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Editor
FOREST STEARNS

TRANSACTIONS OF THE WISCONSIN ACADEMY

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WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

The Wisconsin Academy of Sciences, Arts and Letters was chartered by the State Legislature on March 16, 1870 as an incorporated society serving the people of the State of Wisconsin by encouraging investigation and dissemination of knowledge in the sciences, arts and letters.

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ROBERT A. McCABE

57th President 1979
WISCONSIN ACADEMY OF
SCIENCES, ARTS AND LETTERS

STATE OF THE ACADEMY

Robert A. McCabe

Presidential Address

April 1979

Seven score and 19 years ago our forefathers brought forth for this State a new association . . . our Academy. It was dedicated to the proposition that there was a need to encourage investigation and disseminate views of the various departments of Science, Literature and the Arts. Now we are engaged in a grave financial crisis testing whether this academy or any academy so conceived and so dedicated can long endure without direct public support—in whose interest it directs its efforts and its programs.

* * *

I acknowledge paraphrasing our most illustrious U. S. president for that introduction. It would have been a great relief for me at the outset to recite for you our accomplishments over the past year, compliment those who have performed well, tell a light story or perhaps a few jokes and to have thus amused you without being very enlightening.

What I am about to relate to you is not meant to be nor should it be construed as criticism or complaint, neither is it a heralding of doom. But . . . our Academy is in serious financial difficulty. The full impact of this difficulty has not yet been felt in our programing or by the membership. Inflation and a virtually static source of income, coupled with litigation of the McCoy trust suspending income from that source are parties to the problem. In short we have had to borrow from the capital of our endowment fund to maintain our program of service. This has been an anathema to the Academy Council. Belt tightening has already begun and more will doubtless follow.

Although some money saving adjustments have been made, the major effort has been voluntarily undertaken by our Executive Director. He has launched a fund raising campaign with the backing of the Academy Council. Three quarters of the Director's time has been and will continue to be devoted to this effort. Results thus far have been encouraging but not overwhelming.

Laudable as this effort is both as a personal undertaking and as an Academy program for self maintenance, the following facts must be understood and acceptable to the membership.

1. That the funds raised and to be raised are not to increase the endowment, or repay funds taken from the endowment; instead, they are to be used to meet current expenses.
2. That until we adjust our life style or obtain outside financial aid, this fund raising effort will be an annual affair. How long we can expect donors to repeat on an annual basis is yet to be determined.
3. If the Executive Director does indeed spend most of his time fund raising, who then minds the shop? We have a dedicated and competent office staff, but it would be unrealistic and unfair to saddle them with responsibilities not in their job descriptions.
4. Can we afford, financially and administratively, to use our Executive Director nine months of each year as a fund raiser? My personal reply is that we cannot!
5. Lastly, unless the Academy is the sole winner in the McCoy court case our financial woes will become chronic.

If this untenable situation distresses you, as it does me, then we must delineate and examine our options. When any company or organization is losing money, its first remedial action is to cut back on goods and services. Our goods are our publications and our first line responsibility. The Academy *Transactions* by common accord must not be diminished or diluted, but since most scientific journals today require a page charge for published articles, this possibility is being exploited but is also under careful study. *The Academy Review* is our most popular publication and is perhaps the major offering the Academy makes to the lay membership. Recent discussions on the *Review* have called for expansion, not retrenchment. Our newsletter, the *Triforium,* is the Academy tom-tom that keeps the membership informed of what is happening in the organization, what events are to take place, and what the status of the Academy programs are at that moment. Who will say what shall fall to the budget ax? Let him also say, how, and then produce a consensus. The savings by reducing publication to *Transactions* alone would not save enough to keep us solvent, and our losses in membership support would very likely outweigh any hoped-for gains.

Raising dues is the standard "easy-out" of a financial bind and it is also an "out" of another kind, namely membership drop-out. The gains of increased levy balanced against lost members and hence lost participation and revenue must be carefully considered. This course should be taken only if it solves the problem and only as a last resort.

The sum total of cost savings by discontinuing nonessential service programs now conducted by the Academy is roughly $200 to $300. The sum is small because the bulk of the cost is hidden in administration and not obvious as cash outlay. This brings us to staff salaries. These salaries by all odds are not even competitive in today's job market for the limited staff now conducting Academy business. Indeed we have not been able to increase salaries commensurate with the rise in cost of living. Whatever services we provide are those generated by the office staff.

The last drain on our budget is the Steenbock Center. We are for all intents and purposes locked into this facility by today's housing costs and appreciating real estate values. Maintenance costs of the Center would be about equal to rent charges for less desirable and certainly less functional quarters, *if* we were to sell the Center property.

* * *

So much for background. The basic option in my opinion and one under which we should have been operating from the outset is: That the Academy be financially supported by the State of Wisconsin. Historically the Academy was meant to be state supported and indeed it was in part until 1960. Each year prior to that time the Academy presented its annual program request (a pittance in relation to other requests) to the legislature and defended the request. The Academy request was not buttressed by great political clout and so was undoubtedly on the list of easy-to-cut items. Eventually by gentle but painful attrition the small budget was cut . . . completely.

With the advent of the Steenbock bequest to the Academy and later by the McCoy trust the need to seek state support through an annual hassle was diminished and all effort abandoned. Ironically this occurred at a time when Academy programs for the people of Wisconsin were increasing.

On the surface this could be regarded as a mistake, but if the Academy could support itself and eliminate the time consuming and arduous task of budget preparation and defense, then the move to become self supporting was correct. Although the monetary saving to the state was insignificant, *it served notice to the legislature that we were trying to help ourselves.*

The fact that we assumed a financial burden that had heretofore been in part a state responsibility does not abrogate legislative involvement in the welfare of the Academy as an agency serving the people of the state.

If it were at all possible, we would not now ask for renewal of state support and conceivably there may come a time when we will again become self sustaining.

We do not come with hat in hand to request help in difficult times but we respectfully ask for financial support because our cause is just.

We ask for no brick or mortar financing.
We ask for no support of our publications.
We ask for no funding of our programs.
We ask for no remodeling or physical expansion monies.
We ask for no land or real estate purchase.

What we request is a sum sufficient to maintain our physical plant and an adequate Academy staff. All other aspects of Academy functioning will be covered by membership dues and endowment proceeds. It is rare when any Academy or professional society can provide services or engage in programs for public benefit on membership dues alone.

The Wisconsin Academy of Sciences, Arts and Letters is 4th in size among 45 state academies and in prestige we rank near the top. We are not elitist in membership; anyone interested in our three major disciplines is welcome to join and participate.

We offer a forum for all who speak or write through our meetings and publications.

We have offered and hold open the offer to provide an unbiased sounding board on legislative or public policy discussions under consideration by our elected representatives at all governmental levels.

We will continue to provide programs of education and enlightenment to the people of Wisconsin (and elsewhere).

We will exchange our *Transactions* of the Academy with over 600 institutions in 60 countries promoting the progress, and the scholarly stance of our State in the fields of science, arts and letters.

We will strive to be self-supporting and frugal with public funding.

We will promote Wisconsin's people, its programs and its products by all means at our disposal.

* * *

The National Academy of Science is supported by the U. S. Government and performs a service to the nation by its response to problem solving and to policy solutions for the national welfare.

We ask only that the Wisconsin Academy be supported by the State of Wisconsin so we may likewise respond for the welfare of our State.

* * *

Thus my presidential address is ended. The epilogue that I pass on to fellow members of the Academy is this: I will appoint a committee to prepare an official position on this basic premise of state support and to develop a strategy on which to proceed. There are key people I have in mind and a tentative plan as a starting point for action, but the team is not complete. If we are to strive in this direction every last member will be asked to help. At the proper time when all is in readiness the program will be made a matter of Academy record and membership participation will be solicited for support in an effort to enlighten our legislature on the necessity and wisdom for providing state support.

So important is this effort that it must not rest solely with a small committee of dedicated people. The Academy rank and file must become involved. The need is urgent and our cause justified!

PALEOLATITUDE AND PALEOCLIMATE

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Abstract

In light of large-scale displacements of continents through time, restoration of paleolatitudes is critical to any paleoclimatic reconstruction. Paleomagnetic studies over the past two decades have provided estimates of paleolatitude that are more and more widely accepted. It was important, however, to test those estimates with independent geologic evidence—especially for pre-Permian time for which paleomagnetic data is less satisfactory. On the other hand, geologic coupled with paleomagnetic evidence should provide powerful constraints for paleoclimatic interpretations.

Paleomagnetic data suggest a Paleozoic equatorial position for most of North America with a progressive relative counterclockwise rotation of the continent of about 60°. Long-recognized reef and species-diversity patterns support a Paleozoic low latitude, and Ordovician and Devonian volcanic ash fallout by trade wind dispersal is consistent with the paleomagnetically-indicated equator positions. Mid-continent early Paleozoic paleocurrent and conglomerate size-rounding data also agree with a tropical location characterized by episodic violent storms. And Permo-Triassic plant and evaporite evidence is consistent with both latitude and terrain restorations. As North America moved northward (and more counterclockwise) since the Triassic, its central part came into the westerly wind belt as evidenced by fallout of volcanic ash from the Cordillera. Most post-Triassic geologic indicators of humid-arid conditions, paleocurrents and oxygen-isotope data, are consistent with latitudinal and terrain restorations.

Introduction

In 1958, when I began teaching, enough paleomagnetic evidence of ancient latitudes had accumulated that the student of earth history could hardly ignore it. Yet, there were large gaps in the data and some untidy anomalies. Many, if not most, geologists doubted the results, perhaps because shifting poles or continents seemed non-uniformitarian. But by the mid-sixties, the data had begun to show enough of a systematic pattern of latitudinal change that one could begin to consider a number of geologic implications of the paleomagnetic results in addition to continental drift. Indeed, it became intriguing to compare—and even test—the paleomagnetic data against sedimentologic and paleontologic evidence of latitude. While paleoclimatology still seems more art than science, it is nonetheless fruitful to examine the consistency of phenomena.

The distributions of ancient reefs, evaporites, tillites, coal, certain fossil plants, red beds, and presumed eolian desert deposits have long been used to try to interpret paleoclimatic zones and even paleolatitude (e.g. Köppen and Wegener, 1924). Clearly, all of these geologic phenomena should provide tests of the paleomagnetic data. In 1956 Shotton and in 1960 Opdyke and Runcorn presented the first comparisons of wind-influenced cross bedding orientations with paletomagnetically-indicated latitudes (see also Opdyke *in* Nairn, 1961, and *in* Runcorn, 1962). Then Eaton in 1963, Powers and Wilcox in 1964 and Wilcox in 1965 showed that fallout distributions of volcanic ash could reveal prevailing paleowind directions, adding still another dimension to paleoclimatic and paleolatitudinal analysis. About 1960 I began cataloguing these diverse kinds of data on paleogeographic maps (Dott and Batten, 1971).

To many the present large mass of paleomagnetic evidence of drastically different past latitudinal positions of continents may make further comparison of paleomagnetic and paleoclimatic data seem redundant. However enough skepticism exists (e.g. Meyerhoff and Meyerhoff, 1972; Stehli, 1973) to warrant a concise, up-dated assessment. Although this paper deals almost exclusively with North America, the approach is universally applicable. My objective is not to prove or disprove continental drift, but only to assess *consistency* of unlike data. Distributions of reefs, evaporites, red beds, coal and the like have been catalogued before (e.g. Nairn, 1961; Runcorn, 1962, Schwarzbach, 1963; Dott and Batten, 1971 and 1976). Therefore, more attention is given here to paleowind indicators and to a few stratigraphic intervals that have not previously received adequate treatment.

Working Assumptions

Certain climatic assumptions provide a background. We must first assume that a significant temperature difference has always existed between the poles and equator simply as a consequence of the difference in angle of incidence of solar radiation. The intensity of the pole-equator gradient has almost certainly varied through time, and such variations would have greatly affected world climate. This thermal gradient, coupled with the rotation of the earth and the positions of land masses, controls the first-order patterns of atmospheric circulation. One consequence of variations of the pole-equator gradient is the positioning of subtropical high pressure cells. With a stronger gradient, these highs are pushed equatorward, whereas with a weaker gradient they move somewhat poleward.

The general climatic importance of the ratio of land to sea (or continentality) was appreciated as early as Lyell's time. It is well known that the relative area of sea and land greatly affects the overall heat budget of the earth because of the 10-15 percent difference in albedo of land versus water. Moreover, being fluid, the seas can transport heat from low to high latitudes. It follows that the location of a pole in a continent or a restricted sea (such as the present Arctic Ocean) will be much colder than a pole located in an open ocean area.

The spin of the earth and the resulting Coriolis effect, allow steady trade winds on either side of the equator to be assumed for all times. The Westerly wind belts probably also have always existed, but seemingly they were more variable than the trades because of variations of the pole-equator temperature gradient and of land masses. Landmasses greatly influence second-order atmospheric circulation patterns by localizing or blocking the more or less permanent high and low pressure cells. Mountainous barriers obviously may produce strong rain shadows.

Paleomagnetic Latitudinal Restorations for North America

Latitudinal shifts of North America are indicated by paleomagnetic data for the past 700 million years (Fig. 1). The paleoequators have been up-dated from those of Dott and Batten (1971 and 1976). Locations are better established for some ages than for others, nonetheless, the counterclockwise rotation and northward motion of the continent presents an impressively systematic picture. Only the details of exact position for the more poorly controlled periods remain to be documented.

Paleoclimatic Phenomena Compared With Paleomagnetic Evidence

Working backward through time, let us compare some climatically sensitive geo-

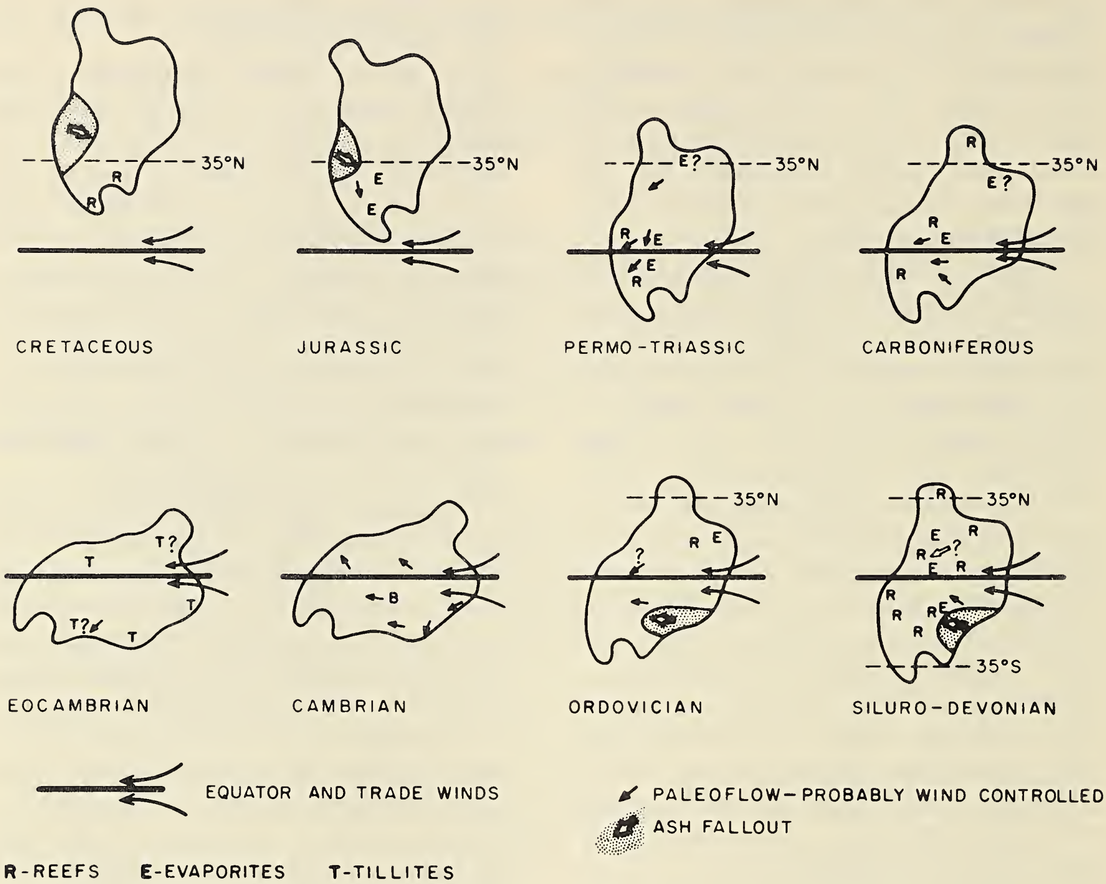

Fig. 1. Ancient latitudinal positions of North America based upon paleomagnetic data compared with sedimentary data. Note systematic counterclockwise rotation and northward shift of the continent. (Paleomagnetic results from: Irving, 1964; McElhinny, 1973; Hicken, and others, 1972; Van der Voo and Williams, 1975; French, and others, 1975; Proke and Hargraves, 1973; McElhinny and Opdyke 1973; Van der Voo and French, 1974. Sedimentary data after Dott and Batten, 1971 and 1976, who include detailed maps and references.)

logic phenomena with the paleomagnetic latitudinal data to see whether or not the two independent types of evidence agree paleogeographically. The fallout patterns of late Cenozoic (especially Pleistocene) volcanic ash erupted in the Cordillera (Wilcox, 1965) and paleontologic evidence of a rain shadow effect east of the mountains agree with the present location of that region in the mid-latitude westerly wind belt (Dott and Batten, 1971, chapter 14). The same is true also for Cretaceous and Jurassic ash fallout (Fig. 1; Slaughter and Earley, 1965). Cretaceous humid, subtropical plant types (Arnold, 1947; Andrew, 1961) and oxygen isotope evidence for warm sea temperatures of 20°-25°C (Lowenstam and Epstein, 1959) are consistent with a lower latitude (Fig. 2). Cretaceous plants apparently adapted for humid conditions in the present Rocky Mountain region, however, seem anomalous as they grew leeward of the rising Cordilleran mountainous mass. According to Millison (1964), the lack of a clear rain shadow here is the result of humid air flowing from the southeast over the adjacent Cretaceous epeiric seaway and along the eastern front of the Cordillera. In light of the probable paleolatitude, however, it appears more probable that moisture was acquired from that seaway by winds of the sub-tropical high pressure system flowing south along the mountain front (Fig. 2). However, fine ash blown higher into the atmosphere would be blown straight east by upper atmosphere winds.

The latest Jurassic Morrison Formation of the western United States was deposited to the lee of the embryonic Cordilleran mountains (Fig. 3). The Morrison accumulated at about 30°-40° N latitude; it was within a westerly wind belt as indicated by volcanic ash that could only have blown from the west. Oxygen isotope studies of shells from underlying Upper Jurassic (as well as overlying Cretaceous) marine rocks indicate warm ocean temperatures around 20°-25°C (Bowen, 1961), at least 10° warmer than is typical of that latitude today. Moreover, Bowen (1961) argues that the maximum latitudinal surface Jurassic sea water temperature gradient then was only about 20°C as opposed to 60°C today. Local evaporites in the same underlying strata also indicate high evaporation potential.

Sedimentary facies, petrography, and paleocurrent data prove that the Morrison was deposited on an eastward-sloping, low coastal plain; Dawson (1970) estimated the

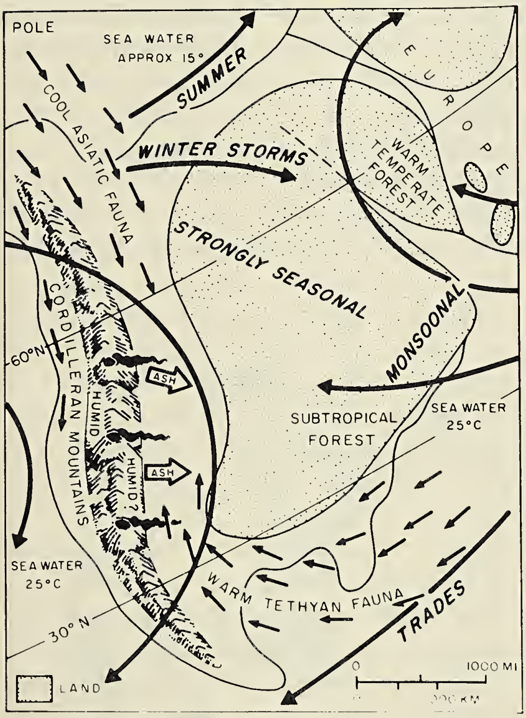

Fig. 2. Generalized Cretaceous paleogeography and paleoclimatology showing paleomagnetic latitudinal results, volcanic ash dispersal (wide arrows), oxygen isotope results, and paleobotanical evidence. Superimposed are the expected atmospheric circulation patterns; subtropical highs appear at higher latitudes than today because of a lesser pole-equator temperature gradient. Small arrows indicate dispersal of warm- and cool-water faunas. Sea water temperatures are obtained from oxygen isotope studies. (Modified after Dott and Batten, 1976). Compare with Figure 1.

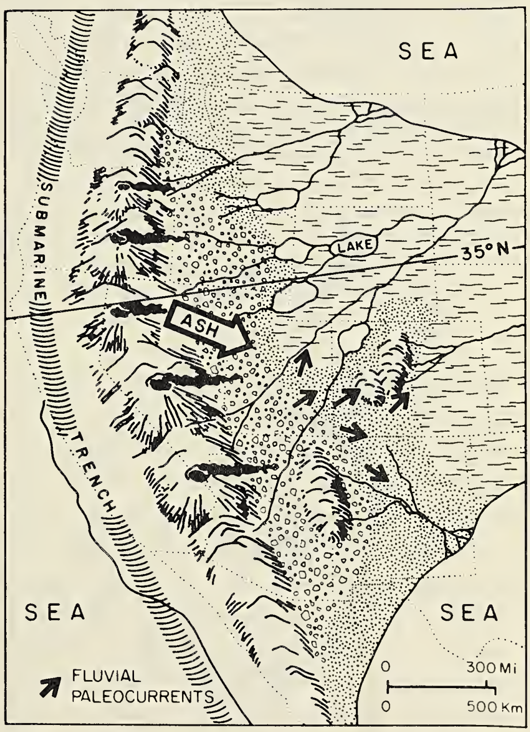

Fig. 3. Paleogeography during deposition of the nonmarine Morrison Formation clastic wedge in the western United States. The formation was deposited on a coastal plain sloping eastward from the rising Cordilleran volcanic arc whence ash was carried by westerly winds. (Adapted from Dawson, 1970 and Dott and Batten, 1971; see latter, Fig. 13.19, for ash fallout.)

gradient to have been of the order of 0.5-1.0 m per km. Widespread fresh-water limestones attest to a rather wet landscape, and the large herbivorous dinosaur fossils for which the formation is famous suggest at least moderate humidity. Yet, coal is almost totally lacking and fossil plant material (chiefly cycad wood and reeds) is rare. Why? Dead plant material must have been thoroughly oxidized at the soil surface, which seems consistent with the abundance of red- and yellow-colored sediments. Either the Cordilleran mountains were not yet high enough to form a strong rain shadow, or the Morrison coastal plain was relatively dry except along broad river valleys. Dawson (1970) suggested a strong seasonal distribution. This was based upon the apparent thorough oxidation of vegetation, well-developed growth rings in fossil wood, and the texture of fluvial conglomerates interstratified with the dominantly fine-grained Morrison sediments. To move the largest cobbles (13 cm), which are now at least 200 km from their western upland source, maximum shear velocity must have been at least 50 cm per second, while the maximum river velocity near the water surface could have been roughly 200-600 cm per second.[1] Such large velocities seem surprising for the apparently low gradient of the Morrison coastal plain; the most probable explanation is that the coarse gravel was moved only incrementally in wide, braided channels during seasonal flooding.

Westerly winds are also indicated for latest Triassic to earliest Jurassic time in the western United States by the orientations of large-scale cross bedding in the Navajo and related sandstones. Whether this famous sandstone represents entirely eolian or partly shallow marine dunes—both of which have been claimed—they must have been deposited under the influence of the prevailing westerly winds of that time as first suggested by Poole (1957).[2] If the Navajo is, in fact, largely eolian, as I now believe, it would seem to represent a large dune field

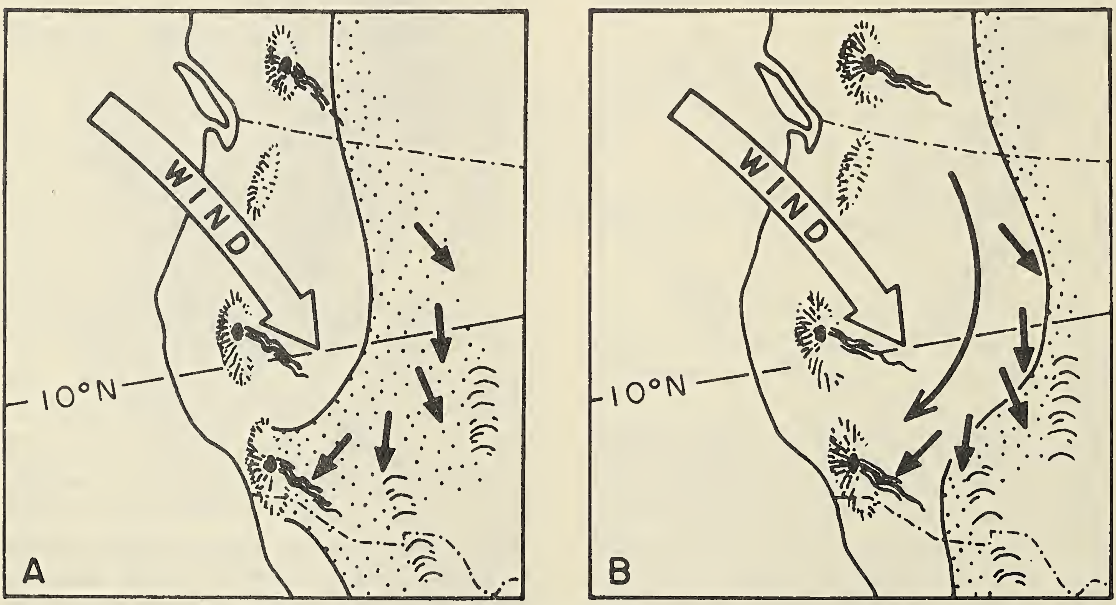

Fig. 4. Alternate paleogeographic interpretations of the Navajo Sandstone. A. Classic hypothesis of a vast eolian dune field, for which the evidence seems strongest; B. Hypothesis of a combination of shallow marine and coastal eolian dunes (Stanley, Jordan and Dott, 1971). In either case westerly winds apparently controlled sand dispersal.

formed by onshore winds from the northwest (Fig. 4A). In its western extent, some of it appears marine and one can infer that nearshore dispersing currents were induced by westerly winds, with a strong southerly longshore drift component (Fig. 4B), (see Stanley, Jordan and Dott, 1971; Dott, 1979).

For Permo-Triassic times, both the paleomagnetic and geologic data bearing upon climate are among the most complete. Tropical to sub-tropical latitudes for North America are indicated by paleomagnetism with the paleoequator (Fig. 1) almost exactly coincident with that inferred by Wegener a quarter of a century before any paleomagnetic data existed. The consequences of expected atmospheric circulation patterns for Permo-Triassic North America can be tested geologically (Fig. 5). Paleowinds over the western United States as indicated by widespread Permian cross bedded sandstones (whether eolian or very shallow marine) conform well with expected trade wind orientations. Extensive evaporites in the central United States conform well with a down-wind tropical continental margin to the leeward of high mountains. Permian plants with features adapted to aridity occur in Arizona, while the inferred humid-tropical lowland plants associated with Pennsylvanian coals had given way to drought-tolerant gymnosperms in eastern United States and humid-temperate forms in East Greenland (Frederickson, 1972). But, with Africa and Europe adjacent to eastern North America how could eastern America have been humid? One would expect a dry interior of the Gondwana supercontinent like central Asia today? Apparently the Tethys seaway and epeiric seas over central Europe during part of Permian and Triassic times supplied moisture to westerly-blowing trade winds (Fig. 5).

The Carboniferous latitude of North America seemingly was similar to that of the Permian. Widespread Mississippian organic reefs are consistent with a low latitude location, and trade winds apparently influenced the deposition of cross bedded Pennsylvanian quartz sandstones over the western United States as it did later in the Permian (Fig. 1). Unlike Permian time, however, no strong rain shadow is evident across the continent, for humid-tropical to sub-tropical lowland swamp forests cloaked the eastern interior. This suggests that the Appalachian mountains were not yet very high. Nonetheless Mississippian evaporites of the Williston Basin and Pennsylvanian ones in Utah indicate an evaporation potential that was significant where marine circulation became restricted.

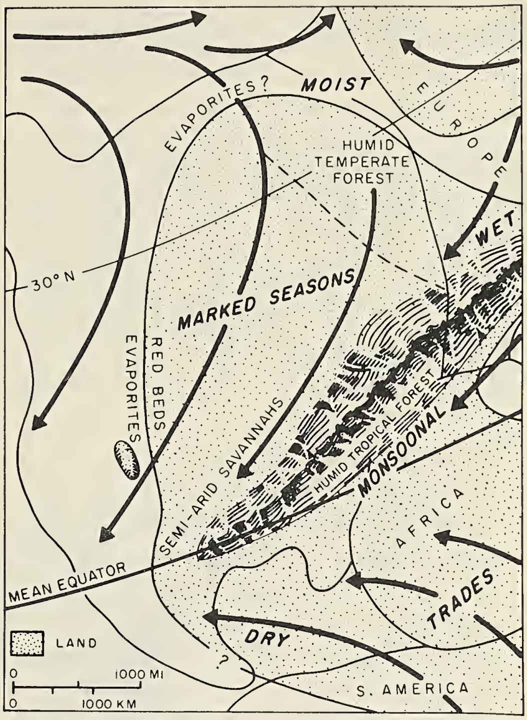

Fig. 5. Generalized Permo-Triassic paleogeography and paleoclimatology showing comparison of equator positions from paleomagnetism with sedimentary and paleobotanical evidence (see also Fig. 1). Superimposed are the expected atmospheric circulation patterns with sub-tropical highs shifted poleward for the same reason as in Fig. 2. (After Dott and Batten, 1971 and 1976).

The abundance and widespread distribution of organic reefs in Devonian and Silurian times long ago provided arguments for a low-latitude location of North America, although a good case also could be made for a weaker pole-equator temperature gradient and a generally warmer, more uniform climate during a time of small, low continents (Dott and Batten, 1971, Fig. 11.46 or 1976, Fig. 13.24). Major evaporites attest to high evaporation potential and areas of restricted circulation. The inferred tentative windward side of some of the Canadian reefs (Andrichuk, 1958) would face into the trade winds expected for the restored paleoequator. Finally, Late Devonian volcanic ash distribution over the eastern United States conforms to fallout for winds expected for the paleoequator (Fig. 1).

For the Ordovician, ash fallout from volcanic events in the Appalachian region conforms well with trade winds expected for the apparent paleoequator (Fig. 1). What little is known of the dispersal patterns for the St. Peter Sandstone also conforms to such

Fig. 6. Paleogeographic restoration of the middle Late Cambrian Baraboo (Wisconsin) islands according to paleomagnetic evidence for a southern tropical setting. Trade winds inferred from regional cross bedding orientations in shallow marine sandstones. Episodic storm waves must have approached from all sides judging from the uniform distribution of largest rounded quartzite clasts (dots). Fine pebbles were dispersed to the left (lee) by normal currents following storms (shaded area). (From Dott, 1974.)

winds (Dapples, 1955; Dott and Roshardt, 1972). Finally, the great species diversity and sheer abundance of Ordovician marine faunal elements is consistent with a tropical to subtropical setting.

Cambrian strata of the central United States provide some additional evidence for a low latitude for early Paleozoic North America. The paleocurrent pattern, for which there is abundant data, conforms to trade-wind-driven shallow marine currents expected for the paleomagnetically indicated equator. In Wisconsin, the presence of Cambrian islands that shed coarse gravel has provided an unusual opportunity to estimate the magnitude of ancient storm waves and also to contrast effects of day-to-day processes with those of so-called rare events. A broad range of gravel clast diameters from 1 cm granules up to 8 m boulders occurs, but there is no rounding of boulders larger than 1.5 m. Clearly the waves that pounded Cambrian sea cliffs around Baraboo, Wisconsin were not capable of moving larger boulders frequently enough to abrade them. Two slightly different approaches are available for making quantitative estimates of the Cambrian storm wave heights.[3] Both results indicate that breakers at least 8-10 m high crashed upon the islands and tumbled boulders up to 1.5 m in diameter with moderate frequency; almost certainly still higher waves developed on rare occasions. Rounded boulders occur all around the Baraboo islands, thus rare-event storm waves must have approached from all directions, not just from the apparent normal trade winds direction suggested by paleocurrent data (Fig. 6). Trade winds themselves, though very steady, are not sufficiently strong to generate the large waves required to move boulders. Therefore, large storms are indicated, and, while other types are possible (e.g. mid-latitude Nor'easters on our present Atlantic coast), tropical storms seem most probable in light of the conformance of the regional paleocurrent pattern with the paleomagnetically indicated latitudinal position of Wisconsin (Fig. 1).

Conclusions

Comparison of climatically-sensitive geologic phenomena with paleomagnetic evidence for ancient latitude presents generally consistent restorations. North America apparently was dominated by Trade Winds throughout Paleozoic time, but moved into the Westerly wind zone during Mesozoic and Cenozoic times. For some eras in North American (e.g. late Mesozoic, Permo-Triassic and Late Cambrian times), a satisfying degree of completeness of paleoclimatic restoration is possible. At best, however, such restorations are largely qualitative. Not all available data provide a clear picture; the hardly disputable Eocambrian glaciation is a case in point. Tillites or tilloids are known today in Eocambrian strata from all continents except Antarctica. Indeed, their widespread distribution is the problem, for they seem to occur at all paleolatitudes. Was the climate so rigorous and completely unzoned that glaciation occurred from pole to equator (Fig. 1)? At present the Eocambrian paleoclimatic data cannot be satisfactorily reconciled with paleomagnetic evidence, which points up the need for additional comparative studies of both phenomena.

Acknowledgements

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Literature Cited

Andrichuk, J. M. 1958. Stratigraphy and facies analysis of Upper Devonian reefs in Leduc, Stettler, and Redwater areas, Alberta. Amer. Assoc. Petroleum Geologists Bull., **42**:1-93.

Andrews, H. N. 1961. Studies in paleobotany. Wiley, New York, 487 p.

Arnold, C. 1947. An introduction to paleobotany. McGraw-Hill, New York. 433 p.

Blatt, H., Middleton, G. V., and Murray, R. C. 1972. Origin of sedimentary rocks. Prentice-Hall, Englewood Cliffs, New Jersey. 634 p.

Bowen, R. 1961. Paleotemperature analyses of belemnoida and Jurassic paleoclimatology. Jour. of Geol. **69**:309-320.

Dapples, E. C. 1955. General lithofacies relationship of St. Peter Sandstone and Simpson Group. Amer. Assoc. Petroleum Geologists Bull. **39**:444-467.

Dawson, J. C. 1970. The sedimentology and stratigraphy of the Morrison Formation (Upper Jurassic) in northwestern Colorado and northeastern Utah. Ph.D. thesis. University of Wisconsin. 125 p.

Dott, R. H., Jr. 1974. Cambrian tropical storm waves in Wisconsin. Geology **2**:243-246.

———. 1979. The Nugget-Navajo environmental war—can trace fossils help? (Abstr.) Bull. Amer. Assoc. Petroleum Geologists **63**:441.

——— and Batten, R. L. 1971. Evolution of the earth. 1st ed., McGraw-Hill, New York 649 p. (2nd ed., 1976, 504 p.).

——— and Roshardt, M. A. 1972. Analysis of cross-stratification orientation in the St. Peter Sandstone in southwestern Wisconsin. Geol. Soc. America Bull. **83**:2589-2596.

Eaton, G. P. 1963. Volcanic ash as a guide to atmospheric circulation in the geologic past. Jour. Geophys. Res. **68**:521-528.

Frederickson, N. O. 1972. The rise of the mesophytic flora: Geoscience and Man, **IV**: 17-28.

French, R. B., Grubbs, K. L., and Van der Voo, R. 1975. Paleomagnetism of Cambrian dikes from Colorado (abs.). EOS, Trans. Amer. Geophys. Union, **56**:353-354.

Hicken, A., Irving, E., Law, L. K., and Hastie, J. 1972. Catalogue of paleomagnetic directions and poles. Publ. Earth Physics Branch, Dept. Energy Mines and Resources, Ottawa. v. 45, 135 p.

Irving, E. 1964. Paleomagnetism and its application to geological and geophysical problems. Wiley, New York. 339 p.

Köppen, W. and Wegener, A. 1924. Die klimate der Geologischen Vorzeit. Berlin, Borntraeger. 255 p.

Lowenstam, H. A. and Epstein, S. 1959. Cretaceous paleo-temperatures as determined by the oxygen isotope method, their relations to and the nature of rudistic reefs. *In* El Sistema Cretacico (primer tomo), 20th Internat. Geol. Cong., Mexico, p. 65-76.

McElhinny, M. W. 1973. Palaeomagnetism and plate tectonics. Cambridge Univ., Cambridge. 357 p.

——— and Opdyke, N. D. 1973. Remagnetization hypothesis discounted: a paleomagnetic study of the Trenton Limestone, New York state. Geol. Soc. America Bull. **84**:3697-3708.

Meyerhoff, A. A. and Meyerhoff, H. A. 1972. The new global tectonics: major inconsistencies: Amer. Assoc. Petroleum Geologists Bull. **56**:269-336.

Millison, C. 1964. Paleoclimatology during Mesozoic time in the Rocky Mountain area. Mountain Geologist, **1**:79-88.

Nairn, A. E. M. (editor). 1961. Descriptive paleoclimatology. Interscience, New York. 380 p.

Opdyke, N. D. and Runcorn, S. K. 1960. Wind direction in the western United States in the late Paleozoic. Geol. Soc. America Bull. **71**:959-972.

Poole, F. G. 1957. Paleo-wind directions in late Paleozoic and early Mesozoic time on the Colorado Plateau as determined by cross-strata (abs.). Geol. Soc. America Bull. **68**:1870.

Powers, H. A., and Wilcox, R. E. 1964. Volcanic ash from Mt. Mazama (Crater Lake) and Glacier Peak. Science **144**:1334-1336.

Proko, M. S. and Hargraves, R. B. 1973. Paleomagnetism of the Beemerville (New Jersey) alkaline complex. Geology **1**:185-186.

Runcorn, S. K. (editor). 1962. Continental drift. Academic Press, New York (Internat. Geophys. Ser. v. 3) 338 p.

Schwarzbach, M. 1963. Climates of the past—an introduction to paleoclimatology. Van Nostrand, London. 328 p.

Shotton, F. W. 1956. Some aspects of the New Red desert in Great Britain. Liverpool and Manchester Geol. Jour. **1**:450-465.

Slaughter, M. and Earley, J. W. 1965. Mineralogy and geological significance of the Mowry bentonites, Wyoming. Geol. Soc. of America Spec. Paper 83, 116 p.

Stanley, K. O., Jordan, W. M., and Dott, R. H., Jr. 1971. New hypothesis of Early Jurassic paleogeography and sediment dispersal for western United States. Amer. Assoc. Petroleum Geol. Bull. **55**:10-19.

Stehli, F. G. 1973. Review of paleoclimate and continental drift. Earth Sci. Rev. **9**:1-18.

Wilcox, R. E. 1965. Volcanic-ash chronology. *In* Wright, H. E., Jr., and Frey, D. G. (editors), The quaternary of North America. Princeton Univ. Press, Princeton, N.J., p. 807-816.

Van der Voo, R. and French, R. B. 1974. Apparent polar wandering for the Atlantic-bordering continents: Late Carboniferous to Eocene. Earth Sci. Rev. **10**:99-119.

———, and Williams, D. W. 1975. Paleomagnetism of the Cambrian Wilberns Formation (Texas) and the Cambrian and Hadrynian poles for the North American Continent (abs.). EOS, Trans. Amer. Geophys. Union, **56**:596.

Notes

[1] Bed shear velocity (U^*) was estimated from the relation $U^* = \sqrt{\tau/\rho}$ where τ is shear stress (derived from the Shield's Diagram) and is fluid density. The lower limit for maximum channel velocity above the bed was determined from the Hjulstrom-Sundborg graph, while the upper limit was estimated from the relation $\left(\frac{\bar{U}}{U^*} = \sqrt{\frac{8}{f}}\right)$ assuming a value of about 0.05 for f for a gravelly bed. (See Blatt and others, 1972). This equation is suspect for hindcasting channel flow, however, because the friction factor (f) is based upon flow in pipes; it is very sensitive to bedforms and hydraulic radius as well as to grain size and velocity in channels.

[2] Some prominent cross bedded sandstones long interpreted as eolian have been reinterpreted as shallow submarine sand wave deposits like those of the present Georges Bank, North Sea, Irish Sea and English Channel (Stanley, Jordan and Dott, 1971). When they were first interpreted to be eolian, the existence of underwater dune forms was unknown. Because in shallow epeiric seas currents are so strongly influenced by prevailing winds, the orientations of cross strata formed in submarine dunes also should reflect such winds unless tidal currents (or the Ekman effect) completely masked the wind's influence on sand dispersal. The thorny issue of environment of these sandstones is sidestepped in this paper because none of the cross bedded sandstones in question show any definitive tidal features.

[3] Breaker height can be estimated from experimental data for breakwater design derived in large wave tanks, and from empirical equations relating threshold velocity to boulder diameter and velocity to breaker height:

$$U_t = 9d^{1/2} \text{ and } C_b = 2U_t \text{ and } H_b \approx \left(\frac{C_b}{8}\right)^2$$

Where U_t is threshold velocity to move boulders of diameter d; c_b is solitary wave velocity at the point of breaking, and H_b is height of breaker. (Dott, 1974).

SOILS AND SURFICIAL GEOLOGY OF FOUR APOSTLE ISLANDS

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Abstract

The soils and surficial geology of Rocky, Oak, York, and Raspberry Islands, members of the Apostle Islands group, were surveyed in 1976 and 1977.[1] The considerable diversity of environmental conditions affecting soil development has given rise to complex soilscapes. Most common on Rocky, York, and Raspberry Islands are fertile deciduous forest soils (Eutroboralfs of the Alfisol order) formed in deposits of fine-grained glacial and glacio-lacustrine material. On Oak Island the soils are primarily sandy Podzols (Harplorthods of the Spodosol order) formed in coarse beach deposits more than one meter thick. Since moderate slopes of 5 to 20% provided the best opportunity for thick sand and gravel accumulations in the ancient beach zones, the pedologic uniqueness of Oak Island is explained by the sloping surfaces it presented to subsiding post-glacial lake levels.

Introduction

The Apostle Islands are located in the northernmost part of Wisconsin, clustered at the tip of the Bayfield Peninsula. Except for Madeline Island, the Apostle Islands are accessible only by boat. Isolation of the islands has protected some of the best examples of wilderness remaining in the eastern United States. Although logged as recently as 50 years ago, the islands still harbor some stands of mature northern mesic forest. Many species of native animals also inhabit the islands and are relatively undisturbed.

In recognition of the special quality of the recreational resources present in the area, the U. S. National Park Service has been assigned jurisdiction over most of the islands (see Fig. 1). To provide a basis for determining the recreational carrying capacity the Park Service launched a program of resource evaluation studies. Results of study of soils and surficial geology of Bear Island were reported by Kowalski (1976). This paper presents observations made during two field seasons on York, Raspberry, Rocky, and Oak Islands. Descriptions and maps of the major soils are supplemented with a discussion of the environmental factors which influenced soil development. Features of the soil landscapes and an important relationship between soils and topography are also discussed.

Geologic History of the Apostle Islands Area

Although tectonically stable at present, the Lake Superior region in early Precambrian time (about 3 billion years ago) was a region of active mountain building. The crystalline rocks which constitute the bedrock in northern Wisconsin and most of Canada are the fluvially and glacially eroded remnants of the once broad mountain belt. Further tectonic activity opened a huge trough, or graben, which eventually filled with thick deposits of sand and gravel

[1] Work was done under the general direction of Prof. R. T. Brown, Michigan Technological University, and funded through that institution by the U. S. National Park Service. Work was guided by Prof. F. D. Hole, University of Wisconsin-Madison. Terminology is from *Soil Taxonomy* (Soil Survey Staff, 1975).

Fig. 1. The Apostle Islands and the Bayfield Peninsula of northern Wisconsin.

eroded from the nearby highlands and deposited in the Precambrian sea (Martin, 1965). Excavation of some of the sandstone over many millions of years by rivers and glaciers created the Lake Superior basin. The Bayfield Peninsula and all of the Apostle Islands are underlain by portions of the remaining sandstones belonging to the Bayfield group.

Much of the Lake Superior basin was hollowed out during the Pleistocene Epoch —the most recent 3 million years of geologic history. Continental glaciers repeatedly advanced southward from Canada, following and deepening the lowlands in which the Great Lakes now lie. Evidence from the most recent glacial advance indicates that after ice filled the Lake Superior basin the Bayfield Peninsula upland forced the growing ice mass to split. The Superior lobe

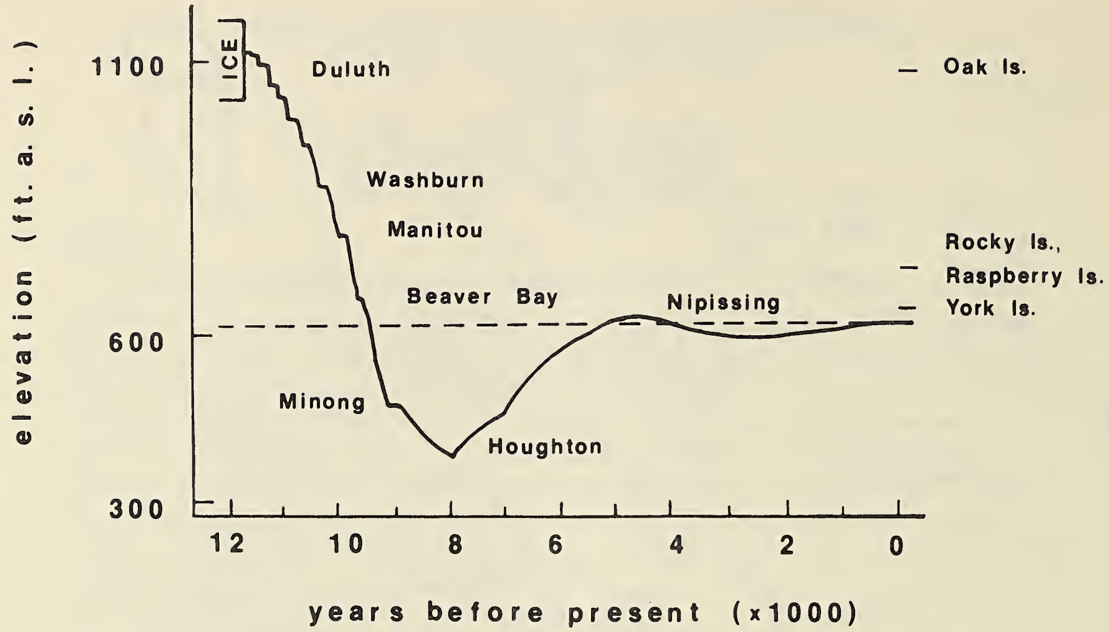

Fig. 2. Postglacial changes in the level of Lake Superior; names of some abandoned shorelines are given. The topmost elevation of the four islands studied is given at right (after Farrand, 1969).

flowed westward while the Chippewa lobe filled Chequamegon Bay and spilled into what is now the Chippewa River basin. The Apostle Islands were probably separated from the mainland by glacial enlargement of preglacial river valleys (Collie, 1901; Irving, 1880). Its interlobate position caused the Bayfield highland to receive great volumes of glacial debris. In general, the current land surface of kettles, kames, and moraines is more than 120 m (400 ft) above the bedrock. Some of the till deposited by the ice is very sandy and acid, but other till bodies are very clayey and somewhat calcareous. The contrasting source materials, Bayfield sandstone and Pleistocene lake sediments, are responsible for the differences.

Retreat of the last continental glacier began about 12,000 years before the present (BP). As the ice mass wasted back into the Lake Superior lowland, meltwater accumulated between the ice front and the southern rim of the basin. Glacial Lake Duluth stabilized at about 329 m (1,085 ft) above sea level and drained south at Solon Springs, Wisconsin into the St. Croix and Mississippi Rivers. These conditions lasted until about 11,000 years BP (Farrand, 1969, p. 195), at which time all of the Apostle Islands were submerged. The ice mass then wasted rapidly, opening lower eastern outlets into the Lake Michigan basin. Subsequent rapid lake level decline was marked by only minor halts until about 8,000 years BP, when the low-water Houghton stage, 114 m (375 ft) above sea level, was reached. In about 3000 years the water level fell about 210 m (700 ft), for an average rate of 70 cm (2.33 ft) per decade, or almost 8 cm (3 in) per year (Fig. 2).

During the first part of this period of lake level recession all of the Apostle Islands emerged. The abandoned strandlines visible on the islands, including the Highbridge, Moquah, Washburn, Manitou, and Beaver

Bay shorelines named by Farrand (1960), were formed between 11,000 and 8,000 years BP. At the time of the Houghton stage water levels were so low that the Apostle Islands were part of the mainland. Buried peat found in places beneath 12 m (40 ft) of water and 4 m (13 ft) of sand marks this lake level minimum among the Apostle Islands (Taylor, 1931).

Lake level gradually rose for the several thousand years which followed as isostatic rebound lifted the outlet at Sault Ste. Marie, Michigan. The Nipissing stage, only slightly higher than the present water level, was reached at 5,500 years BP (Saarnisto, 1975, p. 312). Beaches formed at that time are difficult to distinguish from current Apostle Islands beaches, as they are only 1 m (3 ft) higher than the present lake elevation of 182 m (602 ft) above sea level (Farrand, 1969).

As soon as dry land became available, colonization by tundra and boreal forest plants and animals began. Spruce was the dominant tree in these early woodlands, but as climate ameliorated, spruce was gradually superceded by pine. Eventually the transition was made to the present northern mesic forest, which contains both hardwoods and conifers (Saarnisto, 1974; Maher, 1977). Thus Quaternary geologic history provided diverse initial conditions for development of the soils presently found on the Apostle Islands.

Environmental Factors Affecting Soil Formation

Initial Material

The recent geologic history of the Apostle Islands is one of continental glaciation, inundation by postglacial lake waters. and reexposure. In most places, deposits of glacial till are covered by lake sediments of varying thickness. High water levels in the Lake Superior basin and copious amounts of sediment from melting glacial ice promoted deposition of clay and silt in deep water and coarser-textured material in shallows and on beaches. Typically one would expect to find lacustrine sediments deposited in a vertical sequence which coarsens upward because lake levels were falling, but in many places there are only small amounts of sand or gravel overlying clayey material. Some soils formed in thin coarse deposits over fine-grained lake sediments or till (which are often difficult to tell apart), while other soils formed in thick sand and gravel deposits.

Surface modification of the islands, since their emergence from receding glacial lake waters, has been chiefly by stream activity. On Oak Island, deep ravines are prominent. In the ravine bottoms one finds small alluvial terraces and narrow incipient floodplains.

Time

All soil formation presently evident on the Apostle Islands has taken place in the last 11,000 years. As soon as the topmost points on the islands were exposed, weathering, plant colonization, and soil formation (pedogenesis) began. The only major variation results from recent increasing emergence of the lower parts of the islands. Soil formation has proceeded for a longer time on the top of Oak Island than on low-lying York Island, for example. However, this potential time difference is not very great (Fig. 2). Rapid lake level recession exposed all land elevations in about 2,000 years. The 9,000 years that have since elapsed have been sufficient to obscure any time-related differences between the soils at high elevations and those on the lower flanks of the islands. This is particularly true for Spodosols, which may be formed in only a few hundred years (Buol, Hole, and McCracken, 1973, p. 254). On Oak Island, spodosols with well-cemented ortstein horizons, indicators of advanced pedogenesis, were identified throughout the full range of elevations.

Formation of soil horizons depends on downward water movement. Soil development has not proceeded as far on steep slopes where much water runs off as on more nearly level areas where most water percolates into the soil. Thus, rates of pedogenesis are different in different landscape positions.

Topography

There are considerable differences between islands with respect to topography. Most of the 22 islands in the group are relatively level and low-lying; York, Raspberry, and Rocky Islands are good examples. On these islands runoff is limited and drainage networks are poorly developed. Most rainfall and melted snow must move downward. Such infiltration is often slow, as lacustrine clays are frequently near the soil surface where they impede drainage. The subdued relief provides relatively uniform microclimatic and hydrologic environments for plant growth and soil formation.

Oak Island, on the other hand, is comparatively rugged. Although it is less than 19 km^2 (8 mi^2) in area, it has almost 150 m (500 ft) of relief. The sloping landscape is cut by numerous deep ravines. A diversity of microclimates, microhabitats, and soils matches the complexity of landform.

Climate

Although the Apostle Islands, at nearly 47° latitude, constitute the northernmost land in Wisconsin, the climate is more temperate than in many areas to the south. The moderating influence of Lake Superior causes cool summer temperatures, relatively mild winter temperatures, and growing seasons of more than 150 days—much longer than in most of northern Wisconsin (Finley, 1975). Like much of Wisconsin the area of the Apostle Islands receives about 0.75 m (30 in) of precipitation each year. Most of this precipitation falls as rain in the summer when convectional storms are most frequent. By comparison, winters are relatively dry, although snowfall usually exceeds 1.75 m (70 in) (Finley, 1975). Northwesterly winds bring cold, dry Canadian or arctic air which gains moisture from Lake Superior and occasionally drops snow. Springs and autumns are moderately wet. In summary, the Apostle Islands experience moderately long growing seasons and receive enough moisture to provide significant downward movement of water for leaching.

Organisms

The dominant plant communities on the Apostle Islands are northern mesic forests (Curtis, 1959). Although heavily logged in the early 20th Century, the second and third growth forests appear similar to presettlement composition. Important tree species are sugar maple (*Acer saccharum*), hemlock (*Tsuga canadensis*), yellow birch (*Betula lutea*), paper birch (*Betula papyrifera*), and basswood (*Tilia americana*). Locally common are red oak (*Quercus borealis*), white pine (*Pinus strobus*), white cedar (*Thuja occidentalis*), and balsam fir (*Abies balsamea*). Red oak and hemlock were selectively logged during the 1930's (Beals and Cottam, 1960). While conifers and hardwoods make up the canopy, the forest floor is usually heavily populated with sugar maple seedlings. The Canadian yew (*Taxus canadensis*) was once a major ground cover species, but over-browsing by deer has made it rare on some islands (Beals, 1958). Scarcity or absence of deer on some of the smaller islands has allowed yew to remain dense. The importance of coniferous and hardwood vegetation and litter to soil development is discussed by Buol, Hole, and McCracken (1973). Also important on the Apostle Islands is the high frequency of wind-throw. When trees are uprooted by strong winds, tip-up mounds are formed. This process creates depressions and mounds and churns the soil locally. The impact of the process on soil horizon development has been studied by Gaikawad and Hole (1961) and Graumlich (1978).

Soils

Since the landscape of the Apostle Islands is geologically young, soil forming processes have had relatively little time to work. Consequently, soil development has usually affected no more than the upper 1.3 m (4 ft) of surficial material. Soil profiles are shallow. As stated earlier, the climate provides sufficient water to ensure soil leaching, a regime conducive to downward translocation of nutrients and organic colloids as part of the process of podzolization. Similar downward movement of colloidal clay is termed lessivage (Buol, Hole, and McCracken, 1973). Leaching occurs in most humid climates. If nutrient-rich litter and organic matter is not continually added to the soil surface, podzolization will create a Spodosol (Podzol), an infertile soil. Spodosols are commonly found associated with coniferous vegetation and loamy or sandy parent materials.

Most evergreen trees produce nutrient-poor, acid litter. Coarse-grained parent material is easily leached and is incapable of retaining many nutrients necessary for plant growth. The profile of a Spodosol usually has an ashy grey, well leached zone at the top over a dark brown horizon of illuvial organic matter, iron and aluminum oxides, and some colloidal clay. Beneath that spodic horizon the concentration of illuviated materials decreases and the brown color fades. At depths of 1 m or more the geologic material has not been significantly affected by pedogenesis.

Spodosol formation is inhibited if base-rich litter is available to the soil, permitting organic matter to accumulate. Most deciduous hardwood trees, particularly sugar maple, supply abundant fertile litter to the forest floor. Substantial amounts of silt and clay, if present in the soil profile, allow retention of nutrients within reach of plant roots and soil organisms. The soil which forms under these conditions is called an Alfisol (Gray-Brown Podzolic). The vertical profile differs from that of a Spodosol in that the B2 or illuvial horizon (called an argillic horizon) is largely a zone of clay accumulation rather than of iron and organic material. Also characteristic of Alfisols is a dark surface horizon rich in organic matter, 7-16 cm (3-6 in) thick, overlying the grey leached horizon.

In the Apostle Islands, conditions promote development of Spodosols in some areas and Alfisols in others. Where glacial or lacustrine fine-grained material is at or near the surface, Alfisols have formed. The initial material was somewhat calcareous and the clays have retarded leaching of the calcium and other cations. Where surface drainage is good these soils are termed Typic Eutroboralfs (Hibbing and Ontonagon series) (Fig. 3a). Where drainage is somewhat poor these soils are termed Aquic Eutroboralfs (Rudyard and Selkirk series). Eutroboralfs are fertile northern Alfisols and are extensive on four of the five mapped Apostle Islands.

Sand mixed with gravel occurs in deposits which may exceed 1 m in thickness. These materials have experienced long-continued podzolization and typically have formed Spodosols. On steep slopes, where much water runs off, the development of soil horizons has been retarded, giving the soils a young appearance. In other areas, the spodic horizon and podzolic profile are well formed. These two kinds of soils are classified as Entic (young) and Typic Haplorthods (Bibon, Vilas, Rubicon, Rousseau, and Karlin series). Moderately well drained soils in the catena are included in the Typic Haplorthods (Croswell and Orienta series) (Fig. 3b), but somewhat poorly drained members are Typic Haplaquods (AuGres series). Extremely gravelly deposits associated with ancient beaches have also given rise to Typic Haplorthods (Pence, Waiska, and Allouez

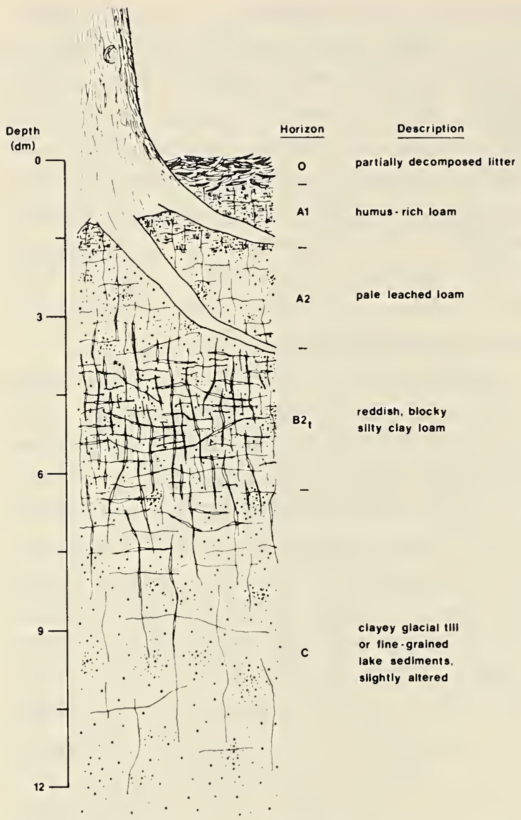

Fig. 3a. Schematic diagram of a Typic Eutroboralf on the Apostle Islands. The soil is well-drained, fertile, and characteristic of northern deciduous forests.

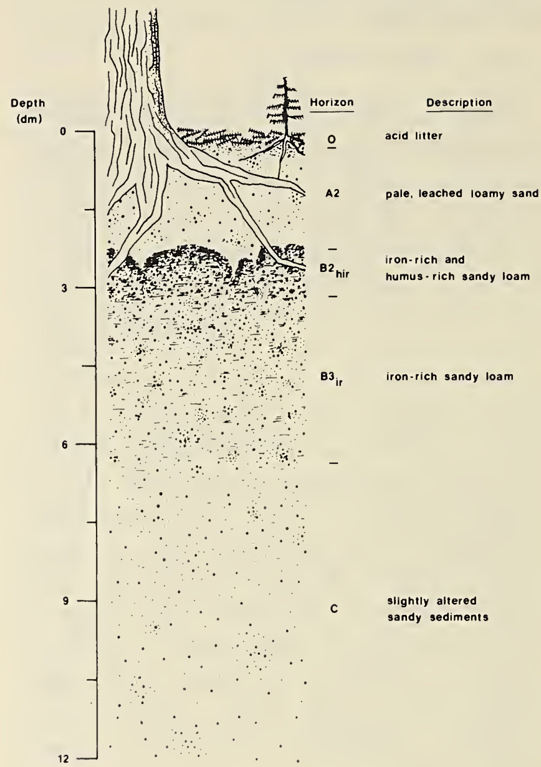

Fig. 3b. Schematic diagram of a Typic Haplorthod on the Apostle Islands. The soil is sandy, well-drained, infertile, and characteristic of coniferous forests.

series) (Fig. 3c). Typic Haplorthods represent the central concept of the Spodosol soil order.

In many areas, coarse materials overlying the glacial and lacustrine clays are of only moderate thickness (.3-1 m). There soil formation can be complex. The usual sequence of events includes leaching and formation of a spodic horizon in the coarse upper layer followed by leaching and clay concentration at and below the clay contact. The appearance is that of a Spodosol formed on top of an Alfisol (Fig. 3d). Such soils are termed "bisequal" (Hole, 1976). Bisequal soils are one form of intergradation between Spodosols and Alfisols; appropriately they are called Alfic Haplorthods (Superior, Dryburg, and Manistee series) when well drained, and Aqualfic Haplorthods (Allendale and Dafter series) when somewhat poorly drained.

In scattered depressions drainage is so poor that pedogenic processes have done little in 10,000 years but add organic material. These youthful soils are placed in the Inceptisol order and are called Mollic Haplaquepts (Munuscong series) because of the thick organic-rich surface horizon similar to that of Mollisols formed under prairie vegetation.

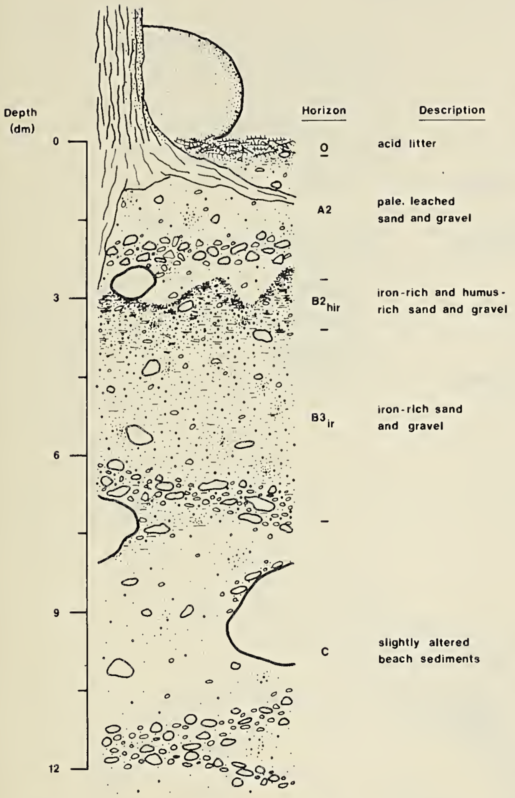

Fig. 3c. Schematic diagram of a Typic Haplorthod formed in gravelly beach deposits on the Apostle Islands.

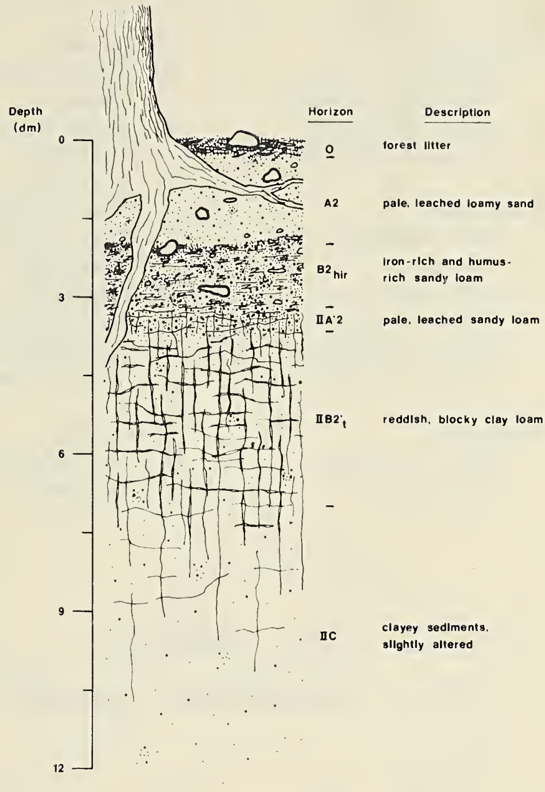

Fig. 3d. Schematic diagram of an Alfic Haplorthod formed in surficial beach sediments and underlying clayey sediments on the Apostle Islands. The soil is well-drained and has characteristics of both Alfisols and Spodosols.

Since soils are three-dimensional bodies (Buol, Hole, and McCracken, 1973) study of horizontal soil variability is important. The soil maps of Raspberry, York, Rocky, and Oak Islands (Figs. 4, 5, 6, 7) show major soil bodies. The soil pattern is more complex than can be mapped at the scales indicated. Not shown are inclusions of smaller soil bodies and the gradual and interfingering nature of lateral boundaries for which a drawn line is a gross simplification. Also designated for each soil body is the approximate land surface slope. Level land is placed in slope category *a* (0-2%), while land inclined at 20-30% is placed in slope category *e*. The steepest land, with slopes greater than 30%, usually occurs in association with bluffs or ravine systems, shown as land types.

The physiographic uniqueness of Oak Island is evident in the slope designations. Oak Island has a large part of its land surface in moderate slopes in contrast to York, Rocky, Raspberry, and most other Apostle Islands, which are chiefly level (0-2%) and gently sloping (2-6%) land (Fig. 8).

The soil maps reveal that Oak Island is also pedologically distinct. The soilscapes of the three smaller islands are dominated by Eutroboralfs and Alfic Haplorthods—soils

TABLE 1. Legend for figures 4, 5, 6 and 7.

Eutroboralfs	*Haplorthods*	*Miscellaneous Land Types*
A Typic Eutroboralf (Ontonagon, Hibbing)	G Typic Haplorthod (Bibon)	V Shallow to bedrock
		W lake sand
B Aquic Eutroboralf (Rudyard, Selkirk)	H Aquic Haplorthod (Orienta)	X organic material
		Y ravine complex
	I Typic (Entic) Haplorthod (Vilas, Rubicon)	Z bluff
Haplorthods		
C Alfic Haplorthod (Superior)	J Typic (Entic) Haplorthod (Croswell)	*Slope Classes*
		a 0-2%
D Alfic Haplorthod (Manistee, Dryburg)	L Typic Haplorthod (Rousseau, Karlin)	b 2-6%
		c 6-12%
E Aqualfic Haplorthod (Allendale, Dafter)	M Typic Haplorthod (Waiska, Pence, Allouez)	d 12-20%
		e 20-30%
Haplaquepts	*Haplaquods*	
F Mollic Haplaquept (Munuscong)	K Typic Haplaquod (AuGres)	

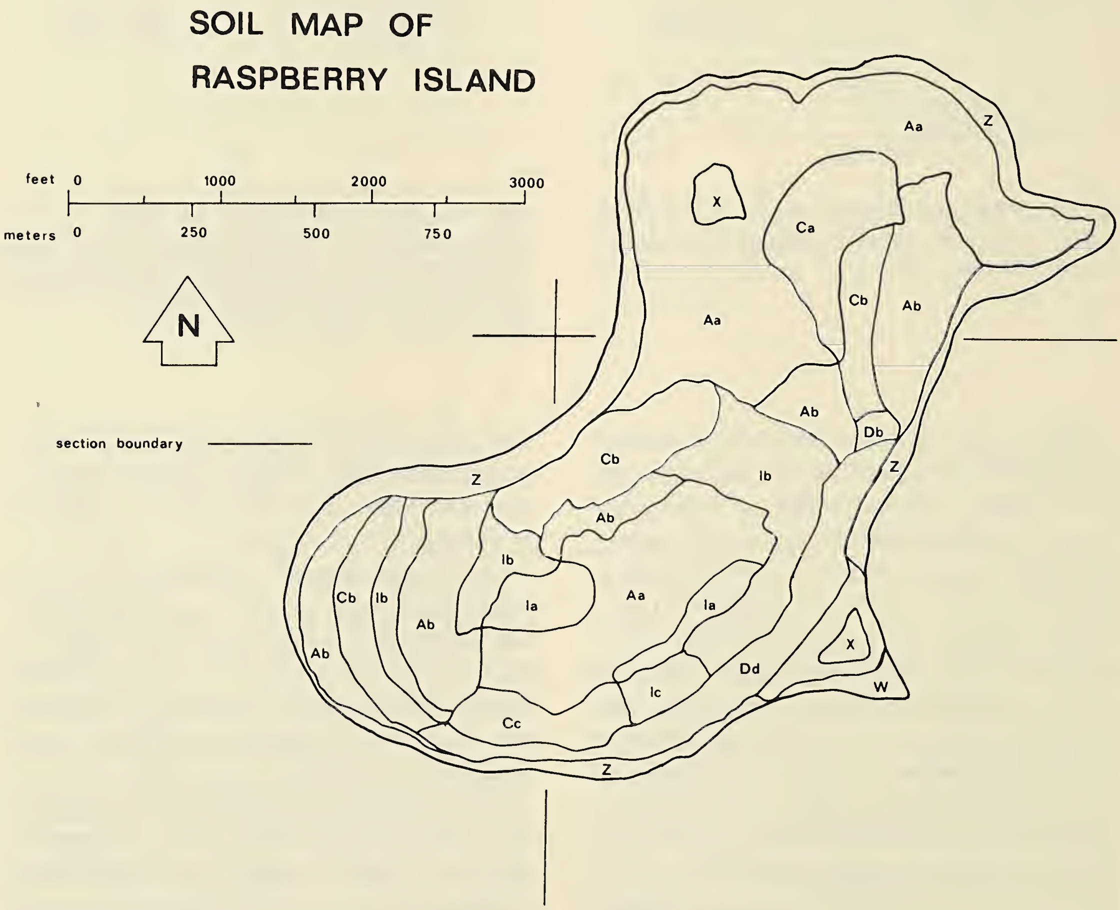

Fig. 4. Soil map of Raspberry Island.

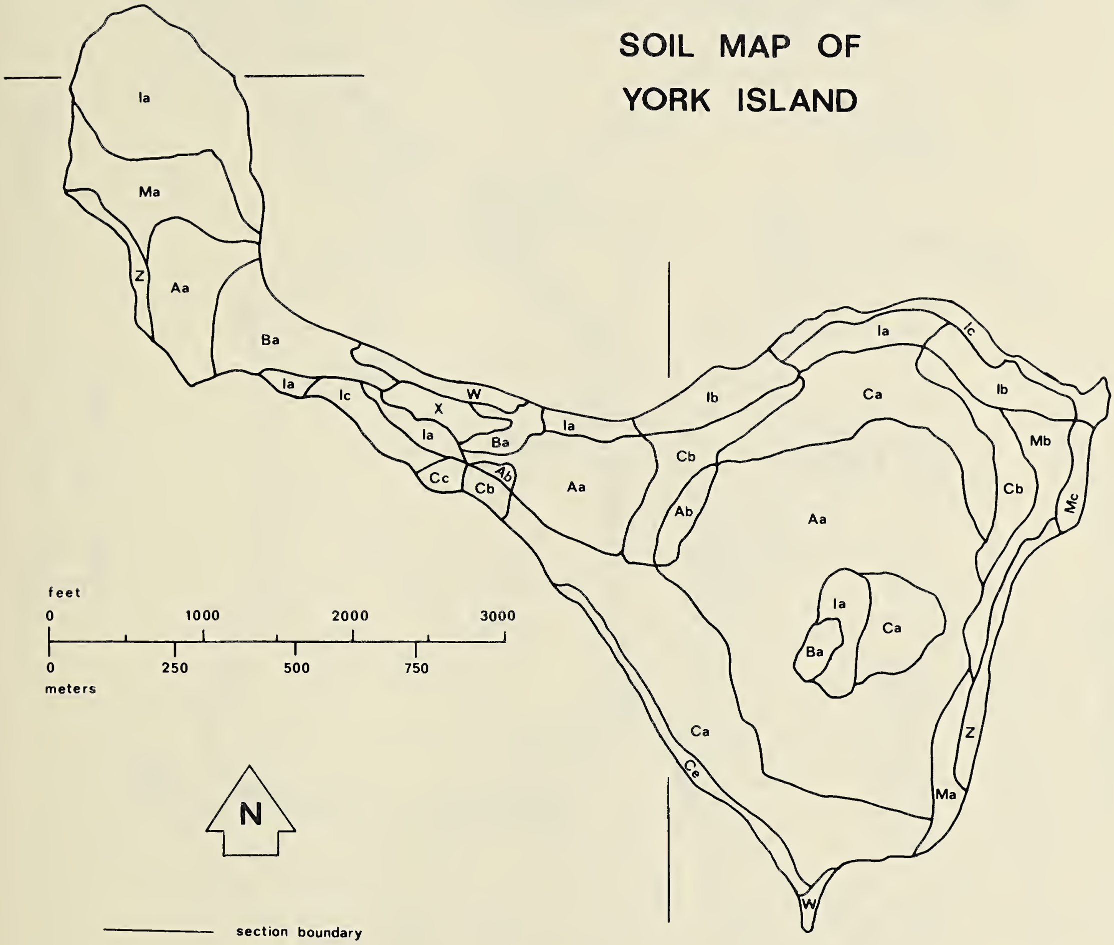

Fig. 5. Soil map of York Island.

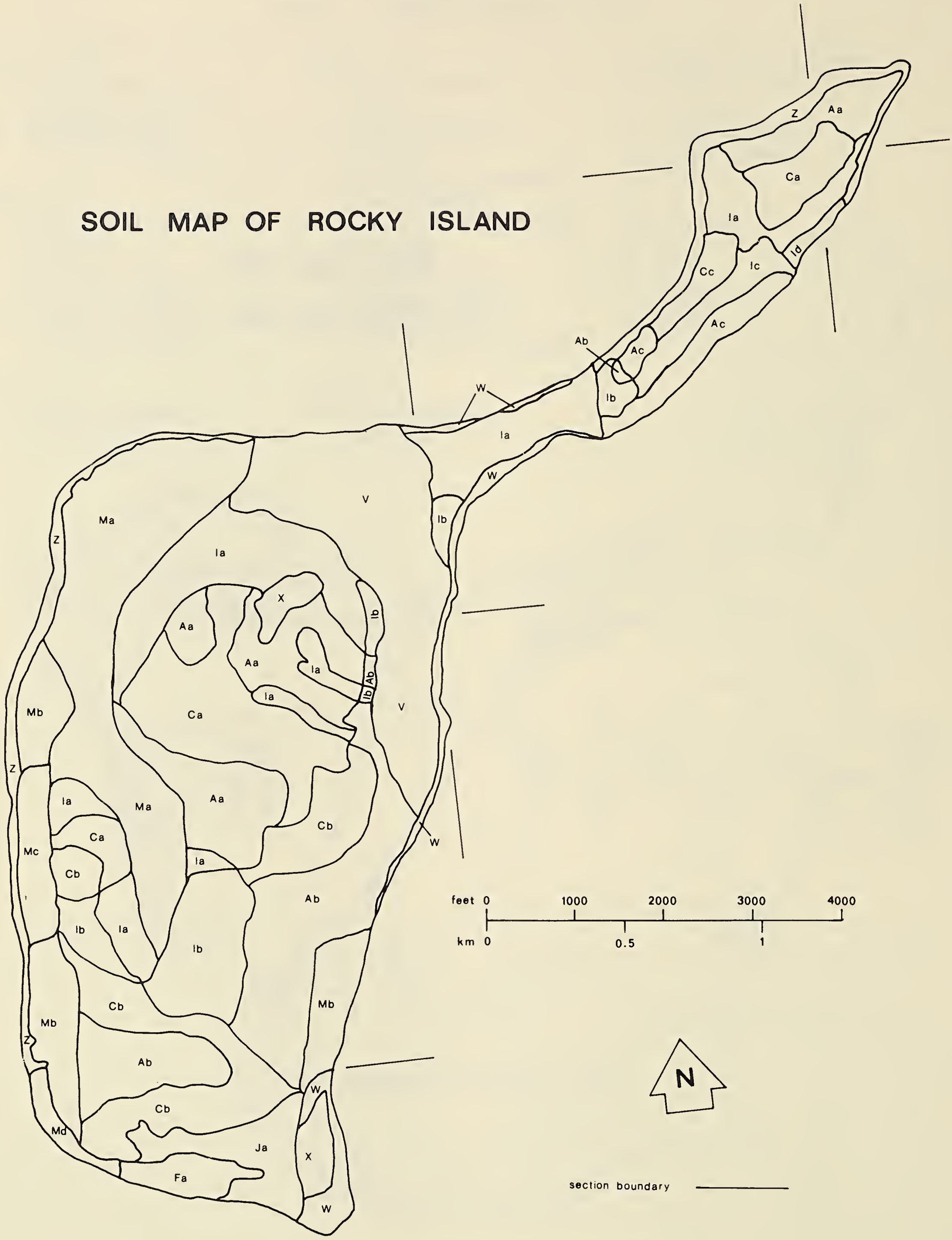

Fig. 6. Soil map of Rocky Island.

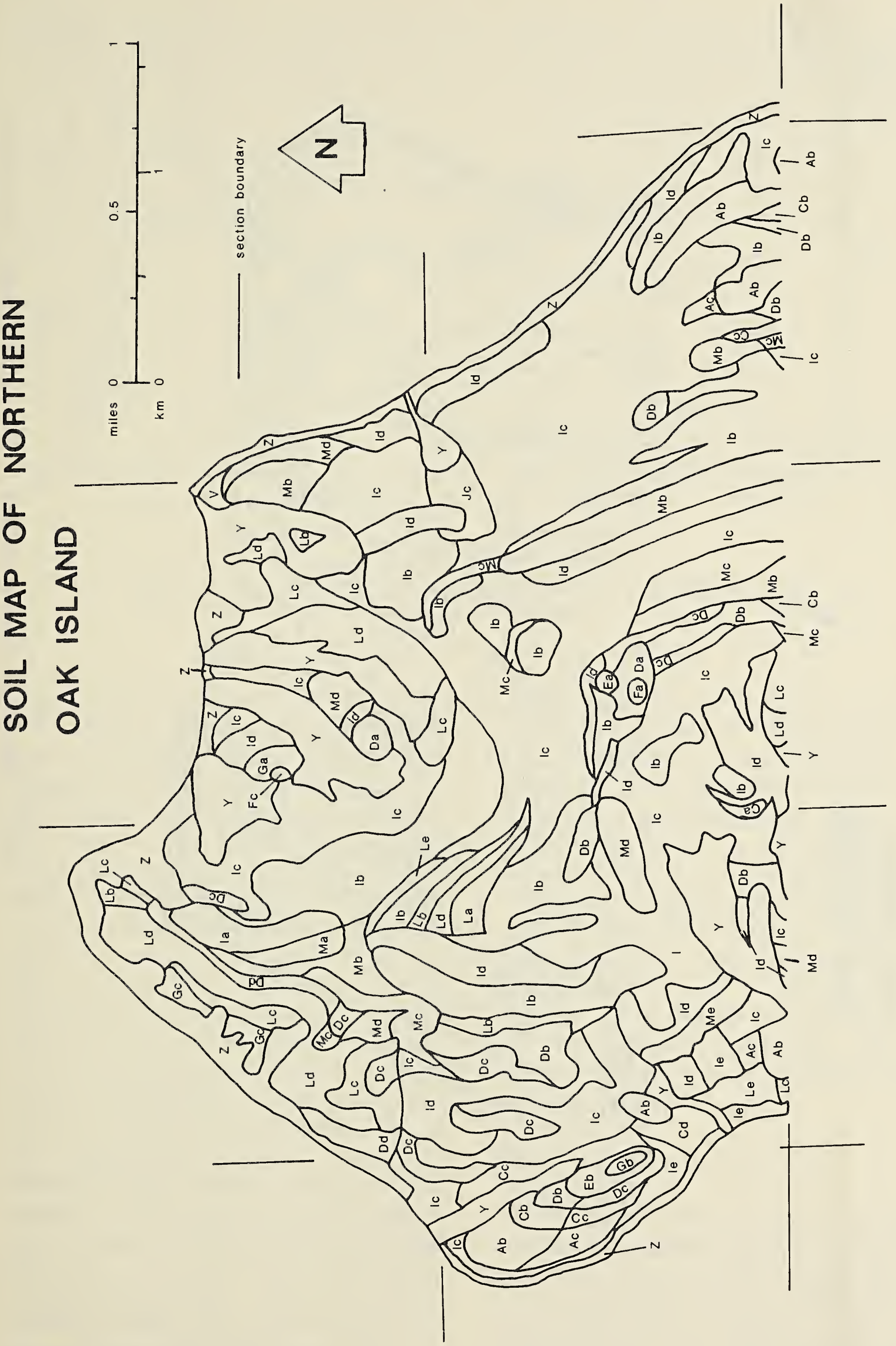

Fig. 7a. Soil map of northern Oak Island.

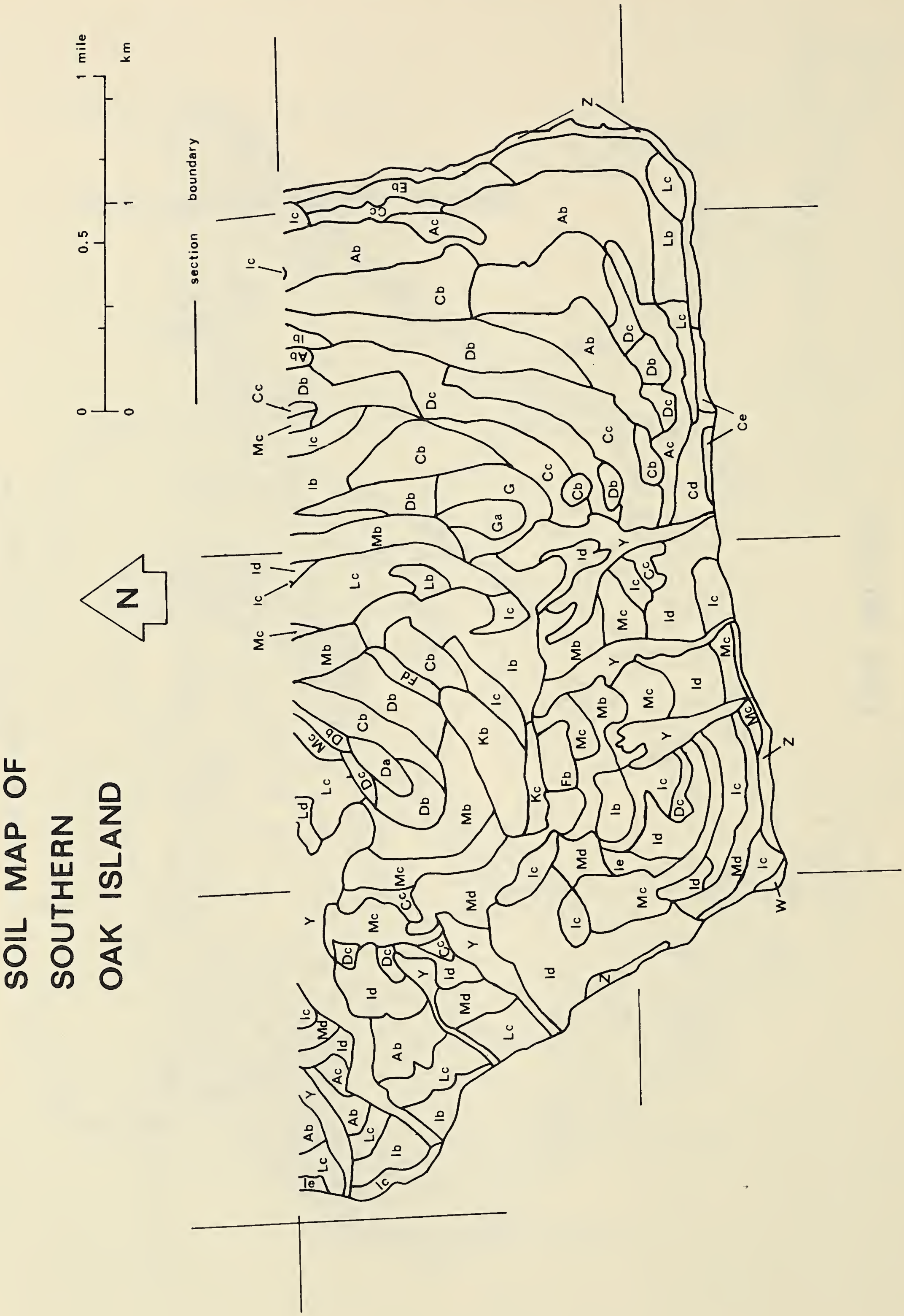

Fig. 7b. Soil map of southern Oak Island.

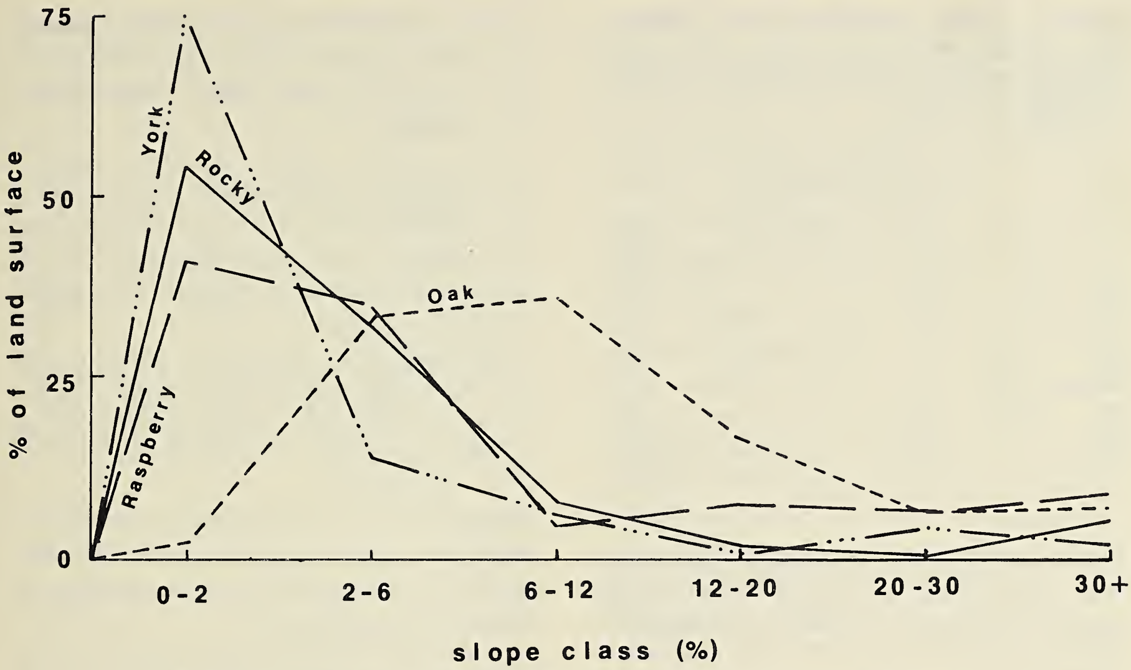

Fig. 8. Proportion of land area on Raspberry, Rocky, York and Oak islands in different slope classes.

formed in less than 1 m of coarse sandy material overlying glacial or glaciolacustrine clayey material. The coarse surficial layer, deposited by beach processes at times of higher water levels, is generally thin (less than 1 m) on these islands. On the other hand, more than 75% of the surface of Oak Island is covered with Typic Haplorthods or less well drained Spodosols, which typically form in thick (more than 1 m) deposits of coarse-grained materials. In only a few locations on Oak Island does the basal clayey sediment lie close enough to the surface for soil formation. However, the clayey substrate can significantly affect pedogenesis even if it is buried by more than 1 m of coarse beach deposits. Indirect evidence of subsurface clayey material, in the form of mottling was often present in profiles which were of loamy or sandy texture throughout their upper 1.5 m (5 ft). Oak Island soils are sandy and sloping, while the soils of Raspberry, Rocky, and York Islands are generally fine-textured and fairly level.

More detailed analysis suggests that sandy soils are associated with sloping land while clayey soils are associated with level land (Table 2). Observation points were selected by randomly overlaying grids (adjusted for differences of scale) on the soil maps; observations were recorded at each grid point.

If no relationship existed between thickness of coarse surface deposits and land surface slope, the observation frequencies should resemble those of Table 3. A contingency table analysis was performed to test for a possible relationship. The Chi Square statistic (χ^2) was calculated according to the formula

$$\chi^2 = \Sigma f_o^2/f_e - N$$

where f_o is the observed frequency at a given position in the table, f_e is the expected frequency assuming no relationship between the variables, and N is the total number of observations (252) (Blalock, 1972). The calculated chi square value was 62.6, highly

TABLE 2. Frequencies (%) for given combinations of land surface slope and surficial sand thickness, includes all points on Rocky, Oak, York and Raspberry Islands.

		Thickness of coarse surface layer (cm.)			
		0-25	25-100	100+	total
Slope angle (%)	0-2	27	17	14	58
	2-6	23	25	37	85
	6-12	5	15	55	75
	12-30	0	3	31	34
	total	55	60	137	252

TABLE 3. Frequencies (%) at which points on all four islands would be expected to possess the specified combinations of land surface slope and surficial sand thickness, if the two properties are not related.

		Thickness of coarse surface layer (cm.)			
		0-25	25-100	100+	total
Slope angle (%)	0-2	13	14	31	58
	2-6	19	20	46	85
	6-12	16	18	41	75
	12-30	7	8	19	34
	total	55	60	137	252

significant at a probability level of 0.001. There is less than one chance in a thousand that the positive association between land surface slope and coarse surficial material thickness results from chance.

The most probable explanation for the observed correlation between land surface slope and thickness of the coarse surficial material relates to the beach processes which deposited the sandy, gravelly sediment 8,000 to 11,000 years ago. Thick layers of coarse sediments can accumulate in the littoral (beach) zone only if three conditions are more or less satisfied:

1) a sediment surplus must exist; incoming material from erosion or longshore transport must exceed outgoing material;
2) a suitable depositional zone must be present; in excessively steep areas the suitable zone is very narrow; on broad, level beaches wave action causes the sand deposits to be extensive but thin;
3) sufficient time must be available; for sedimentation to build thick deposits, i.e. lake level must remain constant for a period.

The degree to which these three conditions were met differs between the islands, thus there are differences in the thickness of coarse beach sediments.

Although longshore drift has created a few small spits and forelands at former and present lake levels (Engstrom, 1972), the major source of sediment for beaches on all of the islands has been bluff erosion. Bluff erosion is favored by the presence of steep slopes above the beach level. When a relatively steep face is present, sediment is eroded from the face through undercutting by wave and ice action, followed by slumping, through sheet and rill erosion on the bluff face, and through gravity-induced slope processes. Sorting by wave action at the beach may remove the fine fraction of the bluff material, leaving coarser beach deposits, including boulders.

If conditions are favorable for bluff erosion, sediment surplus at the beach will lead to the accumulation of thick beach deposits. During emergence of the Apostle Islands these conditions were met on Oak Island, an island with great vertical relief and relatively steeply sloping flanks. There bluff erosion has contributed large amounts of sediment to beaches at all lake levels throughout the post-glacial period. On York, Rocky, and Raspberry Islands a large proportion of the land surface is in gentle and flat slopes, with no steep land above these surfaces to contribute sediment. Wave action on the relatively flat tops of these islands probably sorted and reworked the original surfaces, but the supply of new beach material was small.

Slope of the island surface at beach level determines the zone available for deposition of beach sediment. Thick accumulations of material are favored by moderate slopes. When the littoral zone is fairly level expenditure of wave energy over a wide area discourages thick sand accumulation by spreading the material laterally. On flat-topped islands like Raspberry, York, and Rocky, the wide littoral zone has a thin layer of beach deposits spread over the fine-textured material from the original surface. On an island with moderately steep slopes, such as Oak Island, the width of the littoral zone is limited, and sand accumulation is thicker. On a very steep original slope, a shelf-like littoral zone, with relatively thick sediment accumulation, may be constructed by wave action if ample time and surplus sediment are available. Some of the flatter slopes on the west side of Oak Island may be beaches built onto or cut into the original steep face.

Although the lake level fell rapidly, the unconsolidated glacial debris mantling the islands and the relatively high wave energy of Lake Superior allowed beaches to build rapidly. An island with moderately sloping sides always had sand accumulating as long as island emergence continued. The flat-topped, steep-sided islands were less likely to receive similar accumulations. Regardless of the elevation at which lake level temporarily stabilized, thick sand accumulations were unlikely; either there was a paucity of coarse sediment or there was an unfavorable depositional zone. Moderate slopes (approximately 5-20%) thus seem to be important in the accumulation of thick sand deposits. Differences in initial soil material between islands can be partially explained by this phenomenon.

The above discussion is important from a practical, as well as a theoretical, view. Recreational development of the Apostle Islands is proceeding under the direction of the U. S. National Park Service. Assessment of soil resources and evaluation of soil limitations for various recreational activities is essential for planning. Drainage is an important soil property and poor drainage presents serious problems for septic tank disposal fields or for more primitive waste disposal methods, as well as for paths, trails, and campgrounds. Poor drainage is most often encountered on level, fine-textured soils. Steep, sandy soils may present a serious problem because of the great erosion potential. The apparent correlation between surface slope and thickness of coarse surficial material suggests that most areas will have one problem or the other. Level land with loamy or sandy soil has few limitations but is not common on the mapped islands. It does not seem likely that other islands in the archipelago will have soils more suited to recreational uses, because all the islands were subject to the same beach processes. The biologic and pedologic environments of the Apostle Islands are fragile and development will demand great care.

Conclusion

This paper presents the findings of two field seasons work in the Apostle Islands. The prevalent soils on the four islands studied are of two basic kinds: fertile Alfisols, formed in deposits of fine-grained glaciolacustrine material (Eutroboralfs), and sandy Spodosols developed in coarse beach deposits (Haplorthods). The Apostle Islands possess a landscape with widely varying characteristics of initial material and topography, and which, in conjunction with the cool, humid continental climate, allow a variety of biotic communities to thrive. The coexistence in this region of Alfisols, usually found in more southerly locations under deciduous forest, and Spodosols, typically found in more northerly climatic zones with evergreen vegetation, attests to the diversity and complexity of the pedogenic environment.

Development of soil maps for the four islands surveyed allows analysis of the spatial variability of soils. Reconnaissance soil surveys completed 10 or more years ago (Ableiter, and Hole, 1961; Hole, *et al.*, 1968) show virtually all the Apostle Islands as having soils formed in thin coarse deposits overlying basal clayey material (Eutroboralfs, Alfic Haplorthods). This portrayal is accurate for York, Rocky, and Raspberry Islands, but not for Oak Island. Oak Island is dominated by thick surficial sand and gravel deposits and the Typic and less well drained Haplorthods formed in them. The preponderance of sandy soils on Oak Island is explained by the correlation between thick coarse deposits and steep land surface slope.

Literature Cited

Ableiter, J. K., and F. D. Hole. 1961. Soil Survey of Bayfield County, Wisconsin. U.S.D.A. Soil Cons. Service, Series 1939, No. 30, 77 p., 12 maps.

Beals, E. W. 1958. The phytosociology of the Apostle Islands and the influence of deer on the vegetation. M.S. thesis, Univ. of Wisconsin, Madison.

Beals, E. W., and G. Cottam. 1960. The forest vegetation of the Apostle Islands, Wisconsin. Ecol. **41**:743-751.

Blalock, H. M., Jr. 1972. Social Statistics. McGraw-Hill, New York. 583 p.

Buol, S. W., F. D. Hole, and R. J. McCracken. 1973. Soil Genesis and Classification. Iowa State Univ. Press, Ames, 360 p.

Collie, G. 1901. Wisconsin shore of Lake Superior. Geol. Soc. Amer. Bull. **12**:197-216.

Curtis, J. C. 1959. The Vegetation of Wisconsin. Univ. of Wisconsin Press, Madison, 657 p.

Engstrom, W. N. 1972. Spatial patterns in beach morphology and sedimentology in the Apostle Islands of northern Wisconsin. Ph.D. dissertation. Univ. of Wisconsin, Madison, 236 p.

Farrand, W. R. 1960. Former shorelines in western and northern Lake Superior basin. Ph.D. dissertation. Univ. of Michigan, Ann Arbor, 226 p.

Farrand, W. R. 1969. The Quaternary history of Lake Superior. Proc. 12th Conf. Great Lakes Res.: 181-197.

Finley, R. W. 1975. Geography of Wisconsin. Univ. of Wisconsin Press, Madison. 472 p.

Gaikawad, S. T., and F. D. Hole. 1961. Characteristics and genesis of a Podzol soil in Florence County, Wisconsin. Trans. Wis. Acad. Sci., Arts, Letters **50**:183-190.

Graumlich, L. J. 1978. An analysis of the spatial variation of soil microtopography and surface horizon thicknesses. M.S. thesis. Univ. of Wisconsin, Madison.

Hole, F. D. 1976. Soils of Wisconsin. Univ. of Wisconsin Press, Madison. 223 p.

Hole, F. D., M. T. Beatty, C. J. Milfred, G. B. Lee, and A. J. Klingelhoets. 1968. Soils of Wisconsin. Univ. Wisconsin Ext., Madison, map (1:710,000).

Irving, R. D. 1880. Coastal features of the eastern Lake Superior district. Geol. of Wis. 1873-1879, v. 3, pp. 70-76.

Kowalski, W. L. 1976. Geology, soils, and recreational limitations of Bear Island, Wisconsin, Apostle Islands National Lakeshore. M.S. thesis. Michigan Tech. Univ., Houghton, 207 p.

Maher, L. J., Jr. 1977. Palynological studies in the western arm of Lake Superior. Quaternary Res. **7**:12-44.

Martin, L. 1965. The Physical Geography of Wisconsin. Univ. of Wisconsin Press, Madison, 3rd ed., 608 p.

Saarnisto, M. 1974. The deglaciation history of the Lake Superior region and its climatic implications. Quaternary Res. **4**:316-339.

Saarnisto, M. 1975. Stratigraphical studies on the shoreline displacement of Lake Superior. Can. J. Earth Sci. **12**:300-319.

Soil Survey Staff. 1975. Soil Taxonomy. U.S.D.A., S.C.S., Agric. Handbk. 436, Washington, D.C., 754 p.

Taylor, F. B. 1931. Submerged peat beds among the Apostle Islands. Science **74**:265-267.

THE CADDISFLIES (TRICHOPTERA) OF PARFREY'S GLEN CREEK, WISCONSIN[1]

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Abstract

Life cycles, biology and ecology of 17 species of Trichoptera in Parfrey's Glen Creek are reported. *Wormaldia moestus* and *Oligostomis ocelligera,* rare in Wisconsin, were found. Other species such as *Diplectrona modesta, Parapsyche apicalis, Rhyacophila vibox,* and *Dolophilodes distinctus,* which seldom occur commonly in any stream, were a significant part of the fauna. Closely related species were often segregated temporally or spatially. *Limnephilus rossi* is reported from Wisconsin for the first time and its larva is described.

Parfrey's Glen Scientific Area in Sauk County, Wisconsin has a unique flora and fauna that has received much attention (Vorhies, 1909; Hilsenhoff, 1974; Webb, 1974; Wynn and Loucks, 1975). Flowing southward through the area is Parfrey's Glen Creek, a small, permanent, spring-fed stream. Its insect fauna differs significantly from most other streams in southern Wisconsin, and is dominated by an unusual assortment of caddisfly larvae (Trichoptera). It also has significant populations of the stoneflies *Isoperla clio* (Newman), *Allocapnia nivicola* (Fitch), *A. rickeri* (Frison), *Amphinemura delosa* (Ricker), and *A. linda* (Ricker), the mayfly *Baetis vagans* (McDunnough), the beetles *Optioservus fastiditus* (LeConte), *Helichus striatus* (LeConte), *Agabus seriatus* (Say), *A. confusus* (Blatchley), and *Hydrobius melaenus* (Germar), and several unidentified Diptera. Because of increased public use of this area (Wynn and Loucks, 1975), a study was begun in 1975 to document the unique caddisfly fauna and to learn more about their biology and ecology.

[1] Research supported by the College of Agricultural and Life Sciences, University of Wisconsin-Madison and carried out in cooperation with the Wisconsin Department of Natural Resources.

Parfrey's Glen Creek is characterized by series of riffles, rapids, small waterfalls, and occasional pools. In winter it is frozen, and in summer most of it is densely shaded by vegetation, and in the gorge by cliffs. Only a few patches of aquatic mosses are present, mostly outside of the gorge. The average flow is 21 l/sec and varies little seasonally, with currents mostly 15 to 45 cm/sec and depths of 1 to 40 cm. Temperatures vary from 0 to 18°C, the maximum occurring in early spring before the trees are in leaf. After the stream is shaded, temperatures remain fairly constant at 16.5°C throughout the summer. Except for some siltation due to visitor use, the stream is free of pollution with oxygen at or near saturation level. The stream has a gradient of 1.92 hm/km, a pH of 7.8, total alkalinity of 216 mg/l, and a specific conductance of 528 μmhos/cm.

Methods

To collect caddisflies for determination of life cycles, a D-frame aquatic net with a 1.0 mm mesh was held against the stream bottom and the substrate immediately upstream was thoroughly disturbed (using one's feet) for approximately one minute to dislodge insects. Insects and debris collected in the net were placed in a white plastic pan with a little water. Caddisflies were removed from large pieces of debris, water, and the net and preserved in 70% ethanol. The remaining debris was preserved for more thorough examination in the laboratory. Large rocks or logs that could not be sampled by this method were lifted from the water and caddisflies were scraped into the net or directly into collecting jars. Prior to disturbing the substrate to dislodge larvae, and with the D-frame net in position, substrate materials were removed from the water and examined for pupae. All possible microhabitats were sampled semimonthly from March 19, 1975 to November 6, 1975; six or seven sites were sampled on each date.

To determine microdistribution, sampling sites were selected to be as homogeneous as possible with respect to current, substrate type, and water depth. Current was measured with a pigmy current meter 2.5 cm above the substrate and water depth was calculated as the average of measurements taken at the corners and center of a sampling site. Stones were measured after sampling to determine the greatest diameter. Substrate units sampled were silt, detritus, leaves, moss, sand (1 mm to 2 mm), gravel (3mm to 2 cm) and stones 2-5 cm, 5-10 cm, or >10 cm). An average of 45 samples were collected each spring (April-June), summer (July-September), autumn (October-December), and winter (January-March).

Flight periods were determined from adult collections and laboratory reared insects. Daytime collections were made by sweeping riparian vegetation and by picking adults from tree trunks near the stream or exposed rocks in and along the stream; at night, adults were collected in light traps. In the laboratory, adults were reared from pupae, prepupae or mature larvae in aerated water maintained within 2°C of the stream temperature.

Life cycles were determined by analyzing larval growth rates and the presence of prepupae, pupae, and adults. Each larval instar was determined by head capsule width measured with an ocular micrometer.

Larvae were identified using keys by Ross (1944), Flint (1960, 1961, 1962), and Hilsenhoff (1975). *Lepidostoma* larvae were identified using the metamorphotype method of Milne (1938). Adults were identified using keys and illustration by Betten (1934, 1950), Ross (1944, 1946), and Leonard and Leonard (1949a). Specimens were also compared with identified adults in the University of Wisconsin Insect Collection, and voucher specimens were deposited in this collection. The reported distribution in Wisconsin is based on Longridge and Hilsenhoff (1973), and specimens in the University of Wisconsin Insect Collection.

Seventeen species of caddisflies were collected from Parfrey's Glen Creek; these are the only species known to occur in this stream. Life cycles and numbers collected of the fourteen most common species are summarized (Table 1) and notes on the biology and ecology of all species follow.

Caddisfly Biology and Ecology

Dolophilodes distinctus (Walker) 1852

Dolophilodes distinctus has been found in rapid, cool streams in northern Wisconsin and a few streams in Sauk County. It was relatively common in Parfrey's Glen Creek. Adults were captured every month except September and October, and other workers have noted adults present over much or all of the year (Longridge and Hilsenhoff, 1973; Ellis, 1962; and Leonard and Leonard, 1949b). The population in Parfrey's Glen Creek is bivoltine with peaks of emergence in March-April and July-August. Tebo and Hassler (1961) also noted two peaks of emergence in this species, in April and in September.

Brachypterous females were collected from late February to the first week of April. They were found crawling on the stream bank, under rocks and logs near

TABLE 1. Development of 14 species of Trichoptera in Parfrey's Glen Creek indicating life stages[1]

Species	No. of larvae	Month									
		Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.
				3	2,3	3		2	3		
Dolophilodes distinctus	451				4	4,5	4,5	5	4,5	4,5	5
		P,A	P,A	P,A	A	A	P,A	A	PP	PP	PP,P,A
		3	3	3	3	2	1,2	2,3	3		3
Diplectrona modesta	4,255	4,5	4,5	4,5	4,5	4,5	5	5	4,5	4,5	4,5
				PP,A	PP,A	A					
							1,2,3	2,3	3		
Parapsyche apicalis	795	5	5	4,5	4,5	5			4	4,5	4,5
				PP,P,A	PP,P,A	A					
		2	2	2,3	2,3			2	1,2,3	1,2,3	2
Hydropsyche slossonae	2,418		5	5	4,5	4,5	5	5	5	5	5
					PP,P,A	A	A	P,A	PP,A		
				2,3		2	1,3	1,2,3	2,3		
Rhyacophila vibox	1,838	4,5	5	5	5			4	4	4,5	4,5
					PP,P,A	P,A					
		3	3	3			3	1,2	1,2	2,3	3
Glossosoma intermedium	16,129	4	4	4,5	4,5	4,5	4,5				4
				PP,P,A	A	PP,P	PP,P,A	A	A	A	
							2	3	3		
Brachycentrus occidentalis	58	4,5							4,5	4,5	4,5
				P,A							
										3	2,3
Pycnopsyche guttifer	118	4,5	5	4,5	5	5					4
									A	A	A
							2,3	2,3			
Hesperophylax designatus	27	5					4	4	4	5	5
				P	P,A		A				
		2		2,3	3	2		3			3
Limnephilus rossi	304			4	4,5	5	4,5	4,5	5	4	
									PP	P	
		2	2	2,3	3		3				1,2,3
Neophylax concinnus	1,731	3,4	3,4	4,5	4,5	5					
						PP	PP	PP,P	A	A	A
						1,3	2,3	2,3	3		
Lepidostoma bryanti	296	4,5	5	4,5	5					4	4,5
				A	P,A	A					
		2	2	2,3	2,3	3			3	3	2,3
Lepidostoma costalis	893				4	4,5	5				
							PP	P,A	A		
		2	2	2,3	2,3					2	1,2,3
Lepidostoma griseum	939				4	4,5	5	5			
								PP,P,A	P,A	P	

[1] Life stage noted only if it constituted 10% or greater of the months sample of that species. 1,2,3,4,5 = Larval Instar; PP = prepupae; P = Pupae; A = Adult.

the stream, and on exposed rocks in the stream. Ross (1944) also found only wingless females in winter and noted that winter males were winged and tended to be larger than in other seasons. In warmer months, adults were found on tree trunks close to the stream and under rocks and logs along the stream.

Larvae that hatched from eggs laid in March and April grew very rapidly and by the end of June nearly 90% were in the fifth instar. Pupae were first noticed in early July. Early instar larvae from the July-August emergents were first noticed in mid-August. They grew rapidly and by November all were in the fifth instar. The winter was spent mainly as pupae, but prepupae and fifth instar larvae were also present. By late February more than 80% were in the pupal stage. Throughout the winter a small number of adults emerged to produce the brachypterous phenotype. The presence of some adults quite removed from periods of peak emergence may be attributable to a long adult life span.

Larvae inhabited a wide range of substrates, currents and water depths. They were found in currents ranging from 5 cm/sec to 97 cm/sec, mostly on the under surface of rocks 12 cm or larger. Depths greater than 15 cm were preferred, but larvae were not uncommon in water as shallow as 5 cm.

Pupal chambers were fastened to the under surface of stones, usually 10 cm or larger. Pupae were found in currents of 19 to 70 cm/sec at depths of 4 cm to 20 cm and preferred currents faster than 30 cm/sec.

Wormaldia moestus (Banks) 1914a

Wormaldia moestus is rare in Wisconsin. Besides Parfrey's Glen Creek and one other Sauk County stream, it has been collected only in the northeastern counties. Eight larvae were found, all of them in the densely shaded stream gorge, mostly on the under sides of rocks 10 cm or larger, in currents of 23 to 70 cm/sec and water 10 to 16 cm deep. The two smallest larvae were collected in early and late April (head capsule widths 0.35 and 0.50 mm respectively). Those collected in June, November, and February had head capsule widths of 1.70-1.80 mm. Larvae apparently grow rapidly in spring and spend summer, autumn and winter in the terminal instar. Pupation probably occurs in late winter with emergence in early spring. Ross (1944) collected adults in Illinois during the first week of March.

Diplectrona modesta (Banks) 1908b

Diplectrona modesta frequents rapid clear brooks and streams throughout Wisconsin. In Michigan Leonard and Leonard (1949b) found it only in tiny, spring-fed brooks. Parfrey's Glen Creek is one of the few streams in Wisconsin where it comprises a significant part of the caddisfly fauna, and here it was the dominant hydropsychid. *Diplectrona modesta* was univoltine with adults present from early May to July, and peak emergence the last week of May and first week of June. Adults were found resting on tree trunks.

A wide range of instars was often present, indicating an extended hatching period. Larvae grew steadily over the summer and by mid-August more than 80% were in the fourth and fifth instar. The larvae developed little during the winter, with growth resuming in early spring. Prepupae were found from April 29 to July 9, pupae from June 12 to July 24.

First and second instar larvae preferred 2-5 cm stones in currents of 13 to 29 cm/sec; depth was not important. They were mostly on the undersurface, but were found on other faces if vegetation was present. Later instars were less selective and inhabited all sizes of stones and occasionally vegetation in currents of 12 to 68 cm/sec, but preferred currents of 15 to 36 cm/sec. Mostly on the undersurfaces of stones, they inhabited other faces if fissures or protuberances protected them from the current. In late spring, fifth instar larvae preferred deeper water (>12 cm), larger stones (>10 cm) and slower currents (<46 cm/sec) than in other seasons, probably as a result of movement to pupal habitat in spring. Pupae attached chiefly to the undersurface of rocks greater than 10 cm in water deeper than 11 cm with currents of 15 to 44 cm/sec.

Parapsyche apicalis (Banks) 1908b

In Wisconsin *Parapsyche apicalis* occurs in small, cold, rapid streams, mostly in the north. It was not common in Parfrey's Glen Creek. Adults of this univoltine species were present from April 30 to June 12 with the emergence peak the last two weeks of May. Longridge and Hilsenhoff (1973) and Leonard and Leonard (1949b) collected adults into summer and early autumn.

First instar larvae were collected first on July 9 indicating an incubation period of 3-4 weeks. The larvae grew slowly in July and August and more rapidly in September so that by the end of September almost 80% were in the fourth instar. Winter was spent mainly as fifth instar larvae, but second, third and fourth instars were also present. Prepupae and pupae were present from April 29 to May 12.

Developmental stage and season influenced larval distribution. First and second instar larvae clearly preferred vegetation in currents of 30 to 78 cm/sec and depths less than 12 cm. In autumn, third and fourth instar larvae were most common on stones 5 cm or larger in currents of 23 to 53 cm/sec and depths greater than 6 cm. In winter, they also colonized vegetation growing on rocks. Fifth instar larvae were found at all depths and in autumn and winter were most common on rocks greater than 10 cm and in currents faster than 30 cm/sec. They occurred on the bottom of bare rocks, and on other faces if vegetation was present.

Approximately 60% of the pupal chambers were constructed of vegetation, the rest of sand grains. Flint (1961) noted that pupal cases were almost exclusively organic material and only rarely constructed of sand grains. Pupal cases of vegetation were found in vegetation and completely enclosed the pupa. Sand cases were found on the undersides of stones larger than 5 cm in diameter in currents less than 15 cm/sec and at depths greater than 6 cm.

Hydropsyche slossonae (Banks) 1905

Hydrosyche slossonae is widely distributed in clear, cool, swiftly flowing streams throughout Wisconsin, and was the second most common hydropsychid in Parfrey's Glen Creek. It is univoltine with a long flight period (Longridge and Hilsenhoff, 1973; Leonard and Leonard, 1949b; Ellis, 1962; and Ross, 1944). Adults were collected from May 19 to September 18. On August 28, 1975, 161 females and 5 males were caught in a light trap. While males may not be as strongly phototropic as females (Leonard and Leonard, 1949a), Schuhmacher (1970) found females to be generally more prevalent than males in the genus. Eggs were found in late August and September on the sides and beneath rocks and logs. They were roundish, off-white, and laid in one-layered patches of about 260 eggs.

Early instar larvae were first evident in early July. Most grew very slowly and overwintered in the second instar. Growth resumed in late March and by the end of April, 80% were in the third instar. Some larvae overwintered in the fifth instar and pupated in late spring, accounting for adults in May and June.

Segregation of instars was evident. First and second instar larvae were most common on vegetation while later instar larvae preferred bare stones 5-15 cm in diameter at depths less than 11 cm. Nets were spun in areas protected from the full force of the current. Fifth instar larvae were also found in vegetation on the upper surface of rocks in currents greater than 65 cm/sec. All larvae were most common in currents greater than 18 cm/sec.

Pupae were attached to vegetation or to the bottom of stones 5 cm or larger in diameter, usually in currents of 12 to 36 cm/sec. Depth did not significantly limit distribution, although pupae were not found at depths less than 4 cm unless the current was greater than 30 cm/sec.

The three hydropsychids, *H. slossonae, D. modesta* and *P. apicalis* were segregated temporally and spatially. *Hydropsyche slossonae* was temporarily isolated by growing in late spring while *D. modesta* and *P. apicalis* grew most actively in autumn. Early instars of *D. modesta* and *P. apicalis* were segregated spatially, with *P. apicalis* being found in vegetation on upper surfaces of rocks in fast moving shallow water and *D. modesta* mostly under bare stones over a wide range of depths and currents. Later instars were not segregated spatially, but mature larvae eat different foods (Shapas and Hilsenhoff, 1976).

Rhyacophila vibox (Milne) 1936

Rhyacophila vibox is found throughout Wisconsin in small, cold, spring-fed streams. Flint (1962) reported larvae only in springs and spring brooks less than two feet wide. It was a common univoltine species in Parfrey's Glen Creek. Adults were collected mostly from cracks or fissures of tree bark. They were found May 22 to June 20 corroborating published flight periods (Longridge and Hilsenhoff, 1973; Ross, 1944; Ellis, 1962). First instar larvae appeared in early July and grew slowly so that by mid-August more than 70% were still in the first and second instar. Growth accelerated in September, and by early November more than 70% were in the fifth instar. Winter was spent in the fourth or fifth instar and by March most were in the fifth instar. Prepupae were found April 20 to May 5 and pupae April 29 to June 12.

Life stages showed some segregation by microhabitat. First instar larvae were found only in currents less than 45 cm/sec, while later instars had no current limitations, except in spring and summer when they were most abundant in currents faster than 30 cm/sec. All larvae avoided pools. Vorhies (1909) reported *R. vibox* larvae in the moderately swift portions of Parfrey's Glen Creek. First instar larvae were limited to the lower surfaces of stones. Later instars also inhabited vegetation on the upper surfaces and sides of stones, but were most common under stones of 5-10 cm. During autumn, winter, and spring, larvae were also found in leaf mats, under the bark of submerged logs, and on large stones isolated in sandy stretches. Depth never restricted larval distribution.

Pupae were most common in currents greater than 25 cm/sec and depths greater than 10 cm. Stones greater than 3 cm in diameter were preferred as pupation sites, although some pupal chambers were attached to stones barely larger than the chamber.

Glossosoma intermedium (Klapalek) 1892

Glossosoma intermedium occurs in cool, woodland streams throughout Wisconsin, and was the most abundant caddisfly in Parfrey's Glen Creek. At some sites their cases almost covered the stream bottom. *Glossosoma intermedium* was univoltine with overlapping generations, the adults having two periods of emergence. From April 19 to June 1, less than 10% emerged, with peak emergence during the first half of May and a male: female ratio of 9:1. More than 90% emerged from July 7 to October 23, mostly during the last two weeks of July and first week of August. During this second emergence period the male:female ratio was 1:2. Adults were found resting on trees and riparian vegetation.

First instar larvae of the spring generation were noticed first in mid-June. They grew steadily and by the first week of November were in the fifth instar or prepupal stage in which they overwintered. By early April most individuals were prepupae, and pupae were found from the first week of April to the end of May. First instar larvae from the summer emergence were first collected July 24 and grew slowly over the autumn, overwintering as third and fourth instars. Growth accelerated in mid-April and by mid-June more than 70% were prepupae.

Larvae were found over a wide range of currents, substrate types, and water depths. There was some segregation of life stages, and seasonal differences in distribution were also evident. First and second instar larvae preferred currents less than 30 cm/sec and stones 3-7 cm. A few were found in gravel. Instars three to five were found in currents ranging from pools to 96 cm/sec, but most were in currents of 15 to 30 cm/sec. They inhabited a wide range of substrates, but were most common on stones 5 cm or larger. Larvae occurred only on the downstream side of rocks or other protected areas in currents greater than 30 cm/sec, but on all sides in slow currents. Larvae in pools were found only on stones or logs free of silt or detritus. In summer, fifth instar larvae even occurred on rocks and logs that protruded above the water's surface provided the surface was continually wetted.

Just prior to pupation the bottom strap of the case is cut away and the dome-shaped upper portion is cemented to a rock or other support (Ross, 1944). Most pupae were found in currents greater than 22 cm/sec, at depths greater than 12 cm, and on rocks larger than 10 cm in diameter. Pupae were also found on logs and smaller stones, though much less frequently. A few were found in pools. In currents greater than 30 cm/sec pupae occurred on surfaces protected from the full force of the current, while in slower currents pupae were present on all surfaces. Pupae occurred in aggregations, with some clusters containing more than one hundred individuals.

Oligostomis ocelligera (Walker) 1852

Oligostomis ocelligera is uncommon in Wisconsin and rare in Parfrey's Glen Creek; only two larvae were found during this study. Both had head capsule widths of 2.25 mm and were collected February 29, 1976, from detritus on the stream bottom at a depth of 10 cm in a current of 24 cm/sec. Lloyd (1921) stated that the larvae are bottom dwellers that crawl over the stream floor, or rest among the trash and litter. He reported pupation in mid- or late April in the stream bed or in dead wood; in New York emergence occurs during the last two weeks in May. Longridge and Hilsenhoff (1973) collected adults May 28 and June 4 in Wisconsin.

Brachycentrus occidentalis (Banks) 1911

Brachycentrus occidentalis occurs in cold streams in all but the southeastern corner of Wisconsin. Only 58 larvae were collected, and the species was regarded as uncommon in Parfrey's Glen Creek. Extensive notes on various aspects of its biology have been published recently by Gallepp (1974, 1976) and Gallepp and Hasler (1975). Adults were found in Parfrey's Glen Creek April 29.

Early instar larvae were noticed first in late July. They grew steadily and by the end of September almost all were in the fifth instar, the stage in which they overwintered. Gallepp and Hasler (1975) observed the same pattern of growth in Lawrence Creek, Wisconsin.

In summer, larvae were found on the upper surface of rocks in currents of 10 to 31 cm/sec and water less than 6 cm deep. Throughout the year larvae were found in open areas or lightly shaded sections of the stream. Gallepp (1976) also noted the preference of this species for areas exposed to bright sunlight. No pupae were collected.

Pycnopsyche guttifer (Walker) 1852

Pychnopsyche guttifer has been collected throughout Wisconsin. Adults of this uncommon, univoltine species were collected September 18 to November 6 from riparian vegetation. On November 6, when snow was present, they were found crawling on the stream banks.

Early instar larvae were noticed first in mid-October. They grew actively over the autumn and winter months so that by early March all were in the fifth instar. This was the only caddisfly in Parfrey's Glen Creek to grow rapidly during the winter, thus avoiding competition with most other herbivores and detritivores. Only fifth instar larvae were found in spring and early summer; no larvae were found in late summer. Cummins (1964) reports that during the summer larvae fasten their cases to sticks, aquatic vegetation, or cobbles, and remain inactive until pupating in early autumn. Neither pupae nor prepupae were found in this study.

Larvae were most abundant in pools or along the banks where they crawled over debris and leaves. Depth was not significant in determining distribution. A few individuals collected in the autumn were found on the bottom of loosely packed stones (5-10 cm in diameter) in currents up to 20 cm/sec. Cummins (1964) found that during low flow larvae moved into the middle of the stream if periphyton was abundant. Feldmeth (1970) found that *P. guttifer* larvae were swept off the substrate by currents greater than 15 cm/sec.

Early instar larvae constructed cases from leaf and stick matter, the leaf material predominating. As the larvae grew, the ratio was reversed and stick material dominated as described by Flint (1960).

Hesperphylax designatus (Walker) 1852

Hesperophylax designatus occurs throughout Wisconsin in small, cold streams. Only 27 larvae were found in Parfrey's Glen Creek. Adults of this univoltine species were collected May 22 to July 24 from riparian vegetation, with peak emergence in late May. In other Wisconsin studies Longridge and Hilsenhoff (1973) noted a flight period from April 27 to August 24, and Vorhies (1905) found adults March 15 with peak emergence in mid-April.

Early instar larvae were noticed first the last week of July. They grew steadily over the summer and autumn, and overwintered as fifth instar larvae. Prepupae were found the first week of April and pupae the last week of April and first week of May. Vorhies (1905) noticed that in mid-February most larvae had begun to prepare for pupation.

A seasonal difference in habitat selection was evident. In summer, larvae inhabited mostly logs and occasionally gravel and small stones (less than 5 cm). They were found only in currents slower than 20 cm/sec. In autumn and winter, larvae preferred the undersides of stones 5-10 cm in diameter or vegetation on these stones, and were found mostly in currents faster than 40 cm/sec. Water depth did not restrict distribution.

Detailed descriptions of cases are in Vorhies (1905, 1909) and Lloyd (1921). Pupae were found clustered on undersides of rocks greater than 10 cm in pools or in currents less than 15 cm/sec and depths greater than 20 cm. Clustering of pupae has been reported previously for this species (Vorhies, 1909; Denning, 1937).

Limnephilus rhombicus (Linnaeus) 1758

Limnephilus rhombicus has previously been collected in Wisconsin only from the northeast and southwest counties. One larva with a head capsule width of 1.55 mm was collected July 9, 1975, from a pool with a detritus substrate and a depth of 8 cm. Reported flight periods are June 10 to June 29 for Wisconsin (Longridge and Hilsenhoff, 1973), the end of June to the first half of July for Michigan (Ellis, 1962), and early June to late August for Illinois (Ross, 1944).

Limnephilus rossi (Leonard and Leonard) 1949a

Leonard and Leonard (1949a) described this species from adults collected September 18 to October 6 from dry grass overhanging the banks of spring-fed streams in Michigan. The larvae were not described, and the identity of those collected from Parfrey's Glen Creek remained unknown until 1977 when two males were reared September 21 and 27 from pupae or prepupae collected September 5. This is the first record of this species in Wisconsin.

Early instar larvae were collected first at the end of February. They grew slowly until the end of April, and then rapidly, reaching the fifth instar by early summer. The summer was spent in the fifth instar, with pupation in late summer. Early instar larvae were collected easily, but fifth instar larvae and pupae were difficult to find. Larvae and pupae occurred on the bottoms of rocks of all sizes and on logs over a wide range of currents. A distinct preference was exhibited for depths greater than 8 cm.

Larval description: (fifth instar): Length 16.2-18.4 mm, width 2.7-3.0 mm. Head mostly light brown with dark muscle scars most numerous on the vertex and dorsoposterior and ventral sections of the genae. Ventral half of genae medium brown, gula light brown. Frons with an anteriorly directed triangle composed of dark muscle scars. Legs light brown with infrequent muscle scars. Thoracic nota light brown with numerous dark muscle scars. Anterior edge of pronotum medium brown; posterior corners black. Mesonotum with central third of posterior margin and posterior third of sides black. Metanotum with four ovoid sclerites having 11-12 setae each. Abdominal segments 1 and 8 with 15-19 setae dorsally on each side. Gills mainly in clusters of two or three, with occasional single gills. Chloride epithelia present on ventor of segments 2-7. Anal claw with one large and one small accessory tooth.

Larval case: Constructed mainly of mineral particles averaging 0.8 mm anteriorly and 0.4 mm posteriorly with a few bits of organic material distributed randomly. Tapered posteriorly and slightly curved with a dorsal hood projecting about 2 mm anteriorly. Total length 13 to 16 mm for mature larvae.

Neophylax concinnus (McLachlan) 1871

Previous collections from Wisconsin indicate that *N. concinnus* is restricted chiefly to the northern half of the state, but it was common in Parfrey's Glen Creek. Adults were present September 6 to November 30, with peak emergence the last half of September. Sedell (1972) found emergence in this species was highly synchronized. Longridge and Hilsenhoff (1973) collected adults July 7 and September 13 in Wisconsin, while Leonard and Leonard (1949b), and Vorhies (1909) found adults flying as late as November.

Early instar larvae were first noticed in early November. They grew slowly in late autumn and winter so that by early April more than 60% were still in the third instar. Growth accelerated in late April and by the end of June nearly all were prepupae. Prepupae were found April 29 to August 15, but first occurred in significant numbers the end of June. Other workers have noted this long prepupal period for *Neophylax* (Vorhies, 1909; Lloyd, 1921). The pupal period appeared to be short, as pupae were collected only on August 15.

Early instar larvae were found mostly on stones 2 cm or larger. In currents less than 15 cm/sec larvae occurred on all faces of stones, but in faster currents they sought the downstream side or other sheltered areas. They were frequently found on large stones isolated in sandy stretches, and in spring preferred larger rocks. A few individuals were found on logs. Terminal instar larvae were often found out of the water on rock surfaces that were continually wetted. Throughout the year, larvae were found in a wide range of currents and depths.

Larvae pupated in the larval case, which they attached chiefly to rocks 8 cm or larger in currents ranging from pools to 30 cm/sec. In currents of 15-30 cm/sec pupae were found mainly in sheltered areas on the lateral and downstream sides of rocks; in pools they occurred on all sides except the bottom. Water depth did not limit distribution, and some larvae pupated so close to the water line that when the water level dropped slightly during the summer they became exposed and dried out.

Lepidostoma bryanti (Banks) 1908a

Lepidostoma bryanti has been found in all except the southeast corner of Wisconsin. In Parfrey's Glen Creek it was less abundant than the other two species of

Lepidostoma. Adults were collected April 30 to June 27, with most emerging during mid-June. They were found generally resting on tree bark and in riparian vegetation.

First instar larvae were noticed first the last week of June. They grew slowly throughout the summer and 90% were still in the third instar in late September. Growth increased greatly in late autumn and by the end of November more than half were in the fifth instar. The winter was spent as fourth or fifth instar larvae; by mid-March almost all were in the fifth instar. Pupae were found May 5 to May 28. Vorhies (1909) noted that in Parfrey's Glen Creek pupae were abundant on June 1.

Except in autumn, larvae were found exclusively in pools, the preferred substrate being leaf material and detritus. In autumn, perhaps in response to an increased need for food during their period of active growth, larvae were found on the exterior and beneath the bark of submerged logs, and were common beneath leaves. A few individuals were found in crevices or holes in rocks isolated in sandy stretches. Water depth did not limit distribution in any season.

Lepidostoma costalis (Banks) 1914b

Lepidostoma costalis was common in Parfrey's Glen Creek, but the only previous Wisconsin record is from farther north in Waushara County. Adults were collected August 2 to September 18, mostly in the last half of August. They were found most commonly resting in bark fissures.

Larvae first appeared in mid-August and grew slowly. Winter was spent as second and third instar larvae. Active growth resumed in mid-April and by late June most larvae were in the fifth instar. Prepupae and pupae were found July 24 to August 15.

In late fall and winter, larvae were found mostly in pools with a substrate of leaves or detritus, but they were also present on logs and in gravel. Larvae were found only in areas where the current did not exceed 14 cm/sec; water depth did not limit distribution. In spring, larvae were found in currents of 15 to 30 cm/sec, clinging to leaf jams in mid-stream or to rocks greater than 6 cm in diameter. Those on stones were either in crevices or on the bottom. As the larvae grew they moved back to the pool habitat and areas of very slow currents; fourth and fifth instar larvae were found only in these sites.

Pupae attached directly to vegetation in currents up to 78 cm/sec. They also commonly attached to the exterior of logs and cracks and holes beneath the bark. Pupae in pools were attached to pieces of bark, twigs, or bits of leaves. Some attached to lateral and downstream faces of rocks in the middle of sandy stretches.

Lepidostoma griseum (Banks) 1911

Lepidostoma griseum has previously been collected only from northern Wisconsin. Although uncommon in Wisconsin, it was the most common lepidostomatid in Parfrey's Glen Creek. Adults were collected August 12 to September 28, with most emerging the last half of August. This flight period is similar to that reported by Longridge and Hilsenhoff (1973), Ellis (1962), and Leonard and Leonard (1949b).

Early instar larvae were collected first on October 16. Growth was slow throughout the autumn, and winter was spent in the second and third instar. Active growth resumed in late April and at the end of June 70% were in the fifth instar. Prepupae were found on August 15; pupae occurred from August 15 to November 6.

During autumn and winter, larvae occurred in pools and currents ranging up to 30 cm/sec. The preferred substrate in pools was detritus; in riffles it was stones greater than 8 cm in diameter. In spring, when growth was most rapid, larvae concentrated in pools that had leaves and detritus as a substrate. Depth did not limit distribution in any season.

Larval cases were constructed of organic material and were similar to those of *L. bryanti,* but the cases of mature larvae differed in being shorter and stockier. Early instar larvae constructed cases entirely of small sand grains. Some fourth and fifth instar larval cases were mainly organic material, but even these always had at least a few sand grains present.

Pupae were found in currents of 4 to 31 cm/sec. They were common in cracks and holes in the bark of submerged logs, but also occurred on the underside of stones 5 to 10 cm in diameter and in sheltered areas on the lateral and downstream sides.

The three species of *Lepidostoma* coexisting in Parfrey's Glen Creek were separated temporally or spatially during periods of active growth. *L. bryanti* larvae grew most rapidly in summer and early autumn and by mid-autumn were in the fourth or fifth instar. *L. costalis* and *L. griseum* larvae grew most rapidly in late spring and early summer, and were segregated during this period, utilizing different habitats. *L. griseum* occurred almost exclusively in pools while *L. costalis* was most common in areas of moderate current and stony substrates. During periods of slow growth or pupation, no significant segregation of these two species was evident.

Summary

The 17 species of caddisflies that inhabit Parfrey's Glen Creek represent a fauna that is unusual in southern Wisconsin and more representative of faunas in northern Wisconsin streams. The small size of the stream, its low summer temperature (16.5°C), and dense woodland setting are probably responsible for maintenance of this fauna. Species competing for the same resources were found to be segregated either temporally or spatially, permitting maximum use of these resources and allowing many species to coexist in the stream. Distribution of species within the stream results from a complex interaction of environmental factors, of which current, substrate and food are probably most important.

Literature Cited

Banks, N. 1905. Descriptions of new Nearctic neuropteroid insects. Trans. Am. Entomol. Soc. 32:1-20.

———. 1908a. Some Trichoptera and allied insects from Newfoundland. Psyche 15(4): 61-67.

———. 1908b. Neuropteroid insects-notes and descriptions. Trans. Am. Entomol. Soc. 34: 255-267.

———. 1911. Descriptions of new species of North American neuropteroid insects. Trans. Am. Entomol. Soc. 37(4):335-360.

———. 1914a. American Trichoptera-notes and descriptions. Can. Entomol. 46:201-205.

———. 1914b. American Trichoptera-notes and descriptions. Can. Entomol. 46:261-268.

Betten, C. 1934. The caddisflies or Trichoptera of New York State. N.Y.S. Mus. Bull. 292: 1-576.

———. 1950. The genus *Pycnopsyche* (Trichoptera). Ann. Entomol. Soc. Am. 43(4): 508-522.

Cummins, K. W. 1964. Factors limiting the microdistribution of larvae of the caddisflies *Pycnopsyche lepida* (Hagen) and *Pycnopsyche guttifer* (Walker) in a Michigan stream. Ecol. Monogr. 34:271-295.

Denning, D. G. 1937. The biology of some Minnesota Trichoptera. Trans. Am. Entomol. Soc. 63:17-44.

Ellis, R. J. 1962. Adult caddisflies (Trichopera) from Houghton Creek, Ogemaw County, Michigan. Occ. Pap. Mus. Zool. Univ. Mich. 624:1-16.

Feldmeth, C. R. 1970. The respiratory energetics of two species of stream caddisflies in relation to water flow. Comp. Biochem. Physiol. 32:193-202.

Flint, O. S. 1960. Taxonomy and biology of nearctic Limnephilid larvae (Trichoptera) with special reference to species in eastern United States. Entomol. Am. 40:1-117.

———. 1961. The immature stages of the Arctopsychinae occurring in Eastern North America (Trichoptera: Hydropsychidae). Ann. Entomol. Soc. Am. 54(1):5-11.

———. 1962. Larvae of the caddisfly genus *Rhyacophila* in eastern North America (Trichoptera: Limnephilidae). Proc. of U.S. Nat. Mus. Smithsonian Institute 113:465-493.

Gallepp, G. W. 1974. Behavioural ecology of *Brachycentrus occidentalis* Banks during the pupation period. Ecology 55(6): 1283-1294.

———. 1976. Temperature as a cue for the periodicity in feeding of *Brachycentrus occidentalis (Trichoptera).* Animal Behavior 24:7-10.

——— and A. Hasler. 1975. Behavior of larval caddisflies (*Brachycentrus* spp.) as influenced by marking. Am. Midl. Nat. 93: 247-254.

Hilsenhoff, W. L. 1974. The unusual larva and habitat of *Agabus confusus* (Dytiscidae). Ann. Entomol. Soc. Am. 67:703-705.

———. 1975. Aquatic insects of Wisconsin. Generic keys and notes on biology, ecology and distribution. Tech. Bull. 89 Wisconsin Dept. of Natural Resources.

Klapalek, F. 1892. Trichopterologicky Vyzkum Chech v.r. 1891. Ceska akademie cisare Frantiska Josefa provedy, slovesnost a umeni v Praze. Rozpravy 5:1-22.

Leonard, J. W. and F. A. Leonard. 1949a. Noteworthy records of caddisflies from Michigan, with descriptions of new species. Occ. Papers. Mus. Zool. Univ. Mich. 520: 1-8, pls. 1-5.

———. 1949b. An annotated list of Michigan Trichoptera. Occ. Papers Mus. Zool. Univ. Mich. 522:1-35.

Linnaeus, C. 1758. Systema Naturae. Tenth Edition. Stockholm.

Lloyd, J. T. 1921. The biology of North American caddisfly larvae. Lloyd Lib. Bull., Entomol. Ser. 21: 1-124.

Longridge, J. L. and W. L. Hilsenhoff. 1973. Annotated list of Trichoptera (Caddisflies) in Wisconsin. Trans. Wisc. Acad. Sci. Arts and Letters 61:173-183.

McLachlan, R. 1871. On new forms etc., of extra-European Trichopterous insects. J. of the Linnean Soc. of London, Zoology 11: 98-141.

Milne, L. J. 1936. Studies in North American Trichoptera. Pt. 3, 56-128, with 2 pls. Cambridge, Mass.

Milne, M. J. 1938. The metamorphotype method in Trichoptera. J. N. Y. Entomol. Soc. 46: 435-437.

Ross, H. H. 1944. The caddisflies or Trichoptera of Illinois. Ill. Nat. Hist. Surv. Bull. 23:1-326.

———. 1946. A review of the nearctic Lepidostomatidae (Trichoptera). Ann. Entomol. Soc. Am. 39: 265-290.

Schuhmacher, H. 1970. Untersuchungen zur Taxonomie, Biologie und okologie einiger Kocherliegenarten der Gattung *Hydropsyche* Pictet (Insecta, Trichoptera). Int. Revue ges. Hydrobiol. 55: 511-557.

Sedell, J. R. 1972. Trophic ecology and natural history of *Neophylax concinnus* and *N. oligius.* Diss. Abs. 5747-B.

Shapas, T. J. and W. L. Hilsenhoff. 1976. Feeding habits of Wisconsin's predominant lotic Plecoptera, Ephemeroptera, and Trichoptera. Great Lakes Entomol. 9:175-188.

Tebo, L. B., Jr. and W. W. Hassler. 1961. Seasonal abundance of aquatic insects in western North Carolina trout streams. J. Elisha Mitchell Scient. Soc. 77:249-259.

Vorhies, C. T. 1905. Habits and anatomy of the larvae of the caddisfly. *Platyphylax designatus* Walker. Trans. Wisc. Acad. Sci. Arts Letters 15:108-123.

———. 1909. Studies on the Trichoptera of Wisconsin. Trans. Wisc. Acad. Sci. Arts Letters 16:647-738.

Walker, F. 1852. Catalogue of the specimens of neuropterous insects in the collection of the British Museum. Pt. I. 192 pp. London.

Webb, D. W. 1974. New Species of *Panorpa* (Mecoptera: Panorpidae). Entomol. News. 85:171-173.

Wynn, S. and O. Loucks. 1975. A social and environmental history of human impact on Parfrey's Glen. Trans. Wisc. Acad. Sci. Arts Letters 43:26-54.

GARRISON LIFE IN THE NOVELS OF CHARLES KING

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Life in the "Old Army" of the Indian Wars has been admirably documented in such books as *Forty Miles a Day on Beans and Hay* and *Frontier Regulars,* both of which treat the enlisted soldier primarily as a fighting man, despite the inclusion of brief episodes of garrison life.[1] More recently *Glittering Misery* has made a conscientious effort to document the garrison life of officers' dependents in their sometimes heroic efforts to maintain islands of civilization on the western frontier.[2] But *Glittering Misery* by the sheer painstaking research that went into its composition, chiefly proves how little evidence remains for a reconstruction of garrison life among the officer class. The reasons for that state of affairs are not far to seek. First, of the innumerable letters that were written to mothers and friends back east, only a small portion has survived and few of those contain the kind of information historians desire. Second, officers' wives, after all, were no more likely to be gifted correspondents than the general proportion of educated women. And third, much of what historians now wish to know were the commonplaces of garrison social life and were omitted because of their very familiarity.

On the other hand, when officers or their wives wrote for publication they designed their works for an Eastern audience which wanted to read of Indians and picturesque frontiersmen rather than the problems of educating children in Wyoming or Arizona. Probably neither men nor women habituated to garrison life foresaw a day when army social rituals enacted in the wilderness would seem as exotic as the Indian rituals they supplanted. Moreover, publishing memoirs was complicated by conventions decreeing that few people could be named in such memoirs and circumscribing what could be said even of those. Nineteenth century decorum threw a fierce privacy about a "good" woman. Even in conversation a gentleman spoke only of "my wife" or "Mrs. ____." He never employed her given name except among her intimates. He could not describe his wife's activities or those of other officers' wives without giving offense. In consequence even married officers so completely omitted accounts of social life from their recollections that on a first reading their books appear to have been written by bachelors.[3]

In the absence of detailed and even gossipy diaries, perhaps the best pictures of garrison life available to historians today are those created by the Milwaukee novelist, General Charles King (1844-1933) who had served in the Indian fighting army before turning author. General King was the son of the editor of the Milwaukee *Sentinel.* He grew up in Milwaukee and began his military career by serving as an aide to his father, General Rufus King, during the Civil War. He subsequently graduated from West Point, served briefly as an instructor there, and after being stationed at New Orleans requested assignment to Arizona where he took part in the Apache campaign of 1874. He was severely wounded at Sunset Pass and awarded the Silver Star for "gallantry in action" at Diamond Butte. His regiment, the 5th cavalry, moved to Wyoming for the Sioux campaign of 1876-77 during which King was promoted to Captain and shortly thereafter retired because of disability due to his earlier wounds. He returned to Milwaukee where, because his account *Campaigning with*

Crook had been published by the *Sentinel,*[4] he already enjoyed a literary as well as military reputation, and turned to novel writing as a means of supplementing his retirement pay. He was recalled to service during the Spanish American War, serving in San Francisco and Manila and participating in the defense of Manila during the Philippine Insurrection which followed. Once more he returned to Milwaukee and novel writing. Although he was active in the Wisconsin National Guard and trained troops for World War I he was not permitted to go overseas in that war. He remained a familiar figure in military and social circles in Milwaukee until his death in 1933.

He employed all his military experience in the approximately sixty volumes of novels, stories, and histories which he published during his lifetime, but his best and most interesting novels are those laid on the Great Plains or in Arizona during the years 1871-78, particularly the group of novels in which he follows the fortunes of a cavalry regiment, rather like the 5th Cavalry, from Arizona to Wyoming.[5] In these novels he drew heavily upon his own experiences and, in fact, probably appears in them in the secondary role of Billings, the adjutant.[6]

Because he unabashedly wrote to make money, King developed a fool-proof plot formula which combined a garrison love story with one or more episodes in which the cavalry is hotly engaged against hostile Indians, thus assuring his readership among both men and women. When his garrison plots are stripped of such obvious plot devices as concealed identities, mistaken identities and service in the field, a reader discovers that a fourth reason so few officers' wives kept diaries or wrote their recollections was the same reason that drove trooper Charles E. Springer to discontinue his daily journal, "to repeat day for day the life of a frontier garrison in winter is no charm."[7] Winter or summer, garrison life was more notable for its sameness than its variety. The degree of hardship undergone in following one's officer husband might vary with the distance to the nearest railhead; the chief discomfort might be heat or cold, sandstorms or blizzards, depending upon the geographical location of the fort; there might be many women or few, depending upon the size and remoteness of the fort; but army routine and army protocol were the same. Everywhere their husbands were posted, the women awakened to the same bugle notes and made the same duty calls among virtually the same people. In King's novels, whether laid in Arizona or on the great plains, it is the routine and predicability of garrison life which forms the background for the action of the plots and, in fact, sometimes sets the plots in motion. Ennui drives garrison inhabitants to seek new amusements and focuses their attention upon minor infractions of social or military convention.

Even the passage of years did not alter army routine; although it added new forts to the frontiers and slowly and subtly changed the composition of the officer corps.

In King's early novels, the majors and colonels who commanded posts were usually veterans of the Civil War who had risen to command by service in the Union Army. Among them were men who held brevet rank considerably higher than their permanent army rank. Men such as these, without formal military training, might be admired by their troopers, but in King's novels were eyed askance by their subordinate West Point officers unless they were truly exceptional commanders.[8] The young first and second lieutenants and some of the captains were usually West Point graduates, often the sons of army officers who, like King himself, were carrying on a family military tradition. The social uneasiness generated by a situation in which the West Point men were often outranked by men they considered their social inferiors was not dissipated until, with the passage of time, King's West Point heroes rose to command. Under those conditions an officer's wife needed the diplomatic skills of an ambassador to prevent being drawn into one camp or another, but such social manuevering is a subject better fitted for a novel than for memoirs.

King wrote about the officer class not only because it was the class he knew best but probably because as Fred Dustin has commented, "In 1876 the average enlisted man counted for little: in the army he was only a number on the rolls. By the comfortable civilian he was despised."[9] King created a few vivid and sympathetic sketches of cavalry troopers but he almost completely ignored their wives. Although there was an area of each post known as "sudsville" it constituted an entirely separate social entity. Even when, as in the novel *Captain Blake,* troopers and their wives attended a play produced by the officers, they were seated in a separate section from that reserved for officers and their wives.[10]

Although in King's garrison novels, money was never an acceptable substitute for courage or breeding, officers were expected to have private means by which to supplement their pay. It was axiomatic that a lieutenant could hardly maintain himself, much less a wife and family, upon his officer's pay. Precisely because garrison life was remote, it was also costly. Household goods had to be transported long distances and were expensive upon the frontier. In addition there were visits to be made to aging parents, and son and daughters to be sent away to appropriate Eastern schools. The sons in these novels often followed in their father's footsteps at West Point. The women vacationed near West Point in order to visit their sons and brothers and to meet eligible young officers. As a result of army marriages, garrison society was knit not only by bonds of comradeship but by ties of blood.

The education of officer's daughters was obtained in good finishing schools rather than colleges. None of the women in King's novels was bookish, although a few of the young officers had scholarly interests. In fact, although army wives supervised the children's lessons, in King's novels they were rarely seen with books in their hands except when reading to invalids. Neither did they do much sewing, usually buying or ordering their clothes on trips to Chicago or New York. Paris couture was a matter for comment, but dresses from the East were commonplace.

Officers' daughters became officers' wives at 18 or 19 in many cases, so that in these novels they were often ten years younger than their husbands. Families, however, were small and that fact combined with the presence of servants freed the women from the demands of domesticity. Many of the women rode well and several of the wives who had grown up in frontier garrisons could handle a Smith and Wesson revolver competently. These were women whom King and the garrison unanimously approved.

Once married, King's heroines conducted their domestic lives in a succession of adobe or drab frame houses constructed by army labor. Most of them were built as double houses with a common wall.[11] They varied somewhat in overall size and in the number of bedrooms, but all were shaded by verandas facing the parade ground. They usually ended in lean-to kitchens giving upon small yards bounded by a low fence. They had at best only partial basements, or cellars. In summer the wooden walls cracked and peeled under the heat of the plains winds; in winter the foundations were banked with straw and the snowdrifts piled to the second story. Gales from the mountains swayed the Navajo blankets (brought from Arizona) hanging across the interior doorways, despite storm sashes and the layer of cotton stuffed around the windows. The carpets, stretched over several thicknesses of newspaper, rose and bellied under the force of winter winds. Parlor and kitchen stoves provided heat and kerosene lamps, light, during the long winter evenings. The cry of "fire" echoes through General King's novels somewhat monotonously, but undoubtedly reflects an ever-present danger. Whether because of the possibility of fire or because there was no suitable storage place provided, in at least two of King's novels the family silver seems to have been kept in a box or basket under the bed when it was not used for entertaining.[12]

Such were the houses available to the officers and their wives. And even these were assigned by rank. One house, the largest and best, was designated for the Colonel commanding. Two houses, on larger posts, might be generally considered to belong to the majors. Thereafter the captains chose their quarters in order based on the date of their promotions. The 1st Lieutenants followed, also in order of promotion and finally the 2nd Lieutenants, almost invariably bachelors, doubled up in the houses no superior had claimed. An officer newly transferred to a post had "bumping rights" over all his subordinates so that he had the power to set off an elaborate series of housing shifts each giving rise to politely concealed ill-will. King illustrates the operation of this ritual when an entire regiment was assigned to a new post.

> The bachelor officers pitched tents on the parade and placidly waited their turn to choose quarters, a ceremony which impressed Miss Leroy as something incomprehensible. It was not easy to make her realize just why Captain Ray couldn't move Mrs. Ray and the baby boys up from the hotel until Captain Freeman had chosen, and why Mrs. Blake should remain at Cheyenne near her old home until the Truscotts and Rays had settled on what houses they would take. (They wanted the big double brick next but one to the Colonel's, but were afraid to move in, lest the new surgeon ordered out from Omaha should take a fancy to that very set.)[13]

It is no wonder that seasoned army wives like Mrs. Stannard who appears in many of King's novels learned to live with as few chattels as possible. But beyond the inconvenience of housing shifts there was another crueler consequence of the limited post housing. An officer killed in action was promptly replaced on post. That meant that his widow was forced to vacate her house, leaving behind not only the army life that she knew but the friends who could best understand her grief and bewilderment.[14]

In addition to the officers and their families, garrison houses often accommodated live-in servants. Bachelor officers had army strikers to serve them, but married men employed either a combination cook and housemaid or both. In families with children a nursemaid was not uncommon. Such servants were drawn from diverse sources, but the majority of the servants in King's novels were Irish. Sometimes a veteran trooper no longer fit for military service took civilian service with an officer in order to stay with the life he knew. The wives and daughters of troopers were also employed by officers' households, but since many of the troopers were Irish they and their families merely swelled the Irish servant brigade. These servants were important in King's novels, as they probably were in life, because they provided a channel of unofficial communication between the troops and the officers' households. They formed an excitable, gregarious society from which the Blacks, Chinese and the occasional Indian girl were largely excluded. However an immeasurable gulf separated a pretty Irish servant girl from the daughter of the house. The servant girl could be courted by troopers; the daughter of the house only by officers. Despite the scarcity of women on post, in King's novels no young officer ever falls in love with an

Irish servant girl. On the other hand, Mrs. Snaffle and Mrs. Wilkins, captain's wives, lapse into brogue when excited, thus suggesting that officers of an earlier generation had been less fastidious.[15]

The lives of all these people, officers, troopers, wives and servants, moved to the measure of trumpet calls and focused, in good weather at least, upon the parade ground. Each day began with the boom of the morning gun and ended with the sunset gun. Between those events the trumpet called Reveille, Stables (this was a cavalry regiment), Sick call and Fatigue, Boots and Saddles for morning parade, Adjutant's call, Guard mounting, Drill call, Recall, Dinner, Squad drill, Company drill, Stables, Retreat and Evening Dress Parade.[16] After the Sunset Gun it called Tattoo, and Lights Out, although those calls spoke only to the barracks. No village clock ever regulated lives as rigidly as did those trumpet calls. They also had power to disrupt lives—to sound "officers call" or more importunately "the General" (general assembly) at any hour; thus sending troops and their officers to intercept Indians off reservations, to relieve some beleaguered stage station, or to quell riots in town. In King's novels men welcomed "the General" almost as fervidly as women dreaded it.

As the day was ordered by trumpets so the night was divided by sentry calls. The sentries posted on the perimeter of the garrison did not walk beats which met. Instead, at regular intervals, they called off and the sound moved in order around the post. Like Tattoo and Lights Out the call of the sentries did not concern most of the officers, but only the Officer of the Guard.

For the other officers and their wives evening parade signalled a transition from business to pleasure, from army time to time that might be called their own. Evening parade was not only a military but a social event. The women of Officers Row, freshly dressed and at leisure before dinner, sat on the verandas facing the parade or strolled from house to house to exchange the day's news, to admire their husbands in dress uniform to watch parade and listen to the band. Even small posts maintained a band and large forts such as Russell and Cushing prided themselves on the excellence of their music. As parade broke up, the officers, released from their day's routine, had time to join their wives and friends. Courtesy required that all acquaintances be acknowledged and since everyone knew everyone else the way homeward was more social than military.

Bachelor officers might go to the post or trader's store, there to get a drink and settle down for an evening of poker. Married officers sometimes joined them briefly. Although a room at the store was usually the only approximation of an Officers' Club, the officers who spent too much time there were suspect in King's novels. If married, they were assumed to frequent the club because they did not get along with their wives; if single, because they were unable to command invitations to the better homes on the post. The cardroom, King implied, attracted grumblers, created ill will, and fomented the male equivalent of female gossip.

Generally the social life of the Garrison was orderly, decorous, and predictable. There were frequent invitations to dine, but since rooms were small, dinner parties of more than ten were practically unknown. However there was a great deal of casual calling and stated occasions when formal calls were *de rigeur*. Thus dinner required a proper dinner call the following day. All guests in the garrison and all new families posted to the fort were to be called upon immediately. Engagements, birthdays and promotions required calls of congratulation, and bereavement calls of sympathy. All these were the common courtesies of a somewhat formal age, and would have been conducted equally punctiliously by ladies and gentlemen in any Eastern city. However, garrison social life produced some distinctive patterns. For one thing many of the wives, all in fact of the most admirable in King's eyes, did not entertain while their husbands were off on campaign. When three or four troops were out of the fort this convention necessarily created periods of social doldrums even during the winter, when the social season was at its height. During the summer, the usual campaign season, the effect was exaggerated by the fact that many wives summered in the East.

When wives returned in the fall they often brought guests to spend the winter. One might suspect that the number of attractive feminine guests thus introduced to fort society was merely a device employed to provide the love interest General King required for his plots. However, a story which might have been written by General King himself is contained in the memoirs of General Cruse. His wife's sixteen year old sister spent the winter at Fort Lowell, was courted by Lt. Hodgson over the family objections that she was too young, and married her cavalry officer the following year.[17]

The Custer's, also, apparently made a practice of inviting pretty girls for extended visits.[18] Thus Elizabeth Custer's narratives of life in the Plains forts serve to substantiate the pretty roommates, cousins and nieces who enliven garrison life in King's novels.

For entertainment these girls were offered dinners with the middle aged, the spectacle of parade, informal evening parties, escorted rides into the surrounding country, skating on the Platte, sleigh rides after sufficient snowfall, band concerts, an occasional formal German and even amateur theatricals. In suitable fall weather there might also be a jack rabbit hunt over the hills, ending in a picnic to which the ladies who neither rode nor hunted were conveyed by ambulance. The chief entertainments, however, were the frequent informal dances, or hops. When young Mrs. Turner complained bitterly that the hops, held almost nightly in Arizona, were less frequent in the Wyoming garrisons, Mrs. Stannard explained that in Arizona the band had not been mounted and therefore did not have to attend morning and evening stables.[19] Therefore, evening duty for hops was not an unreasonable demand upon them. Since the bands in Wyoming were mounted, nightly hops would be an unwarrantable imposition even though hops broke up early. In fact all the social life of the garrison except the most formal dances ended by eleven or twelve o'clock. The army world believed in early to bed and early to rise. Stable call, attended by the officers, sounded at 6:00 a.m.

Although much of an officer's life was regulated by official duties and protocol there was another, generally female, side of garrison life not subject to official rules. Secrets and news, passing through official channels among the men, passed also from veranda to veranda among the women, and from kitchen to kitchen among the cooks. Cut off from their families women supported each other through illnesses and bereavements. Their hospitality was boundless, for new faces and new conversation were both welcome means of enlivening garrison social life. Not only were guests invited for months, but the same generosity was extended to the relatives of bachelor officers, to wives until they were settled on a post and to young officers convalescing from wounds. Women lent silver, dishes and recipes, sat with invalids, encouraged courtships, wrote innumerable letters linking garrison to garrison and frontier to families in the East, mentored young officers, read weeks old newspapers, and speculated on their next removal. In such enterprises the women were restrained only by their own discretion and their husbands' authority. And therein lay the danger.

Duane N. Greene wrote in a sketch of army life that "The most discordant garrisons are those comprising the greatest number of ladies."[20] Novelist King, despite his frequent praise for Officers' wives who left comfortable Eastern homes to follow the cavalry into frontier garrisons, tends to substantiate Greene's pronouncement. Women were at the root of almost all garrison trouble in his novels. Mrs. Pelham interferred in the promotions and leaves granted her husband's men.[21] Mrs. Turner gossiped until her husband's friends one by one deserted him.[22] Mrs. Wilkins was the terror of social engagements despite her warm heart.[23] Nanette Flower proved a spy and a traitor[24] and Mrs. Granger enthralled Tommy Hollis and Captain Blake for her own ends.[25] Younger women disrupted the post by their very presence—two of them attracted undesirable kinsmen to the area of the fort.[26] Other girls evoked rivalries between officers. It may seem unreasonable to include male rivalries in the list of women's derelictions, but King himself raised the issue in *Marion's Faith* when he wrote "Things were in almost as eruptive a state at Russell . . . as they had been at old Sandy during the Pelham regime, only—only who could this time say there was a woman at the bottom of it? And yet was it not Gleason's unrequited attention to our heroine that prompted much of the trouble?"[27]

Taken altogether the roles of women in General King's novels are fairly unambiguous. The women he admired, the women he assigned to his heroic officers as rewards for valor and patience, proved to be fine wives, but they served the garrison by their discretion and their adoption of the officer's code. They became army. Other women, and even those before their marriages, were sources of disruption. Since the army could not drill women into shape like a slack cavalry troop, it was with a sense of real relief on the part of both author and characters that men took the field. Once on campaign the desirability of order and discipline became self-evident and the foe could be neatly identified by his warpaint. When King's officers responded to "the General" they moved from a world complicated by women to the simpler, if more violent, world of primal landscapes and single purposes. In King's novels they went gladly, for as Captain Ray, one of King's chief heroes announced profoundly, "Garrison life and girls spoil many a good cavalryman."[28]

Notes

[1] Don Rickey Jr., *Forty Miles a Day on Beans and Hay* (Norman, Oklahoma, 1963), Robert M. Utley, *Frontier Regulars* (New York, 1973).

[2] Patricia Y. Stallard, *Glittering Misery,* Dependents of the Indian Fighting Army (San Rafael, California, 1978).

[3] General Crook refers to "Mrs. Crook" only in two consecutive paragraphs. *General George Crook, his Autobiography* ed. Martin F. Schmitt (Norman, Oklahoma, 1946) p. 155. General Miles refers once to "my wife" and once, mentioning the Custers at Fort Hays, says "Mrs. Miles being with me, we frequently met them socially and enjoyed many hunts and pleasure parties together." Nelson A. Miles, *Personal Recollections of General Nelson A. Miles* (New York, 1969) pp. 151, 256. George A. Custer, *My Life on the Plains* (Norman, Oklahoma, 1962) refers to his wife once as "Mrs. Custer" and once as "my wife," pp. 68, 66.

[4] Campaigning with Crook was first published serially in the *Sentinel* and then in a paperbound edition (Milwaukee, 1880 before being published by Harper and Brothers, New York, 1890.

[5] Charles King, *The Colonel's Daughter* (Philadelphia, 1882). Charles King, *Marion's Faith* (Philadelphia, 1886). Charles King, *Captain Blake* (Philadelphia, 1892). Although the characters introduced in *The Colonel's Daughter* appear in, or are mentioned in, other novels by King, the three listed here are the most important to the history of King's fictitious regiment.

[6] For King's employment of his own experiences see Harry H. Anderson, "Home and Family as sources of Charles King's Fiction," Milwaukee County Historical Society *Historical Messenger*" 31:68 (Summer, 1975).

[7] Charles E. Springer, *Soldiering in Sioux Country, ed.* Benjamin Franklin Cooling III (San Diego, 1970), p. 73.

[8] In King, *Marion's Faith,* Colonel Whaling and his wife are condescended to by almost all the cavalry officers. Also in Charles King, *Ray's Recruit* (Philadelphia, 1898) Capt. Mainwaring is a decent officer whose selfconsciousness about

his lack of formal education makes him the butt of some of the younger officers' humor.

[9] Fred Dustin, in W. A. Graham, *The Custer Myth* (New York, 1953), p. 369.

[10] King, *Captain Blake*, p. 190.

[11] The composite description derived from King's novels can be compared with the following descriptions from the annual inspection of public buildings which appears in Richard Upton, *Fort Custer on the Big Horn* (Glendale, California, 1973).

No. 6. Commanding Officer's Quarters, frame, single set, 1½ stories, size 42 by 36 feet, four rooms on each floor; "L" to same embracing kitchen, pantry, closets, with attic chamber; size 20 by 16 feet. Porch in front.

No. 1 to 5, and 7 to 11. Officer's quarters, frame, ten double sets, 1½ stories, size 48 feet by 46 feet six inches, six rooms on first and four rooms on second floor; "L" to same, size 34 by 14 feet embracing two kitchens, with pantries, closets and attic chambers. Porch in front." p. 280.

[12] Charles King, *A Daughter of the Sioux* (New York, 1903), p. 215 and Charles King, *A Garrison Tangle* (New York, 1896), p. 163.

[13] King, Ray's Recruit, p. 102.

[14] Mrs. Farrar is widowed in Charles King's *Fort Frayne* (New York, 1895), Mrs. Turner in *Captain Blake* and Mrs. Winn in Charles King's *A Trooper Galahad* (Philadelphia, 1898).

[15] Charles King, *Lanier of the Cavalry* (Philadelphia, 1892) and *The Colonel's Daughter*.

[16] This list (which is not exhaustive) is based on a list of calls in Charles King, *Trials of a Staff Officer* (Philadelphia, 1895), p. 15.

[17] Thomas Cruse, *Apache Days and After* (Caldwell, Idaho, 1941), pp. 181, 191.

[18] Elizabeth Bacon Custer, *Tenting on the Plains*, 1887 (reprinted Williamstown, Massachusetts, 1973) p. 208.

[19] King, *Marion's Faith*, p. 35.

[20] Duane N. Greene, *Ladies and Officers of the United States Army; or American Aristocracy, A Sketch of the Social Life and Character of the Army* (Chicago, 1880).

[21] King, *The Colonel's Daughter.*

[22] King, *Captain Blake.*

[23] King, *The Colonel's Daughter.*

[24] King, *A Daughter of the Sioux.*

[25] King, *Captain Blake.*

[26] King, *A Garrison Tangle, Lanier of the Cavalry.*

[27] King, *Marion's Faith*, p. 314.

[28] King, *Ray's Recruit*, p. 40.

AGENTS OF THREE NATIONS IN THE FOX RIVER VALLEY, 1634 TO 1840

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While explorers, fur traders, Indians, priests and a very few white settlers were the major actors in the early history of the Fox Valley, an impressive number of noteworthy events were set in motion by people carrying out the policies of distant governments.

FRENCH ERA TRAVELERS THROUGH THE FOX VALLEY 1634-1763

The first government to wield any sovereign authority in the present-day Fox Valley of northeastern Wisconsin was the colonial government of French Canada. Permanent French settlements were established at Quebec in 1608, Three Rivers in 1634 and Montreal in 1642. Only twenty-six years elapsed from the founding of Quebec to the day when Jean Nicolet, an official emissary of Governor Champlain, fired his pistols and wore his finest damask robe to impress Winnebago Indians at Red Banks northeast of Green Bay. Nicolet's arrival within the boundaries of present-day Wisconsin was the first expression of European authority in the Fox Valley wilderness.

The first reference on any map to the Fox River Valley was a map drawn by Jean Boisseau at Paris in 1643 which shows the Fox River (Riviere des Puans), Lake Winnebago (Lac des Puans), and the tribal region in which the Winnebagoes resided in 1643 (La Nahon des Puans). The map references to the Winnebagoes presumably came from hearsay reports obtained by Nicolet from Indians familiar with the topography of the Fox Valley.[1]

The first official agents of governmental action in the Fox Valley appear to have been the seven members of the Louis Joliet expedition. Joliet and his interpreter-cartographer-chaplain associate, Father Jacques Marquette voyaged up the Fox River in late May and early June of 1673 at the order of Canadian Intendant Talon to investigate reports that there was a great river in the west of New France called the Mississippi.[2] Father Marquette's map accurately shows the Fox-Wisconsin river system including Lakes Winnebago and Butte des Morts, indicates the Wolf River and sketches correctly the Illinois River from the Mississippi (R. de la Conception) to Lake Michigan (Lac des Illinois).

The first large scale governmental action within the Fox Valley was the invasion in 1716 by a French military expedition during the First Fox War. The French "army" was organized at the order of Canadian Governor Philippe Vaudreuil and commanded by the King's Lieutenant at Quebec, French Army Major Louis de la Porte, Sieur de Louvigny. The force consisted of some 225 French soldiers and fur traders, and 600 armed Indians, two brass cannon and a brass grenade mortar. Louvigny's orders were to clear the Fox River of all hostile blockading forces, including a fortification of the Fox Indians located on the southwestern shore of Big Lake Butte des Morts.

The Fox fort, some four miles west of the present-day site of Oshkosh and a short way east of the main Fox village on Big Lake Butte des Morts was described by Father Pierre F. X. Charlevoix, the expedition's chaplain, to his Jesuit superiors, as a "sort of fort surrounded by three ranges of oak palisades with a good ditch in the rear." Both Louvigny and Charlevoix said the Fox fort was garrisoned by 500 warriors (300 additional warriors were absent on a war party) and 3,000 women.

Louvigny bombarded the Fox fort with his two cannon and grenade mortar, until

> "On the third day . . . while I was preparing to undermine their works by placing mine boxes under their wall the Foxes proposed terms of capitulation . . . and I . . . concluded peace with the Foxes.[3]

Records of Louvigny's siege do not indicate the fort's exact location, but in "The Bell Site: an early Fox village" archaeologist Warren Wittry reported finding iron grenade fragments on the southwest shore of Lake Butte des Morts, thus suggesting that:

> ". . . this site might be the one attacked by Louvigny in 1716 . . . So far as is known to the writer, the grenades fired by Louvigny are the only ones ever shot in central Wisconsin. . . ."[4]

The First Fox War ended in 1716 and the Second Fox War began in 1728, largely because the Foxes, according to Father Charlevoix:

> "infested with their robberies and filled with murders not only the neighborhood of Green Bay, their natural territory, but almost all the routes communicating with the remote (French) colonial posts."[5]

Canadian Governor-General Beauharnois, desiring to end the Fox Indians outrages, believing French lives must not go unavenged and being determined to overawe both the Iroquois and the Foxes by a brilliant stroke, sent a second military force to present Winnebago County in the summer of 1728. Commanded by Constant Marchand, Sieur de Lignery this force, consisting of 400 French and 1,100-1,200 Indians left Mackinac August 10, 1728 and advanced along Green Bay in bateaux and canoes (Fig. 1). Lignery provoked and then defeated the Menominees on August 15th and reached the west end of Big Lake Butte des Morts by August 25th.[6]

Having had timely notice of the French army's approach, and lacking warriors to match Lignery's force, the Foxes retreated up the Fox River and into the forests west of Omro, where Lignery felt it imprudent to pursue them.

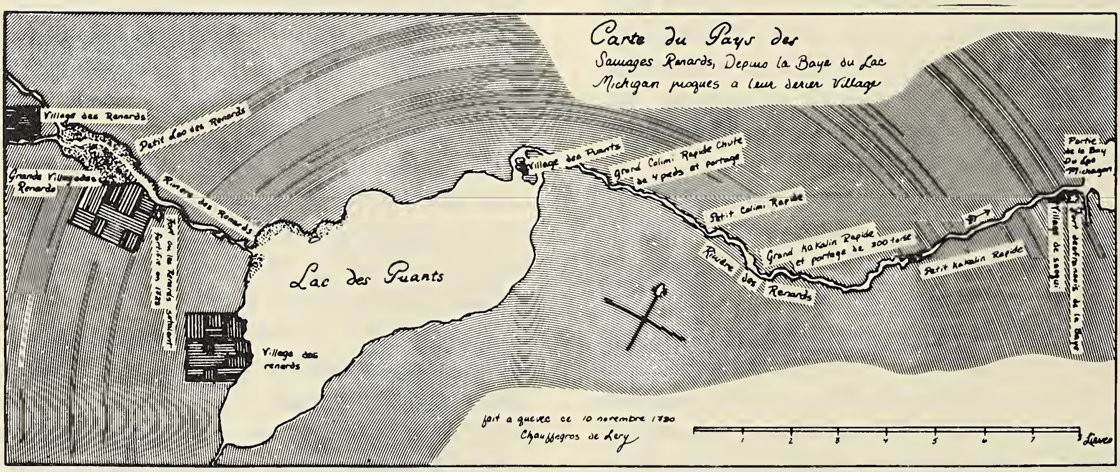

Fig. 1. This "Map of the Land of the Savage Foxes," was published in 1730 by Gaspard Chaussegros de Lery, to illustrate his account of the Lignery expedition's attack in 1728 on the fort of the Fox Indians, then resident on Big Lake Butte des Morts and Lake Winnebago in east central Wisconsin. De Lery's map appears to be the first to show details of the Fox River valley including vicinities of present day Omro, Oshkosh, Appleton, Kaukauna, and Green Bay. Source: L. P. Kellogg, *French Regime in Wisconsin* (1925), 314.

