had now been thrown over it, to gleam forever on its surface. If it were the vast old sea, even the deep immensity of its dread bosom seemed to swell the higher, as if moved by the emotions of the song. Thus the world assumed another and a better aspect from the hour that the poet blessed it with his happy eyes. The Creator had bestowed him, as the last best touch of his own handiwork. Creation was not finished till the poet came to interpret, and so to complete it." (III, 432–433) Broadly speaking, Hawthorne's presentation of the poet who idealizes "the mountains which had been familiar to him in his childhood" belongs to the tradition associated with Wordsworth. Nature, as represented by the Stone Face, had "become a teacher to him [Ernest], and . . . the sentiment which was expressed in it would enlarge the young man's heart, and fill it with wider and deeper sympathies than other hearts. They [the villagers] knew not that thence [from nature] would come a better wisdom than could be learned from books, and a better life than could be moulded on the defaced example of other human lives. Neither did Ernest know that the thoughts and affections which came to him so naturally in the fields and at the fireside, and wherever he communed with himself, were of a higher tone than those which all men shared with him." (III, 421). Cf. Wordsworth's doctrine that "one impulse from a vernal wood" can teach man more "than all the [human] sages can." Second, as regards aesthetics, "The Great Stone Face" also contains Hawthorne's sharpest statement as to the reality of nature and its beauty as opposed to the current transcendental doctrine that nature's beauty exists only in the human observer's fancy. Some of the villagers who looked upon the Stone Face were given to "affirming that all the beauty and dignity of the natural world existed only in the poet's fancy." Notice Hawthorne's own editorial verdict: "Let such men speak for themselves, who undoubtedly appear to have been spawned forth by Nature with a contemptuous bitterness, she having plastered them up out of her refuse stuff, after all the swine were made. As respects all things else, the poet's ideal was the truest truth." Finally, much as Ernest admired "the living images which the poet flung out of his mind, and which peopled all . . . with shapes of beauty," the poet himself in his humble self-appraisal recognized that he was "not worthy to be typified by yonder benign and majestic image,"—i.e., the Stone Face. Why? Because his conduct, his life, has not been sincerely organic with his poetic professions. "My life, dear Ernest," the poet says, "has not corresponded with my thought. I have had grand dreams, but they have been only dreams. . . . Sometimes even—shall I dare to say it?—I lack faith in the grandeur, the beauty, and the goodness, which my works are said to have made more evident in nature and in human life. Why, then, pure seeker of the good and the true, shouldst thou hope to find me, in yonder image of the divine?" In contrast, Ernest's own words from his "natural pulpit" had organic "power, because they accorded with his thoughts; and his thoughts had reality and depth, because they harmonized with the life which he had always lived. It was not a mere breath that this preacher uttered; they were the words of life, because a life of good deeds and holy love was melted into them. . . . The poet, as he listened, felt that the being and character of Ernest were a nobler strain of poetry than he had ever written. . . . Behold! Behold! Ernest is himself the likeness of the Great Stone Face" so "imbued with benevolence" and a "grand beneficence." This doctrine that the expresser of beauty must go beyond mere verbal technique and must make the "deeds" of his actual life and his personal thought harmonize with his words and vitalize them belongs to the tradition of John Milton and his lofty organic doctrine that no man can be a true poet who has not first made his own life a noble poem. This organic doctrine links Hawthorne's religious-ethical doctrine with his aesthetic doctrine, and helps to explain why he has so little to say, relatively, about technical matters. (II, 433–38)

In conclusion, what artistic problems do these stories show Hawthorne concerned with? First, in "The Artist of the Beautiful" he reflects a transient pique because the artist feels himself at times out of accord with the multitude, but as an ardent member of George Bancroft's Jacksonian party Hawthorne more characteristically thinks that the artist should be the spokesman for deeper insights shared by all men. Second, in "Prophetic Pictures" he warns the artist against excessive *pride* as an irresponsible creator of portraits which prophecy a character's future development while he retained faith that the artist could exert free will to forestall his own bad influence. But in "Randolph's Portrait" he seems to excuse the use of art to prophecy when such art was used in the interest of political freedom as against tyranny. Third, Hawthorne was deeply concerned with the relative values of the mechanistic versus the organic, the latter being essential to the greatest art. The organic approach was inspired by an artist's sincere love even if unilateral (as in "Drowne's Wooden Image") and by a life of genuine ethical elevation and selfless magnanimity (as in "The Great Stone Face"). (For orientation, see R. R. Male's " 'From the Innermost Germ' ". . . . ELH, XX, 218ff., Sept. 1953). Fourth, while he honored two writers of "transcendent imagination," Swedenborg and Goethe ("Hall of Fantasy"), he thought that counterfeit art could mislead a viewers' imagination toward ruinous wishful thinking, as in "Sylph Etherege." Imagination needed to be balanced by reasonableness, warmth of heart, and a vigilant regard for actuality. (For orientation, see R. J. Coanda's unpublished dissertation, "Hawthorne on the Imagination," University of Wisconsin, 1960). Fifth, the stories surveyed help to round out Hawthorne's evaluation of literary masters, including his contemporaries such as Shelley whose later work he exalted. Sixth, while in "Chippings" he thought symbols (such as tombstones) unnecessary, he has his narrator in "The Antique Ring" say that the symbol and the idea symbolized cannot be separated, thus moving toward a less mechanical and a more fused and organic view of symbolism as transcending allegory, Seventh, he resigns himself to the fact that beauty on earth cannot be perfect, that one should learn to live with some imperfection, as in "The Birthmark." As an anti-transcendental empiricist in part, he is not satisfied to have round Mother Earth "exist only in Idea" (as in "The Hall of Fantasy"), although he does take hope in the fact that the cloudiest mud-puddle can reflect the purest Heavens. The true writer can idealize. Eighth, Hawthorne is concerned with the way in which literature can make use of the timely or the familiar scene to transcend itself and suggest in symbols timeless and hence enduringly suggestive human and spiritual values, as in "The Hall of Fantasy" and especially in "Earth's Holocaust," where he tries to show that man's transient reforms and even fire cannot destroy the deathless works such as *The Bible,* and those of Shakespeare and Milton.

As regards chronological development in these stories by Hawthorne one can note his *growth* toward an increasing fusion of image and idea, culminating in "The Artist of the Beautiful, perhaps his most subtle story on an artist, as well as a growth toward more concern with the organic, with a concern with the artist's need for love and sympathy, a recognition of the perils of the artist succumbing to pride in the sense of prophecy, and, after variants, a growing sense of the artist's need to reconcile faith in his art with his role as spokesman of insights shared by all men, along with a need to try to balance the imagination with understanding of reality and with reason, a need for the "counterpoise between his mind and heart" (N.P., 1194). If these stories on artists are not without a few apparent contradictions or inconsistencies, it should be recalled that R. H. Fogle's excellent book, *Hawthorne's Fiction: The Light and the Dark* (1952), p. 192, concludes that in general "there is no synthesis in Hawthorne's thinking, only thesis and antithesis in balance. . . .His only reconciliation is acceptance of life's differences and contradictions." Finally, for a general, overall brief survey, the reader is directed to C. H. Foster's useful study by C. H. Foster of "Hawthorne's Literary Theory," PMLA, LVII (March, 1942), pp. 241–54, a study which the present one is intended to supplement in its concern with the way the artist and his concern with beauty function in terms of images within actual stories as works of art.

"THE ACTUAL AND THE IMAGINARY": HAWTHORNE'S CONCEPT OF ART IN THEORY AND PRACTICE

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Few students of modern fiction—that peculiarly Western evolution—deny Nathaniel Hawthorne's "absolute greatness as a writer and the centrality of his position in American literature."[1] But too many go on to assert that "allegory is organic" to Hawthorne's work.[2] As a result, the familiar deduction from these casual premises is the widely accepted assumption that Hawthorne wrote great allegory. By such an approach we can prove that every play that Shakespeare wrote was good. However, in point of fact, no one has shown satisfactorily either that *Titus Andronious* is a good play or that Hawthorne was a great allegorist. If we are to reach a sound critical understanding of Hawthorne and his place in literature, we must come to grips with the unconscious syllogism which has weakened many of the recent, generally perceptive studies of him.[3] What must be decided is how "organic"—or central, to be more exact—to Hawthorne's artistic purposes and methods was his "inveterate love of allegory."[4]

A more helpful hypothesis is that an inveterate love of human life—that odd mixture of body and soul—was central to, and controlled Hawthorne's philosophy of art. His particular understanding of the nature of man led him to a parallel, but elevated view of the artist as one who lives and works among the Actual and the Imaginary for the purpose of giving the ordinary man a greater appreciation of life. By seeing then, (1) what elements it takes to make an artist and (2) how an artist goes about his work, we can reach (3) an understanding of Hawthorne's aesthetic of the Actual

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[1] Roy R. Male, *Hawthorne's Tragic Vision* (Austin, Texas, 1957), p. 19. But see also Rudolph Von Abele, *The Death of the Artist: A Study of Hawthorne's Disintegration* (The Hague, 1955), a work based on the assumption that "in his own right Hawthorne is moderately interesting, but scarcely great" (p. 101).

[2] Richard H. Fogle, *Hawthorne's Fiction: The Light and the Dark* (Norman, Oklahoma, 1952), p. 7.

[3] See, for example, Fogle, *Hawthorne's Fiction*, p. 41, for the clearest evidence of the syllogism; Ivor Winters, "Maule's Curse: or Hawthorne and the Problem of Allegory" (1938), *In Defense of Reason* (Denver, 1947), pp. 157–175, who assumes the validity of the minor premise in order to deny Hawthorne's greatness; and Mark Van Doren, *Nathaniel Hawthorne* (New York, 1949) who reveals that he accepts the syllogism when he is forced to say that "without his allegory Hawthorne would be nothing" (p. 66).

[4] Certainly the main line of Hawthorne criticism from Poe and James; down to Newton Arvin, Austin Warren, Randall Stewart, and Leon Howard; and including now H. H. Waggoner and Harry Levin has reflected the idea that Hawthorne was "more than a mere allegorist"; however, the fact that each of these students of Hawthorne has felt he had to make some sort of general qualification with regard to "Hawthorne's allegory" shows the pervasiveness of the assumption being examined in this article. Only F. O. Mathiessen, to date, has undertaken a similar study.

and the Imaginary. Once we understand Hawthorne's theory of art we shall be able (4) to see to what degree and how "allegory" and imagination figure in his work, and (5) to come to a more exact estimate of his genius.

Melville long ago warned the "mere critic" of the futility that lies in trying to analyze Hawthorne's genius, "for it is not the brain that can test such a man; it is only the heart. You cannot come to know greatness by inspecting it; there is no glimpse to be caught of it, except by intuition." Nevertheless, any intuitive discoveries made by a critic can be reported only in the rhetorical patterns of humble prose. These two observations need not discourage us in our attempt to sound Hawthorne; they should remind us, rather, that the orderly progressions and philosophical schemes that follow are the report of a reader, not the product of an artist. No claim is made for Hawthorne as a logically consistent philosopher; insight and reflection can work together productively in an intelligent, sensitive adult without his knowing how or caring why. And, it should be needless to add, the processes of such cerebral production can be haphazard and apparently confusing without impairing the end result. Let us accept, then, the challenge offered by Hawthorne to "look through the entire range of his characters, good and evil, in order to detect any of his essential traits."[6]

I

Hawthorne quite rightly placed himself "between the Transcendentalists . . . and the great body of pen-and-ink men who address the intellect and sympathies of the multitude."[7] This could be taken as merely an evasive circumlocution concerning that fictitious alter-ego, M. de l'Aubépine; however, I find it to be an exact delineation of the area where Hawthorne felt that, as an artist, his creative work would be most effective. He affirms repeatedly that man, above the animals, has *soul, intellect,* and *heart.*[8] The Transcendentalists were overly concerned with the soul, while the majority of writers ignored what might be the divine or immortal—"ethereal" is Hawthorne's preference—aspect of man and stayed within the limits of the body's head (intellect) and heart. But Hawthorne felt that neither the body nor the soul should be neglected in favor of the other; rather, he attempted to formulate his work in such a

[5] "Hawthorne and His Mosses," *The Apple-tree Table and Other Sketches,* ed. Henry Chapin (Princeton, 1922), pp. 63–64.

[6] Preface, *The Snow Image,* III, 386. All references are to the Riverside Edition of *The Complete Works.* ed. G. P. Lathrop, 13 vols. (Boston, 1882–84). When the general source of a quotation is clear, its exact location will be noted in the text.

[7] Preface, "Rappaccini's Daughter," II, 107.

[8] E.g., *The Scarlet Letter,* V, 33–34; *The American Notebooks,* ed. Randall Stewart (New Haven, 1933), p. 126. See Marvin Laser, "'Head', 'Heart', and 'Will' in Hawthorne's Psychology," *Nineteenth Century Fiction,* X (September, 1955), 130–140 for an account of the academic roots of Hawthorne's working hypothesis concerning man.

way that it would be written from, and addressed to, the total man: soul, intellect, and heart.

At first glance, Hawthorne's view of man appears to follow traditional humanistic thought. However, Hawthorne separated what Shakespeare would have called simply "the rational soul" into intellect and soul; the soul alone remained uncorrupted by Adam's fall, while reason (intellect) lost its divine efficacy, a view in accord both with Hawthorne's Puritan heritage and with his exposure to Romanticism. The heart, in turn, serves as a kind of middle ground. Bodily and impure, it is "that foul cavern . . . wherein existed the original wrong of which the crime and misery of this outward world were merely types."[9] Yet, the two *Allegories of the Heart* (II, 303–346) remind us that the redeeming power of love also resides within the heart. Thus, although the soul alone is spiritual while the head and the heart are earthly, they must all work in harmony if man is to be happy and at peace with himself.

Basically, the artist is representative of Everyman;[10] however, his innate moral characteristics of intellect, soul, and heart are expanded to "thought, imagination, and keenest sensibility."[11] These three powers must be acute, but also must remain in balance, if they are to produce great art: if they are "to put the very spirit of beauty into form and give it motion."[12]

The first step necessary in artistic creation is the full exercise of intellectual power in the analysis of actual material flux and fact, be it butterflies, a birthmark, or the "varying characteristic traits" of a young couple.[13] This is the step which Hilda could not accomplish; she had the requisite imagination and sensibility (soul and heart) which could re-create some one else's analysis of external reality, but she did not have enough mind to be an original artist. "Instructed by sorrow," however, at the end of *The Marble Faun*, Hilda had lost her ability to copy, for "she could not yield herself up to the painter so unreservedly as in times past; her character had developed a sturdier quality, which made her less pliable to the influence of other minds. . . . She had known such a reality, that it taught her to distinguish inevitably the large portion that is unreal, in every work of art."[14]

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[9] "Earth's Holocaust," II, 445. (On the same page, the intellect alone is shown to be powerless with regard to the heart.)

[10] See "The Procession of Life," II, 240, and "Drowne's Wooden Image," II, 362.

[11] "The Artist of the Beautiful," II, 525. See also, Preface, *The Scarlet Letter*, V, 44, and "P's Correspondence," II, 420.

[12] "The Artist of the Beautiful," II, 509.

[13] "The Prophetic Pictures," I, 199.

[14] *The Marble Faun*, VI, 427. This passage is important not only because it reflects Hawthorne's views on aesthetics but also because it gives support to that school which sees the theme of the work as a reaffirmation of *felix culpa:* Hilda clearly has been educated now that her virtue is no longer fugitive and cloistered. Perhaps the violence of her retort to Kenyon in the next chapter (XLII) is the reflection of her realization of this fact. In any case, the entire present chapter (XLI) should be read, for it supplies a wealth of evidence which supports the thesis being presented in this article.

Once we make this discovery, that appearance is unreal, we fall apart like Feathertop unless our new knowledge leads to a sense of a higher reality. Hence, at this stage, Hawthorne's conception of the imagination enters into his aesthetic, for the imagination is an "innate tendency of soul"[15] which reaffirms with the new Adam and Eve that 'heaven is my home.' It is necessary in art, for "it is only through the medium of the imagination that we can lessen those iron fetters, which we call truth and reality, and make ourselves even partially sensible what prisoners we are" (II, 278). Hawthorne was not a Subjective Idealist—witness the fate of Sylph Etherege who lived entirely within "the haunts of imagination" (III, 510)—, nor was he a Transcendentalist; nevertheless, he did believe that there was a truth and a reality higher than those represented by material flux and fact alone. No weighty metaphysic such as Coleridge's, nor a well defined theology such as Edwards' specifically informed his thought; but, brought up in the mixed atmosphere of both philosophies and being a man of sensitive mind and spirit, Hawthorne was conditioned to accept some sort of heaven, absolute, or perfect Idea as an empirical fact. We need look no further than "The Old Manse" to see that, in truth, he did. There, it is clear that the beauties of nature, especially as reflected in the river, informed his soul of an ideal realm;[16] but even at the mundane Salem Custom House, he believed with all his power that there was a "true and indestructible value that lay hidden in . . . petty and wearisome incidents, and ordinary characters" (V, 57). It is the function of the imagination to discern "in this sphere of strangely mingled elements, the beauty and the majesty which are compelled to assume a garb so sordid."[17]

But "the coolness of a meditative habit" and the "glittering icicles" of imagination[18] will remain cold and lifeless "till the heart is touched," until thought and imagination (mind and soul) are warmed by mixing with the artist's sensibility or sympathy. The warming, humanizing power of the heart hardly needs to be labored anymore,[19] but it receives an interesting illustration in the Preface to *The Scarlet Letter.* There, Hawthorne's innate sympathy was so stirred by the "A" that it scorched him.

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[15] "The Artist of the Beautiful," II, 515.

[16] Malcolm Cowley, "Hawthorne in the Looking Glass," *Sewanee Review,* LVI (Autumn, 1948), 545–563, and Jesse Bier, "Hawthorne on the Romance: His Prefaces Related and Examined," *Modern Philology,* LIII (August, 1955), 17–24, have pointed out that the reflections seen in mirrors, rivers, and ponds are symbols of the imagination in Hawthorne.

[17] *The House of Seven Gables,* III, 59.

[18] Preface, *Twice-told Tales,* I, 16; "The Village Uncle," I, 356.

[19] See, for example, John W. Shroeder, " 'That Inward Sphere': Notes on Hawthorne's Heart Imagery and Symbolism," *PMLA,* LXV (March, 1950), 106–119; Donald A. Ringe, "Hawthorne's Psychology of the Head and Heart," *PMLA,* LXV (March, 1950), 120–132; and Roy R. Male, "Hawthorne and the Concept of Sympathy," *PMLA,* LXVIII (March, 1953), 138–149.

Yet, he could not write his novel at that time, for even though the story was "subtly communicating itself to my sensibilities, . . . it was evading the analysis of my mind," and "my imagination was a tarnished mirror" (V, 50, 53). How, then, does the artist combine and mold his creative powers? To answer this question we must delve into the light and shade, and enter the lives of every day affairs and of solitude. When we come out, we should have a clearer idea of Hawthorne's conception of the Actual and the Imaginary, and should be in a better position to interpret his "inveterate love of allegory."

II

From Hawthorne's *Note-books,* his Prefaces (especially those to the *Twice-told Tales* and *The Scarlet Letter*), the many sketches such as "Snow-flakes" and "Fragments from the Journal of a Solitary Man" [Oberon], the tales "Drowne's Wooden Image" and "The Artist of the Beautiful," and some passages in *The Marble Faun* we get a consistent picture of the artist at work.[20] In all, the artist lives a divided life: half in the sunshine amid nature or the bustle of life, half in the shade and in solitude. The sun is necessary for the studied and passive observation of all the potential materials and subjects later to figure in artistic creations. But the sun shines equally on the just and the unjust, confusing apparent reality with the manifestations of a higher reality. Thus, the artist must retire to a study where daylight does not interfere with the figuring forth of the imagination. Hawthorne's warning to his fiancé could have been addressed as well to a young artist: "Keep thy imagination sane—that is one of the truest conditions of a communion with Heaven."[21]

In solitude, then, surrounded by shade created by fire or some subdued light, an artist can serve his imagination—the shade hiding "whatever was unworthy to be noticed" and the fire picturing forth "golden glimpses of a better world."[22] Thus, the study itself becomes a symbol of the imagination, just as is Miriam's studio in *The Marble Faun,* which was

> one of those delightful spots that hardly seem to belong to the actual world, but rather to be the outward type of the poet's haunted imagination [See "The Haunted Mind]", where there are glimpses, sketches, and

[20] Annette K. Baxter, "Independence vs. Isolation: Hawthorne and James on the Problem of the Artist," *Nineteenth Century Fiction,* X (December, 1955), 225–231, correctly warns us not to assume that Hawthorne projected himself in the pictures of his own artists, for his total achievement reads otherwise; and Arlin Turner, "Hawthorne as Self-Critic," *South Atlantic Quarterly,* XXXVII (April, 1938), 132–138, points out that Hawthorne purposely underrated himself as a kind of protective device.

[21] *The Heart of Hawthorne's Journals,* ed. Newton Arvin (Boston, 1929), p. 86.

[22] "A Select Party," II, 71–72; "Fire Worship," II, 162. ("Fire Worship" serves as "Il Penseroso" to his "L'Allegro": "Buds and Bird Voices.")

> half-developed hints of beings and objects grander and more beautiful than we can anywhere find in reality. The windows were closed with shutters, or deeply curtained, except one which was partly open to a sunless portion of the sky, admitting only from high upward that partial light which, with its strongly marked contrast of shadow, is the first requisite towards seeing objects pictorially. (VI, 57)

Yet, if the hints of the imagination are to receive full development, the artist even in solitude must somehow keep his heart warm so that his natural sensibility will be communicated to his artifact. As Kenyon fell in love, his "genius unconsciously wrought upon by Hilda's influence, took a more delicate character than heretofore"; when she is lost, "imagination and the love of art" die within him (VI, 426, 483).

Hawthorne often repeated this conception of how a creative imagination functioned; let us take our summary, then, from *Dr. Grimshawe's Secret,* in order to show his consistency. In describing Ned, he says, "there were the rudiments of a poetic and imaginative mind within the boy, if its subsequent culture should be such as the growth of that delicate flower requires; a brooding habit taking outward things into itself and imbuing them with its own essence until, after they had lain there awhile, they assumed a relation both to truth and to himself, and became mediums to affect other minds with the magnetism of his own." Like Hawthorne, Ned grew up in a shadow, "with less sunshine than he needed for a robust and exuberent development, though enough" to cultivate his imagination. Ned, too, lived "an inward life . . . , keeping his imagination always awake and strong." Although he lived in a "castle in the air" [see *Our Old Home,* VII, 150–51, "A Select Party," and "The Hall of Fantasy"], Little Elsie was there "to keep life real, and substantial" (XIII, 108–110).

