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OF

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VOL. XLIX

NATURAE SPECIES RATIOQUE

MADISON, WISCONSIN
1960

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The *Transactions* welcomes sound original articles in the sciences, arts, and letters. The author or one of the co-authors must be a member of the Academy. Manuscripts must be typewritten, and should be double-spaced throughout, including footnotes, quotations, and bibliographical references. Footnotes should be numbered consecutively and compiled at the end of the manuscript. The name and address to which galley proofs are to be sent should be typed in the upper left-hand corner of the first page. Manuscripts should be mailed flat or rolled, never folded. They should be addressed to Stanley D. Beck, 100 King Hall, University of Wisconsin, Madison 6. Papers received prior to July 31, 1961 will be considered for inclusion in the *Transactions*, volume 50.

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

* 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

[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

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[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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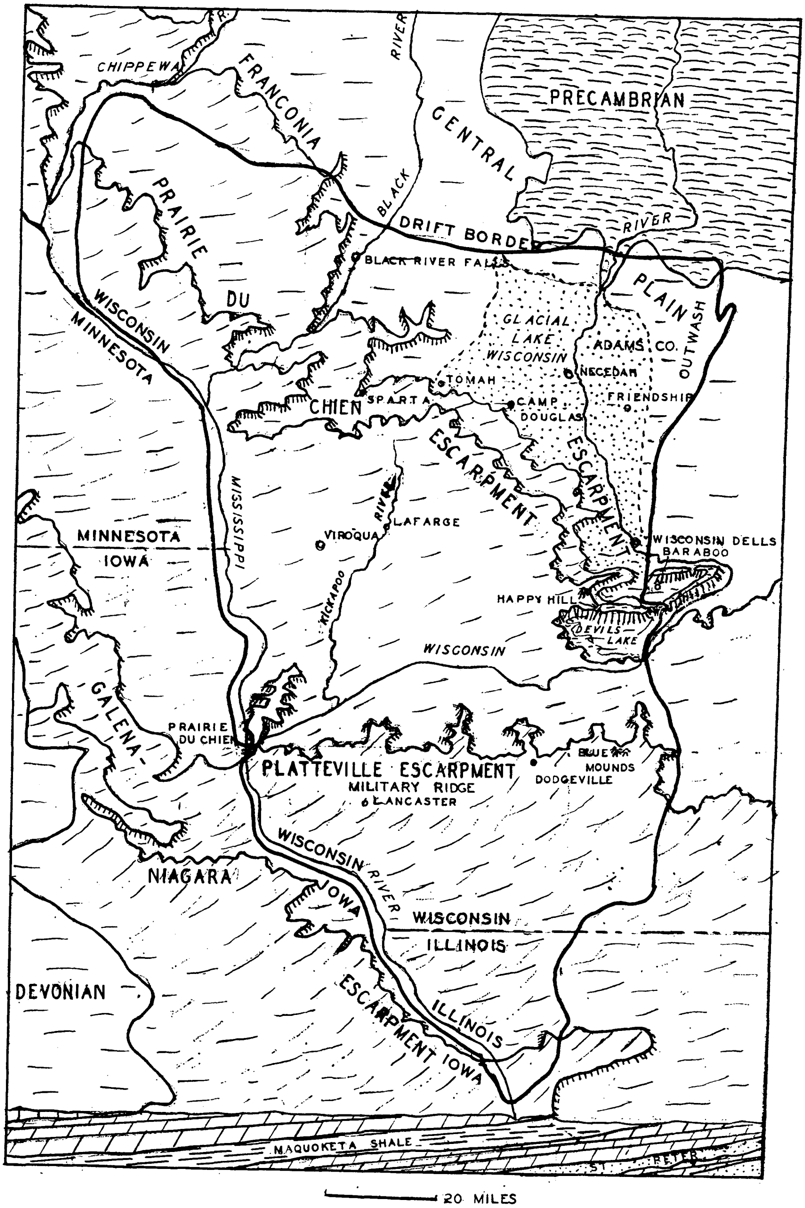


FIGURE 1. Physiographic diagram of the Driftless Area showing the escarpments of the three major dolomite formations and that due to the resistant Franconia sandstone. Valleys within the cuestas which expose lower formations were omitted.

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",

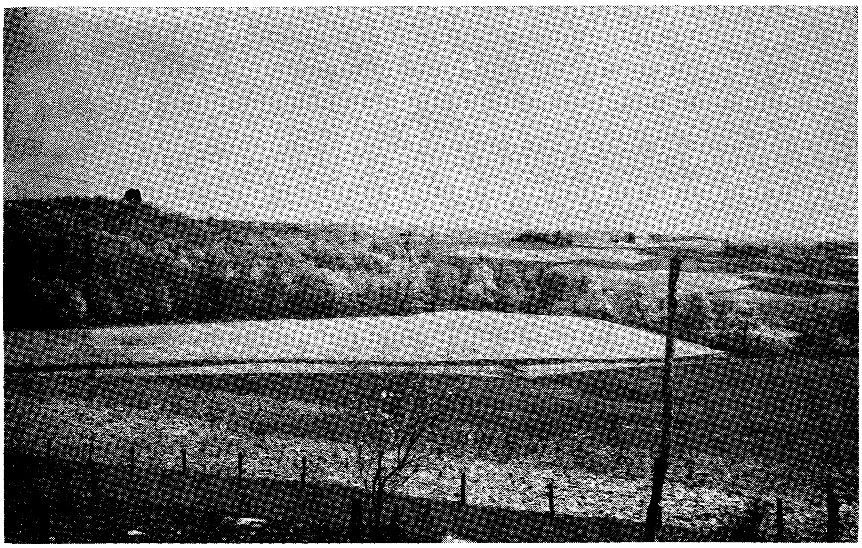


FIGURE 2. Break between upland on Prairie du Chien dolomite at right and Platteville dolomite at left. Steep slope is due to St. Peter sandstone which makes crags and towers at nearby points. Locality is at north end of section shown in Fig. 5. The bevel of the lower dolomite ends against this escarpment 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

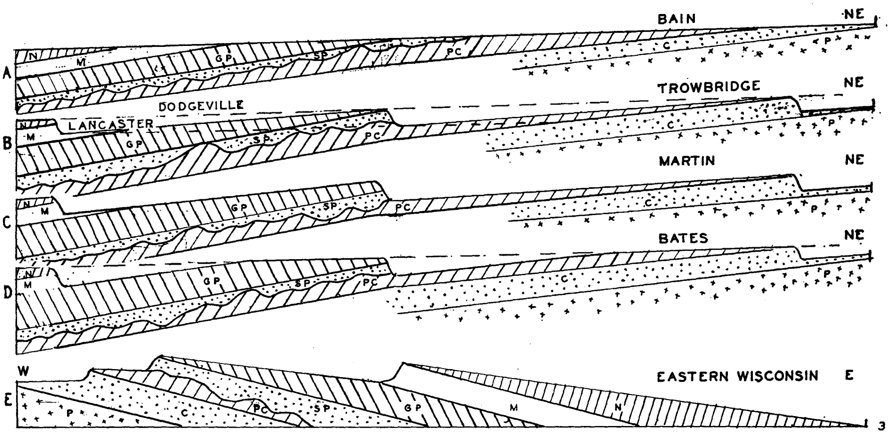


FIGURE 3. Diagram showing basic ideas of different hypotheses of the origin of the topography of the Driftless Area.

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

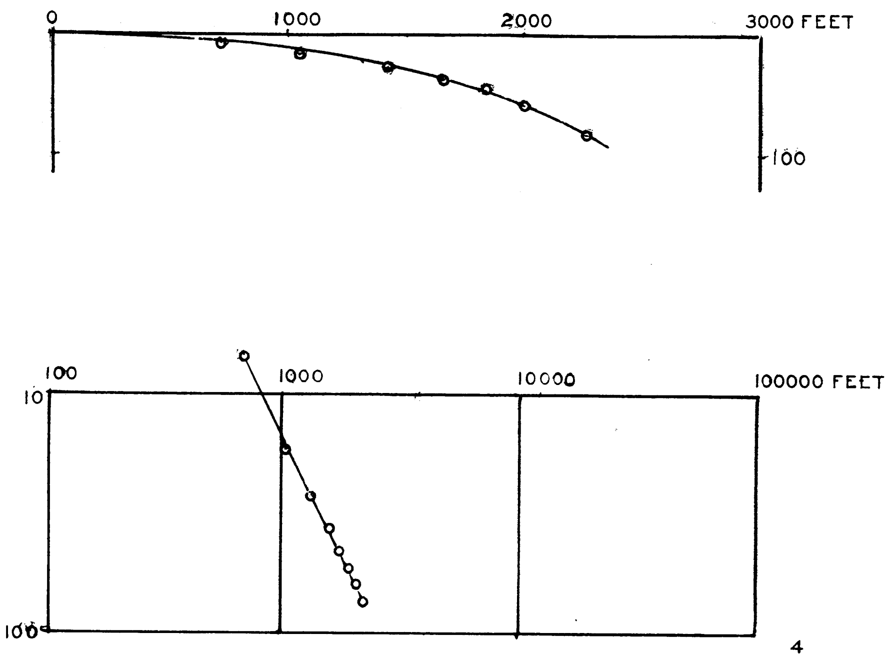


FIGURE 4. Profiles of slope below a divide in southwestern Wisconsin on Galena dolomite. The upper diagram is on ordinary coordinates and shows that the divides are smoothly convex, a fact confirmed by map study. The lower profile is on logarithmic coordinates and indicates that the fall is proportioned 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

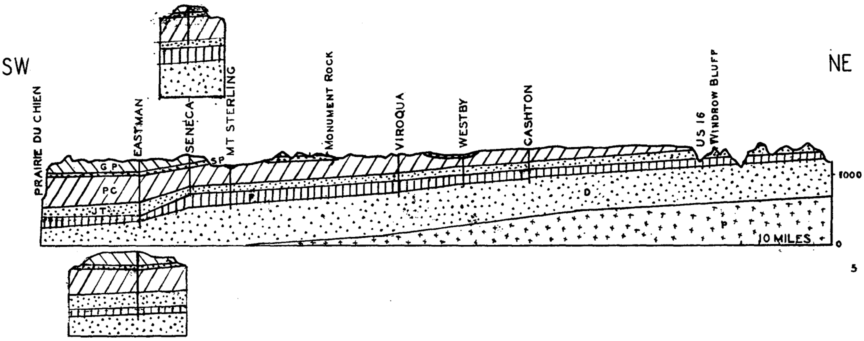


FIGURE 5. Profile of the Kickapoo-Mississippi divide in southwestern Wisconsin. This area was regarded by Trowbridge as a "bridge" connecting two cuestas. The uplands on the two dolomite formations are at the same level because there is a local abnormally steep dip. Moreover, the St. Peter sandstone 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-

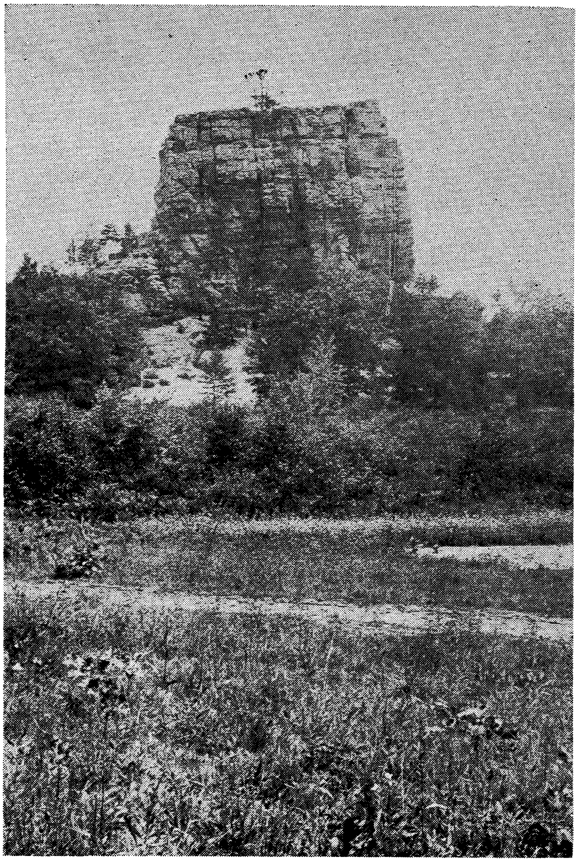


FIGURE 6. Butte of Galesville sandstone near Camp Douglas rising from lacustrine plain of central Wisconsin which was once described as a peneplain. The relationship could only be explained by lateral stream erosion of the plain which is graded to the post-Cary rock gorge at the Dells of the Wisconsin.