Lignery remained at Lake Butte des Morts only briefly because his army had to return to Montreal before the rivers froze and the first snows fell. Consequently he was able only to burn the Fox villages and destroy their unharvested cornfields and gardens. In retreating down to Green Bay, Lignery withdrew the La Baye garrison and burned the fort since his expedition had chiefly succeeded in infuriating the Foxes without inflicting significant damage. Lignery concluded that the small fort at Green Bay would not be able to defend itself against the certainty of revenge attacks in the following fall and winter.[7]

Weighed on a scale of military success or failure, it would seem that it was the Foxes, not the French who were victorious. Actually, a delayed consequence of Lignery's invasion of 1728 was that the Fox Confederacy of anti-French tribes suddenly began to crumble. News came to the Fox villages on Lake Butte des Morts that their Kickapoo and Mascouten allies had made peace with the Illinois Indians. At the same time the Sioux refused to continue their agreement to grant the Foxes refuge in Sioux country if they could not resist the onslaught of the French. Perhaps most upsetting to the Foxes was the fact that Montreal was crowded in 1729 with delegates from western tribes of the upper Great Lakes, all declaring their love for the French and their hatred for the Foxes.

Canadian Governor Beauharnois now changed his commander. Paul Marin, former commandant at Fort La Baye was selected to lead a third expedition against the Foxes in 1729. Marin's party left Montreal in the summer of 1729 but he came only as far west and south as the vicinity of former Fort La Baye, where he wintered. Early in the spring of 1730 a great military opportunity suddenly presented itself to Marin. A portion of the Winnebago who had deserted the Fox confederacy returned to their village site on Doty Island in Lake Winnebago and were suddenly attacked by a large force of Foxes. Marin's party hurried to the assistance of the Winnebagoes with a force of Menominees and a few fur traders. After five days of grim fighting the Foxes broke off their attack during the night.[8]

Disasters now began to fall on the Foxes like hailstones. One was an incredible effort in 1730 to move the entire tribe to present-day New York state to seek refuge among the Iroquois who had long solicited their alliance and had offered them asylum. This effort was thwarted by the cooperation of the French settlements at St. Joseph and Detroit, Michigan; in the Illinois Valley; at Vincennes, Indiana and Miami, Ohio, which raised a combined force of 1,400 French and Indians to besiege the Foxes who had halted and erected a fort on the Illinois prairie on an eastern branch of the Kaskaskia River. The Foxes defended their position for 23 days, abandoning it under cover of darkness and a storm on September 9, 1730. Next day, the Foxes, burdened with their families, were overtaken and two or three hundred warriors with an equal number of women and children were massacred. Four or five hundred more were captured and scattered as slaves among the Indian allies of the French. Only several hundred Foxes escaped and fled back to Wisconsin.[9]

Another disaster befell the Foxes in the winter of 1731-32 when Governor Beauharnois connived at the departure from Montreal of a war party of mission Indians who came to Wisconsin to "eat up Reynards." Proceeding part of the way overland on snow shoes, the mission Indians attacked a Fox village of fifty cabins on the Mississippi River about five miles above the mouth of the Wisconsin River, killing or capturing 300, only "thirty 'true' Reynards" escaping.[10]

It was a poignant disaster for the Foxes when war chief Kiala and three fellow chiefs surrendered themselves to Commandant Villiers at Fort La Baye as hostages to the French, in the hope the remainder of the

Fox tribe would be spared. Instead of being merciful, Governor Beauharnois condemned the Fox chiefs to a slow death by chain gang labor and tropical heat at a sugar cane plantation on Martinique.[11]

The crowning Fox disaster came in September, 1733. Captain Villiers returned to Fort La Baye with orders from Governor Beauharnois to exterminate all remaining Foxes; men, women and children. When rumors of Villiers' orders reached the Sauk village at La Baye, the Sauks were seriously alarmed, as they had permitted the few remaining Foxes to take refuge with them in their village. If the French were to insist on the surrender of the Fox refugees, the Sauks would be forced to break the customary Indian obligation of hospitality and protection to their persecuted relatives. Their alarm would have been even greater had they realized that the stage was being set for the bloodiest battle ever to occur in Winnebago County, the Battle of Little Lake Butte des Morts.

When Commandant Villiers walked up to the locked gate of the Sauks' palisaded village at La Baye on September 16, 1733 with less than a squad of the more than 300 garrison troops, fur traders and allied Indians under his command and rashly tried to break open the gate, a shot from within the village killed one of Villiers' sons. Villiers angrily returned the fire, at which a twelve year old Sauk in one shot killed the commandant. A brief fire fight at the Sauk gate now ensued in which ten French attackers, including Repentigny, second in command at Fort La Baye, were killed and three others wounded.[12]

When the Sauk chiefs realized this much French blood had been shed they also realized that French retribution would come quickly and that they had no alternative but to retreat from La Baye as quickly and secretly as possible. The Sauk-Foxes left their village under cover of darkness on the third night following the fight at their village gate, proceeding up the Fox River.

The next day the dead commandant's oldest son, Ensign Louis Villiers, organized a pursuit force of most of the La Baye garrison plus whatever fur traders were in town. Villiers' party overtook the fleeing Sauk-Foxes by late afternoon at a point somewhere close to the present-day high level bridge across Little Lake Butte des Morts. The historic Battle of Butte des Morts then began. According to Louise Kellogg:

> "The French lost heavily as well as the Sauk-Foxes. Among the French officers alone, one or more members of the Villiers, Ailleboust, Du Plessis and other well-known families, mourned the death of their youth. . . . Ensign Louis Villiers was wounded and Augustin Grignon recalled at a later time that two of his uncles were killed in this battle. It is believed that the great mound at (Little) Butte des Morts was erected to cover the tribesmen slain in this battle."[13]

Canadian Governor-General Beauharnois reported to France on November 11, 1733, that the losses of the French and their Indian allies at the Battle of Butte des Morts were 34 dead and about 20 wounded. These casualties were in addition to the ten killed at the Sauk-Fox village gate. The Sauk-Fox left 20 Sauk and six Fox dead on the field and had an unknown number killed and wounded.[14]

The Sauk-Foxes who could travel now abandoned the Fox River country, moved west of the Mississippi, found refuge among the Sioux and built a palisaded village on the Wapsipinicon River in eastern Iowa. Years later they established themselves for several generations on the lower Rock River in northwestern Illinois. After the Battle of Butte des Morts, several other tribes, secretly pleased with the resistance of the Foxes, returned their Fox captives, so that Sauk-Fox numbers in Iowa and Illinois again became substantial.

The final French effort to exterminate

the Foxes in the Second Fox War was a winter expedition in 1734-35 organized at the order of Governor Beauharnois and commanded by Captain Nicolas Joseph de Noyelles. De Noyelles' force consisted of 84 French soldiers, habitants and 200 mission Iroquois Indians. When de Noyelles moved up the Fox Valley, winter had already begun. Abandoning their canoes and proceeding on snow shoes, de Noyelles finally found the tribesmen he sought in early April, 1735, fully entrenched on an island in the Des Moines River. After futile attacks in which several French officers were killed, de Noyelles abandoned his objective, his party making their way to the nearest French settlement south of present-day St. Louis.[15]

When the chiefs from the upper country, assembled at Montreal in 1737, asked for mercy for the Sauks and Foxes, Governor Beauharnois agreed and sent Pierre Paul Marin to conciliate them. Marin succeeded, first at an Iowa post and later at a trading post among the Sioux on Lake Pepin.

When friction between French and British colonies in North America developed into armed conflict in 1755, French governmental recruiters and their Indian enlistees passed through the Fox Valley repeatedly. Paul Marin and Charles de Langlade both recruited and commanded increasingly large contingents of Western Indians in support of French Canada. Langlade and his Indians were sent home in 1760 only a few days before the surrender of the final French Canadian stronghold, Montreal, to British General Amherst. Langlade brought the news to Mackinac and La Baye that all of French Canada had surrendered to the English on September 8, 1760.

The last French governmental force to traverse the Fox-Wisconsin was the combined garrisons and officers of fort Mackinac and La Baye, commanded by Captain Louis Beaujeau. They retreated up the Fox River in October of 1760 and ultimately reached New Orleans. The French era in Wisconsin was at an end.[16]

British Era Travelers Through the Fox Valley 1763-1816

Jonathan Carver in 1766 was the first Englishman to travel up the Fox Valley, and Peter Pond, in September, 1773, was probably the first Yankee to travel from Green Bay to Prairie du Chien.[17] Neither Carver nor Pond came to the Fox Valley as a consequence of any governmental policy. However, during the American Revolutionary War, it was British policy that caused Charles Langlade of Green Bay to lead Wisconsin Indians to Quebec in 1776, 1777, and 1778. Some of Langlade's Wisconsin Indians supported British General Burgoyne's campaign in upstate New York and became a scourge to American frontier settlements.

In 1780 Menominee and Winnebago Indians accompanied the unsuccessful British attack of Emanuel Hess on the American fort at Cahokia (East St. Louis) and the Spanish fort at St. Louis. George McBeath, a fur trader and interpreter for Langlade, was the last British traveler along the Fox-Wisconsin having a role in the American Revolutionary War. He announced to a council of tribesmen at Prairie du Chien on May 24, 1783, the approach of peace and advised the Indians to devote their future energies to hunting.[18]

Once the United States had become an independent nation, its sovereignty extended west to the Mississippi and north to the Canadian border. Wisconsin supposedly was American. In reality British fur traders continued to operate at will throughout the area. Wisconsin Indians were British in sympathy and the Wisconsin fur trade functionally was still Canadian.

It was about May 1, 1812, that Francois Reaume, a secret courier from Canadian General Isaac Brock, passed along the Fox-Wisconsin with an urgent message for

Robert Dickson, chief trader at Prairie du Chien for the Northwest Company. General Brock's message to Dickson, who now became a colonel in the Canadian army, warned of the near approach of war between Britain and the United States and in guarded terms suggested Dickson begin recruiting Indians. In the ensuing months, hundreds of Indians from the Sioux, Sauk, Winnebago and Menominee tribes, Including Menominee Chief Tomah and his protege Oshkosh and 200 Sauk-Fox warriors under Sauk Chief Black Hawk reported to Robert Dickson for British military duty.

A British surprise attack on Fort Mackinac captured the American island fortress in the War of 1812 before the American garrison even knew war had been declared. The British had not only prepared for war by inflaming Indian tribes against the Americans, but had secretly set their various forces in motion before the actual outbreak of war, thus enabling them to achieve tactical surprise at Fort Mackinac.[20]

The only military action on Wisconsin soil during the War of 1812 occurred in 1814 when Americans at St. Louis moved up the Mississippi and built Fort Shelby at Prairie du Chien. British Colonel Robert Dickson recognized that an American strong point at such a strategic location would undermine continued British control of the fur trade in Wisconsin and the upper Mississippi valley. Accordingly, he quickly organized a force of Indians, fur traders and a few British soldiers under the command of Lt. Col. Wm. McKay which compelled the American construction party commanded by Lt. Perkins to surrender Fort Shelby before the regular American garrison arrived.[21]

While Col. McKay's capture of Fort Shelby temporarily restored the British flag to all of Wisconsin, the Treaty of Ghent in 1815 required all British Canadians to leave Wisconsin. Captain Andrew Bulger, the last commandant of Fort McKay, lowered the Union Jack, burned the fort and embarked his garrison on the Fox-Wisconsin waterway for their voyage back to Canada.[22]

The Fox Valley 1816-1840

American defeats at Fort Mackinac, Fort Dearborn, Fort Shelby and the surrender of American General Hull's army at Detroit in the War of 1812 caused the U.S. War Department to establish and garrison a chain of frontier forts from the Canadian border to the Gulf of Mexico. It was hoped the forts would protect American frontier communities against future Indian attacks, aid in the establishment of American control of Wisconsin and block Canadian fur traders from using the Fox-Wisconsin and the upper Mississippi Rivers.

An early step in implementing the War Department's plan for frontier forts was the arrival of the American Third Infantry Regiment at Green Bay on August 7, 1816, and the subsequent construction of Fort Howard. When Col. Chambers and Third Infantrymen were ordered to Prairie du Chien in the spring of 1817 to rebuild and garrison a fort there, Fort Howard's second commanding officer was Major Zachary Taylor, the hero of Buena Vista and later the President of the United States. When Col. Chambers' Third Infantrymen passed up the Fox River in the spring of 1817 they were the first American military force to travel through the valley.[23]

Two years later in the summer of 1819, the Fifth Infantry Regiment under the command of Col. Henry Leavenworth traveled up the Fox, through Lakes Winnebago and Butte des Morts and up to the portage, in the process of being redeployed from Detroit to the western frontier. The Fifth Infantry garrisoned Forts Armstrong and Crawford, and built Fort Snelling, the northern anchor of the frontier fort system, at St. Paul, Minnesota. Captain Henry Whiting, an officer in Leavenworth's command, wrote a journal describing the Fifth Infantry's journey and sketched a scene at Neenah and Big Lake Butte des Morts and two of the "Grand Kakalin" portion of the Fox River rapids which are probably the oldest existing sketches by an American of scenes in the Fox Valley. Captain Whiting's report, including these watercolored sketches brought him a commendation from the Secretary of War, John C. Calhoun.[24]

In the summer of 1820, the Territorial Governor of Michigan, Lewis Cass, his secretary, James Duane Doty, later a Wisconsin Territorial governor. Henry Schoolcraft, famous Indian agent-author-anthropologist, Dr. Alexander Wolcott, expedition physician and a party of forty men passed down the valley bound for Green Bay and Detroit on the last leg of perhaps the most unusual canoe trip ever taken through this area. The Cass party were completing a 4,200 mile "Voyage of Inspection" through Michigan Territory which then included most of the present-day states of Minnesota and Wisconsin, as well as Michigan. The Cass expedition rode in three birch bark canoes each of which was 36 feet long, had a beam of seven feet, carried a mast and sail and was propelled by eight-man crews.[25]

By August of 1823 James Duane Doty had become the newly appointed Circuit Judge of western Michigan and had been married. Doty and his bride traveled up the valley on the Fox-Wisconsin to Prairie du Chien in August of 1823 to spend the winter and to hold the first session in Wisconsin of the Michigan Territorial Superior Court at Prairie du Chien in May, 1824.[26] In the fall of 1824, Doty convened his court at Green Bay and there built his first home in Wisconsin.

When a series of murders of Whites by Winnebago Indians in the vicinity of Prairie du Chien and La Crosse threatened to precipitate an Indian war in 1826-27, a detachment of more than 500 men under the command of Gen. Atkinson moved from Jefferson Barracks at St. Louis to Wisconsin by keel boat. Two hundred soldiers from Col. Snelling's garrison at Fort Snelling came down the Mississippi to Fort Crawford at Prairie du Chien. An additional force of soldiers, militia and Indians, under the command of Major Whistler from Fort Howard, marched up the Fox Valley to the Fox-Wisconsin portage and dug in on the hill east of the Fox River where Fort Winnebago was built in 1828.

The rapid concentration of American military power in the heart of the Winnebago country so stunned the Winnebago chiefs that they concluded fighting would be useless,, and assigned Chief Red Bird and an accomplice in the murders to sacrifice themselves to the Americans to preserve the Winnebago tribe. The Winnebagoes had helped to demonstrate that interlocking support from the frontier forts could not only safeguard the white man's frontier but had made effective Indian warfare in Wisconsin obsolete.[27] Unfortunately, Sauk Chief Black Hawk triggered a second demonstration of the futility of frontier forays by Indians when he precipitated the Black Hawk War in 1832.

When Sauk Chief Black Hawk led his "British Band" of nearly 2,000 Indians east across the Mississippi River in 1832, it was the final Sauk effort to reoccupy lands in the Rock River Valley of northwestern Illinois which the Sauks had owned for several generations.

Black Hawk was aware that Americans had built forts at Rock Island, Prairie du Chien, St. Paul and Green Bay since the War of 1812, but probably had no adequate understanding of the improved effectiveness of the American army despite the Winnebago tribe's humiliation by the Americans in the Red Bird Disturbance of 1828. Black Hawk's ignorance or bull-headedness was to cost his band the loss of nearly ninety percent of their number in about ninety days. The Sauk's stunning losses in 1832 made it clear to tribes in the upper Mississippi Valley that the advance of the white man's agricultural frontier could no longer be halted by Indian murders or gunfire. Perceptive tribal chiefs, i.e., Sauk Chief Keokuk and Menominee Chief Oshkosh, also concluded that tribesmen had no alternative to negotiating a final surrender of their tribal lands to the accelerating flood of land-hungry Americans.

During the Black Hawk War two companies of Menominee Indians were enlisted at Green Bay and commanded by Col. Samuel Stambaugh, the new Indian agent at Green Bay. Augustin Grignon of Butte des Morts was the captain of one of the Menominee companies; his lieutenants were his son, Charles, and his nephew, Robert. George Johnston, former sheriff of Brown County, was the captain of the second Menominee company; Johnston's lieutenants were William Powell whose farm was in the present-day town of Algoma, and James Boyd, son of the former Indian agent at Green Bay.[28]

The last traveler up the Fox Valley from the Black Hawk War was Chief Black Hawk himself. After captivity as a prisoner of war at Jefferson Barracks, Missouri and Fort Monroe, Virginia, Black Hawk was escorted back to Fort Armstrong and released to his detested tribal rival, Sauk Chief Keokuk. When Black Hawk traveled up the Fox Valley and west along the Wisconsin to the Mississippi, the Black Hawk War was finally over.[29]

This chronicle of early Fox Valley events triggered by governmental action should include the survey and construction of the military road from Fort Howard to Prairie du Chien. In 1829, frontier promoters James Duane Doty of Menasha and Morgan L. Martin of Green Bay urged General Macomb in Washington, D.C. to use troops to open a road from the head of Lake Winnebago to Green Bay. Since it was politically more justifiable to build a road linking the frontier forts, in 1832 a party led by Lt. Alexander Center completed surveys and construction plans for a 234 mile military road from Fort Howard at Green Bay to Fort Winnebago at Portage and to Fort Crawford at Prairie du Chien (Fig. 2). Actual road construction began in the spring of 1835.

The section of the military road between Fort Crawford and Fort Winnebago was built by three companies of soldiers from Fort Crawford under the direction of Col. Zachary Taylor. Three companies from Fort Winnebago built the middle section of the road from Portage to Fond du Lac and the third section from Fond du Lac to Green Bay was built by three companies from Fort Howard.

The Fort Howard-Fort Crawford military road was a thirty foot wide lane through the timber. It was unpaved and in wet weather was virtually impassable for wagons. Grading was slight and so many high stumps were left standing that carriages and sleighs found travel difficult. It was not until the end of 1837 that the road was even nominally complete. Nevertheless, for many years the military road was the only overland route between Green Bay, Fond du Lac, Portage, Madison, the lead region and Prairie du Chien. Military troops and supplies passed over it frequently, and a growing stream of settlers increased the flow of traffic.[30]

In August, 1836, Henry Dodge, the newly appointed Territorial Governor of Wisconsin, crossed the Fox River at Algoma in present-day Oshkosh, paying a toll on a ferry belonging to James Knaggs. Governor Dodge was on his way down the Fox to negotiate the Treaty of Cedar Point by which the U.S. Government purchased 4,100,000 acres from the Menominee Indians on September 3, 1836 for $700,000. By this treaty the Menominees gave up title to all land in Wisconsin north of the Fox River and east of the Wolf.[31]

In the summer of 1837, troops commanded by General Henry Atkinson journeyed up the Fox Valley by the new mili-

2nd Lt. Alexander J. Center commanded an Army survey party in 1832 which mapped the Fox River in the process of looking for an appropriate location for a military wagon road between Forts Howard, Winnebago and Crawford. The Military Road was built in 1835-37, and ran along the east shore of Lake Winnebago.
Source: State Historical Society of Wis.

Fig. 2. Lieutenant Center's map of Lake Winnebago in 1833.

tary road from Fort Howard to Fort Winnebago and thence by keel boat to Fort Snelling. In 1839 a survey party of the U.S. Bureau of Topographical Engineers led by Captain Thomas J. Cram surveyed the potential of the Fox-Wisconsin rivers for steamboat navigation, concluding that the route could be made navigable (Fig. 3).[32]

A different kind of survey of the land area of the Fox Valley was conducted by contract surveyors working under the direction of the U.S. Surveyor General's office. Since enactment of the Northwest Ordinance of 1787, a rectangular system of mapping had been developed in which the government surveyors established boundary lines of Indian treaty lands, exterior township lines and then established subdivision lines including section, town, range and lot lines. Mapping of the Fox Valley south of the Fox River and Lake Butte des Morts was completed by 1834 and the map published by the Surveyor General's office in Cincinnati, October 23, 1835. The field work of mapping valley areas north of the Fox River and east of the Wolf seems to have still been in progress in January, 1839, but the completed map was published by the U.S. Surveyor's office at Dubuque, September 28, 1839. Once the maps were published, the

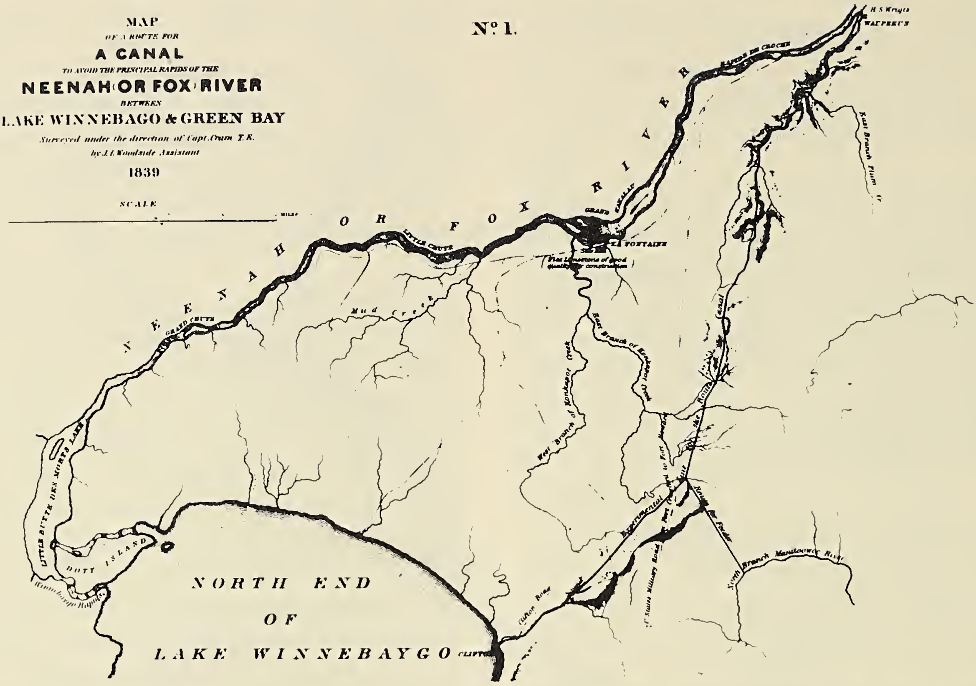

Fig. 3. U. S. Topographical Engineers Captain T. G. Cram led a party in 1839 which surveyed the potential for steamboat navigation of a canal from Lake Winnebago to Wrightstown. While this canal was never built, the cartographic skill of the engineers clearly had reached modern professional standards.

land offices could begin to throw the land open for public sale.[33]

County government first appeared in the Fox valley wilderness in 1818 when Governor Cass of Michigan Territory proclaimed a division into three counties of the territory's lands lying west of Lake Michigan and north to the Straits of Mackinac. Two of the counties, Brown and Crawford, comprehended the Fox-Wisconsin waterway. The county seat for Brown county was Green Bay and for Crawford County Prairie du Chien.

County affairs in Michigan Territory in 1818 and hence in the Fox River valley, were in the hands of a board of three county commissioners. Originally appointed by the territorial governor, by 1825 the county commissioners had become elective. The boards of county commissioners in Michigan Territory were replaced in 1827 by boards of county supervisors, one supervisor to be elected from each town.[34]

Direct participation by Fox valley citizens in the government of Michigan Territory began at Green Bay in 1821 when 42 votes were cast for Michigan territorial delegate to the U.S. Congress. More to the point, Fox valley and other Brown County voters in 1823 elected Robert Irwin of Green Bay representative to the Territorial Legislative Council from west of Lake Michigan.

The Fox valley was still a wilderness in 1823 but the tendency of significant historical events in the valley to be initiated by the agents of distant governments had now been largely reversed by the significant fact that the citizenry of the valley could express their needs to county, territorial and Congressional representatives or to judicial officers.

The Michigan Territorial Legislature

created Iowa County in 1830 and Milwaukee County in 1835 from the southern portions of Crawford and Brown counties, respectively. Thus when Wisconsin Territory began to function on July 3, 1836 there were four counties within the present day boundaries of Wisconsin, i.e. Brown, Milwaukee, Crawford and Iowa. The total white population of these counties in 1836 according to the territorial census was 11,683. Once Wisconsin legally became a territory in 1836 the Wisconsin Territorial Legislature created fifteen additional counties; those in or near the Fox valley were Calumet, Fond du Lac, Manitowoc, Sheboygan, Marquette and Portage. Three additional counties were created in 1840 including Winnebago in the Fox valley.[35]

The closing of the American Fur Company at Green Bay in 1844 was an historically symbolic requiem for Indians and fur trading in the Fox valley. Governmentally, the arrival of a new era was symbolized by the creation in the valley of the new counties of Fond du Lac, Winnebago and Calumet. Federal troops left the valley with the deactivation of Fort Howard in 1841. The arrival in the valley of the American agricultural frontier was marked by the first sizeable influx of settlers at Oshkosh in the summer of 1846, and by the platting of the villages of Neenah in 1847 and Menasha in 1849. Wisconsin Territory became the State of Wisconsin in 1848. Clearly, an era of more than two centuries of exploration, fur trading and the initiation of most major events in the Fox valley by governmental agents came to an end shortly after 1840.

Notes

[1] Thwaites, Reuben Gold, ed., *The Jesuit Relations and Allied Documents . . . Jesuit Missionaries in New France 1610-1791* (Cleveland, 1896-1901) 23: 1642-43. Jean Boisseau's map faces page 234.

[2] Charlevoix, Pierre F. X., *History of New France*, III (Paris, 1744), 178-179 (translation of John Gilmary Shea).

Severin, Timothy, *Explorers of the Mississippi* (New York, A. A. Knopf, 1968), 83-92.

[3] Charlevoix, *op. cit.*, V, Book 20, 257, 305-307.

S.H.S.W., *Collections*, 5:77-85.

Smith, Alice E., *The History of Wisconsin: From Exploration to Statehood*, I (Madison, Wis., State Historical Society of Wisconsin, 1973), 41.

[4] Wittry, Warren L., "The Bell Site: An Early Fox Village," *Wisconsin Archaeologist*, 44(1): 45-46.

[5] Charlevoix, *op. cit.*, 5:305.

[6] Hebberd, S. S., *History of Wisconsin Under the Dominion of France* (Madison, Wis., Midland Publishing Co., 1890), 121.

[7] Kellogg, Louise P., *The French Regime in Wisconsin and the Northwest* (Madison, Wis., State Historical Society of Wisconsin, 1925), 320-321; S.H.S.W., *Collections*, X, 47-53. The Chaussegros de Lery map in Kellogg, *op. cit.*, 314 seems to be the earliest existing map which shows substantial detail of the general vicinity of present-day Oshkosh, Lake Winnebago (Lac des Puants), Big Lake Butte des Morts (Petit Lac des Reynards) and the lower Fox River (Riviere des Reynards). The Fox fort east of the largest Fox village had been in existence, according to de Lery's map, since at least 1723 (Fort ou les Reynards sentient fortifie in 1723).

[8] Alvord, Clarence W. (ed.), *Centennial History of Illinois: The Illinois Country 1673-1818* (Springfield, Ill.: Illinois Centennial Commission, 1920), 163; Kellogg, *op. cit.*, 324.

Kellogg, L. P., "Fox Indians During the French Regime," S.H.S.W., *Proceedings*, 1907, 142-188.

[9] Kellogg, L. P., "Fox Indians . . ." *op. cit.*, 327; Alvord, *op. cit.*, 163-164.

[10] Kellogg, *op. cit.*, 329-330.

[11] Kellogg, *French Regime, op. cit.*, 329-331.

S.H.S.W., *Collections*, 17:210.

[12] Letter from Governor Beauharnois and Hocquart to the French Minister, Nov. 11, 1733 and Oct. 5, 1734, in S.H.S.W., *Collections*, 17:189-191, and 202-203.

[13] Kellogg, *op. cit.*, 331-332.

S.H.S.W., *Collections*, 17:188-191, 200-204; 3: 200; 8:207-208.

[14] Letter from Governor Beauharnois . . . to French Minister, *op. cit.*, 17:188-191.

[15] Kellogg, *op. cit.*, 334-335.

S.H.S.W., *Collections*, 17:221-229 and 216-221.

[16] Kellogg, *op. cit.*, 432, 436.

[17] "Narrative of Peter Pond," in Gates, C. M., *Five Fur Traders of the Northwest* (Minnesota Historical Society, 1965), 30-39.

S.H.S.W., *Collections*, 18:314-354.

[18] S.H.S.W., *Collections*, 2:165-170,174.

Kellogg, *op. cit.*, 191-192.

[19] Thwaites, Reuben Gold, *Wisconsin in Three Centuries,* II, 101, 140.

Kellogg, *op. cit.,* 282.

[20] Kellogg, *op. cit.,* 284.

[21] Kellogg, *op. cit.,* 315-319.

[22] Kellogg, *op. cit.,* 325.

[23] Prucha, Father Francis Paul, *Broadax and Bayonet* (Madison, Wis., S.H.S.W., 1953), 18-21; 54.

[24] *Captain Whiting's Journal, unpu*blished mss. in National Archives Microfilm Reel #1, No. 130, Rep. Book Pa397, in Fort Howard Consol. File 1819-1873.

[25] Schoolcraft, Henry R., *Summary Narrative of an Exploratory Expedition to the Sources of the Mississippi River in 1820 . . .* (Philadelphia: Lippincott, Grambo & Co., 1855), 190.

[26] Smith, *op. cit.,* 168.

[27] Prucha, *op. cit.,* 23-24. For a superb description of Red Bird at the moment of his surrender, see S.H.S.W., *Collections,* 5:178-204 in Col. Thomas McKenney, "The Winnebago War."

[28] Strong, Moses, "The Indian Wars of Wisconsin," S.H.S.W., *Collections,* 8:276.

[29] Hagen, William T., *Sac and Fox Indians* (Norman, Okla., University of Oklahoma Press, 1958), 200-201.

Smith, *op. cit.,* 133-150.

Nesbit, R. E., *Wisconsin: A History* (Madison, Wis., Univ. of Wisconsin Press, 1973), 95-100.

[30] Prucha, *op. cit.,* 135-144.

[31] Harney, Richard J., *History of Winnebago County* (Oshkosh: Allen and Hicks, 1880), 101.

[32] Source of Capt. Cram's map: U.S. Senate, 26th Congress, 1st Session (1840), Document 318, 16.

[33] Smith, *op. cit.,* 457.

[34] Wisconsin Historical Records Survey, *County Government in Wisconsin,* Vol. 1. 1942, 3-4.

[35] State of Wisconsin, *Wisconsin Blue Book, 1977,* (Madison, Wisconsin, 1977) 727.

PERCEPTION OF THE PRAIRIE IN A LETTER FROM PRAIRIEVILLE

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The arrival of a few Scots in 1840 marked the beginning of a sizable rural Scotch settlement that would develop in what was then Milwaukee County, but today Waukesha County, with Vernon Township as its center.[1] Within a short period of time, additional pioneers joined the vanguard to form a relatively dense settlement of Scots. Whereas a substantial number came directly from Scotland to the Wisconsin Territory, most of the initial settlers came from the general area of Livingston County, New York, where they or their families had settled earlier in the nineteenth century.

Included among the earliest arrivals in the Vernon area was the Robert Weir family,[2] which had reached Milwaukee by boat on October 26, 1841, and journeyed westward to Prairieville[3] the following day. Like so many others who eventually settled in Vernon, Weir had emigrated to New York from Scotland, where he was born in 1809.[4] Weir may have been attracted to the Prairieville area by a letter much like the one he sent back to New York encouraging friends to move west and join the growing settlement.

Weir's letter was addressed to William Fraser, postmaster of Fowlerville, New York, a small village in Livingston County.[5] The contents indicate, however, that it was an open letter intended for old friends; because of his position as postmaster, Fraser was being asked to pass on the news. Weir, in addressing the letter to Fraser, might have been epitomizing the popular stereotype of the frugal Scotsman. It has been suggested that "In order to save the 25 cent postage, Weir addressed the postmaster, . . . postmasters then enjoying the frank."[6] On the other hand, sending the letter to Fraser was necessitated, perhaps, by Weir's own strained financial resources resulting from a costly trip and subsequent investment in land. Although one cannot be sure that Weir was describing his personal financial situation, he wrote in the letter that "An empty purse and a new country maketh a hard beginning."

On the surface, Weir's letter might be considered typical of its genre. Many of the topics common in pioneer letters—the trip, family health, finances, general economic conditions and opportunities, prospects for agriculture, and perception of the new environment—are all covered in some depth. It is this last item, Weir's perception of the prairie, oak opening, and forest biotic communities, that is of particular interest and importance in this letter. The attitudes expressed and preserved in the personal papers of people like Weir have provided for a continuing re-evaluation of the importance of the prairie in the process of westward settlement.[7] Weir's pre-arrival perception of a section of the Milwaukee County prairie was somewhat at odds with his on-the-scene perception. Whereas Weir left New York intending to settle on a prairie farm, upon arriving he chose land[8] that, according to his own description, most likely would be classified as an oak opening. This change did not detract from Weir's enthusiasm for his new home. Weir's optimism remained high, although it was tempered by the reality of the frontier situation in which he found himself. His plan for success was altered somewhat (as is revealed in the letter) to fit his changing perception of the new surroundings, which were quite unlike those of his native Scotland or those of New York, his intermediate residence.

Weir's initial, positive perception of the Milwaukee County prairie he expected to encounter upon arrival was contrary to the general attitudes many historians have attributed to the so-called eastern woodland mentality. In his discussion of the settlement of the Lake Plains (which encompass a major portion of Wisconsin), Ray Allen Billington, for example, commented on the impressive beauty of the prairie, but he was quick to suggest that "Yet the prairie country was shunned by the first settlers, whose frontier technique was adjusted to a wooded country."[10] Moreover, he accounted for the early settlement of the wooded sections of southern Indiana and Illinois specifically by suggesting that "*adequate soil* [italics mine] and familiar vegetation" were available.[11] In a far more balanced treatment of the prairie-woodland controversy in Southeastern Wisconsin, Schafer felt obliged to point out that "The answer [to the question of whether to take a prairie or woodland farm] turned sometimes on men's belief in the superiority of forested land as land. . . ."[12] That Weir intended to take a prairie farm while he was still in New York indicates that he did not fit the supposed popular mold. Whatever his sources of information were about the physical fundament of a portion of old Milwaukee County, they did not allow him to conclude that prairie soil was "inadequate" or inherently less fertile than that of the East.

A change in Weir's on-the-scene perception is evident when he wrote that ". . . I do not think they [prairie farms] are as good for wheat as the [oak] openings or timber land. . . ." However, it does not seem reasonable to conclude that the change was prompted by any empirical evidence indicating the prairie soils were inferior; quite the opposite appears to have been the case. Later in the same paragraph where he compared the Genesee country with his new home, Weir was very explicit: ". . . the soil is better [in the Prairieville area], there is no mistake about it. . . ." Earlier in the letter Weir expressed satisfaction with his choice of land when he stated, "I think that I have got a good wheat farm."

One question remains: What motivated the change in perception then, if it was not the real or imagined low fertility of prairie soils? Throughout the letter, Weir's preoccupation with the forest resource was evident. He wrote of his desire to acquire timber land to complement this prairie farm; he bemoans the fact that "There is but little timber on it [the farm], say enough to fence it into 20 acre lots." Another reference to "trees [being] thinly scattered over" the farm suggests a dissatisfaction with the timber supply and is not a reflection of poor soil quality. This writer contends that Weir's perception is summarized well when he writes that ". . . it is hard to get a prairie farm and timber enough for the same." In other words, he valued the prairie soil but viewed the paucity of timber as a definite drawback.

Weir's actions support the contention. In the spring of 1842, he sold his land in section 12 and purchased 160 acres in section 1, about one mile north.[13] Apparently his desire to obtain some "first rate timber land" was realized in this transaction.[14] It is quite possible that included within his purchase was some of the desirable timber land to which he made reference in the letter.

It seems clear that Weir's perception and subsequent actions were not unique among settlers on those portions of the American frontier where the prairie was encountered. Mounting evidence suggests that early settlers did not shun the prairie because of assumed greater fertility of woodland soil. Studies centered in Iowa,[15] Illinois,[16] Texas,[17] and Michigan[18] have revealed, as John Fraser Hart has suggested, "that the pioneers, wherever possible, preferred to settle along the prairie—woodland edge, so that they might enjoy the advantages of both types of country."[19] The fertility of the prairie soil combined with the wood from forested areas used to build houses, barns, fences, and used to make fires for warmth and cooking offered an attractive inducement for settlement among pioneers like Weir.

In his letter that follows, Weir wrote forcefully in a style that ranges from folksy to simple eloquence. For clarity, punctuation and capitalization have been provided where they were absent in the original. The spelling and grammar have not been changed from the original, because they do not detract from a complete understanding of Weir's thoughts.

Mr. Wm. Fraser

Dear Sir:

According to promise I set down to give you a few lines. I hope you will excuse me in being so long in writing, as I sent word to you by Mr. Dn. [Duncan] Cameron[20] [of] Caledonia [New York] that we had got here safely. And I am happy to inform you that we are all in good health at present. And it may aford you comfort to know that we are in a healthy country blessed with a good appetite and plenty to satisfy the same. It may be that you have heard that we had a rough passage on the Las [lakes]. We were nine days on the water and part of the time it was very stormy. When when [sic] we came into Lake Huron we had a high head wind and a heavy sea, so much so that we had to turn round and go with the wind for sometime, and when we came into Lake Michigan we were again able to put round again and take shelter at an island and remain for one day. Yet we enjoyed ourselves as well as could be expected. We were on a first rate Boat, had a good Captain and a respectable set of hands, likewise a good Bar, and we were some[what] like Tom O'Shanter—we did not mind the storm a whistle. I did not get sea sick at all. My family did a little, yet stood it better than might be expected. We landed at Milwaukie on the 26th [of] Oct. and came to Prairieville [Waukesha] the 27th. James Wallace, James Begg [Jr.] and their families arrived at Prairieville on the 26th. James Begg [Sr.] and his [family] who came by land arrived on the 28th. Strange to think that we all started from home at different times to come such a distance, some by water and some by land and to arrive here in such rotation on the 26th, 27th and 28th. Prairieville is 18 miles west from Milwaukie and I think in a short time will be a great place for business. There is now a first rate flowering mill, one saw mill, one blacksmith's shop and plenty of business for three hands (James Wallace is employed in the same). There is a good waggonmaker's shop built last faull. There is two copper shops, three stores and one tavern, one drug store, one saddler, a number of shoemakers and tailors well employed there, one meeting house finished and two not finished, one stone Academy not finished inside, preachers without number, such as they are, and two or three Doctors but little employment for the same. Milwaukie will be a great place. She is in much want of a Harbor and has likewise been wanton for water power, but it is thought money will be granted this winter for a harbor and there is a damm across the Milwaukie river nearly finished, which is said will give her water power sufficient for one hundred run of stores. If a good harbor is got and good flowering mills built, the market here will be much better. When these things are done Milwaukie will be to this country as Rochester is to western N. [New] York. Wheat has been carried from here to Buffalo for 15 cents per bus. [bushel] but 18 pence [or] 2/ is the general price.[21] Wheat is worth at present from 70 to 75 cents, corn 2/9, oats 1/6, pork 2 dollars and 50 cents, beef about the same. Goods are but little higher here than they are in Fowlerville and plenty of everything to be got. Money is rather scarce, but it is known to be so in every new country. I think this will be fine wheat growing country although there is but little raised as yet for export. Farmers that have been here 4 or 5 years appear to have but little done by way of improvements. They say it is hard beginning. The fact is many come here poor and have nothing to begin with. An empty purse and a new country maketh a hard beginning. This country is settling very fast. I was much disappointed in finding the land so much taken up as it is. I looked round thinking to find land at government prices, [$1.25 per acre] but I could not find it good and in a convenient place, although I did not go more than 35 miles back from the Lake [Michigan]. The people say that more land has been taken since last spring than was taken in two years previous.

You may tell Neil McDugal[22] that I have bought a farm in his neighborhood. It is between his son-in-law[23] and the Milwaukie road.[24] My south line and his north line is the same on the west side of the cross road, or as it is called, the Rochester road,[25] and James Begg has bought on the west side of the said Rochester road. His south line and McDugal's north line is the same. James Wallace has bought John McIntyre's farm in the same neighborhood. I am nearly two miles west from him.[26] William Begg is thinking of buying Mr. Plumm's[27] farm in said neighborhood. It is going to be quite a Scotch settlement, and tell the Deacon[28] if he doth not come on to his land we will either sell it or burn it up, and tell him that I think there is Deacons enough where he is and we want him to be the old Deacon amongst us here, and tell him further that the best wheat that I have seen in the Ter. [Territory] was raised in that neighborhood. I think that I have got a good wheat farm. I bought 160 acres, and I intend to buy 40 acres more which joins said 160, which will make 200 acres for cultivation, and there is 80 acres of first rate timber land 1½ mile to the north which I was intending to take at gov't. price to keep as a timber lot, but it is thrown out of market at present, and I do not know if I can get it. If not, there is 60 acres equally as good timber and about the same distance from me which I can get for 3 Dollars per acre. My best respects to James Hamilton and not forgetting his Lady. Tell him that I think I have got as good a wheat farm as there is in Sugarburry [New York].[29] There is but little timber on it, say enough to fence it into 20 acre lots. Large trees [are] scattered thinly over it consisting of white oak, black oak, black walnut and some maple, and part of it is thickly grown over with hazel brush. There is a small log house on it and 8 acres broken up [and] 10 acres fenced. It will require three yoke of oxen to plough it the first time. Stone enough but not too many apparently.

When I left [New] York state I was fully in the belief that I would take a prairie farm. They are pleasant to the eye, but I do not think they are as good for wheat as the [oak] openings or the timber land, and it is hard to get a prairie farm and timber enough for the same. Water is likewise hard to be got on many of them. I think the land in this country is good in general, but I do not think the face of the country so handsome as the Genesee [New York] country is. It is more rolling or broken, but the soil is better, there is no mistake about it, and the healthiness of this country will speak loudly her praise. I have been in through Milwaukie, Racine and Walworth counties, and I have not seen man, woman or child sick.

Give my respects to all enquiring friends and acqus. [acquaintances]: Edward Craig the first time you see him, Js. Hamilton, Jn. Hamiltons, Rt. Wallance, An. Frrasers, As. McBean, Ts. Howie, all the old women about Fowlerville and espec. in Sugarburry and write to me as soon as this comes to hand.

If any letters come from Scotland send them to me. Direct [them] to me, Rt. Weir, Prairieville Post Office, Milwaukie County, Wisconsin Territory.

Robt. Weir
Dec. 27, 1841

Notations

[1] A brief history of the settlement is the focus of Edward C. Wicklein, *The Scots of Vernon and Adjacent Townships, Waukesha County, Wisconsin* (Waukesha, 1974). Wicklein reprints a copy of the letter (pp. 28-29) that is taken from a transcribed copy of the original, which contains errors and omissions. For a description of the contents and availability of this work see "Wisconsin History Checklist," *Wisconsin Magazine of History*, 57:326 (Summer, 1974).

[2] At the time of arrival, the family consisted of Robert and his wife Mary, both 30 years of age, and young daughters Margaret and Mary Jane, 5 and 2 years of age, respectively.

[3] The present City of Waukesha was formerly known as Prairieville. When Waukesha County was separated from Milwaukee County in 1846—to create a separate political unit—the name change took place. Prior to being called Prairieville, the little settlement was known as Prairie Village for a short period of time.

[4] It is difficult to determine the date of Weir's arrival in the United States. A Declaration of Intention to Become a Citizen of the United States in the name of Robert Weir is not on file in either Livingston County, New York (personal communication from Miss Anna Patchett, County Historian, Livingston County, May 29, 1975) nor Waukesha County, Wisconsin. It is certain that Weir was in New York by 1832 as his name is included on a list of members of the United Presbyterian Church of York for that date (Mary R. Root, *History of the Town of York, Livingston County, New York* (Caledonia, 1940), 99).

[5] The original Weir letter is in an unclassified collection of the Waukesha County Historical Museum, Waukesha, Wisconsin.

[6] John G. Gregory, ed., *Southeastern Wisconsin: A History of Old Milwaukee County*, Vol. II (Chicago, 1932), 965. Excerpts of the Weir letter are provided on pages 965 and 966. However, errors are apparent when the excerpts are compared with the original letter.

[7] An effective use is made of letters and other personal papers in this regard by Douglas R. McManis, *The Initial Evaluation and Utilization of the Illinois Prairies, 1815-1840* (Chicago, 1964).

[8] A deed dated December 11, 1841 records Weir's purchase of the NW1/4 of Sec. 12, T. 5 N., R. 19 E., from John C. Snover for a sum of $450, or just over $2.80 per acre, which was more than twice the price of government land.

[9] A map entitled Presettlement Vegetation of Waukesha County, 1836, prepared by Marlin Johnson and Jerry Schwarzmeir (1973) from the Public Land Survey Notes and Plats shows this to be the case. In addition, a portion of the land that became Weir's farm was reported to have been burned over shortly before the surveyor reached the area and appears on Johnson and Schwarzmeir's map as "burned."

[10] Ray Allen Billington, *Westward Expansion* (New York, 1949), 294.

[11] *Ibid.*

[12] Joseph Schafer, *Four Wisconsin Counties: Prairie and Forest* (Madison, 1927), 107. In an explanatory footnote for this point, Schafer adds: "Many Yankees had this belief until the virtues of the prairie lands had been thoroughly tested."

[13] Weir sold his farm for $650.00 and purchased the SW1/4, Sec. 1, T. 5 N., R. 13 E. from Caleb Nanscawen for the sum of $775.00.

[14] In addition to wanting timber for use on the farm, it seems reasonable to suggest that Weir's desire for acquiring good timberland was motivated by his intent to engage in the sawmill business in the very near future. "Mr. Robert Weir . . . built a saw-mill at Big Bend, which ran by steam. At this mill, most of the plank used in constructing the Muk[wonago] and Mil[waukee] road was sawed" (*The History of Waukesha County, Wisconsin* (Chicago, 1880), 791). The mill was built between December 27, 1841, the date of Weir's letter, and 1848, the date of incorporation of the road (*Ibid.*, 387).

[15] Leslie Hewes, "Some Features of Early Woodland and Prairie Settlement in a Central Iowa County," *Annals*, Association of American Geographers, 40:40-57 (March, 1950).

[16] McManis, *The Initial Evaluation and Utilization of The Illinois Prairies, 1815-1840.*

[17] Terry G. Jordan, "Pioneer Evaluation of Vegetation in Frontier Texas," *Southwestern Historical Quarterly*, 76:233-54 (January, 1973).

[18] Bernard C. Peters, "Pioneer Evaluation of the Kalamazoo County Landscape," *Michigan Academician*, 3:15-25 (Fall, 1970).

[19] John Fraser Hart, *The Look of the Land* (Englewood Cliffs, 1975), 7-8.

[20] Like Weir, Cameron reached Vernon Township in October, 1841, in the company of three other bachelors. Apparently Cameron returned to New York shortly thereafter, as did Donald

Stewert (*Waukesha Freeman,* September 3, 1910), a fellow traveller, to report in person to relatives on the opportunities in the Wisconsin Territory. In subsequent years a number of Cameron's relatives settled in Vernon Township.

[21] The following monetary equivalents apply to the prices quoted:

One pence = 1 cent or 10/125 shillings

One shilling = 12½ cents

[22] The reference here is obviously to Neil McDougal, who has been credited with being the founder of the Scotch settlement in Vernon (see the *Waukesha Freeman,* September 3, 1910 and September 16, 1943). McDougal was a wealthy New York farmer who came west to invest in real estate. In 1840 he purchased a number of tracts of land, and then returned to New York where he was at the time Weir's letter arrived with the message for him.

[23] McDougal's daughter Ellen was married to Findley Fraser, who owned the E1/2, SW1/4, Sec. 12, which, in part, was adjacent on the south to Weir's property.

[24] Reference here is to the Milwaukee-Janesville (via Mukwonago) road, which passed through section 1 about a half mile north of Weir's property. Presently this route is designated CTH ES (formerly STH 15) or National Avenue. For a map of territorial roads in Waukesha County, see: Southeastern Wisconsin Regional Planning Commission, *A Jurisdictional Highway System Plan for Waukesha County,* Planning Report No. 18, (Waukesha, 1975), 19.

[25] The road mentioned here, with a north-south trend, passed through the middle of section 12 and in section 13 angled to the west and south where it entered Big Bend, and then it continued in a southerly direction, closely paralleling present-day CTH F, to Rochester in Racine County.

[26] The record does not indicate such a purchase. A Hugh (not John) McIntyre owned the S1/2, NW1/4 of Sec. 5, T. 5 N., R. 20 E., the Township of New Berlin, which is immediately east of Vernon. Weir's property would have been "nearly two miles west from" the McIntyre land.

[27] Apparently Weir is referring to Joseph A. Plumb here. There are no Plumms listed as being land owners in the vicinity at this time.

[28] The reference to "the Deacon" in the broader context of the idea being developed coupled with the fact that Neil McDougal was an elder in the United Presbyterian Church of York, New York, suggests that Weir is still referring to McDougal here, as he was at the outset of this paragraph.

[29] The common spelling is Sugarbury. This small village was located in the Town of York across the Genesee River from Fowlerville, which was in the Town of Avon.

THE PHYCOPERIPHYTON COMMUNITY OF THE LOWER BLACK RIVER, WISCONSIN

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Abstract

Phycoperiphyton taxonomic composition was determined from materials gathered from the Black River, La Crosse County, Wisconsin. Phycoperiphyton samples were collected from two stations at each of four sites during the open water season, April through November 1976.

Fifty-six genera and 205 species were found. The phycoperiphyton community was dominated by members of the class Bacillariophyceae (ca. 98% of the total community). *Achnanthes lanceolata,* was the dominant species during spring months. *Melosira varians* dominated by mid-June and was succeeded by *Cocconeis placentula euglypta* during July through late September. *Navicula cryptocephala* followed in the autumn, and during the final sampling period in November *Diatoma vulgare* was the dominant species.

INTRODUCTION

The Black River is a tributary of the Mississippi River with the confluence located 11.5 km (7 mi) north of La Crosse, Wisconsin. From its headwaters, located approximately 267 km (160 mi) NNE in Taylor County, to the Mississippi drains 5490 km^2 (2129 m^2). This investigation, performed during April through November 1976, was undertaken to determine the taxonomic composition of the phycoperiphyton community and to establish the density and relative density of the several species.

DESCRIPTION OF THE STUDY AREA

The southern portion of the Black River, located between. lat. 43° 57″ to 44° 03″ and long. 91° 12″ to 91° 16″, forms the northern boundary of sections 1 and 2 and the western boundary of sections 10, 16, 21, and 27 of Holland Township, La Crosse County, T. 18 N., R. 8 W. (Fig. 1). United States Geological Station 05382000 is located about 50 m upstream from the first set of sampling stations used in this study. The study area covered 11 km (6.6 mi) of river which in the study area meanders through an area known as the Black River Bottoms. Agricultural crops and a few pastures are found along the Trempealeau County side of the river. Swimming, canoeing, and fishing are popular recreational activities on the Black River.

Two stations were established at each of four sites. At each site, one station was placed where the current velocity was greatest, and a second station where current velocity was least. Direct sunlight was also considered in station location because it greatly affects phycoperiphyton distribution (Table 1). United States Highway 53 spans the Black River at a crossing known as Hunter's Bridge, 3.5 km (2 mi) southeast of Galesville, Wisconsin. This bridge serves as a reference point for site locations (Fig. 1). Stations have the designation of N or S which indicate that the locations were nearer to the northern (N) or southern (S) bank of the river.

MATERIALS AND METHODS

Phycoperiphyton samplers were constructed from plastic slide boxes (Strenski, 1977). Two samplers, each containing eight evenly spaced glass slides, were set at each

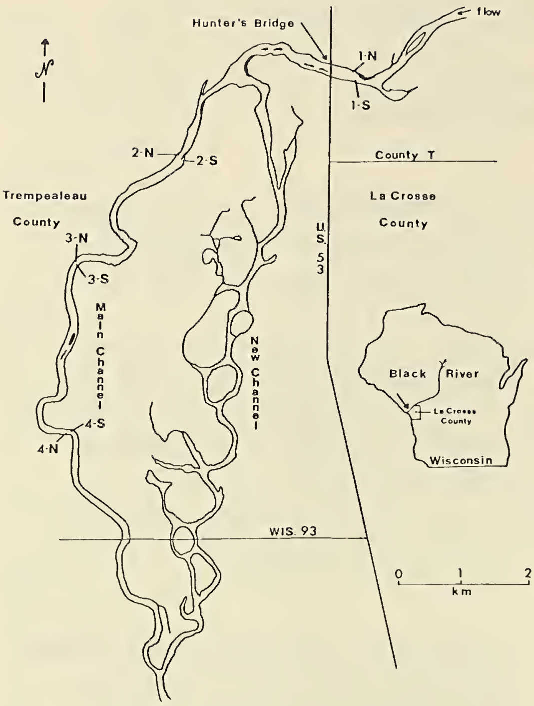

Fig. 1. Black River between Trempealeau and LaCrosse counties. Locations of paired sampling stations are indicated as 1-N and 1-S, etc.

TABLE 1. Direct sunlight estimates, mean and range values for current velocity (m/sec), and depth (m) at each station in the Black River, 10 April through 20 November 1976.

Station	*Direct[a] Sunlight*	*Current Velocity*	*Depth*
1-N	1	0.01 (<0.01-0.03)	0.27 (0.15-0.50)
1-S	3	0.14 (0.03-0.23)	0.70 (0.35-1.05)
2-N	2	0.23 (0.10-0.36)	0.42 (0.20-0.70)
2-S	2	0.01 (<0.01-0.06)	0.91 (0.50-1.35)
3-N	1	0.28 (0.04-0.39)	0.70 (0.20-1.50)
3-S	3	0.26 (0.11-0.50)	0.44 (0.15-1.00)
4-N	1	0.16 (<0.01-0.42)	0.26 (0.07-0.55)
4-S	2	0.30 (0.21-0.48)	1.17 (0.85-1.75)

[a] Direct Sunlight = 1—Direct sunlight at least until early evening.
2—6 to 8 hr of direct sunlight daily.
3—Less than 3 hr of direct sunlight daily.

station. Slides were inserted vertically to avoid sedimentation. Duration of slide exposure ranged from 14 days during the spring and summer, to 18-21 days during the autumn.

Material for identification was scraped from the glass slides into a solution of "M[3]" preservative (APHA 1975). Diatoms were cleared and permanently mounted in Hyrax® prior to analysis (APHA 1975). The phycoperiphyton was identified to the lowest taxonomic level possible using bright-field microscopy. Taxonomic keys used included those of; Bourrelly (1968), Cleve-Euler (1955), Hansmann (1973), Hohn and Hellerman (1963), Huber-Pestalozzi (1942), Hustedt (1930a, 1930b), Patrick and Reimer (1966), Prescott (1962), Smith (1950), Tiffany and Britton (1952), and Weber (1971).

A standard Palmer-Maloney cell (Palmer and Maloney 1954) was used to determine density of all living cells (diatoms and nondiatoms) and for the identification of nondiatoms. At least 500 organisms per counting cell were tallied. The relative densities of each taxa within the diatom community were estimated by the species proportional count method (APHA 1975). A minimum of 500 cells were counted from each Hyrax® mount.

RESULTS AND DISCUSSION

The phycoperiphyton in the Black River represented four classes of algae: Bacillariophyceae (diatoms), Chlorophyceae (green algae), Dinophyceae (dinoflagellates), and Myxophyceae (blue-green algae). Fifty-six genera and 205 species were identified; twenty-nine of the 205 species were further identified to include 75 varieties.

Members of the class Bacillariophyceae were the major dominants. This class was represented by 192 species in 35 genera and accounted for approximately 98% of the phycoperiphyton community. Diatoms from 28 species belonging primarily to the genera *Fragilaria, Synedra, Achanthes, Navicula,* and *Pinnularia* were further identified to variety level. Seasonally dominant taxa included *Achnanthes lanceolata, Melosira varians, Cocconeis placentula euglypta, Navicula cryptocephala,* and *Diatoma vulgare.* These five taxa comprised about 44% of the phycoperiphyton. Two species, *Navicula cryptocephala* and *Nitzschia palea,* occurred in each sample while 15 taxa appeared in at least 93.9% of the samples. *Navicula cryptocephala* ranked first in relative density (16.72%). *Cocconeis placentula euglypta* and *Melosira varians* ranked second and third with 12.55% and 8.24%, respectively.

The Chlorophyceae were represented by 20 genera but the group was not a major community component. This class contributed only 2.24% of the algae encountered but representatives of Chlorophyceae were found in 85.7% of the samples. The most frequently encountered green algae were *Scenedesmus quadricauda, Pediastrum duplex,* and *Scenedesmus dimorphus,* which were found in 71.4%, 43.9%, and 42.9% of the samples, respectively.

Single species of *Merismopedia* and of *Oscillatoria* represented the class Myxophyceae; each occurred in early autumn at different stations.

Ceratium hirundinella was the sole representative of the class Dinophyceae and was noted only once.

The rank of the common phycoperiphyton taxa according to mean relative density (% of the total community) was determined (Table 2). Common taxa are those taxa with a relative density of $\geq 1\%$. Eighteen taxa were specified as common. *Navicula cryptocephala* (16.72%), *Cocconeis placentula euglypta* (12.55%), and *Melosira varians* (8.24%) ranked first through third, respectively. These were followed by *Nitzschia palea* (4.44%) and *Navicula exigua capitata* (3.91%). Six taxa had relative densities between 3.72% and 2.74%, while seven other taxa each comprised be-

TABLE 2. Common phycoperiphyton taxa in the Black River ranked according to mean relative density. Ranking is based on samples from all stations, 10 April through 20 November 1976.

Rank	*Taxon*	*Relative Density (%) (mean and range)*
1	*Navicula cryptocephala*	16.72 (0.36-60.78)
2	*Cocconeis placentula euglypta*	12.55 (0.00-56.02)
3	*Melosira varians*	8.24 (0.00-54.43)
4	*Nitzschia palea*	4.44 (0.37-12.38)
5	*Navicula exigua capitata*	3.91 (0.00-14.26)
6	*Cocconeis placentula*	3.71 (0.00-18.55)
7	*Achnanthes lanceolata*	3.67 (0.00-34.55)
8	*Melosira italica tennuissima*	2.92 (0.00-12.35)
9	*Diatoma vulgare*	2.87 (0.00-66.60)
10	*Cyclotella stelligera*	2.85 (0.00-14.38)
11	*Cyclotella atomus*	2.74 (0.00-15.30)
12	*Achnanthes lanceolata rostrata*	2.31 (0.00-12.05)
13	*Gomphonema angustatum producta*	2.07 (0.00-29.55)
14	*Melosira italica*	1.56 (0.00-19.93)
15	*Synedra ulna oxyrhynchus*	1.54 (0.00-14.31)
16	*Nitzschia linearis*	1.40 (0.00-10.05)
17	*Navicula viridula*	1.24 (0.00-9.37)
18	*Navicula hungarica captitata*	1.19 (0.00-7.32)

TABLE 3. Common phycoperiphyton taxa in the Black River ranked according to frequency of occurrence (%). Ranking is based on samples from all stations, 10 April through 20 November 1976.

Rank	Taxon	Frequency of Occurrence (%)	Rank	Taxon	Frequency of Occurrence (%)
1	*Navicula cryptocephala*	100.0	27	*Melosira italica tennuissima*	72.4
	Nitzschia palea	100.0	28	*Achnanthes delicatula*	71.4
3	*Cocconeis placentula*	99.0		*Cymatopleura solea*	71.4
	Navicula exigua capitata	99.0		*Cymbella tumida*	71.4
5	*Achnanthes lanceolata rostrata*	98.0		*Scenedesmus quadricauda*	71.4
	Cocconeis placentula euglypta	98.0	32	*Navicula cuspidata*	69.4
	Melosira varians	98.0	33	*Navicula pupula*	68.4
8	*Achnanthes lanceolata*	96.9	34	*Navicula Bremeyeri*	67.3
	Cyclotella stelligera	96.9	35	*Cocconeis pediculus*	66.3
	Navicula hungarica capitata	96.9	36	*Diatoma vulgare*	63.3
11	*Melosira italica*	95.9	37	*Fragilaria pinnata*	62.2
	Nitzschia linearis	95.9	38	*Synedra rumpens*	61.2
13	*Cyclotella meneghiniana*	93.9	39	*Gomphonema angustatum*	60.2
	Gomphonema angustatum producta	93.9	40	*Fragilaria construens*	58.2
	Synedra ulna	93.9		*Fragilaria leptostauron rhomboides*	58.2
16	*Amphora ovalis*	89.8	40	*Navicula hungarica*	58.2
17	*Surirella tenera*	84.7	43	*Navicula tripunctata*	56.1
18	*Gyrosigma kutzingii*	81.6	44	*Cymbella ventricosa*	55.1
	Navicula viridula	81.6		*Tabellaria fenestrata*	55.1
20	*Opephora martyii*	80.6	46	*Cymbella naviculiformis*	54.1
21	*Achnanthes detha*	78.6		*Surirella ovata*	54.1
	Nitzschia amphibia	78.6	48	*Achnanthes exigua heterovalvata*	53.1
23	*Epithemia turgida*	76.5		*Caloneis lewisii*	53.1
	Stauroneis crucicula	76.5		*Surirella angustatum*	53.1
25	*Cyclotella atomus*	74.5	51	*Navicula elginensis*	52.0
26	*Rhiocophenia curvata*	73.5	52	*Eunotia lunaris*	51.0

tween 2.31% and 1.19% of the total community.

Common taxa were ranked by frequency of occurrence (Table 3). Frequency of occurrence is defined as the percentage of samples within which a taxon was found. Common denotes those taxa whose frequency of occurrence was at least 50%. This ranking included only one non-diatom taxon, *Scenedesmus quadricauda*. It ranked twenty-eighth with three diatom taxa. Several taxa including *Cyclotella meneghiniana* (frequency 93.9%), *Synedra ulna* (93.9%), *Amphora ovalis* (89.8%), *Surirella tenera* (84.7%), *Gyrosigma kutzingii* (81.6%), and *Opephora martyii* (80.6%) ranked in the top twenty but were never abundant in any sample. Only 52 of the 254 taxa occurring in the Black River had a frequency of occurrence $\geq 51\%$.

The algal density (cells/m^2) was calculated at each station. Stations which were heavily shaded, e.g. 3-S and 1-S which averaged about 1.70×10^9 cells/m^2, had phycoperiphyton communities with the lowest densities. This contrasted with 4-N (no shade) and 3-N (shaded only in the evening) where densities were about 3.00 X10^9 cells/m^2 (Fig. 2). Direct sunlight affected the density at each station and was categorized into three groups: those exposed to direct sunlight at least until evening (1-N, 3-N, 4-N), those exposed to 6 to 8 hr of direct sunlight (2-N, 2-S, 4-S), and those exposed to less than 3 hr of direct sunlight (1-S and 3-S). The "Student's" t-distribution was used to examine the effect of direct sunlight. Algal communities at stations with direct sunlight until evening had significantly greater densities than those at stations receiving less than 3 hr of direct sunlight ($P < 0.001$). Similarly, densities at stations with 6 to 8 hr of direct sunlight had significantly greater densities than those receiving less than 3 hr of direct sunlight ($P = 0.012$).

Sampling began during April when the high water resulting from the spring thaw began to subside. Low densities were found during April and May (8.8×10^8 cells/m^2). This may have resulted from the high spring discharge scouring the glass substrate. A spring maximum of 3.34×10^9 cells/m^2 was noted during early June; however, the greatest density occurred in early autumn when 3.47×10^9 cells/m^2 were observed. The lowest density (7.0×10^8 cells) was found during the final sampling period in November (Fig. 3).

Five species reached dominance during the study. Early in the season, from April to mid June, *Achnanthes lanceolata* was the dominant species. Its highest relative density was observed from 19 May through 2 June when it accounted for 21.00% of the total community. It remained common until 12 October when it comprised <1% of the total community. During its dominance, other common taxa included *Gomphonema angustatum producta, Achnanthes lanceolata rostrata, Nitzschia palea, Navicula cryptocephala* and *Achnanthes lanceolata ventricosa* (in order of decreasing relative density). Peak density of *Achnanthes lanceolata* (4.3×10^8 cells/m^2) occurred after *Melosira varians* became dominant (Fig. 4). At heavily shaded stations (1-S and 3-S) *Achnanthes lanceolata* had a relative density of 13%, while at stations with little or no shade (1-N and 4-N) this species had a relative density of about 18%.

Melosira varians dominated the community by mid-June. It attained a peak relative density of 34.14% and an average of 27% during the period 16 through 30 June. This was the only species that also exhibited a fall peak, reaching a value of 13.17% during the final sampling period. It remained a common taxon during each sampling period. Its relative density fell to approximately 1.50% during August and September. Peak density 16 through 30 June

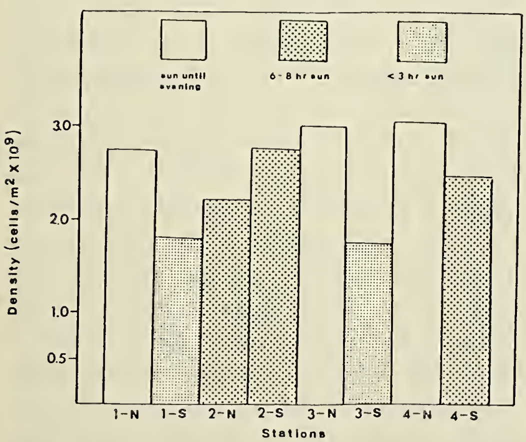

Fig. 2. Mean density of phycoperiphyton with respect to direct daily sunlight at each sampling station in the Black River, 10 April through 20 November 1976.

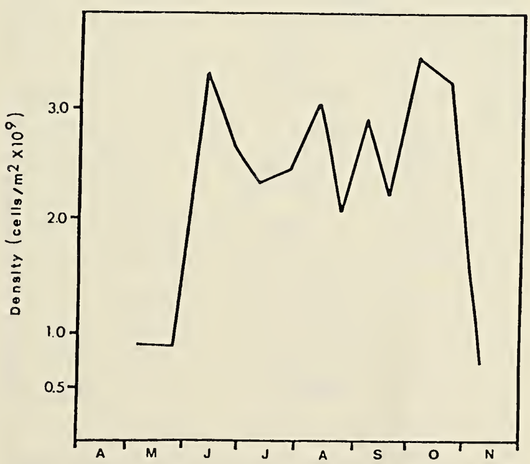

Fig. 3. Seasonal mean density of phycoperiphyton in the Black River, 10 April through 20 November 1976.

was 8.2 × 10^8 cells/m^2. A fall peak of 4.0 × 10^8 cells was observed during 12 October through 2 November (Fig. 4), Smith (1950) documented this genus as the most commonly encountered of all freshwater Centrales. He further stated that *Melosira varians* may dominate during the early spring and late fall months. This species was also one of the two principal species found during October and November on the Ohio River (Weber and Raschke 1970). In the Black River the distribution of this species appeared to be relatively unaffected by direct sunlight. Relative density of *Melosira varians* at well-shaded stations differed from unshaded stations by only 3%. For example, during the period 2 June through 14 July relative density at 1-N and 4-N (no shade) was 24% while 1-S and 3-S (well-shaded was 21% for this species. Other common taxa occurring while *Melosira varians* dominated were *Navicula cryptocephala, Cocconeis placentula euglypta, Achanthes lanceolata,* and *Nitzschia palea* and *Navicula exigua capitata.*

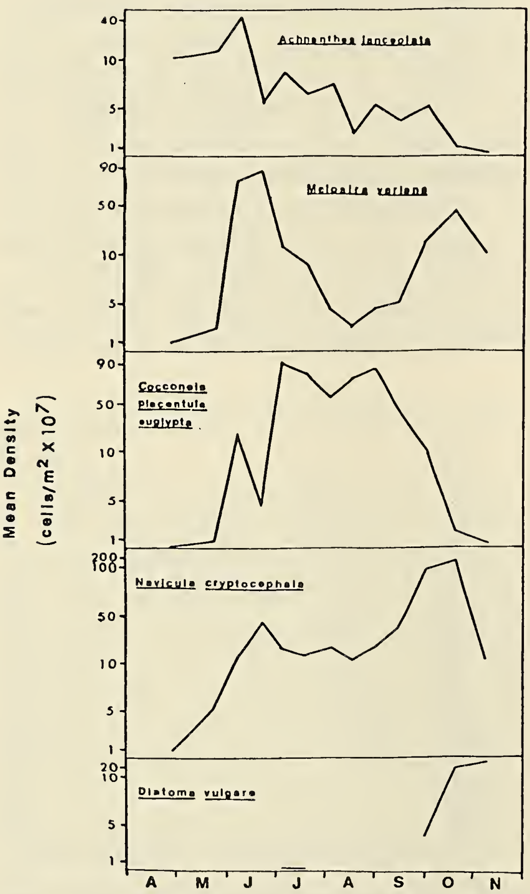

Fig. 4. Seasonal mean density of the five dominant phycoperiphyton taxa in the Black River, 10 April through 20 November 1976.

During July, August, and much of September, the dominant taxon was *Cocconeis placentula euglypta.* During that time this taxon ranged in relative density from 19.41% to 39.53% (14 thru 28 July). In contrast, *Achnanthes lanceolata* and *Melosira varians* were found in rather uniform relative densities while they were dominant. *Cocconeis placentula* was also a common taxon at this time. Massey (unpublished data) found this species and several varieties dominant in Pool 8 of the Mississippi River during midsummer. Weber and Raschke (1970) reported it as dominant in the Kalmath River, Oregon, during August. From 30 June through 22 September shading appeared to inhibit growth of this species. A relative density of about 37% was noted at stations 1-N and 4-N. During the same period the relative density at stations 1-S and 3-S only about 18%. A peak density of 9.2 × 10^8 cells/m^2 was noted during the sampling period 14 through 28 July (Fig. 4). *Navicula cryptocephala, Cocconeis placentula, Navicula exigua capitata, Nitzschia pales* and *Cyclotella stelligera* were also common throughout the summer months.

A shift in dominance to *Navicula cryptocephala* occurred during the autumn. This species was found only as a trace during the extended first period (10 April through 19 May), but comprised at least 5.24% of the algal community and was common throughout the remainder of the study. It attained its peak relative density of 53.27%, from 12 October through 2 November. At the same time it reached a peak density of 1.76

$\times 10^9$ cells/m^2 (Fig. 4). This was the only taxon to yield a density greater than 10^9 cells/m^2 during any one sampling period and it was found in all samples. A variety of *Navicula cryptocephala* was reported by Bahls (1971) as a dominant species in the Upper East Gallatin River, Montana and was found in all samples collected from natural substrates. In the Black River, direct sunlight did not appear to significantly affect its relative density. Heavily shaded stations had 28% and essentially unshaded stations 29% from 8 September through 2 November. Taxa also common at this time were *Melosira varians, Synedra ulna oxyrhynchus, Nitzschia palea, Nitzschia linearis,* and *Diatoma vulgare.*

Diatoma vulgare appeared only in small amounts throughout most of the season; however, it became the dominant alga during the cooler autumn months, comprising 32.3% of the community. This taxon was reported by Blum (1957) in the Saline River, Michigan, as characteristic of the fall and winter diatom flora in unpolluted waters. Drum (1964) also found it most abundant during October and November in the Des Moines River, Iowa. Low relative densities were observed in the early sampling periods of the study, thus suggesting that it had been present throughout the winter months. Apparently direct sunlight was not a significant factor affecting distribution. Its relative density at station 3-S during the final period was 66.60%. This was the greatest dominance exhibited by any taxon during this study. A density of 2.4×10^8 cells/m^2 was recorded at this time. Other common taxa during this time included *Melosira varians, Synedra ulna oxyrhynchus, Nitzschia palea,* and *Navicula exigua capitata.*

Diversity indices were calculated for each sample both spatially and seasonally using the Shannon-Wiener (1963) index which ranged from 3.45 (4-S) to 4.19 (1-S) over the eight stations. Shading appeared to have a marked influence on diversity. Stations with less than 3 hr of direct sunlight daily had significantly greater diversities than stations that received direct sunlight until the evening ($P = 0.014$). Those stations which received less than 3 hr of direct sunlight also had significantly greater diversity than stations with 6 to 8 hr ($P = 0.034$). High mean diversity (>4.36) was observed during the early sampling periods (10 April through 2 June). Seasonal changes were most significant in the autumn when the mean diversity was reduced from 3.93 (July through mid-October) to 2.95 (for the remainder of the study). The overall seasonal mean diversity was 3.89.

Lloyd and Ghelardi proposed the term "equitability" to compare the observed mean diversity with the maximum possible diversity (EPA 1973). The normal range is 0 to 1. In the Black River this index ranged from 0.28 (4-N) to 0.46 (1-S) with respect to spatial distribution, with an overall mean of 0.36. Seasonal changes ranged from 0.19 (12 October through 2 November) to 0.55 (19 May through 2 June), with an overall mean of 0.33.

Current velocity is also a critical factor affecting the distribution of algae. Odum (1956) implied that the depleted life requirements needed by the algal flora were renewed and the accumulated by-products were removed by the water flowing over the organisms. Whitford (1960) stated that swift currents rapidly remove the somewhat impoverished water around a community and replenish it with fresh nutrient-rich water. Experiments conducted by Whitford and Schumacher (1961) demonstrated high rates of respiration and phosphorous uptake in algal cultures when exposed to currents of 0.15 m/sec as compared to still water. McIntire (1966) investigated the structure of two laboratory stream periphyton communities in which the currents were very slight in one stream and moderate (comparable to the swifter currents at stations in this study) in the other. He found that species composition of the two laboratory stream periphyton communities were approximately the same but that the relative densities differed significantly. This was also observed in the Black River with *Achnanthes lanceolata* which had relative densities of 11% (slow) and 17% (fast). *Melosira varians* showed relative densities of 17% (slow) and 22% (fast), while *Cocconeis placentula euglypta* had 27% (slow) and 33% (fast). *Navicula cryptocephala* with relative densities of 24% (slow) and 28% (fast), showed the smallest difference. *Diatoma vulgare* was markedly affected with 11% in slow currents in contrast to 24% in fast currents.

In a review of 165 studies, Palmer (1969) listed 80 of the most tolerant species of algae with respect to organic pollution. Included in his list were greens, blue-greens, diatoms, and flagellates. Twenty-three species that appeared on Palmer's list were identified in the Black River; however, only five were noteworthy. These species were (Palmer's rank in parenthesis) *Nitzschia palea* (2), *Melosira varians* (13), *Navicula cryptocephala* (17), *Diatoma vulgare* (40), and *Cocconeis placentula euglyypta* (58). *Nitzschia palea* was a commonly occurring species; however, in the Black River it never attained a position of dominance and always appeared in rather uniform relative densities. The remaining four species appeared in significant quantities; however, their presence was related to seasonal changes and apparently not to organic pollution.

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Literature Cited

American Public Health Association. 1975. Standard methods for the examination of water and wastewater. 14th ed. APHA, New York.

Bahls, L. L. 1971. Ecology of the diatom community of the Upper East Gallatin River, Montana with *in situ* experiments on the effects of current velocity on features of the *Aufwuchs*. Ph.D. Disertation. Montana State University, Bozeman, Montana.

Blum, J. L. 1957. An ecological study of the algae of the Saline River, Michigan. Hydrobiol. **9**:361-405.

Bourelly, P. 1968. Les algues d'eau diuce. Tome II les algues jaunes et brunes Chrysophycecees, Pheophycees, Xanthophycees et Diatomees. Boubee and Cie, Paris.

Cleve-Euler, A. 1955. Die diatomeen von Schweden und Finnland, Vol. I-V, Almquist und Wiksells Boktryckeri, Stockholm.

Drum, R. W. 1964. Ecology of diatoms in the Des Moines River, Ph.D. Disertation. Iowa State University of Science and Technology, Ames, Iowa.

Hansmann, E. W. 1973. Diatoms of the streams of Eastern Connecticut. State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, Bulletin 106.

Hohn, M. H. and J. Hellerman. 1963. The taxonomy and structure of diatom populations from three eastern North American rivers using three sampling methods. Trans. Amer. Microscop. Soc. **82**:250-329.

Huber-Pestalozzi, G. and F. Hustedt. 1942. Die Kieselalgen. *In* A. Thienemann, ed., Das Phytoplankton des Susswassers, Die Binnengewasser, Band XVI, Teil II, Halfs II. E. Schweizerbant'sche Verlagsbuch-Han dlung, Stuttgart.

Hustedt, F. 1930a. Bacillariophyta. *In* A. Pascher, ed., Die Suswasser-Flora Mitteliuropas, Heft 10. Gustav Fischer, Jana.

Hustedt, F. 1930b. Die Kieselalgen. *In* L. Rabenhorst, ed., Kryptogamen-Flora von Deutschland, Osterreich, und der Verlagsellschaft m.b.h., Leipzig.

McIntire, C. D. 1966. Some effects of current velocity on periphyton communities in laboratory streams. Hydrobiol. 27:559-570.

Odum, H. T. 1956. Primary production in flowing waters. Limnol. and Oceanogr. **1**: 102-117.

Palmer, C. M. 1969. A composite rating of algae tolerating organic pollution. J. Phycol. **5**:78-82.

Palmer, C. M. and T. E. Maloney. 1954. A new counting slide for nanoplankton. Amer. Soc. Limnol. and Oceanogr. Spec. Pub. No. 21: 1-6.

Patrick, R. and C. M. Reimer. 1966. The diatoms of the United States. Vol. 1. Monograph 13, Philadelphia Acad. Natur. Sci.

Prescott, G. W. 1962. Algae of the Western Great Lakes Area, 2nd ed. W. C. Brown, Dubuque, Iowa.

Shannon, C. E. and W. Weaver. 1963. The mathematical theory of communication. University of Illinois Press, Urbana.

Smith, G. M. 1950. The freshwater algae of the United States, 2nd ed. McGraw-Hill Book Co., New York.

Strenski, M. R. 1977. A study of the phycoperiphyton community in the Black River, La Crosse County, Wisconsin. M.S. thesis. University of Wisconsin-La Crosse, La Crosse, Wisconsin.

Tiffany, L. H. and M. E. Britton. 1952. The algae of Illinois. University of Chicago Press, Chicago.

United States Environmental Protection Agency. 1973. Plankton. p. 13-20, and Periphyton. p. 1-6 *in* Biological field and laboratory methods for measuring the quality of surface waters and effluents. EPA-670/4-73-001. EPA, Cincinnati.

Weber, C. I. 1971. A guide to the common diatoms at water pollution surveilance system stations. EPA, Cincinnati.

Weber, C. I. and R. L. Raschke. 1970. Use of a floating periphyton sampler for water pollution surveilance. USFWPCA, Cincinnati.

Whitford, L. A. 1960. The current effects and growth of fresh-water alga. Trans. Amer. Microscop. Soc. **79**:302-309.

Whitford, L. A. and G. J. Schumacher. 1961. Effects of current on mineral uptake and respiration by a freshwater alga. Limnol. and Oceanogr. **6**:423-425.

Whitford, L. A. and G. J. Schumacher. 1973. A manual of fresh-water algae. Sparks Press, Raleigh, North Carolina.

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN NO. 67. VERBENACEAE—THE VERVAIN FAMILY

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Abstract

The Verbenaceae, a huge, tropical plant family, is represented in Wisconsin by the genera *Verbena,* with five native and three cultivated species, and six hybrids, and *Phyla,* with one species. Wisconsin distribution maps plotted from herbarium specimens show the ranges of the above taxa. Dichotomous keys to genera and species, and descriptions, geographic range, ecology, phenology, and chromosome number for each species are given.

Introduction

The Verbenaceae, a large, primarily tropical family, is relatively poorly represented in Wisconsin, with only two genera and 15 taxa, including six native species, their six hybrids, as well as three garden ornamentals which are rare escapes. Of these, the taller, common, often weedy *Verbena hastata,* Blue Vervain, *V. urticifolia,* White Vervain, and *V. stricta,* Hoary Vervain are familiar plants.

The Verbenaceae present no special problems to floristic workers despite the many hybrids, largely because Harold N. Moldenke, formerly of the New York Botanical Garden, has monographed the Verbenaceae and published treatments in many regional floras. Some 70 publications on *Verbena* alone by this prolific author have appeared in *Phytologia* since 1961; those pertinent to Wisconsin are listed in the bibliography. Much information regarding species ranges, descriptions of hybrids, and taxa of infrequent occurrence in Wisconsin has been taken from the publications of Dr. Moldenke, who, in addition to verifying the identification of most of our specimens, commented helpfully on this manuscript. Since Dr. Moldenke, above all others, has made an accurate treatment of the Wisconsin Verbenaceae possible, this report is dedicated to him.

This study is based primarily on specimens deposited in the herbaria of the University of Wisconsin-Madison (WIS), UW-Milwaukee (UWM), and the Milwaukee Public Museum (MIL), as well as UW-Oshkosh (OSH), UW-La Crosse (UWL), UW-Stevens Point (UWSP), UW-Superior (SUWS), UW-River Falls (RIVE), UW-Rock County Campus, Janesville (UWJ), the University of Iowa (IA), University of Minnesota (MIN), University of Michigan (MICH), Beloit College (BELC), the Morton Arboretum (MOR), Field Museum of Natural History (F), and the private herbarium of Mrs. K. Rill, Oshkosh. Grateful acknowledgment is extended to the administrators of these herbaria for loan specimens. Dr. Edward G. Voss, University of Michigan, Dr. Gerald Ownbey, University of Minnesota, and Vicki Funk, Ohio State University, provided distribution records of *Verbena urticifolia* to complete the range map for that species.

Each solid or hollow circle, square, or plus (+) symbol on the Wisconsin maps represents the exact location where specimens were collected; triangles indicate county records without specific locations. Dots on the United States map indicate specimen occurrence by county. Numbers in the state map insets record by month the number of specimens examined in flower or fruit, i.e. the phenology of the species.

Since the Verbanaceae, world-wide, are morphologically a most diverse group, the descriptions that follow refer only to the Wisconsin species.

VERBENACEAE Saint-Hilaire
Vervain Family

Herbs, shrubs, vines or trees in the tropics. Leaves (in ours) opposite, exstipulate, simple; blades entire to dentate, incised or cleft. Inflorescences axillary or terminal, ours in heads (*Phyla*) or spikes (*Verbena*). Flowers perfect, hypogynous, more or less irregular. Calyx lobes fused, campanulate to tubular or salverform, 2- or 5-lobed. Corolla with fused petals, funnelform or salverform, tube well developed, the limb 4- or 5-lobed, more or less weakly 2-lipped. Stamens 4, didynamous (2 long, 2 short), inserted on the corolla tube. Ovary superior, sessile, somewhat 4-lobed, 2-carpellate, 2- or 4-celled with one ovule in each cell. Fruit a dry schizocarp splitting into 2 (*Phyla*) or 4 (*Verbena*) nutlets at maturity.

A large, morphologically heterogeneous family, widely distributed throughout the world, most abundant in the tropics, with 76 genera and 3,400 species and subspecies (Moldenke 1971), the largest genera, *Vitex, Clerodendrum, Verbena* (including *Glandularia*) and *Lantana,* containing both widely used ornamentals and pernicious weeds. The hard, heavy, durable wood of teak (*Tectona grandis*) is economically important in many tropical areas.

The Verbenaceae, together with Lamiaceae (Labiatae), Boraginaceae, Callitrichaceae and Phrymaceae, comprise the order Lamiales, with 7800 species (Cronquist 1968). The Lamiales, Scrophulariales and Polemoniales comprise the super-order Tubuliflorae. The monotypic, temperate, herbaceous Phrymaceae (*Phryma leptostachya;* cf. Iltis 1957), sometimes included in Verbenaceae (Thorne 1976) or segregated as a separate family on the basis of its reduced and highly specialized ovary, is clearly derived from Verbenaceae (Cronquist 1976). Most closely related to Verbenaceae, but more advanced, are the Lamiaceae, distinguished by a gynobasic style, deeply 4-cleft ovary, sharply 2-lipped flowers, and aromatic foliage. In contrast, Verbenaceae have a terminal style, only slightly or unlobed ovaries, at most weakly 2-lipped flowers, and often nonaromatic foliage.

Key To Genera

A. Flowers in elongated spikes, these terminating stems and branches; calyx 5-lobed; and cylindrical; corolla 5-lobed fruits separating into 4 nutlets. ....1. Verbena.

AA. Flowers in dense heads axillary on long, bare peduncles; calyx 2-lobed and compressed; corolla 4-lobed; fruits separating into 2 nutlets. ....2. Phyla.

1. Verbena L. — Vervain

Herbs, erect, ascending or procumbent, perennial. Leaves opposite, toothed, incised, lobed or pinnatifid. Inflorescences terminal or axillary, spicate, loose to dense, few to often many and paniculately arranged. Flowers small or rather large in Sect. Glandularia, solitary and sessile in the axil of a bractlet. Calyx tubular, 5-ribbed, unequally 5-toothed. Corolla salverform or funnelform, its tube curved, villous within, a ring of hairs closing its mouth, the limb spreading, weakly 2-lipped, 5-lobed, slightly zygomorphic. Stamens 4, inserted on the upper portion of the tube, included. Style one, 2-lobed, the anterior lob stigmatiferous. Ovary superior, with one ovule in each of four cells. Fruit enclosed by the mature calyx, splitting at maturity into four small, linear nutlets.

A highly complex genus of 206 species, 122 subspecific taxa and 49 hybrids, native primarily to the New World (Moldenke 1971), most frequent in the southcentral United States, Mexico, and South America, with three species native to the Mediterranean region, several American species are weeds in the Old World and many species widely cultivated ornamentals. The showy Section *Glandularia* is now often elevated to generic status (Umber, 1979).

Several Wisconsin species of *Verbena* (e.g. *hastata, stricta, urticifolia, bracteata*) contain in their leaves and stems the bitter glucoside Verbenalin. Verbenalin, with the disagreeable tasting seed oils, may provide a competitive advantage in Wisconsin pastures, the plants being selective ignored by livestock. Singly or in various combinations, these species (especially *V. stricta*) are abundant in grazed areas throughout southern and western Wisconsin.

Originally, the three most common Vervains were probably ecologically segregated, with *V. hastata* in marshes, *V. stricta* in prairies, and *V. urticifolia* in woodlands. Today however, disturbance in most areas has obliterated this separation, and our native Vervains not only flourish but hybridize in such disturbed habitats. Considering the ubiquitous joint occurrences of many of these species, the relative rarity of hybrids is remarkable.

Verbena officinalis has been attributed erroneously to Wisconsin on the basis of two specimens (WIS) collected at Baraboo, Sauk County in 1861 (Hartley 1966). Both are *V.* x *perriana* (*V. urticifolia* x *V. bracteata*), their pinnatifid leaves resembling those of *V. officinalis.*

Key to the Wisconsin Species of Verbena

(Hybrids among the first five species are not separable in this key; cf. pp. 89-93, Figs. 1, 4, 5, and *The New Britton and Brown Illustrated Flora* 3: 126-127).

A. Sterile style-lobe not protruding beyond the stigmatic surface; flowers 3-9 mm long, 3-9 mm broad; calyx 1-6 mm long; flowers in elongate, slender spikes; native species (Section VERBENA).
  B. Spikes usually many, paniculate; fruiting calyx 1.8-3 mm long; corolla 2.5-4.5 mm broad.
    C. Spikes slender, the fruiting calyces more or less remote; calyx 1.8-2.4 mm long; corolla dull white, its tube 1.8-2.5 mm long. .... 1. V. URTICIFOLIA.
    CC. Spikes thick, densely flowered, the fruiting calyces imbricate; corolla deep blue, lavendar or purple (white in occasional albinos); calyx 2.5-3 mm long; corolla tube 3-4 mm long or more. .... 2. V. HASTATA.
  BB. Spikes solitary or in 3's; fruiting calyx 2.9-5-6 mm long; corolla 3-9 mm broad.
    D. Stems prostrate-ascending, often forming extensive mats, 5-10 (20) cm tall; bracts divergent, foliaceous exceeding the calyx; leaves lobed or incised usually near the base. . . 3. V. BRACTEATA.
    DD. Stems erect, 3-11 dm tall; bracts appressed, subulate-lanceolate, shorter than or equalling the calyx; leaves toothed, rarely lobed.
      E. Plants sparsely strigose; leaves lanceolate to oblanceolate, 3-11 mm wide; rare in southeastern Wisconsin. 4. V. SIMPLEX.
      EE. Plants densely pubescent; leaves elliptic to orbicular, 13-50 mm wide; common throughout southern Wisconsin. .... 5. V. STRICTA.

AA. Sterile style-lobe protruding beyond the stigmatic surface; flowers 10-30 mm long, 8-30 mm broad, very showy; calyx 8-15 mm long; flowers in flat-topped, foreshortened spikes; rare garden escapes (Section GLANDULARIA).

F. Corolla 20-30 mm long, 10-25 mm broad, the tube twice as long as the calyx.

G. Leaves appressed strigose or glabrate; flower rose to purple. . . . . 6. V. CANADENSIS.

GG. Leaves densely pubescent; flowers violet to red and white, often with a white central eye spot in the throat. . . . . 7. V. X HYBRIDA.

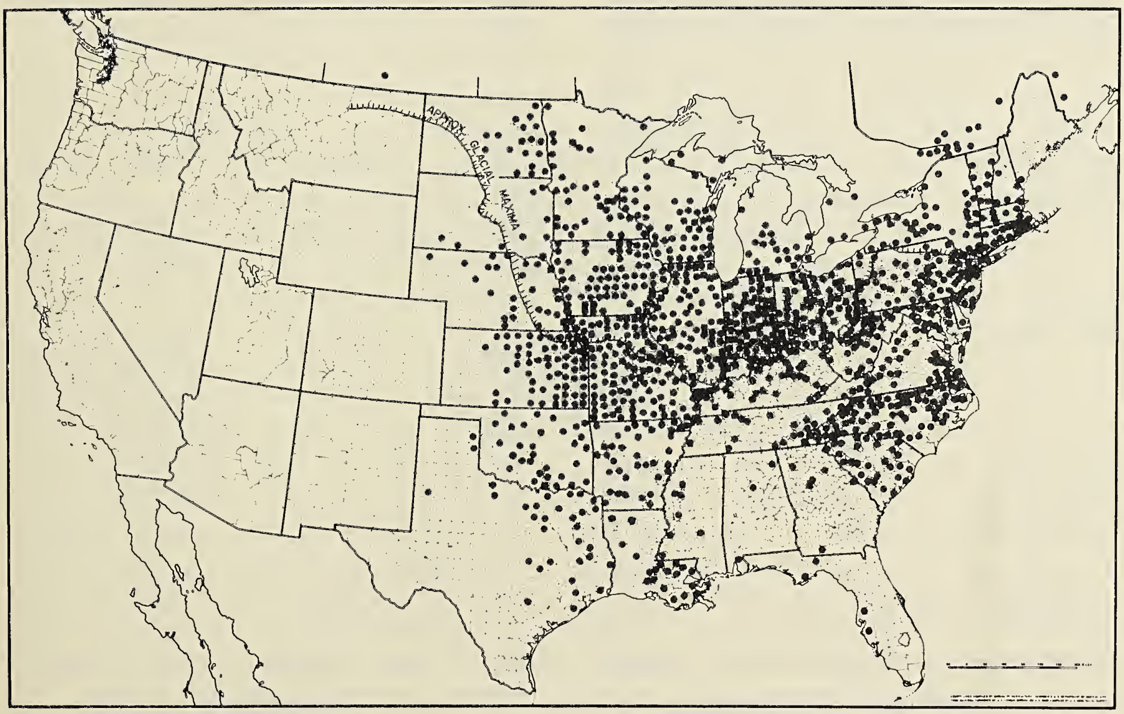
FF. Corolla 10-15 mm long, 8-10 mm broad, the tube 1.3-1.5 times as long as calyx; flowers rose to purple. . . . . 8. V. BIPINNATIFIDA.

SECTION VERBENA (NATIVE SPECIES)

1. VERBENA URTICIFOLIA L. Maps 1-3.

White Vervain, Nettle-leaved Vervain

Herb, perennial, 5-15 (−25) dm tall. Stems erect, simple or with ascending branches, quadrangular. *Leaves ovate* to elliptic, occasionally lanceolate, 4-14 cm long, 3-7 cm wide, with pustulate hairs above, subglabrous to densely velutinous beneath, acute, abruptly attenuated to the 1.5-3.5 cm long petiole, coarsely serrate or biserrate. Leaf hairs simple, sometimes gland-tipped on the main veins beneath. Spikes slender, becoming remotely fruited, 5-28 cm long, numerous in open panicles. Bractlets ovate-acuminate, 0.7-1.2 mm long. Calyx 1.8-2.4 mm long, minutely pubescent, the subequal teeth not connivent. Corolla *dull white*, slightly surpassing the calyx, 2.5-3.5 mm long, the tube 1.8-2.5 mm long. Nutlets oblong, 1.5-2.0 mm long, raised re-



MAP 1. North American distribution of *Verbena urticifolia* by country.

ticulate-striate. 2n = 14 (Lewis & Oliver 1961).

Widespread and common in eastern North America (Map 1), from Quebec to Saskatchewan south to Florida and Texas, in Wisconsin primarily south of the "Tension Zone" in a great variety of habitats, from dry oak to moist maple-basswood and flood-plain forests, and sedge meadows (there modal, fide Curtis 1959), an aggressive weed tolerant of disturbance, common in grazed or cut-over woods, pastures, grazed or drained sedge meadows, roadsides, and railroad rights-of-way and other sunny or shaded, mesic and moist degraded sites.

Verbena urticifolia is one of the few native weeds frequently seen co-dominant with grasses in heavily grazed pastures. Here an obvious increaser (as is *V. stricta,* which may occur with it but in drier spots), it is avoided by cattle.

Flowering from the end of June through the end of September, fruiting from July through October.

Verbena urticifolia tends to be autogamous, its minute flowers setting seed whether excluded from or exposed to insect pollinators. Self-pollination occurs when the wilting of the persistent corolla allows the anthers to contact the stigma. Pollinating insects are chiefly flies (Perkins *et al.* 1975).

In Wisconsin, *Verbena urticifolia* hybridizes most frequently with *V. hastata* (*V.* x *engelmannii*) and rarely with *V. bracteata* (*V.* x *perriana*) and *V. stricta* (*V.* x *illicita*).

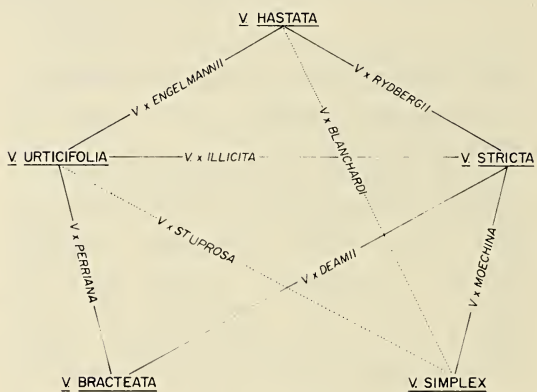


Fig. 1. Species of *Verbena* native to Wisconsin and their hybrids. Those connected by dashed lines have not been collected in the state.

Character	var. *urticifolia* Fernald (1936)	var. *urticifolia* Wisconsin Material	var. *leiocarpa* Fernald (1936)	var. *leiocarpa* Wisconsin Material
● leaf pubescence	strigose-hirsute beneath with stiff hairs up to 1-1.3 mm long or glabrate	glabrate to strigose-hirsute beneath with hairs mostly 0.5-0.8 mm long, rarely to 1.1 mm long	velutinous or subvelutinous with minute hairs to 0.3 mm long	subvelutinous to densely velutinous with hairs up to 0.4 mm long
● glandular hairs	————	rare on sparsely hirsute specimens, more common on densely hirsute specimens, especially northward	————	stalked glandular hairs rare to frequent at the nodes, rachis, petioles and midveins on the ventral leaf surface
● inflorescence	stiffly ascending	ascending	lax	ascending
● calyx length	2-2.3 mm	1.5-2.5 mm	rarely to 2 mm	(1.75) 1.9-2.2 (2.4) mm
● bractlet length	1-1.5 mm	0.9-1.5 mm	0.5-1 mm	0.9-1.3 mm
● nutlet length	about 2 mm	1.55-2.05 mm	only 1.5 mm	1.6-1.9 mm
● nutlet ribbing	ribbed on the back	ribbed on the back	smooth on the back	ribbed on the back

Fig. 2. Characters utilized to distinguish *Verbena urticifolia* var. *urticifolia* and *V. urticifolia* var. *leocarpa*—after Fernald (1936) and from Wisconsin material identified by Moldenke.

A hybrid with *V. simplex* (*V* x *stuprosa*) has not been found here (Fig. 1).

Variability in Verbena urticifolia

Verbena urticifolia exhibits much variability, as expected of such a wide-ranging species occurring in diverse habitats. One of the variants has been segregated as var. *leiocarpa* Perry & Fernald (Fernald 1936). The characters originally used to separate the variety, as well as an additional one correlated with it, are listed in Fig. 2. In the original description, var. *leiocarpa* was said to occur from "Eastern Virginia to South Carolina" (and rarely northward to Connecticut), in contrast to the widespread distribution of the typical variety. While this variety was originally claimed to be a Coastal Plain endemic, Moldenke subsequently identified many of the Wisconsin specimens as var. *leiocarpa,* apparently on the basis of the velutinous pubescence on the underside of the leaves.

On the basis of Perry and Fernald's original taxonomic characters (length of calyx, corolla and bractlet, inflorescence angle, nutlet ribbing) the Wisconsin specimens of *Verbena urticifolia* can not be separated into two varieties. There is no correlation between calyx length, bractlet length and nutlet length for specimens separated into two varieties on the basis of pubescence (Fig. 3). Even Fernald's best distinguishing character, the soft pubescence on the underside of the leaves, is variable and intergrading. Nevertheless, it does seem to correlate slightly with geography, for var. *leiocarpa* is found primarily south of the Tension Zone in Wisconsin (Map 3), while the typical variety (Map 2) does range north of the Tension Zone, although infrequently. A similar, and hence significant, restriction of var. *leiocarpa* to more southerly areas has been reported for Western Pennsylvania (Jennings 1953). Correlated with distribution, again in a poorly defined way, are the additional characters of presence and rela-

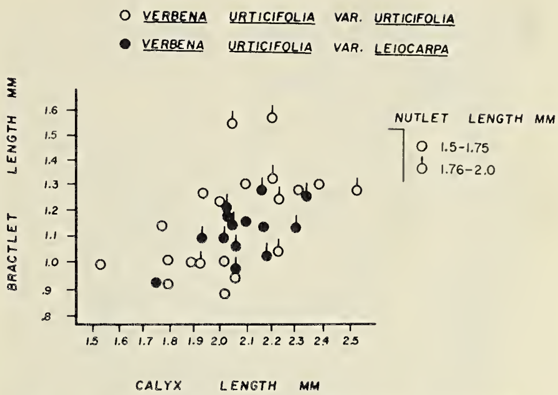
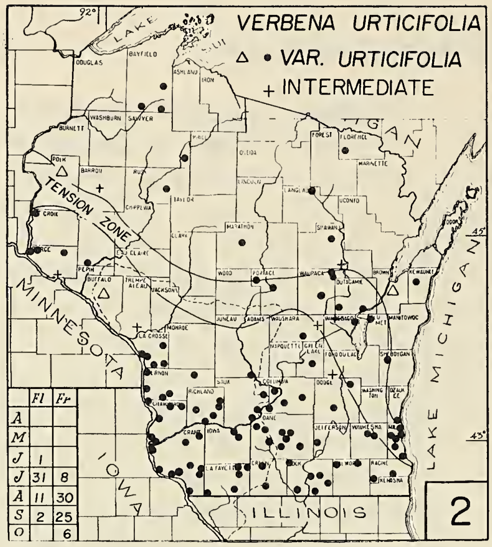


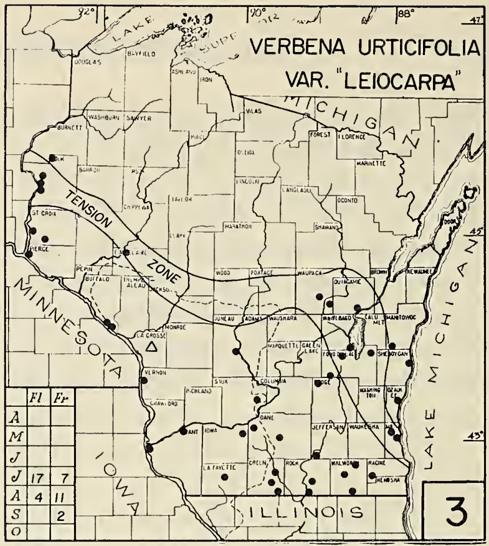
Fig. 3. Scatter diagram of Wisconsin specimens of *Verbena urticifolia* var. *urticifolia* and var. *leiocarpa* (determined by Moldenke) illustrating the lack of correlation between three of the taxonomic characters Fernald utilized to separate the variety.

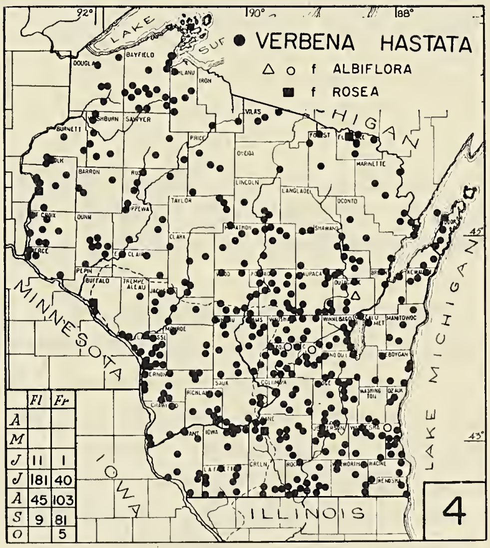
tive abundance of gland-tipped hairs, these primarily on the rachis, petioles, upper nodes and midveins on the ventral leaf surface.

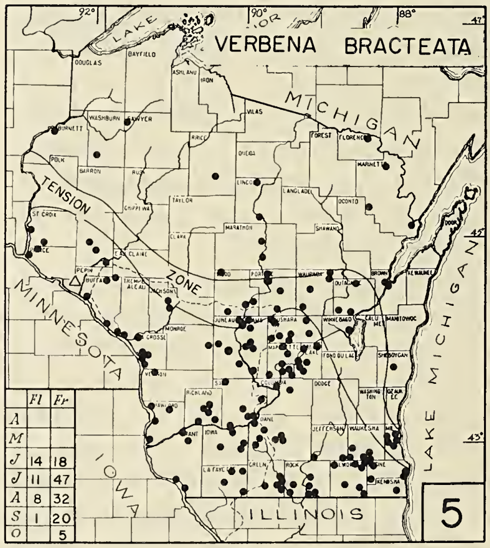
In summary, while these distinctions seem hardly worthwhile, the map and scatter diagram suggest that originally there may have been a Coastal Plain population differentiated from an inland one. With the waning of the Pleistocene ice, both varieties migrated into the formerly glaciated lands to become sympatric. With differential selection pressure relaxed, morphological distinctness was reduced by exchange of genetic material in many populations, and continued evolutionary divergence of the varieties was swamped through recombination. Perhaps the descendants of the Coastal Plain population are the velutinous ones which now seem to be restricted to the warmer parts of Wisconsin, a region harboring many Coastal Plain taxa.

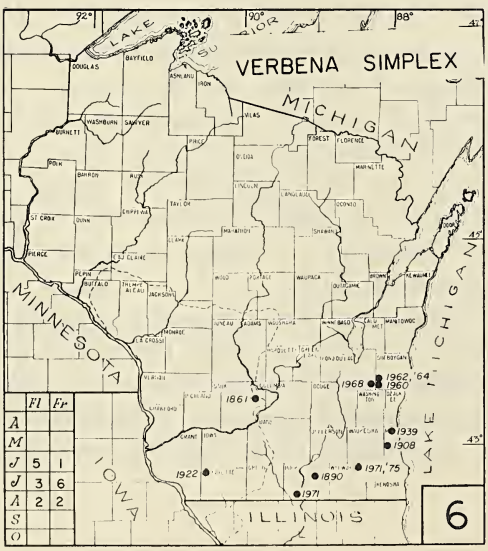
While most floras disregard Fernald's variety (e.g. Radford, et al. 1968), calling attention to such variability does serve a useful biogeographic purpose. Fernald, a genius at recognizing subtle plant variation in the

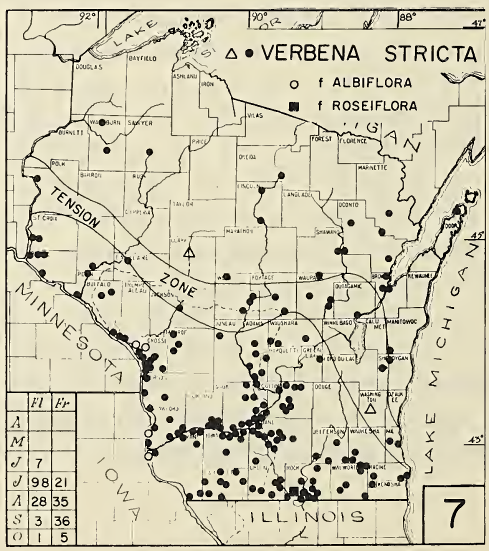

VERBENA URTICIFOLIA
△ • VAR. URTICIFOLIA
+ INTERMEDIATE
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 1
J 31 8
A 11 30
S 2 25
O 6
2

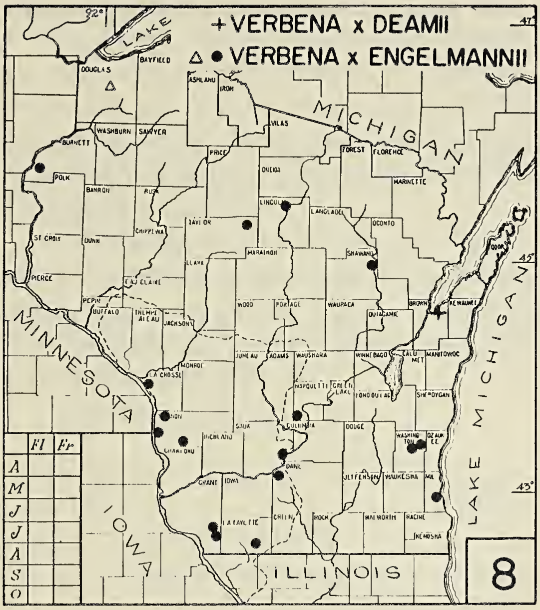

VERBENA URTICIFOLIA
VAR. "LEIOCARPA"
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 17 7
A 4 11
S 2
O
3

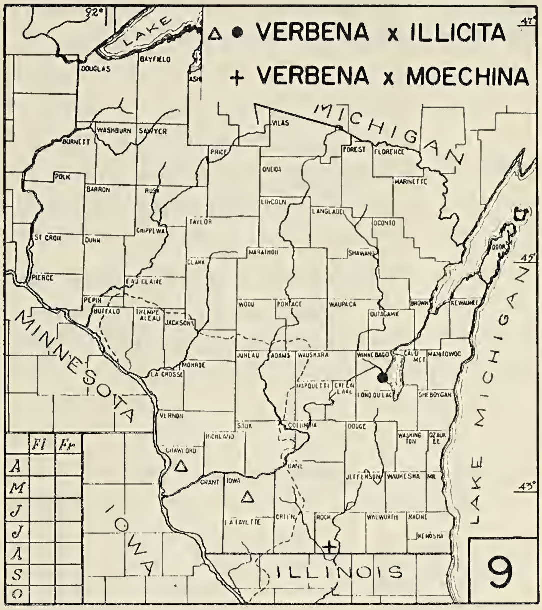

• VERBENA HASTATA
△ ○ f ALBIFLORA
■ f ROSEA
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 11 1
J 181 40
A 45 103
S 9 81
O 5
4

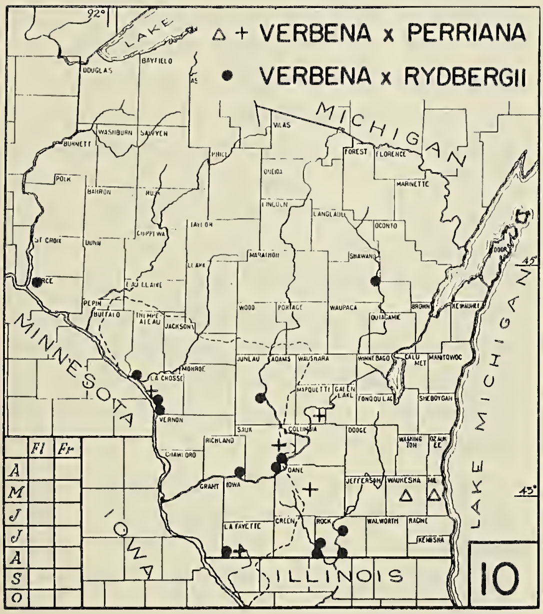

VERBENA BRACTEATA
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 14 18
J 11 47
A 8 32
S 1 20
O 5
5

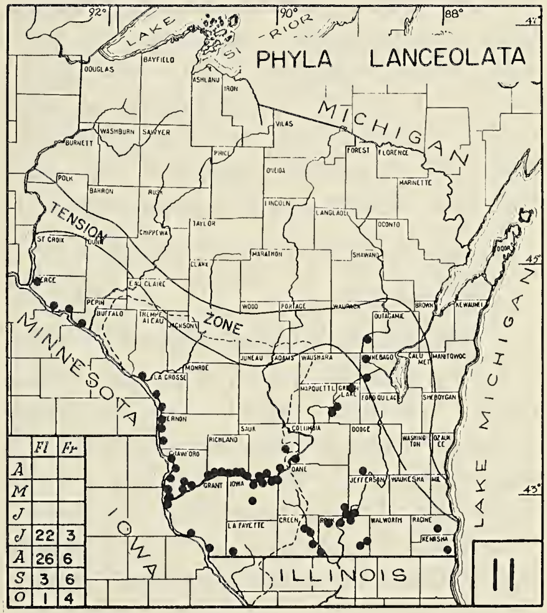

VERBENA SIMPLEX
1962, '64
1968
1960
1861
1939
1908
1922
1971, '75
1890
1971
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 5 1
J 3 6
A 2 2
S
O
6


△ • VERBENA STRICTA
○ f ALBIFLORA
■ f ROSEIFLORA
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 7
J 98 21
A 28 35
S 3 36
O 1 5
7


+VERBENA x DEAMII
△ ● VERBENA x ENGELMANNII
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A M J J A S O
8


△ ● VERBENA x ILLICITA
+ VERBENA x MOECHINA
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A M J J A S O
9


△ + VERBENA x PERRIANA
● VERBENA x RYDBERGII
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A M J J A S O
10


PHYLA LANCEOLATA
MICHIGAN
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 22 3
A 26 6
S 3 6
O 1 4
11

field, may not have been totally wrong! Only detailed population studies of this species throughout its range can resolve this question.

KEY TO VARIETIES

A. Leaves nearly glabrous to hirtellous beneath; hairs 0.5-1.1 mm long; gland-tipped hairs rarely present except in more densely pubescent specimens; nearly throughout Wisconsin. . . . . 1a. VERBENA URTICIFOLIA var. URTICIFOLIA.

AA. Leaves more or less densely velutinous below; hairs mostly less than 0.4 mm long; scattered gland-tipped hairs usually present on upper nodes, rachis, petolies and midrib of ventral leaf surface; mostly south of the Tension Zone. . . . . 1b. VERBENA URTICIFOLIA var. LEIOCARPA.

1a. VERBENA URTICIFOLIA L. var. URTICIFOLIA Map 2.

1b. VERBENA URTICIFOLIA L. var. LEIOCARPA Perry & Fernald Map 3.

Morphological intermediates between these ill-defined variants possess either a dense pubescence of mixed long and short hairs with gland-tipped hairs, or a sparse but very short pubescence without or with few gland-tipped hairs, in each example illustrating continuous variation. These are indicated on Map 2 with plus symbols.

2. VERBENA HASTATA L. Blue Vervain, Simpler's Joy Map 4.

Verbena hastata L. var. *scabra* Moldenke

Herb, perennial, 2-13 dm tall. Stems erect, 1-several, simple or ascending branched, scabrous with short antrorse hairs on the angles. Leaves to 15 cm long, 5.5 cm wide, narrowly ovate to elliptic, on narrow winged petioles, reduced upwards, gradually accuminate and rounded at base, coarsely serrate or biserrate, *the larger sometimes* hastately lobed, scabrous to rough hirsute on both surfaces but softer beneath. Spikes 5-12 cm long, rarely solitary, usually numerous in a dense terminal panicle, erect and densely many-flowered. Bractlets 1.8-2.8 mm long, lanceolate-subulate, shorter than the calyx. Calyx 2.5-3.0 mm long, its acute lobes with subulate, connivent tips. Corolla deep lavender or purple (white in forma ALBIFLORA Moldenke, rose in forma ROSEA Cheney), 3-4.5 mm broad, the tube 3-4 mm long surpassing the calyx. Nutlets linear, 1.8-2.1 mm long, faintly striate. 2n = 14 (Mulligan 1961).

Widespread from Nova Scotia to British Columbia, south to Florida, Texas, and Arizona, but only sporadic in the Western States, rare in the Southern and Southeastern States (cf. Moldenke 1963b for map), in Wisconsin the most common Vervain, occurring in a variety of usually moist, sunny habitats, as in marshes, stream edges, lake shores, shrub-carrs, low prairies, sedge meadows (where modal: Curtis 1959), and rarely in moist forests, tolerating much habitat disturbance, hence common in heavily grazed pastures, roadsides and railroad rights-of-way, and occasionally abandoned sandy fields.

Flowering from late June through September, fruiting from early July to mid-October.

In describing var. *scabra,* Moldenke (1963b) states that "This variety differs from the typical form of the species in having its leaf blades more rigid, conspicuously scabrous above, and often more or less conspicuously pubescent beneath," and later (1971), "Probably most, if not all, of the material now passing as *Verbena hastata* from west of the Mississippi, or at least, west of the Great Plains, is actually var. *scabra*." While Moldenke has identified specimens from several counties in the state as var. *scabra*, all Wisconsin specimens of *V. hastata* are rough hispid to scabrous above and pubescent beneath, and seem to be part of the western, more scabrous end of a subcontinental, taxonomically indivisible cline.

In Wisconsin, *Verbena hastata* hybridizes with *V. stricta* (*V.* x *rydbergii*) and *V. urticifolia* (*V.* x *engelmannii*). A hybrid with *V. simplex* (*V.* x *blanchardi*) has not been collected here (Fig. 1).

3. Verbena bracteata Lag. & Rodr.
Creeping Vervain, Large-bracted Vervain Map 5.
Verbena bracteosa Michx.

Herb, perennial. Stem *prostrate-ascending*, diffusely branched from a thickened tap root, to 6 or more dm long, 5-20 cm tall, often forming large, round mats, coarsely hispid-hirsute. Leaves 1-4.5 cm long, 0.8-3.2 cm wide, lanceolate to ovate, *pinnately incised or 3-lobed*, gradually narrowed into a short petiole. Spikes few to many, elongating in fruit, densely flowered and conspicuously bracteate. Bractlets *7-13 mm long and much longer than the calyx*, foliaceous, spreading to recurved in age, hirsute. Calyx 2.9-4.3 mm long, white-hispid, the acuminate lobes connivent. Corolla lavender-purple to pink, 2.5-4.0 mm broad, the tube about 4 mm long and slightly exsert from the calyx. Nutlets linear, 2-2.5 mm long. 2n = 14 (Jackson 1960).

Wide ranging from Maine to British Columbia, south to Florida, Texas, and Mexico (cf. map in Moldenke 1962b), and introduced in Western Europe, in Wisconsin primarily south of the Tension Zone, a weed (Curtis 1959) of droughty and sunny disturbed habitats as sandy or gravelly roadsides, railroad rights-of-way, quarries, open woods, sandy river terraces, trails, and waste places in towns.

Flowering from the first week in June, fruiting from mid-June through October.

Once established, the ability of Creeping Vervian to persist is exemplified by a Richland County collection (*Nee 13,460, WIS*) where it is reported to be "common, in decumbent mats in heavily grazed hog lot . . . now the only living plant."

Although common and apparently indigenous, it appears not to be part of any native plant community (Swink 1974), excepting perhaps sandy river terraces and dry rocky exposed cliffs where it is rarely collected. These, supposedly undisturbed sites include Brady's Bluff Prairie (Trempealeau County), Ferry Bluff (Sauk County), and Observatory Hill (Marquette County), all rocky, xeric "open" habitats with minimal competition characterized by bedrock exposures and shallow soils.

But even the earliest Wisconsin collections stress disturbance: "A roadside weed very plentiful in some places" (*Lapham s.n.*, Waukesha Co., 11 Aug. 1847, *WIS*): ". . . in waste places" (*Cheney s.n.*, Lafayette Co., 27 Aug. 1888, WIS); "On ballast of C.M.St.P.&P. RR near University Farm." (*Heddle 706*, Dane Co., 1 Aug. 1907, MIL). C. C. Parry (1852), who cataloged the plants during a geological survey of Wisconsin, Minnesota and Iowa in 1848, characterized the habitat of *V. bracteata* as "roadsides." Although the plant probably existed in Wisconsin prior to settlement certainly its frequency has increased greatly from the time of the first settlers.

Capable of autogamy, *Verbena bracteata* shows a tendency for cross-fertilization, with butterflies the primary visitors (Perkins *et al.* 1975).

In Wisconsin, *Verbena bracteata* hybridizes with *V. stricta* (*V.* x *deamii*) and *V. urticifolia* (*V* x *perriana*) (Fig. 1).

4. Verbena simplex Lehm.
Narrow-leaved Vervain Map 6.
Verbena angustifolia Michx.

Herb, perennial, 2.8-5 dm tall. Stems erect, and simple, or ascending and sometimes spreading branched, sparsely strigose. Leaves 4.5-7.5 cm long, *3-11 mm wide*, *linear to narrowly oblong or spatulate,* tapering to a subsessile base, serrulate often only toward the acute apex, sparsely strigillose to scabrous on both surfaces. Spikes 3-24 cm long, slender, stiffly erect. Bractlets 2.5-4.3 mm long, lanceolate-subulate, shorter to as long as the calyx. Calyx 3-4.5 mm long, the five accuminate lobes erect to spreading in fruit. Corolla light blue to purple or rose, 5-7.1 mm broad, the tube 3.8-4.8 mm long, slightly surpassing calyx. Nutlets linear, 2.3-3 mm long, raised reticulate above, striate below. 2n = 14 (Noack 1937).

Widespread from New Hampshire and Massachusetts to Ontario, southern Minnesota, and Nebraska, south to Florida and Oklahoma (cf. map in Moldenke 1964c), in Wisconsin only in the southern third, where rare in open, dry, calcareous sites such as gravelly moraines, roadsides, or railroad rights-of-way.

Flowering from mid-June through mid-August, fruiting late June to September.

In Wisconsin, *V. simplex* hybridizes with *V. stricta* (*V.* x *moechina*). Hybrids with *V. hastata* (*V.* x *blanchardi*), and *V. urticifolia* (*V.* x *stuprosa*) are not known from Wisconsin (Fig. 1).

5. VERBENA STRICTA Vent.
Hoary Vervain Map 7.

Verbena stricta Vent. forma *albiflora* Wadmond, in *Rhodora* 34:19. 1932. (Type: "southeastern Wisconsin," in Gray Herbarium Harvard U. (?), not seen).

Herb, perennial, 2.9-11 dm tall. Stems erect, robust, simple to branched, *densely pubescent.* Leaves 3.2-9.4 cm long, 1.3-5 cm wide, *narrowly elliptic, orbiculate, or widely ovate,* sessile or nearly so, sharply serrate, biserrate or irregularly incised-serrate, thick-textured, *hirsute and rugose above, densely canescent below. Spikes usually 1,* or 3 to 5, or more, *thick and stiffly erect,* hirsute throughout, to 3.1 dm long. Bractlets 3.8-5.6 mm long, lanceolate-subulate, hirsute, shorter or equalling the calyx. Calyx 3.8-5.6 mm long, densely hirsute, its five lobes acuminate. Corolla purple, lavender or blue (pink or rose in forma ROSEIFLORA Benke, white in forma ALBIFLORA Wadmond) 7.5-9 mm wide, the tube 3.8-6.4 mm long, surpassing the calyx. Nutlets ellipsoid, 2.3-3 mm long, raised reticulate above, striate below. 2n = 14 (Noack 1937).

A native of the Great Plains, from Ontario and Ohio to Montana, south to Texas, Arizona, and Mexico (cf. map in Moldenke 1964c), in Wisconsin south of the Tension Zone in many dry, sunny habitats such as xeric and sandy prairies, limey or "goat prairies" (here modal, Curtis 1959), abundant in heavily grazed, sandy or gravelly pastures or abandoned fields, less frequently in open oak or oak-jack pine woods, roadsides, and railroad rights-of-way.

Flowering from late June to early October, fruiting from early July through October.

In studying effects of grazing on thin soil Wisconsin prairies, Dix (1959) gave *V. stricta* a high negative grazing susceptibility rating because of its greatly increased frequency on grazed hill prairies.

Capable of autogamy as are many weeds, *V. stricta* shows a tendency for cross fertilization due to partial self-incompatibility. Selfing is thwarted by the position of the corolla tube which, horizontal and partially closed by hairs, prevents pollen falling onto a stigma unreceptive until anthesis. Insect visitors are equally divided between Diptera, Hymenoptera, and Lepidoptera (Perkins *et al.* 1975).

In Wisconsin, *V. stricta* hybridizes with each of the other four native species (Fig. 1), but most commonly with *V. hastata* (*V.* x *rydbergii*).

SECTION GLANDULARIA Schauer
(Adventive Species) (See Umber 1979)

6. VERBENA CANADENSIS (L.) Britton
Rose Vervain

Herb, annual or perennial. Stems erect or decumbent, often rooting at the nodes, glabrous to spreading-hirsute. Leaves coarsely *incised, pinnatifid or 3-cleft,* glabrous to hirsute on both sides. Spikes with many large flowers in flat-topped, showy clusters. Bractlets mostly shorter than calyx. Calyx 10-13 mm long, glandular-hirsute, with subulate lobes. *Corolla usually purplish-rose, 11-15 mm broad,* the tube about twice as long as the calyx. Nutlets 3-3.5 mm long. 2n = 30 (Dermen 1936).

Common from Pennsylvania, Tennessee and Colorado south to Florida and Texas, most abundant in the Ozarks, cultivated and sometimes naturalized in Minnesota and southern Michigan (cf. map in Moldenke 1962c), its seeds available commercially and in Wisconsin occasionally planted in cemeteries or flower gardens. Two specimens were observed: "in landscaped roadside gravel," (Walworth County, T4N R18E NE¼SW¼ Sect. 7, Sept. 4, 1975 *Tans 1976*); "dry roadside, south shore Lake Wingra, UW-Arboretum," (Dane County, Sept. 5, 1971 (*Reardon 045,* OSH).

7. Verbena x hybrida Voss ex Rumpler
Garden Verbena

Herb, annual or perennial. Stems freely branched, procumbent, forming mats to 1 m wide, densely hirsute or villous. Leaves 1.5-8 cm long, 1.5-8 cm wide, *dentate,* truncate to cuneately narrowed to petiole, both sides densely soft pubescent. Spikes a flat-topped corymb, the flowers large and showy. Bractlets 5-6 mm long, lanceolate, shorter than calyx, densely soft pubsecent. Calyx 8-15 mm long, densely white-hirsute. Corolla showy, variously colored (blue, deep violet, red, etc.), usually with a prominent *central white "eye,"* 10-25 mm broad, the tube 15-30 mm long.

A polymorphic hybrid of uncertain ancestry, supposedly involving the South American *V. platensis, V. phlogiflora, V. incisa, V. peruviana,* and *V. tenera* (Moldenke 1963b), commonly cultivated as an ornamental throughout the world, known in Wisconsin only from gardens since at least the 1860's (*T. J. Hale s.n.* WIS). 2n = 10, 20 (Furusato 1940).

8. Verbena bipinnatifida Nutt.
Cutleaf Verbena

Herb, annual or perennial. Stems erect or procumbent, diffusely branched, hispid-hirsute. Leaves 2-6 cm long, ovate in general outline, delicately bipinnatifid or tripinnatifid with the divisions deeply cleft. Spikes, canescent, with showy flowers in dense flat-topped clusters. Bractlets 8-9 mm long, narrowly lanceolate, surpassing the calyx. Calyx 6-7.5 mm long with 2-3 mm long setaceous teeth. Corolla pink to rose, purple or blue, *8-10 mm wide,* the tube about 10 mm long and 1.3-1.5 times as long as the calyx. Nutlets cylindric, 2-3 mm long. 2n = 30 (Solbrig 1959).

Primarily a Great Plains and southwestern United States species, ranging from South Dakota to Missouri and Georgia, west to Texas and Arizona (cf. map in Moldenke 1962a), the only Wisconsin collection from a Green County roadside (T3N R9E Sect. 21, May 24, 1969, *Maurer 311* OSH).

Hybridization Among Native Species of Verbena

The Vervains native to Wisconsin (Sect. VERBENA) are all wide ranging sympatric species interfertile with one another. All are diploid, with x = 7 (2n = 14). Ecological factors, no doubt, were responsible for isolating species and preventing hybridization in pre-settlement times. Now, however, Vervains are common in many disturbed sites, especially where human activities have eradicated some or all of the native flora, as for example in pastures. Of the three *Verbena* hybrids in Kansas studied by Poindexter (1962), all were found in overgrazed pastures, roadsides or waste places.

Hybridization is enhanced not only by their tolerance of disturbance, with the resultant breakdown of ecological isolation, but also by their extended flowering periods (2½ to 3½ months), allowing any two spe-

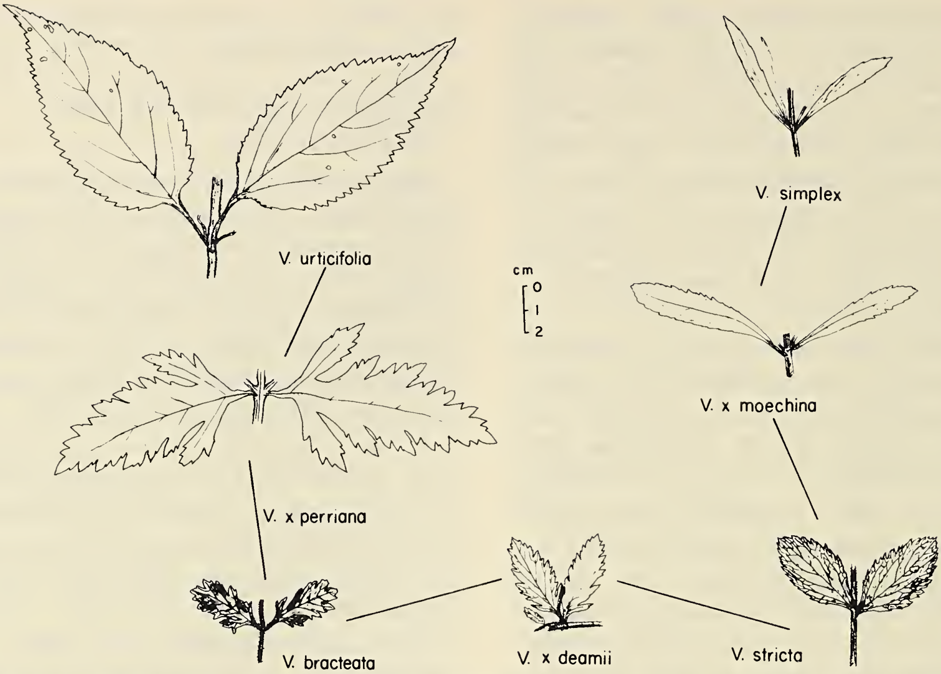


Fig. 4. Middle stem leaves of *Verbena urticifolia, V. bracteata, V. stricta* and *V. simplex* and their hybrids native to Wisconsin.

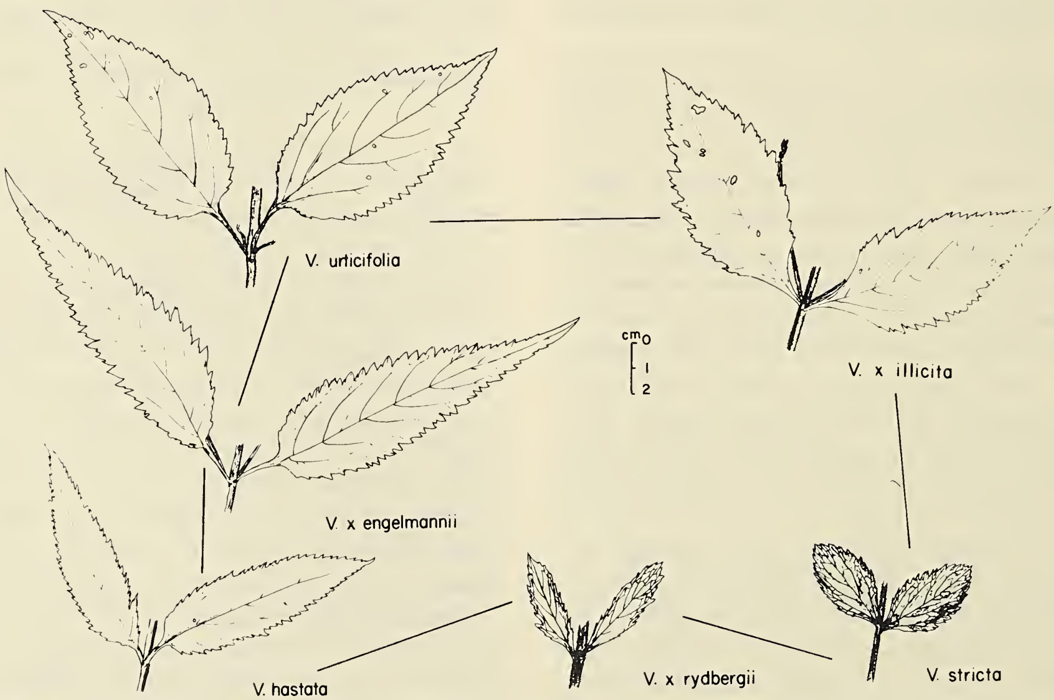


Fig. 5. Middle stem leaves of *Verbena urticifolia, V. hastata* and *V. stricta* and their hybrids native to Wisconsin.

cies to flower contemporaneously, and by the wide variety of pollinators from many insect orders.

Even though first generation hybrids are relatively common in *Verbena,* the vast majority of Vervains encountered in the field are not hybrids. Introgression, apparently, is limited, for the distinctness of the parental species has not been reduced as, for example, in *Tradescantia, Iris,* or *Helianthus.* As the parental species themselves are well adapted to disturbed sites, such introgressants may have no competitive advantage, and, due to partial sterility, may have relatively short survival.

The following six hybrids occurring in Wisconsin often can be recognized by intermediate leaf shape (Figs. 4, 5), pubescence, flower size, and inflorescence, as well as reduced fertility, and the nearby presence of their parental species.

VERBENA X DEAMII Moldenke
Deam's Vervian Map 8.

Intermediate between *V. bracteata* and *V. stricta.* Ascending to procumbent, resembling *V. bracteata* in habit, but with larger, less laciniate, and reticulate leaves, larger flowers, and bractlets usually not foliaceous, the spikes more slender than in *V. stricta,* often poorly fruited, the leaves, stems, branches and inflorescences softly villous.

Known from the central United States where the parental species are sympatric, in Wisconsin, from Brown County ("Bay Settlement" July 19, 1883, *Schuette s.n.,* DS), this erroneously attributed by Moldenke (1963a) to Pierce County, perhaps because the town of "Bay City" is located there.

VERBENA X ENGELMANNII Moldenke
Engelmann's Vervain Map 8.

Intermediate between *V. hastata* and *V. urticifolia.* Resembling *V. urticifolia* but with denser, often poorly-fruited spikes usualy with overlapping calyces, and blue to purple flowers, the leaves coarsely serrate to biserrate, larger than those of *V. hastata,* the leaves, stem, branches and inflorescences from nearly glabrous to evenly pubescent. Corolla tube and calyx intermediate in length, and pollen fertility reduced (Poindexter 1962).

Occurring in northeastern United States where the parental species are sympatric, in Wisconsin known from some 17 collections from moist open woods, roadsides, stream edges and wet meadows.

VERBENA X ILLICITA Moldenke
Bastard Vervain Map 9.

Intermediate between *V. stricta* and *V. urticifolia.* Resembling *V. urticifolia* in habit, the spikes denser with some of the mature calyces overlapping, often poorly fruited, but similar to *V. stricta* in its densely pubescent leaves, stems, branches and inflorescences. Nutlet length and ribbing and calyx and corolla lengths intermediate, the pollen fertility greatly reduced (Poindexter 1962).

Known primarily from the central United States where the parental species are sympatric, in Wisconsin only from Crawford (*A. R. Moldenke 995,* KANU, U), Iowa (*A. R. Moldenke 1003* KANU) (Moldenke 1965) and Winnebago Counties (Oshkosh, July 30, 1909, *M. K. Clemens s.n.,* POM) (Moldenke 1964a).

VERBENA X MOECHINA Moldenke Map 9.

Intermediate between *V. simplex* and *V. stricta.* Resembling *V. simplex* in habit, with oblanceolate leaves, but with a dense, short pubescence on leaves and stem, as well as smaller flowers and shorter bractlets, often poorly fruited.

In Wisconsin known only from Rock County "on north side of St. Lawrence Ave., 1.4 miles west of Paddock Road, T1N R11E Section 36," (*Souter & Rice 1692,* July 31, 1972 *BELC UWJ*), (*Tans 1431,* August 23, 1975 *WIS*), a small population in roadside gravel and in an abandoned limestone quarry, growing with *V. stricta* and such prairie plants as *Asclepias verticil-*

lata, Andropogon gerardi, Eragrostis spectabilis. Kuhnia eupatorioides, Ratibida pinnata, and *Solidago nemoralis.* While the other parent, *V. simplex,* could not be found nearby, a notation on the sheet of V. simplex collected from Rock County (*Furnish s.n.,* July 24, 1971, UWJ) by W. Rice suggests that it may be mislabeled, its probable collection site being a small gravel pit in Sect. 36, Newark Township, this, in fact, the site of *V.* x *moechina.*

VERBENA X PERRIANA Moldenke
Perry's Vervian Map 10.

Intermediate between *V. bracteata* and *V. urticifolia.* Sometimes a large, diffuse plant, stouter than *V. bracteata* and erect when young, often decumbent at maturity, the leaves much larger than in *V. bracteata,* laciniate, the larger often with two basal lobes characteristic of *V. bracteata,* the *bracteata,* the bractlets equalling to surpassing the calyx.

Known from eastern and central United States where the parental species are sympatric, in Wisconsin from Sauk Co. (Baraboo in 1861, *Hale s.n.,* WIS); Dane Co. (1858, *Shears s.n.,* WIS; Madison in 1860's?, *Hale s.n.,* WIS); Waukesha Co. (Aug. 22, 1891, *Dunlap 9163,* MIL); and Marquette Co. (roadside, T14N R10E NW¼ Sect. 31, Oct. 3, 1958, *Iltis 12,361,* WIS). According to Moldenke (1964b), known from La Crosse Co. (La Crosse, July 20, 1887, *L. H. Pammel s.n.,* ISC); Lafayette Co. (Shulsburg, July 19, 1883, *Manning s.n.,* NY); and Milwaukee Co. (*J. S. Douglas s.n.,* WJC).

VERBENA X RYDBERGII Moldenke
Rydberg's Vervian Map 10.

Intermediate between *V. stricta* and *V. hastata* and resembling either parent. Leaves wider and more deeply serrate than *V. hastata,* but reticulate and velutinous beneath, fruits irregularly produced. Intermediate in leaf length/width ratio, nutlet length, corolla and calyx lengths with pollen fertility greatly reduced (Poindexter 1962).

Occurring in central and eastern United States where the parental species are sympatric, in Wisconsin known from some 15 collections from river bottom forests, dry prairies and, most frequently, roadsides and pastures.

2. PHYLA Lour. Fog-fruit

A small, mostly tropical New World genus of 10 species with only the following in Wisconsin:

1. PHYLA LANCEOLATA (Michx.) Greene
Fog-fruit Map 11.

Lippia lanceolata Michx.
Lippia lanceolata Michx. var. *recognita* Fern. & Grisc.

Herb, perennial. Stems *creeping,* to 8 dm long, simple or branched at the base and *rooting at the nodes,* occasionally with ascending flowering branches, evenly pubescent with *short malpighiaceous* (attached at their center) *hairs.* Leaves 2-8 cm long, 6-30 mm wide, lanceolate to narrowly ovate, sharply serrate above the middle, evenly pubescent on both surfaces. Heads dense, *borne singly or in pairs from middle and upper leaf axils on 4-12 cm long peduncles,* at first globose, later to 15 cm long and cylindrical. Flowers sessile, solitary, in the axils of short bractlets 2-3 mm long. Calyx membranous, 2 mm long, compressed and keeled, 2-fid. Corolla white or flushed with purple, 2.5-3 mm long, salverform the slender tube cylindrical, surpassing the calyx, the limb oblique, somewhat 2-lipped, 4-lobed. Stamens included to barely exserted. Fruit globose, 1-1.2 mm long, dividing into 2 nutlets. 2n = 32 (Smith 1966); 2n = 36 (Lewis 1961).

Widespread across the United States and northern Mexico, in Wisconsin south of the Tension Zone, a "tropical element" of open habitats such as sunny, dry to wet sands or silt along major streams, most frequent along the lower Wisconsin and Mississippi Rivers on gravel bars and sandy mudflats, upstream as far as Columbia and Pierce Counties, also along the lower Kickapoo River, Galena River in Lafayette County, Sugar and Rock Rivers and Fox and Wolf Rivers in Winnebago and Waupaca Counties, occasionally on bare lake shores.

Flowering from the second week of July through the first week in October, fruiting from late July through October.

Literature Cited

Beale, G. H. 1940. The genetics of *Verbena.* I. J. Genetics **40**:337-358.

Correll, D. S., and M. C. Johnston. 1970. Manual of the Vascular Plants of Texas. Texas Research Foundation, Renner. 1881 p.

Cronquist, A. 1968. The Evolution and Classification of Flowering Plants. Houghton Mifflin Co., Boston. 396 p.

Curtis, J. T. 1959. The Vegetation of Wisconsin. University Wis. Press, Madison. 657 p.

Deam, C. C. 1940. Flora of Indiana. Indiana Dept. Conservation, Indianapolis. 1236 p.

Derman, H. 1936. Cytological study and hybridization in two sections of *Verbena* Cytologia **7**:160-175.

Dix, R. L. 1959. The influence of grazing on the thin-soil prairies of Wisconsin. Ecology **40**:36-49.

Federov, A. A. (ed.). 1969. Chromosome Numbers of Flowering Plants. Leningrad. 926 p. Reprint 1974, Otto Koeltz Science Publishers, Koenigstein, West Germany.

Fernald, M. L. 1936. Plants from the outer coastal plain of Virginia. Rhodora **38**:414-452.

———. 1950. Gray's Manual of Botany. 8th Ed. Amer. Book Co., New York. 1632 p.

Furusato, K. 1940. Polyploid plants produced by colchicine. Bot. and Zool. (Tokyo) **8**:1303-1311.

Gleason, H. A. 1963. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. The New York Botanical Garden, New York. Vol. **3**:125-139.

———, and A. Cronquist. 1963. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. D. Van Nostrand Reinhold Co., Princeton. 810 p.

Hartley, T. G. 1966. The Flora of the "Driftless Area." Univ. Iowa Stud. Natural History **21**:1-174.

Iltis, H. H. 1957. Preliminary reports on the flora of Wisconsin. No. 39. Phrymaceae-Lopseed Family. Trans. Wis. Acad. **46**:105.

Jackson, R. C. 1960. Documented chromosome numbers of plants. Madrõno **15**:220.

Jennings, O. E. 1953. Wild Flowers of Western Pennsylvania and the Upper Ohio Basin. Univ. Pitt. Press, Pittsburgh. Vol. 1, 574 p.

Jones, G. N., and G. D. Fuller. 1955. Vascular Plants of Illinois. Univ. Ill. Press. Urbana. 593 p.

Junell, S. 1934. Zur Gynaceummorphologie und Systematik der Verbenaceen und Labiaten. *In* Federov, A. (ed.). Chromosome Numbers of Flowering Plants. 1969. Leningrad. 926 p.

Kanda, M. 1920. Field and laboratory studies of *Verbena.* Bot. Gaz. **69**:54-71.

Lewis, W. H. 1961. Index to plant chromosome numbers for 1961. M. S. Cave, ed. Univ. North Carolina Press, Chapel Hill. 1962.

Lewis, W. H. and R. L. Oliver. 1961. Cytogeography and phylogency of the North American species of *Verbena.* Amer. J. Bot. **48**:638-643.

Moldenke, H. N. 1937. Notes on new and noteworthy American plants. Revist. Sudamer. Bot. **4**:15-20.

———. 1940. Verbenaceous novelties. Amer. Midl. Nat. **24**:750-754.

———. 1958. Hybridity in the Verbenaceae. Amer. Midl. Nat. **59**:333-370.

———. 1961-65. Materials toward a monograph of the genus *Verbena.* I-XXIX. Phytologia, vols. 8-11 (a series of 29 consecutively numbered publications) as follows:

1962a. III. **8**:175-216.
1962b. V. **8**:274-328.
1962c. VI. **8**:371-384.
1963a. X. **9**:59-97.

1963b. XII. **9**:189-238.
1964a. XIV. **9**:351-407.
1964b. XX. **10**:271-319.
1964c. XXV. **11**:155-213.
1965. XXIX. **11**:435-507.

———. 1966-77. Additional notes on the genus *Verbena.* Phytologia vols. 13-36. (A series of 27 consecutively numbered publication.)

———. 1971. A Fifth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World as to Valid Taxa, Geographic Distribution and Synonymy. Braun-Brumfield, Inc., Ann Arbor, Mich. 2 Vol., 974 p.

———. 1972-77. A fifth summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the world as to valid taxa, geographic distribution, and synonymy. Phytologia 23-36 (a series of 7 consecutively numbered supplements to the fifth summary).

———. 1974. Notes on new and noteworthy plants. LXIX. Phytologia **28**:401-404.

———. and A. L. Moldenke. 1946. A brief historical survey of the Verbenaceae and related families. Plant Life **2**:13-98.

Mulligan, G. A. 1961. Chromosome numbers of Caandian weeds. III. Canad. J. Bot. **39**:1057-1066.

Noack, K. L. 1937. Die Chromosomenzahlen einiger *Verbena.* Cited in Federov, A. (ed.). Chromosome Numbers of Flowering Plants. 1969. Leningrad. 926 p.

Parry, C. C. 1852. Systematic catalogue of plants of Wisconsin and Minnesota made in connection with the geological survey of the Northwest, during the season of 1848. *In* Owen, David Dale. 1852. Report of a Geological Survey of Wisconsin, Iowa, and Minnesota; and Incidentally of a Portion of Nebraska Territory. Pp. 606-622. Lippincott, Grambo Co., Philadelphia.

Patermann, H. 1935. Beitrage zur Zytologie der Verbenaceen. Cited in Federov. (ed.). Chromosome Numbers of Flowering Plants. 1969. Leningrad. 926 p.

Perkins, W. E., J. R. Estes, and R. W. Thorp. 1975. Pollination ecology of interspecific hybridization in *Verbena.* Bull. Torrey Bot. Club **102**:194-198.

Perry, L. M. 1933. A revision of the North American species of *Verbena.* Ann. Mo. Bot. Gard. **20**:239-362.

Poindexter, J. D. 1960. Documented chromosome numbers of plants. Madrõno **15**: 220.

———. 1962. Natural hybridization among *Verbena stricta, V. hastata,* and *V. urticifolia* in Kansas. Trans. Kansas Acad. Sci. **65**:409-419.

Radford, A. E., H. E. Ahles, and E. R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. Univ. North Carolina Press, Chapel Hill. 1183 p.

Smith, E. B. 1966. IOPB Chromosome numbers reports VII. 1966. Taxon **15**:155-163.

Solbrig, O. T. 1959. Documented chromosome numbers of plants. Madrõno **15**:51.

Steyermark, J. A. 1963. Flora of Missouri, Iowa State Univ. Press, Ames. 1725 p.

Swink, Floyd. 1974. Plants of the Chicago Region. Ed. 3. The Morton Arboretum, Lisle, Ill. 474 p.

Thorne, Robert F. 1976. A phylogenetic classification of the Angiospermae. Evol. Biol. **9**:35-106.

Umber, Ray E. 1979. The genus *Glandularia* (Verbenaceae) in North America. Systematic Bot. **4**:72-102.

Wadmond, S. C. 1932. Notes from southeastern Wisconsin. Rhodora **34**:18-19.

Zufall, C. J., and W. O. Richtmann. 1943, 1944. A Pharmacognostical study of certain American species of *Verbena.* Pharmaceutical Archives **14**:60-96; **15**:1-9.

A MASS BALANCE OF NITROGEN IN WISCONSIN

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Abstract

A mass balance of nitrogen (N) in Wisconsin, with emphasis on the flows and reservoir sizes in agriculture, was constructed. The model assumes steady state and is on an annual basis. The data used were available statistics and literature values. The calculations show that fixation of N by legumes is an important component of the agricultural nitrogen balance, estimated at about 2.5 times the inputs of N from fertilizer. The N fixed by legumes, when cycled through animals and returned as wastes or when plowed under as residues, is a major input to the soil organic N, and eventually available N pools. Further evaluation of this phase of the cycle, particularly the net mineralization estimate, is needed. Such evaluation is required to improve the efficiency of use of N fertilizer and minimize agricultural impacts on the environment.

Introduction

Nitrogen is a key element in crop production; of the essential elements supplied from the soil or fertilizers, it is required in the highest amounts and is the element most often inadequate (Viets, 1965). Recent increases in fertilizer nitrogen prices resulting from rising energy costs have focused attention on the need for a better understanding of N in agriculture. Of equal importance are the potential environmental impacts of the increased flow of fixed N from man's activities. These include: high nitrate in potable waters, associated with toxicities from methemoglobinemia (NRC, 1978); excessive productivity (eutrophication) of surface waters (Keeney, 1972); formation of carcinogenic nitrosamines (NRC, 1978); and ozone depletion in the stratosphere linked to production of nitrous oxide during denitrification (Crutzen and Ehalt, 1977).

Evaluation of human influence on the flows and storage of N in the environment is difficult because of the numerous diffuse sources of N, and its many biological and chemical conversions. A first and important step in this evaluation is the construction of a materials (mass) balance. A mass balance permits study of the behavior of an element or compound in a defined system. This is contrasted to the more common pollution monitoring methods, which are expensive and do not detect serious impacts until after they have occurred. The mass balance method emphasizes interactions between components in the system and thus facilitates prediction of future impacts. Further, it serves as an organizational tool and permits evaluation of information gaps and data needs.

The mass balance approach also has formidable problems. Usually the data base is insufficient, and verification by independent method is difficult. The degree of aggregation of various pools and transformations is also important; usually aggregation increases as the complexity of the system increases. For example, a global mass balance for N would have much higher degree of aggregation than a confined laboratory system. Assigning ecosystem boundaries is also a problem. Since N transfers are linked to atmospheric and water transport vectors, political boundaries are seldom realistic. However, they have the dual advantage that the data base is more readily defined from available

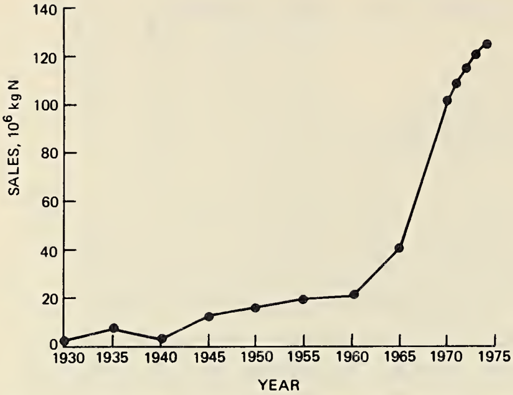

Fig. 1. Nitrogen fertilizer sales in Wisconsin, 1930-1975. Data from Wisconsin Department of Agriculture, October 1975.

statistics, and practical decisions on material flows are often made at the political level.

My colleagues and I often deal with difficult questions about the sources, fate and impact of N in Wisconsin agriculture. The exercise reported here is an attempt to construct a meaningful statewide N mass balance at low cost. Data are from published statistics and the scientific literature. A steady-state system is assumed, and the flows are on an annual basis.

The State

Wisconsin is largely a rural state, with a mixed cash grain, dairy, vegetable crop, and general farm-based agriculture. The total area is 14.64×10^6 ha, with 54 percent in farmland. In 1974, there were 105,000 farms, averaging 75.6 ha. The population was 4.6 million, with a heavy concentration around Milwaukee and its surrounding counties. About 179,000 workers are employed on farms. In 1973, gross farm cash receipts were $2,540 million, with dairy products accounting for $1,198 million and livestock products for $690 million of the gross income (Wisconsin Agricultural Statistics, 1975).

Table 1. Area in corn grown for grain, rate of application of nitrogen fertilizer, crop yield, and nitrogen removal in grain for Wisconsin, 1964-1974.

Year	*Hectares*	*Fertilizer N applied*	*Average yield*	*Crop N removed*
		kg/ha		
1964	577,000	32	4710	65
1968	710,000	70	5960	82
1970	752,000	76	5150	71
1972	867,000	89	5960	82
1974	919,000	70	4270	59

Nitrogen Inputs

Fertilizer

The use of nitrogen fertilizer has increased rapidly in Wisconsin in the past decade (Fig. 1). In 1974, Wisconsin used 127×10^6 kg, about 1.5 percent of the U.S. consumption of 8.5 million metric tons.

The area in corn grown for silage, about 400,000 ha, has remained roughly constant in recent years. However, the area devoted to corn that is grown for grain increased more than 59 percent in the past decade, and the average fertilizer N rates have more than doubled (Table 1). The statewide average yields of corn (about 80 percent of the corn grain is raised in the southern and eastern portions of the state) reflect the effects of weather, however, more than they do N fertilizer rates. For example, the summer of 1970 was hot and dry, and corn yields suffered from lack of moisture. In 1974, a late spring coupled with an early killing frost resulted in a short growing season and low yields. Hence, in 1974 (the year I chose for this balance) N removal by corn was below average.

Nitrogen Fixation

Symbiotic N fixation, mainly by alfalfa, is a major part of Wisconsin's agricultural N budget (Table 2), but the amount of N added to the soil when an alfalfa stand is plowed under is difficult to estimate. There are no data on accumulation of N by plant roots for stands of alfalfa more than 6 to 9 months old. Several long-term experiments with crop rotations under conditions found in Wisconsin indicate that an alfalfa

TABLE 2. Nitrogen removal by legumes in Wisconsin.

Crop	10^3 ha	N removed[a] kg/ha	N removed[a] 10^6 kg	Residual N kg/ha	Residual N 10^6 kg
Alfalfa	1,215	162	197	56	68
Mixed hay[b]	385	88	34	28	11
Soybeans	88	72	6.3	−24	−2
Snap beans	25	13	0.4	0	0
Field peas	53	26	1.4	0	0
Total	1,766		239		77

[a] From estimates in Boone and Welch (1972), Johnson et al. (1975), Welch (1972), and Wisconsin Agricultural Statistics (1975).
[b] Largely red clover and timothy mixture.

meadow will supply the equivalent of about 120 to 135 kg/ha of fertilizer N (Rohweder and Powell, 1973; Shrader and Pierre, 1966). The availability of N in legume residues ranges from 28 to 50 percent of the equivalent amount of fertilizer N (Shrader and Pierre, 1966). Assuming that the uptake of fertilizer N is about 70 percent, the residues of N in alfalfa amount to about 170 kg/ha. Since these residues accumulate over the lifetime of the average crop rotation (about 3 years in Wisconsin), I estimated the input of alfalfa-N to the soil reserve at 56 kg N/ha-yr and of mixed hay systems at half this amount (28 kg N/ha-yr). Soybeans fixed about two-thirds of the N they remove (Johnson, Welch and Kurtz, 1975).

The rate of nonsymbiotic N fixation in various ecosystems was estimated by Burns and Hardy (1975) as follows: cropland, 5 kg N/ha-yr; grassland, 15 kg N/ha-yr; forests, 10 kg N/ha-yr. Fixation in wetlands and surface waters was estimated at 20 kg N/ha-yr and includes fixation in sediment as well as that by algae in the water (Macgregor and Keeney, 1975).

Precipitation

A recent survey of N in precipitation in Wisconsin (Hoeft, Keeney and Walsh, 1972) gave a weighted average flux of 3.5 kg NO_3-N, 3.5 kg NH_4-N, and 7.5 kg particulate N (total N minus inorganic N) per hectare per year. Particulate N is assumed to be derived largely from windblown soil material, and thus its net contribution is zero. Undoubtedly some of the N in precipitation comes from agricultural activities through volatilization from fertilizers and manure. In this sense, the estimated inputs of nitrogen in Wisconsin precipitation involve some double accounting (that is, an input is counted twice).

Total Inputs

Total inputs of N for various Wisconsin land uses in 1974 are summarized in Table 3. Agriculture (categories 1-5) received 585×10^6 kg N/ha-yr, with 21 percent from precipitation, 62 percent from biological fixation, and 10 percent in feed supplements.

NITROGEN REMOVAL BY CROPS AND NITROGEN TRANSFERS

Nitrogen removal by nonleguminous crops in Wisconsin was calculated on the basis of N contents of various crops (Agricultural Research Service, 1971; Boone and Welch, 1972; Welch, 1972) and on the basis of reported yields (Wisconsin Agricultural Statistics, 1975). An estimated 144×10^6 kg of N were removed in 1974 (Table 4).

Some of the crop N is transferred out of the state in grain and vegetables and in animal products; some is used in the state and reappears in the production of wastes by the animal and human populations. A large amount of protein concentrate is imported. Estimates for these N transfers are given in Tables 4 and 5.

ANALYSIS OF INPUT, OUTPUT AND TRANSFER ERRORS

Of the N inputs listed in Table 3, the quality of the estimates of fertilizer and precipitation sources can be considered good. In contrast, there is undoubtedly some error in the estimates of symbiotic and nonsymbi-

TABLE 3. Estimated nitrogen inputs to Wisconsin, 1974.

		Source of nitrogen (10^6 kg N)[a]			
Land use	*10^3 ha*	*Nitrogen fixation*	*Fertilizer*	*Import of feed supplements*	*Inorganic nitrogen in precipitation*
Grain, cereals, potatoes	2,025	10	115	—	14.0
Alfalfa, mixed hay	1,600	316	0	60	11.0
Soybeans	88	4	0	—	0.6
Specialty crops	99	2	12	—	0.7
Pastures	1,795	27	0	—	13.0
Forest and idle land	7,573	76	0	—	53.0
Urban	200	1	0	—	1.4
Wetlands and water	1,260	26	0	—	9.0
Total	14,640	462	127	60	103
Total nitrogen added			752×10^6 kg/yr		

[a] From estimates in Welch (1972), Burns and Hardy (1975), Johnson et al. (1975), and Wisconsin Agricultural Statistics (1975).

TARLE 4. Nitrogen transfers for Wisconsin farm products, 1974[a].

		Transfers			
Product	*Annral production as N*	*Within state*	*Exports*	*Total*	*Residual in soil*
	10^6 kg N				
Crop products (nonlegumes)					
Corn grain	65	40	14	54	11
Corn silage	31	31	0	31	0
Small grains	30	23	4	27	3
Specialty crops	6	3	2	5	1
Pasture	27	27	0	27	0
Total	159	124	20	144	15
Crop products (legumes)					
Alfalfa	317	238	0	238	79
Soybeans	6	6	0	6	–2
Total	323	246	0	246	77
Animal products					
Dairy	68	13	55	68	—
Eggs	10	5	5	10	—
Meat	19	18	1	19	—
Feeding & breeding livestock	5	0	5	5	—
Total	112	36	66	102	—

[a] Estimates from Agricultural Research Service (1971), Boone and Welch (1972), Welch (1972), Wisconsin Agricultural Statistics (1975). Corn grain, 138 kg N/1,000 kg; corn silage, 3.3 kg N/1,000 kg; sweet corn. 35 kg N/1,000 kg; wheat, 31 kg N/1,000 kg; barley and rye, 18 kg N/1,000 kg; oats, 20 kg N/1,000 kg; potatoes, 2.8 kg N/1,000 kg.

TABLE 5. Nitrogen as human or animal wastes produced annually in Wisconsin.

Producer	Population (millions)	kg N/yr per unit[a]	Total produced (10^6 kg N)
Humans	4.6	6.0	28
Cattle	4.64	52.0	240
Swine	1.40	7.0	10
Sheep	0.10	9.0	1
Chickens			
Laying	6.8	0.6	4
Broilers	11.3	0.2	2
Turkeys	4.6	0.4	2
Total			287

[a] From estimates in National Research Council (1972) and Taiganides and Stroshine (1971).

otic N fixation. However, inputs from nonsymbiotic N fixation are relatively small, particularly in the agricultural sector. Inputs from symbiotic fixation have been estimated from data on crop harvests (Table 2). Fixation of N by alfalfa is by far the largest component of such inputs. A range of ±10 percent in the N content of alfalfa is likely in practice, giving a range in removal of 197 ± 20 × 10^6 kg N. A further source of error is the allocation of residual N from alfalfa, an important value because it affects the size of the pool of available N in the balance, as discussed later. Alfalfa also takes up some N from the soil; accounting for this transfer would reduce the net value of the contribution by legumes through fixation. The estimate used in Table 2 is based on observation of the relative yield response of corn and alfalfa fields the first year after plowing. The actual value will depend on weather and farm management practices and it is therefore difficult to estimate possible error.

Nitrogen production and transfer estimates (Table 4) were made by multiplying accepted values for the N content of each product by the appropriate production, consumption, or export data, available from Wisconsin Agricultural Statistics (1975). Similarly, N waste production values were obtained by multiplying accepted per-unit N excretion values by the populations. The N transfer and waste production values (Tables 4 and 5) are thought to be reliable, with the possible exception of the data for pastures (Table 4), where N uptake was equated to N fixation. This estimate would be low if the N in the excreta of grazing cattle were considered, and high if considerable immobilization of N were occurring in the topsoil. On balance, the estimate seems low, since uptake of 22 kg N/ha (40 × 10^6 kg N/1.8 × 10^6 ha of pastureland; Tables 3 and 4) is equivalent to the production of only about 1500 kg (1.5 percent N in herbage)/ha of dry matter. However, since extensive data on the productivity of Wisconsin pastures are lacking, no better estimates are available.

AGRICULTURAL NITROGEN BALANCE IN WISCONSIN

Estimates of the sizes of pools and fluxes of N in Wisconsin agriculture are presented in Figure 2. Two models were examined for their applicability in this exercise. One involved consideration of the total soil N as the receptor of the annual N flux, assuming steady state in this pool. The pool of organic N in the soil in Wisconsin was estimated, assuming 0.15 percent N (4000 kg N/ha in 20 cm of soil), for a total of 22,500 × 10^6 kg N. This pool is several orders of magnitude larger than any of the N inputs (see Table 3 and Fig. 2). Thus, the steady-state assumption with respect to soil organic N would have to be extremely accurate to permit estimation of an output by difference (Kohl, Shearer and Vithayathil, 1977).

The problem can be overcome in part by considering the pools of available N and slowly-available organic N in the soil to be dynamic. The steady-state assumption can be applied with greater accuracy to the soil available N pool because this would not be expected to vary markedly on an annual basis. This pool, which is essentially the inorganic N in the root zone, also is of the same magnitude as the annual N fluxes. Experi-

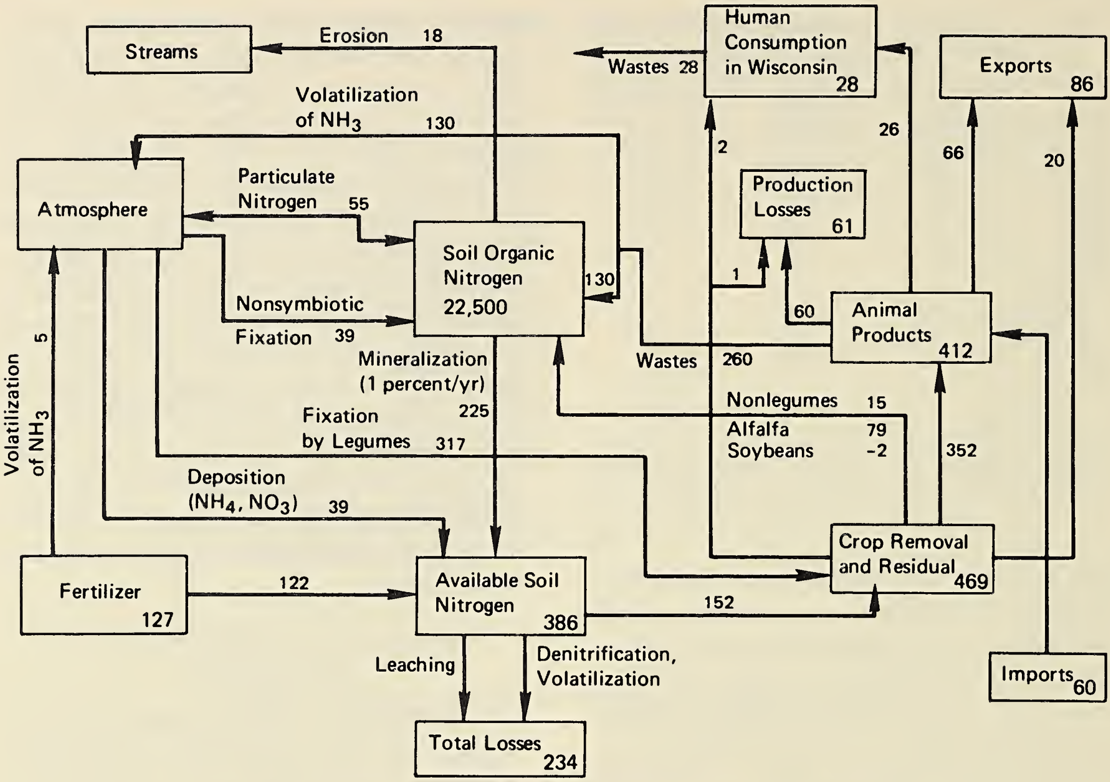

Fig. 2. The flow of nitrogen in Wisconsin agriculture in 1974. Pool sizes and fluxes are expressed in 10^6 kg N.

ence has shown, however, that the main problem with the latter approach is in estimating the net mineralization from the soil organic N pool. This is particularly true in respect to the assignment of mineralization (availability) rates of crop residues and manure, two major inputs to the Wisconsin agricultural N budget.

Rather than assign separate mineralization values to various inputs of organic N, I treated them as an integral part of the soil pool of organic N, and estimated a mineralization rate for this pool. It was assumed that inputs of organic N from crop residues and manure are small relative to the total pool of organic N in the soil. Net mineralization of N from the organic pool is normally considered to range between 1 and 3 percent a year (Bremner, 1967). Under the cool temperate conditions in Wisconsin, the lower value is probably more realistic. Thus, net mineralization was estimated at 225×10^6 kg N/yr. Other inputs to the soil pool of available nitrogen are 39×10^6 kg N/yr from the atmosphere and 122×10^6 kg N/yr from fertilizers.

The organic N input from manures was estimated at 130×10^6 kg N/yr assuming 50 percent loss from volatilization (Frere, 1976). Total annual input from plant residues was estimated at 94×10^6 kg N, and nonsymbiotic fixation was estimated at 39×10^6 kg N/yr. The total input of organic nitrogen was thus 263×10^6 kg N/yr. Nitrogen outputs by erosion to streams were estimated at 3 kg N/ha-yr (Shrader and Pierre, 1966), for a total loss of 18×10^6 kg N/yr by that route. Although inputs to and outputs from the pool of organic N are nearly balanced, unknown errors in the assumptions are too great to determine net gain or loss in this pool.

The uptake of N from the pool of available N in soil was estimated at 152×10^6 kg N/yr, or 39 percent of the total flux (386×10^6 kg N/yr) in that pool. The value was obtained by the difference between the total for removals and residual N, and the estimate for fixation by legumes. This estimate is reasonably close to the 50 percent value commonly cited for overall efficiency of N uptake by crops, especially considering that 1974 was a year of relatively poor corn harvests. The remainder of the total flux, 234×10^6 kg N/yr, or 42 kg N/ha-yr, is assumed to be lost to the environment by leaching and denitrification, but present data do not permit apportioning this loss between the two routes. Furthermore, an analysis of potential errors in estimates is difficult. If the estimate of the pool of organic N were in error by ± 10 percent, and if actual net mineralization ranged from 1 to 1.5 percent, the per hectare loss of nitrogen would range from 36 to 66 kg/yr. This loss seems high and could be the result of overestimation of the rate of mineralization of soil organic N, or of underestimation of the amount of inorganic N taken up by legumes. The high degree of aggregation also limits the usefulness of the model, which reveals little about possible site-specific problems (e.g., much of the agriculture is in the fertile lands in the southern part of Wisconsin).