III

A castle in the air, a study, or living an inward life should not be taken as evidence of a denial of actual life. Hawthorne calls the world unreal because it is not complete reality; it has the appearance of reality only when close contact with earthly things successfully masks the higher reality. Since the degrees of reality and unreality which the world offers will vary from person to person, Hawthorne avoids confusion by calling material fact and flux "the Present, the Immediate, the Actual."[23] In spite of his use of the diction of Berkeleian psychology, his emphasis was of an opposite nature. The Actual exists and man exists within it.

[23] Dedication *Our Old Home,* VII, 16. The rest of the dedication may be read in support of the present article.

On the other hand, the Ideal may lie "above, below, or beyond the actual."[24] It matters little, for the Ideal can only be imagined within each person. The Imaginary, then, is just that: a condition of the mind. But the imagination, nevertheless, can have a real effect on man. Having its origin in the soul, it can bring to bear on man's vision the soul's knowledge of the Ideal. Through the imagination, a man is given an elevated perception of the material fact and flux which might otherwise cloud his vision of a better life. By exercising the active faculty of his soul he can purge away the petty aspects of earthly life so that life is endowed with a purer meaning.

In spite of my separation of the Actual and the Imaginary for purposes of definition, they play equally important roles in artistic creation, the purpose of which is to "affect other minds with the magnetism" of the artist's mind. If a work is too imaginary, or exclusively Transcendental, contact cannot be made with other minds. If it is too much a pen-and-ink copy of actual life, there will be no magnetism, no shock of human recognition, no impulse along the magnetic chain of humanity. Effective art lies somewhere in between.

Hawthorne observed in his *American Notebooks* that "on being transported to strange scenes, we feel as if all were unreal. This is but the perception of the true unreality of earthly things, made evident between ourselves and them. By and by we become mutually adapted, and the perception is lost" (IX, 109). The artist's retreat to some kind of study is necessary, then, so that the imagination can work to regain that perception.

This idea receives dramatic illustration from an incident reported in *Our Old Home*. Hawthorne had gone to Uttoxeter because the story of Dr. Johnson's having done penance there as an old man had always touched him deeply. Once arrived, however, he was surprised to find that he felt no emotional reaction; rather, he walked around the market place quietly bemused, observing and pondering the details of the setting, but careful not to fall into a literal reenactment of the penance. Hawthorne understood that

> a sensible man had better not let himself be betrayed into these attempts to realize the things which he has dreamed about, and which, when they cease to be purely ideal in his mind, will have lost the truest of their truth, the loftiest and profoundest part of their power over his sympathies. Facts, as we really find them, whatever poetry they may involve, are covered with a stony excrescene of prose, resembling the crust on a beautiful sea-shell, and they never show their most delicate and divinest colors until we shall have dissolved away their grosser actualities by steeping them long in the powerful menstruum of thought. And seeking to actualize them again, we do but renew the crust. If this were otherwise,—if the moral sublimity of a great fact depended in any degree on its

[24] "The Hall of Fantasy," II, 197.

> garb of external circumstance, things which change and decay,—it could not itself be immortal and ubiquitous, and only a brief point of time and a little neighborhood would be spiritually nourished by its grandeur and beauty. (VII, 165–66)

Even though Hawthorne was careful, then, not to stand in the middle of the market place, he felt no grandeur and beauty while visiting Uttoxeter. As soon as he had left the town, however, "this sad and lovely story . . . [became] holy to my contemplation, again. . . . It but confirms what I have been saying, that sublime and beautiful facts are best understood when etherialized by distance" (VII, 16).

It is clear now why an artist needs a study, why he needs to enter "a neutral territory, somewhere between the real world and fairy-land, where the Actual and the Imaginary may meet, and each imbue itself with the nature of the other."[25] When such a mixture of the Actual and the Imaginary is obtained, the result will be effective art. We get a total view of this aesthetic theory through "The Hall of Fantasy."

The Hall of Fantasy, like the soul and heaven itself, "is likely to endure longer than the most substantial structure that ever cumbered the earth." It is important for the artist to visit the hall, for "here the wise head and capacious heart may do their work; and what is good and true becomes gradually hardened into fact." Yet the hall can not be a home, for "the root of human nature strikes down deep into this earthly soil, and it is but reluctantly that we submit to be transplanted, even for a higher cultivation in heaven." No, that "allegoric structure," the Imaginary, is only a "place of refuge from the gloom and chilliness of actual life." Granted that "there is but half a life—the meaner and earthlier half—for those who never find their way into the hall," it is equally true that the Imaginary is but half a life, and good art will mix the Actual and the Imaginary to soften the "hard angles" of earthly existence. Hawthorne concludes, "Let us be content, therefore, with merely an occasional visit to the Hall, for the sake of spiritualizing the grossness of this actual life, and prefiguring to ourselves a state in which the Idea shall be all in all" (II, 196–211).

Hawthorne's mention of 'prefiguring the Idea' seems to lay the ground work for Symbolism and the idea of 'spiritualizing this life' could validly lead to Allegory. But symbolism demands a kind of imagination which Hawthorne did not have; moreover, a symbol tends to separate the Actual and the Imaginary, even while yoking them. Allegory, indeed, does mix the Actual and the Imaginary; however, it demands a strict and well-defined philosophy or theology which it wishes to expound. But Hawthorne would join neither the 'School of Philosophy' nor any church; they were too narrow

[25] Preface, *The Scarlet Letter,* V, 55.

in their approaches to life. What then of his confessed "love of allegory"? The phrase is a vague expression which described the manner in which Hawthorne's imagination worked—a manner partly symbolical and partly allegorical.

IV

With Hawthorne's constant emphasis on the necessity of the imagination's working hand and glove with the head and the heart, we are reminded of Coleridge's metaphysic of Organic Vitalism. Drowne's repetition of the aesthetic commonplace that a "figures lies hidden within that block of oak, and it is my business to find it" (II, 353) has, in fact, suggested to recent critics that Hawthorne knew Coleridge's theory.[26] But the correspondence between Hawthorne and Coleridge is only a similarity, not an identity, for Hawthorne's conception of the imagination was not so rarefied as the Englishman's. F. O. Matthiessen was quite right when he said that Hawthorne never distinguished between the imagination and fancy,[27] and we can agree with Coleridge that the distinction, in itself, is rather pointless. Nevertheless, his analysis of the imagination does give us a measure which we may use to determine the degree of esemplastic creative power which lies within Hawthorne's conception of the imagination.

Coleridge's primary imagination is "the living Power and prime Agent of all human Perception, and is a repetition of the eternal act of creation of the infinite I AM."[28] This is the power in the theory of Organic Vitalism which can create a world above nature by using its knowledge to postulate the essential creative process of nature. But Hawthorne was mystified by that process. Although he saw that somehow the Gothic represented "the very process of nature", he was equally sure that it "produces an effect we know not of." Because he took the world as he found it and believed that its essential qualities could not be changed, he affirmed that his taste was Gothic, not Platonic as was Coleridge's: "classic statues escape you with their slippery beauty, as if they were made of ice. Rough and ugly things can be clutched." Hence, Hawthorne's reac-

[26] Roy R. Male, "'From the Innermost Germ': The Organic Principle in Hawthorne's Fiction," *ELH*, XX (September, 1953), 219. See also, Male, *Hawthorne's Tragic Vision* (Austin, Texas, 1957), p. 20 ff., et passim; C. H. Foster "Hawthorne's Literary Theory," *PMLA*, LVII (March, 1942), 241–254; and Jesse Bier, "Hawthorne on the Romance: His Prefaces Related and Examined," *Modern Philology*, LIII (August, 1955), 17–24.

[27] *American Renaissance* (New York, 1941), pp. 249–250. Matthiessen tends to overrate the archetypal thrust of Hawthorne's imagination; he, like Male, *Tragic Vision*, pp. 29–32, has to draw heavily from Melville in order to illustrate the esemplastic power of Hawthorne's mind. Hawthorne did not have enough self-reliance, in the Emersonian sense, to be a symbolist.

[28] *Biographia Literaria*, Ch. XIII (*Criticism: The Major Texts*, ed. Walter Jackson Bate (New York, 1952), p. 387).

tion to nature and the Gothic was "moral rather than intellectual"; he needed the Actual "where human feelings may cling and overgrow like ivy."[29]

The difference between the two men is most clearly seen in "The Artist of the Beautiful" (II, 504–536). Hawthorne's delineation of Owen Warland's attempt to create "a beauty that should attain to the ideal which Nature proposed to herself in all her creatures, but has never taken the pains to realize" entails both a Platonic conception of art and the creative process of Organic Vitalism. But what is Hawthorne's evaluation of Owen's desire? He suggests ironically that "the chase of butterflies was an apt emblem of the ideal pursuit in which he had spent so many golden hours." He further implies that had Owen spent his golden hours (hours in which the spirit and imagination are exercised) in courting Annie and had he fallen in love with her, "his lot would have been so rich in beauty that out of its mere redundancy he might have wrought the beautiful in many a worthier type than he had toiled for." Once Owen's aim had been realized, the result fell far below any Coleridgean Ideal. Hawthorne keeps reminding us that it was a mechanical butterfly, that it sought humans before heaven, and that when it did attempt heaven, a ceiling—"that earthly medium"—prevented any escape from the world. If we recall that Hawthorne repeatedly symbolized the heart by a house, the implication at the end of "The Owen's heart so warmed that he could turn his attention to earthly beauty as represented by a mother and child before a domestic fire. Because, as Owen realized, the butterfly contained "the intellect, the imagination, the sensibility, the soul of an Artist of the Beautiful," he had to reject the symbol if he was to affirm his own life and reality. After the butterfly had been exorcised, Owen's "spirit possessed itself in the enjoyment of the reality." He had learned how to perceive beauty on earth and how to bring others closer to a perception.[30]

Coleridge's primary imagination leads to a symbolism which expands from the material and points to the supernatural, to the realm of archetypes; but Hawthorne was so committed to existence in this world that his imagination could conceive only of symbols which pointed to life itself. His was the imagination which saw a

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[29] *The French and Italian Note-books,* X, 399–400. See also Matthiessen, pp. 269–270, for a discussion of Hawthorne's Gothic taste.

[30] Contrasting readings can be found in Geo. E. Woodberry, *Nathaniel Hawthorne: How to Know Him* (Indianapolis, 1918), pp. 74–89; R. H. Fogle, *Hawthorne's Fiction,* pp. 70–90; and Rudolph Von Abele, "Baby and Butterfly," *Kenyon Review,* XV (Spring, 1953), 280–292. Woodberry believed that the story is a perfect illustration of Hawthorne's artistic aim and method; Fogle believes that Warland's achievement represents the superior spiritual validity of aesthetic experience; and Von Abele believes that there is a tension in the tale which is a projection of Hawthorne's inability to reconcile the contradictory allegiances to which he was committed as a man and as an artist.

house not as a type of eternity but as the human heart, which was able to put the music of the spheres into a music box, and which believed that the microscopic techniques of "the old Dutch masters" get "at the soul of common things, and so make them types and interpreters of the spiritual world."[31] A description of such an imagination can be found in Coleridge on Fancy:

> FANCY, on the contrary, has no other counters to play with, but fixities and definites. The Fancy is indeed no other than a mode of Memory emancipated from the order of time and space; while it is blended with, and modified by the empirical phenomenon of the will, which we express by the word CHOICE. But equally with the ordinary memory the Fancy must receive all its materials ready made from the law of association.[32]

If this is a just delineation of Hawthorne's "imagination," and if, as Matthiessen says, "allegory deals with fixities and definites which it does not basically modify,"[33] then we should be able to conclude that Hawthorne wrote Allegory. But the essential quality of Allegory is that it has a particular philosophy or theology from which it deduces its particular symbols and to which those symbols must consistently refer. In this respect *The Fairie Queene* and *The Pilgrim's Progress* are allegories, but *Gulliver's Travels* is not. And, in spite of Melville and Fogle, I should say that neither "A Select Party" nor "The Celestial Railroad" is, strictly speaking, an allegory.[34] They present us with types, not archetypes; hence, they are quasi-allegorical in that they contain Imaginary figures, which are deduced from Actual life and refer to Actual life, and quasi-symbolical in that they contain Actual symbols which only pass through the Imaginary and refer back to the Actual.[35]

V

Against the background of Hawthorne's ideas concerning the function of the artist and his theory of the Actual and the Imaginary, I have tried to estimate the nature of his imagination in order to show that neither symbolism nor, more particularly, allegory, considered as genres, plays a central part in his conception of art. Because Hawthorne did work with the Imaginary, however, a tendency towards symbolism and allegory seemed to enter his

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[31] *The American Notebooks*, ed. Randall Stewart (New Haven, 1933), pp. 98, 145; and *The English Notebooks*, ed. Stewart (New York, 1941), p. 556.

[32] *Biographia Literaria*, Ch. XIII (Bate, p. 387).

[33] Matthiessen, p. 249. See Edwin Honig, "In Defense of Allegory," *Kenyon Review*, XX (Winter, 1958), 1–19, for an excellent discussion of the rhetorical nature of Coleridge's distinctions and of the comprehensive nature of allegory in general.

[34] "Hawthorne and His Mosses," *The Apple-tree Table and Other Sketches*, ed. Henry Chapin (Princeton, 1922) pp. 82–83; *Hawthorne's Fiction*, p. 13. The ensuing quotations of Melville are from this famous review and will not be noted.

[35] H. H. Waggoner, *Hawthorne: A Critical Study* (Cambridge Mass, 1955), p. 58 (et passim) presents the same general conclusion, but without much clarity of definition: "Hawthorne's best tales exist . . . in a realm somewhere between symbolism and allegory, as those terms are used today."

writing, but the following remarks concerning M. de l'Aubépine in the preface to "Rappaccini's Daughter" show that Hawthorne was not entirely happy with that tendency: "His writings, to do them justice, are not altogether destitute of fancy and originality; they might have won him greater reputation but for an inveterate love of allegory, which is apt to invest his plots and characters with the aspect of scenery and people in the clouds, and to steal away the human warmth out of his conceptions" (II, 107). Hawthorne here apologizes because the "love of allegory" over-balances and has not mixed with "human warmth." The whole context, then, supports his belief that the Actual and the Imaginary must "each imbue itself with the nature of other" in order to create scenes "that seem the reality of a better earth, and yet are the very truth of the scenes around us."[36] Unless the scenes around us can be recognized in an artistic form, their potential spiritual manifestations will not be felt or communicated. The artist must return all the way to earth from the Hall of Fantasy.

A return is necessary because of the simple empirical fact that a man cannot shake the dirt off his feet. Man may have a spirit, but it is a "spirit burdened with clay and working in matter." Even though we must accept the "composite" condition of human life, the soul can permeate the material, enabling man to weave this "mortal life of the selfsame texture with the celestial."[37]

Hawthorne, then, accepted the fact of material human existence, but he did not believe that man was necessarily forced to live a life of materialism. The soul must be given as much freedom as is possible in order that life may be preserved in its *purest* earthly form. In his 'L'Allegro,'—"Buds and Bird Voices"—he affirms, "There is no decay. Each human soul is the first-created inhabitant of its own Eden" (II, 175). By approaching life through the "renewing power of the spirit" (hence through the imagination) life can be preserved *as created,* and it is the role of the artistic imagination to save men such as the watchmaker Peter Hovenden from getting so enmeshed in the fact and flux of material decay that they cannot respond to the impulses of the soul. Hawthorne was an existentialist with enough general theology and a large enough heart and mind to see a beauty in life above a hampered existence in time and space. This is the man that Melville recommended to an American audience, for "the smell of your beeches and hemlocks is upon him; your own broad prairies are in his soul; and if you travel inland into his deep and noble nature, you will hear the roar of his Niagara." This is the man whom Julian Hawthorne knew:

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[36] *The Marble Faun,* VI, 160.
[37] "The Birthmark," II, 62, 69.

> Even when we enter the "Hall of Fantasy", or are among the guests at "A Select Party," or try the virtues of "Dr. Heidegger's Experiment," still we feel that the "great, round, solid earth" of which Hawthorne speaks so affectionately is beneath our feet. He does not float vaguely in mid-air, but takes his stand somewhere near the center of things, and always knows what he is about. Tracing back his fanciful vagaries, we invariably find them originating in some settled and constant middle ground of belief, from which they are measured and which renders them comprehensible and significant.[38]

Julian felt the empirical commitment of his father, but Hawthorne would have disagreed when Julian said his father never floated vaguely in mid-air. Hawthorne thought that at times he did get lost in the clouds, and his uncertainty greatly contributed to the shade and gloom in his work.

The major reason for the shadows in Hawthorne is, of course, artistic. His belief that the pervasiveness of variegated, attention-binding fact and flux can negate the power of the soul to see a higher reality led him to create gloomy projections of life. Life lived without relief is painted without relief. In addition, Hawthorne's portrayal of this aspect of life derives a great part of its force, as Melville realized, from its appeal to a "Calvinistic sense of Innate Depravity and Original Sin." Still, this "power of blackness" is mainly aesthetic.[39] For example, in *The Scarlet Letter* all the themes and motifs combine in a plea for man to live and act in accordance with the spiritual potential given him at birth. The fact of a 17th century Puritan colony in New England is real, but, at least in 1850, Hawthorne felt that the inherent qualities of men were allowed a freer action and more natural play in 17th century Old England; hence, fair England represented a closer approximation to the "better life." Nevertheless, I suggest that the gloom and shade in Hawthorne is antecedent to his artistic handling of the Actual; it involves the man in relation to his work. By understanding this relationship, we can see why Hawthorne apologized for his so-called "love" of allegory.

Hawthorne held in theory that an artist must visit some Hall of Fantasy in order to get a true perspective of the Actual and that he must descend to earth and "open an intercourse with the world" if his art is to serve its purpose. But at the end of "A Select Party" he says,

> How, in the darkness that ensued, the imaginary guests contrived to get back to earth, or whether the greater part of them contrived to get back at all, or are still wandering among clouds, mists, and puffs of tempestuous wind, bruised by the beams and rafters of the overthrown castle in

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[38] "Hawthorne's Philosophy," *The Century Magazine*, XXXII (May, 1886), 86.

[39] Harry Levin, *The Power of Blackness* (New York, 1958), p. 40, reminds us that Hawthorne always assumed that aesthetics and ethics were inseparable; for R. H. Fogle, the light and the dark in Hawthorne's fiction are primarily the result of the artist's moral vision.

> the air, and deluded by all sorts of unrealities, are points that concern themselves much more than the writer or the public. People should think of these matters before they thrust themselves on a pleasure party into the Realm of Nowhere. (II, 87–88)

This passage can be read as a clear description of what Hawthorne felt was his actual artistic predicament. Realizing that the Imaginary was, in point of fact, an unreality, and that its only purpose was to serve and rescue the soul imprisoned among the temporal and spacial realities of the Actual, Hawthorne knew that he must execute on paper what he could see and feel in his imagination while in his study. The cloudy figures and scenes which he talks about in his discussion of M. de l'Aubépine are not trying to escape the world through allegory or symbolism; rather they are merely trying to get back to earth. He wanted to make his pale flowers and nearly blank pages strong enough not just to withstand, but also to shape and order the Actual. All his 'Oberon's,' 'P's,' and Solitary Men lament that they cannot give material life and warmth to their creatures of imagination, and Melville almost could be quoting Hawthorne in any number of places when he says, "the immediate products of a great mind are not so great as that undeveloped and sometimes undevelopable yet dimly-discernible greatness" which lies within. Melville saw such a greatness in Hawthorne "to which these immediate products [the *Mosses*] are but the infallible indices." In spite of Melville's optimism, Hawthorne always felt that he failed in giving shape and substance to the vision which he saw. Whereas Melville says that the greatness of Shakespeare lies in "those occasional flashings-forth of the intuitive Truth in him," Hawthorne puts this telling parenthesis into a speech of Holgrave: "A mere observer like myself (who never have intuitions, and am, at best, only subtile and acute), is pretty certain to go astray" (III, 215). Even as late as the second edition of *The Marble Faun,* Hawthorne confesses,

> The idea of the modern Faun . . . loses all the poetry and beauty which the Author fancied in it, and becomes nothing better than a grotesque absurdity, if we bring it into the actual light of day. He had hoped to mystify this anomalous creature between the Real and the Fantastic, in such a manner that the reader's sympathies might be excited to a certain pleasurable degree, without impelling him to ask how Cuvier would have classified poor Donatello, or to insist on being told, in so many words, whether he had furry ears or no. As respects all who ask such a question, the book is, to that extent, a failure. (VI, 522–23)

Thus we see that, although he followed a consistent conception of the imagination, Hawthorne felt that he never successfully created anything "at once earthly and immortal,"[40] never imbued the

[40] "The Prophetic Pictures," I, 207.

Actual and the Imaginary each with the nature of the other. Because he felt frustrated by his own theory, part of the gloom which suffuses his work is subjective. On one hand, he believed that the shadows of half-created figures fluttered about his work, but on the other, Hawthorne himself asked Kenyon at the very end of the Conclusion to *The Marble Faun,* "Did Donatello's ears resemble those of the Faun of Praxiteles?" (VI, 527). But does such a question necessarily indicate an artistic weakness in the novel? Is it a revelation of aesthetic insensitivity to ask the question? Or to put your finger into the muzzle of Rob Roy's pistol to determine its calibre, to imagine the music of the spheres in a music box, to be overcome by the noble proportions of St. Peter's, or to feel a message in the Swiss Alps but be unable to express it? These human experiences of Hawthorne show an awe for life, an awe so strong and embracing that it cannot fail to engage our hearts and minds. I wonder if indeed he failed in his purpose of exercising the spirit through the material. If we insist on wrestling with Hawthorne's shadows, we are in great danger of missing the genius of the man that really existed. We would do well to heed this warning from *The American Note-books:* "It is dangerous to look too minutely at such phenomena ['lights and shadows']. It is apt to create a substance where at first there was a mere shadow" (IX, 219).