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

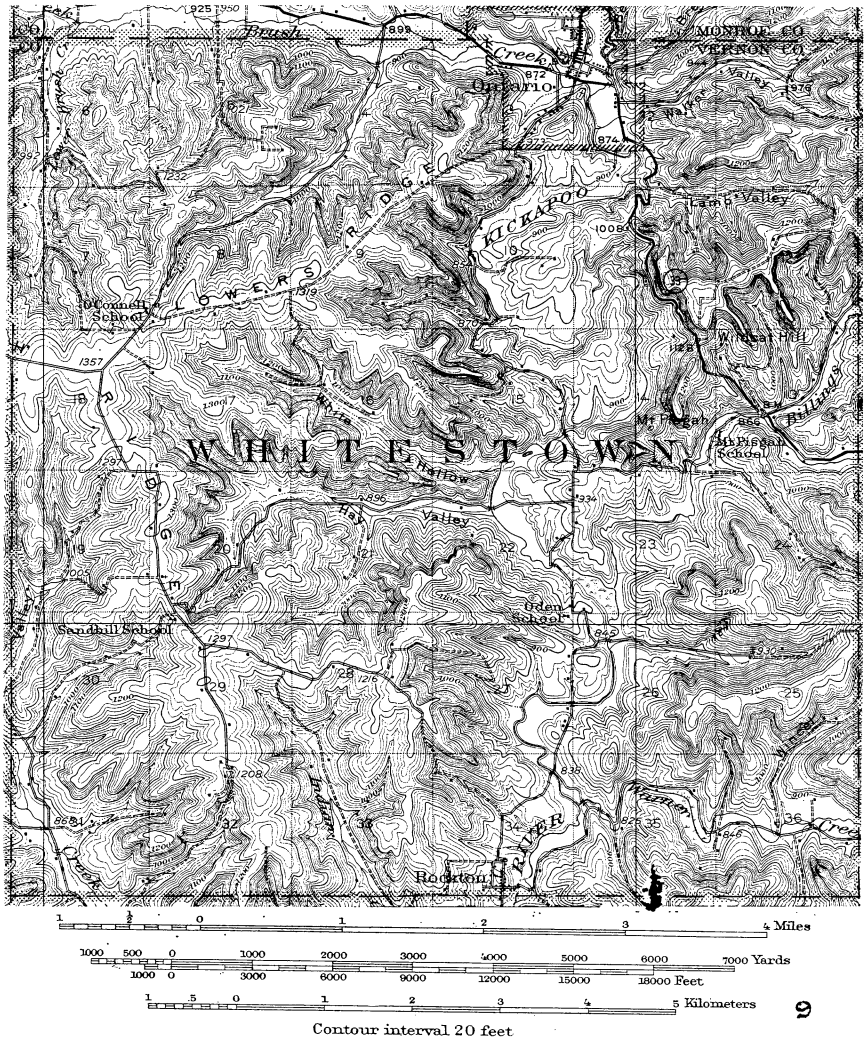
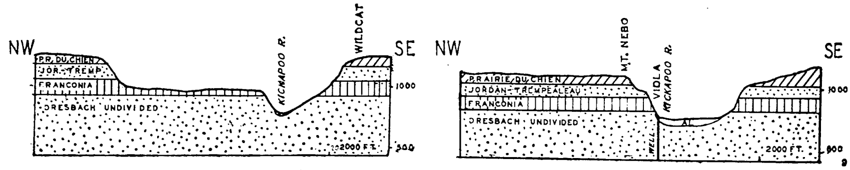


FIGURE 9. (In two parts, section and map) Entrenched meanders of Kickapoo River. The bluffs of the outer valley are capped by Prairie du Chien dolomite. The terrace is underlain by the Cambrian Franconia sandstone. This terrace is absent farther downstream where erosion does not extend as far beneath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



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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

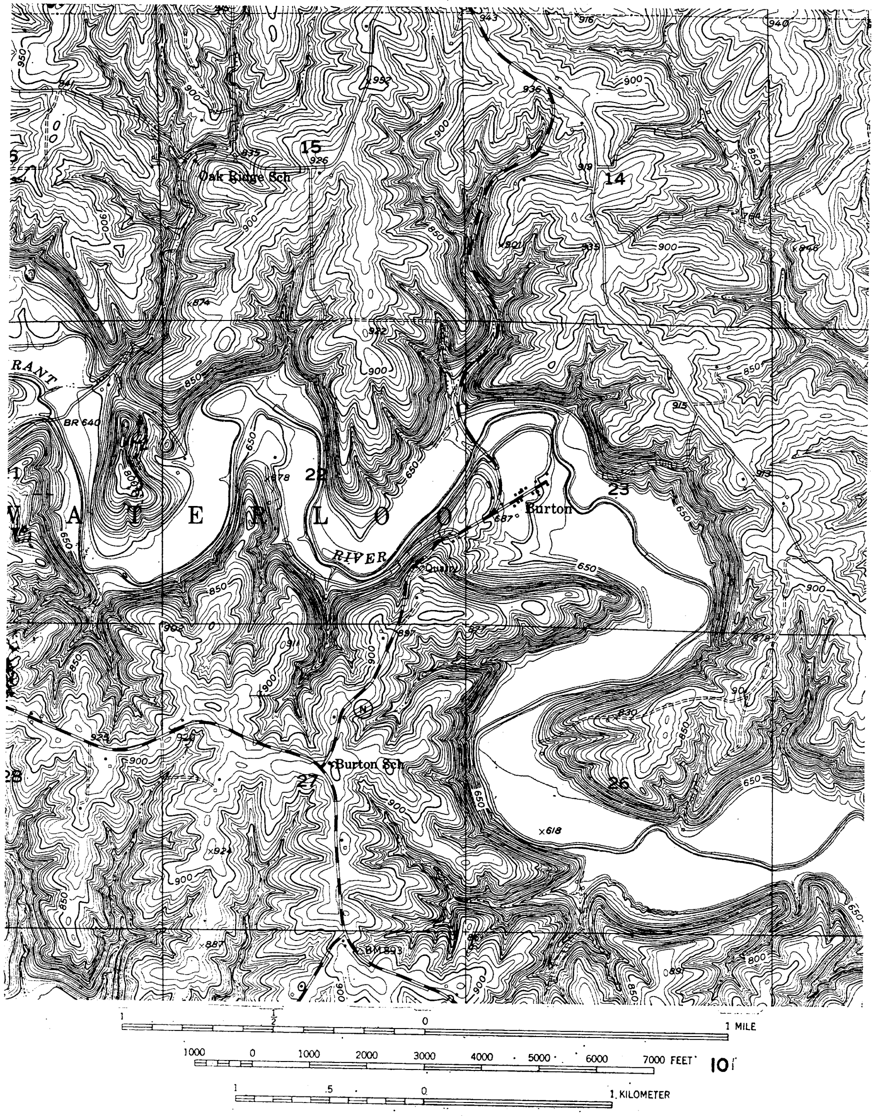

FIGURE 10. Entrenched meanders of Balltown Quadrangle Wisconsin. The bluffs are capped by Galena dolomite. The meanders are apparently of the "ingrown" type and originated when the surface was much higher than it now is but was not necessarily a peneplain.

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

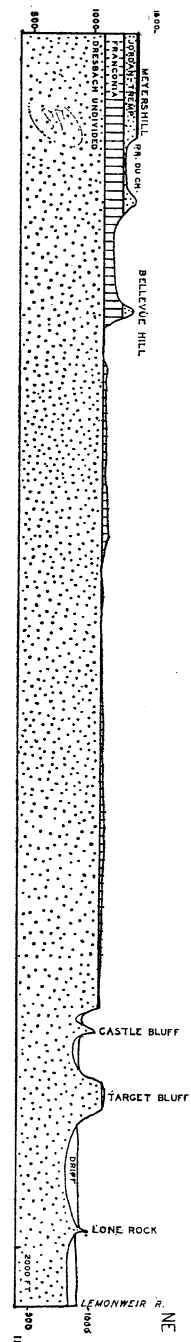

FIGURE 11. Profile on a divide from the Prairie du Chien upland at left to the castellated sandstone bluffs at Camp Douglas. The divide forms a bench on the front of the Prairie du Chien upland which is obviously due to the relative resistance of the Franconia sandstone above the weaker Galesville member 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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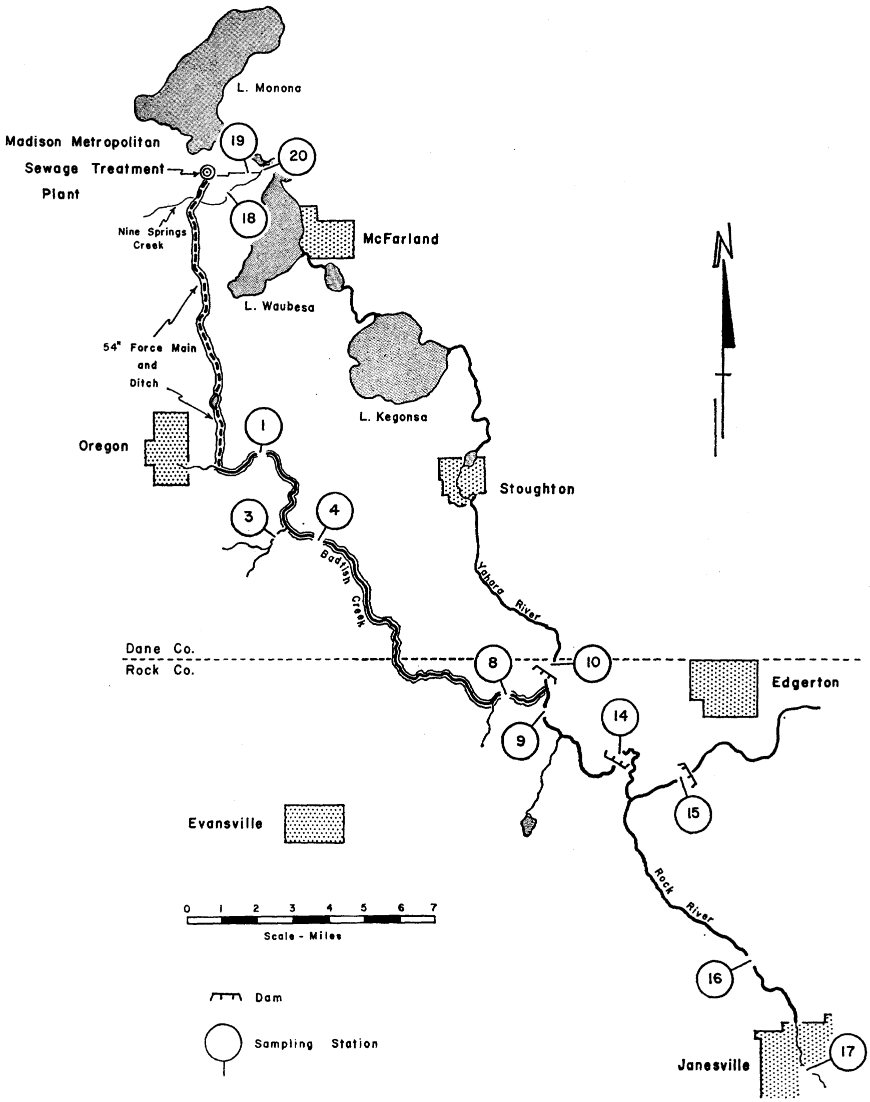

FIGURE 1. Map showing diversion route of Madison Metropolitan Sewage Treatment Plant effluent. Sampling stations are indicated by number inside of small circles.

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

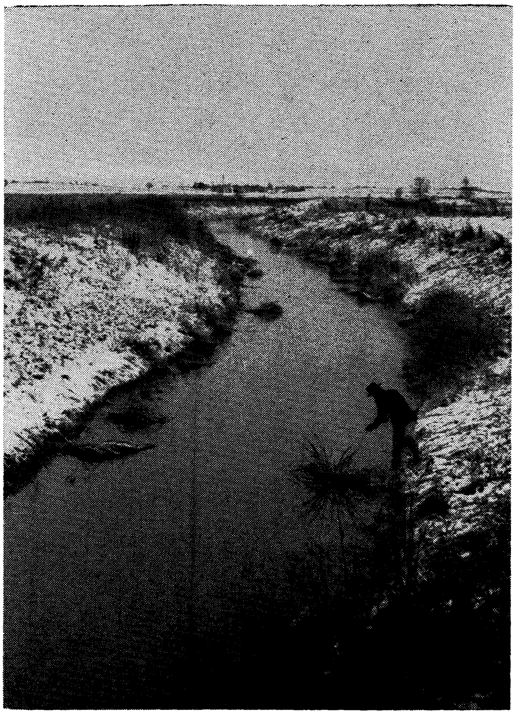

FIGURE 3. Ditch about 1½ miles below pipe outfall. Roundstem bulrush can be noted in some sections of stream.

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.