Most of the crop N is transferred to animals, and the majority of this N is transferred to wastes (Fig. 2). Volatilization is estimated to be a major loss of N from the system. This output has not been balanced by an equivalent atmospheric input, because some of this ammonia is deposited on nonagricultural lands and some is transferred by the prevailing winds across the state boundary.

Human consumption of grain and meat, and exports from the state, account for 114×10^6 kg N (27 percent of the harvested plant N). Human waste production (Table 5) does not equate exactly with the estimated consumption of food N (Fig. 2). The difference may be the result of losses in food preparation, or of errors in estimates of the transfer functions. The amount of N in human wastes that is now deposited on land in Wisconsin is negligible.

The N in the animal products compartment is partitioned into wastes and edible products. Fifty-six percent of the total (260×10^6 kg N) was estimated to be transferred as wastes. Production losses, the unaccounted for portion of the animal products pool, represent about 14.6 percent of the total (60×10^6 kg N). This value seems high, and suggests some errors in the analysis.

Summary and Conclusions

Because Wisconsin is largely a rural state, the N mass balance is dominated by agriculture. However, it differs from the Corn Belt states in that the major N input is from symbiotic N fixation by legumes in association with the livestock (primarily dairy) industries. Of the 585×10^6 kg of N estimated to be cycled in Wisconsin agriculture in 1974, fertilizer N supplied 22 percent, N fixation 61 percent, and atmospheric N 7 percent. Crops remove about 65 percent of the total N cycled, and a major portion of this N estimated at about 68 percent, reappears as animal wastes.

Despite some of the large uncertainties, several interesting points emerge from this mass balance. For example, in good crop years corn production required more N than was added to the soil while in poor years, excess fertilizer N was added. The model does point out that about twice as much N is imported into the state as is exported in food and feed products, and that better utilization of manure and legume residue N might help bring imports more in balance with exports. The use of an "available soil N" pool indicated that the system is relatively more responsive to fertilizer N than the proportion of fertilizer N input to agriculture would indicate. Hence, a doubling in fertilizer use would more than double the losses of N in the system. However, it also indicates that at present fertilizer N does not appear to be causing a statewide pollution problem.

Acknowledgments

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Literature Cited

Agricultural Research Service. 1971. Nutritive value of foods. Home and Garden Bulletin 72, Consumer and Food Economics Institute, U.S. Dept. Agric., Washington, D.C.

Boone, L. V. and L. F. Welch. 1972. The more nitrogen in corn, the less in our water supply. Illinois Res. **14**:5-7.

Bremner, J. M. 1967. Nitrogeneous compounds, p. 19-66. *In* A. D. McLaren and G. H. Peterson (eds.) Soil biochemistry, Volume I. Marcel Dekker, Inc., New York.

Burns, R. C. and R. W. F. Hardy. 1975. Nitrogen fixation in bacteria and higher plants. Springer-Verlag, Inc., New York.

Crutzen, P. J. and D. H. Ehalt. 1977. Effects of nitrogen fertilizers and combustion on the stratospheric ozone layer. Ambio **6**: 112-117.

Frere, M. H. 1976. Nutrient aspects of pollution from cropland, p. 59-60. *In* Control of water pollution from cropland, Volume Illinois Res. **14**:3-4.
II—An overview. Report Nos. EPA-600/2-75-026b and ARS-H-5-2, U.S. Dept. Agric. and U.S. Environmental Protection Agency, Washington, D.C.

Hoeft, R. G., D. R. Keeney and L. M. Walsh. 1972. Nitrogen and sulfur in precipitation and sulfur dioxide in the atmosphere in Wisconsin. J. Environ. Qual. **1**:203-208.

Johnson, J. W., L. F. Welch and L. T. Kurtz. 1975. Environmental implications of N fixation by soybeans. J. Environ. Qual. **4**: 303-306.

Keeney, D. R. 1972. The nitrogen cycle in sediment-water systems. J. Environ. Qual. **2**:15-29.

Kohl, D. H., G. Shearer and F. Vithayathil. 1977. Some comments on nitrogen mass balance studies. Paper presented at the Lake Arrowhead Conference on Nitrogen, Lake Arrowhead, California, January 1977.

Macgregor, A. N. and D. R. Keeney. 1975. Nutrient reactions, p. 237-257. *In* N. F. Stanley and M. P. Alpers (eds.) Man-made lakes and human health. Academic Press, London.

National Research Council. 1978. Nitrates: An environmental assessment. National Academy of Sciences, Washington, D.C. 723 p.

Rohweder, D. A. and R. Powell. 1973. Grow legumes for green manure. Fact Sheet A2477, Univ. of Wisconsin Extension, Madison.

Shrader, W. D. and J. J. Pierre. 1966. Soil suitability and cropping systems, p. 1-26. *In* W. H. Pierre, S. R. Aldrich and W. P. Martin (eds.) Advances in corn production: Principles and practices. Iowa State Univ. Press, Ames, IA.

Taiganides, E. P. and R. L. Stroshine. 1971. Impact of farm animal production processing on the total environment, p. 95-98. *In* Livestock waste management and pollution abatement. Proceedings Internatl. Symposium on Livestock Wastes, Ohio State University, Columbus.

Viets, F. G. 1965. The plant's need for and use of nitrogen, p. 503-509. *In* W. V. Bartholomew and F. E. Clark (eds.) Soil nitrogen. Agronomy 10, Am. Soc. Agron., Madison, WI.

Welch, L. F. 1972. More nutrients are added to soil than are hauled away in crops.

Wisconsin Agricultural Statistics. 1975. Wis. Dept. Agric. and U.S. Dept. Agric., Madison, WI.

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN NO. 68. CAPRIFOLIACEAE—HONEYSUCKLE FAMILY

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Department of Botany
University of Wisconsin-Milwaukee

An earlier study (Wade & Wade, 1940) described the food and cover values for wildlife and the distribution of the native species of the Caprifoliaceae. This study expands that work by including descriptions of the native and adventive genera and species, updating the nomenclature and distribution records, supplying additional habitat information and including keys to the identification of various taxa. Most of this information was compiled from specimens in the herbaria of the University of Wisconsin-Madison (WIS), University of Wisconsin-Milwaukee (UWM), Milwaukee Public Museum (MIL), University of Minnesota (MIN), University of Wisconsin-Oshkosh (WSO), University of Wisconsin-LaCrosse (UWL) and the University of Wisconsin-Stevens Point (UWSP). Other sources are cited in the text.

Dots, triangles and crosses on the maps indicate exact locations where specimens have been collected. The numbers within the map corner inserts indicate the number of specimens noted which were flowering or fruiting in the respective months and indicate when the species may be expected to flower or fruit in Wisconsin. Specimens in vegetative conditions, in bud or with immature fruits were not included. The nomenclature and descriptive features generally follow Gleason and Cronquist (1963) and Fernald (1950); however, more recent taxonomic treatments of certain taxa are discussed in the text or cited in the bibliography.

Grateful acknowledgment is made to the curators of the above herbaria for the loan of specimens; to many of my students who supplied additional specimens for examination; and to Dr. Hugh H. Iltis for his suggestions in the preparation of this report as well as his critical reading of the manuscript.

CAPRIFOLIACEAE A. L. DE JUSSIEU HONEYSUCKLE FAMILY

Upright, climbing or trailing shrubs or rarely perennial herbs (*Triosteum*) with opposite, simple or compound, mostly exstipulate (except in *Sambucus* and *Viburnum*), deciduous or sometimes evergreen leaves. *Flowers regular or irregular, epigynous, perfect or rarely sterile, subtended by 2-4 bracts or bracteoles,* in corymbs, cymes, in spike-like whorls at the tips of branches or in pairs in the axils of leaves. Calyx of 3-5 small or tooth-like sepals. Corolla gamopetalous, 3-5 lobed, rotate, tubular or campanulate, sometimes gibbous near the base and often bilabiate. Stamens 4-5, epipetalous, alternating with the corolla lobes; filaments long or short; anthers oblong or linear, longitudinally, dehiscent and versatile. *Ovary inferior, 2-5-locular* with 1-many seeds (stones) per locule.

A family of 18 to 20 genera and about 500 species, chiefly of the North Temperate Zone, with many species in eastern Asia and eastern North America and several species ranging southward in mountainous areas to South America, Australia and New Zealand.

In two regional floras (Fernald, 1950; Gleason & Cronquist, 1963), the family Caprifoliaceae is included, with the morphologically similar and largely tropical family Rubiaceae, in the order Rubiales. Some authors have suggested uniting them into one family; however, Ferguson (1966) listed several problems of such a union.

Hillebrand and Fairbrothers (1969, 1970a, and 1970b) have concluded, from serological investigations, that some genera of the Caprifoliaceae (*Sambucus* and *Viburnum*) are more closely related to the genus *Cornus* (Cornaceae) than to other genera of either the Caprifoliaceae or Rubiaceae. In the classification systems proposed by Cronquist (1963), Takhtajan (1969) and Thorne (1968), the Caprifoliaceae is placed in the order Dipsacales, which also includes the families Adoxaceae, Valerianaceae, Dipsacaceae and Calyceraceae. More detailed investigations are needed on the relationships of these families and this report will not include the Caprifoliaceae in a specific order.

Key to Genera

A. Corolla rotate or nearly so, regular; style very short or absent; stigmas 3 or 3-lobed.
  B. Leaves pinnately compound; fruit berry-like with 3 stone-like seeds. .... 1. SAMBUCUS.
  BB. Leaves simple; fruit a drupe with 1 stone-seed .... 2. VIBURNUM.
AA. Corolla campanulate, funnelform or tubular, often more or less irregular or bilabiate; style elongate; stigma capitate.
  C. Herbaceous perennials; flowers sessile in the axils of cauline leaves. .... 3. TRIOSTEUM.
  CC. Shrubs or woody vines; flowers in corymbs, cymes, whorled spikes or pedicelled in pairs in the axils of cauline leaves.
    D. Trailing or creeping shrubs, slightly woody at the base; stamens 4. .... 4. LINNAEA.
    DD. Erect shrubs or climbing woody vines; stamens 5.
      E. Corolla campanulate; ovary 4-locular; fruit a 2-seeded berry. .... 5. SYMPHORICARPOS.
      EE. Corolla funnelform, tubular or bilabiate; ovary 2-5-locular; fruit fleshy or dry, several seeded.
        F. Fruit a capsule, with persisting calyx lobes; leaves serrate. .... 6. DIERVILLA.
        FF. Fruit a berry, with short or non-persisting calyx lobes; leaves entire. .... 7. LONICERA.

Tribe SAMBUCEAE HBK. ex DC.

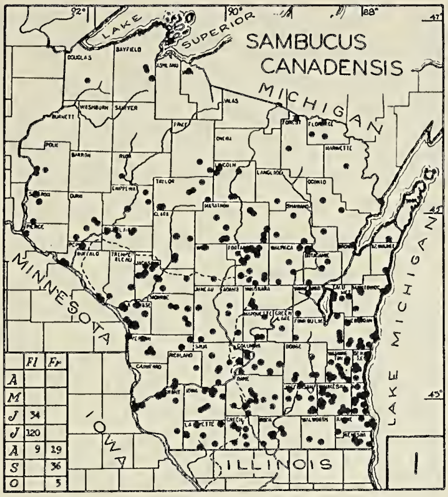
1. SAMBUCUS L. Elderberry

Tall shrubs or small trees, often spreading from root sprouts, with grayish, sometimes warty, bark and *stems with large piths. Leaves pinnately or rarely bipinnately compound,* with serrate leaflets and sometimes having small stipules or glands at the bases of the petioles. Flowers small, whitish, regular in terminal bracteolate compound cymes or panicles. Calyx of 5-teeth, or nearly absent. Corolla rotate, 5-lobed, with a short tube. Stamens 5, inserted near the base of the corolla; filaments slender, short; *anthers short, oblong, extrorse.* Ovary 3-5-lobed. Fruit a drupaceous berry containing 3-5 stone-like seeds.

A genus of about 20 species, widespread in the North Temperate Region; approximately ten species occurring in North America, including several introduced from Eurasia. The two species native in Wisconsin may be distinguished as follows:

Key to Species

A. Flowers in flat-topped umbelliform cymes; pith white; fruits black. .... 1. S. CANADENSIS.
AA. Flowers in ovoid cymes or panicles; pith brown; fruits red. 2. S. RACEMOSA.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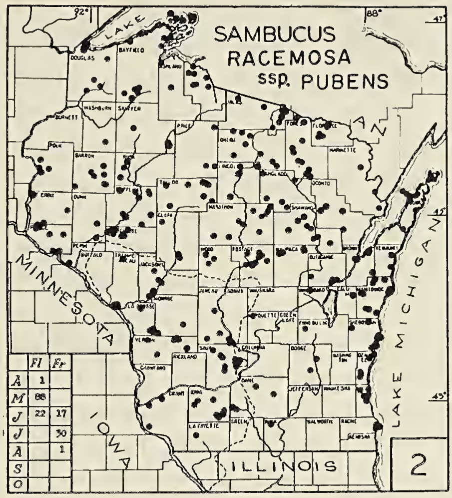
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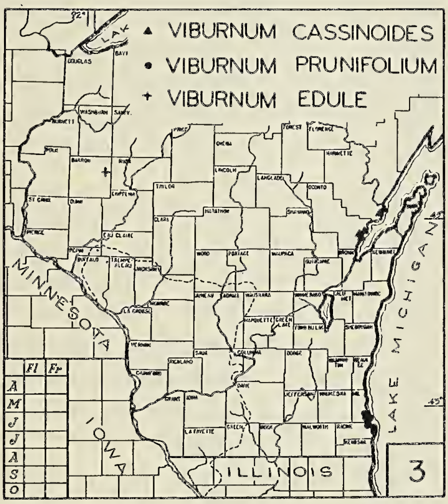
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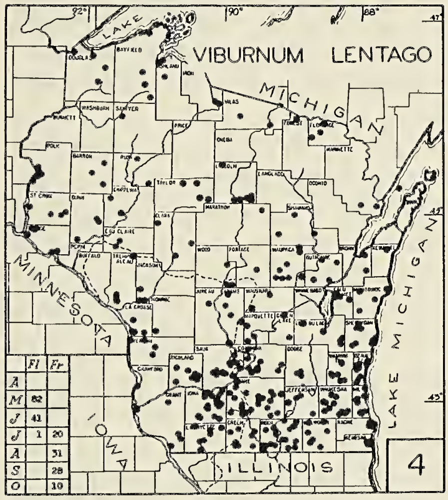
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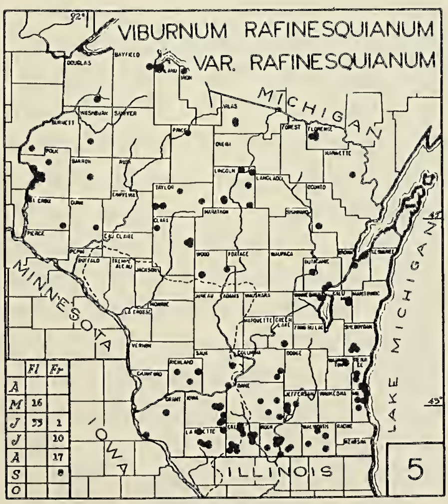
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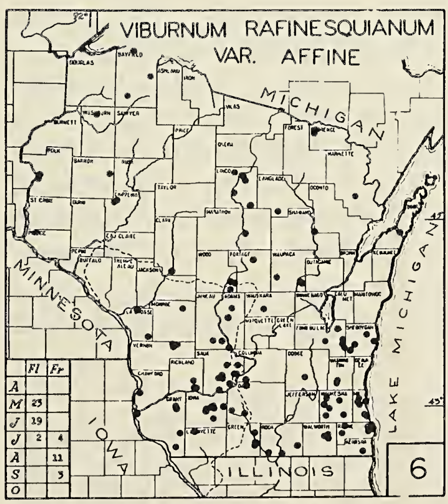
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1. Sambucus canadensis L. var. canadensis Common Elder Map 1.

Shrub up to 4 m tall, readily sprouting from the roots and bearing *flowers and fruits in flat-topped terminal cymes,* 10-20 cm broad. Stems and branches with grayish-brown, smooth to slightly rough bark and *large white pith. Leaves pinnately compound; leaflets 5-11,* lanceolate to elliptic, 5-15 cm long and 3-6 cm wide, sharply serrate, acuminate at the tips and with rounded bases, short-stalked, essentially glabrous on both surfaces or sometimes hirtellous on the veins beneath. Flowers white, rotate, 5-6 mm wide, fragrant. *The drupaceous berries purplish-black* (rarely red, yellow, orange or green), 5-6 mm in diameter, with 3-5 (usually 4) stone-like seeds. Ripe fruits are used for making pies, pancakes, jellies and wine. 2N = 36.

Widespread in Wisconsin on moist or damp soils bordering upland woods, edges of swamps and bogs, in sedge meadows, along banks of streams and lakes and in lowland woods. Less common in mesic or dry deciduous or coniferous woods, especially in northern and northwestern counties. It is widely planted as an ornamental in parks, yards and along fencerows. A number of horticultural varieties have been described (Bailey, 1949) based on variations in fruit color, leaf color and dissection of leaves. The var. *laciniata Gray,* which should be more appropriately designated as a form, often escapes to railroad embankments and waste areas. Pith of this species is often used in botanical laboratories for holding specimens in preparation for freehand sectioning. Flowering chiefly from mid-May to August; fruiting in August to October.

2. Sambucus racemosa L. subsp. pubens (Michx.) Hulten Red-berried Elder Map 2.

Sambucus pubens. Michx.

Sambucus racemosa L. var. *pubens* Wats.

Tree-like shrub, up to 3 m tall, with flowers and fruits in *paniculate inflorescences. Stems grayish with warty bark, brown pith and finely pubescent twigs. Leaves pinnately compound; leaflets 5-7,* ovate-lanceolate to narrowly oblong, 5-12 cm long and 2-6 cm wide, with finely serrate margins, acuminate tips and rounded bases and more or less downy pubescent beneath. Flowers yellowish-white, ill-scented, similar in size and form to *S. canadensis.* Fruits *bright red* (sometimes greenish, white or yellow) *drupaceous berries* with 3-5 stone-like seeds; edible when ripe. 2N = 36.

Fernald (1950) and Gleason and Cronquist (1963) list this shrub as a distinct species, *S. pubens* Michx., although the latter authors suggest it may be considered a variety of the Eurasian species, *S. racemosa* L. Hulten (1970) investigated the Asian, European and American taxa and concluded they should be considered as subspecies of one polymorphic species. His treatment is followed in this report.

Variations in dissection of leaves, pubescence and color of flowers and fruits have been given varietal or forma designations and are listed in Bailey (1941) and Fernald (1950). Several specimens with finely dissected leaves (f. *dissecta* (Brit.) Fern.) were noted in several herbaria, but were too few in number to be mapped.

Native to the boreal and northern hardwood forests of North America (Newfoundland and New England to Alaska, southward to Oregon, South Dakota, northeastern Iowa, northern Illinois and Indiana and in the eastern uplands to Tennessee and Georgia). In Wisconsin it is more common northward in open conifer woods, mixed conifer-deciduous forests, rich maple woods and at the bases of rocky bluffs and along stream banks, southward it occurs infrequently in ravines and along cool stream valleys in the southeast and along moist stream banks and cool slopes on sandstone bluffs and in rocky woods in central and southwestern Wisconsin. Flowering late-April to early-June; *fruiting mid-June to early-August.*

Two European species, *S. nigra* L. and

S. Ebulus L. have been introduced into eastern North America and have been reported as becoming established along roadsides and in waste areas; however, no specimens have been noted in any Wisconsin herbarium.

Tribe VIBURNEAE Fritsch

2. VIBURNUM L. Viburnum

Deciduous (some introduced species are evergreen) erect or decumbent shrubs or small trees. Leaves simple, opposite or rarely whorled, entire, serrate, dentate or lobed, glabrous or pubescent (sometimes with stellate hairs), petioled, exstipulate or stipulate (some stipules reduced to glands). Flowers perfect or occasionally sterile, regular, subtended by cauducous bracts and bracteoles, in terminal or axillary compound cymes or panicles. Calyx of 5 tooth-like lobes, persistent. Corolla rotate to broadly campanulate, 5-lobed, white or sometimes pinkish. Stamens 5, inserted near the base of the corolla; filaments slender; anthers oblong, 4-lobed introrse. *Ovary 3-locular, only one fertile with a single pendulous ovule;* style short; stigma 3-lobed. *Fruit a globose or ellipsoid, 1-seeded drupe, topped by the persistent calyx.*

Chiefly a North Temperate Zone genus of about 250 species of which 25 are native to North America. Three or four Asian and European species have become naturalized. This complex genus has been divided into nine sections based on the shape and furrowing of the stone-seeds, winter buds and leaf venation. Wisconsin species are included in the sections: *Lantana* Spach, *Lentago* (Raf.) DC., *Odontotinus* Rehder and *Opulus* DC. Many of the species are widely planted as ornamentals in city, county and state parks, home yards, arboretums and botanical gardens. A detailed list of cultivated species in the University of Wisconsin Arboretum was compiled by Wood (1976). Fruits of most species are eaten by a variety of birds and wildlife.

Key to Species

A. Leaves pinnately veined, not lobed.
- B. Leaves entire, wavy-margined or finely serrate, the lateral veins curved and branching near the margins, not terminating in the teeth; buds naked or with one pair of scales.
  - C. Lower surfaces of leaves and branchlets stellate-pubescent; winter buds naked. .... 1. V. lantana.
  - CC. Lower surfaces of leaves and branchlets glabrous or scurfy, not stellate pubescent; winter buds with one pair of scales.
    - D. Inflorescence definitely peduncled; margins of leaves entire, undulate to crenate. .... 2. V. cassinoides.
    - DD. Inflorescence sessile or nearly so; margins of leaves serrate or serrulate with sharp teeth.
      - E. Leaves mostly with sharp acuminate tips; branchlets slender and whip-like. .... 3. V. lentago.
      - EE. Leaves with acute, obtuse or nearly rounded tips; branchlets stiff, often nearly at right angles to the main branches. .... 4. V. prunifolium.
- BB. Leaves dentate, the lateral veins straight or with only 1-2 branches and terminating in the teeth; buds with 2 pairs of scales. .... 5. V. rafinesquianum.

AA. Leaves palmately veined and, except for the uppermost pairs, mostly palmately lobed.

F. All flowers perfect, regular; petioles without stipules or glands.
G. Leaves stellate-pubescent beneath; drupes blue-black .... 6. V. ACERIFOLIUM.
GG. Leaves glabrous or with only simple hairs beneath; drupes yellow-orange to red. .... 7. V. EDULE.
FF. Marginal flowers sterile, with enlarged and more or less irregular corollas; petioles with stipules at the bases and glands at the summit.
H. Glands at the tips of the petioles stalked and round-topped; stipules with thickened tips. .... B. V. TRILOBUM.
HH. Glands at the tips of the petioles sessile or nearly so, cup-shaped; stipules filiform with slender tips. .... 9. V. OPULUS.

SECTION LANTANA Spach

1. VIBURNUM LANTANA L. Wayfaring Tree

Shrub, up to 5 m high, with *cinerous-stellate pubescent branchlets and naked winter buds.* Leaves broadly ovate, oblong-ovate to nearly oval, 5-12 cm long and nearly and broad, acute or obtuse at the tips and rounded to cordate at the bases, the margins finely serrate and both surfaces stellate-pubescent; petioles 1-2 cm long, pubescent. Flowers perfect, white, 4-18 mm wide, in short-peduncled cymes about 5-10 cm broad; stamens exceeding the corolla lobes. Fruits flattened, ovoid drupes, 8-10 mm in diameter, red but becoming dark purple-black at maturity. 2N = 18.

Introduced from Eurasia and commonly planted in home yards, parks and other landscaped areas; frequently escaping to adjacent open woods, roadsides and along fencerows. Because few specimens outside of cultivation were noted in the various herbaria, the extent of naturalization in Wisconsin could not be mapped. Flowering May-June; fruiting late August to September. *V. carlesii* Hensl. (Carleś Viburnum), which differs in having fragrant salverform flowers and leaves with more widely spaced serrations, is often planted as an ornamental and may occur in similar habitats.

SECTION LENTAGO (Raf.) DC.

2. VIBURNUM CASSINOIDES L. Witherod; Wild Raisin Map 3 (triangles).

Shrub, up to 4 m tall, with smooth to *brownish-scurfy branchlets and winter buds covered by a pair of connate, yellow or golden scurfy scales.* Leaves lanceolate, ovate, obovate to oval, 3-12 cm long and 2-6 cm wide, on scurfy petioles, the tips short-acuminate, bases rounded to tapering, *margins subentire to crenate,* pinnately veined with the lateral veins curved and branching near the margins. Flowers perfect, white, ill-scented, with exserted stamens, in cymes 3-10 cm broad, on peduncles 0.5-2 cm long. Drupes flattened-ovoid to nearly subglobose, 8-10 mm in diameter, blue-black, but often appearing bluish because of dense bloom. 2N = 18.

Native to the northern hardwood forests of eastern North America, reaching its western limit in upper Michigan and northeastern Wisconsin where it occurs at the margins of moist woods, damp clearings and in damp or swampy shrubby areas. Wisconsin collections are only from Marinette and Oconto Counties. None of the herbarium specimens had flowers and only two had fruits, hence flowering and fruiting times are assumed to be similar to those of other Viburnums.

3. VIBURNUM LENTAGO L. Nannyberry; Sheepberry Map 4.

Tall shrub or small tree, up to 10 m, *with slender whip-like, ascending branchlets.* Winter buds slender-conical, 1-2 cm long, those with floral primordia with swollen bases, *enclosed by a pair of valvate, gray-scurfy scales.* Leaves ovate, elliptic-lanceolate to oblong, 5-10 cm long and 3-6 cm wide, on *wavy-margined petioles* 1-3 cm long, exstipulate, glabrous on both surfaces or sometimes reddish-scurfy on the veins beneath, *lustrous above,* the margins sharply serrulate, usually with sharply acuminate tips and acute to rounded bases, and the lateral veins curved and anastamosing before reaching the margins. Cymes sessile or on short peduncles (rarely exceeding 1 cm), 5-12 cm broad; flowers perfect, white, fragrant with exserted stamens. Fruits blue-black, glaucous, globose to ellipsoid drupes, 8-15 mm long, often persisting throughout the winter. 2N = 18.

Common throughout Wisconsin in moist borders of upland woods, in open floodplain woods, copses, thickets bordering swamps and bogs and on wooded lake and stream banks and seepage slopes; less common in dry upland woods, dry bluffs, roadsides and pastured woods. It is frequently planted as an ornamental in parks and to attract birds in home yards. Flowering mid-May to mid-June; fruiting July to October.

4. Viburnum prunifolium L. var. prunifolium Black Haw
Map 3 (dots).

Coarse shrub, up to 8 m tall, *with stiff branchlets, often nearly at right angles to the main branches,* the lower ones nearly thorn-like. Winter buds similar to *V. lentago,* but mostly 5-13 mm long and with *reddish-scurfy scales.* Leaves ovate, obovate-oblong to broadly elliptic, 3-10 cm long and 2-6 cm wide, on slightly margined petioles (0.5-2 cm long), exstipulate, the dull subcoreaceous blades with acute to rounded (rarely acuminate) tips and rounded to cuneate bases, serrulate margins, glabrous but sometimes pubescent with reddish scurf beneath and the less prominant lateral veins curving and branching near the margins. Cymes sessile or nearly so, 3-12 cm broad, the flowers white, perfect, slightly scented. Fruits blue-black, elliptical drupes, 7-15 mm long, persistent into the winter. 2N = 18.

Native to the deciduous forest region of eastern North America, reaching its westward limit in southeastern Wisconsin. The few Wisconsin specimens were collected in thickets and along margins of maple-beech woods in Milwaukee and Racine Counties. Absence from Kenosha County is probably the result of inadequate collecting. This shrub is often planted as an ornamental in horticultural gardens. Flowering and fruiting times are similar to those of *V. lentago.*

Section ODONTOTINUS Rehder

5. Viburnum rafinesquianum Schultes
Downy Arrowwood

Shrub, 1-3 m tall, with many branches from the base, the bark smooth, dark gray and the twigs yellow-brown. Winter buds with *two pairs of overlapping scales.* Leaves short-petioled, stipulate, the blades ovate, oblong-ovate to suborbicular, 2.5-10 cm long and 1-6 cm wide, with acute to acuminate tips and obtuse to subcordate bases, the *lateral veins straight or sometimes forking and extending to the 4-10 coarse dentations on each margin,* the upper surfaces glabrous or sparsely pubescent, the lower surfaces downy at least on the veins with both simple and stellate hairs. Cymes 1.5-7 cm broad, with 4-7 branches; flowers on pedicels 0.5-3.5 cm long, perfect, white, the corolla lobes rounded to sub-acute and finely serrate on the margins, only slightly recurved; hypanthia glandular. Fruits purplish-black, flattened, ellipsoid drupes, 6-9 mm broad. 2N = 36. Two varieties have been described, both occurring in Wisconsin:

5a. Viburnum rafinesquianum Schultes var. rafinesquianum Map 5.

Leaf blades pilose beneath; petioles 3-8 (mostly less than 7) mm long, often exceeded by the stipules. General distribution is from Vermont and southern Quebec to Manitoba, southward to Georgia, Kentucky and Missouri. Widespread throughout Wisconsin, in similar habitats, but more common, than the following variety.

5b. VIBURNUM RAFINESQUIANUM Schultes var. AFFINE (Bush) House Map 6.

Leaf blades glabrous beneath, except pilose on the veins or in the axils of the veins; petioles 5-12 (mostly about 10) mm long, usually longer than the stipules. Range extends from southern Ontario to Minnesota, southward to Virginia and Arkansas.

Intermediates with short petioles and sparsely pubescent blades or with long petioles and pubescent blades occasionally occur. Although var. *affine* is less common, both varieties are widespread in habitats ranging from dry to moist deciduous and northern hardwood stands, on rocky, sandy and ravine slopes, in thickets along fencerows, along power line right-of-ways and sometimes in dry, open or pastured oak woods and in clearing. Flowering mid-May to late-June; fruiting mid-July to late-September.

Two other species in this section often planted as ornamentals are: *V. molle* Mich. (Kentucky Viburnum), with long-petioled (2 cm or more) and deeply cordate leaves and *V. dentatum* L. (Southern Arrow-wood) with long-petioled leaves with rounded bases. The hardiness and the extent of establishment outside of cultivation of these species is not known.

6. VIBURNUM ACERIFOLIUM L. var. ACERIFOLIUM Maple-leaved Viburnum; Dockmackie. Map 7 (dots).

An erect, slender-branched shrub, 1-2 m tall, the branches upright, pilose at first becoming glabrate, and with scaly winter buds. Leaves elliptic to nearly orbicular, palmately veined, usually 3-lobed (rarely lobeless), 4-12 cm long and nearly as wide, with acute to acuminate tips, coarsely serrate to toothed margins and rounded to cordate bases, the upper surfaces glabrous to sparsely pubescent, *the lower surfaces downy with stellate pubescence and numerous reddish or black dots;* petioles 0.8-4 cm long, pilose to nearly glabrous; *stipules sometimes present.* Cymes 2.5-8 cm broad with white or pinkish flowers. Fruits purple-black (rarely white), ellipsoidal to globular drupes, 5-10 mm in diameter. 2N = 18.

Plants with pink flowers have been designated as f. *collinsii* Rouleau, those with white fruits as f. *eburneum* House and those with ovate, unlobed leaves as f. *ovatum* Rehd. Only f. *ovatum* has been observed sufficiently to be plotted (crosses) on Map 7.

Common in northern and central Wisconsin in mature northern hardwood forests, maple-beech-basswood forests and sometimes in jack pine stands, second-growth aspen and birch woods, on wooded talus slopes and rocky outcrops and in wooded ravines along the Lake Michigan shoreline. It is less common in southern Wisconsin in maple-basswood and oak woods. The absence of specimens in the westernmost counties indicates that this species probably reaches its western limit here. Rosendahl (1955) does not list this species for Minnesota. Flowering late-May to early-July; fruiting late-July to October.

SECTION OPULUS DC.

7. VIBURNUM EDULE (Michx.) Raf. Squashberry Map 3 (crosses).

An erect or straggling shrub, 0.5-2 m tall, with grayish bark, *glabrous, reddish-brown, ridged branchlets* and winter buds with 2 connate outer scales. Leaves nearly orbicular, 3-11 cm broad, palmately-veined and shallowly 3-lobed or some unlobed, the margins coarsely serrate, the upper surfaces glabrous, the lower surfaces more or less pubescent on the veins and *sometimes with glands above the junction with the petioles;* petioles exstipulate, 1-3 cm long. Cymes 1-3.5 cm broad, mostly 5-rayed, on short peduncles, bearing white, perfect flowers, 5-6 mm wide, with included stamens. Fruit a red or orange, ovoid to nearly globose drupe, 8-10 mm in diameter. Chromosome number not determined.

A boreal species which ranges from Labrador to Alaska, southward to New York, Ontario, northern Michigan and Minnesota and in the Rocky Mountains to Colorado and Oregon. It has been reported in only one locality in Wisconsin, at the base of a quartzite talus slope in the Barron Hills, near Leheigh in Barron County. The specimen cited was collected in 1933 and no other plants have been observed since; therefore, if it is not extinct it is one of the rarest plant species in Wisconsin. Flowering late-May to early-June; fruiting August to October.

8. Viburnum trilobum Marshall
American Highbush Cranberry; Pembina Map 8.

Viburnum opulus L. var. *americanum* Ait.
Viburnum opulus L. var. *trilobum* Marsh.
Viburnum opulus L. subsp. *trilobum* R. T. Clausen
Viburnum americanum of various authors, not Mill.

Coarse shrub or small tree, up to 4 m tall, with grayish bark and smooth branchlets bearing *reddish, ovoid, bluntly apiculate winter buds* which are enclosed by two connate scales. Leaves broadly ovate, 3-9 cm long and 3-6.5 cm wide, palmately-veined, 3-lobed, the lobes elongated and coarsely toothed and the bases obtuse, rounded or truncate, the upper surfaces glabrous or sparsely strigose, the lower paler and with scattered appressed hairs to nearly glabrous; petioles 1-2.5 cm long with *one or more pairs of stalked, round-topped glands at the tips and with one or two pairs of slightly clavate stipules at the bases.* Cymes 4-15 cm broad, on peduncles 2-6 cm long. Flowers white, perfect, 8-15 mm wide in the center of the inflorescence; sterile marginal flowers 15-18 mm wide, with slightly irregular corollas. Fruits orange to red, subglobose to ovoid pulpy drupes, 7-10 mm in diameter; edible and often used in jellies. 2N = 18.

Generally distributed throughout the state in poorly drained peaty soils, bogs, low swampy woods, moist alder thickets, edges of wet pastures and along moist stream and lake banks; infrequent on north-facing slopes, moist deciduous woods and mesic to dry wooded bluffs. Flowering May to June; fruiting July to September.

9. Viburnum opulus L. European Highbush Cranberry; Guelder Rose Map 9.

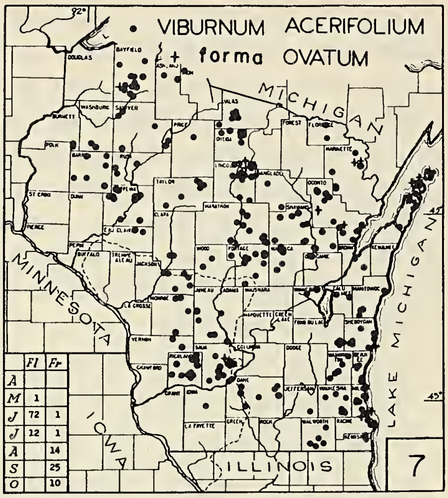
Viburnum opulus L. var. *opulus*

Similar to *V. trilobum* except the leaves are more rounded and the lobes less prolonged, *the petioles with sessile, concave-topped glands at the tips and the stipules are filiform or attenuate.* Fruits are more bitter and less pleasant to the taste than *V. trilobum,* often persisting through the winter. 2N = 18.

A horticultural variant, the snowball-tree, var. *roseum* L., with a rounded inflorescence and only sterile flowers, is sometimes planted as an ornamental.

This Eurasian species, frequently planted in parks, yards, botanical gardens and arboretums, has become established, probably through dispersal by birds, in open and pastured woods, along fencerows, in shrubby roadsides and in waste areas. The sparsity of records in the northern half of the state may be the result of limited collecting or the preference of botanists for the native species, *V. trilobum.*

The similarity in morphological features of *V. trilobum* and *V. opulus* is the reason some workers consider them as varieties or subspecies of *V. opulus.* Since no recent investigations have been carried out concerning actual or potential hybridization between them and because of distinguishing features of the petiolar glands, stipules, fruit taste, habitat preferences and their allopatric natural ranges, I have considered them to be distinct species.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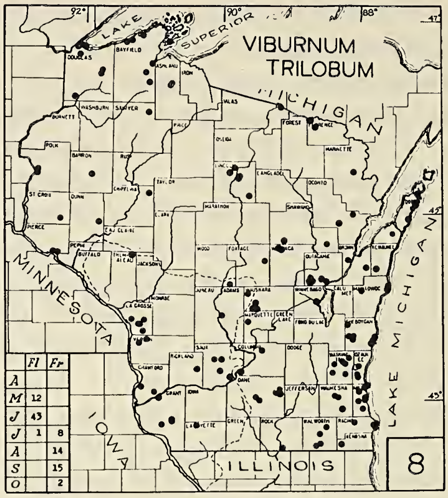
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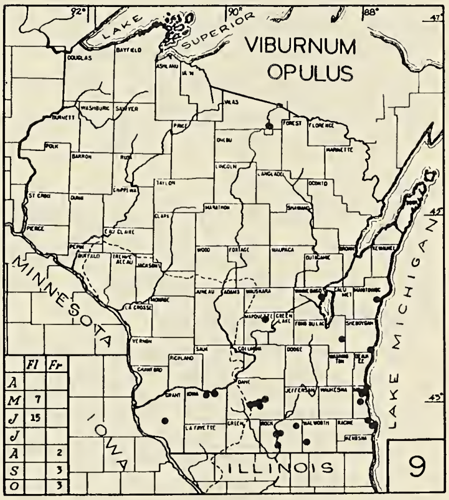
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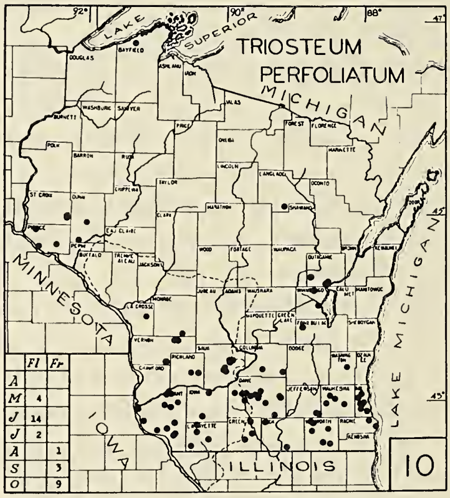
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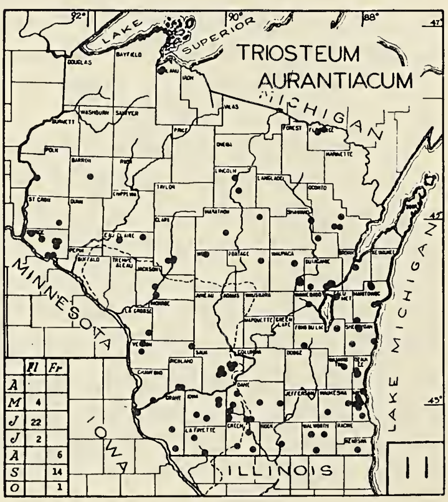
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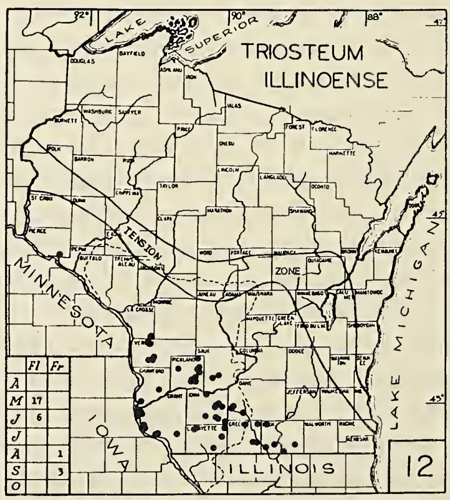
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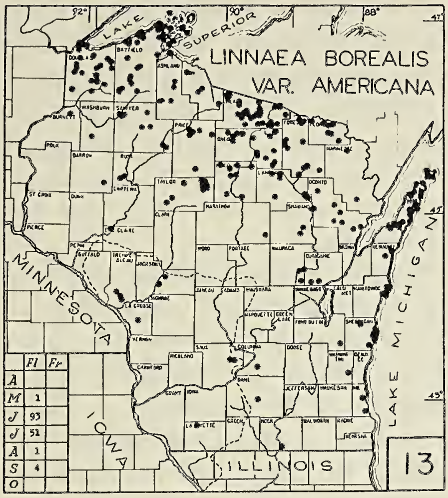
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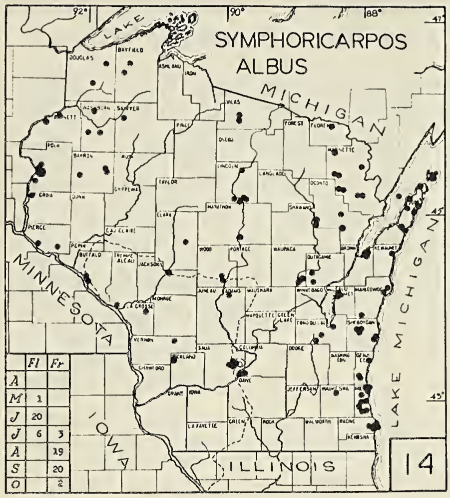
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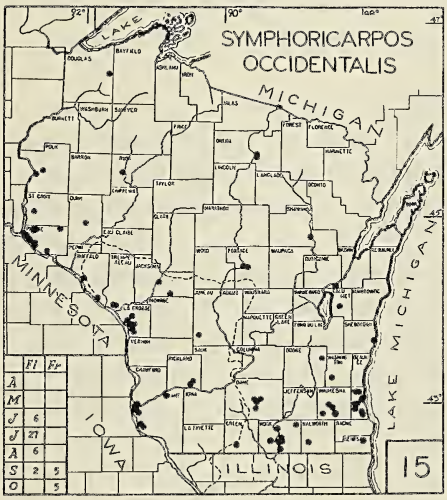
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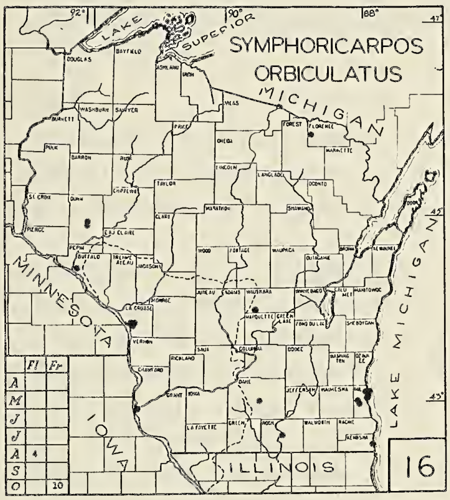
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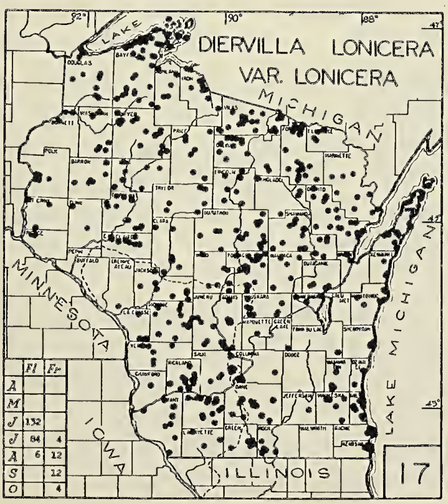
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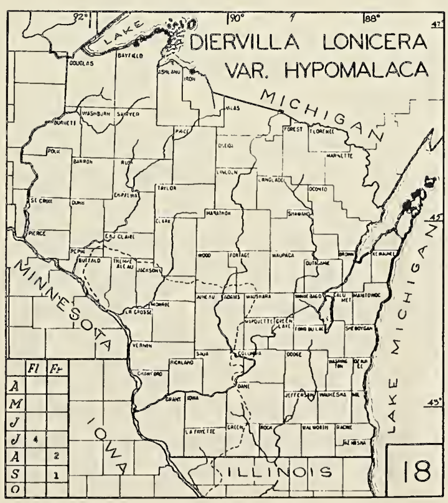
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J 4
A 2
S 1
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18

3. TRIOSTEUM L. Horse Gentian; Feverwort; Wild Coffee

Perennial herbs with erect, coarse, simple and more or less pubescent stems. Leaves opposite, entire, sessile, exstipulate, usually hairy, the blades obovate, oblanceolate to panduriform, tapering to the bases or connate about the stem. Flowers perfect, irregular, sessile, solitary or *in clusters of 2-4 in the axils of leaves,* subtended by bracts or bracteoles. Calyx of 5 linear-lanceolate, foliaceous lobes, persistent Corolla 5-lobed, slightly longer than the calyx, greenish-yellow to dull red, tubular, often hairy within and slightly gibbous at the base. Stamens 5, inserted about the middle of the corolla tube, usually included; filaments short, hairy; anthers linear to oblong, more or less united. Ovary 4-5-locular, but only 3 functional with a solitary ovule in each; style included or slightly exserted, usually hairy below; stigma capitate, 3-5-lobed. Fruit a yellow or red berry, crowned by the persistent calyx, enclosing 3 bony seeds, becoming hard and dry with age.

A genus of 10-12 species, chiefly in eastern Asia and eastern North America. Although included in the tribe Viburneae (Ferguson, 1966), other authors have placed this genus in the Caprifolieae (Lonicereae) or consider it between Viburneae and Linnaeeae. The taxonomic treatment of Lane (1955) is used for the Wisconsin taxa.

Key to Species

A. Principal leaves panduriform, with broadly connate-perfoliate bases; stems mostly glandular-pubescent, the abundant hairs chiefly less than 0.5 mm long; style exserted about 2 mm beyond the corolla; fruit yellow-orange. ....1. T. perfoliatum.

AA. Principal leaves mostly with narrow bases, sometimes narrowly panduriform and slightly connate at the bases; stems with both glandular and glandless hairs or chiefly with long glandless hairs, over 0.5 mm long; style equalling the corolla or included; fruit bright orange, red or reddish-purple.

B. Stems with glandless hairs, 0.5-1.5 mm long, overtopping shorter glandular hairs; fruit bright orange. ....2. T. aurantiacum.

BB. Stems with glandless hairs up to 3.0 mm long; fruit red or reddish-purple. ....3. T. illinoense.

1. Triosteum perfoliatum L. Tinker's Weed Map 10.

Triosteum perfoliatum L. var. *perfoliatum*

Coarse plant, 0.2-1.0 m tall, with a simple, *densely glandular-puberulent stem. The principal (middle) leaves strongly panduriform,* 1-3 dm long and 3-9 cm wide *with connate enlarged bases* 3-9 cm wide, the upper ones obovate to oblong-ovate, with attenuate bases, velutinous beneath, or glabrous to sparsely pubescent in f. *glaucescens* Weigand. Flowers erect, 3-4 in each leaf axil; calyx lobes 0.9-2 mm wide, with acute or attenuate tips; corolla tubular, slightly bilabiate, yellowish-green to dull purple, densely glandular, the mouth 5-6 mm wide; stamens about equalling the corolla; style usually exserted about 1.5-3.0 mm. Fruit yellow-orange, densely puberulent. 2N = 18.

Locally common in brushy fields, thickets and open woods, often in gravelly or rocky areas, less frequent in open fields or pastured woods, chiefly in the southern one-half of the state. Flowering mid-May to early-July; fruiting early August to October.

2. TRIOSTEUM AURANTIACUM Bicknell
Wild Coffee Map 11.

Triosteum aurantiacum Bicknell var. *aurantiacum*
Triosteum perfoliatum L. var. *aurantiacum* (Bicknell) Weigand

Similar to *T. perfoliatum* but *stems with both glandular and glandless hairs, the latter up to 1.5 mm long. Leaves ovate to oblong-ovate with long tapering bases,* rarely 1-3 pairs slightly panduriform and connate, the lower surfaces densely pubescent. Flowers mostly 1-3 in leaf axils; calyx lobes 1.5-2.8 mm broad, blunt or acute at the tips; corolla red-purple, distinctly bilabiate, the month 7-9 mm wide, exceeding the stamens; style mostly included. Fruit ellipsoid, bright orange-red. 2N = 18.

Plants with glabrous lower leaf surfaces have been designated f. *glaucescens* (Weigand) Lane, and plants with leaves in whorls of 3 have been observed, but no special taxonomic treatment has been described. Scattered throughout the state in rich moist soils along wooded river banks, in moist upland deciduous woods and, occasionally, in conifer-deciduous woods, dry open deciduous woods and in thickets. Flowering mid-May to late-June; fruiting August to October.

3. TRIOSTEUM ILLINOENSE (Weigand) Rydberg Horse Gentian Map 12.

Triosteum perfoliatum L. var. *illinoense* Weig.
Triosteum aurantiacum Bicknell var. *illinoense* (Weig.) Palmer & Steyermark.

Differing from *T. perfoliatum* and *T. aurantiacum* in the *stems having glandless hairs, 1.5-2.5 mm long,* and few or no glandular hairs; *upper leaf surfaces hispid-strigose with hairs up to 1 mm long; calyx ciliate,* with hairs exceeding 1.5 mm in length. Fruits red to reddish purple. Plants with glabrous lower leaf-surfaces have been designated f. *glabrescens* Lane. 2N = 18.

In open oak woods, lightly wooded rocky hillsides, open bluffs and infrequently on slopes above streams in southwestern Wisconsin, extending north to Vernon and Pierce Counties. The distribution pattern and preferences for drier habitats of this species suggests a phytogeographic history which may be associated with the extension of the prairie peninsula during post-glacial time (Iltis, 1963).

TRIBE LINNAEAE FRITSCH

4. LINNAEA Gronovius Twinflower

Trailing or creeping shrub with thin, slightly ligneus, stoloniferous stem and numerous short, erect leafy stems, 3-10 cm high. Leaves *evergreen,* broadly elliptical to suborbicular, 0.5-2 cm broad, slightly crenate above the middle, sparingly ciliate, with obtuse to acute tips and abruptly contracted at the bases into short petioles. *Flowers perfect, borne in pairs (infrequently 3-6) on erect, glandular-setulose peduncles 2-10 cm high.* Calyx of 5 subulate teeth, glandular pubescent. Corolla regular, funnelform to campanulate, 5-lobed, constricted at the base, white and tinged with rose-purple, pubescent within. Stamens 4, in pairs, included within and attached near the base of the corolla tube. Ovary 3-locular, with two abortive and one functional ovule, enclosed by the glandular-pubescent hypanthium; style slender, exserted; stigma capitate. Fruit a 1-seeded capsule (achene), up to 3 mm in diameter, topped by the persistent calyx. 2N = 32.

Named by Jan Fredrik Gronovius to honor the eminent taxonomist, Carolus Linnaeus (1707-1778), who was particularly fond of this plant, one of his portraits shows him holding it.

A circumboreal, and possibly monotypic genus (a morphologically similar taxon has been noted in China which may be a distinct species) with the species, *L. borealis* L., subdivided into Eurasian and American subspecies or varieties. The corolla of the Eurasian plants is companulate, mostly less than 10 mm in length with the tube flaring from within the calyx and the leaves are mostly orbicular to ovate, rarely elliptic. In contrast, our plants have a funnel-form corolla, often 10 mm or more long, with the tube flaring at or above the tip of the calyx teeth and the leaves are usually elliptic to obovate and less commonly orbicular. Gleason and Cronquist (1963) consider all American plants as *L. borealis* var. *longifolia* Torr., while Fernald (1950) and Hulten (1970) separate them into two varieties or subspecies. Hulten's treatment seems valid in considering the west coast plants, with longer corollas and more acute-tipped leaves, as distinct subspecies from the wide-ranging eastern and northern plants with shorter corollas and obtuse to nearly round-tipped leaves. Fernald (1950) also distinguishes between these two races, but designates them as varieties. It is also possible to consider the American entities as a distinct subspecies which contain two geographic races which may be designated as varieties. This latter treatment is used in this report to maintain the taxonomic treatment which has long been used.

The Wisconsin plants are designated:

1. Linnaea borealis L. var. americana (Forbes) Rehd. American Twinflower Map 13.

Linnaea borealis L. subsp. *americana* (Forbes) Rehd.
Linnaea borealis L. var. *longiflora* Torr.
Linnaea americana Forbes

Locally abundant in the northern one-third of Wisconsin (often with *Cornus canadensis, Trientalis borealis, Coptis trifolia, Clintonia borealis* and *Lycopodium* spp.) on hummocks and on decaying stumps and logs in sphagnum bogs, hemlock-hardwood forests, maple woods and pine forests, less common on sandy soils in pine woods. In southeastern Wisconsin it occasionally occurs in bogs or in wooded ravines along the Lake Michigan shore, while in central and southern parts of the state it persists in boreal relicts and sandstone rock outcrops. Flowering late-May to July; however, no mature fruits were observed on any Wisconsin specimens nor on any specimens from elsewhere in northeastern North America. Fernald (1950) and Gleason and Cronquist (1963) also mention little or nothing about the fruits. Polunin (1959) indicates the fruit size is about 3 mm long and remarks, "they are rarely developed." This species ranges throughout the boreal zone of the northern hemisphere, including the western cordilleran region of North America. The question arises as to how such a widespread migration could have occurred with such limited seed production. Apparently the climatic conditions favorable for seed production presumably present during the time of post-glacial migration no longer prevail, or occur sporadically, and the species is perpetuated where it presently occurs chiefly by vegetative propagation.

5. SYMPHORICARPOS Duhamel
Snowberry

Branching low, upright or arching shrubs, 0.3 to 2 m tall, sometimes sprouting from the roots and with *flowers or fruits sessile or on short pedicels in terminal or axillary racemes or spikes.* Winter buds with 2 pairs of scales. Leaves are ovate-oblong, oval to rotund, exstipulate, short petioled, entire to coarsely crenate or shallowly lobed with acute to rounded tips and bases. Flowers perfect, subtended by small bracts or bracteoles. Calyx 4-5 toothed, persistent. Corolla 4-5-lobed, white to purplish, regular or slightly irregular, campanulate to tubular-funnelform or salverform, sometimes slightly gibbous at the base and often villous within. Stamens 4-5, equal, inserted near the top of the corolla tube, included or exserted; filaments short, sometimes villous; anthers oblong or linear. *Ovary 4-locular, with 2 fertile 1-ovuled locules;* style glabrous or hairy, shorter than the corolla; stigma capitate or slightly lobed. Fruit a white or red globular or ellipsoid berry (drupe) containing 2 oblong stony seeds, with small embryos and copious endosperm.

A genus of 15-16 species in North America and one in central China.

Key to Species and Varieties

A. Corolla 5-9 mm long; fruit white; twigs with hollow pith.
  B. Corolla 5-6 mm long; style and stamens shorter than or equalling the corolla, not exserted; style 2-3 mm long, glabrous.
    C. Low shrub, less than 1 m tall; young twigs pubescent with short incurved hairs; leaves glaucous and pilose beneath. .... 1a. Symphoricarpos albus var. albus.
    CC. Erect or arching shrub, 1-3 m tall; young twigs glabrous; leaves glabrous to sparsely pilose beneath. .... 1b. Symphoricarpos albus var. laevigatus.
  BB. Corolla 6-9 mm long; style and stamens exserted; style 4-8 mm long, pilose near the middle, rarely glabrous. .... 2. Symphoricarpos occidentalis.
AA. Corolla 3-5 mm long; fruit red or coral; twigs with solid pith. .... 3. Symphoricarpos orbiculatus.

1a. Symphoricarpos albus (L.) Blake var. albus Snowberry Map 14.

Low, bushy shrub, 0.2 to 0.8 m tall, with slender, *minutely pubescent branchlets* and *winter buds with ciliate or pubescent scales.* Leaves elliptic-ovate to suborbicular, 1-5 cm long and 1-4 cm broad, on petioles 2-5 mm long, the margins ciliate, entire to undulate or rarely lobed on the young branches, tips acute to apiculate and bases acute to nearly rounded, *lower surfaces glaucous and pilose at least on the veins* or frequently densely pilose throughout, upper surfaces green, sparsely puberulent to glabrous. Flowers on short pedicels, 1-5 in terminal clusters or in the axils of the upper leaves. Calyx 5-toothed, glabrous or slightly ciliate. Corolla white or pink, campanulate, somewhat gibbous at the base, mostly 5-6 mm long, *the lobes 2-3 mm long, shorter than the tube,* bearded within. *Stamens shorter than the corolla;* anthers 1-1.5 mm long. Style 2-3 mm long, shorter than the corolla; stigma capitate. Fruit a white berry, 6-10 mm in diameter, with 2-stony seeds, pendent from the underside of the branchlet. 2N = ca.54.

Chiefly a northern species, extending southward to Richland, Sauk and Racine Counties where it is locally abundant at the margins of open northern hardwood forests, in jack pine woods, on wooded ravine slopes and on stabilized, lightly wooded sand dunes, less common on gravelly, rocky and sandy slopes, sandstone and limestone rock outcrops, dry wooded slopes, sandy oak woods and in second growth forest stands. Flowering late-May to July; fruiting late July to October.

1b. Symphoricarpos albus (L.) Blake var. Laevigatus Blake Western Snowberry

An erect, branching shrub, 1-3 m tall, with slender, *usually glabrous branchlets* and *winter buds with glabrous scales.* Leaves oval to nearly orbicular, 2-3 cm long and 7-15 mm wide, on petioles 2-4 mm long, tips acute to obtuse and bases acute, the upper surfaces green and glabrous, *the lower slightly paler, glabrous or slightly* *pubescent,* margins entire to sinuate or lobed on young shoots, glabrous or sparsely ciliate. Flowers numerous in short peduncled racemes 1-2.5 cm long at the tips of the branches and sometimes in the axils of the upper leaves. Floral features similar to var. *albus* except *corolla lobes longer than the tube.* Fruit white, subglobose or ellipsoid, the larger ones 12-15 mm in diameter, pendent in clusters. 2N = 54.

A western species, ranging from southeastern Alaska to California and eastern Montana; frequently planted as an ornamental in parks and home yards, escaping to adjoining open woods, thickets and along railroad embankments. Only a few non-cultivated specimens were observed in the various herbaria; therefore, this variety is not mapped. Flowering and fruiting dates are similar to those of var. *albus.*

2. Symphoricarpos occidentalis Hooker
Wolfberry Map 15.

Densely clumped shrub, 0.3 to 1 m tall, *sprouting from rhizomes* and with *reddish-brown, puberulent branchlets.* Leaves oval, 2.5-11 cm long and 1.5-7 cm wide, *thick and firm when mature, entire or often with undulate, coarsely crenate or lobed margins,* with obtuse and apiculate tips, cuneate to rounded bases and petioles 4-10 mm long, upper surfaces dull, dark green, glabrous to sparsely pilose, lower surfaces pale green, thinly pubescent at least along the veins, rarely glabrous. Flowers sessile, in terminal spicate clusters 1-2.5 cm long and in dense axillary clusters. Calyx 5-toothed, the teeth ovate, ciliate, 0.7-0.8 mm long. Corolla campanulate, pinkish, 6-9 mm long, *the lobes 3-4 mm long, longer than the tube.* Stamens 5, *exserted.* Style 4-8 mm long, exserted, longer than the stamens, pilose near the middle; stigma capitate, yellow. Fruit globose, pale greenish-white, 6-8 mm in diameter. Chromosome number not determined.

Locally abundant, in the southern one-half of the state, in prairies, on railroad embankments, dry hillsides and bluff tops, along borders of upland woods and sandy roadsides, occasionally in pastures, extending northward and northwestward in sandy barrens and along railroad embankments. Flowering mid-June to early-September; fruiting September to October.

3. Symphoricarpos orbiculatus Moench
Coralberry Map 16.

Leafy, erect shrub 0.5 to 2 m tall, with *light brown to purplish branches* and densely puberulent twigs. Leaves oval, ovate to nearly orbicular, 1-4 cm long, on petioles 2-4 mm long, the blades with entire to undulate margins, acute to obtuse tips, rounded to acutish bases, dull green and glabrous or sparsely pilose on the upper surfaces and paler, glaucous to soft pubescent beneath. Flowers densely crowded or on short spikes in the axils of several to many of the upper leaves. Calyx 5, tooth-like, *persistent in fruit to form a beak about 1 mm long.* Corolla, *3-5 mm long,* pink, broadly campanulate, villous within, the lobes about as long as the tube. Stamens 5; anthers about 1 mm long, shorter than the filaments. Style 2 mm long, pilose. Fruit elliptical, 5-7 mm long and 4-5 mm broad, glabrous, *coral-red, pink or sometimes purplish.* 2N = 18.

Infrequent at margins of woods, along railroad embankments, on dry open or lightly wooded hillsides and along riverbanks in southern Wisconsin, elsewhere escaping from yard plantings or parks to roadsides and open woods. Flowering July to September; fruiting September to October.

Kolkwitzia amabilis Graebn., the beauty bush, a tall shrub with peeling bark, *bristly-hairy pedicels and hypanthia* and rose-colored, tubular to campanulate flowers is often planted as an ornamental in home yards, city and county parks and in horticultural gardens. Its hardiness especially in southern Wisconsin indicates it may eventually escape to adjacent roadsides, fencerows and open woods.

Tribe DIERVILLEAE C. A. Meyer

6. DIERVILLA Miller

Bush Honeysuckle

Stoloniferous, upright or slightly arching shrubs, up to 1.5 m tall. Winter buds with several pairs of pointed scales. Leaves ovate, ovate-lanceolate to oblong-ovate, 6-12 cm long and 2-7 cm broad, *with acuminate tips* and acute to nearly rounded bases, finely serrate, glabrous above and glabrous to densely pubescent beneath, *on short petioles, 5-10 mm long, from which extend two hispid decurrent lines on the stem.* Flowers several on short pedunculate cymes, terminal or axillary in the upper leaves. Calyx lobes 5, linear-lanceolate, extending from the constricted neck of the hypanthium. Corolla, funnelform, yellow, becoming orange or red after anthesis, 5-lobed, more or less bilabiate, with a 4-lobed upper lip and a single lower lip, the tube slightly gibbous at the base and densely hairy within. Stamens 5, inserted near the tip of the tube; filaments pubescent; anthers linear, pubescent, introrse, usually exserted. Ovary elongate, *2-locular with many ovules and parietal placentation;* style long, slender, densely pubescent in lower portion, equal in length or slightly longer than the corolla tube; stigma capitate. *Fruit an elongated, thin-walled, septicidal capsule, beaked with the persistent calyx.* Seeds small, ovoid, with large cotyledons and fleshy endosperm.

A genus of 2 (or 3) species in eastern North America and about 12 species in eastern Asia, sometimes combined with the genus *Weigela* Thun., which is characterized by larger pink to red flowers, woody capsules and winged seeds. *Weigela florida* (Bunge) A. DC., a shrub 1-3 m tall, with large (3-3.5 cm long and nearly 3 cm broad) and pink to crimson flowers, is widely planted as an ornamental and occasionally is found persisting in abandoned gardens and in open areas adjacent to parks and botanical gardens.

Diervilla lonicera Mill. is the only native species in Wisconsin and is represented by two varieties:

1a. Diervilla lonicera Miller var. lonicera Map 17.

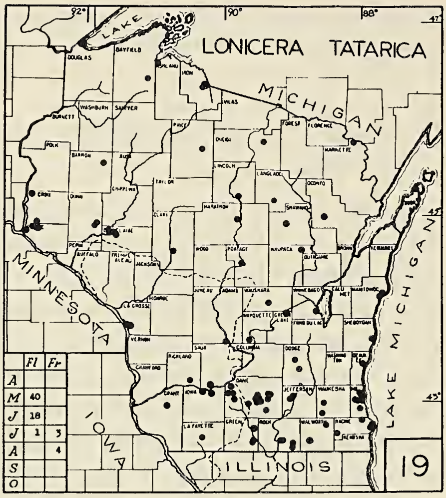
Shrub up to 1.5 m tall, with glabrous twigs, except for 2-hispid decurrent lines extending from the petiole of each leaf and with ovate, ovate-lanceolate to oblong-ovate leaves, on petioles 5-10 mm long, the tips acute to acuminate and bases acute to rounded, margins finely serrate, more or less ciliate; upper surfaces glabrous; *lower surfaces glabrous to more or less pubescent on the veins.* Flowers 10-12 mm long; corollas funnelform, yellowish, turning orange to red after anthesis. Fruit 10-15 mm long, constricted near the tip and beaked with the persistent calyx lobes. 2N = 18.

Widespread throughout the state, often locally common in large clones at the margins of dry to mesic upland hardwood forests, northern hardwood forests, pine woods, cut-over areas, open or lightly wooded rocky slopes, less abundant in pastured woods, on dry hillsides, along railroad embankments and roadsides. Flowering June to mid-August; fruiting late-July to October.

1b. Diervilla lonicera Miller var. hypomalaca Fernald Map 18.

Similar to var. *lonicera* but *leaves densely pilose beneath.*

Chiefly in Door County and along the Lake Superior shore in Iron and Bayfield Counties where it occurs with var. *lonicera* in open northern hardwoods stands, on sandy beaches above the high water mark and in aspen stands. It is also present in northeastern Minnesota, upper Michigan and along the northern shore of Lake Huron. The greatest concentration of these densely pubescent plants, according to Fassett (1942), is in the area north of Lake Huron. Flowering and fruiting dates are similar to those of var. *lonicera.*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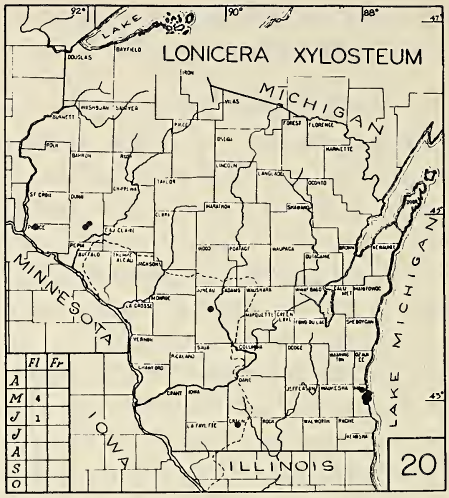
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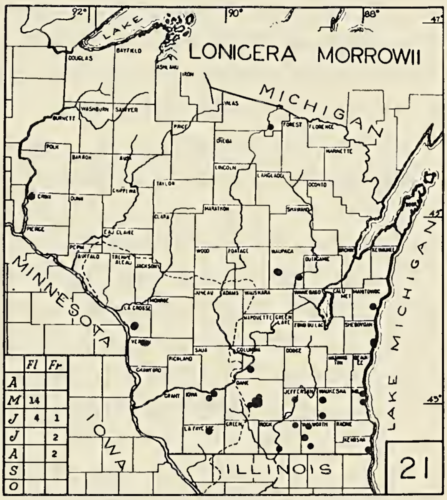
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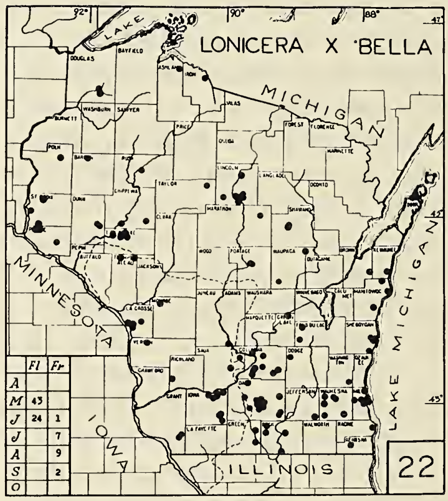
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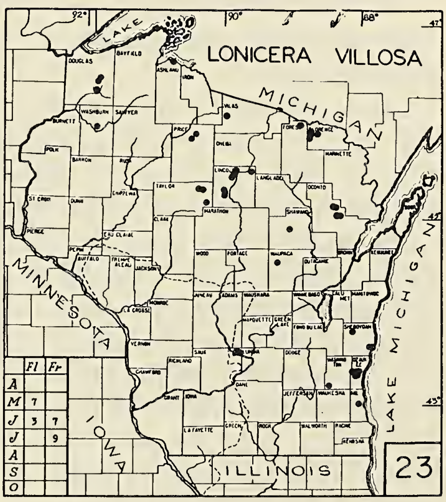
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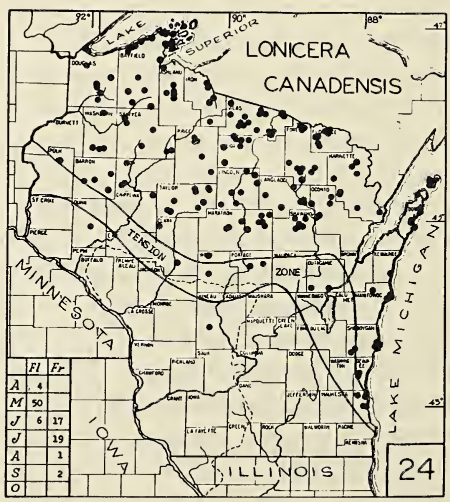
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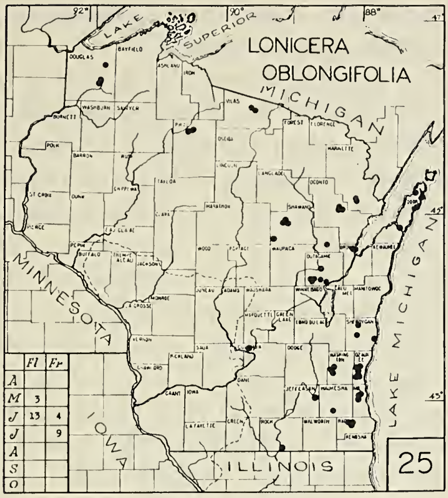
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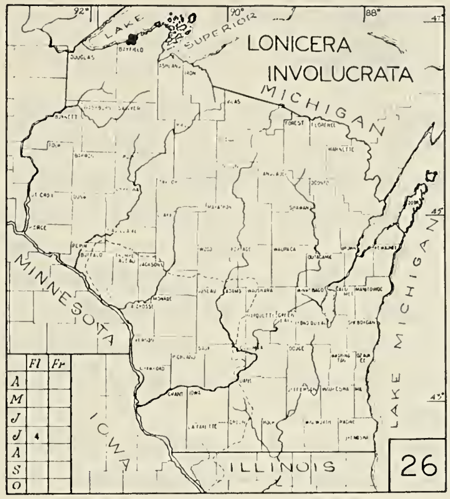
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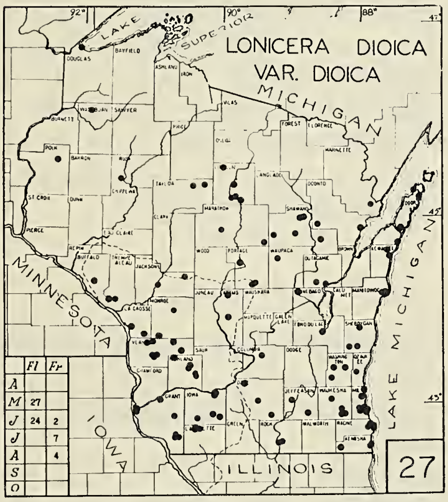
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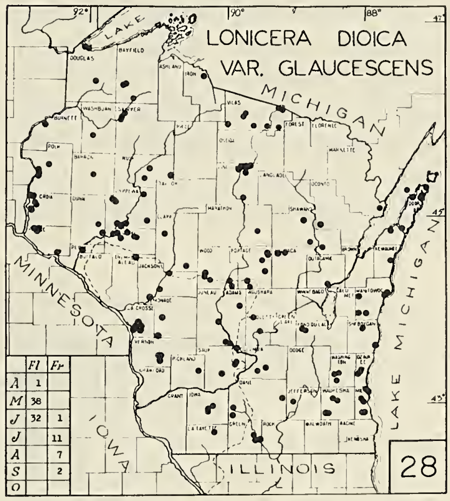
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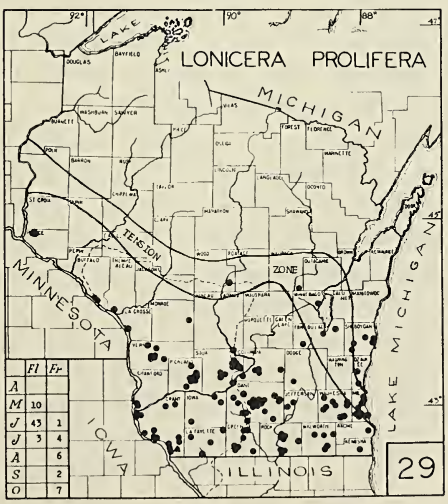
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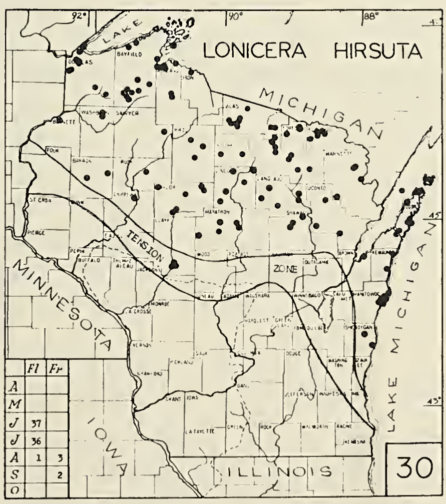
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LAKE MICHIGAN
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J 36
A 1 3
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30

TRIBE LONICERAEAE R. BROWN EX. DC.

7. LONICERA L. HONEYSUCKLE

Climbing or erect, deciduous shrubs. Winter buds with 2-several outer scales. *Leaves entire* (slightly lobed or toothed in one introduced species), *exstipulate, short-petioled, sessile or connate,* the surfaces glabrous or hairy. Inflorescences of 2-3-flowered axillary cymes, or in axillary or in terminal clusters. Flowers regular or irregular, perfect, subtended by *2-4 paired bracteoles.* Calyx 5-toothed, short. Corolla tubular or funnelform, sometimes gibbous, 5-lobed, regular or bilabiate with a 4-lobed upper lip and a 1-lobed lower lip. Stamens 5, attached near the top of the corolla tube; filaments long and slender; anthers oblong to linear, introrse, usually exserted. *Ovary mostly 2-3 locular with 3-8 ovules* and axillary placentation; style slender, equalling or slightly longer than the corolla tube; stigma capitate. Fruit a several-seeded berry. Seeds ovoid, with a smooth or reticulate seed coats and fleshy endosperms.

A genus of about 180 species in temperate regions of the northern hemisphere with several species extending to tropical regions at higher elevations. About 25 species occur in North America; seven are native to Wisconsin and five are introduced and have become established. A number of other introduced species are planted in horticultural gardens. The species are classified into two subgenera: *Lonicera* (*Chamaecerasus* L.), characterized by axillary inflorescences with the flowers in pairs and the leaves distinct, and *Caprifolium* (Mill.) Pers. (*Periclymenum* L.), with the flowers in terminal cymes and the upper leaves usually connate (Ferguson, 1966). These subgenera are sometimes further divided into sections based on the regular or irregular corolla, length of corolla tube, erect or climbing habit and whether the bracteoles are free or connate (Rehder, 1903).

KEY TO SPECIES

A. Leaves all distinct; flowers or fruits in pairs on single axillary peduncles.
- B. Erect or ascending shrubs; corollas 1-2 cm long.
  - C. Bracts below the flowers scale-like or linear, less than .5 cm long.
    - D. Pith of twigs hollow.
      - E. Leaves and twigs glabrous. . . . . .1. L. TATARICA.
      - EE. Leaves and twigs more or less pubescent.
        - F. Flowers pale yellow; filaments pubescent; leaves elliptic-ovate to obovate. . . . . .2. L. XYLOSTEUM.
        - FF. Flowers pink or white, fading to yellow; filaments glabrous; leaves ovate to oblong.
          - G. Leaves pubescent beneath; peduncles, twigs and calyx densely hairy; bractlets between ¾ and the full length of the ovary, hairy; flowers white fading to yellow. . . . .3. L. MORROWII.
          - GG. Leaves sparsely pubescent, with a few hairs on the veins beneath; peduncles, twigs and calyx sparsely hairy; bractlets mostly up to ½ the length of the ovary (occasionally up to ⅔ its length), sparsely hairy and sometimes with a few glands flowers pink fading to yellow. . . . . .4. L. X BELLA.
    - DD. Pith of twigs solid.

H. Peduncles rarely more than 1 cm long, usually shorter than the flowers; ovaries wholly united; fruit blue. ....5. L. VILLOSA.

HH. Peduncles mostly 2-4 cm long, longer than the flowers; ovaries separate; fruit red.

I. Lobes of the corolla much shorter than the tube; leaves oblong-ovate, glabrate, the margins and petioles ciliate. ....6. L. CANADENSIS.

II. Lobes of the corolla nearly as long as the tube; leaves oblong to narrowly obovate, minutely pubescent beneath, not ciliate. ....7. L. OBLONGIFOLIA.

CC. Bracts below the flowers broadly oval and leaf-like, almost enclosing the flowers, 1-2 cm long. ....8. L. INVOLUCRATA.

BB. Climbing or trailing vines; corollas 2-4 cm long. .....9. L. JAPONICA.

AA. Uppermost leaves connate; flowers or fruits in sessile, terminal or sometimes axillary clusters.

J. Leaves glabrous above, glabrous or minutely pubescent beneath; margins glabrous.

K. Connate upper leaves longer than broad, green above and whitened beneath, pointed or mucronate at the tips. ....10. L. DIOICA.

KK. Connate upper leaves forming a nearly round disk; glaucous above. ....11. L. PROLIFERA.

JJ. Leaves pubescent and green on both sides or grayish beneath; margins villous-ciliate. ....12. L. HIRSUTA.

SUBGENUS LONICERA

(Subgenus *Chamaecerasus* Rehd. not L.)

1. LONICERA TATARICA L.
Tartarian Honeysuckle Map 19.

Upright shrub, 1.5 to 3 m high, the stems with grayish bark, glabrous twigs and brown hollow pith. *Leaves mostly ovate, sometimes oval to oblong,* 3-7 cm long and 1.5-4 cm wide, on petioles about 5 mm long, with acute to obtuse tips and *cordate or rounded bases, glabrous or with a few sparse hairs* beneath. Flowers white to pinkish-purple, in axillary pairs on slender glabrous peduncles, 1.8-2 cm long, subtended by two *glabrous ovate bractlets which are rarely half as long as the ovaries,* and two longer essentially glabrous bracts which are shorter or longer than the ovaries. Calyx of 5, lanceolate sepals. Corolla bilabiate, about 1.5 cm long, glabrous, gibbous at the base and hairy within, the lobes linear to lanceolate, as long or longer than the tube. Stamens slightly exserted, the filaments hairy. Ovaries slightly united at the base, glabrous, the *styles hirsute.* Fruit a red or sometimes yellow berry. 2N = 18.

White-flowered forms have been designated f. *albiflora* (DC.) House.

A species of central Asia which is often planted as an ornamental in home yards, parks and botanical gardens, and is now widely distributed, probably transported by birds, throughout Wisconsin in open woods, pastured woodlots, on gravelly and quarry bluffs, along roadsides, fencerows and railroad embankments and edges of woods, often bordering parks and horticultural gardens. Flowering early-May to late-June; fruiting July to August.

2. LONICERA XYLOSTEUM L.
European Fly Honeysuckle Map 20.

Upright shrub, 1-2.5 m high, with soft-pilose to glabrous twigs and hollow branches. *Leaves elliptic-ovate to obovate, usually* *broadest above the middle,* 3-6 cm long and 1-4 cm broad, acute to slightly acuminate at the tips and rounded to broadly acute to obtuse at the bases, sparingly pilose above and densely pubescent beneath. Flowers axillary, on pubescent, filiform peduncles 0.6-2 cm long, *subtended by two elliptic or oval, pubescent and glandular bractlets* which are about one-half to two-thirds as long as the ovary and two linear, pubescent-glandular bracts which equal or exceed the ovaries. Calyx 5-lobed, pubescent-glandular. Corolla bilabiate, *yellowish-white* to sometimes slightly pinkish, 7-12 mm long, pubescent. Stamens 5; *filaments pubescent.* Ovaries densely pubescent with simple and glandular hairs. Fruits are deep red berries. 2N = 18.

An Eurasian species which is sometimes planted as an ornamental and occasionally escapes into waste areas, into open woods bordering parks and horticultural gardens, and sometimes persists on abandoned homesteads. Flowering May to June; fruiting July to August.

3. Lonicera morrowii Gray
Morrow's Honeysuckle Map 21.

Upright shrub, up to 2 m tall, with grayish-brown bark, spreading branches and finely pubescent twigs. *Leaves oblong to narrowly elliptic,* 2.5-5 cm long and 1.5-2.5 cm wide, on short petioles, with obtuse to nearly rounded tips and cordate to rounded bases, the upper surfaces finely and sparsely pubescent, the *lower surfaces grayish-tomentose.* Flowers in pairs, on densely pubescent axillary peduncles 0.5-1.5 cm long, subtended by two ciliate-tipped *bractlets which are three-fourths of or equal in length to the ovaries,* and by two densely pubescent bracts which exceed the ovaries. Calyx 5-toothed, *ciliate. Corolla white, fading to yellow,* pubescent externally, about 1.5 cm long, the 5-lobes only slightly irregular. Stamens exserted; *filaments glabrous.* Ovaries separate, glabrous. Fruit a red or yellow berry. 2N = 18.

A native of Japan which is sometimes planted as a border shrub in home yards, parks and in horticultural gardens, occasionally escaping to nearby roadsides, abandoned fields and infrequently persisting about abandoned dwellings. Flowering early-May to mid-June; fruiting late-June to late-August.

4. Lonicera X bella Zabel
Bell's Honeysuckle Map 22.

Similar to *L. tatarica* but the *twigs are sparsely pubescent and the leaves are somewhat pubescent beneath, at least on the veins.* Flowers pink to purple-red fading to yellow, 1.5-1.8 cm long, on sparsely pilose peduncles 10-12 mm long, subtended by more or less *ciliate bractlets which are mostly one-half, but sometimes two-thirds, the length of the ovary* and by sparsely pubescent bracts which exceed the ovary in length.

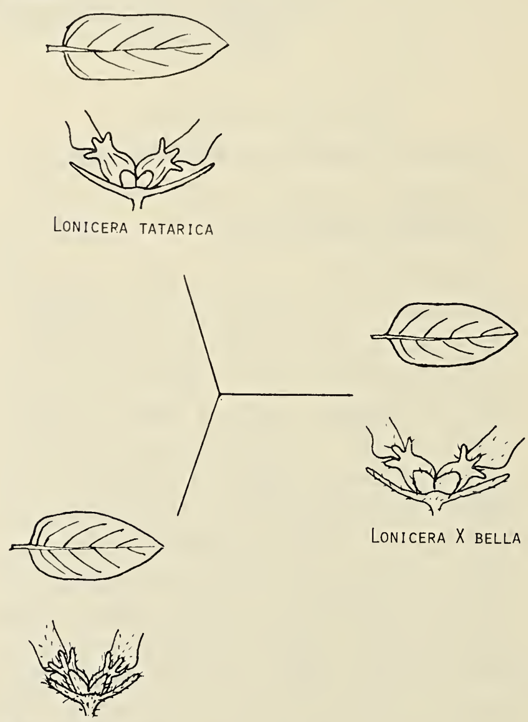

Fig. 1. Sketches of ovaries, bractlets, bracts and leaf outlines of *Lonicera tatarica, L. morrowii* and their hybrid, *L.* X *bella* (adapted from Green (1966)

This honeysuckle is a fertile hybrid between *L. tatarica* and *L. morrowii* (Fig. 1) which has been reported to arise spontaneously in cultivation from naturalized plants of the parental species (Green, 1966, Hauser, 1966; Barnes and Cottam, 1974). Backcrosses with both parents apparently occur as a number of specimens show wide variations in the degree of pubescence of the leaves, bractlets and bracts which sometimes make it impossible to clearly identify individuals. 2N = 18.

This hybrid plant appears to be more adaptable than its parents growing in woodland borders, fallow fields, pastured woodlots, second growth woods of oak, ash and basswood, on open slopes and sometimes along lake and stream banks and river bottoms. Flowering early-May to late-June; fruiting July to September.

Lonicera maackii Maxim, an introduction from Asia, has been sighted as an escape in several southern counties. This upright shrub is distinguished by the elliptic, oblanceolate to obovate leaves with acuminate tips and long-tapering bases and the flowers and fruits borne in pairs on bractless peduncles which are shorter than the petioles. Hauser (1965) reported this species is reproducing and spreading in Ohio's strip mining areas, and it may be only a question of time before it is established in Wisconsin.

5. Lonicera villosa (Michx.) R. & S.
Mountain Fly Honeysuckle Map 23.

Low, diffuse or erect shrub, up to 1 m tall, *with strongly ascending branches,* shreddy bark, and *reddish brown, more or less pilose-villous twigs.* Winter buds scaly, appressed or ascending, usually without accessory buds. *Leaves narrowly oblong to oblong-lanceolate or elliptic,* 2.4 cm long and 0.8-1.6 cm wide, sessile or on short petioles, the tips rounded or obtuse and generally mucronate, the bases rounded or obtuse, margins ciliate, upper surfaces glabrous to slightly strigose, the *lower surfaces with prominent veins and more or less villous.* Flowers paired on axillary peduncles (3-10 mm long), *their ovaries completely united* and appearing as one, *the subtending bractlets enclosing the ovaries* and the bracts 3-5 mm long, longer than the ovaries. Calyx of 5 teeth-like lobes. *Corolla pale yellow, narrowly campanulate,* 10-15 mm long, the tube slightly gibbous at the base and slightly longer than the nearly equal 5 lobes, glabrous or sparsely pubescent externally and villous within. Stamens 5, exserted. United ovaries glabrous or sparsely pubescent; styles glabrous. Fruit a bluish berry, bearing the scars of the two flowers at the summit. No chromosome numbers have been recorded.

Gleason and Cronquist (1963) consider this species as variable in pubescence and suggest it may be better considered as a variety of the Eurasian *L. caerulea* L. Fernald (1950) describes it as a polymorphic American species and divides it into five varieties. If Fernald's treatment is followed, the Wisconsin plants are designated *L. villosa* var. *solonis* (Eat.) Fern.

This boreal shrub is occasionally present in moist, acidic soils of open *Chamaedaphne-Sphagnum* bogs, *Picea-Larix* bogs and sometimes in alkaline to acidic *Carex-Eriophorum* meadows in northern Wisconsin; it is infrequent to rare in bogs of southeastern Wisconsin and is apparently absent in the Driftless Area. Flowering early-May to late-June; fruiting mid-June through July.

6. Lonicera canadensis Marsh.
Fly Honeysuckle Map 24.

Straggly-branched shrub, up to 1.5 m high, with grayish bark, glabrous twigs and scaly winter buds. *Leaves ovate to oblong-ovate,* 3-10 cm long and 2-4 cm wide, on short, distinct, *ciliate petioles,* acute to obtuse at the tips, with *cuneate, rounded or rarely cordate bases,* glabrous or sparsely pubescent beneath and the *margins ciliate.* Flowers axillary in pairs, on peduncles 2-3 cm long, subtended by *minute bractlets* (or none) and orbicular to elliptic bracts which are shorter than to slightly longer than the ovaries. Calyx of 5 lobes, about 1 mm long. Corolla greenish-yellow, *nearly regular,* 1.2-2 cm long, gibbous at the base, funnelform, expanding into nearly equal 5 lobes which are *shorter than the tube,* slightly hairy within. Stamens glabrous, mostly included. Ovaries of the paired flowers distinct and divergent in fruit, glabrous; style glabrous. Fruit a reddish, elongated berry. 2N = 18.

General range in Wisconsin is north of the Tension Zone where it is locally common in northern hardwood forests, maple-beech woods, pine-maple woods and less commonly in second-growth maple-birch woods and in boggy woods; it also occurs infrequently in rocky maple-oak woods of the central counties and in maple-beech-basswood stands in ravines, on bluff tops and on morainic ridges in the southeastern counties. Flowering late-April to mid-June; fruiting mid-June to September.

7. Lonicera oblongifolia (Goldie) Hook.
Swamp Fly Honeysuckle Map 25.

Shrub up to 1.5 m high, with grayish bark, ascending, minutely pubescent branches and scaly winter buds. Leaves oblanceolate to oblong, 3-10 cm long and 1-3 cm wide, the tips acute to obtuse and the *bases tapering to short petioles* (mostly less than 2 mm) or sessile, the margins not ciliate, upper surfaces glabrous or sparsely puberulent and the lower surfaces puberulent. Flowers in the axils of leaves, in pairs on *peduncles 1-3 cm long,* the *subtending bracts much shorter than the ovaries* or early deciduous. Calyx of 5 minute teeth, less than 0.5 mm long. Corolla pale yellow, 10-15 mm long, *deeply bilabiate,* gibbous near the base, the upper lip 4-lobed and the lower 1-lobed, more or less pubescent within and without. Stamens 5, with hairy filaments. Ovaries of the two flowers slightly united at their bases; styles hirsute. Fruits are reddish or purplish berries, more or less united in pairs. Chromosome numbers have not been determined.

A native shrub of the coniferous forest region, occurring in bogs, sedge meadows, boggy lake shores and moist willow thickets, chiefly in the glaciated northern and eastern portions of the state. The sparsity of dots on the map is probably the result of limited collecting because of its affinity for moist mucky habitats. Flowering mid-May to mid-June; fruiting late-June through July.

8. Lonicera involucrata (Richards) Banks Fly Honeysuckle Map 26.

Upright to sometimes straggling shrub, 1-3 m tall, often spreading by root sprouts, with stout branches and glabrous 4-angled twigs. *Leaves ovate, obovate to elliptic-oblong, 6-12 cm long and 2-5 cm broad,* short acuminate at the tips, tapering at the bases to short petioles, green and glabrous above, paler and hirsute on the veins beneath. Flowers in axillary pairs, on peduncles 2-4 cm long, subtended by *4 greenish to dark purple, ascending to reflexed, foliaceous bracts 1-2 cm long.* Calyx minute or obsolete. Corolla yellow, 10-13 mm long, tubular to funnelform and saccate at the base, nearly regular, the short, slightly subequal lobes erect, mostly less than half as long as the tube. Stamens glabrous, shorter or about as long as the corolla. Ovaries 3-celled, distinct; style exserted and glabrous. Berries purple-black, subtended by the persisted bracts. Chromosome numbers have not been determined.

A boreal-cordilleran species which occurs in cool, moist, shaded sites in the northern Great Lakes region. It has been collected at only one locality in Wisconsin: Bayfield County, Lake Superior region near Port Wing (*L. S. Cheney, 7055, July 9, 1897, WIS, UWM; 7169, July 10, 1897, WIS; 7173, July 11, 1897 WIS*). Flowering June to July; fruiting in August.

9. Lonicera japonica Thumb.
Japanese Honeysuckle

Climbing or trailing vine with pubescent young twigs and branches. Leaves ovate to oblong, 4-8 cm long and 2-4 cm wide, entire or *sometimes slightly toothed or lobed,* short petioled, with obtuse to acute tips and rounded or broadly cuneate bases and both surfaces slightly pubescent to nearly glabrous. Flowers in axillary pairs, on peduncles 5-10 mm long, subtended by ovate, *foliaceous bracts which are longer than the ovary and by rotund, ciliate bractlets that are shorter than or nearly equal in length of the ovary. Calyx long-toothed.* Corolla bilabiate, 3-5 cm long, white or cream-colored, sometimes tinged with purple, becoming yellow with age, very fragrant, the pubescent tube about equalling the limb. Stamens exserted. Ovary pubescent. Fruit a black berry. 2N = 18.

A species of eastern Asia which has become a noxious weed in southern and southeastern United States where it overwhelms shrubs and small trees. It has been planted in several places in southern Wisconsin as an ornamental and to stabilize steep slopes. Recently it has been reported as an escape along the bank of the Milwaukee River in Milwaukee County. Except for the Milwaukee specimens there is no other evidence of the extent of naturalization or hardiness of this species in the state. Flowering May to June; fruiting September to October.

SUBGENUS CAPRIFOLIUM (MILL.) PERS. (Subgenus *Periclymenum* Rehd. not L.)

10. LONICERA DIOICA L. Wild Honeysuckle

Twining, trailing or loosely ascending shrub with glabrous and glaucous twigs and the older stems with grayish, peeling bark. *Leaves oblong, elliptic or obovate,* 4-10 cm long and 1.5-4 cm wide, rounded, obtuse to sometimes acute at the tips and tapering at the bases or sometimes with short petioles, *green above and whitened beneath,* the upper 1-4 pairs connate-perfoliate, *the uppermost pair forming an elliptic-ovate to rhombic involucral disk.* Flowers terminal, in 1-3 whorls on short peduncles. Calyx obscurely 5-lobed, glabrous. Corolla bilabiate, 1.5-2.5 cm long, pale yellow to reddish or purplish, glabrous to pubescent externally and hairy within, the tube gibbous on one side at the base and gradually expanding upward, about equal in length to the lobes. Stamens exserted, the slender filaments hairy. Ovary glabrous; the style more or less hairy. Fruit a red berry. 2N = 18.

Gleason and Cronquist (1962) and Fernald (1950) recognize several varieties and forms of this species. The following are present in Wisconsin:

10a. LONICERA DIOICA L. var. DIOICA Map. 27.

Leaves glabrous and glaucous beneath, the corolla glabrous externally and hairy within and the *style glabrous to sparsely hairy.* Plants with upper leaves in whorls of three have been designated f. *trifolia* Vict. & Rolland.

This variety ranges from New England to southeastern Minnesota, south to Georgia and Missouri. In Wisconsin it is found most commonly in the southern two-thirds of the state on wooded bluffs, in moist thickets, lowland woods, wooded ravines, along lake and river banks and sometimes in moist upland woods and cut-over coniferous and deciduous woods. It is less common than the following variety. Flowering May to June; fruiting mid-June to August.

10b. LONICERA DIOICA L. var. GLAUCESCENS (Rydb.) Butters Map 28.

Differs from var. *dioica* in having the *leaves pubescent beneath, the corolla villous and sometimes glandular externally* and hairy within and the *style hirsute.* Widely ranging from western Quebec to British Columbia, south to Ohio, Iowa and Oklahoma. The widespread variety in Wisconsin. Habitats, flowering and fruiting are similar to those of var. *dioica.*

11. LONICERA PROLIFERA (Kirchner) Rehder var. PROLIFERA Grape Honeysuckle Map 29.

Twining or climbing vine with glabrous twigs and glossy, pale-brown bark which is often peeling on the older branches. Leaves broadly oval to obovate, sessile or nearly so, 4-8 cm long and 2-4 cm wide, *rounded, obtuse or slightly notched at the tips* and tapering at the bases, *the upper surfaces green and more or less glaucous,* the lower surfaces pale, glaucous and glabrous to slightly appressed-puberulent, *the uppermost connate-perfoliate, forming an oval or subrotund disk with obtuse to retuse tips.* Flowers in 2-6 whorls on terminal spikes in the uppermost disks. Calyx obscurely 5-lobed, glabrous. Corolla pale yellow, 2.5-3 cm long, slightly gibbous at the base, the tube equalling or slightly longer than the lobes, glabrous externally, hairy within. Stamens exserted, the filaments slightly hairy. Ovary glabrous; style slightly hairy to nearly glabrous. Fruit a red berry. 2N = 18.

Chiefly south of the Tension Zone where it is locally common along the margins and in open oak and maple woods, logged-off woods, wooded hillsides, talus slopes, bluff tops, sometimes in thickets and along brushy stream banks, and rarely along edges of marshes and bogs and in open pine woods. Flowering mid-May to July; fruiting mid-July to October.

12. Lonicera hirsuta Eat. var. interior Gl. Hairy Honeysuckle
Map 30.

Climbing vine with hirsute twigs and smooth grayish-brown bark which becomes shreddy on older branches. Leaves broadly elliptic to oval, 5-12 cm long and 3-8 cm wide, dull green and *sparsely to densely appressed-puberulent on the upper surfaces,* downy-pubescent and paler or sometimes grayish beneath and with *ciliate margins,* the lower with acute tips and rounded to acute bases, with *short petioles,* the upper one or two pairs connate-perfoliate, the *terminal pair forming a rhombic to elliptic or nearly orbicular disk, with abruptly acuminate tips.* Flowers in 2-several whorls on short-peduncled terminal spikes. Calyx obscurely 5-lobed. Corolla 10-18 mm long, pale yellow to orange, slightly gibbous at the base, 2-lipped, the lobes nearly equal to the tube in length, more or less glandular-pubescent externally and hairy within. Stamens exserted; filaments hairy. Ovary glabrous or sparsely glandular; style somewhat hairy. Fruit a red berry. 2N = 18.

A species of the northern hardwood forest, ranging from Quebec and New England to Saskatchewan, south to Pennsylvania, northern Michigan, Wisconsin and Minnesota. In Wisconsin it is found north of the Tension Zone on calcareous, quartzitic, granitic and morainic sandy soils in maple-birch-white pine forests, in cut-over areas regenerating to aspen-birch woods, sometimes in low, moist aspen woods and occasionally in open areas along stream banks and margins of bogs. Flowering June to August; fruiting August to September.

The Trumpet Honeysuckle, *Lonicera sempervirens* L. a glabrous high-climbing vine is sometimes planted in southern Wisconsin for its showy scarlet-orange, nearly regular, tubular, flowers which are 3.5 to 8 cm long. There are no records of its establishment outside of cultivation.

Literature Cited

Bailey, L. H. 1949. Manual of Cultivated Plants. 2nd Ed. Macmillan Co., New York. 1116 pp.

Barnes, W. and G. Cottam. 1974. Some autecological studies of the *Lonicera* X *bella* complex. Ecology **55**:40-50.

Cronquist, A. 1968. The Evolution and Classification of Flowering Plants. Houghton Mifflin Co., Boston. 396 pp.

Egolf, D. R. 1962. A cytological study of the genus *Viburnum*. J. Arnold Arb. **43**:132-172.

Fassett, N. C. 1942. Mass collections: *Diervilla lonicera*. Bull. Torrey Bot. Club **69**: 317-322.

Ferguson, I. K. 1966. The genera of Caprifoliaceae in the southeastern United States. J. Arnold Arb. **47**:33-59.

Fernald, M. L. 1950. Gray's Manual of Botany. Ed. 8. American Book Co., New York. 1632 pp.

Gleason, H. A. and A. Cronquist. 1963. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. Van Nostrand Co., Princeton, N.J. 810 pp.

Green, P. S. 1966. Identification of the species and hybrids in *Lonicera tatarica* complex. J. Arnold Arb. **47**:75-88.

Hauser, E. J. P. 1965. The Caprifoliaceae of Ohio. Ohio J. Sci. **65**:118-129.

———. 1966. The natural occurrence of a hybrid honeysuckle (*Lonicera* X *bella*) in Ohio and Michigan. Mich. Bot. **5**:211-217.

Hillebrand, G. R. and D. E. Fairbrothers. 1969. A serological investigation of intrageneric relationships in *Viburnum* (Caprifoliaceae). Bull. Torrey Bot. Club **96**:556-567.

———. 1970a. Phytoserological systematic survey of the Caprifoliaceae. Brittonia **22**: 125-133.

———. 1970b. Serological investigation of the systematic position of the Caprifoliaceae. I. Correspondence with selected Rubiaceae and Cornaceae. Amer. J. Bot. **57**:810-815.

Hulten, E. 1970. Circumpolar Plants II. Dicotyledon. Kungl. Sv. Vetenskap. Handl. Band 13, Nr. 1. Almquist & Wiksell, Stockholm.

Iltis, H. H. 1963. *Napaea dioica* (Malvaceae): Whence came the type? Amer. Midl. Nat. **70**:90-109.

Jones, G. N. 1940. A monograph of the genus *Symphoricarpos*. J. Arnold Arb. Vol. XXI.

Lane, F. C. 1955. The genus *Triosteum* (Caprifoliaceae). Ph.D. Thesis, University of Illinois, Urbana.

McAtee, W. L. 1956. A Review of the Nearctic Viburnums. Privately Published, Chapel Hill, N.C. 125 pp.

Polunin, N. 1959. Circumpolar Arctic Flora. Oxford University Press, London. 514 pp.

Rehder, A. 1903. Synopsis of the genus *Lonicera*. Missouri Bot. Gard. Rep. **14**:27-232.

Rosendahl, C. O. 1955. Trees and Shrubs of the Upper Midwest. Univ. of Minn. Press, Minneapolis. 411 pp.

Rudenberg, L. and P. S. Green. 1966. A karyological survey of *Lonicera*, I. J. Arnold Arb. **47**:222-247.

Sax, K. and D. A. Krebs. 1930. Chromosomes and phylogeny in Caprifoliaceae. J. Arnold Arb. **11**:147-153.

Takhtajan, A. 1969. Flowering Plants: Origin and Dispersal. (Translated from the Russian by C. Jeffrey). Smithsonian Institution Press, Washington, D.C. 310 pp.

Thorne, R. F. 1968. Synopsis of a putatively phylogenetic classification of the Flowering Plants. Aliso **6**:57-66.

Wade, D. R. and D. E. Wade. 1940. Preliminary report on the flora of Wisconsin No. 28. Caprifoliaceae. Trans. Wis. Acad. **32**:91-101.

Wood, K. 1976. Viburnums at the Arboretum. Univ. Wisconsin Arboretum News **25**:1-23.

DROUGHT IN WISCONSIN

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Abstract

Drought in Wisconsin is not as uncommon as the abundant agriculture and the beautiful greenery of the state might suggest. Both agricultural and hydrologic droughts, as defined by a simple precipitation criterion, occur in some part of the state on the average of once in about seven years. Statewide drought occurs less frequently. There appears to be no cyclical pattern to drought occurrence in Wisconsin.

INTRODUCTION

Drought is a word that brings to mind parched land, desicated crops and blowing soil. This, of course, is often the result of severe or extreme drought. However, drought need not be extreme to be important.

In this paper, two types will be considered, hydrologic and agricultural drought. Hydrologic drought affects stream flow and lake and water table levels. Agricultural drought comes at a time and intensity to affect crop production. Both types may, but need not, occur simultaneously.

The effects of hydrologic drought result from integrated changes in precipitation over a moderately long time period. As a result, annual precipitation is used here as an index of hydrologic drought. For agricultural drought, rainfall from May through August is used as an approximation of the growing season precipitation. Droughts are not limited to a growing season nor to the calendar year, but vary in timing and length. However, for an initial look at Wisconsin drought, these two periods proved to be meaningful.

APPROACH

The term drought is difficult, if not impossible, to define precisely because it deals with one end of a precipitation continuum along which there are no breaks that make division into wet and dry periods possible. In this paper, no all-inclusive definition of drought will be attempted, but rather a simple approach to drought based on an analysis of mean precipitation and variability about that mean is used.

The determination of drought used in the following discussion is based on the years 1904 through 1977. This period is the longest for which continuous precipitation records are available for the 18 stations considered (Fig. 1). Drought is defined as a period (either annual or May-August) when the precipitation for a specific location is equal to or less than the mean precipitation minus one standard deviation. For example, the annual mean precipitation of the Antigo station is 30.30 inches and the standard deviation is 5.29. Thus, any year in which the precipitation is equal to or less than 25.01 inches would be considered a hydrologic drought year.

Basing a definition of drought on precipitation alone ignores important meteorological parameters such as temperature and wind as well as non-meteorological aspects of importance. However, this simple approach provides a beginning to the consideration of drought in Wisconsin.

Fig. 1. Locations of 18 precipitation recording stations (closed circles) used in this study.

Results

Graphs of annual precipitation for each of the 18 stations from the beginning of the period of record through 1977 all show certain characteristics. These characteristics are evident in Fig. 2 which represents a north-south transect across the state. A consideration of the graphs helps point out the similarities and the differences in the space and time variation of drought years.

Year to year variability in precipitation is relatively high in all parts of the state. Years with above average precipitation and years with below average precipitation are common. In some cases, there is a statewide correspondence in wet or dry years, but there are many more years where the wet or dry years are not correlated across the state. The four stations, of the 18 studied, presented here, represent the characteristics of the other 14 satisfactorily.

Over the period considered, hydrologic drought occurred at irregular intervals with an average of one statewide drought in 35 years. It is important to remember that the 35 year interval is only an average. Averages are often based on widely varying occurrences as is true in this case.

In growing season totals as in annual precipitation certain years stand out as

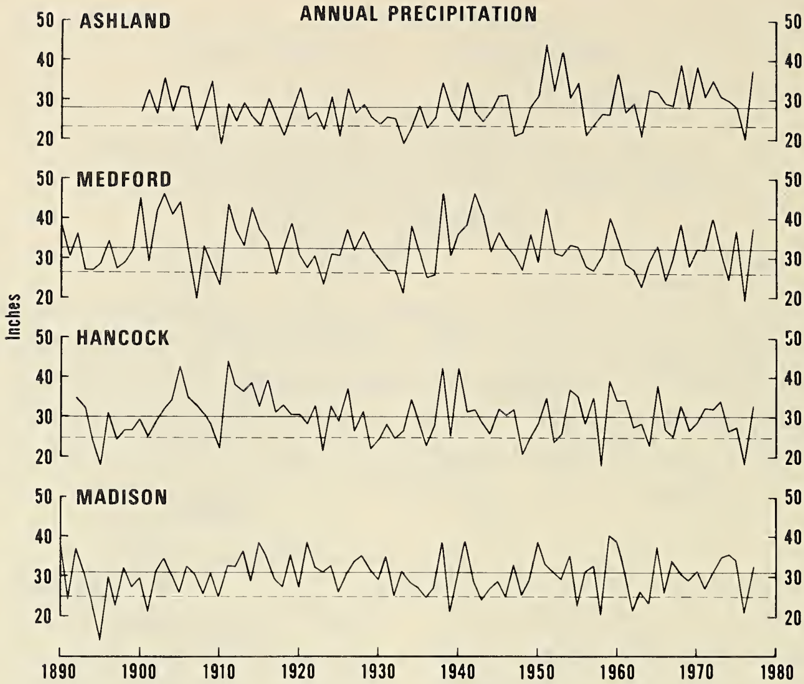

Fig. 2. North to South transect of annual precipitation showing 1904-1977 mean (solid line) and one standard deviation below the mean (dashed line). Years below the lower line have hydrologic drought.

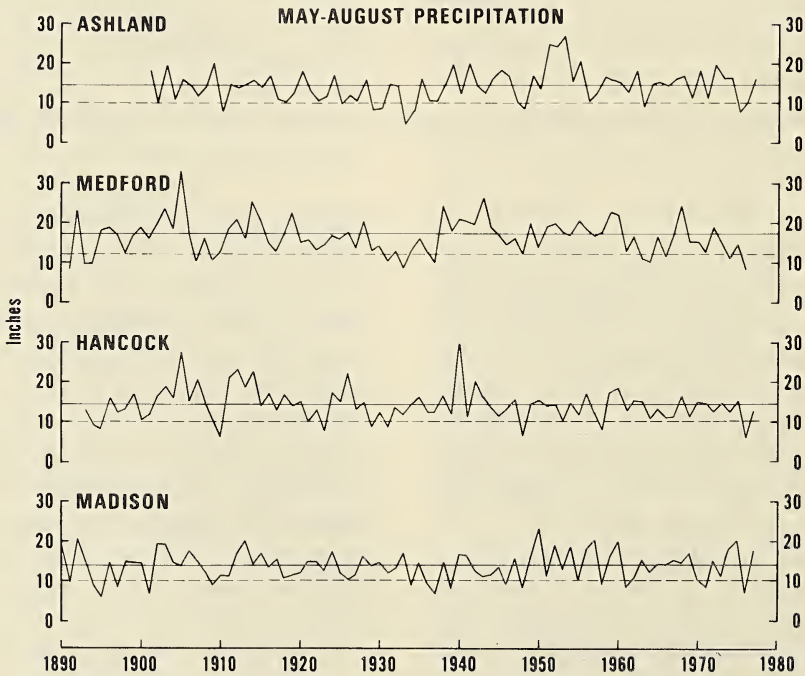

Fig. 3. North to South transect of May-August precipitation totals. Mean values (solid line) and values one standard deviation below the mean (dashed line) are shown. Years below the dashed line are years with agricultural drought.

drought years (Fig. 3). The most outstanding years with agricultural drought seasons occurring essentially statewide were 1895, 1910, 1929, 1936, 1937, 1943, 1963, and 1976. Some, but not all, of these years correspond to years of hydrologic drought. As for annual precipitation, in some years, the state responded as a unit or a whole, and in other years, only part of the state was affected.

It is evident that agricultural drought occurs more frequently than hydrologic drought. This suggests that the frequency of dry periods decreases as the length of the dry period increases.

Statewide similarity and variability may also be shown by graphing the percentage of stations undergoing drought in a given year. As a result of differences in the length of precipitation records, the number of stations used to compile the values will vary (Fig. 4). For the 1894-1899 period, 16 stations were used. Ashland was added in 1900 and Minocqua Dam was added in 1904 to bring the total to 18 stations from 1904 through 1977.

Figures 2, 3 and 4 convey two important facts, drought does occur in Wisconsin frequently enough to be highly significant and, drought may be statewide, but more commonly occurs in only a part of the state in any given year or season.

As pointed out earlier, droughts are not limited to a single growing season or a given calendar year. In addition, the arbitrary definition of drought used here does not address the problem of a dry period that does not meet the criterion of the definition. Hence, only the extreme conditions are dealt with here. The frequency and timing of drought or near drought is well illustrated by the 1930's, a decade infamous for drought throughout much of the country, including Wisconsin. It is instructive to consider this decade in more detail although there were droughts in Wisconsin both before and after the 1930's. Drought was not uncommon during the 1885-1900 period (Fig. 4). However, because there was a smaller population and a less well developed agriculture, the droughts of that period are not as well documented as those of the 1930's.

The growing season of 1929 is included with the 1930's since over 50% of the 18 stations endured a drought during that growing season. Agricultural drought occurred in some parts of the state in nine of the eleven years considered (Fig. 4). However, agricultural drought was reasonably widespread

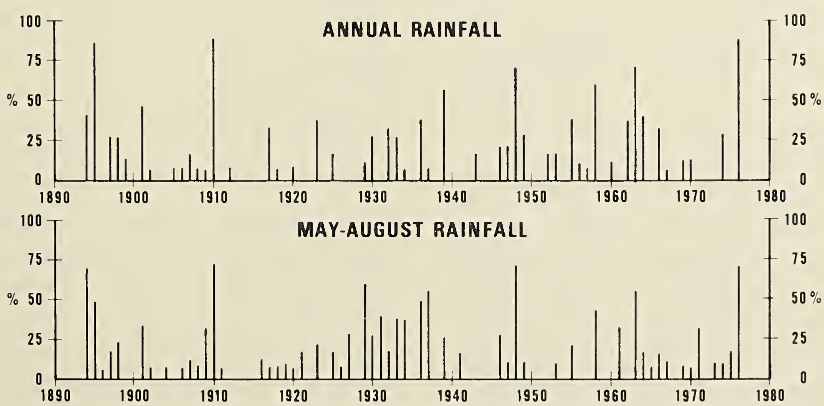

Fig. 4. Percentage of the 18 locations used that have either hydrologic or agricultural drought in a specific year.

in only three years—1929, 1936, and 1937. In those years, it affected approximately 50% of Wisconsin. During these eleven years, agricultural drought was more or less randomly distributed in both time and space. Locations varied experiencing droughts from only one to as many as five years during the period.

The 1930's also illustrate the occurrence of drought in a time frame different from that specified by a rigid definition. In Madison, 1936 with a total precipitation of 25.81 inches was not dry enough to meet the criterion for hydrologic drought. However, 1936 was a devastating drought agriculturally. This year is remembered in Madison and the surrounding area for both the severe dryness and the intense heat of July. A record high temperature for Madison, 107° F, occurred on July 14th. The drought began in March and lasted to mid-August. From March 1st through August 16th, 6.33 inches of precipitation fell, only 36% of the normal for that period. The drought ended when 5.22 inches of rain fell during the last half of August. This illustrates well the problem of considering drought over a specific period. Many more similar cases could be listed.

Summary and Conclusions

Although the climate of Wisconsin is one where precipitation is usually adequate for abundant crop production and to provide the state with many lakes and streams, drought is not uncommon. Using a simple definition of drought we can show that statewide hydrologic drought occurs on the average of about once in 35 years at irregular intervals. Droughts covering portions of Wisconsin are much more frequent. Although these limited droughts are more common than statewide drought, there appears to be no pattern in either time or space. No one part of the state experiences drought more frequently than another part. During the growing season each part of the state is hit by drought on the average of once in seven years, again there seems to be no cycle or pattern.

Acknowledgements

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T. C. CHAMBERLIN: THE KETTLE MORAINE AND MULTIPLE GLACIATION

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On the crest of Observatory Hill between Washburn Observatory and a bird effigy mound, stands Chamberlin Rock, a huge, pinkish gray boulder, that bears a plaque acknowledging Thomas Chrowder Chamberlin's contributions to Wisconsin:

> This tablet commemorates the services to Wisconsin of Thomas Chrowder Chamberlin, leader in science and education, State Geologist of Wisconsin, 1873-1882, President of the University, 1887-1892. As State Geologist he conducted a survey distinguished for high scientific and economic value. As President he made the spirit of research effective in the organization and life of the University. He first distinguished and named the drifts left in this region by successive ice advances. This boulder, brought by the continental glacier from ancient Pre-Cambrian bedrock in Canada, was deposited here in the Wisconsin, or latest glacial drift, of which this hill is a part.

T. C. Chamberlin (1843-1928) was an eminent American geologist. He enjoyed a distinguished career as scientific researcher, educator and government scientific administrator, and is best known for his glacial studies, the planetesimal hypothesis and the method of multiple working hypotheses.[1] Chamberlin's long and successful career began in Wisconsin.

The Chamberlin family, its possessions loaded in two prairie schooners and a small band of livestock in tow, arrived in Wisconsin when Thomas was two years old. Thomas's father, John Chamberlin, a farmer and a circuit-riding Methodist preacher originally from Camden County, North Carolina, had migrated westward with the frontier. He married Cecilia Gill in Palestine, Illinois in 1835. The Chamberlins settled on the Illinois prairie near present-day Mattoon, where, on September 25, 1843, Thomas was born. In 1845 the family moved again to escape malaria, then endemic to east central Illinois and elsewhere in the Mississippi River Valley. John Chamberlin purchased a one hundred and sixty acre homestead about four miles northwest of Beloit.

Wisconsin was still frontier when the Chamberlins arrived. Native prairie grassland and scattered oak openings covered most of southern Wisconsin and the prairie burned seasonally. A little farther to the north, Indians hunted and trapped in the woods and along the streams. Flocks of passenger pigeons darkened the sky during spring and fall migrations, and an occasional wolf came sniffing around the Chamberlins' new log cabin. The Chamberlins arrived in Beloit at about the time Beloit College was founded. The college received its charter from the territorial governor in 1846, and one of Thomas Chamberlin's earliest boyhood memories was of his father describing the ceremony of laying the cornerstone.

After Thomas and his four brothers attended the district grammar school, the Reverend John Chamberlin gave all his sons the opportunity to continue their education. The family moved temporarily into town as the Chamberlin boys began to enter Beloit's preparatory academy. Thomas entered the academy in 1858 and followed the prescribed curriculum of arithmetic, geography, English grammar, spelling, composition, reading, Greek and Latin.

In September, 1862 Thomas began the traditional course of Greek, Latin, and mathematics, with lesser amounts of philosophy, history, literature, and science, in the college. Young Chamberlin acquired a budding interest in science under the guidance of Professor Henry B. Nason, a chemist and mineralogist who had travelled widely and was familiar with American and European geology.[2] Chamberlin earned his college expenses teaching in county grammar schools in the vicinity of Beloit and nearby Rockford, Illinois. A country school teacher's compensation was uncertain however, as Chamberlin learned when a member of the Rockford district school board (who owned a nursery) persuaded the young teacher to take his salary in trees. Those he could not sell, Thomas planted on the family farm.[3]

Thomas Chamberlin graduated from Beloit College in 1866 and that fall became high school principal at nearby Delavan. There he instituted a series of "lecturettes" in the natural sciences and led his students into the nearby countryside on sunny afternoons so that they might learn to identify rocks, plants, and animals and observe their natural relations. The students became so enthusiastic over this innovation that the young schoolmaster frequently had to resort to textbooks to keep up with their curiosity. This experience made Chamberlin uncomfortably aware that his classical education had prepared him inadequately to teach the sciences, and after two years in Delavan he decided to undertake graduate study to broaden his foundation in science. Following a year at the University of Michigan studying geology under Alexander Winchell, Chamberlin returned to southeastern Wisconsin, in 1869, to teach natural sciences in the Whitewater State Normal School. During four years at Whitewater, Chamberlin strengthened instruction in the natural sciences and motivated several students toward careers in science teaching.

In 1873, Thomas Chamberlin returned to Beloit College, teaching geology, zoology, and botany until 1880, when the department was subdivided and he became Beloit's first Professor of Geology. Professer Chamberlin was regarded as a stern but inspiring and innovative teacher, and geology became a popular subject. As a teacher Chamberlin endeavored to focus on current geologic problems, stressing the broader aspects and the methods of the science. A favorite pedagogical practice was to take his classes to the cupola of the Middle College building and to ask his students then and there to write down their interpretation of the gently rolling, glacially contoured topography that lay below them. His advanced senior course included the microscopic study of thin sections of rocks with a polarizing microscope, then a relatively new technique being pioneered by Roland D. Irving.[4] Chamberlin conducted field work for the Wisconsin Geological Survey concurrently with his teaching. When professional geology began to absorb the greater portion of his energies, Chamberlin resigned the chair of geology at Beloit College in the spring of 1882, continuing as an occasional lecturer for five years.

Prior to statehood, David Dale Owen had surveyed Wisconsin's mineral resources in 1839-1840. Two other geological surveys of the state followed, one in 1853-1856 headed by Edward Daniels and J. C. Percival, and the second during 1857-1862 under the direction of New York state geologist James Hall.[5] In 1873 the legislature appropriated funds providing for a complete and systematic four-year geological survey of Wisconsin; the survey was later extended into 1879.

Chamberlin and fellow members of the Wisconsin Academy of Sciences, Arts and Letters were influential in securing political support for the 1873 survey. The Academy had been organized in 1870 with Chamberlin as one of its charter members. In the early years several of the prominent members were geologists, among them Wisconsin's versatile naturalist Increase A. Lapham, Chamberlin, and Roland Duer Irving, professor of geology at the University of Wisconsin (and nephew of the New York author Washington Irving).[6] When the state survey was organized, largely as a result of the lobbying of these men, I. A. Lapham was appointed state geologist, and R. D. Irving, T. C. Chamberlin, and Moses Strong were named as assistants. Lapham, through no fault on his part, was not reappointed, and in 1875 O. W. Wight, a political appointee, took charge of the survey. Wight lasted for one year and then was replaced by Chamberlin in February, 1876. Irving and Strong remained as assistant geologists.

Irving was responsible for surveying the ancient crystalline rock formations, including the Penokee iron and copper ores, of the north central portion of the state. He was assisted in his microscopic study of the Precambrian rocks during the closing years of the survey by a promising University of Wisconsin geology student (and future president of the University), Charles Van Hise. This work of Irving and Van Hise, as well as Chamberlin's own microscopic analysis of the state's sedimentary rocks, distinguished the Wisconsin survey as among the first to employ microscopic petrology.[7]

Strong was to survey the western part of the state, and particularly the economically important lead and zinc deposits in the southwest. At the time of the survey much of northern Wisconsin was heavily forested and sparsely populated. There were few roads. Field work was a rugged, occasionally hazardous undertaking. In 1877 Moses Strong drowned in the Flambeau River while attempting to negotiate a tricky stretch of rapids. After Strong's death, Chamberlin completed the final revision of Strong's reports for western Wisconsin. Like Josiah D. Whitney, geologist with James Hall's earlier survey, Chamberlin decided that the lead and zinc ores had originated as precipitates from the early Paleozoic seas. However, Chamberlin's interpretation differed from the previous one in his recognition of the role of ground water in concentrating the metals in economically significant amounts. Chamberlin proposed that the lead and zinc minerals had accumulated simultaneously with, and had originally been dispersed throughout, the layers of sediments. Later the minerals were deposited in cracks and fissures by ground water seeping through the sedimentary rocks after the area had risen above sea level.

As chief geologist, Chamberlin was responsible for compiling and editing the survey reports. In addition, he was personally responsible for the survey of southeastern Wisconsin. He began field work in that area as assistant geologist in 1873 and continued after his appointment as director in 1876. At the time of his field assignment, a friend commiserated, "Mr. Chamberlin, you are shelved. What is there to be found in southeastern Wisconsin?"[8] Compared to Irving's and Strong's assignments in areas of economically interesting ore rocks, Chamberlin's assignment seemed mundane. The lower Paleozoic sedimentary strata of southeastern Wisconsin were for the most part buried under unalluring heaps of glacial drift. But rather than shelved, Chamberlin became America's leading glacial geologist.

Southeastern Wisconsin was a particularly propitious area in which to study glacial geology. Most of Wisconsin, with the exception of the southwest corner, is covered with a veneer of loose, glacially transported boulders, gravel, and soils, called "drift" because, during the first half of the nineteenth century, geologists had thought that this material had been carried by flotillas of icebergs that had broken off from glaciers to the far north. These icebergs, it was assumed, had drifted over submerged areas of the continent, and dropped their embedded cargo of rocky materials as they thawed. By the time Chamberlin began his field studies, most of the drift was recognized as actual glacial deposits, rather than the jetsam of hypothetical icebergs.

The drift, also known as "ground moraine" or "till," had been spread over the surface as the ice sheet that had carried the rocks and soil melted and retreated. In Chamberlin's section of Wisconsin the glacial drift was deployed in an arcuate pattern of ridges. The ridges were known locally as the Potash Kettle Range because the drift contained many pits and kettle-like depressions of varying shapes and depths.[9] Occasionally the depressions were filled with water, forming kettle lakes. Chamberlin concluded that the Kettle Range was "evidently a gigantic moraine." The outermost ridge, or terminal moraine, marked the farthest advance into southern Wisconsin of the tongue of the continental ice sheet that had extended over Green Bay and the Fox River valley, south into the Rock River valley. Chamberlin remarked of this feature: "It is improbable that the whole glacial field, when fully explored, will offer a better type-example of the formation of a glacial tongue in open and comparatively plain country, and of the remarkable laws that governed its action, than did the little glacier of the Green Bay-Rock River Valley, one of the least among its brethren."[10] Another tongue of the ice sheet had extended the length of the Lake Michigan basin, lapping over the eastern edge of Wisconsin. The main, roughly north-south section of the Kettle Range included the moraine formed along the western edge of the Lake Michigan ice lobe and the moraine marking the eastern edge of the Green Bay lobe. Chamberlin termed this range of moraines, formed intermediate between two glacial tongues, an "interlobate" moraine.[11]

Chamberlin considered the Kettle Moraine to be "a peculiar and irregular aggregation" of the widespread ground moraine, and thought at first that the ridges and hills formed when the ice had halted in the midst of its retreat and readvanced, plowing the materials it had deposited into immense ridges. He supposed the series of more or less parallel ridges could be explained by alternating retreats and readvances of the ice repeated several times.[12] The kettles were formed as large remnant blocks of glacial ice incorporated within the drift melted, leaving a depression.[13] Chamberlin also suggested that they might represent original irregularities in the surface of the drift or be the result of a sinking and settling of the drift material in places where loose sandy material had been carried away by under-drainage.[14]

The state geologist studied the striae caused by rocks frozen into the bottom of the glacier scraping over the bedrock surfaces, and from the orientation of these scratches and grooves parallel to glacial motion was able to determine the direction of ice movement within the two glacial lobes. The movement of the ice had been generally south and southwestward, parallel to the axes of the ice lobes and to the trend of the present basins formerly occupied by the ice. However, as the ice had fanned outward from the axes of the lobes, its movement had been directed at right angles to the margins of the lobes. Thus the striae on the bedrock in the peripheral glaciated areas were generally oriented perpendicular to the moraines.[15] Other features that Chamberlin used in interpreting ice movement were the elongated, somewhat "whale-shaped" hills of unsorted drift known as drumlins. The axes of the drumlins tend to parallel the flow of the ice that shaped them and their steeper ends face in the direction from which the ice came. The distribution of boulder trains also indicated the direction of ice flow. The boulders in these 'trains' were of native Wisconsin bedrock, unlike the many erratics brought into the state by the ice, and could be traced to certain distinctive local source areas. The ice, as it passed over these source areas, dislodged weathered chunks of the rock and carried them away, 'downstream' from their source, and then abandoned the boulders as it retreated. Quartzite boulder trains, strewn in a generally southwesterly direction as far as

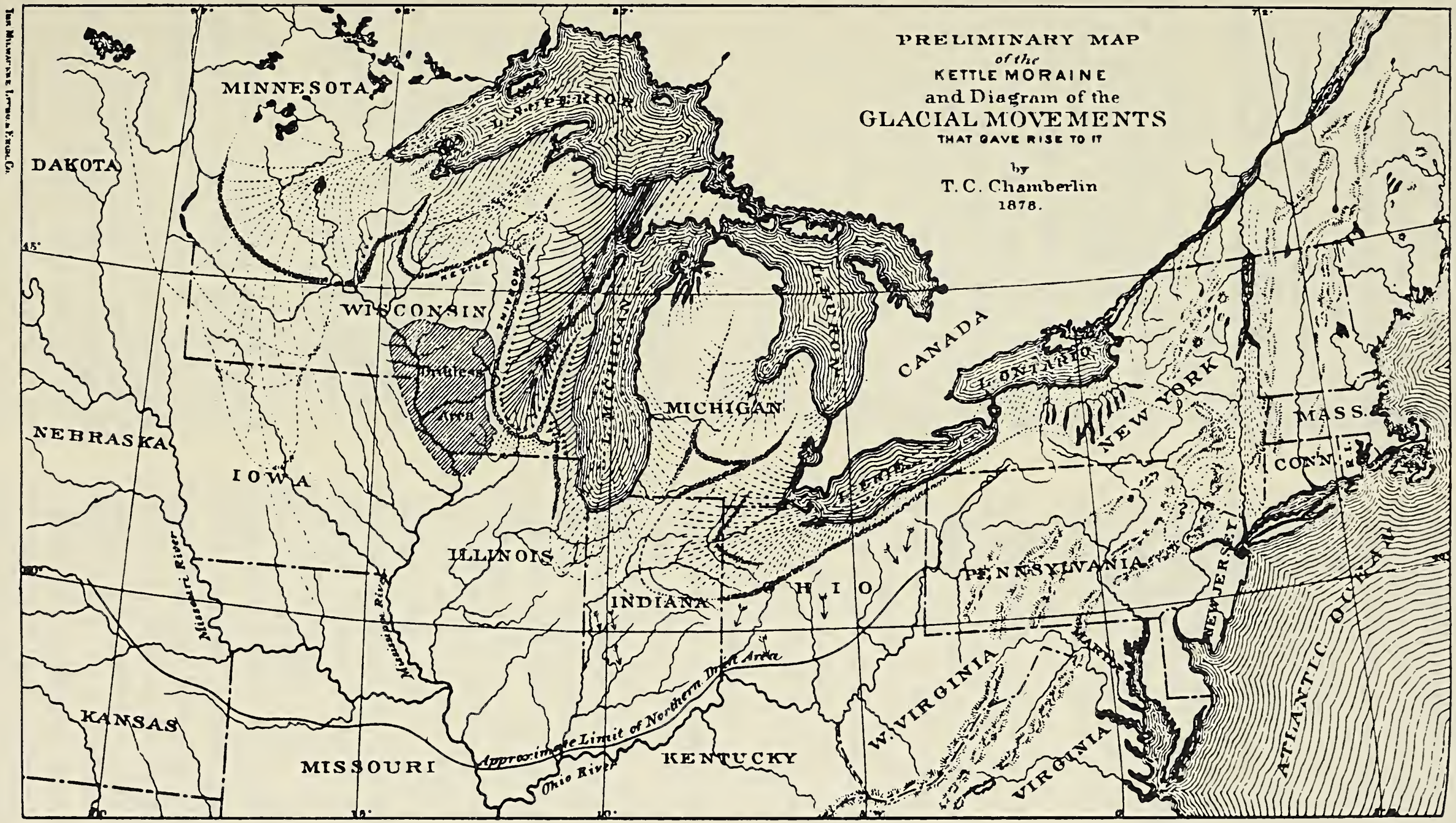

Fig. 1. Preliminary map of the Kettle Moraine and diagram of glacial movements. (From T. C. Chamberlin. 1878 Trans. Wis. Acad. Sci. Arts and Letters, Vol. IV, p. 208.)

sixty miles from their source near Waterloo, where the quartzite outcrops, indicated to Chamberlin that ice movement there had been from northeast to southwest. Southeastern Wisconsin drift was also characterized by kames—moundlike hills of sorted drift deposited by flowing melt-water in openings in, or on the surface of, stagnant ice or against the margin of the ice sheet; and eskers (Chamberlin used the Scandinavian term "osar" in his early writings)—long, serpentine ridges of drift deposited by meltwater flowing through tunnels at the base of the ice.

In 1878 Thomas Chamberlin was sent to Europe as Wisconsin's delegate to the Paris Exposition. During this visit he presented a paper on his glacial studies to the International Geological Congress and took advantage of the opportunity to observe Alpine glaciers and their associated phenomena. While distinguishing important differences between the phenomena produced by glaciers confined to narrow mountain valleys and those produced by a massive continental ice sheet, Chamberlin noted certain aspects of Alpine glaciation that seemed roughly analogous to some features of Wisconsin's drift.[16] In particular, the "Jardin" in the Chamonix region of the French Alps, an area that was free from ice though surrounded by active glaciers, reminded Chamberlin of Wisconsin's driftless area. Chamberlin later made a detailed study of the driftless area with his associate and former student at Beloit, Rollin Salisbury.[17] Unlike the Alpine Jardin which stood above the bordering glaciers, the driftless area in southwestern Wisconsin, southeastern Minnesota, and northeastern Iowa lay in the Mississippi Valley with higher land to the north. Chamberlin concluded that . . . "Diverted by highlands, led away by valleys, consumed by wastage where weak, self-perpetuated where strong, the fingers of the mer de glace closed around the ancient Jardin of the Upper Mississippi Valley, but failed to close upon it."[18] The driftless area provided a standard of comparison particularly valuable because the bedrock formations of the driftless area were the same as those underlying the surrounding glaciated region. The driftless area suggested how the preglacial surface of the glaciated region may have appeared, thus providing Chamberlin with a means for better judging the work of the ice.

In his discussion of Wisconsin glaciation for the state survey reports Chamberlin had concerned himself with the moraine only as it occurred in the state. In a paper prepared for the Wisconsin Academy of Sciences, Arts and Letters, he pointed out that Wisconsin's Kettle Moraine was but the local segment of the great moraine which had bordered the lobate edge of the former vast North American ice sheet (Fig. 1).[19] He observed that this entire moraine was not necessarily coincident with drift marking the farthest extent of the ice, and hinted at the possibility of two separate stages of glaciation in North America.

> If the evidence adduced to show that the Kettle moraine was due to an advance of the glaciers be trustworthy, then, to the extent of that advance, whether much or little, the moraine marks a secondary period of glaciation, with an interval of deglaciation between it and the epoch of extreme advance. Its great extent indicates that whatever agency caused the advance was very widespread, if not continental in its influence. The moraine, therefore, may be worthy of study in its bearings upon the interesting question of glacial and interglacial periods.[20]

The Scottish geologists James Geikie and James Croll had already suggested that there had been more than one episode of glaciation in Europe.[21] In Scotland, Geikie had found marine sediments containing shells, fresh water deposits, and vegetal soils interstratified with glacial tills containing the bones of arctic mammals, indicating that the glacial conditions during which the tills had been deposited had been interrupted at least once, and perhaps several times, by submergence and milder climates. Croll related the occurrence of glaciation to periodic episodes of maximum eccentricity in the earth's orbit.

Evidence suggesting two occurrences of glaciation had been accumulating gradually in the United States. As Chamberlin noted, there was the distinct terminal moraine to the north, while the drift south of the moraine had a more weather-worn appearance, suggesting that it had been subjected to erosional processes longer than the drift bounded by the moraine. More convincing were the "forest beds," layers of decayed vegetable matter found buried between two distinct sheets of glacial drift at various locations.[22] These forest beds and layers of soil suggested that the ice had been absent and the climate had been warm enough for forests to grow upon the lower till before the next ice advance. Despite this evidence, the interpretation involving alternating glacial and interglacial phases was not readily received in the United States. Chamberlin explained in volume one of the *Geology of Wisconsin* (1883), the fourth and last volume of the state survey reports to be published, that he had not formally advocated the hypothesis of multiple glaciation in previous volumes "due partly to the fact that investigations were still in progress, which made it injudicious to prejudice results by broad conclusions in advance of the fullest available data, and partly to the fact that the existence of two such periods had not been generally recognized by American geologists, although the doctrine of separate glacial periods had been entertained by several in this country, following the lead of the Scotch school."[23] Chamberlin, as a result of an extended survey of the moraine, became more firmly convinced that there had indeed been two episodes of glaciation in North America.

> Our present firmness of conviction arises (1) from the discovery and working out of an extended moraine stretching across the whole of the glaciated area and belonging to a system of glacial movements which differ in many important respects from the earlier ones; and (2) from the differences of surface contour due to the greater erosion of the earlier, as already indicated. We believe that this line of evidence, when developed in its fulness, will prove entirely demonstrative. Only a small part of the results now gathered fall specifically within our present province as chronicler of the geological history of Wisconsin, but the total result is, in some important measure, the outgrowth of investigations begun in this State.[24]

Field work for the Wisconsin Geological Survey ended in March, 1879, but Chamberlin continued his editorial duties into 1882. The reports formed an impressive four-volume description and interpretation of Wisconsin's natural resources with practical suggestions for their utilization. The exemplary character of the survey reports, Chamberlin's successful administration of the survey, and his particular interest in glacial phenomena attracted the attention of John Wesley Powell, Director of the United States Geological Survey. In 1881 Powell appointed Chamberlin to head the new glacial division of the USGS. Chamberlin hired as an assistant Rollin D. Salisbury, a geology student from Beloit College, thus beginning a close professional association that was to last forty years.[25] R. D. Irving was given charge of the USGS Lake Superior division in 1882. Irving retained Charles R. Van Hise as his assistant and together they continued their pioneering microscopic study of the Precambrian rocks. Following Irving's death six years later, Van Hise succeeded his mentor as head of the division and rose to national prominence as a metamorphic geologist.[26]

Chamberlin's first undertaking was the detailed survey and mapping of the entire extent of the drift, from the Atlantic coast across the Midwest and Dakota Territory into Montana. He spent field seasons tracing what he considered the more or less continuous, looping "terminal moraine" which marked the former position of the multilobate edge of the ice sheet, the same formation he had correlated with Wisconsin's Kettle Moraine. As a result of these field studies, Chamberlin became intimately familiar with the wide range of Pleistocene phenomena. Early in this survey he corroborated his Wisconsin observations and their suggestion of two glaciations in North America. Chamberlin's first report was titled "Preliminary Paper on the Terminal Moraine of the Second Glacial Epoch."[27]

After 1882 Chamberlin pursued U. S. Geological Survey work full time, occasionally teaching at Columbian (now George Washington) University in Washington, D.C. In 1887, he returned to Wisconsin to become President of the University. He continued his research and his administration of the USGS glacial division while successfully guiding the growth of the University of Wisconsin. President Chamberlin's five-year administration is credited with strengthening organization, curriculum, and faculty, and accomplishing the transition from a college to a true university.[28] In 1892, to devote more time to teaching and geological research, Thomas Chamberlin became head of the Department of Geology at the new University of Chicago.

As a result of the investigations of the USGS Pleistocene division, which included the field work of such able assistant geologists as R. D. Salisbury, Warren Upham, Frank Leverett, and William Alden, it became apparent that North American glacial history was indeed complex. One of the major problems facing American glacial geologists was the correlation of midwestern glacial deposits with those in the East. As Chamberlin had noted during the course of his earlier Wisconsin studies, the extreme border of the drift, was not coincident with the terminal moraine. This divergence of the moraine from the drift border was particularly apparent in the Midwest where the moraine, after forming the loop that outlined the Green Bay lobe of the ice sheet, crossed Wisconsin north of the driftless area, entered Minnesota, dipped into north central Iowa and continued northwestward across northeastern Nebraska. Yet drift material could be found beyond the morraine as far south as north central Missouri and northeastern Kansas. However, east of Ohio the discrepancy between the moraine and the southernmost extent of the drift was not so remarkable, nor was the lobate pattern of the moraine conspicuous in its eastern reaches. While Chamberlin recognized, in the weathered drift south of the moraine, evidence of an earlier glaciation, with the moraine delimiting the drift of a second more recent ice advance, geologists in the East were more inclined to interpret the eastern drift as evincing only one major glaciation, with perhaps minor oscillations in the position of the ice front.

The drift in Pennsylvania had been surveyed by Henry Carvill Lewis and George Frederick Wright. Following the death of Lewis, Wright, a professor of theology at Oberlin College and an enthusiastic self-taught geologist, continued the work as a member of Chamberlin's USGS Pleistocene group. Wright thought that drift found beyond the distinct drift border that Chamberlin had identified as the "terminal moraine" in northwestern Pennsylvania was merely a "fringe" deposited by the same ice sheet that had left the moraine, with the moraine itself marking where the ice front had halted for a considerable period of time. Chamberlin contended that the moraine-bordered drift and Wright's extramorainal "fringe" indicated two "somewhat widely separated epochs of glaciation."[29] At issue were whether the difference in character and position between the moraine-bordered drift and the extramorainal drift represented a full-scale retreat or a minor "oscillation" of the ice front, the amount of time involved, and whether the retreat of the ice had been accompanied by a significant change in climate. Wright argued that the forest beds of the Midwest, accepted by Chamberlin and others as evidence of a considerable interglacial interval of warmer climate, represented forests that had grown along the margin of the ice sheet, much as conifer forests grow near valley glaciers in Alaska. Chamberlin correlated river terraces and gravels in the Mississippi and Ohio valleys with two episodes of glaciation, and the erosion of the major portion of the valley trenches between upper and lower level terraces with the interglacial interval. Wright thought the drainage features and gravel terraces of the Ohio River valley could be attributed to one episode of glaciation and the presence, during much of the Pleistocene epoch, of a huge lake behind a hypothetical ice dam in the vicinity of Cincinnati. In addition, the chief of the Pleistocene division and the Oberlin theologian differed significantly in their broad conceptions of the ice age. Wright assumed that the glacial epoch had commenced perhaps one hundred thousand years ago (when a hypothetical elevation of the continent triggered climatic cooling) and a gradual spread of the ice sheet, with the ice dominating North America for a scant twenty-five thousand years. Wright's ice age was relatively brief, relatively recent, and one continuous event. Chamberlin believed that the glacial epoch had been multiple in nature and of much greater duration.

Upon completing his field studies, Wright promptly set about writing a popularized account of the ice age in North America, aspiring to emulate James Geikie's European work, *The Great Ice Age and Its Relation to the Antiquity of Man.* Chamberlin attempted to discourage him, because he questioned Wright's scientific abilities, suspected Wright of fame-seeking motives, and believed that North American Pleistocene research was not yet far enough advanced to supply a definitive account of the ice age. Chamberlin undoubtedly also assumed, and not altogether unjustly, that if a generalized history of North American glaciation were to be written, he was the one best qualified to do it. Nevertheless, Wright's *Ice Age in North America and Its Bearing upon the Antiquity of Man* was published in 1889, attracted the popular interest that Chamberlin feared it would, and went through three editions in three years. In 1892 Wright produced a similar work, *Man and the Glacial Period.* Chamberlin was scathingly critical of Wright's efforts, both in his private correspondence to fellow geologists and in print.[30] In 1892, Wright also prepared a paper on the "Unity of the Glacial Epoch" which was critical of Chamberlin's advocacy of two glaciations.[31] Chamberlin responded with a defense of "The Diversity of the Glacial Epoch,"[32] and the great American glacial debate was launched. The disagreement over the nature of the glacial epoch between Wright and Chamberlin and their various supporters enlivened many sessions at geological meetings and resulted in many pages in geological journals. T. C. Chamberlin emerged as the foremost advocate of multiple glaciation among American geologists.[33]

James D. Dana, of Yale, the dean of American geologists in the late nineteenth century and editor of the *American Journal of Science,* suggested that the main difference among geologists in the glacial debate was geographical. Those who had done field work in the East seemed to favor unity, whereas geologists familiar with midwestern Pleistocene phenomena discerned at least two glacial epochs. Dana thought the underlying reason for this was meteorological. The higher elevation of the eastern region and proximity of the Atlantic Ocean would have produced great amounts of snow, Dana supposed, while in the drier Midwest more thawing and more retreats and advances of the ice would have occurred. Dana concluded that there had been only one continuous glacial epoch with greater variations in the position of the ice front having occurred in the Midwest.[34] Chamberlin replied to Dana that geologists only found one drift sheet in New England because the drifts of earlier glaciations had been overridden and buried under the most recent drift, whereas in the Midwest a series of several drifts was exposed to the south of the drift of the last glacial advance. If the different deployments of the drift in New England and in the Midwest were related to different meteorological conditions as Dana had suggested, then the greatest expansion of the drift should not have occurred, as it had, on the midwestern plains where climatic and topographic conditions were supposedly less favorable. Chamberlin wrote: "The inferiority of the drift of New England in extent, in massiveness, and in serial development is the feature that calls for explanation in adverse conditions rather than the magnificent deployment of the glacial series on the plains of the interior."[35]

In 1894 Chamberlin supplied a description of the North American Pleistocene succession for the revised third edition of James Geikie's *Great Ice Age,* in which he subdivided the drift into three glacial formations representing three stages of glaciation, with two intervening interglacial formations.[36] On this occasion Chamberlin for the first time proposed tentative names for the North American drift sheets. Employing geographic nomenclature, he suggested the name "Kansan" for the bottommost layer of drift deposited during the earliest ice invasion that had extended the farthest southwestward into Kansas. The Kansan till was overlapped by another sheet of drift which Chamberlin christened the "East Iowan." Between this second drift and the older Kansas till were a well-developed soil horizon and forest beds. As the name implied, the East Iowan drift was most characteristically displayed in northeastern Iowa, and like the Kansan, was not usually bordered by any definite terminal moraine. Above the East Iowan drift sheet was a second horizon of soils, peat, and vegetal accumulations indicating another noteworthy interval of deglaciation. Further evidence of such an interval was the generally eroded topography of the surface of the East Iowan drift. In addition, fossiliferous strata containing a moderate-climate flora and fauna sandwiched between glacial deposits had recently been reported near Toronto, Canada, indicating a significant retreat rather than a minor oscillation of the ice front.[37] Chamberlin tentatively correlated these fossiliferous beds with the soils overlying the East Iowan drift. Topping off the North American Pleistocene sequence was the complex, moraine-bounded drift which Chamberlin named the "East Wisconsin." Chamberlin subsequently shortened the names of the two younger drifts to "Iowan" and "Wisconsin" and suggested locale names for the interglacial deposits. The forest bed between his Kansan and his Iowan tills was named the "Aftonian," for its exposure at a railway excavation near Afton Junction, Iowa. The second interglacial formation between the Iowan and Wisconsin drifts was called the "Toronto" formation.[38]

Meanwhile the glacial drift of the upper Mississippi Valley was being subjected to detailed scrutiny by Samuel Calvin and H. Foster Bain of the Iowa Geological Survey and by Frank Leverett, one of Chamberlin's assistants, in Illinois. Previously, W J Mc Gee of the United States Geological Survey had distinguished a lower till and an upper till separated by a forest bed in Iowa. Under Chamberlin's classification these became the Kansan drift sheet, the Aftonian interglacial beds, and the Iowan drift. During 1895 and 1896 Calvin and Bain sorted out a third till sheet and a second forest bed in northeastern Iowa. The Iowa geologists applied the term "Iowan" to the newly differentiated uppermost till sheet and shifted the term "Kansan" to the till sheet that Chamberlin had named "Iowan." During this time Frank Leverett had discerned a drift sheet in Illinois referable to a separate stage of glaciation. Leverett traced the Kansan drift across the Mississippi River into Illinois where it lay underneath the "Illinoian" drift, and in turn had traced his Illinoian drift sheet west across the Mississippi into Iowa where it underlay the new Iowan drift. Thus by 1896 there seemed to be five distinct North American glacial formations: 1) the sub-Aftonian drift sheet (Chamberlin's original Kansan), overlain by the Aftonian interglacial beds; 2) the Kansan drift (Chamberlin's original Iowan), separated by an interglacial deposit from 3) Leverett's Illinoian drift sheet, above which were more interglacial soils; 4) the Iowa geologists' Iowan drift, overlain by an interglacial deposit which possibly corresponded with the Toronto interglacial fossil beds; and 5) the complex Wisconsin drift.

Chamberlin went over parts of central Iowa with Assistant State Geologist H. Foster Bain, who was at the time working up a section of that area for his doctoral dissertation under Chamberlin, and in 1896 Chamberlin was willing to accept the transfer of the Kansan and Iowan terms with only slight reluctance.[39] However, he later came to regret this change in nomenclature and wished to re-establish his original designations. His original Iowan till, the Kansan of the Iowa geologists, seemed to Chamberlin to be more distinctively displayed in Iowa than elsewhere and to be the most extensive and typical of Iowa's drifts.[40] But the patriarch of American glacial geology was not heeded by the younger generation of geologists. Chamberlin's Iowan drift became the Kansan and the lowest, sub-Aftonian till sheet was renamed the "Nebraskan" drift. The name Iowan was applied to the till sheet between the Illinoian and Wisconsin drifts. Leverett named the upper three interglacial intervals the "Yarmouth," between the Kansan and Illinoian drifts, the "Sangamon," between the Illinoian and Iowan drifts, and the "Peorian," between the Iowan and Wisconsin drifts. In the early twentieth century, Geikie's six European glacial epochs were trimmed to four stages and the comparatively insignificant drift of northeastern Iowa, which brought the number of North American glacial formations to five, became an embarrassing anomaly. Although Thomas Chamberlin did not live to see it, this Iowan till sheet later was demoted from a formation representing a major ice invasion to a substage of the Wisconsin glaciation, leaving Iowa, though covered by several tills, with a namesake in none of them.[41]

For the quarter of a century following his appointment as head of the United States Geological Survey Pleistocene division, Thomas Chamberlin dominated American glacial geology. After the turn of the twentieth century, Chamberlin's research focused less on glacial problems and more on the circumstances surrounding the origin of the Earth. During the 1890's Chamberlin became interested in theories of climatic change and the causal factors of the glacial epoch. His attention was drawn to the possibility that a decrease in the amount of carbon dioxide in the atmosphere had lowered the earth's ability to retain heat and may have led to a glacial climate.[42] Periods of low atmospheric carbon dioxide content would correlate with periods of glaciation. Chamberlin suggested a mechanism which might cause atmospheric carbon dioxide to fluctuate. During the chemical weathering of silicate rocks atmospheric carbon dioxide combines with minerals to form new carbonate compounds. Chamberlin assumed that this was the chief process by which carbon dioxide was subtracted from the atmosphere and locked up in the earth's crust. The erosion of massive continental areas following a major uplift would deplete the atmospheric store of carbon dioxide and lead to cooling. An additional factor was the ocean's ability to act as a reservoir of carbon dioxide: the colder the ocean, the more carbon dioxide it can hold. Then, as ice sheets covered large areas of crystalline silicate rocks, the carbonation process would be halted, depletion of atmospheric carbon dioxide would be curtailed, the cooling trend would be reversed, and glaciers would retreat. As the ice melted and the crystalline rocks were again exposed, atmospheric erosion and carbonation would recommence and another stage of glaciation would occur. Alternating glacial and interglacial phases would continue until erosion brought continental areas low, the rate of weathering processes slowed, and shallow seas crept over the continental margins providing a habitat for marine organisms that secreted calcareous skeletons. During the organic lime-secreting process carbon dioxide is removed from sea water and released to the atmosphere. According to Chamberlin, the lime-secreting activities of myriads of marine organisms would contribute a sufficient amount of carbon dioxide to the atmosphere to effect a warming trend. A mild subtropical climate would ensue until a large-scale tectonic uplift again exposed vast continental areas.[43]

Chamberlin's consideration of the interaction of the earth's crust, atmosphere, and oceans led him deeper and deeper into geologic history. In conjunction with his study of climatic change Chamberlin proposed a new hypothesis for the origin of the earth—the planetesimal hypothesis—and developed it over a period of twenty-five years in association with the astronomer Forest R. Moulton. At the time of Chamberlin's death in 1928 the planetesimal hypothesis ranked as a major twentieth-century cosmogony. As Chamberlin had remarked, "the cold trail of the ice invasion had led by this long and devious path into the field of genesis."[44] For Thomas Chamberlin, this path began in the Wisconsin Kettle Moraine.

Notes

[1] Biographical material on Chamberlin can be found in Rollin T. Chamberlin, "Thomas Chrowder Chamberlin, 1843-1928," *National Academy of Sciences Biographical Memoirs,* 15 (1934): 305-407; George L. Collie and Hiram D. Densmore, *Thomas C. Chamberlin, Ph.D., Sc.D., LL.D. and Rollin D. Salisbury, LL.D. A Beloit College Partnership* (Madison: State Historical Society of Wisconsin, 1932); Carroll L. Fenton and Mildred A. Fenton, *Giants of Geology* (Garden City: Doubleday and Co., 1952), pp. 302-317; Kirtley F. Mather, "Thomas Chrowder Chamberlin," *Dictionary of Scientific Biography,* vol. 3, pp. 189-191; Bailey Willis, "Memorial of Thomas Chrowder Chamberlin (1843-1928)," *Bulletin of the Geological Society of America* 40 (1929): 23-44; Herbert C. Winnik, "Science and Morality in Thomas C. Chamberlin," *Journal of the History of Ideas* 31 (1970): 441-456; Susan Schultz, "Thomas C. Chamberlin: An Intellectual Biography of a Geologist and Educator" (Ph.D. dissertation, University of Wisconsin, 1976). In addition, the May-June, 1929 issue of the *Journal of Geology,* vol. 37, pp. 289-392 contains several articles on various aspects of the life and work of Chamberlin, and a bibliography of his works.

[2] Thomas C. Chamberlin, Memorial editorial on Henry B. Nason, *Journal of Geology* 3 (1895): 342-343.

[3] For Chamberlin's student days and later teaching career at Beloit College, see Collie and Densmore, *Chamberlin and Salisbury.*

[4] T. C. Chamberlin, "Roland Duer Irving," *Trans. Wisc. Acad.* 8 (1892): 433-437.

[5] See Ernest F. Bean, "State Geological Surveys of Wisconsin," *Trans. Wisc. Acad.* 30 (1937): 203-220 and Walter B. Hendrickson, "Nineteenth-Century Geological Surveys: Early Government Support of Science," *Isis* 52 (1961): 357-371.

[6] Chamberlin later noted that thirty-five per cent of the papers presented during the first two years of the Academy's existence were on geological topics ("The Founding of the Wisconsin Academy of Sciences, Arts and Letters," *Science* 52 [1920]: 7).

[7] George P. Merrill, *Contributions to a History of American State Geological and Natural History Surveys,* United States National Museum Bulletin 109 (Washington, D.C.: Government Printing Office, 1920), pp. 531-532; Louis V. Pirsson, "The Rise of Petrology as a Science," in *A Century of Science in America,* ed. E. S. Dana, New Haven: Yale University Press, 1918), p. 255; T. C. Chamberlin, "Charles Richard Van Hise," *National Academy of Sciences Memoirs* 17 (1924): 145; Maurice M. Vance, *Charles Richard Van Hise, Scientist Progressive* (Madison: State Historical Society of Wisconsin, 1960), pp. 24-25.

[8] R. T. Chamberlin, "Chamberlin," *Biographical Memoir,* p. 312.

[9] The term "potash kettle" refers to the large vessel commonly used in the frontier process of

obtaining potash, a crude form of potassium carbonate, used in making soap. Wood ashes were lixiviated (leached) and the solution was evaporated over a fire in large iron pots, yielding the potassium carbonate as, literally, pot ash.

[10] Chamberlin, "Preliminary Paper on the Terminal Moraine of the Second Glacial Epoch," *United States Geological Survey Third Annual Report* (1882), p. 315.

[11] Chamberlin, "Preliminary Paper on the Terminal Moraine," pp. 301-302.

[12] Chamberlin, T. C., *Geology of Wisconsin, Survey of 1873-1877,* 4 vols. and atlas (Madison: Commissioners of Public Printing, 1877-1883), 2: 214. When Chamberlin later visited Greenland as geologist with the Peary auxiliary relief expedition in 1894 and observed glaciers in action, he realized that moraines are not the result of plowing action on the part of the ice, but rather that the debris carried within the ice accumulates as the ice at the glacial margin melts and sloughs off its load of boulders, gravel, and soil while the ice front is stationary. When the ice front re-advances, it does not plow the debris, but rides over it ("Recent Glacial Studies in Greenland," *Bulletin of the Geological Society of America* 6 [1895]: 214).

[13] This interpretation, the currently accepted explanation of true kettles, had previously been advanced by Charles Whittelsey in "On the Drift Cavities, or 'Potash Kettles' of Wisconsin," *Proceedings of the American Association for the Advancement of Science* 13 (1860): 297-301.

[14] Chamberlin, *Geology of Wisconsin,* 2: 214.

[15] Chamberlin later made a comprehensive study of glacial striae, "The Rock-Scorings of the Great Ice Invasions," *USGS Seventh Annual Report* (1885-1886), pp. 147-248.

[16] Chamberlin, "Observations on the Recent Glacial Drift of the Alps," *Trans. Wisc. Acad.* 5 (1877-1881): 258-270.

[17] Chamberlin and Rollin D. Salisbury, "Preliminary Paper on the Driftless Area of the Upper Mississippi Valley," *USGS Sixth Annual Report* (1884-1885), pp. 205-322.

[18] Chamberlin and Salisbury, "Driftless Area," p. 322.

[19] Chamberlin, "On the Extent and Significance of the Wisconsin Kettle Moraine," *Trans. Wisc. Acad.* 4 (1876-1877): 201-234. This paper was apparently first presented in 1875.

[20] Chamberlin, "Wisconsin Kettle Moraine," pp. 233-234.

[21] James Croll, "On the Physical Cause of the Change of Climate During Geological Epochs," *Philosophical Magazine* 28 (1864): 121-137; James Geikie, "On Changes of Climate During the Glacial Epoch," *Geological Magazine* 8 (1871): 545-553; 9 (1872): 23-31, 61-69, 105-111, 164-170, 215-222, 254-265, and *The Great Ice Age,* 1st and 2nd eds., 1874 and 1877.

[22] In 1868 A. G. Worthen had described buried soils between two tills in Illinois. Between 1869 and 1874 Edward Orton, J. S. Newberry, and N. H. Winchell also described forest beds, a peat bog, vegetal material, and soils interstratified between two tills in Ohio and Minnesota and recognized these deposits as representing an interglacial interval. See Herman L. Fairchild, "Glacial Geology in America," *Proceedings of the American Association for the Advancement of Science* 47 (1898): 272; F. T. Thwaites, "The Development of the Theory of Multiple Glaciation in North America," *Trans. Wisc. Acad.* 23 (1927): 41-164; G. F. Kay and E. T. Apfel, "The Pre-Illinoian Pleistocene Geology of Iowa," *Iowa Geological Survey Annual Report* 34 (1929): 71-72; and R. F. Flint, "Introduction: Historical Perspectives," in *The Quaternary of the United States,* ed. H. E. Wright, Jr. and D. G. Frey (Princeton: Princeton University Press, 1965), p. 5. Thwaites has surveyed and chronologically summarized the literature pertaining to the concept of multiple glaciation in North America.

[23] Chamberlin, *Geology of Wisconsin,* 1: 271-272.

[24] Chamberlin, *Geology of Wisconsin,* 1: 272.

[25] For the teacher-student relationship between Chamberlin and Salisbury and their subsequently interrelated careers as geologists, see Collie and Densmore, *Chamberlin and Salisbury.*

[26] For Van Hise's career, see Vance, *Charles Richard Van Hise.*

[27] *USGS Third Annual Report* (1882), pp. 291-402.

[28] Merle Curti and Vernon Garstensen, *The University of Wisconsin. A History, 1848-1925,* 2 vols. (Madison: University of Wisconsin Press, 1949), 1: 534-560 and James F. A. Pyre, *Wisconsin* (New York: Oxford University Press, 1920).

[29] See G. Frederick Wright, *The Glacial Boundary in Western Pennsylvania, Ohio, Kentucky, Indiana, and Illinois* with an Introduction by T. C. Chamberlin, United States Geological Survey Bulletin no. 58 (Washington, D.C.: Government Printing Office, 1890).

[30] See for example, Chamberlin, "Geology and Archaeology Mistaught," *Dial* 13 (1892): 303-306 and "Professor Wright and the Geological Survey," *Dial* 14 (1893): 7-9. Chamberlin's papers are located in the Department of Special Collections, Joseph Regenstein Library, University of Chicago. The controversy broadened and

several articles and editorials attacking and defending Wright and his argument for man's presence in North America during the ice age appeared in the *Journal of Geology* (edited by Chamberlin), the *American Geologist,* and *Popular Science Monthly* in 1892 and 1893. For a discussion of this controversy over man's relationship to the glacial epoch in North America, see Schultz, S. Ph.D. dissertation, University of Wisconsin, 1976, "Thomas C. Chamberlin," Chapter IV.

[31] *American Journal of Science* 144 (1892): 351-373.

[32] *American Journal of Science* 145 (1893): 171-200.

[33] For additional papers relating to this issue, see Chamberlin, "Some Additional Evidences Bearing on the Interval Between the Glacial Epochs," *Trans. Wisc. Acad.* 8 (1888-1891): 82-86; G. F. Wright, "Continuity of the Glacial Period," *American Journal of Science* 147 (1894): 161-187; Chamberlin and Frank Leverett, "Further Studies of the Drainage Features of the Upper Ohio Basin," *American Journal of Science* 147 (1894): 247-283, 483. See also "Subdivisions or Unity of the Glacial Period," *Popular Science Monthly* 44 (1893): 279-280 and "Reviews of the Ice Age at the World's Congress on Geology," *American Geologist* 12 (1893): 223-231.

[34] James D. Dana, "On New England and the Upper Mississippi Basin in the Glacial Period," *American Journal of Science* 146 (1893): 327-330. See also Warren Upham, "Diversity of the Glacial Drift along Its Boundary,"*American Journal of Science* 147 (1894): 358-365 for a similar argument. In the fourth edition of his venerable *Manual of Geology* Dana does subdivide the glacial period into three "epochs," but Dana's "subdivisions" tend to de-emphasize and obscure the multiple nature of the glaciation. His early, middle, and later glacial "epochs" are actually one phase of advance and two phases of retreat separated by "a long halt" of the same, single ice sheet (*Manual of Geology,* 4th ed. [New York: American Book Company, 1895], p. 934). In these discussions of Pleistocene glaciation there seems to have been no consistent attempt to limit the use of the terms "period" and "epoch" to any strict stratigraphic time connotations. Hence glacial "period," glacial "epoch," and ice "age" were often employed indiscriminately and interchangeably. This may have contributed to the lack of agreement.

[35] Chamberlin, Editorial, *Journal of Geology* 1 (1893): 847-849, quotation from p. 849.

[36] Chamberlin, "Glacial Phenomena of North America," Chapters 51 and 52 in *The Great Ice Age* by James Geikie, 3rd ed. (London: Edward Stanford, 1894), pp. 724-775. In preceding chapters Geikie had recognized six distinct glacial epochs and five interglacial intervals in Scotland.

[37] A. P. Coleman, "Interglacial Fossils from the Don Valley, Toronto," *American Geologist* 13 (1894): 85-93, and "Glacial and Interglacial Deposits Near Toronto," *Journal of Geology* 3 (1895): 622-645.

[38] Chamberlin, "The Classification of American Glacial Deposits," *Journal of Geology* 3 (1895): 270-277.

[39] See Chamberlin, Editorial on the nomenclature of the glacial formations, *Journal of Geology* 4 (1896): 872-876.

[40] Chamberlin, Review of "Comparison of North American and European Glacial Deposits" by Frank Leverett, *Journal of Geology* 18 (1910); 473.

[41] Current Pleistocene nomenclature recognizes the following stages:

IV. Wisconsinan glacial (Chamberlin)
Sangamonian interglacial
III. Illinoian glacial
Yarmouthan interglacial
II. Kansan glacial (Chamberlin's original Iowan)
Aftonian interglacial (Chamberlin)
I. Nebraskan glacial (Chamberlin's original Kansan)

[42] A paper by Svente Arrhenius, "On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground,"*Philosophical Magazine* 5th ser., 41 (1896): 237-276, convinced Chamberlin that a sufficient depletion of the atmosphere's carbon dioxide content would be quantitatively adequate to initiate glacial conditions. The relationship between atmospheric carbon dioxide and the retention of heat had been demonstrated three decades earlier by the British physicist John Tyndall.

[43] Chamberlin, "A Group of Hypotheses Bearing on Climatic Changes," *Journal of Geology* 5 (1897): 653-683; "The Ulterior Basis of Time Divisions and the Classification of Geologic History," *Journal of Geology* 6 (1898): 449-462; "The Influence of the Great Epochs of Limestone Formation upon the Constitution of the Atmosphere," *Journal of Geology* 6 (1898): 609-621; "An Attempt to Frame a Working Hypothesis of the Cause of the Glacial Periods on an Atmospheric Basis," *Journal of Geology* 7 (1899): 545-584, 667-685, 751-787.

[44] Chamberlin, *Origin of the Earth* (Chicago: University of Chicago Press, 1916), p. 9.

100 YEARS OF WISCONSIN PUBLIC WATER SUPPLIES

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Abstract

Over 70% of Wisconsin population is served by public water-supply systems which provide water to Wisconsin people for more than a century. History of Wisconsin public water supplies began relatively late, compared to other states. In Wisconsin, the first system was built in the city of Milwaukee in 1873. By 1886, 19 more systems were installed. Since then the number of public supplies has grown steadily at an average rate of little over six systems per year, a rate which has been declining in the last decade. Especially rapid rate of growth was experienced in the periods of 1892-96, 1935-1942, 1946-49 and 1964-68. The rate of growth of the number of public systems and of the population served by these systems follows closely the rate of increase in Wisconsin's population. At present, there are well over 500 public systems which provide water of good quality to more than 70 percent of the state's population, comparing to merely 10 percent in 1878.

INTRODUCTION

In December 1974, 93rd Congress enacted PL 93-523—as an amendment to the Public Health Service Act, under Title XIV, Safety of Public Water Systems—to assure that the public is provided with safe drinking water. This Act, known as the Safe Drinking Water Act, is the first major U.S. legislation for water management which recognizes ground water as an indispensable part of the total national water resource. In June 1977, uniform federal drinking water regulations went into effect for the first time for every public water system. The U.S. Environmental Protection Agency, responsible for the implementation of the Act recognized that states must be allowed maximum flexibility to address their problems. Therefore, the states had the option to utilize the State Public Water System Supervision Program with the help of EPA grants. As of September 1, 1979, all but 6 states were involved in the program. In Wisconsin, the responsibility for the program was delegated, in March 1978, to the Department of Natural Resources that conducts a regular surveillance of all community water systems.

Wisconsin public water supplies have recently celebrated an unnoticed 100-year anniversary, and their significance and history is worth remembering. The importance of water, one of mankind's vital commodities, is generally underestimated and overlooked. Many people take their water supply for granted and regard it as a common holding, similar to electricity, gas, or telephone utilities. They expect water to be instantly available in good quality and adequate quantity. One can substitute other light sources for electricity or open fires for gas, and certainly one can survive without a telephone. But no one can replace water or survive without it. It is essential that our water supplies are strictly protected.

HISTORY OF WISCONSIN WATER SUPPLIES

Wisconsin people have been well served by public water supplies for more than a century. However, public water supplies in Wisconsin were relatively slow in developing. The first public water system began op-

TABLE 1. The oldest public water supplies of Wisconsin

Name	Year of installation	Source of supplies	
		Original	Present
1. Milwaukee	1873	R+L	L
2. Prairie du Chien	1876	G	G
3. La Crosse	1877-8	R	G
4. Kenosha	1879	G+L	L
5. Hammond	1880	G	G
6. Appleton	1882	G+R	R+L
7. Madison	1882	G	G
8. Green Bay	1883	G	G+L
9. Oshkosh	1884	G+L	L
10. Ashland	1884-5	L+I	I
11. Beloit	1885	S+O	G
12. Chippewa Falls	1885	S+O	G
13. De Pere	1885	G	G
14. Menomonie	1885	G+R	G
15. Neilsville	1885	O+R	G
16. Wausau	1885	O+R	G
17. Bayfield	1885-6	L	G
18. Stoughton	1885-6	R+G	G
19. Fond du Lac	1886	G	G
20. Superior (City)	1886-8	L+I	I

Explanation: G–ground water, I–infiltration well, L–lake, O–large open well, R–river, S–spring.

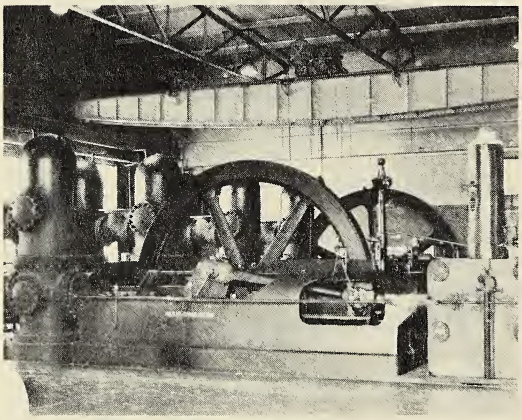

Fig. 1. The Madison Water Utility crank-and-flywheel pump, one of the few steam-driven pumps still existing in the country. It was built by Allis-Chalmers of Milwaukee, and it served Madison residents for 50 years, from 1917 to 1967, at the old Nichols pumping station on Hancock Street. (Photo: J. Brania)

erating in Boston, Massachusetts in 1652. The second system was constructed in Bethlehem, Pennsylvania in 1754. In 1873, the first public water system in Wisconsin was installed in Milwaukee. In the same decade, three other cities built public water systems: Prairie du Chien in 1876, La Crosse in 1877-78, and Kenosha in 1879. By 1886, twenty cities and villages were supplied with public systems (Table 1). Most of these communities were rapidly growing cities and villages located on large lakes or rivers.