There is an object lesson in reading Hawthorne to be found in the account of his first view of Litchfield cathedral, "so vast, so intricate, and so profoundly simple, with such strange, delightful recesses in its grand figure, so difficult to comprehend within one idea, and yet all so consonant that it ultimately draws the beholder and his universe into its harmony." Draw, yes; but not absorb, for Hawthorne remained "a gazer from below, . . . excluded from the interior mystery." Hence, his rapture waned, he lost "the vision of a spiritual or ideal edifice behind the time-worn and weather-stained front of the actual structure," and began a "minute investigation of . . . the intricate and multitudinous adornment that was lavished on the exterior wall of this great church." But Hawthorne turned his attention to material detail neither completely frustrated by, nor happily oblivious of, his just-experienced wonder, for

> it was something gained, even to have that painful sense of my own limitations, and that half-smothered yearning to soar beyond them. The cathedral showed me how earthly I was, but yet whispered deeply of immortality. After all, this was probably the best lesson that it would bestow, and, taking it as thoroughly as possible home to my heart, I was fain to be content. (VII, 155–54)

Hawthorne should have been content, as well, with his own work, for it reveals that he would have been one of the few people who could have understood what Howells really meant by 'the smiling aspects of life.'[41] Hawthorne, with Ernest, could see in the Great Stone Face the "glow of a vast, warm heart, that embraced all mankind in its affections, and had room for more" (III, 414). Hawthorne says that it took imagination to feel the spirit of the Face, and in Hawthorne imagination is a quality of the soul. Hawthorne's man of imagination, then, does not have to live in the clouds; rather, he chooses, as the politician did not will to do, to enlarge his spirit by living on this earth by the truths of imagination. Having no strict philosophy of his own, Hawthorne could not say just what those truths might be. Young Goodman Brown could have exercised his spirit equally well either through religion or by an abiding love of his wife. The choice is unimportant to Hawthorne, so long as a choice is made. He implied as much when he had the occupant of the Intelligence Office confess, "I am no minister of action, but the Recording Spirit" (II, 380), for Hawthorne professed no special philosophy, but recorded the truths of men's successes and failures in choosing to exercise their spiritual potential. Because he sincerely believed that "the deeds of earth, however etherealized by piety or genius, are without value, except as exercises and manifestations of the spirit,"[42] it mattered little to him whether a man should choose to live by a Romantic ideal or by Calvinism or by any other philosophy or religion, for "each human soul is the first-created inhabitant of its own Eden."

All men have minds, hearts, and souls; therefore, all men can understand, feel, and act upon the imaginative figurings-forth of an artist. Hawthorne ultimately suggests, then, that "he whose genius appears deepest and truest excels his fellows in nothing save the knack of expression; he throws out occasionally a lucky hint at truths of which every human soul is profoundly, though unutterably, conscious."[43] Hence, "there is no harm, but, on the contrary, good, in arraying some of the ordinary facts of life in a slightly idealized and artistic guise";[44] so doing affords the reader an opportunity to exercise his spirit, raising him out of time and space to a position where he can better enjoy the potential richness of this life. Hawthorne's fiction reminds us that, "the great book of Time is still spread before us; and, if we read it aright, it will be to us a volume of eternal truth."[45]

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[41] Although their reports of the human scene differed in tone both writers wrote from a comic point of view. R. R. Male, however, believes that Hawthorne's was a tragic vision, in spite of the fact that he also believes that "the last four books of *Paradise Lost* remain the best possible introduction to Hawthorne" (*Tragic Vision*, p. 162).

[42] "The Artist of the Beautiful," II, 527.

[43] "The Procession of Life," II, 240.

[44] Preface, *The Snow Image*, III, 386.

[45] "Earth's Holocaust," II, 449.

Hawthorne is a great writer, great not because he attempted allegory, but because he did not. G. P. Lathrop believed that Hawthorne was a "man of reverie, whose observation of the actual constantly stimulates and brings into play a faculty that perceives more than the actual." He called that faculty "the idealizing, imaginative faculty," and concluded with words which show us where Hawthorne's imaginative genius lay: "capable of extracting the utmost intellectual stimulus from the least of mundane phenomena, he maintained intact a true sense of relativity and a knowledge that the attainable best is, in the final analysis, incomplete."[46] Perhaps we no longer need the subtle corrective at the end of Hawthorne's critique on M. de l'Aubépine:

> His fictions are sometimes historical, sometimes of the present day, and sometimes, so far as can be discovered, have little or no reference either to time or space. In any case, he generally contents himself with a very slight embroidery of outward manners,—the faintest possible counterfeit of real life,—and endeavors to create an interest by some less obvious peculiarity of the subject. Occasionally a breath of Nature, a raindrop of pathos and tenderness, or a gleam of humor, will find its way into the midst of his fantastic imagery, and make us feel as if after all, we were yet within the limits of our native earth.

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[46] "A Biographical Sketch," *Works of Hawthorne,* XII, 516, 534, and 567.

THE PROTESTANTISM OF THE ABBÉ PREVOST*

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André Chamson of the French Academy writes the preface to the latest biography of the Abbé Prévost by Claire-Eliane Engel. He begins by telling the rather sensational legend about the Abbé's death. Prévost, it is said, was walking in the forest of Chantilly when he was stricken with apoplexy. There he was found by peasants who carried the body to the priest of a nearby village. Since the cause of death was uncertain and some persons suspected foul play, a surgeon began at once to perform an autopsy upon the supposed corpse. Suddenly the surgeon and his assistants were startled by a horrible cry. The corpse came to life. Unfortunately, the autopsy had proceeded so far that the Abbé actually did die soon after his brief return to life.

M. Chamson uses this story to make the analogy that the author of this latest biography of Prévost, *Le Véritable Abbé Prévost,* has chosen for her subject, not a cadaver, but a man very much alive through his great work *Manon Lescaut.*[1] For me, also, Prévost is very much alive, but he lives for me through his novel *Cleveland.* The true Abbé Prévost is for me not exactly the same person whom Miss Engel presents. Her portrait is for me only a partial one which needs to be completed by a study of Prévost's later novel, *Le Philosophe anglais,* or *Cleveland,* as it is usually called, the story of the search for a satisfactory philosophy of life by the English philosopher Cleveland.

Miss Engel's recent biography enlarges upon an interpretation of Prévost which she presented in a 1952 article, "La Vie secrète de l'Abbé Prévost."[2] Here she argued that in 1728, just before he fled from the Benedictine order to six years of exile in Holland and England, he was a convert to Protestantism. Part of her evidence is drawn from letters she has discovered. Except for some minor reservations,[3] I can accept the conclusions she draws from these letters. It is consistent with earlier events in the Abbé's life that he may have been a proselyte at that time. He had been a Jesuit, had twice escaped from that order, been twice forgiven and reinstated

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[1] "Preface," *Le Véritable Abbé Prévost* (Monaco: Rocher, 1957), pp. 7–8.

[2] *Revue des sciences humaines,* Juillet–Septembre, 1952, pp. 199–214.

[3] Note her explanation that the reference to "Dom Prévost et il s'apelle de l'Islebourg," may be an error for Prévost d'Exiles. Ibid., pp. 202–203.

before he fled again and later entered the Benedictine order, taking his vows, he himself says, with mental reservations that would justify breaking these vows later.

My real difference with Miss Engel's conclusions in her 1952 article concerns her use of passages from *Cleveland* as evidence that Prévost was a convert to Protestantism. She fails to consider the context of these passages and their relation to the purpose and the structure of the whole novel.[4] The purpose of this paper is to discuss these passages in relation to the question of Prévost's Protestantism and to consider the theme, plot structure, and tone of the novel as further evidence toward reaching a conclusion as to Prévost's attitude toward Protestantism, an important consideration in any complete evaluation of his character and work.

In her recent critical biography, *Le Véritable Abbé Prévost,* Miss Engel finds the real Abbé to be an extremely unstable person.[5] Near the end of her book, she summarizes what she feels are his intellectual deficiencies:

> Une seule croyance reste inébranlable chez Prévost: sa foi en la bonté de la nature. On peut se demander si cette idée enracinée en lui n'est pas l' unique dogme auquel il finisse par rattacher sa vie spirituelle. La philosophie pure ne l'a jamais tenté. Sa religion n'est qu'une morale, qui ne le lie pas. Il discute la religion, toutes les religions, en se fiant aveuglément à la raison humaine, la sienne. Les croyances orthodoxes se concilient chez lui, avec une aisance extraordinaire, avec des opinions religieuses à la fois avancées et timides. Une nécessité intellectuelle ne lie pas jamais. D'où son arrogance sur certains points, ses crises de certitude et ses refus soudains de prolonger une recherche ou d'en admettre les résultats. Lorsque l'intuition sentimentale lui fait défaut, il sombre dans l'incohérence. Toute spéculation abstraite se révèle contraire à sa nature profonde, le rebute et éveille sa sensibilité. La culte du vrai et de l'utile amène Prévost à révéler avec complaisance et souvent avec génie une âme bien curieuse: la sienne.[6]

Like nearly all the biographers and critics who have preceded her, Miss Engel praises the Abbé's contribution to the sentimental novel and the emotional power of his masterpiece, *Manon Lescaut.*

There is plenty of evidence to support this estimate, but I maintain that it is only a partial estimate and that Miss Engel ignores qualities of the real Abbé Prévost which are revealed by a study of his novel *Cleveland.* Prévost's statement of his purpose and his plan for the novel, the structure of the plot, and the intellectual content of the story show Prévost as an author who has a deep concern for the intellectual life of his period, as a man who is attracted, not repelled by philosophical speculation.

[4] Ibid., pp. 209–210.
[5] *Le Véritable Abbé Prévost,* p. 46.
[6] Ibid., pp. 282–283.

Of the biographers and critics who have written on Prévost, only Franz Pauli has given a detailed analysis of the intellectual content of Cleveland.[7] Even such an authority as Gustav Lanson, writing on the revolt against orthodoxy in the France of 1700–1750, groups Prévost with Marivaux and Piron among those early eighteenth century writers who were unaffected by the violent religious and philosophical controversies of their time.[8]

It seems strange that nearly all critics have ignored the several pieces of evidence in the case of *Cleveland* that the author was much concerned with religious and philosophical controversy, that in spite of that side of his nature which responded to the call of the world and to the sensuous and sentimental, there was another side of his nature which has never been adequately recognized.

Important pieces of evidence for such a revised estimate of the true character of Prévost are his defense of his purpose in writing *Cleveland,* his statement that his views are the same as his hero's, the structure of the plot, the content and tone of the narrative.

Prévost has made a clear statement of the theme of *Cleveland.* After the publication of the first four volumes (1731–32), he published an answer to the criticism that the novel was deistic in which he stated that his purpose was to show that peace of mind and true wisdom came only through religion. This defense he republished in the preface to the continuation volume of 1738.[9] He had said in an earlier preface that his views so closely resembled Cleveland's that their minds might be said to be cast in the same mold.[10]

An examination of the plot structure and content of *Cleveland* supports Prévost's statement of the theme and indicates an author who is concerned with religious and philosophical controversy. The views of the hero of the novel, with which the author says he agrees, are not those of a man repelled by philosophical speculation. Without minimizing the evidence for the sentimental aspects of the many-sided character of Prévost, a careful reading of *Cleveland* supports the contention that the usual estimate of the author's character and interests needs to be revised and enlarged.

The reader who looks beneath the superficial plot of melodrama and sentiment finds in *Cleveland* a novel of ideas. The fundamental theme, obscured by the intrigue and adventure of the typical eighteenth century novel, is the hero's search for a religious faith that is rational in its basis. The conclusion of the search is the rec-

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[7] Franz Pauli, *Die Philosophischen Grundanshauungen in den Romanen des Abbé Prévost im Besonderen in der Manon Lescaut,* Marburg, 1912.

[8] Gustav Lanson, "Questions diverses sur l'histoire de l'esprit philosophique en France avant 1750," *Revue d'histoire litteraire de la France,* XIX (1912), 2–4.

[9] "Avertissement," *Le Philosophe anglais* (Utrecht: Neaulme, 1738) VI, ii–iv.

[10] "Preface," Ibid. (1736), I, iii–iv.

ognition that man has need for both intellectual and emotional satisfaction. The structure of the plot is broken into five stages

1. The period of Cleveland's faith in natural philosophy, of which the fundamental doctrine is Stoical, that the passions are responsible for all evil and that man could be happy if he could overcome the passions by the use of reason.
2. The period of disillusionment with natural philosophy because it fails to bring strength to bear great sorrow.
3. The examination of orthodox religions, all of which fail because they do not meet Cleveland's standards of rationalism.
4. A period of alliance with a group of French *philosophes* who are influenced by Hobbes' materialism.
5. The conversion to "true religion" which reconciles rational philosophy with religious faith, or as Cleveland puts it, shows that natural law needs to be supplemented by the law of grace.

Such a plan for a novel is scarcely evidence that Prévost was not concerned, as Lanson has stated, with the controversial matters in the philosophy and religion of his period, or, as Miss Engel has stated, that he becomes incoherent when sentimental intuition fails him and is repelled by philosophical speculations. In fact so many pages of *Cleveland* are given to long discussions of philosophical and religious controversies that a sort of *Reader's Digest* condensed novel was published in 1788, which omitted all pages of intellectual discussion and gave the reader only the melodramatic story of Cleveland's adventures in England, America, and France.

Cleveland's natural philosophy is summarized and the deistic religion, which he taught to a tribe of American Indians during his period of rationalism, is explained in detail. In his period of disillusionment, he carefully analyzes his former views to see if he can find any flaw in them. He finds no logical flaw, only their failure to bring comfort in his time of great sorrow. When, to please two members of his household, he listens to the views of both a Protestant clergyman and a Catholic priest, the conversations and expositions are painstakingly recorded. The *philosophes* are treated at less length. But the resolution of the conflict between rationalism and religious faith through Cleveland's conversion to a religion that satisfies his reason and gives him a comforting faith, produces pages of discussion of philosophy and religion.

This emphasis upon the religious and philosophical controversies of the early eighteenth century does not support Miss Engel's conclusion that pure philosophy never holds Prévost, that abstract speculation is contrary to his nature, that it repels him. This novel of ideas presents a side of Prévost's character which is a part of any just estimate of Prévost. The real Abbé Prévost is more than a sentimentalist.

Another point upon which I disagree with Miss Engel's interpretation is her use of Cleveland's conversations with the Protestant minister as evidence for Prévost's being a convert to Protestantism. The speech of Minister C., says Miss Engel, could have been written only by a Protestant.[11]

Here, I feel, Miss Engel has lifted the words of Minister C. out of the context of the novel and has not considered the manifest theme of the novel, the contribution of this conversation to the development of the theme, and the satirical tone of all the incidents concerning Cleveland's investigation of orthodoxy. Miss Engel states that Cleveland sends for the Protestant clergyman,[12] but Cleveland says that his sister-in-law and his friend Mme. Lallin were so concerned over his depression and his attempt at suicide that they arranged to distract his mind by conversations with some of the intellectuals residing in Saumur. Since Mrs. Bridge, the sister-in-law, was a Protestant and Mme. Lallin was a Catholic, Cleveland agreed to discuss religion with both the Protestant Minister C. and the Jansenist priest Father LeBane.[13]

These conversations about orthodox religion are a contribution to the third step in the evolution of Cleveland's ideas from natural philosophy and deistical religious belief toward the "true religion" which he finally accepts. The theme of the search for a satisfying religion is worked out by a plan of eliminating one by one the views that either fail to satisfy his reason or to meet the needs of his heart after he has suffered great personal loss. The conversations with Minister C., with Father Le Bane, and later with a member of the Jesuit order are all parts of the eliminating process in the search for the truth.

The tone of Cleveland's comments in introducing these conversations is satirical. On the matter of the many Protestant sects, he says that sectarian differences have hitherto prevented him from examining orthodox religion. If the total number of religious sects were reduced to fifty, each one would consider the other forty-nine in error and itself the sole possessor of the truth. Where, he asks, can I find light enough to discover which one does possess the truth?

> Supposons, avois-je dit, que le nombre de toutes les Sectes se réduise à cinquante. Il n' y en a pas une seule qui ne condamne toutes les autres, & qui ne se croye seule en possession du vrai culte. Mais les quarante-neuf autres, qui s' attribuënt le même avantage, la condamnent aussi. Si je les interroge séparément, ou toutes ensemble, je trouve toujours quarante-

[11] "La Vie secrète . . . ," p. 210.
[12] Ibid., p. 209.
[13] *Le Philosophe anglais* (Neaulme, 1736), V:69–72; 80–83.

> neuf voix, qui sont contraires à chacune, & une seule voix qui lui est favorable: encore n'est-ce que sa propre voix. J'ai donc toujours quarante-neuf motifs contre un, pour les rejetter toutes, & les croire fausses sans exception. Je veux néanmoins supposer encore qu' il n'y ait que quarante-neuf Sectes dans l'erreur, ce qui est absolument necessaire, s'il est vrai qu'il y en ait une qui n'y soit point: Suis-je plus avancé après cette supposition? Où trouverai-je assez de lumieres pour démêler celle qui posséde le précieux trésor de la vérité?[14]

As Cleveland has anticipated, both the Protestant Minister C. and the Catholic Father Le Bane attempt to demonstrate that his church represents the only true religion.

Cleveland finds that the Catholics look upon the Protestants as rebels who have risen against a good king, a king who ruled with a code of laws that had for its purpose the happiness of all people. This rebellion was incited by obscure persons motivated either by resentment or a love of change. On the other hand, the Protestants regard themselves as patriots who have put down a usurper, one who overthrew the legitimate king, instituted new laws, and denied the people the right to read the laws of the legitimate king.[15]

Both Catholic and Protestants lack logical proofs for their views, Cleveland thinks. He says of the Protestant minister that "his system seemed reasonable enough to make me wish he were able to support it with some solid proofs."

> . . . son Systême parut assez raisonnable pour me faire souhaiter qu'il pût l'appuyer dans la suite par des preuves solides.[16]

After talking with the Jansenist, Cleveland remarks that since he had never been disposed to believe without proofs, it would take something less general to persuade him.

> Cependant comme je n'étois pas disposé à croire sans preuves, je lui fis connoître qu'il falloit quelque chose de moins général pour me persuader.[17]

He later characterizes the picture he received of orthodox religion as "sad and repulsive."[18]

The tone throughout the novel is equally satirical and objective whether the orthodox views are Protestant or Catholic.

Satire of the Protestants is introduced even before the conversations on orthodox theology by incidents and characterization. Cleveland is the natural son of Oliver Cromwell, who abandoned his mistress, Elizabeth Cleveland; and it is his malicious plotting against the lives of Cleveland and his mother that initiates the action in the

[14] Ibid., pp. 75–76.
[15] Ibid., pp. 82–86; 88–91.
[16] Ibid., p. 80.
[17] Ibid., p. 86.
[18] Ibid., (Rouen: Racine, 1785), VIII, 205. It is necessary to refer to a different edition for this passage as the last volume of the 1736–38 continuation volumes is missing.

superficial melodramatic plot. Bridge, another illegitimate son of Cromwell, has an experience in the Protestant colony on St. Helena which shows the Protestant minister of the group to be one of the most bigoted and cruel of men.

In satirizing the Catholics, Prévost is just as severe. Because Cleveland becomes confused by listening alternately to Catholic and Protestant dogma, he decides to hear all Minister C. has to say and then to listen to Father Le Bane's counter-arguments. When the Catholic hears this decision, he takes action. Cleveland receives a *lettre de cachet* and with his two sons is made a prisoner by the church. The reason given him is that he has showed so great an interest in religion that the church wants him to receive correct instruction.[19] Standing on his rights as a British citizen and appealing to the British-born Duchess d'Orléans, Cleveland gets his freedom.[20]

Then, through the Duchess, Cleveland is introduced to a worldly Jesuit who, the Duchess assures him, will give him a cheerful view of religion. A series of episodes here satirize this Jesuit. He recommends light reading and falling in love as a cure for Cleveland's melancholy. With convenient casuistry, he persuades the Catholic Mme. Lallin to betray Cleveland's plan to escape to England.[21] (These passages and all passages satirical of the Catholic religion were amended or omitted in the censored editions of 1757–1785)[22]

The relation of Cleveland's examination of orthodox religion to the theme and structure of the whole novel argues rather for an objective disapproval of all bigotry and dogmatism and any kind of narrow sectarianism than for a sympathetic attitude toward Protestantism on the part of Prévost. It may indeed be true that he was for a period a proselyte to Protestantism but the content and tone of *Cleveland* is such that it is difficult to accept Miss Engel's argument that the speech of the Protestant Minister C. could have been written only by a Protestant. In relation to the development of the plan for the whole novel, the conversation with Minister C. appears to be one incident of several which reveal the weakness of orthodoxy.

To the satire of orthodox religion, both Catholic and Protestant, should be added a passage lamenting the divisions of religious people into sects separated by narrow dogmatism; this passage occurs at the end of the story of Cleveland's conversion and was omitted from the censored editions published between 1757 and 1785.

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[19] Ibid., (Neaulme, 1736), V, 93–94; 102.
[20] Ibid., pp. 102–108.
[21] Ibid., pp. 257–289.
[22] See my paper, "Variations in the Texts of Eighteenth Century Editions of *Le Philosophe anglais*," *Transactions of the Wisconsin Academy of Sciences, Arts and Letters*, XXXII (1940), pp. 187–198.

> Je tremble néanmoins que ce ne soit faire tort à la religion que d'en resserrer les élemens dans les bornes si étroites. . . . J'ajoute que , n' étant encore qu' à l'entrée de la Foi, je ne pouvois être arrêté par la concurrence de quelques Religions monstrueuses qui sont opprobre de la Raison; et quand mon objection auroit eu quelque force, ce ne pouvoit être qu' à l'égard des différentes sectes qui partagent le Christianisme.[23]

These passages are representative of many others which deal with the principal religious and philosophical controversies in the thought of the early eighteenth century. On the one hand is the rationalism of natural religion; on the other, the supernaturalism of the revealed religion of orthodoxy.

An analysis of the "true religion" to which Cleveland is converted shows that he resolves the conflict by accepting the best in each but without becoming a convert to any orthodox church.[24] He appears to have no connection with any organized group. He is converted by a layman, Lord Clarendon, who at this time is living in exile in France. There is no mention of any clergyman or any church. Orthodox ideas such as a conviction of sin, salvation through repentance and the vicarious sacrifice of Christ, the sacraments of baptism and communion play no part in the discussions of this "true religion." Conversion seems to be an individual matter of intellectual acceptance of the fact that man needs supernatural help in order to lead a good life and to bear the sorrows that are a part of life.

Cleveland discovers that his earlier views are incomplete and need to be supplemented, although they are consistent with his new views and have prepared the way for them.

> . . . sans abandonner l'étude de la nature, dont je n'avois guere moins de fruits à tirer pour les mêmes vues, puisqu' à des yeux biens êclaires par le Religion l'ordre naturel se raporte à Dieu comme celui de la grace . . . cette disposition, dans laquelle il [le Chrétien] est soutenu par les secours intérieurs de la Religion, lui fait conserver cette paix & cette égalité d'âme dont la seule Philosophie ne donne que l'ombre, & qui est déja comme une anticipation de bonheur auquel il aspire.[25]

Again, I can partially agree with Miss Engel, for she says that Cleveland almost returns to his first position of rationalism.[26]

But she does not note that Cleveland has reconciled the differences between rational philosophy and revealed religion, that he is in agreement with many English and French rational theologians of his period in maintaining that a true religion can stand the tests of the rational point of view.

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[23] Ibid., p. 187.

[24] See my paper, "The Religious Convictions of the Abbé Prévost," *Transactions*, XLI (1952), 189–199.