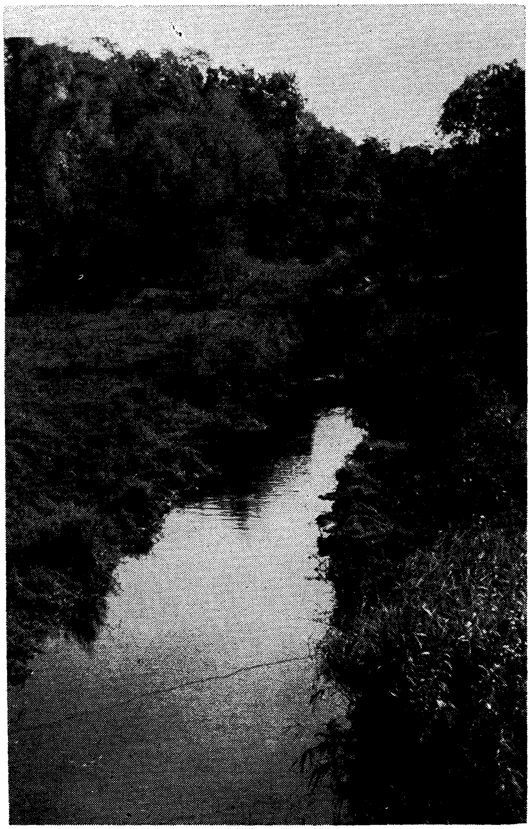

FIGURE 4. Station 1 on Badfish Creek before improvement.

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

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

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-

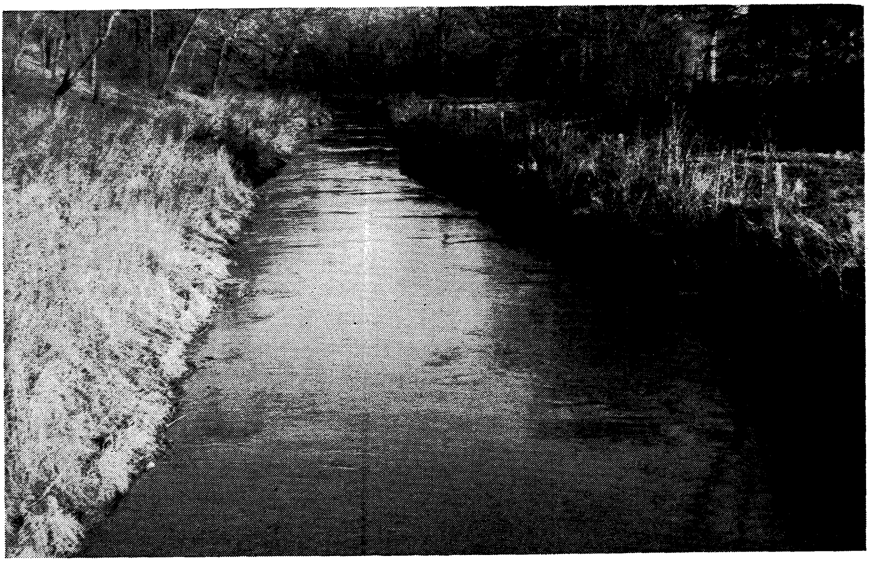

FIGURE 5. Station 1 on Badfish Creek following diversion.

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 ± 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		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 ± 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

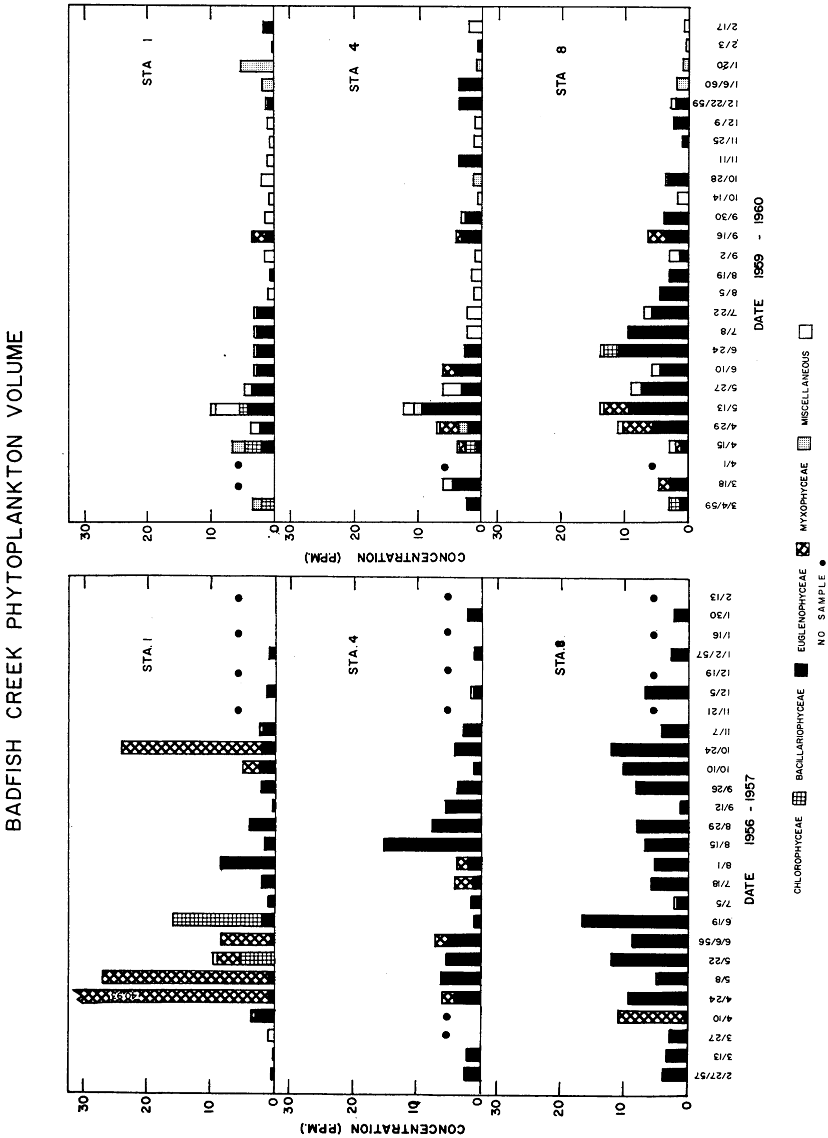

FIGURE 7. Badfish Creek Phytoplankton Volume.

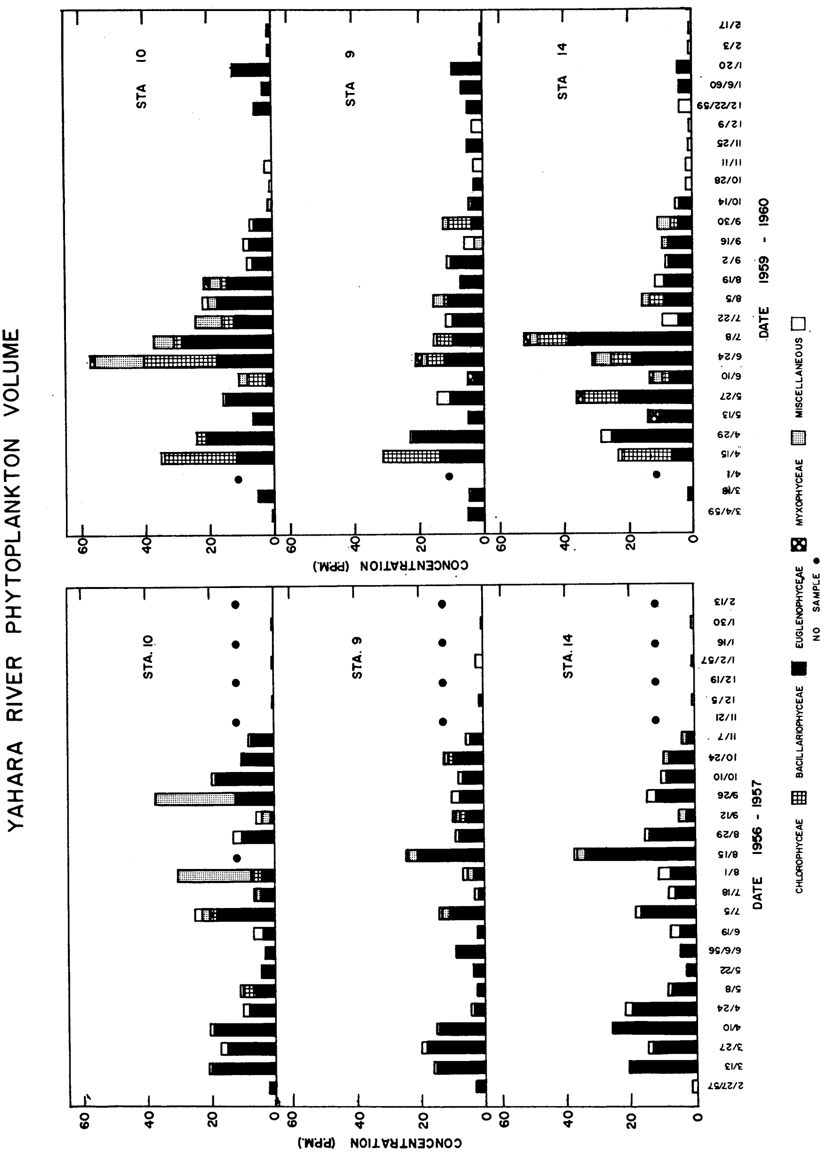

FIGURE 8. Yahara River Phytoplankton Volume.

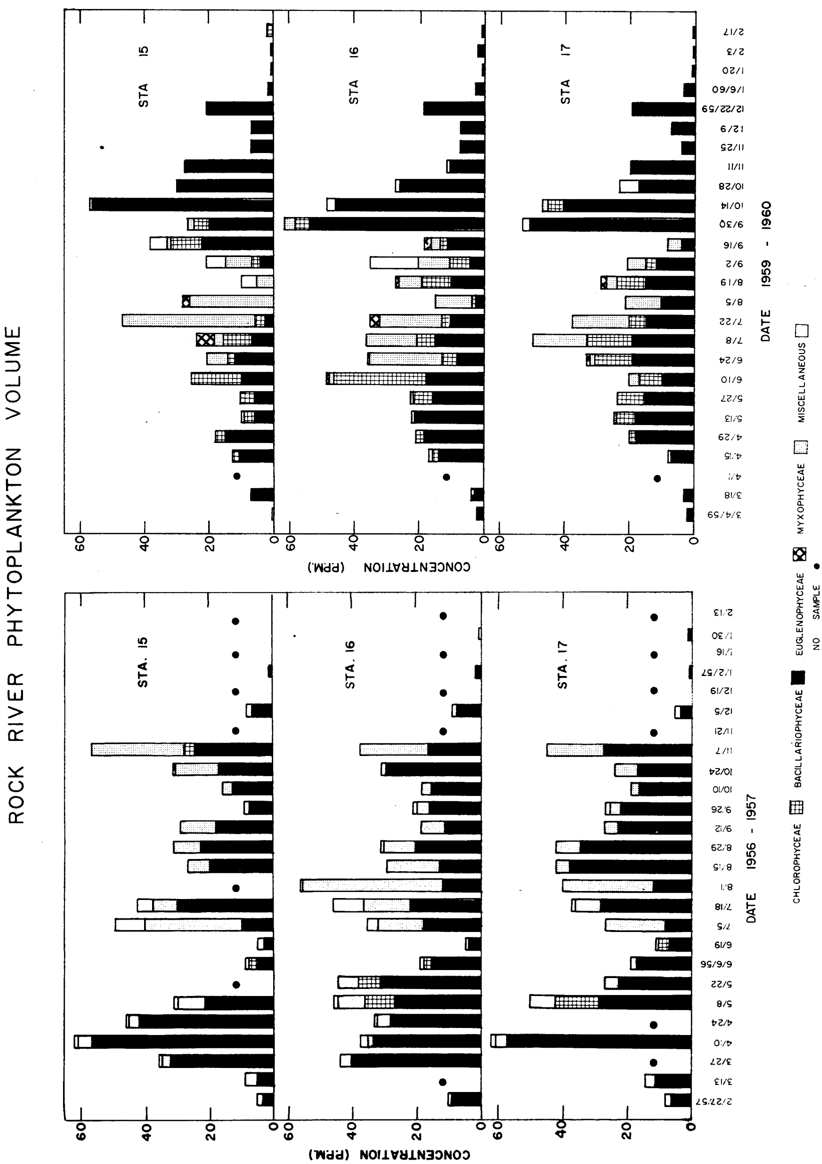

FIGURE 9. Rock River Phytoplankton Volume.