Most of the early systems were supplied by surface water from lakes or rivers, surface water was easy to obtain—inexpensive, and at that time, of good quality. However, as the surface water became more polluted, more communities turned to ground water. The first two cities supplied by ground water from deep wells were Prairie du Chien and Madison. Classification of existing sources reveals that most communities served by public systems (about 90%) now use ground water from wells and springs. In addition, five communities have combined surface and ground-water supplies, and seven use water from surface bodies infiltrated through horizontal collectors and infiltration wells. Only seven percent of all communities served are supplied by treated lake or river water. However, these communities happen to represent a large segment of population which results in a 56:44 ratio of surface to ground-water use.

The increase in the number of public water supplies reflects the history of Wisconsin's development and the relatively uniform growth of its population. Early growth was slow from the time Wisconsin became a state in 1848 until 1884. In the early days, waterworks were unnecessary for it was easy to get satisfactory water from springs or individual wells. The first settlements were built on lakes or rivers and proximity to the surface waters also aided in fire protection.

In 1873, when the first system was built in Milwaukee the city's population was already about 80,000 and its citizens were

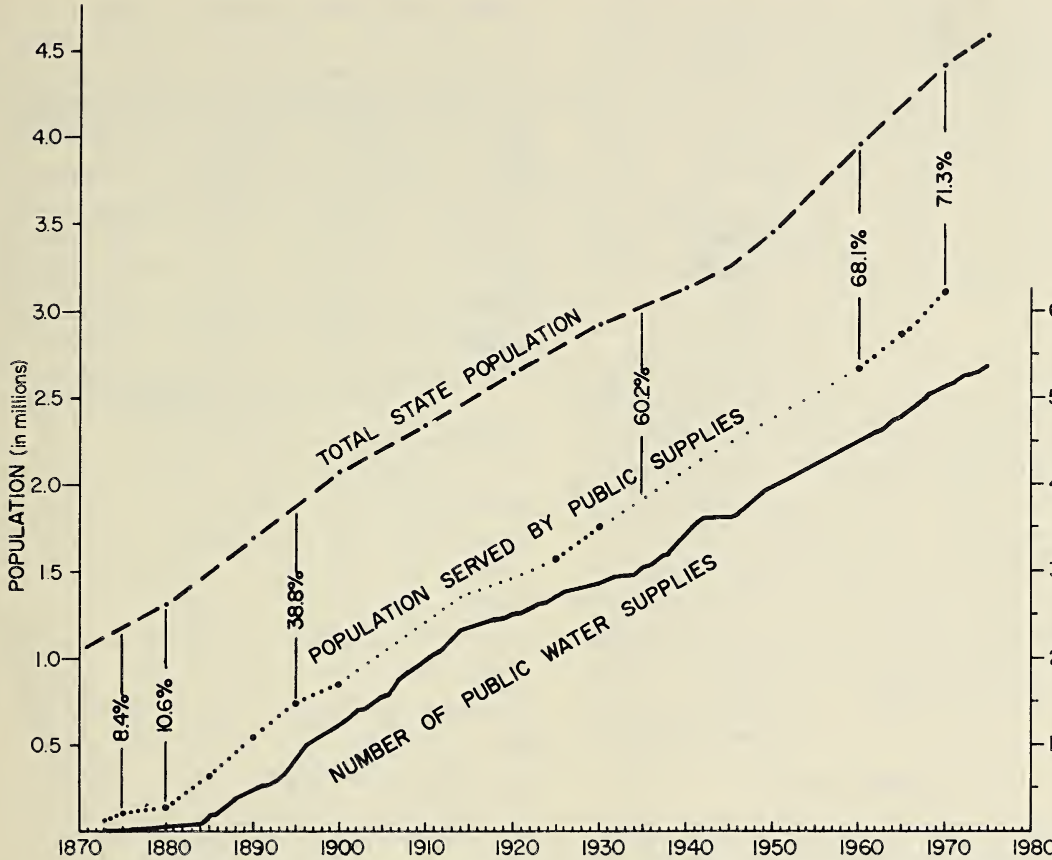

Fig. 2. Population supplied by public water systems and the number of water supplies.

dependent entirely upon domestic wells, springs, and vendors (who distributed water taken from Lake Michigan in water wagons) for water for household and industrial purposes. Fire protection for the city was primitive. Prairie du Chien, La Crosse, and Kenosha—followed the City of Milwaukee in rapid succession, forced into construction of central water systems by similar unsatisfactory water supplies.

Public demand resulted in a rapid increase of water systems from 1885 to 1891. Kirchoffer (1905) attributed this increase also to the effect of dry weather and changes in technology. Low precipitation in 1881 followed by drying up of private wells and increased danger from fire might have provided strong motivation. The introduction of the gasoline engine as a cheap source of power and the low price of iron might also have been factors. An increase in the Wisconsin population was certainly involved. The especially fast rate of growth in the years 1892-96 (over 10 new supplies each year) might also have been influenced by inexpensive material and the influx of immigrant labor, as well as by the major drought of 1894-95.

From 1897 to 1914 the number of public systems increased rather uniformly in accordance with the steady population growth. New systems averaged over seven per year. In the years 1915-1934, reflecting the economic troubles of that period culminating in the deep economic depression, only a few public supplies were built. In 1935-1942, economic recovery, stimulated new public systems at the rate of eight per year.

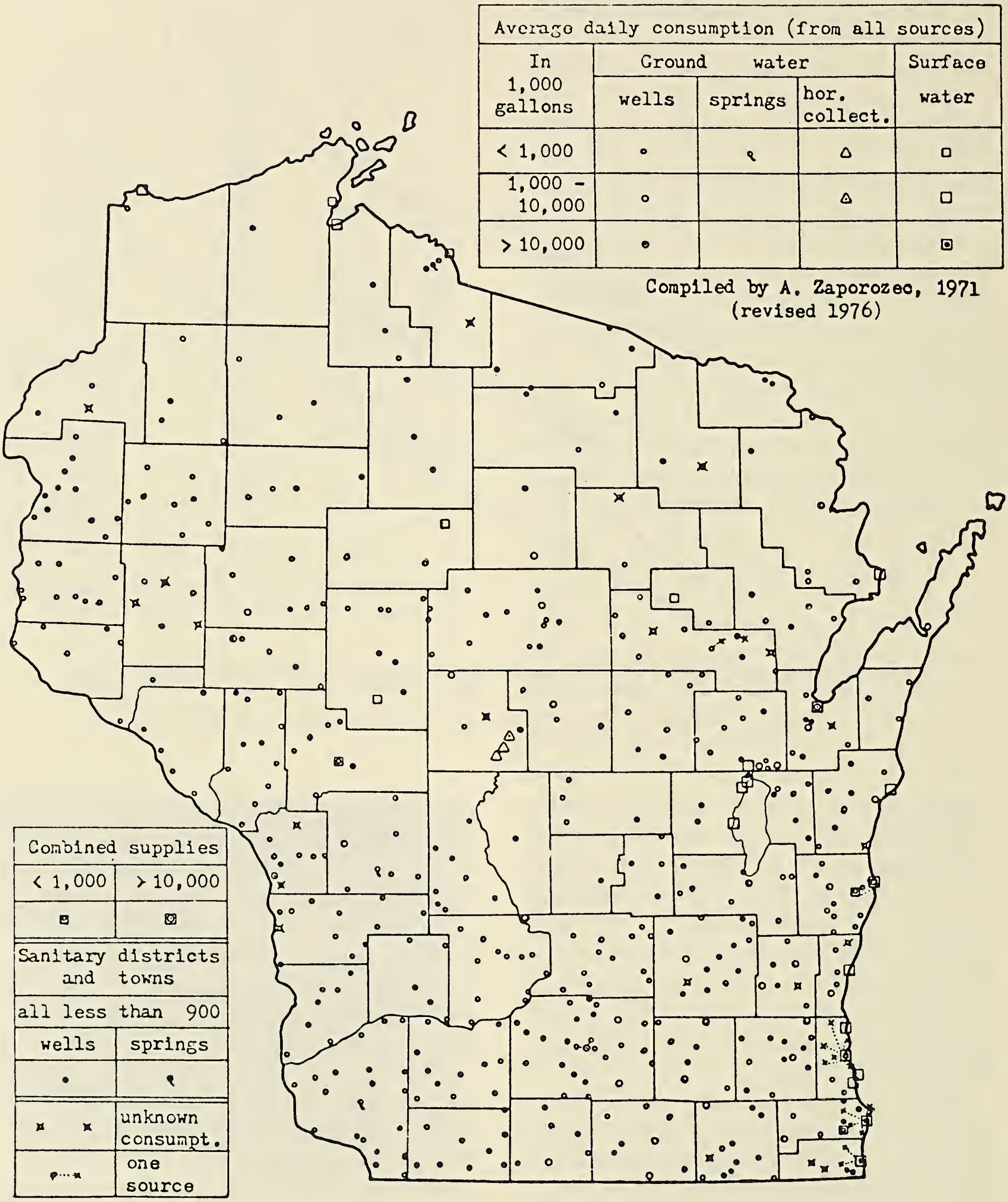

Fig. 3. Public water supplies of Wisconsin.

No public supplies were built during World War II (1943-45). The post-war economic boom and the increase in state population were probably the principal reasons for a rapid increase in public systems from 1946 to 1949, an average of over nine new supplies each year. In the 1950's to 1970's, the increase was steady, with an average of five new supplies per year from 1950-1963, and about seven new supplies per year for 1964-68. In the years 1969-1975, the rate dropped to less than five new supplies each year.

The growth in the population supplied by public systems has nearly equalled the increase in the total population of Wisconsin. At present, more than 70 percent of the population (more than 3.2 million people) is served by a public water supply system, comparing to merely eight percent in 1875, when only about 100,000 people were served. The most dramatic increase occurred in the period 1880-1895 when the percentage of the population served increased fourfold, from about ten percent to almost 40 percent of the population. The rate of increase in population served was steady between 1896 to 1935 reaching 60 percent by 1935. In the following period, 1936-1970, the percentage of population served increased only slightly to 71.3 percent. Presumably, the population supplied by public water systems will eventually level off at about 80 percent since the remaining 20 percent will be difficult or uneconomical to reach with central systems.

In 1976, there were 576 cities and villages in Wisconsin of which 461 (over 80%) have public water supplies. In addition, many towns and sanitary districts provide water for the public, bringing the total of public supplies to 533. There are also 96 private systems serving subdivisions and cooperatives. This list does not include semipublic supplies in governmental, educational, charitable and penal institutions, state parks, camps, summer resorts, etc. Many of these institutions have water supplies separate from any municipality.

Conclusion

This analysis of historical data demonstrates the importance of water supplies in Wisconsin. The need for adequate protection is evident. The State Supervision Program will certainly be an important step toward the protection and enhancement of quality in public water sources. Moreover, the cooperation of Federal and State governments in the Program, if successful, may become a model for the implementation of future legislation in such sensitive areas as consumer protection.

Acknowledgment

My sincere thanks to Mr. Robert A. Baumeister, Chief, Public Water Supply Section, Wisconsin Department of Natural Resources, and his staff for providing updated information on public supplies published in 1970 (Wis. DNR, 1970), and on the implementation of the State Surveillance Program.

Literature Cited

Kirchoffer, W. G. 1905. The sources of water supply in Wisconsin: Univ. Wis. Bull. No. 106, Eng. Series, v. 3, no. 2.

Wis. Dept. of Natural Resources. 1970. Public water supply data: Wis. DNR, Div. of Environ. Protection, Madison.

CHANGING RAIL PATTERNS IN WISCONSIN

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INTRODUCTION

The railroad industry of the United States has undergone rapid change during the 1970's. Mergers of formerly competitive railroads into combined systems have created railroads larger than ever before. On the other hand, a growing number of short lines have been established on lines abandoned by Class I railroads (railroads with annual gross revenues of $50,000,000 or more). These changes are combined with a growing number of bankruptcies and increasing federal involvement in railroad matters. The national trends are also evident in Wisconsin. This paper will examine changes taking place in railroad service in Wisconsin and will: (1) analyze the changing spatial pattern of rail service in Wisconsin, and (2) describe the current traffic density patterns on lines serving the state.

RAIL ABANDONMENTS IN WISCONSIN

Railroads in Wisconsin often mirror national trends. For example, In 1920 Wisconsin had 7,550 miles of railroad line, but in 1970 only 6,000 remained, a reduction of approximately 20 percent.[1] Concurrently, railroad mileage in the United States fell from 253,000 miles in 1920 to 206,000 miles in 1970, a reduction of 19 percent.[2] However, beginning in 1977, Wisconsin has experienced a far more rapid proportional decline in railroad mileage. Railroad service to many Wisconsin communities is likely to be lost in the next five years. The enactment of the Railroad Revitalization and Regulatory Reform Act of 1976 (4R Act), required that railroads provide states with information regarding potential abandonments. Under revised abandonment procedures growing out of the 4R Act, railroads are now required to submit maps of their lines grouped into the following categories:

- Category 1—all lines which the railroad will seek to abandon within three years
- Category 2—all lines under study by the railroad which may be subject to future abandonment attempts
- Category 3—all lines for which an abandonment application is pending before the Interstate Commerce Commission (ICC)
- Category 4—all lines that are being operated under the rail service continuation provisions of the 4R Act
- Category 5—all other lines the railroad owns or operates

Service over 942 miles of rail line or 17 percent of the 1980 rail system could be lost within the next five years (Table I). Losses are expected throughout the state, but the most severe effects are centered in three areas: (1) southwestern Wisconsin, (2) the Horicon-Ripon area, and (3) from Green Bay to the Michigan border. Southwestern Wisconsin will be particularly severely affected (Fig. 1), no less than 300 miles of track are either up for abandonment or expected to be put up for abandonment. Abandonment impacts may also be severe in the Horicon-Ripon area where nearly 200 miles of line may be abandoned. Further, 100 miles of railroad line extending north from Green Bay may be abandoned. Recent efforts by the Wisconsin Department of Transportation to purchase and arrange for short line operation may permit some of these lines to remain in operation. The restructuring of the Milwaukee Road, now in the hands of a federal bankruptcy court, could result in additional abandonments.

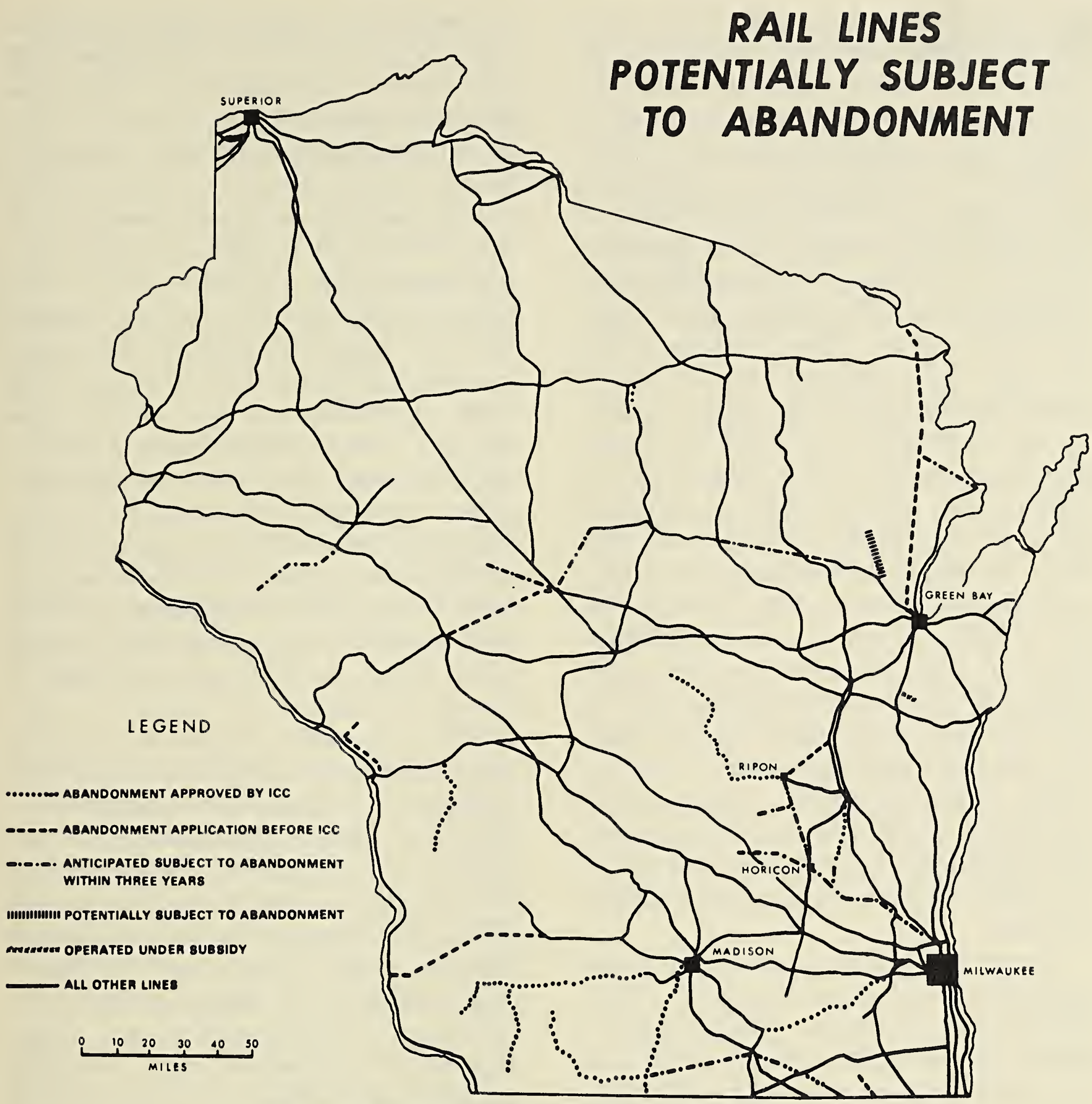

Fig. 1. Wisconsin rail lines subject to abandonment.

TABLE 1. Potential Abandonments by Wisconsin's Railroads
January 1, 1980

Railroad company	*Mileage subject to abandonment by category* 1	2	3	4	*Mileage with preliminary approval for abandonment from ICC*	*Total*
Milwaukee Road	215.1	0.0	161.6	0.0	165.0	541.7
C&NW	73.2	16.2	68.8	0.0	156.6	314.8
Soo Line	26.2	0.0	0.0	0.0	0.0	26.2
All others	7.2	0.0	0.0	6.7	45.4	59.3
Total	321.7	16.2	230.4	6.7	367.0	942.0

Source: Wisconsin Department of Transportation

Conceivably, the entire Milwaukee Road mileage in Wisconsin could be subject to abandonment if that company was completely liquidated. The mileages listed in Table 1 do not reflect this remote possibility.

Railroad abandonments in Wisconsin have not been confined to recent decades, in fact, they have been occurring for 100 years. Since 1977, however, abandonments have accelerated and will probably peak within the next few years. What factors lie behind increasing rail abandonment? Early rail abandonments often resulted from depletion of resources such as minerals or forests. Abandonments in northern Wisconsin in the early decades of this century represent this type. Abandonments of short stub-ended lines represent a second type. These lines constructed to serve small farm communities have suffered from truck competition. Trucks enabled farmers to carry their agricultural products to larger markets and at the same time to purchase necessary supplies from these same markets. Loss of traffic resulted in declining revenues and subsequent application for abandonment. Many abandonments in western and central Wisconsin between 1920 and 1970 represent this type.

The number of abandonments also reflects the financial condition of the individual railroads serving Wisconsin. During the depression of the 1930's over 600 miles of rail lines were abandoned in Wisconsin.[3] Economic expansion following World War II saw the number of miles abandoned decrease as the railroads serving Wisconsin regained economic health. More recently, major segments of the American rail industry have plunged into financial difficulty and bankruptcy. The Milwaukee Road, which accounts for over 1,300 miles or approximately 25 percent of the rail mileage of the state, entered voluntary bankruptcy in December, 1977. The Chicago and Northwestern Railroad, which accounts for 40 percent of Wisconsin's rail mileage, has not been among the more profitable United States railroads in recent years. Together these two railroads account for over 90 percent of the potential rail abandonments in Wisconsin. Often railroads have been forced to reduce scheduled maintenance of their lightly used branch lines in an effort to allocate their limited resources to more productive segments of the system. Deferred maintenance, if continued over a period of years, greatly reduces efficiency by reducing operating speeds to as low as 10 miles per hour. With an operating speed of 10 miles per hour much railroad crew time is used in slow traveling between stations. As crew costs are rising, revenues are probably falling because of low speed which results in poor service and diversion of traffic to trucks. The cost of rehabilitating such a line becomes prohibitive in relation to the revenues generated. At some point in this process the railroad may petition the ICC for permission to abandon the line.

Wisconsin, unlike neighboring states to the south and west, does not originate large volumes of feed grains. The crops grown by Wisconsin farmers are converted to milk which is trucked directly to fluid milk markets or sold locally for processing into cheese. The abandonment of rural lines in Wisconsin results partly from the lack of sizable quantities of originating traffic.

In recent years, the 100 ton open or covered hopper car (used to carry coal, grain products, and fertilizers) has gained wide acceptance. These cars, with a loaded weight of 263,000 lbs. can carry 20 percent more weight than the cars they are replacing. However, they cannot be used on rail lines constructed around the turn of the century that have a light weight rail of 65 to 80 lbs. per yard. These older lines cannot compete with other rail lines capable of handling the heavier more efficient cars. Alternatives involving the use of smaller less efficient cars or partial filling of the larger cars are unattractive. Many of the lines proposed for abandonment have been those which could not handle hopper cars.

The nearly total demise of passenger service during the 1950's and 1960's, eliminated the need to maintain through lines for passenger trains. For example, a portion of the direct Milwaukee Road line between Madison and Chicago has been proposed for abandonment. This line which had passenger service as recently as April, 1971, will now cease to exist if the abandonment application is approved. As the abandonment process has accelerated, longer lines are now facing abandonment as Wisconsin railroads seek to concentrate traffic on better utilized and maintained lines.

The 4R Act provides a means whereby two railroads may meet under the auspices of the Secretary of Transportation to discuss coordinated action leading to agreements whereby one railroad agrees to abandon service to a particular market, in effect leaving all traffic to the other railroad.[4] This is considered necessary where traffic levels are insufficient to support service by two railroads. The benefits to the two railroads may be substantial, reducing costs and eliminating the need to rehabilitate track which will be abandoned. Further, provisions are made for two railroads to discuss consolidation of operations on one of two parallel main lines, thereby reducing the need to maintain duplicate trackage. Such consolidations have been discussed between the Chicago and Northwestern and Milwaukee Road railroads and one outcome could be the elimination of some parallel main line mileage.

This paper has outlined many reasons why Class I railroads are seeking to abandon lightly-used rail lines. There is, however, a growing interest by public officials and shippers in keeping these lightly used lines functioning, usually by having short line operators provide service following abandonment. Several individuals have expressed interest in establishing short line service on Wisconsin branch lines now up for abandonment. Lower operating costs coupled with federal aid for rehabilitation of the line and financial contributions from local units of government and shippers can make short line operation attractive. The alternative, providing a subsidy to a Class I railroad to operate the branch line, is considered unattractive because of high subsidy costs for a low level of service. Service on a number of Wisconsin branch lines abandoned by Class I railroads and purchased by the State of Wisconsin has been maintained by the establishment of several short line railroads.

Traffic Densities on Wisconsin Railroads

Until recently density maps of rail traffic were not generally available to the public. However, with increasing governmental involvement in railroad matters at both federal and state levels, this information is now available in state and federal reports.[5] A simplified map (Fig. 2) depicts the wide variation in traffic densities on Wisconsin rail lines. The gross tonnages include the weight of loaded and empty cars, locomotives, and cabooses passing over each mile of railroad.[6] The actual weight of the cargo is estimated to be slightly less than one-half the gross tonnage.[7] It is evident that most

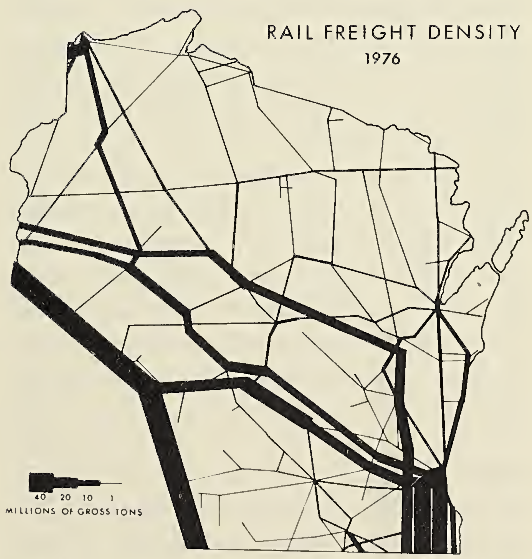

Fig. 2. Wisconsin rail freight density in 1976.

TABLE 2. Railroad Company Mileage by Density Group (1976)

	Millions of gross tons per mile					*Total*
Railroad	0-0.9	1.0-4.9	5.0-9.9	10.0-19.9	20 & Over	*miles*
C&NW	807	818	420	240	48	2333
Milw. Road	638	395	124	89	139	1385
Soo Line	122	816	75	293	0	1306
All Other	162	246	29	10	236	683
Total	1729	2275	648	632	423	5707
Percentage	30.3%	39.9%	11.4%	11.1%	7.4%	100.0%

Source: Wisconsin Railroad Plan, December, 1979 p. V-21

rail lines in the state carry only light traffic. Seventy percent of Wisconsin's rail mileage carries branch line densities of less than five million gross tons per year (Table 2).[8] Nationally, 49 percent of United States rail lines carry less than five million gross tons.[9]

Wisconsin lines bearing the heaviest traffic connect Chicago with Minneapolis-St. Paul. Much of the traffic carried by these lines is moving through the state rather than originating or terminating there. The highest density line, that of the Burlington Northern paralleling the Mississippi River, carries little traffic originating or terminating in Wisconsin. Instead, it carries low sulfur coal and lumber products east and manufactured products west. The Milwaukee Road, Chicago and Northwestern, and Soo Line routes between Chicago and the Twin Cities also carry heavy volumes of through traffic. On the other hand, much of the traffic moving south from Green Bay and other Fox Valley cities consists of paper and related products manufactured in these cities. Considerable tonnages of raw materials and steel products move into Milwaukee where they are converted into automobile frames, beer, and other manufactured products, then shipped south through Chicago for distribution throughout the United States. Large tonnages of iron ore, low sulfur coal, and grains move by rail to the port of Superior for shipment on the Great Lakes. These tonnages move only a few miles in Wisconsin. The majority of the remaining lines in Wisconsin carry only light traffic densities, a fact reflected in the growing number of petitions for abandonment.

CONCLUSION

Wisconsin railroads face an uncertain future. Recent growth in traffic has been confined to the more heavily used routes. Lightly used branch lines are increasingly being proposed for abandonment. Whether merger of the Milwaukee Road and the Chicago and Northwestern with stronger railroads would materially change the existing situation is difficult to assess. It is hoped that the railroads serving Wisconsin will regain their vitality so that they may again contribute to Wisconsin's economic well being.

NOTES

[1] Wisconsin Department of Transportation, Wisconsin Railroad Plan. August 1, 1977, p. V-2.

[2] Association of American Railroads, Yearbook of Railroad Facts, 1978 ed., p. 46.

[3] Wisconsin Railroad Plan, p. V-2.

[4] United States Department of Transportation, News Release, June 15, 1978.

[5] Wisconsin Railroad Plan, p. V-24, and United States Department of Transportation, United States Transportation Zone Maps, 1975.

[6] Wisconsin Railroad Plan, p. V-22.

[7] Ibid., p. V-22.

[8] Ibid., p. V-23.

[9] United States Department of Transportation, Final Standards, Classification, and Designation of Lines of Class I Railroads in the United States, Vol. 1, January 19, 1977.

FIELD IDENTIFICATION OF *PEROMYSCUS LEUCOPUS* AND *P. MANICULATUS* WITH DISCRIMINANT ANALYSIS

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Abstract

Discriminant analysis produced non-overlapping groups of scores for morphologically similar individuals of *Peromyscus maniculatus bairdi* and *P. leucopus noveboracensis* from southern Wisconsin. This analysis was based on standard external measurements and can be used in field studies requiring identification of these mice.

Biologists have been hampered in studies of closely related species of *Peromyscus* because of difficulty in the identification of individuals with intermediate characteristics. This difficulty has been cited by Hall and Kelson (1959), Jackson (1961), and Findley, et al. (1975) and appears to be a widespread problem in North America (Hooper, 1968). Many keys to the species are based on skull characteristics (Hall and Kelson, 1959; Findley, 1975, Lechleitner, 1969) although external attributes may be included.

Experiments with *Peromyscus* frequently require identification of species based on intact specimens (McNab and Morrison, 1963). However, criteria for separating southern Wisconsin, *Peromyscus* species on the basis of external characteristics, do not always provide satisfactory identifications (Fig. 1). This paper demonstrates the use of discriminant analysis for field identification of *Peromyscus maniculatus bairdi* (*P. m. b.*) and *P. leucopus noveboracensis* (*P. l. n.*). Individuals of these species are difficult to tell apart in areas of sympatry (Hall and Kelson, 1959:628; Jackson, 1961:213) yet the species are frequently used in ecological studies (Miller, 1975; Master, 1977). Although morphologically similar, these species show no evidence of inter-fertility (Dice, 1933). Habitats are partitioned by these species when they co-occur: *P. l. n.* occupies deciduous forests but can survive in fields (Stromberg, 1979), *P. m. b.* selects old fields or prairies (Wecker, 1963; Master, 1977) and cannot survive as well in forests (Stromberg, 1979).

Four field measurements (total length, tail length, hind foot length, and ear length) were made on each animal following Hall (1962). The same four measurements were made on museum specimens at the Zoology Museum, University of Wisconsin, Madison. Data on tags were frequently incomplete so all skins were re-measured following Hall (1962). The number of museum specimens examined of *P. l. n.* and *P. m. b.* respectively are given following the Wisconsin county name: Clark 1,1; Dane 4,15; Dodge 9,16; Door 1,0; Jackson 3,0; Jefferson 1,1; Kewaunee 0,1; Langlade 1,0; Manitowoc 2,0; Marathon 0,1; Marinette 5,0; Milwaukee 4,0; Monroe 1,0; Oneida 1,0; Racine 2,0; Rock 2,4; Sauk 1,0; Shawano 1,0; Sheboygan 1,0; Waukesha 6,1; Waupaca 5,6. A few specimens from other areas were available. These include, Long Island, New York 1,0; Hyattsville, Mo. 1,0; Carthage, Mo. 0,2.

Mice were trapped from September 1976 to Septetmber 1977 at two locations in Sauk County, Wisconsin. Specimens of *P. l. n.* were measured in the Potter Preserve (T-

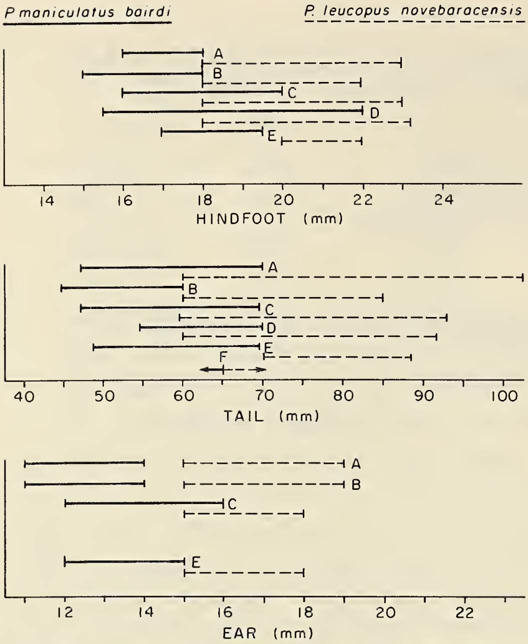

Fig. 1. Range of hindfoot, tail and ear lengths for *P. maniculatus bairdi* and *P. leucopus novaboracensis*. Sources: A. Peterson, 19666; B. Hoffmeister, Mohr, 1957; C. Burt, 1946;; D. Hamilton, 1943; E. Jackson, 1961; F. Hall and Kelson, 1959.

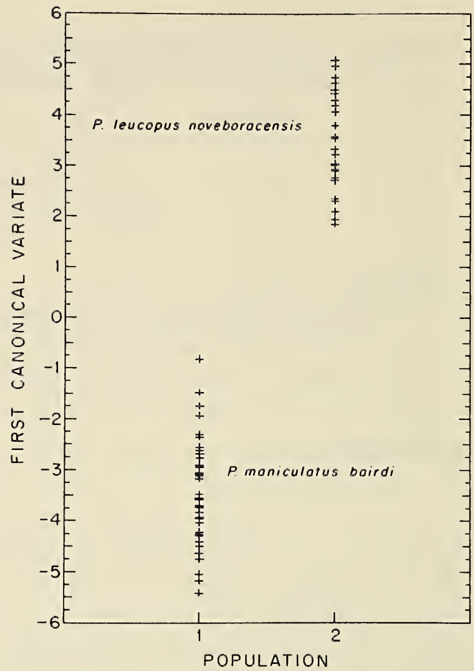

Fig. 2. Discriminant scores for individual *Peromyscus* measured in the field in Sauk Co., Wisconsin.

11N, R-7E, S-2) in oak-hickory forest. Specimens of *P. m. b.* were measured in Peetz's Prairie and Schluckebier Prairie (T-9N, R-6E, S-4) a dry undisturbed prairie dominated by *Andropogon scoparius*.

Discriminant analysis (Seal, 1964; Rao, 1952) produces a linear function (scores), based on the original variables:

$$y = \sum_{i=1}^{4} a_i x_i$$

(where the x_i's are the four characters {total, tail, hind foot, ear} and the a_i's are four coefficients) which maximize the F-ratio of variance among groups to pooled variance within groups allowing calculation of the position of a point for each specimen along a single synthetic axis. Once this linear function is determined for a reference set of animals, future field identification can be done using portable pocket calculator to calculate scores for new specimens.

A constant was added to the function so that the values center on zero. This does not affect the properties of the discriminant function (Seal, 1964). I used the program CANON (Kowal, et al., 1976) on a Univac 1110 computer.

The validity of a discriminant function must be evaluated (Morrison, 1969). This was done by calculating a discriminant function based on field measurements and then using the resultant coefficients to re-classify reference museum specimens. The museum specimens chosen were only those Wisconsin specimens which had been previously classified to species by H. H. T. Jackson, F. J. W. Schmidt or W. E. Snyder. The percentage of correctly classified museum specimens reflects the validity of the discriminant function based on field characteristics. Voucher specimens identified with this discriminant function are available in the University of Wisconsin Zoology Museum.

TABLE 1. Coefficients of the discriminant function based on field measurements. These coefficients depend on the units of measurement and are for use on raw data. Standardized coefficients are independent of the units of measurement and allow comparisons of the absolute value of the coefficients to determine relative importance of each character in discrimination. Means (mm) and standard deviations (S.D.) are included. Double asterisk indicates significant difference ($p < 0.01$) between field and museum measurements. Field sample size for *Peromyscus leucopus noveboracensis* (P.l.n.) is 41; for *P. maniculatus bairdi* (P.m.b.) is 28. Museum sample sizes (respectively) are 53 and 48.

Character	*Coefficients*	*Standardized Coefficients*	*Mean* *P.l.n*	*Mean* *P.m.b.*	*S.D.* *P.l.n.*	*S.D.* *P.m.b.*
(Field)						
1. Total	—0.01841	.28225	168.70	137.46	9.07	7.73
2. Tail	—0.05168	.49557	77.90**	58.85	5.52	4.84
3. Hindfoot	—0.84200	.99905	20.24	16.96	0.592	0.727
4. Ear	—1.12028	1.00000	15.05	12.82**	0.552	0.390
Constant	37.62291	37.62291	—	—	—	—
(Museum)						
1. Total	0.00013	—.00174	167.77	138.50	11.561	9.335
2. Tail	—0.02021	.14996	74.72**	57.25	5.879	5.601
3. Hindfoot	—1.07210	.76205	20.13	17.08	0.556	0.539
4. Ear	—1.84249	1.00000	14.91	11.94**	0.295	0.522
Constant	45.99161	45.99161	—	—	—	—

RESULTS

There is no overlap in discriminant scores between the two species for mice measured in the field (Fig. 2). The Mahalanobis' distance (in standard deviation units) between means of each group is 6.8. Males and females were evenly scattered over the range of scores for each species, hence data were combined for presentation. Coefficients and data parameters for field measurements (Table 1) indicate that the ear, and hind foot were most useful in discrimination. Again for the mice measured in the museum, ear and hind foot were the most useful characters in discriminating *P. l. n.* and *P. m. b.* (Table 1). Most means for museum measurements are not significantly different from field measurements ($p > 0.05$, t-test). However, in the field, ear length of *P. m. b.* and tail length of *P. l. n.* are longer ($p < 0.01$, t-test).

The field discriminant function was used to score museum specimens to evaluate the function's validity. There was no overlap in the scores and no individuals were misclassified. Mahalanobis' distance between the means of each group is 7.3. This implies a probability of less than 0.01 of mis-classification when using the discriminant function for mice measured in the field (Fig. 3).

DISCUSSION

The agreement of museum and field measurement is generally good. When differences occur, they suggest shrinkage, which reduces comparable field values by a small factor. This factor is likely constant for all four characters; each depends on shrinkage of similar skin.

Because the field and museum data are so similar, the fact that the field discriminant function performed well (100% correct) on museum specimens seems reasonable. Moreover, a constant shrinkage factor essentially multiplies the field data by a constant, which does not change the relative position of discriminant scores.

Discriminant analysis assumes an *a priori* grouping of individuals (Seal, 1964). In this case, there was no overlap in field hind foot measurements. Individuals with hind feet of 19 mm or larger were considered *P. l. n.* and those with hind feet 18 mm or shorter were tentatively classified as *P. m. b.*

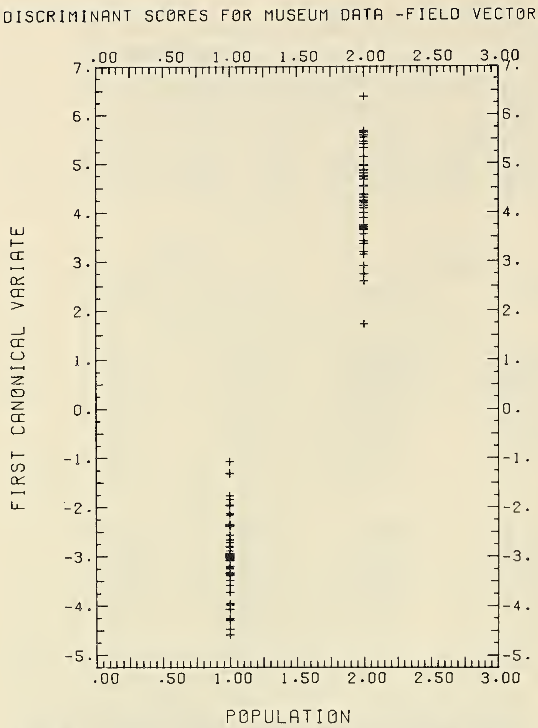

Fig. 3. Discriminant scores for previously identified (reference) museum specimens using the discriminant function derived from field measurements of intact individuals in Sauk C., Wisconsin. Population one is *Peromyscus leucopus noveboracensis* and population two is *P. maniculatus bairdi*.

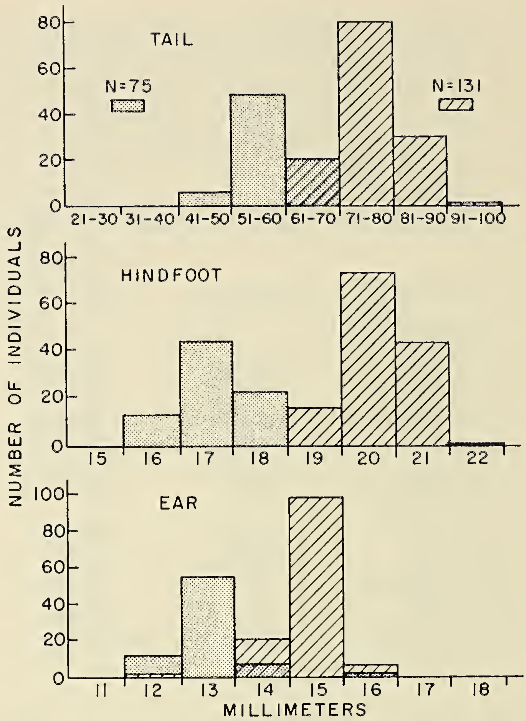

Fig. 4. Data from individual mice measured in the field were plotted as shaded (left) if hindfoot was $\leq$ 18 mm, or slashed (right) if handfoot was $\geq$ 19 mm. Additional mice from Dane, Columbia, and Rock Co., Wisconsin are included. Smaller individuals were tentatively identified as *P. maniculatus bairdi* based on non-overlap of hindfoot measurements. Larger individuals were tentatively classified as *P. leucopus noveboracensis* for later discriminant function calculation.

(Fig. 4). Although this one character showed an apparent consistent difference, other measurements for most individuals were not useful in discrimination. Field data for tail and total length showed extensive overlap. I have used the field function on intermediate, unidentified specimens in the museum (U.W.-Madison) and their scores fall clearly within one of the distinct groups determined by the above verification process.

Use of a discriminant function accomplished several things in an objective manner. First, it demonstrates that two groups may be distinguished on the basis of external characters (Fig. 2) although previous workers implied that separation on field data was difficult or impossible (Peterson, 1966); Hoffmeister and Mohr, 1957; Burt, 1946; Hamilton, 1943; Jackson, 1961; Hall and Kelson, 1959). Discriminant analysis with large sample sizes will not produce distinct groups if indeed the *a priori* grouping was meaningless (Kowal, et al., 1976). Second, many characters are considered simultaneously in the classification process so that mis-classification resulting from the use of a single spuriously errant character is avoided. Third, intact individuals can be classified with reasonable confidence. Thus, the use of this discriminant function in identification of *Peromyscus* with field characters should offer behaviorists, ecologists and physiologists a dependable alternative to use of cranial measurements.

This example clarifies the distinction between *P. maniculatus bairdi* and *P. leucopus noveboracensis* in southern Wisconsin)Jackson, 1961). Considerable variation exists in these two species, and this discriminant function must be used only in southern Wisconsin. The function is probably not valid over the entire range of overlap between the two species. For instance, the hindfoot pattern allowing initial *a priori* groupings of these mice does not hold true in Minnesota (E. C. Birney, pers. comm., 1979). To help discriminate between these species over their entire range of sympatry, canonical analysis, an extension of discriminant analysis can be used. Principal component analysis may be a useful way to establish *a priori* grouping (Seal, 1964) of local populations. This may also be useful in the western U.S. where many morphologically similar species of *Peromyscus* occur together (see Findley, et al., 1975; Hall and Kelson, 1959).

These two *Peromyscus* species in Minnesota are apparently externally more similar than in southern Wisconsin (E. C. Birney, pers. comm., 1979). Horner (1954) found tail length to be related to climbing ability: long tails meant better climbing in forest habitats. Dice (1940) suggested the general correlation of longer tail length and hind foot length with increased arboreal habit in relation to the shorter forms in prairie habitats. Miller (1975) found a transition in habitat utilization by *P. m. b.;* from northern Minnesota to Iowa and southern Michigan, this species shows a gradual increase in field versus forest habitat use. Iverson, et al. (1976) observed *P. m. b.* from northwestern Minnesota in aspen and riparian habitats wherever *P. l. n.* was absent. Perhaps the morphological similarity between these species reflects convergence in their habitat use in Minnesota. This possible character displacement (Dunham, et al., 1979) could be studied by comparing the allopatric forest populations of northwestern Minnesota to sympatric populations in southern Wisconsin or Michigan. Greater differences in habitat use and in morphology may be evident in southern Wisconsin and Michigan where these populations are thought to have co-occurred for a relatively long time since the glacial retreat (Miller, 1975).

Acknowledgments

I wish to thank Dr. R. Kowal for his patient advice and use of his program CANON. The Department of Zoology, University of Wisconsin-Madison, provided computer time. Cheryl Hughes prepared the figures. Mr. and Mrs. Edwin Young graciously provided the facilities of the Howard I. Potter Preserve, University of Wisconsin Foundation. The Nature Conservancy allowed use of the Schluckebier Prairie; Mr. Peetz allowed me to sample his prairie relict. Dr. Ed Beals provided assistance in several ways and I appreciate this help.

Literature Cited

Burt, W. H. 1946. The Mammals of Michigan. Univ. Michigan Press, Ann Arbor, Mich., 288 p.

Dice, L. R. 1933. Fertility relationships between some of the species and sub-species of mice in the genus *Peromyscus.* J. Mammal. **14**:298-305.

Dice, L. R. 1940. Ecologic and genetic variability within species of *Peromyscus.* Amer. Nat. **74**:212-221.

Dunham, A. E., G. R. Smith and J. N. Taylor. 1979. Evidence for ecological character displacement in western American Catostomid fishes. Evolution **33**:877-896.

Findley, J. S., A. H. Harris, D. E. Wilson and C. Jones. 1975. Mammals of New Mexico. Univ. of New Mexico Press, Albuquerque, 360 p.

Hall, E. R. 1962. Collecting and preparing study specimens of vertebrates. Misc. Publ. No. 30. Univ. Kansas Museum Nat. History, 46 p.

Hall, E. R., and K. R. Kelson. 1959. The Mammals of North America. Ronald Press, New York, 1083 p.

Hamilton, N. J. 1943. The Mammals of the Eastern United States. Comstock Press, Ithaca, New York, 432 p.

Hoffmeister, D. E., and C. O. Mohr. 1957. Fieldbook of Illinois Mammals. Dover edition, 1972. Dover Publ., New York, 233 p.

Hooper, E. T. 1968. Classification. pp. 27-69 *in* Biology of *Peromyscus* (Rodentia) (J. A. King, ed.) Spec. Publ. No. 2, Amer. Soc. Mamm., 593 p.

Horner, E. B. 1954. Arboreal adaptations of *Peromyscus* with special reference to use of the tail. Contrib. Lab. Vert. Biol. Univ. Mich. No. 61, 85 p.

Iverson, S. L., R. W. Seabloom, and J. N. Hnatiuk. 1967. Small mammal distributions across the prairie-forest transition of Minnesota and North Dakota. Am. Midl. Nat. **78**:188-197.

Jackson, H. H. T. 1961. The Mammals of Wisconsin. Univ. of Wisc. Press, Madison, 504 p.

Kowal, R. R., M. J. Lechowicz, and J. J. Adams, 1976. The use of canonical analysis to compare response curves in physiological ecology. Flora, **65**:29-46.

Lechleitner, R. R. 1969. Wild Mammals of Colorado, their appearance, habits, distribution and abundance. Pruett Publ. Co., Boulder, Colo., 241 p.

Master, L. L. 1977. The effect of interspecific competition on habitat utilization by two species of *Peromyscus*. Ph.D. dissertation, Univ. Michigan, Ann Arbor, 179 p.

McNab, B. P., and P. Morrison. 1963. Body temperature and metabolism in subspecies of *Peromyscus* from arid and mesic environments. Ecol. Monogr., **33**:63-82.

Miller, C. A. 1975. Habitat utilization in *Peromyscus maniculatus bairdi*. Part I: Effects of competition by *Microtus pennsylvanicus* and *P. leucopus* on habitat utilization in *P. maniculatus bairdi* from two geographical localities. Ph.D. dissertation, N. Dakota State Univ., 70 p.

Morrison, D. G. 1969. On the interpretation of discriminant analysis. J. Market Res., **6**:156-163.

Peterson, R. L. 1966. The Mammals of Eastern Canada. Oxford Univ. Press, Toronto, 465 p.

Rao, C. R. 1952. Advanced statistical methods in biometric research. John Wiley, New York, 390 p.

Seal, H. L. 1964. Multivariate statistical analysis for biologists. Methuen, London, 209 p.

Stromberg, M. R. 1979. Experimental analysis of habitat performance and direct observation of deermice (*Peromyscus*) in southern Wisconsin. Ph.D. dissertation, Univ. of Wisconsin-Madison. 224 p.

Wecker, S. C. 1963. The role of early experience in habitat selection by the prairie deer mouse, *Peromyscus maniculatus bairdi*. Ecol. Monogr. **33**:307-325.

THE NORTHERNMOST STATION FOR *ASPLENIUM PINNATIFIDUM*

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Abstract

Lobed spleenwort (*Asplenium pinnatifidum*) is reported from 148 counties in the Appalachian Mountains and 49 counties in east-central United States. The northernmost station of this fern is found on Pinnacle Rock in Iowa County, Wisconsin. The markedly discontinuous distribution of the lobed spleenwort outside of the Appalachians is largely determined by its requirement for an acidic substrate and for a rock cliff habitat.

Although long considered one of the Appalachian Aspleniums,[1,2] the lobed spleenwort (*Asplenium pinnatifidum*) has been reported from 49 counties in east-central United States (Fig. 1), ranging northwest to Wisconsin and southwestward to Oklahoma. The record of this fern in each of the 197 counties (Table 1 and Table 2) is based upon collections reported in a publication or established by correspondence with herbarium curators and pteridologists. Records were discounted if a correction had been published,[3] or if there was evidence of confusion in identification or uncertainty of the collection site.

The markedly discontinous distribution of *Asplenium pinnatifidum* outside of the Appalachian Mountains is largely determined by its requirement for an acidic or sub-acidic substrate and for the exacting microclimate associated with rock cliffs. In all of the 19 states where the fern has been reported, it occurs in restricted localities growing usually on sandstone, but occasionally on gneiss,[4,5,6] or granitic rock.[7,8]

The northernmost station for *Asplenium pinnatifidum* is on Pinnacle Rock in the Town of Arena, Iowa County, Wisconsin. Discovered by Hugh Iltis in 1958,[9] the colony has numbered about 80 plants over the last 21 years. The fern grows in small crevices in St. Peter sandstone principally on the east and northeast face of the rock, although deeper sheltered crevices on the south support a few plants. It is not associated with any other fern or higher plant in these crevices.

A second station in Wisconsin is located on Pompey's Pillar in the Town of Highland in Iowa County. Discovered by William Tans in 1969,[9] this colony, also in crevices of the St. Peter sandstone, has numbered over 50 plants for the last 10 years. The largest number of ferns are on the south face of the pillar, but a few grow on the north face.

The third and fourth stations, one on Cave Bluff in the Town of Brigham, and the other on Iron Rock in the Town of Arena, were discovered by the authors in 1970.[9] More than 100 plants have maintained their numbers over the past 9 years on Cave Bluff and several bluffs that face it across a narrow valley. These cliffs of St. Peter sandstone have a verticle exposure of 50 to 80 feet. On Iron Rock, 15 ferns make up the colony growing on the east and north face. The St. Peter sandstone of this outcrop has weathered more deeply than that of the other sites and is colored with iron pigment. However, none of the crevices occupied by the fern on this rock, or those of the other three sites allow accumulation of leaf litter, or provide a site for other plants.

The two Arena stations and the Brigham station are within 2 miles of each other, and

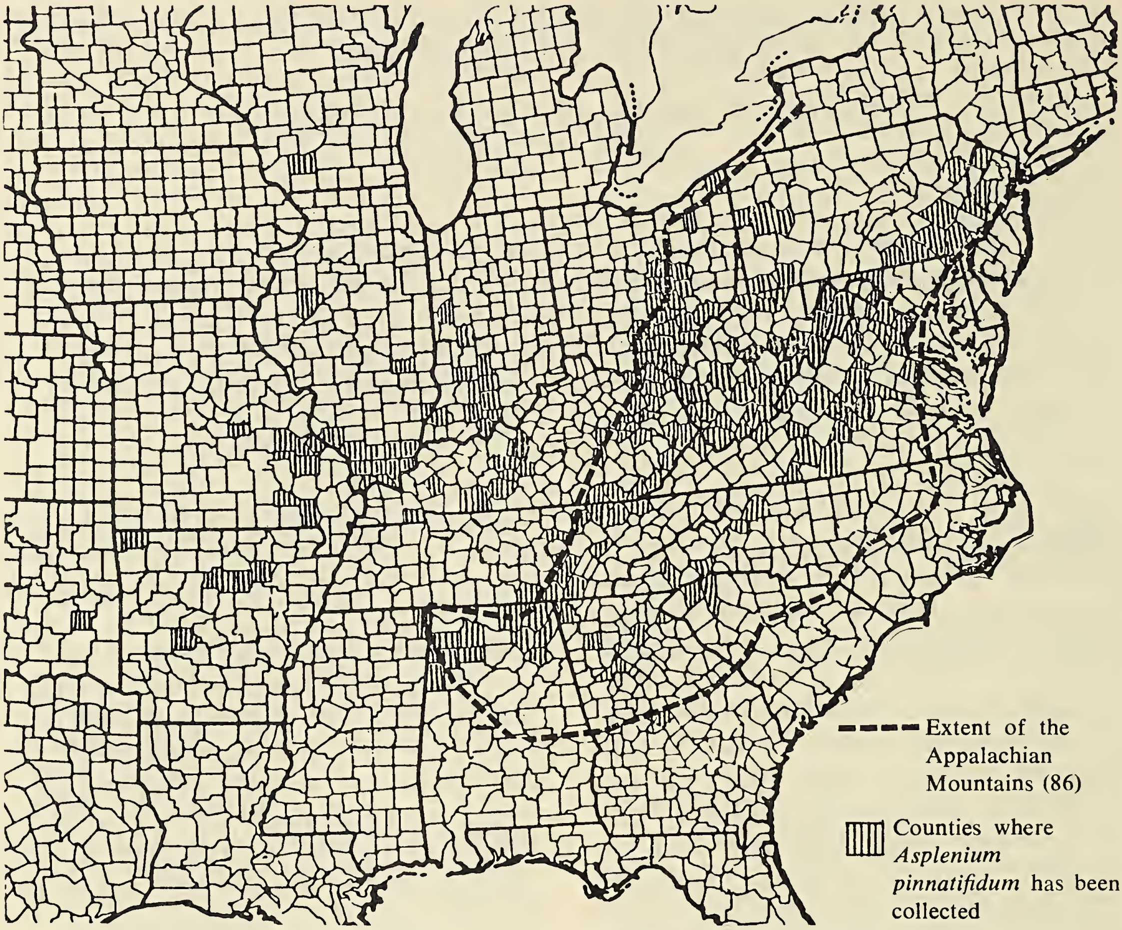

Fig. 1. County distribution of *Asplenium pinnatifidum* in the United States in relation to the Appalachian Mountains.

TABLE 1. Distribution of *Asplenium pinnatifidum* by counties in east-central United States

State	*Counties*	*State*	*Counties*
Northern Arkansas	Benton (11,12,13) Cleburne, Van Buren (12) Garland, Independence (11,12)	Western Kentucky	Caldwell, Grayson, Hart, Logan, Todd (26) Calloway, Edmonson (26,27) Hardin (26,28) Warren (26,27,29,30,31)
Illinois	Cumberland, Fulton, Massac (14, 15) Gallatin, Hardin, Jackson, Johnson, Pope, Saline, Union, Wabash, Williamson (15,16) Pulaski (17) Randolph (17,18,19)	Southeastern Missouri	Butler, Carter, Iron, Madison, Maries, Saint Francois, Sainte Genevieve, Washington (32)
		Eastern Oklahoma	Latimer (25,33,34,35,36)
Indiana	Crawford, Martin (20,21,22,23,24) Dubois, Gibson (23) Fountain (20,21,22,25) Greene, Orange, Perry (21,22) Lawrence (20,21,22) Monroe (2,23) Putnam (22)	Southwestern Wisconsin	Iowa (9,37)

TABLE 2. Distribution of *Asplenium pinnatifidum* by counties in the Appalachian Highlands

State	*Counties*
Northern Alabama	DeKalb (38,39)
	Etowah (38,40)
	Franklin, Lamar, Lawrence, Madison, Marion (41)
	Jackson (38,41)
	Marshall (38)
	Winston (42)
Northern Georgia	Bartow, DeKalb (5,43,44)
	Bibb (25,43,45)
	Dade (5,8,39,43,46)
	Fulton (5,43)
	Hall (43,47)
	Stephens (6,8,43)
	Twiggs (8, 43)
	Walker (5,8)
Eastern Kentucky	Bell, Boyd, Carter, Elliott, Floyd, Greenup, Madison, McCreary, Morgan, Rockcastle, Rowan, Whitley (26,27)
	Breathitt, Lee, Menifee, Wolfe (48)
	Harlan, Letcher, Lewis, Pike (26)
	Powell (26,27,48)
Northern Maryland	Cecil (49,50,51)
	Washington (52)
Northeastern Mississippi	Tishomingo (53,54,55)
Northern New Jersey	Hunterdon, Sussex (56,57)
Western North Carolina	Caldwell, Wilkes (58,59)
	Henderson, Jackson (58,59,60)
Eastern Ohio	Ashtabula (61)
	Athens, Coshocton, Fairfield, Hocking (61,62)
	Jackson, Pike (62,63)
	Knox, Summit (64)
	Lawrence, Meigs, Muskingum, Perry, Ross, Scioto, Vinton, Washington (62)
	Licking (2,62)
Pennsylvania	Adams, Chester (65,66)
	Armstrong, Greene (65,66,67)
	Berks (65,66,67,68)
	Bucks (66,69)
	Butler, Lawrence (65,67)
	Delaware (70)
	Fayette (65,66,67,70,71)
	Lancaster (40,65,66,67,70)
	Monroe (67)
	Philadelphia (4,25,65,66,67,70)
	York (2,40,65,66,67,70)
Western South Carolina	Greenville (58,59,72)
	Pickens (58,59,72,73)
Eastern Tennessee	Bledsoe, Campbell, Fentress, Franklin, Hamilton, Putnam, Roane, Scot, Sequatchie, Van Buren (74,75)
	Claiborne (74)
	Marion (74,75,76)
Virginia	Albemarle, Alleghany, Amherst, Appomattox, Buchanan, Buckingham, Caroline, Fluvanna, Franklin, Goochland, Greene, Nelson, Page (77)
	Campbell, Fairfax, Giles, Loudoun, Patrick, Pittsylvania, Rockbridge, Stafford (77,78)
	Clarke (40,79)
	Fauquier, Prince William (78)
	Roanoke (7,77,78)
	Shenandoah (2)
West Virginia	Baxton, Kanawha, Lincoln, Logan, Marion, Mercer, Mingo, Nicholas (80)
	Calhoun, Fayette, Grant, Hampshire, Mineral, Monongalia, Pendleton, Pocahontas, Randolph, Summers, Wayne, Wetzel, Wyoming (80,81)
	Greenbrier, Monroe (80,81,82)
	Hardy (2,80,81)
	Jefferson (80,81,83,84,85)
	McDowell (81)
	Upshur (40,80,81)

lie 22 miles east of the Highland station (Fig. 2). Over 15 similar sandstone bluffs and pinnacles within this area of the Wisconsin driftless region have been examined without finding a single plant. There is no reason to believe that collectors have extirpated this fern in Wisconsin, as they have not known of its presence. Nor is there any

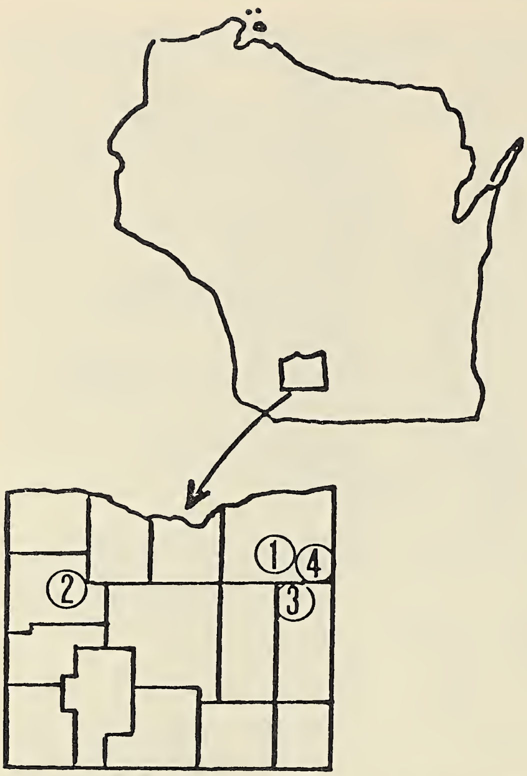

Fig. 2. Four stations of *Asplenium pinnatifidum* in Iowa County. 1. Pinnacle Rock 2. Pompey's Pillar 3. Cave Bluff 4. Iron Rock.

obvious reason why the fern should have disappeared from apparently suitable sandstone bluffs within southwestern Wisconsin, or should have failed to colonize them.

Wisconsin colonies of the fern appear to have been unaffected by fluctuations in the weather during the 21 years of observation in which some of the driest and wettest years on record have occurred in Iowa County.[10] For most of the past 100 years, the land around the bluffs has been periodically burned and continuously pastured. This is now changing as the present owners of all 4 sites have allowed afforestation to take place, a practice which creates shade where it never existed and modifies the force and flow of the wind.

Periodic inventory of the Wisconsin population of the lobed spleenwort should reveal any biologic response such as reduction in numbers, altered growth, or appearance of disease that may result from environmental change. By comparing the relative persistence of the fern at the four sites, it may be possible to develop a management strategy that will insure the survival of this rare fern.

Notations

1. Wherry, E. T. 1925. The Appalachian Aspleniums. Amer. Fern J. **15**:47-54.
2. Wagner, W. H., Jr. 1954. Reticulate evolution in the Appalachian Aspleniums. Evolution **8**:103-118.
3. Wherry, E. T. 1935. Two recent fern books. Amer. Fern J. **25**:59-68.
4. Bates, E. 1898. The Linnaean Fern Chapter. Fern Bull. **6**:12.
5. McVaugh, R., and J. H. Pyron. 1951. Ferns of Georgia. Univ. of Georgia Press, Athens. p. 58.
6. McDowell, G. W. 1965. Return to Panther Creek, Georgia. Amer. Fern J. **55**: 80-81.
7. Wood, C. E., Jr. 1944. Notes on the flora of Roanoke County, Virginia. Rhodora **46**:69-86.
8. Duncan, W. H. 1966. *Asplenium x Kentuckiense* on granitic gneiss in Georgia. Amer. Fern J. **56**:145-149.
9. Hanson, M. G. 1970. Lobed spleenwort in Wisconsin. Bot. Club of Wisconsin Newsletter. **2(4)**:1-2.
10. Environmental Data Service. 1968 through 1977. Climatological Data-Wisconsin. Nat. Climate Center, Asheville, N.C.
11. Smith, E. B. 1978. Personal correspondence. University of Arkansas, Fayetteville.
12. Taylor, W. C. 1978. Manuscript. Bot. Div. Milwaukee Public Mus.
13. Wagner, W. H., Jr. 1958. Notes on the distribution of *Asplenium Kentuckiense.* Amer. Fern J. **48**:39-43.
14. Jones, A. G. 1978. Personal correspondence. University of Illinois, Urbana.
15. Mohlenbrock, R. H., and D. M. Ladd. 1978. Distribution of Illinois Vascular Plants. Southern Illinois Univ. Press, Carbondale, 282 pp.
16. Mohlenbrock, R. H. 1967. The Illustrated Flora of Illinois—Ferns. Southern Illinois Univ. Press, Carbondale, pp. 148-149.

17. Mohlenbrock, R. H. 1978. Personal correspondence. Southern Illinois University, Carbondale.
18. Mohlenbrock, R. H. 1955. The Pteridophytes of Jackson County, Illinois. Amer. Fern J. **45**:143-150.
19. Mohlenbrock, R. H., and J. W. Voigt. 1959. A Flora of Southern Illinois. Southern Illinois Univ. Press, Carbondale, pp. 49-50.
20. Blanchard, O. J., Jr. 1978. Personal correspondence. Purdue University, West Lafayette.
21. Deam, C. C. 1940. Flora of Indiana. Dep. Conserv. Indianapolis, pp. 53-54.
22. Gastony, G. J. 1978. Personal correspondence. Indiana University, Bloomington.
23. Greene, F. C. 1911. The fern flora of Indiana. Fern Bull. **19**:102-115.
24. Tryon, A. F. 1971. American Fern Society report of the 1970 fern foray. Amer. Fern J. **61**:44-47.
25. Broun, M. 1938. Index to North American Ferns. Maurice Broun Publ. Orleans, MA. p. 21.
26. Cranfill, R. 1978. Personal correspondence. University of Kentucky, Lexington.
27. McCoy, T. N. 1938. The ferns and fern allies of Kentucky. Amer. Fern J. **28**: 101-110.
28. Holbert, G. K. 1937. Ferns of Hardin County, Kentucky. Amer. Fern J. **27**:3 and 91-97.
29. Price, S. F. 1904. Contribution toward the fern flora of Kentucky. Fern Bull. **12**: 68-69.
30. Underwood, L. M. 1897. Ferns of Scolopendrium Lake. Fern Bull. **5**:67.
31. Youmans, W. B. 1933. Ferns of the Mammoth Cave National Park region. Amer. Fern J. **23**:113-116.
32. Steyermark, J. A. 1963. Flora of Missouri. Iowa State Univ. Press, Ames. p. 30.
33. Correll, D. S. 1956. Ferns and Fern Allies of Texas. Texas Res. Found. Renner, Texas. p. 174.
34. Gentry, J. L. 1978. Personal correspondence. University of Oklahoma, Norman.
35. Little, E. L., Jr. 1932. *Asplenium pinnatifidum* Nuttall in Oklahoma. Amer. Fern J. **22**:23.
36. Lundell, C. L. 1966. Flora of Texas. Texas Res. Found. Renner, Texas. p. 120.
37. Wagner, W. H., Jr. 1968. Hybridization, taxonomy and evolution. *In*: Modern Methods in Plant Taxonomy. V. H. Heywood, editor. Acad. Press, New York. p. 125.
38. Graves, E. W. 1920. The fern flora of Alabama. Amer. Fern J. **10**:65-82.
39. Graves, E. W. 1921. An interesting trip. Amer. Fern J. **11**:86-88.
40. Darling, T., Jr. 1957. In search of the rock-fern hybrid *Asplenium Gravesii*. Amer. Fern J. **47**:55-66.
41. Haynes, R. R. 1978. Personal correspondence. University of Alabama, University.
42. Crawford, L. C. 1951. A new fern for the United States. Amer. Fern J. **41**:15-20.
43. Bruce, J. G. 1978. Personal correspondence. University of Georgia, Athens.
44. Harper, R. M. 1905. The fern flora of Georgia. Fern Bull. **13**:10-11.
45. Wherry, E. T. 1967. The Bibb County, Georgia occurrence of *Asplenium pinnatifidum*. Amer. Fern J. **57**:90.
46. Maxon, W. R. 1918. A new hybrid Asplenium. Amer. Fern J. **8**:1-3.
47. Duncan, W. H., and D. Blake. 1965. Observations on some ferns in Georgia. Amer. Fern J. **55**:145-153.
48. Smith, D. M., and D. A. Levin. 1963. A chromatographic study of reticulate evolution in the Appalachian Asplenium complex. Amer. J. Bot. **50**:952-958.
49. Ralph, R. D. 1978. Personal correspondence. University of Delaware, Newark.
50. Tatnall, R. R. 1946. Flora of Delaware and the Eastern Shore. Soc. Natur. Hist. Delaware. p. 3.
51. Waters, C. E. 1921. The ferns of Baltimore and vicinity. Amer. Fern J. **11**:19-25.
52. Shreve, F., M. A. Chrysler, F. H. Blodgett, and F. W. Besley. 1910. The Plant Life of Maryland. Johns Hopkins Press, Baltimore. pp. 241 and 263.
53. Jones, S. B., Jr., T. M. Pullen, and J. R. Watson. 1969. The Pteridophytes of Mississippi. SIDA **3(6)**:359-364.
54. Pullen, T. M. 1966. Additions to the fern flora of Mississippi. Amer. Fern J. **56**: 37.

55. Pullen, T. M. 1978. Personal correspondence. University of Mississippi, University.
56. Chrysler, M. A., and J. L. Edwards. 1947. The Ferns of New Jersey, Including the Fern Allies. Rutgers Univ. Press, New Brunswick. pp. 88-89.
57. Fairbrothers, D. E. 1978. Personal correspondence. Rutgers University, Piscataway.
58. Massey, J. R. 1978. Personal correspondence. University of North Carolina, Chapel Hill.
59. Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. Manual of the Vascular Flora of the Carolinas. Univ. North Carolina Press, Chapel Hill. pp. 30-32.
60. Blomquist, H. L. 1934. Ferns of North Carolina. Duke Univ. Pub. Durham. pp. 83-84.
61. Brunken, J. 1978. Personal correspondence. Ohio State University, Columbus.
62. Cusick, A. W., and G. M. Silberhorn. 1977. The vascular plants of unglaciated Ohio. Bull. Ohio Biol. Surv. **5(4)**:22 and 27.
63. Montgomery, J. D. 1969. Report of the 1968 fern foray. Amer. Fern J. **59**:36-39.
64. Cusick, A. W. 1978. Personal correspondence. Dep. Natur. Resources, Columbus, OH.
65. Keener, C. S. 1978. Personal correspondence. Penn State University, University Park.
66. Tees, G. M. 1978. Personal correspondence. Acad. Natur. Sci. Philadelphia.
67. Brown, P. 1978. Personal correspondence. Carnegie Mus. Natur. Hist. Pittsburg.
68. Gruber, C. L. 1940. Ferns and fern allies in Kutztown-Fleetwood area, Berks County, Pennsylvania. Amer. Fern J. **30**:98.
69. Rugg, H. G. 1913. A Pennsylvania fern trip. Amer. Fern J. **3**:92-94.
70. Poyser, W. A. 1909. The fern flora of Pennsylvania. Fern Bull. **17**:65-83.
71. Hopkins, L. S. 1911. A list of the ferns found in the vicinity of Ohio Pyle, Pennsylvania. Amer. Fern J. **1**:101-103.
72. Matthews, V. D. 1941. The ferns and fern allies of South Carolina. Amer. Fern J. **30**:119-128.
73. Rodgers, C. L. 1978. Personal correspondence. Furman University, Greenville, S.C.
74. Evans, A. M. 1978. Personal correspondence. University of Tennessee, Knoxville.
75. Shaver, J. M. 1954. Ferns of Tennessee with Fern Allies Excluded. Bur. Pub. George Peabody College for Teachers, Nashville. pp. 113-119 and 463-464.
76. Ferriss, J. H. 1899. The Tennessee locality for the Hart's-tongue fern. Fern Bull. **7**:98-99.
77. Harvill, A. M., Jr., C. E. Stevens, and D. M. E. Ware. 1977. Atlas of the Virginia Flora. Part I. Virginia Bot. Assn. Farmville, VA. p. 21.
78. Massey, A. B. 1944. The ferns and fern allies of Virginia. Virginia Polytechnic Inst. Bull. **37(7)**:41.
79. Wagner, W. H., Jr. 1966. Illustrations of transient fern forms. Amer. Fern J. **56**: 101-107.
80. Rader, L. L. 1978. Personal correspondence. University of West Virginia, Morgantown.
81. Strausbaugh, P. D., and E. L. Core. 1952. Flora of West Virginia. West Virginia Univ. Bull. Ser. 52, No. 12-2, pp. 32-36.
82. Gray, F. W. 1924. Ferns of eastern West Virginia. Amer. Fern J. **14**:1-13.
83. Darling, T., Jr. 1959. Recent field notes. Amer. Fern J. **49**:119-121.
84. Trudell, H. W. 1929. American Fern Society field trip. Amer. Fern J. **19**:134-141.
85. Wherry, E. T. 1923. Ferns of eastern West Virginia. Amer. Fern J. **13**:104-109.
86. Lobeck, A. K. 1948. Physiographic Provinces of North America. Geogr. Press, Columbia University, New York.

SENECELLA CALANOIDES JUDAY (CALANOIDA, COPEPODA), *MESOCYCLOPS LEUKARTI* CLAUS (CYCLOPOIDA, COPEPODA), AND *DAPHNIA LAEVIS* BIRGE (CLADOCERA) IN INLAND WISCONSIN LAKES

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Whitefish Lake (Sawyer County, Wisconsin) was found to support a population of *Senecella calanoides* Juday. Whitefish Lake is a softwater drainage lake, maximum depth of 31 m and an area of 371 ha. The littoral zone is unsorted sand and gravel with muck bottom in the deeper areas; aquatic vegetation is scarce. Cisco (*Coregonus artedi*) and whitefish (*Coregonus clupeaformis*) are common. Dissolved oxygen was present (0.7 mg/L) at the bottom in late August and secchi disc visibility ranged from 3-4 m.

Senecella calanoides was collected in August and November 1978 by vertical tows using a no. 10 mesh (120 u pore size) conical net (15 cm mouth). On these dates *S. calanoides* was uncommon and only fifth copepodid (CV) males and females were found. *Senecella* is known to be univoltine with long generation times, usually shedding eggs during the winter (Carter 1969; Selgeby 1975). *S. calanoides* is distinguished by its large size (2.4-2.9 mm), the male right first antenna not being geniculate and females lacking fifth legs. The male fifth copepodid (CV) stage can be identified on the basis of its large size and the structure of the fifth legs (Wilson 1959). Other species found in Whitefish Lake were *Skistodiaptomus oregonensis, Leptodiaptomus minutus, L. sicilis, Acanthocyclops vernalis, Tropocyclops prasinus, Cyclops bicuspidatus thomasi, Daphnia catawba, D. retrocurva, Sida crystallina,* and *Holopedium gibberum.*

Much attention has been given to "glacial relicts" *Mysis, Limnocalanus, Pontoporeia* and *Senecella* in the Great Lakes (Carter 1969; Torke 1974; Selgeby 1975; Morgan and Beeton 1978); investigations in Ontario and eastern North America have examined occurrence and glacial dispersal of the deepwater zooplankton communities in inland lakes (Martin and Chapman 1965; Hamilton 1971; Patalas 1971; Dadswell 1974). Dadswell (1974) demonstrated a relationship between the distribution of these deepwater communities and the extent of glaciation in North America. His observations suggest that the deepwater plankton community invaded inland fresh waters either by marine flooding or through water ponded in front of advancing ice. The latter mechanism seems probable in Wisconsin.

Reports of *Mysis relicta* Lovén in four inland Wisconsin lakes and *Limnocalanus macrurus* Sars in one (Marsh 1893; Juday 1904; Juday and Birge 1927; Couey 1934; Mcknight 1976) support Dadswell's conclusions and match the extent of Wisconsin glaciation. *Senecella* has not been recorded previously in an inland Wisconsin lake. Recent collections from Geneva Lake (Walworth County), where *Limnocalanus* had been reported (Juday 1904), have failed to produce specimens of *L. macrurus* or *S. calanoides*. Gannon, et al. (1978) report *S. calanoides* in one inland Michigan lake.

These deepwater species may be present in other lakes within the glacial boundaries but sampling has been limited. A conical plankton net with a large mesh size (No. 6) and large mouth (30 cm), or a trawl would be most productive in sampling for these deepwater species; net avoidance and low density may be problems.

Mesocyclops leuckarti Claus and *Daphnia laevis* Birge were collected from Lilly

Lake (Kenosha County, Wisconsin). Because it is small and shallow (maximum depth of 2 m and 32 ha in area), Lilly Lake experiences problems with aquatic weed growth and winterkill. It has a fish population composed primarily of bass and panfish. The zooplankton community reflects the habitat and is comprised of *Bosmina longirostris, Eubosmina coregoni, Diaphanosoma leuchtenbergianum, Daphnia laevis, Ceriodaphnia lacustris, C. reticulata, C. quadrangula, Skistodiaptomus oregonensis, Epischura lacustris, Mesocyclops edax, M. leuckarti, Tropocyclops prasinus, Macrocyclops albidus,* and numerous chydorids and ostracods.

Adult *M. leuckarti* were collected in small numbers in 1978. *M. leuckarti* was distinguished from *M. edax* on the basis of the hyaline membrane of the terminal segment of the first antennae, lack of hairs on the inner margin of the caudal rami and structure of the fourth and fifth legs (Yeatman, 1959). Immature individuals were indistinguishable from immature *M. edax* with which it occurs.

In examining collections from 190 inland Wisconsin lakes, Torke (1979) did not find *M. leuckarti,* nor has its presence in Wisconsin waters been reported elsewhere. Yeatman (1959) describes this species as being widely distributed in North America but scarce and suggests that many individuals recorded as *M. leuckarti* are actually *M. edax.* In Canada, Smith and Fernando (1977) found *M. leuckarti* to inhabit diverse habitats, from bogs and marshes to large clear lakes. This species has been reported from British Columbia, Quebec and Saskatchewan (Willey 1925; Carl 1940; Moore 1952).

In 1978, adult *D. laevis* were collected in samples from Lilly Lake, but were always rare. Males and females closely resembled the specimen described by Brooks (1957, p. 120; plate 21 E,F,K,L) from a temporary pool in New Haven, Connecticut. Torke (1979) did not find *D. laevis* in his original work on 190 Wisconsin lakes, however, it was later found in Little Mud L., Fond du Lac Co., Camp L., Bayfield Co. and Rush L., Douglas Co. (Torke, pers. comm.). Brooks (1957) describes *D. laevis* as a species of the southern United States, but notes it has been found as far north as southern Michigan, Minnesota and New England.

Brooks also considers *D. laevis* to be parent stock of the pelagic *Daphnia dubia.* Specimens described by Brooks (1957) were collected in temporary ponds and pools, habitats similar to Lilly Lake.

This work, that of Torke and of the Wisconsin DNR Bureau of Research, continues the early studies of Birge, Juday, Marsh and others in an attempt to more fully understand and document the distribution and ecology of Wisconsin zooplankton.

Literature Cited

Brooks, J. L. 1957. The systematics of North American *Daphnia.* Mem. Connecticut Acad. Arts, Sci. **13**:180 p.

Carl, G. C. 1940. The distribution of some Cladocera and free-living Copepoda in British Columbia. Ecol. Monogr. **10**:55-110.

Carter, J. C. H. 1969. Life cycles of *Limnocalanus macrurus* and *Senecella calanoides,* and seasonal abundance and vertical distribution of various planktonic copepods in Parry Sound, Georgian Bay. J. Fish. Res. Board Can. **26**:2543-2560.

Couey, F. M. 1934. Fish food studies of a number of northeastern Wisconsin lakes. Trans. Wis. Acad. Sci. Arts, Lett. **29**:131-172.

Dadswell, M. J. 1974. Distribution, ecology and post glacial dispersal of certain crustaceans and fishes in eastern North America. National Museum Nat. Sci., National Museum of Can. Special Report, Cat. #NM95-10/11.

Gannon, J. E., D. J. Mazur and A. M. Beeton. 1978. Distribution of glacial relict crustacea in some Michigan inland lakes. Mich. Acad. **11(1)**:5-18.

Hamilton, A. L. 1971. Zoobenthos of fifteen lakes in the Experimental Lakes Area, Northwestern Ontario. J. Fish. Res. Board Can. **28**:257-263.

Juday, C. 1904. Diurnal movement of plankton crustacea. Trans. Wis. Acad. Sci. Arts, Lett. **14(1)**:534-568.

Juday, C. and E. A. Birge. 1927. *Pontoporeia* and *Mysis* in Wisconsin lakes. Ecologist **8**: 445-452.

Marsh, C. D. 1893. On the Cyclopidae and Calanidae of central Wisconsin. Trans. Wis. Acad. Sci. Arts, Lett. (1892-1893) **9**:189-224.

Martin, N. V. and L. J. Chapman. 1965. Distribution of certain crustaceans and fishes in the region of Algonquin Park, Ontario. J. Fish. Res. Board Can. **22**:969-976.

McKnight, T. 1976. Opossum shrimp (*Mysis oculata relicta:* Lovén) discovered in Stormy Lake, Wisconsin. Trans. Wis. Acad. Sci. Arts, Lett. **64**:154-155.

Moore, J. E. 1952. The Entomostraca of southern Saskatchewan. Can. J. Zool. **30**: 410-449.

Morgan, M. D. and A. M. Beeton. 1978. Life history and abundance of *Mysis relicta* in Lake Michigan. J. Fish. Res. Board Can. **35**:1165-1170.

Patalas, K. 1971. Crustacean plankton communities in forty-five lakes in the Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. **28**:231-244.

Selgeby, J. H. 1975. Life histories and abundance of crustacean zooplankton in the outlet of Lake Superior, 1971-1972. J. Fish. Res. Board Can. **32**:461-470.

Smith, K. and C. H. Fernando. 1977. New records and little known freshwater copepods (Crustacea, Copepods) from Ontario. Can. J. Zool. **55**:1874-1884.

Torke, B. G. 1974. An illustrated guide to the identification of the planktonic Crustacea of Lake Michigan with notes on their ecology. Univ. Wisconsin, Center Great Lakes Stud., Spec. Rep. No. 17, 42 pp.

Torke, B. G. 1979. Crustacean zooplankton data for 190 selected Wisconsin inland lakes. Wisc. Dept. Nat. Resour. Research Report 101. 69 pp.

Willey, A. 1925. Northern Cyclopidae and Canthocamtidae. Trans. R. Soc. Can. Sect. 3. **19**:137-158.

Wilson, M. S. 1959. Calanoida, pp. 738-798. *In* W. T. Edmondson (ed.), Freshwater Biology, 2nd ed., Wiley, New York, 1248 pp.

Yeatman, H. C. 1959. Cyclopoida, pp. 795-814. *In* W. T. Edmondson (ed.), Freshwater Biology, 2nd, ed., Wiley, New York, 1248 pp.

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THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

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Volume 68, 1980

Editor

FOREST STEARNS

TRANSACTIONS OF THE WISCONSIN ACADEMY

Established 1870
Volume 68, 1980

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

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This edition of the TRANSACTIONS
of the Wisconsin Academy of Sciences,
Arts and Letters is dedicated to:

DR. ELIZABETH F. McCOY

(1903-1978)

Dr. Elizabeth F. McCoy served as editor of the TRANSACTIONS of the Wisconsin Academy of Sciences, Arts and Letters from 1973 until the time of her death in March, 1978. She had served the Academy also as Vice President for Sciences in 1972 and as President in 1976. She was accorded the Academy Citation, highest award authorized by the Wisconsin Academy, in 1977 and in that same year was named by the Academy Council as the first Honorary President in the history of the organization.

Dr. McCoy's distinguished record as a professor of bacteriology at the University of Wisconsin-Madison; her many professional accomplishments; her remarkable life as teacher, researcher, environmentalist and benefactor; her reputation as a human being of warmth and wisdom—all have been well described in the pages of our companion journal, the *Wisconsin Academy Review,* and need not be recounted here.

For one who so singularly honored us through such service and friendship, it is difficult to find adequate honors to return. Perhaps, however, none would be more appropriate, nor more appreciated by Dr. McCoy in her modest manner, than the dedication of the 1980 issue of the TRANSACTIONS. Thus, we do so dedicate this volume: to Dr. Elizabeth F. McCoy, whose very life was characterized in part by the diversity and knowledge that are the hallmarks of the TRANSACTIONS and of its publisher, the Wisconsin Academy of Sciences, Arts and Letters.

Thank you, Elizabeth, for everything.

EDITORIAL POLICY

The TRANSACTIONS of the Wisconsin Academy of Sciences, Arts and Letters is an annual publication devoted to original papers, preference being given to the works of Academy members. Sound manuscripts dealing with features of the State of Wisconsin and its people are especially welcome; papers on more general topics are occasionally published. Subject matter experts review each manuscript submitted.

Contributors are asked to submit *two* copies of their manuscripts. Manuscripts should be typed double-spaced on 8½ × 11 inch bond paper. The title of the paper should be centered at the top of the first page. The author's name and brief address should appear below the title. Each page of the manuscript beyond the first should bear the page number and author's name for identification, e g. Brown-2, Brown-3, etc. Identify on a separate page, the author with his institution, if appropriate, or with his personal address to be used in Authors' Addresses at the end of the printed volume.

The style of the text may be that of scholarly writing in the field of the author. To expedite editing and minimize printing costs, the Editor suggests that the general form of the current volume of TRANSACTIONS be examined and followed whenever possible. For Science papers, an *abstract* is requested. Documentary *notations* may be useful, especially for the Arts and Letters papers, and should be numbered for identification in the text. Such *notations* as a group, should be separate from the text pages and may occupy one or more pages as needed. *Literature Cited* should be listed alphabetically at the end of the manuscript unless included in *notations*. The style of the references will be standardized as in the current volume to promote accuracy and reduce printing costs.

Figures should be prepared to permit reduction. Lettering should be large enough to form characters at least 1 mm high after reduction. Ink drawings or high contrast glossy prints, not larger than 8½ × 11 inches, are necessary.

Printing is expensive. Each paper will be subject to a per page charge to the author, the rate being determined yearly. When a paper is accepted, authors without departmental or grant funds for publication should request that the Director of the Academy (at the Academy address) waive page charges. Galley proofs and edited manuscript copy will be forwarded to the authors for proof reading prior to publication; both must be returned to the editor within one week. Reprints should be ordered when proof is returned; forms and instructions will be sent to the authors. Each author will receive one complimentary copy of the volume of Transactions in which his work appears.

Papers received on or before November 30 will be considered for the next annual volume. Manuscripts should be sent to:

PHILIP AND KATHRYN WHITFORD Co-Editors: TRANSACTIONS
2647 Booth Street
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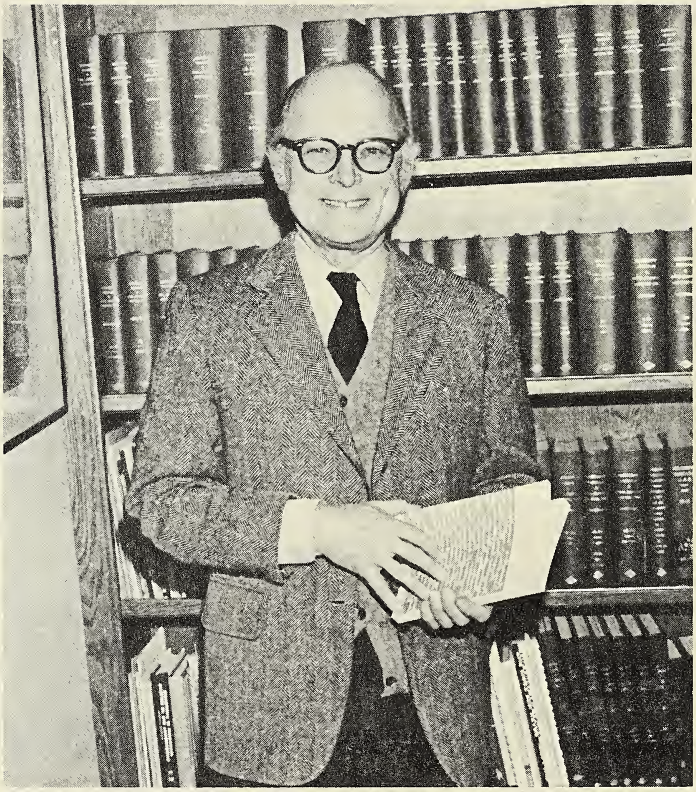
The editor wishes to express appreciation to the incoming editors, Philip and Kathryn Whitford, for their assistance in completing this volume. The work of many colleagues as reviewers and consultants is gratefully acknowledged. The editor appreciates also the patience that authors involved in this volume have shown with the editorial process.

FOREST STEARNS
Editor: TRANSACTIONS

Department of Botany
University of Wisconsin-Milwaukee



Thompson Webb

58th President 1980

WISCONSIN ACADEMY OF SCIENCE,
ARTS AND LETTERS

PRESIDENT'S REMARKS

Thompson Webb
April 1980

The twelve months since the annual meeting in Kenosha have been a difficult and painful period for the Academy. The officers have spent much time considering financial matters and adjusting Academy affairs to the dimensions of the Academy's reduced income. The McCoy Trust may or may not be irretrievably lost, but the income from that source on which the Academy had come to depend has dried up and will certainly not be available in the near future, if ever again. My distinguished predecessor bore the full impact of the unexpected termination of this revenue. President McCabe, Executive Director Batt, and members of the Council serving in that distressing time deserve the gratitude of all of us for the time and dedication that they gave to Academy affairs in making the transition to present fiscal circumstances as gracefully as they did.

That is now behind us. We can wish for return of the McCoy Trust; but, meanwhile, we have to live within present means. Squeezing Academy programs into a reduced budget in inflationary times has been no small task, a heavy burden especially on our Executive Director; but somehow here we are, one quarter into the current year with the prospects of a balanced budget and, so far, no major activity suspended. The Academy is not without resources. If they are used carefully and if realistic expectations for gifts materialize, no invasion of the endowment will be required this year. The Academy's transition to more straightened circumstances has been a process that has absorbed the full attention of both elected and staff officers for more than a year. It is time now that attention be returned to program.

It is regrettable that the staff has been reduced by one full position, which puts a greater burden on remaining personnel. The Academy is more dependent than at any time in recent years on grants from donors and on the dues of membership, and generating revenue of these kinds will inevitably take up increasing amounts of staff time. Nevertheless, the Academy must turn attention back to its program. The Executive Director and the elected officers must now consider the goals of the Academy, as defined in charter and by-laws and as eloquently expanded from time to time in our publications and committee reports. What is needed, and I consider this imperative, is a plan of action. The objectives of the Academy need no further statement; we know what they are. With the brush fires of recent months beaten back, what is urgently called for at this time is a concrete program based on a clear set of priorities, a program that identifies a short list of specific steps that are to be the Academy's principal concern through the short-term future.

A year or more ago, President McCabe set in motion important steps which, in time, may result in legislative support to supplement income from endowment, dues, gifts, and grants. Our Executive Director is actively and successfully engaged in soliciting donations, and he promises further efforts toward attracting additional members. On such activity the Academy depends; but we face what is almost a "hen-and-egg" problem. Funds are needed to support programs; but my feeling is that programs are needed to attract funds. When the Academy goes to the legislature for an appropriation, the question is what does the Academy do that deserves taxpayer's money? When foundation, commercial, and business executives are approached, they want to see persuasive evidence of accomplishment. Surely the prospective new member wants to know how the Academy contributes to specific interests of his in order to be entitled to his support. To all these it is helpful but not wholly sufficient to point to *Transactions,* to the *Review,* to the Youth Program, and to other Academy work, though the questioners may respect those activities as we do. The Academy's major responsibility after *Transactions* is to facilitate studies and investigations, as we all know; but few funds are likely to be attracted on the basis of potential alone. This is a what-have-you-done-for-me lately matter. Initiative will have to come from the Academy. It should turn its attention as actively as present resources permit to the search for projects and programs of the kinds defined in our charter and to attracting funds to implement such activity. An outgoing schedule of that sort is an effective answer to questions from legislators, from foundations, and from prospective new members.

The Academy was established as a service agency. It has provided distinguished service for more than a century and is respected for its accomplishments and what it is continuing to accomplish, but laurels are not enough. The Academy must continue to look for jobs that need doing. The respect that it enjoys depends on its own ability to find significant ways of serving Wisconsin and our fellow citizens. I intend to make it my objective in my term of office, which continues through 1980, to consult closely with the Executive Director on the program of the Academy and the search for ways in which the Academy can contribute as in the past to the state and its people.

This brings me to a related, and final, point: consideration of the length of terms of elected officers. One year is simply not enough time for a president to become fully acquainted with Academy affairs, to develop a mature response to them, and to see any resulting program even well begun. He, and perhaps other officers, need longer terms in order to be effective and to contribute significantly to the direction of the Academy. I have therefore appointed a by-laws committee to review several constitutional questions, including lengths of terms. My predecessor, Robert McCabe, has agreed to serve as chairman of that committee and to report to us at the annual meeting next year in Madison with recommendations on this important issue.

As you see, complaining of the brevity of my term, I am obviously saying that my association with the Academy as its president seems too short. It is a pleasure to have a part in Academy affairs at an interesting if not always happy time. In 1981, I will pass my responsibilities to my distinguished successor, Professor Reid A. Bryson, confident that the Academy will be in competent hands and with gratitude to all of you for this opportunity to serve an organization that has contributed so much to the intellectual and cultural community that we share.

WISCONSIN ACADEMY AWARDS—1980

Wisconsin Academy of Sciences, Arts and Letters—Honorary Membership

Each year the Academy elects to honorary membership, residents of Wisconsin who have brought unusual recognition and honor to our state by achieving great distinction. At this time, the Academy extends honorary membership to three of our fellow citizens, Robert H. Burris, Joseph O. Hirschfelder and Verner E. Suomi. To each of them, the President of the United States gave the National Medal of Science, this country's highest award for scientific achievement.

Joseph O. Hirschfelder, Homer Adkins professor of theoretical chemistry at the University of Wisconsin-Madison, is credited with being the first scientist to predict that nuclear explosions would produce radiation fallout. Most of his research has been conducted in molecular quantum mechanics, theory of liquids, transport properties of gases, and flames and detonations. Joseph Hirschfelder is a fellow of the American Association of Arts and Science and holds the Debye Award of the American Chemical Society for his achievements in theoretical and physical chemistry, as well as the Sir Alfred Egerton Gold Medal of the International Combustion Society for his development of the theory of flames and detonations. The National Medal of Science was presented to him in 1976 for his fundamental contributions to atomic and molecular quantum mechanics. In presenting him an honorary doctor of science degree in January, the University of Southern California cited him as a respected and devoted teacher, caring advisor to students, and as one who "pursues with imagination and success the most rigorous and challenging research."

Verner E. Suomi, professor of meteorology, and director of the Space Science and Engineering Center of the University of Wisconsin-Madison, headed the Wisconsin team that developed experiments aboard Explorer VII and the TIROS-TOSS satellites. He invented the spin-scan cameras aboard the ATS-1 and ATS-3 satellites, and directed the design and construction of atmospheric heat-measuring devices on three of the Pioneer Venus probes. He holds the Mesinger Award for aerological research achievement, the Carl-Gustof Rossby Research Medal, highest award of the Meteorological Society, and the Charles Franklin Brooks Award of the American Meteorological Society, an organization which he has served as president. He was honored recently with the Exceptional Scientific Achievement Medal from the National Aeronautics and Space Administration (NASA) for his role in the Pioneer spaceshot to Venus.

Robert H. Burris, W. H. Peterson Professor of biochemistry at the University of Wisconsin-Madison, is best known for his research on nitrogen fixation. His discoveries hold promise of great practical value for agriculture in Wisconsin and throughout the world. Robert Burris, author of more than 200 technical papers, is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, the American Society of Biological Chemists, the American Chemical Society, and has served as President of the American Society of Plant Physiologists and on the Executive Committee of the Assembly of Life Sciences of the National Research Council. In 1977 he received the Charles Reid Barnes Life Membership Award, presented by the American Society of Plant Physiologists.

Academy Citations

Mark Hoyt Ingraham

Mark Hoyt Ingraham, born in Brooklyn, New York, came to Wisconsin in 1919 with a bachelor's degree in economics from Cornell in order to pursue a masters in mathematics. Since then, in more than sixty years, he has wandered off the reservation only twice, and then briefly—two years for his doctoral degree from the University of Chicago and two years as an assistant professor at Brown University. In 1927, he returned to Madison for good. I used the word advisedly. That is what Mark Ingraham has done for our University, our community, and our state for over half a century.

At 22, he was a captain in the United States Army in France. He has been president of the AAUP. He is a national authority on faculty retirement matters and has served for many years on University, state, and national boards concerned with them. He is the author of six books.

As a professor of mathematics, as Dean of Letters and Science, as counsellor to presidents and chancellors, and to all who consulted him, he has been friend and guide, and a source of wisdom to countless students and colleagues. A pillar of strength on fundamental issues—academic freedom, human rights, the true liberal education as opposed to narrow specialization, and faculty voice in academic affairs—Mark Ingraham has come to embody the liberalism and enlightenment that characterize Wisconsin far beyond the state borders.

With gratitude and respect, the Wisconsin Academy of Sciences, Arts, and Letters acknowledges a profound debt to Mark Hoyt Ingraham, for which this Wisconsin Academy Citation is offered as a token.

Frederick Nelson MacMillin

At the retirement in 1965 of Frederick Nelson MacMillin, the Milwaukee Journal described him as ". . . one of the strongest pillars undergirding the quality and the integrity of both local and state government in the last 35 years."

Born in Dayton, Ohio, educated at Columbia University and the University of Wisconsin, Frederick MacMillan became the first full-time executive secretary of the League of Wisconsin Municipalities in 1929, and he made it an effective voice of Wisconsin cities and villages. He served as president of the American Municipal Association, now known as the National League of Cities. He has been a lecturer in political science at the University of Wisconsin and a frequent contributor of articles to professional journals in the fields of municipal government and public management. In 1943, he formulated and was responsible for the enactment of what is now the Wisconsin Retirement Fund.

Frederick MacMillin was a charter member of the Wisconsin Investment Board, on which he served until after his retirement; and played a key role in making that board a national model. He wrote the constitutions of both the National Association of State Retirement Administrators and of the National Conference of State Social Security Administrators and served the latter as president. Through the Committee on Retirement of the American Municipal Association, he was influential in extending social security coverage to public personnel nationwide and guided through Congress in 1953 the bill that provides social-security coverage to persons under the Wisconsin Retirement Fund. He formulated and administered the group life insurance program as well as the group health insurance program for state personnel.

Frederick Nelson MacMillin has devoted his life to the advancement of the well being of the State of Wisconsin and its citizens. It is, therefore, with pleasure that the Wisconsin Academy of Sciences, Arts and Letters takes this occasion to bestow upon him this Wisconsin Academy Citation, indicative of the honor in which he is held and the appreciation of his fellow citizens.

Martha Elizabeth Peterson

Martha Elizabeth Peterson, born and educated in Kansas, first became associated in higher education at the University of Kansas as a member of the faculty in mathematics and then as Dean of Women. In the latter capacity, she came to the University of Wisconsin in 1956, where for ten years she administered student affairs, becoming Dean of Students in the evolving University of Wisconsin System. In 1967, she left Wisconsin to spend eight years as President of Barnard College and Dean of Columbia University. Wisconsin, however, was fortunate enough to be able to claim her again in 1975, when she returned to take her present post, President of Beloit College.

She is also a trustee of Notre Dame University, a member of the President's Commission on White House Scholarships, a member of the Rhodes Scholar Committee in Wisconsin, recipient of sixteen honorary degrees, of numerous awards, and a member of an impressive list of major corporate boards.

At the University of Wisconsin, Martha Peterson was largely responsible for the major change in the policy in higher education from treating undergraduates as children to respecting them as adults. In Madison and in New York, she faced the problems of those troubled years with calm integrity, defending academic freedom and standards.

To Martha Elizabeth Peterson, citizen of our state, who has contributed in so many ways to the values that the Academy represents, the Wisconsin Academy of Sciences-Arts, and Letters presents this Wisconsin Academy Citation.

TECHNOLOGICAL ERRORS AND HUMAN DIGNITY—THE PROBLEM OF BIOMEDICAL PROGRESS

Kuang-ming Wu
Philosophy Department
University of Wisconsin-Oshkosh

One of the problems of biomedical progress can be summed up in one phrase—the confrontation between errors inherent in technology and the equally inherent dignity of human persons. The tragedy is that the confrontation threatens to resolve itself in a ruthless triumph of biomedical technology which reduces human dignity to nothing. And since biotechnics serves *human* welfare, elimination of humanness by such "successes" of biotechnics amounts to the latter's failure. The triumph of biotechnology is, therefore, precisely its failure; our biomedical progress is caught in a suicidal treadmill.

This paper proposes to attack the problem by (A) taking a close look at the nature of technological errors, in the light of which (B) a new understanding of human nature can be brought about. And from this new understanding (C) a fresh guideline can be derived for biotechnical progress which includes errors.

(A) First, consider the nature of human error. Technology is peculiarly ambiguous when it comes to error. On the one hand, one of the purposes of technics is to accomplish its goal with few, if any, errors. The intention of technical operation is to reduce the margin of error to zero; every error is an occasion for learning how not to repeat it in the future. On the other hand, since in this contingent world technics always partakes of the character of trial and error, error is operationally inherent in technics. Hence, the ambiguity: Technology can neither do with errors (whose elimination is its goal) nor can it do without them. Errors go inescapably with technics, the purpose of which is to eliminate them.

This technological ambiguity becomes serious when technics is medically applied to humans, for one cannot morally afford a single mistake on a human being. The significance of the difference in frequency of errors, usually taken as a distinguishing factor between a therapy and an experiment, is reduced by the equality, in both areas of operation, in the moral cruciality of biomedical errors.

Biomedical error takes on a sinister character when one turns from errors that are expected to those unexpected. There are many errors in biomedicine that at the moment of treatment are not at all apparent. They brood under the so-called experimental or therapeutic "successes." Consider, for instance, the use of Thalidomide by pregnant women. Effective as a tranquilizer, it turned out to be a cause of gross malformation in new-borns. It produced its intended benefit—it was a success—only to cause unforeseen tragic consequences. Genetic "improvement" is another example. We think we have succeeded in eradicating "bad" genes, such as sickle cell genes, only to strip ourselves of protection from malaria. "Bad" genes eliminated mean genetic elasticity reduced, and reduction of genetic variety impoverishes our ability to cope with environmental change. Genetic manipulation executed to meet present conditions sows the seed for future genetic havoc.[1]

Furthermore, not only are biotechnical errors serious (because they are concerned with humans) and sinister (because no one knows which present "successes" will be the cause of future disasters). The very success of biotechnics threatens to break down our idea of humanness. As Kass puts it,

> We are witnessing the erosion, perhaps the final erosion, of the idea of man as something splendid or divine, and its replacement with a view that sees man, no less than nature, as simply more raw material for manipulation.

As a result, we have lost our sense of who we are and where we are going:

> Hence, our peculiar . . . painful irony. our conquest of nature has made us the slave of blind chance. We triumph over nature's unpredictabilities only to subject ourselves to the still greater unpredictability of our capricious wills and our fickle opinions. That we have a method is no proof against our madness. Thus, engineering the engineer as well as the engine, we race our train, we know not where.[2]

This self-defeating predicament of biotechnics culminates the serious and sinister errors of biomedical revolution. When technics in our hands confronts ourselves, it tends to corrode ourselves; the situation is grim and pervasive. One only vainly tries to impose a solution external to the situation. For instance, an effort to stop or reverse scientific-technological progress is both otiose and impossible.

(B) However, it is not without reason that humans are plagued with such biotechnological errors. For it is human nature to change things (including humans themselves) by the use of tools, that is, to be technical. And if technics is error-prone, it is because humans are. Therefore, the solution to the above problem lies in discerning humanness through examining the nature of error itself. Then the ancient wisdom, "To err is human," shall be seen not only to yield fresh insights into human nature, but also to disclose *positive* significance within technological errors themselves.

Advancement in technics is part of human growth in power. And the progress of biotechnics is for an improvement of humanity. And yet, as was noted above, biotechnics is error-prone; the more biotechnics progresses, the more serious the errors it is likely to commit. Thus, the growth in biotechnical power amounts to an increase in the pendulum swing between improving humanity and annihilating it.

What is noteworthy is that the above fact implies more than a counsel of futility and despair. For "the pendulum swings" above is synonymous with the range of freedom. To be free is, among other things, to be prone to error. And to be free to err is to be human. Therefore, the growth in biotechnics is growth in human freedom, accompanied by growth in seriousness of errors which could destroy freedom. In short, thus to be free is to be human; that is, since biotechnics, the power of self-transformation, and its concomitant challenge, errors, are both typical of being human, to describe biotechnics and its threats (errors) is to describe humanness. And so, paradoxically, the growth in seriousness in errors testifies to the growth in humanness.

Moreover, a recognition of error is implied in its commission and its judgment. If to err is human, it is also human to *know* its commission. This is indicated in the human cries of warning, even of woes, such as Kass's mentioned above. But to warn oneself is to arm oneself. Cries of woes of biotechnics testify to an initiation of human self-rectification. Thus to cry out in warning is to grow in the capability to detect and to control what would, if unchecked, destroy humanness.

In short, to be human, to be technical, to be error-prone, and to be able to recognize error, are all mutually co-implicative. And it is this co-implication that is typical of humanness, and it is this humanness that will in the final analysis save humanity from self-annihilation. By recognizing error, human beings move toward the truth.

It is crucial to note how the above positive conclusion was derived from the seemingly negative notions such as "errors" and "cries of warning" thereof, both of which were discerned to contain rays of hope. It is imperative to demonstrate that such reasoning is anything but arbitrary. In fact, the route to positive implications of humanness from the human proclivity to error is a well-trodden road in philosophy. It suffices here briefly to take note of three philosophers: R. Descartes, J. Royce and P. Ricoeur.

To Rene Descartes it is indubitable that "I" know I am imperfect, capable of "the infinitude of errors." The problem is how this knowledge is possible. I both must know that perfection exists, in the light of which I recognize my imperfection, and must not be perfection myself, before I can avow my imperfection, which is characterized by my errors. I must therefore be "something intermediate between God and naught." Thus is paved a Cartesian route from my imperfection (capability to err) to perfection, whose intimation I possess, and whose imperfect copy I am.

Josiah Royce discovered the condition for the definite possibility of error. There must be the All-Enfolder, the universal Thought, of which all judgments, true or false, are but fragments. It is a relational Whole, a Unity in which error is erroneous and truth true. Since to every truth there are opposed an infinite number of errors, and since those errors are real, such all-inclusive Thought must be infinite and real.

For Paul Ricoeur man is a "disproportion," (a) a noncoincidence with himself, (b) an internal polarity of the finite and the infinite, and (c) an act of intermediation between those two poles. Such an internal rift is responsible for man's fallibility, for man is capable of evil only because of that from which he falls, de-viates. Evil is to be understood by freedom, and freedom, by evil. Freedom recognizes evil as evil, and is responsible for it; evil, in turn, is an occasion for a deeper understanding of freedom.[3]

The three philosophers are at one in pointing to the possibility of error and its recognition that discloses the overall rubric of our intuition of the universal all-Enfolder, the Perfection. The significance of human life lies in this disproportionate intermediation between the finite and the infinite. Biomedical progress is one manifestation of such human life.

Now if the above analysis of the human capacity to err is tenable, our worries about the unpredictable future provide clues to what it means to be human. Our worries exhibit the following features about ourselves: 1) our tremendous growth in bio-capability, 2) our capacity to remake ourselves, which in turn implies 3) our inchoateness, in its twofold meaning of imperfection and incipiency, and hence 4) our malleability, our openness to all possibilities. Besides, so long as we worry, we have 5) an intuition (albeit an imperfect one) of some perfection by which we measure our shortcomings.

Drawing on the works of biologist A. Portmann, anthropologist M. Landmann, and child psychologist S. Fraiberg, among others, Jack Bemporad said that the biological make-up of humans, in contrast to that of animals, is essentially incomplete, unspecified and open-ended. Hence the historical nature of man. Man *is* self-making. He is the artist of himself, open to the future by his decisions and his design of self-transformation.

Similarly, agreeing with physiologist and animal psychologist F. J. J. Buytendijk, Marjorie Grene said that only we humans have the freedom of self-determination in our handling of situations. In other words, only for man are things equivocal; only for man can an object take on several aspects and carry a multiplicity of possible uses. We have an open situation, because we are open, transcending our immediate milieu and needs. Thus we have an equivocal relation to our world in a variety of ways.[4]

In sum, the scholars agree on one point: Man is self-changing, as a consequence of his essential incompleteness and openness to the future. Biotechnical error is but one manifestation of such self-change. Since man is open to alternative visions he sees things *differently* at different times. These differences create dissatisfaction with the status quo, and, hence, biotechnical transformation of man himself. These differences are also the basis for judging some biotechnical consequences to be errors. Thus man by his capacity to change himself is the source of his biomedical progress and its concomitant errors.

(C) What guidelines for biotechnics can be drawn from humanness disclosed in technological errors? How does human self-creation differ from self-manipulation that degrades his dignity? In order to answer these questions, one must return to examine human nature.

As stated above, man is open, unspecialized, and can/does plan and execute self-renewal. This means that man is not material to be manipulated but the principle and the process of self-transformation. Life is nothing else than "to live," and to live is to spend and to change, which includes the choice of a direction in which to change. The seeming constant "life" is really a performative. Man *is* self-change, not a substance.

From this humanness can be drawn two guidelines: Human self-transformation ought to be a continuous self-*transformation* (not self-destruction), and such transformation ought to be a *self*-transformation (not self-alienation).

(1) Teleologically speaking, human self-*transformation* must be such that it facilitates further transformation. Since man's nature is self-change, any change that results in a stunting of further change is self-defeating, a destruction of human dignity; and therefore it is unethical. Disease is stunting; so is any irresponsible behavior that brings about disease.

One's duty to oneself, then, is to promote further changes, and conversely, to prevent a future stoppage of self-change. Brainwashing, genetic designing of man for *specific* purposes (the breeding of legless, prehensile and muscular dwarfs for space travel), creating cyborgs, are all unethical. For though the victims' biological functionings continue, such genetic manipulation kills the human potentials for self-change, narrowing the range of future choices.

(2) Ontologically speaking, human transformation is good when it is *self*-transformation, not only of the self but for the self, if not always by the self. Parents raise their children, not primarily for parental satisfaction but for the sake of the children themselves. Analogously, physicians serve as agents for the health of their clients.

By contrast, a manipulation of material occurs when a person is the subject of purposes he has not endorsed. Again, brain washing, genetic designing of men for specific purposes, even babies produced in hatcheries, are all unethical manipulations because they are executed for purposes alien to the victims. Any agent of change in another person has done evil if he acts without the person's informed consent.

Similarly a person acting for himself indulges in irresponsible self-manipulation when he disregards his own inner nisus. He alienates himself from himself in his self-manipulation for purposes other than his own self-fulfillment. Such actions are no less than frivolity or fanaticism.

Man's action upon himself, however, is a legitimate self-assertion and -creation when the act fulfills his decision for himself, that is, expresses his responsibility for himself. A deliberate decision to incorporate into oneself a mechanical device (either for therapeutic or for eugenic purposes) is ethical when the decision is made self-responsibly. Such decisions include the use of biomedical devices such as the heart pacer, the kidney machine, the mechanical limbs, of many sorts. Thus, ethical judgment depends upon whether the change effected was meant for self-integration or -alienation, self-furtherance or -destruction.

So far some positive implications of technological error have been explored. One cannot, however, brush aside the negativity of error, which is, after all, what is meant by error; it is something to be averted, though due to our human nature, we can not completely avert it. Our biotechnical self-transformation intended for self-integration and -furtherance may turn out to be a disaster. We cannot morally afford to commit biomedical errors, yet we cannot avoid them entirely.

In this context, it is important to remember that risks are inherent in the human freedom of self-transformation. Such freedom should include the freedom to learn from misfortune. Errors committed unintentionally, once fully studied, can become important knowledge by which humanity can guide itself in a safer and more reasonable manner. Those misfortunes are now rendered significant. Thalidomide victims will, if they allow their case histories to be studied, have reasons to feel proud that their lives spent (and what life is not spent?) in unforeseen miseries are at least partially "redeemed" in human dignity.

There is, however, a world of difference in significance (if not in frequency) between the above *retrospective* exploration of biomedical errors committed unintentionally and intentional experiments on human miseries.[5] Retrospective investigation is a conscientious redemptive act in the face of inevitable occasional errors. Experimentation is, by contrast, an unethical utilization of humans as guinea pigs, by purposely inducing biomedical disasters so as to observe their process and extent, usually without the victims' prior informed consent.

In the final analysis, biomedical experience is a ruthless exploration into what maximum humanness can mean, in all its physiopsychological aspects. The exploration is ethically fruitful so far as it is faithful to whatever has been disclosed as genuinely *human.* It is fidelity to the importance of being human that keeps biomedical exploration on the right track. As soon as biotechnics abstracts the human body from humanness, the purpose of biotechnics is thwarted and human dignity violated. By contrast, humanness is preserved and enhanced when human values are respected in all the stages of biomedical progress.

Even human errors can contribute to human dignity since the freedom to risk error in conscious planning for the future is a uniquely human characteristic.

Notes

[1] Nature has a convenient remedy called genetic mutation. Yet to rely on natural mutation for our genetic salvation is to admit the futility of our genetic maneuver. Moreover, it is self-defeating to rely for our remedy on something natural (which has been with us without our genetic endeavors), that cancels the fruits of our labor. There is something strange about safe-guarding our deliberate and systematic efforts by natural randomness which nullifies them.

[2] Leon Kass, "The New Biology: What Price Relieving Man's Estate?", in *Science,* Vol. 174 (19 November, 1971), pp. 785f.

[3] Rene Descartes, "Meditations on First Philosophy," meditations 3 and 4; I consulted Norman Kemp Smith, *Descartes' Philosophical Writings,* The Modern Library, Random House, 1958, etc., pp. 193ff.

Josiah Royce, *The Religious Aspect of Philosophy* (1885), Harper Torchbook 1958, pp. 384ff. (reprinted in *Josiah Royce: Basic Writings,* Vol. 1, University of Chicago Press, 1969, pp. 321ff.) *The World and the Individual,* Vols. 1 and 2 (1899), Dover, 1959, is his later expansion of this seminal idea.

Paul Ricoeur, *Freedom and Nature,* Northwestern University Press, 1966; *Fallible Man,* Henry Regnery, 1965; *The Symbolism of Evil,* Beacon Press, 1967.

[4] Jack Bemporad, "From Biology to Spirit: The Artistry of Human Life," in *The Journal of Medicine and Philosophy,* June, 1978, pp. 74ff.

Marjorie Grene, *The Knower and the Known,* Basic Books, 1966, pp. 172f.

[5] Such as the ghastly Tuskegee syphilis study in Alabama in 1930 on black farmers. For this experiment and for others similar to it, see Richard M. Restak, *Premeditated Man,* Penguin Books, 1973, etc., pp. 111ff., 119ff.

THE GRIGNON HOTEL AT BUTTE DES MORTS, WISCONSIN: AN ESSAY IN HISTORIC PRESERVATION[a]

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One of the older buildings in Winnebago County, Wisconsin, the hotel constructed by Augustin Grignon at the village of Butte des Morts is an attractive subject for an essay in historic interpretation. The builder was a person representing the French presence in historic Wisconsin at its best. Born at Green Bay in 1780, Grignon was a grandson of the colorful Charles Langlade and a subject of the British Empire. As an adult, he occupied a prominent branch on "the wide-spreading tree of the Grignons"; and after the United States barred outsiders from its Indian trade, he abjured "all allegiance . . . to every foreign prince . . . particularly to the king of the United Kingdoms of Great Britain & Ireland . . ." to become an American citizen on July 27, 1820.[1] Recognizing Grignon's grasp of early times in Wisconsin, Lyman C. Draper believed that an interview which he obtained from "The Capt." in 1857 would be regarded by future historians as "the most valuable individual narrative ever contributed to the State Historical Society of Wisconsin."[2]

When he died in 1860, Grignon left a legacy of interests in a variety of far-ranging pursuits. He had been an entrepreneur in the Indian trade of Wisconsin. He had pioneered at farming in the Lower Fox River Valley. He had acquired widespread holdings in land. And he had been a community founder and promoter. In that role, he had striven to enlarge the importance of Butte des Morts which he platted in 1848.[3] The hotel he built there not only figured in the development of the village, but also was a potential means of keeping Grignon afloat financially as settlers from outside Wisconsin shouldered their way into the affairs of the region.

Built in the simple Greek revival architectural style popular in America between 1830 and 1850, the Grignon Hotel stands at its original location on the southeast corner of the intersection where Main and Washington streets meet in Butte des Morts. Once, the hotel looked southward over a broad marsh through which flowed the Upper Fox River and across which passed the trail from Portage to Green Bay. After the damming of the Lower Fox, however, the waters of Big Lake Butte des Morts rose, so that today a mere city block separates the hotel from the north shoreline of the lake.[4]

Although the Grignon Hotel has endured more than 130 years of weather and wind, its original appearance is largely unaltered. Admittedly, the building has suffered wear and tear, and it has undergone both interior and exterior changes. For example, a central staircase which extended upward to the second floor from a point facing the main entry on the first floor has been replaced by narrow steps ascending along the interior of the front wall. At the rear of the hotel, an outside stairway built to allow guests independent access to the second floor sleeping rooms has disappeared and with it, an entry door at the top of the stairs. Some items of hardware remain as do window panes which may be the original ones as they are of poor quality glass badly marred by cords and

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[a] Published with the permission of the Winnebago County Archeological and Historical Society. For certain suggestions concerning subject matter, the writer is indebted to Mrs. Lynn Webster and Mr. Dean Sandeman of Oshkosh, Wisconsin.

seeds. Other original features of the interior construction are the door-like shutters covering the windows. (One writer has claimed that these devices shut off light from the rooms and thereby dampened the urge of a red man to put an arrow through a lighted window.) A bar—or counter—also remains which reputedly served a first-floor tavern. On the second floor, there are chimneys for stoves used to heat the rooms during the chill of Wisconsin winters. A large third-floor room whose precise purpose has been the topic of some speculation appears to have experienced little, if any, alteration. A door between the stairs from the second to the third floor contains a peep-hole which can be opened and closed by a small shutter. On the east side of the building there is an attached apartment presumably intended as living quarters for the hotel manager; but none of the detached structures which once served the establishment and its guests remain.[5]

Whatever the condition of the Grignon Hotel at the time of this writing, in the day when it was constructed the building stood in surroundings that could only have pleased the eye. An early picture demonstrating that condition, is a sketch of the Grand Butte des Morts with its "bold shores" drawn by Captain Henry Whiting in 1819. Marching with the Fifth Regiment from Fort Howard to Prairie du Chien when he captured the view, Whiting estimated that "about ten lodges" of Menominees dotted the bluff where one day Augustin Grignon would build his hotel. But in Whiting's time, the Butte served the red men either by affording the living a place to camp, or by furnishing the dead a place to sleep through the ages.[6]

A year before Whiting sketched the site of the future village, Augustin Grignon and Jacques Porlier had built a trading post where a stream now called Daggett's Creek emptied—in the words of Porlier's son Louis—into the "upper end of Lake Butte des Morts, two miles below the present village of that name." According to Louis Porlier, Grignon brought his family to that post in 1840. Porlier's word has the ring of authority; in 1840, he became Grignon's business manager, and in 1841, he married Grignon's daughter, Sophia.[7] Writing in observation of America's Centennial, reporter Reuben Gold Thwaites of the *Oshkosh City Times* also fixed 1840 as the year marking Grignon's permanent residence in the Butte des Morts neighborhood.[8] And, in 1839 a surveyor of the area not only referred in his field notes to Grignon's house and improvements, but also mapped farm land belonging to Grignon.[9] The 1840 federal census was the first to show Grignon to be living in Winnebago County. At that time, the sixty-year-old Grignon headed a household of four females and seven males.[10]

Having established his family on the soil of Winnebago County and having improved his land, Grignon seems to have anticipated a busy life as a farmer. In November, 1842, he contracted with one Thomas Evans to have a new barn built. The agreement called for the barn to be finished by July 31, 1843; the building was to measure 30′ by 50′, and it was to be of pine lumber. The contract stipulated, too, that Grignon was to pay Evans $450 of which $300 was to be due at the "Monomonee" [*sic*] payment in the fall of 1843; should that source not allow Grignon sufficient funds to settle in full, the balance was to be paid in livestock at the going cash price.[11] Completing the circle in 1876, Reuben Gold Thwaites wrote that in the winter of 1842 Evans "worked up his crops at the Stockbridge mill"; then, from what appears to be an omission in newsprint, Thwaites went on to remark, "and used most of the boards in building a barn for Augustin Grignon."[12]

Although Grignon had settled down to follow a rustic existence which—according to the census of 1860—depended on twenty-two acres of improved land and fifty acres that were not,[13] in 1840 he made two entries of land which are of especial concern to this discussion. One parcel lay in Section 30, Township 19, North, Range 16 East in the Green Bay Land District. It was the site of Grignon's farm home until his death. When the federal government opened former Menominee lands lying north and west of the Fox River for sale in 1840, Grignon entered another 205.50 acres in Section 24, Township 19 North, Range 15 East. It was on this land that Grignon platted the village of Butte des Morts where stands the hotel, which he built on lots one and two in block twelve of the young settlement.[14]

Being in his late sixties did not deter Augustin Grignon from promoting the fortunes of Butte des Morts. It has long been reported that Grignon tried to have the county seat of Winnebago County, which had been created in 1840, located there permanently. As an inducement, in December, 1845, he deeded to the County a plot containing 90,000 square feet of land—about 2¼ acres—for a courthouse site, even though the village was not to be platted until 1848. The County accepted the gift and obligation; but there is a curiosity about it as the deed—and related documents to follow—located the parcel in Section 24, Township 19 North, Range 16 East.[15] In other words, Grignon's proposed courthouse location lay six miles due east from the spot where it might be needed. But no matter, the business of the County came to be conducted at Oshkosh despite the fact that Grignon had donated a site for the county courthouse and that Butte des Morts had been selected as the county seat in 1845.[16] To the Oshkoshites, it was fitting that county affairs be so handled; to Augustin Grignon it was another matter. In 1849 he served public notice in the *Oshkosh True Democrat* of his intention to seek legislative approval for the purpose of locating the county seat permanently at Butte des Morts. Moreover, he intended to request the lawmakers at Madison to approve either his establishing a ferry or building a bridge across the Fox, and he wanted their approval for him to construct a plank road to a ridge of timber near the farmstead of his nephew Robert.[17]

Butte des Morts possessed some points favoring its becoming the seat of justice in Winnebago County. One was its position on the historic trail between Portage and Green Bay. Another, making its selection "eminently proper," was its central location in Winnebago County.[18] In response to Grignon's plans, the *Oshkosh True Democrat* noted that the rapidly growing village of Oshkosh was really the business center of the County; besides, the Indian country north and west of the Fox and the Wolf Rivers was not yet settled. In addition, Oshkosh was to be the location of a new jail costing $500 to which sum the Oshkoshites were to contribute $200. To the *Democrat,* it seemed hardly fair to have the taxpayers of Oshkosh pay so much toward the construction of the jail only to have the county seat moved to Butte des Morts.[19]

Despite the contentions of the *Democrat,* the legislative wheels began to turn. That Grignon's hope to move the county seat enjoyed strong support can be substantiated by the fact that one petition sympathetic to the change went to Madison with 800 signatures.[20] Next, on January 30, 1850, the lower house of the legislature received a bill having the purpose of authorizing the electors of the County "to vote on the removal of the County Seat." The first version of the bill provided for an election to be held in November, 1850, plus a fifty-dollar fine for anyone who offered, gave, or promised to any elector either money or property in return for voting "for or against such removal." The same penalty was applicable to a voter who yielded to such temptation. A substitute bill provided that the citizens were to make their choice at the yearly meeting of their towns on the first Tuesday of April, 1850; it dropped the clause concerning the fine of fifty dollars. The substitute bill received legislative approval, and on February 9, 1850, Governor Dewey signed it into law.[21]

Although Butte des Morts had some points in its favor for becoming the County seat, that does not mean that Oshkosh was without advantages for the electorate to consider. Oshkosh was on the main line of communication between Milwaukee and Green Bay; indeed, the *Democrat* was soon to proclaim that the telegraph was coming to Oshkosh. In addition, Oshkosh was where the people were; the census of 1850 showed that it outnumbered Butte des Morts by a ratio of fourteen to one.[22] It was hardly surprising, therefore, that when the voters cast their ballots they favored Oshkosh by a comfortable margin.[23] In December, 1852, the Winnebago County Board returned to Grignon his gift of land for a county courthouse.[24]

Thus it was that Augustin Grignon's hope to give Butte des Morts a brighter then ordinary place in the sun suffered eclipse. But the grandson of Charles Langlade was no quitter. In 1853, he organized a company to build a plank road to run from Butte des Morts to Ripon, and besides, platted an addition to Butte des Morts lying on the north side of the town.[25] Had the county seat been located in Butte des Morts, his hotel would have looked out on the courthouse square and doubtlessly would have given its owner a position of prestige as well as profit.

Meanwhile, in 1849 the United States government had taken a step related to Grignon's building the hotel. On June 15 of that year, it established a post office at Butte des

Fig. 1. Line drawing of the Grignon Hotel at Butte des Morts. Artist, C. F. Norris, Oshkosh, Wisconsin. Courtesy of the Winnebago County Archeological and Historical Society.

With deep regret the writer reports the death of Charles F. Norris on November 19, 1981. He was a man of great talent devoted to serving others.

Morts with Grignon as postmaster. The new post office was a "special" office; that is, it received mail only once a week because Butte des Morts did not lie on a direct mail route.[26] Moreover, by terms of the law in effect, the income from the postmastership could have been only modest as the compensation of the postmasters was geared to the postage on pieces of mail handled.[27] Hence, Grignon soon relinquished the position. Grignon's successor was Finley F. Hamilton, a man of affairs both at Butte des Morts and in the county of Winnebago.[28] *A History of Northern Wisconsin* published in 1881 made the following remark about the time when the hotel went up:

> In 1849, a post office was established and Augustin Grignon appointed Postmaster. The Postmaster, not content with the 'emoluments of his position,' put up a house which he called a hotel. F. F. Hamilton opened a general store in the first frame building erected in the village, which saw the light of day also *during that year.*[29] (Italics mine.)

Although others have suggested various dates for building the hotel, the writer has discovered no evidence so sure as the above statement relative to its construction. Oddly enough, accounts concerning Grignon and early Butte des Morts left by Thwaites, Draper, and Porlier are silent on the subject; nor has diligent search in papers associated with the Grignons discovered a date when the hotel was built. The nomination for enrolling the structure on the National Register of Historic Places stated simply that it was built in 1852, while Harry Ellsworth Cole in his *Stagecoach and Tavern Tales of the Old Northwest* wrote that it "was erected about 1848." On the other hand, the *History* of 1881 not only gave a time for building the hotel but also related it to a contemporary venture in construction. Furthermore, the *History* provided a reason for Grignon's erecting the building in connection with his disappointment over the financial returns from the postmastership at Butte des Morts.[30] The earliest association of the hotel with Grignon's name to come to the writer's attention was in a legal instrument negotiated by Grignon in early January, 1852. The document referred to the building as "Grignon's Tavern."[31]

Louis Porlier and Mrs. Ebenezer Childs (Grignon's daughter Margaret) managed the hotel until 1855 when they leased it to one Thomas B. Petford, a native of England. Petford may have been in the hotel business before 1855 as the census of 1850 gave his occupation as landlord, and showed him as heading a household of ten persons, four of whom were not members of his family.[32] An advertisement appearing over Petford's name in the *Oshkosh Courier* of August 16, 1854, invited the public to attend an "Opening Ball" to be held in the St. Charles Hotel at Butte des Morts. That Petford operated the Grignon establishment during the time indicated can be substantiated by a rent receipt acknowledging that Petford had paid Grignon "fourty [*sic*] three Dollars and Seventy five Cents being in full for the Rent of the Tavern House up to February 16/56."[33]

Evidence suggests that Butte des Morts may have had more hotels—or at least buildings called by that name—than that of Augustin Grignon. While visiting the village in January, 1851, editor Charles D. Robinson of the *Green Bay Advocate* reported stopping at a hotel owned by a man named Bell.[34] Moreover, on August 15 of that year, the *Oshkosh True Democrat* reported that "Mr. Jones, from . . . , New York," was erecting "a very large building" intended to be a hotel. "It is a fine structure," stated the *Democrat,* "and is most conveniently planned." Mr. Jones also had something to say about the "fine structure." In January, 1852, he invited the "young bloods of the county" to visit his cotillion hall where, in parties of twelve, they could dance and dine for a dollar a couple.[35] Just a week before Jones' advertisement appeared, the *Democrat* mentioned a party to be held at Church's Hotel in the village.[36] Surely, it appears that for a hamlet numbering only 102 souls in 1850, Butte des Morts was performing well in providing overnight facilities for the public.

Whatever the number of hotels at Butte des Morts, a report concerning that of Augustin Grignon alleges that a destructive fire caused it to be rebuilt. But when George Overton, local historian of Butte des Morts, remarked that just before the Civil War "fire completely destroyed the Grignon establishment," he also stated, "Mr. Grignon did not rebuild but put in a stock of goods in a building near his . . . [farm] residence." However, the fire reported to have destroyed the old hotel could not have done so; it is likely that a mercantile concern which Grignon operated "on the east side of Main street, north of Washington street" was the building destroyed.[37] A recent analysis of the soil on which the building stands has shown no indication of any fire.[38] Therefore, it can only be concluded that the report of the hotel's having been reduced to ashes is faulty. The same statement cannot be made, however, of the fact that Grignon rendered his connection with the building somewhat uncertain when, in 1852 he put it in hock and did not redeem it by the time of his death in 1860.

Why did Grignon turn to borrowing in 1852? Did he borrow because of the decline in the local Indian trade after 1848 when the Menominees left the neighborhood around Butte des Morts for the reservation?[39] Was he attempting to raise funds for his plank road plan? Did he wish to defray any unsettled costs related to building the hotel? Had his failure to receive compensation long due him from the Indian trade entangled Grignon in a financial morass from which he could not extricate himself? Or, had time run out for the fur traders of the area?

With regard to the last two questions, there are some observations to be made. According to the terms of the Menominee Treaty of 1836, Grignon had received $10,000 in settlement for credit extended members of that nation; in 1837, however, he received only $1759 under the terms of a treaty applying to credit allowed the Winnebago.[40] Grignon tried to collect more after the settlement as he entered a claim amounting to $20,000 for goods which he had supplied the Winnebago year after year without adequate repayment, according to depositions of old associates in the Indian trade.[41] Describing as "erroneous" the "impression that the old fur traders waxed very rich," Louis Porlier once pictured the "universal credit" they granted the red men as being most uncertain because the system contained numerous risks which could spell disaster to a man in Grignon's position.[42] A document that leaves little doubt as to the hazards of the fur trade by the 1840's is a letter written by Ramsay Crooks of the American Fur Company to John Lawe at Green Bay. Writing on April 3, 1843, that in a bygone day the traders could "provide bountifully and run some risks," Crooks told Lawe:

> The winter has been unusually mild all over Europe, and fears have been entertained that Furs would consequently sell badly this spring. . . . Beaver has fallen about a dollar per pound, compared with the sales 12 months ago. This is caused principally by the introduction into England of the French *silk* Hat, which looks nearly, or quite as well, as those made of Beaver, and unfortunately last almost as long, while they are sold for much less money.[43]

Equally gloomy were Crooks' comments concerning prices being paid for American muskrat skins in Europe as a result of the Hudson's Bay Company's unloading 500,000 rat pelts on the markets there.[44]

Even so, a generation later Reuben Gold Thwaites wrote that "the glory of Butte des Morts" was its annual catch of muskrats.[45] And although the natural habitat of muskrats was destroyed in 1905 when the bog in Lake Butte des Morts began to disintegrate, George Overton claimed that the "sales of fall rats alone at Butte des Morts totaled more in 1935 than the entire year's business done by Augustin Grignon in 1816 [*sic*]."[46] Ergo, it would seem that in Grignon's day, the fur trade, as then conducted, had become an unreliable source of income: even the American Fur Company—whose papers disclose that on occasion the skins of dogs, groundhogs, and house cats were in the shipments overseas—was forced to suspend payments in 1842.[47]

Whatever Grignon's reasons for turning to the money lenders, on January 14, 1852, he mortgaged the hotel property to one Francis B. Webster of Oshkosh. The sum Grignon obtained was $800; the interest he paid was 12 percent per annum.[48] When the census of 1850 was taken, Webster told the enumerator that he was a liquor dealer by occupation; but when he died in 1860, *The Oshkosh Courier* complimented Webster as having been "a shrewd and successful financial operator."[49] Whether or not the compliment was deserved, Grignon continued to borrow so that by July, 1854, he was obligated for well over six thousand dollars with relatively short due dates.[50] The upshot of it all was that he was unable to clear the slate, and litigation over payments in arrears occurred before he died intestate on October 2, 1860.[51]

Although the census of 1860 showed Grignon to be the owner of real estate worth $20,000 and personal property worth $800,[52] Mrs. Ebenezer Childs stated that her father's finances were largely encumbered. On the ground that Louis Porlier best knew Grignon's business affairs, Mrs. Childs petitioned that he become executor.[53] It followed that in December, 1860, Porlier received the responsibility of settling with the creditors of his late father-in-law.[54] In 1861, the value of all Grignon's worldly goods stood at $15,424.18; and, as Mrs. Childs had stated, her father's debts were nearly as great. But if Augustin Grignon's estate were obligated beyond redemption's cure, the final expenses connected with his journey through life were modest; his funeral costs totaled only $62.00. Forty dollars of that sum went for teams and drivers to Kaukauna and return plus entertaining friends of the family. Burial clothes took five dollars as did the services of a priest. It cost eleven dollars for a coffin and one dollar more to dig a grave.[55]

Pursuing his duty as executor of Grignon's estate, Louis Porlier decided that because of Grignon's heavy indebtedness, all of the property would have to go on the auction block to satisfy his creditors' claims. The courts so ordered on September 16, 1861. Of greatest interest to this discussion, the valuation of the hotel property was fixed at $1,000.[56] A settlement over the hotel did not become final, however, because—among other reasons—a Grignon grandson and heir was serving in the Twenty-First Wisconsin Regiment and so enjoyed immunity from civil actions.[57] But in due course, by sheriff's sale in September, 1866, the hotel went to Gabriel Bouck, an Oshkosh attorney.[58] Bouck retained the tavern property for only a few weeks, and, in November, 1866, sold it for $500 to Louise McCord and Julia Jenney both of whom bore the Grignon name before marriage. Like Gabriel Bouck, Jenney and McCord soon disposed of the hotel. In 1869, they sold it for $450 to Peter C. Peterson, a Norwegian immigrant who arrived at Butte des Morts in the 1850's and had begun to keep a store in the hotel after the expiration of the Petford lease, presumably in 1859.[59] An associate in the venture was Tomms Tonneson, another migrant from Norway. Except for a brief period, 1863-1865, which he spent at Virginia City, Nevada, Peterson kept the store until his death on May 28, 1900.[60]

Like Augustin Grignon, Peter Peterson died intestate. His son Percival became administrator of the estate; in 1901, settlement provided for the real property to go to him and his sister Frances. By land contract, Peterson sold the property to John J. Boe, aged thirty-one and born in Norway. In 1902, Boe married Peter Peterson's fifty-three-year-old widow Bertha, and in 1911 obtained full ownership of the hotel. Boe operated the store in it until his death in 1952. Under the terms of Boe's will, the hotel went to his stepdaughter, Mrs. Frances Donkle.[61] In 1953, she sold the hotel to Emma Ann Strauss (now Mrs. George Nevitt of Oshkosh). After operating an antique store in the building for some years, Mrs. Nevitt gave the old Grignon Hotel to the Winnebago County Archeological and Historical Society. The structure is presently undergoing extensive restoration.

There is a postscript to the story of Augustin Grignon. Until 1941, he and ten members of his family lay in unmarked graves near Butte des Morts. In that year, under the direction of Arthur Kannenberg, archaeologist of the Oshkosh Public Museum, the bones of all were disinterred preparatory to being placed in a crypt at the Grignon Mansion near Kaukauna, Wisconsin. The transfer did not take place however, with the result that for about twenty years the undertaker to whom the bones were consigned kept them in storage. At long last, on October 12, 1961, the remains were buried in an unmarked plot of the Holy Cross Cemetery at Kaukauna. As an associated curiosity, it was alleged that according to family accounts, Augustin's skeleton was identifiable by a gold Cross and chain suspended from the neck. The tale appears, however, to have been confused with a Cross painted in yellow on the lid of his coffin. Indeed, no artifacts were present with Grignon's remains except a button presumed—because of its location among the bones—to have been from his trousers.[62]

Whatever the changes in the ownership of the Grignon Hotel, this paper has attempted to identify its history with that of Augustin Grignon and his times. True, Grignon owned the hotel for a scant eleven years, but during his ownership economic and social institutions in the Fox River Valley had begun to change rapidly and profoundly. In that era Grignon and his kind were finding it increasingly difficult to accommodate their ways to those of a new breed of Wisconsinites who had little regard for the men who had once bargained over furs with the Indians. In essence, the hotel stands as a testimonial to its builder's efforts to bridge the gap between a way of life that had room for persons like himself and a newer way that did not.

Documentation

[1] Mrs. John H. Kinzie, *Wau-Bun The Early Day in the Northwest* (1948 reprint, Menasha, Wisconsin), p. 48 identifies the Grignon family as stated. For the document assigning American citizenship to Grignon, see State Historical Society of Wisconsin, Division of Archives and Manuscripts, Grignon, Lawe, and Porlier Papers, 1820-1822, LXI, pp. 13 and 14, Territory of Michigan, County Court of Michilimackinac, action of July 27, 1820, taken in accordance with "An Act to establish an uniform rule of naturalization. . . ." Hereafter, materials used from the Archives and Manuscripts Division will be cited as A.M.D., S.H.S.W. See also Reuben Gold Thwaites, editor, *Collections of the Statte Historical Society of Wisconsin* (Madison, 1911), XX, pp. 120-121. Cited subsequently as *Collections.* The law closing American Indian trade to non-citizens is available in Richard Peters, Esq., editor, *The Public Statutes at Large of the United States of America, . . .* (Boston, 1848), III, pp. 332-333. Cited subsequently as *U.S. Statutes.*

[2] *Collections,* III, p. 195; IV, p. 102. Draper's interview with Grignon is in *ibid.,* III, pp. 197-295.

[3] For the plat of Butte des Morts, see County of Winnebago, Oshkosh, Wisconsin, Registrar of Deeds, Plat Book #1, pp. 10-11.

[4] Nomination Form, National Register of Historic Places Inventory, Offices of the National Register of Historic Places, Washington, D.C. Cited subsequently as Nomination, National Register.

[5] Information in this paragraph is derived from *ibid.:* and also Martha Wohlford, "Butte des Morts Has Its Place in History of State," in *Oshkosh Daily Northwestern,* July 1, 1969. Hereafter, the *Oshkosh Daily Northwestern* will be cited as *Northwestern.*

[6] A description of the Grand Butte des Morts is available in Winnebago County Courthouse, Zoning Office, Commission of Public Lands Interior

East Field Notes, CLV, p. 70, Township 19 North, Range 16E, D. Giddings, Assistant Surveyor, June 29, 1839. Cited subsequently as Surveyor's Field Notes. See also Journal of the March of the 5th Regiment in June, 1819, from Green Bay to Prairie du Chien, kept by Captain Henry Whiting, General Services Administration, The National Archives, 1949, microfilm in A.M.D., S.H.S.W. In 1887, Louis B. Porlier indicated that the name Butte des Morts was based on the place being "a higher point of land" than customary in the area and that it was "a principal burying place" for Sacs, Fox, and Menominees. See "Narrative by Louis B. Porlier," in *Collections,* XV, pp. 439-444. In 1857, Augustin Grignon stated that certain burial mounds at the Grand Butte des Morts were "ordinary burial places" not connected with any military contest. See Grignon's "Seventy-two years' Recollections in Wisconsin" in *Collections,* III, p. 293. Concerning the burials at Little Butte des Morts (sometimes confused with the Grand Butte) see an essay entitled "Little Butte des Morts, its former appearance," by Charles V. Donaldson, A.M.D., S.H.S.W. Donaldson wrote in 1905 from memories extending back to 1848 or 1849.

[7] *Collections,* XV, pp. 439 and 445-446. Daggett's Creek was formerly called Overton's Creek. For data concerning Porlier's marriage, I am indebted to John Ebert, Archivist, Catholic Diocese, Green Bay. Porlier and Sophia Grignon were married at St. John's Church, Little Chute, Wisconsin.

[8] Beginning on April 29, 1876, Thwaites contributed to the *Oshkosh City Times* a series of articles on the history of Winnebago County in relation to the Centennial observances. Cited subsequently as Thwaites, *Times.*

[9] Surveyor's Field Notes, 1839, maps and pp. 57 and 68.

[10] United States Census, Manuscript, County of Winnebago, 1840, p. 128. The total population of the county in 1840 was 132; hence, the Augustin Grignon household amounted to 6.6 percent of the tally. Hereafter, all census reports of this class will be cited as U.S. Manuscript Census with the appropriate year.

[11] See A.M.D., S.H.S.W., Contract of Grignon and Evans, November 10, 1842, in Grignon, Lawe, Porlier Papers, B, LXV, p. 49.

[12] Thwaites, *Times,* April 29, 1876.

[13] U.S. Manuscript Census, 1850, Winnebago County, Town of Oshkosh, Agriculture, p. 228c.

[14] Concerning Grignon's land entries, see John L. Homer, Statement of Certification, September 1, 1843, in Grignon, Lawe, Porlier Papers, B, LXV, p. 51. See also the National Archives, National Archives and Records Services, General Services Administration (Washington, 1951), Record Group 49, Records of the General Land Office, Local Tract Books Wisconsin, XLV, pp. 169, 176-177, Certificates 2399 and 2455, in A.M.D., S.H.S.W. Cited subsequently as Local Tract Book. Grignon purchased these lands under terms of an "Act Making Further Provision for the Sale of the Public Lands," approved on April 24, 1820. For precise definition of lots and acreages, the writer has used Joseph H. Osborne, compiler and publisher, Sectional Map of the County of Winnebago, State of Wisconsin (Oshkosh, 1855). Descriptions of land under Certificates 2399 and 2455 are also available on microfilm of Book M, pp. 105-106 and 107, Register of Deeds Office, County of Winnebago. Original documents are in storage with the Winnebago County Highway Commission, Oshkosh, Wisconsin.

[15] Grignon made his offer on July 16, 1845; the County Board approved and ordered the land to be surveyed. See A.M.D., S.H.S.W., Winnebago Small Series 1, Clerk, Board Proceedings, 1843-1847, July 16, 31, and Dec. 2, 1845. The survey was done by S. L. Brooks, county surveyor; it locates the site in "Sec. 24 of Township 19, North of Range 16 East." These documents are in the University of Wisconsin-Oshkosh Area Research Center of the State Historical Society of Wisconsin. Cited subsequently as Clerk, Board Proceedings. See also Augustin Grignon Deed to Winnebago County, Wis., December 8, 1845; in Book A, Deeds, pp. 120-121, in the Office of the Register of Deeds, County of Winnebago. The location of the tract in the deed corresponds with Brooks' Survey.

[16] See Charles D. Goff, "War for the Courthouse," in James J. Metz, editor, *Prairie, Pines, and People, Winnebago County in a New Perspective* (Menasha, 1976), pp. 149-154. Cited subsequently as Goff, "War."

[17] Issue of November 23, 1849. Cited subsequently as *Oshkosh Democrat.*

[18] See "Petition of Burr S. Craft and 800 other citizens of Winnebago Co. asking the legislature to pass an act fixing upon the Village of Butte des Morts as a point to be voted upon by the people of the county in reference to the removal and permanent location of the County Seat of said County" in Secretary of State Election and Records, Petitions 1836—1850-1851, A.M.D., S.H.S.W.

[19] *Oshkosh Democrat,* December 7, 1849.

[20] A.M.D., S.H.S.W., "Petition of Burr S. Craft. . . ."

[21] A.M.D., S.H.S.W., Secretary of State Elections and Records Legislative Bills 1836—Assembly Bills 1849-51 no.194(a) A Bill to authorize the Electors of Winnebago Co. to vote on the removal of the

County Seat cites the action taken in the legislature. For the text of the law authorizing the vote, see *Acts and Resolves passed by the Legislature of Wisconsin* (Madison, 1850), p. 138. Cited subsequently as *Wisconsin Laws* with appropriate date and whether general or private and local.

[22] Issues of August 16 and September 27, 1850. The census enumeration of 1850 was then in process.

[23] On April 10, 1850, the *Milwaukee Sentinel* reported that of 1,111 votes cast, the majority in favor of making Oshkosh the permanent county seat was 279; *The Green Bay Advocate* gave the figure as 253. See also Goff, "War."

[24] *Oshkosh Democrat,* January 30, 1852.

[25] An act to incorporate the plank road company was approved early in 1853. See *Wisconsin Laws, Private and Local,* 1853, pp. 155-160. Grignon already had under construction a plank road across the low lying land before Butte des Morts. See *Oshkosh Democrat,* February 21, 1851. The plat of Grignon's addition of 1853 is available in Winnebago County Plat Book #1, p. 52.

[26] *The Milwaukee Sentinel* reported Grignon's appointment on August 10, 1849. Eli Bowen, *The United States Post Office Guide, . . .* (New York, MDCCCLI), p. 71 defines "special" status. Cited subsequently as Bowen, *Post Office Guide.*

[27] For rules defining salaries of postmasters for the period, see *U.S. Statutes,* LX, pp. 147-148, and 202.

[28] Hamilton built a warehouse and dock at Butte des Morts in 1851; see *Oshkosh Democrat,* June 27, 1851. He also served as county treasurer from 1848 to 1849.

[29] Bowen, *Post Office Guide,* p. 149, lists F. F. Hamilton as postmaster at Butte des Morts in 1851, as does *Table of Post Offices in the United States on the First Day of January, 1851, . . .* (Washington, 1851), p. 36. For Grignon's decision to build the hotel, see *History of Northern Wisconsin . . .* (Chicago, 1881), p. 1191. Cited subsequently as *Northern Wisconsin.*

[30] Nomination, National Register; Harry Ellsworth Cole, *Stagecoach and Tavern Tales of the Old Northwest* (Cleveland, 1930), p. 173. Cole quoted entries from "account books kept by the landlords" during 1854 and 1855 showing that "there must have been lively times at Butte des Morts . . ." (See pp. 234-235). Unfortunately these ledgers could not be located. *Northern Wisconsin,* p. 1191.

[31] County of Winnebago, Mortgages, Book N, pp. 14-15. These records are on microfilm: the originals are in storage with the Winnebago County Highway Commission. Cited subsequently as Winnebago County, Mortgages.

[32] *Northwestern,* August 10, 1936; U.S. Manuscript Census, 1850, Winnebago County, p. 162.

[33] This receipt is in the Harry Ellsworth Cole Papers, A.D.M., S.H.S.W.

[34] *Green Bay Advocate,* January 23, 1851.

[35] *Oshkosh Democrat,* January 23, 1852.

[36] *Ibid.,* January 16, 1852.

[37] *Northwestern,* August 10, 1936.

[38] Statement of Daniel M. Seurer, c. February 1, 1981; and verbal communication from Robert Hruska, Oshkosh Public Museum, March 17, 1981.

[39] For Porlier's remarks concerning the Indian trade after 1848, see *Collections,* XV, p. 447.

[40] Charles J. Kappler, *Indian Affairs Laws and Treaties* (Washington, 1904), II, pp. 466 and 499. See also Louise Phelps Kellogg, "The Menominee Treaty of the Cedars, 1836," *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* (1931), XXVI, pp. 127-135. A.D.M., S.H.S.W., Louise Phelps Kellogg Papers, Notes and Transcriptions re Indian Treaties, 1794-1836; transcriptions and translations re social and military Wisconsin, 1805-1848, Box 48, Winnebago Tribe of Indians to Augustin Grignon, Dr., and Baird to Dear Sir [Augustin Grignon], November 28, 1838. Cited subsequently as Kellogg Papers.

[41] For an example, see Affidavit of Francis Lousignon given with "the assistance of a sworn interpreter" on June 22, 1839, in Grignon, Lawe, Porlier Papers, B, LXV, pp. 5-6.

[42] "Narrative by Louis B. Porlier," *Collections,* XV, pp. 441-442.

[43] Kellogg Papers.

[44] *Ibid.*

[45] Thwaites, *Times,* January 27, 1877.

[46] *Northwestern,* August 10, 1936.

[47] Papers of the American Fur Company, shipment from Detroit Department, November 22, 1838; and Shipments to London 1838 August 30; see also Grace Lee Nute, "The Papers of the American Fur Company: A Brief Estimate of Their Significance," in *The American Historical Review* (New York, 1927), XXXII, p. 538.

[48] Winnebago County, Mortgages, Book N, p. 15, Augustin Grignon Mort. to Franc. B. Webster.

[49] U.S. Manuscript Census, 1850, Winnebago County, p. 63; and *Oshkosh Courier,* January 27, 1860.

[50] In addition to the mortgage for $800 dated January 1, 1852, Grignon borrowed $1025 in February, 1852; see Winnebago County, Mortgages, Book N, p. 17; in July, 1852, he borrowed $2475.68, *ibid.,* pp. 403, 404; in 1854, he borrowed

$2188, Book T, p. 320. The Abstract of Title to the hotel property outlines Grignon's record of borrowing: cited subsequently as Abstract.

[51] See Winnebago County Circuit Court, Judgement Rolls, #1657, September term, 1859.

[52] U.S. Manuscript Census, Winnebago County, 1860, p. 161.

[53] Winnebago County, Probate Court, Documents 36 and 4, Augustin Grignon Estate, on microfilm; the original documents are in the possession of the Harry M. Schmitt Abstract Company of Oshkosh. They include Mrs. Child's petition. Cited subsequently as Grignon Estate Papers. A copy of Mrs. Child's petition is also available in Charles A. Grignon Papers, A.M.D., S.H.S.W. It was addressed by Mrs. Child "To the Honorable R. P. Hodges County Judge of Winnebago County, Wisconsin."

[54] Porlier received his appointment on December 3, 1860. See Abstract, sheet number 5; and Grignon Estate Papers.

[55] Grignon Estate Papers.

[56] *Ibid.*

[57] William Frances Raney, *Wisconsin A Story of Progress* (Appleton, Wisconsin, Perrin Press, 1963), p. 163.

[58] Abstract, sheet number 8.

[59] Abstract, sheet number 11. In 1860, Julia Jennie (Jenne or Jenney) lived with her husband in the home of Louisa Grignon, Town of Winneconne, U.S. Manuscript Census, 1860, p. 375. In 1870, Louisa McCord lived at Winneconne Village, see *ibid.*, 1870, II, p. 382. See also *Northwestern*, August 19, 1936.

[60] U.S. Manuscript Census, 1860, Winnebago County, pp. 362 and 129; *Northern Wisconsin*, p. 1191; *Northwestern*, July 1, 1967.

[61] *Northwestern*, August 10, 1936; See also, Abstract, sheet number 29.

[62] "Bones of Early Trader in Valley Are Removed from Unmarked Grave," in *Northwestern*, October 26, 1940; and "Century Old Bones of Grignon Pioneers Reburied Today," *Appleton Post-Crescent*, October 12, 1961. For a convenient reference to the story of the Cross, see *Northwestern*, October 29, 1940, quoting Arthur Kannenberg. The Oshkosh Public Museum's Report of the Excavations of Augustin Grignon, November 2, 1940, details the disinterment operation and the identification of Grignon's remains.

THE SAPROLITE AT THE PRECAMBRIAN-CAMBRIAN CONTACT, IRVINE PARK, CHIPPEWA FALLS, WISCONSIN

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Abstract

The contact between metamorphosed Precambrian rocks and Cambrian sandstones in west-central Wisconsin is a sharp angular unconformity. Weathering of trondhjemite gneiss during the late Precambrian and possibly early Cambrian developed a saprolite that is exposed at Irvine Park, Chippewa Falls, Wisconsin. The saprolite is mainly kaolinite, quartz and chlorite, its minerology suggests that weathering occurred in a tropical climate that developed in the Wisconsin area as the North American continent drifted southward across the paleoequator in the late Precambrian. Weathered materials from the saprolite became part of the detrital material deposited in the basal unit of the upper Cambrian Mt. Simon Formation.

Introduction

In the upper Midwest the contact between metamorphosed Precambrian basement rocks and upper Cambrian sandstone is a sharp angular unconformity. The erosional surface at the top of the Precambrian rocks is an irregular surface that truncates the typically steeply-dipping structural grain of the basement. The basal upper Cambrian sedimentary rocks are subhorizontal conglomeratic to fine-grained sandstones and in west-central Wisconsin are the Mt. Simon Formation. Often at the contact is a clay-rich zone for which the time of formation and origin are questioned. This contact is exposed at several localities in west-central Wisconsin including Irvine Park, in southern Chippewa County, Big Falls County Park in north-central Eau Claire County, the Neillsville area in Clark County and south of Ladysmith in Rusk County.

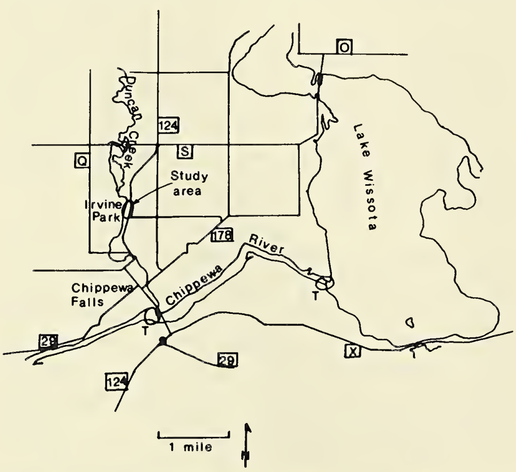

Fig. 1. Map of the Irvine Park study area. T indicates the location of outcrops of trondhjemitic rock at Wissota dam and the dam in Chippewa Falls.

The Precambrian-Cambrian contact and the basal Mt. Simon Formation were studied the Irvine Park (Fig. 1) where they are exposed in the east bank of Duncan Creek. A rock fall during the spring of 1979 provided an excellent unweathered outcrop which instigated this study. The elevations of Precambrian exposures in the immediate area suggest that the Precambrian outcrop at Irvine Park is a topographic high in the basement surface. A zone, at least 2 m and possibly 3.5 m thick, of gray-green, clay-rich material occurs immediately below the contact of the basal Mt. Simon Formation. Approximately 13 m of sandstone are exposed at the site; the lower 5 m and the Precambrian contact are exposed in an unweathered outcrop.

This study was undertaken to 1) determine the mineralogy of the Precambrian basement and the clay-rich zone, as well as the heavy mineral suite of the lower part of the Mt. Simon Formation; and 2) determine the mode and time of formation of the clay-rich zone.

Previous Work

The Precambrian rocks of west-central Wisconsin are strongly deformed amphibolite gneisses and schists, and quartzo-feldspathic gneisses that have been intruded by granitic to tonalitic intrusives. The time of plutonic emplacement relative to regional deformation and metamorphism during a complicated geologic history is reflected in the textures and structures of the intrusives (Myers, 1976, Cummings and Myers, 1978, Cummings, 1975). The amphibolites are considered Archean while the intrusives are of differing ages. Many were intruded during the Proterozoic I Penokean orogeny, *circa* 1850 m.y. (Van Schmus, 1976, 1980).

The lower Paleozoic Mt. Simon Formation was deposited during the Dresbachian stage (late Cambrian). The formation increases in thickness to the south from 100 feet thick in the Chippewa Falls, Wisconsin, area to approximately 800 feet thick in southern Wisconsin (Asthana, 1969). Outcrops of the Mt. Simon Formation occur for at least 50 miles north of Chippewa Falls (e.g. outcrops at Conrath and Ladysmith, Wisconsin). The northernmost outcrops apparently represent the original northern extent of the formation. However, Asthana (1969), on the basis of lithologic characteristics and mineralogical composition, suggested that the Mt. Simon Formation was correlative with the Jacobsville Formation of northern Michigan, part of the Bayfield Group of northern Wisconsin, and the Hinckley-Fond du Lac Formations of Minnesota. Drill core data from central Minnesota indicates that the Mt. Simon Formation is stratigraphically above the Hinckley-Fond du Lac Formation, which, with the Bayfield Group and Jacobsville Formation are believed to be upper Precambrian Formations (Tryhorn and Ojakangas, 1972). However, the absence of fossils in the postulated upper Precambrian sandstones and the lower unit of the Mt. Simon Formation leaves the age question unsettled.

The Mt. Simon Formation is divided into 3 units: the lower of conglomerate to pebbly sandstone, the middle of coarse to medium-grained sandstone and the upper of coarse to very fine-grained sandstone. Fossil fragments and trace fossils are present especially in the upper unit and indicate marine deposition. Trace fossils are the only evidence that the lower and middle Mt. Simon Formation are marine deposits.

The upper Cambrian section in the Mid-continent Region has traditionally been interpreted as sediment deposited during repeated marine encroachments onto the Wisconsin dome. Asthana (1969) interpreted the Mt. Simon Formation as the lowermost formation in a transgressive sequence. The overlying Eau Claire Formation, a fine-grained sandstone to shale, represents the near shore environment.

Byers (1978), citing a lack of recognizable "quiet water" offshore environments, lack of fossil diversity, and exposure indicators, argued that the basal sandstones of the Cambrian sequence were best interpreted as subtidal shelf or tidal-channel deposits. The Eau Claire and Mt. Simon sequence was considered pro-gradational. Driese (1979b), basing his arguements on sedimentary structures and paleontologic evidence, interpreted the Mt. Simon Formation 'as largely pro-gradational, shoaling- and fining-upward tidal sequence." The same sedimentation pattern continued during deposition of the Eau Claire Formation.

The sandstones exposed at Irvine Park are part of the lower and middle units of the Mt. Simon Formation (Driese, 1979a).

Method of Study

Phe Precambrian trondhjemite and clay-rich zone were sampled to represent the gradation from fresh to altered rock. The trondhjemite was studied in thin section and chemically stained to indicate feldspar types. The intensely altered trondhjemite was disaggregated in water and sieved. The coarser fractions were studied under a binocular microscope, the clay fraction was x-rayed and the heavy mineral suite was separated from the fine sand fraction and studied under a petrographic microscope.

Two stratigraphic sections of the Mt. Simon Formation were measured from the basal contact and samples representing the main lithologies were fragmented and sieved. Histograms and cumulative percent curves were constructed from sieve analyses. A Franz-Isodynamic separator was used to separate the heavy minerals from the fine sand fraction. The suites were mounted and studied under a petrographic microscope.

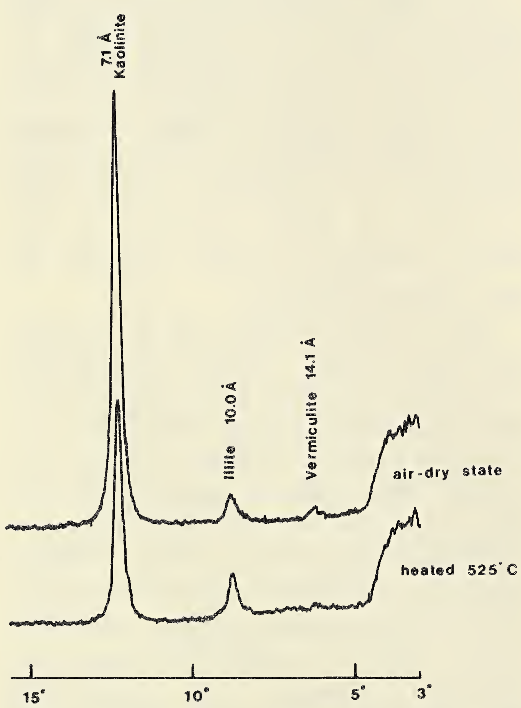

Fig. 2. X-ray diffraction pattern for clays from the Precambrian regolith at Irvine Park. Analyses were provided by S. W. Bailey, University of Wisconsin-Madison.

Description of Units

The basement rock at Irvine Park is medium grained, weakly foliated, reddish-pink trondhjemite. The minerals of the trondhjemite are plagioclase, quartz, and biotite. Zircon and ilmenite are accessory. Similar trondhjemite rocks crop out at dams on the Chippewa River at Lake Wissota and Chip-

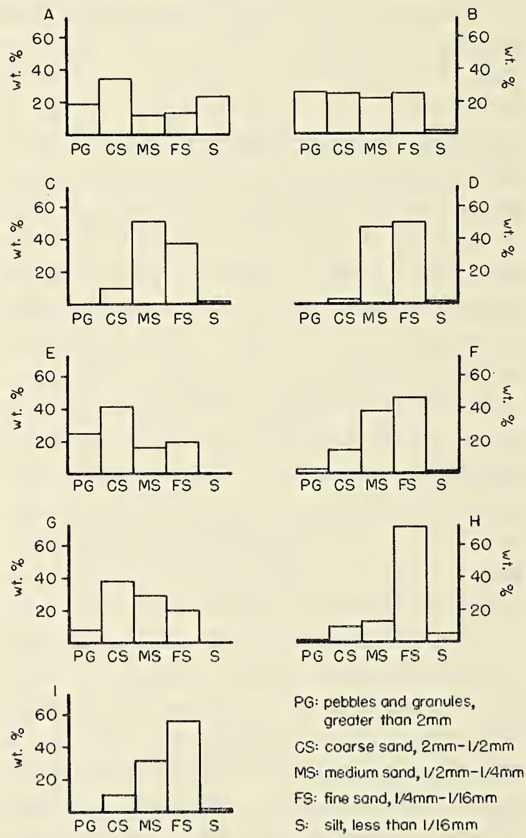

Fig. 3. Histograms of the Mt. Simon Formation and weathered trondhjemite at Irvine Park. A) Weathered trondhjemite, B) Subunit 1, sample 1, C) Subunit 1, sample 3, D) Subunit 2, sample 4, E) Subunit 3, sample 6, F) Subunit 3, sample 7, G) Subunit 4, sample 15, H) Subunit 4, sample 19, I) Subunit 5, sample 18.

pewa Falls (Fig. 1), but the relation among the outcrops is not certain.

The fresh trondhjemite becomes increasingly altered to clay minerals as the contact with the overlying sandstone is approached. At the contact the minerals of the altered rock are chiefly quartz, clay minerals and chlorite. Strongly altered plagioclase, ilmenite and zircon are accessory minerals. Biotite in the trondhjemite apparently is altered to chlorite and plagioclase mainly to clay minerals. Clay minerals separated from the zone were analyzed by x-ray diffraction: 80-90% of the clay is kaolinite while the remaining 10-20% is illite and vermiculite (Fig. 2). The altered trondhjemite is soft and upon drying can be disaggregated and sieved (Fig. 3). Examination of the various size fractions indicate that grains greater than 1.0 mm are composites of quartz and plagioclase. The composite grains are as small as 0.59 mm but are absent in finer size fractions. Although the alteration of the trondhjemite is extreme, metamorphic textures of gniess are preserved in the clay-rich zone to the contact; a paleosol has not been observed.

Locally the altered material has been exposed to recent weathering and is maroon-red rather than the usual gray-green. The color of the clay-rich zone results primarily from the chlorite. Upon weathering hematite becomes concentrated as red spots in the chlorite producing the maroon-red color of the zone.

The lower unit and lower 3 m of the middle unit of the Mt. Simon Formation are exposed at Irvine Park. The lower unit is divided into 4 subunits (Fig. 4). The subunits are generally similar to the sequences defined at the park by Driese (1979a). The reader is directed to the work of Driese who provides a thorough and extensive description of the lithologic units. This report presents information obtained from recent slumps that was not available to earlier authors.

The lowermost subunit contains interbedded and cross-bedded conglomerate, conglomeratic sandstone and fine to medium sandstone (Fig. 3, Table 1). The subunit unconformably overlies the irregular surface at the top of the clay-rich zone. Quartz clasts up to 7 cm long occur immediately above the basal contact. These clasts represent vein quartz that has weathered from the Precambrian basement. Sandstones at the contact, which are generally conglomeratic, are locally fine-grained and greenish clay occurs locally on cross-bed surfaces and discontinuous thin partings on the bedding planes. Cross-beds are poorly developed. The composition of the heavy mineral suites of two samples from the subunit was determined (Table 2). In sample 10, immediately above the contact, 20-30% of the heavy

TABLE 1. Mean diameters and sorting coefficients for the Mt. Simon Formation and regolith at Irvine Park, Chippewa Falls, Wisconsin. Units are listed in order of decreasing stratigraphic position.

Mt. Simon Formation	*Mean Diameter (mm)*	*Sorting Coefficient*	*Sample Number*
Subunit 5— Middle Unit	0.25	2.30	18
Subunit 4— Lower Unit	0.39	2.27	17
	0.55	3.93	16
	0.20	1.81	19
	0.64	4.54	15
Subunit 3	0.30	2.26	7
	0.24	2.18	20
	1.30	2.77	6
Subunit 2	0.27	1.32	5
	0.30	1.79	21
	0.28	1.27	4
Subunit 1	0.35	1.51	3
	0.73	3.58	1
	0.66	2.96	9
	0.83	3.21	10
Regolith Altered trondhjemite	0.85	21.25	8

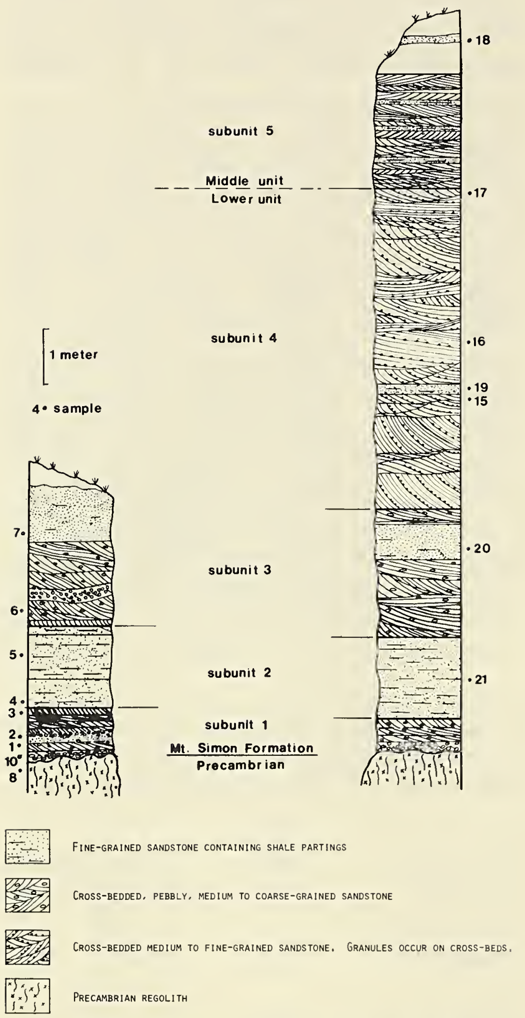

Fig. 4. Stratigraphic columns for the Mt. Simon Formation at Irvine Park, Chippewa Falls, Wisconsin. The left column (no. 1 in text) was prepared from an area of recent rock falls.

mineral suite is green chlorite, however, in sample 1, 0.5 m above the contact, chlorite is present in trace amounts. Altered grains of plagioclase are common to both samples.

The second subunit is well-sorted fine to medium sandstone (Fig. 3, Table 1) with parting lineation and low angle cross-lamination present. The top of the subunit in column 1 (Fig. 4) is marked by a mudstone bed up to 10 cm thick. The bed extends laterally only 5 m because at both ends it is erosionally truncated by a prominent cross-bedded bed 15 cm thick that defines the base of the third subunit. The top of the mudstone bed contains polygonal cracks believed to be dessication cracks, suggesting subaerial exposure of the bed before it was partially eroded. The top of the second subunit is also the top of an upward fining sequence from the bottom of subunit 1 at the basal contact of the formation (Table 1).

The base of the third subunit is marked by prominent through-set cross-bedding. Clasts of shale from the top of the underlying mudstone bed occur in the lowest beds of the third subunit in the area of column 1 (Fig. 4). The base of the subunit is much coarser and more poorly sorted (Table 1) than underlying subunit 2. The subunit contains medium to coarse-grained sand and granules which commonly occur on cross-bed surfaces. Interbedding of fine-grained and medium to coarse-grained sandstones is a common feature of subunits 3 and 4 (Table 1).

Table 2. Heavy minerals from the Precambrian regolith and the Mt. Simon Formation at Irvine Park, Chippewa Falls, Wisconsin. Minerals are listed in order of decreasing relative abundance.