[25] *Le Philosophe anglais* (Rouen: Racine, 1785), VIII, 213–214; 215.

[26] *Le Véritable Abbé Prévost*, p. 282.

Cleveland's unorthodox religion retains his earlier beliefs that the reason must be satisfied, that love of God and of fellow men, regard for principles of justice, and a high standard of ethics are more important than dogma. But I can not agree with Miss Engel that this is a reconciliation of orthodox views with religious opinions that are at the same time advanced and timid, a reconciliation attained with extraordinary ease.[27] A reconciliation of conflicting views which has been attained through years of search for a satisfying faith that will meet the needs of both head and heart, has not been easily attained.

In using Cleveland's final statement of his religious views as evidence for a fairer estimate of the character of the real Abbé Prévost, it is important to remember these words from the author's preface to the novel:

> Je trouvai en effet de rapport entre les inclinations de Mr. Cleveland & les miennes, tant de ressemblance dans notre maniere de penser & dans nos sentimens, que je confessai au Fils, que je m'étois reconnu dans les traits de son Pere, & que nos coeurs, si l'on me permet cette expression, étoient de meme trempe & sortis de même moule.[28]

An examination of the principles of this "true religion" shows that they are more advanced in tolerance and breadth of ideas than is the dogmatic sectarian religion of orthodoxy, but the satire of orthodoxy which precedes Cleveland's conversion is far from timid.

The story of his examination of Protestant and Catholic orthodoxy occurs in the volumes published in 1731–32 when Prévost was an exile from France and the church. The story of Cleveland's conversion concludes the continuation volumes of 1736–38, published after Prévost's reconciliation with the church and the Benedictine order in 1734.

The satire of the Jesuits in these continuation volumes is milder and more tolerant in tone than the previous satire of orthodoxy, but the tone is not timid; it is mildly amused over the inconsistencies of human beings and it accepts the fact that there are great differences of opinion in matters of religion; it is the tone of a man who views life as it is, not as it ought to be.[29] As mentioned above, Cleveland still regrets the many sectarian divisions among religious people.[30]

In his fairly detailed summary of the principles of his new religion, Cleveland arranges in order of rank according to importance

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[27] Ibid.

[28] *Le Philosophe anglais* (Utrecht:Neaulme, 1736), I, iii–iv. The explanation of the reference to Cleveland's son is that Prévost first represented the novel to be the memoirs of an actual person, Mr. Cleveland, published from a manuscript obtained from his son.

[29] Cooper, "The Abbé Prévost and the Jesuits," *Transactions,* XLIII (1954), pp. 125–132.

[30] See footnote 23.

the desires of his heart and the duties and pleasures of life: first, love of God and heavenly things; then, in order of descending importance, religious duties, love for his wife, duties toward friends and society, study of the Bible without abandoning the study of nature, and last the moderate use of pleasures of the world. He stresses moderation in the use of pleasure and condemns absolute withdrawal from the world, although he does not specifically mention monastic life in his condemnation of such withdrawal as excessive zeal, and a fanaticism which wounds religion as well as nature.[31]

These views are closer to Deism than to orthodox Protestantism. They are very far from Catholicism, and it is interesting to note that Cleveland's wife has been converted to Catholicism, that before his own conversion Cleveland envied his wife the comfort she drew from her religion; also it is interesting that his wife shows no zeal for converting Cleveland to Catholicism and seems to approve of and agree with many of the ideas of his "true religion" after his conversion. In this respect the narrative is an example of the principle of tolerance.

Cleveland's religion has much in common with the views of various free-thought groups of the late seventeenth and early eighteenth centuries. In the emphasis upon belief in God with no mention of Christ or of any Trinitarian ideas, this religion has the characteristics of Unitarianism which was influencing thought in Europe and England during this period. English Latitudinarians would agree with Cleveland's emphasis upon beliefs fundamental to all religions and his disregard for sectarian creeds.

On the basis of the principles of Cleveland's religion, with which Prévost states he agrees, on the basis of the theme of the novel as stated in the preface and the structure of the plot which consistently supports this theme, and on the basis of the tone toward orthodoxy, the conclusion offered by this paper is that Prévost was a protestant without the capital letter. He protested narrowness and unreasonable views in matters of religion. He protested the intolerance and bigotry of those who called themselves religious leaders. He protested pure materialism and an exclusively rational philosophy. He asserted that both reason and emotion must be the basis of any satisfactory religion.

For the reader who will consider the integration of theme, structure, intellectual content, and tone of the novel *Cleveland,* there is evidence that the Abbé Prévost was not only a master of the sentimental novel, but a writer so deeply concerned with the issues in the intellectual controversies of his time that he wrote a coherent

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[31] *Le Philosophe anglais* (Rouen: Rouen, 1785), VIII, 213–214.

argument for a religion purified from the corruption of narrow dogmatism. The novel *Cleveland* emphasizes ethical living rather than orthodox creed as the basis of true religion.

The evidence presented in this paper is only a small part of the evidence which exists in the bibliographical history of Cleveland, in the structure, and in the content of this novel to support the thesis that a complete portrait of Prévost and a fair estimate of his work recognizes his contribution to the intellectual history of his time. From an examination of the novel *Cleveland,* this reader can not accept a characterization of the author as a shallow thinker to whom abstract speculation is repulsive.

EXISTENTIAL NIHILISM AND HERMAN MELVILLE*

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There are many critical manners of looking at any writer. It is impossible for anyone to absolutely disclaim the validity of any of these manners. For instance, we can study Shakespeare from the varying points of view of (1) the Renaissance stage conventions that shaped his work, (2) historical and biographical data that illuminate his work, (3) problems in textual scholarship, (4) the New Criticism's wholly aesthetic approach, or (5) the medieval and renaissance notions of cosmology and ethics that inform his plays—and there are many more approaches. This study explores the point of view of the existentialist as critic of life and literature and then suggests how this point of view may be valuable in regarding the works of Herman Melville.

I

Existentialism is in our time a household word, and it is applied to every study from politics to literature—often wrongly, often cheaply and sensationally. It has been commandeered by novelists like Richard Wright to explain the plight of the Negro as an *outsider*. It has been attached to singer Juliette Greco; and it has been taken over in part by the San Francisco Beats. But in its most seriously philosophical terms, it is a form of ontology or at least of phenomenology. And it can, as such, direct the thinking of a literary critic in exegesis of certain kinds of literature.

Existentialism as a philosophical movement, or rather as a way of looking at oneself and the world about one, is not a recent phenomenon. For the average reader it has been linked only with certain bohemian cafes in Paris after World War II. Undesirable sensationalism, faddism, cultism, and superficial sophistication have all unfortunately attached themselves to the most recent manifestations of this method of thought and drawn upon it the disapproval of the serious intellectual in other countries besides France. I say that this is unfortunate not out of pity for the existentialists, but out of regard for the general understanding of intellectual movements and their consequences in history. Existential thought is a very real and a very potent force in modern living, and a blindness to this movement or trend is a blindness to what is happening

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around one. I fear that our conservative scholars, disgusted by some of the lunatic fringe and the cultism of modern existentialism, have committed themselves to a seriously debilitating blindness in the field of modern philosophical movements. This is particularly true, I think, of our literary critics. Existentialism in the twentieth century is closely linked to literary art. The most important of recent existential thinkers have not been philosophers only, but literary artists. I am thinking particularly of Jean-Paul Sartre, Albert Camus, and Simone de Beauvoir.

A literary critic whose field is American literature of the period from 1830 to 1860 would scarcely dream of divorcing an examination of the works of Ralph Waldo Emerson, Henry David Thoreau, and Walt Whitman from Transcendentalism, that extraordinary brand of idealism which dominated the thought and literary creations of these men. Even the critics of their era were aware of their philosophical biases and duly noted them. By the same token literary critics of our time should not close their eyes to existentialism.

Existentialism is not new. Its elements certainly appear in the fragmentary philosophies of the pre-Socratic philosophers. Thales, Heraclitus, and the major Sophists all represent certain existential attitudes. With the coming of Socrates and Plato, idealism swept away the relativism and pluralism of the pre-Socratics, and the ordered rationalism of Aristotle's mind denied the irrational elements which are foundations of existential thinking. On Socrates, Plato, and Aristotle the philosophy of twenty centuries was built. With a few notable exceptions the philosophical and religious thought of those centuries was dominated by three factors: by idealism, optimism, rationalism, or by a combination of two or three of them. It is true that some of the Church mystics were irrationalists. There were also some heretic, pantheist mystics in the history of Western thought. Indeed, late Roman Stoicism was a tiny camp of pessimism and anti-idealism in the Western world, but it was eventually smothered by a combination of Christianity, Platonism, and Aristotelianism. In general this long twenty-century period was thoroughly dominated by the rationalism of Plotinian Christian Platonism, the rationalism of St. Thomas Aquinas' Aristotelian Christianity, and a general feeling—despite human cruelty, plagues, fires, pestilence, wars, famines—that God was in his heaven and all was right with the world.

The eighteenth century saw a de-emphasis of God and a deification of Reason. But this was merely an emphasis on another aspect of the same general train of thought that had prevailed since the great Greeks. Granted, the eighteenth century upheaval was enormous. The movement from religious to secular thinking was profoundly disturbing to the world, but in some respects it was merely a surface manifestation of something far more significant going on underneath.

During the second half of the eighteenth century and throughout the entire nineteenth century, Germanic idealism seemed to dominate Western thinking. Kant, Fichte, Hegel, and the English and American transcendental followers of these philosophers were the important thinkers of the time. But it is important to notice that contemporary with these men arose two movements in thought which were to overthrow this brand of idealism. On the one hand were Marx, Engels, and dialectical materialism; on the other were Kierkegaard, Nietzsche, and the existentialists. It is ironic to note that both of these movements derived their vitality from a reaction to the systematic idealism of G. W. F. Hegel.

At this point we must be certain to note the vast differences that exist within the broad term "existentialism." One of the disturbing factors to the student of philosophy in approaching existential thought is the fact that he finds difficulty in systematizing it. There is a very good reason for this. One of the few things which all existentialists have in common is a rebellion against all systematization or attempts to unify things into wholes. It is easy to see then why Kierkegaard rebelled so violently against Hegel. The vast, artificial "world career" of Hegel, so carefully worked out through thesis, antithesis, and synthesis, was maddening to Kierkegaard. He saw it not as the dynamic process which Hegel had intended, but as an empty shell without a self. The thing which was missing was the philosopher himself. No man, said Kierkegaard, can set up an artificial system which actually represents external reality, because all he can know is within himself. His senses are faulty, even with the most intricate extensions of them which man can contrive. Knowledge comes from within, but not from Kant's ordered categorical and intuitive Reason. Rather "Truth is subjectivity," says Kierkegaard. Nietzsche extends this thought to the extreme of the Superman. The will to power is the subjective force of truth. Man alone must breed moral superiority by reversing the weak moral tenets of Christianity.

For both of these men the world presented a welter and a chaos. It was "absurd," in the sense that it was, they felt, vastly different in its physical and psychological reality from what man, through scientific rationalism and blind idealism, attempted to bend it into. The "absurd," then, arises out of the ironic disparity between what promises the world actually makes to man and what man fancies he sees in the world or what he, with his infinitely complex moral imagination, thinks that the world should be. This element of existentialism can be recognized as a favorite theme of world literature. It is the basis of Shakespeare's *Hamlet*. For the existentialist, Hamlet is the "absurd" man. It is a particularly potent theme in literature beginning with the Romantic movement in the late eighteenth century and continuing with some abatement through the nineteenth and twentieth centuries. The definition of "Byronism" is contained within the dichotomy of the ironic "should-be" and "is." Goethe, Keats, Tennyson, Baudelaire, Poe—all of these men represent this theme in their works and lives.

But Nietzsche was an atheist (or at any rate a violent anti-Christian), and Kierkegaard was a great Christian theologian. How can this wide disparity occur? I suggested previously that all existentialists are different. Since they are anti-systematists it is difficult to make philosophies or systems out of their thinking. Kierkegaard said that the fact that man feels himself alone within his subjective being, that he is riddled with the anguish of existence, aware of the chaos of the real world around him, aware that existence and the universe are "absurd"—this is the fact, Kierkegaard says, which helps produce the leap of faith by which man discovers that God *is* the "absurd." There is a bitter relief and glory in this realization which is one way of regarding the gift of Grace. It is perhaps easy to see in this what some of the more realistic and less sanguine Christians have maintained about Christianity from the very beginning. All the great mystic saints of the Church have been aware of the "dark night of the soul," the agony of being a Christian.

Modern atheistic existentialists such as Martin Heidegger, Jean-Paul Sartre, Albert Camus, and Simone de Beauvoir are probably most responsible for the twentieth century revivification of existentialist thought. But there are Christians among these contemporary existentialists. Father Gabriel Marcel, Karl Jaspers, and even Reinhold Niebuhr can be classified, at least in part, as existential thinkers. There is a similarity in thought amongst all these writer-philosophers, up to the point, that is, at which the Christians make the leap of faith. Existentialists see man thrown alone into a materialistic jungle. If he keeps good faith with himself, he realizes his aloneness and does not create moral fantasies around himself. This realization causes dread, anguish, "fear and trembling," and even "nausea." Concomitant with this feeling of aloneness comes a nauseating awareness of subjective selfhood. The existentialist becomes terribly aware of himself as a single, individual entity in the process of creating itself. In a world with no external values, the individual is faced with the fact that he is merely a blob of sentient and intelligent protoplasm with the necessity of shaping not only its own personality, but its entire code of values. In other words, in every action a choice is made by the individual which helps to delineate the values of the individual and therefore adds to the totality of his personality. This holds particularly true in the case of the actions of an individual facing death. The way he faces death sums him up.

Thus the existentialist sees that the world is "absurd." It is "absurd" because of the incongruity between the chaotic nature of the universe into which man is thrown and the functioning of man's moral imagination. In other words, man's mind is so constructed that he conceives of an ordered moral universe. He does not live in such a place, they say. Consequently, he is torn among the following possibilities: living in a constant dream fantasy (where, by the way, he is continually betrayed); not living in this impossible environment at all (suicide); or living in this chaos stripped bare of the trappings of all false systems, schemes, moral formulae, easy religions, God-comfort, "Ben-Franklin" type moral virtue—everything.

These are the only three paths. The first—for the person who respects intellect and reality—is unthinkable. It is hiding; it is unreal; it is escape. It might be a solution, of course, but in the long run reality will betray the illusion. All the false codes and formulae break down and betray. So the strong man has only two paths to choose; he may commit suicide, or he may face the chaos of living in this bitter world he never chose and learn to live without hope in the midst of absurdity—in fact, to become an "absurd" man as did Hamlet. Hamlet suddenly sees the world bare, denuded of the pretty formulae presented him in youth and in "your philosophy" at Wittenberg. And the world becomes an "unweeded garden." Things "rank and gross in nature" possess it entirely. Hamlet sees the vast absurdity of man in this world (note his "What is man?" speech), and for a time, when he realizes the horrible necessity for self-definitive action on his part, he contemplates the other path—suicide (note the "To be or not to be" soliloquy). But when he decides to live in the chaos in which love is a liar; his mother a whore; his unshriven, ghostly father a wanderer in an earthly purgatory; his uncle a bestial, lecherous murderer; his school chums his potential murderers—when he decides to live in such a world, he realizes that the "readiness is all." Note that he comes close to accepting the philosophy of Horatio, the friend who admits that he is "more of an antique Roman than a Dane." Horatio is a Stoic, and we have already observed that is many respects Roman Stoicism was a sort of ancient existentialism. For the Senecan Roman there was no moral fantasy. The Stoic admitted he had been tossed into a chaotic universe. He either learned to live in that bitter environment (as did Marcus Aurelius) or he calmly slashed his wrists and bled to death while unconcernedly gossiping or reciting poetry (as did Petronius Arbiter).

Hamlet, in some respects, follows both paths. He learns how to live in this world in the sense of performing the necessary self-definitive actions. But his actions lead inevitably to his own destruction. So Hamlet becomes an excellent archetypal existential figure.

At the point of choosing one of the three possible paths—the moral dream-fantasy, suicide, or living without hope—the Christian existentialists and the atheists part. The Christian feels that at that point the leap to faith in God is made—that He *is* the "absurd," that finding him is an agony, a little Crucifixion, a bitter but glorifying experience. This, they feel, is the way to learn to live without hope—by living with faith in God. The atheistic existentialists, of course, would say that the so-called Christians are actually creating another fantasy world to live in.

Of the other two paths—suicide or actually living without hope—either is acceptable, say the atheistic or agnostic existentialists. A man may kill himself or learn to live without systems. This is why Albert Camus says in the first sentence of *The Myth of Sisyphus*, "There is but one truly serious philosophical problem and that is suicide."[1] He feels that before man can solve any other problems, he must ask himself if the pain of living is worth remaining alive. If not, suicide. But if remaining alive is worth the pain, the man must find some way to live in a bitter world and reconcile himself to the absurdity about him.

Herman Melville is one of the supreme examples of a man continuously shuttling between these two possibilities—self-destruction and learning to live in a bitter world without hope. He never succeeded in either, but he poured both of these possibilities into his literary works. As a result, in Melville's writing we find a continual undertone of actual, symbolic, and vicarious suicide, while at the same time we find a collection of heroes or major figures who are trying to come to grips with reality, to strip the world of pretenses and to learn to live outside the aegis of moral and religious fantasies and wish-fulfillment dreams. The fact that almost without exception these heroes annihilate themselves in the process is significant.

In other words, in Herman Melville, one finds an existential writer (but then, so was Shakespeare) who had probably never heard of Kierkegaard and who lived long before Heidegger, Sartre, Camus, and company.

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[1] Albert Camus, *The Myth of Sisyphus* (London: Hamish Hamilton, 1955), p. 11.

II

This discussion of existentialism will serve to place Melville in the proper category of thinkers. It is tremendously important to understand the relative intellectual and artistic position of this man who—in an age of transcendental idealism, optimism, progressivism, false liberalism, Utopian Brook-Farmism, "best-of-all-possible-worlds" philosophy, comfortable Christianity, platitudinous poets afraid of a single real idea or image in their poetry, Victorian novelists with one foot in syrup and the other being twisted by Mr. Bowdler—dared "to eat a peach," dared to "roll the universe into a ball" and hurl it at the "overwhelming question" that faced and will always face humanity. It is not necessary to call Melville an existentialist. It would be wisest not to call the existentialists by that name. The term has come to be so inclusive as to be of little value. But one must have a label for certain kinds of thinking, certain attitudes toward life. Ralph Waldo Emerson was a Transcendentalist. No one would gainsay that fact. And I think it is obvious that Herman Melville was as far from the thinking of Ralph Waldo Emerson as it is possible to go. Why not give Melville's attitudes a title also? Since existentialism is such a broad term, and since it implies a connection with people and concepts Melville never dreamt of, I use the word "nihilism" to categorize Melville's view of life. Melville's nihilism, then, is the opposite side of the coin of transcendental idealism, optimism, and general nineteenth century namby-pambyism. Is it any wonder that *Moby-Dick* and *Pierre* were such failures in their time?

Melville did not actually commit suicide; he learned to live without hope. But in his inner world of images, the world that he depicted in words on paper, Melville committed suicide over and over. Like his leaning "Tower of Pisa," he was actually only a "would-be suicide." In a late poem entitled "Pisa's Leaning Tower," Melville discusses the tower's construction and then finishes with the following personification of the masonry.

> It thinks to plunge—but hesitates;
> Shrinks back—yet fain would slide;
> Withholds itself—itself would urge;
> Hovering, shivering on the verge,
> A would-be suicide![2]

But vicariously through Taji, Ahab, Pierre, Bartleby, Benito Cereno, Billy Budd, and even through Tom (in *Typee*), Ishmael, Israel Potter, Redburn, and White-Jacket—through all these Melville vicariously indulged his self-destructive wishes.

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[2] Herman Melville, *Works* (London: Constable and Company Ltd., 1922), XVI, p. 279.

First of all, Melville represented in *Pierre* an actual suicide. Pierre, in prison for murder, takes poison—and it is interesting to note that his actions throughout the novel are self-destructive and in the process destructive to all the other major figures. Through Pierre Glendinning's desire to act virtuously, he destroys his mother, his cousin Glen, Lucy Tartan, his sister Isabel, and himself. And death imagery vies with love imagery throughout the book. Love, it is suggested by Melville, is ultimately self-destructive and universally destructive. Mrs. Glendinning's possessive love of Pierre contributes to Pierre's dilemma and to her death. The unnatural love of Isabel and Pierre precipitates Pierre's flight from the prelapsarian Eden of Saddle Meadows. Lucy Tartan's misplaced, almost religious, devotion to Pierre motivates the fatal duel. At one point Melville says, "Love is here, love is there, love is busy everywhere,"[3] and the careful reader recognizes ironic Melville's echoing the lines of a late poem by the suicidal Percy Shelley—"Death is here, death is there, death is busy everywhere."[4]

The masterpiece *Moby-Dick* contains actual suicide. Mad Ahab, certainly one of the most important examples of what Mario Praz calls "The Fatal Men of the Romantics," is suicidal. He is determined, at the end of the novel, to "strike God and die." He recognizes his finiteness and the infinite qualities (represented by the white whale) against which he rebels. But like Milton's Satan who says "better to reign in Hell than serve in Heaven," Ahab would rather die (as he knows he must) than submit to any force beyond his own ego. And it is again worth noting that he carries his entire world to destruction with him. His crew become the willing tools of their "monomaniac commander's soul," and even Starbuck (who represents orthodox Christianity) is unable to act against this destructive tendency as is pagan but quiescent Ishmael, whose physical salvation at the end of the novel was a matter of pure expediency on Melville's part. Note that he is ironically saved on a coffin.

The novels of Melville written before *Moby-Dick* show the suicide motif in varying degrees of intensity. The plunge of Tommo and Toby into the Vale of Typee in Melville's first novel seems totally suicidal. And as a matter of fact, the theme of "ship-jumping" (taking French-leave from the microcosm of a ship to plunge into a destructive environment such as the ocean or a cannibal isle) becomes symbolically an act of physical or moral suicide in at least three of Melville's novels—*Typee, Omoo,* and *Mardi.* In *Mardi,* of course, the actions of the protagonist, Taji, at the end of the novel,

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[3] *Ibid.,* IX, p. 45.

[4] Percy Bysshe Shelley, *The Complete Poetical Works* (Boston: Houghton Mifflin, 1901), p. 398.

are distinctly self-destructive. All of his companions finally leave him, and he sails in search of Yillah (his lost love) "beyond the reef" that encircles the islands that make up Mardi. Since in the novel Mardi comes to represent the world, Taji's sailing "beyond the reef" suggests suicide.