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

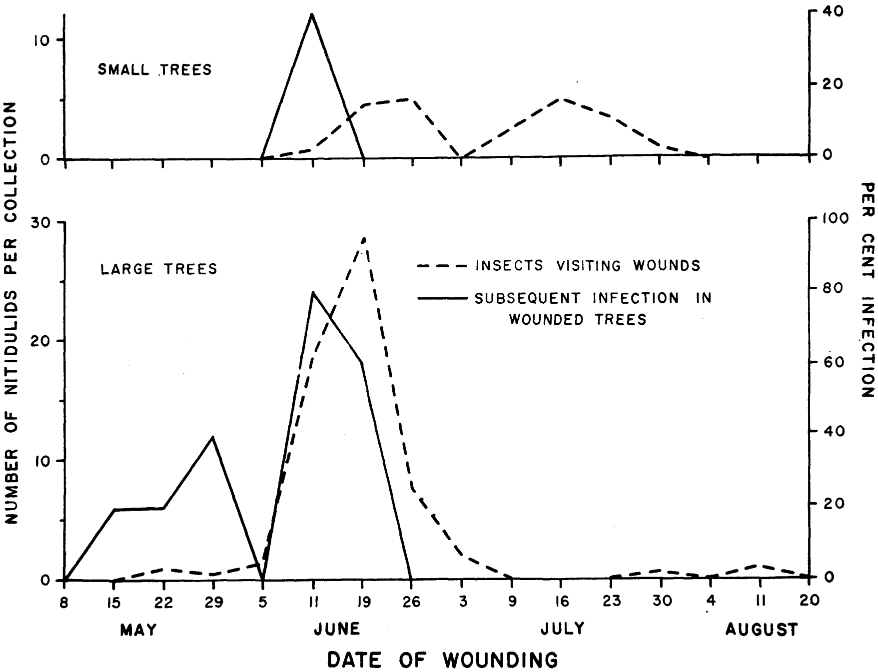

FIGURE 1. The relationship between time of infection in wounded trees and time of insect visitation to the wounds.

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-

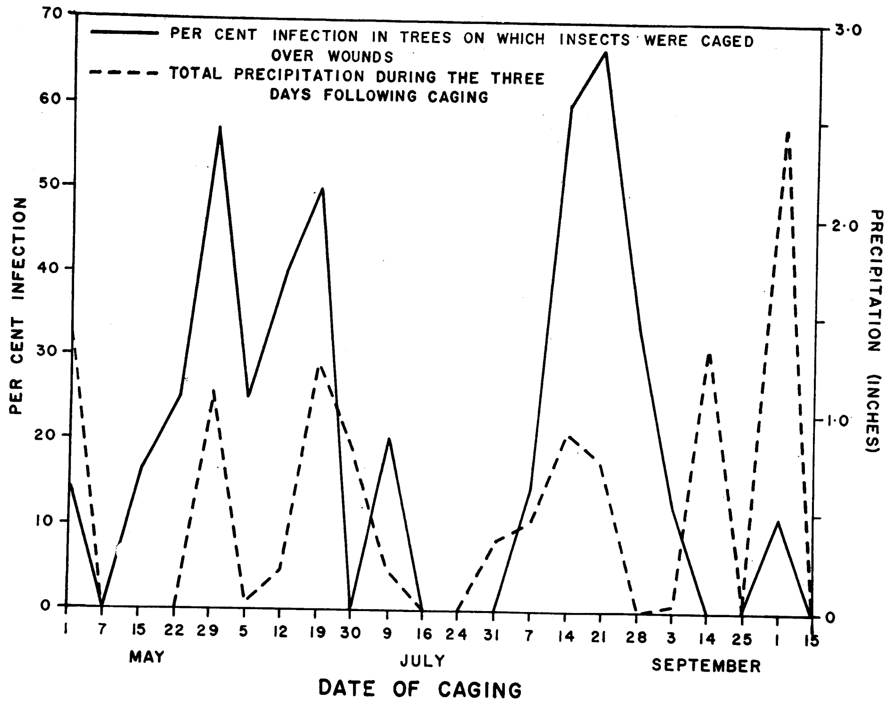

FIGURE 2. The relationship between precipitation and the incidence of wilt in the caging tests.

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 above-mentioned 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.

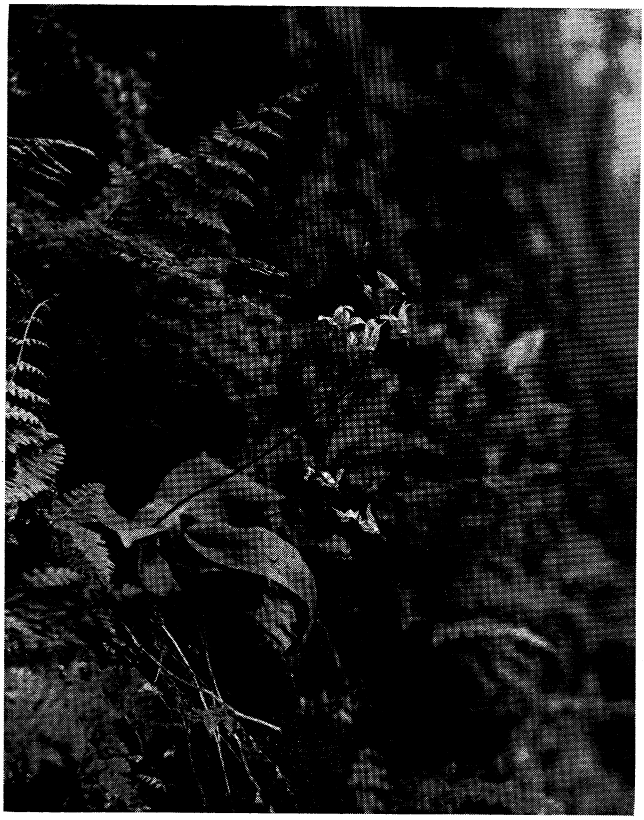
PETRAKIA ECHINATA (Pegl.) Syd. on *Acer saccharinum.* Vernon Co., Wildcat Mt. State Park, September 9. The Wisconsin specimen corresponds closely to European material on *Acer pseudoplatanus.*

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

HUGH H. ILTIS and WINSLOW M. SHAUGHNESSY
Herbarium of the University of Wisconsin

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)]

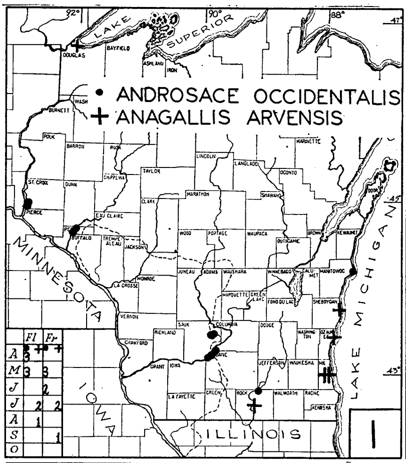
A. Corolla-lobes pale pink to deep red-purple ______________________ *D. amethystinum* f. *amethystinum*

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.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ANAGALLIS ARVENSIS
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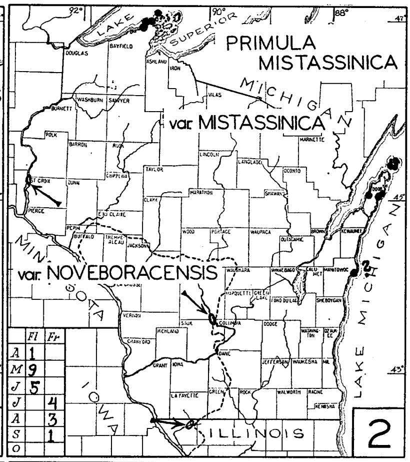
IOWA
ILLINOIS
LAKE MICHIGAN
1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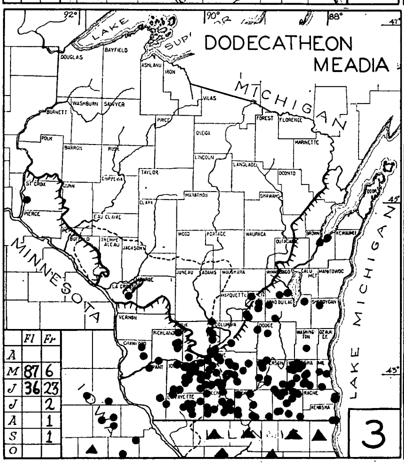
2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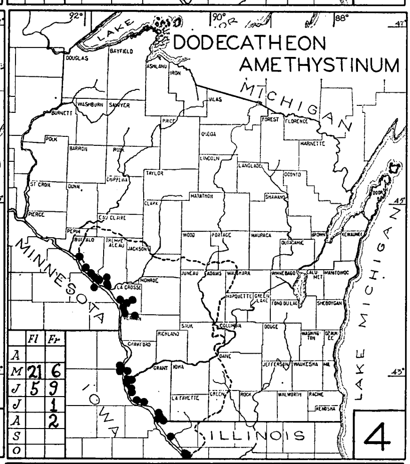
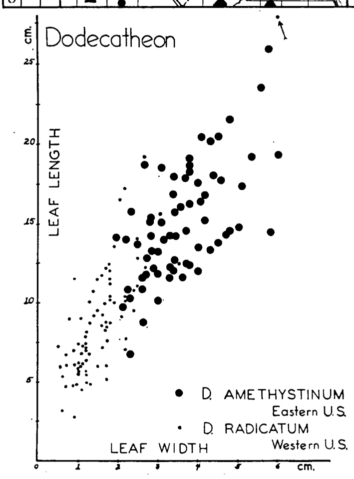
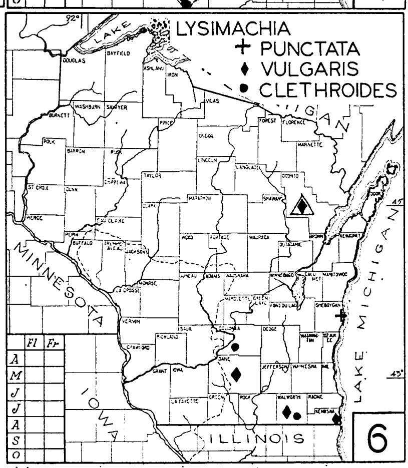

LAKE
DODECATHEON
AMETHYSTINUM
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
4


cm.
Dodecatheon
LEAF LENGTH
D. AMETHYSTINUM
Eastern U.S.
D. RADICATUM
Western U.S.
LEAF WIDTH
cm.


LAKE
LYSIMACHIA
PUNCTATA
VULGARIS
CLETHROIDES
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
6

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 Paperbirch, 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.).

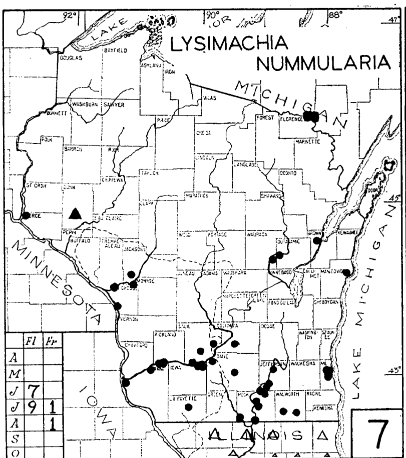
In open wet (acidulous?) habitats throughout most of Wisconsin, lacking in most of the well-drained Driftless Area and (excepting stations on Lake Michigan) from the area underlain by Niagara Dolomite; in muddy or sandy lake-shores, marshes, low wet prairies, sedge meadows, tamarack swamps, cranberry and leather-leaf 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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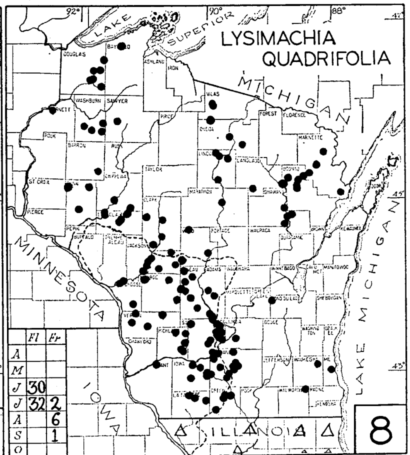
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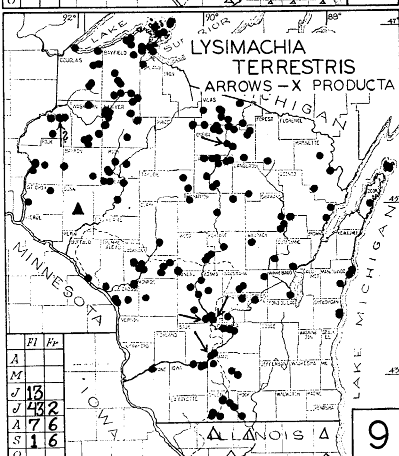
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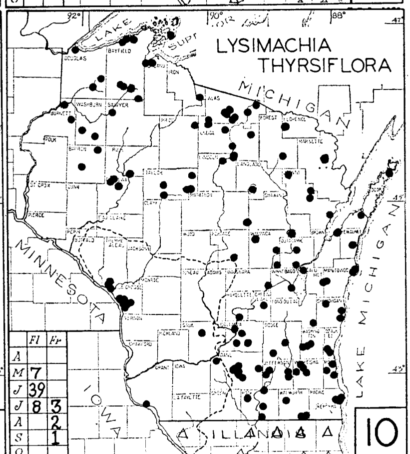
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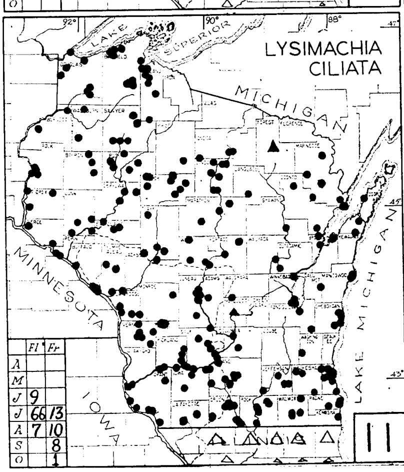
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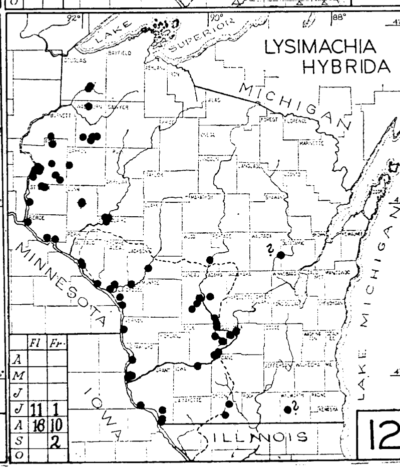
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have an extra lateral inflorenscence or two, a condition which we suppose to be within the normal variational amplitude of *L. terrestris.*