Regolith	*Minerals are Mt. Simon Formation*		
Sample 8 chlorite (green)	Subunit 1 Sample 10	Subunit 1 Sample 1	Subunit 4 Sample 17
ilmenite	ilmenite	ilmenite	ilmenite
zircon	tourmaline	tourmaline	tourmaline
tourmaline	epidote	epidote	zircon
	chlorite (green)	zircon	garnet
	zircon	garnet	epidote
	garnet		chlorite (red-green)

The fourth subunit is characterized by large-scale tabular cross beds. Granules of quartz occur on cross-bed surfaces in medium to coarse-grained sandstone. In general this subunit has the greatest variability in sorting. Small amounts of reddish-green chlorite flakes occur in the heavy mineral suite of sample 17 (Table 2), approximately 9.5 m above the basal contact. Tourmaline, zircon and ilmenite are also present. The uppermost subunit defines a receding slope underlain by medium to fine-grained friable sandstone. The sandstone is locally finely cross-laminated. The fifth subunit of this study is the lowermost exposure of the middle unit of the Mt. Simon Formation.

Interpretation

This study is concerned with the time of formation and origin of the clay-rich zone at the Precambrian-Cambrian contact. The angular unconformity between the Precambrian basement and the Mt. Simon Formation represents a time gap of several hundred million years in the geologic record of west-central Wisconsin. During this time the clay-rich layer at the contact developed either 1) by sedimentation, 2) by *in situ* chemical weathering of the basement during the late Precambrian or 3) by ground-water leaching after deposition of the Mt. Simon Formation.

We believe that the upward gradation from fresh trondhjemite to clay-rich material which preserves relic gneissic fabric precludes formation of the deposits by sedimentation during the late Precambrian.

Ground water seepage along the Precambrian-Cambrian contact is commonly observed in west-central Wisconsin. As water percolates down through the sandstone and migrates laterally, seeps develop along valleys that have been cut into the Precambrian basement. Such interaction between ground water and the basement rock could have leached and altered the Precambrian material after the Mt. Simon Formation was deposited. The fabric of the basement rock would be preserved under these conditions. Examples of saprolitization occurring beneath cover have been described by Carroll (1969). The saprolite develops if water percolates down through the overlying material and the covering material protects the developing saprolite from erosion.

Saprolites formed by Pre-Cretaceous weathering and characterized by excellent preservation of primary structures in Precambrian gneiss are recorded in the Minnesota River Valley (Goldich, 1938). Actually two extended periods of weathering are recorded in the Paleozoic-Mesozoic stratigraphy of Minnesota. The older occurs between the Precambrian basement and the Cambrian Mt. Simon Formation; the younger developed prior to deposition of the Cretaceous system. The clay-rich zone at Irvine Park is in the same relative stratigraphic position as the older saprolites in Minnesota, suggesting a similar origin.

If weathering in the late Precambrian formed the clay-rich zone, one would expect weathering products to occur in the Mt. Simon Formation. Two approaches to the problem were pursued: 1) comparison of the grain sizes of materials collected from the clay-rich zone and from the Mt. Simon Formation, 2) comparison of the heavy mineral suites of the materials.

The clay and silt sizes prominent in the clay-rich zone are not present or are present in small amounts in the sandstone (Fig. 3). Also the composite grains commonly observed in the sand-sized fractions from the clay-rich zone are not observed in the sandstone. However, the silt size fractions of both units contain altered plagioclase grains. The silt and clay size fractions from the clay zone were apparently winnowed from the sediment and the composite grains of plagioclase and quartz were destroyed during deposition of the sandstone. However, the altered plagioclase grains suggest a link between the two units.

The composition of the heavy mineral suites from the sandstone is more diverse than from the clay zone (Table 2). Garnet and epidote in the sandstone are possibly derived from locally occurring garnet amphibolites. Zircon, ilmenite and tourmaline are found in all suites. Zircons from the clay zone are zoned as are zircons from the basal sandstone, but the zircons occur in a coarser size-fraction (0.125 – 0.250 mm fraction) in the clay zone than in the sandstone (most occur in 0.062 – 0.125 mm, a few in 0.125 – 0.250 mm fractions). The difference in size does not allow a clear determination of local provenance for zircon in the sandstone but such a suggestion is not negated.

The best diagnostic mineral in the heavy mineral suites is chlorite. Chlorite is the primary heavy mineral in the clay zone (sample 8), occurring as thin, pale to medium green flakes of uniform color. Chlorite of the same physical appearance comprises 20-30% of the heavy mineral suite in sample 10 immediately above the contact. Chlorite flakes are rare 0.5 m above the contact and are present in small amounts in sample 17 approximately 9.5 m above the contact. The chlorites from sample 17 are more reddish-green than in sample 10, possibly indicating post-depositional oxidation. The chlorite flakes in the basal Mt. Simon Formation strongly suggest that the clay-rich zone provided weathered sediment to the Mt. Simon Formation and that the clay-rich zone is a saprolite that formed before the deposition of the Mt. Simon Formation.

The excellent unweathered exposures of the basal Mt. Simon Formation that were developed for a brief time at Irvine Park contain discontinuous clay partings and clay occurs interstitially to sand grains on cross-beds and bedding planes. These features are not visible on weathered outcrop surfaces. Such features occur mainly in the lower two subunits of the Mt. Simon Formation. The clays may have been derived from the clay zone, however available data does not confirm this interpretation.

If the clay zone developed by weathering during the late Precambrian, what were the conditions of weathering? The formation of clay minerals is a function of temperature, precipitation, topography, drainage and parent material (Loughnan, 1969). Kaolinite, illite and vermiculite are the clay minerals at the top of the weathering profile at Irvine Park. Kaolinite, the main clay mineral, can be formed by weathering of any aluminum silicate material by leaching of K^+, Na^+, Ca^{2+}, Mg^{2+}, and Fe^{2+} provided H^+ is added. The general conditions require precipitation greater than evaporation, permeable rock, percolating fresh water and oxidation of Fe^{2+} (Keller, 1970). The associated illite and vermiculite can be derived from weathering of micas and chlorite under the same conditions. The clay minerals from the regolith in the Minnesota River Valley indicate illite is the main clay deeper in the regolith and kaolinite is the main clay in the upper regolith (Morey, 1972). The sampling at Irvine Park was confined to the upper 0.2 m of the regolith so a similar pattern is not documented.

Paleomagnetic data indicate that western Wisconsin was equatorial during the late Precambrian. The paleoequator passed through Central Wisconsin in the Eocambrian (700 m.y. Dott and Batten, 1971) and by the late Cambrian Wisconsin was approximately 15° south latitude (Irving, 1964). Equatorial climates include humid tropical or tropical savanna; either would meet the requirements to produce kaolin-rich clay deposits such as those found in the saprolites of this period.

The weathering of the Precambrian rocks in west-central Wisconsin during the late Precambrian occurred under a humid tropical climate as the mid-continent region drifted southward from the equator. (Reconstructions based on the present configuration of the continents show the paleoequator north and south during the Precambrian so that the North American continent appears to have migrated from east to west during the Cambrian.) The tropical weathering conditions formed saprolites from Wisconsin into central and western Minnesota. The extent of the saprolites formed during the same weathering period in the mid-continent region is not known.

Conclusions

The exposures of the Precambrian-Cambrian contact and the lower unit of the Mt. Simon Formation at Irvine Park suggest the following conclusions.

1) The Precambrian trondhjemite was weathered to form a kaolinite-rich saprolite prior to deposition of the Mt. Simon Formation. Clastic materials from a saprolite were deposited in the basal Mt. Simon Formation.

2) Weathering to form a saprolite was controlled by a humid tropical climate that developed as the mid-continent region drifted southward during the late Precambrian.

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References Cited

Asthana, V. L. 1969. The Mt. Simon Formation (Dresbachian Stage) of Wisconsin. Ph.D. dissertation, Univ. of Wisconsin-Madison.

Byers, C. W. 1978. Enigmas in Wisconsin Cambrian and new depositional model for type St. Croixan (abs.). Amer. Assoc. of Petr. Geol. Bull. 62:502.

Carroll, D. 1969. Rock weathering. Plenum Press, New York. 200 pp.

Cummings, M. L. 1975. Structure and Petrology of Precambrian amphibolites, Big Falls County Park, Eau Claire County, Wisconsin (abs.). 21st Ann. Inst. on Lake Superior Geology.

Cummings, M. L., and Myers, P. E. 1978. Petrology and geochemistry of amphibolites, Eau Claire River, Eau Claire County, Wisconsin (abs.). 24th Ann. Inst. on Lake Superior Geology.

Dott, R. H., Jr., and R. L. Batten. 1971. Evolution of the Earth. McGraw-Hill, New York. 620 pp.

Driese, S. G. 1979a. Paleoenvironments of the upper Cambrian Mt. Simon Formation in Western and West-central Wisconsin. M.S. Thesis, Univ. of Wisconsin-Madison. 207 pp.

Driese, S. G. 1979b. Depositional Environment of the Upper Cambrian Mt. Simon Sandstone in Western Wisconsin (abs.). North-central Section of the Geol. Soc. of Amer. 11(5):228.

Goldich, S. S. 1938. A study of rock weathering. J. of Geology. 46:17-58.

Irving, E. 1964. Paleomagnetism and its application to geological and geophysical problems. John Wiley and Sons, New York. 384 pp.

Keller, W. D. 1970. Environmental aspects of clay minerals. J. of Sedimentary Petrology. 40:788-813.

Loughnan, F. C. 1969. Chemical weathering of the silicate minerals. American Elsevier, New York. 142 pp.

Morey, G. B. 1972. Pre-Mt. Simon Regolith, *in* Geology of Minnesota: A Centennial Volume, pp. 506-508.

Myers, P. E. 1974. Precambrian geology. Guidebook, 38th Annual Tri-state Geological Field Conference.

Tryhorn, A. K., and Ojakangas, R. W. 1972. Sedimentation and Petrology of the Upper Precambrian Hinckley Sandstone of East-Central Minnesota, *in* Geology of Minnesota: A Centennial Volume, pp. 431-435.

Van Schmus, R. W. 1976. Early and Middle Proterozoic History of the Great Lakes Area, North America. Philos. Trans. of the Royal Society of London. 280:605-628.

Van Schmus, R. W. 1980. Chronology of igneous rocks associated with the Penokean orogeny in Wisconsin, *in* Selected Studies of Archean Gneisses and Lower Proterozoic Rocks, Southern Canadian Shield, ed. Morey, G. B., and Hanson, G. N. Special Paper 182, Geol. Soc. of Amer. pp. 159-168.

VERBAL NONVERBAL COMMUNICATIONS AND RELATED DEVELOPMENTS IN THE DRUM DANCE RELIGION

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The Native American Drum Dance religion probably originated among the Sioux, according to my Menominie informants, and was brought to the Menominies by the Chippewas. It has been practiced among the Menominies for at least three generations and perhaps much longer. It centers on a sacred drum, or drums, which carry the petitioners' prayers to God. The present followers of the Drum Dance religion constitute a very small group with a principal center of population in Zoar, Wisconsin. This settlement is the northernmost of the three major communities located on the Menominie Reservation in the northeastern part of the state.

The greater portion of this religious community is made up of people who prefer to retain a more traditional life style than do the Menominie of the other two communities, Neopit and Keshena. Possibly as a result, this northern community has remained quite isolated, maintaining its detachment from the outside world to the extent of refusing to have telephones within the settlement.[1] Because of such isolationist practices, the people of Zoar are regarded by the other two Menominie communities as backward and pagan.[2]

The purpose of this paper is to examine closely those current internal and external factors that are important to both the success and future of the ritual process of the Drum Dance religion among the people of Zoar. I shall concentrate on the various forms and levels of communication within the ceremony as they are experienced by an apprentice ceremonial leader. Finally, I shall speculate on the direction that this native religion may take in the near future.

Ideally the people of Zoar would prefer to keep religious membership within a single tribe. However, there are too few of their own people to carry out ritual acts related to the specific Drums that form the focal point of their religious ceremony: For them to have a full service, they must rely on help from followers of the same religion who belong to other tribes. Therefore Chippewa, Potowatomie, and Winnebago attend Menominie ceremonies, and in turn, the Menominie reciprocate by helping any of the other groups with their ceremonies in the northwestern part of the state. Furthermore, Kansas Potowatomie and Kickapoo adherents of the same religion (with slight variants) make special trips to Wisconsin to serve as supporters for the Wisconsin groups. These Wisconsin people and religious groups from the Plains and Southwest also invite Canadian Indians, as well as Wisconsin Indians from other religions, to their major seasonal ceremonies. One sees the greatest mixture of people from different tribes when a specific rite is to be conducted at a ceremony such as the installation (initiation) of a member who will be assigned to a vacant station on a specific Dream Drum. The other major occasion calling for a confluence of members from different tribes is the death of one of the main ceremonial members.

Thus the religious ceremonies held by the Drum Dance people have become intertribal, creating the necessity for intergroup relations as well as for contact with outside tribal groups and native religions. However, it is important to realize that even though all these people practice the same native religion, each group retains certain nuances particular to its life style and world view.

The oral tradition, is basic to the structure of the ritual process. The oral aspect of the Drum Dance ceremony is thus significantly affected when a mixed tribal ceremony takes place, for traditional oral presentations have a tendency to create both a communications barrier and animosity between local people and visiting members of a different tribe who do not speak or understand one another's language. The lack of a common language is not troublesome when a ceremonial leader prays in his native tongue. The acceptance of this practice lies in the old Indian belief that it is very important for one to pray in his own language because the Creator gave all peoples on this earth their own language so they might address him very specifically in their prayers. Therefore, members of all Indian religious societies recognize that each tribe must pray in its native tongue.

Problems arise, however, when leaders deliver advisory speeches (as opposed to prayers) in their native language. Although almost all of the participants understand English, anyone who delivered a speech or prayers in that language would be reprimanded by older traditionalists (a good example of the power of tradition).

The rigors of comprehending and adjusting to levels of communication, and to various other nuances that occur in such a complex ceremony, can best be viewed by following the instruction of an apprentice ceremonial leader. One of his first lessons is to learn the prescribed order in which speeches are presented in the ritual process, such as the designated points in the ceremonial structure when chiefs are expected to speak. The prescribed times for such speeches are as follows: 1) When the Drum Chief calls upon either one of the sub-chiefs, or when another Drum Chief whom he knows presents an eloquent and spontaneous speech to the group; 2) when a chief assistant is called upon by the main Drum Chief to speak to the congregation (each can expect to be called on at any time during the ritual); and 3) when the Chief, the assistants, or any other member of the congregation requests the floor for the purpose of addressing either a religious or secular issue. These impromptu speeches may be directed to the whole congregation or only to specific members within that ceremony. There are occasions when a ceremonial leader will arise to rebuke an inappropriate ritual act or some deviant behavior which has occurred within the prescribed ritual. When something of that kind occurs the ceremonial leader will not call attention to the deviant act at the time it takes place. In accordance wih prescribed ritual order, he will wait until the appropriate time to do so—one of the times when Chiefs are expected to speak. Furthermore, instead of addressing the person or persons who broke the ritual, the ceremonial leader will direct his reprimand to the entire congregation. This tactic achieves its point but does not directly embarrass the offender. It is also important to note the prescribed manner in which the floor is obtained by ceremonial leaders. In lieu of a verbal request, the speaker simply rises, steps out toward the middle of the floor, and begins his address. The apprentice as well as the congregation is well aware of the meaning of this act, for upon seeing this movement they know that the individual has an important statement to convey to the membership. In other words, the speaker utilizes both body language and group cultural space as a mechanism to show that he has something important to say to the congregation. The members in turn recognize the meaning of this particular ritualistic act. Should it happen that a member does not respond to this symbolic act, it is the duty of one of the sub-chiefs, the one closest to the individual, to call tactfully for his attention.

As the apprentice becomes better acquainted with the ceremony, he acquires the ability to discern when an orator is presenting a religious prayer rather than a secular speech. The interaction between the speaker and the participants, as well as within the group, is different in each case. When a speaker is praying or addressing the congregation with regard to religious matters, movement within the congregation is stilled. Mothers and fathers, relatives, and friends do their best to quiet a crying baby. If this is not possible, someone will take the child out of the ceremonial area. In addition, the caretaker who is seated by the eastern entrance, which is his ceremonial station, sees to it that any young child, adolescent, or adult who may be moving around or talking, restrains himself. These restrictive measures are instituted so that the congregation may hear what the orator is saying. The attention given to the speakers is very noticeable, for the congregation becomes a captive audience. Body movements and behavior are so contained when someone is praying that there is almost a dead silence, unlike the atmosphere during a secular speech. A deep reverence is felt among the communicants during the time a religious prayer is offered.

All the speeches in a Drum Dance ceremony are related to religious matters, but there is a distinct difference evident between those of a very sacred nature, and those which lean more toward secular, everyday life. During the latter babies are allowed to cry, and the children, even though they are discouraged from doing so, are permitted to move about a bit. In this atmosphere, communicants may, if necessary, speak to each other even during a speech.

The apprentice ceremonial leader must learn that two types of orators are sanctioned within the Drum Dance religion. One memorizes his material and the other is a spontaneous orator. The communicants differentiate clearly between the two types. For example, those speakers who memorize the sayings and teachings of old ceremonial leaders are considered "long-winded." Because they have memorized what should be said during each particular occasion of the rituals, they are thought of as men who speak from the head. More highly revered speakers "speak from their heart and not their head." They do not memorize their prayers. When these religious leaders recite the teachings of the older people they do so in their own words while maintaining the general sense of what the old people have said. Such orators adapt the teachings and prayers of the older generation to meet current problems. As part of his education the apprentice learns that members of his religious society feel that the man who speaks from the heart is not only more sincere, but, in a sense, is holier, because he is inspired by the needs of the congregation and by his helpers such as the Thunderbirds.

The problems of communication become acute for an initiate who does not understand the language of a particular native speaker, either because he has not learned his own native tongue or because he is from a different tribe. He may overcome this handicap by learning to read and understand the gestures of the native speaker as well as the responding proximic behavior of the comcunicants and older ceremonial leaders. The apprentice learns to recognize the symbolic signs such as body language and the various sounds that are used by the congregation to sanction or disapprove of a ritual act. He is also expected to realize the importance of dance in the ritual.

Part of this instruction is carried out by participating in the religious dances which form a significant part of the ritual. He must recognize the meaning of symbols which announce an upcoming event in the ceremony. For example, if there is going to be a Belt Dance he must learn to recognize the signs which will announce its occurrence: the Belt Dance Song must be played four times on the second night of the four-day ceremony. If the Song is not sung four times there will be no Belt Dance on Saturday, the third day. Members of the congregation also recognize this symbolic language. They rely on and thus listen for such signs as the Belt Song. No one announces or asks if there will be a Belt Dance. The songs carry this message. The apprentice must also know when it is appropriate only for men to dance and when women are permitted to dance, as in a secular ceremony. He must learn that, with few exceptions, only men may dance during the first three days and nights of a four-day-and-night major seasonal religious ceremony. Women are allowed to dance only when their song is sung during a religious ceremony or during a Squaw Dance or a Chief's Dance. During the sacred Belt Dance which takes place on the third day he sees that great caution is taken that no child runs loose or falls for such an event might prestate a future tragedy.

The apprentice must also recognize the symbolic meaning of a feather which falls from a sacred Belt (there are generally two Eagle feather Belts in a Belt Dance). Feathers used in the Drum Dance ceremony are considered sacred; they are also symbols of power. In earlier times in most Indian societies, as today among the more traditional groups, different feathers signified different powers, such as those obtained through spiritual contemplation in a vision quest. Warriors were the only ones who could wear eagle feathers. Only a warrior had the power to pick up a power object such as a feather. This belief and practice is still maintained in the Drum Dance religion. Thus, only a war veteran or the close male relative of a deceased war veteran can pick up a fallen feather. For an apprentice to learn all of these rules and regulations he must be present and participate actively in the ritual process of both sacred and secular ceremonies.

After the apprentice learns the basic structure of the ritual he begins to achieve a higher level of awareness. He functions within a nonverbal communication system which binds the orator and the group.[3] He comes to realize that there are some aspects of the Drum Dance ceremony that are so spiritually related to his education that they can be apprehended only in a state of total immersion. He must let the ritual speak to him and for him, must lose his own sense of immediate identity in an essentially mystical unity with the group.

The complexity of the communications problems experienced by the apprentice is difficult for non-Indians to understand. The closest analogy in Western society may be the traditional Roman Catholic ritual (prior to the 1960's) that members of an American congregation might not understand because the Mass was conducted in Latin. In this situation, however, Catholics could rely upon written translations, for they had hand missals designed to aid them in following the liturgy. Within the oral tradition of the Drum Dance religion, however, there is no missal. In these ceremonies the people basically rely on their faith, their knowledge of the order of the ritual process and the body language of the speaker.[4] These people adhere so tenaciously to their traditional ways that, unlike the members of the inter-tribal Native American Church who use English to convey an advisory message or to relate the subject of a prayer, the people of the Drum Dance religion cling to their native speech. This is not to say that communicants in the Drum Dance religion never converse with each other in English after a ceremony. However, when they speak English they carefully refrain from discussing religious experiences connected with their ceremonies, making a point of keeping their conversation within a social context.

After being intensely involved in an electrifying religious experience which lasts four days and four nights the initiate inevitably feels a sense of anticlimax when the ceremony ends. Half a dozen ceremonial apprentices have described their emotional state in interviews.[5] To his dismay, he realizes that he has lost sight of many of the significant rites which had taken place within the ritual. Not only does he experience a sense of emptiness and exhaustion, but he also finds himself questioning what he had, in reality, learned from his first experiences as a ceremonial apprentice. He also recognizes the possibility that perhaps he is just temporarily disillusioned because of the overwhelming effect of what he has experienced. He further rationalizes that, by going through such a traumatic experience, he actually may have learned more than he consciously realized during particular periods in the ceremony. As he sums up these experiences he is aware that he has been deeply affected by all the energy forces released in the ceremony, especially those rites that rely on subtle means of non-verbal communication. He realizes that the role of an apprentice is much more psychologically taxing than being a member of the congregation. To add to his state of confusion and frustration, the priestly elder who had been working with him throughout the ceremony asks him if he has learned anything. After hesitating for a moment or two while rhetorically asking himself "What can I say?" he confesses that he feels he is not really sure that he can say what he has actually perceived in his first experience as novice ceremonial leader. At the same time he assures his teacher that he has undergone an intense metaphysical and physical experience. Finally, he summarizes his total experience in one dramatic statement: that both physically and mentally he experienced the feeling of being in a vacuum—he had a sense of abandonment and helplessness—even though he was among his own people.

After hearing the apprentice speak of his first experiences, members of the veteran priestly class lift his depressed spirits simply by smiling and saying that the next time will be better. By this they mean that the more the apprentice participates in the ceremony, the more he will know when specific rites should take place during the ritual process and the more acutely he will perceive all the nuances inherent in them. The communication medium is participation and experience.

After several years of learning his new role, the apprentice assistant leader realizes the significance of being keenly in tune with the physical behavior of the communicants. In time, he learns the importance of being aware of the congregation's kinesics as a vital element interrelated with the oral communication process.[6] He knows what is taking place between the speaker as narrator and actor as well as what simultaneous symbolic interactions and metaphysical phenomenon are taking place for narrator, audience, and other ceremonial assistants.

There are indications, however, that the education of an apprentice may be made slightly easier in the future. In the past few years, a number of older orators have responded in an interesting way to the language problem. They have begun to break with the old tradition of presenting their speeches entirely in an Indian language. To reach out to the younger members of the tribes these orators are moving toward the use of English as a *lingua franca*. They preface speeches they deliver in their native tongue by using one or two explanatory phrases in English. A few older members of the Drum Dance religion have stated that they realize the reason so many of their younger members, the below-thirty age group, do not speak an Indian language is because many of them are sons and daughters of tribally mixed marriages. In such cases the parents who speak their own tribal language as well as English but do not understand each other's language use English in the home. Ironically, in this situation most of the children do not learn either of the Indian languages and thus grow up knowing only English. To further complicate the problem, some of the younger members are offspring of an Indian and a non-Indian parent. Such children usually hear only English spoken in their homes. Other youths are not able to learn an Indian language because they live in cities where Indian languages are seldom spoken in the schools or in the working milieu of the parents. In few cases does an adolescent in his late teens, and out of school, have the opportunity to live and work in a rural Indian atmosphere and thus, in time, learn the Indian language of a particular community.[7]

From a traditional point of view the older people would prefer to have their prayers and speeches presented in an Indian language. However, as a result of the environmental and sociocultural factors involved, the majority of native orators may one day use English, even for their ceremonial speeches, thus significantly altering current practice.

In addition to changes designed to solve the language problem, other changes can be noted in those impromptu religious speeches that are presented by orators who "speak from the heart." These leaders, as well as members of the lay congregation, are moving away from the older custom of preaching and responding to a way of life related to an older tradition. This does not mean that they do not respect the customs of the older members of the church, but rather that, as younger religious leaders, they realize that they must communicate with God according to the current needs of their religious society. They realize that the older church people led a more placid and stable way of life in which there were fewer stressful encounters with either whites or Indian people of different tribes. These leaders are also aware that their young people face totally different encounters in Western-oriented society: young people often find themselves in a world of rapid change that has created a different set of needs than those expected in the old days. There are leaders in the Drum Dance religion who would like to maintain and revitalize some of the older traditional ways of life, although they must use discretion in stressing such things in prayers that must also be relevant to the younger generation. They know that what their elders taught often is no longer directly applicable to everyday life. In response to such internal and external pressures, their speeches have become more complex, and are often more eloquent than earlier narratives. Such orations deal with sociocultural factors—for example, change within the group—as well as providing church members with spiritual support to aid them in their adaptation to the pressures of the dominant Anglo-American society. Modifications of the ceremony are also made to accommodate people of different tribal backgrounds who may have different world views. All these factors will have a significant effect upon the communication process in the Drum Dance religion as it is now practiced among the people of Zoar.

Notations

[1] This is not to say that they do not have any contact with the outside world, for I do not know of any Indian reservation in the Northern Hemisphere which has not been exposed to and affected by the ways of Western society. The Zoar community, in fact, is comparable to those communities which make up the major populated sections of the Hopi Reservation.

[2] This particular point of inter-group reference may be the result of the influence and impact that Christianity has had upon the people in the southernmost Menominie settlements. It is safe to state that the greater portion of the population within Neopit and Keshena have acquired the beliefs and values of the Western world of Christianity. In contrast it is important to note that the Zoar people, even though being exposed to great pressures from the outside world, from their counterparts, continue to maintain and practice many of the old traditional ways of life.

[3] See Edward T. Hall's *The Hidden Dimension* for a discussion of proximic behavior.

[4] The repetition of the ritual reaffirms their faith and helps to maintain the religious values within

the society. For further reference to a major study on this type of phenomenon, see Victor Turner's *Ritual Process.*

[5] Wallace Pyawasit, 60, Potowatomie-Menomonie
Johnson Awonahopay, 63, Potowatomie-Menomonie
Jerry Hawpetoss, 27, Potowatomie-Menomonie
Littie Dixon, 41, Cherokee
Irene Mack, 65, Menomonie
Max Dixon, 43, Menomonie
Kevin Dixon, 20, Menomonie-Cherokee

Wallace Pyawasit and Johnson Awonahopay are ceremonial leaders, Jerry Hawpetoss and Max Dixon are sub-leaders, and the others are apprentices. It is important to note that there is no set age at which a person becomes a ritual apprentice. These interviews were done in 1976-77.

[6] See Ray Birdwhistell's *Kinesics and Context; Essays on Body Motion Communication* for the kinesics theory.

[7] It is important to note that this language problem is now being addressed by the University of Wisconsin at Oshkosh, Green Bay, and Milwaukee as well as Northland College in Ashland, Wisconsin. These institutions offer Indian language programs which are geared to help older native speakers learn how to teach their native language. In turn, it is expected that these people will obtain positions in public schools which have Indian students and teach these young people the language of their heritage. It is too early to predict whether or not these programs will affect the direction the ceremonial speeches will take in the Drum Dance religion in comparison to their current presentation in a native language.

IS THE *CHRISTOS PASCHON* THE PROTOTYPE OF CHRISTIAN RELIGIOUS DRAMA?

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In his *Essai sur les Moers et L'Espirit des Nations,* Voltaire states his belief that Christian religious drama was originated by Gregorio Nazianzeno, the 4th century bishop who served briefly as patriarch of Constantinople.[1] Since the only drama attributed to Gregorio Nazianzeno is the *Christos Paschon,* we may conclude that Voltaire based his remarks on his familiarity with this play, which has come down to us through a 12th century manuscript.

The *Christos Paschon* is of great interest for a wide variety of reasons, not the least of which is that it is the earliest known complete dramatization of the passion of Christ. It is composed in the form of a cento, a style of poetic composition popular in the fourth and fifth centuries. This poetic form has repulsed many later critics because it has appeared to them to be based on plagiarism. The form requires the composer to select his lines from well-known works of poetry or drama and re-work them into a separate, self-contained poetic composition. In the case of the *Christos Paschon,* more than 80 percent of the lines are recognizably derived from a wide variety of Euripides' plays. It should be noted that this was a perfectly acceptable and respectable poetic form that came into being around the 4th century A.D. and continued in use for some centuries thereafter. Once the play is translated into the vernacular, the resemblance of its lines to those of Euripides vanishes and the play stands forth as a strikingly original dramatization of the passion of Christ.

Although Gregorio Nazianzeno is the author to whom the play is most frequently attributed, it has also been attributed to a variety of subsequent sources, some as late as the 12th century. Even if the latest attribution is accepted, the *Christos Paschon* remains the earliest example of a complete dramatization of the passion of Christ. If the earliest attribution is accepted, then it is clearly the earliest example of a Christian liturgical drama.

André Tuilier consulted twenty five extant manuscripts of the play in thirteen different libraries in Europe and Asia Minor.[2] While his main effort is devoted to establishing the authenticity of the authorship of Gregorio Nazianzeno, his scholarship indicates that the manuscripts were circulating in the west as early as the twelfth century and perhaps earlier.[3] In a recent paper "Grégoire de Nazianze, La Passion du Christ, Tragédie," which includes a fully annotated publication of the Greek text with a French translation, Tuilier concludes that the play is very probably the work of the 4th century patriarch, Gregorio Nazianzeno, who lived from 330 to 390 A.D.[4] In another article containing an excellent thematic analysis of the play, Sandro Sticca also concludes that the play should be attributed to Gregorio Nazianzeno.[5] Professor Sticca pays particular attention to the theological intent of the author, which he thinks parallels the theological interests of Gregorio. In "Liturgical Drama in Byzantine Literature," Theodore Bogdanos, while recognizing the persuasiveness of Professor Sticca's arguments, nevertheless believes that the play is a literary exercise of the eleventh or twelfth centuries.[6] Professor Bogdanos' opinion seems to be based on his extreme distaste for the form of the cento. In an earlier article, "La datation et l'attribution du *Christos Paschon* et l'art du centon," Tuilier clearly established the historical fact that the cento was an art form that flourished in the 4th and 5th centuries.[7]

The early date of the play is further supported by Vénétia Cottas who presents a fascinating argument that the *Christos Paschon* served as a direct inspiration for most of the iconographic works dealing with the passion of Christ from as early as the fifth century A.D.[8] While admitting that she is unable to present direct testimony on this point, she nevertheless presents numerous persuasive examples of art works whose details coincide meticulously with the scenic details set forth in the dialogue and action of the *Christos Paschon*.

Regardless of the fact that over eighty percent of its lines may be shown to have been adapted from various sources in Euripides and elsewhere, an objective examination of the work reveals that it is a self-contained dramatization of the passion of Christ presented through the perspective of his mother, Mary. Tuilier aptly refers to the play as.

> ". . . la tragédie Chrétienne par excellence. Ce drame imite les Anciens pour le fond et pour la forme. Tout en reprenant les expressions mêmes du grand Tragique, l'auteur utilize les thèmes et la mis en scene du théâtre grèc.[9]

The play's dramaturgy is wrought with great technical skill, and its thematic development presents considerable insight into the human condition. It assumes the fundamental dignity of man and womankind, emphasizes free will and responsibility in the area of moral choices, and assumes the existence of a supernatural force that is concerned with human affairs. It then proceeds to dramatize the conflict between its tragic heroine and the problem of evil in the universe. The pattern of action thus presented is tragic in form.

The text of the play, as translated by Tuilier, commences with a thirty line prologue. The author states his intent to dramatize the passion of Christ after the manner of Euripides, and outlines his theme of the redemption of humanity through the sacrifice of Christ. The action starts with a monologue by Theotokos, the virgin mother of Christ, who explains that she is abroad in the night to witness the passion of her son. She is shortly joined by a chorus of holy women, and, together, they witness the approach of an armed crowd that is cursing and beating Christ. A messenger enters and describes the betrayal of Christ by Judas and the condemnation of Christ to death. They follow the mob to Calvary, where Christ speaks to her from the cross, entrusting John to her care and consoling her in moving terms. From this point on, Mary assumes the additional role of the mother of humanity. Christ grants her pleas for the forgiveness of Peter and the descendants of those who are tormenting him. After his death, John, who is also referred to as the Theologian, predicts his resurrection. The chorus then divides itself into two parts to interpret and discuss the preceeding events. Their dialogue is interrupted by the episode of the centurion Longinus and his miraculous conversion. Joseph of Aramithea and Nicodemus then arrive to recover Christ's body. They lower it into the arms of Mary, who gives voice to a particularly poignant lamentation over the body of her son. This scene is felt by Vénétia Cottas, the author of *L'influence du drame Christos Paschon sur l'art chrétienne d'Orient* to have served as the initial inspiration for many subsequent depictions in the graphic arts of Mary mourning over the body of her son.[10] Joseph then announces the death of Judas, and the chorus gloats in a manner strongly reminiscent of the Bacchae exulting over the death of Pentheus. Joseph and Nicodemus then carry the body to the tomb, and all of the characters repair to John's house to rest for the night. In his role as Theologian, John explains the Christian mysteries and describes the harrowing of Hell to Joseph and Nicodemus. In the morning, a messenger arrives to report that a guard has been placed over the tomb of Christ. This persuades them to remain in the house until Easter morning. That night the Virgin asks for a volunteer to reconnoiter the tomb and Mary Magdalene agrees to do it. The Virgin then decides to accompany her and (from lines 2020 through 2097) the visit of the Marys to Christ's tomb on Easter morning is acted out. Christ appears to them and instructs them to inform the disciples of the good news. On their way to do so, they are stopped by a messenger who relates the dialogue he has just overheard between the tomb guards and the Temple priests after the resurrection. The priests have bribed the guards to hide the truth. As the messenger repeats the words of one of the guards, his speech gradually assumes the characteristics of that guard until he actually becomes the guard. At this point, he is joined by the High Priests and Pilate and they proceed to act out the scene that the messenger has been describing. The dramaturgic intent of the author seems clearly to have been to insert a flashback scene into his play at this point. It is probably the earliest example of the use of a flashback scene in dramatic literature. At the end of this scene, the messenger reassumes his initial characterization, and the focus of the scene returns to Mary, the chorus and Mary Magdalene, with no sign of a break in the continuous action of these scene. Presumably, Pilate, the High Priests and the other guards leave the stage as the flashback ends.

The characters then return to John's house, where Christ again appears and instructs the disciples to preach his word throughout the world. The play concludes with a prayer or *exodos* celebrating the dual nature of Mary, both as Mother of God and as the mother of humanity.

While it cannot be denied that there has been a great deal of controversy concerning the authorship of the *Christos Paschon,* the latest, most meticulous scholarship appears to indicate that it is the work of Gregorio Nazianzeno. It would therefore seem to be an authentic drama of the 4th century A.D.

In "Il *Christus Patiens:* Rassegna Delle Attribuzioni," Francesco Trisoglio presents an exhaustive review of research concerning the play.[11] It is by far the best bibliographical study of the problem to date. While he does not seem to clearly state his own opinion concerning the attribution of the play, the latest research covered by his study seems to favor the authorship of Gregorio Nazianzeno, lending further credence to its standing as a 4th century A.D. drama.

While there is no evidence that it directly inspired a Latin liturgical drama, the mere existence of *Christos Paschon* lends considerable support to Voltaire's assertion that Christian Greek religious drama influenced the origins of medieval Italian and French religious drama. If the latest scholarship dating the play from the 4th century A.D. is accepted, then it is undoubtedly our earliest example of Christian drama.

Notations

[1] Voltaire, *Essai sur les Moers et L'Esprit des Nations,* in *Oeuvres Complètes,* tome 17 (L'Imprimérie de la Société Littéraire-Typographic, 1785), pp. 376-7.

[2] Tuilier, André, "Grégoire de Nazianze, La Passion du Christ," *Sources Chrétienne,* tome 149 (1969), pp. 75-116.

[3] *Loc. Cit.*

[4] Tuilier, André, "Grégoire de Nazianze, La Passion du Christ, Tragédie, Introduction, Texte, Traduction, Notes et Index," *Sources Chrétienne,* tome 149 (1969), p. 116. Eds du cerf, Paris.

[5] Sticca, Sandro, "The *Christos Paschon* and the Byzantine Theater," Comparative Drama, Spring, 1974, pp. 28-41.

[6] Bogdanos, Theodore, "Liturgical Drama in Byzantine Literature," *Comparative Drama,* 1976-77, p. 208.

[7] Tuilier, André, "La datation et l'attribution du *Christos Paschon* et l'art du centon." *Actes du VI^e Congrès International d'études byzantines* (Paris: 1948), tome I (1950), pp. 403-9.

[8] Cottas, Venetia, *L'influence du drame "Christos Paschon" sur* l'art chrétien d'orient (Paris: Librairie Orientaliste Paul Guenthner, 1931), pp. 110-13.

[9] Tuilier, André, "Gréboire de Nazianze, La Passion du Christ," p. 19.

[10] *Ibid.,* pp. 36-42.

[11] Trisoglio, Francesco. "Il Christus Patiens: Rassegna delle attribuzioni," *Rivista di Studi Classici,* 22: 351-423.

FINNEGANS WAKE AND THE LINGUISTIC RENAISSANCE

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In James Joyce's *Finnegans Wake,* there is a passage in which Shaun the Post describes the interior of his brother's house. Because his brother, Shem the Penman, is a writer, it isn't surprising to find that Shem's house is cluttered with literary debris which has collected like dust-balls and cobwebs over the years:

> You brag of your brass castle or your tyled house in ballyfermont? Niggs, niggs and niggs again. For this was a stinksome inkenstink, quite puzzonal to the wrottel. Smatterafact, Angles aftanon browsing there thought not Edam reeked more rare. My wud! The warped flooring of the lair and the sound-conducting walls thereof, to say nothing of the uprights and imposts, were persianly literatured with burst loveletters, telltale stories, stickyback snaps, doubtful eggshells, bouchers, flints, borers, puffers, amygdaloid almonds, rindless raisins, alphybettyformed verbage, vivlical viasses, ompiter dictas . . . once current puns, quashed quotatoes, messes of mottage, unquestionable issue papers (*FW* 183).[1]

Besides an impression of general clutter, the last thing we get from this description is a clear picture of Shem's room. It is as if such a picture were irrelevant. The words are so busy calling our attention to themselves that the things they refer to get lost. Shem's room is buried in "messes of mottage"; it is hidden beneath the very "alphybettyformed verbage" which should reveal it. The words themselves have more being and substance than the things they refer to. Moreover, though this is one of the clearer passages in *Finnegans Wake,* in order to puzzle it out, we will need either some knowledge of half a dozen languages or else own half a dozen dictionaries.

We might well ask, what ever happened to the straightforward story with a straightforward narrative? Why this apparent linguistic anarchy which Joyce himself calls the "abnihilisation of the etym?" What happened in the period between Jane Austin's genteel descriptions of drawing rooms and this seemingly chaotic version of a description?

To begin to answer these questions, I will first examine briefly the so-called 19th century discovery of language; then, I will outline the way in which much of 20th century literature embodies three ideas emerging from the linguistic renaissance: first, that words are objective, concrete entities; second, that words are "rooted" in the past and connect us with the order and culture of our ancestors; and third, that languages are interrelated. I will concentrate on Joyce's last work, *Finnegans Wake,* which is in many ways a paradigm for the linguistic concerns of many of the writers of the 20th century.

During the 17th century the works of Descartes and Locke shifted attention to the nature of mind and thought, and thus eventually to language, the medium of thought. Language became the subject of a renaissance of scientific and philosophical inquiry which inevitably influenced literature, though not overtly until the end of the 19th century when writers began to scrutinize their artistic medium with a new intensity, making it part of their message. Thus, one of the characteristics of 20th century modernism is its linguistic self-consciousness, its unprecedented, heightened awareness of language.

This awareness, it is true, is in some degree an innate part of the genius of every poet; but by the 20th century, it had become an overtly conscious part.

When the philologists Rasmus Rask and Franz Bopp in the first decades of the 19th century led the way into the uncharted land of languages, the only equipment they took with them was the scientific method. The purpose of their expedition, and of the more refined ones conducted later, was to gather phonological and morphological specimens from several Indo-European languages, and, by comparative analysis, inductively to derive laws of linguistic change. For the first time with any real depth or consistency, language was being treated as an observable phenomenon. Words and their sound patterns were empirical entities that could be studied.

By the turn of the 19th century, after decades of scientific philology, the impact of which was popularly felt in the monumental and scholarly *Oxford English Dictionary,* the writer as never before was aware of his medium as a medium, with its own ontology. Words were now no longer simply transparent signifiers, but were seen to participate more directly in reality; they were objects in a world of objects. This insight was exploited not only by Joyce, but by Pound, Eliot and others, and forms a foundation for the poetic theory and works of William Carlos Williams, the Objectivist and later Projectivist poets, as well as the group of artists writing in what David Hayman calls the wake of the *Wake.*

Joyce's work in this regard is paradigmatic. To his fictional protagonists, words first have an objective and empirical identity. The boy in the story "Sisters" is fascinated by the words "paralysis," "gnomon," and "simony," which "had always sounded strangely in" his ears (*D* 9). Stephen Dedalus, whom Joyce called a "gentleman wordsharper," also makes various lexical discoveries, including as a child the word "suck" whose "sound was ugly" (*P* 11). When we come to *Finnegans Wake,* however, like Stephen and the boy in the story, we, the readers, are the protagonists and discoverers of linguistic artifacts in the rubble heap of the book. When, for example, in the beginning we are confronted by a thunderword, we cannot help but marvel at the ridiculous thing snaking across the page as if it were alive, having a separate, unlikely existence of its own:

> The fall (bababadalgharaghtakamminarronnkonnbronntonnerronntuonnthunntrovarrhounawnskawntoohoohoordenenthurnuk!) of a once wallstrait oldparr is retaled early in bed and later on life down through all christian minstrelsy (*FW* 3).[2]

It is a word gone beserk, an impossible word which insists on its individuality as an aural and visual entity and on its right to exist as a thing, a sound-image which has meaning.

In *Finnegans Wake* the thunderword is the primordial sound of the Fall of God into his creation, of the fall of Finnegan, the hod carrier, off his ladder, and of humpty dumpty off the wall, events which initiate new cosmic and historical cycles. It is also the primal linguistic stuff of prelapsarian Babel, the divine first substance, Logos. Not only does its strange sound as a word draw attention to its substance and essence, but its visual, printed form is a necessary part of its being. Indeed, *Finnegans Wake* and many other "verbivocovisual" modern works need to be read with the eyes as well as with the ears.

The tendency in modern literature to treat words as objects is probably grounded as much in the technology of printing as it is in the scientific method of philology; in fact, taking a cue from Marshal McLuhan, it could be argued that the phonetic alphabet and the printing press necessarily had to be invented before the linguistic renaissance could develop. Print makes language an object, giving it a visual presence which the artist can exploit. To appreciate much of modern literature, particularly poetry, we as readers must be "abcedminded" (*FW* 18.17) without being absent minded. We must be attuned to the visual puns and to the physical appearance of the word on the page, as well as to the music of the text. The "alphybettyform" of each thunderword, for example, consists of 100 letters except for the tenth thunderword which has 101 letters, making 1001 letters in all. Letters are the building blocks, the atoms of this linguistic universe, and the total number of them in the thunderwords is symbolic of birth and renewal, for the one thousand and first letter is the beginning of a new millenium, of a new cosmic cycle.

Philology, in addition to enhancing the modern writer's ontological awareness of words, gave him an awareness of the history and interrelatedness of languages. Comparative and historical linguistics discovered that the genealogy of a word or family of words could frequently be traced to a single source or an a-priori root-word. Through metaphorical process and ordered phonetic change which could be stated in terms of laws, the root metamorphosed into various forms at various times in its descent to the present. Language, as Hugh Kenner has observed, was discovered to be

> a complex coherent organism that is no more the sum of its constituent words than a rhinoceros is the sum of its constituent cells, an organism that can maintain its identity as it grows and evolves in time, that can remember, that can anticipate, that can mutate. Latin is not a dead language; everyone in Paris speaks it, everyone in Rome, everyone in Madrid. The poetic of our time grows from this discovery.[3]

Or as the *Wake* puts it: "the sibspeeches of all mankind have foliated . . . from the root of some funner's stotter" (*FW* 96).

Though such a discovery seems rather commonplace today, when Joyce was a young man studying Skeat's *Etymological Dictionary,* it was a vision which had many implications for literature. Because language could be seen as something organic rooted in and growing out of the past, it was testimony to the continuity of human experience. At a time when science and Darwinism seemed to be cutting man away from God and meaningful existence, language was reconnecting him with his past, creating order and meaning for the present.

The language of *Finnegans Wake,* which Shaun calls "root language," is the artistic embodiment of this second philological insight. It is constructed (though that is too static an image) out of the bricks of etymological root-words. With the Greek word "Bronton" (see note 2) embedded in the thunderword, for example, Joyce is connecting with the ancient world where the Thunderer, Zeus, ruled myth and religion.

Moreover, some of the techniques which Joyce uses to derive the *Wake*'s "root language" or "ur sprogue" are analogous to many of the theoretical processes which occur in the evolution of language. To give one example, Joyce plays with the phonetic law that describes one of the developments of the Celtic languages from proto-Indo-European, namely, the shift from /p/ to /k/, as seen, for example, in the cognate forms for "foot" which are in Latin *pes,* Greek *pous,* and Gaelic *cos.*[4] Hence, the *Wake* word, "quotatoes." A more involved example is Shaun's attempt to convert Roman Catholics into proper Irish Catholics by calling them "roman pathoricks" (*FW* 27.02). Shaun's word also demonstrates Joyce's use of the linguistic phenomenon of L/R interchange. That is, he takes "Roman Catholics," applies the P/K shift to derive "Roman Patholics," to which he then applies the L/R interchange rule to arrive at "roman pathoricks."

Finally, if the word is a thread extending into the past, binding the past to the present, it is also a part of a fabric woven and interwoven with the threads of many other words or many other languages. That is, the philologist's comparative method revealed that all Indo-European languages are interrelated. No language is an island. This awareness recovered for the modern artist some of the lost social and metaphysical coherence he was desperately seeking. Men are united by virtue of their language. In part for this reason, many 20th century writers, particularly Pound, Joyce and Eliot, freely use foreign words and phrases. Pound in the *Cantos,* for example, borrowed freely from Greek, Latin, French, Provencal, Spanish, Italian, as well as Arabic, Chinese and Egyptian Hieroglyphic languages. One shrinks from making an inventory for *Finnegans Wake* where such languages as Swahili and Polynesian have been identified. The thunderword, for example, is made up of many foreign words, as well as roots which mean noise and thunder (see note 2). It is an attempt at universality, at connecting all men and nations in a timeless moment.

I have tried here to sketch some of the ideas of the linguistic renaissance which affected one of the more obvious works of linguistic experimentation, a work whose major theme, as Hugh Kenner noted, is language itself. In this sense, *Finnegans Wake* can provide a key to the further linguistic study of modern literature, as well as to the concept of modernism in literature.

Notations

[1] References to Joyce's works will be cited parenthetically using the editions and abbreviations noted below:

James Joyce, *Dubliners* (New York: Viking Press, 1967). Abbreviated as *D.*

———, *Finnegans Wake* (New York: Viking Press, 1939). Abbreviated as *FW.*

———, *A Portrait of the Artist as a Young Man* (New York: Viking Press, 1964). Abbreviated as *P.*

[2] A partial gloss of the thunderword:

-gharaghtak-	Gaelic: gaireachtach = boisterous
-bronnto-	Greek: to thunder
-bronnton-	Greek: Thunderer, epithet for Zeus
-ton-	Latin: tono = to thunder
-tonner-	French: tonner = to thunder
	German: Donner = thunder
-skawn-	Gaelic: scan = crack
-thurnuk-	Gaelic: tornach = thunder

[3] Hugh Kenner, *The Pound Era* (Berkeley: University of California Press, 1971), p. 96.

[4] See Brenden O'Heir, *A Gaelic Lexicon of "Finnegans Wake"* (London: Oxford University Press, 1970), pp. 198-208, for a discussion of the P/K shift.

SNOW CRYSTALLOGRAPHY AND STRENGTH
An Index of the Effectiveness of Roof Insulation

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Abstract

Crystallographic and strength profiles taken in the mid-winter snowpack on a residence-laboratory roof in south central Wisconsin show a close correlation with the internal thermal regimen and ceiling architecture of the building. These relationships suggest the feasability of using these two snowpack parameters as a field index of the effectiveness of insulation.

Introduction

On a cold winter day, melting snow on the roof of a heated building is an obvious indication of poor insulation and excessive heat loss. More subtly, a roof supporting a snowpack with a basal ice layer indicates greater heat loss than one with no basal ice. In this case the capillarity and low temperature of the snow was capable of "blotting-up" and refreezing the small amount of melt water which had been released.

Today, with increased emphasis on home insulation there is a corresponding increase in survival of snow on the roof, often without formation of basal ice. However, even with roof temperatures less than 0°C the heat flow seems to be sufficient to metamorphose the snow, modifying both its crystal structure and its mechanical properties. The degree of metamorphosis is proportional to the heat flow.

This paper describes how, with the use of simple equipment, the crystallinity and strength of snow on a roof can be examined to quickly give an index of relative heat loss.

Swiss avalanche researchers were the first to describe the relationship of the thermal regimen to the crystallography and strength of snow on the ground (Bader *et al.,* 1939). La Chapelle (1969) noted that two kinds of recrystallization take place in snow on the ground at temperatures less than 0°C. *Equi-temperature metamorphism* produces fine granular snow which becomes well bonded (sintered) and stronger as time passes. *Temperature gradient metamorphism* interferes with the sintering process and over time produces beautiful, coarse, euhedral crystals called *depth hoar.* Thus there is the general association of weakness with depth hoar development.

A temperature gradient in the snowpack implies the flow of heat through the pack. The normal source for this heat is energy stored in the ground during the summer and gradually released in winter. At any given moment, the thermal gradient in snow is a function of the temperature difference between the ground-snow interface and the snow-air interface distributed over the depth of the snowpack. The steeper the gradient, the greater the heat flow, the more complete the metamorphism, and the more perfect the euhedral development of depth hoar crystals.

Since the ground is the heat source and the oldest snow is nearest the ground, the crystal development of the basal snow provides the clearest index of heat flow.

Regarding snow strength, Bradley *et al.* (1978) showed that while gradient metamorphism causes snow to lose strength with time, the weakest snow is actually associated with partially developed (subhedral) depth hoar a few centimeters above the base, and that in the last phase of crystal perfection there is a slight gain in strength. This study demonstrates that the same holds true for snow on the roof and hence snow strength again can be used as an index of heat flow.

The winter of 1978-79 in southern Wisconsin produced heavy snow loads. Roof collapse was common. This winter was also a time of protracted cold. From December 30 until mid-February the temperature never rose above freezing on the Leopold Memorial Reserve near Baraboo, Wisconsin. The diurnal temperature typically ranged from about $-25°$ to $-15°C$. By February, the bottom half of the 50 cm. of accumulated snow on the ground was composed largely of depth hoar, so weak that the pack tended to collapse under the load imposed by a skier.

On January 19, we decided to unload snow from the roof of the Reserve Study Center. Spontaneous collapse of a small area of the roof snowpack occurred as the first shovel was inserted. The Center is well insulated even by modern standards but this evidence of extreme fragility indicated significant heat flow from the roof. In addition, as the roof snow seemed even weaker than the snow on the ground, a different thermal regimen was indicated although the nature of the difference was not immediately clear. A search for heat loss indices was conducted over the next two days as 23 metric tons of snow were shoveled from the roof.

Methods

The degree of gradient metamorphism in the snowpack was determined using two kinds of vertical profiles: 1. crystal perfection of the depth hoar; 2. snow strength (See Fig. 1).

Crystal perfection was observed with a hand lens (10×) on samples taken at 5 cm-intervals from a vertical cut face of the pack. Special attention was given to weak zones near the base. Three categories were selected: *Anhedral,* irregular grains but no crystal faces visible. *Subhedral,* scattered crystal faces visible. *Euhedral,* crystal facets clearly dominant in the entire sample.

Snow strength was observed in two ways. The first is qualitative. Immediately after cutting the vertical face the surface of the cut was brushed lightly with a whisk broom which etches the weaker layers leaving the stronger layers as ridges. By giving approximately equal treatment to the entire face the relief produced by the whisk broom is a fairly reliable measure of the relative strength of the various layers.

A snow resistometer was used to obtain a more quantitative measure of strength. The instrument consists of a metal probe with a conical point. The probe is pushed vertically into the snowpack. A sensitive displacement dial mounted in the spring handle records the force per unit area of the cone (N/m^2) necessary to achieve penetration. The instrument has an accuracy in excess of $0.5\ N/m^2$.

Using preliminary vertical measurements from the whisk broom profile as a guide for the resistometer I obtained spot strength measurements of preselected zones in the snowpack. The mean of four probes represent each point plotted. The points were then connected on a line sketched from the whisk broom profile. The plotted profiles also show those particular layers that were seen to collapse on the pit face when disturbed by the shovel or by pressure deliberately applied to the upper snow surface.

The decision to study the roof snowpack was made too late for a proper investigation of the actual thermal history of the pack. Still, the imprint of that history was sufficiently clear for a qualitative comparison of four roof areas each of which had had a different thermal regimen. For additional comparisons profiles of snow on the lawn and one from snow on the unheated woodshed where gradient metamorphism should have been minimal were included.

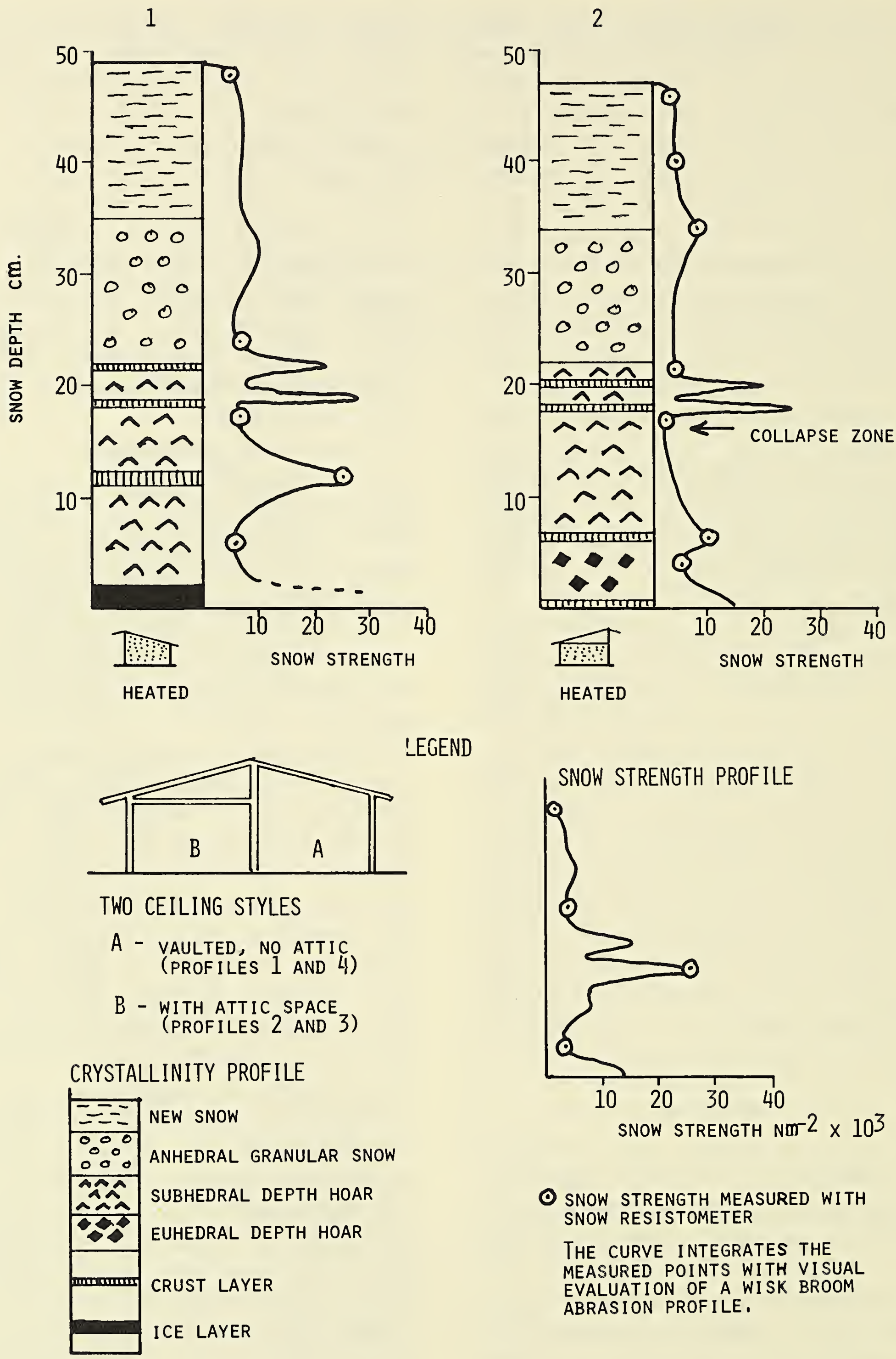
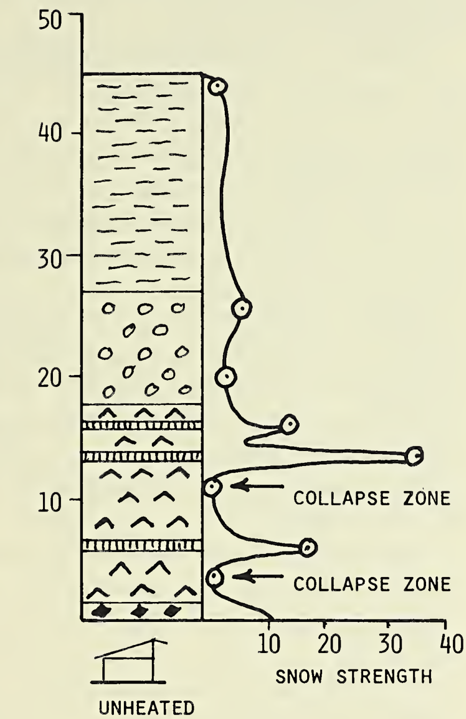


Fig. 1. Crystallinity and strength profiles of snow on the roof of the study center, Leopold Memorial Reserve, obtained January 19-20, 1979.

3


50
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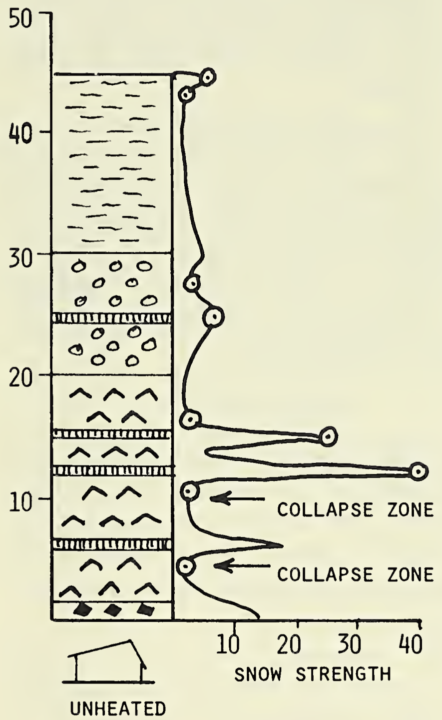
COLLAPSE ZONE
COLLAPSE ZONE
10 20 30 40
SNOW STRENGTH
UNHEATED

4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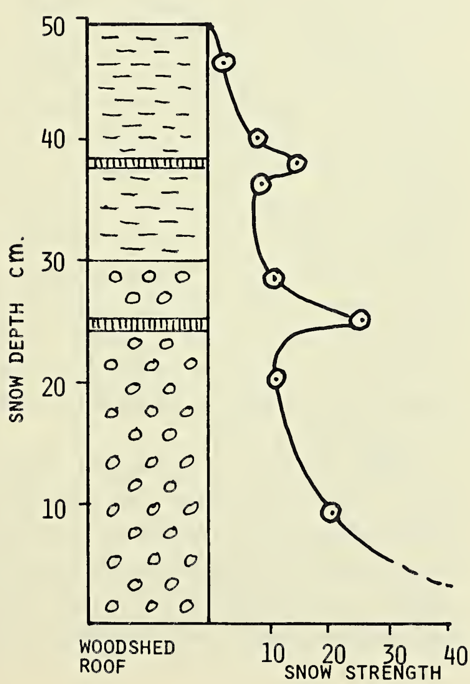
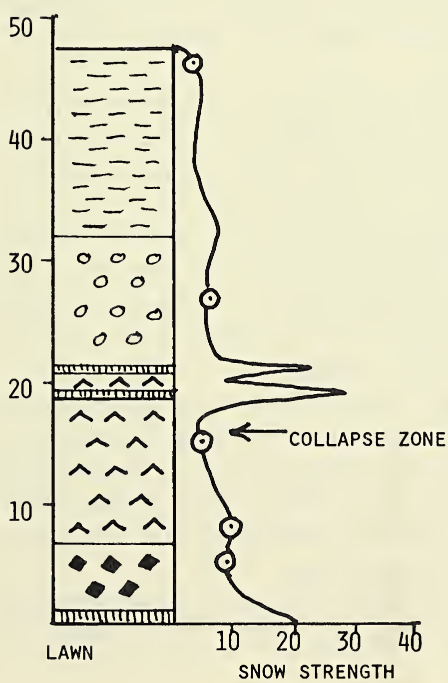
COLLAPSE ZONE
COLLAPSE ZONE
10 20 30 40
SNOW STRENGTH
UNHEATED

5


SNOW DEPTH cm.
50
40
30
20
10
WOODSHED
ROOF
10 20 30 40
SNOW STRENGTH

6


50
40
30
20
10
COLLAPSE ZONE
LAWN
10 20 30 40
SNOW STRENGTH

Temperature readings reported in the study were obtained mainly during the period of shovelling and hence only suggest the thermal regimens influencing the snow metamorphism.

The living room roof, alone of the four areas, faces south. The others face north. But, since outside air temperatures had not approached melting point all winter and since light penetration into snow is low, it seems safe to assume that this difference was unimportant. The profiles tend to confirm that assumption (Fig. 1).

Observations

Six pairs of profiles were prepared, one pair each for the four roof areas of the Center, and one pair each for the woodshed and lawn (Fig. 1). Except for the lawn profile the profiles are arranged in order of decreasing thermal gradient.

Profile 1 was taken over the living room where internal temperatures at shoulder height were held between 12°C and 18°C. Temperatures measured at the peak of the high (3.5 m) vaulted ceiling were 4 or 5 degrees higher. The ceiling-roof consists of 5 cm. styrofoam insulation sandwiched between wood with a total thickness of about 15 cm.

Profile 2 was taken over the hallway which has the same internal temperature as the living room (12° to 18°) but has a low ceiling and is separated from the roof by an attic space. Both the ceiling and the roof are well insulated but the attic area has a restricted opening into the unheated garage and remains cold in winter. Attic temperatures were not taken.

Profile 3 taken in the snow over the shop, represents an area architectually similar to the hallway #2 but unheated. Temperature readings in the shop remained near 10°C during the cold weather, a result of leakage from the heated area.

Profile 4 was obtained over the unheated garage where the architecture is similar to the living room. Near the vaulted ceiling the temperature was 0°C when the outside temperature was −15°C.

Profile 5 represents snow conditions on the woodshed. Metamorphism of this pack must have been about as close to equitemperature as one would find in nature. The snow was subjected mainly to the diurnal flux of air temperature. Probably, heat flow from the ground through the wood-pile to the roof was negligible.

Profile 6 represents the lawn conditions. This profile provides a basis for estimating the prevailing thermal gradient. The fact that the ground beneath the snow was unfrozen but the basal snow was unmelted suggests a steady ground-snow interface temperature approximating 0°C. Most of the metamorphism would have occurred during periods of low air temperature. The mean nightly temperature during the winter approximated −25°C. Assuming a 50 cm. snow pack, this temperature gives a mean gradient of 0.5°C/cm. But even this value probably represents the minimum because much of the metamorphism of the basal snow would have taken place when the pack was thinner and the gradient steeper.

Comparison of profiles 1 through 4 show a progressive change in crystallinity and strength to match the progressive drop in temperature gradient. In Profile 1 the roof temperature was high enough to melt the basal snow preventing the development of euhedral depth hoar and producing basal ice. In Profile 2 a lower roof temperature resulted in a thick layer of euhedral depth hoar; Profile 2 shows a closely similarity to Profile 6 and hence probably had a very similar thermal history including a roof temperature close to 0°C.

Profiles 3 and 4 developed under still lower roof temperatures and had little euhedral development. Both show a broad zone of subhedral crystals and such fragility that under the overlying snow load it was virtually impossible to insert the shovel without initiating snowpack collapse. As expected Profile 5, with minor perturbations, shows increasing strength with depth—the expected equitemperature profile.

Conclusions

It seems clear that a correlation exists between the strength and crystallinity of snow on the roof and the heat loss from the house under study.

A thoroughly quantitative study of heat loss through a roof and its effect on snow would require an imposing array of instruments to measure the pertinent variables involving roof, snow and weather throughout the course of the winter. However it is evident that an observer with handlens, whisk-broom and shovel could tell, with a brief examination of the basal snow, which areas of a roof were losing the most heat and which the least.

Literature Cited

Bader, H. *et al.* (1939) "Der Schnee und seine Metamorphose" Beitrage zur Geologie der Schweiz. Geotechnishe Serie, Hydrologie 3.

Bradley, C. C., Brown, R. L., Williams, T. (1978) "Gradient metamorphism, zonal weakening of the snowpack and avalanche initiation." *in* Symposium on Applied Glaciology 19 no. 81 pp. 411-417.

LaChapelle, E. (1969) "Field guide to snow crystals" University of Washington Press pp. 15-21.

DOUGHBOYS AND HOME FOLKS
Observations from Rusk County, Wisconsin, at the Opening of World War I

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A verse from a marching song found in the papers of a Rusk County, Wisconsin, soldier read:

> Goodbye maw, goodbye paw,
> Goodbye mule with your old he-haw.
> I don't know what this war's about,
> But you bet by gosh I'll soon find out.
> And Oh! my sweetheart don't you fear
> I'll bring you a king for a souvenir.
> I'll get you a Turk and the Kaiser too,
> And that's about all one fellow can do.[1]

More than six decades have passed since the United States plunged into the Great War in 1917. But perhaps no conflict of this century has had a greater impact on the American people. This article examines the initial effects of World War I on a portion of northern Wisconsin—Rusk County and vicinity—and upon its young men who shouldered arms in defense of their country.

Both those who left and those who remained at home found that their cultural isolation, security, and attendant parochialism came under attack; rural values and beliefs were subjected to severe stress. Individualism was subordinated to uniformity, while the presumed moral superiority of the countryside was confronted with the reality of twentieth-century American urban life.

A location in upper Wisconsin was selected because most of what has been written about Wisconsin in the Great War concentrates upon the activities of the more urbanized and politically active southern part of the state. In addition, if tensions existed between the two halves of the state because of political and economic disparities, as they apparently did, it would be interesting to know how they manifested themselves in the general war effort.

The Rusk County area, with Ladysmith as the county seat, was typical of northern Wisconsin in the period. It was sparsely populated, and depended upon marginal agriculture, the railroad, light industry and wood products for its survival. When war broke out, the county threw itself energetically into the war effort, contributing more than her share of men to the military.[2]

As part of the research for this article, thirty-eight local veterans cooperated by completing questionnaires and/or granting personal interviews. The questions were designed to elicit information regarding family background, educational attainment, social position of the individual, occupations both before and after the war, military experiences, and personal prejudices and attitudes. This sampling is not large enough to render precise measurements of attitudes, but suggests their general magnitude. Also, secondary sources have been utilized, as have local newspapers and hitherto untapped personal correspondence from the period.

The news which had electrified Europe in June of 1914, that the heir to the Austro-Hungarian throne had been assassinated, initially registered only a tingle in the northern Wisconsin papers. But within weeks, foreign affairs had become a ubiquitous topic of conversation. As great armies swung into action, northern Wisconsinites settled down to enjoy the spectacle. "A new history of Europe is being written," observed one editor; "We will publish a thrilling chapter every week."[3] Movie theaters capitalized on the moment; for example, in Ladysmith the theater screened on consecutive weekends in September 1914 "War is Hell," "Napoleon," "Faithful unto Death," and "The Last Volunteer."

Inevitably, some Rusk County area residents identified with one or another of the belligerents. Many inhabitants of the region were foreign-born, some of German extraction. The concentration of German-Americans in this area was lower than in the southern part of the state, but there were some Teutonic communities with strong feelings about the war.[4] More than balancing these, however, were settlements of French, Italians, and Belgians, which, in the opinion of one veteran, gave the area a pro-Allied bias. Veteran E. A. Preston of Ladysmith recalled that pacifism was the most prominent sentiment in this hometown, while another veteran, Private Allen Cooper, remembered the district around the village of Dallas in neighboring Barron County as isolationist, albeit "certain folks wanted to get us involved in the fracas." A similar view was expressed by Private Henry Plagge from adjacent Chippewa County.[5]

Although public sentiment might have been gauged somewhat differently by the interviewees, a common belief seems to have existed until the eleventh hour that our involvement in Europe was unlikely.[6] However, by February 1917, Washington and Berlin were clearly on a collision course, and the *Rusk County Journal,* among others, now dismissed those who said war was impossible, adding:

> While the American people should pray that war may be averted, they should get busy at once and prepare for the emergency that looms up close.[7]

By 12 March 1917, President Wilson had ordered the arming of U.S. ships. On April 2, the President delivered a stirring message to Congress requesting a declaration of war against Germany, which Congress granted on April 6.

The citizens of the Badger State found themselves in a rather uncomfortable position. Wisconsin had a large (42%) and vocal minority of German-Americans, which led to the nickname "the 58% State."[8] Because of this, neighboring states and even the War Department feared that Wisconsin might have to be subdued in case of hostilities.[9]

Then, too, there were the anti-war activities of Wisconsin's Senator Robert M. LaFollette, or "Von LaFollette," as he was labeled by the *Cincinnati Post.*[10] His actions outraged many in the Rusk County area, for, as one local weekly editorialized,

> On account of the attitude of the senior U.S. Senator from this State, Robert M. LaFollette, on the armed neutrality bill, which measure he led to destruction by his filibustering methods, . . . Wisconsin is in the limelight, scorned and humiliated by every American newspaper and citizen. . . . He . . . sets an example that will be quickly taken up by the belligerents who will not be slow to sow the seeds of discord among American citizens.[11]

When the President's war message came to the floor of the House of Representatives, nine of Wisconsin's eleven members voted nay, the exceptions being Irvine Lenroot and David Classon, both representing northern Wisconsin.[12]

To dispel suspicion of its patriotism Wisconsin quickly swung into action. On April 12, the first State Council of Defense in the nation was established, soon followed by branches in every county; a thousand Four Minute Men toured the state, rallying support, and funds were solicited for the Red Cross, YMCA, and Liberty Loans.[13] Victory gardens sprang up in vacant lots and school children were organized to tend them. The capstone was Wisconsin's gift to the nation of statewide "wheatless" and "meatless" days.

Madison's war mobilization efforts met with mounting approbation in Rusk County and its environs. Patriotic meetings were held monthly in rural schoolhouses; all boys ages twelve to twenty in Sawyer County were mobilized for farm labor; loyalty was taught in the schools, when necessary to the exclusion of normal courses of study; and "go to work or go to jail" was becoming the motto of the area. Conservation and rationing were accepted as necessary. The mood of the people was expressed in the following verse, entitled "Hooverizing":

> My Tuesdays are meatless, my Wednesdays are wheatless,
> I'm getting more eatless each day.
> My home it is heatless, my bed it is sheetless,
> They're all sent to the YMCA.
> The barrooms are treatless; my coffee is sweetless,
> Each day I get poorer and wiser.
> My stockings are feetless, my trousers are seatless,
> My God, I do hate the Kaiser![14]

The economic and financial contributions demanded of the area were hotly debated. What was needed was not an exodus, but an inflow, of capital if this raw new country were going to be able to clear land and increase food production for the war effort.[15] Instead, the Liberty Loan drives, among others, drained liquid assets from the region. The total subscription for Liberty Loans in Wisconsin was $333,633,800; Rusk County contributed $510,300, a sum which represented less than half the average per capita contribution in the state. Yet the sacrifice was heavy, and, when the newspapers were asked to publish the statement, "No man is too poor to do his bit by subscribing," the editor of the *Rusk County Journal* expostulated:

> We object . . . to publish[ing] stuff that contains such a damnable lie as the foregoing. It is safe to say that more than half the men of the country are too poor to buy a Liberty Bond.[16]

Nevertheless, Rusk County did its best by contributing not only to the Liberty Loans, but also the Red Cross ($4,922), and to savings stamps ($101,000).[17]

The dark side of the war effort throughout the nation and in the Rusk County area was the mounting hysteria, more violent than in the Civil War or in World War II.[18] The situation was exacerbated by the Espionage Act of October 1917 and the Sedition Act of May 1918 (under which, for example, refusal to purchase a Liberty Bond or the use of imprudent language could lead to a maximum sentence of twenty years in prison and a $20,000 fine).[19] Vigilante groups bent on patriotic missions were organized, and the word "slacker" reverberated in civilian and army life. Sauerkraut and German measles were rechristened, respectively, liberty cabbage and liberty measles. A final indignity proffered by the American Defense Society was their suggestion that all Germans not well known locally be considered potential spies.

Those German-Americans and aliens living in the Rusk County area found themselves uncomfortably conspicuous. In the best of times, provincial people have difficulty understanding dual loyalty.[20] It was no accident, therefore, that with the arrival of hostilities, xenophobic tendencies increased. Even before the President's war message, concern about the presence of foreigners was voiced in the local press. On 9 March 1917, the editor of the *Ladysmith News-Budget* reviewed a film entitled "Fall of a Nation," in which a European army invaded the U.S. with the assistance of foreign immigrants. "This," declared the editor, "provides an awful warning." On 12 April, the *Rice Lake Chronotype* advised the alien to "obey the laws and keep your mouth shut." And within months he was further told that "the day will come when foreign [language] newspapers will not be tolerated."[21] All things alien obviously were suspect, but not even naturalization could satisfy the zealots, as this editorial suggests:

> On reading over the list of applications [for citizenship] one cannot escape the thought there ought to be some legal way to Americanize some of the names to some extent while Americanizing their citizenship.[22]

The plight of the aliens worsened in June when their true numbers became known through the registration of all men eligible for the draft.

The situation for German-Americans was particularly sensitive. A portion of a song which one Ladysmith soldier kept among his papers illustrates the dilemma of many:

> I am a Deutscher man
> But I'll fight for Uncle Sam
> And I want you to know
> Where ever I go
> I'll do the best I can.[23]

Recruits with Teutonic names were given pamphlets with titles such as "American Loyalty" which argued that Prussianism, not the German people, was the foe, and that the nation was on a crusade to rescue Germany.[24] However, treason stalked the Northwoods, often appearing in isolated German communities whose inhabitants, deemed insufficiently patriotic, might be labeled Kaiserites or worse.[25] Several area residents were arrested for sedition, while the *Phillips Bee* reported that a "nest of disloyal Americans" infested their town.[26] An organization calling itself "The Loyalty Legion" was soon established in the Rusk County area, welcomed as an ally in the unmasking of treason. The editor of the *Rusk County Journal* approved, arguing

> . . . that patriotic societies with or without name be organized where there may not be any today, to oppose treason and line up traitors where ever they may be found. Before the year 1918 is closed there ought to be thousands of disloyal or semi disloyal men put into stockades until the war is over.[27]

Against this general background, it might be well to turn to the Northwoodsmen who took up arms in their country's behalf.

The first in Wisconsin to be summoned to the colors in April 1917 were the National Guard, veterans of the Mexican imbroglio of 1916, who were dispatched to protect ore docks, railroad bridges and other strategic points. A second brigade of three regiments was immediately planned, with Camp Douglas selected as its rallying point. Men ages eighteen to thirty-five were encouraged to enlist, and to fire the blood frequent allusions were made to the State's glorious heritage from the Civil War. For example, Lieutenant Maloney of Rusk County wrote, "Recovery of the American spirit, the aggressive liberty loving and self sacrificing spirit of . . . the Boys of '61 have been the source of our greatest national pride."[28]

Initially, volunteers had been few, and as one recruitment officer observed later:

> Like the generality of Americans, the people of Rusk County were slow to realize the possibility of war. No great war having been experienced during this generation, they could not bring themselves to believe that war was a possibility. The young men felt that joining the troop would tie them down to useless drill.[29]

Recruitment techniques in the Rusk County area included speeches, public meetings and automobile cavalcades.

After the commencement of hostilities, many men had left the area to join the Allied armies, and their letters home, published in local papers, were filled with war experiences that evidently stimulated enlistment. Positions in the cavalry and aviation corps offered high drama and consequently were most alluring.[30] "Some unthinking recruits," editorialized the *Ladysmith News-Budget,* considered the plan for national defense "as only a means of recreation and excitement."[31] Romantic illusion was maintained through provocative war movies and literature. Today the novels and poetry of the period seem maudlin, but their effects should not be ignored.

A powerful attraction for volunteers in Ladysmith was the opportunity to enlist in a cavalry troop, with all its attendant dash and excitement. War arrived at an auspicious season for enlistment in the Northwoods, for, as one veteran recalled, the "river pigs" and "cruisers" were at slack time, allowing logging crews to volunteer en masse. That veteran also reported that some men of German descent even volunteered with the understanding, which was honored, that they would not have to fire at the enemy, as did also an army cook who said he had "ein fodder 'n' two bridders" in the ranks of the Kaiser.[32]

Nationwide volunteerism proved inadequate for the country's needs. It was obvious, therefore, that conscription was the only solution. On 18 May 1917 the Selective Service Act was passed; and 5 June 1917, designated "Duty Day," saw the uneventful registration of eligible men ages twenty-one to thirty-one. Overall, enlistment in Rusk County was excellent, with the result that the impact of the Selective Service Act was minimized, since volunteers were counted as substitutes for draftees.[33]

Eventually the northern twenty-nine counties of Wisconsin contributed approximately thirty-four percent of the State's total draft, although they held only a quarter of the State's population. Thus, some northern communities found themselves short of manpower. In Cumberland (Barron County), for example, 78 of the 120 registered men were taken on the first round.[34] One young lady writing in the summer of 1917 complained, "How about the Ladysmith Girls—they can't find a fellow here if they wanted to for they're like hen's teeth—scarce."[35] Her lamenting finally prompted this rejoinder from her doughboy fiancé:

> I suppose the girls are organizing a football team to take the place of men that would play if they weren't in the army. You know that all over the country the women are learning to do things that were formerly proformed [sic] by men and Ladysmith don't want to be behind the times.[36]

Some men, much to their dismay, were rejected as volunteers but were later drafted.[37]

Rivalries among Wisconsin recruits divided them in several ways. First, the cavalry troops had the conviction that they were unquestionably superior to the infantrymen. This resulted in clashes such as the general melée reported by a Ladysmith trooper in August 1917 at Camp Douglas, after which some commanding officers were punished along with their men for their reluctance in quelling the disturbance.[38]

Another cleavage separated the volunteer and the draftee. The motto of the Wisconsin National Guard was "Come in out of the draft," showing disdain toward conscription. The enlisted men at camp might be curious to know who back home had been drafted, but, as Private William Bretag of Ladysmith wrote, "We're not proud of them."[39] A poem which was circulated among the northern Wisconsin men, evidently describing their feelings, read in part:

> Why didn't I wait to be drafted,
> And led to the train by a band,
> And put in a claim for exemption?
> Oh, why did I hold up my hand?
> Why didn't I wait for the banquets,
> Why didn't I wait to be cheered?
> For the drafted men got all the credit,
> While I merely volunteered.[40]

One sympathetic editor in Ladysmith suggested that there be no fanfare when the draftees departed.[41] Often this tension was channeled into athletic activities; as one

Rusk County man wrote after a football game, "I knew all the time that the volunteers could beat drafts any day."[42]

The words "slacker" and "draftee" were synonymous in the minds of some; as one enlistee grumbled,

> Speaking of slackers, they seem to fare pretty well. . . . All the drafted men have overcoats and winter clothes while we [volunteers] still wear our summer issue.

In another letter he reported that

> They say the officers can't do anything with them [the draftees]. They won't obey orders at all and if they are put on guard they go to sleep.[43]

Obviously not all drafted men fit this description, but the reality of the situation was not as important as the perception of it.

It has been suggested that the bastions of super-patriotism in Wisconsin lay in the small towns.[44] Communities in the isolated northern portion of the state were naturally more cohesive than their larger urban counterparts in the south. Troops were recruited at the county level and local sentiment favored having hometown men serve together. Initially every effort was made to maintain parochial entities, such as local cavalry troops, within the armed forces. This sentiment was extended to other units of the armed forces as well, such as the Fourth Wisconsin Infantry Regiment, which was to be recruited only from the upper part of the State.[45] There were many advantages to hometown units; parents formed permanent organizations, auxiliaries were established to make comforts for the boys; community-wide drives successfully gathered quantities of small luxuries which were sent to their own fighting units; and employers promised publicly to rehire the veterans.

In Ladysmith, for example, support for the cavalry troop was considerable. Here, the Campfire Girls and other civic groups raised a mess fund of $1500 for Troop K prior to its departure for Camp Douglas.[46] A large crowd, complete with band, was at the Ladysmith depot at 5:20 a.m. on 27 July 1917 to bid farewell to Troop K. Their trip was punctuated by a stop at Weyerhaeuser, where the men detrained to parade *ad hoc* through the streets, and a long festive layover at Eau Claire while that city bid farewell to its recruits. Five hundred dollars had been allocated from the Rusk County treasury to buy uniforms for the cavalry.[47] These were a luxury no other unit at Camp Douglas possessed, which prompted the remark, "When we first came they called us the Millionaire Lumberjacks because we wore leather putees and our uniforms looked good."[48]

From the start, a moral influence was exercised over the boys from Rusk County. The war effort was characterized as a religious crusade and after academicians the clergymen were the most outspoken hawks in the country.[49] "Clean Christian living" in the camps was the desire of the home folks, an ideal supported by the federal government as well as the State of Wisconsin.[50] For Northwoodsmen this meant availability of nightly Bible classes, sending home of signed temperance pledge cards, and mandatory church attendance on Sundays.[51] The ubiquitous YMCA and like organizations fostered rectitude and promoted such events as a "Night to Write to Mother," while Wisconsin's Governor Philipp imposed a 'dry zone' around Camp Douglas. When Troop K was transferred to Camp McArthur, near Waco, Texas, there was concern back home that the innocents from the north would be led astray, a fear not completely allayed even when the city fathers of Waco made assurances they would keep the boys moral at the cost of closing saloons and driving out disreputable individuals.[52]

For many doughboys, the gilt of army life began to tarnish almost immediately. Homesickness was rampant; one newcomer at Camp Douglas said of the well-wishers at the send-off, "Some of them made so much fuss it made it pretty hard for the boys and I was glad when we got away."[53] A couple of the stalwarts complained bitterly about the hardness of the beds and the absence of pillows.[54] Setting the matter of discipline aside for the moment, the raw recruit found his illusions sorely tested by reality. The widely applauded bravado of a Washburn County swain, who declared upon enlistment, "Now I don't give a damn just so long as they bury me on German soil," illustrated the misconception that the only way one could die in the army was valiantly, at the front.[55] But there were many inglorious ways of forfeiting one's life without ever seeing the enemy. Accidents on the practice range were common—even the hospital at Camp McArthur was shelled by novice gunners.[56] More disheartening were the deaths by disease which ravaged the camps. Many of the men were quarantined with mumps at Camp Douglas in the summer of 1917, but this was nothing compared to the pneumonia, rheumatism, and tuberculosis which struck them down in Texas.[57] Yet the following year brought an even greater disaster, the influenza epidemic. There were also occasional instances of maltreatment by officers. A Ladysmith private risked chastisement by writing home that he had heard that a major at Kelly Field in Texas had so mistreated his men that eight had cut their throats, many had deserted, and still others had perished by freezing.[58]

The sobering of one Northwoods volunteer might represent the experiences of many of his companions. After the heady days of departure with Troop K, Private William Bretag underwent a change of heart. In October 1917, his only desire was to go to Europe, have it out and survive. While at Camp McArthur, Bretag and his companions saw ruined French equipment on display at the Cotton Palace in Waco, but instead of eliciting sympathy the sight depressed them, for it graphically illustrated the firepower of the foe. In early November Bretag wrote that it was "barbarous and against the law of men and God" to shoot down such fine troops and horses as those in the American Army.[59]

Of course, all presentiments were as nothing compared to the reality of the trenches, but here the censor reigned supreme and all that the home folks received were vague statements in letters defaced by razor blades and ink. Within a few months after U.S. entry into the war, the flow of information to the media from the doughboys began to dwindle as the recruits were warned not to write the "inside dope" and the government ordered that military personnel could not act as correspondents for newspapers.[60] The results were predictable. Private Bretag wrote from Waco:

> I just read an article . . . out of a Milwaukee paper describeing [sic] this hospital we are in, was sure great. It stated we had the best of cooks which is a very good joke.[61]

For the Northwoodsman, military life meant a sharp circumscription of his freedom. The propaganda mills had long ground out the message that Prussian obedience and discipline were anathema to the American spirit, but after April 1917, as one Barron County doughboy reported, the boys were taught that obedience was the highest virtue.[62] "Rigid discipline was required in everything, even games," which dazed the newcomers; as one of them wrote after four days at camp,

> Lots of the boys would leave right now if they had a chance but nothing doing. . . . New rules new regulations and everything done under a system.[63]

By reading the correspondence of Rusk County veterans, one can see that they felt enmeshed in regulations. Topics of complaint included: drill; lack of leisure time; not being allowed to wear homemade sweaters because not all the men had them; being given a week of fatigue duty for failing to request a pass from a high enough officer; a month of hard labor and the guardhouse for participating in a friendly scrap; and a week's confinement to troop street for staying out too late. Where possible there was resistance, but never victory; Private Bretag recounted that

> some of the fellows has been in the habit of covering up there [sic] dirty clothes with clean ones and the major looked them over this a.m. The result is that some of them have something coming.[64]

In some respects the doughboys could breathe easier after they left Wisconsin. Beneath the parental gaze of Governor Philipp and the folks back home, Camp Douglas had been so tightly sealed that not even the newsboys could enter. "While we are well fed and not over worked," wrote a Rusk County volunteer, "we have some idea of what a prison camp would be."[65] This feeling of incarceration was not entirely accounted for by the three-mile *cordon sanitaire* encompassing the camp, nor yet by the discipline or the quarantines due to infectious diseases. State planning had been weak. There was little training, no ammunition, much boredom, and, for a short time, half rations.[66] To be fair, not all men found the experience unpleasant, for as Private Bretag said after cataloging some new regulations, "It may seem very foolish . . . and it seems very queer to us . . . yet I can't say I don't like it [army life]."[67]

Although the country more thoroughly understood the importance of discipline once the nation was involved in the war, the American Expeditionary Force never matched European standards of military nicety, and even the *Stars and Stripes* made jests on this topic.[68] Many veterans would argue that in their youth discipline, both in school and on the job, had been harsh, yet the difference was that the army regimentation was not merely a restricting, but a standardizing process out of which the mass man of the century would appear.

In many cases the attitude of recruits toward discipline was determined by the relationship between the officers and their men. With the outbreak of hostilities, the National Guard was mobilized and expanded preparatory to being placed under federal authority. The Adjutant General of the State recommended, and the Governor approved, the commissioning of many new captains and lieutenants who were then summoned to Milwaukee for a few weeks of training. This accomplished, the captains were free to appoint other officers who in turn were sent downstate for training.[69]

Interviews with Northwoods veterans, most of whom came from low socio-economic backgrounds, suggests that there was some discontentment over this selection process. Officers were drawn from the wealthier, better educated segment of society, which in the small communities of the area meant the "uptown people" or businessmen, and from the larger urban centers. Undoubtedly, local politics were another ingredient in selection and promotion.[70] Nevertheless, at the time, ill will was concealed, leaving an esprit based upon their shared background. Commanders of contingents from small northern Wisconsin towns might view themselves as *in loco parentis;* Captain A. H. Hadden wrote home from Camp Douglas to his local paper in this vein: "If the boys do not write home, let me know of it. They do not need to tell me when home folks do not write."[71]

As units arrived at Camp Douglas, Wisconsin, questions arose as to whether the new officers were qualified to fulfill their duties. Several were demoted, but all too often the replacement officers were from the southern part of the state. This caused some irritation. As one veteran recalled, "It is true that we suffered some from being an 'Upstate Troop'—our officers replaced by Milwaukee men."[72]

This situation altered again when the Wisconsinites passed into the jurisdiction of the regular army. Once again, locally-appointed officers were scrutinized for fitness, and some enlisted men who were successful in passing written examinations were raised to the rank of second lieutenant by the division commander. These officers were trained in the evening after drill and were called "ninety day wonders" by the men.

Transfers and demotions were to continue. "Some of these new sergeants," wrote Private Bretag, "just can't find a hat big enough for their heads and they try to show their authority like young roosters learning to crow."[73] Higher officers were not immune from dismissal, as this letter showed:

> We are going to loose [sic] our captian [sic] again. Every captian [sic] in our three artillery regiments are going to be changed. They say its because the old captians are to [sic] well acquainted with the men and are apt to show partiality. I guess there is a good deal in that.[74]

To the folks back in Rusk County the tidings of demotion, forced retirement, and even court-martial of their heroes caused cries of indignation. Widespread dissatisfaction was expressed in the press:

> This is being done by regular officers, to whom a man from Hicks Corners, Milwaukee or Frisco looks all the same. The idea of local patriotism is a foreign subject—he only wishes to create a fighting machine and men are only so much blood and iron.[75]

In general, the uprooting of the average recruit from the Rusk County area and his arrival at training camp was a memorable experience. Of those veterans interviewed, over one-third left Wisconsin for the first time when they joined the Army, while ten percent left their counties for the first time. Most Rusk County doughboys had traveled by train before their enlistment, which was not true for many recruits.[76] Railways were very important in the north and had been used in immigration; among the veterans questioned in this study, the average year for a first train trip was 1907, when most of them were still children.

Automobile travel, on the other hand, was another matter. Maintainance of both vehicles and roads in the north was a major expense, a problem which hindered the state in meeting its quota of experienced drivers for the military.[77] In the Rusk County area, 1921 was the average year of purchase of the first car among those veterans questioned.

America in these years revealed a growing disdain for rural society, for the drabness of village and small town life, and for the 'hick,' clumsy and stupid, who was equated with the farmer. "Much of the contempt of rural life," suggested one writer, "represented a larger revolution against . . . Puritan moralism."[78]

One out of four veterans questioned recalled some incident of anti-rural prejudice in the army, and in turn one discerns a certain deference by Northwoodsmen toward urban society. The highest ranking officer of Rusk County, a captain and successful lawyer, reported that he was

> over-awed when he considere[ed] that he [was] superior in rank to some of Chicago's finest lawyers, bankers, and preachers. At first . . . he almost hesitated at commanding a bank president or preacher to clear up cigarette or cigar butts.

Or again, when Troop K from Ladysmith arrived at Camp Douglas in their new uniforms which the County had purchased, one man wrote, "We looked so good in our nice clothes that we were mistaken for the Milwaukee ('A')."[79]

To loggers, farmers, and semi- and unskilled workers in Rusk County, school attendance was far less important than earning a livelihood. An eighth grade education was the norm, and a high school diploma was a rarity. One sergeant from Bruce, Wisconsin, recalled that only five out of a company of 150 were high school graduates. It was believed that the urban environment held more educational possibilities; thus one Northwoodsman, after acting as scribe for a stranger, wrote home, "It certainly is a shame that a young fellow coming right from the city . . . hasn't any better education than he has." At camp the recruits were given written examinations, and Wednesdays, Saturdays and Sundays were partially set aside for the "training of backward individuals."[80] Book drives back home helped in establishing libraries at the camp YMCAs; however, one soldier observed that they were definitely underutilized. While on duty, some men were given an opportunity for self-improvement. For example, a company of National Guard from Barron County, stationed in Superior to protect the ore docks, could take courses in such subjects as hippology, military cartography, shorthand, and typing, though fewer than half of them ever did so.[81]

To be at a disadvantage vis-à-vis the city dwellers was one thing, but to be considered unpatriotic by them was an outrage. A statement by Mr. E. D. Hurlbert, president of the Merchant's Loan and Trust Company of Chicago, which was circulated in the Rusk County area, said, "Farmers will not buy Liberty Loans, pay taxes, sell their produce or fight."[82] Thus, when a Four Minute Man arrived to preach patriotism in Ladysmith, the response was quite peppery, as in this editorial from the *Rusk County Journal:*

> The small caliber flunky, Julian S. Nolan, of Chicago, was sent to tell us lumberjacks what patriotism is. . . . Now, we don't care a darn for Nolan—a nobody coming from a town that is full of them.[83]

Local pride rested not only on patriotic efforts, past and present, but also upon the virtues of Northwoods fighting men. Chief among these were strength and physical endurance. Although labor shortages were acute, rural editors chuckled over the proposal that soft city kids should be organized as farm workers, and crowed when the attempt failed. And compared to agricultural work, a doughboy's life was a perpetual vacation, at least Stateside. "Drill five hours and up at 7:00," wrote Private Bretag, "we are sure having it easy now and I sure hope it continues." Ten days later he declared, "Oh yes, I am getting heavier then [sic] I was. I always do when I quit hard work."[84] Another private, Orville Shannon, spelled out his contentment in this manner:

> Well army life is sure easy. All we have to do is drill every day and eat three times a day and sleep all night; now if you can[,] find an easier job than this for $30 per month and no chance to get fired.[85]

Over all, the most important impact upon the Rusk County area doughboy was the socialization and acculturation he experienced. With the exception of the veterans who had been wounded, most interviewees in this study declared that the war had not changed their lives greatly. However, after further investigation, it was evident that their understanding of the world had indeed changed.

From their first stop at Camp Douglas, Wisconsin, and from the federal training facilities across the nation, the recruits sent home a torrent of memorabilia and photographs, mostly of the men themselves in their new woolen uniforms, and of such exotica as skylines of Hoboken and Abilene. They also penned tales of army cookery to weaken the stomach and stories to illustrate that everything Uncle Sam bought was the cheapest. But above all, there was a shock from the new turn life had taken; as Private Allen Cooper of Barron County wrote, "I can't make myself believe I am away down in Georgia in the Army with U.S.A. on my collar."[86]

The men of the Rusk County area were thrown into contact with a broader spectrum of society than existed back home. For the first time, many of them had contact with large numbers of Blacks. Five draft calls in Wisconsin had produced only twenty-five

Negroes; thus they were at first photographed along with other sights of interest.[87] But social intercourse was impossible, as the military instructed soldiers to steer clear of Negro neighborhoods in the light of potential racial conflicts. There was, however, some opportunity to become better acquainted with Wisconsin Indians who had volunteered and at many camps a Continental flavor was supplied by the presence of numerous Allied officers.

A high mark in the peripatetic lives of the men—dwelt upon in letters to the home folks—was the arrival at one of the major training facilities. These camps, compared to Camp Douglas, were well constructed and had electric lights, an item considered to be "real class" by Rusk County men.[88] But after the novelty of their new surroundings had worn thin, homesickness revealed itself. For example, a Barron County man said he "would not trade the west end of Cedar Lake for Texas and Arizona, sagebrush, coyotes and sand 6 inches deep."[89] From Private Cooper at Camp Greenleaf, Georgia, came the similar comment, "If I had ten acres of Wisconsin I wouldn't trade it for the whole d--n state [of Georgia]," while Private Bretag wrote from Texas, "Im getting tired of the sameness of the landscape and long for the big timber. We don't have grand refreshing days as you have in Wisconsin."[90]

A natural reaction of the country boys was to appraise the agricultural potential of other states; some states given high marks were Oregon and Missouri, but Mississippi and Texas soil were rated poor.[91] They were delighted with their first views of cotton fields and outraged at scorpions, and discovered the discomforts of adjusting to different climatic conditions.

Southern ways were both pleasing and exasperating to the Wisconsinites. "They talk as lazy as they act," wrote one man, and as for the languid southern belles, his verdict was that they had "no get up and dust."[92] A Rusk County editor who visited the local volunteers at Waco, Texas, sent back a similar appraisal:

> Here was another characteristic feature of the South. 'Do It Now' signs would have little sale here. Southerners are forward looking, always ready to chance on tomorrow.[93]

But a different view was stated by one engineer: "After making this trip of the entire South, I have an altogether different view of it. . . . They sure are great on hospitality."[94]

In general, the men of the Rusk County area had experienced an exciting cultural awakening. Discoveries of all sorts were made, as Private Orville Shannon, stationed in Oregon, indicated:

> When you speak about the nice garden I get the rambles. . . . I sure do like fresh garden truck but we have something out here that almost holds it level and that is fresh salmon.[95]

A popular song in the post-war era was "How Ya Gonna Keep 'Em Down on the Farm after They've Seen Paree?" There is no doubt that the flight from rural America was a reality, but was it stimulated by the sight of Paris or by the stateside equivalents? Some men of Troop K were impressed with the size of New Orleans, the beauty of Atlanta and Washington, D.C., and the historical qualities of Nashville, and there were even a few who resettled abroad or in some newly-discovered community in America after the war. Twenty percent of the veterans questioned for this study stated they were favorably impressed by the cities they visited, while thirty-six percent felt they had not had enough opportunity to judge, since many of the troop trains bypassed the big cities and the officers at camps kept the men on a short lead. About seventy-five percent of these veterans reported they had intended to return home to stay after the war, as opposed to ten percent who had not. In fact, over fifty percent returned to their home communities to remain for stays averaging sixteen years.[96]

Those who left their hometowns after a short stay cited economic conditions as the primary motive for departure. Perhaps one laconic Rusk County man spoke for most when he wrote, "Me for the farm when I'm thru here."[97]

In conclusion, what emerges is the picture of an area which initially remained aloof from the problems of war, but which mobilized energetically when hostilities were declared. This potent spirit of patriotism with its admixture of parochialism often manifested itself in animosity toward the State's capitol, and in strong community support for the local doughboys, even including attempts to exert moral influence over them at camp.

Of interest, too, are the antagonisms which developed under pressure of the times, such as those of volunteers against draftees, '100% patriots' against things foreign, and rural versus urban society. Finally, although the training period for the average individual may have been relatively brief, and in retrospect seemed of less consequence than battlefield experience, it was of great importance in the cultural shaping of the raw recruits from the Northwoods.

The experience of Rusk County illustrates how the discipline resulting from the national crisis touched both the doughboys and the homefolks, and contributed to the shaping of the new mass man of the twentieth century.

Notes

[1] Marching song included in a letter from Private William Bretag, Camp McArthur, Waco, Texas, 2 November 1917, to Miss Eva Ross of Ladysmith, Wisconsin. In personal correspondence collection of Mrs. Eva Ross Bretag, Ladysmith, Wisconsin (hereafter shown as Bretag Correspondence).

[2] Lieutenant Gerald C. Maloney, *Rusk County in the World War* (Ladysmith, Wisconsin: The Rusk County Journal, 1920), p. 19. Maloney pointed out that 1 out of 25 Americans, as a national average, were in the armed forces, while in Wisconsin the ratio was 1 in 22, and in Rusk County it was 1 in 20.

[3] *Ladysmith News-Budget,* 28 August 1914, p. 1.

[4] Edward Fitzpatrick, *Wisconsin* (Milwaukee: Bruce Publishing Co., 1928), p. 253. For example, in neighboring Barron County the *Barron County* Shield ran a weekly column entitled "In the Fatherland: Interesting Bits of News from the Great German Empire," which was discontinued when the U.S. became involved.

[5] Questionnaire from Clarence E. Soderberg, of Barron, Wisconsin, December 1978; questionnaire and correspondence from E. A. Preston, of White Bear Lake, Minnesota, 7 and 15 December 1978; questionnaire and correspondence from Allen W. Cooper of Hillsdale, Wisconsin, 1978; questionnaire from Henry A. Plagge, of Holcombe, Wisconsin, 15 October 1978.

[6] George Kolar recalled that, on the other hand, some National Guardsmen who were called up in June 1916 for service on the Mexican border privately believed that they were actually being trained for European duty, a very unpopular idea. From conversations and tape recordings of George Kolar, of Ladysmith, Wisconsin, 12 November 1978.

[7] *Rusk County Journal,* 9 February 1917, p. 4. The *Barron County Shield* concurred (8 February 1917, p. 8).

[8] Karen Falk, "Public Opinion in Wisconsin During World War I," *Wisconsin Magazine of History* 25 (June 1942): 390.

[9] Russel Austin, *The Wisconsin Story* (Milwaukee: Milwaukee Journal Co., 1964), p. 298.

[10] David Thelen, *Robert M. LaFollette* (Boston: Little, Brown, 1976), p. 134.

[11] *Sawyer County Record,* 15 March 1917, p. 2.

[12] Richard N. Current, *Wisconsin: A History* (New York: W. W. Norton, 1977), pp. 211-12.

[13] Falk, "Public Opinion," p. 399; *Wisconsin Blue Book for 1919* (Democrat Printing Co., 1919), p. 417.

[14] *Rusk County Journal,* 11 January 1918, p. 1.

[15] This point of view was stated by the manager of the Wisconsin Development Association (*Ladysmith News-Budget,* 17 April 1917, p. 5).

[16] *Rusk County Journal,* 8 June 1917, p. 4.

[17] Drawn from tables in *Wisconsin Blue Book for 1919,* pp. 420, 431-32.

[18] Henry May, *End of American Innocence* (Chicago: Quadrangle Books, 1967), pp. 387-88.

[19] Oscar Barck and Nelson Blake, *Since 1900: A History of the U.S. in Our Time* (New York: Macmillan, 1965), pp. 231-32. Most of those convicted under these laws were Socialists and IWW members. About ninety-two persons were arrested

in northern Wisconsin on slight provocation indeed [Robert Nesbit, *Wisconsin* (Madison: University of Wisconsin Press, 1973), p. 447].

[20] H. C. Peterson, *Propaganda for War* (Norman: University of Oklahoma, 1939), p. 173.

[21] *Ladysmith News-Budget,* 2 March 1917, p. 2, and also 9 March 1917, p. 1; *Rice Lake Chronotype,* 12 April 1917, p. 4; *Ladysmith News-Budget,* 26 October 1917, p. 2.

[22] *Ladysmith News-Budget,* 16 February 1917, p. 2.

[23] Bretag Correspondence.

[24] Citizens of German Descent, "American Loyalty" (Washington, D.C.: War Information Service, 1917), pp. 5-8. Preserved among the papers of Henry Plagge.

[25] The Germans of Tony, Wisconsin, received this appellation, according to one interviewee, Mrs. Alice Reimert, of Ladysmith, Wisconsin, 30 December 1978. Elsewhere people were allegedly arrested because they persisted in speaking their native tongue (questionnaire from Henry Plagge, Holcombe, Wisconsin, 15 October 1978). This phenomenon recurred throughout the United States [Robert Billigmeier, *Americans from Germany* (Belmont, Cal.: Wadsworth Press, 1974), p. 143].

[26] *Barron County Shield,* 12 April 1917, p. 4; *Phillips Bee,* quoted in the *Rusk County Journal,* 25 January 1918, p. 4.

[27] *Rusk County Journal,* 25 January 1918, p. 4.

[28] Maloney, *Rusk County,* p. 3.

[29] *Ibid.,* p. 5.

[30] May (*End of American Innocence,* p. 371) suggests that the middle class felt an instinctive dislike for kings and aristocrats, thus their enlistment.

[31] *Ladysmith News-Budget,* 17 April 1917, p. 5.

[32] Questionnaire from E. A. Preston. The Northwoods was a prime recruiting ground for engineering and forestry regiments.

[33] In all, seven of the twenty-nine northern counties of Wisconsin were passed over in the first draft since their quotas had been filled by volunteers; *Ladysmith News-Budget,* 27 July 1917, p. 2. Price County was conspicuous with 200 volunteers [R. B. Pixley, *Wisconsin in the World War* (Milwaukee: S. E. Tate, 1919), p. 106].

[34] *Ladysmith News-Budget,* 27 July 1917, p. 3.

[35] Miss Eva Ross to William Bretag, 16 August 1917, in Bretag Correspondence.

[36] William Bretag to Miss Eva Ross, 21 November 1917, in Bretag Correspondence.

[37] Maloney, *Rusk County,* p. 19.

[38] William Bretag to Miss Eva Ross, 18 August 1917, in Bretag Correspondence.

[39] Ibid., 25 September 1917.

[40] "Only a Volunteer," in Bretag Correspondence.

[41] *Ladysmith News-Budget,* 5 October 1917, p. 2.

[42] William Bretag to Miss Eva Ross, 12 November 1917, in Bretag Correspondence.

[43] Ibid., 19 November 1917 and 2 November 1917.

[44] Nesbit, *Wisconsin,* p. 447.

[45] In fact, not enough men could be found, so that companies from the south had to be included (Pixley, *Wisconsin,* pp. 21-22).

[46] William Bretag to Miss Eva Ross, 23 November 1917.

[47] Maloney, *Rusk County,* p. 6.

[48] William Bretag to Miss Eva Ross, 1 August 1917. Unhappily, the County had purchased shoddy merchandise and in short order they were rechristened "the Sears and Roebuck troop."

[49] Charles Genthe, *American War Narratives 1917-1918* (New York: David Lewis, 1969), p. 30.

[50] Frank Friedel, *Over There* (Toronto: Little, Brown and Co., 1964), p. 27.

[51] William Bretag to Miss Eva Ross, 7 November 1917, in Bretag Correspondence.

[52] *Ladysmith News-Budget,* 28 September 1917, p. 4.

[53] William Bretag to Miss Eva Ross, 29 July 1917, in Bretag Correspondence.

[54] *Ibid.,* 7 August 1917.

[55] *Sawyer County Record,* 7 June 1917, p. 3.

[56] William Bretag to Miss Eva Ross, 23 November 1917, in Bretag Correspondence.

[57] *Ibid.,* 15 August 1917, 19 October 1917, and 10 January 1918.

[58] *Ibid.,* 24 January 1918.

[59] *Ibid.,* 17 October 1917 and 7 November 1917.

[60] *Ibid.,* 14 September 1917; *Ladysmith News-Budget,* 7 September 1917, p. 2.

[61] William Bretag to Miss Eva Ross, 12 October 1917. Some interesting anecdotes on the science of military medicine of the period can be found in these letters.

[62] Genthe, *Narratives,* p. 36; Private Allen Cooper to his parents, 27 October 1918, in Cooper Correspondence in Mr. Cooper's possession.

[63] Joint War Historical Commissions of Michigan and Wisconsin, *The 32nd Division in the World War: 1917 to 1919* (Madison, 1920), p. 31; William Bretag to Miss Eva Ross, 1 August 1917, in Bretag Correspondence.

[64] *Ibid.,* 19 October 1917; 23 October 1917; 19 November 1917; 18 August 1917, 1 December 1917.

[65] Maloney, *Rusk County,* p. 119, letter of E. W. Richardson.

[66] William Bretag to Miss Eva Ross, 1 August 1917, in Bretag Correspondence.

[67] William Bretag to Miss Eva Ross, 1 August 1917, in Bretag Correspondence.

[68] Genthe, *Narratives,* p. 87; Preston Slossen, *The Great Crusade and After* (New York: Macmillan, 1930), p. 47.

[69] *Ladysmith News-Budget,* 22 June 1917, p. 1.

[70] Questionnaires from Albert A. Johnson (Cameron, Wisconsin), George Kolar, and Allen Cooper. Approximately one in four of those questioned could be said to have harbored some resentment over the process of officer selection. The impact of local politics was asserted, for example, by Jim Carlson, of Cumberland, Wisconsin, in his questionnaire in December 1978.

[71] *Ladysmith News-Budget,* 17 August 1917, p. 1.

[72] From correspondence with E. A. Preston, December 1978. Also, William Bretag to Miss Eva Ross, 28 September 1917, in Bretag Correspondence, relates the arrival of Milwaukee officers in their unit.

[73] William Bretag to Miss Eva Ross, 31 December 1917, in Bretag Correspondence.

[74] *Ibid.*

[75] *Ladysmith News-Budget,* 5 October 1917, pp. 1-2.

[76] Slossen, *Great Crusade,* p. 36.

[77] *Rusk County Journal,* 25 January 1918, p. 1. In 1917 there were 160,000 registered vehicles in Wisconsin (*Ladysmith News-Budget,* 5 October 1917, p. 2).

[78] Howard P. Chudacoff, *The Evolution of American Urban Society* (Englewood Cliffs: Prentice-Hall, 1975), p. 180.

[79] *Ladysmith News-Budget,* 5 October 1917, p. 4; 5 August 1917, p. 1.

[80] Conversation with Sergeant Ralph D. Jenkins, of Bruce, Wisconsin, in November 1978; William Bretag to Miss Eva Ross, 25 September 1917, in Bretag Correspondence; *ibid.,* 10 September 1917 and 28 September 1917.

[81] *Rice Lake Chronotype,* 26 April 1917, p. 7.

[82] *Ladysmith News-Budget,* 26 October 1917, p. 2.

[83] *Rusk County Journal,* 7 December 1917, p. 4.

[84] William Bretag to Miss Eva Ross, 25 October 1917 and 4 November 1917, in Bretag Correspondence.

[85] Orville Shannon at Fort Stevens, Oregon, to his sister Mrs. Joyce Matthews, 11 April 1918, in correspondence collection of Mrs. Joyce Matthews of Ladysmith, Wisconsin.

[86] Allen Cooper to parents, 18 September 1918, in Cooper Correspondence.

[87] *Wisconsin Blue Book for 1919,* p. 340.

[88] William Bretag to Miss Eva Ross, 14 September 1917, in Bretag Correspondence.

[89] *Barron County Shield,* 16 August 1917, p. 1.

[90] Allen Cooper to parents, 24 September 1918, in Cooper Correspondence; William Bretag to Miss Eva Ross, 5 November 1917, in Bretag Correspondence.

[91] Eldon Shannon at Camp Shelby, Mississippi, to his sister Mrs. Joyce Matthews, 16 November 1918, in Matthews Correspondence; William Bretag to Miss Eva Ross, 31 October 1917, in Bretag Correspondence.

[92] *Ibid.,* 31 October 1917 and 19 November 1917.

[93] *Rusk County Journal,* 8 February 1918, p. 3.

[94] *Ladysmith News-Budget,* 27 August 1917, p. 6.

[95] Orville Shannon at Fort Stevens, Oregon, to his sister Mrs. Joyce Matthews, 15 July 1918, in Matthews Correspondence.

[96] A fuller study which included American veterans of both World Wars indicated that only twenty-five percent of returning veterans moved away from their home counties [Peter Karsten, *Soldiers and Society* (Westport, Conn.: Greenwood Press, 1978), p. 32].

[97] Maloney, *Rusk County,* p. 120.

ARTS SUPPORT GOES PUBLIC IN WISCONSIN

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The State of Wisconsin holds the distinction of being the last state in the Union to achieve a statutory agency for the arts. Yet, it was one of the earliest states to explore the concept of a state council. Why the delay?

Is this a classic case of "the first shall be last"? Was it due to ineptitude, mismanagement, apathy? Is the delay an example of the ability of Wisconsin citizens to discuss everything into a comatose condition? Was it lack of political acumen?

Some of these and none of them. We shall leave the finger pointing for future historians and attempt in this paper only to chronicle briefly the long, tortuous and often heartbreaking efforts of many dedicated men and women who worked for nearly two decades to make recognition of the arts a legitimate concern of the state.

From papers of the period and recollections of those involved, come the patterns of interest in developing an organized citizen support for the arts.[1] In 1953, Extension Arts Professor Robert E. Gard was in England examining the activities of the British Arts Council. He returned to discuss the idea with Extension Dean Lorenz H. Adolfson, who appointed a committee chaired by Extension English Professor George B. Rodman to explore the concept.

Origin of the Wisconsin Arts Foundation and Council

On December 3, 1956, representatives of a variety of cultural organizations met in Madison to review the need for a statewide council for the arts, to determine what purposes it could serve beyond those of the Extension Division, to decide how best to organize, and who should be invited to membership. As a result, the Wisconsin Arts Foundation and Council was incorporated on May 2, 1957. The word "foundation" was included in the hope that a capital fund might eventually be established on behalf of the arts.

People instrumental in these early developments included Robert Gard, who was elected president in January 1958, Robert Schacht, S. Janice Kee, Helen Lyman, William W. Cary, LaVahn Maesch, David H. Stevens (newly retired head of the Rockefeller Foundation arts and humanities division), Mrs. B. C. Ziegler, Eli Tash, James Schwalbach, Walter Meives, George Foster, Elmer Winter, Al P. Nelson, Edward H. Dwight, William Feldstein, Mrs. Mary John, Mrs. Lela Smith and G. Ellis Burcaw.[2]

Other groups in the state, beyond the original organizers, became interested. Movements to create state arts councils were gaining momentum throughout the country as a result of the successful community councils that had been functioning for 25 years or more. In New York, the state legislature was in the process of discussing a state arts council. Canada had already passed the Canada Council Act.

In 1959, Gard took a year's leave of absence and Mrs. Bernard Ziegler, vice president, headed the organization until the membership meeting in November 1959 at which William W. Cary, public relations director of the Northwestern Mutual Insurance Company, was chosen president. Mrs. Ziegler obtained the services of counsel for drafting by-laws and obtaining tax exempt status under Internal Revenue rulings. Cary began a Quarterly Arts Calendar which for more than a decade faithfully listed cultural activities over the entire state.

The group established a pattern of arts seminar meetings around Wisconsin. For example, in 1959, the annual meeting was held in Appleton where contralto Maureen Forrester was appearing in a concert at Lawrence College. The membership also heard an address by University of Wisconsin graduate Charles C. Mark, then executive secretary of the Winston-Salem, North Carolina, Arts Council.

The annual meeting in November 1962 was held at the Johnson Foundation headquarters at Wingspread in conjunction with a conference entitled "Common Threads in Contemporary Art." This national assembly on the arts was initiated by the Extension Division with Professor Edward L. Kamarck chairing the faculty planning committee, and was one of the first such interdisciplinary meetings in the country.

By 1963, the idea that the federal government should become involved in support of the arts was encouraged by the report of August Heckscher to President John F. Kennedy, entitled "The Arts and the National Government."

A month after the Heckscher report the *New York Times* published a national study about arts development around the nation. Sometimes when the *New York Times* looks beyond the Hudson, it becomes nearsighted. Wisconsin, it claimed, was "a cultural dust bowl" because the state had been laggard in developing a state-wide planning effort for the arts.[3]

Of course the judgment entirely overlooked the pioneering impact on national cultural patterns from the University of Wisconsin's long and innovative support of activities such as the artist-in-residence and radio station WHA, the "oldest station in the nation," which had filled the air waves for years with "Music of the Masters" and "Chapter A Day." It took no account of the rich cultural growth from ethnic roots which has never been allowed to wither in Wisconsin.

Not having a Rockefeller up the Hudson to help develop our cultural potential, Wisconsin had no official state arts council—but neither did many other states. Wisconsin was not a cultural desert; it just needed watering.

Governor's Council on the Arts

Governor John Reynolds may have been somewhat annoyed by the *New York Times* statement which was widely quoted. Perhaps, and more probably, given the nature of political pressures, someone influential in the arts reached the governor, and said loudly, "Do something!"

Reynolds acted. In the fall of 1963 apparently without reference to the existence of the Wisconsin Arts Foundation and Council, he created a Governor's Council on the Arts to "call attention to public events and exhibitions in the performing arts, issue a bimonthly digest of current cultural events and displays, to serve as liaison for public and private organizations concerned with the arts and to issue awards to citizens who have attained distinction in the arts."[4]

Dean Adolph A. Suppan of the University of Wisconsin-Milwaukee was appointed chairman by the Governor. Suddenly, there were two organizations in Wisconsin struggling to further the cause of the arts, statewide.

Without funding the Governor's Council had difficulty being effective but at the May meeting at Wingspread it established several committees, including one on awards, as directed by the Governor. Dr. Abraham Melamed of Milwaukee chaired the committee. The Governor's Council also urged support for the bill to establish a National Council on the Arts which had just passed the United States Senate and was pending in the House.

Governor's Awards

By September 9, 1964, the Governor's Awards Committee reported nominations for recognition in six categories: the arts in general, the visual arts, music, drama, literary arts, dance, and, in addition, a special citation and award. Governor Reynolds agreed to host a dinner at the Governor's Mansion on October 8 when the announcement of the arts awards to citizens was to be made. The dinner was given as scheduled, although the Governor was unable to attend. The citations represent the first major notice by the State of the contributions of the arts to Wisconsin society.

All of this activity and public notice was not well received by the Wisconsin Arts Foundation and Council. On September 28, 1963, meeting at Janesville, the Board instructed George Richard, Secretary, to write to Governor Reynolds. He said "since it seemed clear your advice on planning the Governor's Council did not provide you with a thorough background on the related developments in the arts area, our board of directors and arts committee thought it advisable to let you know something about . . . the Wisconsin Arts Council"[5]

Bewildered by the Governor's Arts Council, the WAFC discussed the possibility of formal liaison with the "political group." They agreed, however that nothing should be done until the Governor's Council had longer experience and had formulated its goals and objectives more explicitly.

Mrs. Carl T. Wilson, director of the Door County Festival, was a member of both the WAFC and the Governor's Council. In March 1964, at Mount Mary College, Milwaukee, she told the WAFC board that her first impression was that the Governor's Council was to concentrate on promotion of Wisconsin arts activities outside the state. WAFC members foresaw conflicts between the two groups with confusion inevitable in the public mind.

The WAFC also had internal problems. At another Wingspread meeting in November 1964, persistent absenteeism on the part of Board members and continuing resignations prompted a resolution that directors would be expected to attend at least fifty percent of the Board meetings.

Times changed. A new election brought Warren P. Knowles to the Governor's post. He abandoned the idea of an appointed Governor's Council on the Arts and instead requested the WAFC Board to recommend nominees for eight governor-appointed board members to their organization. The WAFC changed its by-laws making the Governor an ex-officio director of the corporation with power to appoint eight directors.

WAFC Designated Federal Agency

On April 2, 1965, Governor Knowles designated the Wisconsin Arts Foundation and Council as the official state coordinating group for the arts.[6] This was a tremendous step forward, but there was still no tax money to implement the challenge.

Once again the Johnson Foundation stepped in with help and offered $5,000 for support of a "summit conference" at Wingspread to be attended by art delegates from seven regions of the state. The conference was in part a response to the passage of federal legislation which had created the National Endowment for the Arts. It was also conceived as an effort to involve the whole state in determining goals for long-term art growth. The University Extension assumed responsibility for organization and promotion of the effort. William Cary and Edward Kamarck chaired the program and eight regional meetings were held before the culminating conference at Wingspread, entitled "Project: Wisconsin and The Arts" on November 20, 1965. The session in Madison was recorded by Lee Sherman Dreyfus.

At the Wingspread meeting, nearly 80 state and national leaders assembled. Among the speakers were Julius Bloom, Executive Director of Carnegie Hall, who gave the keynote address on "Our Cultural Economy," and Ralph Burgard, Executive Secretary of the Arts Councils of America. The proceedings were published in a handsome booklet.

Throughout 1965 the WAFC was busy. It decided to continue the Governor's Awards and developed a "Festival Planning Booklet." In cooperation with the State Free Library Commission a bibliography was prepared called "The Arts Are For All," which recommended basic art study materials for every public library. The Wisconsin Federation of Women's Clubs undertook to see that all state public libraries would receive them.

In February 1966, President Cary attended meetings in Chicago, sponsored by the National Endowment for the Arts, and reported "WAFC is doing about as much as any state council, excluding four or five which have state appropriations." He also found that a $25,000 "study grant" from the Arts Endowment would be available to Wisconsin.[7] The Johnson Foundation again helped with "seed money" to implement the use of the federal funds.

In July 1966, WAFC Vice President George Richard became executive director with responsibility for directing the study. The funds were to support a staff and office for nine to twelve months. The state study group was divided into three task forces as follows: Task Force I—to explore the advisability of forming a state arts agency, Task Force II—to explore creation of a statewide cultural inventory; Task Force III—to explore the Wingspread conference recommendations pertaining to the arts in education. Eleven statewide meetings were arranged between September 17 and October 15. By the November annual meeting a plan was outlined with legislative as well as gubernatorial blessing to support the formation of a state arts agency.

Program suggestions arising from the study included forming pilot touring companies in the performing arts, encouraging greater communication in the arts, establishing more local arts councils and local arts festival workshops, and continuing the work of Task Force III on educational needs in the arts. An appropriate budget was proposed: office —$50,000, calendar and information services — $30,000, regional assistance — $30,000, pilot touring projects—$100,000.

Task Force I reviewed three possible options for the WAFC organization: To continue WAFC with legislative support; To reorganize WAFC into a state agency; To form a new agency. On November 5, 1966, Charles McCallum reported that the task force he chaired recommended the third option, formation of a new non-membership organization with a board appointed by the Governor. Presumably, legislators would not support a membership organization and the chance of obtaining legislative approval was better for a standard state agency than for a hybrid.

Meantime, there was some progress on the state level.

Senate Bill 30 was introduced in the 1967 Wisconsin Legislature, at the request of Governor Knowles, by Senators Jerris Leonard of Milwaukee and Fred Risser of Madison, and Assemblywoman Esther Doughty of Horicon. The bill called for the establishment of a fifteen member state arts commission to be called the Wisconsin State Arts Council. The Council was to establish public policy on encouragement of the arts in Wisconsin and the bill provided specific safeguards for freedom of artistic expression.

The measure provided for a state appropriation of $25,000 for each year of the 1967-69 biennium—the minimum necessary to establish an administrative office to: 1. Act as an information exchange agency for state arts groups and individual artists. 2. Make available for arts activities (sponsored by organizations and institutions in Wisconsin) up to $50,000 a year in grants from the National Endowment for the Arts. 3. Help arts organizations in Wisconsin to obtain private contributions and other federal aid. 4. Work with federal, state and local agencies and private organizations and institutions in strengthening the arts, and education in the arts, in Wisconsin.

Senate Bill 30 was referred to the Legislature's Joint Committee on Finance, chaired by Republican Senator Walter G. Hollander of Rosendale and Republican Assemblyman Byron Wackett of Watertown.

Hope for passage of the bill ran high, not only because of the intrinsic value of the legislation but because broadly based support for the concept of state involvement in the arts had been expressed in the 1965 and 1966 regional meetings. There was also the implicit understanding that if state action were not taken to establish an adequately financed administrative framework, the state might lose opportunities for obtaining federal funds.

There were still problems. In March 1967 the WAFC Board passed a motion to approve all actions taken during the preceeding 12 months at meetings at which a quorum was not present. The need for this action suggests why, despite all the meetings and the effort expended in the sixties, the WAFC was never quite able to succeed in its mission.

By August 1967, the Johnson Foundation grant was running out and money to support the necessary administration and WAFC funds were gone. The Board decided to write the membership for emergency assistance. Also, at the August meeting, a new need for arts development support appeared. Requests for help came from some several "inner city" groups—perhaps a reflection of the turmoil in the American cities which had erupted during the hot summer of 1967.

There was considerable gloom at the November annual meeting. The year which had begun so well was ending in disappointment. About $1,800 remained in the treasury. The Legislature had recessed without taking action to establish a statutory arts agency. The WAFC Board faced the need to raise administrative funds to allocate the federal grants; this need put WAFC in direct competition with the very groups it was trying to help. The newsletter headline was "Gray Day for the Arts in Wisconsin" and the text stated that only Mississippi, Delaware and American Samoa were as "behindhand" as Wisconsin in setting up state-supported arts programs. Nevertheless, continuing efforts by the WAFC to provide service were documented in a series of printed reports from the Wisconsin Arts Resources Study committee.

In 1968, the agency continued to function, receiving and dispensing federal funds and attempting to raise private money for administrative needs. Funding became so acute for the office that at the July 1968 meeting at Spring Green, the position of the Executive Director George Richard was reduced to half time. Young Audiences of Wisconsin utilized the other half of his time for their administrative needs and agreed to share their Milwaukee Headquarters with WAFC.

Nine months later William Boyd, representing attorney Harry Franke, reported that the financially conservative attitude in the State Assembly would now make the establishment of a state agency very difficult. George Richard resigned as director.

Summer was dismal. The Board had a balance of $4,100 and on the federal level the National Endowment for the Arts was also without funds, because Congressional action for the current fiscal year was delayed, The Arts Endowment was able to allocate only $20,000, of a potential $39,000, available to Wisconsin for project grants.

At this point, Oscar Louik, the WAFC Treasurer, volunteered to serve as Executive Director for the coming year for a salary of $6,000, half of which he would raise himself. On the recommendation of a special committee, he developed a state-wide arts resources and information service to coordinate and publish information and give administrative counseling to arts groups.

At the November annual meeting, Louik brought good news. A legislative measure establishing a statutory arts council, without state funding, had been introduced in the Senate. Within a month, there was gloom again. The *Milwaukee Journal* reported:

> The Joint Finance committee added new luster to its negative reputation Thursday when it tabled a bill that would have permanently designated the Wisconsin Arts Foundation and Council the official state body to coordinate the use of federal funds to support a variety of fine arts programs. The reason given for the committee's tabling action was that the bill might open the doors to the use of state funds to support the arts. And what's wrong with that? The nation has experienced a growing awareness in the last decade that fine arts should be officially supported. President Nixon has just called on Congress to double—to $40,000,000— federal support of the arts through the National Foundation on the Arts and Humanities. It is this body that has distributed money to the Wisconsin council.
>
> Legislative action is needed to give some fine arts body permanent designation as the state's representative. The bill now tabled is the minimum that should be done in this area. The Joint Finance committee should reconsider its moves.[8]

On February 21, 1970, because of continuing confusion, Louik recommended that the word "foundation" be dropped from the organization's name. Audrey Baird of Milwaukee moved that the name be officially changed to Wisconsin Arts Council. At a July meeting the change was approved. A quarterly publication, "Wisconsin Arts Fare," was established to provide visibility for the arts around the state.

At the 1970 annual meeting President William Cary announced his wish to retire, and a search committee was established under Charles McCallum of Milwaukee. Cary continued for some months, assisted by Vice President Donovan Riley of Milwaukee. The search committee recommended adding a Chairman of The Board and a Second Vice President to the list of officers.

WAC Again Becomes an Official Agency

At the March 1971 meeting the history of the on-going Governor's Awards in the Arts was clarified; the by-laws of the WAC were amended, and Oscar Louik reported that the incoming Democratic governor, Patrick W. Lucey, had on January 25, 1971, once again designated the WAC as the official arts body for the state.

At the annual meeting on November 13, 1971, Donovan Riley of Milwaukee was elected president and Gerald A. Bartell of Madison Chairman of the Board. Bartell at once put his years of media experience to work to create broader public recognition for the WAC through use of television spot announcements. Subsequently these short 15 and 30 second spots were seen throughout the state. They emphasized that "The Arts Are For Everyone. Support. Enjoy." There were other activities: Lee Sherman Dreyfus became chairman of the Arts Committee; the Wisconsin Graphics project with portfolios of ten prints by state artists was made available for sale;[9] the by-laws were again revised. A new category of members was established for long-time board members, and Robert Gard, Lloyd Schultz, Fannie Taylor, Mrs. Edward Weiler, and Mrs. Carl T. Wilson were named emeritus board members.

Once again the Governor appointed a committee—this time a Governor's Study Committee on the Arts with Dean Adolph A. Suppan, University of Wisconsin-Milwaukee, as chairman, to review the role of the State Arts Council.[10]

A special conference at Wingspread on September 29, 1972, brought Governor Lucey to make the Governor's Arts Awards in person. One of these awards was made, appropriately, to William W. Cary for his long and dedicated support. Keynote speaker for the conference was Frank Stanton, vice-chairman of the Columbia Broadcasting System. Notables from the state and from the National Endowment for the Arts attended.

At the November annual meeting the Board authorized a formal request from Chairman of the Board Bartell, and William C. Kidd, State Secretary for Business Development, to Governor Lucey as follows in "considering your 1973-75 budget for the State of Wisconsin or special legislation for the 1973 Legislature you include and endorse the following: Creation of a statutory state arts council. Appropriation of state funds to such a council, the amount of money not to exceed $150,000 the first year of the biennium and $200,000 the second year." The money thus requested was intended to match federal support to Wisconsin from the Arts Endowment, and the message to the Governor again emphasized that Wisconsin, alone among the fifty states of the Union, had no statutory arts agency.

In 1973, the efforts to garner support continued briskly. Executive Director Oscar Louik resigned, however,[11] blasting the Governor's Study Committee on the Arts for: recommending a combined arts and humanities commission, its incomplete records of what were intended to be public hearings around the state, its lack of understanding of the relationship between the state arts agencies and the National Endowment for the Arts, and its injecting the arts council staff into the political arena.

Throughout the summer of 1973 there was considerable activity back and forth between the council offices and the Governor's office by the Wisconsin Arts Council executives, and ultimately the suggestion of the Governor's study committee did not prevail. The arts and humanities were allowed to retain their separate status.

The next crisis arose from the possibility that the Governor might make a line-item veto because modifications were made during the legislative process. A letter was sent to "Friends of the Arts in Wisconsin" alerting them to the possibility and suggesting that the "Friends" inform Gerald Bartell and Donovan Riley of their support for positive action by the Governor.

Wisconsin Arts Board

Then suddenly, the long years of effort were rewarded. On August 2, 1973 the Governor signed the budget bill. The "endless haggling" over the budget stopped, and with that signature, Section 20 15.53 of the Statutes of Chapter 90, Laws of 1973, became law. "There is created an arts board to consist of 12 members appointed for staggered

Fig. 1. Three individuals were cited for support of the arts at 1980 Governor's Award dinner. Left to right they are, Ralph Goldsmith, publisher of the Boscobel Dial; Mrs. Betty Foster, advocate of cultural projects at the Wausau Hospital Center, and (center) Mrs. William D. Hoard, Jr., chairman and benefactor of the Hoard Museum and its annual art show in Fort Atkinson. They are shown here with Gerald A. Bartell, chairman of the Wisconsin Foundation for the Arts, sponsor of the ceremony for Governor Lee Sherman Dreyfus.

3-year terms from among the citizens of the state who are known for their concern for the arts."

The budget bill provided administrative support in the amount of $94,000 for the biennium, divided $45,200 the first year and $49,100 the second. No state funding was provided for gifts or grants, but specific authorization was given to receive federal grant monies. Provision was made for an executive secretary, and all authority previously given to the Wisconsin Arts Council and Foundation was transferred to the new Wisconsin Arts Board.

Finally, the Wisconsin Arts Board was provided with state funds for gifts and grants as well as for administrative support; the 1979-80 biennium budget for WAB was $1,471,650. Jerrold B. Rouby headed the agency as Executive Director.

The Wisconsin Arts Council, whose various board members struggled for so many years to achieve a statutory agency in our state, reassumed a portion of its original name on December 2, 1977. As the Wisconsin Foundation for the Arts it now continues to act as a citizen membership organization and arts advocate and its most recent activity was to sponsor a new version of the former "Governor's Awards."

In the fall of 1980, the WFA with the help of Governor Lee Sherman Dreyfus reinstituted the Governor's Awards. Recognition of the need for business support of the arts was incorporated in the "Governor's Awards in Support of the Arts," which were given to seven corporate executives and three individuals at a gala dinner at the Governor's mansion on October 9, hosted by Governor and Mrs. Dreyfus (Figs. 1 and 2).[12]

Fig. 2. Recipients of the Governor's Awards in Support of the Arts are cited for corporate support at the Governor's awards dinner, October 9, 1980 (left to right): Herbert V. Kohler, Jr., Robert Hartwig, Donald J. Schuenke, Hal C. Kuehl, Gerald A. Bartell, chairman of the Wisconsin Foundation for the Arts, John S. Sensenbrenner, Jr., Oscar G. Mayer, and James R. Schweiger.

The new version of the Governor's Awards points up the strong support for creative activity that exists throughout the state, much of it fostered by citizen endeavors to form a state agency. Throughout Wisconsin there are flourishing arts groups, many of which did not exist fifteen years ago. The requirement for matching money to obtain support from the public sector, a concept now routinely required on both the federal and state level, has become an important force in opening new opportunities for artists and their organizations. But the most important support for public funding has come from the artists, the arts organizations, the audiences, and the public, all of whom have insisted that the arts must be an integral part of our everyday lives.

Notes

[1] Gard, R. E., Unpublished letter to the author, April 1979.

[2] "A Brief History of the Wisconsin Arts Foundation and Council," as provided by U.W. Extension, n.d.; and WAFC Minutes of April 12, 1957.

[3] Esterow, Milton, *New York Times,* June 15, 1963.

[4] Wisconsin Blue Book 1964, p. 303. "Governor's Council on the Arts."

Also appointed: Gordon Berchardt, Richard Gregg, Mrs. Harold Groves, Tom Holter, Roland A. Johnson, Sister M. Laudesia, Mrs. John Marshall, Dr. Abraham Melamed, Rudolph Morris, Leslie Paffrath, Jack Rudolph, Sister Mary Remy, Fannie Taylor (Secretary), Sister Thomasita, Mrs. Carl T. Wilson, Elmer Winter, Mrs. Webster Woodmansee, Robert Zigman (Leonard Zubrensky, legal counsel for the Governor, attended *ex officio*).

[5] By-laws and Minutes, Governor's Council on the Arts, F. Taylor Collection, Wisconsin State Historical Library Archives.

[6] Wisconsin Blue Book 1973, p. 346. "The Governor's Council on the Arts, created as a special committee in 1963, and the Wisconsin Arts Foundation and Council, a private statewide organization representing all of the arts, were merged in April 1965. Among its 200 members, the Wisconsin Arts Council includes some 50 organizations—art centers, colleges, merged organizations—to effectively explore and develop ways of increasing cultural opportunities and resources in Wisconsin. In 1971 the council was designated as the official state body through which the public interest in the arts and culture should be maintained, encouraged, and disseminated in Wisconsin" (Senate Joint Resolution 22).

The governor appoints 8 public directors. There are also 15 elected directors.

[7] "A Review of Art Activities in Wisconsin," National Endowment for the Arts Fact Sheet, April 1966.

[8] *The Milwaukee Journal* Dec. 19, 1969.

[9] A "pre-publication" offer for $500 was made to museums on March 12, 1971. Artists represented in the portfolio were: Robert Burkert, Warrington Colescott, Jack Damer, Raymond Gloeckler, Victor Kord, Dean Meeker, Frances Meyers, Marko Spalatin, Arthur Thrall and William Weege.

[10] Wisconsin Blue Book 1973, p. 347. Study Committee on the Arts in the State of Wisconsin and the Wisconsin Arts Council. Members Adolph A. Suppan, chairman, Mrs. Marion Baumann, Mrs. Ralph Brandon, Tom Evans, John Gauthier, Tom Harris, Edward Kamarck, Michael Kazar, Charles Krause, Mrs. Mary Lewis, Roger Mitchell, Don Reitz, Don Rintz, O. Vernon Schaffer, Ray Taylor, Mrs. Mary Alice Wimmer. Committee created February 1972 "to review the state of the arts in Wisconsin and the role of the Wisconsin Arts Council . . . what programs can the arts council undertake to increase the number of citizen participants in all of the creative arts? How can it best recognize and encourage promising individual artists in Wisconsin? How can minority projects be best assisted by the Arts council? The final report of the study committee was issued in January 1973."

[11] *The Milwaukee Journal,* February 23, 1973.

[12] *Wisconsin State Journal,* October 12, 1980.

[13] GOVERNOR'S AWARDS IN THE ARTS

1964

Mrs. H. L. Bradley, River Hills
Edna Ferber, New York
Lynn Fontanne and Alfred Lunt, Genesee Depot
Margaret H'Doubler, Sister Bay
Robert Osborn, Conn.
Peninsula Music Festival, Door County
Edward Steichen, Conn.
University of Wisconsin-Madison
University of Wisconsin-Milwaukee
Robert von Neumann, Milwaukee
Father John Walsh, Milwaukee
Thornton Wilder, Conn.
Wisconsin Painters and Sculptors
Frank Lloyd Wright (posthumous)

1965
August Derleth, Sauk City
Georgia O'Keefe, Taos, N.M.
Ralph Votapek, N.Y.
Johnson Foundation, Racine
Elsa Ulbricht, Milwaukee
Milwaukee Symphony Orchestra
Marine National Exchange Bank, Milwaukee
Wisconsin Federation of Music Clubs

1967
Robert E. Gard, Madison
Thor Johnston, Evanston, Ill.
Charlotte Partridge, Mequon
Wm. P. Wenzler & Assoc. Milwaukee
Milwaukee Repertory Theater
Milwaukee Art Center
Schlitz Brewing Co., Milwaukee

1968
Fine Arts Quartet, Milwaukee
Roland Johnson, Madison
Pabst Brewing Co., Milwaukee
Sr. Thomasita, Milwaukee
Sr. Mary Remy, Milwaukee
John Anello, Milwaukee
Aldo Leopold (posthumous)

1969
Warrington Colescott, Madison
Aaron Bohrod, Madison
James S. Watrous, Madison
Mrs. Ronald A. Dougan, Beloit
Phillip Sealy, Appleton
Peninsula Arts Association, Door County
Wisconsin Ballet Company, Madison

1970
Emmett Sarig, Madison
Edna Meudt, Dodgeville
Donald Reitz, Spring Green
Edward A. Boerner, Milwaukee
Mrs. Carl T. Wilson, Milwaukee
Marie A. Endres, Madison
Gunnar Johansen, Madison

1971
Madison Art Center
James R. Schwalbach, Madison
Richard W. E. Perrin, Milwaukee
O. V. Shaffer
Milwaukee Inner City Arts Council

1972
G. Lloyd Schultz, Lake Mills
Clair Richardson, Milwaukee
Mrs. Elmer J. Einum, Rice Lake
William W. Cary, Milwaukee
Frank Italiano, La Crosse
Ruth Mary Fox, Madison
Ruth Milofsky, Milwaukee

GOVERNOR'S AWARDS IN SUPPORT OF THE ARTS

1980
(Corporate citations)
John S. Sensenbrenner, Jr., president of Kimberly-Clark Foundation, Neenah
Donald J. Schuenke, president of Northwestern Mutual Life Insurance Co., Milwaukee
Oscar G. Mayer, Oscar Mayer & Co., Madison
Hal C. Kuehl, president of First Wisconsin Corp., Milwaukee
James R. Schweiger, president of Schweiger Industries, Jefferson
Herbert V. Kohler, Jr., chairman of the board of Kohler Co., Kohler
Robert Hartwig, president of Hartwig Manufacturing Co., Wausau
(Individual citations)
Robert Goldsmith, Boscobel
Mrs. Betty Foster, Wausau
Mrs. William D. Hoard, Jr., Fort Atkinson

VEGETATION CHANGE ON THE GOGEBIC IRON RANGE (IRON COUNTY, WISCONSIN) FROM THE 1860s TO THE PRESENT

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Abstract

This study documents the impact of iron mining activity and associated settlement on the vegetation of a portion of the Gogebic Iron Range in Wisconsin. Land cover was determined and vegetation maps prepared for three different periods: 1) The 1860s representing pre-mining conditions, 2) The 1930s representing peak development, and 3) The 1970s representing declining human activity. Importance Values and size class distributions were calculated for the major tree species of the 1860s and 1970s based on Feberal Land Office Survey data and field sampling.

At the time of initial settlement the dominant upland vegetation was mesic forest with sugar maple (*Acer saccharum*), hemlock (*Tsuga canadensis*), and yellow birch (*Betula lutea*) as major components. Much of this forest was cleared for mining timber and to create farmland around the mining communities. With the cessation of mining, the area is gradually returning to mesic forest. The forest of the 1970s appears younger and more diverse than that of the 1860s with greater dominance of sugar maple and lower importance of hemlock and yellow birch. Human activities have altered both the present condition and future composition of the forest to an extent that evidence of this disturbance will not disappear in the near future.

Introduction

Iron County is located in north-central Wisconsin, where it borders Lake Superior and the western end of the upper peninsula of Michigan (Fig. 1). The Gogebic Range extends across the northern portion of Iron County, from Ashland County on the southwest into Michigan on the northeast.

The Gogebic Range is best known for its iron deposits which were mined heavily from the mid 1880s until operations ceased in the mid 1960s. Permanent settlement began with the development of the first mines. By 1920, the mines on the Range were shipping approximately 6 million tons of ore per year (Mladenoff 1979). The population of Iron County reached over 10,000 persons in the 1930s, but by the 1970s had declined to 6500 inhabitants, fewer than in 1900.

Our purpose was to document the impact of the characteristic "boom and bust" cycle of mining activity on the vegetation of the Gogebic Range. To do this the land cover was analyzed during three periods which represent different parts of the cycle: the 1860s, 1934, and the 1970s. By comparing the plant communities of these three eras, the extent and duration of the impact of mining and its associated activities were traced.

Geology, Soils and Climate

Two parallel ridge systems comprise the Gogebic Range (Fig. 1). The southern Iron Range is composed of resistant quartzite, granite and the iron formation. The northern Gabbro-Trap Range is composed of highly faulted and eroded Keweenawan lava flows of basalt and gabbro. Between them lies a lower central valley of less resistant slate

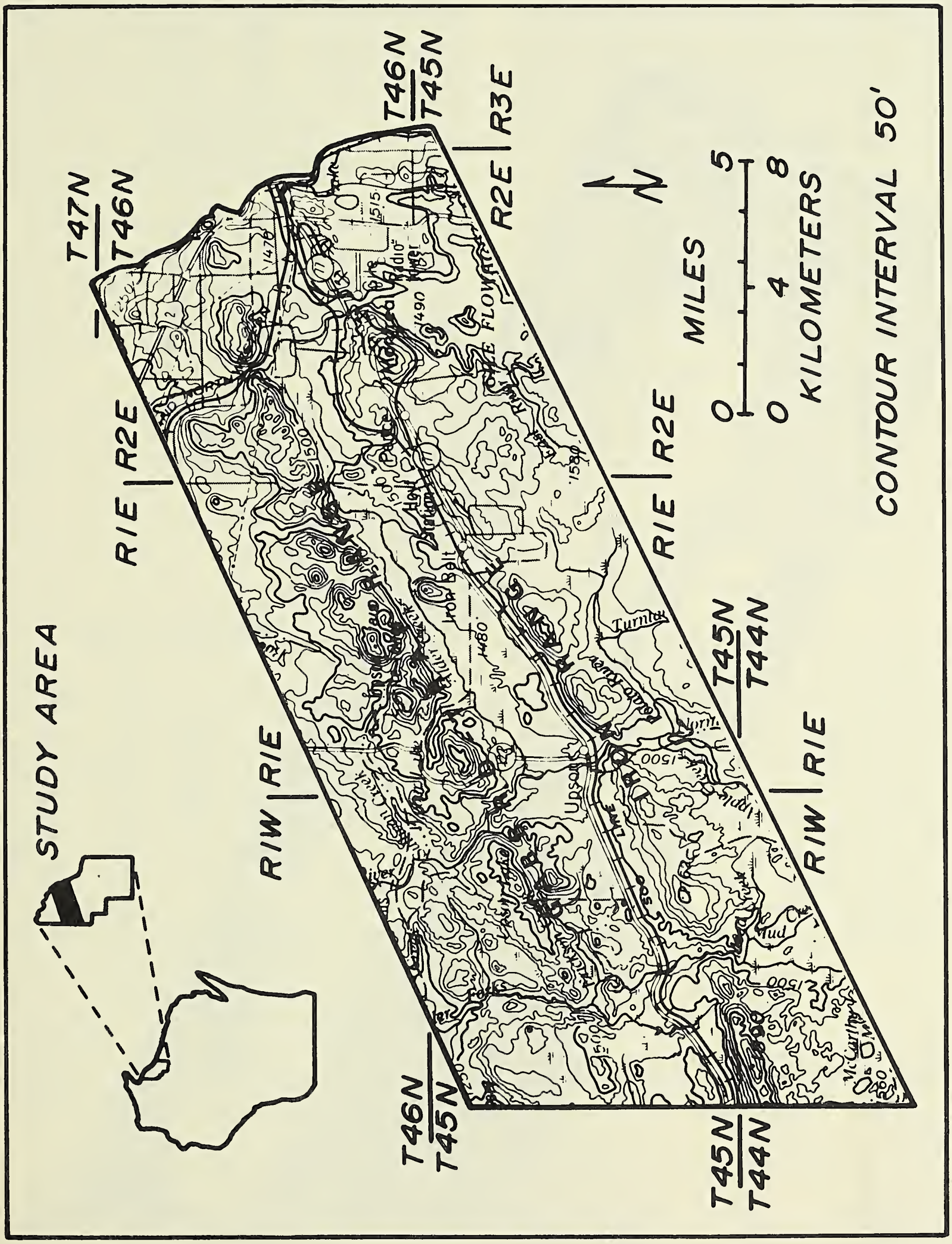

Fig. 1. Topographic map of study area and location in Iron County, Wisconsin.

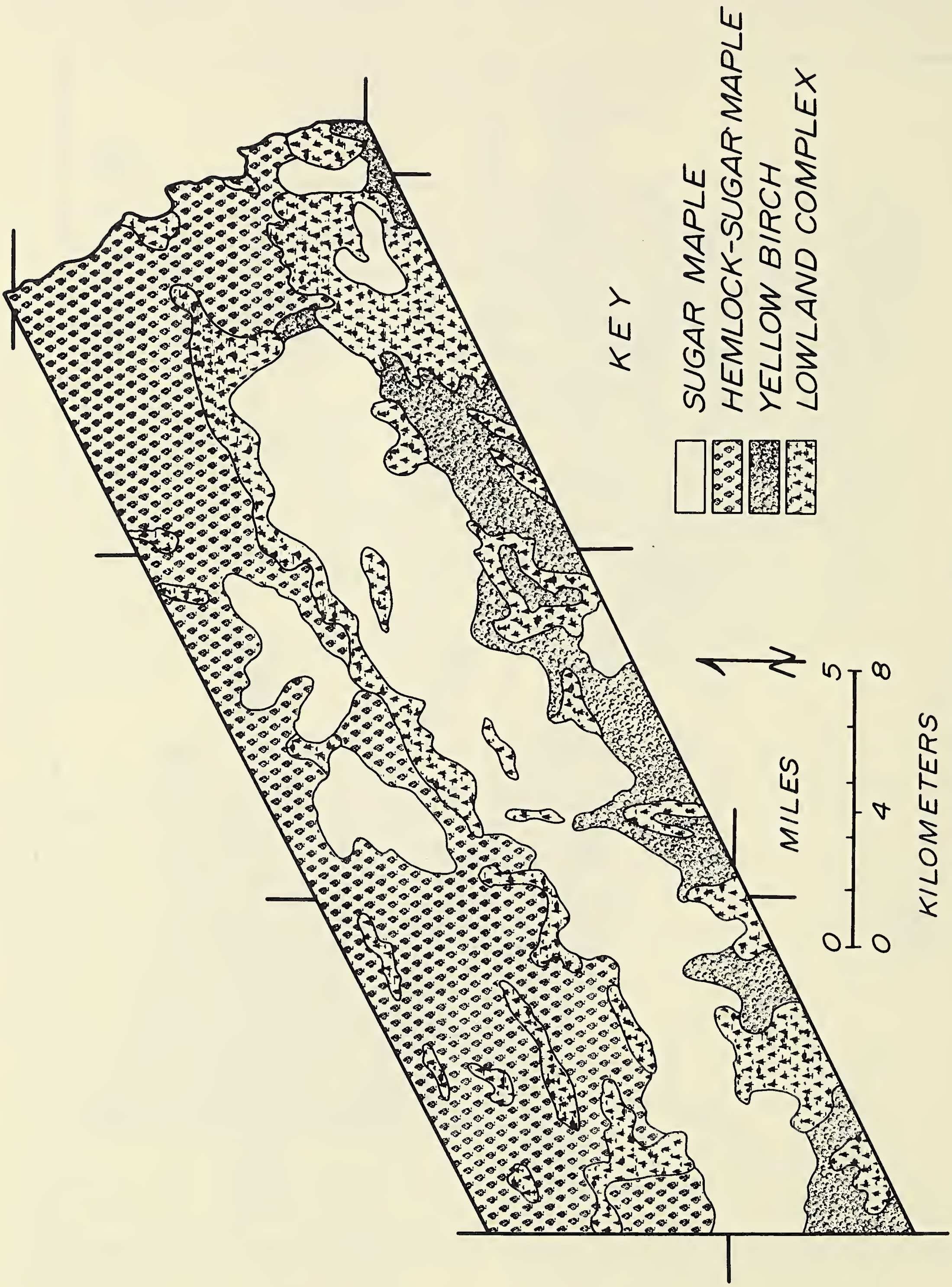

Fig. 2. Presettlement (1860) vegetation communities.

rock. All formations dip sharply to the northwest. The ridges reach an elevation of 520 to 580 meters (1700 to 1900 feet) above sea level, or approximately 365 meters (1200 feet) above Lake Superior. The low points, approximately 335 meters (1100 feet) in elevation, occur in the central valley and to the north of the Range, and give a local relief of about 245 meters (800 feet) (Martin 1965).

Soils in the study area are derived from glacial materials, primarily ground moraine with reddish-brown till. Soil types vary from Orthods (Podzols) to Inceptisols (Low Humic Gley and Brown Forest Soils) (Hole 1976).

In general, the climate of the Gogebic Range study area is typical of northern Wisconsin and is characterized as temperate humid continental, with cool, short summers and cold winters. Locally, however, the mesoclimate is influenced by the proximity of Lake Superior, and more distinctively, the steep elevational gradient from the Lake to the Range. The prevailing movement of weather systems over Lake Superior results in a narrow band of slightly moderated temperature and significantly increased precipitation along the Gogebic Range, when compared with more interior locations. The average annual precipitation of 91 cm. (36 in.) and, in particular, the mean annual snowfall of 391 cm. (154 in.) are substantially greater than in other portions of the state. Adjacent Wisconsin stations report average annual precipitation of 76 to 81 cm. (30 to 32 in.). Ashland, Wisconsin, 56 kilometers (35 miles) west, has an average annual snowfall of 152 cm. (60 in.). The average annual temperature in the study area is 5°C (41.5°F) (Waite 1960, Strommen 1974).

The Vegetation of the 1860s

The presettlement vegetation of the study area was reconstructed and mapped using the field notes of the Federal Government Land Survey. The purpose of the Survey was to delineate township and section lines and to note the general condition of the land in terms of agricultural and timber production potential (Bourdo 1956). Different portions of the study area were surveyed at various times from 1856 to 1867 by using two different procedures. On the exterior township lines, the section and quarter section corners were marked by recording the distance from each corner to the closest tree in each compass quadrant. To identify these "witness" trees, the species and trunk diameters were noted. At corners on the interior lines only two witness trees were used.

These survey data were used to generate a plant community map following techniques similar to those employed by Kline and Cottam (1979). The township and section lines on the study site were mapped at a scale of 1:24,000. On this map species-keyed letter codes and colored symbols were placed in the appropriate location for each witness tree. The map was overlayed onto a topographic map for interpolation.

Areas on the map determined by visual inspection to be reasonably homogeneous for species were delineated and designated as communities. Two major vegetation groups were so delineated: the Lowland Complex and the Upland Communities. Three upland communities were identified and named for their dominants: Yellow Birch (*Betula lutea*) Forest, Sugar Maple (*Acer saccharum*) Forest, and Hemlock-Sugar Maple (*Tsuga canadensis-A. saccharum*) Forest (Fig. 2, Table 1).

Table 1. Area of presettlement (1860) vegetation communities of Gogebic Iron Range

Community	*Percentage of area*	*Hectares (Acres)*
Hemlock-Sugar Maple	34.6	10,762 (26,573)
Sugar Maple	27.0	8,398 (20,736)
Yellow Birch	5.6	1,742 (4,300)
Lowland communities	30.8	9,580 (23,654)

Lowland Complex

The Lowland Complex made up 31 percent of the study area and occurred primarily along the streams of the central valley and in the area south of the Iron Range, and in scattered locations among the ridges of the Gabbro-Trap Range. The largest single expanse was south of the Iron Range at the eastern end of the study area. Conifer swamps of white cedar (*Thuja occidentalis*), spruce (*Picea* spp.), tamarack (*Larix laricina*), and yellow birch predominated.

Based on historical records and the scale of the surveys used in this study, the Lowland Complex received less impact than the Upland Communities (Mladenoff 1979). Nor did the Lowland Complex change as significantly in composition. Consequently, the Lowland Complex will not be considered further here.

Upland Communities

The three upland communities were mesic forests (Curtis 1959), and were dominated by sugar maple, hemlock, and yellow birch in different proportions. The development of much of the Lakes States forest, of which this was a part, has been postulated to result from climatic shifts in the mid-sixteenth century (Graham 1941, Potzger 1946). Judging by growth tables for northern hardwood species (Gates and Nichols 1930), the largest hemlocks recorded in the Land Survey notes may date to that period.

To describe the structure of each community, an Importance Value (I.V.) (Curtis 1959) based on relative density, frequency, and dominance was calculated for each species of witness tree located within it (Cottam 1949, Ward 1956), and a species-size distribution graph was prepared.

Yellow Birch Forest: The Yellow Birch Forest occupied approximately 6 percent of the study area (Table 1), and occurred primarily in the uplands south of the Iron Range (Fig. 2). In general this area is lower than its surroundings (Fig. 1), and thus is a cold air sink subject to advection frost at any time of year. The southwestern exposure also makes it subject to periodic disturbance from windthrow and also from fire, especially during extremely dry years.

Yellow birch was by far the leading dominant in the community with an Importance Value of 34.1 (Table 2). The largest individuals in the forest were yellow birch and this species also had the highest density. Although common in many northern Wisconsin stands, yellow birch does not often reach such a position of dominance (Brown and Curtis 1952, Winget *et al.* 1965). The reported heavier precipitation for this portion of the state may partially explain this anomaly. Hemlock and sugar maple were second in importance with I.V.'s of 18.8 and 17.2 respectively. In addition, balsam fir (*Abies balsamea*), white cedar (*Thuja occidentalis*), and white spruce (*Picea glauca*) were prominent members of this community.

The size class distribution (Fig. 3) indi-

Table 2. Importance values for species in the presettlement forest communities. Values > 1.0.

Community	*Acer saccharum*	*Tsuga canadensis*	*Betula lutea*	*Tilia americana*	*Ostrya virginiana*	*Quercus rubra*	*Acer rubrum*	*Abies balsamea*	*Thuja occidentalis*	*Prunus serotina*	*Picea glauca*
Hemlock-Sugar maple	30.4	33.5	18.6	4.3	1.8	—	1.8	4.1	2.8	—	—
Sugar maple	52.9	11.8	19.9	4.2	1.5	1.2	2.0	3.2	1.5	—	—
Yellow birch	17.2	18.8	34.1	1.2	2.5	—	—	14.6	6.1	1.2	3.3

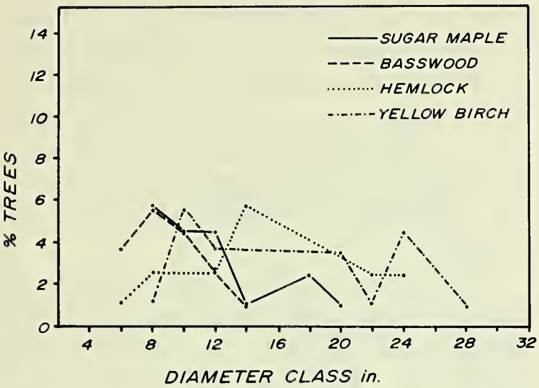

Fig. 3. Size class distribution of major tree species in the presettlement Yellow Birch Forest.

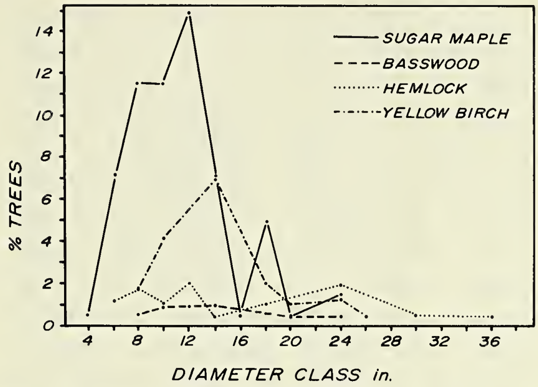

Fig. 4. Size class distribution of major tree species in the presettlement Sugar Maple Forest.

cates that yellow birch and hemlock were evenly represented across the range of diameter classes, evidence that these species were reproducing in the area. However, the distributional patterns of these species were different from that which might normally be assumed—i.e., having many individuals in smaller size classes and progressively fewer in the larger sizes. The skewed distribution curves found here could have been the result of size bias by the surveyors, or it could be hypothesized that it was a composite picture of an area which had experienced a history of periodic disturbance (Loucks 1970). If this hypothesis were correct, the Yellow Birch Forest would have been a mosaic of even-aged stands of trees with each "pocket" dating from a small-scale perturbation. Yellow birch tends to reproduce well under conditions following fire as do balsam fir, white cedar, and white spruce (Fowells 1965). It is also possible that the mosaic was one of diverse micro-climates as well as of disturbance. The scale of the land survey vis-a-vis that of the units of the mosaic makes it difficult to investigate these theories.

Sugar Maple Forest: The sugar maple community was centered along the Iron Range and made up approximately 27 percent of the study area (Table 1). A small area also occurred in the center of the Gabbro-Trap Range. Sugar maple was by far the leading dominant with an Importance Value of 52.9, twice as high as that of the second leading dominant, yellow birch (19.9), and four times that of hemlock (11.8) (Table 2).

The dominance of sugar maple resulted from its extreme abundance in the lower size classes (Fig. 4), although it also was represented in larger size classes. Yellow birch followed a similar pattern, but individuals were much less numerous (43 vs. 152). Hemlock was represented in small numbers across all size classes, being greatly exceeded in the smaller sizes (<16″) by sugar maple; neither yellow birch nor sugar maple approached its presence in larger sizes (>20″).

The high ridges of the Iron Range provided an environment which was not as cold as that of the Yellow Birch community. In addition, the area was protected somewhat from fire by the surrounding wetlands and the steep topography. These conditions were excellent for sugar maple and hemlock, and also for the basswood (*Tilia americana*) and and red oak (*Quercus rubra*) which were scattered throughout this area; the environment was less favorable for yellow birch (Fowells 1965).

Hemlock-Sugar Maple Forest: This community occupied the largest portion of the study site (35 percent) (Table 1) and was centered along the Gabbro-Trap Range (Fig. 2). Hemlock (I.V. 33.5) and sugar maple (I.V. 30.4) were codominant (Table 2). Yellow birch (I.V. 18.6) played a lesser role; also present were basswood, ironwood (*Ostrya virginiana*), red maple (*Acer rubrum*), balsam fir, and white cedar. Sugar maple, hemlock, and yellow birch all had similar size class distributions, with many stems in the smaller size classes and few in the larger sizes (Fig. 5)—an indication that all three species were reproducing in the area. Hemlock present were as large as 142 cm. (48 in.) in diameter; there were no maples or birch larger than 71 cm. (28 in.).

Because of its rugged topography the Gabbro-Trap Range provided a wide variety of habitats. The system of small ridges and intervening small valleys allowed maple, birch and hemlock to reach a more equal development than in either of the other two communities; the warmer slopes favored the sugar maple, and the cooler, more moist coves provided optimal conditions for hemlock and yellow birch (Stearns 1949, Fowells 1965).

The Vegetation in 1934

The vegetation of the study area as it appeared during the period of peak development was reconstructed by using the Land Economic Inventory for Iron County (Bordner 1934). The Inventory was compiled by field workers who traversed each quarter mile of land and noted vegetation communities and the current human land usage. From this detailed survey, a map was constructed (Fig. 6).

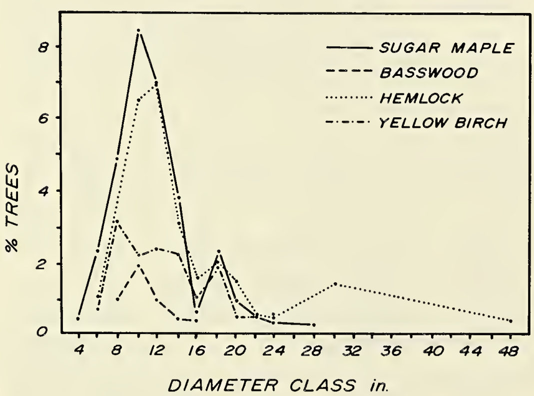

Fig. 5. Size class distribution of major tree species in the presettlement Hemlock-Sugar Maple Forest.

Lowland communities, here identified as Woody Lowland and Marsh and Lakes, still occupied approximately the same proportion of the study area as they did in the 1860s (Tables 1 and 3). The upland forests, however, had been reduced to about 75 percent of their former extent by clearing for farmland and dwellings; those areas which remained forested had been greatly changed in composition.

Because the categories used in the Bordner Survey were different from those used to interpret the Federal Land Survey, it is difficult to make exact comparisons between the eras; nevertheless several trends are evident. The Mixed Hardwoods and Conifers of the Bordner Survey were equivalent to the upland mesic forest types of the 1860s. In 1934, these communities made up only 20 percent of the area. In addition, their structure had changed significantly because of logging for timber for building and for extensive use in the mines (Mladenoff 1979). Whereas the presettlement forests had an average tree diameter of 30 cm. (12 in.), most of the trees recorded in 1934 were between 2.5 and 15 cm. (1 and 6 in.).

Another type of upland forest, Hardwoods and Conifers with Aspen (*Populus* spp.), occupied 21.5 percent of the 1934 land cover. This type occurred along the Iron Range and across the western portions of the Gabbro-Trap Range. Aspen was not recorded as a witness tree in the 1860s survey of the area and its importance in 1934 was probably a result of recent logging and fire. Aspen as a community type also occurred in 1934 in the most recently logged areas.

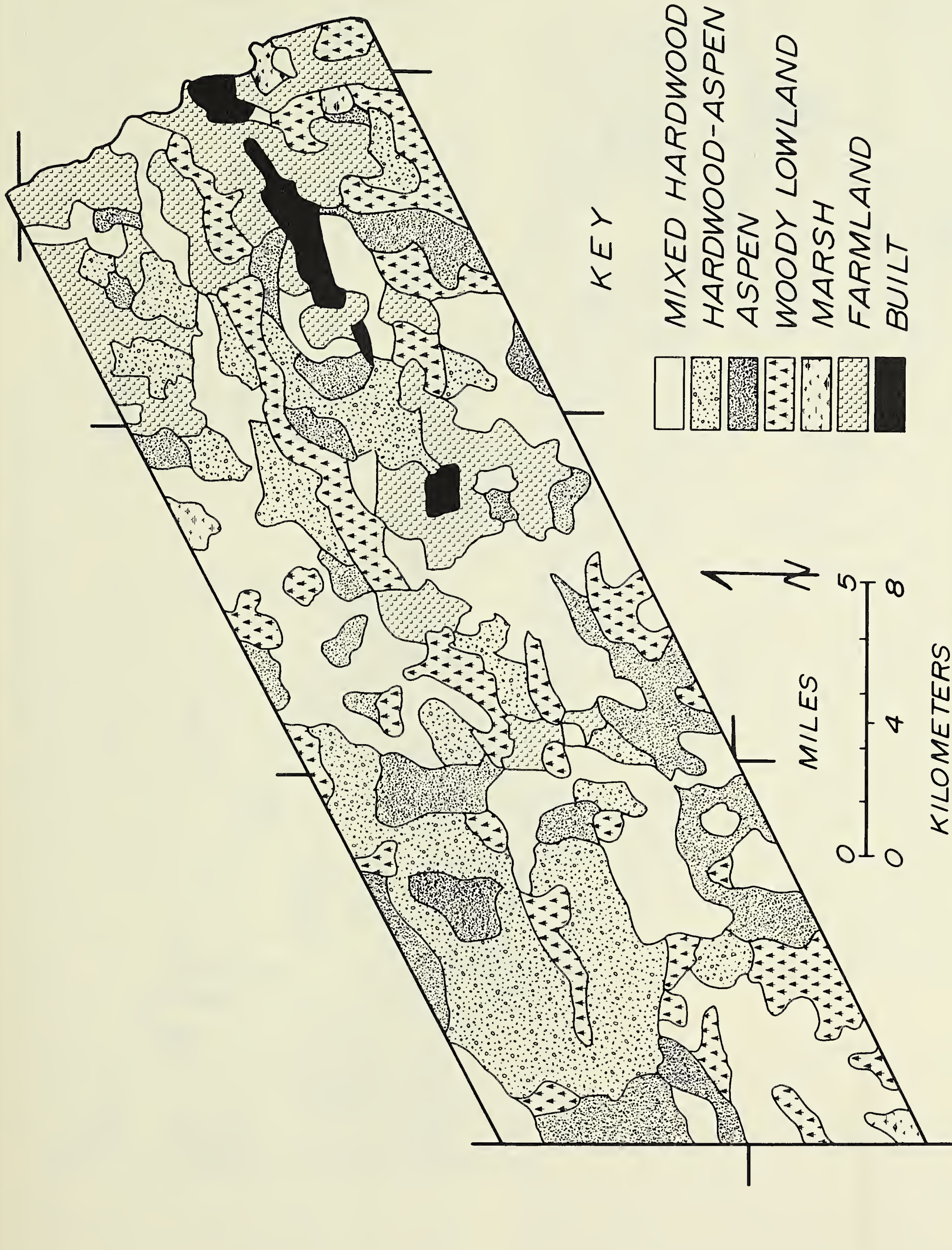

Fig. 6. Vegetation and land cover types, 1934.