It would be possible to show the suicide motif also in such minor works as *Redburn, White-Jacket, Israel Potter,* and even in the quietistic deaths of Bartleby the Scrivener and Billy Budd—but this brief synopsis of the theme in the major works would indicate Melville's literary preoccupation with this existential drive toward self-annihilation—what Freud called the *Thanatos urge.*

Was this sublimated suicide, then, an act of bad faith on Melville's part? Probably not. Albert Camus speaks of various suicidal and non-suicidal writers who held that life was meaningless. The most significant that he mentions is Arthur Schopenhauer! He says, "Schopenhauer is often cited, as a fit subject for laughter, because he praised suicide while seated at a well-set table."[5] Obviously there is the other path of living without hope. We presume that this was Schopenhauer's path. (It is interesting to note that Schopenhauer was Melville's major reading during the last years of his life.) The evidence of interest in suicide in a man's writing, however, identifies him with this particular attitude toward life, and indicates a desire channeled off into fantasy creation.

But is this shuffling off of the suicide urge through created characters, then, pure fantasy or should it be considered more closely connected with a man's life? According to Albert Camus, creative fiction is inextricably bound up with the life of the creator of that fiction. An observation which Camus makes concerning actors is applicable also, I believe, to writers. He says,

> It is certain that apparently, though I have seen the same actor a hundred times, I shall not for that reason know him any better personally. Yet if I add up the heroes he has personified and if I say that I know him a little better at the hundredth character counted off, this will be felt to contain an element of truth. For this apparent paradox is also an apologue. There is a moral to it. It teaches that a man defines himself by his make-believe as well as by his sincere impulses.[6]

Melville "defined himself by his make-believe," that is, by his make-believe characters, "as well as by his sincere impulses." And since nearly all Melville's major characters are suicidal, and nearly all of his works contain the theme of self-destruction, Melville defined himself as a "would-be suicide."

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[5] Camus, p. 14.

[6] *Ibid.*, p. 17.

III

To turn briefly from Melville's themes of self-destruction to the author's metaphysical or cosmic nihilism, we shift from the existentialist who desires to leave this world because of the pain which living entails, and turn to the existentialist who has decided to live without hope. To keep good faith with himself, if he is to live in this world, the existentialist learns to live without hope. This means to live without reliance on any system of religious, moral, or ethical principles, without faith in any ordered doctrine or philosophy. In this respect Melville certainly fills the bill. His entire literary life was devoted to a graphic demonstration that no philosophy, religion, or pattern of thought is adequate for man in the face of the inscrutable universe into which he has been cast. One may haul the Kantian whale's head up on one side of the ship to balance the Lockeian whale's head on the other side, but the two together merely weigh the ship down without helping it in any way through the sea of life. Better it is, says Melville, to cut both philosophical heads away and steer the ship in a lonely, nihilistic manner. Nowhere is this nihilistic attitude toward life-guides, toward moral and religious systems, toward a concept of a benevolent creator in the universe, toward even a belief in Fate, more completely rehearsed than in *Moby-Dick* where many approaches toward life—Ahab's fanatical pursuit of truth and the infinite, Ishmael's fatalistic resignation, Starbuck's orthodox Christianity, Stubb's self-blinding escapism, Flask's unthinking materialistic utilitarianism, and Pip's insane mysticism—all prove futile in the face of the chaotic universe, so completely malignant in its relationship to the humans who inhabit it and try to understand it. In various fashions Melville demonstrates the same concept in all of his works—even in the so-called final "testament of acceptance"—*Billy Budd.*

But for a moment let us return to the modern existentialists for a background against which to place Melville's metaphysical nihilism.

The closest that modern existentialist writers have come to real metaphysical and ethical explorations is probably Simone de Beauvoir's book, *The Ethics of Ambiguity.*[7] Most contemporary existential thinkers restrict their publication to works on psychoanalysis and phenomenology. Madame de Beauvoir, however, insists that there can be a positive ethical value-scheme even within the limits of atheist existentialism's chaos-ridden universe. The book just mentioned explores this possibility—the creation of a positive ethical attitude in a world without any absolute values. A human discovers

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[7] Simone de Beauvoir, *The Ethics of Ambiguity* (New York: Philosophical Library, 1949).

this ethical positivity, says Madame de Beauvoir, in a realization of the relationship between himself and other selves, and this relationship is a balance of freedoms. One's moral freedom is the most important aspect of his existence. On another level, it is his struggle for self-realization. And while in certain respects, say Jean-Paul Sartre and Madame de Beauvoir, every other person's freedom is a threat to my own self-realization, still I cannot really be free without the concomitant moral freedom of others. It is by a complicated process of ontological juggling that the existentialist arrives at this position, and it is not the purpose here, nor is it necessary, to explain the process in detail. The point is that there is an attempt by the modern existentialists to draw away from a sense of quiescent fatalism on the one hand and sheer nihilism on the other.

In drawing away from these possible alternate existential world-outlooks, Madame de Beauvoir presents a very interesting and a very valuable picture of what she calls the "serious" man and his ultimate extreme—the "nihilist." Her book is especially valuable for a student of Melville, since it seems to present in capsule form a description of the Melvillean attitude toward life. By Madame de Beauvoir's definition Melville is unquestionably a nihilist.

First of all, Madame de Beauvoir discusses what she calls the "serious" man. This is, essentially, man in society or societal man carried to his ideal and fanatic extremes. This is the man who willingly gives over his attempts at subjective self-realization because he understands that this will conflict with society. Consequently, he subordinates himself to something in which he believes (or in which he tries desperately hard to believe). This may be a cause, a religion, a movement, science, philosophy—any organized system of moral or religious thought. "The thing that matters to the serious man is not so much the nature of the object which he prefers to himself, but rather the fact of being able to lose himself in it."[8] This serious man is actually making a subjective value-choice, but he refuses to realize this, says Madame de Beauvoir; he assumes that the values are absolute and smothers himself in them. This is dishonest and dangerous, according to the existentialists. It leads to fanaticism, tyranny, and despotism. Ordinarily this person does not put all his eggs in one basket. He believes in a number of causes. But occasionally fanaticism centers a man in one cause. If this fails him, the "serious" man is destitute. Then he "joins the sub-man [an unthinking amoeba], unless by suicide he once and for all puts an end to the agony of his freedom."[9]

The only possibility for the disillusioned "serious" man is to put himself the question "What's the use?" And with this question

[8] *Ibid.*, p. 47.
[9] *Ibid.*, p. 51.

should come an insight into the absurdity of the universe. At this point, "Conscious of being unable to be anything, man then decides to be nothing. We call this attitude nihilistic," says Madame de Beauvoir.[10] To put it another way, Nihilism is disappointed seriousness which has turned back upon itself."[11]

In a further discussion of the nihilist, as he is seen by the practicing existentialist, Madame de Beauvoir presents for us a picture which might be that of Herman Melville as well as of Baudelaire.

> It sometimes happens that, in his state of deception, a man maintains a sort of affection for the serious world; this is how Sartre describes Baudelaire in his study of the poet. Baudelaire felt a burning rancor in regard to the values of his childhood, but this rancor still involved some respect. Scorn alone liberated him. It was necessary for him that the universe which he rejected continue in order for him to detest it and scoff at it; it is the attitude of the demoniacal man as Jouhandeau has also described him: one stubbornly maintains the values of childhood, of a society, or of a Church in order to be able to trample upon them. The demoniacal man is still very close to the serious; he wants to believe in it; he confirms it by his very revolt; he feels himself as a negation and a freedom, but he does not realize this freedom as a positive liberation.[12]

Thus the values of Melville's youth and of the bourgeois American world around him are constantly returned to in his novels. By returning to God, idealism, Saddle Meadows, the "prosy old Guide Book" of Redburn's father, Romantic aspiration, and prelapsarian innocence, Melville could try to believe in them and scorn them at the same time. More important, he was well equipped with values to scorn. He insisted on retracing the same path of his rejection again and again, employing each time a new work of art and sometimes new symbolism.

But, says Madame de Beauvoir, "One can go much further in rejection by occupying himself not in scorning but in annihilating the rejected world and himself along with it." And it was in this area of endeavor that Melville proved himself undeniably a metaphysical nihilist. A man may devote himself to a lost cause or fritter his life away on trivialities. Or he may follow other paths.

> Surrealism provides us with a historical and concrete example of different possible kinds of evolution. Certain initiates, such as Vache and Crevel, had recourse to the radical solution of suicide. Others destroyed their bodies and ruined their minds by drugs. Others succeeded in a sort of *moral suicide;* by dint of depopulating the world around them, they found themselves in a desert, with themselves reduced to the level of the subman.[13]

Melville's entire canon manifests this "moral suicide" by which he depopulated his created worlds. (Witness the decimation of char-

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[10] *Ibid.*, p. 52.
[11] *Ibid.*
[12] *Ibid.*, p. 53.
[13] *Ibid.*, pp. 54–55.

acters in *Moby-Dick* and *Pierre* in particular.) In addition to this, Melville systematically disproved the validity of every system of morality, metaphysics, and philosophy maintained by his various characters. In so doing he reduced to zero the possibilities of his own belief in anything. He had become a nihilist. Melville committed a continual vicarious suicide in his literary world; and he also reduced all the metaphysical possibilities in his created worlds to nothing.

First of all, since he was born and baptized into Christianity, we might infer his major interest in the religion of his fathers. Three major proponents of the Christian way seem to leap out at us from his works—Starbuck in *Moby-Dick,* Pierre, and Billy Budd. In Starbuck, orthodox Christianity is suggested, and we see in this man the "fall of valor in the soul." Unable, through religious scruples, to kill Ahab, Starbuck and his Christian world are carried helplessly to destruction. And in Pierre we see the opposite kind of Christian from Starbuck. Pierre acts too rashly in the name of Christian virtue and in the process destroys all around him. In Billy Budd, Melville attempted to picture a boy who approximated perfection in Christian ethics (although Billy is too unlearned in all ways to understand the rudiments of Christianity). Billy is as close to complete goodness, Melville implies, as man perhaps ever reaches. But when he is trapped by the utter depravity of a Claggart, his basic human fallibility arises in him in the form of a speech defect, and he commits unwitting murder. Human imperfection eventually defeats Christian virtue.

In *Clarel,* Melville's long poem concerning his pilgrimage in the Holy Land, the poet very straightforwardly and unsymbolically indicates that Christian faith, or religious faith of any sort, is impossible for the man of a "deep-diving temperament," however much he may *wish* he could believe. It is a poem as arid as the Holy deserts which it treats.

But Melville does not stop with decimation of religion. The major philosophies of the Western world are all tried and found wanting. Melville was a formidable opponent of nineteenth century German idealism as it derived from Kant and was developed by Hegel. And he was no less an attacker of American Transcendentalism. Plinlimmon and his followers in the novel *Pierre* suggest Emerson and the Concord Platonists. And the character of Mark Winsome in *The Confidence-Man* is obviously a vicious burlesque of the personality of Ralph Waldo Emerson. All transcendental idealism appalled Melville. His major warning against it occurs in the chapter of *Moby-Dick* called "The Mast-Head," where he warns the young look-out in the crow's nest not to be lulled into a sense of oneness with the beautiful ocean, because one misstep can send him hurtling eighty feet to a death by drowning or a discovery of sharks under the beautiful surface of the water.

But Melville was not a proponent of those philosophies that run counter to idealism. One remembers that he likens, in *Moby-Dick,* the two whales' heads that are hoisted on either side of the *Pequod* to the philosophies of Kant and Locke. These represent the two great streams of modern Western philosophy—rationalism and empiricism. One is needed to balance the other. But Melville suggests cutting them both away and sailing without either.

About modern pragmatism and scientific positivism, Melville had less to say, since they were not in his time serious avenues of belief as they have become in our time with the deification of science. But Melville does indicate his distrust of these atheistic, materialistic approaches to life in his attack on Margoth—the Hegelized, science-ridden Jew in the poem *Clarel.*

So in his literary works, Melville destroyed all possibilities of faith or belief and in nearly all he committed vicarious suicide through his characters. And in a manner of speaking he committed actual literary suicide, since after his first two successes, he deliberately wrote unpopular books and spent the last thirty years of his life in relative literary silence. When he died he was actually forgotten as a literary figure.

He was indeed the "disillusioned serious man" of the existentialists—if you wish, the "nihilist," the man who—in an era when it was popular to be the smiling optimist—said "No" to practically all aspects of the wretched existence into which he found himself thrown.

A portion of Melville's letters to Nathaniel Hawthorne makes a fitting summation of Melville's world-view and a good summary of this study. The letter was written to Hawthorne in praise of the latter's *House of the Seven Gables.* Melville says:

> There is the grand truth about Nathaniel Hawthorne. He says *No!* in thunder; but the Devil himself cannot make him say *yes.* For all men who say *yes,* lie; and all men who say *no,*—why, they are in the happy condition of judicious unincumbered travellers in Europe; they cross the frontiers into Eternity with nothing but a carpetbag,—that is to say, the Ego.[14]

[14] Jay Leyda, *The Melville Log* (New York: Harcourt Brace and Company, 1955), I, p. 410.

AMERICAN PROTESTANTISM AND THE HIGHER CRITICISM, 1870–1910*

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The last quarter of the nineteenth century proved to be a most difficult period in the history of American Protestantism. Plagued by the social problems inherent in an emerging urban, industrial society, Protestantism was also confronted with the theological problems posed by evolution and the historical criticism of the Bible. The question of Biblical criticism was especially crucial to Protestantism, for during the Reformation the reformers had utterly abolished belief in the infallibility of ecclesiastical authority in interpretation and rested their entire position on belief in the infallibility of the Scriptures. This Protestant doctrine of the infallibility of the Bible assumed its complete authority not only in the area of religion but in science and history as well. There was no place in the inherited theologies for growth, correction, or further revelation. Lyman Abbott phrased the orthodox view of the Bible in these words:

> The Bible was dictated by God to amanuenses; it is wholly free from error; if in our version there are errors, they are due to copyists or translators; the inspiration is verbal, for there can be no inspiration of ideas or sentiments except by means of words . . . it is not only the infallible word of God, it is his final word and there can be no further revelation; the Bible is the truth the whole truth and nothing but the truth.[1]

The higher criticism, or the study of the Bible by critical methods of historical and literary analysis, began in Europe early in the nineteenth century with Germany as the center of the new Biblical scholarship. The Bible was treated as a collection of literature whose date, authorship, and character should be investigated critically, rather than a book known in advance to be inerrant and the product of inspiration. The impact of these ideas was by no means immediate. As late as 1875 it was known only to some in the United States that a critical study of the Bible was being made by German scholars, and very little was known of the results either in the churches or the seminaries of this country.[2]

With the publication of Professor Charles A. Briggs' *Biblical Study: Its Principles, Methods and History* in 1883, a wider con-

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* Paper read at the 91st annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

[1] Lyman Abbott, *Reminiscences,* (Boston, 1915), p. 447.

[2] Washington Gladden, *Recollections,* (Boston, 1909), pp. 259 f.

sciousness of Biblical scholarship began to develop in America. This study was designed to acquaint both the intelligent laymen and the clergy with the field of Biblical study. As a liberal Presbyterian professor at Union Theological Seminary, Briggs was convinced that piety and scholarship should be combined for the best results.[3] Yet, the scientific approach was the essence of this method of Biblical criticism, for Briggs later stated that it was the purpose of the higher criticism to determine on purely scientific principles the integrity, authenticity, literary form, and credibility of the Scriptures. These principles were:

1. The writing must be in accordance with its supposed historic position as to time, place and circumstances.
2. Differences of style imply differences of experiences and age of the same author, or, when sufficiently great, differences of author and period of composition.
3. Differences of opinion and conception imply differences of author when these are sufficiently great, and also differences of period of composition.
4. Citations show the dependence of author upon author, or authors cited.
5. Positive testimony.
6. The argument from silence.[4]

Regardless of the amount of piety involved, the application of these rules to the study of the Bible indicated that a large part of the traditions as to authorship, date, style, and integrity had no solid ground.

Prior to the turn of the century it was the regular practice of a great part of the Protestant clergy to expound the Scriptures to their congregations in long and minute exegesis. Consequently men knew their Bible, and it was used in family devotions, as well as public orations. Its wisdom on all subjects was considered irrefutable. Through various channels people now heard that some of the books were not composed by the authors to whom they had been attributed; that the first five books were not written by one person, and only a very few of the Psalms were written by David; that the Levitical ritual was not practiced in the wilderness, or even until some centuries afterward; and that the account of Jonah was a parable.[5] The first reaction on the part of many individuals was a profound sense of shock. Essentially, it did not make much difference what errors were found or how trivial they were, for to many,

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[3] Charles A. Briggs, *Biblical Study: Its Principles, Methods and History,* (New York, 1887), p. viii.

[4] Charles A. Briggs, *Church Unity: Studies of its Most Important Problems,* (New York, 1909), p. 326.

[5] George Harris, *A Century's Change in Religion,* (New York, 1914), pp. 76 f.

both clergy and laity, the admission of any error seemed fatal to the authority of the Bible and therefore undermined the very basis of their faith.

One of the early difficulties was a lack of finality in the conclusions of the Biblical scholars. Conclusions drawn by some scholars were bitterly contested by others. Where the specialists found themselves in doubt, the average man was in a state of utter confusion.[6] It is obvious from the sermons of the last two decades of the nineteenth century that even the more liberal denominations mentioned the results of the Biblical scholars from the pulpit very infrequently. Apparently this was due to fear on the part of the clergy that their congregations would misunderstand the implications of the findings and their faith, in what was already a period of spiritual unrest, would be further unsettled.

One liberal minister who felt that the people had a right to know what was going on in the field of Biblical scholarship was Washington Gladden. He was convinced that the Bible, even when all the findings of the scholars had been presented, would still remain the most precious and inspiring book in the world. In fact, he felt that it would be even more precious and inspiring when all the truth had been told about it than it ever could be as a mere object of superstition.[7] It was with this aim in mind that in 1891 Dr. Gladden published his book, *Who Wrote the Bible?* Delivering it originally as a series of sermons, he stated at the very outset his reasons for undertaking this work.

> The results of conservative scholarship have been very imperfectly reported to the laity of the churches. Many facts about the Bible are now known by intelligent ministers of which their congregations do not hear. An anxious and not unnatural feeling has prevailed that the faith of the people in the Bible would be shaken if the facts were known. The belief that the truth is the safest thing in the world, and that the things which cannot be shaken will remain after it is all told, has led to the preparation of this volume.[8]

Concentrating principally on the Old Testament, Dr. Gladden attempted to "put into compact and popular form, for the benefit of intelligent readers, the principal facts upon which scholars are not generally agreed concerning the literary history of the Bible."[9] The last chapter of this study is entitled, "How Much is the Bible Worth?" Here he concluded that the Bible was not infallible historically, scientifically or morally, but, "The Bible is the record of

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[6] Gaius Glenn Atkins, *Modern Religious Cults and Movements,* (New York, 1923), pp. 56 f.

[7] Gladden, *Recollections,* p. 319.

[8] Washington Gladden, *Who Wrote the Bible? A Book for the People,* (Boston, 1891), pp. 5 f.

[9] *Ibid.,* p. 1.

the development of the kingdom of righteousness in the world."[10] Gladden was very much gratified to find that no excitement or controversy had developed in his congregation while his lectures were in progress. However, from outside his congregation he received much censure and condemnation.[11]

On the basis of the continuing study of the Bible, Washington Gladden at the turn of the century published another work entitled, *How Much Is Left of the Old Doctrines?* This was an attempt to set forth the doctrinal position on which he, as a liberal who had kept abreast of the findings of science and Biblical scholarship, then stood. "I am going to maintain that the intelligent Christian may stand in the presence of modern thought, and accept everything that has been proved by science or history or criticism, and not be frightened at all by any of it; firmly believing that the great verities of the Christian faith will still remain untouched."[12]

Many conservative Protestants felt strongly that there could be no compromise, that they must stand firm in the face of threats to true religion. This group knew that they were in the right, by holding to the old faiths, for they could see the hand of God working in the world to illustrate that any revision of faith was false. One of the most obvious results of this dilution according to the Presiding Elder of the Detroit Conference of the Methodist Church was the depression of 1893. National prosperity was absolutely impossible in the absence of political and commercial confidence. Since all confidence, political and social, ultimately rested in faith in the Bible, the existing lack of faith had obviously caused the downfall of the whole system of American prosperity.[13]

That there was an increasing amount of vice and crime, such as homicide, suicide, adultery, and kindred sins was not a mere coincidence to conservatives. The logical explanation for this was in the fact that men had departed from the fear of the Lord. Having nothing to fear, men went their own way "like the wild asses of the wilderness."[14] The dilution of orthodox theology had not only affected the national prosperity and the morals of the times but it had affected church attendance as well. The churches had once been crowded Sunday after Sunday, it was held, with congregations eager to hear the unadulterated Word of God; but by 1911 these churches

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[10] *Ibid.*, p. 362.

[11] Gladden, *Recollections*, pp. 321 f. Also, *The Milwaukee Journal*, December 19, 1904, p. 4.

[12] Washington Gladden, *How Much is Left of the Old Doctrines? A Book for the People*, (Boston, 1899), pp. 15 f.

[13] *The Methodist Episcopal Church Pulpit*, Charles T. Allen, "Christ Glorified in His People," (Monroe, Michigan, 1897), p. 35. Also, ed., Knut Seehuus, *The Old Paths*, (Decorah, Iowa, 1914), p. 173.

[14] J. Sheatsley, *Sermons on the Eisenach Gospels*, (Columbus, 1915), p. 68. Also, Samuel Smith Harris, *The Dignity of Man; Select Sermons*, (Chicago, 1889), pp. 160 f.

were reported to be practically empty. This was because the pastors of many churches had read the "so-called higher critics" more than they had their Bibles and, therefore, had lost their faith in the Inspired Word of God. Consequently, they had no message for the people that was worth hearing. "God will not bother Himself to send hearers to false messengers."[15]

From the decade of the 1870's on, some conservative groups to an ever increasing extent attempted to discourage the growth of the new ideas through the use of heresy trials. Since the Lutherans were practically unanimous in maintaining their orthodox theology, they had little occasion to resort to such drastic means. The Baptists and the Disciples had no ecclesiastical courts for dealing with matters of heresy, so their only recourse was to thresh out cases involving heretics in their religious papers without decisive results. Both the Congregational and Episcopal faiths developed a marked degree of theological tolerance at a relatively early date and therefore had little intradenominational difficulty over the question of the higher criticism. The Methodists did have some heresy trials before the turn of the century, but for the most part they were more interested in administrative efficiency than in doctrinal uniformity.