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

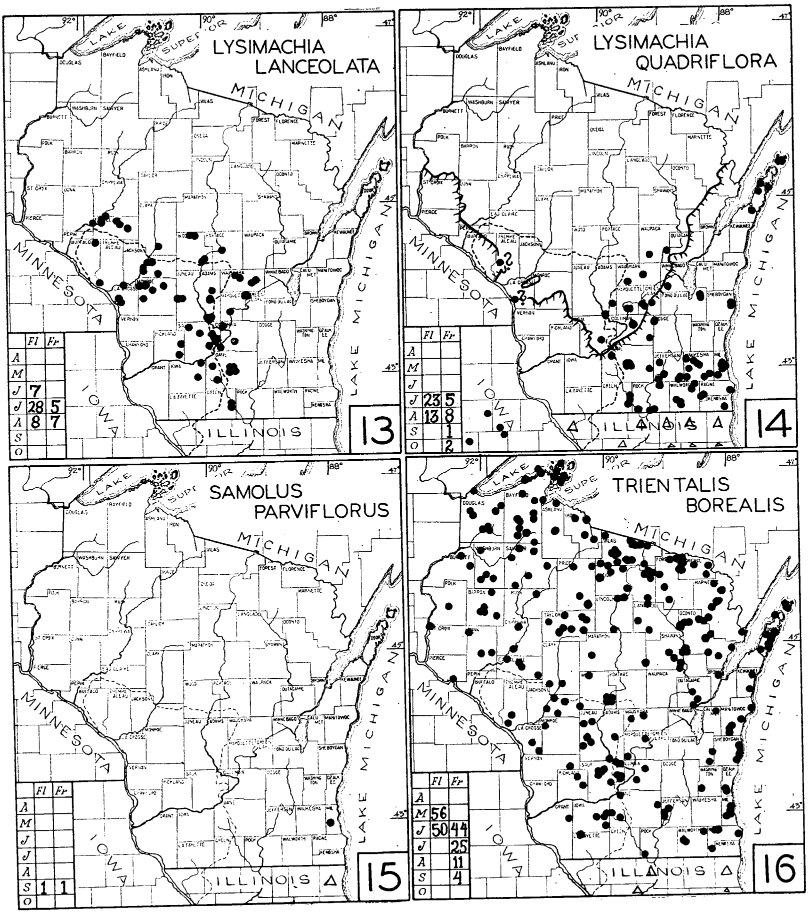
Steironema lanceolatum (Walt.) Gray

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.


LYSIMACHIA LANCEOLATA
13
LYSIMACHIA QUADRIFLORA
14
SAMOLUS PARVIFLORUS
15
TRIENTALIS BOREALIS
16
LAKE SUPERIOR
MICHIGAN
LAKE MICHIGAN
MINNESOTA
IOWA
ILLINOIS

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. Secondly, 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

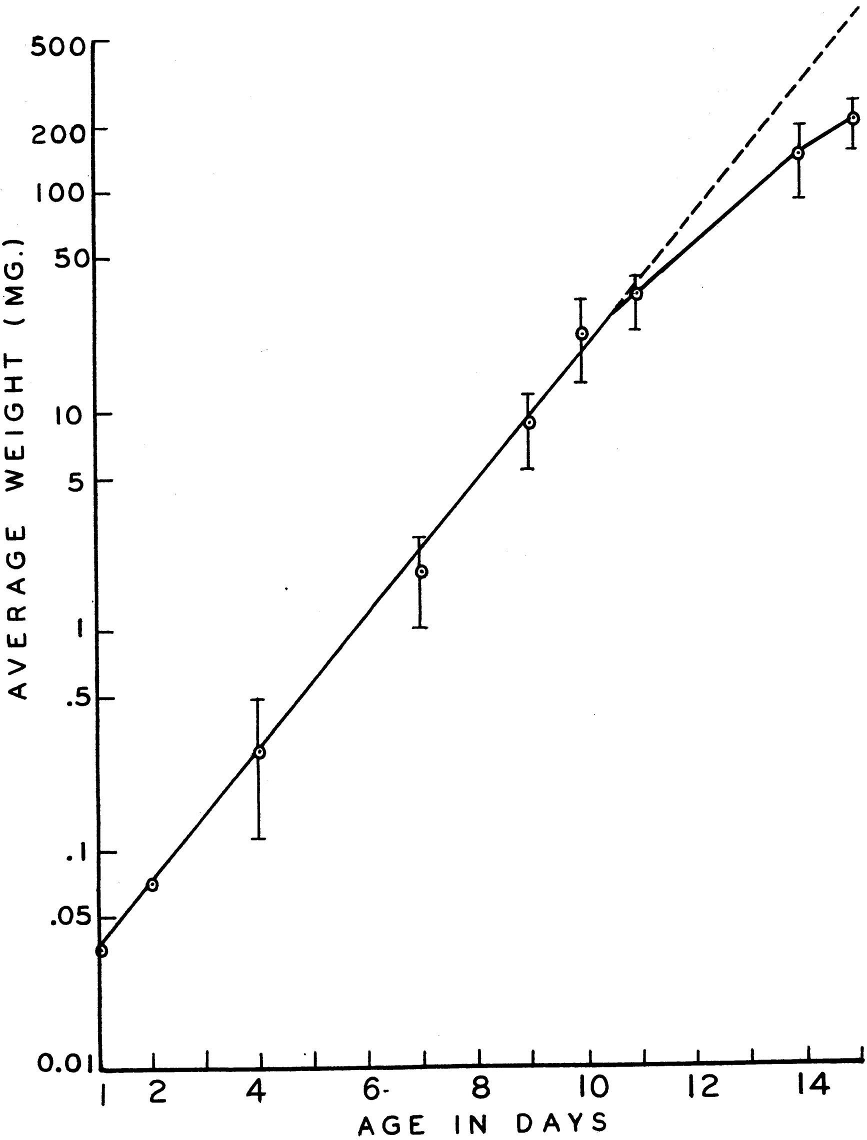

FIGURE 1. Larval growth curve of the greater wax moth at 35° C.

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.

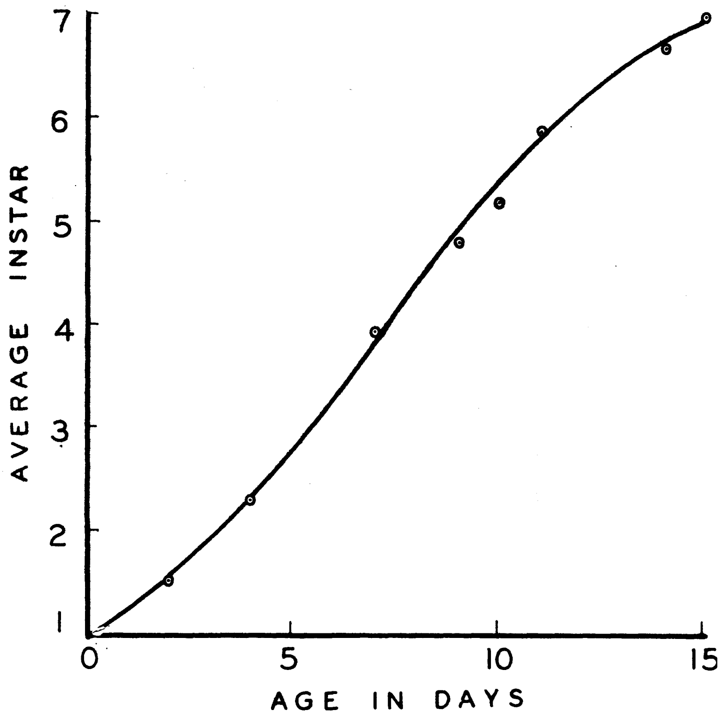

FIGURE 2. Larval growth of the greater wax moth, in terms of instar progression.

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.

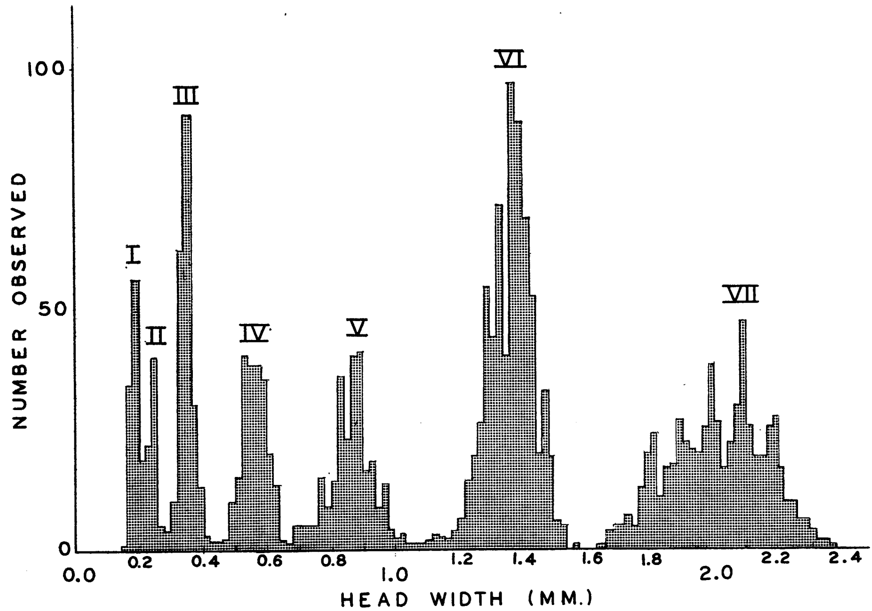

FIGURE 3. Frequency histogram of head capsule width of larvae of the greater wax moth, showing seven larval instars.