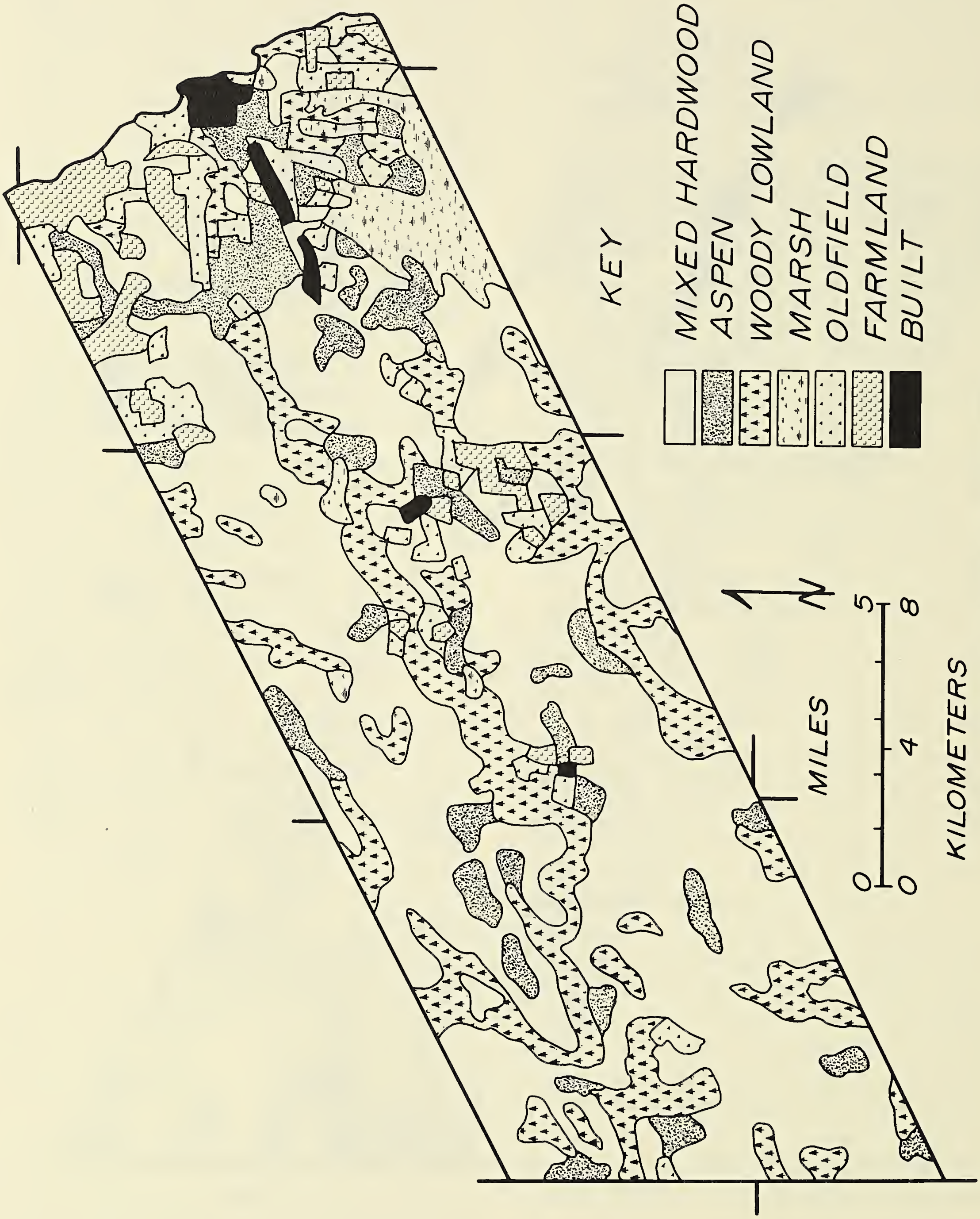

Fig. 7. Vegetation and land cover types, 1973.

TABLE 3. Land cover in the Gogebic Iron Range, 1934.

Land Use	*Percentage of area*	*Hectares (Acres)*
Mixed hardwoods and conifers	20.0	6,221 (15,360)
Hardwoods and conifers with Aspen	21.0	6,687 (16,512)
Aspen	9.2	2,861 (7,065)
Woody lowland	28.1	8.740 (21,580)
Marsh and lakes	.09	28 (69)
Farmland	18.5	5,754 (14,208)
Built	1.9	591 (1,459)

TABLE 4. Land cover in the Gogebic Iron Range, 1973.

Cover Type	*Percentage of area*	*Hectares (Acres)*
Mixed hardwood	52.1	16,205 (40,013)
Aspen	6.4	1,991 (4,915)
Woody lowlands	27.7	8,616 (21,274)
Marsh and lakes	3.7	1,151 (2,841)
Farmland	4.2	1,307 (3,226)
Old field	4.1	1,275 (3,148)
Built	1.9	591 (1,459)

THE VEGETATION OF THE 1970S

The vegetation of the 1970s was documented by constructing a map of land cover types using U.S. Agricultural Stabilization and Conservation Service (ASCS) black and white infrared aerial photographs at a scale of 1:15,460, and by field sampling 15 upland forest stands. The map was based on visual inspection of changes in the pattern shown on the photographs supplemented by ground inspection to verify the classification of the patterns. Sites for the field sampling were chosen by locating random points on U.S. Geological Survey (USGS) topographic maps (scale 1:24,000) and sampling the upland forested area closest to the point. The point-quarter method was used to sample trees in each stand (Cottam and Curtis 1956). This method evolved from the technique used in the Federal Land Survey in recording witness trees at section corners. The sample sites were divided into two groups: those which occurred in the location of presettlement Sugar Maple Forests and those which were located in areas of presettlement Hemlock-Sugar Maple Forests. The data were tabulated for each community in the same manner as that described for the presettlement data.

In 1973 the lowland communities still appear remarkably consistent, occupying approximately 31 percent of the study area (Fig. 7, Table 4). Farmland has decreased greatly since 1934 and wooded areas have increased. The most notable change in the composition of the upland forests is the reduction in the area of aspen and the increase in sugar maple-dominated hardwood. The Mixed Hardwoods community increased from 20 percent in 1934 to 52 percent—seemingly at the expense of aspen dominated communities. The actual presence of aspen (primarily *P. tremuloides,* but including *P. grandidentata*) however, is underestimated to some extent under this classification. In some of the areas where it was listed in 1934 in mixture with hardwoods, by 1973 it had been selectively cut or was dying. In other locations it is present in the stand as scattered large individuals; sugar maple is generally replacing it on the upland sites. A considerable area of the aspen community surrounding the mining towns occupies areas that were pastured in 1934. Areas listed as Old Field in the 1970s are recently abandoned farmlands being invaded by shrubs and aspen.

COMPARISON OF UPLAND FORESTS OF THE 1860S AND 1970S

The vegetation map for the 1970s, an era of declining development, is more similar to that of the 1860s than it is to the 1934 map representing peak development. This is primarily because the upland communities of the presettlement era are still, or are once

TABLE 5. Density, mean basal area, and dominance for presettlement communities and corresponding sample stand averages for 1978.

	Density stems/ha	*Mean basal area (dm^2)*	*Dominance dm^2/ha*
Hemlock-sugar maple			
1860	546	10.2	5,580
1978	923	4.0	3,513
Sugar maple			
1860	548	8.6	4,709
1978	762	6.3	4,403

again, hardwood dominated by sugar maple. The field data were used to determine the extent of changes in structure which may have occurred in these communities and which are not evident in the mapped classifications.

Tree densities and mean tree sizes for the presettlement Sugar Maple and Hemlock-Sugar Maple communities of the 1860s were compared with those in the 1970s (Table 5). In this time span there have been dramatic increases in density. The size of the average tree (basal area measured at breast height) has changed from 10 to 4 dm^2 in the Hemlock-Sugar Maple type, and from 8.6 to 5.9 dm^2 in the Sugar Maple type. These size and density changes are, as noted by Rogers (1959), an expected change in mesic forests which have experienced heavy cutting. The size difference between the two present communities may have resulted in part because the sugar maple type, which is largely along the Iron Range, was cut 20 to 40 years earlier and is thus an older forest. As expected, dominance (dm^2/ha) has also decreased in both areas, with the greatest difference being noted in the Hemlock-Sugar Maple community.

Importance Values of the dominant species were calculated for both periods (Table 6). In both vegetation types the most dramatic change has been the greatly increased value for sugar maple in particular; this increase has apparently been at the expense of hemlock and yellow birch. In the Hemlock-Sugar Maple type, the relative importance of sugar maple has increased from 30.4 to 50.8 (>65%). Hemlock has decreased from an I.V. of 33.5 as a leading dominant to an insignificant 1.5. Yellow birch, which had been the third leading dominant (I.V. of 18.6) has been reduced by 62% (I.V. 7.1). The major increases in I.V.s in this community are in basswood, which has more than tripled, and in red oak, white ash (*Fraxinus americana*) and aspen.

Similar changes have taken place in the Sugar Maple community where sugar maple has increased in I.V. from 52.9 to 68.4. The former second dominant, yellow birch, has

TABLE 6. Importance values for dominants in presettlement communities and corresponding sample stand averages, 1978.

Community	*Year*	*Sugar Maple*	*Hemlock*	*Yellow Birch*	*Basswood*	*Red Ooak*	*Elm*	*Red Maple*	*White Ash*	*Balsam Fir*	*White Cedar*	*Aspen*
Hemlock-Sugar Maple	1860	30.4	33.5	18.6	4.3	—	—	—	—	4.1	—	—
	1978	50.8	—	7.1	14.4	5.5	—	—	—	—	—	5.5
Sugar Maple	1860	52.9	11.8	19.9	4.2	—	—	—	—	3.2	—	—
	1978	68.4	—	3.1	16.3	—	5.9	4.1	—	—	—	—
Yellow Birch	1860	17.2	18.8	34.1	—	—	—	—	—	14.6	6.1	—

decreased in I.V. from 19.9 to 3.1; and hemlock again is reduced to insignificance. Major increases again are in basswood, a quadrupling in value, the appearance of American elm (*Ulmus americana*) as the third dominant, and increase in red maple and white ash.

The similarity of change in the two communities is striking. It seems likely that the minor differences result from compositional differences in the original communities rather than the results of differing histories since that time. Sugar maple shows vigorous reproduction with no other species competing closely in the smaller size classes (Figs. 8 and 9). The other important species have increased in the moderately small sizes, but then again drop off. The greater irregularity of the curves representing the Hemlock-Sugar Maple community may be another indication of more recent cutting and disturbance.

In both of these types, the pattern shows near elimination of the codominants of the sugar maple—hemlock and yellow birch—and an increase in a group of less mesic species. Although these species differ somewhat between the two communities, they are generally those species present in the original forest, which would have benefited from and responded to the increased light following cutting of the more sought after dominants (Kline and Cottam 1979). In particular, the marked increase in I.V. of basswood is probably associated with its sprouting ability (Stearns 1951).

During the mining era the mixed hardwood forests were generally selectively cut, to varying degrees, depending largely on the market conditions as well as the age and condition of the various species present in a stand (Frothingham 1915). This was true in particular along the Trap Range where many areas were cut during the erratic and depressed market conditions of the early 1930s (Corrigan 1976).

Hemlock and yellow birch were in greatest demand for lumber (Corrigan 1976) and were both present in the desirable larger size classes. Sugar maple, which was present in smaller sizes, would have been cut less severely. Conditions resulting after large-scale cutting would have been unfavorable to the survival of the remaining hemlock and yellow birch, because of their greater sensitivity to exposure, fire, and drought and their inability to sprout in comparison to sugar maple (Fowells 1965, Godman and Krefting 1960).

The structural and compositional changes from the presettlement condition to the present, particularly the large reduction in mean

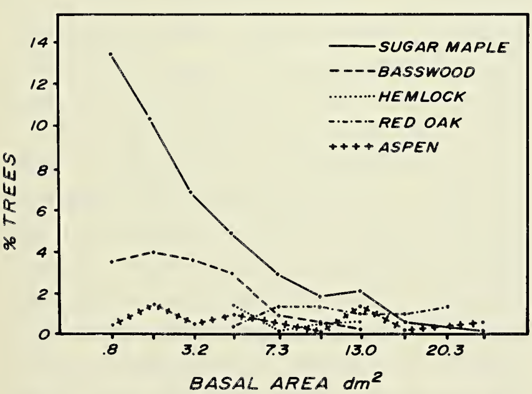

Fig. 8. Size class distribution of major tree species in 1978 in the former Hemlock-Sugar Maple Forest.

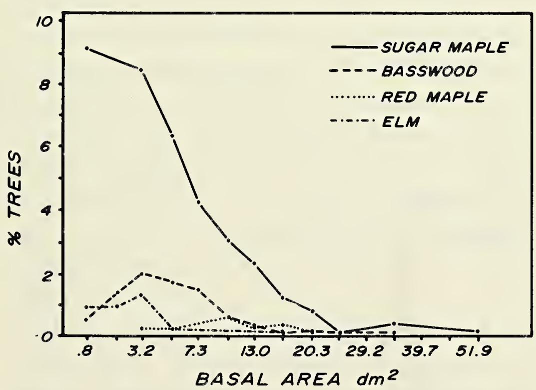

Fig. 9. Size class distribution of major tree species in 1978 in the former Sugar Maple Forest.

basal area, can be attributed to several factors, the massive disturbance which apparently took place in the study area and the ensuing response of the vegetation. Elimination of the trees in the larger size classes is evident from the data (Figs. 8 and 9). This is particularly true of hemlock and yellow birch, which as dominants in the presettlement communities also constituted the largest individuals. Consistent with removal of the large trees is the reduction in dominance in the present forests. Goff and Zedler (1968), in a structural analysis of a large number of stands in the western Great Lakes area, found a high positive correlation between basal area per unit area and mean diameter, particularly in the northern forests. This may explain the reduction noted in mean basal area in the two types of 61% and 27%, respectively, and the corresponding reductions in dominance of 37% and 6.5% (Table 5).

However, the most significant factor in the reduction in mean basal area appears to be the dramatic increase in the smaller size classes. Tree sizes in the presettlement communities suggest relatively mature, mesic forests with stem distribution in all size classes indicating no severe, recent disturbance. Removal of large trees would be necessary for any increase in density and reduction in basal area to occur in this forest. However, the magnitude of change in mean basal area, in particular in the Hemlock-Sugar Maple community, does not appear to be accounted for directly by the elimination of the larger trees. Goff and Zedler (1968) also found a significant negative correlation between density and mean diameter. Correspondingly, the increases in density for the two forest types in the study area are 69% and 39%, respectively; both are of a significantly greater magnitude than the change in dominance, and much more closely in proportion to reductions in mean basal area. A higher peak is also evident in the small size classes in the present forests, and that peak occurs at sizes which are even smaller than those for the presettlement forests. Several less mesic species occur with significant importance values; these species were not present in the presettlement communities. Auclair and Goff (1971), in another study of the western Great Lakes area, found that tree species diversity is greatest for young, successional forests at the midpoint along time and environmental gradients (mesic). They also found that a greater diversity of successional tree species indicates a high density, successional forest. Our data and the assumed site history point to a similar conclusion; that the pronounced structural changes, particularly the large reduction in mean basal area, cannot be attributed primarily to the mere removal of a portion of the larger diameter trees, *per se,* but rather to the severe disturbance and opening of the canopy of the original mesic forest to an extent that resulted in the wide-spread, rapid reproduction with a greater variety of species (Loucks 1970). This resulted in the high diversity forest of today, and more fully accounts for the changes in mean basal area and other structural changes.

Several workers in Wisconsin have cited damage by browsing deer as being the primary cause in the reduction of hemlock reproduction in particular (Beals *et al.* 1960, Swift 1948). Evidence that browsing was an important factor does not seem to be present. Northern Iron County, because of its heavy winter snows and extensive mesic forests, affords less food and traditionally has had a lower deer population than adjacent counties. This can be illustrated by comparing the ratio of deer kill per square mile for Iron County and several adjacent counties (Fig. 10). The yearly data were taken from Bersing (1966). For the entire period from 1912 to the present, Iron County has the lowest ratio, varying from 0.22 to a high, in post logging years, of only 0.96. Adjacent counties have varied over the same period

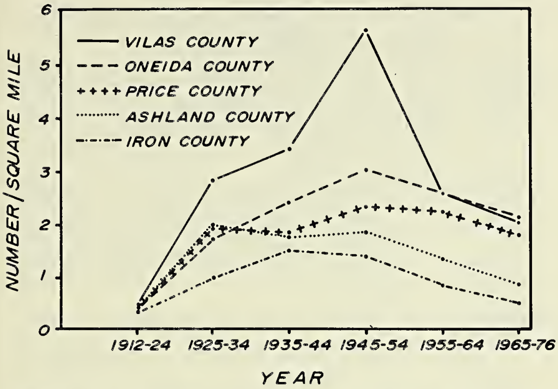

Fig. 10. Average annual deer harvest per square mile for Iron County and adjacent Counties 1912-1976. Data from: Bersing (1966), Wisconsin DNR (1966-76).

from 0.26 to 5.6 and a mean of 2.3 deer taken per square mile. Hunter pressure and weather may also influence the ratio. Hunter pressure, however, does not account for the consistent ratio noted, an opinion shared with Department of Natural Resources foresters in Iron County (Hanson 1979).

If deer are not a major factor, climate and site history must account for a greater part of the vegetation pattern as it appears today and for the direction in which it appears to be moving.

Conclusions

At the time of initial settlement of Iron County, the dominant upland cover was mesic forest with sugar maple, hemlock, and yellow birch as major components. Relative importance of the species varied with local topography, soils, and site history.

From the 1860s to the 1930s, the region underwent rapid development with intensive exploitation of iron ore and forest resources. Development produced mainly secondary regional impacts, *i.e.,* extensive timber cutting and land clearing resulting in the spread of farms around the mining communities. There were of course, intensive site-specific impacts from the mining, such as subsidence and lack of reclamation in and around populated areas, and, not least, the social problems that resulted from this boom and bust economy. However, despite the once dramatic changes in the landscape, the area is generally reverting to mesic forest. This is consistent with the findings of Kline and Cottam (1979) in southwestern Wisconsin where, despite significant impacts, the overriding climatic influence has resulted in re-establishment of vegetation similar to the original forest.

Compositionally, the mesic forests along the Gogebic Range are considerably different today from those in 1860. In terms of tree species with significant importance values, the forests appear to be considerably more diverse. This is, in part, because the forest is now younger; many of the species present today are pioneer species which could not survive and reproduce under the dense shade of the mature maple-hemlock presettlement forest.

The forests along the Gogebic Range have in fact been affected by human activity in such a manner that despite reversion to a mesic forest type, the regional vegetation will not have the same composition which characterized its presettlement condition, even if undisturbed for a considerable time. Climate appears to remain the dominant factor determining vegetation of a region. The compositional changes described in this paper are not unusual for the mesic forests of northern Wisconsin. However, the timing of disturbance and the driving forces behind it form a unique relationship between the forest and the mining economy. These human activities have altered the present condition and future composition of the forest to an extent that will not be erased on a regional scale in the foreseeable future.

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Literature Cited

Auclair, A. N., and F. G. Goff. 1971. Diversity relations of upland forests in the western Great Lakes Area. Am. Midl. Nat. 105: 497-528.

Beals, E. W., Grant Cottam, and R. J. Vogl. 1960. Influence of deer on vegetation of the Apostle Islands, Wisconsin. J. Wildlife Mgmt. 24:68-80.

Bersing, O. S. 1966. A century of Wisconsin deer. 2nd edition. Wisconsin Conservation Dept. Publ. 353. Madison, Wisconsin.

Bordner, J. S. 1934. Wisconsin land economic inventory: Iron County. State of Wisconsin. Madison, Wisconsin.

Bourdo, E. A. 1956. A view of the General Land Office survey and of its use in quantitative studies of former forests. Ecology 37: 754-68.

Brown, R. T. and J. T. Curtis. 1952. The upland conifer-hardwood forests of northern Wisconsin. Ecol. Monographs. 22:217-34.

Corrigan, G. A. 1976. Calked boots and cant hooks. McGregor Litho., Park Falls, Wisconsin.

Cottam, Grant. 1949. The phytosociology of an oak woods in southwestern Wisconsin. Ecology 30:271-87.

Cottam, Grant and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37:451-460.

Curtis, J. T. 1959. The vegetation of Wisconsin. University of Wisconsin Press. Madison, Wisconsin.

Fowells, A. 1965. Silvics of forest trees of the United States. Agric. Handbook No. 271. USDA, Washington, D.C.

Frothingham, E. H. 1915. The northern hardwood forest: Its composition, growth, and management. U.S. Dept. of Ag. Bull. No. 285. USDA, Washington, D.C.

Gates, F. C. and G. E. Nichols. 1930. Relation between age and diameter of trees of the primeval northern hardwood forest. J. Forestry 28:395-398.

Goff, F. G., and P. H. Zedler. 1968. Structural gradient analysis of upland forests in the western Great Lakes area. Ecol. Monographs 28:65-86.

Godman, R. M. and L. W. Krefting. 1960. Factors important to yellow birch establishment in Upper Michigan. Ecology 41:18-28.

Graham, S. A. 1941. Climax forests of the upper peninsula of Michigan. Ecology 15: 343-57.

Hanson, M., Forester, Department of Natural Resources, Iron County, Wisconsin. 1978, 1979. Personal communications.

Hole, F. D. 1976. Soils of Wisconsin. University of Wisconsin Press. Madison, Wisconsin.

Kline, V. M. and G. Cottam. 1979. Vegetation response to climate and fire in the Driftless Area of Wisconsin. Ecology 60:861-868.

Loucks, O. L. 1970. Evolution of diversity, efficiency, and community stability. Am. Zoologist 10:17-25.

Martin, L. 1965. The physical geography of Wisconsin, 3rd edition. University of Wisconsin Press. Madison, Wisconsin.

Mladenoff, D. J. 1979. Vegetation change in relation to land use and ownership on the Gogebic Iron Range, Wisconsin. M.S. Thesis. University of Wisconsin, Madison, Wisconsin.

Potzger, J. E. 1946. Phytosociology of the primeval forest in central northern Wisconsin and Upper Michigan, and a brief postglacial history of the lake forest formation. Ecol. Monographs. 16:211-50.

Rogers, D. J. 1959. Ecological effects of cutting in southern Wisconsin woods. Ph.D. Thesis. University of Wisconsin. Madison, Wisconsin.

Stearns, F. W. 1949. Ninety years of change in a northern hardwood forest in Wisconsin. Ecology 30:350-358.

———. 1951. The composition of the sugar maple—hemlock—yellow birch association in northern Wisconsin. Ecology 32:245-265.

Strommen, N. D. 1974. The climate of Michigan. In: *The Climates of the States.* Vol. 2: 192-214. USDC, Washington, D.C.

Swift, Ernest. 1948. Wisconsin's deer damage to forest reproduction survey—final report. Wis. Conservation Dept. Publ. 347. Madison, Wisconsin.

Waite, P. J. 1960. The climate of Wisconsin. In: *The Climates of the States.* Vol. 2:437-452. USDC, Washington, D.C.

Ward, R. T. 1956. The beech forests of Wisconsin—changes in forest composition and the nature of the beech border. Ecology 37: 407-419.

Winget, C. H., G. Cottam, and T. T. Kozlowski. 1965. Species association and stand structure of yellow birch in Wisconsin. Forest Science 11:269-383.

Wisconsin Department of Natural Resources. 1966-76. Annual big game harvest statistics (various titles), Madison, Wisconsin.

THERMAL STRATIFICATION OF WISCONSIN LAKES

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Abstract

A model predicting summer temperature stratification in lakes utilizing lake surface area and maximum depth information was developed from vertical profile temperature and dissolved oxygen data collected on approximately 500 Wisconsin lakes. From the model, the number of stratified versus non-stratified lakes (natural and impoundments) was estimated for the 3,000 plus Wisconsin lakes with surface areas 25 acres (10 hectares) or greater. Statewide, about one-half of the lakes are predicted to be non-stratified. Impoundments, which represent about 16 percent of the state's lakes, are about 86 percent non-stratified. Potential uses for the lake stratification model are noted.

INTRODUCTION

Thermal stratification in moderately deep temperate latitude lakes is a well documented phenomenon. Hutchinson (1957) provides a thorough discussion of the contributions of earlier researchers. Thermal stratification results from density differences in lake water of varying temperatures (Birge, 1916). After the winter ice melts, water temperatures increase above the point of maximum density of 4°C until maximum Wisconsin lake surface temperatures, generally between 21°-27°C (Wisconsin DNR, Bureau of Research lake data files), are reached by mid-summer. The wind provides energy during the spring to circulate the warming surface waters throughout the entire water column (spring overturn) maintaining homoiothermal (uniform) lake temperatures. As water temperatures increase above 4°C, water density decreases, with each successive degree of rising water temperature resulting in a greater decrease in water density. Consequently, more wind energy is required to completely circulate the warmer lake surface waters with the cooler, more dense bottom waters.

In deeper lakes, as surface temperatures increase on calm, warm spring days, the density differences between surface and bottom waters become too great for the wind to maintain complete homoiothermy. Thermal stratification results with the establishment of an *epilimnion* (upper warm water, freely circulating), *hypolimnion* (deep, cold, relatively undisturbed water), and a zone of steep thermal gradient called the *metalimnion* (or *thermocline*). These regions exist throughout the summer months until fall, when the lake surface water cools sufficiently to again equalize water density differences between top and bottom, thereby initiating fall overturn.

Shallow lakes exhibit complete mixing regularly throughout the summer as the wind provides enough energy to destabilize the minor density differences that develop between the surface and bottom as a result of surface warming on hot, calm summer days. Certain lakes have sufficient depth to allow for temporary thermal stratification, which persists until major weather systems with high winds again cause complete mixing. These weather systems occur frequently enough during the summer months in Wisconsin (Stauffer, 1974) that these weakly stratified lakes can be considered as non-stratified. Stratified lakes do not exhibit complete mixing during the summer, although metalimnetic deepening, as a result of these strong weather fronts, does occur (Stauffer, 1974).

Rigorous mathematical expressions have been developed to describe the heat flux processes of lakes that ultimately result in thermal stratification (see Hutchinson, 1957). Calculations based on various physical lake characteristics can describe the *stability* of a lake, or the amount of work needed to cause a lake to destratify to a uniform temperature. Lake depth is an important variable in the calculation. However, the lake depth required before thermal stratification develops varies greatly between individual lakes as a function of lake surface area, basin orientation relative to prevailing winds, lake depth-volume relations, protection by surrounding topography and vegetation, and other factors (Wetzel, 1975).

Few generalizations about stratification have been attempted for diverse groups of lakes. Hutchinson (1957) noted that the eddy diffusivity (related to the process of turbulent mixing) is greatest in the windswept epilimnion of large, exposed lakes. Consequently, lakes of similar maximum depths may be either stratified or non-stratified, depending on their surface area.

Ragotzkie (1978), using data from Wisconsin and central Canadian lakes, developed one of the first simple lake stratification models. Lake fetch (F) was used to predict the depth of the summer thermocline (D_{th}) for lakes having fetches from 0.1 to over 20 km:

$$D_{th} = 4\sqrt{F}$$

Summer stratification of a lake has a tremendous impact on the chemical constituent concentrations of each lake and a great influence on the lake's biological community structure. Although Wisconsin lakes are very diverse in their geochemical characteristics (Poff, 1961) and watershed nutrient loadings, particularly between northern and southern Wisconsin, they are also greatly affected by thermal stratification (Lillie and Mason, in press). In general, southern Wisconsin lakes are more fertile, and those that stratify usually exhibit dissolved oxygen depletion throughout the hypolimnion as a result of respiration and bacterial decomposition of organic matter. The lack of oxygen in the colder hypolimnion precludes the survival of cold-water-adapted fish such as trout since surface water temperatures are high where dissolved oxygen concentrations are adequate. Other aquatic life such as bottom feeding insects and zooplankton are restricted from the anoxic hypolimnion except for brief periods when certain species migrate into the hypolimnion. Northern Wisconsin lakes are generally less fertile and therefore in many cases do not undergo complete hypolimnetic oxygen depletion. Cold-water-adapted fish do well in the hypolimnion of these lakes during the summer months when surface waters are too warm.

The lack of oxygen in the hypolimnion of fertile lakes causes the hypolimnetic lake sediments to release such dissolved constituents as inorganic phosphorus, ammonia, and hydrogen sulfide into the overlying water throughout the summer stratification period (Mortimer, 1941-1942). In shallow, fertile lakes a significant amount of dissolved nutrients released from the lake sediments during periods of brief stratification can be transported by subsequent mixing to the surface waters where high levels of algal production are maintained.

Resuspension of sediments is another important effect of lake mixing. Shallow lakes continually resuspend nutrient rich sediments that contribute to increased nutrient concentrations for algal growth.

The combined result of sediment resuspension and frequent stratification followed by lake mixing in shallow lakes results in potentially high rates of internal nutrient recycling during the summer months. As a result, surface waters of non-stratified lakes in Wisconsin generally show a net increase in total phosphorus concentration from spring to summer, while deep stratified lakes usually exhibit a net decrease in total phosphorus concentration (Lillie and Mason, in press. Thermal stratification effectively creates a temporary nutrient barrier between the epilimnion and the hypolimnion, while nutrients are being removed from the epilimnion by sedimenting algae. The importance of this barrier varies between lakes as a function of lake basin morphometry.

The classification and inventory of lakes in relation to their trophic status has been emphasized increasingly in recent years by state and federal agencies. Since thermal stratification can significantly affect lake water quality and concomitant recreational potential of a lake, a model capable of predicting stratification in Wisconsin lakes from limited data could provide useful information for the classification process.

Methods

Data used in this report came from two sources: (1) vertical profile temperature and dissolved oxygen data on approximately 500 lakes 25 acres (10 hectares) or greater in surface area, collected by the Wisconsin DNR, Bureau of Research; and (2) lake surface area and maximum depth information on Wisconsin lakes 25 acres or greater (data compiled by DNR Bureau of Fish Management). The lake inventory data was subdivided into natural lakes and impoundments.

Decisions about the establishment of thermal stratification are based on inspection of the temperature and dissolved oxygen vertical profiles. Three main types of tem-

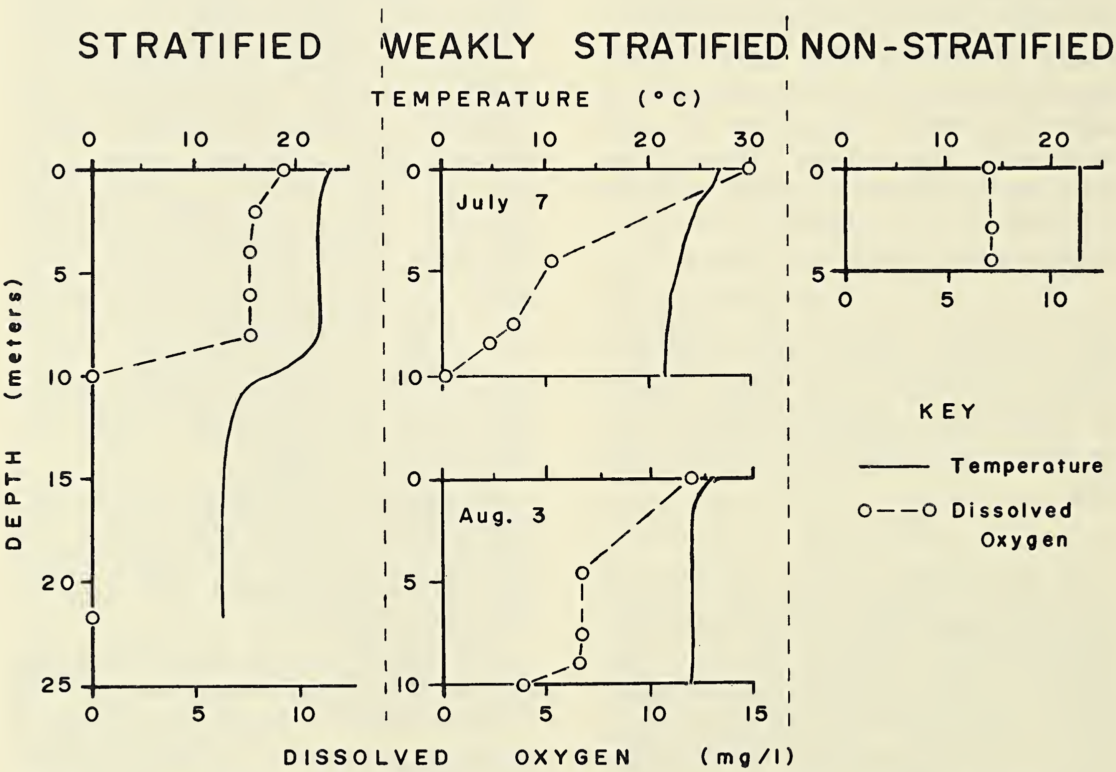

Fig. 1. Temperature stratification patterns found in Wisconsin lakes. (Stratified = Lake Monona, Dane Co., Aug. 1, 1978; Weakly Stratified = Lake Waubesa, Dane Co., July 7 and Aug. 3, 1976; Non-stratified = Round Lake, Chippewa Co., July 15, 1975).

perature profiles are found in Wisconsin lakes (Fig. 1). The stratified lake has a distinct epilimnion, metalimnion, and hypolimnion. The hypolimnion in the example is completely anoxic, indicating the absence of mixing with the epilimnion. The non-stratified lake is homoiothermal; dissolved oxygen concentrations demonstrate well-mixed conditions.

The weakly-stratified lake (Fig. 1) demonstrates the difficulty in deciding whether or not the lake is capable of developing permanent stratification throughout the summer season (late June, July, and August). On July 7, the lake appears to be stratified and dissolved oxygen depleted near the lake bottom. However, on August 3, the temperature gradient is not as steep (with bottom temperatures being more than 2°C higher) and dissolved oxygen concentrations are higher in deeper waters, indicating that some recent mixing has occurred. The July 7 data provides a clue to the lake's ability to destratify; bottom water temperatures are almost 22°C. Any cooling and/or mixing of the lake's surface waters as a result of a weather front would reduce the density differences between the top and bottom waters sufficiently to allow complete vertical mixing.

Consequently, any lakes with mid-summer bottom water temperatures above 20°C were generally considered to be weakly stratified and were combined with the more obvious non-stratified lakes for the purposes of this study. For the few lakes where stratification or lack of it was even more difficult to determine, the authors assigned lakes to the appropriate category based on their judgment about the influence of other factors affecting stratification, such as lake shape and surrounding topography.

Results and Discussion

Lake surface area and maximum depth information were plotted for all natural lakes that could be classified as either stratified or non-stratified based on interpretation of the temperature and dissolved oxygen vertical profile information (Fig. 2). A generally linear separation between the stratified and non-stratified lakes resulted from a logarithmic presentation of lake area. Those lakes

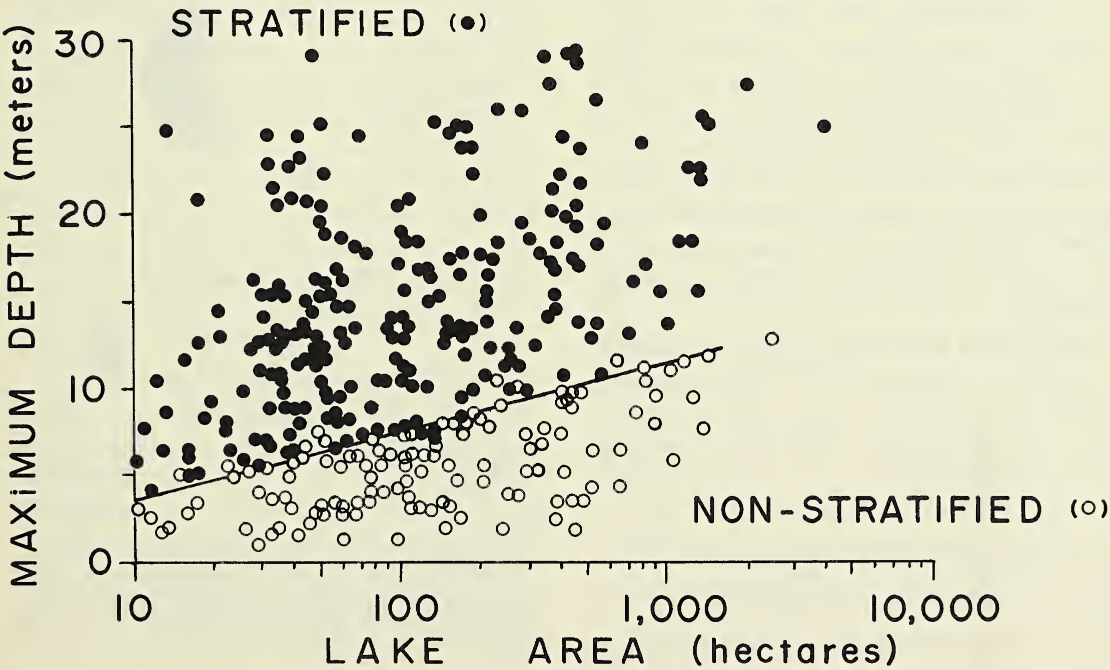

Fig. 2. Lake stratification model for Wisconsin lakes.

lying close to the stratification/non-stratification interface (Fig. 2) represented borderline cases, with stratified lakes having less stability when in close proximity to the interface. Many of the non-stratified lakes near the interface were weakly stratified.

Impoundments plotted in this same manner showed somewhat similar results, however a few anomalies were noted. In some cases stable temperature stratification occured in small, relatively shallow depressions near the spillways of dams where there was no circulation and warmer surface waters were passing over the spillway. A number of impoundments (and a few natural lakes) receive large river discharges in relation to their volume and thereby experience a physical flushing which precludes the establishment of thermal stratification. Lack of stratification in Wisconsin impoundments with high flushing rates was found in depths up to 22 meters. Because of these abnormal stratification characteristics impoundments were excluded from the development of the final stratification model (Fig. 2). However, the model should be applicable to most impoundments.

Color, caused by dissolved humic substances, is one important variable affecting the depth of thermocline development in all lakes. The increased absorptive capacity of colored water restricts penetration of radiant energy. Consequently, colored lakes frequently have shallower epilimnions and narrower thermoclines than clear-water lakes (Wisconsin DNR, Bureau of Research lake data files).

Because of the linear separation between stratified and non-stratified lakes, a simple mathematical model was developed to predict lake stratification based on maximum depth and lake area:

$$\frac{\text{Maximum Depth (meters)} - 0.1}{\text{Log}_{10}\text{ Lake Area (hectares)}} > 3.8 - \text{Lake should be stratified}$$

This model allowed for the prediction of the number of stratified versus non-stratified lakes for Wisconsin from surface water inventory data. As the model was based only on lakes with surface areas 25 acres (10 hectares) or greater and because smaller lakes may be heavily influenced by surrounding topography, the model was only applied to the 3,000 plus Wisconsin lakes in this size range. Impoundments and also lakes with high color were included in the data set. The number of poor predictions was relatively small.

Since the mathematical expression was developed using a data set from Wisconsin lakes, application of the model to other areas of the country may result in inaccurate stratification predictions because of differences in basin configuration, climate, or other factors. However, lakes in the upper Midwest should be reliably predicted by the model.

The lake stratification model, when compared to the model developed by Ragotzkie (1978), produced corresponding results.

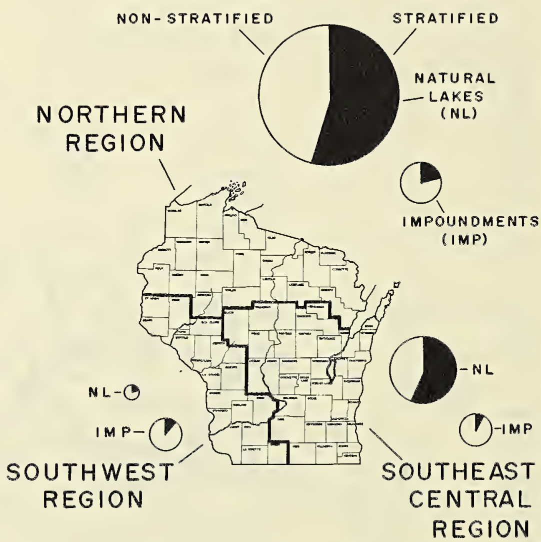

Fig. 3. Regional stratification characteristics of Wisconsin natural lakes and impoundments. (Number of lakes proportional to area of circle; Stratified lakes = solid area, Non-stratified lakes = open area).

His equation predicted the top of the thermocline, whereas the line drawn in Figure 2 would correspond approximately to the bottom of the thermocline. Consequently, Ragotzkie's equation for lakes between 10 and 20,000 hectares (after fetch was converted to circular lake area) when plotted was somewhat parallel to our line in Figure 2, but at shallower depths for corresponding lake areas. As lake area increased, the two models predicted a more extensive thermocline; this is consistent with observational data on Wisconsin lakes (Wisconsin DNR, Bureau of Research lake data files).

For identification of lake stratification characteristics Wisconsin is divided into three regions (Fig. 3). The southwest region generally coincides with the Western Upland Geographical Province of Martin (1965), part of which includes the Driftless or unglaciated area. The topography is highly dissected with few natural lakes present. The northern region includes a majority of the state's lakes; these are characterized by low alkalinity (Lillie and Mason, in press) as a result of the igneous bedrock geology (Hanson, 1971; Poff, 1961). The southeast central area of the state generally has lakes of higher alkalinity and poorer water quality than northern lakes; this is particularly true in the southern part of the southeast central region (Lillie and Mason, in press). Separation of the state into distinct regions based on county lines is arbitrary, but lake inventory information was available on a county basis. The bedrock and surficial geology each indicate much more complex regional distinctions.

Natural lakes and impoundments are unevenly distributed throughout the three state regions (Fig. 3). Approximately 75 percent of Wisconsin's 3,000 plus lakes of 25 acres (10 hectares) or greater surface area are located in the northern region of the state. The southeast central region has roughly 20 percent of Wisconsin lakes in this size range, and the remaining 5 percent are located in the southwest region. Impoundments comprise less than 16 percent of the total number of Wisconsin lakes 25 acres or greater. The number of impoundments is similar in all three regions. Most lakes in the northern region are natural; impoundments represent only about 8 percent of the total number. Impoundments constitute about 75 percent of all lakes found in the southwest region. There are few natural lakes in southwestern Wisconsin since that area was not covered by the Wisconsonian ice (Martin, 1965).

Slightly more than one-half of Wisconsin's lakes with surface areas of 25 acres or greater are predicted by the lake stratification model to be non-stratified throughout the summer (Fig. 3). About 26 percent of the impoundments are predicted to be non-stratified, compared to only 45 percent of the natural lakes.

Impoundments are 80, 93, and 84 percent non-stratified in the northern, southeast central and southwest regions, respectively. The high percentage of non-stratified impoundments is not surprising since they represent shallow lakes on dammed rivers. Natural lakes are predicted to be 55 and 58 percent stratified in the northern and southeast central regions, but only 22 percent stratified in the unglaciated southwestern region.

Striking water quality differences have been noted between stratified and non-stratified lakes. From data collected on approximately 500 lakes throughout the state, average summer secchi disc (water transparency) readings were 2.8 and 1.5 meters for stratified and non-stratified lakes, respectively (Wisconsin DNR, Bureau of Research, unpublished data). Differences in water transparency were related to greater concentrations of chlorophyll (algal biomass) and higher turbidity in nonstratified lakes.

The lake stratification model has potentially important applications for the classification of Wisconsin lakes. The combined effect of generally poorer water quality in non-stratified lakes resulting from greater efficiencies in internal nutrient recycling, coupled with the large number of non-stratified lakes in Wisconsin, necessitates careful selection of lakes as candidates for limited non-point pollution control efforts. Lakes that are chosen for programs designed to restrict nutrient inputs, which are often expensive, should possess characteristics that would indicate a high probability of water quality response (improvement or long-term protection), thereby ensuring a high benefit to cost ratio. Temperature stratification would seem to be a very important characteristic in lake selection.

The thermal stratification model has other potential uses in water resource management activities. The model may be useful for the initial selection of lakes capable of supporting cold water fisheries, particularly in northern regions where hypolimnetic dissolved oxygen concentrations are likely to be adequate. The model can also serve as a guide to lake managers conducting dredging projects. By predicting lake depths needed for the development of thermal stratification, dredging can be planned to reduce internal nutrient recycling in fertile lakes. The stratification model could also be used in the design of impoundments for the above reasons or to maximize sediment trap efficiency.

Other more theoretical uses of the temperature stratification model may have management implications. The sediments contain a history of the lake's development, and lakes of certain depths may have accumulated sufficient bottom sediments over time to convert the lake from stratified to non-stratified. Probable trophic changes in the lake may be deduced by interpretation of differences in the physical and chemical sediment characteristics. Differences in the biological remains present, above and below the sediment depth where the lake should no longer be stratified, also provide clues. Such interpretation might allow the prediction of projected water quality changes in stratified lakes that are currently experiencing a high rate of in-filling and sediment deposition.

Finally, a stratification model similar to the one presented here may be developed to predict the depth of the epilimnetic/metalimnetic boundary. This depth could be used to calculate the lake bottom area exposed to wind mixing, thus providing an index of potential internal nutrient recycling, as well as information useful for calculating total lake sedimentation rates. This model, coupled with other lake morphometric data, may also help to refine existing lake eutrophication models that relate external phosphorus loadings to in-lake water quality.

Literature Cited

Birge, E. A. 1916. The work of the wind in warming a lake. Trans. Wis. Acad., Sci., Arts, Lett. 18, Part II: 341-391.

Hanson, G. F. 1971. Geologic map of Wisconsin. Wis. Geol. and Nat. Hist. Survey, Madison, 1 p.

Hutchinson, G. E. 1957. A Treatise on Limnology. I. Geography, Physics, and Chemistry. John Wiley & Sons, Inc., New York, 1015 pp.

Lille, R. A. and J. W. Mason (in press). Limnological characteristics of Wisconsin lakes. Wis. Dept. Nat. Resources Tech. Bull.

Martin, L. 1965. The Physical Geography of Wisconsin. University Wisconsin Press, Madison, 608 pp.

Mortimer, C. H. 1941-1942. The exchange of dissolved substances between mud and water in lakes. J. Ecology 29:280-329; 147-201.

Poff, R. J. 1961. Ionic composition of Wisconsin lake waters. Wis. Dept. Nat. Resources, Fish Mgmt. Misc. Rept. No. 4, 20 pp.

Ragotzkie, R. A. 1978. Heat budgets of lakes. Ch. 1 in Lerman, A. (ed.) Lakes: Chemistry, Geology, Physics. Springer-Verlag, New York. 363 pp.

Stauffer, R. E. 1974. Thermocline migration-algal bloom relationships in stratified lakes. Ph.D. Thesis. Water Chemistry Program, Univ. Wisconsin, Madison, 526 pp. + App.

Wetzel, R. G. 1975. Limnology. W. B. Saunders Co., Philadelphia, 743 pp.

ECOLOGICAL RELATIONSHIPS OF RUFFED GROUSE IN SOUTHWESTERN WISCONSIN[1]

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Abstract

Ruffed grouse (*Bonasa umbellus*) were studied in southwestern Wisconsin from 1976 through 1978. Eighty-six of 87 activity centers were situated on slopes of less than 25 degrees. Spring densities of territorial males were 8.8 and 11.4 birds per 100 wooded ha in 1976 and 1977, respectively. Unusually warm springs allowed most females to nest prior to the peak of drumming. Brood break-up began in mid-August and dispersal reached maximum intensity in late September. Mean and maximum dispersal distances were 2.2 and 7.4 km respectively. Females had red tails proportionally more often than did males. Less than five percent of the 216 reward bands were returned indicating light hunting pressure. Territorial males had an annual survival rate of 53 percent.

The ruffed grouse is one of the most intensively studied upland game birds in North America. However, there remain large areas within this species' broad range from which there is little information. The unglaciated region of southwestern Wisconsin is such an area. This study was designed to provide greater insight into the ecology and harvest of ruffed grouse in southwestern Wisconsin.

The Driftless Area, as this region is known, also extends into northeastern Iowa and southwestern Minnesota and is typified by dendritic drainage patterns and steep slopes. Nearly all of the land is in small, privately owned farms. The creek bottoms and many ridgetops have been cleared for crops or pasture.

Five areas located in northeastern Iowa County, approximately 50 km west of the city of Madison, were studied. These areas totaled 889 ha of which 589 ha were forested. The woodlands are dominated by oak (*Quercus spp.*) and closely resemble the southern xeric forests described by Curtis (1959). Porath and Vohs (1972) reported on ruffed grouse research from forests of a similar nature in northeastern Iowa. Maximum relief on the study areas is 105 m.

METHODS

Field work began on 25 March, 1976 and continued through 15 May 1978. Observations were discontinued between 15 October and 20 March each year.

Drumming sites were located by systematically searching the wooded portions of the study areas. One or more drumming logs within 100 m of each other used by an individual territorial male were considered to delineate an activity center (Gullion 1967). I did not rely on hearing drumming to locate display sites, but looked for accumulations of droppings on logs or rocks. Other clues such as dense shrub-layer vegetation, leaf-free spots adjacent to logs, and worn areas on logs aided in location of potential drumming sites. The presence of droppings was considered the only conclusive proof of re-

[1] Research supported by the College of Agricultural and Life Sciences, University of Wisconsin, Madison, the Wisconsin Department of Natural Resources, and the U.S. Fish and Wildlife Service.

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cent activity. This method minimized the possibility of missing silent, but territorial cocks as identified by Dorney *et al.* (1958). Single logs showing only slight use (less than five droppings) that were greater than 100 m from other drumming logs were not considered activity centers, but were classified as light-use logs. The designation of activity centers and light-use logs was substantiated through trapping and banding.

Ocular estimates were made of the species composition of thickets that could make drumming logs essentially "predator proof" (Gullion and Marshall 1968:132). Data were taken only at the primary log (most used) of any given activity center. All woody vegetation within approximately 5 m of the stage (the point of drumming) was classed by occurrence and composition (percentage of stems present). These values were combined to obtain an index to the relative importance of various species in providing protection from predation.

Mirror traps (Tanner and Bowers 1948) were used to capture territorial males on drumming logs during the spring. For this purpose, single-door National live traps were fitted with mirrors and covered so that the interior was completely darkened once the trap was sprung. Two nesting females were caught with a lift net of sufficiently large mesh to allow the eggs to slip through and remain in the nest bowl. Between 5 August and 15 October of 1976 and 1977, grouse were captured in lily-pad traps (Dorney and Mattison 1956) with 37 m leads and small funnel traps at each end. All birds were marked with color-coded combinations of aluminum leg bands (Gullion et al. 1962), one of which was inscribed with a $5 reward notice and the return address.

Sex and age were determined for all grouse using plumage characteristics. Techniques reported by Bump *et al.* (1947:84-90, 98) and Hale *et al.* (1954) were used for sex and age discrimination. Feather measurements were helpful, but apparently vary geographically (Dorney and Holzer 1957, Davis 1969). However, the ratio of the calamus diameter of primaries 8 and 9 (Rodgers 1979) provided excellent age separation. A sexing criterion based on the number of whitish dots on the rump feathers (Roussel and Ouellet 1975) was also used and has the added advantage of being applicable to juveniles that had not completed growth of adult tail feathers. Juveniles were further examined for progression of the primary molt. The use of several techniques assured reliable sex and age determination.

Color phase was determined by examining all rectrices during the handling of each bird. Each grouse was categorized as being red, gray, or intermediate.

Timing of hatch was approximated principally by using the primary molt progression to backdate juveniles trapped in late summer (Bump *et al.* 1947). Estimates of nest initiation were calculated by assuming 17 days for a hen to lay an average clutch of 11 eggs and a 24 day incubation period (Bump *et al.* 1947). This information was supplemented with known dates from three nests.

Results and Discussion

Eighty-seven activity centers and 24 light-use logs were located during the springs of 1976 and 1977. Nine of these activity centers were found off the study areas. Light-use logs probably represented trial sites of males seeking to establish a territory. This apparent testing of logs for suitability has been noted by Gullion (1967:98-99). Frank (1947:308) also made reference to such sites, and similarly, did not consider them to be part of an established territory. Alternatively, some light-use logs may have been challenge sites used by males to engage in temporary drumming duals with other males (Gullion 1967:90). Light-use logs were typically in poorer habitat than activity centers.

Drumming Site Characteristics

Activity centers were most commonly located on or near ridgetops. This may indicate a preference for relatively level drumming sites. Only one activity center was found on a slope of greater than 25 degrees. Boag and Sumanik (1969) and Porath and Vohs (1972) found no drumming logs on slopes exceeding 22 degrees and 45% (24 degrees) respectively. Taylor (1976) suggested that the drumming ritual may be difficult to perform on logs sloping more than 20 degrees. He found that, in Tennessee, 71% of the drumming logs had an incline of less than ten degrees. The only activity center that I found on a hillside of greater than 25 degrees was composed of two logs which had fallen parallel to the contour and, consequently, were level. The tendency for trees to fall downhill might severely limit the potential of steep hillsides as drumming sites. Thus, an apparent preference for ridgetops may result since these areas constitute a major portion of the relatively level wooded terrain in this region. Activity centers were found below ridgetops on slopes of less than 25 degrees. Vegetational differences may also have some bearing on selection of ridgetops as drumming sites, however, this possibility was not quantified.

Male ruffed grouse might be encouraged to increase use of steep slopes for activity centers by providing sufficiently level drumming stages. This could be accomplished without significant expense when logging by leaving waste logs roughly parallel to the contour. Such a practice probably would not increase populations, since ruffed grouse are promiscuous (Brander 1967). However, it could be aesthetically valuable by distributing drumming grouse onto tracts of land which have little woodland other than that on steep slopes.

Several workers have indicated that male ruffed grouse select drumming logs which have a relatively high density of stems surrounding them (e.g. Gullion and Marshall 1968, Boag and Sumanik 1969). Observations made during this study appeared to substantiate these results. Gullion and Marshall suggested that this high stem density provides protection from avian predators. Subjective estimates made at the primary logs of 51 activity centers indicate that prickly ash (*Zanthoxylum americanum*), hazelnut (*Corylus americana*), and grey dogwood (*Cornus racemosa*) contribute most to high stem densities around southwestern Wisconsin drumming logs (Table 1).

Prickly ash probably furnishes the best

TABLE 1. Woody species that contribute to high stem density and may provide protection from avian predation. Relative percentage of stems obtained from ocular estimates at 51 primary drumming logs in southwestern Wisconsin.

	A *Occurrence* %	*B* *Composition*[1] %	*(A × B)/100* *Species Importance Index*
Prickly ash (*Zanthoxulum americanum*)	49.0	56.0	27.4
Hazelnut (*Corylus americana*)	47.1	26.7	12.6
Grey dogwood (*Cornus racemosa*)	29.4	33.7	9.9
Black cherry (*Prunus serotina*)	45.1	18.4	8.3
Riverbank grape (*Vitus riparia*)	25.5	31.2	8.0
White oak (*Quercus alba*)	41.2	15.5	6.4
Missouri gooseberry (*Ribes missouriense*)	33.3	12.8	4.3
Shagbark hickory (*Carya ovata*)	37.3	8.7	3.2

[1] Proportion of stems within 5 m of stage where species is present.

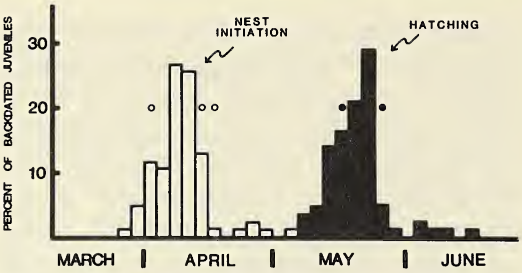

Fig. 1. Ruffed grouse nesting chronology for southwestern Wisconsin, 1976 and 1977. Bars represent 3-day units of pooled data derived by backdating juvenile grouse based on progression of the primary molt. Circles indicate actual nests.

protection against predators because it grows in dense thickets approximately 2 m in height and is armed with sharp thorns. Furthermore, little herbaceous vegetation grows within these thickets, thus affording the grouse a nearly unobstructed view of the area around it. Such a view would facilitate early detection of ground predators (Boag and Sumanik 1969, Gullion 1970). Small trees and shrubs and the riverbank grape (*Vitus riparia*) provide the greatest degree of protection around drumming logs in this region.

Nesting Phenology

No significant difference between hatching dates from 1976 and 1977 was detected by a t-test, consequently, all data were pooled. Approximately 80% of the 86 juveniles examined were estimated to have hatched between 12 May and 24 May (Fig. 1). Similar nesting synchrony has previously been reported by Hale and Wendt (1951) and Cringan (1970). Hale and Wendt suggested that a sharp hatching peak was indicative of high success of the first nests. They related this to warm, dry spring weather. The springs of 1976 and 1977 both began unusually early and were substantially warmer, but not drier, than normal in southern Wisconsin (U.S. Department of Commerce 1976, 1977).

The early spring probably influenced the onset of mating and nest initiation. Most nests were begun in the first and second weeks of April. This is roughly two weeks earlier than was reported for 1966 and 1967 in northeastern Iowa, only 110 km to the west of my study areas (Porath and Vohs 1972).

Intensive roadside drumming counts, conducted on a transect which passes through the study areas (Rodgers 1981), indicated that peak drumming (approximately 15 April) occurred after most females had initiated nesting. The peak of copulation is often concurrent with the peak of drumming (Brander 1967, Porath and Vohs 1972, Archibald 1976). This, apparently, was not the case in 1976 and 1977, particularly if copulation occurred three to seven days prior to nest initiation (Bump *et al.* 1947:471). These results are not incompatible with those of other researchers, but may represent the first time that both nesting and drumming data could be collected under such unusually favorable spring conditions.

Several workers have indicated that the timing of nesting in tetraonids is flexible and dependent on temperature (e.g. Neave and Wright 1969, Zwickel 1977). Conversely, there is increasing evidence which suggests that the peak of ruffed grouse drumming is more strongly determined by photoperiod than by temperature (Gullion 1966, Rodgers 1981). It does not appear to be mandatory that peak copulation coincide with the peak of male display, but rather that the level of display only be adequate for the females to locate males successfully. Zwickel (1977: 191) states that, in blue grouse (*Dendragapus obscurus*), "the breeding period of males has likely been selected to cover the entire receptive period of females, including annual, geographical, and age-class variations." This conclusion is probably also applicable to ruffed grouse.

Movements

Lily-pad trapping commenced too late in the summer to yield substantial information

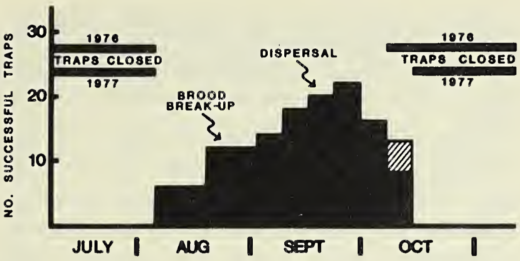

Fig. 2. Lily-pad trap success as an index to movement in the juvenile cohort of a southwestern Wisconsin ruffed grouse population. Bars represent 7-day intervals of pooled lily-pad trapping data from 1976 and 1977. Arrows indicate general periods of brood break-up and dispersal. Hatched area represents the projected 2-year level.

on brood movements. However, limited data from trapping and sporadic contacts with broods corroborate observations on brood movements made by Porath and Vohs (1972) in northeastern Iowa.

Timing of brood break-up and dispersal was estimated by comparing success in lily-pad traps during different periods. A trap was considered successful if it captured one or more ruffed grouse, thus individual and multiple captures were weighted equally. Consequently, a plot of total successful traps per day (Fig. 2) illustrates the timing of brood break-up and dispersal since these periods are characterized by the presence of solitary juveniles (Godfrey and Marshall 1969). Because captures in these traps depend on ground movements of the target species, dispersal was further emphasized by the relatively high level of movement within the juvenile cohort during this period.

Brood break-up apparently began in mid-August. Recapture data appear to confirm conclusions by Godfrey and Marshall (1969: 615) that juveniles wandered as individuals within their previous brood ranges at that time. I recorded 16 recaptures of solitary juveniles within 200 m of the previous capture between 16 August and 15 September; only six such recaptures occurred in the following month. Capture of a solitary juvenile is not an indication of brood break-up, however, an increase in the relative frequency of such captures could be indicative. Dispersal probably began the second week of September and peaked near the end of that month. Recaptures of juveniles at greater than 400 m from the original capture sites also suggested this timing. One such recapture was recorded on 6 September and four others occurred between 24 September and 7 October. These data tend to support the assertion of Godfrey and Marshall that brood break-up and dispersal are distinct and temporally separate events for any given individual, although they overlap at the population level (Rusch and Keith 1971).

No significant differences were detected in the sex ratio of juveniles captured in four one-week intervals between 10 September and 7 October (χ^2), indicating no differential timing of dispersal between the sexes.

Linear distances between observations were similar to those reported by other workers (e.g. Chambers and Sharp 1958, Hale and Dorney 1963) for adult males and juveniles. No useful movement data were obtained for adult females.

Adult males appeared to be the most sedentary cohort. These birds were trapped up to 200 m from their respective activity centers during the fall, although one adult male was shot 685 m from his activity center in mid-winter. Movement by this cohort is generally believed to be highly restricted during the spring drumming period. One drumming male was, however, recaptured on a log 335 m from the original capture site only three days after banding in April, 1976. These captures were each in mirror traps suggesting that this bird defended both sites. This situation is similar to the "expanded occupancy" noted by Gullion (1967:91) in low density populations. Drumming counts conducted in the spring of 1976 were among the lowest recorded for this area in 26 years (Hale, Unpublished data; Rodgers 1981). In 1977 after an apparent population increase, this bird defended only one of these sites. The other was occupied by a first year male.

Dispersal distances were determined for eight juveniles from which bands were returned and for two juvenile males recaptured on drumming logs. Data obtained via recaptures in lily-pad traps were not considered to represent completed dispersal movements since these traps may have interrupted ongoing dispersal movements. Mean dispersal distance was 2.2 km with a maximum of 7.4 km obtained for one female. In this limited sample, a t-test indicated no difference in dispersal distances between male and female juveniles.

In the disjunct woodlands of southwestern Wisconsin, movements of the magnitude noted above necessitate the traverse of relatively large open areas. Godfrey and Marshall (1969) have indicated that dispersing juveniles tend to avoid extensive open habitats, however, recaptures and band returns obtained in this study indicate that many juveniles crossed open areas as much as 300 m wide. Crossing large open habitats could increase the vulnerability of dispersing juveniles to predation.

Coloration

Records of adult plumage coloration were obtained for 205 birds. Color variation between birds was most pronounced in the rectrices. No birds with gray contour feathers were observed. Although tail color was categorized for convenience, I found no justification for considering this population to be comprised of distinct color morphs and, therefore, prefer a continuum concept. Porath and Vohs (1972) classified 71% of their northeastern Iowa ruffed grouse as red. If the group of birds which I classed as intermediate was evenly divided into the red or gray categories, again, 71% of the population would be classed as red. The dominance of oak in the woodlands of southwestern Wisconsin results in a reddish-brown leaf litter against which red coloration is probably more cryptic than gray.

TABLE 2. Tail color of southwestern Wisconsin ruffed grouse by sex and age.

	Red	*Intermediate*	*Gray*	*Total*
Sex[1]				
Male	65	49	26	140
Female	51	10	4	65
Age				
Adult	22	10	10	42
Juvenile	94	49	20	163
Total	116	59	30	205

[1] Color differs significantly ($P < 0.001$) between sexes.

A higher proportion of females than males possessed red tails (χ^2, $P < 0.001$, Table 2). This substantiates findings by Bezdek (1944) with central Wisconsin ruffed grouse. In contrast, Porath and Vohs (1972) found no differences in color between sexes, however, they examined only 58 birds. Bezdek suggested that this characteristic might be sex linked, but did not rule out other possibilities. Differential selection between sexes appears to be an unlikely cause since these differences were again significant ($P < 0.02$) in juveniles of only four to five months of age. Juveniles of this age were either acquiring or had just recently acquired adult plumage, thus allowing little time for a selective process to operate. No differences between adult and juvenile coloration were detected. The greater tendency toward red coloration in females is, therefore, either sex-linked or hormonally influenced.

Population Statistics

Spring densities of territorial males were 8.8 and 11.4 birds per 100 wooded ha in 1976 and 1977, respectively. These figures compare favorably with densities of 5.5 to 8.7 reported by Gullion (1966) in Minnesota between 1959 and 1965. They are higher than densities found on the northern Wisconsin areas studied by Dorney *et al.* (1958). While I have no direct census information for all cohorts, drumming counts as well as information obtained from hunters indicated that populations were lower than normal through the spring of 1976. On the basis of the densities observed, I agree with the assertion of Porath and Vohs (1972) that the Driftless Area lies within the optimal range of ruffed grouse although it is on the fringe of the current range of the species.

A sex ratio of 1.3 males per female was obtained for 163 juveniles captured in lilypad traps. Deviation from the expected 1:1 ratio was not significant (χ^2), however, significance was approached ($P < 0.08$). Dorney (1963) found a similar sex ratio of 1.2 males per female in a sample of 508 juveniles shot in southwestern Wisconsin. This was a significant deviation ($P < 0.05$) from a 1:1 ratio. It is unlikely that this skewed ratio resulted from procedural error since Dorney (1963) found nearly even ratios in other regions of Wisconsin using identical techniques. Reports on sex ratios of juvenile ruffed grouse from other localities are about evenly divided between those with even sex ratios and those skewed in favor of males (Davis and Stoll 1973). The cause of an unbalanced sex ratio within juveniles of four to five months of age remains unclear.

Since drumming ruffed grouse generally utilize only one activity center throughout their lives, annual survival of banded territorial males can be easily determined. In this study, a drumming male was assumed dead if, in a subsequent year, his activity center was not occupied or if another bird was captured at that activity center. These assumptions are not flawless. Gullion (1967) has recorded instances in which established males shifted activity centers. As a result, the following survival estimates must be regarded as minimal.

Of 36 territorial males whose fates were determined, 19 (53%) were known to be alive the following spring. This value compares favorably to 44% survival in northern Wisconsin (Dorney and Kabat 1960), 47% at Cloquet, Minnesota (Gullion and Marshall 1968), and 36% at Rochester, Alberta (Rusch, personal comm.). My data represent only two years compared to three, seven, and eight for the northern Wisconsin, Minnesota, and Alberta figures, respectively. Study of survival over a more extended period may produce a somewhat different value. Nevertheless, survival of territorial males in Southwestern Wisconsin is, at least, comparable to that in other regions. Although Porath and Vohs (1972) suggested a high turnover within this cohort, their suggestion was based on only five banded adult males.

Hunting pressure evidently was light; bands from only ten birds were returned in the two years of the study. This represents a crude return rate of under 5% and is lower than any previously reported rate. Unreported kills should have been reduced by the $5 reward. This apparent low harvest occurred despite close proximity to the Madison metropolitan area (population 300,000).

There are at least three factors contributing to this low rate. As Dorney (1963) pointed out, the rugged terrain automatically limits hunting pressure in the Driftless Area. Steep slopes and dense and often thorny undergrowth undoubtedly discourage many hunters. Second, the region is not well suited for road hunting, a practice common in northern Wisconsin where approximately 32% of the ruffed grouse harvest was taken along roads (Dorney 1963). The corresponding figure for southwestern Wisconsin was only 5%; there roads usually follow the valley bottoms or major ridgetops, most of which have been cleared for agriculture. Third, almost all land in southwestern Wisconsin is in small privately owned farms, a fact that probably further limits ruffed grouse harvest. Virtually all land in the vicinity of my study areas is posted against hunting or trespassing. Access is limited for hunters lacking personal contact with landowners.

Nine of ten band returns were from birds shot on or after 29 December. The ruffed grouse hunting season in the Driftless Area counties extended through 31 January, a full month longer than in the remainder of Wisconsin. The extended season appears to be effective in increasing the harvest. Without the additional month, the grouse harvest in southwestern Wisconsin might drop to a fraction of its current low level.

Management Implications

The ruffed grouse population in southwestern Wisconsin appears generally capable of sustaining increased hunting pressure. This conclusion contrasts with recent information from east-central Wisconsin which suggests a potential for over-harvest of ruffed grouse on public wildlife lands (DeStefano and Rusch, pers comm). Over-harvest in southwestern Wisconsin is unlikely for several reasons: 1) posting reduces access to private land; 2) the rugged terrain limits hunting pressure on both public and private lands; and, 3) the ratio of population to public land in southwestern Wisconsin is only about one-fourth that of east-central Wisconsin (Carley 1962). Individual public holdings in southwestern Wisconsin are comparatively small. Thus, ingress of birds would probably compensate for losses should an unusually heavy ruffed grouse harvest occur on a given public area. I believe the extended season, overall, is an excellent management practice for the Driftless Area.

A larger ruffed grouse harvest in southwestern Wisconsin could probably be obtained by shifting the entire season back about two weeks. A delayed opening in the southwest might attract many Wisconsin hunters. The present statewide opening brings few grouse hunters to the southwest; many hunters travel north to better known grouse coverts. A two week extension of the closing would provide quality hunting at a time when relatively few outdoor activities are available to sportsmen. There would be no interference with spring breeding. With this later opening, a greater proportion of the season would occur after leaf-fall, which is relatively late in the southwest.

Evaluation of ruffed grouse harvest, particularly on public lands, and of public reaction should precede and follow any regulation changes.

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Bibliography

Archibald, H. L. 1976. Spring drumming patterns of ruffed grouse. Auk 93:808-829.

Bezdek, H. 1944. Sex ratios and color phases in two races of ruffed grouse. J. Wildl. Manage. 8:85-88.

Boag, D. A. and K. M. Sumanik. 1969. Characteristics of drumming sites selected by ruffed grouse in Alberta. J. Wildl. Manage. 33:621-628.

Brander, R. B. 1967. Movements of female ruffed grouse during the mating season. Wilson Bull. 79:28-36.

Bump, G., R. W. Darrow, F. C. Edminster, and W. F. Crissey. 1947. The ruffed grouse: life history, propagation, management. New York State Conserv. Dept. 915 pp.

Carley. D. 1962. Recreation in Wisconsin. Dept. Resource Development, Madison. 97 pp.

Chambers, R. E. and W. E. Sharp. 1958. Movement and dispersal within a population of ruffed grouse. J. Wildl. Manage. 22:231-239.

Cringan, A. T. 1970. Reproductive biology of ruffed grouse in southern Ontario, 1964-1969. J. Wildl. Manage. 34:756-761.

Curtis, J. T. 1959. The vegetation of Wisconsin. Univ. Wisconsin Press, Madison. 657 pp.

Davis, J. A. 1969. Aging and sexing criteria for Ohio ruffed grouses. J. Wildl. Manage. 33:628-636.

——— and R. J. Stoll. 1973. Ruffed grouse age and sex ratios in Ohio. J. Wildl. Manage. 37:133-141.

Dorney, R. S. 1963. Sex and age structure of Wisconsin ruffed grouse populations. J. Wildl. Manage. 27:598-603.

——— and H. M. Mattison. 1956. Trapping techniques for ruffed grouse. J. Wildl. Manage. 20:47-50.

——— and F. V. Holzer. 1957. Spring aging methods for ruffed grouse cocks. J. Wildl. Manage. 21:268-274.

———, D. R. Thompson, J. B. Hale, and R. F. Wendt. 1958. An evaluation of ruffed grouse drumming counts. J. Wildl. Manage. 22:35-40.

——— and C. Kabat. 1960. Relation of weather, parasitic disease and hunting to Wisconsin ruffed grouse populations. Wis. Conserv. Dept. Tech. Bull. No. 20. 64 pp.

Frank, W. J. 1947. Ruffed grouse drumming site counts. J. Wildl. Manage. 11:307-316.

Godfrey, G. A. and W. H. Marshall. 1969. Brood break-up and dispersal of ruffed grouse. J. Wildl. Manage. 33:609-620.

Gullion, G. W. 1966. The use of drumming behavior in ruffed grouse population studies. J. Wildl. Manage. 30:717-729.

———. 1967. Selection and use of drumming sites by male ruffed grouse. Auk 84:87-112.

———. 1970. Factors influencing ruffed grouse populations. Trans. North Am. Wildl. and Natural Resources Conf. 35:93-105.

———, R. L. Eng, and J. J. Kupa. 1962. Three methods for individually marking ruffed grouse. J. Wildl. Manage. 26:404-407.

———, and W. H. Marshall. 1968. Survival of ruffed grouse in a boreal forest. Living Bird 7:117-167.

Hale, J. B. and R. F. Wendt. 1951. Ruffed grouse hatching dates in Wisconsin. J. Wildl. Manage. 15:195-199.

———, R. F. Wendt, and G. C. Halazon. 1954. Sex and age criteria for Wisconsin ruffed grouse. Wis. Conserv. Dept. Tech. Bull. No. 9. 24 pp.

———, and R. S. Dorney. 1963. Seasonal movements of ruffed grouse in Wisconsin. J. Wildl. Manage. 27:648-656.

Neave, D. J. and B. S. Wright. 1969. The effects of weather and DDT spraying on a ruffed grouse population. J. Wildl. Manage. 33:1015-1020.

Porath, W. R. and P. A. Vohs, Jr. 1972. Population ecology of ruffed grouse in northeastern Iowa. J. Wildl. Manage. 36:793-802.

Rodgers, R. D. 1979. Ratios of primary calamus diameters for determining age of ruffed grouse. Wildl. Soc. Bull. 7:125-127.

———. 1981. Factors affecting ruffed grouse drumming counts in southwestern Wisconsin. J. Wildl. Manage. 45:409-418.

Roussel, Y. E. and R. Ouellet. 1975. A new criterion for sexing Quebec ruffed grouse. J. Wildl. Manage. 39:443-445.

Rusch, D. H. and L. B. Keith. 1971. Seasonal and annual trends in numbers of Alberta ruffed grouse. J. Wildl. Manage. 35:803-822.

Tanner, W. D. and G. L. Bowers. 1948. A method for trapping male ruffed grouse. J. Wildl. Manage. 12:330-331.

Taylor, D. A. 1976. An analysis of some physical characteristics of ruffed grouse (*Bonasa umbellus*) drumming sites and logs in middle and eastern Tennessee. Tenn. Wildl. Resour. Agency Tech. Rept. No. 75-25. 72 pp.

U.S. Department of Commerce. 1976, 1977. Climatological data, Madison, Wisconsin. Annual Summary. 4 pp.

Zwickel, F. C. 1977. Local variations in the time of breeding of female blue grouse. Condor 79:185-191.

HELMINTH AND ARTHROPOD PARASITES OF SOME DOMESTIC ANIMALS IN WISCONSIN

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Abstract

Nineteen species of intestinal helminths (cestodes and nematodes) and 15 species of arthropod ectoparasites (fleas, ticks, botflies, chewing lice, and mites) are reported from six species of domestic animals (dog, *Canis Familiaries;* cat, *Felis catus;* chicken, *Gallus domesticus;* turkey, *Meleagris gallopavo;* pig, *Sus scrofa;* and horse *Equus caballus*) in southeastern Wisconsin. Most are first state records. Data on frequency and intensity of infection are discussed in relation to results from similar surveys elsewhere.

Introduction

Surveys of parasites of domestic animals, particularly those of dogs, are common in the literature. Surveys of helminth parasites of dogs are usually based on fecal examination (Burrows and Lillis, 1960; Jaskoski, 1971; Loenbenberg and Waitz, 1977; and Mann and Bjotvedt, 1965), and less commonly on autopsy material (McGuire, 1964 and Palmieri, Thurman and Andersen, 1978). Helminths of cats from the Midwest were surveyed by Christie, Dubey and Pappas (1976), Cross and Allen (1958), and Power (1971). Surveys of helminths from the other domestic animals examined in this study are not uncommon except that those from turkeys dealt primarily with wild turkeys rather than with the domestic form, e.g., Hon, Forrester and Williams (1978), Jackson, Andrews and Ridgeway (1977), and Pence and Bickel (1977).

The present study was undertaken to account for the parasites of these animals because such published information is not known in Wisconsin except for the arthropod ectoparasite surveys by Amin (1973, 1976a, b).

Materials and Methods

This report is based on material collected from Racine and Kenosha counties in southeastern Wisconsin, during the autumn (September-November) of five years for dogs, three years for horses, two years for cats, chickens, turkeys and one year for pigs between 1972 and 1977. Dogs and cats were obtained from the Racine Humane Society and other mammals were obtained from various Racine and Kenosha farms and stables. Eggs of intestinal helminths of horses were screened through fecal examination. In other hosts, the entire alimentary tract of freshly killed animals was examined for helminths. All helminth and arthropod parasites were routinely processed and permanently mounted for identification.

Specimens

Representative specimens are deposited in the Milwaukee Public Museum; museum accession members are listed in tables 1 and 2. Additional arthropod ectoparasites from wild mammals (Amin, 1976a, b) are deposited in the same museum; numbers are available from the author.

Results and Discussion

Survey results are summarized in Tables 1 and 2. Ectoparasitic species of dogs and cats were previously reported from smaller collections by Amin (1973, 1976a, b). All other parasites appear to represent first records for Wisconsin. Almost all these para-

TABLE 1. Intestinal helminths from domestic animals in southeastern Wisconsin.

Host: Species Number examined	Host: Number infected (%)	Parasite: Species	Group[a]	Number recovered	Sex ratio m:f	Mean Parasites/host	Location[b]	Museum number
Dog 74	1(1.4)	*Mesocestoides* sp.	C	1	—	1.0	SI	IZ326a
	2(2.7)	*Taenia pisiformis*	C	22	—	11.0	SI	IZ326b
	3(4.0)	*Dipylidium caninum*	C	9	—	3.0	SI	IZ326c
	12(16.2)	*Ancylostoma canium*	N	205	1:2.42	17.1	SI	IZ326g
	8(10.8)	*Toxocara canis*	N	53	1:0.77	6.6	SI	IZ326h
	7(9.5)	*Toxocaris leonina*	N	141	1:1.88	20.1	SI	IZ326i
	4(5.4)	*Trichuris vulpis*	N	339	?	84.7	C	IZ326j
Cat 23	5(21.7)	*Hydatigera taeniaeformis*	C	12	—	2.4	SI	IZ326d
	3(13.0)	*Dipylidium caninum*	C	117	—	39.0	SI	IZ326e
	2(8.7)	*D. sexcoronatus*	C	24	—	12.0	SI	IZ326f
	10(43.5)	*Toxocara cati*	N	87	1:1.74	8.7	S,SI	IZ326k
	3(13.0)	*Toxocaris leonina*	N	13	1:0.3	4.3	S,SI	IZ326l
	1(4.4)	*Ancylostoma tubaeforme*	N	12	1:5.00	12.0	SI	IZ327a
Chicken 26	16(61.5)	*Heterakis gallinarum*	N	454	1:1.29	28.4	C	IZ327b
	18(69.2)	*Ascaridia galli*	N	118	1:1.36	6.5	SI	IZ327c
	1(3.8)	*Ascaridia* sp.	N	1	1:0	1.0	SI	IZ327d
Turkey 41	5(12.2)	*Ascaridia galli*	N	17	?	3.2	SI	IZ327e
Pig 5	1(20.0)	*Ascaris suum*	N	1	0:1.00	1.0	SI	IZ327f
	1(20.0)	*Oesophagostomum brevicaudum*	N	23	1:2.83	23.0	CC	IZ327g
Horse 14	14(100.0)	*Strongylus* sp.	N	27-211 eggs/fecal smear (3 smears/horse)		—	GI	
	uncommon	*Parascaris* sp.	N	only 7 eggs found		—	GI	

[a] C = cestodes; N = nematodes
[b] SI = small intestine; C = cecum; CC = colon and cecum; S = stomach; GI = gastrointestinal tract

sites are widely distributed in North America and many must have been recovered by other investigators elsewhere in the state. However, a literature search failed to reveal such published accounts.

Dog parasites. Seven helminth species were recovered from dogs in this study. Dogs were more frequently and heavily infected with nematodes; 16.2% were infected with *Ancylostoma canium* (Ercolani, 1859). A mean value of 85 *Trichuris vulpis* (Fröhlich, 1789) per infected dog was calculated. This latter figure was exceptionally high due to the infection of one dog with 339 *T. vulpis*. Infection with cesodes was lower. The *Mesocestoides* specimen belonged to either *M. latus* Mueller, 1927 or *M. corti* Hoeppli, 1925. The highest intensity of cestode infection was with *Taenia pisiformis* Bloch, 1780, the larvae of which were commonly found in the body cavity of many local cottontail rabbits, *Sylvilagus foridanus*.

The prevalence of helminth infections in Racine-Kenosha dogs appears to be intermediate between that of well cared for dogs (Jaskoski, 1971) and of those examined from the dog pound in the city of Chicago (Cross and Allen, 1958). Prevalences are

TABLE 2. Arthropod parasites from domestic animals in southeastern Wisconsin.

Host			Parasite					
Species	Number examined[a]	Number infected (%)	Species	Group[b]	Number recovered	Sex ratio m:f (nymphs)	Mean Parasites/host	Museum[c] number
Dog	47	1(2.1)	*Cediopsylla simplex*	F	1	0:1.00	1.0	
	47	11(23.4)	*Ctenocephalides canis*	F	141	1:2.81	12.8	
	47	28(59.6)	*C. f. felis*	F	202	1:3.21	7.2	
	47	1(2.1)	*Pulex irritans*	F	1	0:1.00	1.0	
	17	1(5.9)	*Dermacentor variabilis*	T	1	0:1.00	1.0	IZ327h
	17	1(5.9)	*Ixodes scapularis*	T	1	0:1.00	1.0	IZ327i
	17	2(11.8)	*Rhipicephalus sanguineus*	T	2	0:2.00	2.0	IZ327j
	17	1(5.9)	*Cuterebra* sp.	BF	1	larva	1.0	
Cat	52	1(1.9)	*Cediopsylla simplex*	F	1	1:0	1.0	
	52	16(30.8)	*Ctenocephalides f. felis*	F	424	1:2.16	26.5	
	52	1(1.9)	*Tamiophila grandis*	F	1	0:1.00	1.0	
	52	1(1.9)	*Orchopeas h. howardii*	F	1	1:0	1.0	
Chicken	45	6(13.3)	*Menopon gallinae*	L	46	1:1.37:(0.50)	7.7	
	45	29(64.4)	*Menacanthus stramineus*	L	338	1:2.21:(0.96)	11.6	
	45	3(6.7)	*Goniodes dissimilis*	L	5	all nymphs	1.7	
Horse	24	5(25.0)	*Gastrophilus* sp.	BF	eggs on hairs		—	
	56	31(55.4)	*Sarcoptes scabiei equi*	M	undetermined ?		?	

[a] When different for same host species indicates separate collections examined independently for parasitic groups noted.
[b] F = fleas; T = ticks; BF = botflies; L = lice; M = mites.
[c] Insects are not given accession numbers.

usually higher in the south, i.e., Vaughn and Jordan (1960) from New Orleans, and lower farther north, i.e., Dorman and Ostrand (1958) from New York, presumably reflecting the harsher and less favorable environment in northern localities (Jaskoski, 1971). The frequency of at least *A. caninum* and *T. vulpis* infections was clearly related to certain climatic factors by Becker et al. (1977).

The sex ratio of all dog helminths, except *Toxocara canis* (Werner, 1782), and all all arthropods obtained in significant numbers was biased in favor of females rather than males.

Ctenocephalides f. felis (Bouché, 1835) was the most common arthropod ectoparasite of dogs. The prevalence of *Ctenocephalides canis* (Curtis, 1826) fluctuated; it was rare in some years (Amin, 1976a) and considerably higher in others and averaged 23.4% with a higher mean per infected dog than *C. f. felis* (Table 2). Infections with ticks were scarce from dogs, as well as from other mammals in southeastern Wisconsin (Amin, 1976b).

Cat parasites. The prevalence of cat helminth parasites was comparable to that reported for cats from Illinois and Kentucky (Power, 1971) but less than that in stray cats from Ohio (Christie et al., 1976) for *Toxocara cati* (Schrank, 1788) Brumpt, 1927 and *Ancylostoma* sp. *Hydatigera taeniaeformis* (Batsch, 1786) and *Dipylidium sexcoronatum* von Ratz, 1900 do not appear to be widely spread elsewhere. Local cats were most frequently and heavily infected with *T. cati* (43.5%) and *Dipylidium cani-*

num (39 worms per infected host), respectively. Only the sex ratio of *Toxocaris leonina* (V. Linstow, 1902), Leiper, 1907 was biased in favor of males.

The most common flea species infesting cats is *C. f. felis.* Accidental infestations with *Cediopsylla simplex* (Baker, 1895), *Tamiophila grandis* (Rothschild, 1902) and *Orchopeas h. howardii* (Baker, 1895) probably result from predatory associations with cottontail rabbits, eastern chipmunk, *Tamias striatus ohionensis* and eastern gray squirrel, *Sciurus carolinensis,* respectively.

Chicken parasites. Chickens were frequently infected (>80%) with *Heterakis gallinarum* (Schrank, 1788) Madsen, 1949 and *Ascardia galli* (Schrank, 1788) and most heavily infected with the first species (28.4 per infected host). These figures are comparable to those for chickens from Manitoba (Hodasi, 1966) and elsewhere in Canada (Stephen, 1976). Infestation with *Menacanthus stramineus* (Nitzsch, 1818) was markedly more frequent and heavier than with *Menopon gallinae* (Linné, 1758). Older chickens were noticeably more heavily infested with *M. stramineus* than younger ones, particularly under crowded conditions. Only five *Goniodes dissimilis* Deny, 1842 nymphs were recovered. No mixed infestation with *M. stramineus* and *M. gallinae* in the same chicken farm was observed.

Domestic turkey parasites. Only light infections with *A. galli* were encountered. The lighter and less prevalent infection of domestic turkey with *A. galli* (this report) compared to the greater diversity of parasitifauna in wild turkey (Hon et al., 1978; Jackson et al., 1977; Pence and Bickel, 1977) are probably related to the rearing conditions of the domestic form in farms. Jackson et al. (1977) speculated that the high incidence of *A. galli* in wild turkeys "may be attributed to domestic fowl contaminating parts of the turkey range with ova passed in feces."

Pig parasites. Only one of five pigs was infected with one *Ascaris suum* Goeze, 1782 and another with 23 *Oesophagostomum brevicaudum* Schwartz and Alicata, 1930. This incidence is low compared to reports elsewhere particularly from southern locations (Stewart and Hale, 1975, and Lindquist, 1975).

Horse parasites. Infections with *Strongylus* sp. [probably *S. vulgaris* (Looss, 1900) Raillet and Henry, 1909] were more common (100%) than with *Parascaris* sp. [probably *P. equorum* (Goeze, 1782) (York and Maplestone, 1926)] as revealed by egg counts in fecal smears. Eggs of the horse botfly *Gastrophilus* sp. [probably *G. intestinalis* (de Geer, 1776)] were recovered from hairs mostly on upper half of forelegs and shoulders. The mite *Sarcoptes scabiei equi* Gerlach, 1857 was common (55.4%) particularly on horses held in holding pens before shipping. The damage caused by *S. vulgaris* to horse intestinal arteries and the role played by other horse parasites were discussed by Georgi (1977).

Literature Cited

Amin, O. M. 1973. A preliminary survey of vertebrate ectoparasites in southeastern Wisconsin. J. Med. Entomol. 10:110-111.

Amin, O. M. 1976a. Host associations and seasonal occurrence of fleas from southeastern Wisconsin mammals, with observations on morphologic variations. J. Med. Entomol. 13:179-192.

Amin, O. M. 1976b. Lice, mites, and ticks of southeastern Wisconsin mammals. Great Lakes Entomol. 9:195-198.

Becker, S. V., Selby, L. A., Hutchenson, D. P., and Hacker, D. V. 1977. The association of selected climatic factors with natural alimentary parasites of dogs. Environ. Res. 14: 141-151.

Burrows, R. B. and Lillis, W. G. 1960. Helminths of dogs and cats as potential sources of human infection. N. Y. State J. Med. 60: 3239-3242.

Christie, E., Dubey, J. P., and Pappas, P. W. 1976. Prevalence of *Sarcocysts* infection and other intestinal parasitisms in cats from a humane shelter in Ohio. J. Am. Vet. Med. Assoc. 168:421-422.

Cross, S. X. and Allen, R. W. 1958. Incidence of intestinal helminths and Trichinae in dogs and cats in Chicago. N. Am. Vet. 29:27-30.

Dorman, D. W. and Ostrand, J. R. Van. 1958. A survey of *Toxocara canis* and *Toxocara cati* prevalence in the New York City area. N. Y. State J. Med. 58:2793-2795.

Georgi, J. R. 1977. Parasites of the horse, in Evans, J. W., Borton, A., Hintz, H. F. and Van Vleck, L. D. *The Horse*. San Francisco, CA. W. H. Freeman and Co.: 573-604.

Hodasi, J. K. M. 1966. A note on some helminths of Manitoba chickens. Can. J. Comp. Med. 30:26-27.

Hon, L. T., Forrester, D. J. and Williams, L. E., Jr. 1978. Helminth acquisition by wild turkeys (*Meleagris gallopavo osceola*) in Florida. Proc. Helminthol. Soc. Wash. 45: 211-218.

Jackson, J. W., Andrews, R. D., and Ridgeway, B. T. 1977. Helminth parasites from Illinois wild turkeys. Trans. Ill. State Acad. Sci. 69:455-460.

Jaskoski, B. J. 1971. Intestinal parasites of well cared for dogs. Am. J. Trop. Med. Hyg. 20:441-444.

Lindquist, W. D. 1975. Nematodes, acanthocephalans, trematodes, and cestodes. In Dunne, H. W. and Leman, A. D. (editors) *Diseases of Swine*. Iowa State Univ. Press., 4th ed.: 780-815.

Loebenberg, D. and Waitz, J. A. 1977. Intestinal helminths and Protozoa of New Jersey dogs. J. Parasitol. 63:1139-1140.

Mann, P. H. and Bjotvedt, G. 1965. The incidence of heartworms and intestinal helminths in stray dogs. Lab. Anim. Care. 15: 102.

McGuire, S. L. 1964. Intestinal helminths of stray dogs. Vet. Med. 59:1132.

Palmieri, J. R., Thurman, J. B. and Andersen, F. L. 1978. Helminth parasites of dogs in Utah. J. Parasitol. 64:1149-1150.

Power, L. A. 1971. Helminths of cats from the Midwest with a report of *Ancylostoma caninum* in this host. J. Parasitol. 57:610.

Pence, D. B., and Bickel, S. 1977. Helminths of wild turkeys in west Texas. Proc. Helminthol. Soc. Wash. 44:104-105.

Stephen, L. E. 1976. Poultry diseases diagnosed in Canadian laboratories for the year 1974. Can. Vet. J. 17:145-149.

Stewart, T. B. and Hale, O. M. 1975. Swine parasite transmission in relation to housing. J. Anim. Sci. 40:192-193.

Vaughn, J. and Jordan, R. 1960. Intestinal nematodes in well-cared for dogs. Am. J. Trop. Med. Hyg. 9:29-31.

THE PHYSICAL AND CHEMICAL LIMNOLOGY OF A WISCONSIN MEROMICTIC LAKE

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Abstract

Numerous physical and chemical parameters of a small central Wisconsin lake were monitored over an 18 month period. Included in these parameters were temperature, light, conductivity, pH, oxygen, sulfide, sulfate, iron, nitrate, nitrite, ammonia, phosphate, dissolved inorganic carbon, and methane. Chlorophyll a and bacteriochlorophyll d were also measured. The lake was determined to be biogenically meromictic. Because of its meromictic state, the lake provides a favorable environment for the development of populations of anaerobic bacteria such as photosynthetic sulfur bacteria and methanogenic bacteria.

Introduction

Meromictic lakes, since they do not undergo complete vertical turnover, provide permanently anaerobic habitats in the deeper portions. Such lakes provide favorable locations for the study of many limnological and biogeochemical processes related to anaerobiosis such as carbon, nitrogen, and sulfur cycles. Meromictic lakes also provide an extremely favorable environment for the development of diverse and relatively stable populations of anaerobic bacteria.

Hutchinson (1957) describes three types of meromictic lakes: those displaying ectogenic, crenogenic or biogenic meromixis. According to this classification, ectogenic and crenogenic meromictic lakes have a dense, saline layer covered by a less dense freshwater layer. Lakes displaying biogenic meromixis have a dense bottom layer as a result of biological decomposition which releases high concentrations of solutes into the bottom waters. In each type, the different dissolved solute concentrations between the bottom (monimolimnetic) and surface (mixolimnetic) waters creates a density difference which prevents mixing when the lake is isothermal. A chemocline separates the mixolimnion and the monimolimnion. The mixolimnion of meromictic lakes exhibits changes similar to those of a holomictic lake. It may develop thermal stratification and completely mix at some time of the year. The terms epilimnion and hypolimnion are used to describe portions of the mixolimnion, when thermally stratified, in a manner analogous to holomictic lakes.

Several meromictic lakes have been studied with respect to chemical balances and causes of meromictic stability. Many meromictic lakes have been shown to remain stratified as a result of dense saline bottom water (Matsuyma, 1973; Takahashi et al., 1968). Walker (1974) has used stability calculations to compare several saline meromictic lakes in Washington. In most of the lakes studied, the meromictic stability has decreased with time. In biogenic meromictic lakes, additional factors besides density aid in preventing mixing. Weimer and Lee (1973) concluded that the morphometry of the lake basin and topography of the surrounding watershed were major factors in maintaining meromixis in Lake Mary, Wisconsin. Similarly, Culver (1975) concluded that lack of wind action was necessary to maintain meromixis in Hall Lake, Washington.

The discovery in central Wisconsin of Knaack Lake, a sharply stratified meromictic lake, allowed the authors to conduct detailed studies of physical and chemical changes in such a lake over a two year period. In addition, this paper provides necessary field background for subsequent studies on microbial activities in the lake.

Materials and Methods

Study Areas. Knaack Lake is located in northern Waupaca county approximately 8 miles south of the town of Marion, Wisconsin. The lake and surrounding farm lands are owned by Mr. Carl Knaack. Douglas Caldwell, who first studied this lake in 1972 and 1973, referred to it as Hirsch Lake (Caldwell, 1977). The lake lies in the northwest corner of section 22, R. 13 E., T.25 N.

The lake has a surface area of approximately 1.1 hectare and a maximum depth of 22.0 m. The water is yellow-brown in color, a result of high levels of dissolved humic and tannic compounds. The lake is bounded on three sides by farm fields while a peat bog extends from the northeast shore a distance of about 0.3 k. A dense stand of hardwood, hemlock, and pine lies between the fields and the lake shielding it from the predominant northwestly winds. A hill to the northwest of the lake contributes additional shielding. No wind speed measurements have been made, however the authors have never observed waves in excess of 5 cm at the lake surface. There are no visible inflows or outflows to or from the lake, thus the major source of water input appears to be groundwater seepage and rainwater.

Lake Morphometry. During the winter the depth of the water was measured along six transects across the lake. Holes were drilled through the ice at 10 m intervals along each transect and measurements were made using a weighted hand line marked at 0.5 m intervals. The depth readings were then transferred to an enlarged copy of the USGS topographic map (7.5 minute series, Marion Quadrangle), and bathymetric contours drawn.

Sampling Techniques and Field Measurements. Initially, water samples were collected using a horizontal Van Dorn water sampler (Wildco Wildlife Supply Co., Saginaw, Michigan). Beginning in December 1976, water samples were collected using a peristaltic pump (Horizon Ecology Co.). Water was pumped through 3/16 inch inside diameter latex tubing weighted at one end. The weighted end was attached to a chain which was used to regulate sampling depth. The chain prevented stretching of the tubing, and the system allowed accurate sampling at narrow intervals, and minimized exposure of the anoxic water to oxygen. Unless otherwise stated, samples were collected from a station located over the deepest area of the lake. Water was sampled through holes in the ice during the winter and from a canoe when the lake was ice free.

Seepage meters following Lee's (1977) design were placed around the perimeter of Knaack Lake. Rates of groundwater seepage into the lake were estimated by collecting the water which flowed from the meters into plastic bags. The volumes of water collected were measured and seepage times noted. Rates were calculated as ml flow/m^2/min.

Temperature and oxygen were measured *in situ* with a combination temperature-oxygen probe (Yellow Springs Instruments Co.). Conductivity was measured *in situ* with a combination salinity-conductivity-temperature probe (Yellow Springs Instruments Co.). pH measurements were made in the laboratory on water samples collected in glass stoppered BOD bottles using a Corning Model-12 pH meter. A 30 cm diameter Secchi disk was used to estimate water transparency and a Li-Cor model-185 quantum meter combined with an underwater silicon photodiode quantum sensor (Lambda Instruments Corp., Lincoln, Nebraska) was used to measure light extinction in the lake. To determine the underwater spectral distribution of light in the lake, water samples were brought to the laboratory, filtered, and the optical characteristics of the water were determined following James and Birge (1938). Ten cm glass cuvettes were used with a Beckman DK-2 scanning spectrophotometer.

Chemical Assays. Samples for nutrient assays were collected in polyethylene bottles and placed on ice. Immediately upon returning to the laboratory (ca. 4 hours) the water samples were filtered through Whatman GF/C glass fiber filters and Gelman GN-6 0.45 μm membrane filters. After membrane filtration, the water samples were frozen; soluble phosphate, nitrite, nitrate, and ammonia concentrations were determined at a later date. The glass fiber filters were extracted with 90% acetone and refrigerated overnight before chlorophyll analysis. Chlorophyll a was determined as described by Vollenweider (1969) and bacteriochlorophyll as described by Takahashi and Ichimura (1968). Absorbances were determined in a Beckman DB-G spectrophotometer or a Beckman DK-2 scanning spectrophotometer. Glass fiber filters were found to retain more than 95% of the chlorophyll present in the lake water.

Nitrite and soluble reactive phosphate were determined by the method of Strickland and Parsons (1968). Ammonia was initially determined according to Strickland and Parsons (1968). However, this method gave questionably low values of ammonia in the bottom water. A second method (Strickland and Parsons, 1972) was then used and yielded considerably higher values. Nitrate was initially measured by the method of Mullen and Riley (1955). This method proved satisfactory in other lakes, but resulted in formation of a brown precipitate in the monimolimnetic water samples from Knaack Lake. In these samples the precipitate was filtered out, using a 0.45 μm membrane filter (Gelman), and the absorbance of the colored filtrate was measured. To examine the accuracy of this procedure, nitrate was determined by a second method (Strickland and Parsons, 1968). The methods gave comparable results ($\pm$5%) on the same water sample. Using either method unusually high concentrations of nitrate were detected in the monimolimnetic waters. Water below 15 m, but not the surface water, had values often higher than 200 μg/l when filtered through the Gelman filters. However, nitrate was not detected when the same water samples were analyzed for nitrate before filtration or assayed after filtration through glass fiber filters alone. Gelman GN-6, 0.45 μm membrane filters are composed primarily of esters of cellulose nitrate (>95%). Apparently some compound, present in the monimolimnion, possibly an organic acid, was able to extract nitrate from the filters resulting in false positive values.

Iron was quantified by means of a modification of the assay described in American Public Health Association (Taras *et al.*, 1971). Samples for ferrous and ferric iron were collected anaerobically in glass-stoppered bottles and transported to the laboratory on ice. Ferrous iron was determined by adjusting the pH of the water samples to 4.0 with ammonium acetate buffer, adding a solution of 1,10 phenanthroline monohydrate, and reading the absorbance at 510 nm. Total iron was determined by adding concentrated HCl and a hydroxylamine solution to water samples which were then heated at 100°C for 30 minutes in teflon-capped screw-cap test tubes. After heating, the pH of the sample was adjusted to 4.0, the phenanthroline reagent added, and absorbance read at 510 nm. The ferric iron concentration was calculated by subtracting the ferrous concentration from the total concentration. This method did not distinguish between particulate and soluble ferrous or ferric iron.

Ten ml water samples for sulfate and sulfide analysis were collected in screw-cap test tubes containing 0.5 ml of a 0.2% solution of zinc acetate in 0.2% acetic acid. Sulfide was determined by the colormetric method of Pachmayr as described by Brock *et al.* (1971) modified in that only 1 ml of the amine reagent and 0.5 ml of the ferric iron reagent were added to the 10 ml water samples. Sulfate was determined by the turbidometric method of Tabatabai (1974). All chemical assays were performed on a Bausch and Lomb Spectronic 20 or Gilford Model 420 spectrophotometer.

During the fall of 1977 Winkler titrations were used for oxygen determination as low levels of oxygen were present in the mixolimnion. Winkler titrations were performed as described in Strickland and Parsons (1972), with the modification that samples were fixed immediately at the lake with the addition of manganous sulfate and alkaline iodide. Since oxygen levels were very low, the thiosulfate titrant was diluted ten fold to attain better sensitivity.

Dissolved methane and dissolved inorganic carbon ($DIC = CO_2 + HCO^-_3 + H_2CO_3$) were measured by modification of the gas stripping technique of Rudd *et al.* (1974). Water (5 ml) was collected by inserting a 10 ml glass syringe (without needle) into the outlet of the sampling pump. The syringe was held pointing downward to prevent any degassing bubbles from escaping. It was fitted with a 23 gauge needle, and the water injected into a 18 by 240 mm butyl rubber stoppered anaerobic tube (Bellco Glass Co.) containing 0.5 ml of 6 N HCl. Upon returning to the laboratory, tubes were assayed for for CH_4 and CO_2 on a Packard 419 gas chromatograph (Nelson and Zeikus, 1974). DIC was calculated using the Bunsen absorption coefficients for dissolved CO_2.

Calculation of Stability. Stability, the minimum amount of work required to mix a chemically stratified lake that is devoid of thermal stratification, was calculated by Schmidt's stability equations (Walker 1974). The density of Knaack Lake was calculated by summing the total dissolved solutes present at a given depth and adding this mass to the density of the water.

Results

Physical Characteristics

Lake Morphometry and Seepage. The physical characteristics of the lake basin and surrounding watershed were mapped (Fig. 1A). Bathymetric contours and position of the seepage meter sites were established and a cross section of the lake along the major axis prepared (Fig. 1B and 1C). The positions of the thermocline, present during the spring, summer, and autumn months, and the chemocline, which is present year-round, are represented by broken lines.

Since there are no visible inflows to the lake, a survey was made to determine the rate of groundwater seepage and the points of maximum seepage. Meters were placed at the deeper stations in the lake by a SCUBA

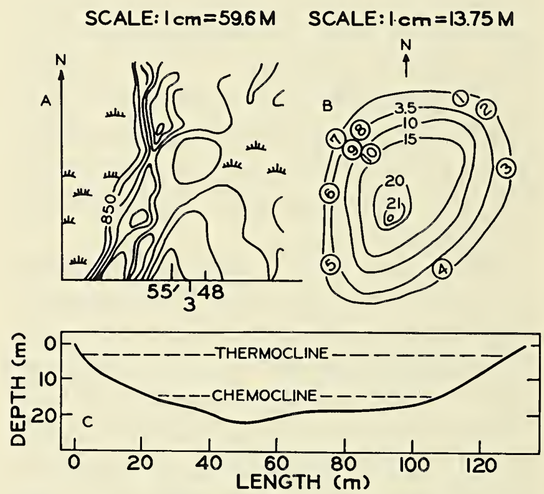

Fig. 1. Morphometry of Knaack Lake and topography of the surrounding watershed. A. Topography of watershed from the Marion county Quadrangle (USGS). B. Bathymetric contours (meters). The sampling station was located over the deepest portion of the lake (22 m). Circled numbers indicate locations of seepage meter sites. C. Cross section of the lake along the major axis. Dashed lines designate the location of the summer thermocline, which separates the epilimnion and hypolimnion, and the chemocline, which separates the mixo- and monimolimnion.

diver. Maximum seepage into the lake was found to occur along the northwest shore (Table 1). These data, collected in the spring of 1977, coincide with visual observations made during the winter. In determination of morphometry of the lake basin many holes were drilled through the ice. At that time, it was observed that the ice near the northwest shore of the lake was 70 to 80% thinner than the ice at any other location on the lake, suggesting larger flows of warmer groundwater.

TABLE 1. Seepage into Knaack Lake.

Station	*Depth (m)*	*Seepage rate ($ml/m^2/min$)*
1	1.2	1.7
2	1.1	6.3
3	1.0	4.8
4	0.9	5.5
5	1.1	0
6	1.2	15.6
7	1.0	32.1
8	1.9	11.1
9	6.0	8.25
10	12.0	4.2

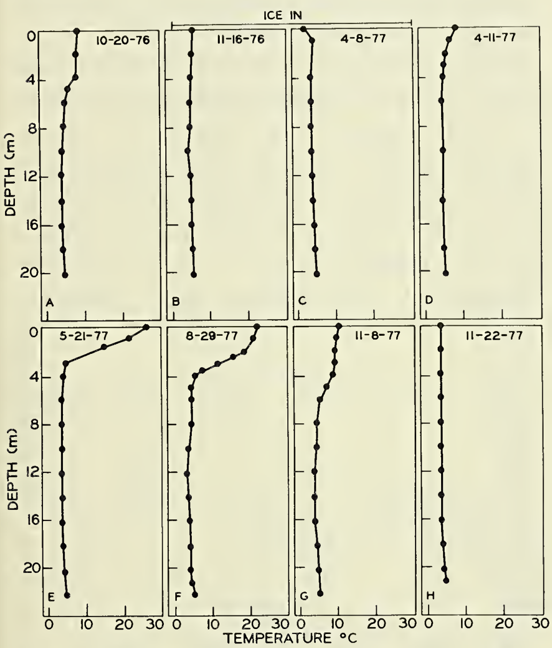

Fig. 2. Temperature profiles in Knaack Lake from 20 October 1976 through 22 November 1977. Profiles just prior to lake freezing (A), during the period of ice cover (B and C), immediately after "ice-out" (D), during the stratification period (E through G), and when the lake was isothermal (H).

Temperature and Oxygen. Temperature profiles were measured throughout the year (20 October 1976) to 22 November 1977) (Fig. 2). After the lake became isothermal in the fall, the surface temperature dropped rapidly until the lake froze. Temperature increased with depth reaching 4°C at 6-8 m. Water temperature from 8 to 15 m was 4°C, while below 15 m the temperature again increased to a maximum of 5°C at the bottom. Temperature profiles remained constant throughout the winter (Figs. 2B and 2C). After "ice-out" in the spring (Fig. 2D) the surface temperature increased rapidly and a sharp thermocline was formed at 1 to 2 m (Fig. 2E). Throughout the year the water below the thermocline remained at 4°C and increased to approximately 5.5°C at the bottom. In the late summer and fall, surface temperatures decreased and the thermocline dropped (Figs. 2F and 2G) until the upper 15 m of the lake became isothermal (Fig. 2H).

In the fall of 1976 oxygen was present down to the thermocline (Fig. 3A). The lake quickly became anaerobic after freezing in the winter of 1976-1977 (Figs. 3B and 3C). However, the measurements were made with an oxygen meter which could not detect small (less than 0.5 mg/l) concentrations. The lake remained anaerobic throughout the winter except for a period in March (Fig. 3D) when an algal bloom formed under the ice and 9 to 10 mg/l oxygen was detected. The lake again became completely anaerobic after the algal bloom disappeared (Fig. 3E). After "ice-out," oxygen (8-12 mg/l) was present above the thermocline and oxygen concentrations in the epilimnion remained fairly constant throughout the summer (Figs. 3F and 3G). As the lake began to mix in the fall, oxygen concentrations in the sur-

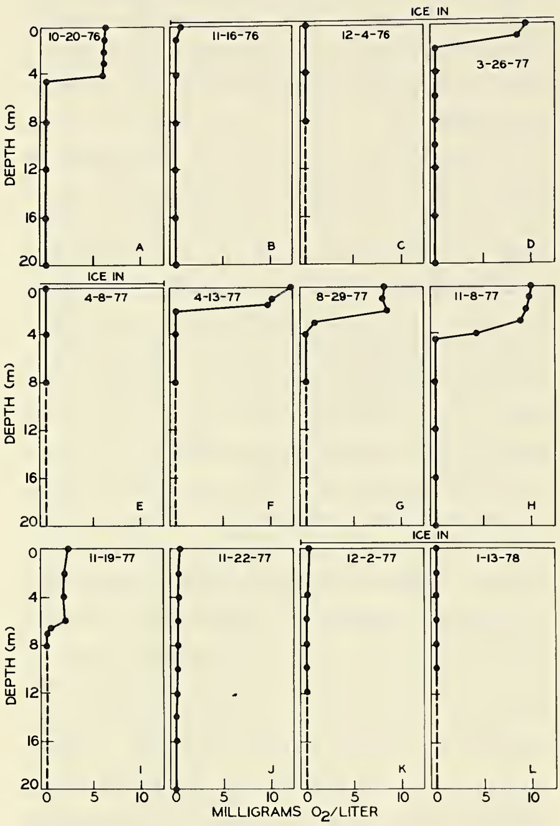

Fig. 3. Oxygen profiles in Knaack Lake from 20 October 1976 through 13 January 1978. Oxygen concentrations during the periods when the lake was stratified (A. F. G. H. and I), when the lake was isothermal (B and J), and when the lake was covered with ice (C, D, E, K, and L).

face waters decreased and oxygen was detected in deeper waters (Figs. 3H and 3I). When the lake became isothermal in the fall (Fig. 3J), oxygen was detected at 12 m at a concentration of 0.4 to 0.8 mg/l. Traces of oxygen were present for several weeks after ice formed (Fig. 3K) but by 1-3-78 oxygen was absent (Fig. 3L).

Conductivity. Conductivity was measured throughout the study period (Fig. 4). Conductivity was low in the surface water and increased at the thermocline (Figs. 4A, 4B and 4C). This increase followed the thermocline down the water column in the fall. Below the chemocline (14 to 15 m) conductivity increased rapidly with depth, reaching 300 to 400 μmhos at the bottom. This corresponded to high concentrations of ammonia, phosphate, and carbonate found in the monimolimnion. When the lake was isothermal in the fall (Fig. 4D), conductivity was nearly constant to 14 m, as a result of mixing of the mixolimnetic waters.

Light. The color of the lake water and the presence of suspended particles results in rapid dissipation of light as it travels through the water column. The transparency of the lake water was estimated with a Secchi disk, as the depth of Secchi disk extinction may be interpreted as 1 to 15 percent transmission of incident light (Wetzel,

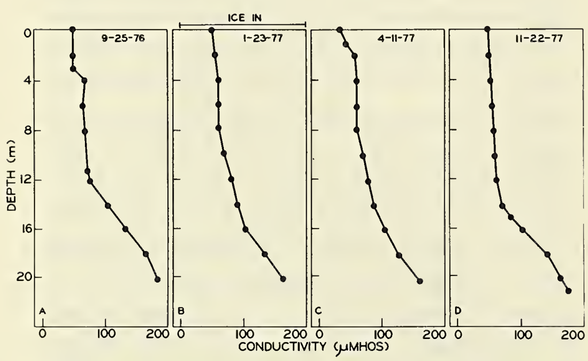

Fig. 4. Conductivity profiles for selected sampling dates. Conductivity when the lake was thermally stratified (A), during ice cover (B), immediately after ice-out (C), and when the lake was isothermal (D).

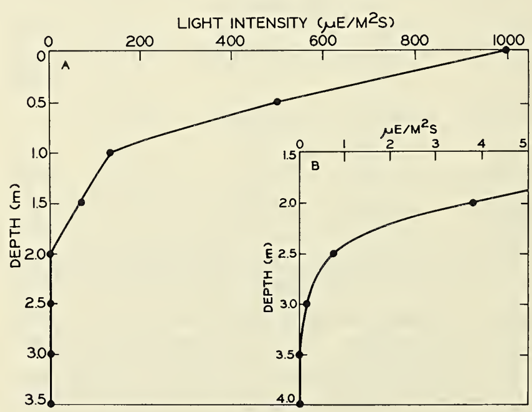

Fig. 5. Light extinction in the Knaack Lake water column from 0 to 4 m (A). Details of light extinction from 2 to 4 m (B).

1975). Depths of Secchi disk transparency ranged from 0.6 to 1.1 m throughout the year. Using the data of Aberg and Rodhe (1942), that relate lake water color and disk transparency as a hyperbolic function, the water of Knaack Lake has an estimated color of 130 Pt units. Light extinction was also measured with a submersible quantum detector. This method of measuring the penetration of light through the water column is more useful, in that it directly measures the quanta of light available for phytoplankton photosynthesis. It is evident that the lake water absorbs light effectively and that below the depth of 4 m no light is present (Fig. 5). Large amounts of dissolved organic compounds impart a yellow-brown color to the water, suggesting that changes in light quality with depth be examined. Extinction coefficients were determined by scanning filtered lake water in a spectrophotometer, and using the formula given by Hutchinson (1957); $T\% = 100e^{-n}$, where n is the extinction coefficient and T is transmission. Using the extinction coefficients it was possible to determine which wavelengths penetrated farthest into the lake. Calculations employed the formula $I_z = I_o e^{-nz}$ where I_z is the light intensity at depth z, I_o is the light intensity at the surface, and n is the calculated extinction coefficient (Hutchinson, 1957). The transmission spectrum for a 0 to 3.5 m integrated water sample was measured in a 10 cm glass cuvette (Fig. 6) and extinction coefficients were calculated for selected wavelengths. Percent transmission is low and extinction is high for wavelengths greater than 725 nm. Maximum transmission occurs at 700 nm and transmission decreases sharply from 640 to 400 nm.

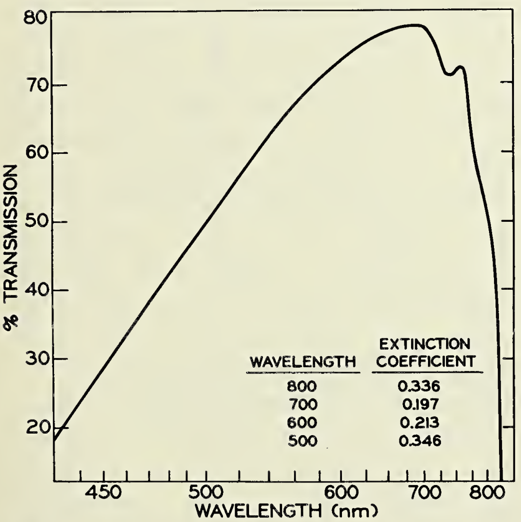

Fig. 6. Transmission spectrum for a filtered, 0 to 3.5 m integrated lake water sample. The integrated sample was prepared by pooling samples collected at 0.5 m intervals with a vertical Van Dorn water sampler to the 3.5 m depth. Extinction coefficients are shown for several wavelengths.

Chemical Parameters

Chemical parameters of Knaack Lake water were determined during an 18 month period in an attempt to characterize the chemistry of the lake over an annual cycle. The chemical parameters monitored were pH, nitrite, nitrate, ammonia, soluble reactive phosphate, sulfide, sulfate, DIC, methane, ferric iron, and ferrous iron.

pH. During the winter (Fig. 7A) pH values were relatively constant with depth throughout most of the water column (5.9 to 6.2). During the months when the lake was ice free, increased pH values were observed in the surface water, although the pH below the thermocline remained constant (Figs.

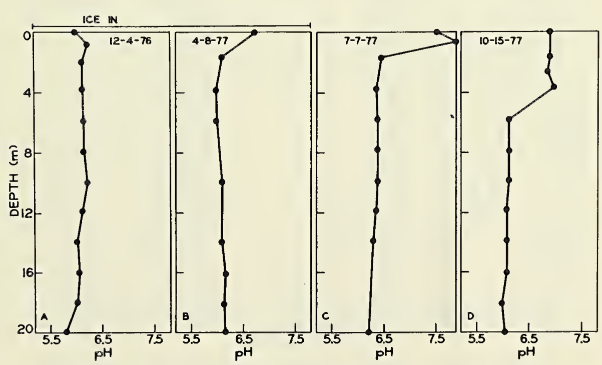

Fig. 7. pH profiles in Knaack Lake during the period of ice cover (A), after ice-out (B), and during summer (C) and autumn (D) stratification periods.

7C and 7D). During mid-summer, the highest pH values were observed in the epilimnion and the pH below the thermocline was slightly higher than observed at other times of the year. The increased pH reached down to 4 m during the fall due to the lower thermocline at this time.

Nitrogen Species. Nitrite and nitrate concentrations in the water column were measured throughout the sampling period. Nitrite concentrations greater than the sensitivity of the assay (10 μg/l) were never observed. Nitrate was not detected below a depth of 2 m, although nitrate was periodically detected in the surface water (Fig. 8). Surface values ranged from less than 10 μg/l to 390 μg/l. Increased groundwater seepage due to rainfall and phytoplankton activity influenced nitrate concentrations. When the lake was ice-free, oxygen was present in the surface water and nitrate, a chemically stable species under aerobic conditions, was often present. On some dates during the ice-free period, dense populations of phytoplankton were observed in the epilimnetic waters and nitrate was not detected in the surface water (7 July 1977 and 23 May 1977). At times, however, pulses of nitrate were observed in the surface water when phytoplankton was present (17 May 1977 and 30 June 1977). These pulses of nitrate occurred after periods of heavy rainfall (the lake received 1.4 in of rain on 16 May 1977 and 1.75 in on 28 June 1977) and it is likely that heavy rainfall significantly accelerated the rate of groundwater seepage resulting in a higher input of nitrate.

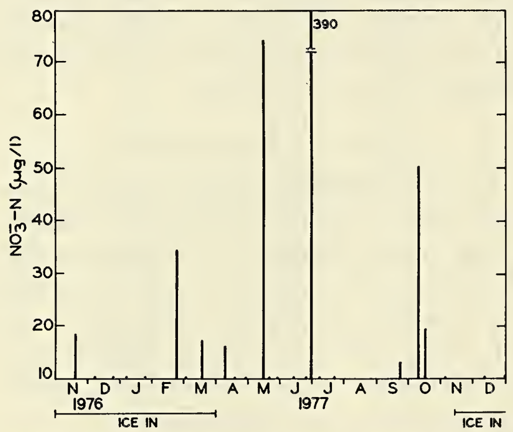

Fig. 8. Nitrate-nitrogen concentrations of the epilimnion (0 to 2 meters) throughout the year. Concentrations generally ranged from undetectable (<10 μg/l) to 75μg NO^-_3-N/l. On 30 June, 1977 nitrate concentrations reached 390 μg/l.

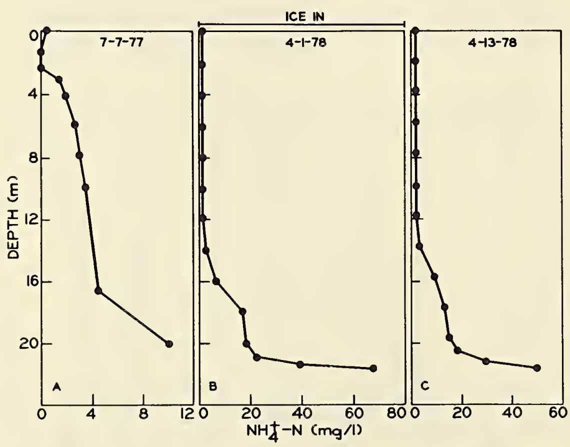

Fig. 9. Ammonia profiles in Knaack Lake during summer stratification (A), during winter ice cover (B) and the spring after ice-out (C). Note that scale of abcissa in A is different from B and C.

Shortly after the lake froze in 1976, oxygen disappeared from the surface water. Nitrate, an energetically favorable electron acceptor for anaerobic respiration in the absence of oxygen, was depleted within three weeks. On several dates during the winter of 1977, nitrate was detected in the surface water. Several of these dates corresponded with the presence of oxygen in the water immediately below the ice. The presence of nitrate on these dates may be a result of increased flow of oxygenated groundwater.

When the lake was thermally stratified, the surface waters contained 0.2 mg/l ammonia and ammonia was not detected at 1 and 2 m (Fig. 9A). At 3 m, ammonia was detected at 1.4 mg/l and increased steadily to a concentration of 3.4 mg/l at 10 m. At 20 m, the ammonia concentration reached 9.0 mg/l. During the winter, ammonia concentrations were relatively low (<2 mg/l) above 14 m, but rose sharply below this depth and reached a maximum of 68 mg/l at 21.5 m (Fig. 9B). A similar profile was observed after ice left the lake in the spring (Fig. 9C).

Phosphate. During the winter of 1977, phosphate was detected at 70 μg/l from the ice down to 8 m (Fig. 10A). Below this depth phosphate values increased reaching 1300 μg/l at 20 m. During periods when the lake was ice-free, phosphate was generally not detected in the surface water. Occasionally, however phosphate was present at the surface. Fluctuations in phosphate in the surface water were probably a result of increased groundwater seepage following periods of heavy rainfall.

On 22 November 1977, when the lake was isothermal, phosphate concentrations were constant to a depth of 14 m (Fig. 10G). In the unmixed water below this depth, phosphate values increased sharply. During the winter months phosphate increased in the upper 14 m of the lake (Fig. 10H-I). This increase was thought to result from liberation of phosphate from decomposing phytoplankton; marked decreases in chlorophyll a were observed during this period.

Sulfur Species. Sulfate and sulfide concentrations in Knaack Lake were measured throughout the sampling period (Fig. 11). In the fall of 1976 (Fig. 11A) sulfide was absent above the thermocline and was present in concentrations of 0.6 to 0.8 mg/l in the anaerobic portion of the lake. Immediately after ice formed (Fig. 11B) sulfide was absent in the top meter of water; phosphate was low from 2 to 10 m (0.1 to 0.2 mg/l) and was approximately 0.7 mg/l below 12 m. Sulfide in the upper 12 m in-

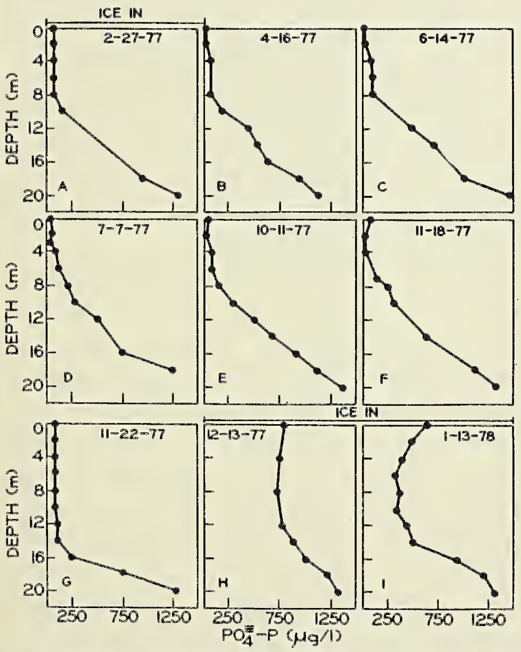

Fig. 10. Phosphate profiles in Knaack Lake throughout the sampling period.

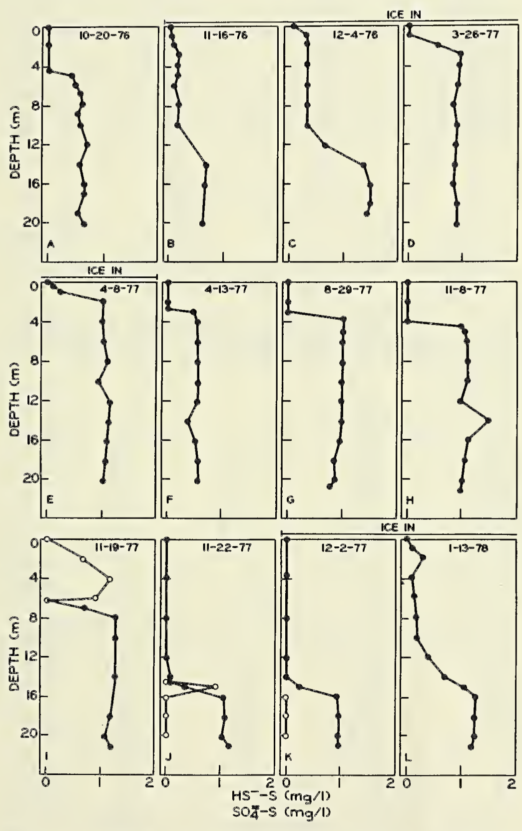

Fig. 11. Sulfate and sulfide profiles in Knaack Lake. Symbols: $SO_4^=$-S (○) mg/l; HS^- and H_2S-S (●) mg/l. Note sulfate was only detectable on two sampling dates (J and K).

creased throughout the winter (Figs. 11C and 11E) and was present to the bottom of the ice except during a period when an algal bloom under the ice depleted sulfide, and oxygen was detected immediately below the ice (Fig. 11D). After "ice-out" (10 April 1977) sulfide was absent above the thermocline and was 0.7 to 1.2 mg/l in the anaerobic water (Fig. 11F). As the upper part of the lake began to mix in the fall (Figs. 11H and 11I) the anoxic waters became oxygenated and sulfide depletion occurred. When the lake was isothermal (22 November 1977) sulfide was not detected in the upper 14 m (Fig. 11J). After ice formed (Fig. 11K) sulfide was absent above 14 m but gradually increased in the upper waters throughout the winter (Fig. 11L).

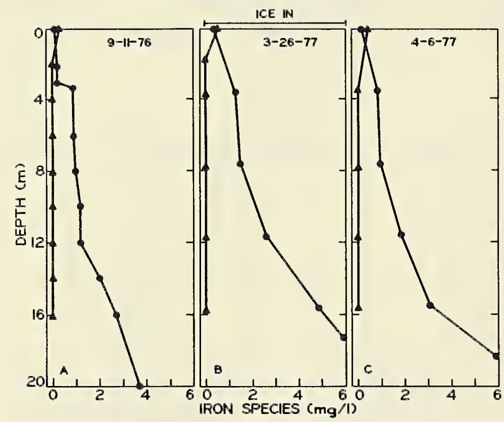

Fig. 12. Profiles of total ferrous and total ferric iron in Knaack Lake. Symbols: Fe^{+3} (▲); and Fe^{+2} (●).

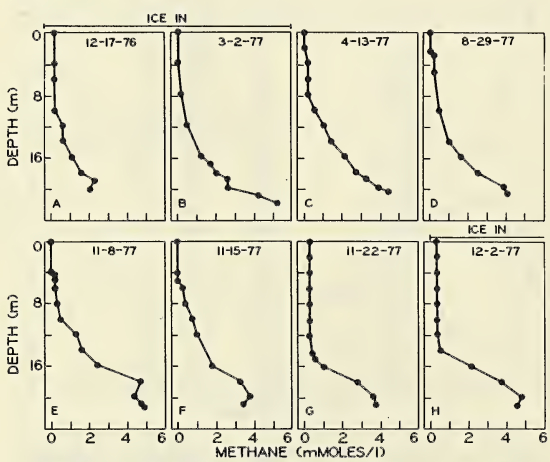

Fig. 13. Profiles of dissolved methane in Knaack Lake from 12-17-76 through 12-2-77.

Sulfate was not detectable in Knaack Lake throughout most of the year. The turbidometric assay for sulfate, however has a lower detection limit, approximatealy 0.5 mg/l SO_4^{-S}, than the colorimetric method for sulfide. Small amounts of sulfate (1-2 mg/l) were detected in the fall of 1977 above the thermocline (Figs. 11I and 11J). This was probably a result of sulfide oxidation as the deeper sulfide containing water was mixed with the shallow oxygenated water.

Iron Species. Ferric iron was detected only in the surface water at concentrations from 0.10 to 0.50 mg/l (Fig. 12). No ferric iron was detected in the anaerobic hypolimnion. In the aerobic epilimnetic waters, ferrous iron concentrations were low 0.1 to 0.38 mg/l), but increased with depth in the anaerobic portions of the lake and concentrations of 4 to 6 mg/l were commonly observed near the bottom.

Ferrous iron concentrations were considerably higher than would be expected from the concentrations of sulfide measured in Knaack Lake. The maximum concentration of sulfide predicted from theoretical calculations was approximately 50 times lower than the actual sulfide concentrations measured in the lake. It is likely that the ferrous iron observed in the bottom water is present as iron chelates of humic acids.

Methane. In Knaack Lake, high concentrations of methane were found in the bottom water throughout the year. After ice formed (Fig. 13A) methane was present in small concentrations in the top 12 m (ca. 100 μmoles/l) and began to increase below 12 m. Methane in the oxygenated surface water probably resulted from mixing of the hypolimnetic waters, which contained methane, with the surface water when the lake was isothermal. Methane concentrations gradually increased throughout the winter (Fig. 13B). When the ice went out in the spring (Fig. 13C), methane was depleted in the aerobic surface water, presumably because of methane oxidation at the thermocline and evasion into the atmosphere at the surface. As oxygen reached greater depths in the fall of 1977, methane was consumed above the thermocline (Fig. 13D-F). When the lake became isothermal on 11 November 1977, water with large concentrations of dissolved methane above 14 m was mixed with overlying water and a concentration of 200 to 300 μmoles/l methane was found throughout the upper 14 m (Fig. 13G). These concentrations stayed constant after the ice formed. Methane concentrations reached levels as high as 4000 μmoles/l in the bottom water and monimolimnetic waters varied little throughout the year.

Dissolved Inorganic Carbon. Dissolved inorganic carbon (DIC) was measured throughout the lake and was generally at 1000 to 3000 μmoles/l in the surface water and increased to 5000 to 10,000 μmoles/l in the monimolimnion (Fig. 14).

Photosynthetic Bacteria. Photosynthetic bacteria were present in Knaack Lake at all times of the year. Microscopic examination of water samples revealed that the predominant photosynthetic bacteria were green sulfur bacteria of the genera *Chlorobium* and *Pelodictyon.* Bacteriochlorophyll assays of water samples indicated only one type of bacteriochlorophyll, bacteriochlorophyll d (bchl d). The relative distribution of oxygen, sulfide and bchl d were compared for a midsummer sampling date (Fig. 15). Usually bchl d was only detected at depths where sulfide was present and maximum concentrations of bchl d were found at depths where sulfide was first noticed in the water column (Fig. 16A). Occasionally bchl d was observed at depths just above the sulfide containing waters (Fig. 16). Sulfide was present between 2 and 4 m during periods of stratification and generally present up to the ice during the winter. In February and March, 1977, a bloom of photosynthetic algae was present under the ice. The water became oxidized and sulfide was not detected above 2 m. In the fall of 1976 and 1977 the point at which sulfide was first detected dropped to depths of 14 and 15 m respectively. These depths indicate the maximum depth of mixing when the lake was isothermal. During the winter of 1977, bchl d maxima were found at depths of 0.5 to 1.0 m (Fig. 16B). On 10 April, 1977 the ice left Knaack Lake

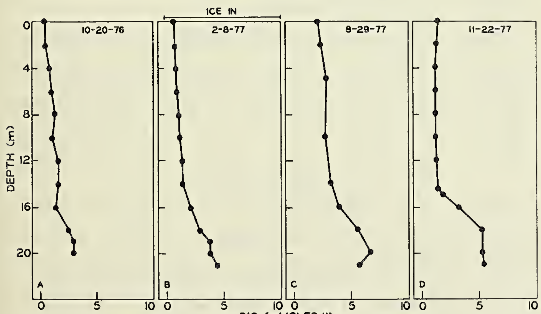

Fig. 14. Profiles of dissolved inorganic carbon (DIC) on selected sampling dates.

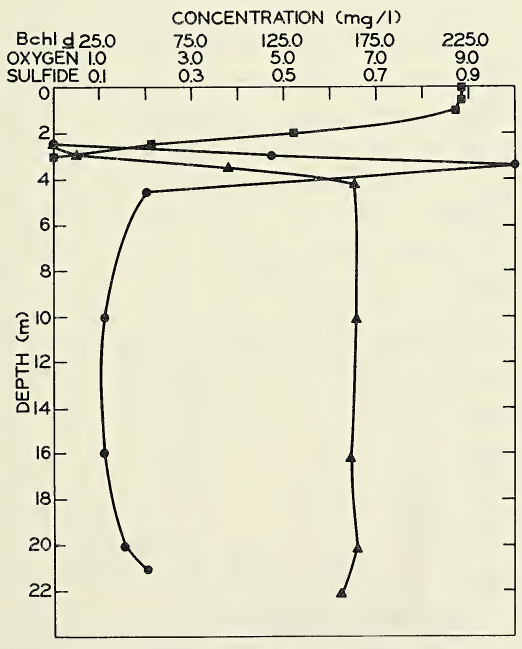

Fig. 15. Distribution of oxygen, sulfide, and bacteriochlorophyll d in Knaack Lake on a midsummer sampling date (7-7-77). Symbols: Bchl d (●); Oxygen (■); and Sulfide (▲).

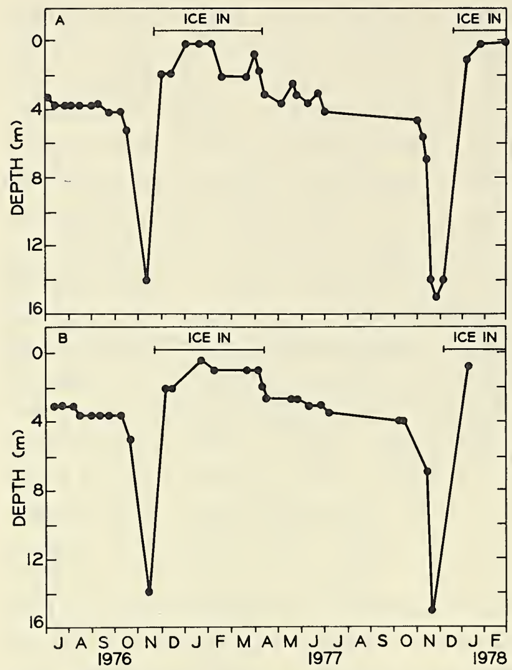

Fig. 16. Variation in depths where Bchl d (A) and Sulfide (B) were first detected in the Knaack Lake water column throughout the sampling period.

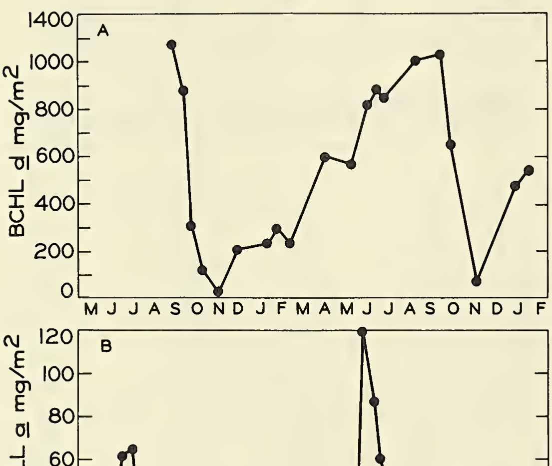

Fig. 17. Integrated Bchl d concentrations (A) and Chlorophyll a concentrations (B) in Knaack Lake throughout the sampling period.

and the surface waters (0 to 2 m) were depleted of sulfide. At this time the bchl d maximum was located at a depth of 2.5 m. By mid-May 1977 the bchl d maximum had migrated to a depth of 3 m. The photosynthetic bacteria remained at depths of 3 to 4 m in the lake from mid-May to mid-October. From 17 October, 1977 to 22 November, 1977 the lake experienced partial mixing. Mixing occurred to approximately 15 meters and not above this depth were sulfide and bchl d present in the water column. By 13 January, 1978 the lake had ice cover and the photosynthetic bacteria were found at a depth of one m.

Integrated bchl d values in Knaack Lake were calculated (Fig. 17A). Concentrations of bchl d exhibit an annual periodicity. After ice forms, the concentrations of bchl d in the lake increased steadily until "ice-out" (10 April 1977) and continued to increase throughout the summer. Maximum concentrations were observed in September at which time concentrations began to decrease. It is thought that this decrease occurred because the thermocline and hence the sulfide containing water became established at a lower depth (4.5 meters). The 4.5 m depth is below the photic zone and, since photosynthetic bacteria require both light and sulfide, the population began to decline. The decrease in bchl d continued through the partial mixing period until the lake became isothermal. After ice covered the lake anoxic conditions became reestablished and bchl d concentrations increased.

Phytoplankton. Chlorophyll a concentration in the epilimnion also seem to exhibit an annual periodicity (Fig. 17B). Peaks occurred in July 1976, October 1976, March 1977, June 1977, and October 1977. The summer chlorophyll peaks were higher than either of the two fall peaks or the winter peak. The predominant photosynthetic organism present in the epilimnion during July 1976 and June 1977 was the filamentous, heterocyst-forming, blue-green alga, *Ana-*

TABLE 2. Meromictic stability of saline and biogenic meromictic lakes.

Lake (location)	*Stability (gm-cm/cm²)*
Soap (Washington)[a]	4,495
Lower Goose (Washington)[a]	720
Blue (Washington)[a]	3,020
Wannacut (Washington)[a]	32,850
Mary (Wisconsin)[b]	1.1
Knack (Wisconsin)	35.8

[a] Data from Walker (1974). All lakes have highly saline monimolimnia; Soap and Lower Goose Lake are thought to be ectogenic.
[b] Data from Weimer and Lee (1973).

baena subcylindrica. The peaks in October 1976 and October 1977 consisted of a mixture of blue-green algae and green algae. *Ceratium, Scenedesmus, Staurastrum, Ankistrodesmus, Coelospherium, Anabaena,* and several types of flagellated unicellular green algae were identified in water samples collected on these dates. These fall blooms disappeared when the lake became isothermal and iced over. In March and April, 1977 a bloom of algae occurred under the ice. This bloom was almost entirely composed of a green flagellated alga.

Meromictic Stability. The density of Knaack Lake at 15 m was estimated by summing the concentrations of the various chemical species measured in the monimolimnetic waters and was calculated to be 1000.455 g/l. Using this value, the stability of Knaack Lake (S) was calculated to 35.8 g-cm/cm² (Table 2). Highly saline meromictic lakes (Soap, Lower Goose, Blue, and Wannacut) have extremely high stability values, while Lake Mary, a biogenic meromictic lake, has a stability value of only 1.1 g-cm/cm².

Discussion

The results presented here show that Knaack Lake is indeed a meromictic lake. A sharp thermocline was established immediately after "ice-out" in the spring and only the upper one to two m of water were mixed. In the fall the thermocline began to drop and partial mixing of the lake occurred to a depth of 14 to 15 m as was evidenced by the uniform profiles of all chemical parameters. Although the turnover was not followed closely in the fall of 1976, chemical data after ice formed indicate that mixing occurred to a depth of approximately 12 to 14 m.

The decreased depth to which the lake mixed in the fall of 1976 probably resulted from the rapid and early freezing. The lake froze two weeks earlier in 1976 following a period of very cold weather. This early freezing and consequent mixing to a shallower depth also affected the water chemistry during the period of ice cover. Sulfide was present to the bottom of the ice immediately after ice formed in 1976 whereas sulfide was not detected in the upper 14 m of water for one month after ice formed in 1977, indicating more thorough mixing in 1977.

Although conductivity increases rapidly with depth in the bottom waters, there is no sharp chemocline dividing the mixolimnion and monimolimnion. Thus, meromixis in Knaack Lake does not appear to be of ectogenic or crenogenic origin. Other factors than salinity must be responsible for maintaining meromixis in Knaack Lake.

Weimer and Lee (1973) have suggested that the major factors allowing meromixis in Lake Mary are biological activity and morphometry of the lake basin. These factors may also be responsible for the meromictic state of Knaack Lake. The concentrations of ammonia, carbonate, phosphate, and methane were extremely high, and (except methane) probably account for the increase in conductivity observed in the monimolimnion. Ammonia, carbonate and methane are all products of biological activity and are relatively stable anaerobically. Thus, biogenic activity is likely a major factor in maintaining meromixis in Knaack Lake. As oxygenated surface water is never mixed with the bottom water, these compounds accumulate and reach extremely high concentrations in the bottom water resulting in increased density in the monimolimnion.

The morphometry of the Knaack Lake basin and surrounding topography probably has a major effect on maintaining meromixis. The lake is surrounded by dense stands of trees and there is a hill on the northwestern shore of the lake which shields the lake from the prevailing winds. The small surface area and the great depth of the lake, combined with the shelter provided by the surrounding watershed prevent extensive mixing of the lake by wind.

Weimer and Lee (1973) calculated that the density difference between the mixolimnetic and monimolimnetic waters in Lake Mary was not sufficient to prevent mixing of that lake. Using Schmidt's stability equation, they calculated the stability to be only 1.1 g-cm/cm^2. They concluded that the physical characteristics of the lake basin and to a lesser extent biogenic activity were responsible for maintaining meromixis. Biological factors may play a more important role in maintaining meromixis in Knaack Lake than in Lake Mary. Conductivity, ammonia, phosphate, methane and DIC concentrations in Knaack Lake were much higher than values reported in Lake Mary. Furthermore, the stability of Knaack Lake (35.8 g-cm/cm^2) was considerably higher than Lake Mary, although the stability of Knaack Lake was several orders of magnitude less than reported values for saline meromictic lakes (Walker, 1974). It appears unlikely that density difference between the mixolimnetic and monimolimnetic waters alone is sufficient to prevent complete mixing of Knaack Lake.

Based on our results, Knaack Lake can be classified as a biogenic meromictic lake, although the morphometry of the lake basin is also an important factor in maintaining meromixis. Since there is no sharp chemocline dividing the mixo- and monimolimnetic waters, the amount of mixing each fall may depend on seasonal factors such as the date the lake freezes and the magnitude and direction of the predominant winds.

The mixolimnetic waters of Knaack Lake behave as a monomictic lake, mixing completely only in the fall. Nutrient input into the lake appears to result primarily from groundwater seepage along the northwest shore. Increases in groundwater after heavy rainfall result in increased nutrients in the surface water which in turn give rise to phytoplankton blooms. The shallow thermocline during spring and summer provides an environment conducive to blooms of photosynthetic bacteria.

Stagnation of the monimolimnetic waters of the lake gives rise to a permanently anaerobic environment high in dissolved solutes. As sulfate and nitrate are absent in the anaerobic water fermentation and methanogenesis are probably the major biological activities occurring in the monimolimnion. The shallow and sharp thermocline and the permanently anaerobic bottom water of Knaack Lake provide an excellent environment for the examination of many microbiological processes such as bacterial photosynthesis, anaerobic decomposition and methanogenesis. The chemical and physical data presented in this paper have been used as a basis for other studies on the microbial activities in the lake.

Acknowledgments

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Literature Cited

Aberg, B. and W. Rodhe. 1942. Uber die Milieufakteren in Einegen Sudschwedischen Seen. Symbol. Bot. Upsalien. 5:256.

Brock, T. D., Brock, M. L., Bott, T. L. and M. R. Edwards. 1971. Microbial life at 90°

C: the sulfur bacteria of Boulder Spring. J. Bacteriol. 107:303-314.

Caldwell, D. E. 1977. The planktonic microflora of lakes. Crit. Rev. Microbiol. 5:305-370.

Culver, D. A. 1975. Physical, chemical and biological factors in the initiation and destruction of biogenic meromixis in a soft water lake. Verh. Internat. Verein. Limnol. 19:776-783.

Hutchinson, G. E. 1957. A Treatise on Limnology, Vol. 1. Wiley. New York.

James, H. R. and E. A. Birge. 1938. A laboratory study of the absorption of light by lake waters. Trans. Wisc. Acad. Sci., Arts and Letters. 1:154.

Lee, D. R. 1977. A device for measuring seepage flux in lakes and estuaries. Limnol. Oceanogr. 22:140-147.

Matsuyama, M. 1973. Some physiochemical features of meromictic Lake Suigetsu. J. Oceanogr. Soc. Japan. 29:47-52.

Mullen, J. B. and J. P. Riley. 1955. The spectrophotometric determination of nitrate in natural waters with particular reference to sea water. Analytica Chemica Acta. 12:464-480.

Nelson, D. R. and J. G. Zeikus. 1974. Rapid method for the radioisotopic analysis of gaseous end products of anaerobic metabolism. Appl. Microbiol. 28:258-261.

Rudd, J. W., R. D. Hamilton and N. E. R. Campbell. 1974. Measurement of the microbial oxidation of methane in lake water. Limnol. Oceanogr. 19:519-524.

Strickland, J. D. H. and T. R. Parsons. 1968. A practical handbook of seawater analysis. Fisheries Research Board of Canada. Ottawa. Bulletin 167, 1st edition.

Strickland, J. D. H. and T. R. Parsons. 1972. A practical handbook of seawater analysis. Fisheries Research Board of Canada. Ottawa. Bulletin 167, 2nd edition.

Tabatabai, M. A. 1974. Determination of sulfate in water samples. Sulfur Inst. J. 10:11-13.

Takahashi, M. and S. Ichimura. 1968. Photosynthetic properties and growth of photo synthetic sulfur bacteria in lakes. Limnol. Oceanogr. 13:644-655.

Takahashi, T., Broeder, W., Thurber, Y. H. L. and D. Thurber. 1968. Chemical and isotope balances for a meromictic lake. Limnol. Oceanogr. 13:272-292.

Taras, M. S., Greenberg, A. E., Hook, R. P. and M. C. Rand (eds.). 1971. Standard methods for the examination of water and waste water. 13th ed. American Public Health Association, Washington, D.C.

Vollenweider, R. A. 1969. A manual on methods for measuring primary production in aquatic environments. IMP Handbook No. 12, London. pp. 37-40.

Walker, K. F. 1974. The stability of meromictic lakes in central Washington. Limnol. Oceanogr. 19:209-222.

Weimer, W. C. and G. F. Lee. 1973. Some considerations of the chemical limnology of meromictic Lake Mary. Limnol. Oceanogr. 18:414-425.

Wetzel, R. G. 1975. Limnology. W. B. Saunders Co., Publisher, Philadelphia, Pa.

FORWARD: COMMON SCHOOLS AND UNCOMMON LEADERS

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Wisconsin's school system, conceived in the northeastern states, was brought into being through the successive labors of six dedicated men. Eleazer Root, Azel P. Ladd, Hiram A. Wright, Alfred C. Barry, Lyman C. Draper, and Josiah L. Pickard came to Wisconsin in the middle of the nineteenth century from New York, New Hampshire, and Maine to serve, each in his turn, as Wisconsin Superintendent of Public Instruction. Each built upon the efforts and achievements of his predecessor, shaping Wisconsin's schools to the philosophy of the Common School Movement that flourished in nineteenth century Massachusetts and Connecticut.

Wisconsin's electorate was already sympathetic with the Common School Movement or it would not have hired these proponents of the movement. But the orientation and energy of these early Superintendents gave direction and thrust to the infant school system. Had any or all of them supported the private tutorial education of the southern states or the sectarian education of the middle Atlantic states, Wisconsin's educational system might have been far different. As it was, these harmonious leaders faced many obstacles.

Teacher preparation, parental apathy, environmental aesthetics, and the search for a responsive and demanding supervisory structure concerned these early educators much as they worry us today. A picture of the conditions and reforms of Wisconsin schools of the time emerges from the thirteen annual reports these first six superintendents were required to file. Each report contained information supplied by clerks of county boards of supervisors. These annual reports provide a record of the recommendations and achievements of each superintendent, as well as a detailed account of the status, problems, and progress of early common schools in Wisconsin.

Territorial statesmen had envisioned a Wisconsin educational system encompassing all levels, elementary through university. The state constitution of 1848 committed land monies and revenues to the support of such a system. Article X, Section 1, specifies the leadership designed to bring the dream to fruition:

> The supervision of public instruction shall be vested in a state superintendent, and such other officers as the legislature shall direct. The state superintendent shall be chosen by the qualified electors of the state, in such manner as the legislature shall provide; his powers, duties and compensation shall be prescribed by law.[1]

Fittingly, the author of Article X was elected the first Wisconsin Superintendent of Public Instruction.

Eleazer Root (1802-1887) was born in the state of New York, earned a law degree from Williams College, and moved to the Wisconsin Territory in 1845, becoming principal of the Prairieville (now Waukesha) Academy. Instrumental in the founding of Carroll College and the University of Wisconsin, he became a professor at Carroll and a member of the first Wisconsin Board of Regents. Root's three year term as state superintendent of the Wisconsin system of common schools began in December 1848.

Delegates to the constitutional convention had voted to adopt the term common schools, defeating the proposal favoring the name public schools. Unlike Europe, where the word "common" denoted inferiority, in the United States a common school was a tax-supported institution intended to offer equal educational opportunity to all children. Root earnestly discharged his responsibility to advance the schools according to this principle.

Root listed three major personal objectives: (1) to promote in-service training programs for teachers; (2) to promote normal schools, (3) to promote grading, i.e. the classification of students by age and ability. Root's annual reports show a determination to personally evaluate school quality. He traveled throughout the state observing and participating in school functioning for as many as seven months in a single year. Various diaries and personal accounts record the conditions Root encountered.

Most schoolhouses were small log or frame buildings with benches for students and a desk on a platform for the teacher. The rooms were drab. Windows were high to minimize distractions, walls were unpainted and pictureless. Ventilation was lacking; a pot-bellied stove emitted uneven heat, and a water pail with a common dipper often spread disease. Globes, blackboards, and standardized textbooks were lacking, making teaching and learning difficult.

Many teachers were teenagers; most were ill-prepared, and all were hired to "keep" school, i.e., administer firm discipline. Teachers' low salaries were supplemented by "boarding round," with various families in the school district. Daniel Thomas described, in a diary, his many years of boarding round. Apparently meals were usually uninspired and often inadequate; a typical breakfast consisted of bread and water, and he was served turkey only once in twenty years. Uncomfortable beds in cold rooms were common; one particularly miserable attic room drove Thomas to sleep in a trunk for warmth. School days for Thomas began when he built a fire at 8:00 A.M., and ended at 4:00 P.M. on weekdays, noon on Saturdays. One diary entry vividly illustrates teacher status within the community. During a blizzard, Thomas waited at school until a parent arrived to call for the last remaining students. Thomas left the schoolhouse with the children whose father had come in a wagon. The father chose not to invite Thomas to ride; furthermore, he admonished him to walk "a respectable distance" behind the wagon.[2]

Teacher improvement was one of Root's major objectives. During his first year in office he formed teacher institutes in all except five counties in Wisconsin, although he regarded institute lectures and discussions as partial, temporary aids to classroom teachers. He judged normal school training essential to prepare future teachers in the subjects they would teach and in pedagogical skills. Commenting that teaching was a profession not unlike law or medicine, Root encouraged normal school administrators to include theory as well as technique in their curricula. He recommended a free five-month university course for all teachers, legal support for teacher institutes, and retention of teacher certification even though he believed the criteria for certification were inadequate. The following copy of one certificate indicates the characteristics the community desired in a teacher.

> We the subscribers, inspectors of Common Schools for the town of Chili in the county of Monroe do certify that at a meeting of the inspectors called for that purpose, we have examined Miss Eliza Dibble and do believe that she is well qualified in respect to moral character, learning and ability to instruct a common school, in this town, for one year from the date hereof.[3]

His extensive school visits gave Root specific ideas for desirable changes in schoolhouses and their sites. Observing that schools often were built on treeless land, sometimes swampland, at a junction of two roads, Root recommended they be built in a dry, healthful, sheltered location on one or more acres of land away from highways and businesses. He specified a need for shade trees and a fence, separate privies and schoolhouse entries for boys and girls, and low windows which could be opened or closed. He preferred buildings with two classrooms which would enable teachers to implement a grading system and eventually eliminate one teacher classrooms with students of varying ages. Large blackboards, maps, charts, pictures, and even useful decorations were advocated, provided they promoted sound morals. Root intended improved common school facilities to increase comfort and practicality as well as to discourage private school enrollment. Always, his emphasis was on the tax-supported education of the public, privileged or poor.

Root requested an expense account and a clerk for the State Superintendent of Public Instruction. He asked that copies of textbooks, samples of school apparatus, and county maps be placed in the office of the superintendent.

Despite public approval of his performance. Root declined to be a candidate for reelection in 1851. In his final month in office, he summarized his recommendations: (1) every township should have primary graded schools taught by female teachers, and higher graded schools equal to high schools and academies; (2) the university should include a non-tuition normal department; (3) county boards of superintendents should conduct institutes and certify teachers; (4) public libraries should exist in every school district supported by public funding; (5) the school fund should be ample and continually increasing; (6) town and county officers, in conjunction with a state officer, should supervise teachers, and strive toward uniformity.

Root's successors restated his recommendations, most of which were eventually enacted. His greatest accomplishments appear to have been the firm establishment of the new office, open communication with teachers and other citizens, and some improvement of teacher competency. After serving as a state assemblyman, Root moved to St. Augustine, Florida in 1853 serving as rector of Trinity Episcopal Church until his death in 1887.

New Hampshire-born Azel P. Ladd (1811-1854), Root's successor (1852-1853), had moved to the Wisconsin Territory in 1842. Some members of the electorate opposed his candidacy for the superintendency because they believed that he, a physician, lacked suitable qualifications. He had, however, shown previous interest in public service by helping to form the Mining Region Teachers' Association in 1848, and by serving as vice president of the State Historical Society of Wisconsin.

Ladd was confident that the common schools would inspire public honor, create a wholesome regard for laws, prevent crime, and infuse kindness. He expressed his faith in this possibility, saying,

> Thus FREE EDUCATION TO ALL may be appropriately inscribed upon the emblem of our State—its present glory, its future hope.[4]

Wealthy parents created an obstacle to public school progress by enrolling their children in private schools, creating by contrast an image of public schools as vulgar and inferior. Responding to parents who expressed fears that their children might acquire habits of vice and vulgarity in common schools, Ladd urged them, as a public duty, to send their children to public institutions so that they might reform, elevate, and purify the schools.

In an attempt to strengthen public schooling, Ladd advocated a tuition-free state system of three divisions: (1) a district school to teach the common and necessary branches of knowledge, (2) a county high school to provide the elements of professional studies and prepare pupils for a business or trade,

(3) a university to equip graduates for an occupation in science or literature. He recommended construction of schoolhouses with two, or even three classrooms to accommodate the separation of pupils into grades.

Ladd observed many schoolhouses, located on wide and shelterless prairies, failing to provide either health or comfort. He condemned overcrowded classrooms with extremes of temperature, impure air and high seats, and without drinking water and teaching apparatus. Ladd advised that no new schoolhouses be built near swamps, marshy river banks, or pools of stagnant water. He recommended shade trees and pleasant playgrounds, a constant supply of fuel and fresh water, windows which opened, high ceilings, low benches, and space to allow movement. Convinced of the value of aesthetics, Ladd remarked, "Beautiful sights create beautiful thoughts, and beautiful thoughts are the germ of pure principles and noble actions."[5]

One of the state superintendent's duties was to recommend textbooks. Ladd devoted many hours to examining textbooks before concluding that Wisconsin's textbooks were inferior, outdated, and deplorable in their diversity. As a remedy, he urged the adoption of uniform textbooks.

Ladd labored to enhance teaching skills. He continued Root's sponsorship of one- to two-week teacher institutes offering professional information during the day and public lectures for the general population at night. Encouraging women, whom he termed "natural guardians of the child," to teach, Ladd catalogues his reasons for asserting their superiority to male teachers: her voice is more inviting, and her language is comprehensible to a child; her affections are stronger than her intellect so her greater concern is for the child's feelings, rather than his intellect; her classroom control is based on kindness, not on fear. Advocating hiring the best, even though the most expensive, teachers available, Ladd cautioned, ". . . no school at all is preferable to one taught by an incompetent and unfaithful teacher."[5]

Ladd was equally interested in the judgment of the men who hired teachers. The town superintendent of schools was charged with responsibility to form school districts, receive and apportion school money among the several districts in the town, and certify teachers. Ladd accused town superintendents of sometimes hiring unqualified relatives, friends, or neighbors. For this reason, he advised the public that the office of town superintendent wielded excessive power.

Clerks of county boards of supervisors were required to submit annual reports to the state superintendent of public instruction for incorporation in the superintendent's comprehensive annual report. Portions of such reports substantiate Ladd's contention that clerks submitted irregular, incomplete, or inaccurate accounts. One clerk reported on a school where classes had been conducted forty-six months during that year. Another described a school which had operated twenty and one-half months over a twelve month period. Furthermore, that community had 327 residents, 436 of whom had attended school that year.[6]

Ladd also attempted to explain the proper relationship of parents to the common schools. He advised parents to display interest in all school affairs, to participate in district school work, and to actively pursue financial aid for schools. He urged parents to visit school frequently and unceremoniously, to associate with the child's teacher and peer group, and to supervise home study. Ladd relied upon community involvement to sustain a successful common school system.

Ladd formed county associations of teachers, as a preliminary step to establishing a state organization. He requested delegates from each county group to attend a meeting in Madison on July 12, 1853. Eight teachers assembled to adopt a constitution, elect officers, and confer with one another for several days. This was a modest beginning for a group that would wield enormous power in later years. Perhaps Azel Ladd's most enduring contribution to Wisconsin education was the founding of the influential State Teachers Association.

Before his death in 1854, Ladd returned briefly to his career as a physician.

Hiram A. Wright (1823-1855) succeeded Ladd as State Superintendent of Public Instruction (1854-1855). He moved from New York state, where he was born, to Prairie du Chien in 1846, and, in the late 1840's published the only newspaper on the upper Mississippi River. He studied law, was admitted to the bar, then served for two years as Crawford County judge. Wright served in both the Wisconsin Senate and Assembly prior to his election to the highest educational post in the state.

In Wright's annual report of 1854, he, like Ladd, called upon parents to participate actively in common school operations, for he believed that properly directed public sentiment would accomplish what laws could not. He issued a warning:

> So long as the people remain indifferent to the character of their school, so long will their children have to attend indifferent schools.[7]

Reporting that teachers unanimously rated "irregular attendance and want of punctuality" as the greatest deterrent to educational reform, Wright blamed parents for perpetuating this problem. He went on to reproach careless and indifferent parents for deficiencies in moral and intellectual training in the schools. Noting that poor schoolhouses contributed to poor attendance, he proposed that parents work to improve physical accommodations.

Wright was repelled by filthy schoolrooms, cracks in the walls, impure air from poor ventilation, and ill-constructed seats that caused pain and, in some instances, permanent bodily distortion. Wright recommended an annual allowance for the purchase of globes, maps, blocks, blackboards, and numerical frames. A clock was indispensible to his standards of orderliness. Advising optimum use of existing facilities, he made two practical suggestions to teachers: paint the cardinal points of a compass on either the platform holding the teacher's desk or the ceiling; mark the measure of an inch, foot, and yard on the edge of the blackboard.

Pointing to the success of the few union schools in existence, Wright encouraged the establishment, in populous areas, of additional institutions of two or more classrooms. He favored, where feasible, combining several district schools into a union school, for union schools would be economical, provide the best schoolhouses and the best apparatuses. Union schools, Wright believed, would permit proper pupil classification, and maintain order and discipline, while attracting the best teachers.

The problem of diverse textbooks, confronted during Ladd's tenure, continued. Because there were almost as many different textbooks as students, teachers were forced to hold excessive numbers of hurried recitations. For this reason, Wright, too, advocated textbook uniformity. Despite his expressed confidence that qualified teachers were capable of selecting textbooks, he recommended that, because of the large number of unqualified teachers, the state superintendent should make the choices.

Apparently annual district and town reports had not improved, for Wright referred to incomplete and erroneous accounts. As had Ladd, Wright charged district clerks and town superintendents with careless recordkeeping. He faulted some teachers, also, for failing to keep a school register as prescribed by law.

Wright believed that the classroom performance of teachers was critical. He stated, "As the teacher is, so is the school. He teaches by example as well as by precept."[8] Wright contended that if a teacher were boisterous, uncourteous, careless, superficial, unzealous, severe, or unreliable these qualities would be transmitted to students. The formation of town teachers' associations would provide a forum for sharing ideas: parental involvement might improve teacher performance, and discriminating certification policies would eliminate unsatisfactory teachers.

Having promoted and participated in institutes, Wright was persuaded they, too, would have a salutary effect on classroom performance. In his opinion, institutes could improve methodology and create an environment in which pupils might reason, understanding principles as well as facts; the mental capacity of students might be enlarged and a love of learning instilled.

Wright requested funds for normal schools as well as for institutes. Citing New York, Massachusetts, and Connecticut for maintaining successful normal schools, he emphasized an immediate need for normal schools in Wisconsin.

Again referring to New York, Wright endorsed that state's system of school libraries, proposing the establishment of similar facilities in Wisconsin. In addition to supplying books for children, such libraries could serve the community by offering adult books. Wisconsin law allocated a maximum of ten per cent of the district school fund for the purchase and continuance of a school library. Wright recommended that use of the entire ten per cent for that purpose be made mandatory.

Also at this time, and with Wright's active support, a bill passed authorizing town libraries to buy a copy of *Webster's Unabridged Dictionary* for each common school under their jurisdiction. Wright wanted a dictionary in each Wisconsin common school, for he viewed the book as an aid in discouraging provincialism, and preventing immigrants from corrupting the English language.

Wright's period in office was characterized by a consistent appeal for parental involvement, endorsement of improvements advocated by his predecessors, and provision for a dictionary in each common school. After suffering from ill health throughout his superintendency, Wright died in May of 1855, less than six months into his second term.

Governor Barstow appointed the Reverend Alfred C. Barry (1815-1888) to complete Wright's term. Barry was later elected to two consecutive one-year terms (1856-1857). Born in New York state, he attended private schools to prepare for the Universalist ministry. After moving to Racine in 1846, he founded and edited a temperance magazine, *The Old Oaken Bucket.* He served as the first Superintendent of Schools in Racine from 1849 through 1853.

Seeking specific additional information, Barry submitted a questionnaire to each town superintendent, then incorporated the responses into his annual reports together with letters from other educators in Wisconsin and the East. Moreover, he clarified his educational goals by supporting the common school intended, according to his interpretation, to foster ". . . the development of a free, true, harmonious human soul."[9] He viewed public education as the safeguard of a democratic government, and an instrument for the advancement of mankind.

Barry contended that it was difficult to learn in uncomfortable, inconvenient, unpleasant, unattractive schoolhouses which he labeled "mean, murderous things." A town superintendent placed a value of three cents on one building. Barry speculated,

> This pre-supposes 'three cent' parents. And we have only to suppose farther a *three cent teacher,* and a *three cent school,* to complete a very interesting and prosperous state of things.[10]

To alter these circumstances, Barry like his predecessors recommended that new schoolhouses be built on pleasant sites consisting of a minimum of one acre of land, although he preferred three to five acres. He stipulated that there be two rows of shade trees, flowers and shrubbery in front of the building, and two playgrounds in the rear. Stressing the desirability of cultivating comfort and health, he recommended high white-painted walls holding maps, charts, and pictures, and a thoroughly ventilated building. To facilitate adoption of his plans, Barry urged each town superintendent to purchase a copy of *School Architecture,* written by Henry Barnard, noted Connecticut educator.

Barry urged the public to endorse a system with a primary school and a high school in each town, an academy in each county, and university for the state, all tuition-free. Opposing small districts, Barry supported formation of union schools, assuring citizens that a two- or three-mile walk would not be a hardship for students. Perhaps to counter parental apathy, he recommended an increase from the then current minimum of three to at least six months of school annually, before a district could receive its share of state aid.

Directing his attention to equipment, Barry quoted numerous town superintendents who approved of the concept of textbook uniformity, and agreed to implement such a plan.

There would be numerous advantages, according to Barry, to the State Superintendent's selecting all textbooks. The often inferior books chosen with haste and partiality by overburdened teachers and town officials would be eliminated by the judicious selections of the state superintendent. Books suitable to each grade level would be the same throughout the state, saving money and time when students or teachers moved across district lines. After telling of the success of a uniform textbook system in other states, Barry mentioned bribery and corruption charges directed toward his office and perhaps in self-defense, carefully documented his reasons for selecting each book on his list.

Barry favored a curriculum which would be pragmatic, promote health and cheerfulness, and achieve a union of moral affections and nature. He recommended study of natural history and natural sciences, botany and zoology, geology and agriculture, anatomy and physiology, citizenship and moral science. In an emotional account of the moral power of music, Barry stressed the importance of music in primary schools. Daily hymns and songs would provide a welcome respite from studies.

Comparing school to a prison, Barry objected strongly to a strict regimen of book learning for small children exposed to six hours of inactivity, impure air, uncomfortable benches, and meaningless memorization. He said,

> . . . the result is seen in the shattered constitution, the ruined health, the enfeebled mind, the perverted moral sense, the nervous excitability of blasted or abused childhood.[11]

To offset these conditions, Barry favored delaying schooling until a child displayed adequate maturity to comprehend subject matter rather than engage in rote memorization. He observed that many great minds, e.g., Newton, Schiller, and Patrick Henry, did not, as youngsters, display intellectual brilliance.

Barry condemned parents, generally, for being apathetic toward education. He also accused parents of frequently keeping their children home from school without a legitimate reason, and not knowing when their own children were tardy. Parents failed to determine whether teachers were fulfilling their duties, whether proper and adequate books were supplied, or whether equipment and environment were satisfactory. Many town superintendents called parental indifference the greatest obstacle to improved schools. In Barry's opinion, the chief educational responsibility lay directly with the parent, while the teacher was intended to be merely a parental agent or surrogate.

Objecting to the popular view of a teacher as a person who simply "keeps" school, Barry asserted that teachers should stand *in loco parentis*. Parents must accept the responsibility for choosing good teachers. Teachers, for their part, must avoid formal, mechanical instruction forcing students to cram, a process Barry termed "sausage stuffing." Barry urged annual funding of institutes as likely to eradicate unacceptable methodology. He insisted that, in addition, it was imperative for Wisconsin to establish a state normal school to enhance teacher preparation. Barry also urged an increase in teacher salaries, hoping thereby to attract competent, well-educated professionals.

Superior teachers deserved skillful leadership. Agreeing with Ladd's assessment, Barry claimed that incompetent or disinterested town superintendents were unable to give such direction. Therefore Barry made the momentous decision to recommend creation of the office of county superintendent of schools. He was convinced that county superintendents would give rigid but practical certification examinations, speak persuasively to influence public opinion, provide efficient leadership, and assume certain duties performed, at the time, by the state superintendent. Because the state superintendent and his assistant worked fourteen to sixteen hours a day, Barry also asked for additional help in the Department of Public Instruction. The state superintendent heard appeals cases, kept records, spent five months a year inspecting schools, apportioned school money, and prepared the annual report. His assistant was fully occupied handling the extensive correspondence.

In 1856, a private periodical, *The Wisconsin Educational Journal,* was renamed *The Wisconsin Journal of Education,* and according to the title page, became the official organ of the State Teachers' Association and the Department of Public Instruction. Barry, a member of the original nine-man editorial committee, contributed frequent articles and printed his annual report in the journal. He sent a copy of each issue to every town superintendent, and expressed the wish that it could be read by every Wisconsin teacher.

After his service as state superintendent, Barry served as a chaplain during the Civil War, and after the war as a hospital chaplain. He worked, also, in the State Assembly, and was chaplain of the Wisconsin Commandery of the Military Order of the Loyal Legion.

Lyman C. Draper (1815-1891), fifth Wisconsin State Superintendent of Public Instruction (1858-1859), attended public schools in his home state of New York before entering Granville College in Ohio. He became corresponding secretary of the State Historical Society of Wisconsin in 1854, two years after moving to Madison. His work for the society helped to expand its membership, library, and state funding. An early fascination with the West, and extensive travel, led him to a career of writing about the land and its people. Draper was influential in bringing to Wisconsin the notable common school proponent, Henry Barnard, admired by Draper's predecessor.

Draper identified the common school system as the hope of the state. In the following statement, he interpreted the role of the common school as a "leveling agent."

> And such must ever be the legitimate results of the Free School system, placing the high and the low, the rich and the poor, upon a common level—where unconquerable devotion and intrinsic worth, however humble or however poor, alone secure the prize.[12]

Unlike his predecessors, Draper did not dwell upon the responsibility of parents and the general public in advancing the Common School Movement, but, instead, relied upon the state legislature to achieve progress.