It was the orthodox group within the Presbyterian Church that made a determined effort to root out evidences of the encroachment of scientific findings in their pulpits and seminaries. In this they were aided by a well-defined ecclesiastical system which embodied excellent provisions for trying suspected heretics. In May, 1891, over seventy Presbyterian ministers, meeting in Detroit, petitioned the General Assembly to bring charges against the distinguished Hebrew scholar of Union Theological Seminary, Charles A. Briggs. Professor Briggs was finally brought to trial in 1893 and was found guilty of violating his ordination vows and suspended from the Presbyterian Church. Briggs promptly withdrew and took orders in the Protestant Episcopal Church. Through this same means the Presbyterian Church lost two more of her distinguished scholars; Henry Preserved Smith in 1894, and A. S. McGiffert in 1899.[16]

Severe as this controversy was, it was not serious enough to produce schisms of major importance. Thus a period of enforced contact was brought about within the denominations between the liberal and conservative elements. This period of enforced contact resulted in some gradual change of position. Within the major denominations this movement was always in the direction of the lib-

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[15] S. P. Long, *Prophetic Pearls*, (Columbus, 1913), pp. 193, 343.

[16] Robert Ellis Thompson, *A History of the Presbyterian Churches in the United States*, (New York, 1895), p. 261. Winfred Ernest Garrison, *The March of Faith; The Story of Religion in America Since 1865*, (New York, 1933), p. 94.

erals. In the more conservative denominations the progress toward a liberal view was sometimes so gradual as to be hardly discernible, but taking a long view of this process, progress was certain.[17] Yet, F. H. Foster caught the sense of impatience with which the liberals witnessed this very gradual progress when he termed it a conservative movement. In fact, some liberals felt that this movement merited criticism for its slowness and hesitation, rather than condemnation for haste and recklessness.[18]

That the period of indiscriminate denunciation of the higher criticism had passed by 1905 for the mass of the Protestant clergy seems to be indicated in a sermon by the Dr. D. W. C. Huntington, Chancellor of Nebraska Wesleyan University. He warned that ministers who engaged in such denunciation were becoming increasingly unacceptable. Such preaching "has prejudiced more thinking men with ministers, than all that is called higher criticism."[19] Moreover, the Methodists by this time were no longer interested in pressing heresy charges against their clergy. Charges were brought against Professor H. G. Mitchell of Boston University in 1905, but they did not reach the General Conference until 1908. The bishops then inserted a clause in the discipline relieving them of the duty of investigating erroneous opinion in the seminaries. The highest Methodist court having ruled itself out of such cases, there was no other body to fill such a position of authority, and as a consequence the Methodist Church was saved from further heresy hunting.[20]

It would be virtually impossible to estimate what proportion of the Protestant clergy held to the ideas of the higher criticism at any given time during the period 1870 to 1910. Some felt that they were restricted intellectually by the conservatism of their congregations and this conservatism, of course, was reflected in the temper of their sermons.[21] However, sermons used in the process of this research would suggest that the decade of the 1880's was, generally speaking, one of opposition to the findings of the higher criticism. The decade of the 90's found an increasing number of liberal clergy, particularly in Congregationalism, embracing these findings. Such conservative denominations as the Lutherans and Presbyterians continued to reject the historical approach through the first decade

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[17] Shailer Mathews, *New Faith for Old: An Autobiography,* (New York, 1936), pp. 77 f. Also, Atkins, *Modern Religious Cults and Movements,* p. 14.

[18] Frank Hugh Foster, *The Modern Movement in American Theology,* (New York, 1939), pp. 11 f.

[19] D. W. C. Huntington, *Half Century Messages to Pastors and People,* (Cincinnati, 1905), p. 16.

[20] Halford Edward Luccock, and Paul Hutchinson, *The Story of Methodism,* (New York, 1926), pp. 428 f. Also, Stewart G. Cole, *The History of Fundamentalism,* (New York, 1931), pp. 185–190, *passim.*

[21] Charles A. Stelzle, *A Son of the Bowery: the Life of an East Side American,* (New York, 1926), pp. 106 f. Ernest Hamlin Abbott, *Religious Life in America; A Record of Personal Observation,* (New York, 1902), p. 354.

of the twentieth century. The majority of such groups as the Methodists, Baptists and Episcopalians raised ever less objection.

It was only in the Congregational Church that we find a genuine acceptance of the historical criticism of the Bible. And this acceptance did not come until mid-way in the first decade of the new century. The election of Washington Gladden to the post of moderator of the Congregational Church in 1904 probably marks the final acceptance. The Reverend Henry Stauffer who was for some years associated with Gladden in his work in Columbus, Ohio, put it this way.

> For many years, Dr. Gladden has been under a cloud, so to speak, because of his advanced views. His recent election as moderator of the national council touched him deeply, not only the honor, but the recognition and acceptance of his views that it indicated. It removed the stigma that had hung over him.[22]

Actually, the number of Protestant ministers who adopted the higher criticism during the period to 1910 was probably something less than one-fourth of the total number. But since this small group was to a very great extent made up of the intellectual and denominational leaders, such as Lyman Abbott, Washington Gladden and Shailer Mathews, its total effect was much more far-reaching than mere numbers would indicate.[23]

The use of historical criticism as applied to the Bible had not been confined to the Old Testament, but only in examining the Old Testament had it been applied in completely thoroughgoing fashion. Unlike the European scene where as early as 1835, Dr. David Friedrich Strauss had written *The Life of Jesus; Critically Examined;* American theologians, even leading liberals such as Gladden, had not pressed the historical examination of the New Testament. However, an Episcopal rector, the Reverend Algernon Sidney Crapsey publicly applied the higher criticism to the life of Christ, in a sermon delivered on February 18, 1905, with startling conclusions.

> In the light of scientific research, the Founder of Christianity, Jesus the son of Joseph, no longer stands apart from the common destiny of man

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[22] *The Milwaukee Journal,* December 19, 1904, p. 4.

[23] The survey of the beliefs of 700 ministers made by Professor George Betts in 1929 gives some indication of the penetration of the higher criticism within Protestantism to that date. It was found that 55% of the ministers believed that the Bible was written by men chosen and supernaturally endowed by God for that purpose, and by him given the exact message they were to write; 70% that the inspiration that resulted in the writing of the Bible is different from that of other great religious literature; 34% that every part of the Bible is of equal validity and authority with every other part; 38% that the Bible is wholly free from legend or myth. In a breakdown by denominations on the question of whether or not the Bible was written by men chosen and supernaturally endowed by God for that purpose, and by him given the exact message they were to write, 98% of the Lutherans, 62% of the Baptists, 44% of the Presbyterians, 40% of the Episcopalians, 30% of the Methodists, and 15% of the Congregationalists believed this to be substantially true. George Herbert Betts, *The Beliefs of 700 Ministers and Their Meaning for Religious Education,* (New York, 1929), p. 45.

> in life and death, but He is in all things physical like as we are, born as we are born, dying as we die, and both in life and death in the keeping of that same Divine Power, that heavenly Fatherhood, which delivers us from the womb and carries us down to the grave. When we come to know Jesus in his historical relations, we see that miracle is not a help, it is a hindrance, to an intelligent comprehension of His person, His character and His mission. We are not alarmed, the fact of His miraculous birth was unknown to Himself, unknown to His mother, and unknown to the whole Christian community of the first generation.[24]

The fact that this sermon was printed gave rise to serious question on the part of some of the Episcopal clergy. In April of 1906 Mr. Crapsey was tried for heresy and forced to renounce the ministry.[25] The Episcopal Church which had provided a haven for Professor Briggs in 1893 when he was expelled by the Presbyterian Church, refused thirteen years later to allow the application of Briggs' principles to the New Testament.

The Crapsey decision could not conceal the fact that conservative Protestants had been slowly but steadily losing ground to their liberal opponents. Some conservatives felt that the situation demanded rapid and forceful action. In 1909 under the leadership of the Reverend A. C. Dixon, pastor of the Moody Church in Chicago, a group of earnest believers organized a movement of protest. "Two Christian Laymen" subsidized the publication of *The Fundamentals*, a series of twelve volumes aimed at "strengthening the faith of Christians, unto the defence of the truth against the various forms of error so prevalent at the present day, and, above all, in stirring up Christians everywhere to more active effort and more earnest prayer for the conversion of a great number of the unsaved."[26] At the expense of the Two Laymen, three million copies of *The Fundamentals* were sent to "All English-speaking Protestant pastors, evangelists, missionaries, theological professors, theological students, Y.M.C.A. secretaries, Y.W.C.A. secretaries, Sunday School superintendents, religious lay workers, and editors of religious publications throughout the earth."[27] Although the leadership seemed to be dominated by the Moody organization, it also cut across denominational lines, for contributions to *The Fundamentals* were received from professors, ministers, and laymen of most of the leading denominations.

This group insisted on re-emphasizing the absolute authenticity of the Word of God. In doing this they cast suspicion on the findings of science and especially of the higher criticism; and not infrequently did they discount the sincerity of the liberal leaders. Canon

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[24] Algernon Sidney Crapsey, *The Last of the Heretics*, (New York, 1924), pp. 251 f.
[25] *Ibid.*, p. 260. See *The Milwaukee Journal*, June 4, 1906, p. 9, for reactions to the Crapsey trial in Wisconsin.
[26] *The Fundamentals*, Chicago, n. d., vol. XII, p. 7.
[27] *Ibid.*, p. 6.

Dyson Hague of London, Ontario, stated the basic assumption of the Fundamentalist movement:

> If we have any bias, it must be against a teaching which unsteadies heart and unsettles faith. Even at the expense of being thought behind the times, we prefer to stand with our Lord and Saviour Jesus Christ in receiving the Scriptures as the Word of God, without objection and without doubt.[28]

The first decade of the twentieth century was, then, the crucial decade for the higher criticism. Its principles and general findings had been largely accepted by liberal Protestants, although the Crapsey trial indicated the possible perils of carrying these principles too far. Moreover, it had spawned a small but vigorous and well-organized opposition movement in Fundamentalism. The higher criticism had, by 1910, come to occupy a recognized place in American Protestantism.

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[28] *The Fundamentals,* Dyson Hague, "The History of the Higher Criticism," Vol. I, pp. 119 f.

PATTERNS OF OBSERVATION: A STUDY OF HAMLIN GARLAND'S MIDDLE BORDER LANDSCAPE

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When an author appoints himself spokesman for a region, as Garland did for the Middle Border, it is useful to have some touchstone by which to measure the quality of his observation. And in applying such a touchstone one frequently learns to what extent an author is dependent on his actual experiences in his creation of fiction. In Garland's case it is probably significant that he never laid a story in a locality he had not visited, and the largest number of his works are laid in the area which he knew best. This area which he termed the "Middle Border" has been facetiously defined as "wherever Hamlin Garland was", but actually he used the term for western Wisconsin, Iowa, and South Dakota.

Although it is, perhaps, theoretically not impossible to reconstruct the way of life of a region more than half a century ago and then to compare one author's account of such a life with the actuality, it would be extremely difficult in practice. Detailed accounts of homestead life are scarce and fragmentary. Moreover the more detailed and intimate they are the less they are able to reflect the diversity of frontier life which was the result of the diverse backgrounds which settlers from Europe and America, the North and South, from rural and urban communities, and from artisan, farm, and commercial classes brought with them to their new homes and which modified the manner of life from community to community and even farm to farm. But the landscape and climate were rather more constant, and botanists and zoologists have recorded the composition of the prairie and oak openings, the ranges of plants and animals in sufficient detail so that Garland's descriptions of such phenomena can serve as a test of his observations.

Lists of Garland's descriptions of nature and of the plants and animals he names reveal similar patterns of observation. First, he works almost entirely from first hand experience, largely uncorrected by subsequent study or learning. Second, his observations are typically those of the farmer, the herdsman and the trailer. His eye for panorama is better than that for detail, except in those cases in which there is some practical reason for observing detail. He is accurate in what he observes but despite the fact that he was familiar with unbroken prairie both in Iowa and in South Dakota his observations would be of little value to a botanist or zoologist.

Garland is at his best in descriptions of weather—the raw autumn mornings which mellow into noon in *Boy Life on the Prairie,* the lowering sky and cold gray wind of the Thanksgiving Day on which young Lincoln Stewart picks corn, the still heat of "Among the Cornrows", the swift mountain showers in *Tyranny of the Dark* and *The Forester's Daughter,* the violent summer storm which destroys Jason Edwards' final crop, and, most frequently, blizzards. There are vivid accounts of blizzards in *Moccasin Ranch,* in *A Little Norsk,* and in *Boy Life on the Prairie* as well as in the autobiographical *Son of the Middle Border.* Actually one of Garland's earliest published pieces is a fictionalized account of going out to his South Dakota claim and being caught there in a blizzard.[1] It is also interesting that, with one exception, the novels which deal with a cycle of seasons are the Middle Border novels. *Rose of Dutcher's Cooley, A Spoil of Office, A Little Norsk, Moccasin Ranch, Boy Life on the Prairie, Trailmakers of the Middle Border,* and the collections of short stories, *Main Travelled Roads, Wayside Courtships, Prairie Folks,* and *More Main Travelled Roads* all contain stories both of summer and winter.

Garland's western novels tend to be stories of summer and fall, the seasons at which he visited the west. The action of *Cavanaugh* takes place in a single summer. The action of *Captain of the Gray Horse Troop,* though it is spread over more than one year, simply omits winter scenes of the reservation. *The Eagle's Heart* chronicles several years of life in the west, but all the action takes place in the summer. The boy's story, *The Long Trail,* parallels Garland's own trip to Alaska, and therefore is restricted to a single summer. *The Forester's Daughter* takes place in autumn, but although it includes a wet autumn snow, the snow is brief, local and not unexpected there early in September or even August. The long serialized novelette, "The Ranger and the Woman", describes only summer scenes. The mountain scenes of *Her Mountain Lover, The Tyranny of the Dark* and *Money Magic* are laid in summer. One is aware of a change of seasons in *Hesper* but it is difficult always to know how much this change is seasonal and how much altitudinal.

"The Outlaw," a story from *They of the High Trails,* contains another description of a mountain snowstorm, this one of blizzard proportions, but it stands as the only approximation of winter in the west except for two stories in *The Book of the American Indian.* The Indian stories are largely transcriptions of stories told to Garland, but in "The Storm Child" he can call his experience with prairie blizzards to aid him and writes authentically. "The Silent Eaters" mentions snow and cold but centers on the summer and

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[1] Hamlin Garland, "Holding Down a Claim in a Blizzard," *Harper's Weekly,* XXXII (Jan. 28, 1888) pp. 66–67.

autumn of the death of The Sitting Bull. By contrast, in the Middle Border stories Garland includes such winter details as the feel of frozen ground underfoot, the ring of horses' hooves on frozen ground, the brief ponds which form on the plowed land in a thaw and then freeze to provide a prairie boy with skating, as well as the cold white fury of snow driven before a prairie wind—authentic details derived from his own experience.

Similarly Garland exhibits a keen eye for panorama, for what his fellow Middle Borderers might have termed the "lay of the land". It is not surprising that he should be aware of the gradual rise of the Great Plains to the mountains and the locations of the major ranges, or even of the vegetation zones of the mountains themselves. After all, generations of naturalists and travelers had described the transitions from hardwoods to pine to timberline and Garland had himself observed the change in Colorado and also on his trail trip to Alaska when the necessity for finding pasture for his horses made him keenly aware of the pattern of grass and forest. He records it in more or less detail in most of his western novels. *Cavanaugh, Money Magic, Spirit of Sweetwater, Captain of the Gray Horse Troop,* and even *The Tyranny of the Dark* contain records of journeys up a mountain, or mountains, but the most extensive descriptions outside of *On the Trail of the Goldseekers* occur in *The Forester's Daughter.*

A better test of Garland's eye for landscape pattern is found in his description of prairie landscape such as that of the "brush" or "hazel" prairie which, with a casual authenticity born of intimate knowledge, combines site, soil and the pattern of the dominant vegetation:

> Scattered over the clay lands were small groves or clumps of popple trees, called "tow-heads" by the settlers. They were commonly only two or three hundred feet in diameter, though in some cases they grew along a ridge many acres in extent. Around these islands seas of hazel brush rolled, interspersed with lagoons of blue-joint grass, that most beautiful and stately product of prairie soil.[2]

It is also noteworthy that in *Boy Life on the Prairie* he correctly charts the vegetation zones from prairie to river bottom in Iowa, a transition which is less readily apparent to an untrained eye than the transition from aspen to pine to timberline of the mountains and one that has found very little place in American literature. Bryant had observed it in Illinois and written a description of it in his letters, but it is not included in his long poem on the prairie. It would seem then, that in this description Garland is working

[2] Hamlin Garland, *Boy Life on the Prairie,* New York, Bacon & Allyn, 1926, p. 90.

from his own observation without benefit of prior prompting by conventional descriptions.

> The Cedar River was about four miles away, a bright, sparkling stream, with occasional pools, overhung by elm and basswood trees, and bordered with drooping watergrasses. The road to these swimmingplaces led through beautiful wild meadows, rich with waving crow's-foot, lit as with flame by pinks, lilies, roses, and sweet-williams. Young prairie chickens rose before each galloping horse with a sudden buzz, and the smell of blossoms burdened the slow wind. A mile of burr-oak openings followed, and then came the dip into the wooded bottom where the river ran.[3]

The foregoing paragraph is also typical of Garland's use of plant names. The paragraph quoted contains one of his most extensive lists of species: it mentions three kinds of trees, a grass and four flowers, but of these only the trees and roses are recognizable to a botanist today. In the plant world Garland was most familiar with trees. He mentions burr-oak, elm, and basswood, willow and soft maple, poplar, aspen, spruce and fir, and recognizes the proper habitats for each. But he does not usually discriminate one oak from another except in the case of burr-oaks. The farmers of the prairie planted willow and poplar and soft maple because they were quick-growing trees, and the practical recognition of the differences in growth habits of the hard and soft maple causes Garland and other farmers to distinguish between them, but such discrimination was the exception rather than the rule.

Garland apparently knew only a few herbs by name. He uses no latin names except in those cases in which the generic name is also the common name as is the case with asters and roses. He actually lists only about a dozen prairie species and no greater number of mountain species despite the fact that of the forty books he published only one or two are entirely without episodes laid in the middle or mountain west. The impression that Garland is not familiar with plant nomenclature is reinforced by the fact that the same plants are referred to in several contexts although others might have been substituted with equal accuracy. As in the case of trees there is no discrimination of species even in genera such as asters which are highly variable. Garland uses only the common inclusive term aster or sunflower, etc.

Thus of the prairie species, Bluejoint grass, wild oats and sunflowers are mentioned in the beginning of *Boy Life on the Prairie* and there are occasional short lists such as "pinks, sweet-williams, tiger lilies and lady slippers"[4] but a composite list made from his lists would hardly begin to enumerate the rich and conspicuous prairie flora.

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[3] *Ibid.*, p. 168.
[4] *Ibid.*, p. 96.

In *The Spirit of Sweetwater* and *The Forester's Daughter* he mentions sage brush, painted cup, cactus, Spanish dagger and also the crow's foot grass and blue joint grass at higher levels. These lists of species which Garland recognized are complicated by the fact that he often included so little reference even to color that it is difficult to establish which plants he was referring to. The brief notes prepared by Garland for the school edition of *Boy Life on the Prairie* indicate that he at least used the names for the three grasses to which he most often refers with some precision. His description of bluejoint,

> "a tall beautiful grass, growing often as high as a man's shoulder: Apparently it is green, but close study shows that the joints, which are six or eight inches apart, are really dark blue or purple, the color shading off above and below the joints. The boys chewed the joints for the sweet juice. In the autumn before withering and becoming sear, the grass turns reddish purple."[5]

rather clearly identifies *Andropogon*. On the other hand the description of what Garland refers to as Crow's-foot, though it certainly indicates that he had a specific grass in mind, fails to provide characteristics necessary for identification as does that for the wild oats.

It is almost as difficult to identify flowers in Garland's writings with any degree of accuracy as it is to identify the grasses. Thus "Pink" and "Sweet William" may both refer to phloxes; although the "Pink" could have been used for the firepink *(Silena Virginica)* and may even have reference to the grasspink orchid *(Calopogon pulchellus)*. Sweet William is given as a common name by Fernald in the new *Gray's Manual of Botany* only for an introduced species, but in the Middle West *Phlox divaricata* is sometimes called by that name. Similarly Fernald and other authorities give Crow's-foot as a common name only for an introduced species of grass. Such use of almost unidentifiable common names suggests that Garland was using highly local nomenclature which has been largely superseded by names taught in the schools. Garland then, apparently learned these names in his childhood and never adopted later, more standard, nomenclature.

All of the species which Garland names identifiably are conspicuous either for their size or color, with the exception of violets which are so commonly known that the veriest novice at botany recognizes violets as easily as roses. It seems probable that what Garland wrote of Lincoln Stewart and his friends, "Almost without realizing it, he and his companions came to know every weed, every curious flower, every living thing big enough to be seen from the back of a horse",[6] was also true of Garland and that the qualification was

[5] *Ibid.*, p. 326.
[6] *Ibid.*, p. 87.

equally accurate in both cases. The only exceptions were plants such as wild buckwheat which interfered with the plowing and wild strawberries which had the virtue of being edible.

As a matter of fact Garland names all the more common fruits, berries and nuts used by the settlers such as crab apples, wild plums, and hazel nuts; although there is no mention of some of those such as hog peanut, Jerusalem artichoke, hackberry, elderberry, and serviceberry used by the Indians and by the first settlers in more southern states. Actually all these latter plants produce meager quantities of food in proportion to the effort required to gather and prepare them; they tend to be foods of desperation or poverty and their omission serves as an indication that the farmers whom Garland knew had never been reduced to a diet so meager or unvaried as to make these wild foods attractive.

But if Garland knew names only for a limited number of prairie plants he nevertheless was able to distinguish prairie species from introduced species. When, in *Boy Life on the Prairie,* Lincoln Stewart returns to his boyhood home and finds that the prairie has vanished, he recognizes the introduced roadside weeds as strangers:

> The wild flowers were gone. Tumble weed, smartweed, pigweed, mayflower, and all the other parasites of civilization had taken the place of wild asters, pea-vines, crow's-foot, sunflowers, snake-weed, sweetwilliams, and tiger lilies.[7]

Also when Lincoln and Rance do finally locate a bit of remnant prairie it is precisely where a modern botanist would expect it—along a railroad right of way. He lists only half a dozen plants, again by common and ambiguous names, but he has accurately located the best place to look for remnant prairie, on land unbroken by the plow and protected by fences from grazing cattle:

> At last, beside a railroad track that gashed the hill and spewed gravel along the bottom of what had been a beautiful green dip in the plain, the two friends came upon a slender slip of prairie sod.
>
> ". . . Here they are—the buffalo berries, the rose bushes, the rattlesnake weed, the wild barley, just as they were!"[8]

It would seem that his train journeys to Colorado and his multitudinous lecture tours provided the same kind of observation which once he had made from the back of a horse. The picture is accurate in outline, but fuzzy in detail.