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

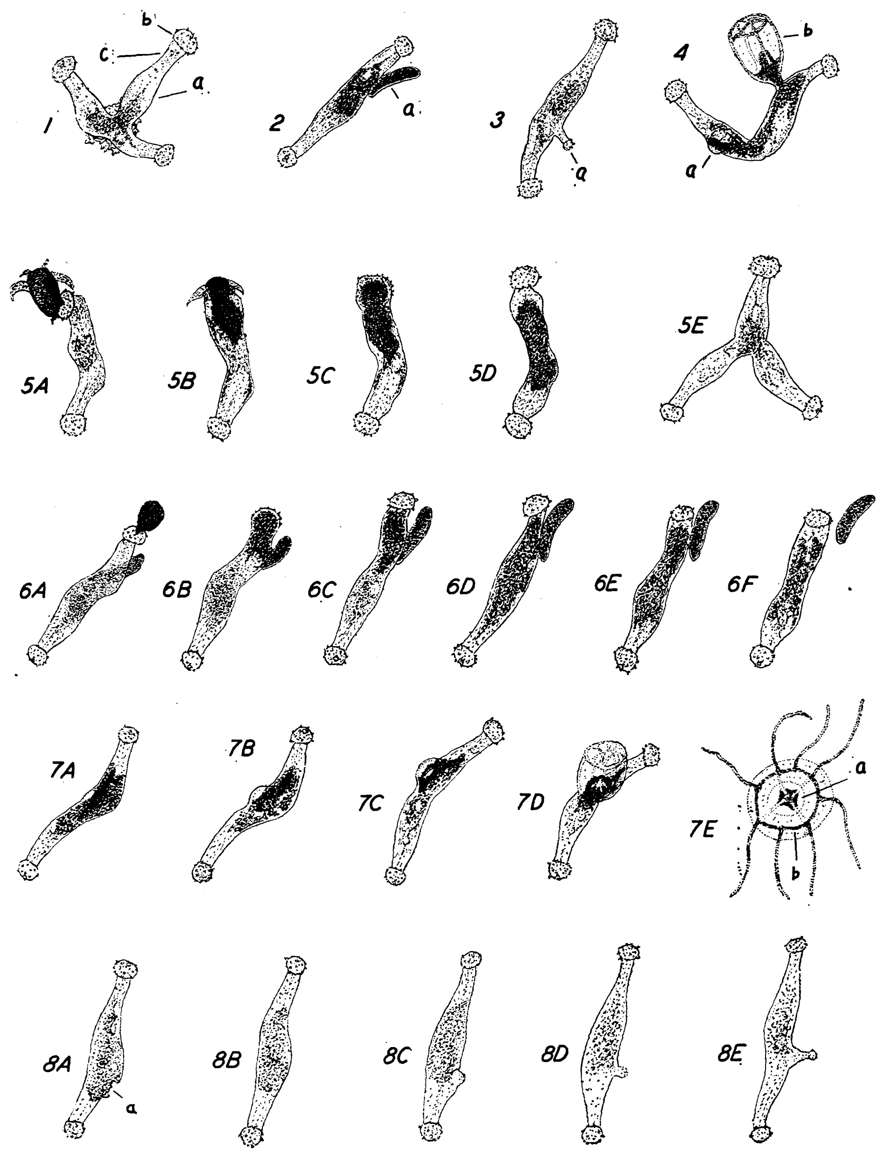
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PLATE I

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

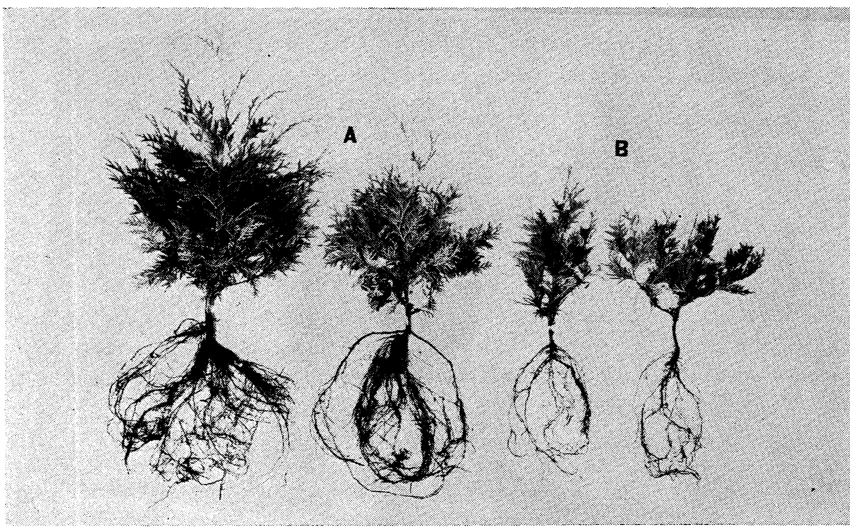

FIGURE 1. A comparison of hydroponic and nursery stock: A—Seedlings of white cedar raised for four months in a nutrient solution and for one growing season in a nursery bed; B—Three-year-old nursery transplants of the same species.

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

[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.

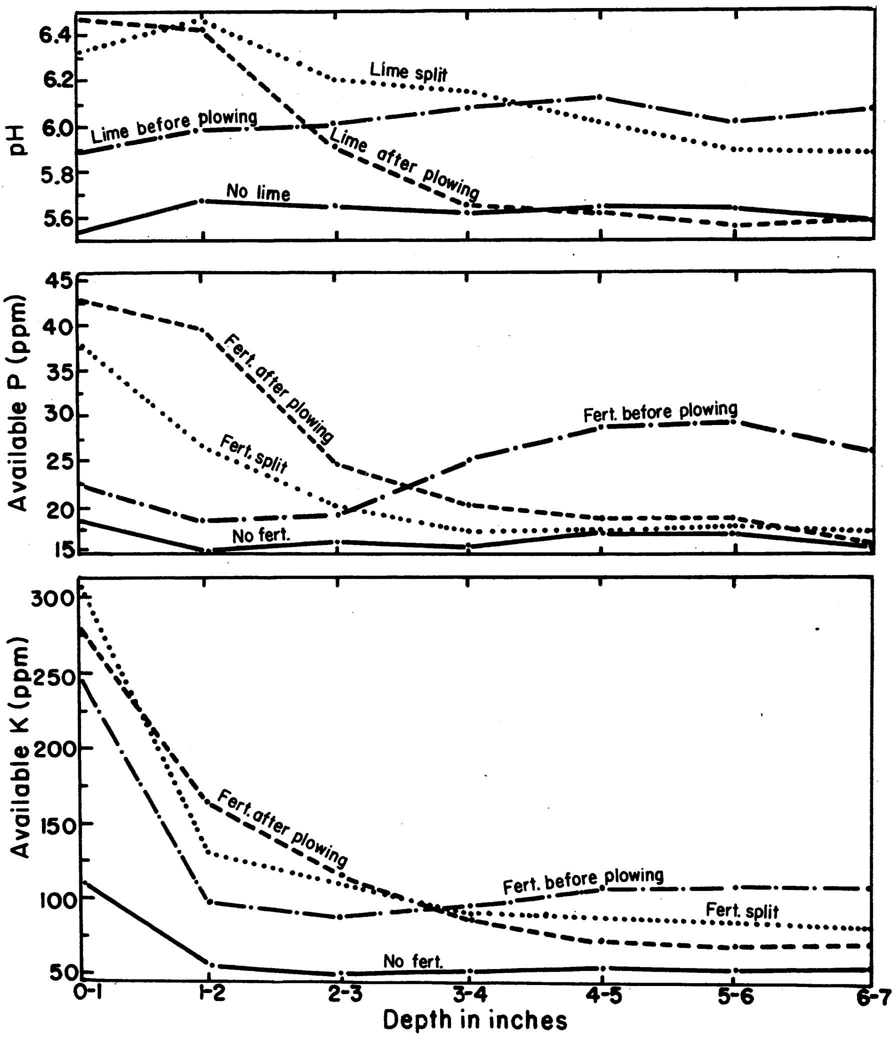

FIGURE 1. Soil reaction and available phosphorus and potassium contents at various depths in the plow layer as influenced by method of lime and fertilizer incorporation. (Materials applied 4/28/52; soil sampled 10/4/52).

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).

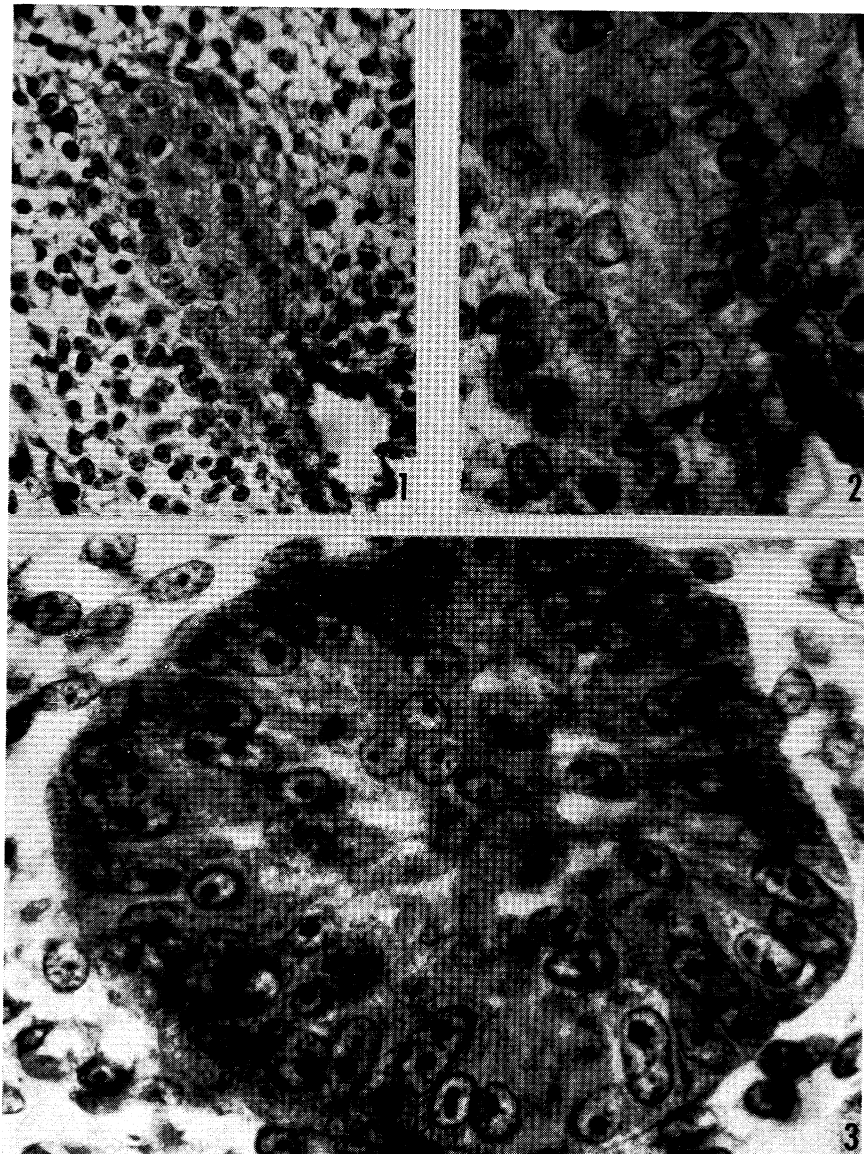
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PLATE I

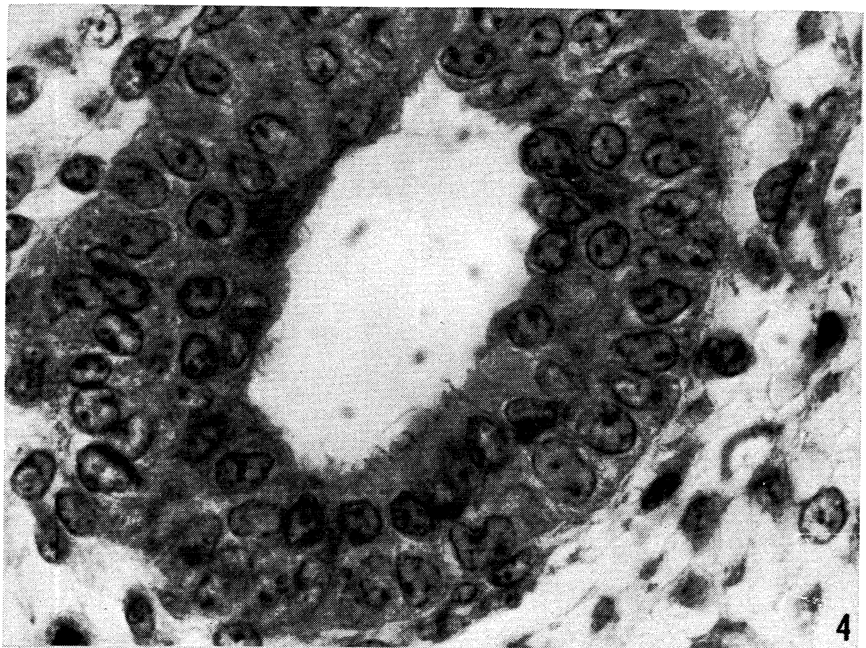
EXPLANATION OF FIGURES

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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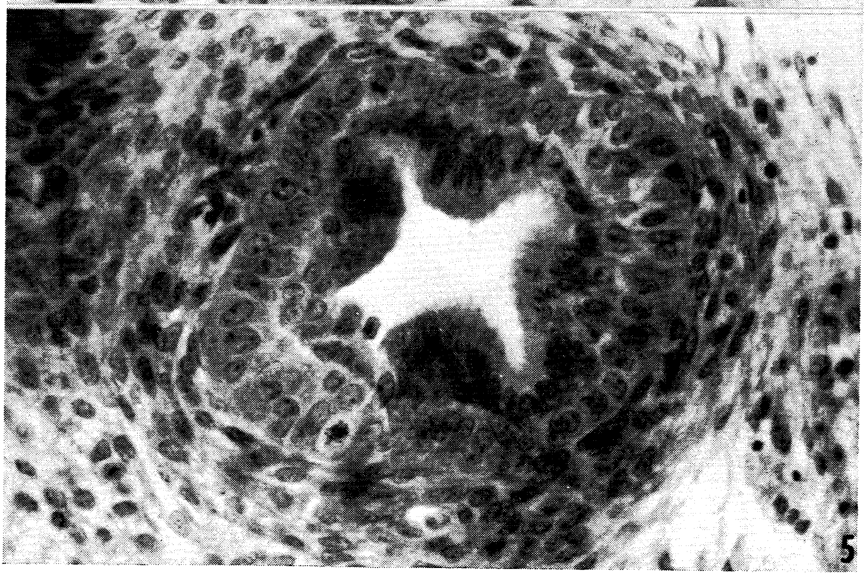
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PLATE II