To implement educational equality, Draper advised legislators to adopt a free graded system of education from primary schools through the university. He reinforced his arguments for a central graded high school for each town in Wisconsin by quoting numerous sympathetic educators from other states. As a further means of strengthening education, he, like Barry, recommended extending the school year from three to six months.

To improve administration, he advised replacing the district system with a township board of education to be composed of a superintendent, school treasurer, and school clerk. Draper, expressing popular disapproval of town superintendents, was hopeful that a board of education would prevent continued hiring of inept town superintendents and clerks. He illustrated the incompetence of some of these officials by examples from his correspondence. In one letter a schoolteacher referred to a man responsible for certifying teachers.

> The District Clerk, ______, cannot read or write. . . .[13]

A letter, from a town superintendent, dramatically displays the academic attainments of another school official.

> May 10th 1860
> Mr. Lyman J. Drayper
> Stait Supertendant
> Madison Wis
> my Dear frend i was Electid town supertendant of the town of ______, ______ co. Wisconsin and i would like to have A new School code of Wisconsin and som Annual Reports of the Clerk of School Distric and all most Repctfuley yors
>
> ______
> town Supertendant of Common Schools in the town of ______, ______ co wis[14]

In a further attempt to upgrade administrative procedures, Draper approved Barry's recommendation for creating the office of County Superintendent with the following duties: (1) supervising teachers, (2) certifying teachers, (3) furnishing statistics and information, (4) adjusting controversies.

According to Draper, the first educational duty was to teach children to read, and the second was to provide them with the right books. To fullfill this obligation, school libraries must be a part of the public educational system. Draper contended,

> I think that it may justly be regarded, that this matter of Township School Libraries is emphatically the present great educational want of Wisconsin.[15]

He underscored this interest, by devoting approximately twenty-five per cent of his annual report to a discussion of libraries. School libraries, Draper declared, would provide incentive for the formation of literary associations and debating clubs. With properly selected books, libraries would be valuable to the entire community when school was not in session. Draper proposed that the libraries include books on history, travel, physiology, chemistry, and geology. In addition, books on the theory and art of teaching would be a less expensive method of improving teacher performance than either institutes or normal schools.

Libraries should not be a substitute for institutes, however, for teachers need a formal learning experience, Draper noted, particularly when they are unable to attend a normal school. A successful institute is dependent upon effective instructors and lecturers, for whom the state should provide funding. Crediting Barnard for improving Wisconsin normal schools and teacher institutes, Draper termed Barnard's association with the state normal schools the most important event ever to occur in Wisconsin's educational history.

The growth of normal schools provided increasing opportunities for women to become teachers. Draper encouraged the acceptance and advancement of women in the teaching profession, declaring,

> Females, in consequence of their higher moral instincts, their more refined tastes, together with their more patient and sympathising natures, are fitted in a more emi-

> nent degree than the male sex for imparting instruction to the young.[16]

Draper proposed that a teacher's association be formed in every county, city, and township in Wisconsin. Information from each chapter could be incorporated into the annual report of the State Superintendent.

Referring to salaries of comparable officials in other states, Draper recommended a wage increase for the State Superintendent, Assistant State Superintendent, and Clerk. Lamenting the intrusion of politics into the office of superintendent, he proposed a change from a fall election for a two-year term to a spring election for a three-year term. He recommended establishing a state board of education authorized to appoint a superintendent and serve in an advisory capacity to him.

After completing his term as State Superintendent, Draper resumed his writing career, traveling extensively to find materials. His personal collection, combined with the 478 volumes he acquired for the society, formed the nucleus of the Historical Society's manuscript collection of frontier history, one of the largest and most important in the nation.

Josiah L. Pickard (1824-1914), who became, in 1860, the sixth State Superintendent, and the last to hold this office prior to the Civil War, was born in Maine. He graduated from Bowdoin College before moving to Platteville in 1846. A professional educator, he was principal of Platteville Academy for fourteen years, and helped to organize the Wisconsin State Teachers' Association.

A public educational system, for Pickard, was essential to prepare citizens for active participation in a democracy, to prevent people from becoming willing tools of demagogues, and to permit persons to appreciate the blessings of civil liberty. Moreover, education, as a preventative to crime, was more effective and less expensive than corrective measures. In the following statement, Pickard voiced his approval of common school principles.

> The general diffusion of knowledge and of correct moral principles, are therefore absolutely essential to the perpetuity of popular institutions.[17]

Pickard was convinced that only public schools were able to equip Wisconsin citizens for self-government inexpensively and universally.

Pickard divided schools into three levels: primary, intermediate, and high schools. Pickard's goals for primary schools were to further physical and moral development, cultivate a taste for study, and provide a transition from freedom at home to restriction at school. Only female teachers should work at this level, he said, for they have quick perception, patience, kindness, a sympathetic nature, and devotion. Intermediate scholars would encounter more severe restraints, longer tasks, greater emphasis upon books, and more variety in daily work. Pupils must be more self-reliant during this transition period. The high schools were to emphasize mental activity in a curriculum including moral and natural science, history and civics, classics and research.

Pickard praised the effectiveness of the graded system, listing many advantages: (1) a teacher taught fewer branches of knowledge, thus utilizing a talent for special work; (2) supervision was more careful; (3) opportunity for promotion stimulated teacher and pupil; (4) permanent, congenial employment appealed to teachers and a larger number of female teachers were employed; (5) expenses did not increase; (6) pupils remained in a school longer, giving character to the school, while sparing parents the expense of sending the child away from home for an education; (7) the system followed natural development.

Aware of circumstances which might make gradation impossible in some districts, Pickard offered several alternatives: giving the younger children more frequent recesses and an earlier dismissal; devoting half a day to the younger children, who would then leave; or dedicating half a day to the younger and half a day to the older children. Each teacher could select from among the three options.

As *ex officio* member of the fifteen-man Board of Regents, Pickard wanted the university to be intimately connected with common schools. He urged free instruction not only in arts and sciences, but also in professional pedagogical training.

Because many Wisconsin schools still had improper lighting and heating, no ventilation, and no coat closets, because blackboards were placed too high and ceilings built too low, because halls were narrow and seats often the wrong size, Pickard recommended that each school library should have a book of schoolhouse architecture, such as Barnard's, to encourage creating useful and beautiful buildings.

Pickard hoped that a pleasant setting might improve attendance and encourage children to take the initiative in attending school, despite parental indifference. Pickard speculated that some needy parents kept their children home to avoid buying books or clothes, or to encourage them to find jobs to supplement the family income. He estimated that one-fourth of Wisconsin children received instruction only in the "school of the street," where they learned corrupting habits running counter to the moral teaching of the common schools.

Pickard, and the public generally, favored a curriculum broader than the "three r's." He quoted Daniel Webster who said,

> Were the branches taught in public schools to be limited, I would select such as would of themselves deeply interest the pupil, and thus create a thirst for knowledge.[18]

Adopting a more rigid stance on textbooks than on curriculum, Pickard advised legislation to force district board members to adhere to the recommended book list of the State Superintendent. Although he regarded textbook uniformity as essential within a school and desirable in a town and county, he believed state uniformity to be unnecessary, for pupils rarely moved great distances. He restricted the need for textbook uniformity to district schools where frequent teacher turnover would lead to confusion or dissatisfaction if each were to follow personal preference. Because of their greater job stability Pickard believed high school teachers might choose their own textbooks to be used over a period of several years.

The 1859 legislature had passed an act to provide a permanent township school library fund. Pickard approved, citing books as ever-present, direct educational agencies which were often more potent than a living teacher. He observed that people with the lowest incomes most needed a library, but could least afford to support one. Pickard claimed to have found no libraries worthy of the name except where a voluntary local tax was added to state money.

Pickard reported that public interest in education increased wherever he conducted institutes. He viewed these classes, varying in length from three days to two weeks, as vehicles to awaken an interest in culture. Perceiving a need for the preparation of greater numbers of teachers than in past years, he advocated placing the state university at the head of a normal school system consisting of a number of local schools financed with state aid and private contributions. In the meantime, growth of the Wisconsin State Teachers' Association prompted the organization of increasing numbers of local chapters which provided an opportunity for teachers to share professional skills and arouse public interest in schools.

The improvement of teacher preparation made it possible to revise teacher examinations. Pickard recommended that examinations be both written and oral, and that they test knowledge of fundamental principles rather than continue to ask ambiguous or puzzling questions. He proposed scheduling examinations for a definite date and time, in preference to the impromptu system then in effect.

During his first year in office, Pickard had repeated his predecessors' appeals for a county superintendency to replace town administrators. The perseverence of state superintendents and others was rewarded in 1861 with the passage of a law creating the office of county superintendent of schools. Persons elected to two-year terms assumed responsibility to: (1) examine and license teachers; (2) visit and inspect schools; (3) organize and conduct at least one teacher institute each year; (4) encourage teachers' associations; (5) advise in all questions arising under county school law; (6) advise on pedagogical skills and schoolhouse design; (7) report on the condition and prospects of schools; (8) collect abstracts of clerks' reports for transmission to the State Superintendent. Problems long confronted by the State Superintendents were, at last, on the way to resolution with the enactment of this law.

Innovations of a different nature occurred with the common school system's expansion to include special schools. The Wisconsin Institute for the Education of the Blind opened in Janesville; the Wisconsin Institute for the Education of the Deaf and Dumb opened in Delavan; a State Reform School opened in Waukesha. The Reform School was intended to prevent crime rather than to reform criminals, to be educational rather than penal.

Although this study ends with the beginning of the Civil War, it should be noted that Pickard served during wartime, resigning in 1864 to become Superintendent of Schools for Chicago, a position he held until 1877. He then accepted another prestigious position as president of the State University of Iowa, remaining from 1878 to 1887.

The shared educational roots of these six superintendents gave Wisconsin's educational system a period of uninterrupted progress. The early superintendents were in general agreement. Each superintendent identified the following obstacles to the achievement of quality education: insufficient state funds, inefficient administration, incompetent district and town officials, inferior schoolhouses, lack of textbook uniformity, ill-prepared teachers, poor attendance, and parental indifference.

Consistent with one another in naming probable solutions to these problems, the superintendents recommended, and were eventually granted, creation of an office of County Superintendent of Schools, graded schools, school libraries, institutes and normal schools, and professional associations and publications.

Several trends between 1848 and 1861 reflect the efforts of the state superintendents. Public interest in education grew, uniformity of textbooks was accepted, and the quality of teacher preparation improved. Teacher salaries increased with teachers' increased professionalism. The average male teacher earned $15.22[19] a month in 1849, but $23.01[20] in 1861, while corresponding figures for female teachers were $6.92[21] and $14.62.[22]

Schoolhouse construction changed slightly. In 1849, five per cent of all schoolhouses were brick, three per cent of stone, fifty per cent of logs, and forty-two per cent frame.[23] In 1861, the number of brick schoolhouses remained at five per cent, stone buildings increased to four per cent, log structures decreased to thirty-two per cent, while frame schoolhouses increased markedly to fifty-eight per cent.[24] The number of schools having blackboards grew from fifty-three per cent in 1849[25] to seventy-nine per cent in 1861.[26] Schools with maps numbered twenty-three per cent in 1848,[27] twenty-nine per cent in 1861.[28]

During these years common schools

reached increasing numbers of children. In 1849, forty-six per cent of children between the ages of four and twenty attended schools[29] which were in session an average of 3.93 months that year.[30] In 1861, sixty per cent of the registered children attended classes regularly[31] in schools open an average of six months yearly.[32] These and other statistics serve only as indicators, for their accuracy is questionable because of the ineptitude of many district clerks and town superintendents. Yet it is evident that vast improvements in the Wisconsin school system were wrought between 1848 and 1861. Root, Ladd, Wright, Barry, Draper, and Pickard championed education despite great obstacles. They were uncommon leaders who shaped the common school system of Wisconsin during its formative years.

Notes

[1] "The Wisconsin Constitution," Wisconsin Legislative Reference Bureau, *The Wisconsin Blue Book,* 1968. Madison Document Sales, 1968, p. 307.

[2] State Historical Society of Wisconsin, *Diary of Daniel Thomas,* SC 145.

[3] State Historical Society of Wisconsin, *James T. Lewis Papers,* Wis Mss VY.

[4] Azel P. Ladd, *Annual Report of the State Superintendent of Public Instruction, For the Year 1852* (Madison: Brown and Carpenter, Printers, 1853), p. 24.

[5] Azel P. Ladd, *Annual Report of the State Superintendent of Public Instruction, For the State of Wisconsin, 1853* (Madison: David Atwood, Printer, 1854), p. 31.

[6] *Ibid.,* pp. 6-7.

[7] H. A. Wright, *Annual Report of the State Superintendent of Public Instruction, Of the State of Wisconsin For the Year 1854* (Madison: Beriah Brown, Printer, 1855), p. 20.

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

[9] A. Constantine Barry, *Annual Report of the State Superintendent of Public Instruction of the State of Wisconsin For the Year 1855* (Madison: Calkins & Proudfit, Printers, 1856), p. 30.

[10] A. Constantine Barry, *Annual Report of the State Superintendent of Public Instruction of the State of Wisconsin For the Year 1856* (Madison: Calkins & Proudfit, Printers, 1857), p. 16.

[11] A. Constantine Barry, *Annual Report of the State Superintendent of Public Instruction of the State of Wisconsin, For the Year 1857* (Madison: Atwood & Rublee, Book Printers, 1858), p. 19.

[12] Lyman C. Draper, *Tenth Annual Report on the Condition and Improvement of the Common Schools and Educational Interests of the State of Wisconsin For the Year 1858* (Madison: Atwood and Rublee, Printers, 1858), p. 34.

[13] *Wisconsin Journal of Education,* V (February 1861), p. 264.

[14] Draper, *1858 Report,* p. 179.

[15] *Ibid.,* pp. 87-88.

[16] *Ibid.,* p. 119.

[17] J. L. Pickard, *Thirteenth Annual Report of the Condition and Improvement of the Common Schools and Educational Interests of the State of Wisconsin For the Year 1861* (Madison: Smith and Cullaton, State Printers, Argus Office, 1861), p. 47.

[48] J. L. Pickard, *Twelfth Annual Report on the Condition and Improvement of the Common Schools and Educational Interests of the State of Wisconsin, For the Year 1860* (Madison: James Ross, State Printer, Patriot Office, 1860), p. 7.

[19] Eleazer Root, *Report of the State Superintendent* (December 31, 1849), Appendix A.

[02] Pickard, *1861 Report,* p. 11.

[21] Root, *1849 Report,* Appendix A.

[22] Pickard, *1861 Report,* p. 11.

[23] Root, *1849 Report,* p. 7.

[24] Pickard, *1861 Report,* p. 5.

[25] Root, *1849 Report,* Appendix A.

[26] Pickard, *1861 Report,* p. 5.

[27] Root, *1849 Report,* Appendix A.

[28] Pickard, *1861 Report,* p. 5.

[29] Root, *1849 Report,* Abstract A (no pagination).

[30] *Ibid.,* pp. 5-6.

[31] Pickard, *1861 Report,* pp. 8-9.

[32] *Ibid.,* p. 112.

TRANSFORMATION OF U.S. AGRICULTURE: THE PAST FORTY YEARS[1]

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The United States, with some exceptions, was settled as a nation of small farmers. The peak number of farms, 6.8 million, was reached in the mid-1930's; the average size was 155 acres. By 1979 there were about 2.4 million farms averaging 443 acres. One-half million of these farms received about 80 percent of the cash receipts from farming. The U.S. farm population reached its peak of about 32.5 million people during the depths of the depression in 1933. Today we have less than 4 percent of the labor force employed in on-farm production with a total farm population of less than 9 million people. These figures imply very rapid changes in the structure and organization of U.S. agriculture over the past 40 years. How were these changes brought about and why?

Factor Endowments and U.S. Agriculture

U.S. agriculture developed under conditions of plentiful land and a scarcity of labor. Thus the emphasis since the beginning of the nineteenth century has been on output and efficiency per person rather than per acre. To be sure, some people were concerned with breeding better livestock, improving soil treatment, better plant varieties, etc. But the major concern was to extend the capacity of labor through mechanical devices and improved tools and equipment.

Our green revolution came more recently. Hybrid corn was introduced in the late 1920's, but the widespread use of commercial fertilizers and, later, of weed and insect-control chemicals did not occur on a massive scale until after World War II. The abrupt increases in yield based on biological-chemical technology came after 1950. But this technology alone would have had little impact on farm size and population structure. The change in structure was brought about largely by the tractor and related mechanization. The shift from oxen to horses in the nineteenth century, and the horse-drawn implements and equipment that were developed throughout that period, did improve labor efficiency and output per worker. Essentially this permitted a better job of tilling the land or perhaps clearing and putting more land under cultivation *within* the 80- or 160-acre family farm unit—rather than expanding the basic size of the farm. Use of tractors and the development of ever larger power units as well as tillage and harvesting equipment required larger farms to utilize the machinery efficiently.

In the United States, as in countries around the world, land-saving technology was essentially neutral to scale or size. There is nothing mysterious or complex about this. Seeds, fertilizers, insecticides, etc. are divisible inputs and can be applied with equal efficiency on small or large farms. Water for irrigation may involve some scale economies, but these can be captured through water user associations, cooperatively owned

[1] Parts of this paper were included in my "Agriculture Within the U.S. Economy: Integration and Interdependence," in *Farm Structure* Committee Print, 96th Congress, 2nd Session, April, 1980, Committee on Agriculture, Nutrition and Forestry, U.S. Senate. A more comprehensive analysis, including parts of this paper, is my "Rural Development Problems and Policies: The United States' Experience," in Background Papers for the United States Delegation to the World Conference on Agrarian Reform and Rural Development FAO Rome 1979, Agency for International Development, Washington, D.C.

tube-wells, etc. Likewise, machines can be small, machine services can be rented, or machines can be jointly owned. In this way, machine services too can be made divisible. However, the basic factor endowments in U.S. agriculture with plentiful land and scarce labor did not encourage the latter development.

Mechanization and Farm Size Expansion

In the early years of mechanization, joint ownership of certain machines was common. This did not generally include the tractor or the basic tillage machines and implements. Machines that were used only a few days during the year and where timeliness of operation (in relation to weather and season) was not crucial were generally prospects for joint ownership. The joint ownership by 6 to 10 farmers of a grain threshing machine was common, at least in the Midwest, until the 1940's. Many farmers hauled their unthreshed grain (in bundles) and stored it at the farmstead, either in relatively weatherproof stacks or in the large lofts above the stables. In either case, the crop was protected by removing any concern for losing the crop because of a prolonged period of rainy weather. The threshing machine could be moved from farm to farm, and there were few conflicts over whose grain was to be threshed first and whose last. With the shortage of farm labor brought about by World War II, farmers switched increasingly to threshing directly from the field. Now timeliness became critical and conflicts arose among the cooperators in a threshing ring. Everyone wanted to be first to avoid loss should the weather turn bad. Most of the sharing and joint ownership of machines disappeared by the late 1940's.

During the prosperous years of World War II, farmers accumulated savings; later credit became more readily available. The machinery companies shifted from war-time production to domestic production, and new and bigger farm machines (tractors and accompanying equipment) were placed on the market. Thus, in the 1950's, there was a major wave of farm mechanization. From one-fifth to almost two-thirds of the farms sold in the late 1950's, depending upon type of farming, were purchased by adjoining farmers who wished to enlarge their farms to achieve the economies of scale associated with the new machines. This process continued throughout the 1960's, but slowed in the 1970's.

How did the small farms (e.g., 80-acre farms) that continued operation during this period succeed financially? Actually, they continued to be productive on the basis of output per acre. In the late 1950's, analysis of a large number of Wisconsin farms showed that the smaller farms produced the same (or even slightly higher) yields for the major Wisconsin crops as did the larger farms. However, output per worker increased much more rapidly on the larger farms. With increased mechanization and *farm-size expansion,* the difference in output per worker between larger and smaller farms grew wider. To own the machines, and to get bigger machines, a farmer was forced to expand. Farmers who increased their land base received higher incomes—as a general rule. Although their costs increased also, the returns increased faster than costs —*always,* however, with the requirement of an expanded land base; otherwise scale economies were not realized and costs went up faster than returns. Realization of these economies was dependent upon farm enlargement and labor displacement. The net outmigration of people from U.S. farms averaged more than a million per year throughout the 1940's and the 1950's and over one-half million per year throughout the 1960's. Outmigration has declined substantially in the 1970's.

Small farmers could survive and stay in business throughout this period—and some did. They had to settle for a lower income and fell behind farmers who were expanding their operations and even farther behind people in urban occupations. However, one must differentiate here between a small farmer who was established before 1940 and one who tried to become established in the 1950's. Throughout this period, land values and taxes were increasing at a fairly rapid rate. Thus a farmer who was established in 1940 and who had his mortgage paid off by 1960 or before could continue operations, although at a reduced return. But, a young family purchasing a farm at the higher land values of 1950 (given the subsequent unfavorable cost/price relations in farming) would find it very difficult to make the higher mortgage payments and pay the higher taxes, and at the same time provide the increasing income needed for a growing family. The late 1940's marked the turning point.

Small farms transferred before 1945 could survive through the 1950's and 1960's, but those transferred later were likely to experience financial difficulties and these farms were again sold and usually combined with a neighboring farm. "Small farm" is not a precise term. Even specifying acreage is imprecise since the significant measure is the size of the business rather than acreage. In the dairy areas of Wisconsin and neighboring states, the 80-acre farm was considered at the margin of being economically viable in the late 1940's. In cash-grain (corn-soybean) farming areas, the 160-acre farm, and in the more arid wheat producing areas, the 320-acre farm were marginal. Of course, farm enlargement in the cash-grain and wheat areas occurred somewhat earlier and was more pronounced than in the dairy areas.

In many cases, the sale of small farms resulted from older farm operators selling farms at retirement. In other cases, however, technological developments drove the small farmer out of business or required that he change his type of farming. One such case involved small dairy farmers; but the more dramatic case was that of the mechanical cotton picker and the displacement of Southern sharecroppers.

A major technological innovation occurred in the 1950's that made it difficult for small farmers to continue in dairying. Until about 1950, farmers stored milk in 10-gallon cans which were kept in a cooling tank. The cans were picked up each morning and delivered to a processing plant. But beginning with the early 1950's, cans were replaced by the refrigerated bulk tank installed in a special milk-house adjacent to the dairy barn. This was accompanied, or soon followed, by the pipeline milking system through which the milk was pumped directly from the milking machine into this bulk tank. Each morning, or in some cases on alternate mornings, the milk was picked up by a tank truck. It soon became almost impossible for the dairy farmer to operate without this new equipment. The bulk tank and pipeline system involved a major investment and required a larger dairy herd than many farmers had to support it. One alternative was to produce milk for delivery to small local cheese factories, but these were also under economic pressure, and were being consolidated. So this new technology created major pressures for farm-size expansion in Wisconsin dairying.

In the South, the mechanical cotton picker had a profound effect on farm structure and employment. Southern plantation agriculture was transformed after the Civil War, not into a system of small owner-operators, but into a system of sharecroppers. These sharecroppers, many of them Black Americans, held very insecure tenure rights to the land and could easily be displaced. The shift from mules to tractors as the major power source resulted in decline of the sharecropping system and increased reliance on wage labor supplied by resident, former sharecropper families, or by workers living in the neighboring villages and countryside. A further decline in sharecropping and in overall labor use resulted from greater mechanization of pre-harvest cotton operations and use of chemical weed control. In addition to the mechanization of pre-harvest operations in cotton, other farm tasks were also increasingly mechanized: corn harvesting, oats and soybean combining, hay baling, and the like. But, although cotton was of key significance, all of this mechanization did not affect the unskilled labor required for the cotton harvest. In fact, seasonal harvest labor per acre of cotton increased as a result of increasing yields. With the introduction of the mechanized cotton picker in the 1940's, however, demand for unskilled labor practically disappeared while that for skilled labor increased. The average unskilled labor input per hundred-weight of cotton was 33.5 hours in 1940; it dropped to 11.5 hours by 1950, and to 2.4 hours in 1957. In the same period input of skilled labor increased eight times (0.32 hours in 1940 to 2.50 in 1957). In the first stage of mechanization sharecroppers were being replaced, but they retained an employment opportunity (although at very low pay) in the cotton harvest. In the final stages of mechanization (which included the mechanical cotton picker), this opportunity disappeared leading to a massive outmigration of poorly educated people seeking employment in industrial centers—especially in the large cities of the North (Day 1967).

Aside from a few such dramatic cases, which were extremely costly and disruptive to the people involved, farmers had a choice. They could continue without expanding if they were willing to accept declining relative incomes. The only way that farmers could keep up with family income growth in non-farm occupations was to buy the machines and expand their land base. This could be done only by combining farms and displacing labor.

Sociological Factors in Farm Size Expansion

Another factor weighed heavily on the minds of operators of family-owned farms. Almost every farmer and his wife wanted the farm to remain in the family. Before the 1940's this was not a major problem. The young people (son and wife or daughter and husband) who got the home farm considered themselves favored and fortunate. The problem was not to persuade one of the children to take over the farm; rather, to figure out how to establish the remaining children—since farms were generally not subdivided to provide for all the children. The farm ordinarily passed to the next generation as a unit. All children usually shared in the parents' will, but this sharing was commonly achieved through the estate which included payment for the farm by the child fortunate enough to become the new operator.

Again, however, changes occurred after 1940. Farm children were no longer isolated from urban society; electrification gave access to radio and television. Many farm boys were involved in World War II. Most farm children attended high school after 1940, whereas before many did not. And after World War II, jobs in the cities were relatively plentiful. Young men and women would not stay on the farm if it meant falling behind in income and sacrificing the amenities which they felt urban life could offer. So, if a farmer did not expand his operation and buy the machines, he fell behind in income and his children left the farm and took city jobs.

The change in the structure of opportunities is well illustrated by two studies of family farming in Wisconsin. A study in the 1940's documented the relation between the size of the farm business and the life cycle of the farm family (Long and Parsons 1950). At that time, a Wisconsin dairy farm was a business closely associated with the physical capacity of the farm operator and his family. A young family would build its business (measured in terms of the number of milking cows) until the farmer reached about age 50. At about that time, there were two possibilities. If a son was available to "work his way into the business," the dairy herd was maintained at the peak size and the son would take over the business when the father reached 60 to 65. Where no sons were available, the herd was gradually reduced and the farmer would sell the farm to a new beginning farmer when he reached 60 to 65. The new family would simply start the cycle over. In the first case, the increased labor (and strength) supplied by a son came at an appropriate time to offset the declining physical capacity of the father. In the latter case, where no sons were available, the waning capacity of the aging farmer resulted in a decline in the business.

Similar studies in the 1960's and 1970's illustrate well the fundamental changes that had occurred. The life-cycle phenomenon and its relation to business size was still pronounced. However, the timing and implications had changed. Farmers without sons at home were able to maintain the size of their business (i.e., the number of milking cows) until they were about 60 years old. Machine technology had reduced dependence on hard, physical labor. Farm wives had become more important in the farm labor force. Furthermore,, it is likely that farm people were healthier and in better physical condition than a generation earlier. Other factors contributed to this greater capacity. Farmers were more knowledgeable about production practices. With the consequent reduction in risks, greater specialization was possible and secondary enterprises could be eliminated. Greater availability of custom machine hire was also a factor. Finally, farmers had achieved coverage under the Social Security system in the 1950's and were less dependent on their children for care and support in old age. Thus, by this time, the parents had achieved greater independence from their children (Dorner and Sandretto 1963; Dorner and Weisblat 1963; Dorner and Marquardt 1979).

Yet, as noted above, the children had also achieved much greater independence from their parents. What these latter studies showed very clearly was that if a farmer was to interest a son in taking over the farm business, he had to expand operations by the time he approached the age of 50. Even though his own increased capacities would permit him to run the business at peak performance ten years longer than his father had, he still had to expand and mechanize further to provide volume sufficient to sustain both himself and his wife and a new (son's or daughter's) family at a constantly rising level.

Prices and Farm Size Expansion

Throughout the 1940's, farm prices were relatively high. Thus a small farmer got a substantial boost (certainly relative to the depressed prices of the 1930's) in his farm income from the higher prices even when his output remained constant. After the first few years of the 1950's, or more precisely, after the Korean War, farm prices fell. They continued to fall, relative to the prices farmers had to pay for production goods, throughout the 1960's and the 1970's. This is evident from changes in the Parity Ratio over these years. The Parity Ratio is a ratio of two indices: Index of Prices Received by Farmers divided by the Index of Prices Paid by Farmers (including in the latter-interest, taxes, and wages). Both indices are on a base of 1910-14 = 100. The ratio is multiplied by 100 and expressed as the percentage that farm prices are of parity. Over the past thirty years, there have been a number of modifications in the formula, especially concerning the base period. These complications do not alter the conclusions. During the 1940's, this percentage averaged 107.4; it fell to an average of 91.7 during the 1950's; fell further to an average of 81.5 during the 1960's; and, despite the high prices during several years, the Parity percentage averaged under 80 during the first six years of the 1970's (Economic Report of the President 1976). In recent years, only dairy product prices have been held at 80 percent of parity by government purchases. Most other commodity prices were consistently below 80 percent. Thus the terms of trade have shifted against farmers since the prosperous 1940's.

The only way to maintain farm family income was to expand production and to increase efficiency (i.e., lower cost per unit of output). But, maintaining income was hardly sufficient. Average farm family incomes had always been considerably lower than urban family incomes, and urban family incomes were rising sharply throughout this period. Farmers were under pressure from a variety of sources: from the machinery companies introducing and merchandizing new and bigger machines; from a cost-price squeeze; from the prospect of income decline relative to urban workers and other farms that were mechanizing; and finally, from their own hopes and desires for keeping the farm in the family.

So, to repeat and to emphasize, the economies of scale in U.S. agriculture were and are associated with machinery, the machines introduced after 1940 and particularly after World War II. This mechanization made sense under conditions of relatively scarce labor and abundant land. However, it did not always make sense everywhere in the country since mechanization came very rapidly, and the movement of people from the farms was overly rapid—especially in cases such as the adoption of the mechanical cotton picker and the displacement of sharecroppers.

Consequences of Agricultural Commercialization

Commercialization of U.S. agriculture occurred throughout the 19th century, and continued with increasing momentum in the 20th and especially during the past 40 years. More and more functions that once were performed on the farm were shifted to the industrial sector, while some service functions which farmers could not provide on their own developed in the non-farm sectors of the economy.

In the early years, capital was created with farm labor and oxen or horse power—land was cleared, buildings were constructed, fences were built, drainage systems were installed, livestock herds were enlarged, and so forth. Horses and mules were home-grown power sources and they used home-grown fuel in the form of hay and oats. Later, purchases of implements and other hardware increased, but throughout most of the 19th century, major reliance was on farm-produced capital. However, with greater commercialization and purchase of equipment, more credit was needed—especially following the Civil War. On the output side, much processing in the early years took place on the farm but, with some exceptions, these functions were soon shifted off the farm.

Gradually those functions where major economies of scale could be realized disappeared from the farm and into the industrial sector. The farmer was left with the increasingly specialized function of producing raw materials for processing. He purchases large quantities of seed, fertilizer and similar materials, some from other segments of the farm sector, combines them with land, labor, machinery, and livestock under his management, and produces raw materials practically all which are sent to market for further processing, packaging, storing, transporting, refrigeration, wholesaling, and retailing. Indeed, in recent years, there has been an increasing industrialization of some of the raw material producing functions—especially in certain lines of livestock production. Highly specialized broiler production operations, some hog operations, and beef feeding lots with as many as 100,000 head resemble much more a factory assembly line than they do the sequential processes associated with crop production; these last continue to be governed by season and climate and are highly dependent on land area.

Given these major shifts of functions from the farm to the industrial sector, it is somewhat misleading to concentrate only on the less than 4 percent of the U.S. population that are engaged in actual farm work. Over the years people and functions have moved from the farm to the factory—some moving relatively close geographically to the on-farm production, and some far distant. These people and these functions remain part of the larger agribusiness food and fiber system. Perhaps one-fourth to one-third of the entire U.S. labor force is engaged in either farm production, production, sale, and servicing of farming inputs, and processing and marketing of food and fiber. However, this larger labor force does not necessarily feel a close and common economic interest with on-farm producers. They are part of the urban-industrial labor force, and their basic interests are shaped by the vicissitudes and the pressures related thereto.

Thus while the land policies of the nineteenth century favored the establishment of a small-farm, owner-operated agriculture, small in the context of available area—the coming of the tractor and the machinery that accompanied it changed the economic circumstances and favored larger and larger farms. Economies of scale in on-farm production did not become important until widespread mechanization occurred. Economies of scale in on-farm production are related directly to this machinery, and can be realized only by farm enlargement and labor displacement. Only relatively minor economies of scale are associated with the technology primarily responsible for increased productivity per acre.

Past Achievements—Continuing Problems

Agriculture has had a highly successful production record in the U.S. economy. That performance has been significantly influenced by developments in the industrial sector. From the early mechanical inventions to the technological revolution of recent decades, industry, with strategic support from public investment in research and education, played a significant role. Agriculture became increasingly dependent on off-the-farm factors —modern capital inputs, research, extension, communication and transportation facilities, markets, credit, and legal and social services.

Notable in U.S. agricultural development has been the absence of comprehensive public planning. There have been no five-year plans or production targets. Yet agriculture has contributed impressively to capital formation and to the economic development of the non-agricultural sector. In recent decades, the U.S. Department of Agriculture has performed a production planning function for agriculture through administration of the price support and production adjustment programs. But, primary reliance is placed on income inducements to elicit voluntary participation.

Despite the good production performance, many problems have emerged from the transformation of U.S. agriculture and the concomitant development of a predominantly urban-industrial society. These problems include those facing the commercial farming sector such as high capital requirements, and those associated with the continuing agricultural transformation such as underemployment and poverty. They are clearly interrelated.

Commercial Farm Problems

The rapid transformation of U.S. agriculture has generated increasingly large capital requirements for an efficient farming unit. For an efficient family-sized unit, although varying by type of farming, capital requirements now range from $400,000 to $600,000 and more. This creates an especially acute problem for young people trying to get a start in farming. Many farms are transferred within the family and special financial arrangements may be worked out between the parents and the children—full market value may not be applied to the land, interest rates asked may be lower than going market rates, allowance may be made for the years of underpaid labor provided by the children, etc. Some young people begin by renting some or all of the land for a number of years and purchasing later. In most cases very substantial borrowing is involved and a heavy debt is assumed by beginning farmers. Federal legislation has been proposed to provide special financing for beginning farmers, but thus far has not been enacted. The Farmers Home Administration has not had sufficient funds or personnel to meet these needs. Several states have passed legislation setting up special state funds to assist young, beginning farmers (Dobson *et al.* 1979).

There is growing concern over the movement into farming by large corporations. Such large corporations are heavily involved in the production of such commodities as fruits and nuts, broilers, some vegetables, sugarcane, and a few others. In the mid-1970s's receipts of corporations whose major income was from farming totalled about 20 percent of U.S. farm product sales. However, this overstates the case since most farm sales by corporations were made by relatively small corporations with less than ten stockholders. In the late 1950's changes in income tax laws permitted farm corporations with ten or fewer (fifteen under the 1976 Tax Reform Act) stockholders to be treated as partnerships for federal tax purposes. If the income is passed directly to the owners who pay the income taxes, no corporate tax is paid. For a number of reasons, including farm transfers within families which may be facilitated by incorporation, many farm families have incorporated their farming operations. According to the most recent estimates, agricultural corporations with more than ten stockholders produced only 5.3 percent of total U.S. farm sales (Edmondson and Krause 1978).

Nevertheless, the issue of increasing corporate control over land and farming operations (either directly or indirectly through vertical integration) is a serious one. There is no special federal legislation but, as of 1977, ten states had legislation providing restrictions on corporate farming and several others required annual reporting by corporations engaged in farming. Seven additional states had legislation pending (Edmondson and Krause 1978).

Finally, an issue that is of increasing concern and significance is the rising cost of energy and the energy-intensive nature of the U.S. food system. The food system uses about sixteen percent of the total energy used in the U.S. Only about 3 percent of total U.S. energy consumption is used directly in farm production and the manufacture of farm inputs produced in the industrial sector. The largest energy users in the U.S. food system are processing and home preparation of food (USDA Handbook of Agricultural Charts, 1977). Efforts to conserve energy and to shift to other sources (wind, biomass, solar—especially for crop drying) are underway, but achieving significant change will take many years. Various experimental and educational programs are being undertaken by the individual states. In this area much will depend on the effectiveness of national energy conservation and development policies (USDA Yearbook of agriculture 1980).

Poverty and Related Problems

Many people were left behind and did not benefit from the rapid increase in labor productivity in U.S. agriculture. The incidence of poverty in both the farm and the nonfarm population is higher among the nonwhite population. However, poverty is by no means confined to that part of the population. Of the 14 million rural poor reported by the National Advisory Commission on Rural Poverty (1967), 11 million were white.

The rapid adoption of labor-saving technologies and the massive displacement of people from farm employment may not be the root causes of urban poverty, but they have certainly intensified the problem. People most adversely affected were those who remaind on farms but were unable to adjust, and those who left the farm but were ill prepared for well-paying city jobs.

Compared to the 1920's and 1930's, most jobs today now require greater skill. Many of the people who have been pushed and/or pulled out of farming face a labor market demanding skills they do not possess. Subsistence employment opportunities have virtually vanished. There are far fewer rungs on the ladder of economic opportunity, both in farming and in nonfarming occupations, within reach of those lacking education and specialized training than in earlier decades. The poverty problem, both rural and urban, would be less acute today if rural migrants had been better trained and if the agricultural sector had not released so many unskilled workers. Furthermore, severe racial and ethnic discrimination intensified the problems for blacks and other minorities.

These problems are extremely complex. They do not lend themselves to quick solutions. Policymakers are recognizing these problems as major issues in economic development. In recent years we have accepted as one measure of economic progress the number of people lifted from the misfortune of being poor.

Historically, there was a strong faith in the ultimate justice and maximum welfare to be derived from a free-enterprise exchange economy. "A man earns what he gets and gets what he deserves." This faith has been badly shaken, especially by the severe depression of the 1930's. In recent decades we have placed great emphasis on the efficacy of fiscal and monetary policies to maintain high levels of effective demand and employment. But, after four decades without a major depression, far too many people still live in poverty—disconnected from the growing points of the system. They remain on the outside looking in.

The history of agricultural development in the United States is illustrative of some major successes intermingled with areas of failure and continuing problems. The productivity of the U.S. system is undisputed. However, the very rapid transformation of the past forty to fifty years created adjustment problems for millions of people. In addition, the environmental long-term effects of these changes are just becoming evident. In countries with factor endowments quite different from those existing in the U.S. (e.g., where capital is scarce and labor is in overabundant supply), any transformation must take different forms and proceed at a slower rate; under such conditions a transformation similar to that which has occurred in the U.S. could be disastrous.

Literature Cited

Day, Richard H. 1967. The economics of technological change and the demise of the sharecropper. American Economic Review 57: 425-449.

Dobson, W. D., Brian Schmiesing and Carol Tank. 1979. The structure of Wisconsin's agriculture in 1990, Economic Issues 39, Department of Agricultural Economics, University of Wisconsin-Madison.

Dorner, Peter and Mark Marquardt. 1979. The family's role in the Wisconsin family farm (A sample study of Wisconsin farms 1950, 1960 and 1975). Department of Agricultural Economics Staff Paper, 171, University of Wisconsin-Madison.

——— and Carmen Sandretto. 1963. Resource adjustments, income growth and tenure: Their interaction on farms in two Wisconsin dairy areas, 1950-13960. University of Wisconsin College of Agriculture, Research Bull. 242.

——— and Abraham Weisblat. 1963. The father-son dilemma. Better farming methods, Central Edition.

Economic Report of the President transmitted to Congress January 1976 together with the Annual Report of the Council of Economic Advisors. Washington, D.C.: U.S. Government Printing Office, 1976.

Edmondson, Thomas D. and Kenneth R.

Krause. 1978. State regulation of corporate farming. ESCS Agricultural Economics Report 419. Washington, D.C.: U.S. Department of Agriculture.

Long, Erven J. and Kenneth H. Parsons. 1950. How family labor affects Wisconsin farming. Madison, Wisconsin: University of Wisconsin College of Agriculture, Research Bull. 167.

National Advisory Commission on Rural Poverty. 1967. The people left behind. Washington, D.C.: U.S. Government Printing Office.

U.S. Department of Agriculture. 1977. Handbook of agricultural charts: 1977. Agricultural Handbook 524, Washington, D.C.: U.S. Government Printing Office.

———. 1980. Cutting energy costs. The 1980 Yearbook of Agriculture, Washington, D.C.: U.S. Government Printing Office.

DEVIL'S LAKE STATE PARK: THE HISTORY OF ITS ESTABLISHMENT

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Although Wisconsin's state park system had an uncertain beginning,[1] Wisconsin now has a total of 54 state parks.[2] Among the earliest was Devil's Lake State Park, located three miles south of Baraboo in south-central Wisconsin.

The establishment of Devil's Lake State Park is an intriguing story centering on public support and the conservation movement of the early 1900's. The story also involved such dissimilar elements as a railway company and geologists, a quarry, and a typhoid outbreak.

Devils Lake is the most popular park in the Midwest and has probably been so since its beginning. Since 1952 it has attracted more than a million people a year. "Large crowds" gathered at the lake "every Sunday" in the early park years, and more than 100,000 people visited the park in the summer of 1919, "the greatest day being July 17, when homecoming exercises were held for the soldiers of Sauk County, and over 10,000 people visited the park." By the 1920's the park was being "visited each season by about 200,000 persons," and by 1940 the annual attendance was approximately half a million.[3]

Tourism at Devil's Lake is an old story. Soon after this area was settled by whites, the lake became a popular place to visit, and heavy use of Devil's Lake began some 50 years before the state park was established in 1911 (Fig. 1).

Among the first to visit, in 1849, was Wisconsin's pioneering scientist, Increase A. Lapham: "A large body of broken fragments have accumulated along the edge of the water rendering it very difficult to walk along shore: yet two of our party made a circuit of the Lake, jumping from rock to rock as best they could."[4] A few years later, in the 1850's, the first building, a bathhouse, was erected on the north shore.[5]

In 1853, 20 years before trains started whistling past the lake, the *Milwaukee Sentinel* commented: "The lake is well worth a visit, and no one should pass by without stopping to examine it." Four years later, a Baraboo newspaper remarked: "This charming piece of water is visited by pleasure parties nearly every day . . ." Lewis Wood, in an 1861 paper on the industry of Sauk County, called Devil's Lake "a noted . . . resort for parties of pleasure," and added prophetically, "and will become eminently so, as population increases."[6]

The first hotel opened in 1866: it was located near the northeastern corner of Devil's Lake, and called the Minniwauken House, after a supposed Indian name for the lake. In that year, a local newspaper predicted that Devil's Lake would become a fashionable summer resort, "not only for the Northwest, but also for the East," and the next year the same paper decided that its prophecy had come true—"It is already a fashionable resort for excursion parties from Chicago, and other places. . . ."[7]

In 1872, a year before the inauguration

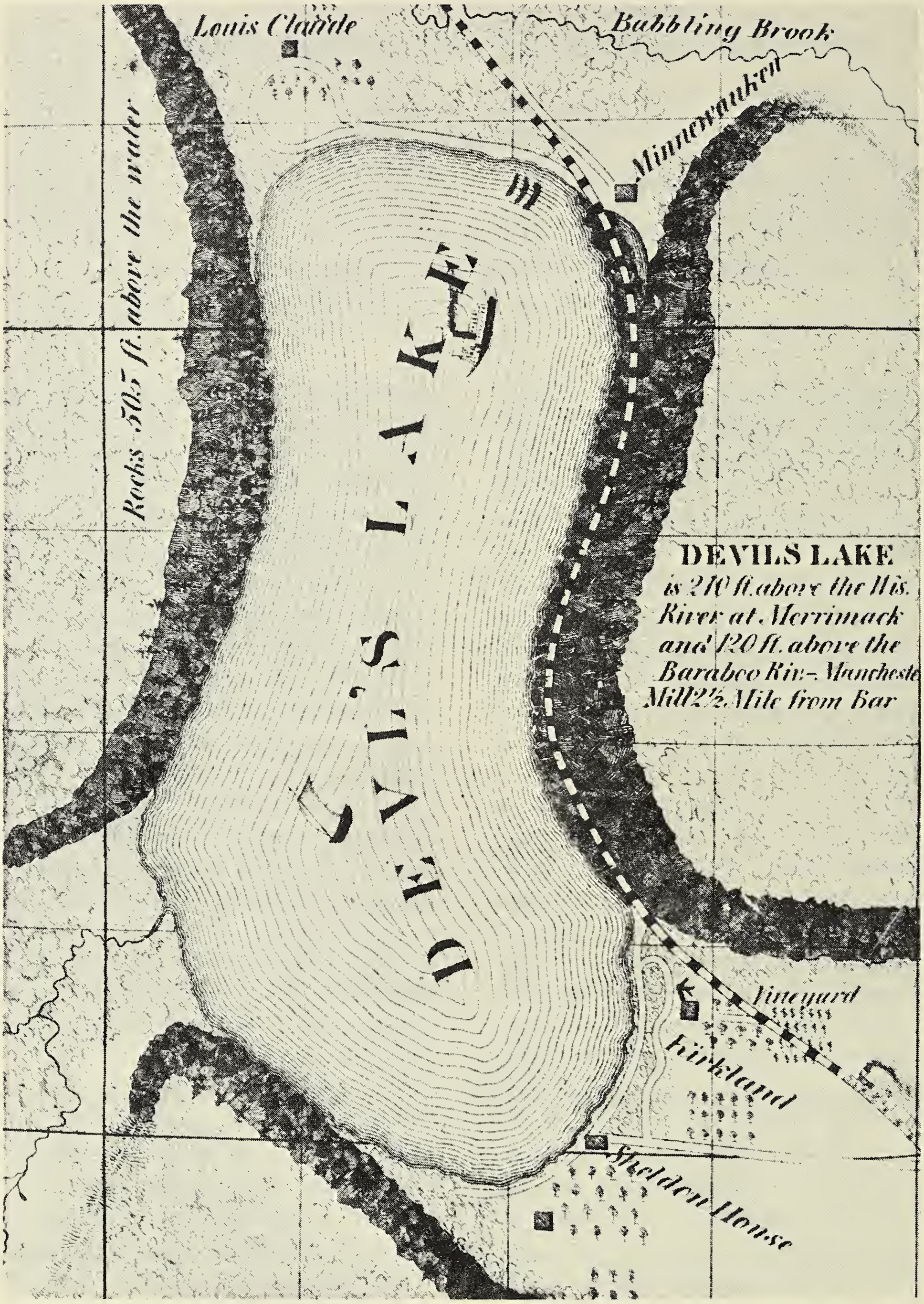

Fig. 1. Devil's Lake as depicted by William H. Canfield about 100 years ago in *Outline Sketches of Sauk County*. The south bluff is at the bottom, with the west bluff on the left and the east bluff on the right. The Sheldon House later was enlarged and renovated by E. T. Hopkins into the Lake View Hotel. Notice Kirkland with its vineyard along the south shore, north of the Sheldon House. This map was drawn before the Messengers developed their resort at the southwestern corner of the lake, between the south and west bluffs. At the north end of the lake, note the Claude property, a creek, and the Minnewauken House, which later was enlarged into the Cliff House. The railroad track runs along the east side of the lake; a steam train is at the lower right.

Fig. 2. Devil's Lake, looking north from the south bluff. The railroad track can be glimpsed at the south end of the east bluff; the track runs along the east side of the lake, past the campground on the right, and east out of the park along the bottom of the south bluff.

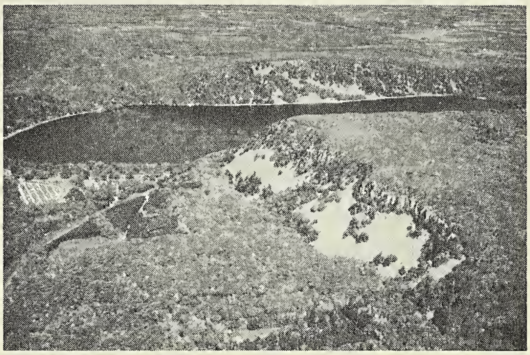

Fig. 3. Devil's Lake from the air, looking west, with the west bluff in the upper part of the picture, the east bluff to the right, and the south bluff to the left. The railroad curves through the left half of the picture.

of regular train service, a LaCrosse, Wisconsin, newspaper was quoting property owners at the lake as estimating that 15,000 people "have already visited the Lake this season, and yet they come. And why should they not, for there is not a place in the State more attractive. . . ." William Canfield, Sauk County's pioneer historian, put the figure for 1872 at "probably 20,000 visitors . . . from regions outside of its immediate neighborhood."[8]

These early tourists took the train to Portage, next a private carriage for the 16 miles to Baraboo, then another private carriage for the remaining 3 miles to the lake. But a new age was dawning for Devil's Lake, created by that wonder of 19th-century technology, the railroad train. At one time as many as nine passenger trains snorted and smoked past Devil's Lake and through Baraboo each way and each day. E. D. Jackson of nearby Greenfield Township in Sauk County recalled the first locomotive he saw: "It was profusely ornamented with brass trimmings as bright as burnished gold, and in the glistening sunshine was something of a marvelous beauty to behold." Railways permeated the American way of life; in some respects, they became the American way of life.[9]

The railway running past Devil's Lake is a main line of the Chicago and Northwestern between Chicago and Minneapolis-St. Paul. Its coming ushered in a hotel-resort era at Devil's Lake that lasted for 30 colorful years and made Devil's Lake a household name.

Publicity for the lake, generated by the Chicago and Northwestern in the form of notes and articles, appeared in such publications as *Railway Age,* but the railway's most effective advertising came from correspondents who wrote alluring and sometimes romantic accounts of this strange and wonderful place (Figs. 2 and 3). Here are the impressions of a visitor from Chicago in 1874: "The loneliness enhanced the beauty. The next minute the train was stopping by a platform at the upper end of the lake . . . and a Swiss cottage, with bright dresses on its ample galleries, came to view through the trees." Rand McNally's *Tourist Guide to the North-West* promised that at Devil's Lake the tourist would see "one of the loveliest sheets of water in the whole world . . . in a tremendous gorge . . . hemmed in on all sides by frowning rocks, of prodigious size, piled up in every conceivable form. . . . Other lakes have much in common. This is absolutely unique. . . ." *The Standard Atlas*

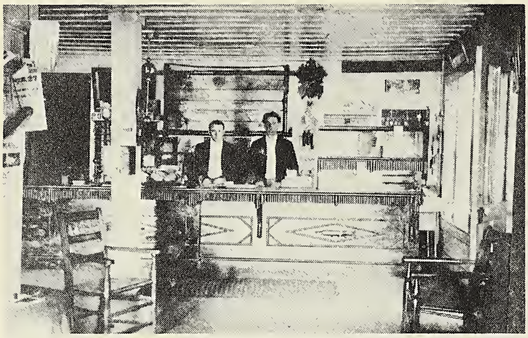

Fig. 4. The lobby of the Cliff House on a summer afternoon about a century ago. William B. Pearl, the manager is on the right and the post office is to the left of Pearl's assistant.

Fig. 5. Hiking at Devil's Lake. People in Sunday attire are climbing the east bluff with the help of wooden steps and a railing. The Cliff House is beyond the trees in the center of the picture. When this picture was taken about the turn of the century the lake was very low.

and Gazetteer of the World, which was published in Chicago in 1890, prefaced the Rand McNally description with a reference to "the wierd beauty of Devil's Lake, which in the mystery of its origin rivals Lake Tahoe. . . ."[10]

In 1873, when train service began for Baraboo and Devil's Lake, the owners of the Minniwauken House enlarged it into a new structure—the Cliff House (Fig. 4). Verandahs and galleries extended around the main part of the building. While the original structure accommodated a maximum of 20 guests, the new hotel, which had some 50 rooms, could house about 200 people.[11]

The Cliff House featured a 40 by 80 foot dining room with a spacious view of the lake; 200 people could eat together in this dining room, but only in the proper attire: suits for the men and dinner dresses for the women. "Elegant" would be an apt description of this resort.[12]

The Cliff House also had a telegraph, ticket and baggage office, a post office, a grocery, a barber shop, a billiard room, and the first bowling alley in the area—"It would make your sides ache with laughter to see the boys at the lower end of the alley dodging the wild projectiles."[13]

This resort became so popular that another building, called the Annex, was added in 1884; it had 30 rooms. With the 63 rooms in the enlarged Cliff House, the two buildings could lodge up to 400 people.[14]

If visitors did not like these accommodations, there were others—family cottages, a log cabin, or in the adjacent sugar maple woods, camping.[15]

What could guests do? Rent fishing tackle and a rowboat. Go swimming. Climb the bluffs (Fig. 5). Play croquet or quoits. Test their archery skill. Take an excursion in a rig ("reasonable rates") to Wisconsin Dells ("this is a full day's trip") or some closer place of interest.[16]

A visitor could also take a ride on the resort's steamboat. The Capitola, launched on Devil's Lake in 1869, was the first sidewheel steamer on the lake; it carried 100 passengers "comfortably." In 1874 it was replaced by another sidewheel steamer, the Minniwauken, which carried 100 people "with safety" (an interesting distinction). This woodburner was still being used on the lake in 1895, but by the turn of the century gasoline launches were becoming popular. Band picnics were held at the lake in the resort years and one moonlit night, the Spirit Lake Band of Baraboo and the Baraboo Choral Society went to the middle of the lake on the Minniwauken, "and there discoursed sweet music with charming effect. . . ." On another moonlight band excursion, all the rowboats were rented because so many people wanted to be near the music.[17]

There were activities at this resort for everyone. Geologists from the University of Chicago spent a month in field work at Devil's Lake in 1894. One of them, Rollin D. Salisbury, gave a public lecture at the resort about the origin of the lake, stressing non-volcanic forces.[18] Once there was "an interesting exhibition of mind reading." Then there was Zenia, "the noted palmister of Chicago," who lectured on her speciality and then examined "the hands of those wishing . . . in a private parlor." One evening the balcony scene from Romeo and Juliet was presented "to a large and enthusiastic audience." Often these activities were concluded with a dance, and nightly dances were a regular feature once the orchestra arrived for the season. The orchestra, at least in 1889, consisted of 2 violinists, a cornet player and a pianist.[19]

Almost every evening some of the guests would walk to a place called Shadow Town to listen to cylinder records played on an Edison phonograph and drink pop and eat cracker jack. This phonograph was one of the first in the area, so Shadow Town was also popular with local people, who came in horse-drawn wagons. Concerts were given from 1899 through 1903 or 1904, when the resort closed, as did Shadow Town.[20]

Many local people visited the lake in those years, arriving by team or train. At that time, a road just to the east of the railroad tracks was the main wagon and carriage route between Baraboo and the lake, and one Sunday in the summer of 1903 a family on this route counted 32 teams in one hour going past their home to the lake.[21]

In the summer there were special trains to Devil's Lake from Baraboo and Chicago, but most exciting were the excursion trains. Although the manager of the Cliff House once wrote, "There is no money in feeding excursionists,"[22] he encouraged train excursions in the hope that they would be profitable for the resort. Coming mainly from Illinois, they became especially popular in the 1890's. One excursion in 1894 consisted of 2 separate trains pulling a total of 22 coaches; both trains stopped at the Cliff House, where some 2000 people emerged, stretched, "and then began gazing in wonder at the sights." Another 1894 excursion is the largest on record: three trains with a total of 34 coaches. The passengers lined the entire north shore of the lake, a distance of one half mile. One can imagine these steel monsters breathing fire and smoke and uttering strange noises as they screech to a halt by the Cliff House and there disgorge up to several thousand cramped tourists.[23]

Excursion fares were within the means of lower income families. In 1906, for example, an excursion from Chicago cost $2, from Milwaukee $1.50, and from Madison, $1.[24]

Before the days of the railroad diner, trains stopped for breakfast and supper at the Cliff House. This resort was also a flag stop, but the train station was located at the southeastern corner of the lake. Later, in 1908, a new depot was built 1200 feet to the south. The popularity of Devil's Lake in these early years was indicated by the fact that an agent was on duty at that station 24 hours a day in the tourist season.[25]

The railroad company was making money but the resort was not. The season was short, June often was rainy and cold, and the buildings, especially the Cliff House, were in constant need of repair. Also involved in the closing of the resort was the railway's decision to reduce the number of passes and their refusal to give a lower rate on a round trip from Chicago. Misunderstandings with local people may also have been a factor. And so, in 1905, the Cliff House was demolished by order of the owner; the Annex stood until 1914.[26]

Today one may search in vain for any

sign of the Cliff House, but in the lawn near the north shore boat landing are a few flat stones. They are part of the foundation of the Annex. This is all that remains of that "elegant" resort.

The southeastern shore was called Kirkland, after Mr. and Mrs. Noble C. Kirk, the owners. The Cliff House was deluxe but Kirkland was rustic, reflecting the personality of the "genial little man" who always kept his property open to the free use of the public. Kirk, in 1854, bought property at the south end of the lake and added to it over the years. Kirkland consisted of a pavilion—a combination kitchen-living quarters-post office which was the focus of life at this resort, about a dozen cottages, a winehouse and cellar, croquet grounds, picnic grounds, and arbors and seats. Kirk's widow had a 14 room hotel built in 1906-1907 and a bathhouse erected in 1910.[27]

Entertainment at Kirkland included dances or masquerades on Friday and Saturday nights for the guests and the help. All day hay rides for guests were another feature. Kirkland was a place lower income families were apt to visit and return again.[28]

The material evidence for Kirkland today is the hotel foundation, but the Kirks, who wanted a park at Devil's Lake, had their wish fulfilled.

The Kirks owned about half of the southeastern valley. Adjacent to Kirkland, on the other half of this valley, stood another of the lake's early hotel-resorts, the Lake View. The most imposing structure there was the hotel, a three-level building with a telegraph office and entertainment halls on the ground level, and eating and sleeping quarters above. This resort also had five cottages and a bathhouse.[29]

There were dances on weekends at the hotel, but not as often as at Kirkland and they were for guests only. The Lake View had a pleasant atmosphere, but it was more formal than Kirks' resort.[30]

Sometimes the people from these two resorts got together for a concert, and on one occasion they united for an evening of singing and story telling, with a "Dutch lunch" at 9:30.[31]

In those years, climbing the bluffs was always popular, and in the evening there might be a dance or a corn roast or a marshmallow roast. Sometimes one of the resorts held a benefit concert for a local church.

The southwestern shore, across from Kirkland and Lake View, was called Messenger shore, after a family that lived there in the hotel-resort years. Oscar Messenger managed the Lake View for a few years in the early 1890's, then he erected his own buildings, including a hotel and a pavilion, at the southwestern corner of the lake.[32]

The Messengers and also Edward Martin, a local farmer, were cutting marsh hay on Messenger shore before the park was established, and this activity continued after 1911. Some of the hay was stored in the Messenger barn. The people from the west and south who journeyed to the lake intending to picnic at Kirkland, left their wagons at Messenger shore and rented a boat for 25 cents. If they wanted their horses to feed while they were at Kirkland, they put the animals in the barn for 10 cents and the horses could munch on hay cut along the lakeshore. The barn might be full on Farmer's Picnic Days, when up to several thousand rural people converged on Messenger Shore or Kirkland.[33]

An annual railroad picnic at Kirkland also attracted as many as several thousand people. The German Club of Sauk City and the Baraboo Maennerchor (Men's Chorus) each had picnics and festivals at the lake, and so did the Grand Army of the Republic and the Baraboo Valley Veterans' Association. A big event was the Grand Regatta of 1877, when several thousand people lined the lakeshore to watch the races and to hear two bands from Baraboo. The 4th of July was often an exciting day at the lake. In 1878, for example, some 2000 people were there: they listened to speeches and watched a horse race and a race between a hiker and an oarsman; in the evening there were fireworks, and, in the Cliff House, a dance.[34]

But publicity for the lake arose not only from the railway and the tourists. Geologists also started coming to Devil's Lake in the early years; for example, Lapham in 1849, and a group of eight men, one of whom was T. C. Chamberlin, the well-known glacial geologist, in 1872.[35]

The *Madison Democrat* in 1906 reported: "Hundreds, perhaps thousands, of students visit this storehouse of knowledge each year to study and admire." The earliest reference to a class of geology students is to one from the University of Wisconsin in 1892; doubtless there were groups here even earlier. Charles R. Van Hise of the University of Wisconsin included field trips to Devil's Lake in his geology courses before 1900. He once said of Devil's Lake: "I know of no other region in Wisconsin which illustrates so many principles of the science of geology." The University of Chicago had a geology camp at the lake, beginning in the 1890's (the earliest reference is 1894), and A. C. Trowbridge of the University of Chicago and later of the University of Iowa began bringing geology classes to the lake in 1905. Trowbridge, in 1908, gave an informal address at Kirkland to the annual state assembly of the Wisconsin Archeological Society, which had included Devil's Lake in its itinerary that year.[36]

Possibly Northwestern University also scheduled geology field trips at Devil's Lake by the turn of the century; however, the earliest recorded date for such trips is 1910.[37]

Because of the publicity the lake was receiving, it was almost inevitable that someone would conceive the idea of developing a summer resort city on the bluffs overlooking the lake. That someone was Arthur R. Ziemer (1871-1895).[38] If his resort had been successful, Devil's Lake State Park might have been very different, if indeed it had been established at all.

The development on top of the west bluff imitated similar enterprises in New York's Catskill Mountains; the west bluff was said by Ziemer to be a "counterpart of the Palisades on the Hudson River." He called his resort "Palisade Park."[39]

For about a year, beginning in 1894, there was much activity: 90 acres were platted into lots, parks, and a hotel site; several cottages were built,[40] a road of crushed stone was constructed, a reservoir of several acres was installed, and a tower 85 feet high was erected.[41]

"The time is now at hand," according to a promotional pamphlet for Palisade Park, "when the great middle class, the heart and soul of our country, can enjoy summer houses. . . . For $500 we will build you an artistic story and a half house with stone fire place, and deed you a lot. . . . No saloons, stores, or boisterous crowds will be tolerated. . . ." Palisade Park was publicized as superior to other midwestern retreats because of its mountainous setting and elevation—"The highest resort within 600 miles of Chicago." Here one could withdraw from the busy and noisy city life to a "quiet mountain retreat." The advertising was especially aimed at Milwaukee and Chicago. Platted lots were sold at a real estate office in Baraboo.[42]

Then, in October of 1895, tragedy struck —Ziemer died of typhoid in his cottage, presumably from drinking contaminated water from the Palisade Park spring.[43] The word spread and with a few exceptions people stayed away from the resort, although there was talk in the early 1900's of reviving the project. A plat of Palisade Park was still being shown in the county atlases of 1906 and 1922.[44]

All that survives today of what the promoters hoped would become the "most prominent summer resort in the northwest" are stone steps and the debris of a fallen sandstone chimney, the foundation of one of the cottages, and 8 flat stones arranged in a square 24 feet on a side—the foundation of the tower.[45]

By 1900 virtually all the shoreline around Devil's Lake was privately owned and developed for catering to summer tourists. While these resorts accommodated people mainly from outside the area, local people were also coming to the lake. Although the resort people allowed the public free use of their grounds and supplied services such as ice water at no charge, they found it necessary to remind non-guests that "special privileges are due only to guests of the hotels and cottages and that they should be treated with due consideration." The resort people also cautioned the public "not to strew victuals promiscuously upon the grounds, nor annoy the innkeepers and their guests by indulging in boisterousness and indiscretion," this being most noticeable "when boys are in bathing." The landlord of the Cliff House probably was speaking for the resort people in general when he said that the visitors "who did not receive a warm welcome were those who desired to use the grounds for picnicking." The resort people were being reasonable and fair in these admonitions, yet one can understand how friction and charges of elitism arose. It is likely that local people had come to regard Devil's Lake as "their lake," and any attempts to control its use or visitation would have met with their resistance. Also, the resort prices, for the most part, excluded people of lower incomes, and at least two of the resorts were for gentiles only.[46]

But what if this area were made a public park? This was a new and strange concept in the early 1900's but most local people liked the idea of making such a choice tract public property.

A proposal made in 1903 envisaged a sort of gigantic zoo. A local newspaper expressed the idea this way: "If the undertaking develops to its fullest possibilities a high fence will be constructed to enclose cliffs and water—a two mile area, more or less, with suitable cattleguards at the points where the Northwestern railway enters and leaves the tract to curtail the range of deer, antelope, buffalo and other animals of harmless nature that may be secured. Bear pits and cages for the more savage beasts and for winged creatures, and the open lake whereon shooting will never occur, for the web-footed, and for fish of all varieties are a part of the pleasing project." Three years later the Baraboo Lodge of Elks "voted its intention of installing a pair of Elks," whereapon one local person decided that he didn't like the idea of a state park at Devil's Lake because, as he put it, a man once had been killed by an elk which had jumped out of an enclosure. The idea of a mammoth zoo was still alive in 1910, but it never gained much support. Many people wondered whether the state would lay out cement walks and flower beds.[47]

By 1903 enough interest had been shown by Baraboo residents to cause Franklin Johnson, the local assemblyman, to introduce a bill in the State Assembly authorizing the governor to appoint a three-member commission "to investigate the advisability of establishing and maintaining a state park about Devil's Lake."[48] Termed a bill "which opens the alluring subject in a modest and rational way," it called for the commission to report its findings and recommendations to the governor on or before March 1, 1904. This bill received additional support from the Senate Committee on State Affairs, which held a hearing on it in March 1903 and presented it for passage. So favorably was this bill regarded that the hearing "was not extended and of course no one appeared to oppose the bill." An option-taking clause was added at the suggestion of Evan A. Evans, an attorney at Baraboo. This bill, approved in May of 1903, later was amended to give the commission until March 1, 1906, to submit its report. In the amended version the commission was given the added responsibility of studying the Wisconsin Dells area for park status. In 1907 this study commission evolved into the State Park Board, which the governor said would guide him and the legislature.[49]

The early 1900's were marked by increasing public sentiment in favor of a state park system. Not only were Wisconsin citizens beginning to realize the benefits of parklands and forest preserves, but a similar movement was taking hold in other parts of the country as well. This national sentiment for protection of America's natural resources was influenced by John Muir and the newly formed Sierra Club, the Theodore Roosevelt administration, and the Progressive era. In 1905 at a meeting of the American Forestry Congress, Roosevelt had said: "You are mighty poor Americans if your care for the well-being of this country is limited to hoping that that well-being will last out your own generation." This was the president who in 1908 called a White House conference of governors to discuss conservation problems.[50] The *Madison Democrat* expressed it this way: "A movement nation wide for the extension of park areas, for a more systematic and intelligent park supervision and for the cultivation of the beautiful and the esthetic is in progress."[51]

In line with these feelings, Assemblyman Estabrook of Milwaukee in 1907 introduced a bill into the state legislature calling for the appointment of a state park board. Citizens supported such a board and a state park system for various reasons. The public, it was believed, needed retreats for its full enjoyment and well-being. "Not only are playgrounds essential for the welfare and happiness of children, but there is a demand, a necessity, for larger playgrounds or parks for older people—and it may be well to remember that men and women are but children a little older grown." Much of the public attitude toward preservation looked to the future. Citizens felt a need to save places of natural beauty, such as Devil's Lake, so that succeeding generations could enjoy nature in much the same form as they knew it. A few people spoke prophetically of the time when the state would be more populous and in greater need of land for public recreation. Charles R. Van Hise, when President of the University of Wisconsin, urged the state to start preserving areas of natural beauty for the future before an increase in population would deplete the land available for public use. A newspaper reporter, in speaking of the proposed State Park Board, stated that we must look ahead, "when Wisconsin shall have become fully settled, with a population of perhaps 10,000,000 people, and when the necessity for parks and playgrounds are more largely felt." A few people were even beginning to favor preserving places of natural beauty for their intrinsic value, and there was a growing realization that areas such as Devil's Lake should be set aside for their scientific and educational importance. As a Madison, Wisconsin, newspaper expressed it: "Such scientific worth, right near the doors of our University, must be preserved to posterity." Lands must also be put into public ownership, people had come to believe, before private interests destroyed them. Wisconsin had witnessed first-hand the destruction of its forest lands, and an increasing number of voices now were being heard in favor of preventing similar occurrences by setting aside acreage in public ownership. The rhetoric for preserving open space was very much like that of today: "With the advance of civilization, one by one all the places of scenic beauty, and historical interest, are passing away. Before it is too late, it is well to pause and consider whether it is not befitting that some of them be preserved for all time as state parks. . . . Once destroyed, they are never restored." In addition to these more or less altruistic considerations, there were utilitarian ones, notably that parks were economic investments, since tourists represented money.[52]

With the passage of the Estabrook bill and the establishment of the State Park Board in 1907, the drive to create state parks in Wisconsin gained momentum.

By 1906 local residents had become formally involved in the effort to establish Devil's Lake State Park. "A goodly number of citizens met at the city hall . . . for the purpose of discussing the matter of establishing a state park at Devil's Lake. Among those present were owners of the property. The meeting was called to order by W. H. McFetridge, who has taken considerable interest in the matter . . . a committee was appointed by Mr. McFetridge, with himself as chairman." Under the direction and inspiration of McFetridge, this committee of eight members worked for a state park. As the chairman related: "Since 1903 certain citizens of Baraboo have been endeavoring to have the state preserve this region. The time is now ripe . . . there is a strong general public sentiment . . . of preserving accessible nature spots like this one."[53]

Evan Evans, the attorney who suggested the option-taking clause to the state park commission and now secretary and treasurer of McFetridge's committee, summarized the committee's thinking: "The Devil's Lake project leads all others in the state because it is easy of access, and because it is located in the southern portion of the state where it is most densely populated. The spot is one of the most beautiful and unique in the state. Another point is that the land is cheap because it cannot be utilized for agriculture. The state must have forest preserves. . . ."[54]

The committee hoped to influence the state legislature to pass a bill providing for an annual appropriation of $35,000 for 3 years for the establishment of a state park at Devil's Lake. One way in which it promoted this goal was through the distribution of a 38 page illustrated booklet entitled *An Appeal for the Preservation of the Devil's Lake Region.* Two thousand copies were printed and sold for 50¢ apiece. The first part of the booklet stressed the need to protect the region from despoilment by commercial and material interests, and the remainder described the area's geology, its potential as a forest preserve, its plant life, its suitability as a bird sanctuary, and its archeology; the last page was devoted to endorsements. Interspersed throughout the prose are full page photographs of the region, attesting to its natural beauty.[55]

The committee also wrote about the proposed park in various publications, advertised in newspapers, exercised "much personal advocacy," and appeared before clubs and other organizations.[56]

One example of the committee's work with organizations is a 1906 meeting of Baraboo's Ten Thousand Club, a business group. McFetridge spoke of the work his committee had been doing on the Devil's Lake project, and Evans also endorsed the park, stating that it would be of "great financial benefit as it would draw more people" to the area. Not surprisingly, the Club then adopted a resolution to appoint a committee of its own to cooperate in efforts to promote the venture.[57]

Local individuals of some influence, for example, Louis A. Goddard, the pastor of the First Congregational Church in Baraboo, also began to speak for the project.[58]

While all these activities were taking place, a local fund was being established to help pay the expenses of advertising the project. Local newspapers published the names of the contributors and at least several hundred dollars were collected.[59]

There was also outside support. In 1906 the *Milwaukee Journal* editorialized for a state park at Devil's Lake—"It is a worthy project which ought to be carried out." Later that year a lengthy article appeared in the *Milwaukee Sentinel,* which referred to McFetridge's committee, quoted extensively from their booklet, and treated the Devil's Lake proposal in considerable detail.[60]

State legislators and guests came to Devil's Lake on a special train for a May Day picnic in 1907. There were speeches; the Baraboo Marine Band "discoursed some choice airs"; a luncheon was served in the Kirkland pavilion, and many of the people climbed the bluffs, where residents and guides pointed out choice views and rare plants, and the work being done by a quarry which had located at the north end of the east bluff in 1906. As it turned out, blasting continued at this site until 1921.[61]

Quarrying at the lake actually was an incentive for establishing a park because with this activity it was possible for McFetridge to write: "Unless the state buys their property several of the largest owners have signified their intention of selling to whomsoever will pay the most, without regard for what use the property is intended. . . . To preserve the region the state must own it—there appears to be no alternative."[62]

In February of 1907 Senator Browne of Waupaca introduced a bill providing an appropriation of $35,000 annually for 3 years to establish a state park at Devil's Lake. The Senate passed this bill, 20 to 2, then in June of that year it came before the Assembly where it was defeated 32 to 31 despite public support and strong pleas by some legislators for preservation of the bluffs. One assemblyman who had spoken for the park stated that he was sure the measure would pass until Thomas Reynolds of Door County voted against it. "He wants a park in his county." Some of the Devil's Lake property owners lobbied against the bill, causing some legislators to conclude that the state would not be able to obtain all the land bordering the lake without "undue expense." The chances of the bill passing were also lessened by the vote coming in the closing days of the session. A local newspaper gave this advice: "Friends . . . should open the campaign now to insure favorable action by the next legislature. . . ."[63]

They did. More people began to speak and write in favor of a state park at Devil's Lake. Women became involved. Mrs. Eliza Mulcahy wrote a poem pleading for the preservation of Devil's Lake which appeared in a local newspaper in August of 1907. Mrs. H. A. J. Upham in 1908 read a paper to the Women's Club of Milwaukee in favor of a "public reserve" at the lake, and later that year talked to the Wisconsin Natural History Society in Milwaukee on the importance of preserving Devil's Lake and the Dells of the Wisconsin River. The Wisconsin State Federation of Women's Clubs saw the need for parks and worked for them; in fact, their principal interest in the first decade of this century became the establishment of Devil's Lake State Park. Club members had drafted and signed resolutions and presented them to legislators in the unsuccessful 1907 project—"this agitation . . . is not given up as a lost cause . . . hopes are entertained that strength may be gathered for a more vigorous attack when the next legislature convenes." Near the end of 1908 the State Federation of Women's Clubs had W. H. McFetridge as a guest speaker and Devil's Lake was the main topic. A member in attendance called upon the women of Wisconsin to "move to the fray," then urged her cohorts to work with legislative candidates before the next election, specifically to extract pledges from them and determine how they would vote on the park question. The meeting ended with the adoption of a resolution for the appointment of a committee to work for passage of the park bill in the next legislature.[64]

Meanwhile a nationally known and respected landscape architect from Boston, John Nolen, was surveying Wisconsin for park sites. His report to the State Park Board, published in 1909, continues to influence Wisconsin's state park system. Nolen devised five criteria for judging a site for state park status: large size, since great numbers of people would destroy the natural qualities of a small area (he recommended a minimum size of 2000-3000 acres with 5000 acres being "even better"); natural beauty; healthy climate; accessibility; and reasonable property cost and maintenance expenditures. Based upon these criteria, Nolen recommended four places as particularly suitable: Wisconsin Dells, Devil's Lake, the Fish Creek area in Door County, and the Wyalusing area in Grant County. Only the Dells did not become a state park. Although Nolen assigned highest priority to the Dells, a dam on the river caused water to rise and submerge much of the area, while land values increased to a level which precluded acquisition by the state for public park use.[65]

The State Park Board was plagued from the beginning by a lack of funds for buying recommended properties. When the Board was originally established, the only money provided was a maximum of $500 for actual expenses incurred by Board members. The breakthrough came in 1909 when Senator C. L. Pearson of the Sauk-Columbia district introduced a bill which called for an appropriation to the State Park Board of $75,000 annually for three years for buying park lands. The legislature acted upon this bill and although it reduced the appropriation to $50,000 annually for two years, this was sufficient to enable the board to start buying land at Devil's Lake.[66]

In 1909 the Board estimated that a park could be established at Devil's Lake for $125,000 and, as it turned out, this was accurate (the initial park holdings cost $128,497.44), except for unforseen troubles with the company that was quarrying the east bluff. At the June 1910 meeting of the Board the members voted unanimously to proceed in securing certain lands around Devil's Lake and by the end of the year the board had acquired 740 of the 1150 acres it deemed essential for the park, namely, the Kirk, Hopkins (Lake View) and Messenger properties and several estates at the south end, and the Vilas estate (the Cliff House property) at the north end.[67]

The board started condemnation proceedings on the remaining acreage, which proved especially difficult to acquire. A number of people had purchased cottage lots along the south shore at the turn of the century, and while most of them sold to the state for a dollar in exchange for a rental-free lease to expire in 60 years, and the understanding that the state would negotiate for the removal of the quarry from the park and build a road into the cottage area, various complications and misunderstandings arose with other property owners. Quite understandably, some of them wanted to remain on the land.[68]

A bill passed by the state legislature allowed for such cases when the owners had occupied the homestead for 25 years or more. It was introduced by Assemblyman C. A. Harper on behalf of Mrs. Louis J. Claude and her daughter, whose family had been among the earliest settlers at Devil's Lake.[69] While the Board had been allowing elderly owners to retain their residences, it did not want to extend the same privilege to younger family members—in this case, Mrs. Claude's daughter. The bill was approved over the objections of the Board and the Claudes were allowed to keep their home and an acre of land. This was a most commendable service, for the Claudes (and the Kirks) could have sold to the quarry companies and retired with much more money than they received from the state for their properties. For a time a quarry company had an option on the west bluff from the Claudes and wanted to build a spur line from the railroad tracks to the property, but the Claudes refused; they preferred the natural setting. These decisions by the Claudes and the Kirks helped make Devil's Lake State Park a reality.[70]

When the park was being established, the State Park Board consisted of Thomas C. Brittingham of Madison, the chairman, L. C. Colman of LaCrosse, and Gustaf R. Egeland of Ephraim. Like McFetridge, Brittingham had a dream of a public park at Devil's Lake and worked long and hard for it. His world travels had convinced him that the lake was a very special place, and he also came to believe that local people did not appreciate the area because of familiarity. He and Colman made themselves personally responsible for certain Devil's Lake properties by agreeing to buy and hold them for the state for 5 years; if the state did not take the land then the owner could repurchase it.[71]

After some misunderstandings had been settled and certain appeals satisfied, the State Park Board controlled about 1100 acres, and in June 1911 newspapers were announcing that there really was a Devil's Lake State Park. The *Baraboo Republic* noted the overall approval of the project: ". . . it is good to know that the beauties of the Devil's Lake region are to be preserved by the great State of Wisconsin. . . . There is no doubt about the action . . . being sanctioned by the people of the state for all time to come."[72]

But the quarry was still there and blasting was still going on. A year after the creation of the park, the State Park Board commented: "It was found impossible to purchase the . . . quarry . . . at a price the board considered reasonable as compared with lands nearby equally suitable for the same purpose." The lands in question amounted to 110 acres and were owned by the American Refractories Company; they were using the rock for fire brick and paving stones. While economic interests were saying that paving stones from the Devil's Lake quarry were being used on "some of the most important avenues inside of the loop district of Chicago," environmentalists countered with charges that quarry blasting caused fish kills in winter—"The theory . . . is that they went into the shallow water to feed during the winter, and because of the ice the concussion of the dynamite blasts caused death to those in the shallow water."[73]

Negotiations to resolve the conflict with the American Refractories Company remained at a standstill until the state legislature in 1919 authorized the Conservation Commission to remove the quarry from the park; if it proved necessary, the Commission could purchase land for exchange. This bill at first was defeated in the State Assembly by one vote, "but on reconsideration a big majority was secured when the facts were fully explained by Sauk County members." In the following year American Refractories sold its property in the park to the state for $75,000 plus a small tract of land at the south end of the east bluff, then purchased a farm adjoining this tract and moved there in 1922. At the time, this area was outside the park boundary. The company worked this site through 1967; the cut that can be seen there is the result of 45 years of quarrying.[74]

In 1970 President Nixon signed the bill creating Wisconsin's Ice Age National Scientific Reserve, which consists of 9 units. One of these is Devil's Lake State Park with an enlarged boundary including the quarry property. Recently the state purchased this property and thus completed a land transaction which had been started in 1910.

A private resort thus evolved into a public park with the impetus of the widespread conservation movement of the early 1900's, evidence of the influence of citizen activity in determining this country's natural resources policies.

Notes

AUTHORS' NOTE: This paper is based upon *A Lake Where Spirits Live: A human history of the midwest's most popular park,* by Kenneth I. Lange and Ralph T. Tuttle, Baraboo Printing—Baraboo, Wisconsin, 80 pages (1975), and *Preserving Wisconsin's Natural Beauty: The drive to establish Devil's Lake State Park,* by D. Debra Berndt, a seminar paper for Urban and Regional Planning—Resource Policy Issues: Regional and National, University of Wisconsin-Madison, 64 pages (1977). See also Chapter 16 (Tourism), pages 97-99, in *A County Called Sauk: A human history of Sauk County, Wisconsin,* by Kenneth I. Lange, Sauk County Historical Society, 168 pages (1976).

We are indebted to George J. Knudsen and especially Walter E. Scott for directing us to sources we would otherwise have overlooked.

[1] *Laws of Wisconsin,* Chapter 324 (1878) and Chapter 367 (1897); *Annual Reports of the Wisconsin Conservation Department, Biennial Reports of the Wisconsin State Conservation Commission,* and James J. Damm, *Development of Wisconsin's Park and Forest Recreation System, 1867-1967,* M.S. thesis, University of Wisconsin-Madison (1968), 81 pp.

[2] *Visitor's Guide to Wisconsin's State Parks, Forests and other Recreation Lands,* Wisconsin Department of Natural Resources, Pub. 4—8400(80). 50 state parks are listed, but Kohler-Andrae is actually 2 parks, not 1, and Lake Mendota, Lake Pepin, and Thunder Mountain are not listed.

[3] *Annual Reports of the Wisconsin Conservation Commission,* and the *Wisconsin Blue Books; Baraboo Republic,* 20 July 1916; *Wisconsin Conservationist,* 1:2 (1920); *Baraboo Weekly News,* 24 April 1924.

[4] Increase A. Lapham, "Geological notes of a tour to the Dells October 22 to Nov. 1st 1849," entry for 28 October, unpublished manuscript, Lapham papers, State Historical Society of Wisconsin. The most comprehensive biographical sketches of Lapham are by S. S. Sherman, "Increase Allan Lapham, LL.D.," Milwaukee News Co., Printers, 80 pp. (1876) and N. H. Winchell, "Increase Allen Lapham," *American Geologist,* 13:1-38 (1894). See also P. R. Hoy, "Increase A. Lapham, LL.D.," *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters,* 3:264-267 (1876); Milo M. Quaife, "Increase Allen Lapham, First Scholar of Wisconsin," *Wisconsin Magazine of History,* 1:3-15 (1917); Walter E. Scott, "An Appreciation of Increase Allen Lapham," *Wisconsin Academy Review,* 22:20-28 (1975).

[5] Mrs. Bella French (Editor), "History of Baraboo and Devil's Lake, Wis.," *The American Sketch Book,* 2:189 (1876).

[6] "The Baraboo Country," *Milwaukee Sentinel,* 11 May 1853; *Baraboo Republic,* 18 June 1857; Lewis N. Wood, "Industry of Sauk County," *Transactions of the Wisconsin State Agricultural Society,* 6:328 (1861).

[7] *Baraboo Republic,* 14, 21 and 28 February 1866, and 19 September 1866 and 26 June 1867.

[8] *Republican and Leader* (LaCrosse, Wisconsin), 27 July 1872; William H. Canfield, "Guide book to the wild and romantic scenery in Sauk County, Wisconsin," in *Outline Sketches of Sauk County* (1873).

[9] *Baraboo Republic,* 19 September 1866; *Baraboo News-Republic,* 10 February 1973; E. D. Jackson, "Old Greenfield Days," *Baraboo Weekly News,* 12 July 1905, also, as "Town of Greenfield," in *A Standard History of Sauk County, Wisconsin,* 1:556 (1918).

[10] *Baraboo Republic,* 12 August 1874; *Tourist Guide to the Northwest,* Rand McNally Company—Chicago, pages 30-31 (1877); Loomis T. Palmer, *The Standard Atlas and Gazetter of the World,* Standard Publishing Company—Chicago, page 375 (1890).

[11] *Baraboo Weekly News,* 7 July 1921; C. W. Butterfield (Editor), *The History of Sauk County, Wisconsin,* Western Historical Company—Chicago, page 700 (1880).

[12] *Sauk County Democrat* (Baraboo, Wisconsin), 19 July 1884; *Baraboo Republic,* 11 August 1875.

[13] Butterfield, *loc. cit.;* James B. Hale, "The postal history of Devil's Lake State Park," *Badger Postal History,* 14:1-2 (1974); *Sauk County Democrat,* 2 August 1894; *Baraboo Republic,* 9 May 1877 and 30 April 1879.

[14] *Sauk County Democrat,* 19 July 1884.

[15] *Baraboo Republic,* 3 May 1882; *Sauk County Democrat,* 21 April and 9 June 1882; N. H. Wood, in *Outline Sketches of Sauk County,* Third Sketch, Devil's Lake, page 22 (1870).

[16] Butterfield, *loc. cit.;* William H. Canfield, *Outline Sketches of Sauk County, Wisconsin. Volume Second—Baraboo. Ninth Sketch,* page 47 (1891).

[17] *Baraboo Republic,* 11 August 1869, 1 July 1874, 29 August 1900, 2 July 1879; *Sauk County Democrat,* 23 August 1894.

[18] *Baraboo Republic,* 15 and 29 August 1894, and *Sauk County Democrat,* 30 August 1894. Salisbury was a geology professor at Beloit College in the 1880's, at the University of Wisconsin

in 1891-1892, and at the University of Chicago from 1892 until his death in 1922.

[19] *Baraboo Republic,* 14 and 21 August 1895; *Sauk County Democrat,* 3 August 1889 and 22 July 1897.

[20] *Baraboo Republic,* 4 July 1900, 19 June 1901, 17 June 1903, and 5 October 1904; Kenneth D. Martin to Lange, letter dated 15 November 1969 (Martin, who died in 1971, was a grandson of William B. Pearl, the manager of the Cliff House from 1878 until its closing in 1904).

[21] Lange interview with Perry Loomis, February 1979.

[22] William B. Pearl, in a letter to William F. Vilas, 20 August 1899, the Vilas papers, St. Hist. Soc. Wis. The Cliff House was owned by the Vilas estate and Pearl always communicated with William F. Vilas; Vilas was a lawyer, lieutenant colonel in the Civil War, member of President Cleveland's cabinet, and U.S. Senator for Wisconsin from 1891-1897.

[23] *Baraboo Republic,* 8 August 1894; *Sauk County Democrat,* 23 August 1894.

[24] *Sauk County Democrat,* 21 June, 26 July, and 9 August 1906.

[25] *Baraboo Weekly News,* 8 October 1908, and *Sauk County Democrat,* 8 October 1908; Ralph T. Tuttle, an unpublished history of Devil's Lake State Park.

[26] Martin to Lange, letter dated 18 September 1969; *Sauk County Democrat,* 16 June 1910; *Baraboo Republic,* 10 June and 1 July 1903, 22 March 1905; *Baraboo Weekly News,* 8 March 1917; "Minutes of Meetings. Wisconsin State Park Board," 4 March 1914.

[27] Canfield, *op. cit., loc. cit.,* and Guy O. Glazier, *Baraboo Weekly News,* 6 October 1938; Katherine Martindale to Lange, letter dated 5 November 1968 (Miss Martindale stayed with her family at Kirkland for 14 summers in the early 1900's); *Baraboo Republic,* 12 June 1895, and *Sauk County Democrat,* 14 July 1892; *Baraboo Republic,* 20 May 1868; Butterfield, page 695 (1880), and Canfield, "Guide book to the wild and romantic scenery in Sauk County, Wisconsin," in Outline Sketches of Sauk County (1873); *Baraboo Weekly News,* 1 May 1907; *Sauk County Democrat,* 4 August 1910.

[28] Lange interview with Ella Marquardt, April 1970 (Miss Marquardt worked at the south shore resorts in the early 1900's); notes written by Katharine Martindale on the back of a 1901 picture of people on a horse-drawn wagon.

[29] Lange interview with Ella Marquardt in 1970 and Louis T. Martin in 1969 (Martin worked at the Lake View in the summer of 1910); an undated Lake View folder; *Sauk County Democrat,* 13 July 1893.

[30] Lange interview with Ella Marquardt, February 1973.

[31] *Baraboo Republic,* 17 and 24 July 1895; *Sauk County Democrat,* 22 August 1901.

[32] *Sauk County Democrat,* 4 June 1891 and 21 April 1892; *Baraboo Republic,* 12 June 1895, and *Sauk County Democrat,* 15 September 1892, 26 July 1894, 10 June and 9 September 1897, and 29 August 1901.

[33] Lange interview with Rollo Martin, a son of Edward Martin, in 1968; *Baraboo Republic,* 16 July 1891; *Baraboo Weekly News,* 5 August 1915 and 13 July 1922; "Northwestern News," *Milwaukee Sentinel,* 21 August 1874.

[34] *Baraboo Republic,* 20 July 1877, 24 July 1889 and 30 July 1890; *Baraboo Republic,* 7 August 1867 and 9 September 1896; *Baraboo Republic,* 18 April and 27 June 1877, "Wisconsin Matters," *Milwaukee Sentinel,* 29 May 1877, and *Portage Democrat,* 29 June 1877; *Baraboo Republic,* 10 July 1878.

[35] *Baraboo Republic,* 14 August 1872. Thomas Chrowder Chamberlin at this time was a professor of natural sciences at the State Normal School in Whitewater, Wisconsin.

[36] *Madison Democrat,* cited in *Baraboo Republic,* 25 April 1906; *Sauk County Democrat,* 12 May 1892 and 11 May 1893; *Baraboo Republic,* 15 and 29 August 1894; *Proceedings of the State Historical Society of Wisconsin,* page 63, 1915 (1916); *Baraboo Republic,* 13 August 1908, and "The Pilgrimage to Devil's Lake," *Wisconsin Archeologist,* 7:152-153 (1908).

[37] Arthur L. Howland, professor of geology at Northwestern University to Lange, letters dated 14 April 1973 and 7 May 1974.

[38] Ziemer was a member of a geology field party from the University of Wisconsin that in 1893 visited Devil's Lake, Rock Springs and Wisconsin Dells (*Sauk County Democrat,* 11 May 1893); perhaps his resort plans originated with this trip. As a student at the university, Ziemer was active in politics, and as the president of the class he gave an oration at graduation (*Baraboo Evening News,* 23 October 1895).

[39] *Baraboo Republic,* 1 August 1894 and (souvenir supplement, page 38) 12 April 1899.

[40] The first cottage, a double one, was dedicated with a banquet and toasts in September 1894, when Ziemer and two companions "furnished amusement by rolling a large boulder over the cliff, just to hear it drop" (*Baraboo Republic,* 26 September 1894). Ziemer's personal cottage, a ten room structure, was completed in the summer of

1895; he called it "Beacon Pines" (*Baraboo Republic*, 12 June and 23 October 1895). One other cottage (the Coleman cottage) was built (*Baraboo Republic*, 17 July 1895).

[41] The view on a clear day would have been magnificent, and the *Baraboo Republic* (12 June 1895) reported that the dome of the capitol in Madison could be seen from the top of the tower. For this tower, see also the *Baraboo Republic*, 22 May 1895, and the *Sauk County Democrat*, 6 June 1895. For the road, see the *Baraboo Republic*, 8 and 29 August 1894, and 12 June 1895, and for the reservoir, see the *Baraboo Republic*, 29 August 1894.

[42] "The New Mountain Summer Resort. Palisade Park. Devil's Lake, Wis.," a 4 page pamphlet (1895); *Baraboo Republic*, 3 July 1895.

[43] *Baraboo Evening News*, 23 October 1895, and *Baraboo Republic*, 23 October 1895. A sister, Myrtle, who lived with Ziemer in "Beacon Pines" also contacted typhoid but she recovered; along with an aunt and uncle, and a nurse, she traveled in a special train car to Milwaukee, where the Ziemers lived (*Baraboo Republic*, 30 October 1895).

[44] *Baraboo Republic*, 9 September 1903; *Standard Atlas of Sauk County Wisconsin*, Alden Publishing Company—Chicago, page 53 (1906); *Standard Atlas of Sauk County Wisconsin*, George A. Ogle and Company—Chicago, page 10 (1922).

[45] *Baraboo Republic*, 5 September 1894.

[46] *Sauk County Democrat*, 9 August 1894 and 3 August 1893; *Baraboo Republic*, 1 July 1903.

[47] *Sauk County Democrat*, 19 February 1903; W. H. McFetridge, *Baraboo Republic*, 25 July 1906; *Baraboo Weekly News*, 1 August 1906 and 14 July 1910.

[48] The three members of the "state park commission" were Alfred C. Clas, E. M. Griffith (the first state forester), and Frank Hutchins of Madison, formerly of Baraboo.

[49] *Sauk County Democrat*, 19 February and 12 March 1903; *Laws of Wisconsin*, Chapter 232 (1903) and Chapter 169 (1905); *Baraboo Weekly News*, 31 October 1906.

[50] This conservation movement of the early 1900's was characterized by two schools of thought. One school, represented by Roosevelt, centered around the conservation of material raw resources for their orderly and rational development. The other arm of the movement, led by such figures as Muir, emphasized the preservation of landscape and wildlife from all development and for the health and enjoyment of the public. For details, see Robert McHenry and Charles Van Doren, editors, *A Documentary History of Conservation in America*, New York, 306 pages (1972); Stewart L. Udall, *The Quiet Crisis*, New York, 120 pages (1963); and Linne Marsh Wolfe, *Son of the Wilderness: The life of John Muir*, Madison, Wis., 315 pages (1978).

[51] Cited in *An Appeal for the Preservation of the Devil's Lake Region*, Lakeside Press—Chicago, page 38 (1906); "That State Park Bill," *Madison Democrat*, 19 March 1907.

[52] *Madison Democrat, loc. cit.*, and 21 March 1907 ("Parks as Investments") and 21 April 1906 ("Devil's Lake Park"); "Letter from President Charles R. Van Hise, University of Wisconsin," in *State Parks for Wisconsin*, Report of John Nolen, page 53 (1909); Message of Governor James O. Davidson on state parks (1909); *Laws of Wisconsin*, Chapter 495 (1907).

[53] *Sauk County Democrat*, 19 April 1906; W. H. McFetridge, *Baraboo Republic*, 25 July 1906. The McFetridge family owned the Island Woolen Mill in Baraboo (*A Standard History of Sauk County Wisconsin*, 1:87, 1918). W. H. McFetridge hoped that all the land in the Baraboo Hills from Durward's Glen on the east to around Leland on the west eventually would become public property (*Baraboo Weekly News*, 31 October 1906), and also wanted to see the "entire Baraboo Valley as one great park system" (*Baraboo Weekly News*, 11 March 1908). He was concerned about people dumping trash in the Baraboo River and pleaded that it be treated with respect (*Baraboo Weekly News*, 26 June 1907); in 1914 he set aside an area on the woolen mill property as a dumping ground in an effort to induce people to stop littering the river and its banks—"Everything which will not float or pollute will be allowed" (*Baraboo Republic*, 23 April 1914).

[54] E. A. Evans, *Baraboo Republic*, 31 October 1906. Evans later became federal judge on the Seventh Circuit (*A Standard History of Sauk County Wisconsin*, 2:1009, 1918).

[55] *An Appeal for the Preservation of the Devil's Lake Region*, 38 pages (1906); *Baraboo Republic*, 26 September and 24 October 1906.

[56] e.g., W. H. McFetridge, "The proposed Devil's Lake State Park," *Wisconsin Arbor Day Annual*, pages 40-43 (1907); also W. H. McFetridge, *Baraboo Republic*, 25 July 1906.

[57] *Baraboo Republic*, 31 October 1906; *Baraboo Weekly News*, 31 October 1906.

[58] *Baraboo Weekly News*, 16 January 1907.

[59] *Baraboo Weekly News*, 21 November 1906.

[60] The *Milwaukee Journal* support is cited in *Reedsburg Free Press*, 25 October 1906; "Preservation of the Devil's Lake Region," *Milwaukee Sentinel*, 2 December 1906.

[61] *Baraboo Republic,* 1 and 8 May 1907; *Baraboo Weekly News,* 7 July 1910. One of the guides was President Charles R. Van Hise of the University of Wisconsin, who led a large party to the top of the east bluff; there he "delivered a short lecture on the surroundings. . . . It was a treat that one rarely hears, for Mr. Van Hise is probably the most noted geologist of the age." (*Baraboo Republic,* 8 May 1907). In just three years Van Hise would be autographing copies of his new book, *The Conservation of Natural Resources in the United States,* a publication that has been called conservation's most valuable book.

[62] *Baraboo Republic,* 25 July and 31 October 1906.

[63] Harriet M. Holcombe, in *Wisconsin State Federation of Women's Clubs, Proceedings of the Eleventh Annual Convention,* pages 50-51 (1907); *Baraboo Republic,* 3 July 1907; *Baraboo Weekly News,* 3 July 1907; *Sauk County Democrat,* 4 July 1907; "Devil's Lake Park Delayed," *Madison Democrat,* 30 June 1907.

[64] *Sauk County Democrat,* 8 August 1907; *Sauk County Democrat,* 12 March 1908 and *Baraboo Weekly News,* 3 June 1908; Mrs. Thos. B. Davies, in *Wis. St. Fed. of Women's Clubs, Proc. Eleventh Ann Conv.,* pages 23 and 24 (1907); Mrs. Charles E. Buell, "Wisconsin," *General Federation of Women's Clubs, Ninth Biennial Convention, Official Report,* page 234 (1908); *Baraboo Weekly News,* 29 October 1908. The contributions of women's clubs to the conservation movement of the early 1900's have been little noted nor fully appreciated. In Wisconsin, in addition to their support of parks, the State Federation sponsored forestry lectures at open meetings and lobbied for protective legislation for birds. Their zeal is evident in these remarks of Mrs. Charles E. Buell: "In my prophetic vision I see the Wisconsin Federation of Women's Clubs, not only aiming to raise themselves to higher planes of living, not only protecting birds, trees, parks, and all the national resources of this God-favored state, helping to make ideal conditions for all our own people, but striving to extend all these services to some sister state." ("President's Address," in *Wis. St. Fed. of Women's Clubs, Proc. Twelfth Ann. Conv.,* page 9, 1908).

[65] John Nolen, *State Parks for Wisconsin,* 56 pages (1909); E. J. Vanderwall, "Historical Background of the Wisconsin State Park System," Wisconsin Conservation Department, page 1 (1953).

[66] "Minutes of Meetings. Wisconsin State Park Board," 1909-1915; *Sauk County Democrat,* 21 May 1908, and 11 February 1909 and 9 February 1911.

[67] *Baraboo Weekly News,* 4 March 1909; *Biennial Report of the Wisconsin State Conservation Commission for the years 1915 and 1916,* page 87 (1916); *Baraboo Weekly News,* 15 December 1910, and *Sauk County Democrat,* 15 December 1910.

[68] *Baraboo Republic,* 14 September 1898 and 9 September 1903; *Sauk County Democrat,* 14 July 1910 and 2 February 1911; *Standard Atlas of Sauk County Wisconsin,* page 53 (1906).

[69] The Claudes were intimately linked with the early history of Devil's Lake. Louis J. Claude (1825-1893) was born and raised near Lake Windemere in the lake country of England, where he was a boyhood friend of Matthew Arnold and possibly knew or met Robert Southey and William Wordsworth, who lived in the lake country when Claude was growing up. Claude was educated as a civil engineer and in his younger years worked in India. When he first came to this country, he settled in Kentucky where he "practiced his profession," but his anti-slavery convictions caused him to leave the South in 1851 and settle in Wisconsin in 1857 along the north shore of Devil's Lake, which reminded him of Lake Windemere. Claude wanted to be near water and a place he could farm. The Claude residence was of Tudor style and in designing it Claude apparently incorporated some of the ideas of Andrew Jackson Downing, America's first important landscape architect. This building was a landmark at Devil's Lake until 1953 when it was removed by the state. Claude also designed the Cliff House, the "elegant" resort at the northeastern corner of Devil's Lake. He married an American woman, Elvira Ward (1834-1929); the two children were Louise (1865-1951) and Louis Ward 1868-1951). Miss Claude, who was educated by her father, loved nature and wrote poetry, and the son became an architect in the tradition of Frank Lloyd Wright. All four Claudes, and the son's wife, are buried in Baraboo's Walnut Hill Cemetery (Canfield, page 47, 1891; *Baraboo Republic,* 11 August 1859 and 29 June 1893; Ralph T. Tuttle, a family friend, personal communications to Lange).

[70] *Laws of Wisconsin,* Chapter 511 (1911); *Baraboo Republic,* 29 June 1911; *Sauk County Democrat,* 8 and 29 June 1911, and *Baraboo Weekly News,* 15 June 1911; L. W. Claude, *Baraboo Republic,* 19 October 1922.

[71] *Sauk County Democrat,* 9 February 1911; *Baraboo Weekly News,* 18 August 1910, and *Sauk County Democrat,* 15 December 1910. Brittingham came to Madison in 1855 and founded a lumber yard. He quickly became prominent in local affairs, e.g., member of the University of

Wisconsin Board of Regents. He was notable for contributions to park and hospital funds and in his will left large sums to the city of Madison and the University of Wisconsin.

[72] *Baraboo Republic,* 22 June 1911, and *Baraboo Weekly News,* 22 June 1911.

[73] "Minutes of Meetings. Wisconsin State Park Board," 13 July 1912; *Baraboo Republic,* 7 May 1914 and 30 May 1912.

[74] *Baraboo Weekly News,* 6 November 1919, and *Baraboo Republic,* 3 July 1919; *Baraboo Weekly News,* 11 November 1920 and 2 March 1922.

THE FOLK SONGS OF CHARLES BANNEN: THE INTERACTION OF MUSIC AND HISTORY IN SOUTHWESTERN WISCONSIN

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The musical tradition of Charles Bannen, an eighty year old dairy farmer living in rural Crawford County, Wisconsin, is a composite of many of the threads that constitute the larger fabric of the folk and traditional music of Southwestern Wisconsin. Bannen is by no means typical of the farmers who work the unglaciated hills of Southwestern Wisconsin, for, in addition to farming, he is a singer of folk songs and a spinner of tales of his family and the area in which he lives. Bannen learned the songs he heard as a child from his family and friends, and he continues to maintain this tradition of folk music. He has been not merely a curator of the family songs, but, throughout his life, he has been a performer at dances, in churches, at social gatherings in nearby towns, and, in short, anywhere a group of neighbors might gather. Bannen does not have to be persuaded to sing; he knows that he has something vital to communicate through his songs.

Because he is aware of the importance of his song tradition, Charles Bannen has put much thought and care into the maintenance of the tradition. He understands how various songs have functioned in his past and in the past of his family, and is quick to explain the importance of music not only in his life, but also in the lives of all people; furthermore, he understands the value of tradition and is willing to undertake the labor and practice necessary to maintain tradition.

The family of Charles Bannen was also musical. He learned songs not only from his parents but also from aunts, uncles, and cousins. Through these family members, the Bannen song corpus reached out into other areas of Southwestern Wisconsin. Many of the Bannens were schoolteachers who collected songs in the small places where they taught. For such reasons, songs of the eclectic Bannen tradition represent more than Irish immigrant songs. The contents range widely: Irish-American; British ballad; translated German; temperance; railroad; dance; school; Christmas and other holidays; Civil War; sea shanties; Child ballads; children's songs; miners' songs; gospel hymns; and country-western. The Bannen song tradition represents music from the many different cultural and social groups found in Southwestern Wisconsin and is a musical representation of the complex cultural contacts that occurred in this hilly, rural region. Much as the social structure of the area has changed, so has the Bannen music tradition changed to reflect that cultural flux.

Southwestern Wisconsin has many unique features which contribute to its unusual history and folklore. The "driftless area" of Southwestern Wisconsin is the only area of the Midwest not to suffer the erosive forces of the huge glaciers. The hilly topography is cut into irregular sections by ancient valleys creating both isolation and unity among the residents. Travel is not as rapid as in other areas of the state, for Southwestern Wisconsin has yet to be served by four-lane highways. Farms and towns are usually formed within the irregular boundaries of winding streams or steep bluffs. The sense of community is intensified by towns strung along a narrow ridge or tucked in a valley served by few roads. It is such Crawford County geography that Ben Logan describes in the following passage:

> Look in any direction and there were other ridges, with dots of houses and barns, and the blue shadows of other ridges still beyond them, each a full world away from the next narrow ridge. Down below, in the valley, was yet another world. The valleys had different trees and animals. Even the seasons were different—watercress stayed green all winter in the valley spring.[1]

But the hills of Southwestern Wisconsin are not only forces of isolation. They are also forces of community, for they act to link people together, to cause people to share, to bind people in a world occupied by friends and neighbors. Again, Ben Logan described this sense of community in a tale of a thresherman of Crawford County:

> Abe took a chew of tobacco and got it going. 'Why, he said a man used to hill country could lose his mind out there [on the Great Plains]. Said that country swallowed you up without even a belch. Said there was no surprises. Country shows itself to you all at once. No privacy either. A neighbor living twenty miles away can look out in the morning, see if you're up and got the fire going yet.'
>
> Abe raised his head. A long stream of tobacco juice went sizzling into the brown grass. 'So he came back here, my grandfather did. Said hill country had a feel of home about it, didn't keep leading a man off toward a horizon that was never there.'[2]

The early settlers of Southwestern Wisconsin represented an ethnic polyglot. French-Canadians were dominant among the earliest to enter the area. They settled in and around Prairie du Chien, which was the fur-trading center of the area because of its location at the confluence of the Wisconsin and Mississippi Rivers. Most of the miners who poured into Southwestern Wisconsin were from the British Isles; albeit, representatives of the different parts of the British Isles brought with them a variety of ethnic traditions. Today, it is still possible to discern which towns were settled by English, Cornish, Welsh, Scottish, and Irish. German settlers also entered Southwestern Wisconsin, although not in the numbers as in southeastern and north-central Wisconsin. Norwegians, too, settled in the area in the later nineteenth century, especially near Vernon and LaCrosse Counties.

In short, Southwestern Wisconsin is not dominated by any single ethnic group. This ethnic variety produces cultural pluralism, a process in which the larger socio-cultural life of a group of people or geographic region becomes a composite of the diverse characteristics of the subcultural groups which constitute the larger society.[3] The history and cultural change of Southwestern Wisconsin provide a prime example of the shaping of social structures by cultural pluralism. On one level, the relative isolation of towns and the variety of ethnic groups encourages the subsocietal maintenance of socio-cultural patterns. On a different level, the unity provided by living in an area which differs from other areas of the state, gives the residents of Southwestern Wisconsin the sense of combining the subsocietal patterns of life into a larger social pattern representative of Southwestern Wisconsin. The recognition of such pluralism by members of a particular society is not always overt and, in many cases, is completely subconscious; yet, within recent years, a growing consciousness of a Southwestern Wisconsin way of life can be seen emerging in the socio-cultural patterns of the residents of this area.

Recent developments in the folklife of Southwestern Wisconsin indicate that the area is evolving a sense of cultural individuation[4] similar to other semi-isolated societies in the United States.[5] In some of these subsocieties, the individuation derives from a racial admixture characteristic of only a small group of people and thus acts as a means of separating that group from the larger society which surrounds it. In other cases, the differences are primarily ethnic.[6] In still other cases, the unique patterns of life are ascribed for reasons which are unconsciously manufactured, often with no basis in reality. Such is the case of the Melungeons of Hancock County, Tennessee. For years, this group of people was believed to be a racially distinct group with ancestors who were Portuguese, Native American, Black, Scotch-Irish, and various other admixtures. The racial uniqueness was manifested in the lifestyle maintained by the Melungeons. Not until the recent work of Saundra Keyes Ivey[7] did it become apparent that the Melungeons were no different than other groups which lived in semi-isolated areas of the Appalachian region of the United States. The concept of being and living like a Melungeon was probably imposed by outside observers and later adopted by the Melungeons themselves.

Certain similarities, although at an incipient stage of development, can be observed in Southwestern Wisconsin. During the early 1970's, the term, "Ocooch Mountains," began to be used to describe Southwestern Wisconsin. Exactly what "Ocooch" means is debatable; most residents believe it a term "the Indians" used to describe the area.[8] In 1975, a quarterly periodical entitled the *Ocooch Mountain News* began publication and established a currency for the term, "Ocooch Mountains." The *Ocooch Mountain News,* which is now published monthly, soon became a purveyor of folklore and helped to establish pride in the special features of Southwestern Wisconsin. It is not unusual to find articles which begin like this: "Does it give you a feeling of special importance to know that you live in a place unlike any other in the world? If you are a resident of Southwest Wisconsin this is true."[9] Moreover, some residents of Southwestern Wisconsin have begun referring to themselves and their neighbors as "Ocooch people." The process of cultural individuation has been progressing rapidly.

It is not my intention to assert that the cultural individuation of Southwestern Wisconsin will develop like that of such groups as the Melungeons in Tennessee; such extremes are probably no longer possible with mass communication as it is today. Furthermore, the cultivation of the term "Ocooch Mountains" with its concomitant folkloric implications lies largely in the hands of newcomers who have settled in Southwestern Wisconsin for a variety of reasons, but virtually all in pursuit of a more fulfilling life which they imagine exists in a rural area like Southwestern Wisconsin. These newcomers to the area, therefore, come to their new way of life with the expectation of finding something very special. Greeting them is the aforementioned pluralism which is, indeed, a special product of the particular diversity of Southwestern Wisconsin. The term, "Ocooch Mountains," evolved as a term of pride on several levels. Outsiders and newcomers used the term in an exoteric fashion; that is to say, the term was used to describe a geographic location which possessed a special pattern of social functions. The long-term residents of the area began to accept the term in an esoteric fashion; for them, the singularity was a matter of unconscious acceptance of the quality of life in Southwestern Wisconsin.

Charles Bannen was born and lives in rural Southwestern Wisconsin. In a sense, he is an "Ocooch person" *extraordinaire.* Bannen was born in 1900 on a farm in section fifteen of Scott Township, Crawford County, just east of Mt. Zion. At the age of sixteen, he moved to a farm on section seventeen of Scott Township, just west of Mt. Zion, where he farms today (Fig. 1).

First settlement of the area around Mt. Zion began in the decade following that of the Black Hawk War. The oldest permanent

Fig. 1. Crawford County, Wisconsin.

settler of the area was John R. Hurlbut, whose relatives remained in the Mt. Zion area for many years. Another early settler of Mt. Zion, Charles F. Coalburn, describes the early settlement of this area:

> Late in the summer of 1846, J. R. Hurlbut, William and Elmer Russell, Anthony Laughlin and myself, all residents of Grant County visited within the present limits of the town of Scott. . . . We followed the road by the left wing of the troops in their pursuit of Black Hawk and his people; this road led from the ferry [across the Wisconsin River] . . . , up Knapp's creek, to a spring branch coming in from the northwest, following the branch up and out onto the ridge, to about the center of section 14, and thence west through sections 15, 16, 17 and 18, and to the Kickapoo.[10] This road was used by the earlier settlers of Scott and adjoining towns in moving in, and is now the main thoroughfare, crossing the town east and west. . . . When we reached the high lands, two or three days after, our dogs struck a bear trail and followed until a little 'too fresh,' for they overtook the animal, and one of them being part bull, had more courage than discretion, and consequently, was badly used up. We found a small cabin near the top of the ridge, which had been occupied, we afterwards learned, by William and Randolph Elliott while hunting, and perhaps by others; here we spent the night. The next day we looked over the land, noting the quality of soil and timber, etc. and then left, favorably impressed with what we saw. Three years later Hurlbut became the first permanent settler of the town. I came back with my family in 1855.[11]

Charles Bannen knows well the history of his area and speaks knowledgeably of the early settlers, some of whom he knew personally. Mt. Zion itself was established in 1881. Even today, the town is small, consisting of a few modest buildings near a crossroads. Mt. Zion is served by the Boscobel School District and the Gays Mills Post Office. Mt. Zion guards the descent from the ridge country of Crawford County into Marietta Valley and the Wisconsin River Valley; today, there is little significance to such a location.

Like the larger population of Southwestern Wisconsin, the immediate environs of Mt. Zion are inhabited by various ethnic groups. Along Mt. Zion Ridge, on which Charles Bannen lives, most of the farms are worked by Irish-Americans and Anglo-Americans; in Crow Hollow, the farms are worked by German-Americans. However, Irish-Americans are found in relatively greater numbers in Scott Township than in most areas of Southwestern Wisconsin. As early as 1860, twenty-one percent of the families in the township were Irish-born, a figure exceeded only by the twenty-four percent in Seneca Township.[12] The history of Scott Township seems to be marked by a balance maintained at times by the Anglo-American Methodists and the Irish-American Catholics, of which group Charles Bannen is a member.

Irish-American Catholicism is central to the musical tradition of Charles Bannen. He represents the third generation of his family to live in the United States. He is well aware of his roots in Ireland and speaks with great pride of his Irish heritage; in October 1977, Bannen and his wife visited Ireland with the hope of gaining a better sense of that heritage. Parts of his family history have passed to Bannen both by means of oral tradition and through the efforts he has made to reconstruct that family history.

Many Irish immigrant families in the nineteenth century remained for a time in the large cities of the East upon their arrival to the United States.[13] Both the Bannens and the O'Kanes, Charles Bannen's paternal and maternal ancestors, demonstrated unusual immigration patterns because they moved westward immediately and settled in the area of Southwestern Wisconsin which is still farmed by their descendants.[14] It is, perhaps, because his ancestors did not remain in the East and therefore were not subjected to major anti-Irish prejudice that the Irish-American songs in Bannen's repertoire are almost devoid of references to anti-Irish sentiments in the New World.[15]

Despite its strength, the Irish-American aspect of Charles Bannen's musical tradition is but one aspect of that tradition. Bannen has always been an inveterate song-monger; his repertoire has continually absorbed new styles and genres. An examination of the songs that make up the active core of Bannen's repertoire (Table 1) evidences the diversity of musical sources from which

TABLE 1. The Active Core of Charles Bannen's Song Repertoire.

A-Bummin' the Railway Train
After the Ball
The Baggage Coach Ahead
Barbara Allen
Barney McCoy
Because We Were Poor
Beyond the Sunset
Blue Tail Fly
Bonny Doon
Boston Burglar
Boston Theater
Danny Boy
Dear, Little Shamrock
Down in Front of the Saloon
Galway Bay
The Green Hills of Atram
Jingle Bells
Just as the Sun Went Down
Kickin' Mule
Kitty Rells
Leaving Dear Old Ireland
The Letter Edged in Black
Listen to the Mockingbird
Little German House Across the Sea
Little Homes of Ireland
Little Old Sod Shanty in the West
Little Peter
McCarthy's Mare
Miss Fogarty's Christmas Cake
Naming the Boy
Odd Fellows' Hall (Cleaning Out Odd Fellows' Hall)
An Old-Fashioned Photograph
Old Hamburger (fiddle tune in scatted version)
O'Shaugassy on the Railroad
Out in the Gloomy Night, Sadly I Roam
Over the Waves (scatted version)
Pat Malone
Put Me in My Little Bed
Rose of Tralee
Redwing
Sailor's Grave
School Days
Schottische (fiddle tune in scatted version)
Seamus O'Brien
Sherman's March to the Sea
Ship That Never Returned
Soft Were the Mountains
Some Twenty Years Ago
Sparkin' Peggy Jane
Streets of Laredo
Sweet Bunch of Daisies
Sweet, Sunny South
Tell 'Em That You're Irish
The Three Leaves of Shamrock
Two Step (fiddle tune in scatted version)
Way Down in Maine
When It's Springtime in the Rockies
When You Have Fifty Cents
Who Threw the Overalls in Mrs. Murphy's Yard?
The Wreck of the Old 97
Young Charlotte

Bannen has drawn his songs. In part, this diversity is due to the dispersion of his family throughout culturally diverse Southwestern Wisconsin. Furthermore, the diversity has resulted from contact with the plethora of music styles that the mass media offers to the American public. However, most important as a catalyst for the diversity of Bannen's musical tradition has been his development of a performance style which facilitates incorporation of different musical styles as well as different musical vocabularies into his music.

Charles Bannen's musical training was mostly rote-learning from his father and other relatives. His inability to read notes at times frustrates him. Nevertheless, Bannen has an insatiable desire to understand and learn music. This desire has resulted in a carefully designed music theory stamped with the musical personality of Charles Bannen. The reed organ that Bannen plays is an indispensable part of his performance style. Despite the few lessons he had with a local teacher, Bannen learned most of his organ technique from his father. The technique was acquired as he repeated the chord patterns used by his father until he learned which chords "sounded good" with certain songs. The harmonic patterns learned by Bannen could be used to accompany most hymns; nevertheless, the patterns are used by Bannen so that the songs assume new versions.

Some of the songs entered the Bannen family repertoire from printed sources whose origins were not in Southwestern Wisconsin. The most important of these sources was the *Renfro Valley Bugle,* a small newspaper containing song texts, printed monthly in Renfro Valley, Kentucky. Renfro Valley is a well-known center of the country music business which, in addition to supporting the *Renfro Valley Bugle,* has, for a number of years, sponsored road shows and radio broadcasts.[16] The *Renfro Valley Bugle* publishes material ranging from gospel to country and western; however, some issues, for example those published near St. Patrick's Day, are occasionally devoted to Irish-American texts, perhaps in deference to the sizable Irish-American population in the southern mountains. A second major written source has been the New York publishing firm of H. J. Wehman. The Wehman firm, which no longer exists, was known as a publisher of Irish-American broadsides, or single sheets of printed song texts. Several of the songs in Bannen's repertoire initially appeared in print in broadsides published by Wehman; for example, one of Bannen's favorite Irish-American songs, "Because We Were Poor," appeared as a broadside with the titles, "The Irish Immigrant" or "I Left Ould Ireland Because They Were Poor," and in a different version in *Wehman's Irish Song Book.*[17]

Songs and tunes entered the repertoire of Charles Bannen from the many dances he attended and at which he often played. Not only did these dances provide an exposure to American fiddle tunes, but they also brought Bannen into contact with ethnic groups other than his own. Very often the fiddlers at the dances were German-Americans, for they were generally known as the best fiddlers in the area. Several of the tunes in Bannen's repertoire are versions of German fiddle tunes which he sings with scat syllables. At such ethnically mixed dances Bannen danced with and courted his wife, Emma, a Bohemian-American from a contiguous area of Southwestern Wisconsin.

Popular music and country music were also absorbed into Bannen's repertoire. Some country and western songs were taken from the *Renfro Valley Bugle.* The currency of both popular and country songs was unquestionably increased through the influence of radio and television as well as by Bannen's frequent performances in diverse settings.

Charles Bannen is more than a simple bearer of tradition; he is a performer who can step out of a single tradition and reshape musical materials so that they will speak more specifically for him and the changing contexts of his performance. When learning new songs, he not only memorizes the words but writes them down, copies them, edits them when he feels it is necessary, and chooses which ones to perform under given conditions. He asserts his personality not only by recreating former versions (one criterion for the role of tradition in a folk setting), but by creating new versions and combinations of music. Bannen's role as a performer is essential to his ability to embrace the various traditions present in Southwestern Wisconsin and to represent this pluralistic culture in his musical repertoire.[18]

Whatever their sources, Charles Bannen invariably accompanies his songs with an organ style which is derived from a rural hymn tradition. Although he is Catholic, Bannen is called upon to sing at the churches of other denominations in Southwestern Wisconsin, usually for funerals or social gatherings. Chord patterns seldom waver from a simple tonic—subdominant—dominant—tonic pattern; chords in such a pattern are built on the notes of the common, seven note scale as follows: first, fourth, fifth, and back to first. Occasionally a supertonic or dominant of the dominant will precede the dominant in a cadential pattern; the supertonic and dominant of the dominant are respectively minor and major chords built on the second degree of the seven note scale. These harmonic patterns are among the most basic found in the music of Europe and the United States. However, the patterns often do not account for the simplicity and/or complexity of some of the songs performed by Bannen.

Often, Bannen sings songs from which only pentatonic (five note) or hexatonic (six note) scales may be abstracted; yet his accompanying patterns imply a heptatonic (seven note), diatonic (using whole steps and half steps) scale structure. The conflict between modal, non-heptatonic scales and the heptatonic scale which is often necessary when instruments accompany a folk tune is common in the history of folk and country music in the United States.[19] In some instances, the conflict has been resolved by simply expanding the five note scale to include seven notes. This technique of scale modification was especially common during the 1920's and 1930's when rural singers, like the Carter Family, recorded old ballads for the commercial record industry.[20] In other instances, the conflict of five note scale versus seven note harmonic system was not resolved or only incompletely resolved. Such an incomplete mixture of musical styles was probably common in rural areas of the United States during the nineteenth century. To understand oral music traditions in the nineteenth century, we are forced to rely on scattered accounts, which tend to support a hypothesis that the syncretism of musical styles often existed in the type of incomplete state of resolution described above.[21] Writing in 1934, Charles Ives speaks of the experiences his father, an observant band leader, had while his band was camped in the South:

> When Father was in the Civil War, a negro boy, whose mother did the washing for the band, would stay around the tent while the band was practising, and Father said that the boy would stand by him whistling and humming the airs and tunes the band would play. And [Father] found quite often that he would change the melody by leaving out the 7th of the scale and sometimes the 4th—for instance, if the tune ended lah-te-doh upward, he would sing either lah-lah-doh or lah-doh-doh. . . . The negroes took many of the phrases, cadences (especially plagal—they liked the fah chord), and general make-up, and the verse and refrain form, and the uneven way many of these hymns

were sung rhythmically, especially the choruses. . . . The Gospels used the 4th and 7th sometimes, but the negroes were still too near Africa and the oriental five-note scale to get these.[22]

The conflict of scale structure was characteristic not only of the oral traditions of black and white singers and musicians in the nineteenth century. It also lay at the root of the rural hymnody traditions which were found among the fundamentalist sects of the southern mountains. In describing the traditions of the southern "fasola" folk, or shaped-note hymn-singers, Jackson describes processes similar to those observed by Charles Ives' father during the Civil War:

Another important modal-melodic peculiarity of the old songs, one whose existence seems nevertheless to have been completely ignored by the fasola folk themselves, was the use of gapped scales, that is, melodic progressions which avoided or skipped regularly certain notes in the diatonic scale with which we are familiar, the one which is conveniently represented by the white keys on the piano. The simplest note avoidance in the major modes was that of the fourth, or E flat in the scale of B flat major. In skipping this note the fasola singers produced what are called six-tone or hexatonic melodies. Another skip was that of the seventh, or A natural in the scale of B flat major. When both four and seven are avoided we have a five-note or pentatonic scale.[23]

The points of melodic conflict which the excerpts from Ives and Jackson described are most often the fourth and seventh degrees of the scale. These are the same points of conflict which can be found in the songs of Charles Bannen. For example, when Bannen sings a song which lacks a fourth scale degree, he still uses harmonic patterns which utilize chords built on a fourth degree. The process which is involved is exactly the same as that used in the camp meetings of the South in the nineteenth century and later taken into hymn traditions which would reach the Midwest in the last part of the nineteenth century. The well-known composer of hymns, Ira D. Sankey, also had problems dealing with the fourth in his four-part harmonizations of hymns.[24] Like the folk singer, Sankey often treated his melody as though it were autonomous from the vertical harmony of a hymn; Charles Bannen certainly conceives of music in this fashion. Such a distinction between melody and harmony provides a sharp contrast with the nineteenth-century art and popular music of urban centers in which melodic and harmonic functions are intertwined. Thus, it is my assertion that Charles Bannen's unfamiliar use of the fourth degree as well as other degrees of the scale, like similar use by Ira Sankey and some other hymn composers, is not the result of an incorrect interpretation of nineteenth-century music theory; on the contrary, it demonstrates a melodic and harmonic independence which was not present in the art music of the nineteenth century.

Charles Bannen and his family have copied the texts of many of their songs into a volume they called the *Old Bannen Song Book*. The *Old Bannen Song Book* exists in two parts. The first part contains primarily "old songs" and Irish-American songs; the second part contains the "new songs." There is no doubt that Charles Bannen prefers the "old songs," for he sings almost entirely from the first part. The *Old Bannen Song Book* contains one "hundred sixty-some odd" songs of which I have now recorded sixty-two over the past three years.[25]

Elements of both stability and flexibility interact in the songs of Charles Bannen. By a close look at different performances of one of his favorite songs, "Pat Malone," it is possible to understand which elements are stable and which elements are flexible in Bannen's tradition. "Pat Malone" is a song Bannen sings wherever he performs. He is known for his performances of "Pat Malone" and the song has become a local favorite because of these performances.[26] Whenever he sings "Pat Malone," he recounts the tale of that Irishman before singing the song:

> See this Irishman, Pat Malone, had a life insurance and they was hard up, pinched for dollars. And his wife tried to tell her husband that if he lay down and pretended to be dead awhile 'cause she could get the insurance check. Now, this is far-fetched, see. Insurance check, why that'd relieve their depressed condition. So, finally, old Pat got right down and laid aside his work. He lay down pretendin' dead and in come the Irish for a wake. Naturally, neighborhood friends and all. And some of those devils brought in some liquor, whiskey and stuff. They was all passin' the bottle around and finally old Pat was layin' there and he could smell that whiskey and he wanted some. When he got some liquor in him, he wouldn't keep still and he'd just talk, talk, talk all the time. He was supposed to be dead but he wasn't minding'; he wouldn't keep quiet!

The tale of Pat Malone is inextricably bound to the song itself. Commentary is added between the verses as well as before and after the song.

The two performances of "Pat Malone" which will be examined here were recorded in September and October of 1977; the September performance was not accompanied by the organ, whereas the October performance employed accompaniment (see Figs. 2 and 3). Variants between the two performances of "Pat Malone" are of two sorts. The first is the result of the differences caused by the accompaniment or lack thereof. The second is a result of the melodic restructuring and flexibility which is widespread in Bannen's melodic vocabulary.

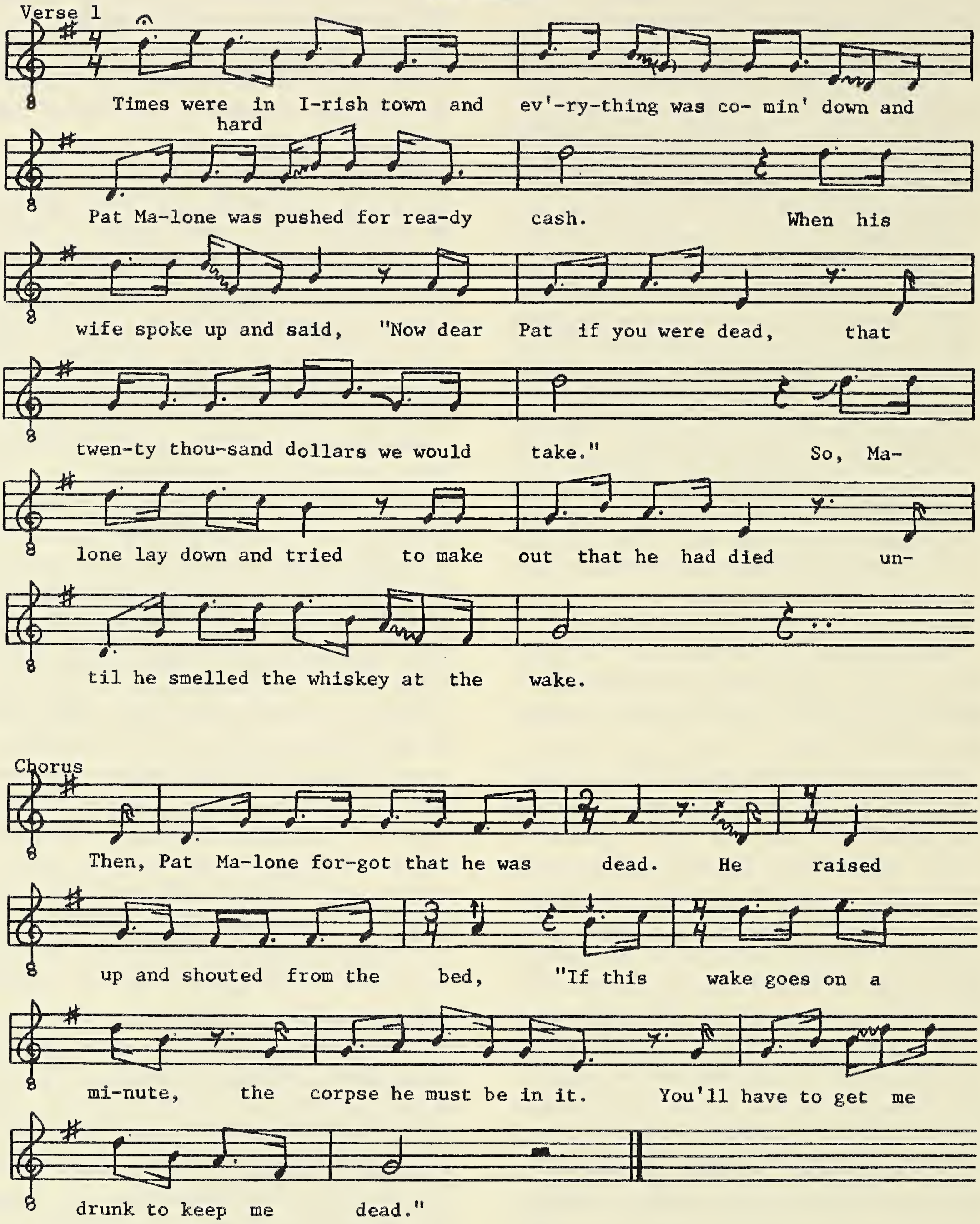
Of the two performances, the unaccompanied version more clearly demonstrates a seven note scale. The melody of the accompanied version has essentially six tones, lacking the seventh note, or leading tone, of the scale throughout much of the song. When the leading tone does occur, Bannen demonstrates instability by singing it out-of-tune. Unlike many of his accompanied songs, the accompaniment of "Pat Malone" does not serve to tie Bannen to a hymn-oriented melodic structure, but instead frees him from the necessity of using a seven note scale throughout the song.

Metric differences between the choruses of the two versions are easily seen; whereas the meter of the unaccompanied version shifts from four beats per measure to two or three beats per measure at the ends of internal phrases, the meter of the accompanied version remains in four throughout. The reason for this is obvious: the organ accompaniment serves to maintain constant meter.

Rhythmically and melodically, differences tween the versions seem restricted to a single beat and seldom demonstrate consistency with regard to the setting of individual words or larger phrases to music. The overall shape of phrases and the initial and final notes of each phrase are in most cases the same. Whereas melodic motion may differ slightly within a phrase, phrases are generally arched or falling in overall shape. The comparison of two performances of "Pat Malone" clearly demonstrates the freedom and flexibility in the performance style of Charles Bannen. Yet, despite the freedom found in the use of smaller units, the larger framework of "Pat Malone" makes it clear that both performances represent the same song.

It is not unusual for Bannen to combine tunes from several songs or several versions of the same song in one performance. Bannen's version of the well-known cowboy song, "Streets of Laredo," demonstrates this curious problem of tune identification: the first verse appears to be taken from a different song than the three subsequent verses. The first verse differs from the other verses both in melodic shape and rhythmic complexity. The lines of the first verse encompass a melodic shape which falls from the initial note of the line, whereas the lines of the other verses rise from the initial note. Furthermore, the harmonic implications of

PAT MALONE



Notational conventions: Bruno Nettl, Theory and Method in Ethnomusicology, (New York: Free Press, 1964), p. 107.

Fig. 2. "Pat Malone": Music and text version of Charles Bannen, September 1977, transcribed by Philip V. Bohlman.

the first verse of Bannen's "Streets of Laredo" are different from those of the last three verses. "Streets of Laredo," also called "The Cowboy's Lament" or "Tom Sherman's Barroom," is one of the most widely circulated songs in North America; thus, it is probable that Bannen has another version of the song, or perhaps a completely different song, in mind when he begins "Streets of Laredo." The ease with which the two versions are combined within a single performance demonstrates Bannen's ability to combine music from different sources into a newly created version.

Verse 1

Times were hard in Irish town and ev'rything was comin' down,
and Pat Malone was pushed for ready cash.
When his wife spoke up and said, "Now, dear Pat, if you were dead,
that twenty thousand dollars we would take."
So, Malone lay down and tried to make out that he had died,
until he smelled the whiskey at the wake.

Chorus

Then, Pat Malone forgot that he was dead.
He raised up and shouted from the bed,
"If this wake goes on a minute, the corpse he must be in it.
You'll have to get me drunk to keep me dead."

Verse 2

So, they gave the corpse a sop, afterwards they filled him up
and laid him out again upon the bed.
And before the mornin' grey, ev'rybody felt so gay,
they forgot the corpse had played off dead.
So, they took him from the bunk, still alive but awful drunk,
and placed him in the coffin with a prayer.
Says the driver of the cart, "But it I'll never start,
until they see that someone pays the fare."

Chorus

Then, Pat Malone forgot that he was dead.
He raised in the coffin and he said,
"If you dare to doubt me credit, you'll be sorry that you said it.
Drive on boys or the corpse will punch your head."

Verse 3

So, the fun'ral started out on a cemetery route,
and the neighbors tried the widow to console,
till they stood beside the base of the lone, last resting place
and quickly lowered Patrick in the hole.
Now, Malone began to see, just as plain as one, two, three,
that he forgot to reckon on the end.
And as the clods began to drop, he kicked off the coffin top,
and to this earth he quickly did ascend.

Chorus

Now, Pat Malone forgot that he was dead,
and from the cemetery quickly fled.
He came nearly going under. It's a lucky thing by thunder,
that Pat Malone forgot that he was dead.

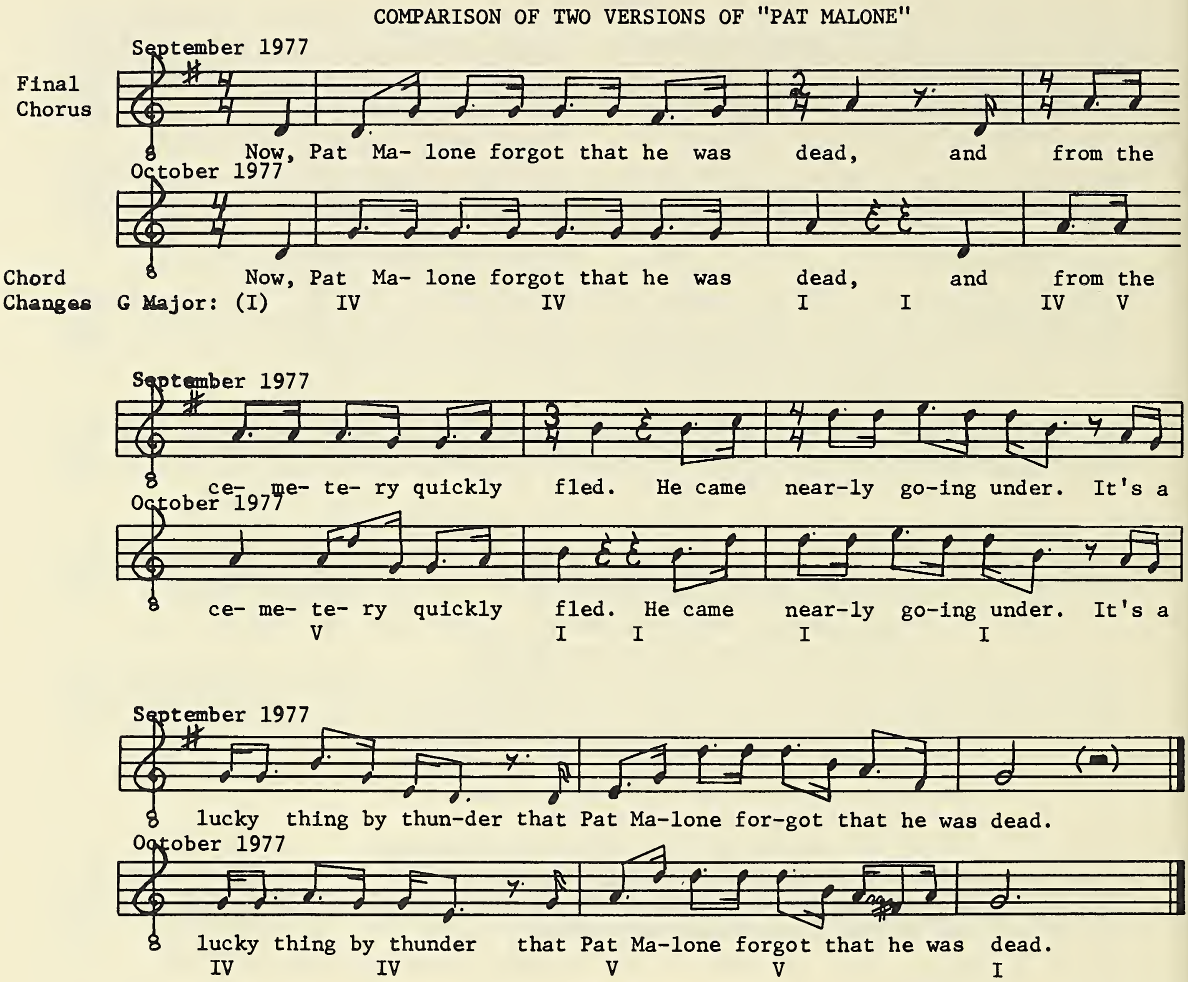


Fig. 3. Comparison of two versions of "Pat Malone."

A particularly striking case of melodic and harmonic conflict can be found in Bannen's version of "Barbara Allen," Child #84. "Barbara Allen" is the only song included by Francis James Child in *The English and Scottish Popular Ballads*[28] which is actively sung by Bannen. Such a situation is not unusual, for the Child ballads are not widespread among most Irish groups. However, because Bannen has chosen to include "Barbara Allen" in his repertoire, it provides one of the clearest examples of the mixture of traditions represented by his music.

The story of "Barbara Allen" is simple and representative of a type of love story which is found in many Child ballads. Sweet William comes to court Barbara Allen, but is shunned. With his love unrequited, William wastes away and is about to die when Barbara Allen decides to return his love. She is too late and when William dies, Barbara Allen soon dies of a broken heart. The ballad ends with the rose from William's grave entwining with the briar from Barbara Allen's.

The version of "Barbara Allen" sung by Charles Bannen is the most common found

BARBARA ALLEN

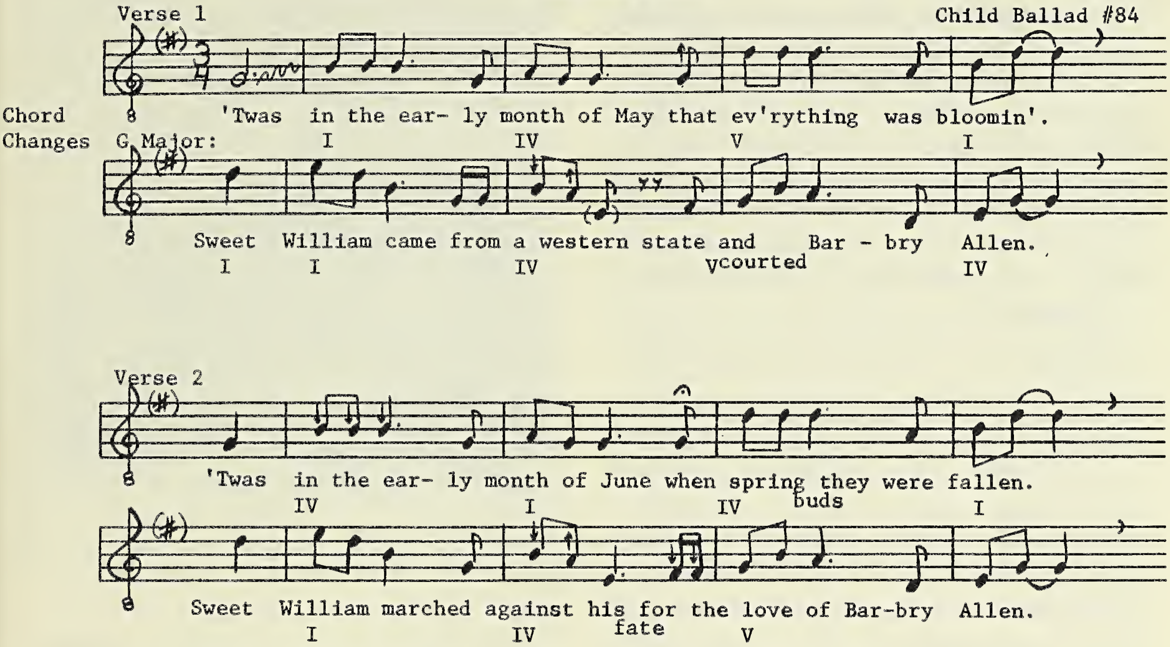


Fig. 4. "Barbara Allen": Music and text, Child Ballad #84, version of Charles Bannen, October 8, 1977, transcribed by Philip V. Bohlman.

Verse 1
'Twas in the early month of May
that ev'rything was bloomin'.
Sweet William came from a western state
and courted Barbry Allen.

Verse 2
'Twas in the early month of June,
when spring buds they were fallen.
Sweet William marched against his fate
for the love of Barbry Allen.

Verse 3
He sent his men unto the town
where Barbry was a-dwellin'.
"See my master dear he has sent for you,
yer name be Barbry Allen."

Verse 4
Then slowly, slowly she got up
and slowly she came nigh him,
and all she said when she got there,
"Young man, I think you're dyin'

Verse 5
Don't you remember in yonder town,
when we were at the tavern?
You gave a hand to the ladies all around
and slighted Barbry Allen."

Verse 6
"Yes, I remember in yonders town,
in yonders town a-drinkin'.
I gave a hand to the ladies all around
but my heart to Barbry Allen."

Verse 7
When she was on the highway home,
she spied his corpse a-comin'.
"Oh, lay down, lay down that corpse of clay
that I may look upon him."

Verse 8
The more she looked, the more she mourned,
till she fell to the ground a-cryin'.
"Oh, pick me up and carry me home,
I am now a-dyin'."

Verse 9
They buried her in the old churchyard
and William close a-nigh her.
'Pon William's grave there grew a red rose
and on Barbry's grew a briar.

Verse 10
They grew to the top of the old church wall,
till they couldn't grow any higher.
They leapt and they twined in a true lovers' knot,
and the rose around the briar.

in the United States.[29] In this version the text is primarily iambic (although the prosody does not make this clear) and is divided into quatrains which usually have an ABCD musical representation. The pentatonic scale used by Bannen is modally major, can be produced by playing the black notes of a piano, and, lacking the fourth and seventh degrees of the scale, is one of the most common five note scales found in British-American folk song.[30]

Of the ten verses sung by Bannen in October 1977 (Fig. 4), he accompanies himself on the reed organ for only four verses. Seemingly, Bannen's performance was encumbered by the organ accompaniment. The encumbrance results from the difficulty of fitting chords derived from a diatonic harmonic system against a pentatonic scale. Bannen's most obvious difficulty is his attempt to harmonize the melody with chords built on the fourth scale degree even though that degree is not found in the melody. At some places, for example in the initial measures of verses two and four, he attempts to harmonize the third degree of the scale (B) with a chord built on the fourth degree (C). The result is a harmony which sounds glaringly "wrong" and the singing of the third degree out-of-tune or off-pitch. Furthermore, Bannen unconsciously adjusts the scale of "Barbara Allen" to make more diatonic sense with the accompaniment by the occasional introduction of a seventh degree into the melody; this note, also, is sung out-of-tune.

In very simple terms, Charles Bannen has created a melody which contains "blues notes." Blues notes are scale degrees, especially the third and seventh degrees of the scale, which sound out-of-tune. They were common in the music of rural, southern blacks and are part of a style of singing which evolved into jazz during the first part of the twentieth century. Yet, it becomes clear upon examining the musical style of Charles Bannen that he, too, uses blues notes in singing. In his case, the returning of certain vocal pitches is a direct result of a melody which conflicts with accompaniment; when the accompaniment is dropped for the last six verses of "Barbara Allen," the blues notes disappear as does the presence of a seventh degree.

The performance of "Barbara Allen" points toward the incompatibility of certain elements in Charles Bannen's musical style. It demonstrates the instability with which a five note melody is realized by hymn-type harmonic functions. More importantly, it also demonstrates the means by which different styles converge in the music of Charles Bannen. Just as the Ocooch Mountains of Southwestern Wisconsin have acquired a particular cultural pluralism derived from a diverse populace, so too has the music of Charles Bannen come to represent diverse music traditions. "Barbara Allen" becomes a way of further examining the manner in which Irish immigrant, rural hymnody, and Anglo-American balladry traditions are brought together by a single performer. Some elements are shared and others are eschewed; nevertheless, the musical tradition of Charles Bannen acquires new directions and new strength.

CHARLES BANNEN SPEAKS: A PERSONAL INTERPRETATION OF MUSIC AND TRADITION IN SOUTHWESTERN WISCONSIN

Introduction

When Charles Bannen talks about his music and life in Southwestern Wisconsin, he does so with a unique eloquence. During his life, Bannen has been a careful observer of the changes in the world about him, and he recounts those changes with the wisdom of a folk historian. In short, the inner qualities which contribute to Charles Bannen's

Fig. 5. Charles and Emma Bannen, 40th Wedding Anniversary photograph (Photo courtesy of Charles Bannen).

aplomb as a performer of folk music also make him a first-rate storyteller (Fig. 5).

It is only fitting that Charles Bannen should be allowed to add a few comments of his own concerning his past and his music. The following narrative is drawn entirely from taped conversations that Charlie and I have had over the past two years. The words are Charlie's alone; I have edited and arranged them so that the story of Charlie's family, music, and experiences in rural Wisconsin unfolds in an orderly fashion. On occasion, I have substituted a few words in parentheses to make sentences flow more smoothly as they make the difficult transition from oral to written presentation.

A few names of families and places will be unfamiliar to those who read the narrative; places like Tom Price's farm are not to be found on most maps of Wisconsin or, for that matter, of Crawford County. Still, the use of such nomenclature best describes the sense of community which lies at the heart of a rural area. The world may be filled with families similar to those described by Charles Bannen; but only through his understanding of the ways in which these people contribute to the web of life in Southwestern Wisconsin can we glimpse the sense of community which is so important for the maintenance of the traditions in Bannen's life. And, perhaps, this glimpse of the people and places in the world of Charles Bannen will serve to remind us all that history and tradition ultimately grow from the interaction of human beings with other human beings on stages as remote and intimate as the parlor in old Bill Hudson's farmhouse.

P.V.B.

Ancestral Emigration from Ireland and Homesteading in Southwestern Wisconsin

Well now, Grandma Bannen, she was a Kelly girl and she came from Offaly County in Ireland from the little village they call Birr, and it was right along in the bend of the Shannon River. The O'Kane side of me, my mother's people, they came from Cork, pretty well south.

The old grandparents on the O'Kane side got onto a sailboat—wasn't a very big one—and the ocean was more or less rough and the wind was the wrong direction part of the time. They had to take down their sails and just drifted. It took 'em six weeks to get across the sea from Ireland to the United States. And they landed on the east coast, of course, of the United States.

After a while they decided to get into a covered wagon and come west to take up land. The government was giving away the land, posted it. So they was ridin' along and my grandma pretty soon said sometime she had to have her first baby girl. And they got out of the covered wagon and she lay down by a big log by the sawmill site and had her first baby girl. In due time they got back in their wagon and took off again. They landed in Marietta Valley back of Tom Price's farm, right close by here.

I can remember my grandmother on my father's side very much. I used to sit on her knee when I was a little kid. We'd go over there; she'd come over to our house. I'd seen her and I's three or four when she died. But I never seen my grandparents on my mother's side. They died before I was even born.

Absorbing Musical Traditions as a Youth

One time Ol' McDaniel and her husband, John, and her son, Johnny that married Blanche Gray, came over to Hudson's one day in the winter with teams and sled. I was a little kid—oh, 'leven years old and my sister was about nine or so—and anyway, after dinner Ol' McDaniel got into the organ in the front room. And, of course, old Bill Hudson liked to hymn-sing, sing the hymns. That was my uncle by marriage. It was Maggy Hudson's house; Will's, see.

And finally Ol' played for quite a little while. Then, Aunt Maggy, my own aunt, she set at the organ and they all sang. But she could read notes pretty good. Then, finally my pa got down into the organ and he could play the chords, and they all sang for a while. Oh, I bet they sang around for about two hours. But, I was a little kid sittin' on a chair and I listened—oh, a lot of them was hymns too.

Pretty soon after a while, why Hudsons —when I was a kid around thirteen or so— they got one of these round records: Edison, you pushed on a little cylinder. And I went up there one wintertime in the afternoon. Of course, they was proud as the dickens of their Edison phonograph. They sit on there different hymns that I have heard the old stock sing; had a big horn on it. And anyway, Aunt Maggy watched me to see if I recognized a lot of those songs. Of course, I did! She could read my expressives on my face; see that I was interested. I enjoyed the records very much. Course, that was way back there, a long time ago.

Grandmother Bannen lived about three miles from here. Hudsons would go there for Christmas dinner, and we'd go there for Christmas dinner. Aunt Mary McCormick and her children would go there, and sometimes a neighbor or two around. Then after dinner, when they'd get done with the meal, they'd go in the front room. There's so many of 'em that the chairs was all taken and the front room was a fair-sized room, too.

I guess pa was at the organ. There was something like a half-a-dozen of 'em singing, and there was no place for me to sit, no chair. So, I'd sit on Lee McCormick's knee while they's performin' for awhile. You see, there was quite a bunch of them when they all got together.

Mother's sisters were good singers: Mrs. Grant Burton, Marian Moran way out west, and Maggy Mulhaire way out west, and Kate that married old Tom McKnight, Civil War guy. Old Tom played the fiddle, and he was a brother to that lady that married old John McDaniel, Olive, that was such a dandy, nice singer and organ player. Old Will Hudson used to sing with her at the funerals at Mt. Zion so many times. Ol' McDaniel was an awful nice singer. She was musical!

Well now, Mrs. Ol' McDaniel played the chords similar to what I'm doing. (Her niece, Maud) could read notes nice, too. She's the one I took music lessons under, what little I got. Maud had a little organ about like (mine), she taught me on. Margaret, my sister, though, she went down there for three different seasons under Maud McDaniel. And she could read notes and do a pretty nice job at one time. But then she kind of lay down on the job and then she got rusty.

Well now, (as schoolchildren we sang from) those old yellow-covered songbooks —I've got one if I dig a while. The teacher would lead usually. And sometimes the teacher (was) Mina Brown, Mina Childs she was; she taught over there at the Coalburn school when I was a chunk of a kid. Sometimes in the Christmas program she'd ask me to take the lead in the program, singing on the stage there. Sometimes she'd ask my sister, Margaret, to take the lead and sing.

I's a little boy and other children would take flowers—would pick 'em out of the woods little 'head of time and keep 'em down cellar. When Decoration Day would come, we'd place 'em on the old soldiers' graves, here and there. My sister and I was the main program, entertainers in singin' different war songs and things. And usually they had Maud McDaniel on the organ and played for us. Generally we'd have to practice ahead.

Musician and Performer

Well, I'd sing the songs when pa got home. We'd milk cows that evening and he'd come home with some of them same hymns. Oh my, I've heard my father sing! We'd be milkin' cows and so on. One of the sisters got large enough, she would help milk too; course, I was milkin' then and we was milkin' by hand. And we children would sing right along with pa. But I can start dance tunes that I never heard a word of what would go with them: all kinds of 'em, off the violin. I can just hum 'em by the dozen: different ones played over at the house dances all over the country. We'd help pa sing as we was all milkin' cows in the barn. And ma sang on some occasions. But he sang three-fourths of the time and ma, now and then. But mother's sisters, most of them were right good singers. She sang too, but she couldn't play the organ; dad could play the organ.

It's about fifty-five years old, the old organ is. We bought it from Emmett Haggerty here at Mt. Zion. Mrs. Bill Campbell really was the owner of it. But she borrowed her some money from her cousin, Emmett, and so he sold the organ to get nearly even as he could. We had it repaired; the bellows was leakin' and we fixed it up so it sounds pretty fair now. We had another old organ. It gave out, so we just tossed it out. Then we got this one; it's a better machine (Fig. 6).

Fig. 6. Charles Bannen at his organ (Photo courtesy of Charles Bannen).

When you're picking out the keys you play on, if they've got sharps and flats on, you know what chords use the sharps and flats. If it's C, you don't use any sharps and flats. Now this is the way my pa and I kinda studied things out from our own experience. If they use a certain amount of these sharps and flats then you know they're either F or A or some of those. These black fellows are halfway between the white ones as a rule on some of the things. Some of them chords I don't use very much. Now some pieces, you know you got to try them out. You can feel them out here (on the organ) first. And then you can try it with a F♯, you can try G or C, or whatever sounds nicest to you.

Oh, fiddle's just lovely! That's tops in waltz music or any other dance music; providing they keep time. But a lot of our old fellows that picked it up by ear, they get into such bad habits and they don't quite finish out the last measure so many times. And they'll throw you out of step when you're waltzing so bad. Or if they hold it over extry long, it'll raise the divil too, you know, the last measure.

One time I was down to a house close to Barnum, down there this side of Barnum in a house dance in a farmhouse. And they had lamps, of course; they didn't have electricity yet. They had a great big old piano, and it was a pretty good piano. Anyhow, this Ward had some young fellow playin' the guitar; he wanted a rest. So, they wanted to get me on the piano there to second for this chunky, short Ward. Oh, he was just as ruthless as he could be on the violin; but that's all right. Anyway, he played a waltz and I was a-followin' him the best I could.

After one of the rest beats I says, "Say, gentleman, you aren't a-finishin' out your last measure on those waltzes. You're puttin' your dancers all out of step."

"Oh, am I?" says he.

And so he got up and he placed his foot on that piano seat-bench right behind me. Now I was a-workin' away like a good fellow and the rosin off that fiddle was goin' right down the back of my neck. I kept still. I didn't howl. He did do a lot better when he watched the chords. He held his measure out where he should. Course, I was just a kid and he was a middle-aged man. Maybe that wasn't quite proper. Oh yah, I helped him out! You know, he was so loud and he's right back of my head there, sawin'. Oh, almost unbearable!

One fellow asked me—he played the fiddle, Will Miller over here, he was on the Tim Freight land in the Hard Times. The land, they took that away from most people and he rented it from the manager of the land bank in this area, down around Steuben. He played fiddle for house dances too. But, he done a sweet job, though, that Will Miller did. Old Will Miller was a pretty sharp old boy now on the violin. He knew that I'd been down someplace to a dance where this Ward had played. And he asked me, "What kind of a job did Mr. Ward do playin' the violin?"

Well, I told him, "He was like the Irishman on the railroad. He was on again, off again, gone again, Finnegan." I told him about helpin' him straighten him up when I was helpin' play the piano. And he just laughed like a good fellow. But he has heard him play somewhere, sometime. He knew that he was kind of punky at it.

The House Dance as a Social Institution in Rural Wisconsin

Oh, my! I loved house dances. I learned square-dancing when I was between sixteen and seventeen years old. I was just as green as they made 'em, and I didn't know how to square dance. But, I danced with the old, middle-aged ladies that knew how so well. It wasn't very long till, oh my Lord, I could just dance as nice as any of 'em.

Walter Shield who lived on the Hudson farm called a lot. Mike Coyne called, down over the hill. Mike Monahan called some, and Hank O'Kane called some now and then. Well, they'd have lots of square dances. 'Bout every third dance would be a square dance, and sometimes the crowd'd be so thick that they'd have to call numbers for the next ones to dance. You know the house'd be stuffed! There wasn't room enough on the floor if they all got on the floor, and they'd call numbers so part of 'em would dance one whirl and part of 'em would dance the other whirl. They had to do it so the crowd would have a fair shake at it. That's the way that was.

Dances were held usually ev'ry other Friday night through this area. Sometimes in the moonshine days they'd bring liquor, and it just messed up the dancin' bad, though, when they done that. Oh they'd fight sometimes. Oh, my! Some of these Irish made moonshine up here a ways. But Steuben had 'em by the bushel down there.

Joe Coyne, the whole Coyne family before Joe got married, was over here where the old Mike Ferrick place just over to the barrel of the hill where Dowling lives now. Well they had a nice square house there, nice big square house. The Coynes were great fellows to dance. The mother was keepin' house for 'em; none of 'em got married yet. Oh, they'd have a dance about ev'ry once-a-month, generally, and ev'rything went off pretty nice though. They generally had old Dean Powers play the violin, and they had one of these self-player pianos there.

Emma, my wife, she lived over here on the Hudson place where Emil Mindham did, and we lived here. Used to dance with her once-in-a-while at the dances around. And one time she started after me and she caught me.

The Bannen Song Tradition and the Old Bannen Song Book

Well you see, I once sent to a music place, where they put out poems and songs, at Renfro Valley, Kentucky. They come once-a-month, and they'd have different poems certain times: different old songs. Those that I didn't have the chords of that I'd heard in my young days; and when those words would appear in that cute little paper, why, I'd think a while and here would come that tune in my head and I could just play it right over those words; just like nothing! I'd heard a lot of that stuff way back.

Songs in the *Old Bannen Song Book* were picked up all over. My Aunt Maggy Hudson was my dad's sister. She taught at North Clayton at one time. I remember Mary McCormick's little sister taught other places. Uncle Will Bannen was the younger one. He taught school at Senicky (Seneca), Bell Center, all over, too. And they brought home songs.

The Daughertys was Irish. The Daughertys, one of them girls, I don't know whether 'twas Nan or which one of 'em, could play the organ. And they knew a lot of songs. Some of these songs the Bannens got out of those old Daugherty books, too. They was back-and-forth. They lived just a hundred rods apart. Sometimes they'd play the organ and sing; sometimes they'd dance.

Oh, I've heard songs. One time in the Hard Times in the thirties, there was a couple of fellows in town, they's younger men, from out of a train. They rode the freight cars west trying to get a job. These were coal miners and one of 'em was a nephew to old Jack Lester. My Uncle Richard Bannen was always after help, more or less, so he brought out these two fellows to his place. They worked for fifty cents a day and their board. They were acquainted and more or less coal miner pals. One of 'em was German, a relation of old Jack Lester's nephew. The other one was an Irishman, McDonnell. That McDonnell, oh he could sing miners' songs that wasn't fit for an ole pig to listen to!

Generally speaking, in my opinion, of course I don't know too much about it, the old music suits me better because I've heard it. And some of the later pieces, oh, there's nothin' to 'em. They jumble up; you're speaking one word or one line over and over and over again. Gets too tiresome to me. It doesn't sound like music.

Well, up here at Mt. Zion about two months ago or thereabout, Emily Yonash sang with me, and Orla May Brown played the piano for us. You know that schoolhouse with a big room there—was big too, but oh was it crowded, my, my! It was so crowded that people just got back to their cars and away they went. It was too bad! We'd a-made a lot more money if they had suitable rooms. We was gonna raise money for North Crawford and ambulance-bus for Boscobel area. First I sang "Dumb Wife." Then I went for "Pat Malone." And, oh my, they did have an awful spell then!

Acknowledgments

Material from this study was presented to the Midwest Chapter of the Society of Ethnomusicology, at the University of Minnesota, May 13, 1978. A version of Charles Bannen's narrative appeared in the *Ocooch Mountain News,* IV, 8 (August, 1978), pp. 22-25. I would like to thank Charles Bannen, Larry W. Danielson and Bruno Nettl of the University of Illinois at Urbana-Champaign, James P. Leary of the University of Kentucky, Paul H. Hass of the State Historical Society of Wisconsin, and Edward D. Ives of the University of Maine, all of whom offered valuable suggestions after reading previous versions of this study.

Notes

[1] Ben Logan, *The Land Remembers* (New York: Avon Books, 1976), p. 7. In *The Land Remembers,* Ben Logan recounts the experiences of his childhood which was spent in northern Crawford County.

[2] *Ibid.,* pp. 141-142. The brackets are mine.

[3] Two theoretical, and rather different, discussions of cultural pluralism are Milton M. Gordon, *Assimilation in American Life* (New York: Oxford University Press, 1964), and Horace M. Kallen, *Cultural Pluralism and the American Idea: An Essay in Social Philosophy* (Philadelphia: University of Pennsylvania Press, 1956). For anthropological interpretations of the process of pluralism see especially Julian H. Steward, *Theory of Culture Changes The Methodology of Multilinear Evolution* (Urbana: University of Illinois Press, 1976); and Frederik Barth, ed., *Ethnic Groups and Boundaries: The Social Organization of Culture Differences* (Boston: Little, Brown and Company, 1969). Two recent studies of German settlement in Wisconsin that assume pluralistic stances are Kathleen Neils Conzen, *Immigrant Milwaukee, 1836-1860: Accommodation and Community in a Frontier City* (Cambridge: Harvard University Press, 1976); and Philip Vilas Bohlman, "Music in the Culture of German-Americans in North-Central Wisconsin," M.M. thesis, University of Illinois, 1980.

[4] I borrow this term from Larry W. Danielson, "The Ethnic Festival and Cultural Revivalism in a Small Midwestern Town," Ph.D. dissertation, Indiana University, 1972.

[5] See B. Eugene Griessman, sub-editor, "The American Isolates," *American Anthropologist,* LXXIV, 3, (June, 1973), pp. 693-734; also Saundra Keyes Ivey, "Ascribed Ethnicity and the Ethnic Display Event: The Melungeons of Hancock County, Tennessee," *Western Folklore,* XXXVI, 1 (Jan., 1977), pp. 85-107.

[6] Danielson, Op. cit.

[7] Ivey, Op. cit.

[8] In the masthead of the *Ocooch Mountain News,* "Ocooch" is defined as "one form of a Winnebago word meaning 'place you go to shoot fish.' The name was used in the 19th Century to refer to the hills of SW Wisconsin."

[9] Halsey Rinehart, "Geology," *Ocooch Mountain News,* III, 5 (May, 1977), pp. 28-29.

[10] This road, the present County W, runs through the middle of Charles Bannen's farm.

[11] Excerpted from Anonymous, compiler, *History of Crawford and Richland Counties, Wisconsin* (Springfield, Ill.: Union Publishing Co., 1884), p. 699. The brackets are mine.

[12] Sister M. Justille McDonald, *History of the Irish in Wisconsin in the Nineteenth Century* (Washington, D.C.: Catholic University of America Press, 1954), p. 280.

[13] *Ibid.,* pp. 9-10.

[14] Joseph Schafer, *Four Wisconsin Counties, Prairie and Forest* (Madison: State Historical Society of Wisconsin, 1927), p. 88, discusses the usual pattern of Irish immigration to Wisconsin.

[15] See Robert L. Wright, ed., *Irish Emigrant Ballads and Songs* (Bowling Green: Bowling Green University Popular Press, 1975), for an excellent compendium of Irish-American songs. For a nineteenth-century description of anti-Irish sentiment and its effects on Irish immigrants, see the June 10, 1887 letter from Dr. P. O'Connell of Chicago to Archbishop Croke of Cashel in Arthur Mitchell, "A View of the Irish in America: 1887," *Eire-Ireland,* IV, 1 (Spring, 1969), pp. 7-12.

[16] Bill C. Malone, *Country Music, U.S.A.: A Fifty Year History* (Austin: University of Texas Press, 1968), p. 194.

[17] Wright, Op. cit., p. 606. The broadside is without imprint; a copy can be found in the Newberry Library in Chicago.

[18] A folk musician as a performer and creator of folk materials has been the subject of several recent studies: Henry Glassie, " 'Take That Night Train to Selma': An Excursion to the Outskirts of Scholarship"; Edward D. Ives, "A Man and His Song: Joe Scott and 'The Plain Golden Band' "; and John F. Szwed, "Paul E. Hall: A Newfoundland Song-Maker and Community of Song" in *Folksongs and Their Makers* (Bowling Green: Bowling Green University Popular Press, 1970); and Almeda Riddle, *A Singer and Her Songs: Almeda Riddle's Book of Ballads,* Roger D. Abrahams, ed., and George Foss, music ed. (Baton Rouge: Louisiana State University Press, 1970). Edward D. Ives, *Joe Scott: The Woodsman-Songmaker* (Urbana: University of Illinois Press, 1978) is one of the most painstaking and poetic examinations of such a folk creator.

The interpretation of folklore as a "process of performance" increasingly characterized the studies of a number of American folklorists in the late

1960's and early 1970's. Two diverse anthologies concerning the performance aspects of folklore are Americo Paredes and Richard Bauman, eds., *Toward New Perspectives in Folklore* (Austin: University of Texas Press, 1972); and Dan Ben-Amos and Kenneth S. Goldstein, eds., *Folklore: Performance and Communication* (The Hague: Mouton and Co., 1975).

[19] Malone, Op. cit., pp. 9-10. For a theory which asserts a relationship among the modes of pentatonicism of African, Anglo-Irish, and Native American music, see Bence Szabolcsi, *A History of Melody,* trans. by Bynthia Jolly and Sára Karig (London: Barrie and Rockliff, 1965 [Budapest, 1950]), especially pp. 226-228; it is my opinion that this theory must be regarded with a degree of circumspection, for it is based on limited historical and ethnographic considerations concerning the settlement of North America.

[20] Malone, Op. cit., p. 66.

[21] See Richard A. Waterman, "African Influence on the Music of the Americas," *Acculturation in the Americas,* Sol Tax, ed. (Chicago: Proceedings of the 29th International Congress of Americanists, 1952), 2: pp. 207-218, for the types and patterns of musical syncretism, or hybridization, which have characterized some styles of American music.

[22] Charles Ives, *Memos,* John Kirkpatrick, ed. (New York: W. W. Norton, 1972), pp. 53-54; the parentheses are added by Charles Ives; the brackets enclose the editorial additions of John Kirkpatrick.

[23] George Pullen Jackson, *White Spirituals in the Southern Uplands: The Story of the Fasola Folk, Their Songs, Singings, and "Buckwheat Notes,"* (New York: Dover Publications, Inc., 1965 [1933]), p. 161.

[24] See, for example, P. P. Bliss and Ira D. Sankey, *Gospel Hymns and Sacred Songs* (Chicago: Biglow and Main; and, Chicago: John Church and Co., 1875); the hymn, "Yet There Is Room" (No. 81), is a prime example.

[25] Recordings of Bannen's songs are deposited in the Archive of Ethnomusicology, University of Illinois, Collection No. 195.

[26] For another Version of "Pat Malone" see Harry B. Peters, ed., *Folk Songs out of Wisconsin* (Madison: State Historical Society of Wisconsin, 1977), p. 300.

[27] Francis James Child, *The English and Scottish Popular Ballads,* Vol. II (New York: Dover Publications, Inc., 1965 [1885]), pp. 276-279.

[28] Charles Seeger, "Versions and Variants of the Tunes of 'Barbara Allen,' " *Selected Reports in Ethnomusicology,* I, 1 (Los Angeles: Program in Ethnomusicology, Department of Music, University of California, Los Angeles, 1966), pp. 120-167. Seeger suggests that Version II of "Barbara Allen" may stem most directly from Ireland and Scotland, and not from England; this is largely speculation on Seeger's part.

[29] Bertrand Bronson, *The Singing Tradition of Child's Popular Ballads* (Princeton: Princeton University Press, 1976), pp. 221-228; and Mieczyslaw Kolinski, " 'Barbara Allen': Tonal Versus Melodic Structure," *Ethnomusicology,* XII, 2 (May, 1968) pp. 208-218, and XIII, 1 (Jan., 1969) pp. 1-73.