A similar pattern of lack of specific names and failure to observe small forms is evident in Garland's references to animals and birds. Blacksnakes and rattlers are mentioned as are prairie dogs, gophers and the rats which infested the corn crib, but although some of

[7] *Ibid.,* p. 311.
[8] *Ibid.,* p. 318.

these are comparatively small creatures they all have economic significance for a farmer. Prairie dog holes were a menace to horses and gopher hunting was a task regularly assigned to farm boys because gophers dig up and eat seed corn. *Boy Life on the Prairie,* in fact, contains an entire chapter on Hamlin Garland's memories of shooting and trapping gophers.

Marmots, foxes, coyotes appear in appropriate contexts in Garland's western novels, and there is a mention of antelope in *Moccasin Ranch.* Joe Gregg kills a mountain sheep in *Cavanagh* and Garland himself deliberately withholds his fire when he sees a deer along the *Trail of the Goldseekers,* but there is really very little mention of large game. The bison of course existed only in a carefully nurtured remnant herd. Elk and bear were largely gone from the middle western frontier. In *The Forester's Daughter,* Berrie tells of an encounter she had previously had with a mountain lion but the cat has no place in the story proper. There are mentions of foxes, a badger, "wolves" and "prairie wolves", which Garland describes as looking like a combination of wolf and coyote, in *Boy Life on the Prairie* and an episode in which wolves follow Richard Graham in *Trail Makers of the Middle Border,* but that is a book set in pre-Civil War Wisconsin and draws not upon Garland's own memories but those of his father.

Paradoxical as the idea appears at first, the absence of large animals, particularly predatory animals, is probably testimony to Garland's faithfulness to his own observations. There was ample literary tradition ranging from Cooper and Simms to Davy Crockett for introducing encounters with ferocious beasts in chronicles of the frontier. But the fact remains that the population of large animals, either game animals or predators, was probably lower in the years when Garland knew the middle and mountain west than it is now after half a century of conservation and game management.

The names of birds appear with greater frequency in Garland's novels than names either of herbs or animals but follow the already established pattern. Few small birds are named and when they are it is only generically, a sparrow or a warbler. In *Moccasin Ranch* in which he writes of homesteading in South Dakota when it was virgin territory he lists plover, redwinged blackbirds, meadow larks, prairie chickens, ducks, geese, and sandhill cranes; all of which are conspicuous and most of which were considered game birds. But even ducks and geese are undifferentiated. In *Money Magic* a magpie steals Mart Haney's strychnine bottle, and jays and grouse appear in the *Forester's Daughter.* From such representative references to herbs, animals and birds, it would seem that Garland learned the details of his nature lore as a child and young man, that he learned them primarily in his occupation as a farmer and to a lesser degree in his recreation as a trailer and that his knowledge exhibits limits characteristic of these occupations.

But the lists serve also to demonstrate that Garland almost never went beyond first hand observation in his use of nature either as a background for his novels or as material for his plots, and his omission of mention of native plants marginally useful for food, together with the almost complete disregard of rabbits, squirrels, ducks, geese or even fish in the Middle Border novels reinforces the impression of those novels that, though Garland's characters may be burdened by mortgages, neither they nor the farmers Garland knew on the Middle Border were ever reduced to consistent use of wild foods, nor even interested in such foods except for those nuts and berries which were generally considered delicacies.[9]

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[9] In *Boy Life on the Prairie* Garland included a chapter on "Prairie Game" which mentions that the boys shot rabbits and squirrels as sport, but "Squirrels they seldom cared to carry home, but occasionally roasted them at their campfires in the woods" (p. 212). Ducks which the boys hunted in season were also largely hunted for sport for "His mother had a prejudice against ducks and never liked to cook them, and, in truth, they never tasted very good". (p. 205) As the boys "grew older and wiser, they considered all the game of the prairie too small". (p. 212)

ILLUSTRATING POLITICAL THEORY THROUGH SPEECH—CHARLES KENDALL ADAMS' "REPRESENTATIVE BRITISH ORATIONS"*

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G. P. Putnam's Sons, the New York publishing house, wanted some one to edit a collection of British orations. Speech anthologies were selling well in the post-Civil War period and Putnam's wanted to bring out a set of its own.[1] The man chosen for the job was the dean of the new school of political science at the University of Michigan. His name was Charles Kendall Adams.

Adams brought to this assignment a truly unique background. He was in the first place a professional historian.[2] While still a freshman at Michigan in 1857, he became a disciple of Andrew Dickson White. White was a brilliant teacher and a first rate historian. It was he who suggested that Adams become a specialist in English political history. After a year and a half of European study, Adams succeeded White in the chair of history at Michigan. In 1870, Adams established the first graduate seminar ever to be offered in an American university.[3] His courses, though usually elective, came in time to be among the most popular in the University.[4] In addition, Adams did much to build up the manuscript collections of the university library, first at Michigan and later at Cornell and Wisconsin.[5] In 1890, he would become president of the American Historical Association.

Adams was equally at home in the field of political science. At Michigan, he formed a student-faculty group known as the "political science association." Adams' group pre-dated the national association of the same name by over fifteen years.[6] Adams' historical

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* Paper read at the 91st annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

[1] An examination of Thonssen and Fatherson's *Bibliography of Speech Education* reveals that at least thirty-five collections of speeches were published during the latter half of the nineteenth century. Lester Thonssn and Elizabeth Fatherson, comp. *Bibliography of Speech Education* (New York, 1939).

[2] For a sketch of Adams' career, see C. F. Smith, "Memorial Addresses: President Charles Kendall Adams," *Transactions of the Wisconsin Academy of Sciences, Arts and Letters,* XIV, Part II, 1903, 670–8.

[3] H. B. Adams, *The Study of History in American Colleges and Universities* (Washington, 1887), p. 240.

[4] *The Chronicle* (University of Michigan student newspaper), April 3, 1880, as quoted in C. F. Smith, *Charles Kendall Adams: A Life Sketch* (Madison, 1924), p. 14.

[5] In fact, Smith credits Adams with being the prime mover in the establishment of the magnificent Historical Library at Madison. *Ibid.*, p. 40.

[6] "Political Science at the University of Michigan, 1910–1960," n.p.

study of the British Constitution now served him well as he prepared new courses in comparative government and constitutional law. Later as president of Cornell, he would seek to unite history, political science and economics into a single administrative unit.[7]

A third field which interested Adams was the field of speech. Since 1846 speech had been taught at Michigan and a historian had usually served as the instructor. In fact, years before Adams arrived at Ann Arbor, there existed an endowed chair of "logic, rhetoric, and the philosophy of history."[8] Far from opposing this speech tradition, Adams sought to build upon it. In his seminar teaching, he incorporated elements of both debate and extempore speaking.[9] Thus Adams' students were exposed to communication skills along with historiography. In his inaugural address as dean of political science, Adams paid special attention to the importance of platform speaking in America.[10] Adams was one of the Michigan faculty who asked the board of regents to expand course offerings in speech.[11] Again and again in his historical writings Adams called students' attention to speeches as important primary source data.[12] Later on, as president of the University of Wisconsin, he would demonstrate a keen interest in the development of intercollegiate debating.[13]

One incident at Wisconsin is an especially vivid illustration of Adams' awareness of the importance of speech in a democracy. Richard T. Ely, director of the University's school of economics, political science and history, was falsely charged with fomenting strikes and boycotts during Adams' term as president. Ely was one of America's foremost political economists. At stake was his right and the right of every other professor in the University to speak out and teach what he believed to be the truth. According to Herfurth, Adams drafted the report of the regents committee which investigated the charges.[14] The concluding statement, long hailed as a milestone of American academic freedom, reads as follows:

> . . . Whatever may be the limitations which trammel inquiry elsewhere, we believe that the great state university of Wisconsin should ever encourage that continual and fearless sifting and winnowing by which alone the truth can be found.

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[7] Adams' efforts in this regard proved unsuccessful at Ithaca, but he was able to achieve this goal later at Madison.

[8] Marvin L. Esch, "Student Speaking at the University of Michigan" (Unpublished Ph.D. dissertation, University of Michigan, 1959), p. 137.

[9] *The Chronicle*, October 18, 1879, as quoted in H. B. Adams, *op. cit.*, p. 106.

[10] "Relations of Political Science to National Prosperity," as quoted in *Ibid.*, p. 117.

[11] Esch, *op. cit.*, p. 174.

[12] Cf. especially C. K. Adams, "The Growth of Liberty in England" (course of lectures for a seminar at the University of Michigan: Ann Arbor, 1870).

[13] C. F. Smith, *Charles Kendall Adams*, p. 71.

[14] Theodore Herfurth, "Sifting and Winnowing: A Chapter in the History of Academic Freedom at the University of Wisconsin" (Madison, 1949), pp. 5–11.

Speech, therefore, along with history and political science, was one of Adams' abiding interests.

The editing of a collection of British speeches gave Adams the opportunity to pool all three of his interests. Speech texts were themselves historical documents. Each text involved the essence of a speaker's political ideas at a key stage in his career. As speeches, Adams felt the texts needed no editing; the speakers themselves had long ago seen to this. But the introductions to each speech gave him the chance to analyze the special qualities which led to each orator's effectiveness. Here was an opportunity to bring political theory to every American in a form both readable and meaningful.

To what degree did Adams accomplish this goal? A critical examination of the volumes themselves should suggest the answer. Each of Adams' academic interests—history, political science and speech—will be analyzed in turn.

As a professional historian, Adams was cautious about describing his collection of speeches in terms of historical cause and effect. He knew that most historical events result from multiple causation. Yet he also knew that occasionally speeches did exercise a force in history. Of the sixteen speeches included in *Representative British Orations,* Adams described only one as resulting in an immediate historical effect.[15] Pym's oration on national grievances in the Short Parliament of 1640 did cause an immediate reaction; Commons at once appointed a committee to look into the wrongs Pym had so carefully catalogued.

Usually Adams would qualify his assertions about cause and effect by grouping speeches together as a force designed to influence events. Thus Macaulay's four speeches on parliamentary reform "contributed not a little to the final triumph of that great movement."[16] Bright's speeches delivered during the American Civil War "more than any other one thing" restrained Britain from recognizing the Confederacy.[17]

Sometimes, too, Adams was forced to admit that a particular speech had no perceptible effect upon the immediate audience. Thus the speeches of Chatham and Burke on American affairs could hardly influence members whose income and position were grants of the king. Fox's plea for negotiations with Bonaparte had little apparent impact on a Pitt-controlled House dedicated to an exactly

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[15] C. K. Adams, *Representative British Orations* (New York, 1884), I, 84. Actually Pym's speech achieved a great deal more. It was the first party platform in English history, a platform Pym's followers would vote into law six months later. See my doctoral study, "The Parliamentary Speaking of John Pym, 1621–1643" (Unpublished Ph.D. dissertation, The Pennsylvania State University, 1958), p. 167, *passim.*

[16] C. K. Adams, *Representative British Orations,* III, 55.

[17] *Ibid.,* III, 157. A later estimate of England in the 1860's contests this position. Cf. E. James Lennon, "The Pro-Northern Movement in England, 1861–1865," *Quarterly Journal of Speech,* XLI (February, 1955), 27–37.

opposite course of action. Historical judgments of this kind are as sound today as when Adams wrote them in 1884.

As a historian, Adams' principal weakness was his biased interpretation of historical events in sixteenth and seventeenth century England. Witness, for example, his account of the country at the end of the reign of Elizabeth. Right after the Spanish Armada, according to Adams, a new question arose:

> That question was whether the English Constitution was to be developed in the direction of its traditional methods, or whether the government and people should adopt the reactionary methods that were coming to be generally accepted on the Continent.[18]

The use of the words "traditional" and "reactionary" are most revealing here. Britain did in time become a parliamentary state but in the sixteenth and seventeenth centuries, it seldom was. The *traditional* form of government at that time was absolute monarchy, not parliamentary democracy. "Reactionary" is a peculiar adjective to use to describe a sixteenth century government whose form had remained substantially the same for centuries. The fact that most historians writing in Adams' day shared this "Whig" or parliamentary bias does not change the situation.

As a further illustration of this weakness, take Adams' account of the impeachment of the Duke of Buckingham in 1626. He describes this trial of the king's favorite as "the constitutional method of redress."[19] The British Constitution is a series of loose historical precedents. But in 1626, precedence for impeachment of a royal minister by the Commons was scarce indeed. Again Adams engaged in an *ex post facto* judgment more in harmony with the nineteenth than the seventeenth century.

From a second point of view, the orations were meant to be a digest of English political thought. Eliot and Pym chronicled the parliamentary indictment of Stuart rule in the seventeenth century. Chatham, Mansfield and Burke debated the rights of crown and colony in the American Revolutionary War period. Pitt and Fox argued about the role England should play on the Continent during Napoleon's reign as Emperor of the French. Mackintosh and Erskine defended freedom of the press and of juries. Canning on imperialism, Macaulay on parliamentary reform, Cobden on the Corn Laws—each of these found a place in *Representative British Orations*. John Bright's indictment of ministerial handling of the Crimean War is included as well. The third volume of the set ends with a statement of party principles by Disraeli for the Conservatives and Gladstone for the Liberals.

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[18] C. K. Adams, *Representative British Orations,* I, 2–3.

[19] *Ibid.,* I, 4.

By and large, Adams' selection of speeches is balanced and inclusive. To be sure, there are a few gaps in the collection. In the matter of subjects covered, for instance, no speeches relating to the Revolutionary Settlement of 1688 or the great anti-slavery movement appear here. And conceivably one might take issue with Adams' decision to start the collection with a speech of Sir John Eliot in 1628. According to Adams, Eliot's oration was "the earliest parliamentary speech of real importance that has been preserved to us."[20] Yet earlier orations of stature by Wentworth, Bacon and Coke come to mind.[21] At any rate, in the time period in which Adams chose to concentrate, his selections did in fact represent the core of the speaker's thinking on the key political issue of the day.

In addition to political science and history, Adams had a third academic interest which was to emerge in this work, his interest in speech. He was concerned about the speaker himself as well as the overall speaking situation. At one stage or another in the three volumes, Adams mentions virtually every phase of rhetorical criticism known to the modern speech scholar. References appear relating to: the authenticity of speech texts; logical, emotional and ethical proof; style, memory and delivery; short and long range effectiveness; theme development; and above all else, speech training and the speaker's overall education. As a speech critic, Adams chose to sift and winnow, to include only the outstanding characteristics of each orator and oration. The result is a primer in that area of modern speech known as British Public Address.

To cite one example of his ability to size up a speaker, here is Adams' terse description of the speaking of Pitt the Elder:

> He was not in a true sense a great debater. His ability lay not in any power to analyze a difficult and complicated subject and present the bearings of its several parts in a manner to convince the reason. His peculiarities were rather in his way of seizing upon the more obvious phases of the question at issue, and presenting them with a nobility of sentiment, a fervor of energy, a loftiness of conception, and a power of invective that bore down and destroyed all opposition.[22]

The weakness in this approach is one of depth rather than scope. No single speaker ever receives a comprehensive analysis. Value judgments about a speaker's effectiveness are presented without supporting evidence. And the sources of information Adams uses are seldom documented.

Nevertheless the end result made rewarding reading. Adams' prose style is refreshingly free of fine writing. His historical de-

[20] *Ibid.*, I, 11.

[21] See for example Peter Wentworth's address on liberty in 1576; Sir Francis Bacon, on the king's electioneers, 1614; and Sir Edward Coke on the Petition of Right, a speech delivered just a few months before Eliot's.

[22] C. K. Adams, *Representative British Orations,* I, 89.

scriptions are vivid and fluent and well coordinated with the biographical and speech detail. And from the outset of volume one, the theme of Britain's struggle for individual rights is clearly associated with the American reader.

In summary, *Representative British Orations* is a collection of English speeches designed to illustrate political theory to the layman. Ahead of its time in its interdisciplinary stress, the set has much about it that is appealing, even today.

At the time of publication, the reaction of Adams' contemporaries could best be described as apathetic. Neither popular magazines nor professional journals bothered to review the work. The publishers were so indifferent that in their advertisement of the set, they credited a non-existent editor and appended an inaccurate description of the content matter.[23]

Yet the evidence suggests that the general public reacted differently. Sixteen years after its release, *Representative British Orations* was reprinted in a second, expanded edition.

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[23] *Publisher's Weekly,* July 19, 1884, p. 97. It was more than a year before the advertisement was corrected.

THE BACKGROUND OF THE ADULT EDUCATION MOVEMENT*

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> The fact that throughout almost the whole nineteenth century constant efforts have been made to build up a system of higher education suited to the needs of adult men and women suggests that they are not the outcome of a merely evanescent interest or fashion, but are founded on permanent needs which, when disappointed in one direction, seek satisfaction in another.[1]

Adult education is not a new concept. Since the beginning of recorded history, we have evidence of men who have learned throughout their individual lifetime, and have used numerous informal methods to perpetuate culture. But formal institutional adult education in any large scale is relatively modern. The development of various programs has been marked by diversity due to the changing interests and the variety of needs of adults. Adult education has been identified with the institutional organizations which have been created within society to provide meaningful learning experiences for individuals and groups. These institutions and agencies of education for adults have usually been organized so that persons at the same stage of development or having similar interests may receive instruction efficiently and effectively. In many ways, there is a similarity in the programs of the different countries, since the basic needs of adults are similar in all countries and at specific stages in man's development. In their particulars, however, the adult educational agencies and institutions of each country tend to reflect the distinctive culture of the country in which they have developed. At times, for example, adult programs in various countries have been so dominant that persons have identified adult education with some particular institution, as in the case of the Danish folk high schools.[2]

Progress and growth in education have developed on four basic levels in our society: the elementary, secondary, higher, and adult educational levels. The progress of each has been dependent on and interwoven with the growth of the others. For example, the leaders of adult education in the lyceums in America during the first half of the 19th century were proponents of more adequate elementary education. This paper will deal with the adult educational aspects

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[1] *A Design for Democracy*, "1919 Report" by the Adult Education Committee of the British Ministry of Reconstruction, p. 161.

[2] Cyril O. Houle, *"Adult Education,"* Encyclopedia Brittanica, Vol. I (1957), 184.

only, since the other levels of education have been treated exhaustively in numerous scholarly studies. To examine a few of the highlights of the institutions of adult education in England and America will provide a background for understanding the movement.

English Heritage in Adult Education

Although the growth in educational opportunities progressed slowly through the centuries, during and following the industrial revolution there began to appear in Britain indications that education was a privilege desired by more than the elite. A British historian, Robert Peers, contends that the movement for adult education was part of the revolution which transformed a country of small scale craftsmen and farmers into a great industrial democracy.[3] He further ties this economic trend to the religious awakening of the mid-eighteenth century, and both of these movements to the dissolution of the old social order in England and the drift of population to the towns.

Mechanics' Institutes. Dr. George Birkbeck, founder of the Mechanics' Institute movement, was Professor of Natural Philosophy at Anderson University in Glasgow in 1799. He had become aware of the unsatisfied desire for knowledge of the workers while supervising mechanics in the production of apparatus required for his demonstrations. Birkbeck was so taken with the interest shown by the workmen that he proposed the establishment of a Mechanics' Class. It was an immediate success. In 1804 Birkbeck moved to London, but the work was carried on by his successor, Dr. Ure.

People's Colleges. In 1842, an independent minister, the Rev. R. S. Bayley, criticized the shortcomings of the Mechanics' Institutes in meeting the needs of working men for higher education. Bayley recognized that many workingmen were not ready for higher studies, and that provision needed to be made for more elementary subjects. He succeeded in establishing a People's College in Sheffield to provide general education of a humane character. The number of students at this College rose rapidly until, in 1849–50, there were 630 enrolled. The London Working Men's College was founded by a group of Christian Socialists in England in 1854. This institution was a practical experiment in social reform undertaken by Frederick Denison Maurice and his colleagues.

University Extension. Frederick Maurice intended that the Working Men's College should work closely with the existing institutions such as the universities. It was his hope that the Universities would accept persons coming from the colleges (such as the

[3] Robert Peers, *Adult Education: A Comparative Study* (London: Routledge and Kegan Paul: New York: Humanities Press) pp. 3–30.

Working Men's Colleges), as they would from any other, and that they would grant students their degrees, through examinations, once the work was completed. Maurice felt confident that no fee would stand in the way of working men obtaining the same advantages as their countrymen possessed.[4] Unfortunately, Maurice's hopes for adult students to go from the London College on to Oxford and Cambridge did not come to realization.

There have been two rather distinct approaches to the conception of University Extension as it was carried on in England. One has been that mainly associated with Cambridge, which concerned itself mostly with the promotion of serious, systematic study. The other, which is characterized mostly by the Oxford movement in university extension, has been the idea of the stimulation of intellectual life at numerous levels of adult development. The university extension lectures tended to accomplish the second objective more successfully than they did the first. The later developments of colleges and centers grew out of a desire for opportunities for more continuous and systematic study than was offered in university extension lectures. One of the leading examples of the expression of the Oxford point of view in university extension was the work of Canon Barnett at Toynbee Hall.

Toynbee Hall. Toynbee Hall was founded in 1883, and expressed a new recognition among the universities of their responsibilities to the underprivileged. Canon Barnett brought many men from the Colleges of Oxford to Toynbee Hall, where they worked in the heart of the slums of London in both social settlement house and educational endeavors. Later movements in adult education in England and America took inspiration from the efforts of these idealistic young scholars. The very idea of tutorial classes grew out of the experience of Canon Barnett in his extension lectures at Toynbee Hall.

Adult Education in the United States

The definitive study of the origins of university extension in this country was published by Herbert B. Adams in 1900.[5] In it he pointed out the interrelationship of democratic traditions of education between England and the United States. England, perhaps, received impulses in the direction of democratic education from the American and French revolutions, but, in later stages, the role of leadership was reversed. The growth in educational democracy was

[4] *A Design for Democracy,* The Adult Education Committee of the British Ministry of Reconstruction commonly called the "1919 Report." New York, Association Press, p. 188. Quoted from the "Original Circular of the Working Men's College," issued in 1854.

[5] Herbert B. Adams, *University Extension in the United States.* (U. S. Government Printing Office, Office of Education, 1900), p. 275.

an outgrowth of the pioneer influence of the English leaders of social enlightenment and was closely tied in with the reform movements in British politics, particularly with the extension of suffrage.

Organized adult education in the United States began in colonial days. It was a fruit of the Protestant revolt of the 16th century and the general awakening of Europe taking place at that time.[6] An early form was the proprietary school which taught vocational subjects and usually met in the evening. Arithmetic and language were staple parts of the curriculum. With the continued influx of early settlers from Europe there developed the need for a culture which would bring cohesiveness to this new land. The founders of the new nation realized that political independence was not sufficient, and that there must be, in addition, an informed electorate. There thus ensued during the early part of the 19th century in the United States a number of loosely organized efforts in adult education, many of them unrelated to each other.