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

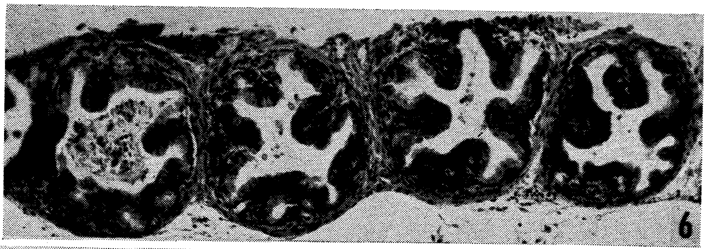
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PLATE III

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

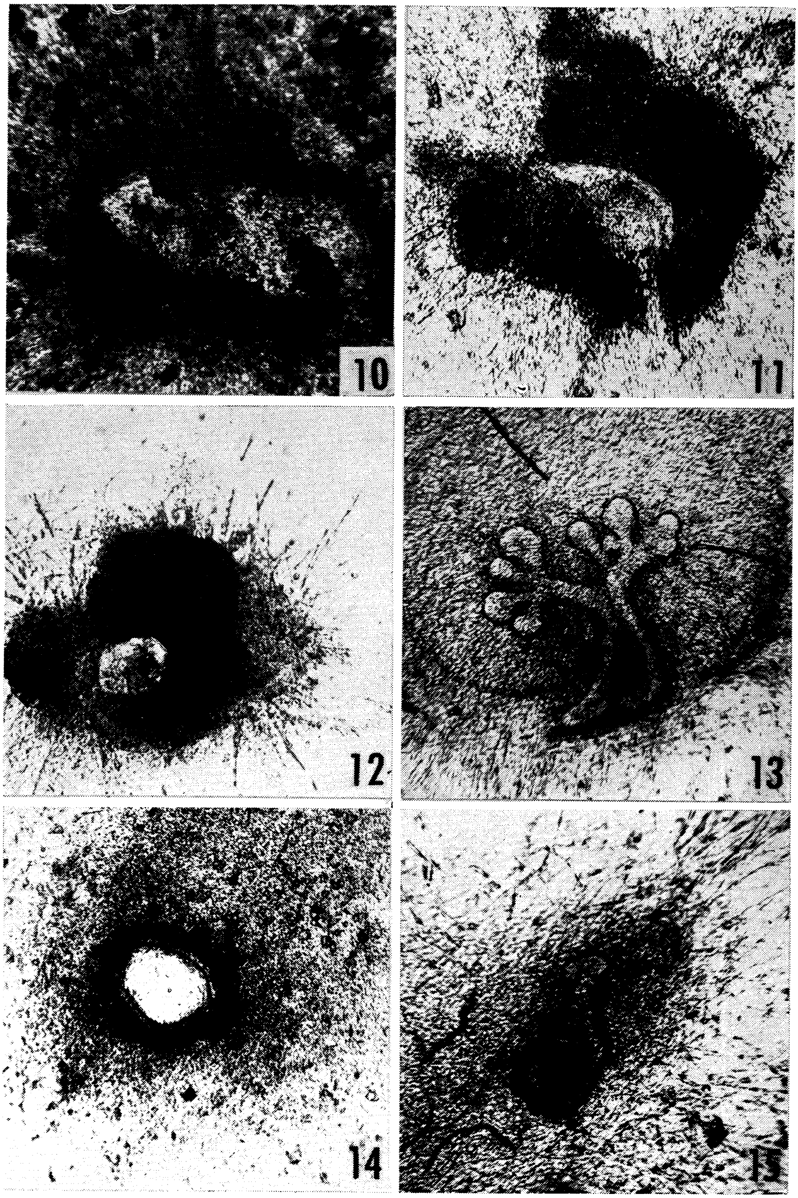
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PLATE IV

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 bursac 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-day)	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

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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.

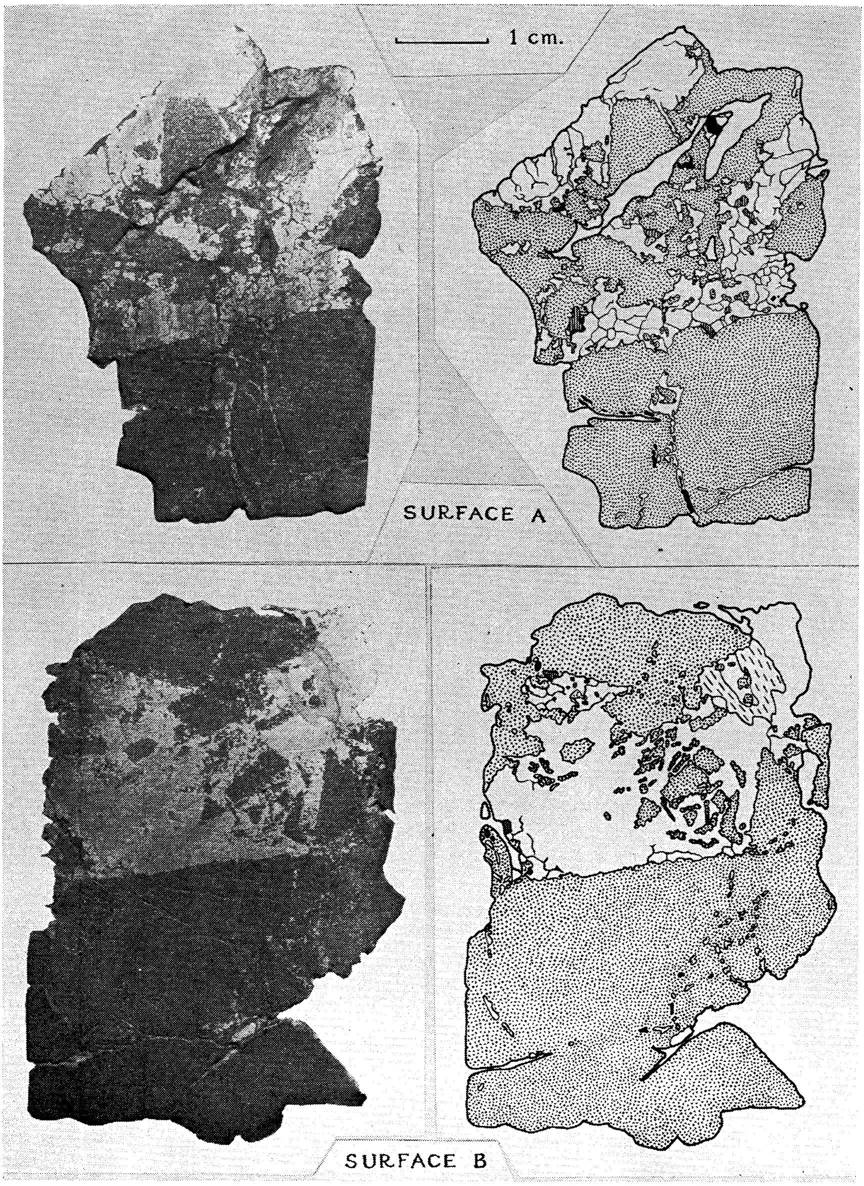

FIGURE 1. Two polished surfaces of the Saxeville meteorite. In the diagrams at the right, blank areas represent Ni-Fe; dots, stony material; vertical lines, schreibersite; solid black, troilite; short diagonal lines, Ni-Fe with abundant minute dark inclusions.

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

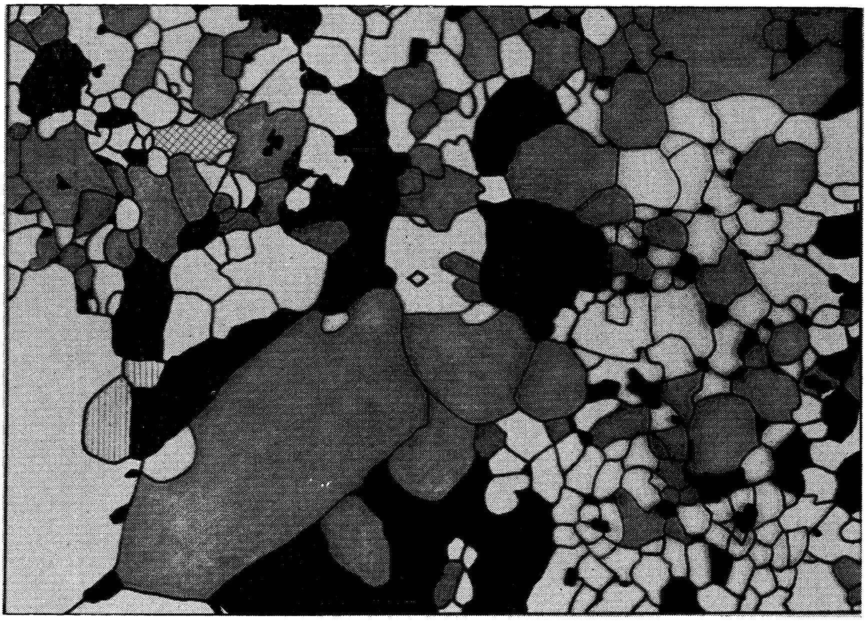

FIGURE 2. Tracing of photomicrograph of stony portion of the Saxeville meteorite, showing boundaries of silicate grains. White is pyroxene; grey, olivine; parallel lines, feldspar; cross-hatched, a hole in the thin section; black, opaque minerals. Area shown measures 1 x 1.4 mm.

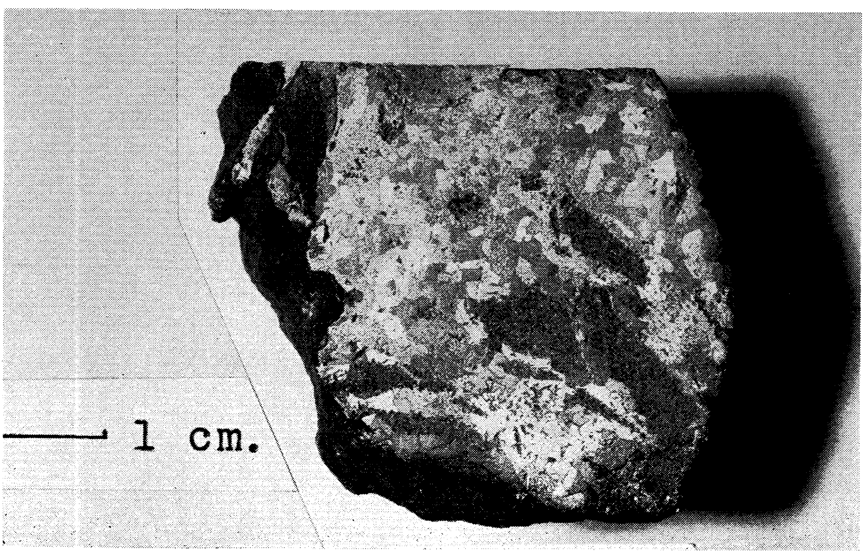

FIGURE 3. Etched surface of Saxeville specimen at the Milwaukee Public Museum, showing structure of the metal.

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.