Lyceums. One of the most important of these individual group efforts was the lyceum. Farmers, mechanics, and other groups with some formal education organized small local associations for the purpose of self-improvement. They were concerned not only with their own improved learning, but with the development of a public school system. Josiah Holbrook was a leader in the establishment of lyceums in New England, the first of them being held at Millbury, Massachusetts, in 1826.[7]

The lyceum had as its purpose self-culture, instruction in speech, debate, and discussion of common public interests. These town lyceums grew rapidly, and by 1839 some three thousand existed throughout the country. Through the years they became potent influences in promoting public education, and many participants assumed educational leadership. These groups had among their number some of the leading intellectual figures of the time, including Henry Ward Beecher, Wendell Phillips, Ralph Waldo Emerson, Oliver Wendell Holmes, Bayard Taylor, Horace Greeley, Frederick Douglass, and George William Curtis. The most famous was Abraham Lincoln.[8]

But like so many ventures of adult education, which tend to be episodic,[9] the lyceum waned just before the beginning of the twentieth century. During the period that the lyceums were gaining strength, there were developing other agencies of adult education.

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[6] Cubberley, Ellwood P. *Public Education in the United States* Boston: Houghton, Mifflin Co., 1947.

[7] Homer Kempfer, *Adult Education* New York: McGraw-Hill Book Co., 1955, p. 4.

[8] Adams, *op. cit.*, p. 298. Also see *American Journal of Education* XIV, October, 1826, 535; and Carl Bode, *The American Lyceum* (New York: Oxford University Press, 1956), pp. 19–26.

[9] Cyril O. Houle, *op. cit.*, p. 185.

Some of these grew out of the interests of those active in the lyceums—museums, libraries, lecture series, mechanics' institutes, and evening schools with public support. While the lyceums tended to decline, many of the other institutions tended to become permanent. For example, 1833 saw the first tax-supported library in Peterborough, New Hampshire.

The Chautauqua Institution. The lyceums had given Bishop John H. Vincent an example of what could be done in adult education. In 1874 Vincent and his colleagues embarked on an expansion of a Sunday school association and established the Chautauqua Institution. The name "Chautauqua" can be considered both as a place and as an idea. Bishop Vincent chose, as the place, Lake Chautauqua in southern New York. The idea was that annually, during the summer months, thousands of persons should go there to hear lectures and music, and to attend courses of instruction especially developed for Sunday school teachers. Vincent's idea was that all learning was sacred, and that the secular life should be pervaded by the religious spirit. This spirit he meant to achieve through the Chautauqua Institution. His early emphasis was on the training of Sunday school teachers, but he soon added to the usual Biblical study in the curriculum a variety of additional subjects: literature, languages (ancient and modern), history, art, science, music, elocution, and physical culture.

Chautauqua offered one of the earliest correspondence study programs in America. The early program was carried on through the Chautauqua Literary and Scientific Circle (known as C.L.S.C.), founded in 1878.[10] Then, as now, C.L.S.C. provided a number of "reading courses" available by mail. In 1883 a program leading to a diploma through correspondence study was also added to Chautauqua, so that a student could continue his study through the mails.[11] This set a pattern later adopted by university extension when William Rainey Harper founded The University of Chicago in 1892.

The Extension of University Teaching

University extension was another expression of the desire of adults in America for increased enlightenment.[12] History records

[10] Ronald Brandt, "Culture by Correspondence: The Chautauqua Literary and Scientific Circle," Unpublished paper, July ,1960, 11 pp., author's files. (Research based on W. R. Harper's Letters, Harper Library, the University of Chicago).

[11] W. S. Bittner and H. F. Mallory, *University Teaching by Mail* (New York: Macmillan Company, 1933), p. 17.

[12] Mr. M. E. Sadler, Secretary of the Oxford Delegacy, is quoted as saying that "the phrase 'University Extension' seems to have become current in the discussions on University reform during the years immediately preceding 1850." George Henderson, *Report Upon the University Extension Movement in England.* Published by order of the Philadelphia Society for the Extension of University Teaching, 1600 Chestnut St., Philadelphia (n.d., *ca.* 1890), p. 3.

that University extension was first publicly presented in the United States at sessions of the American Library Association at Thousand Islands, New York, in September, 1887. This essentially English system, adapted to local needs in America, was taken up by many public spirited librarians in America in Chicago, St. Louis, and New York.[13]

In January, 1888, Melvil Dewey, chief librarian of Columbia University, laid before the regents of the University of the State of New York a plan for university extension in connection with public libraries. On May 1, 1891, $10,000 was appropriated for the state organization of university extension. The bill stipulated that no part of the grant should be used for lectures, but should be used "for purposes of organization, supervision, and printing.[14]

Following the lead of the University of the State of New York, another major educational extension effort in the United States was undertaken by the American Society for the Extension of University Teaching. This Society was organized in Philadelphia in 1890. Public-minded institutions cooperated with able and well trained lecturers (many invited from England), extending their service to the cause of popular education in America. The American Society was supported by subscription, and a periodical, *The Citizen and the University Extension,* was published to unite and promote the extension movement.

For a decade the Society flourished. The University of the State of New York reported in June, 1899, that the American Society for the Extension of University Teaching gave lecture courses in fourteen places in Philadelphia and in twenty-nine different towns throughout Pennsylvania and in states near by.[15] The activities of this society, however, began to wane after the turn of the century.

Other Extension Ventures

During the period of 1880 to 1900 many efforts were made to transplant to the United States the forms of university extension which had proved successful in England. In 1892 at a national congress held for those interested in the extension movement, it was reported that in the past four years twenty-eight states had organized extension programs. The University of Wisconsin listed a group of extension lecturers as early as 1890–91 and offered them to groups off the resident campus.[16] Morton reports that by the turn of the century, however, university extension ventures had dimin-

[13] J. N. Larned, "An Experiment in University Extension," *Library Journal* (March–April, 1888). p. 75.
[14] Adams, *op. cit.,* p. 303.
[15] *Ibid.,* p. 307.
[16] Copy in author's files.

ished almost to the vanishing point.[17] Some of the reasons listed for the decline in extension efforts during this period were inadequate financing, unavailability of suitable lecturers, inability of university staffs to understand the interests and capacities of adults, and the great increase of university campus enrollments. By the early 1900's the enrollment bulge of undergraduate day students taxed university facilities and the energies of the faculty, and most faculty members were unwilling to lecture off campus.

The University of Wisconsin and University Extension

The University of Wisconsin pioneered in the development of a general educational outreach in this country, and over the years has been a leader in dynamic programs of adult education and public services. With the appointment of Dr. Charles R. Van Hise as its president in 1903, Wisconsin led among public institutions of higher learning in taking the stored-up knowledge of the university to the people beyond the immediate campus. James Creese, in his book *The Extension of University Teaching,* has stated that "in the entire history of university extension, no event had more critical importance than the re-establishment of the Extension Division of the University of Wisconsin by President Charles R. Van Hise and Dean Louis E. Reber in 1906–07. The revival at Wisconsin led to restoration of partly abandoned extension divisions in universities all over the country, at privately endowed institutions as well as at state universities."[18]

Wisconsin has provided education for its adults not only through the University of Wisconsin, but through other institutions. A system of Vocational and Adult Schools was founded through the imaginative leadership of Dr. Charles McCarthy in 1911 and is unique to Wisconsin in its statewide pattern. The Free Library Commission through the vision of Frank A. Hutchins has enriched the enlightenment of adults by more than half a century of services to the people of the state. And the Co-operative Extension Service has carried on a broad program of public service through support by U. S. Department of Agriculture, and the county governments. With the rich heritage and background of adult education in Wisconsin it is hoped that the state will continue to pioneer in creative programs for adults in the decades ahead.

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[17] John R. Morton, *University Extension in the United States,* University of Alabama Press (Birmingham: Birmingham Printing Co., 1953), p. 5.

[18] James Creese, *The Extension of University Teaching,* New York: American Association for Adult Education, 1941. p. 98.

ETRUSCAN AND TUSCAN PARALLELS, A STUDY OF THE ETRUSCAN CIVILIZATION AND OF THE FLORENTINE RENAISSANCE

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Part One

The Italian region of Tuscany, once the heart of ancient Etruria, is a land of contrasts. The rocky eastern shores open to the mild winds of the Tyrrhenian sea, recede into a forest of black pine trees tempered by silvery *tamerici* shrubs and red sprays of oleanders. Golden clusters of broom overlooking the sea from barren cliffs are guarded by needled agave-cacti aimed at the sky like naked *daghe*—the deadly short sword the Romans inherited from the Etruscans.

Away from the sea the vegetation changes, but not in color. The black of the pine trees becomes the dark green of the fragrant laurels hiding behind garden walls. The silver of the *tamerici* becomes the shimmer of the olive trees scattered on low, terraced hills among even rows of grapevines. Slender cypresses climb the narrow paths in lonely procession like votive lamps set aglow by the last rays of the sun.

Tuscany is a land of harmony. The brightness of the wild flowers never clashes with the graceful solemnity of the landscape. Perhaps because of this natural propensity to subdue all excesses, Tuscany's history is the history of spring. Like spring it has the feeling for essential values, like spring it has the seed of ideas, like spring it has the creativeness of youth. And this promise of creativeness became a reality during two historical cycles far apart, yet intimately related in their cultural development. The first spanned from the VI century B.C. to the IV century B.C. when Etruscan influence in Italy reached its peak; the second spanned from the XIII century A.D. to the XV century A.D. when Florence, then a prosperous Republic, became the center of the Italian Renaissance.

This presentation deals with the first part of this history: the Etruscan civilization in Italy.

In the first century B.C. Italy experienced two events of great importance. The first event was the rising of dictatorship within the Roman Republic that led to the formation of the Roman Empire, the second event was the hopeless fight of two Etruscan cities, Faesulae (Fiesole in Tuscany) and Perusia (Perugia in Umbria) to regain their freedom from Rome.

In the year 78 B.C. when the Roman leader Lucius Cornelius Silla was dead, Faesulae rebelled against the colonists left by Silla to punish the city for the help it had given his arch-enemy Gaius Marius. The rebellion was unsuccessful, it only worsened conditions for Faesulae. Within thirty-eight years, in 40 B.C. the city of Perusia suffered a much worse fate for aiding Lucius Antonius, the brother of Mark Anthony. Octavianus, the future Caesar Augustus, conquered the city and to commemorate the Ides of March ordered three hundred illustrious citizens put to death.[1]

These instances of rebellion in Faesulae and Perusia, are especially important because they mark the last attempt of any Etruscan city to regain political independence from Rome since the fall of Faleri Veteres (Civita Castellana) in 218 B.C.

During the Roman empire to facilitate administration, the central part of Etruria which included modern Tuscany, northern Latium and parts of Umbria, became known as Region VII. The Emperor Diocletianus (3 century A.D.) reorganized the Region VII into the districts of Tuscia and Umbria[2] with Florence as the most important city.

Except for these geographical informations which reached us through Latin texts, the Etruscans left very few traces of their civilization which became a mystery perhaps as great as the mystery of their provenience. The only documentation the Tusci, as the Latin called them or Tyrseni, as they were known to the Greeks left of their way of life[3] is in the tombs or houses of the dead. where the walls come alive with frescoes depicting their activities and their diversions.

Who were the Etruscans and where did they come from? There are several theories concerning their origin and none can be honestly discarded for a lack of final, negative proof. Nicola Fréret[4] associated the Etruscan word *Rasenna* (probably man or people) to Reti, a section of the Italian Alps still known as Alpi Retiche, forwarding the hypothesis that the Etruscans came from Northern Europe.

Dyonysus of Alicarnassus, historian of the Augustian era, claimed the Etruscans to be autochtonous because their language and customs did not resemble those of any other people in the Italian peninsula.

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[1] Svetonius. Octavianus 15. Applianus. Of Civil Wars, v. 30 & following.

[2] Tuscia et Umbria correspond to the modern regions of Tuscany, with capital Florence, and Umbria, with capital Perugia.

[3] Central Italy became known as Tuscia, Etruria, or Tuscany, from the name of *Tusci* which the Latins used for the Etruscans. Their Greek name *Tyrseni* probably derives from *Tyrsis* or turris meaning tower.

[4] Nicola Fréret was a member of the *Academie D'Iscritions et Belles Lettres de Paris.* (1750).

Most Greek and Latin historians, however, believed the Etruscans came to Italy from Lydia in Asia Minor[5] and Herodotus left a famous legend to describe their arrival. It seems that a famine which lasted eighteen years compelled the King of Lydia, Athis, to send away half of his people led by his son Tyrrenus. After a long journey by sea, Tyrrenus landed on the rocky shores of the Italian peninsula somewhere north of the future Rome, and here he sacrificed a native white pig to Tinia, Uni and Menrva, the three most important Etruscan Gods that the Romans were to adopt with the names of Jupiter, Juno and Minerva.

The Etruscans who were careful with numbers as they considered them an important part of their religious ceremonial, traced their historical beginnings to the XI century B.C., approximately between the years 1045 and 1025 B.C.[6]

It is not until the VII century B.C. however, that we can speak of Etruria proper. The Etruscan civilization was in fact a by product of the peaceful integration of the local Umbrian-Sabellic populations with the followers of Tyrrenus. This process can be traced to the Villanovan cinerary urns[7] where the transition from a cup or *patera* covering the urn to a typical Etruscan helmet or to the clay model of the head of the deceased gives us the important data of this process of acculturation.

Thus the most complete political and artistic development of the Etruscan Dodecapolis or government of the twelve cities can be placed between the VI century B.C. when the Etruscans fully imposed their cultural supremacy in Italy, and the IV century B.C. when the rising power of Rome brought a slow death to the Dodecapolis.[8]

The Etruscan cities were at first governed by some form of a primitive monarchy. The leading citizens of Etruria bore the name of *Lucumones,* but identification between the word *Lucumo* and king is becoming increasingly obsolete.

Between the VI century B.C. and the V century B.C. the Etruscan cities became republics united by a common religious bond.[9]

It seems that the constant preoccupation of these republics was to decrease the power of the individual citizen in order to avoid

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[5] Among the Latin writers we can list Virgil, *Aeneid,* Book 2, v 781; Book VIII, v 479; Book IX v 11. Also Horatius, Ovidius, Cicero, Seneca, Plinius, Tacitus. The related story above is found in Herodotus I. 94.

[6] Varro gives us this information in his *Tuscae Historiae.*

[7] From Villanova a village near modern Bologna in Emilia.

[8] The cities of the Dodecapolis at the time of Roman conquest were: Caere (Cerveteri), Tarquinii (Tarquinia), Vulci, Rusellae (Roselle), Vetulonia, Populonia, Volsinii (Bolsena), Clusium (Chiusi), Arretium (Arezzo), Perusia (Perugia), Volaterrae (Volterra), Faesulae (Fiesole), Cortona. Veii had already been destroyed by the Romans. All the twelve cities of the original dodecapolis were located in central Italy.

[9] The twelve people of Etruria gathered every year at the sanctuary of the Fanum Voltumnae for religious celebrations.

tyranny. This steady mistrust that bordered on anarchy, generated such a hatred for all types of absolute power that when the city of Veii, which had reverted to a monarchy, was sieged by the Romans (396–386, B.C.) no sister city moved to its aid and Veii was completely destroyed.

This rebellion against authority, this exceeding *gusto* for self expression and individualism, is evident in Etruscan artistic manifestations of the golden period which spanned from about the VI century B.C. to the IV century B.C. Though greatly influenced by Greek art, Etruscan art at its best has a unique realism and psychological insight, especially evident in funerary statuary and animal sculpture.[10]

In order to understand Etruscan realism in art is necessary to penetrate the profound implications of religion among the *Rasenna.* The Etruscans believed in a complete, fatalistic submission to the will of the Gods. This need for identification between their daily lives and a preconceived destiny, increased the importance of every action they performed during their stay on earth. The soul went to the underworld equipped with a scroll where its good deeds were registered for the final judgment. The deceased was escorted by a winged creature, a *Lasa*[11] who was to guarantee a safe journey.

Because the after life was intended as a mere continuation of life on earth, nothing could be more appealing to the Etruscans than the blue skies of their native Tuscia where through pirate ships and through great commercial skill they had created a veritable paradise on earth. While the Greeks translated religion into art, the Etruscans translated art into religion, religion into life, life into eternity.

This can be clearly seen in the Tomb of Hunting and Fishing in Tarquinii (VI century B.C.). Here the walls become alive with agile dolphins leaping out of the Tyrrhenian sea, with birds cutting the skies like winged arrows, with brown naked men diving in the green waters.

Above them, in a different panel, husband and wife banquet on the kline, a reclining bed, attended by servants. The woman holds the affectionate hand over the chest of the spouse as if to affirm the very important place she holds in his heart. And indeed the Etruscan woman held a unique place in all the ancient world. She was allowed to take part in every type of amusement the men enjoyed.

The freedom allowed by Etruscan men to their women was often misinterpreted. The historian Ateneus (XII, pp. 517–518) writes

[10] Outstanding are the works of Vulca—the greatest of Etruscan sculptors. Especially notable are his Apollus and Mercury, both from Veii. Other important pieces of Etruscan statuary are Aule Meteli and the Capitoline Brutus. In animal sculpture the Chimaera from Arezzo and the Lupa Capitolina are wonderfully realistic.

[11] Lately scholars tend to identify the *Lasa* with the *Lares* of the Romans.

that Etruscan women "Lie on the kline not only with their husbands but also with strangers and have relations with anyone willing to do so." While Plautus, the Latin playwright in the *Cistellaria* (II, 3 v 20 etc.) calls prostitution, "The Etruscan way to acquire a dowry."

These misconceptions of Etruscan customs may be ascribed to the fact that both writers lived at a time when Rome was extremely proud of its Latin ancestry and regarded the early Etruscan influences on its civilization as a blemish on its past.

Life in Etruria as the murals in the tombs point out was largely given to entertainment.[12] Most games we know through the Romans were of Etruscan extraction. Thus the games of the Gladiators were first played in Etruria and from there they spread to the South, to Campania, where the Romans learned them. The *subulones* or pipe players, so popular in Rome, were Etruscan, and so were most of the pantomime performers and the clowns. Acrobats and trick riders were also Etruscan and polo was one of their favorite games.

The Etruscans were masters in playing the double flute called *tibia* and legend wanted Athena to have invented the horn for their very special use. Ateneus tells us (XII, p. 518 b) "The Etruscans do every thing at the sound of music, they make *pasta* (noodles), they have fist fights, they whip people while listening to the flute."

Their homes were perhaps the most comfortable of ancient times. From the tombs we know the way these homes were built again because of the Etruscan tendency to see in the after life a continuation of the present. The houses were divided into three rooms of which the largest was the nuptial chamber to symbolize the importance of the wedded pair, therefore of the family unit.

The rooms were furnished with throne-like chairs, *bucchero*[13] vases, bronze containers, candelabra, incense holders, kitchen knives, grills, colanders, even knapsacks. Toilette articles consisted of mirrors, safety pins which they called *fibulae,* scissors, depilators, short ivory sticks, and different types of brushes.

The jewelry was exquisite and abundantly used by the women who loved to wear heavy make up on their expressive faces crowned by the blonde hair and a pointed cap called *tutulus.*[14] The make up was not limited to women. The *Lucumones* walked the streets of Rome wrapped in their *tebennos,* the future Roman *toga,* their faces painted in red to assert their proud masculinity.

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[12] This can be seen in most murals of the VI, V century B.C. notably in the Tomb of the Augurs, Tomb of the Lioness, Tomb of the Baron, Tomb of the Triclinii, all in Tarquinii. Also in the Tomb of the Monkey in Chiusi.

[13] *Bucchero* is a native black clay.

[14] On their feet they wore the *calcei repandi,* a pointed shoe of Ionic-Oriental origin.

The Etruscans controlled rain water by an opening on top of the house or *cumpluvium* which allowed the water to gather in a small pool at the center of the atrium. They also used a reclined roof that forced the water to slide on the sides of the house. This type of water drainage was called *displuvium* and is the kind still used today on the roof of modern homes.

The Etruscans were engineers of great skill[15] being able to restore the swamp lands of Tuscany and Latium to cultivation and make them produce great quantities of wheat, lineum, olives, wood, and delicious grapes. The arch which they masterfully used in building bridges, aqueducts and city walls was an Etruscan architectural innovation of probable Oriental origin.

They worked metals, especially iron, with such intensity that the iron scraps they left on the shores of Polpulonia, across from the island of Elba, are still used today.

They were so skilled in medicine that a legend wanted the sons of the enchantress Circes[16] to have found shelter in Etruria where they brought their medical craft. Chirurgical instruments such as bistoury, forceps, tweezers, have been found in different tombs to attest to their widespread use. Dentistry was highly developed in Etruscan times and gold teeth were not a rarity. We know this from a Roman law that forbade bodies to be buried with gold to discourage thieves. An exception was made for the gold in dental work, and the deceased could be buried *auro dentes juncti* or "with the gold that keeps the teeth together" inside the mouth.

The typical Etruscan infernal deity, Charu (Charon) was represented holding a hammer. The meaning was quick death—the mercy killing often inflicted by the Etruscans on their elders when gravely ill.

Charu and his hammer became predominant in Etruscan painting toward the end of the IV century B.C. During the years of Etruscan decadence, the after life became a nightmare of demons and horrible creatures as symbolized by the Lasa Tuchulcha—a winged monster with a beak-like nose and snakes winding around its hair and on its left arm.

The rising danger of the Romans in the south aggravated by the savage excursions of the Gauls in the north impoverished the Etruscans and drained their creative capabilities. Perhaps because of the stress they placed on the resemblance of their after life to everyday reality, they saw no reason for survival in a world ravaged by wars and in a home destroyed by tragedy and mourning. This re-

[15] The *Cloaca Massima* in Rome was built by the Etruscans under the Etruscan king Tarquinius Priscus.

[16] See the *Odyssey* by Homer. Chapter 10. (Valgimigli Italian Translation).

fusal to survive, may be one of the reasons why their language is nearly completely unknown and seems destined to remain a secret forever.

According to the Romans the Etruscans left no noteworthy literary inheritance. Their only books[17] were concerned with rituals and the way to carry them out properly. Possible interpretation of longer funerary inscriptions however, leads us to believe that the Etruscans had some form of *elogia* or dramatic poetry written to honor important deceased.

Whatever the case, the Etruscan language fell into complete disuse during the Roman Empire and the Etruscan civilization withdrew itself in the hidden tombs of the *Lucomones* in a world that in the darkness of the underground seemed to cry for a new chance to live under the limpid skies of beautiful Tuscany.

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[17] Notably the *Libri Haruspicini, Libri Fulgurales, Libri Rituales.*

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