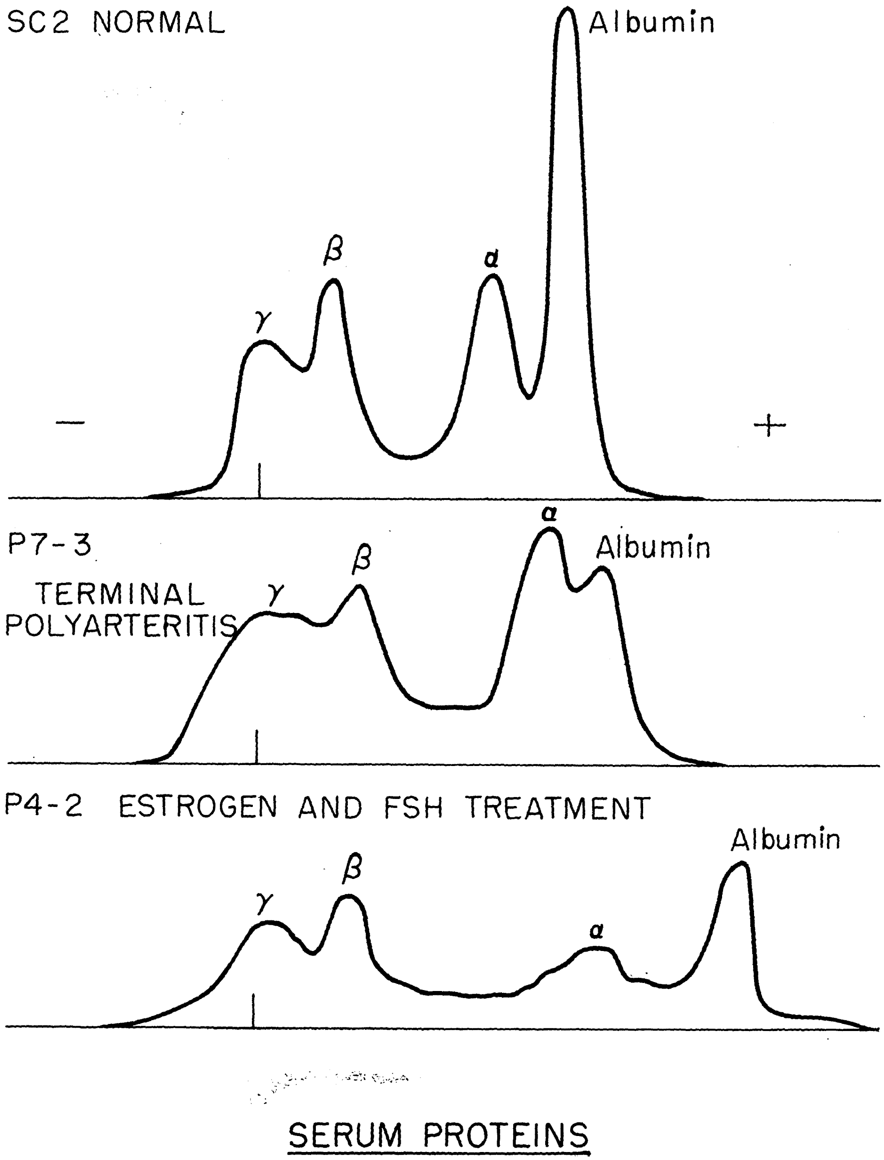
SC2 NORMAL
Albumin
β
α
γ
−
+
P7-3
TERMINAL
POLYARTERITIS
α
Albumin
β
γ
P4-2 ESTROGEN AND FSH TREATMENT
Albumin
β
γ
α
SERUM PROTEINS

FIGURE 1.

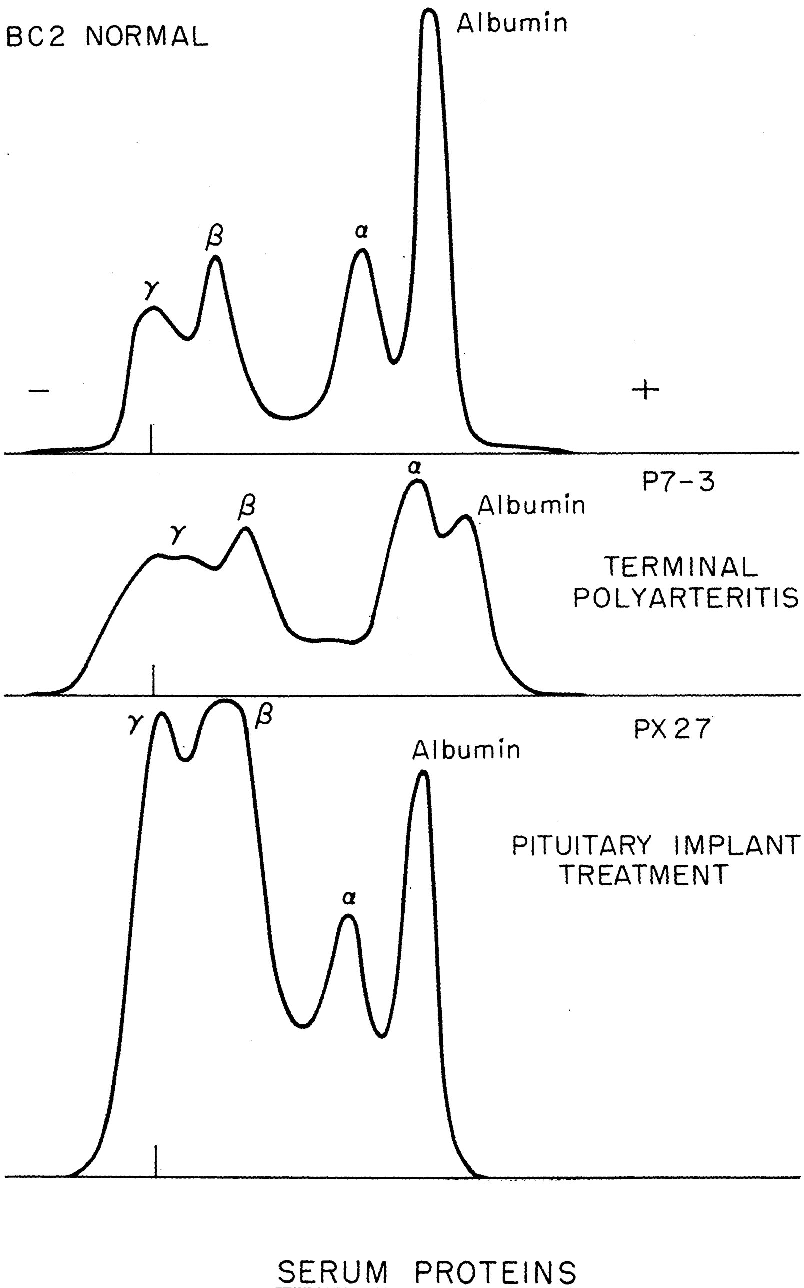
BC2 NORMAL
Albumin
γ
β
α
−
+
P7-3
α
β
γ
Albumin
TERMINAL POLYARTERITIS
PX 27
γ
β
Albumin
α
PITUITARY IMPLANT TREATMENT
SERUM PROTEINS

FIGURE 2.

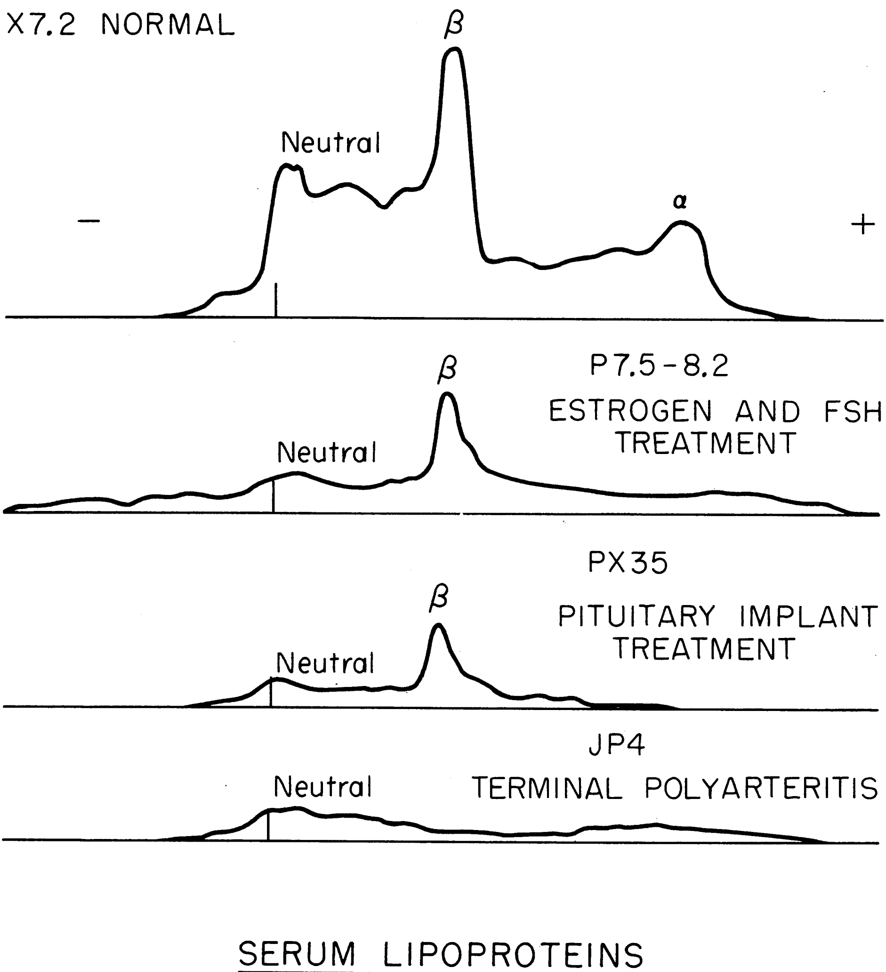
X7.2 NORMAL
β
Neutral
α
−
+
β
P7.5-8.2
ESTROGEN AND FSH
TREATMENT
Neutral
PX35
β
PITUITARY IMPLANT
TREATMENT
Neutral
JP4
Neutral
TERMINAL POLYARTERITIS
SERUM LIPOPROTEINS

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-

[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

[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

[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.

I

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-

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[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

[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

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[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 Littêraire* "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

[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.

[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

[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-

[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

[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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[143] *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-

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

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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 "sa'ubrity 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

183 Preface to *The Sea Lions* (Lovell-Coryell ed.), p. 5.
184 *Ibid.*, p. 6.
185 *Jack Tier*, p. 161, Chap. 6.
186 *Ib'd.*, 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-

[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.

[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

[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

[241] *The Last of the Mohicans,* p. 272, Chap. 25.
[242] *Afloat and Ashore,* p. 422, Chap. 28.
[243] *Ibid.,* p. 423, Chap. 28.
[244] *Ibid.,* p. 444, Chap. 29.
[245] *Home as Found,* p. 262, Chap. 19.
[246] *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

[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-

[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.

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[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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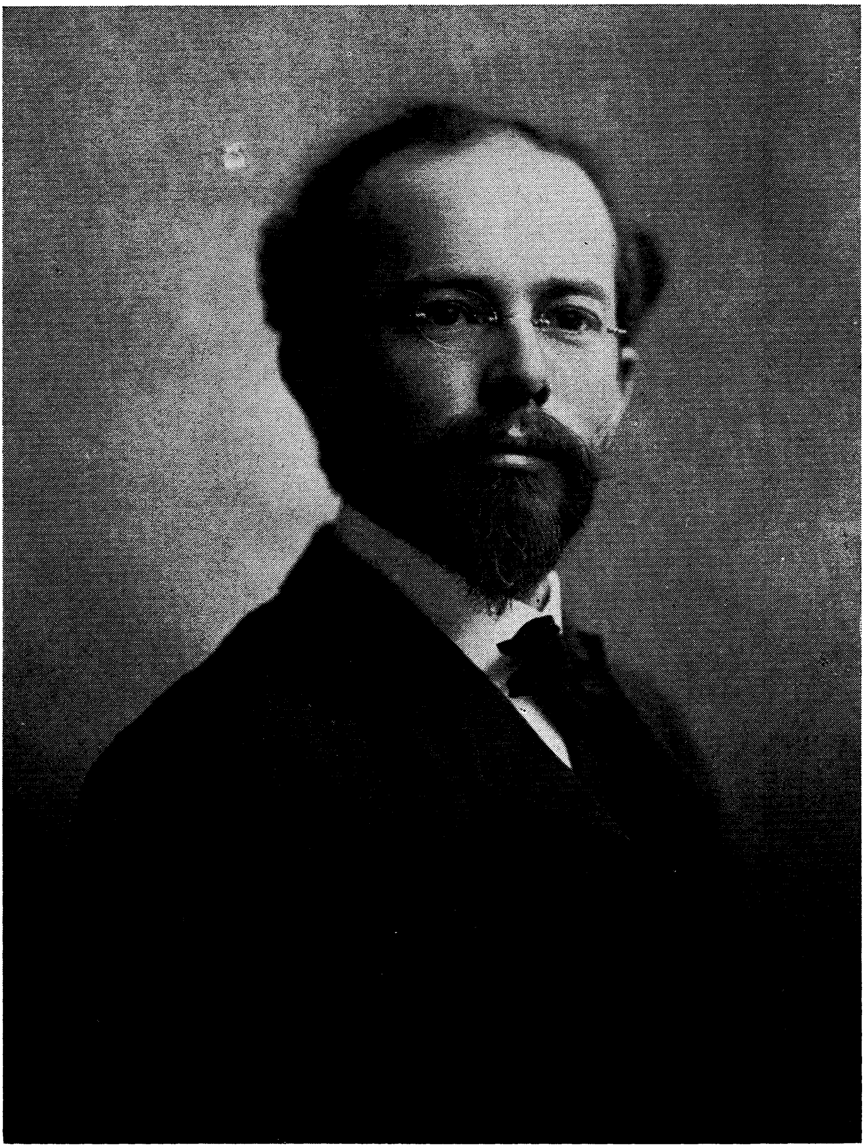
* Paper read at the 90th annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

[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

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[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

[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.

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[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

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[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.

[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*

ROBERT SPENCE
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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

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* 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

[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

[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-

[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,

[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

[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.