THE LATE WISCONSINAN GLACIAL LAKES OF THE FOX RIVER WATERSHED, WISCONSIN

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Abstract

The pre-Woodfordian Fox River flowed through the Marquette bedrock valley to the Wisconsin River. This river was dammed by glacial deposits during the maximum glacial advance of Woodfordian time.

During the Woodfordian and Greatlakean recessions and lesser advances, glacial lakes formed in the Fox River watershed as glacial ice blocked drainage to the north through Green Bay. As the ice retreated, successively lower outlets were exposed, first at Portage and later through the Neshota and West Twin, Kewaunee, and Ahnapee Rivers. The Manitowoc River may have also served as a spillway for waters from the glacial lake.

During glacial advances, lake levels were stable or changed only slowly. During glacial recessions, lake levels changed quickly and perhaps catastrophically. Erosion and alluviation within the outlets of the glacial lakes were more pronounced during times of glacial recession than during times of glacial advance.

The extent of each glacial lake associated with each outlet is illustrated. A change in terminology is proposed to define more specifically the extents and outlets of the glacial lakes.

Introduction

Deposits of lacustrine sediment have been recognized in the Fox River watershed for 125 years. These deposits have traditionally been interpreted as having formed in glacial lakes. Studies of the glacial lakes of the area have proceeded concurrently with studies of regional glaciations. The years of investigation have produced terminology which is in part confusing, poorly-defined, and out-of-date.

This paper presents an historical perspective of studies of the glacial lakes of this area, describes current hypotheses and observations which apply to the topic, and suggests simplifications in terminology.

Study Area

The area of study includes the Fox River watershed and those channels that served as drainageways for water that was present in the watershed at times of glaciation (Fig. 1).

The Fox River watershed of northeastern Wisconsin is irregular in shape, reaching to nearly 46° latitude at its northward extent, 43° 30′ latitude to the south, 89° 45′ longitude to the west, and 87° 45′ longitude to the east. The rivers that may have discharged waters from the watershed during glaciations are the Wisconsin River near Portage, the Rock River, the Manitowoc River, the Neshota and West Twin Rivers, the Kewaunee River, the Ahnapee River, and the strait at Sturgeon Bay (Fig. 1).

Lobation of Glaciers

Two glacial lobes, the Green Bay Lobe and the Lake Michigan Lobe (Fig. 2), are related to the history of the glacial lakes. At several times during the Pleistocene, the Green Bay Lobe, an extension of the larger Lake Michigan Glacier, moved up the north-

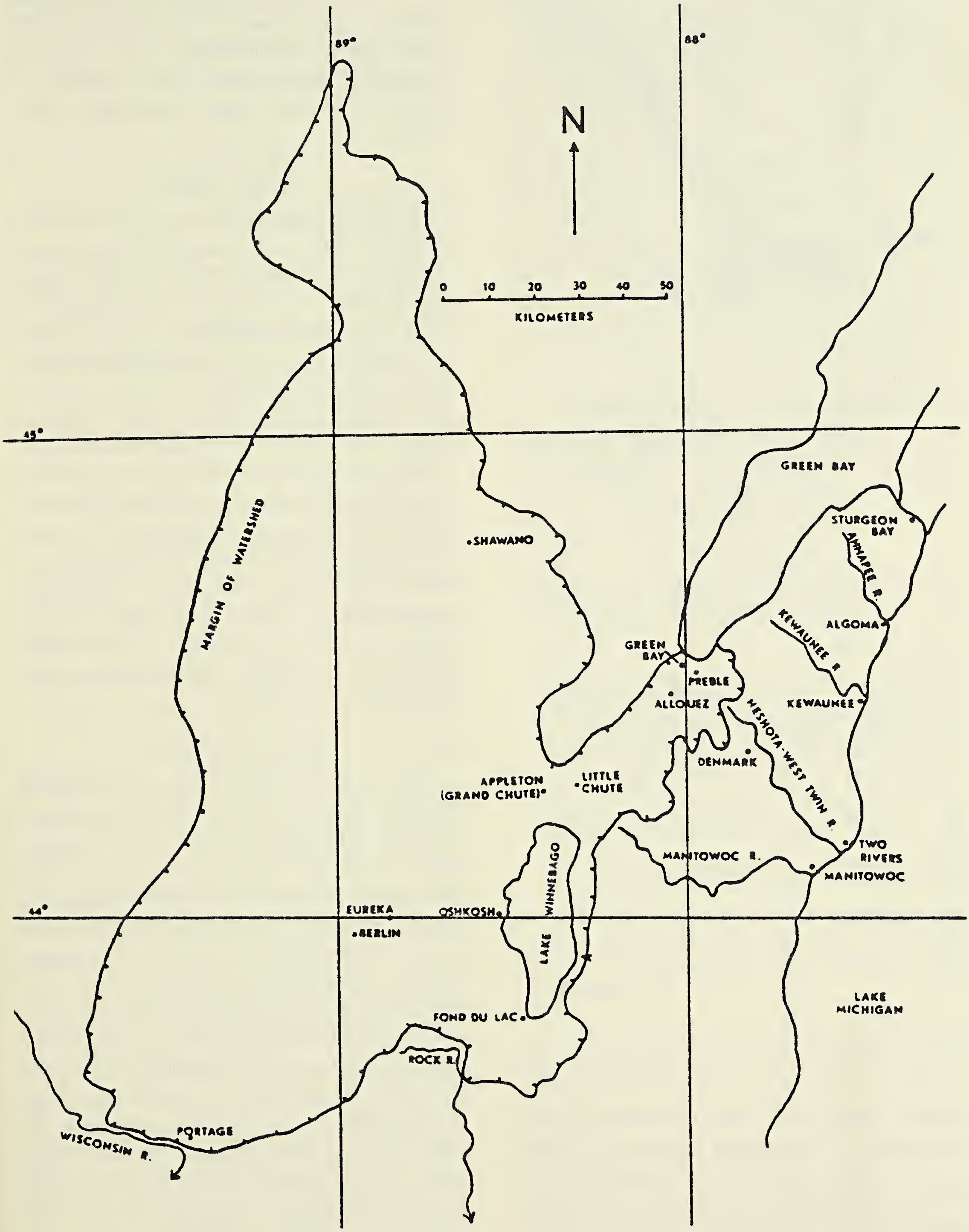

Fig. 1. Area of study in northeastern Wisconsin.

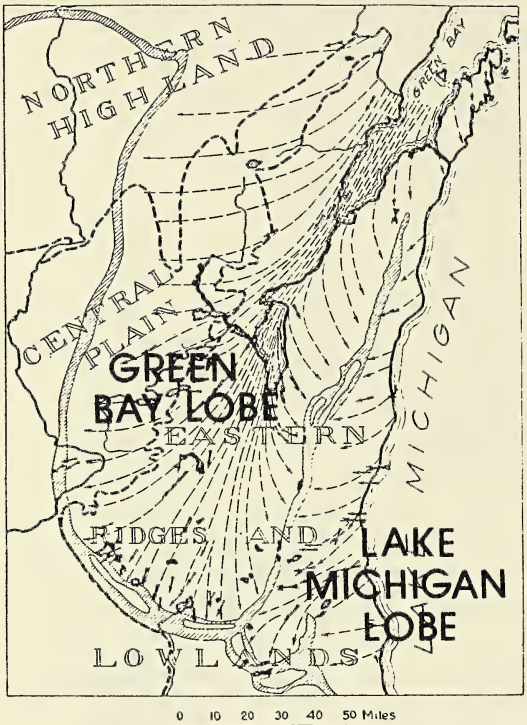

Fig. 2. Location of glacial lobes in northeastern Wisconsin (from Martin, 1932).

TABLE 1. Time terms used in this paper (previously-used terms in parentheses).

Years Before Present			
4,000	Holocene		
8,000	Wisconsinan Stage	Greatlakean	(Valderan)
12,000		Twocreekan	
16,000			(Cary)
20,000		Woodfordian	
			(Tazewell)
24,000			

ward sloping Fox River watershed from Green Bay. Initially, the ice was contained on the east margin of the watershed by the Niagara Escarpment, a cuesta of dolomite extending from the tip of the Door Peninsula southward through eastern Wisconsin. Ice of the Lake Michigan Lobe eventually merged with the ice of the Green Bay Lobe along the Kettle Moraine area. Ice of the Green Bay Lobe spread south and west, at times covering the entire Fox River watershed.

Time Terms

The time terms used in this paper are presented in Table 1. During the Holocene and Twocreekan intervals, ice was not continually present in Wisconsin. During the later portion of the Greatlakean subage, Wisconsin was ice-free. The Woodfordian subage was a period of glaciation when fluctuations in the glacial margins may have rendered Wisconsin free of ice for short periods.

Cary and Tazewell were for many years used as subdivisions of the Wisconsinan age, but are no longer recognized. The term Valderan has been a source of confusion in the literature and the term Greatlakean, suggested by Evenson and others (1976), is being used in this paper. The previous common use of these terms warrants their recognition in this paper.

Previous Studies

The initial report bearing on the glacial lakes of the Fox River valley was that of Charles Whittlesey (1849). This report, part of David Dale Owen's *Report of a Geological Survey of Wisconsin, Iowa, and Minnesota* (1852), noted widespread existence of "loose diluvial material" throughout much of the Great Lakes area. He noted extensive "red clay" deposits throughout the valleys of Lake Winnebago, the Fox River, and Wolf River. He attributed the red clay to inland lakes. The distribution of the red clay deposits in the Fox River valley was not specified, but stratigraphic sections taken from well records included red clay at Fond du Lac, Oshkosh, Green Bay, and Grand Chute. In addition red clay deposits were described from Appleton, Shawano Lake, and the falls of the Wolf River.

General G. K. Warren (1876) mapped the approximate extent of the red clay in the Fox River valley. He regarded it as sediment of a previously larger Lake Winnebago; he believed that the lake had drained past Portage to the Wisconsin River.

T. C. Chamberlin (1878) described the red clay deposits as occurring within the Green Bay valley and extending a few miles south of Fond du Lac, up the Fox River beyond Berlin, and up the Wolf River beyond Shawano. He concluded that the red clay represented a subaqueous deposit that was the result of former higher lake levels of Lake Michigan and Green Bay. To account for differences in the elevations of red clay, he postulated crustal movements associated with or following deposition of the clay. Chamberlin described a second stratigraphically-higher red clay deposit that is restricted to areas adjacent to Lake Michigan north of Manitowoc. He suggested the lower red-clay deposit formed at a higher lake level of Lake Michigan and Green Bay following a glacial retreat. When lake levels then dropped and rose again, the upper red clay unit was deposited only in the Lake Michigan basin. Finally lake levels again dropped. The source of the red clay was thought to be the underlying coarse "bowlder clay." Through shoreline erosion the fine material within the "bowlder clay" was washed out, providing the sediment for the subaqueous red-clay deposits.

T. C. Chamberlin (1883) reiterated these observations and hypotheses and added that the lakes may have gradually formed as the ice retreated, producing great fringing lakes along the border of the glacier. He also noted that at some point the meltwater from the Green Bay Lobe was probably discharged through the Wisconsin River valley. He observed that there had been many important channels of discharge crossing drainage divides that now appear as extinct channels.

Aware of glacial discharge channels from other known glacial lakes, Warren Upham (1903a) visited Portage. He suggested that the northern part of the Fox River valley had at times been blocked with glacial ice and that at these times the lowest point in the Fox River divide had been in the vicinity of Portage. He speculated that water from the glacial lake in front of the Green Bay Lobe had discharged into the Wisconsin River through this divide. Upham found the Fox River above Portage to be decidedly underfit. The river was found to be 10 to 15 m wide and 30 cm deep, while the valley was over 300 m wide and 10 m deep. He concluded that the existing Fox River occupied the ancient eroded channel of a larger river that flowed in the opposite direction.

Upham wrote (1903a p. 111):

> when Warren and Chamberlin thus described the region of the Fox river, lake Winnebago, and Green bay, the effect of the barrier of the waning continental ice-sheet to form lakes in basins sloping northerly toward the receding ice border had not been fully and generally recognized. Neither of these writers appealed to the glacial barrier on the north as the cause of the formerly greater lakes which they mapped and described; nor did Chamberlin refer to the southward outlet at Portage, near the head of the Fox valley, but rather ascribed this entire lacustrine tract to an expansion of lake Michigan when the lake Winnebago region was much depressed below its present altitude.

It was now apparent that meltwaters from the Green Bay Lobe were periodically restricted to the Fox River valley and did not merge with those of the Lake Michigan Lobe. For at least a time there had been two distinct glacial lakes. The lake in front of the Lake Michigan Lobe previously had been named "Glacial Lake Chicago." Upham proposed "Glacial Lake Nicolet" for the glacial lake that had existed in front of the Green Bay Lobe.

The separation of the two glacial lakes made unnecessary Chamberlin's hypothesis of localized crustal movement to account for the differing elevations of red clay in the two lake basins. Upham noted that as the ice receded, the two ice-marginal lakes would eventually merge and assume the same level. The elevation of the floor of the channel that served as the outlet at Portage was estimated to be 780 feet above sea level. Upham also suggested that the red clay was partially reworked red till rather than a sorted fraction of Chamberlin's "bowlder clay."

Upham (1903b) later altered his proposed name to "Glacial Lake Jean Nicolet" to distinguish it from "Glacial Lake Nicollet," named for Joseph Nicollet, the name previously assigned to a glacial lake that had existed in Minnesota.

Weidman (1911) recognized seven ancient shorelines in the Green Bay area and ascribed these to previous shorelines of "Glacial Lake Jean Nicolet." Weidman ascribed the highest two shorelines, at elevations of 800 and 830 feet above sea level, to the Portage outlet. The lower five elevations, at 600, 620, 650, 675, and 730 feet above sea level, were thought to be related to changes in the elevations of outlets of Lake Chicago and later stages of Lake Michigan.

Alden (1918) noted numerous deposits of sand and gravel in the Fox River basin at elevations approximately 800 feet above sea level. These he believed to represent shoreline deposits of water ponded in the basin after the retreating ice front had opened the outlet at Portage. Alden wrote (1918 p. 324-325):

> on the east this glacial lake was limited by the steep slope of the Niagara escarpment, and south and west of Fond du Lac by the red till ridge. The site of Fond du Lac was thus submerged beneath 40 to 60 feet of water. The upper part of the ridge just south of Eureka, as well as other ridges between Fox River and Lake Poygan, in Rushford and Poygan townships, must have stood as islands in the lake. Farther west and southwest, in Waushara and Marquette counties, the water submerged much of the lowlands now occupied by the extensive marshes. North and west of Oshkosh the lake waters extended far up the valleys and spread widely over the intervening lowlands, submerging considerable parts of Marinette, Shawano, Brown, Outagamie, Waupaca, Winnebago, Green Lake, Marquette, and Columbia counties.

Alden recognized that the red clay was derived from a red till that he believed to have been related to the final glacial advance in northeastern Wisconsin. Alden also noted that glacial lakes of similar extent were developed during the retreat of the earlier (Woodfordian-Cary) glacier and with both the advance and retreat of the glacier that deposited the red till. Alden was not satisfied with the name "Glacial Lake Jean Nicolet," and suggested that this name be applied only to the stage at which the Portage outlet was active. Alden suggested that a lower outlet was probably present providing drainage across the Door Peninsula after additional retreat of the glacier. This proposed outlet channeled the water across the Door Peninsula and into Glacial Lake Chicago.

F. T. Thwaites suggested in a 1927 unpublished work that the name "Glacial Lake Jean Nicolet" be discarded, and that the name "Early Lake Oshkosh" be applied to the lake at times when the Portage outlet was active, and the name "Later Lake Oshkosh" be applied to lower levels of glacial waters in the same basin, presumably when some lower outlet was discharging waters from the lake (Ellsworth and Wilgus, 1930).

Martin (1932) recognized the Portage outlet of Early Lake Oshkosh, but proposed an apparently higher outlet that channeled water down the Rock River beginning near Fond du Lac. Martin described possible shorelines of Lake Oshkosh at elevations of 755, 800, and 830 feet above sea level.

Thwaites (1943) concluded that the highest water level of Lake Oshkosh could not have reached the elevation of 822 feet above sea level and suggested a maximum lake level of between 800 and 820 feet above sea level for Lake Oshkosh at times of discharge through the Portage outlet. Thwaites concurred with Alden's view that Lake Oshkosh existed during the recession of the Woodfordian (Cary) Glacier as well as at the times of the advance and recession of the Greatlakean Glacier. Five figures in Thwaites' publication show portions of Lake Oshkosh at various times.

Thwaites continued to distinguish Early Lake Oshkosh from Later Lake Oshkosh, but applied the name "Later Lake Oshkosh" to a stage when lake waters were discharging at Portage. He described a beach deposit of Later Lake Oshkosh at Little Chute at an elevation of 815 feet above sea level, implying a Portage outlet. He seems to have applied the name "Early Lake Oshkosh" to lakes associated with the Woodfordian (Cary) glacial recession and the Greatlakean glacial advance. The term "Later Lake Oshkosh" seems to be applied in this context to lakes associated with the maximum extent and subsequent regression of Greatlakean ice. This represents an apparent change in definition from Thwaites' previous (1927) work.

Thwaites (1957) postulated a glacial lake in the Fox River lowlands in advance of the Woodfordian Glacier based on well records from Preble and Allouez. He applied the name "Early Lake Oshkosh" to the glacial lakes that existed in the same lowlands during the recession of the Woodfordian Glacier and during the subsequent advance of the Greatlakean Glacier. The name "Later Lake Oshkosh" was again reserved for the lake as it existed during the Greatlakean glacial maximum and throughout the following recession.

In addition, he indicated that the history of drainage of Early Lake Oshkosh across the Niagara Escarpment was unknown but implied that the Portage outlet was used during the high water level of Early Lake Oshkosh.

The first outlet of Later Lake Oshkosh was in the vicinity of Portage at an estimated elevation of 800 feet above sea level. The second outlet proposed by Thwaites was through a sag in the Niagara Escarpment near the north end of Lake Winnebago and from there down the Manitowoc River to Lake Michigan. The elevation of this divide was estimated to be 800 feet above sea level, nearly the same elevation as the Portage outlet. The next outlet was through the Neshota and West Twin River at an estimated maximum spillway elevation of 765 feet above sea level. The Kewaunee River with an estimated divide elevation of 682 feet above sea level served as the next outlet. The Ahnapee River with a spillway elevation 640 feet above sea level was the next outlet. This outlet was active until retreating ice opened the strait at Sturgeon Bay, at which point the water levels of Lake Oshkosh and Lake Michigan merged.

Thwaites postulated rapid lowering of lake levels as each succeedingly lower outlet was opened. Erosion within the spillways had, in places, eroded the channels down to bedrock. Thwaites attempted to compute discharge rates for three of the outlets. This computation requires data on channel depth, channel slope, bottom roughness, and channel width. Only channel width was directly measurable. Stream velocities for the Neshota and West Twin, Kewaunee, and Ahnapee spillways were estimated to range from 1.2 to 1.6 m/s once grade was established. Initial velocities were thought to be higher.

Computed discharge values ranged from 4000 m^3/s to 5000 m^3/s. Again initial discharges would be expected to be greater.

Paull and Paull (1977) recognize spillways of Glacial Lake Oshkosh at Portage, the Manitowoc River, the Kewaunee River, and the Ahnapee River. They fail to note the Neshota and West Twin spillway.

Outlets of the Glacial Lakes

The preglacial drainage of the study area has been postulated by Stewart (1976) to have been through the Marquette-Wisconsin system. He suggested that this system was dammed by glacial deposits during the maximum advance of Woodfordian ice. As such, Glacial Lake Oshkosh probably was not present until this damming was accomplished. While it appears likely that the first Lake Oshkosh formed during the recession of the Woodfordian Glacier from its maximum extent, the possibility remains that an earlier glaciation may have blocked the Marquette-Wisconsin system, producing a pre-Woodfordian series of lakes.

Both Goldthwaite (1907) and Thwaites (1957) recognized that postglacial isostatic uplift had raised beaches along Lake Michigan north of Two Rivers. For example, the beach of Lake Algonquin, a high-water stage of Lake Michigan, is present at an elevation of 610 feet above sea level at Two Rivers and occurs at an elevation of 670 feet above sea level at Detroit Harbor. This represents an uplift of 60 feet in approximately 90 miles. Little evidence exists to suggest that isostatic uplift was significant south of Two Rivers.

A significant part of the Fox River watershed lies north of the latitude of Two Rivers, and some evidence of the effects of isostatic rebound might be expected to be present in the watershed. Thwaites (1943) explored this possibility and concluded that there was little definite evidence of tilting of shorelines in the region. He believed that postglacial earth movements were probably confined to a region farther to the north. The factor of isostatic readjustment must be considered to have potential importance in the history of

Table 2. Elevations of locations of outlets proposed as spillways for Glacial Lake Oshkosh.

Outlet	*Divide Elevation (feet above sea level)*	*Location (topographic maps of area in parentheses)*
Rock River	885	NE¼ Sec.18, T.14N., R.16E. N½ Sec.28, T.14N., R.16E. SE¼ Sec.12, T.14N., R.15E. (Waupun 1:62,500)
Manitowoc River	815	W½ Sec.15, T.20N., R.19E. (Chilton 1:62,500)
Portage	780	Sec.16, T.13N., R.9E. (Portage 1:62,500)
Neshota and West Twin River	775	Sec.25, T.23N., R.21E. (Denmark 1:62,500)
Kewaunee River	685	Sec. 30, T.25N., R.23E. (New Franken and Casco 1:62,500)
Ahnapee River	635	NE¼ Sec.35, T.27N., R.24E. (Little Sturgeon 1:62,500)

the glacial lakes even though no evidence of this process has yet been demonstrated in the area.

Six outlets for Glacial Lake Oshkosh have been suggested by previous authors. They are, from highest divide elevation to lowest, the Rock River outlet south of Fond du Lac, the Manitowoc River outlet, the Portage outlet, the Neshota and West Twin River outlet, the Kewaunee River outlet, and the Ahnapee River outlet (Table 2).

Rock River Outlet

The only previous study to propose the Rock River as a spillway for Lake Oshkosh was that of Martin (1932). The proposed outlet was in the vicinity of the Niagara Escarpment north of the Horicon Marsh. The topographic map indicates three potential locations for such an outlet, each with a divide elevation approximately 885 feet above sea level.

The region of the Fox River watershed south of Fond du Lac is surrounded on the east, south, and west by divides (Fig. 1). At various times during glaciation, ice-marginal lakes probably formed in this area as glaciers to the north closed the area, each time producing a lake within this small embayment of the watershed. At these times water probably discharged to the Rock River system through one or more of the divide locations described.

This area was probably isolated before advancing ice reached the Portage outlet and after receding ice cleared the Portage outlet. At each time this small lake was present, it appears likely that a larger Lake Oshkosh still existed to the west and continued to discharge through the Portage outlet. For this reason the Rock River outlet is not considered by this author to represent a primary outlet of Lake Oshkosh.

Manitowoc River Outlet

The lowest point in the divide between the Fox River watershed and the Manitowoc River is at approximately 815 feet above sea level. Although a slight topographic sag is present in the divide area, no distinct channel is present. The Portage outlet, far to the southwest, has a divide elevation of 780 feet above sea level, and considerable evidence exists to suggest that at an earlier time the divide elevation may have been 800 feet above sea level. Since an advancing glacier would cover the Manitowoc River outlet before approaching the Portage outlet, and since the Portage outlet would be open before the retreating glacier opened the Manitowoc River outlet, it appears that this outlet could not have served as a spillway for Lake Oshkosh.

A number of possibilities exist through which this outlet may have been active. During the late Woodfordian glaciation, retreating ice made several minor readvances, depositing considerable thicknesses of glacial debris in the general area of the divide. Prior to that time, the elevation of the divide area may have been considerably lower. If Lake Oshkosh existed prior to the maximum extent of the Woodfordian Glacier, the divide elevation of the Manitowoc River outlet may have been lower than the divide elevation of the Portage outlet. During the advance of the Woodfordian Glacier the water from Lake Oshkosh may have drained through the Manitowoc River valley until the advancing ice closed the outlet. Greatlakean glacial deposits are also present in the area, but typically occur in thicknesses of only a few feet, so their absence probably would not have been sufficient to activate this outlet during the Greatlakean glacial advance.

The Lake Michigan Lobe was much larger than the Green Bay Lobe, and it is likely that any isostatic depression of areas close to the Lake Michigan Lobe was greater than any similar depression associated with the Green Bay Lobe. It is possible that the area of the Manitowoc River outlet was more severely depressed than the area of the

Portage outlet. If the isostatic rebound was slow enough, the retreating ice may have exposed the Manitowoc River outlet at a time when it had not rebounded sufficiently to have a higher divide elevation than the less-depressed Portage outlet. If this were to occur, water from Lake Oshkosh would flow down the Manitowoc River valley until isostatic rebound raised the elevation of the Manitowoc River outlet above the elevation of the Portage outlet, or until further northward retreat of the ice opened the lower Neshota and West Twin River outlet.

The role of the Manitowoc River as an outlet for Glacial Lake Oshkosh must remain problematical.

Portage Outlet

Water from Lake Oshkosh drained out near Portage through a narrow spillway with a current bottom elevation of slightly less than 780 feet above sea level. Water discharging from Lake Oshkosh through this valley merged with water of the Wisconsin River to the south. The Wisconsin River flows on through another narrow spillway near Dekorra at Sec. 12, T. 11 N., R. 8 E. (Poynette 1:62,500). This spillway also has a current bottom elevation of slightly less than 780 feet above sea level. Since water from both the Wisconsin River and Lake Oshkosh flowed through the Dekorra spillway, the elevation of the floor of the spillway at Dekorra appears to have acted as a control of the levels of water in the Wisconsin River and Lake Oshkosh above it.

Many writers have noted beach deposits of Lake Oshkosh at elevations of 800 feet above sea level. Along the Wisconsin River above Portage similar topographic breaks are known to be present. It appears that for significant periods water was stabilized near the 800 foot level both in Lake Oshkosh and in the Wisconsin River valley north of the Dekorra spillway because there are pronounced beaches in the Fox River watershed at 800 feet elevation, and there are large alluvial deposits along the Wisconsin River at a similar elevation. Because the Wisconsin River did not follow its present course past Portage prior to the Woodfordian recession, the 800 foot beaches and alluvial deposits are features that were most likely formed following the maximum Woodfordian glacial advance.

Clearly there was an apparent change in lake level from 800 to 780 feet above sea level. This change may have been caused by downcutting of the Dekorra and Portage spillways during or following the recession of the Woodfordian Glacier or by a combination of isostatic uplift and downcutting of the Dekorra and Portage spillways during or following the recession of the Woodfordian Glacier. In either case it appears that in more recent times the maximum level of Lake Oshkosh when waters discharged through the Portage outlet was approximately 780 feet above sea level.

A definite channel from the spillway north of Portage to the Wisconsin River at 780 feet elevation is not evident, probably because of more recent alluviation by the Wisconsin River during flooding.

Neshota and West Twin River Outlet

The lowest point in the divide between the Fox River watershed and the Neshota and West Twin River is 775 feet above sea level. From this location the Neshota and West Twin River flows southwest to Two Rivers through a valley that is decidedly underfit. The valley walls are steep and high. North of Denmark the valley has been cut more than 30 m below the surrounding terrain. In many places the valley floor is flat, suggesting that alluvium partially fills it.

The well-defined channel, steep valley walls and flat valley floor suggest that this outlet was recently active. Thwaites (1957) noted that in places this valley was eroded down to bedrock. It appears likely that this valley repeatedly served as an outlet for

Lake Oshkosh, most recently during the recession of Greatlakean ice.

Kewaunee River Outlet

The divide for the Kewaunee River outlet occurs south of Dyckesville at an approximate elevation of 685 feet above sea level. The Kewaunee River is decidedly underfit in a larger abandoned channel. The channel is as much as 1 km wide and 35 m deep. The channel floor is flat, suggesting the presence of alluvial fill. Large rounded boulders of dolomite, some exceeding 1 m in diameter, are present in the streambed at the south edge, Sec. 28, T. 24 N., R. 24 E.

The well-defined channel, abandoned cutbanks, and flat valley floor of this spillway suggest that this outlet was recently active. Thwaites (1957, p. 870) suggests that red till of probable Greatlakean age is cut by this valley at Kewaunee, suggesting that this outlet was active following the recession of Greatlakean ice. This valley was probably repeatedly utilized as an outlet for Lake Oshkosh.

Ahnapee River Outlet

The spillway divide between the Ahnapee River and the Fox River watershed occurs at approximately 635 feet above sea level. Although topographic evidence suggests that this valley must have served as an outlet for Lake Oshkosh during times when the channel to the north at Sturgeon Bay was blocked with ice, there is an absence of the deep, flat-floored channel of other outlets.

Alden (1918) mapped the highest level of glacial Lake Chicago, a high-water stage of Lake Michigan, at approximately 640 feet above sea level. Ancient beaches occur along the Wisconsin shoreline of Lake Michigan from Waukegan north to Manitowoc. Mickelson and Evenson (1975) have shown that bluffs of Greatlakean till north of Manitowoc do not have evidence of similar ancient shorelines. This led them to conclude that following the Twocreekan interglacial times, Lake Michigan was at a level lower than 640 feet above sea level. Had Lake Michigan been at the 640 foot level during the Greatlakean recession, similar beaches would be expected to be found cut into the Greatlakean deposits along Lake Michigan.

At times when Lake Michigan water was at the 640-foot level, this outlet would have been entirely submerged, and the level of Lake Oshkosh would have been the same as the level of Lake Michigan. It is only during the Greatlakean glacial recession that Lake Michigan water level was substantially lower than the divide elevation of the Ahnapee outlet. This would have been the only time when major channel erosion was possible. During this recession it is likely that this outlet was active only during the short period of time when it was free of ice and the nearby channel at Sturgeon Bay was still blocked.

The absence of major erosional features in the Ahnapee River outlet can probably be attributed to the fact that erosion must have been active for only a short period during the Greatlakean glacial recession.

Extent of the Glacial Lakes

Any attempt to describe precisely the extent of the various glacial lakes in the Fox River valley is complicated by several factors. Although it is known from stratigraphic studies that there have been several glacial advances and retreats through the Fox River watershed, the specific number, sequence and extents of the glacial advances within this area are not yet established. Although several probable outlets for glacial meltwater have been noted, each outlet may or may not have been used during a specific glacial advance or retreat.

Lake levels may have fluctuated as overriding glaciers partially filled the spillways with sediment, increasing the elevations of the divides within the spillways. In addition, when each outlet was active, erosion could be expected to lower the level of the divide,

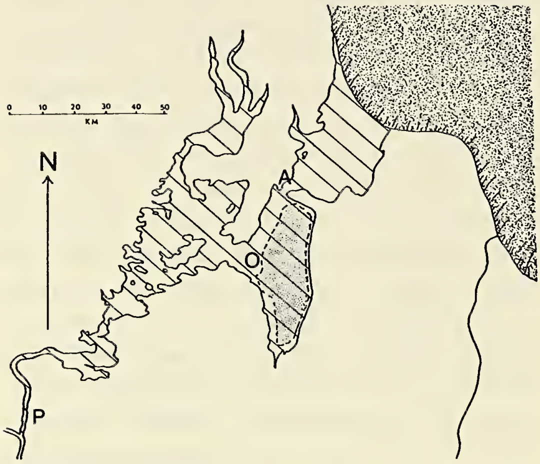

Fig. 3a. Glacial Lake Oshkosh at the Portage level—lake level 780 feet above sea level.

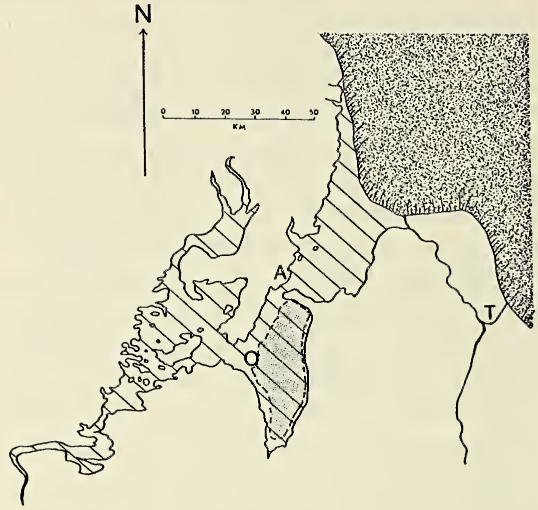

Fig. 3b. Glacial Lake Oshkosh at the Neshota and West Twin level—lake level 775 feet above sea level.

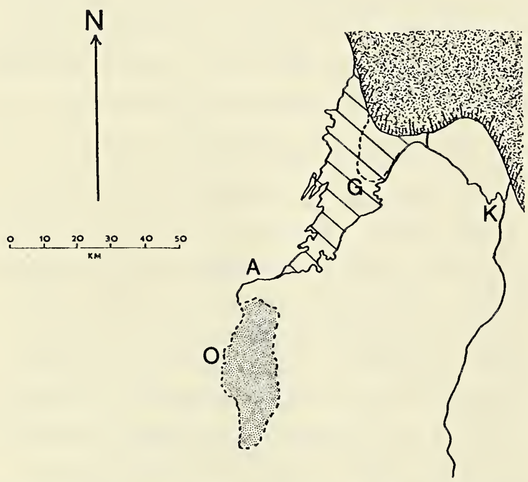

Fig. 3c. Glacial Lake Oshkosh at the Kewaunee level—lake level 685 feet above sea level.

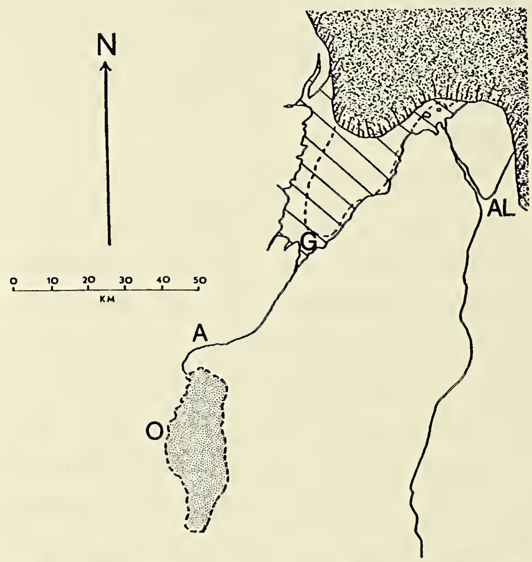

Fig. 3d. Glacial Lake Oshkosh at the Ahnapee level—lake level 635 feet above sea level.

Fig. 3. Approximate extent of Glacial Lake Oshkosh at the Portage, Neshota and West Twin, Kewaunee and Ahnapee levels. The extent of the Lake at each level is shown as a diagonally-ruled area. The outlines of Lake Winnebago and Green Bay are indicated by dashed lines and Lake Winnebago is also stippled. Irregular shading denotes the hypothetical location of glacial ice. Letters indicate the location of cities: P—Portage, O—Oshkosh, A—Appleton, T—Two Rivers, G—Green Bay, K—Kewaunee and AL—Algoma.

producing lower lake levels in the glacial lake behind it. Determination of lake levels on the basis of preserved shoreline deposits is difficult because the advancing glaciers overrode and destroyed many of the previous beaches.

Finally, there have been no detailed stratigraphic studies of the sediment of the glacial lakes. Indeed, until a fuller understanding of the history of glacial movements is reached, study of the stratigraphy may yield findings that are potentially misleading. For example, the past practice seems to have been to identify any buried wood found in Fox River valley sediment as being of Twocreekan age. These deposits were assumed to be correlative with the buried forest deposits near Two Creeks. While the deposits at Two Creeks are, by definition, Twocreekan age, no direct correlations have been made to the similar deposits of the Fox River valley. The radiocarbon ages of the samples generally agree, although the range of experimental uncertainty is such that some of the samples from the Fox River valley may be of latest Woodfordian age.

It should be clear that a detailed chronology of all the glacial lakes that have existed within the Fox River watershed is not within the capabilities of science at this time. It is possible, however, to grossly estimate the extent of the most recent glacial lakes.

The procedure used to determine the areas of the most recent glacial lakes involved determination of the modern divide elevations of the outlets (Table 2). Using 1:62,500 topographic maps when possible, these elevations were mapped throughout the Fox River watershed. In areas where 1:62,500 scale maps were not available, 1:250,000 scale maps were used. Four maps were prepared using this procedure (Fig. 3a, b, c and d).

The extent of each glacial lake is shown as a diagonally-ruled area. The outlines of Lake Winnebago and Green Bay are indicated by dashed lines, and Lake Winnebago is shaded. Irregular shading denotes the hypothetical location of glacial ice. The locations of the glacial termini are largely hypothetical and it is acknowledged that glacial movements would result in modified locations of the termini.

The procedure employed fails to compensate for erosion of divide elevations in recent time, for possible changes in divide elevations due to isostatic readjustment, and for any differences between current divide elevations and the somewhat higher level of water which probably existed in the channel and lake. While the figures presented here may be imprecise, they represent a first attempt to illustrate the extent of the most recent glacial lakes which were present in the Fox River watershed.

Draining of the Glacial Lakes

Conditions and events within the spillways and lake basins of the Green Bay Lobe differed significantly with the direction of movement of glacial ice. It is suggested that during glacial advances, lake levels were stable, or changed only slowly. During glacial recessions, however, lake levels changed quickly and perhaps catastrophically. Erosion of the presently identifiable spillways occurred primarily during intervals of glacial recession.

During glacial advances, lake water ponded in front of the advancing ice and water level within the lake rose until it reached the divide elevation of the next-higher outlet. At this point the elevation of the lake surface stabilized, then slowly decreased as a result of slow channel erosion within the spillway. Eventually the advancing ice covered the spillway and lake level rose again until the next-higher outlet was reached. During glacial advance it is likely that the length of time necessary for the lake level to rise to the next outlet was small in comparison to the length of time during which the lake level was relatively stable and the outlet was active.

During glacial recession it appears logical that when a glacier receded past a lower outlet, this outlet then opened rapidly and large quantities of water surged through the spillway as the level of the glacial lake quickly dropped. When a dam of glacial ice was breached, the effects could be expected to be as violent as those related to the breaching of a modern dam.

A major factor governing the magnitude of such an event is the amount of water which must pass through the spillway before the lake level stabilizes at the elevation of the lower outlet. The difference in lake levels bears consideration. The drop from the Portage level to the Neshota and West Twin level represents a drop of only a few meters, the drop from the Neshota and West Twin level to the Kewaunee level is about 30 m, and the drop from the Kewaunee level to the Ahnapee level is about 15 m.

A second factor is the area of the lake that is drained. Although the change in elevation from the Portage to Neshota and West Twin level is small, the area of the lake at that time was large. The 30 m drop from the Neshota and West Twin to Kewaunee level was significant because the initial extent of the lake was large. The 15 m drop from the Kewaunee to Ahnapee level was less significant because even at the higher Kewaunee level the area of the lake was relatively small.

It is also probable that major erosion of the spillways occurred during these rapid drops in lake levels. Because the major changes in lake volume are associated with the openings of the Neshota and West Twin and Kewaunee spillways, it is likely that erosion would be most severe in these spillways.

Physical effects that suggest rapid draining of the glacial lakes appear to be present. The valley sediment of the Kewaunee River contains large boulders of dolomite. Some exceed 1 m in diameter and most are rounded. These boulders are stratigraphically near the top of the valley alluvium deposits. The rounded character of the boulders and their presence in a deposit of fluvial sediments suggest that they were most likely rounded through fluvial processes. The existing river is narrow, shallow and much too small to move these boulders even in time of flood. The inability of the modern stream to move these boulders suggests that they are relics of a time when the Kewaunee River had much greater current velocity and discharge. It seems probable that these boulders were carried to this location and rounded during times when the Kewaunee River served as an outlet for the glacial lakes. If this interpretation is correct, the stratigraphic location of the boulders near the top of the valley deposits suggests that little erosion or deposition has occurred within this spillway since it was last the site of discharge from a glacial lake, and that the sediment was primarily deposited during the time that water from Lake Oshkosh flowed out through this valley. Excellent examples of the boulders can be seen where a bridge crosses the Kewaunee River at the southeast corner of Sec. 28, T. 24 N., R. 24 E., approximately 1 mile south of Slovan.

In summary, both erosion and alluviation within the outlets of Lake Oshkosh appear to have been more pronounced during times of glacial recession than during times of glacial advance.

A Proposal for Revised Terminology

It is proposed by this author that a revised terminology be used in future descriptions of the glacial lakes of the Fox River valley. It is appropriate to retain the name Glacial Lake Oshkosh, to refer generally to all levels of the glacial lake. In addition, it is proposed that the terms Portage Level, Neshota and West Twin Level, Kewaunee Level, and Ahnapee Level be employed to more fully communicate the respective levels and extents of Glacial Lake Oshkosh during times of discharge through the spillways named. It is also necessary to propose the provisional term Manitowoc Level, should this valley be shown to have been a spillway of Glacial Lake Oshkosh.

While these new terms are not time-dependent, and do not therefore represent or imply sequence, they do impose more specific definitions on the extents and outlets of the various levels of Glacial Lake Oshkosh.

Literature Cited

Alden, W. C. 1918. The quaternary geology of Southeastern Wisconsin with a chapter on the older rock formations. U.S. Geol. Survey Prof. Paper 106. 356 p.

Chamberlin, T. C. 1878. Geology of Wisconsin. Wisconsin Geol. and Nat. Hist. Survey. v. 2. 768 p.

———. 1883. Geology of Wisconsin. Wisconsin Geol. and Nat. Hist. Survey. v. 1. 725 p.

Ellsworth, E. W., and Wilgus, W. L. 1930. The varved clay deposit at Waupaca, Wisconsin. Trans. Wis. Acad. Sci., Arts, and Letters. 25:99-111.

Evenson, E. B., and others 1976. Greatlakean Substage: A replacement for Valderan Substage in the Lake Michigan Basin: Quaternary Research. 6:411-424.

Goldthwait, J. W. 1907. Abandoned shorelines of Eastern Wisconsin: Wis. Geol. Nat. Hist. Survey Bull. 17. 134 p.

Martin, Lawrence. 1932. The Physical Geography of Wisconsin. Univ. Wis. Press. 608 p.

Mickelson, D. M., and Evenson, E. B. 1975. Pre-Twocreekan age of the type Valders Till, Wisconsin. Geology. 3:587-590.

Paull, R. K., and Paull, R. A. 1977. Geology of Wisconsin and Upper Michigan. Kendall/Hunt Publ. Co. 232 p.

Stewart, M. T. 1976. Quaternary geology of the Upper Marquette bedrock valley, East-Central Wisconsin. Ph.D. thesis, part II, University of Wisconsin at Madison 83 p.

Thwaites, F. T. 1943. Pleistocene of part of Northeastern Wisconsin. Geol. Soc. America Bull., 54:87-144.

Thwaites, F. T., and Bertrand, Kenneth. 1957. Pleistocene geology of the Door Peninsula, Wisconsin: Geol. Soc. America Bull. 68: 831-880.

Upham, Warren. 1903a. Glacial Lake Nicolet and the portage between the Fox and Wisconsin Rivers. The American Geologist 32: 105-115.

———. 1903b. Glacial Lake Jean Nicolet. The American Geologist. 32:330-331.

Warren, G. K. 1876. Report on the transportation route along the Wisconsin and Fox River. U.S. Engineers, Washington.

Weidman, Samuel. 1911. The glacial lake of the Fox River Valley and Green Bay and its outlet: Science (n.s.) 33:467.

Whittlesey, Charles. 1849. Geological report on that portion of Wisconsin bordering on the south shore of Lake Superior: *in* Owen, D. D. 1852. Report of a geological survey of Wisconsin, Iowa, and Minnesota: Lippincott, Grambo & Co. pp. 425-480.

A RELICT GEOMORPHOLOGICAL FEATURE ADJACENT TO THE SILURIAN ESCARPMENT IN NORTHEASTERN WISCONSIN

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Abstract

A terrace-like bench and accumulations of coarse talus occur at the foot of the Silurian escarpment in northeastern Wisconsin. Talus slopes, now nearly stabilized, apparently were formed by ice-wedging and shattering of dolomite. Solifluction of loose rock materials apparently formed the bench. Absence of talus and bench forming processes today suggests development during an anomalously severe climatic episode, probably during the final Wisconsinan glacial recession.

INTRODUCTION

In Northeastern Wisconsin, the Silurian dolomite outcrops along the east shore of Green Bay forming the bedrock of the Door Peninsula. In some places northwest-southeast trending drainageways have cut through the dolomite and the rock is covered by various glacial deposits. However, for the most part, the erosional edge forms a prominent northwest facing escarpment (Fig. 1).

Much of the base of the escarpment is fringed by a low-level bench which is readily observable in the field but generally is not pronounced on available topographic maps. On the campus of the University of Wisconsin-Green Bay the bench is well displayed varying in width between 8 and 15 meters and rising an average of 3 to 4 meters above a somewhat more gently sloping surface of lake sediments and thin till. The flat upper surface of the bench is at an elevation of approximately 220 meters, and the lip of the escarpment rises to 230 meters producing a 10-meter step. At that point the edge of the escarpment is approximately 1850 meters from the shore of Green Bay.

Elsewhere along the Bay shore where the bench has been observed it is locally narrower with steeper surface slopes. Talus blocks, some very large, are usually found upslope from the bench. The bench may even be absent where the dolomite is close to the water or actually forms the shoreline. And, in many places the bench has been

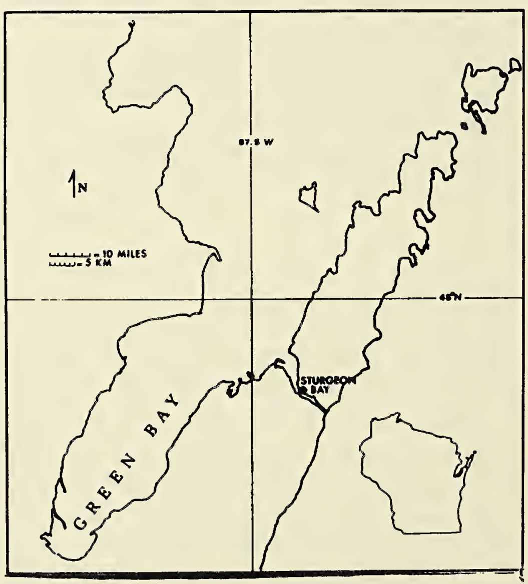

Fig. 1. Location of study area.

modified by human activity including farming, construction, and quarrying.

Research Objective

In the summer of 1977 we began an investigation of the escarpment front. Our purpose was to gather information on the morphology and materials of the bench in order to develop a reasonable hypothesis for its origin. Our ultimate goal was to place the feature in the context of the late glacial or post-glacial history of northeastern Wisconsin.

Several modes of origin for the bench have been suggested informally by various investigators: 1) Some combination of periglacial processes, 2) ice shove or direct deposition from the ice as it spread out of the Bay, 3) meltwater deposits caught between the ice and the escarpment face, 4) washover of material from the top of the escarpment. None of these hypotheses, however, were documented by field evidence.

Investigation

Our approach was two-fold. First, we took cores along the face of the escarpment northward from the UW-Green Bay campus. We then constructed profiles at a number of points along the Bay shore. These profiles taken from 7.5 minute topographic maps—although generalized—are useful for they show a progressive steepening of the escarpment face from profile No. 1 in the south to profile No. 7 in the north (Fig. 2). The steepening reflects a regional trend in which the escarpment becomes more prominent northward and at least partially buried by glacial deposits southward.

Coring was only partially successful. Because of dry conditions and the limitations of our equipment, we could not penetrate the feature to a meaningful depth. Our trailer mounted soil probe enabled us to reach a maximum depth of only two meters. The cores were split, described and samples analyzed for particle size. Layering was not apparent and textural analyses of samples from the upper surface of the bench and adjoining slopes showed the sediment below the soil to be rather homogeneous and composed of red sandy clay.

Inspection of the bench along the escarpment revealed several places where internal characteristics are exposed. A particularly useful exposure occurs at Bay Shore Park about 10 kilometers north of the campus where a road has been cut through the dolomite ledge to provide a boat launching facility. There the edge of the escarpment was, prior to modification, within 10 meters of

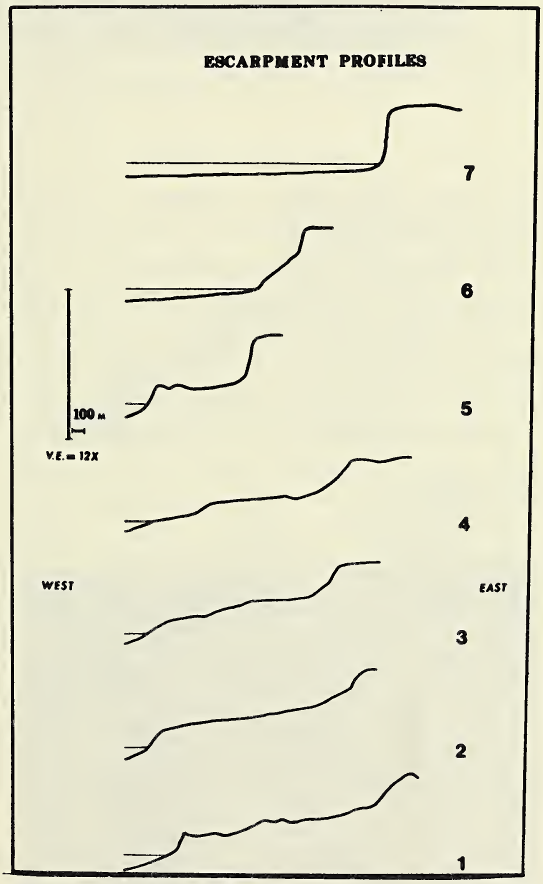

Fig. 2. East-West profiles along escarpment front oriented from south to north (1 to 7).

Fig. 3. View of escarpment front at Bay Shore Park showing park access road and truncated talus slope.

the water's edge and is mantled by a steeply dipping talus slope (Fig. 3). The free face of the dolomite rises approximately 8 to 10 meters above the talus and is well jointed. Large blocks, some the size of houses have been separated along nearly vertical joint planes and occur, in various orientations, downslope. Generally they tilt outward away from the escarpment at the top (Fig. 4). Downslope the size of the blocks decreases over a short distance as they undergo further separation along joint and bedding planes. Rectangular blocks are, for the most part, oriented with their longer axes downslope. Near the base of the slope, although some large blocks several meters across remain, most of the material is much smaller and is mixed with soil (Fig. 5). A low scarp formed

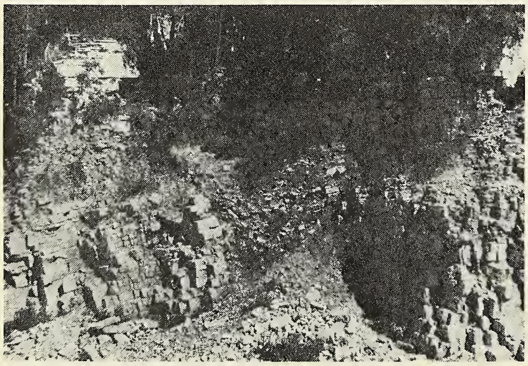

Fig. 4. Large wedge block separated from escarpment front in Bay Shore Park.

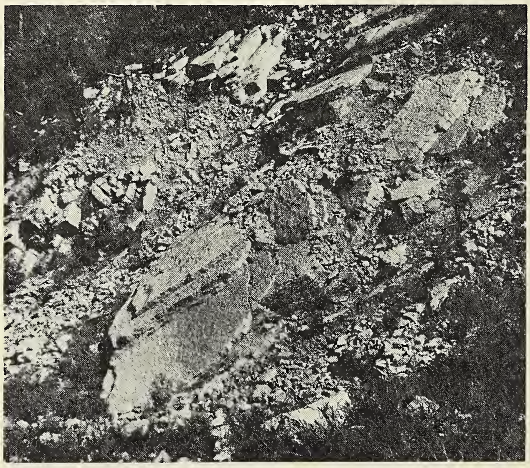

Fig. 5. Typical talus blocks in solifluction apron at base of escarpment in Bay Shore Park.

by wave erosion is found locally at the base of the slope and narrow pebble and cobble beach deposits occur along the water's edge.

The Bay Shore Park road has also exposed the underlying Maquoketa Formation, a soft incompetent clay-rich unit. The exposure appears to show drag and deformation of beds in the upper part of the Maquoketa. The toe of the slope now has been truncated and replaced by fill on which the boat harbor is constructed. North and south of that point the talus slope extends nearly to the water line.

Interpretation

Based upon observations of the escarpment on the UW-Green Bay campus, at several places along its extent, and on the exposure at Bay Shore Park, we believe that there are a number of significant factors that influence the present expression of the bench, and shed light on its origin. These factors are:

1) The presence of talus, expanded joints, and wedge blocks along the escarpment face. The talus slope is tree covered and is now nearly stable. There are some indications of movement (such as tilted trees) but these appear to be minor adjustments possibly related to wave erosion of the toe of the slope. Little new talus is being added.

2) The presence of the incompetent and relatively impermeable Maquoketa Formation below the dolomite. At Bay Shore Park, the exposed upper beds of the Maquoketa are deformed and have shifted downslope. On campus, the Maquoketa is covered but the upper contact is marked by a series of springs and seeps along the escarpment bench.

3) The relationship of the escarpment face to the Bay shore. Where the dolomite is near the shore the slope of the talus is steeper as only the upper part of the feature remains. Where the escarpment is situated a considerable distance from the shore the feature is broader.

4) The feature appears to be controlled to some extent by post-glacial relief, and the thickness of the dolomite beds at the escarpment edge. Locations of high relief and thick dolomite exhibit greater volumes of talus and in some instances larger block failures.

5) Modification of the bench by human activity. In places buildings have been constructed on the bench and the surface has been altered by grading. On the UW-Green Bay campus the escarpment face has been quarried for lime and building material at least as long ago as early in this century. The upper part of the talus slope has been removed and the feature substantially modified.

Based upon our interpretation of these factors, we propose that the feature origi-

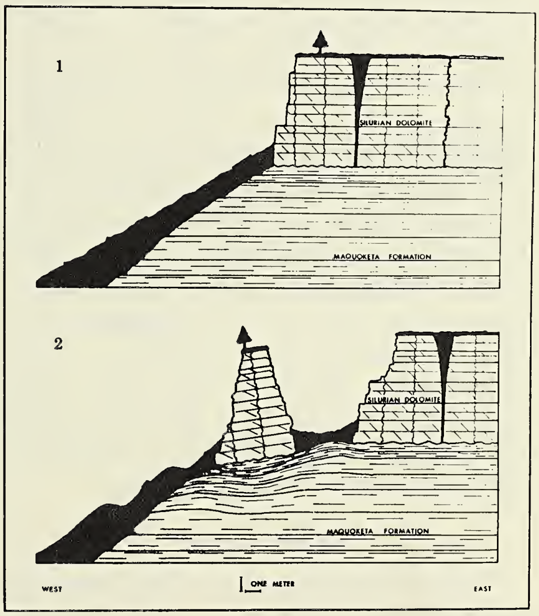

Fig. 6-1. (above) Schematic representation of original escarpment profile and talus slope.

Fig. 6-2. (below) Schematic representation of escarpment front modified by severe periglacial conditions. Note the adjustment of the wedge blocks and talus overlying the Maquoketa Formation.

nated as a talus slope during severe periglacial conditions (Fig. 6-1. Ice-wedging and shattering separated talus blocks from the escarpment face along intersecting vertical joint planes. In some cases very large blocks appear to have been aided in their separation from the dolomite by the failure, along the upper surface, of the underlying shale. Similar talus accumulations and blocks have been reported from Silurian dolomite in eastern Iowa by Hedges (1972), and in Ontario by Straw (1966), and from a much more resistant quartzite in the Baraboo area of southern Wisconsin by Black (1964) and Smith (1949). In each case the features are thought to be consequences of periglacial processes operating during severe glacial climatic episodes.

The next stage in the development of the fringing bench involved solifluction and movement of talus and other loose debris downslope (Fig. 6-2). Originally the base of the talus slope was developed on the Maquoketa Formation and adjustments appear to have occurred on that unit. Solifluction is suggested by the local origin of the angular blocks of dolomite, the mixing of soil and rock, and the distortion of shale layers. The feature is now nearly stabilized as evidenced by vegetation and the presence of structures on the debris-covered talus slope. Movement of the talus is also suggested by the finer material downslope forming a well-defined bench. Where the talus slope closely approaches the Bay shore the lower part of the feature is not preserved, perhaps having been eliminated by wave action.

Significance

Features found along the base of the escarpment are significant for several reasons. If our interpretation of the origin of the talus and the bench at the base of the escarpment is correct, periglacial conditions prevailed in the area during late Wisconsinan time. Black (1964) has mapped the location of periglacial features, including block fields, in Wisconsin and with one exception they are all preserved south of the Woodfordian boundary and were apparently formed under conditions associated with advance of the ice to that position. To our knowledge, no periglacial features have been documented from northeastern Wisconsin and in fact none have been reported from Port Huron or younger materials.

The severe periglacial conditions postulated for northeastern Wisconsin are consistent with reconstructions of climate along the entire ice sheet margin (Péwé, 1973). Paleobotanical evidence (pollen, primarily) indicates that Laurentide ice sheet was bordered by a relatively narrow zone of tundra or taiga-tundra. And, fossilized remains of ice-wedges (and an occasional pingo) suggest that the tundra was sporadically underlain by permafrost. Typically, relic frozen ground features are interpreted as having developed either in nonglaciated regions near the ice front or in drift during deglaciation. It is reasonable to expect that climatic conditions responsible for ice-wedge development would also trigger severe talus activity. This activity would be most pronounced in outcrops exhibiting a favorable geologic structure such as the Silurian escarpment.

It appears that if the talus and bench had formed prior to the last ice advance down the axis of Green Bay, they would have been removed or extensively modified by the ice. However, thick deposits of sand with some coarser and finer beds or lenses are found filling major reentrants in the escarpment that served as drainageways for meltwater. These clastics are covered by a red till and either formed during the retreat of Port Huron ice or in advance of Greatlakean ice. This may suggest that the talus escaped destruction by later, thin ice. We have not found evidence that the sands are younger than the talus. In fact we have not observed the two in contact nor any apparent deformation of the talus by ice.

Following retreat of the ice from the Two

Rivers till limit (Evenson and others, 1976), the waters ponded in Green Bay apparently drained through a series of progressively more northerly outlets until the northern Bay was free of ice. Sometime prior to 11,000 BP temporary stabilization of the ice front along the Sands-Sturgeon moraine in Upper Michigan at the northwestern end of Green Bay (Saarnisto, 1974) may have coincided with periglacial type conditions in parts of northeastern Wisconsin. The Sands-Sturgeon moraine is approximately 120-140 km north of our study area.

Escarpment front features are significant not only in regional glacial history but also to contemporary engineering problems. Much of northeastern Wisconsin, including the escarpment, is experiencing pressures from development. A wide variety of structures are being built along the base or on top of the escarpment. Failure to recognize the presence of buried coarse talus may result in differential support for foundations triggering uneven settling and structural damage. Furthermore, it is possible that structures built on top of the escarpment might be sited on blocks that have separated from the massive rock along expanded joints. Because of the conditions described in this report, such blocks may become unstable under the proper combinations of load and water content.

Finally, the features described here supply evidence of the mechanisms modifying the escarpment front and causing retreat since the last glaciation. [These are subjects of ongoing investigations.]

Literature Cited

Black, R. F. 1964. Periglacial phenomena of Wisconsin, North-Central United States. International Association of Quaternary Research, Report 4:21-28.

Evenson, E. B., W. R. Ferrand, D. F. Eichman, D. M. Mickelson, and L. J. Maher. 1976. Greatlakean Substage: A replacement for Valderan Substage in the Lake Michigan Basin. Quaternary Research 6:411-424.

Hedges, J. 1972. Expanded joints and other periglacial phenomena along the Niagara Escarpment. Bulletyn Peryglacjalny, No. 21: 87-126.

Péwé, T. L. 1973. Ice-Wedge casts and past permafrost distribution in North America. Geoforum 15:15-26.

Saarnisto, M. 1974. The deglaciation history of the Lake Superior Region and its climatic implications. Quaternary Research 4:316-339.

Smith, H. T. H. 1949. Periglacial features in the Driftless Area of Southern Wisconsin. Jour. Geol. 57:196-215.

Straw, A. 1966. Periglacial mass-movement on the Niagara Escarpment near Meaford, Grey County. Geographical Bull., Vol. VIII (4):369-376.

TYPE C BOTULISM LOSSES AT HORICON NATIONAL WILDLIFE REFUGE, 1978[1]

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Abstract

Avian botulism was responsible for the death of over 6,000 waterfowl at Horicon National Wildlife Refuge in Wisconsin in 1978. The outbreak occurred in early fall on a flooded 250 hectare fallow agricultural area, on the northeast end of the refuge. The species most severely affected was the green-winged teal (*Anas carolinensis*), which made up almost 45% of the total birds found. Carcass pick-up, mouse toxicity tests, and antitoxin injections of waterfowl are discussed.

Introduction

Avian botulism (also known as "western duck sickness" and "limberneck disease") has been recognized as a major cause of mortality in wild waterfowl since the early 1900's (Kalmbach and Gunderson, 1934). The lethal toxin produced by the bacterium *Clostridium botulinum,* type C, affects the nervous system and affected birds often lose control of their neck musculature; hence the synonym "limberneck" disease. The combination of high temperature, a shallow aquatic environment, decaying vegetable matter, and the presence of *C. botulinum* may precipitate an outbreak at almost any time, but outbreaks generally occur in late summer or early fall (Rosen, 1971). Lands flooded by heavy rains or pumping that form large expanses of shallow waters appear to be particularly vulnerable. These bodies of water create an anaerobic environment with increased proteinaceous matter that provides conditions conducive to the growth of the *C. botulinum* bacteria and to toxin production. Shorebirds and puddle ducks are the principal victims of the disease since their feeding characteristics bring them into the shallow areas where invertebrates containing toxin are most abundant. Millions of waterfowl have succumbed to botulism over the years in North America (Jensen and Williams, 1964). This paper describes losses from type C botulism at Horicon National Wildlife Refuge (NWR) in Dodge County, Wisconsin, in September and October 1978 when over 6,000 waterfowl died.

Area and Methods

Mortality of waterfowl was first detected on 29 September 1978 by Horicon NWR personnel patrolling the area by air boat. The affected site was about 250 hectares of a flooded fallow agricultural area along Wisconsin Highway 49 east of Waupun. The National Wildlife Health Laboratory (NWHL) at Madison was notified and staff members began an investigation on 30 September. Carcass pickup was immediately initiated to (1) avoid attraction ("decoy

[1] A contribution from USDI Fish and Wildlife Service project 1210-903.02 and 1210-901.04.

[2] Current location Trempealeau National Wildlife Refuge.

effect") of susceptible waterfowl into the area, and (2) eliminate dead birds as contributory factors to *C. botulinum* growth and as toxin-concentrating sources for the fly maggots that susceptible birds might ingest (Duncan and Jensen, 1976). The pickup of carcasses continued for about 3 weeks until losses began decreasing by mid-October. The recovery of moribund and dead birds was accomplished using 4 airboats, a canoe, an all-terrain vehicle, a helicopter and by personnel on foot (Goose Watch III, 1979). These efforts were most intensive the first ten days of the outbreak and were reduced when it was evident that mortality was subsiding (Fig. 1). Necropsies were performed at the Horicon NWR and at the NWHL. Standard mouse toxicity tests to type the botulinum toxin were conducted by the bacteriology section of the NWHL according to the procedure of Quortrup and Sudheimer (1943). The tests involved inoculating 0.5 ml of sera from each bird into two mice, one of which was protected by antitoxin. Death of the unprotected and survival of the protected mice is considered diagnostic for type C botulism. Periodic necropsies performed during the die-off indicated that mortality from other diseases was not occurring. Carcasses retrieved during the pickup operations were burned daily. Sick birds (243 ducks, 24 Canada geese, 22 coots and 2 shorebirds) were housed in cages converted to "hospital" facilities. Most of these sick birds received botulism antitoxin to assist in their recovery. Ducks were injected intraperitoneally with 0.5 ml and the Canada geese (*Branta canadensis*) with 1.0 ml of the Type C antitoxin. All birds were

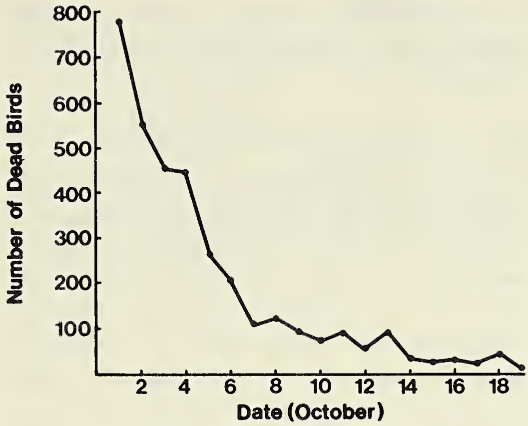

Fig. 1. Daily pick up of waterfowl carcasses at the Horicon NWR during an avian botulism outbreak in October 1978.

TABLE 1. Number of birds collected during the type C botulism die-off at Horicon NWR (30 September-23 October 1978)

Species	*Sex* *Male*	*Female*	*Unknown*	*Total*	*%*
Green-winged Teal	1249	955	719	2923	44.9
Wigeon	424	237	334	995	15.3
Blue-winged Teal	134	172	287	593	9.4
Mallard	75	119	203	397	6.1
Shoveler	31	30	22	83	1.3
Pintail	39	40	16	95	1.5
Wood Ducks	59	12	4	75	1.2
Canada Geese	50	31	30	111	1.7
Coots	—	—	557	557	8.5
Shore Birds	—	—	424	424	6.5
Unknown Ducks	—	—	231	231	3.5
Other Ducks	—	—	33	33	0.5
				6517	

allowed to leave the cages when recovered, except that the Canada geese were physically released.

Results and Discussion

From 30 September to 23 October 1978, 6,517 waterfowl and shorebirds were incinerated at Horicon NWR (Table 1). Losses were heaviest early in the botulism die-off with 61% of the total carcasses retrieved during the first 5 days (Fig. 1). Carcasses picked up early in the epizootic were showing signs of decay, indicating that losses may have been occurring for as long as 3 to 4 days before the discovery.

Birds that probably were exposed to food materials most likely to contain toxins of *C. botulinum* suffered the heaviest losses. Green-winged teal (*Anas carolinensis*), the species most affected, accounted for almost 45% of all losses (Table 1). Losses among other dabblers appeared to be proportional to their numbers present in the area. Wigeon (*Mareca americana*), blue-winged teal (*Anas discors*), and mallards (*Anas platyrhynchos*) constituted 30% of the total retrieved. Shovelers (*Spatula clypeata*), Pintail (*Anas acuta*), and Wood ducks (*Aix sponsa*) made up less than 5% of the total. Coots (*Fulva americana*) constituted 8.8% of total losses, while shorebirds accounted for 6.6% of the total. About 30,000 Canada geese were using the area when the botulism outbreak began but the noise and activity from the pickup operations tended to force the geese to other areas of the refuge, where the epizootic was not occurring. The total number of geese incinerated was 111, or 1.7% of the total waterfowl picked up.

Reported waterfowl losses from this die-off exceeded those noted in NWHL and Wisconsin DNR files from earlier die-offs in Wisconsin at Grand River Marsh in 1975, at Green Bay in 1976 and 1977, and at Horicon NWR in 1976. However, comparable botulism losses occurred in 1973 when 5,009 birds were picked up at Horicon NWR and an additional 5,464 were retrieved at nearby Lake Sinnissippi that same year (Bell and Hunt, 1973).

The 1978 die-off subsided by mid-October with the onset of cooler weather (highs in mid-50's and low 60's) and following concentrated removal of the carcasses. Daily pickup of less than 100 birds after 8 October and of less than 50 after 13 October indicated that the die-off was indeed subsiding. Searches of surrounding areas showed that the die-off was confined to the particular portion of the marsh described previously. Total mortality is unknown, but because of the limited area involved, the majority of the carcasses probably were retrieved. Also, all deaths cannot be attributed definitely to botulism since not all birds were necropsied. The daily pickup ended on 19 October and subsequent periodic checks showed that the outbreak was over by the end of October.

Acknowledgments

We thank all personnel at the Horicon NWR and at the NWHL for their conscientious efforts expended during the die-off. The efforts of Wisconsin DNR in providing surveillance of nearby wetlands was also appreciated. Special appreciation is expressed to J. Toijala for his technical assistance in the NWHL bacteriology laboratory and to L. N. Locke for conducting many of the necropsies.

Literature Cited

Bell, J. G. and R. A. Hunt. 1973. Chronology of events—Botulism Type C outbreak—Horicon Area. Unpublished intradepartmental report. Wisc. Dept. Nat. Res. 10 pp.

Duncan, R. M. and W. I. Jensen. 1976. A relationship between avian carcasses and living invertebrates in the epizootiology of avian botulism. J. Wildl. Disease 12:116-126.

Goose Watch III. 1979. Annual progress report. Canada goose reduction project in East-central Wisconsin, U. S. Fish and Wildl. Serv. and Wisconsin DNR, 34 pp.

Jensen, W. I. and C. S. Williams. 1964. Botulism and fowl cholera, *In* Linduska, J. P. (ed). Waterfowl Tomorrow. USDI, Washington, D.C. pp. 333-341.

Kalmbach, E. R. and M. F. Gunderson. 1934. Western duck sickness a form of botulism. USDA Tech. Bull. 411. 81 pp.

Quortrup, E. R., and R. L. Sudheimer. 1943. Detection of botulinus toxin in the blood stream of wild ducks. J. Am. Vet. Med. Assoc. 102:264-266.

Rosen, M. N. 1971. Botulism, *In* Davis J. W., R. C. Anderson, L. Karstad and D. O. Trainer (eds). Infectious and parasitic diseases of wild birds. Iowa State Univ. Press, Ames. pp. 100-117.

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Reid Bryson

MODERN PROPHECY AND THE ACADEMY

REID BRYSON

Presidential Address
April 1981

The theme of this meeting has been "The Sciences, Arts and Letters in the 1980s." I have not heard any comments to the effect that that constitutes a forecast, or prophecy if you will, for we are only a third of the way into 1981. Why not? I believe it is because this is one of those times in history when people are interested in analysis and prediction, and are exposed to prediction and analysis (some cases instant) every day. The news this week included discussion of "leading economics indicators," measures which are supposed to have a predictive capability with respect to the future state of the economy. The latest issue of *Science* contains a discussion of recoverable domestic petroleum reserves, in the context of prediction of when the oil will run out and what our future dependence on imported petroleum will be. With the successful flight of the "Columbia" we heard repeated "predictions" (which I question) of space colonization, lunar mining and the like.

Along with many varieties of prediction in the media we have available, in almost any magazine we pick up, long articles of an analytical nature. How systems work and what they mean must be interesting to large segments of the population or profit-oriented publishers would not print so many examples. Is this different than the Now generation and instant gratification period of the sixties and early seventies? I think so.

I recently visited the Walt Disney Studios in California as a consultant on a new set of exhibits for Disney World. They are building a very expensive layout called the "Experimental Prototype Community of Tomorrow." It is predictive and analytical. There is no question, when one looks at the financial and attendance aspects of Disney World, but that the people involved in the production know what "turns on" the American public as well as huge numbers of foreign visitors. One of my colleagues on this visit to California was Dr. John Gibbons, Director of the Congressional Office of Technology Assessment. He believes that there is, both in Congress and the general public, intense interest in analysis of the world about us and in where things lead us into the future. At the same time there is a great deal of anti-intellectualism and a stupendous amount of misinformation in circulation. That is where the Wisconsin Academy enters the picture, as I shall indicate later.

I've been involved in prediction and scientific prophesy all my adult life, both short-range and long-range. My first experience with operational weather forecasting in 1944 involved a typhoon. Another Air Corps Officer, Bill Plumley, and I were assigned to work at the Navy Weather Central in Hawaii, and our job was to produce a weather forecast for a fleet air strike against Marcus Island. We were working with a junior Navy officer who had been one of my students at the University of Chicago. We had all day to make the forecast, but very little data on which to base the forecast. It was obvious from the beginning, however, that we had to decide how a typhoon would move in the next two days.

During the day we devised a method for constructing an upper air chart using surface observations from ships and islands, built a slide rule to make the calculations, drew the upper air chart which was needed to estimate the movement of the typhoon and concluded that it would not move safely straight westward, but would curve northward towards Marcus Island and the fleet. Just before we were able to send the forecast to the Admiral, the very senior officer in charge of the weather central came in—very drunk. He looked at the forecast for 20 seconds and said, "Typhoons never recurve at this time of the year. Change the forecast." There is only one answer to a senior officer—"Yes, Sir!" He was wrong. The typhoon met the fleet. As I recall about half a dozen aircraft and crews were lost as a consequence. That was the beginning of my nearly four decades of concern with careful analysis and responsible prediction. It was also a rude introduction to what I call anti-intellectualism and misinformation today.

My next prediction of importance involving a typhoon was a much worse case of ignorance or failure to use available knowledge. I had been following a probable typhoon across the Pacific for ten days. When it passed south of Guam it was quite evident that the "probable" had to be changed to "certain." I ordered a reconnaissance by air, and the aircrew radioed back from the eye that it was very severe and gave the exact location. It was clearly beginning to curve northward and again it was headed towards a large naval concentration. I immediately contacted the fleet weather central on Saipan. They replied, "We don't believe you." I repeated the observational facts. They still didn't believe but said they would watch. I found out later that when the Navy aerologists finally decided I was right and contacted the Admiral with the information that the fleet and the typhoon would rendezvous in a few hours, he replied, "I don't believe any aerologist. Maintain present course." They rendezvoused with the typhoon. Four destroyers were lost along with 250 aircraft, 1700 men and half a cruiser. You may have read a novel about that storm. It was called "The Caine Mutiny." It really happened—due to anti-intellectualism, misinformation, and in my opinion a large dose of stupidity.

Years later Prof. John Thomson, a past president of this Academy, Prof. Robert Ragotzkie, Dr. James Larsen and I camped with a group of Eskimos, called the Utkusiksalingmiut, at the mouth of the Back River in Arctic Canada. We noticed that the forty Eskimos included only four able-bodied adult male hunters and no teenagers who could replace the hunters if they were lost. One dead hunter would represent a 25% reduction in food supply. When we got back to Baker Lake, we reported this to the Department of Northern Affairs people who were responsible for the welfare of the Eskimos. They said they had not visited the Utkusiksalingmiut, but that they would.

We flew over the Eskimo camp each year or so for the next few years and counted the people. The forty dwindled to seventeen, then eleven, then none. Later I saw these same officials and asked if they had visited that group of Eskimos. They answered, "No, but we intend to." Too late. They were gone, presumably by starvation.

With solid information available, with simple rational analysis, with fairly obvious consequences predictable, why do important events still come as disasters which could have been avoided?

The Wisconsin Academy of Sciences, Arts, and Letters was chartered in 1870 to promote Sciences, Arts, and Letters in the State of Wisconsin. Sciences, Arts, and Letters have flourished in the century since, so much so that constant learning is now necessary to keep up with the "explosion" of knowledge, of books, and of art. How many of the issues that face us today, both in the state and in the world, were even discussed when most of us were in school? If we are to make rational assessments of the issues we must have the background of knowledge and the analytical skills which are necessary. If we are to choose between the variety of predictions of the future in order to plot our own course, we must each have our own internal "nonsense detector." If we are to know who we are and where we came from we must *understand* our heritage and what our artists and writers are saying. If we are to comprehend the world around us, we must understand science as well. If we are to face the future with wisdom, we must combine all these in a rational assessment.

The challenge to the Wisconsin Academy of Sciences, Arts, and Letters is greater than it was in 1870. Let us mobilize our efforts to maintain the Wisconsin tradition of an enlightened citizenry as we face a future of rapid change, in a crowded world full of unknowns. With knowledge we can reduce the uncertainty and make Wisconsin an even better place to live.

FACTORS AFFECTING WATERFOWL USE AND PRODUCTION ON MAN-MADE FLOWAGES IN CENTRAL WISCONSIN

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Abstract

Factors affecting waterfowl use and production on 3 man-made flowages (B Flowage, D Flowage, MV Flowage) in central Wisconsin were studied from April 1975—August 1976. Production of ducklings on the 3 flowages combined was 3-8 times lower than reported from natural wetlands in southern Wisconsin. This overall low production was directly related to poor soil and water fertility. Flowage soils were acidic; water was very soft, and both were low in nutrient content. Poor fertility resulted in low invertebrate populations that, on 2 flowages, were largely unavailable to puddle ducks during the breeding and brood-rearing periods. However, waterfowl use days on B Flowage were 6 times that of D Flowage and 12 times the use on MV Flowage. Further, duckling production on B Flowage was 25-32 and 4-5 times that of D and MV Flowage, respectively. Soil and water fertility were not substantially greater on B than on D and MV Flowages, but plant and invertebrate foods were of better quality and more available due to shallower water levels. Puddle duck production and use of flowages in nutrient-poor regions can be increased through manipulation of water levels to increase availability of potentially limiting food supplies to spring migrants, breeding puddle duck hens, and developing ducklings.

INTRODUCTION

Waterfowl habitat in Wisconsin has diminished greatly. Jahn and Hunt (1964) reported destruction of approximately one-half of Wisconsin's original 2,025,000 ha of wetlands. Bennett (1977) estimated a 3% annual drainage rate of privately owned wetlands in 13 southeastern Wisconsin counties while Wheeler and March (1979) reported a 9% loss in wetland acreage during a 3-year study in southeastern Wisconsin.

This habitat loss emphasizes the need for protection and management of remaining wetlands if present population levels and recreational uses of Wisconsin's waterfowl resources are to continue. The Wisconsin Department of Natural Resources (WDNR) owns an estimated 108,540 ha of wetlands (King 1971) with an acquisition goal of an additional 72,495 ha at an estimated cost of $10.5 million (Tyler and Helland 1969). However, March *et al.* (1973) stressed that an investment of this magnitude necessitates knowledge of current and potential waterfowl production and use of existing wetlands. They also stated that increased development and management of state-owned wetlands could increase Wisconsin's duck production by 50%.

Management of man-made impoundments should proceed only after data regarding waterfowl use and production potential have been collected. This study investigated factors affecting waterfowl use and production on 3 man-made impoundments on state-owned wildlife management units in central Wisconsin. Although these units are within a low density production region (Jahn and

Hunt 1964), the factors depressing waterfowl use and production had not been studied intensively. Objectives were (1) to determine waterfowl use, density, composition and production; and (2) to examine soil and water quality, emergent and submergent vegetation, and invertebrate populations.

The study was financed by the WDNR through the Federal Aid in Wildlife Restoration Program. R. Hunt, J. Beule and W. Wheeler (WDNR) contributed suggestions and demonstrations of field techniques. J. Haug (WDNR) provided vehicles, equipment and helpful comments during field work. E. Nelson assisted in all phases of the field work. N. Payne (University of Wisconsin-Stevens Point), R. Owen (University of Maine) and E. G. Bolen (Texas Tech University) reviewed the manuscript.

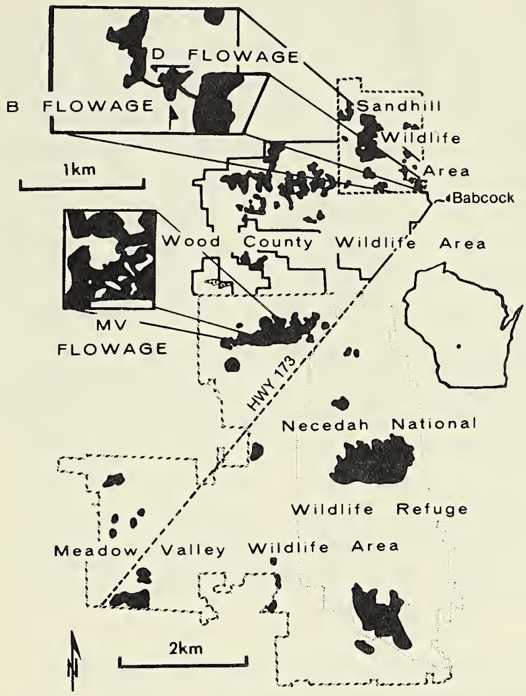

Fig. 1. Location of study flowages showing other wetlands in the area on the state and federal wildlife management units in central Wisconsin.

Study Areas

Two of the study areas (B Flowage and D Flowage) are located on the Sandhill Wildlife Area which is situated in southwestern Wood County, 1.6 km west of Babcock, Wisconsin (Fig. 1). These flowages are located in T2IN, R3E, sections 9 and 10 of Remington Township, Wood County, Wisconsin. B Flowage is a Type IV wetland (Shaw and Fredine 1956), 13 ha in size, and mostly covered by emergent vegetation. D Flowage is a Type V wetland, 37 ha in size, 29 ha of which are open water. The two flowages are connected by a narrow drainage ditch while both are surrounded by upland vegetation, mainly oaks (*Quercus* spp.), aspen (*Populus tremuloides*), and jack pine (*Pinus banksiana*).

The third study area (MV Flowage) is located on the Meadow Valley Wildlife Area which is situated about 9.7 km southwest of the Sandhill Area (Fig. 1). This flowage forms the western boundary of the Meadow Valley Flowage and is located in T20N, R3E, sections 9 and 10 of Kingston Township, Juneau County, Wisconsin. MV Flowage is a Type IV wetland, 53 ha in size, and characterized by emergent vegetation interrupted by several small, shrub-covered islands. The flowage is bordered on the north, east, and west by similar impoundments and to the south by oak-aspen hardwoods.

Methods

Waterfowl Use and Production Estimates

Waterfowl populations were censused between 0430-1300 CST 20 April-8 August 1975 at 7-8 day intervals and from 1 April-24 May 1976 at 2-3 day intervals. Census results were tabulated as use days per species per flowage (1 use day = 1 duck/day/flowage). Breeding pair populations were determined as outlined by Dzubin (1969). Waterfowl nests were located by searching available cover on and within 60 m of each impoundment. Searches were conducted once from 15-21 May 1975 and 2-3 times from

25 April-16 June 1976. Periods of nest initiation were calculated by backdating broods.

Duck broods were censused from tree platforms using a 20-60X spotting scope. Each flowage was censused at least once every 2 weeks from 2 June-23 July 1976, with counts conducted 0.5 hrs before to 1.5 hrs after sunrise or sunset. Brood species was recorded and age class determined (Gollop and Marshall 1954). Duck production represents the number of young/brood to reach age class IIa (18-22 days) or older. A production range was calculated distinguishing resident and transient broods using each flowage. The minimum estimate counted only broods observed 2 or more times on a flowage (residents), whereas the maximum estimate included broods observed only once (transients).

Habitat Analysis (Soil, Water, Vegetation and Invertebrates)

Soil samples were collected from B and D Flowages (4 and 3 sample sites, respectively) on 12 August 1975 and from MV Flowage (5 sample sites) on 30 July 1975. Sample sites were located randomly to provide an even area coverage of each flowage. A core sampler designed by research personnel at the Horicon Marsh Headquarters (WDNR) was used to collect 2 cores/site. The top 7.6 cm from all cores on an individual flowage constituted a composite sample which was frozen until analyzed by the Department of Soil Science, University of Wisconsin-Madison.

Water samples were collected at 2-week intervals, 13 June-15 August 1975 and 31 March-4 August 1976. Samples were taken from surface waters at a station located in the middle and outflow of B Flowage, inflow and middle of D Flowage and the SE, NE, SW, and NW areas of MV Flowage.

Temperature and apparent color were measured in situ using a Hach water analysis kit. Alkalinity, conductivity, turbidity, dissolved oxygen and carbon dioxide were measured at the water analysis laboratory of the Environmental Task Force, University of Wisconsin-Stevens Point (American Public Health Association 1976). Water levels were recorded at 2-7 day intervals at outflow control structures on each flowage.

Emergent vegetation was measured in August 1976 using a series of sample quadrats located within the major vegetative stands on each flowage. Quadrats were 0.25 m^2 and located randomly on transects in the central portion of each stand. Sample size/stand varied dependent on the size of each stand. Parameters measured were (1) number of stems of each species, (2) percent area coverage of each species, and (3) percent area coverage by all species. An importance value (relative density + relative frequency + relative abundance) was calculated for each species within a stand (Cox 1967).

Techniques used to sample submergent vegetation followed Jessen and Lound (1962). Samples were collected from open water areas only and an importance value (relative frequency + relative abundance) was calculated (Cox 1967).

Invertebrates were collected from B Flowage at 2-week intervals, 1 April-8 July 1976 and from D and MV Flowages at 4-week intervals, 15 April-8 July 1976. Sample sites were located randomly in emergent vegetation to provide an even area coverage of each flowage. Samples were taken from the water column (surface samples) and the substrate (bottom samples). At each surface sample site (6 each on B and D Flowages, 9 on MV Flowage) a bottom sample was also taken. Two additional bottom samples were taken on D Flowage and 1 on MV Flowage. Surface samples were taken using a dip net with an area opening of 725 cm^2 and 9 mesh openings/cm^2. Each sample consisted of 4 1-m long sweeps at a depth of 20 cm (0.29 m^3/sample). Bottom samples were collected with a 15.2 cm^2 Ekman grab with 1 grab taken/site (0.02 m^2/sample).

TABLE 1. Waterfowl use days and use days/ha on study flowages in central Wisconsin, 1 April-24 May 1976.[a]

Species	*B Flowage* *13 ha*	*D Flowage* *37 ha*	*MV Flowage* *53 ha*	*Total* *103 ha*	*%* *total*
Mallard	111 (8.5)	128 (3.5)	243 (4.6)	482 (4.7)	8.3
Blue-winged teal	60 (4.6)	108 (2.9)	122 (2.3)	290 (2.8)	5.0
Ring-necked duck	2897 (222.8)	199 (5.4)	404 (7.6)	3500 (34.0)	60.4
Lesser scaup	0 (0.0)	367 (9.9)	11 (0.2)	378 (3.7)	6.5
Canada goose	11 (0.8)	346 (9.4)	245 (4.6)	602 (5.8)	10.4
Other (10 species)[b]	160 (12.3)	305 (8.2)	74 (1.4)	539 (5.2)	9.3

[a] Number in parenthesis is use days/ha.
[b] Green-winged teal (*Anas crecca*), American widgeon (*A. americana*), Shoveler (*A. clypeata*), Wood duck (*Aix sponsa*), Canvasback (*Aythya valisineria*), Common goldeneye (*Bucephala clangula*), Bufflehead (*B. albeola*), American merganser (*Mergus merganser*), Red-breasted merganser (*M. serrator*), Hooded merganser (*M. cucullatus*).

Samples were hand-sorted and invertebrates preserved in 70% isopropyl alcohol. Numbers in each taxon were tabulated and volume determined (Myers and Peterka 1974).

RESULTS AND DISCUSSION

Waterfowl Use and Production Estimates

There were 5791 waterfowl use days (56/ha) on study flowages in 1976, with B Flowage receiving more use than D or MV Flowage (Table 1). Total use days/ha on B Flowage (249) were 6 × D Flowage and 12 × MV Flowage. The ring-necked duck (*Aythya collaris*) comprised 89% of all use on B Flowage while other diving ducks, particularly lesser scaup (*A. affinis*) used D Flowage extensively. Breeding puddle duck (mallard, blue-winged teal) use days/ha was 13.2 on B Flowage versus 6.4 and 6.9 on D and MV Flowages, respectively.

Ring-necked duck use of B Flowage resulted from an abundant food supply. Mendall (1958) reported spring foods of ring-necked ducks in Maine as 89% vegetative matter with burreeds (*Sparganium* spp.) and pondweeds (*Potamogeton* spp.) comprising 31%. These plants were dominant on B Flowage. In contrast, D Flowage lacked vegetation in open water areas and water levels along the shoreline were too shallow to permit feeding by diving ducks.

Lesser scaup use of D Flowage occurred because of deeper water (Fig. 2) and the

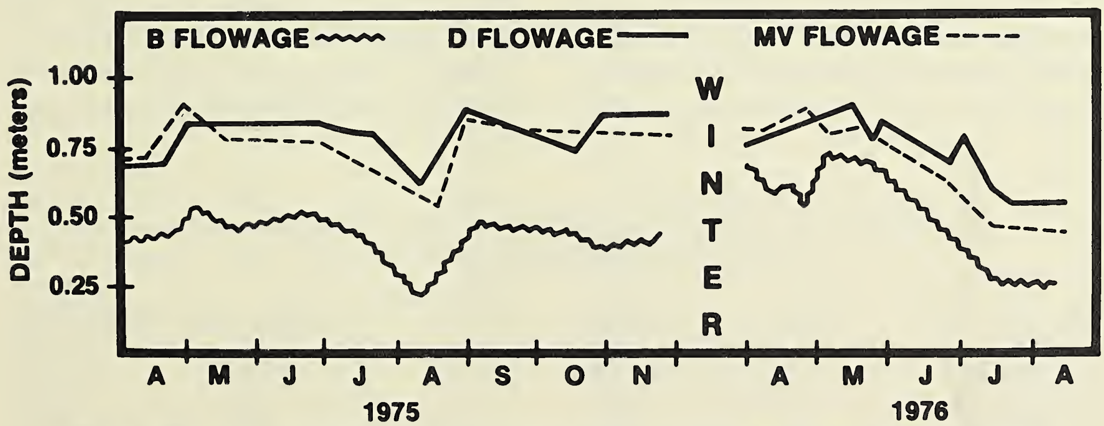

Fig. 2. The water level fluctuations on study flowages in central Wisconsin, 1975 and 1976.

presence of an invertebrate food supply. Bellrose (1976) reported that lesser scaup feed mostly on animal matter and in deeper water than other diving ducks except sea ducks. Invertebrate samples collected on D Flowage contained large leeches (Hirudinea) which were nearly absent from B and MV Flowages. Leeches constitute an important food of lesser scaup (Dirschl 1969, Bartonek and Murdy 1970).

Puddle duck use on all flowages was restricted to areas of shallow water often characterized by emergent vegetation. Water depths on D Flowage exceeded levels recommended by Linde (1969) (Fig. 2) for puddle ducks. Feeding activity occurred in the narrow band of emergent vegetation along the shoreline but as water levels receded during the season this site became unavailable. In contrast, B Flowage received greater puddle duck use/ha because water was shallower and covered with dense stands of quality food plants, most notably manna grass (*Glyceria borealis*) and rice cut-grass (*Leersia oryzoides*).

Deep water restricted feeding sites available to puddle ducks on MV Flowage. Steep-sided dikes surrounded the flowage and did not provide a gradient where shallow water feeding sites could develop. Shallow water sites used by puddle ducks occurred around islands and at the north end of the flowage where an area of upland vegetation between the dike and water allowed development of a shallow water gradient into the flowage.

Restriction of food availability to breeding puddle duck hens is important, particularly when residual seed sources are present. On all flowages, seeds had accumulated in bottom substrates where deep water often rendered them unavailable to puddle ducks (Baldassarre 1980). Seeds provide a ready source of energy (carbohydrates) needed for daily metabolic activity (Bardwell et al. 1962) while protein obtained from invertebrates is used in egg development (Swanson and Meyer 1973). Restriction of residual seed availability may force hens to catabolize valuable protein sources for energy and thus they may not reproduce efficiently, especially if the invertebrate food supply is limiting.

Breeding pair density for all flowages was 0.08/ha in 1975 and 0.10/ha in 1976. Pair density was similar on each flowage (0.08/ha-0.10/ha) except D Flowage in in 1975 (0.02/ha). This density was 6-20 times lower than reported from natural wetlands in southern Wisconsin (Jahn and Hunt 1964). However, although pair density was low, the number of water areas in this region (Fig. 1) may offset a low per ha density and substantially contribute to the state's breeding pair population.

Nest searching (75 hrs) yielded only 3 nests for the 2 years and all were ultimately destroyed by raccoons (*Procyon lotor*). Mallards initiated nests throughout April with a slight peak (24%) occurring in week 3. Blue-winged teal began 59% of their nests from 19-26 May while wood ducks nested from 14-28 April (80%). Although few nests were located, if nest predation is severe its effect may be compounded

TABLE 2. The production per hectare of age Class II and older ducklings on the study flowages in central Wisconsin, 1976.

Flowage	*Hectares*	*Mallard*	*Blue-winged teal*	*Wood duck*	*Total Production/ha*
B Flowage	13	0.5-1.0	0.5	1.5-1.7	2.5-3.2
D Flowage	37	0	0	0-0.1	0-0.1
MV Flowage	53	0.5	0.1	0	0.6

in nutrient-poor regions as renesting hens may have difficulty obtaining sufficient nutrition.

The production of ducklings on all flowages was 0.56-0.73/ha in 1976 (Table 2). Production was highest on B Flowage (2.5-3.2/ha) and lowest on D Flowage (0.0-0.05/ha). Total production per ha was 3-8 times lower than reported in productive marshes in southern Wisconsin (Jahn and Hunt 1964). Jahn and Hunt (1964) considered 2.5 ducklings/ha as good production on quality natural wetlands in that region. Moyle (1961) estimated waterfowl production from soft water areas in Minnesota as 0.31/ha. Although production was low on a per ha basis, this region may be producing a substantial number of fledged ducklings due to the extensive water acreage in the region (Fig. 1).

Habitat Analysis (Soil, Water, Vegetation and Invertebrates)

The soil of each study flowage was strongly acidic, sandy, high in organic matter content and generally low in nutrients (Table 3). Nutrient level requirements for plants in wetland soils are not established, therefore field crop levels were used for comparison (Spencer 1963). Flowage soil levels of nitrate nitrogen, calcium and potassium were low and phosphorus and magnesium were medium when compared to field crop levels. Nutrient levels were also compared to a high quality production area in Wisconsin (Beule and Janisch 1976), where pH and nutrient levels were generally higher than on study flowages.

TABLE 3. The soil analysis of study flowages in central Wisconsin, July and August 1975.

	B Flowage	*D Flowage*	*MV Flowage*
pH	4.9	5.0	4.9
Phosphorus (mg/l)	73	75	33
Calcium (mg/l)	375	400	375
Potassium (mg/l)	38	25	38
Magnesium (mg/l)	100	75	50
Nitrate nitrogen (mg/l)	1.0	4.0	1.0
Sand (%)	81	66	76
Silt (%)	15	28	19
Clay (%)	4	6	5
Organic matter (%)	17	50	12

The high percent of sand and silt comprising study flowage soils is characteristic of Wisconsin's Central Plain Region and is the basic source limiting the fertility of the flowages. Sand and silt are predominantly quartz (SiO_2), a compound usually chemically inactive and therefore of low nutrient supplying capacity (Buckman and Brady 1969).

The high organic content of flowage soils and the fibric to hemic condition of the material limit available fertility because nutrients are accumulating there. When organic matter exceeds about 4% it may become harmful to shallow aquatic systems (Cook and Powers 1958). High nutrient levels often observed shortly after impoundment flooding result from an initial release of soil soluble nutrients and decomposition of preflood vegetation (Whitman 1973). However, as soil conditions become anerobic, the decomposition rate declines, nutrients accumulate in the organic matter and are unavailable for release back into the system (Whitman 1973).

The strongly acidic soil pH accelerates organic matter build-up because decomposition is slowed under acidic conditions (Phillips 1970). Also, anerobic conditions usually exist in submerged organic matter, and decomposition of marsh sediments is often incomplete (Kadlec 1962). Kadlec (1962) suggested that the colloidal content of soil increases with impoundment age as organic matter accumulates. This increases the exchange capacity of that layer, resulting in a loss of nutrients from the water and their accumulation in the soil. Therefore, the accumulation of the limited nutrients present in study flowage soils is of accelerated concern because of initial low fertility.

Water quality of the study flowages was poor (Table 4). Linde (1969) defined unproductive marsh waters in Wisconsin as having an alkalinity less than 10 mg/1. Mean conductivity (24.9 mhos/cm) is below a "low" described by Hem (1970) while a median pH of 6.5 indicated acidic conditions. There was no difference between

TABLE 4. The mean (± SE) value of the water analysis parameters measured on study flowages in central Wisconsin, combining data from 13 June-15 August 1975 and 31 March-4 August 1976.

	B Flowage (n = 36)	*D Flowage (n = 36)*	*MV Flowage (n = 68)*	*All Flowages (n = 140)*
pH (median)	6.6	6.3	6.7	6.5
Alkalinity (mg/1 $CaCO_3$)	8.7 ± 0.5	6.1 ± 0.6	9.2 ± 0.3	8.3 ± 0.3
Conductivity (mhos/cm)	26.6 ± 1.1	21.9 ± 0.8	25.5 ± 0.6	24.9 ± 0.5
Apparent color	145 ± 5	175 ± 8	145 ± 7	153 ± 5
Turbidity (JTU)	1.8 ± 0.2	1.7 ± 0.1	2.2 ± 0.1	2.0 ± 0.1
Dissolved CO_2 (mg/1)	6.1 ± 0.8	6.8 ± 0.6	5.0 ± 0.4	5.7 ± 0.3
Dissolved O_2 (mg/1)	7.0 ± 0.3	7.6 ± 0.3	7.1 ± 0.2	7.2 ± 0.2
Temperature (centigrade)	20.0 ± 1.1	20.2 ± 1.1	19.5 ± 0.8	19.8 ± 0.6

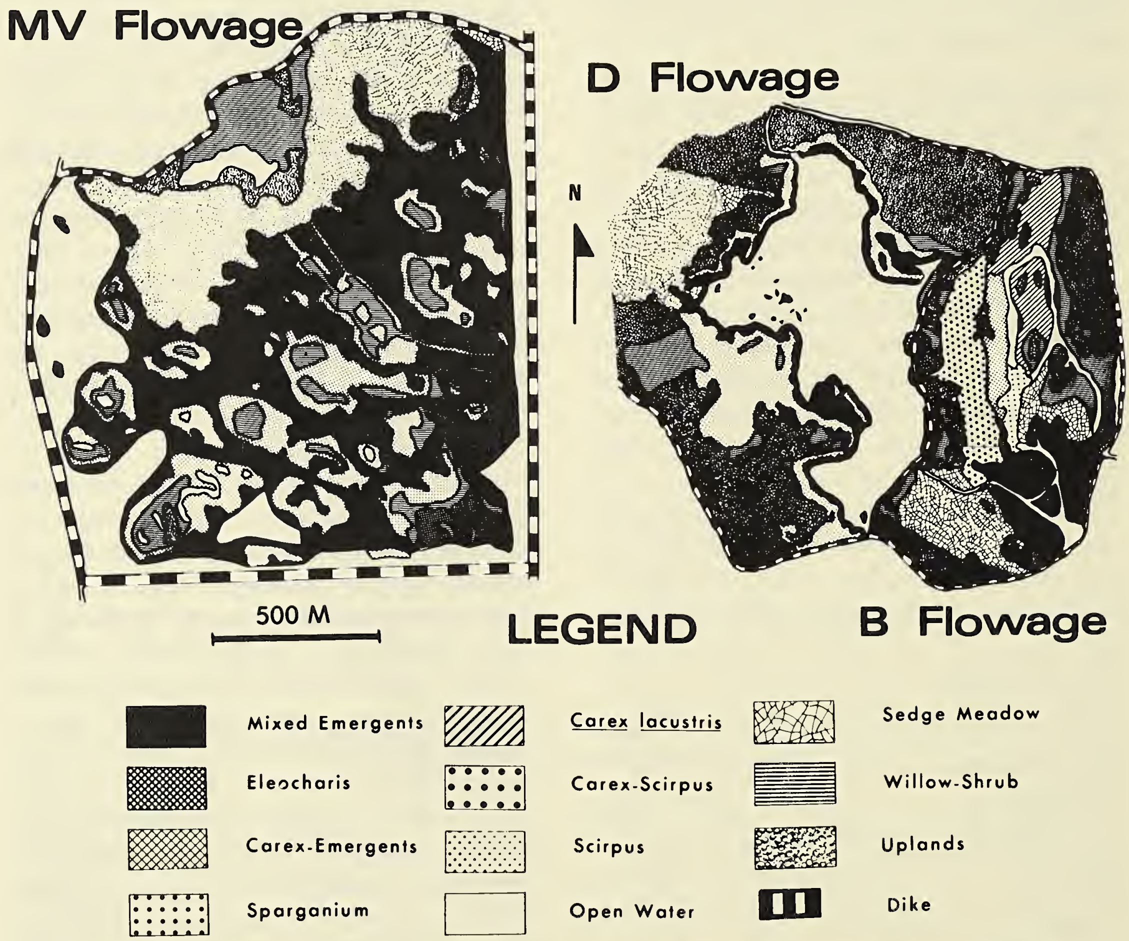

Fig. 3. The vegetative cover type maps of the study flowages in central Wisconsin, 1976.

flowages ($P > 0.05$) in mean temperature, dissolved oxygen or carbon dioxide, but a difference ($P < 0.05$) occurred in mean alkalinity, conductivity, turbidity, color and pH.

Of the major vegetative cover types identified on each study flowage (Fig. 3), only 4 (mixed emergents, Carex-emergents, Eleocharis, Sparganium) were used by feeding waterfowl. Rice cut-grass, a valuable component of the mixed emergents type, and the Sparganium type provided a quality food source on B Flowage (Bellrose 1941, Bellrose and Anderson 1943, Coulter 1955). The Carex-emergents type on MV Flowage covered 10.1 ha, but was not used extensively by puddle ducks, perhaps because *Carex* spp. common in waterfowl marshes do not retain quantities of seed through winter (Coulter 1955). Also, only 0.8% of all seeds collected from 40 bottom invertebrate samples on MV Flowage in 1976 were *Carex* spp. seeds. Stem density for each stand and the major species present are summarized by Baldassarre (1978).

The submergent vegetation of B Flowage was dominated by pondweeds (*Potamogeton* spp.), normally a valuable waterfowl food (Martin and Uhler 1939). Vegetative coverage/sample was 16% but the shallow water may have offset low abundance by increasing food availability, particularly to puddle ducks. In contrast, the submergent community on D Flowage contained little vegetation (4% coverage/sample), thus not producing an abundance of waterfowl food. Also, the deep water almost completely eliminated food availability to puddle ducks which restricted feeding activity to the shallow water band of emergents along the flowage's perimeter.

Submergent vegetation on MV Flowage contained large amounts of vegetation (56% coverage/sample) dominated by pondweeds and waterweed (*Elodea canadensis*). However, waterweed is a low value duck food (Martin et al. 1951) whereas the pondweeds were relatively unavailable to puddle ducks because of deep water.

Invertebrate Populations

The high volume of Chironomidae and Mollusca (78% Gastropoda) in the surface samples on B Flowage (Fig. 4) attracted breeding puddle ducks and duck broods. Many investigators found Mollusca (mainly Gastropoda) and Chironomidae to be important foods of breeding puddle ducks and young ducklings (Krapu 1974, Swanson et al. 1974). Krapu and Swanson (1975) found these taxa to be rich sources of protein and calcium, while Swanson and Meyer (1973) reported that Chronomidae, along

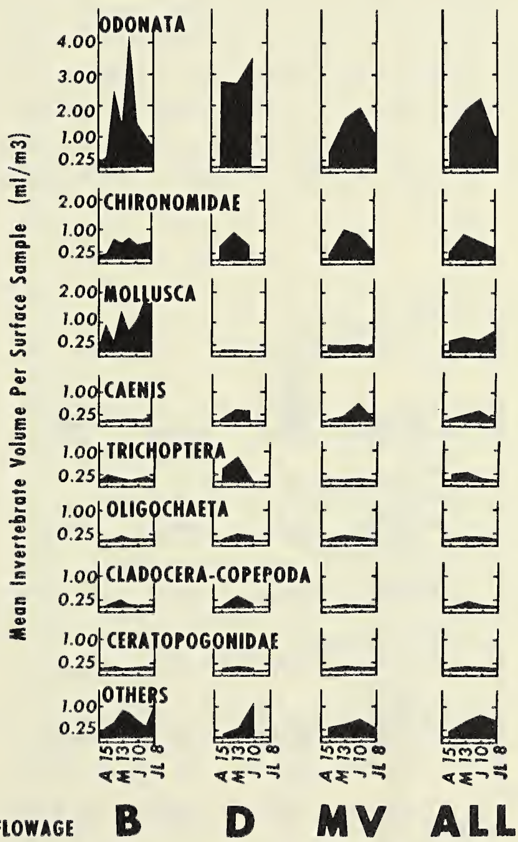

Fig. 4. The mean volume (ml/m^3) of invertebrate taxa collected from the surface samples on B Flowage (n = 6), D Flowage (n = 6), MV Flowage (n = 9) and All Flowages combined (n = 21) in central Wisconsin, 1 April-8 July 1976.

with Corixidae and Gammaridae, provided the most complete range of amino acids based on the requirements of young ducklings. Sugden (1973) stated that the high quality protein provided by Chironomidae larvae is important in the diets of most if not all young ducks.

The shallow water on B Flowage increased the availability of invertebrates, particularly bottom fauna. Sphaeriidae, Chironomidae and other taxa were more abundant than on D or MV Flowages (Fig. 5). The greater abundance and more available taxa in bottom samples on B Flowage may have been the most important factor in attracting broods to this flowage. Swanson and Meyer (1973) stressed the importance of shallow water in increasing invertebrate availability to feeding puddle ducks. High invertebrate populations on B Flowage resulted from the interspersion of shallow water with dense emergent vegetation. Voigts (1976) found high invertebrate populations

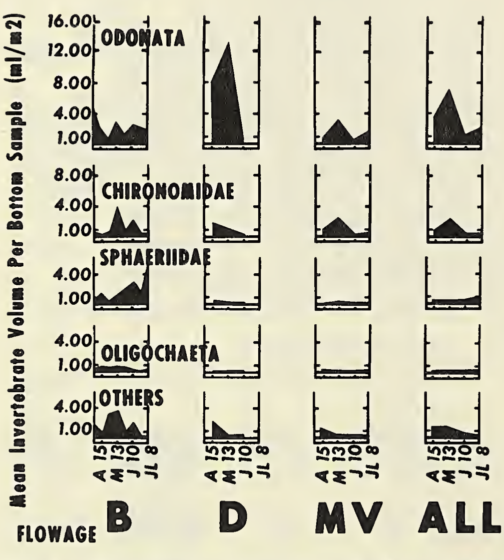

Fig. 5. The mean volume (ml/m²) of invertebrate taxa collected from the bottom samples on B Flowage (n = 6), D Flowage (n = 6), MV Flowage (n = 10) and All Flowages combined (n = 22) in central Wisconsin, 1 April-8 July 1976.

in areas of open water interspersed with emergents. Schroeder (1972) recorded greatest invertebrate abundance in shallow "feather edge" areas of emergents.

Periodic drying and flooding of emergent vegetation also increased invertebrate abundance on B Flowage because much of the vegetation was exposed as water levels receded through summer but was reflooded in spring. These fluctuations also caused the high surface invertebrate populations on D Flowage as all sites were located in shoreline emergents subjected to water fluctuation. Swanson et al. (1974) stated that high invertebrate populations occur when spring runoff water inundates dead vegetation from the previous year. This creates a "hay infusion" which promotes high invertebrate biomass due to the rapid breakdown and utilization of stored organic matter.

The deep open water area on D Flowage characterized by sparse submergent vegetation contained few free-swimming invertebrates. Invertebrate populations on MV Flowage were subjected to these same environmental influences (water fluctuation and substrate); however, population abundance was limited by steep-sided dikes which restricted water fluctuation and invertebrate availability.

Water level fluctuations also were important in determining invertebrate availability. For example, during the 4th week of May 1976 the flowage immediately north of MV Flowage was subjected to complete drawdown. The drawdown greatly increased duck and waterbird use because shallow water increased food availability (Baldassarre 1980). Swanson and Meyer (1977) found that receding water levels create a short term increase in invertebrate availability due to shallow water and concentration of organisms within a reduced water volume. The increase of food availability in nutrient-poor aquatic ecosystems may be of compounded importance to breeding puddle ducks as increased availability may somewhat offset the low food abundance as compared to a more fertile marsh.

The comparatively low invertebrate biomass on study flowages is probably the single most important factor limiting waterfowl production. Krull (1976) reported a mean volume of invertebrates collected from bottom samples in New York marshes as 2-4 times the mean volume of All Flowages and up to 9 times that of any individual flowage. The bottom invertebrate populations on Type 4 wetlands in Wisconsin's Horicon Marsh region (Wheeler and March 1979) were 13-38 times that on all flowages while surface sample volumes averaged 4-10 times greater.

Management Recommendations

The poor flowage fertility will always limit invertebrate abundance; therefore, management should be directed toward increasing invertebrate and plant food availability. During the puddle duck breeding season flowage water levels should be <30 cm, thus increasing food availability.

Selected flowages could be drawn-down during the peak spring migration periods, thus creating a highly available food supply which may attract additional breeding pairs to the area. Higher water levels should be maintained in some flowages to insure a water supply throughout the brood rearing season.

Also, to stimulate soil and water fertility, each flowage should undergo a complete drawdown on a 5-7 year rotational basis (Whitman 1976). The first drawdown should span 2 growing seasons to maximize the decomposition of the heavy organic matter accumulation.

References Cited

American Public Health Association. 1976. Standard methods for examination of water and wastewater (14th ed.). Wash., D.C., 1193 pp.

Baldassarre, G. A. 1978. Ecological factors affecting waterfowl production on three man-made flowages in central Wisconsin. M.S. Thesis. Univ. Wisc.-Stevens Point. 124 pp.

———. 1980. Residual seeds as potential spring waterfowl foods in small, man-made impoundments. Prairie Natl. 21:1-8.

Bardwell, J. L., Jr., L. L. Glasgow, and E. A. Epps, Jr. 1962. Nutritional analyses of foods eaten by pintail and teal in south Louisiana. Proc. S.E. Assoc. Game and Fish Comm. 16:209-217.

Bartonek, J. C., and H. W. Murdy. 1970. Summer foods of lesser scaup in subarctic taiga. Arctic 23:35-44.

Bellrose, F. C. 1941. Duck food plants of the Illinois River Valley. Illinois Nat. Hist. Survey Bull. 21:235-280.

———, and H. G. Anderson. 1943. Preferential rating of duck food plants. Illinois Nat. Hist. Survey Bull. 22:417-433.

———. 1976. Ducks, geese and swans of North America. Stackpole Books. Harrisburg, Pa. 543 pp.

Bennett, A. J. 1977. The present status and future of sandhill cranes in southeastern Wisconsin. Pages 86-93 *in* Eastern greater sandhill crane symposium.

Beule, J. D., and T. Janisch. 1976. Soil sediment survey. Performance Report. P-R project W-141-R-11, Study 304.3. Wisc. Dept. Nat. Res. 3 pp.

Buckman, H. O., and N. C. Brady. 1969. The nature and property of soils. Macmillan Co., New York. 653 pp.

Cook, A. H., and C. F. Powers. 1958. Early biochemical changes in the soils and waters of artificially created marshes in New York. New York Fish and Game J. 5:9-65.

Coulter, M. W. 1955. Spring food habits of surface feeding ducks in Maine. J. Wildl. Manage. 19:263-267.

Cox, G. W. 1967. Laboratory manual of general ecology. W. C. Brown Co., Dubuque, Iowa. 165 pp.

Dirschl, H. J. 1969. Foods of lesser scaup and blue-winged teal in the Saskatchewan River Delta. J. Wildl. Manage. 33:77-87.

Dzubin, A. 1969. Assessing breeding populations of ducks by ground counts. Pages 178-230 *in* Saskatoon Wetlands Seminar. Can. Wildl. Serv. Rept. Series 6. 262 pp.

Gollop, J. B., and W. H. Marshall. 1954. A guide to aging duck broods in the field. Miss. Flyway Tech. Bull. 14 pp. mimeo.

Hem, J. D. 1970. Study and interpretation of the chemical characteristics of natural water (2nd ed.). U.S. Geol. Survey Water-Supply Paper 1473. 363 pp.

Jahn, L. R., and R. A. Hunt. 1964. Duck and coot ecology and management in Wisconsin. Wisc. Conserv. Dept. Tech. Bull. 33. 212 pp.

Jessen, R., and R. Lound. 1962. An evaluation of a survey technique for submerged aquatic plants. Minn. Dept. Conserv., Game Investigation Rept. 6. 10 pp.

Kadlek, J. A. 1962. Effects of a drawdown on a waterfowl impoundment. Ecology 43:267-281.

King, F. H. 1971. Existing state wetland programs for fish and game management and state forests and parks. Wisc. Dept. Nat. Res. 4 pp. mimeo.

Krapu, G. L. 1974. Feeding ecology of pintail hens during reproduction. Auk 91:278-290.

———, and G. A. Swanson. 1975. Some nutritional aspects of reproduction in prairie nesting pintails. J. Wildl. Manage. 39:156-162.

Krull, J. N. 1976. Abundance and diversity of benthos during the spring waterfowl migration. Am. Midl. Nat. 95:459-462.

Linde, A. F. 1969. Techniques for wetland management. Wisc. Dept. Nat. Res. Research Rept. 45. 159 pp.

March, J. R., G. F. Martz, and R. A. Hunt. 1973. Breeding duck populations and habitat in Wisconsin. Wisc. Dept. Nat. Res. Tech. Bull. 68. 36 pp.

Martin, A. C., and F. M. Uhler. 1939. Food of game ducks in the United States and Canada. U.S. Dept. Agric. Tech. Bull. 634. 308 pp.

———, H. S. Zim, and A. L. Nelson. 1951. American wildlife and plants. McGraw-Hill Co., New York. 500 pp.

Mendall, H. L. 1958. The ring-necked duck in the northeast. Univ. Maine Studies, Second Series, No. 73. 317 pp.

Moyle, J. B. 1961. Aquatic invertebrates as related to larger water plants and waterfowl. Minn. Dept. Conserv. Invest. Rept. 233. 24 pp. mimeo.

Myers, G. L., and J. J. Peterka. 1974. A syringe volumetric measuring device. J. Fish. Res. Board Can. 31:1160-1161.

Phillips, J. 1970. Wisconsin's wetland soils. Wisc. Dept. Nat. Res., Research Rept. 57. 22 pp.

Shaw, S. P., and C. G. Fredine. 1956. Wetlands of the United States: their extent and value to waterfowl and other wildlife. U.S. Fish and Wildl. Serv. Circ. 39. 67 pp.

Schroeder, L. 1972. Effects of invertebrate utilization on waterfowl production. M.S. Thesis, Colorado State Univ., Fort Collins. 84 pp.

Spencer, H. E. 1963. Man-made marshes for Maine waterfowl. Maine Dept. Inland Fish. and Game Bull. 9. 79 pp.

Sugden, L. G. 1973. Feeding ecology of pintail, gadwall, American widgeon and lesser scaup ducklings. Can. Wildl. Serv. Rept. Series 24. 45 pp.

Swanson, G. A., and M. I. Meyer. 1973. The role of invertebrates in the feeding ecology of Anatinae during the breeding season. Pages 143-177 *in* The waterfowl habitat management symposium at Moncton, New Brunswick. 306 pp.

———, ———, and J. R. Serie. 1974. Feeding ecology of breeding blue-winged teals. J. Wildl. Manage. 38:396-407.

———, ———. 1977. Impact of fluctuating water levels on feeding ecology of breeding blue-winged teal. J. Wildl. Manage. 41:426-433.

Tyler, D. K., and S. P. Helland. 1969. Report on land acquisition program. Wisc. Dept. Nat. Res. 74 pp. multilith.

Voigts, D. K. 1976. Aquatic invertebrate abundance in relation to changing marsh vegetation. Am. Midl. Nat. 95:313-322.

Wheeler, W. E., and J. R. March. 1979. Characteristics of scattered wetlands in relation to duck production in southeastern Wisconsin. Wisc. Dept. Nat. Res. Tech. Bull. 116. 61 pp.

Whitman, W. R. 1973. Controlled water level impoundments for waterfowl. Pages 201-207 *in* The waterfowl habitat management symposium at Moncton, New Brunswick. 306 pp.

———. 1976. Impoundments for waterfowl. Can. Wildl. Serv. Occ. Paper 22. 22 pp.

AGE, GROWTH AND TOTAL MORTALITY OF RAINBOW SMELT IN WESTERN LAKE SUPERIOR[1]

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Abstract

Age and growth were determined for 962 rainbow smelt, *Osmerus mordax* (Mitchill), captured from western Lake Superior in 1976 and 1977. The body-scale relationship, based on total length (mm, L) and scale radius (mm, S) was $L = 74.3S + 1.2$. Smelt attained average lengths of 64, 126, 162, 184 and 203 mm at ages 1 through 5 respectively. The length-weight relationship based on total length (mm, L) and weight (g, W) was $\log_{10}W = 3.01 \log_{10}L - 5.351$. Back-calculated mean length at age was greater for females than males at ages 3-5. Mortality rate was estimated from a sample of 3050 smelt captured from western Lake Superior between 1973 and 1977. The overall annual total mortality rate was estimated at 57%. Mortality was 40% during the fourth growing season and 69% during the fifth growing season. The mortality rate of males was higher than females as reflected in a sex ratio for mature smelt of 2.37 females per male. Warmer temperature and high food availability in the Superior-Duluth harbor resulted in faster growth of young-of-the-year smelt than in the lake proper.

Introduction

Rainbow smelt (*Osmerus mordax*) support an important commercial fishery in Lake Superior. Commercial harvest of smelt began in 1952 with a catch of 20 metric tons and rose at a rate of approximately 40% per year until 1963 when production stabilized at about 635 metric tons annually (Baldwin and Saalfeld 1962, plus 1970 supplement). By 1975 smelt accounted for 20% by weight of the total commercial catch from Lake Superior. Eighty-nine percent of the total smelt catch is taken from the western end of the lake (Wisconsin and Minnesota waters). The sport fishery for smelt is also significant as evidenced by the thousands of fishermen who travel to the shores of Lake Superior each spring to catch smelt by seine and dip net during the spawning runs. Smelt are also the primary forage for lake trout (*Salvelinus namaycush*) and other salmonids in Lake Superior where alewives (*Alosa pseudoharengus*) have not become as well established as in the lower Great Lakes (Anderson and Smith 1971).

The purpose of this study was to determine mortality and current growth of rainbow smelt in western Lake Superior for use

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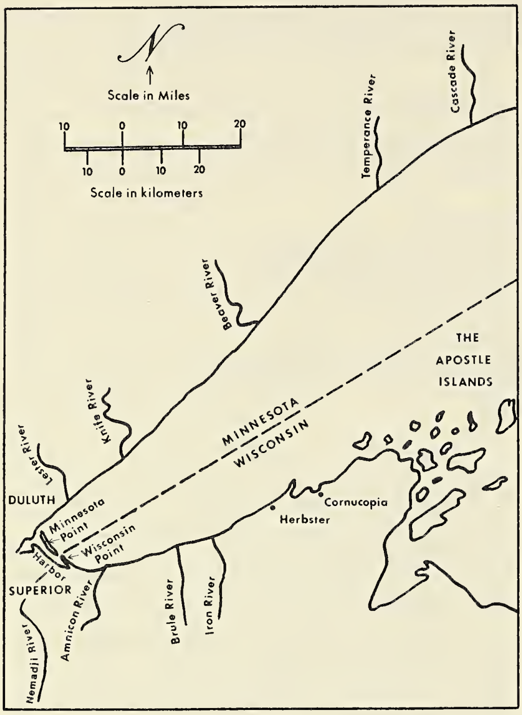

Fig. 1. Study site for the western Lake Superior research.

in continuing studies to determine the role of smelt in the overall ecology of the lake. Growth and abundance of Age 0 rainbow smelt in the open lake and the Superior-Duluth harbor was compared to determine the significance of the harbor as a nursery area.

Growth of smelt in western Lake Superior was estimated by Hale (1960) and Bailey (1964) but mortality estimates have not been presented by these or other authors. In-season growth of young-of-the-year smelt in Lake Superior has not previously been estimated nor has any comparison been made between growth of young smelt in the harbor and in the lake proper.

Methods

Age and Growth

Samples were collected during April-August 1976, 1977 from Superior, Wisconsin to the Beaver River on the north shore and from Superior to the Brule River on the south shore (Fig. 1) at depths of 1 to 40 meters. A total of 611 fish were captured with seines and dip nets during the 1977 spawning season from the following locations: Beaver River (115 fish); Knife River (92 fish); Wisconsin Point (158 fish); Amnicon River (126 fish) and the Brule River (120 fish). Non-spawning fish (351) were captured with semiballoon bottom trawls having 7.6 and 9.5 m headropes. The small net was constructed from 12.7 mm bar mesh with a 6.4 mm cod end liner. Of the 351 non-spawning fish, 322 were captured in the summer of 1976 and 29 in the summer of 1977.

To reduce sampling bias due to strong year classes or smelt segregation by age and size, the subsample of fish to be aged was selected to include adequate numbers of fish at all size intervals between 52 and 242 mm. After preservation in 10% formalin, individual specimens were weighed to the nearest tenth of a gram and measured for total length to the nearest millimeter. Several scales were removed from the right side between the dorsal fin and the lateral line. Scale measurements for age were made under either a light microscope or scale projector, and standardized to mm.

Back-calculations of length at age were based on a linear body-scale relationship. Separate body-scale relationships were estimated for both sexes and a combined sample which included some specimens of indeterminate gender.

The length-weight relationship and the coefficient of condition were estimated. Total length to standard length conversion factors were calculated to allow comparison of the results from this and other studies. The conversion factor was 0.861.

Young-of-the-Year Growth

Using a .571 mm mesh one meter diameter net, age 0 rainbow smelt were collected weekly between 19 May and 18 August 1977. Samples were taken day and night near the surface (0-4 m) over areas 9 m deep east of the mouth of the Nemadji River in the harbor and off Wisconsin and Minnesota points in the lake proper (Fig. 1). A total of 113 samples containing an estimated 22,000 smelt larvae was obtained. A random subsample of up to 100 young-of-the-year rainbow smelt was obtained from each haul and the individual specimens weighed and measured. A total of 2,912 specimens were examined during the sample period.

Mortality

Because smelt segregate by age and show major variations in year class strength as well as seasonal shifts in spatial distribution (MacCallum and Regier 1970; McKenzie 1958, 1964) estimation of mortality is complicated. Mortality of the combined sexes was estimated from postspawning samples collected with 7.6 and 9.5 m trawls near Wisconsin and Minnesota points during May and June, 1973-1977, in water less than 16 m deep. Average mortality for the individual sexes was estimated using 13 trawl samples taken during May and June 1977 from water less than 16 m deep. Random samples from these catches were used with stratified aged samples to estimate population age structure (Ricker 1975). The stratified aged samples were composed of 803 fish captured in 1976 and 1977, including spawners, and were applied to years 1973-1977 under the assumption that growth rate did not change significantly in that time or within those year classes. Catch curves, percentage survival and mortality were estimated from population structure (Ricker 1975). Average annual total mortality rate (A), annual survival rate (S) and instantaneous mortality rate (Z) were estimated using linear regres-

TABLE 1. Average total length (mm), weight (g) and condition of rainbow smelt in western Lake Superior, 1976-77.

		Statistics at Capture							*Back-Calculated Lengths at Age*				
Sex	*Age Class*	*n*	*Length*	s	*Weight*	*s*	*K*[a]	*s*	*1*	*2*	*3*	*4*	*5*
Males[b]	2	54	141	8.5	15.9	3.5	.559	.048		145			
	3	139	164	13.6	26.3	6.9	.582	.047		125	164		
	4	74	179	12.3	34.1	8.0	.585	.044		121	157	176	
	5	8	186	10.3	35.2	8.1	.539	.058		99	141	172	184
Weighted mean										127	161	176	184
Females[b]	2	87	141	12.0	15.9	4.6	.553	.065		144			
	3	162	168	16.8	27.6	8.3	.570	.063		128	169		
	4	104	188	14.2	38.5	9.4	.572	.061		122	164	190	
	5	27	205	15.6	47.9	10.5	.551	.058		112	151	179	204
Weighted mean										129	166	188	204
Total Sample ...	1	106	101	17.4	6.3	3.1	.556	.069	90				
	2	263	137	14.1	15.1	4.9	.567	.062	69	137			
	3	357	166	15.3	72.1	7.6	.575	.057	57	123	165		
	4	193	186	14.9	37.5	9.3	.575	.055	56	118	160	185	
	5	43	204	17.0	47.2	11.6	.547	.061	55	110	152	181	203
Weighted mean									64	126	162	184	203

[a] K is coefficient of condition computed as: $K = W \times 10^5/L^3$, where W is weight in g and L is total length in mm.

[b] Because of the difficulty in determining sex of immature smelt, the body-scale relationships of males and females were based on models which contained no age one fish and therefore were not used to back-calculate lengths at age one.

sion on the descending limbs of the catch curves (ages 3 to 5). Estimates for specific ages (3 to 4 and 4 to 5) were made using percentage survival from the equation $S = (N_{t+1})/N_t = 1 - A = e^{-Z}$.

Results

Age and Growth

The linear body-scale relationships are defined by:

males	$L = 67.3S + 20.1$	$r^2 = 0.87$
females	$L = 70.8S + 8.8$	$r^2 = 0.87$
total	$L = 74.3S + 1.2$	$r^2 = 0.97$

Average lengths at each annulus were back-calculated for males, females and all fish (Table 1). At each age males were smaller than females. Rate of growth in length (total sample) was fastest during the first (64 mm) and second (62 mm) growing seasons. Later length increments decreased with age.

Weight increments were greatest between ages 2 and 3. At ages 3, 4, and 5 females in the sample were heavier than males. The coefficient of condition for males was higher than females at ages 2, 3 and 4 (Table 1). For both males and females the highest condition coefficient occurred at age 4.

The length-weight relationships are described by the following formulae:

males
$$\log_{10}W = (3.1340) \log_{10}L - 5.5368$$
females
$$\log_{10}W = (3.0021) \log_{10}L - 5.2550$$
total
$$\log_{10}W = (3.0477) \log_{10}L - 5.3510$$

Growth estimates from this study were similar to those for Lake Huron (Baldwin 1950) but slower than that reported for Lake Michigan (Robinson 1973) and the Parker River (Murawski and Cole 1978).

Young-of-the-Year Growth

Average total lengths of Age 0 smelt collected from the harbor and the lake show the harbor accommodated faster growth (Figure 2). Length of Age 0 rainbow smelt in the harbor was defined by the equation $L = 0.231T + 7.738$ with $r^2 = 0.90$ where L = total length in millimeters and T = time in days from May 18, 1977. May 18 was selected as the average date of smelt hatch in western Lake Superior on the basis of spawning and incubation periods. Length of Age 0 rainbow smelt in the lake was described by the equation $L = 0.118t + 6.884$ ($r^2 = 0.69$). Comparison of the two regression lines (Fig. 2) showed that growth in length was significantly faster in the harbor (Neter and Wasserman 1974; $F_{2,19} = 21.43$; $p < .001$).

For the harbor the estimated relationship between average Age 0 smelt weight and time was $W = .0539\ T^{2.23}$ with $r^2 = 0.97$ while the corresponding relationship for the lake was $W = .0501\ T^{1.95}$ with $r^2 = 0.67$ where

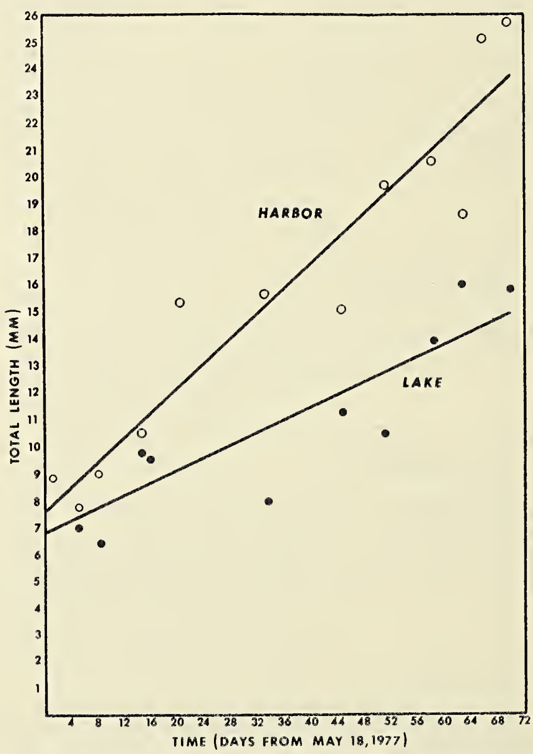

Fig. 2. Comparison of growth in total length of larval smelt in the harbor and in the lake proper.

W = weight in grams $\times 10^4$ and T = time in days from May 18, 1977. After the tenth day, Age 0 smelt in the harbor weighed at least twice as much as those growing in the lake. The rate of growth in weight was significantly faster in the harbor than in the lake proper ($F_{2,17} = 6.76$, $p < .01$).

Mortality

Calculated age distributions for 1973 to 1977 are given in Table 2 and were used to generate catch curves for males, females and the combined sample. An instantaneous total mortality rate (Z) of 0.847, corresponding to an annual rate (A) of 57% was computed for the sexes combined (Table 2). The annual rate for sexes combined between age 3 and age 4 was 40% and between age 4 and age 5 was 69%. The instantaneous mortality rate for males was 1.463 and for females was 0.545. These values corresponded to annual mortality rates of 77% and 42% for the sexes respectively.

The sex ratio, for all postspawning (May, 1977) lake collections in which random samples of smelt were sexed, was 2.37 females to 1 male. There were significantly fewer males in western Lake Superior than expected under the hypothesis that half the population was male and half female ($p < .001$, $\chi^2 = 77.41$, df = 3).

Discussion

The observation that male mortality rate is greater than female mortality is supported by the low ratio of males to females in the shallow water of the lake during the post-spawning period and by studies on Parker River populations by Murawski and Cole (1978). Higher male mortality may be a result of their higher vulnerability to post-spawning die-offs which occur annually in the area (Schaefer 1979). High male mortality rate may also be a result of the rainbow smelt sport fishery in Lake Superior which exerts its greatest pressure during the early portion of the spawning run which is composed principally of males (Bailey 1964).

Several factors could have contributed to the comparatively rapid growth of larval smelt in the harbor. Warm, nutrient-rich water is introduced into the Superior-Duluth harbor by two major rivers. Although this study did not attempt to quantify production of algae or zooplankton, it was evident that the harbor was more productive than the lake. The concentrating cup of the meter net used to sample larval smelt was often filled with zooplankton during collections from the harbor but never during collections from the lake. Temperature profiles showed that water in the harbor averaged 3° C

Table 2. Percent age structure and mortality rate of rainbow smelt in western Lake Superior, 1973-77.

Sample Year	Sex	*n*	Percent At Age *1*	*2*[a]	*3*	*4*	*5*+	*S*	*A*	*Z*
1973	Both	710	7.3	38.2	36.7	15.2	2.6	.266	.734	1.324
1974	Both	303	7.8	26.6	33.8	24.8	7.0	.455	.545	.787
1975	Both	86	12.7	45.9	20.5	9.1	11.8	.759	.241	.276
1976	Both	164	7.4	21.5	42.8	22.6	5.7	.365	.635	1.009
1977	Both	1787	4.3	29.5	33.8	22.7	9.7	.536	.464	.624
1977	Male	288		19.5	50.4	27.4	2.7	.231	.769	1.463
1977	Female	683		23.4	36.9	27.3	12.4	.580	.420	.545
1973-77[b]	Both	2800	6.5	31.4	34.8	20.9	6.4	.429	.571	.847

[a] For males in 1977 and females in 1977 the percent at age two includes both age 1 and age 2 fish.
[b] Because of small sample size, the years 1975 and 1976 were not included.

warmer than near shore water in the lake which also may have promoted faster growth.

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References Cited

Anderson, E. D. and L. L. Smith, Jr. 1971. A synoptic study of food habits of 30 fish species from western Lake Superior. Tech Bull. 279:36-49. Minnesota Agricultural Experimental Station, St. Paul, Minnesota.

Bailey, M. M. 1964. Age, growth, maturity and sex composition of the American smelt, *Osmerus mordax* (Mitchill), of western Lake Superior. Transactions of the American Fisheries Society 93:382-395.

Baldwin, N. S. 1950. The American smelt. *Osmerus mordax* (Mitchill), of South Bay. Manitoulin Island, Lake Huron. Transactions of the American Fisheries Society 78: 176-180.

———, and R. W. Saalfeld. 1962 (plus supplement, 1970). Commercial fish production in the Great Lakes 1867-1970 (supplement 1961-68). Great Lakes Fishery Commission. Technical Report 3.

Hale, J. 1960. Some aspects of the life history of the smelt (*Osmerus mordax*) in western Lake Superior. Minnesota Fish and Game Investigations 2:25-41.

MacCallum, W. R. and H. A. Reiger. 1970. Distribution of smelt, *Osmerus mordax,* and the smelt fishery in Lake Erie in the early 1960s. Journal of the Fisheries Research Board of Canada 27:1823-1846.

McKenzie, R. A. 1958. Age and growth of smelt, *Osmerus mordax* (Mitchill), of the Miramichi River, New Brunswick. Journal of the Fisheries Research Board of Canada 15:1313-1327.

———, 1964. Smelt life history and fishery in the Miramichi River, New Brunswick. Fisheries Research Board of Canada Bulletin 144.

Murawski, S. A. and C. F. Cole. 1978. Population dynamics of anadromous Rainbow Smelt, *Osmerus mordax,* in a Massachusetts river system. Transactions of the American Fisheries Society 107:535-542.

Neter, J. and W. Wasserman. 1974. Applied linear statistical models. Richard D. Irwin, Inc. Homewood, Illinois.

Ricker, W. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada Bulletin 191.

Robinson, R. D. 1973. Age, growth and sex composition of the American smelt, *Osmerus mordax* (Mitchill), from along the western shore of Lake Michigan. Masters thesis. University of Wisconsin-Milwaukee, Milwaukee, Wisconsin, USA.

Schaefer, W. F. 1979. Population Dynamics of Rainbow Smelt in Western Lake Superior. Doctoral dissertation. Brigham Young University, Provo, Utah, USA.

WETLAND ANTS: INTERNAL MOUND TEMPERATURE AND HUMIDITY PREFERENCES; LOCATION AND SHAPE OF MOUNDS AS ADAPTATIONS TO A WETLAND ENVIRONMENT

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Abstract

Formica montana, a mound building wetland ant, was studied during the autumn of 1979 in a sedge meadow at Waubesa Wetlands, town of Dunn, southern Dane County, Wisconsin. The report is divided into two parts.

Part I deals with the effects of temperature and humidity on ant activity within the mound nest. By disecting an ant mound with a clear sheet of plexiglass, the activities of the ants could be observed within the mound. Ants were observed stratified in the warmest and most humid parts of the mound nest, even when the temperature levels within the mound were artificially manipulated.

Part II describes the location and shape of the mound. An association between the location of red-osier dogwood (*Cornus stolonifera*) and *Formica montana* mounds was observed. A number of hypotheses are suggested to explain the association. The shapes of different-aged ant mounds suggest that ants first build their mounds up, above the surface of the wetland, and then out, at which time they crop the vegetation that otherwise shades the mound's surface. By constructing mounds in this manner, wetland ants maximize the range of temperatures and humidities available.

Introduction

Formica is a genus of ants noted for distinct methods of nest construction (Creighton, 1950). According to Wheeler (1910), there is much variability in nest architecture, not only within a genus of ants but also within a species. The architectural variability within a species depends on the habitat and the time of year. *Formica montana,* an ant that builds a mound nest, occupies a variety of habitats with peat soils, including prairie remnants, sedge meadows, and forests (Ohio to Colorado) (Francoeur, 1973). These animals and their mounds were studied in a sedge meadow in southern Wisconsin during the cool autumn months, when the ants stayed inactive within their mounds.

Mound building wetland ants find themselves in a curious situation. I know of no other strictly terrestrial burrowing animal that spends its lifetime in peat soil periodically flooded by a fluctuating water table. Mound flooding is not the only hazard: wetland ants are ectothermic and must also contend with unfavorable temperature fluctuations. This study views these problems by considering certain characteristics of the ants' mound. Denning *et al* (1977) studied *Formica cinerea montana* mounds and found that the mounds' properties were similar to those of gravel; thus the mounds' clayey wetland soil drains quickly. More attention has been given to the thermal properties of mounds. According to Raignier (1948) and von Frisch (1974), an earthen mound offers a selection of temperatures and humidities that can change by the hour. In the early and late hours of daylight, the dome shape allows the mound to receive about three times the solar radiation that could be obtained on a flat area of the same radius.

This study is divided into two parts. Part I reports the investigation of ant behavior within the mound, including adjustments to the fluctuating water-table, natural and controlled autumn temperatures, and humidity. Part II is concerned with the relationship between ant mounds and the surrounding vegetation, and proposes a strategy for mound construction by ectothermic terrestrial animals in a wetland environment.

Methodology

Formica montana, identified by A. Francoeur, Université du Quebec a Chicoutimi, was studied during September, October, and November 1979 at a sedge meadow in Waubesa Wetlands, Dane County, southern Wisconsin.

Part I

Eight ant mounds were excavated to examine their basic structure and stratification of ant activity. One mound, hereafter referred to as the test mound, was bisected by a clear plexiglass sheet that extended well below the water table. One half of the bisected mound was packaged in plastic so that it could be removed during periods of observation and then replaced. Seven copper-constantan thermocouples were secured to the vertical midline of the plexiglass, spaced at 10 cm intervals at and below the surface of the mound (see figure 1). Mound temperatures were taken on seven days in October. Millivolts, later converted to degrees Celsius, were recorded with a potentiometer. An electric heating rod, in circuit with a variable transformer, was placed 35 cm below the mound surface and next to the plexiglass in the permanent half of the mound. The percent moisture available to the soil, recorded with a Bouyocous moisture meter (model BN-2N) on four days in October, was measured at five depths on and below the surface of the test mound (see figure 2).

Part II

Height and width of each mound to the nearest dm, fraction (to the nearest third) of the mound top covered by vegetation, and the distance between a mound and the nearest red-osier dogwood (*Cornus stolonifera*) were recorded for each of 122 mounds. A chi-square test was performed to determine

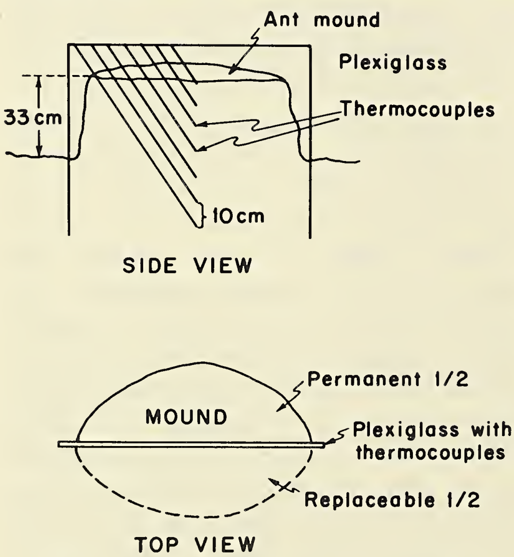

Fig.1. Test mound showing placement of plexiglass and thermocouples.

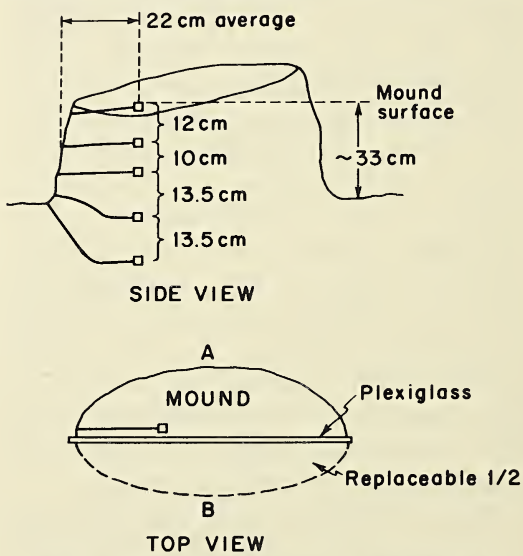

Fig. 2. Test mound showing placement of soil moisture detectors.

whether or not the amount of vegetation covering an ant mound was correlated with the shape of the mound.

Results and Discussion

Part I

Ant Activity Within Their Mounds

Eight excavated ant mounds revealed a network of burrows that extended over 1 m below the wetland surface, more than 65 cm below the lowest recorded water table level. Ants must have been present and active 1 m below the wetland surface when water table levels were lower. Water table levels did drop below 50 cm beneath the wetland surface between 1 April and 30 July 1979 (DeWitt, pers. comm.). Ants were consistently found immediately above the water table in a 2-4 cm horizontal stratum of burrows. These burrows were completely filled with apparently inactive ants. The water table level, measured daily throughout the study period, rose 20 cm. Although appearing completely inactive, the ants were actually active enough to stay just ahead of the rising water. While excavating one of the eight mounds, I discovered a chamber filled with ant pupae. This chamber was unattended and well above the stratified adults. According to Wilson (1970), however, the larvae and pupae are closely attended by adults who move them to areas of preferred temperature and humidity. There are two possible reasons why the pupae were left unattended. First, little development occurs during the cold fall months; chambers at optimal temperatures for pupal development are not available to the ants at this time. Second, *Formica montana* adults are likely to deposit the pupae high in the mound where they will not be flooded by the rising autumn water table.

Temperature Preferences of Ants

Temperatures at the mound-plexiglass interface, level of water to the nearest thermocouple, and location of horizontal strata containing ant activity were recorded on seven days in October (table 1). Because the heating rod was not in place on 13 or 16 October, the highest mound temperatures were at the water table. As expected, the ants clustered in the burrows 5-7 cm above the water table on both these dates. Although the ranges, throughout the entire test mound, of temperatures on 13 and 16 October were only 1.7°C and 2.6°C respectively, the ants were found at the highest constant temperature, that of the water table and peat directly above it. The mound surface temperature fluctuated widely owing to highly variable external weather.

The ants moved from the burrows adjacent to the water table to the preferable

Table 1. Temperatures recorded in 7 different strata within test mound.

Date on which thermocouple temperatures (°C) were recorded	*Thermocouples distances (cm) below test mound surface* 0	10	20	30	40	50	60	*heating rod*	*air temp.*
13 Oct.	9.1	10.6	9.8	10.4	10.75	10.75	10.75$_w$[a]	—	9.25
16 Oct.	13.3	9.5	9.8	10.0	9.3	10.5	10.75$_w$[a]	—	13.0
18 Oct.[b]	15.1	10.3	10.8	10.8[a]	12.6[a]	10.4[a]	10.25$_w$	37.5	—
20 Oct.	22.0[a]	18.75[a]	16.5[a]	16.75[a]	14.5	10.75$_w$	10.5	44.25	—
23 Oct.	5.25	9.5	13.0[a]	12.75	13.74	13.25$_w$	11.0	—	—
25 Oct.	2.75	5.25	8.5[a]	11.75[a]	12.5	10.5$_w$	11.75	39.25	—
30 Oct.	18.0	12.0	16.75[a]	19.25[a]	20.5	11.5$_w$	10.6	74.75	—

[a] Ants active at this depth

[b] Permanent placement of heater

$_w$ water table level to nearest decimeter higher burrows after the placement of the electrical heating rod. The heating rod increased the temperature of that part of the mound by as much as 9.75°C. Before the heating rod was in place, the only special quality of the peat just above the water table was that it had the highest temperature available to the ants. The ants definitely preferred levels in the mound with higher temperatures. No doubt the higher mound temperatures in the summer months would be found at the surface, and one would expect the ants to be active nearer the surface at that time of year.

Soil Moisture Preference

Moisture available to the soil in the part of the mound occupied by ants was always 100%. Drier strata were available to the ants on 13, 16, and 18 October. Although the percent moisture available to the soil is not a measure of relative humidity, the soil surrounding the ant-occupied burrows was saturated. Therefore, I assume that the air in the burrows was close to, if not at, 100% relative humidity. These wetland ants did not differ markedly from those studied by von Frisch (1974) which preferred 100% relative humidity.

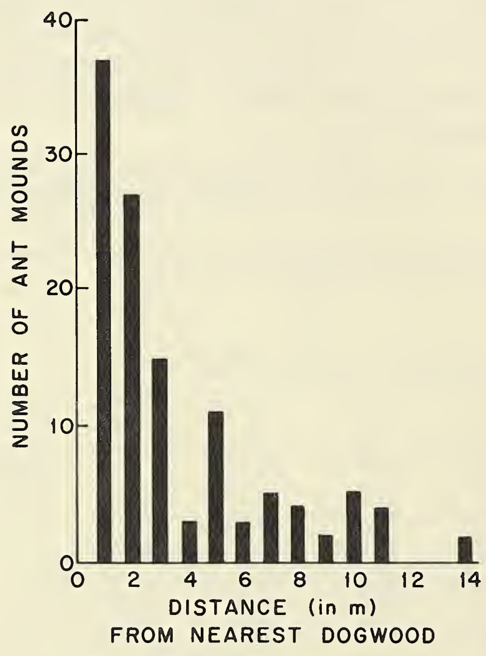

Fig. 3. Number of ant mounds vs. distance from dogwood shrubs.

Part II

Association of Ant Mounds with Vegetation

Mounds were most likely to be near a red-osier dogwood (see figure 3). Red-osier dogwood is a species that tolerates a great deal of water in the soil, but, like the wetland ants, it cannot tolerate permanent submergence of the entire root system. Wetland ants can only survive between the wetland surface, somewhat elevated by their mound, and the water table. With the water table fluctuating as a result of precipitation, artesian water sources, and evapotranspiration during the growing season, the thickness of habitable peat available to these ants changes constantly. A habitat that consistently offers a greater vertical space between the wetland surface and the water table will also offer a greater range of temperatures and humidities. Maximizing this vertical space would be advantageous to an ectothermic animal such as *Formica montana.*

There are many plausible explanations for the observed association between wetland ants and red-osier dogwood:

1) The ants and dogwood are both adapted to a habitat that is not frequently inundated with water.
2) The dogwoods supply the ants with a preferred food source.
3) The dogwoods locally create a suitable ant habitat by evapotranspirative depression of the water table.
4) The ants aerate the soil for the root systems of the dogwood.

Ant Mound Structure

Formica montana mounds are cylindrical. The dimensions of the mounds vary; some mounds are taller than wide while others are

TABLE 2. Number of ant mounds with a specified shape and amount of vegetation covering the top surface.

	Less than ⅓ covered by vegetation	*⅓-⅔ covered by vegetation*	*⅔ to fully covered by vegetation*	*T*
Mound as tall as wide	9	9	12	30
Mound taller than wide	1	16	10	27
Mound wider than tall	21	22	3	46
T	31	47	25	103

Null Hypothesis: The amount of vegetation covering an ant mound is independent of the shape of the mound.
d.f = 4; $\chi^2 = 23.57$; p∠,01

wider than tall. Vegetation is cropped by the ants from the top of some of the mounds exposing bare soil. A chi-square statistic was used to test the null hypothesis that the amount of vegetation covering an ant mound is independent of the shape of the mound. The test revealed that a mound whose width is greater than its height is likely to be void of vegetation on its top, whereas a mound whose height exceeds its width is likely to have an abundance of vegetation on its top (χ^2 = 23.57, p∠0.01; see Table 2).

Assume, as did von Frisch (1974), that a primary function of ant mounds is to increase the surface area exposed to solar radiation, thereby facilitating heating. The data suggest the hypothesis that wetland ants first build their mounds up, and then out, in order to maximize the amount of mound space with preferred temperatures and humidities. The larger the mound, the more ants reside therein. All the ants of a mound are closely related, being the offspring usually of one queen (Wilson 1970). Time is needed to build a population and a mound large enough to house it. The largest mounds are the widest mounds. Since the largest mounds are most likely the oldest, and the narrowest mounds most likely the youngest, ants first build their mounds up and then out. By building their mounds up the ants create a larger vertical habitat subject to a larger range of temperatures and humidities. By building the mounds out, the ants keep the surrounding grasses and sedges from shading the top of the mound. By cropping the top vegetation, the ants allow direct heating from solar radiation incident on the mount top. Once again, the range of temperatures and humidities available to the ants increases. Ants are ectothermic; therefore any architectural adaptations providing them with a greater range of temperatures and humidities would certainly be selected for.

REFERENCES CITED

Creighton, W. S. 1950. The ants of North America. Bulletin of the Museum of Comparative Zoology, Harvard, 104:1-585.

Denning, J. L., F. D. Hole, and J. Bouma. 1977. Effects of *Formica cinerea* on a Wetland soil on west Blue Mounds, Wisconsin. Proc. Waubesa Conference on Wetlands. Inst. of Environmental Studies. Univ. of Wisconsin-Madison.

DeWitt, Calvin. 1980. Pers. comm.

Francoeur, A. 1973. Révision taxonomique des espèces néarctiques du groupe fusca, genre *Formica* (Formicidae, Hymenoptera). No. 3. Memoirs of the Entomological Society of Quebec.

Frisch, Karl von. 1974. *Animal Architecture*. Harcourt Brace Jovanovich. New York, New York, New York.

Raignier, Louvain V. 1948. L'économie thérmique d' une colonie polycalique de la fourmi des bois. Céllule 51(3):279-368.

Wheeler, W. M. 1910. *Ants: Their structure, development and behavior*. Columbia University Press, New York. xxv + 663 pp.

Wilson, E. O. 1979. *Insect Societies*. Harvard University Press, Cambridge, Mass.

THE IMPACT OF NATIVE AMERICANS ON PRESETTLEMENT VEGETATION IN SOUTHEASTERN WISCONSIN

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Abstract

Indians occupied southeastern Wisconsin long before European settlement, utilizing and influencing native vegetation. The magnitude of this influence was studied using the General Land Office surveyor's notes and historical, ecological and archaeological literature. About 15,000 Potawatomi and Winnebago Indians lived in SE Wisconsin immediately before European settlement. Their summer villages and associated winter camps occupied about 1500 acres of cleared land (0.06% of the region). There is little evidence in the surveyor's notes of direct impact on vegetation but other references note Indian fires and dispersal of favored plant species. Other evidence indicates that lightning fires occurred in the region. Apparently, native Americans in presettlement southeastern Wisconsin had little direct impact on the landscape but their indirect influence through fire was probably appreciable.

Introduction

The influence of native Americans on natural vegetation has been examined in several parts of North America. Day (1953) examined the role of Indians in the northeastern U.S. and concluded that their use of fire had a major effect on presettlement vegetation. However, Martin (1973) reviewed the historical record in the same region and concluded that lightning was a more likely cause of fire since eastern tribes appeared to lack fire-setting rituals. Russell (1981) noted the infrequent occurrence of Indian clearings in early descriptions and surveys of northern New Jersey. Lewis (1980) reported on the ritualistic use of fire by several western Canadian Indian tribes. Barrett (1980) described the impact of Indian fires on vegetation in western Montana. In Wisconsin, Curtis (1959) noted several historical references to Indian-caused fires and concluded that Indian fires determined the presettlement vegetation in southern Wisconsin, especially by maintaining prairies and savannas. Hibbard (1904) noted a 400 acre corn field of the Sauk and Fox tribes in Sauk City along the Wisconsin River. This report describes settlement patterns of native Americans in southeastern Wisconsin just before extensive European settlement and Indian impact on the vegetation through land clearing, fire and other activities.

Methods

Information on Indian village and campsite location, population sizes, and patterns of subsistence and resource utilization were needed to examine the impact of Indians on vegetation. Historical and archaeological publications were reviewed. Information on modern lightning fire frequency was obtained from the Wisconsin Department of Natural Resources publications. The General Land Office (GLO) surveyor's notes from 1836-37 were used to develop detailed vegetation maps (see Dorney 1980 for details). These

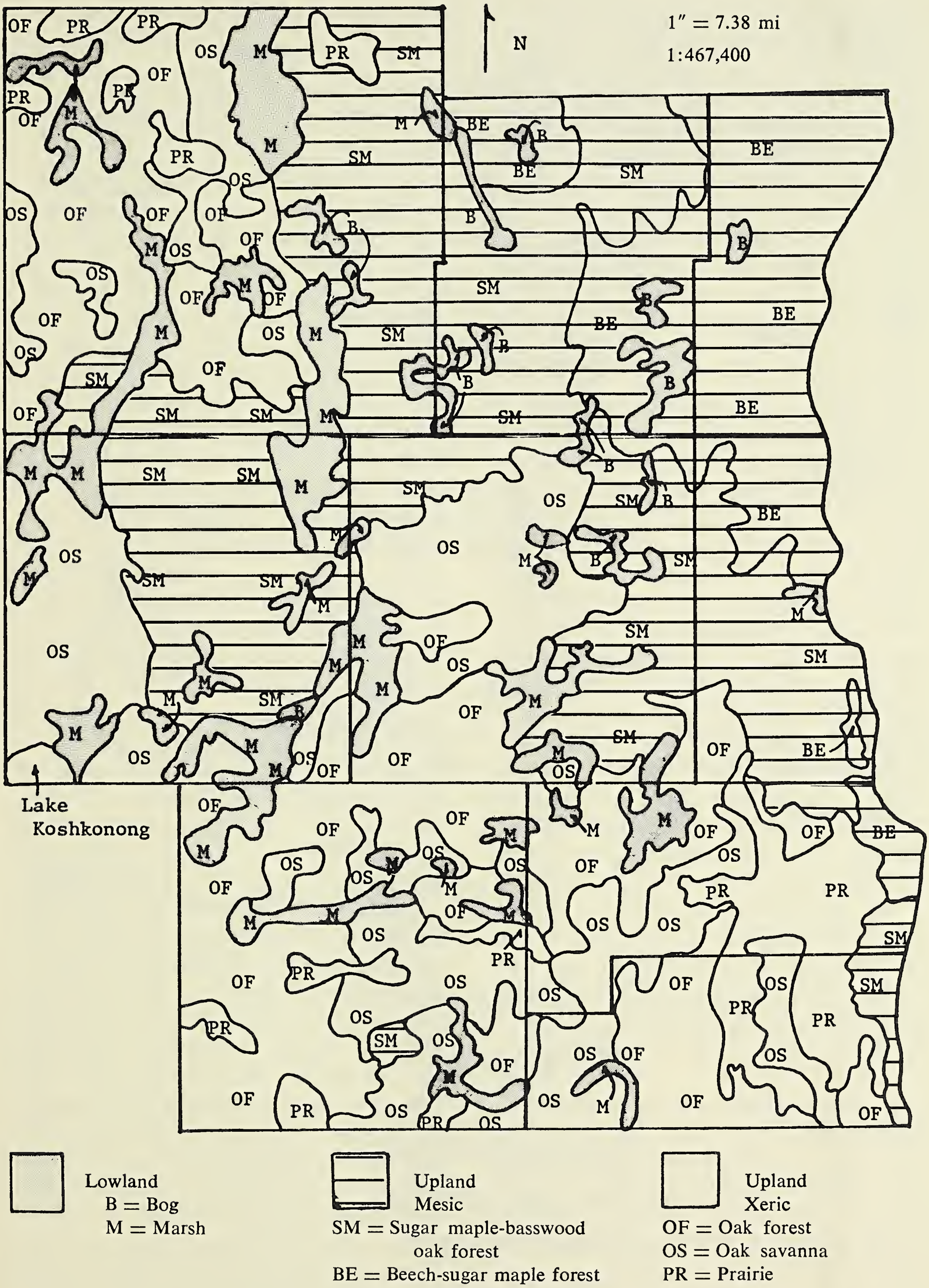

Fig. 1. Presettlement vegetation of southeastern Wisconsin (from Finley 1976).

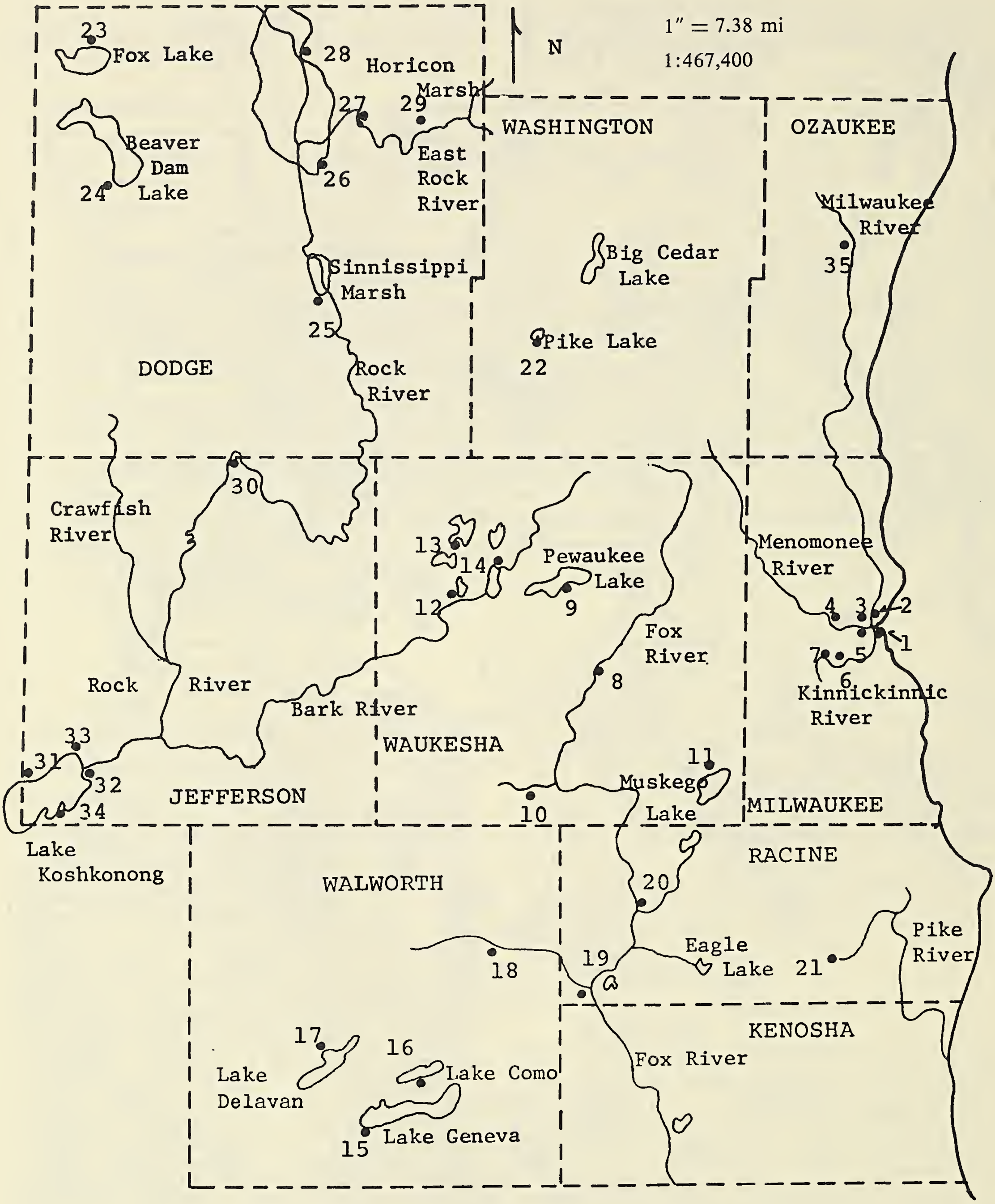

Fig. 2. Indian Village Sites in S.E. Wisconsin: late 1820's and 1830's.

notes were also examined for mention of Indian village sites.

Results

Presettlement Vegetation

Oak forest was the predominant vegetation type in SE Wisconsin before European settlement and occupied 18.5% of the region (Fig. 1). Sugar maple-basswood-oak forest (17.9%) was predominant in the north but toward the south was restricted chiefly to locations adjacent to Lake Michigan. Beech-sugar maple forest (8.5%) was present along Lake Michigan. Oak savanna (14.9%) and prairie (8.3%) were also common especially on the southern and western portions of the region. Open marsh (12.3%) was the most common lowland vegetation type. Tamarack bogs (3%) were present on organic soils mostly in the northern part of the region.

There was no significant correlation between vegetation and soil properties such as drainage class, slope, texture, or available soil water, based on a multivariate discriminant analysis among major vegetation types. For instance, oak and sugar maple forest occupied similar soils. Most of these forests occurred on sites with slopes less than 6%, on well drained clay loams and silty clay loams and on sites with four to six inches of available soil water (Dorney 1980). Instead, the vegetation pattern reflected differing degrees of disturbance, primarily caused by fire. Fire dependent vegetation such as prairie and oak savanna were generally found west of fire barriers formed by wide marsh/river complexes, such as the Rock River. The predominance of prairie, oak savanna and forest in Racine, Kenosha and Walworth Counties apparently resulted from the absence of effective fire barriers. Soil differences can be ruled out since silt loams occupied by prairie and oak savanna were similar to those supporting sugar maple-basswood-oak forest in the northern part of the region (Dorney 1980).

Presumably, fire was more frequent westward and southward where fire dependent prairie and savanna were more abundant. Other ecosystem properties such as tree density and abundance of fire tolerant species also indicated frequent fires. Based on present weather data, tornadoes were infrequent events with a calculated return time of 2930 years. In contrast (based on vegetation types present), fire showed an estimated average return time of 16 years west of fire barriers and 112 years east of them (Dorney 1980).

Indian Population and Settlement Pattern

Southeastern Wisconsin (like the rest of the state) experienced numerous changes in Indian populations, tribes and settlement locations. This became especially evident after the fur trade began in the 1700's. The fur trade may have caused a considerable change in Indian lifestyle and settlement patterns (Kay 1977). The Iroquois wars also had a major influence on Indian settlement. These wars drove the Potawatomi from Michigan and Indiana to eastern Wisconsin. There they initially occupied the western shore of Lake Michigan and gradually spread southward and westward into the Milwaukee area (Lawson 1920).

By the late 1700's and early 1800's, the Potawatomi controlled the Lake Michigan shoreline from Kewaunee to Kenosha and inland to Walworth County (Fig. 2). To the west, mostly along the Rock River drainage, the Winnebago were numerous. Menomini and Chippewa were also present in smaller numbers often living in Potawatomi villages where the city of Milwaukee now stands.

The Potawatomi and Winnebago were semi-sedentary people who lived in semi-permanent summer villages. In the winter, they left these villages for smaller, more numerous hunting camps. By the early 1800's the population had increased and village fragmentation occurred (Kay 1977). In the winter, the Winnebago hunted in the

Madison area while the Potawatomi usually camped within 20 miles of their main village (Kay 1977). Summer villages had extensive agricultural fields where corn, tobacco, beans and squash were grown. Pumpkins, melons and potatoes are also mentioned (Jones 1974).

In the spring, Indians gathered at sugar maple camps for the spring "sugaring"; later, they moved to summer villages to plant crops. Summers were spent in the village tending gardens while hunting and gathering nearby. Harvest of crops and wild rice in the fall was followed by a communal deer hunt. Village groups then broke up into smaller winter camps for trapping and hunting. Fishing was a common activity, especially for coastal tribes (Kay 1977). The impact of European settlers on this pattern is not clear. Kay (1977) believed that disruption of settlement patterns and lifestyle was dramatic; for example, fall fishing camps were abandoned in favor of fall trapping. Spector (1974) thought that the Winnebago lifestyle changed little after contact.

Population size varied considerably as a result of tribal boundary changes, trading post locations and disease. Population estimates were provided for most of the villages mentioned in the historical literature. However, there were no estimates for 14 of the 35 villages cited. It was assumed in this analysis, that these villages were small and arbitrarily assigned a population of 50 people. Evidence suggests that between 1820 and the late 1830's, about 14,700 Indians lived in SE Wisconsin; of these, 8700 were Potawatomi and 5950 were Winnebago (Table 1). There was one small Ojibawa village in Ozaukee County. Milwaukee, Waukesha and Dodge Counties had the highest populations, a result of association with the fur trade and favorable environmental features such as extensive marshes, rivers and large lakes.

Indian Impact on Their Environment

Settlement locations were fairly well documented, especially in the *Wisconsin Archaeologist* (Brown 1906, 1908, 1909, 1911, 1925 and 1926a,b,c). Sizes of the settlements and agricultural fields were not always recorded and density varied. Thwaites (undated) referred to a Potawatomi village on the Manitowoc River stating that "It must not be understood that all this described territory [the village site] was densly [sic] covered by lodges . . . rather [it] was occupied by detached groups of greater and smaller size as well as solitary huts here and there." Actual cleared areas associated with villages are unknown. Therefore, it was assumed that the entire village site was cleared. This yields a maximum estimate for cleared land which was probably not achieved.

Acreage and population data were avail-

TABLE 1. Location and size of Southeastern Wisconsin Indian villages in the late 1820's and 1830's.

Tribe and Village Location	*Population*	*Village Size*	*Surrounding vegetation*	*Reference*
Potawatomi				
Milwaukee County				
1. Jones Island	200 to 500	21 acres	Marsh	2
2. East Water Street	200	13 acres	Sugar maple forest	2
3. Kenozhaykum's Camp	100	6 acres	Sugar maple forest	2
4. Lime Ridge (Bread's)	2000	24 acres	Sugar maple forest	2
5. Pauchkenan's (Walker's Point)	1200	n.a.	Sugar maple forest	2
6. Muskego Avenue	150 to 200	n.a.	Sugar maple forest	2
7. Layton Park	200	n.a.	Sugar maple forest	2

Tribe and Village Location	*Population*	*Village Size*	*Surrounding vegetation*	*Reference*
Waukesha County				
8. Waukesha City	2000	14 acres corn		
		121 acres village	Sugar maple forest	5, 10, 12
9. Pewaukee	540	n.a.	Oak savanna	5, 10, 12
10. Muckwanago	300 to 500	n.a.	Oak forest	5
11. Muskego Lake	300 to 400	n.a.	Sugar maple forest	5
12. Nemahbin Lake	50[a]	n.a.	Oak savanna	4
13. Oconomowoc Lake	50[a]	n.a.	Sugar maple forest	4
14. Nagawicka Lake	50[a]	n.a.	Oak savanna	4
Walworth County				
15. Lake Geneva	500	n.a.	Oak forest	8
16. Lake Como	50[a]	n.a.	Sugar maple forest	6
17. Lake Delavan	50[a]	n.a.	Oak forest	9
18. Spring Prairie	50[a]	n.a.	Oak forest	1
Racine County				
19. Burlington	50[a]	n.a.	Prairie	15
20. Waterford	50[a]	n.a.	Oak forest	15
21. Skunk Grove	50[a]	n.a.	Prairie	1, 15
Winnebago				
Washington County				
22. Pike Lake	50[a]	n.a.	Sugar maple forest	7
Dodge County				
23. Fox Lake	86	n.a.	Oak forest	7, 11
24. Beaver Dam Lake	150	several acres of corn	Prairie	3, 11
25. Hustisford	10	n.a.	Oak savanna	11
Horicon Marsh Area				
26. Site 1	2000	n.a.	Sugar maple forest	1
27. Site 2	50[a]	n.a.	Sugar maple forest	1
28. Site 3	1500 to 1800	n.a.	Sugar maple forest	1
29. Theresa	50[a]	n.a.	Sugar maple forest	1
Jefferson County				
30. Watertown	400	10 acres corn	Sugar maple forest	13
Lake Koshkonong Area				
31. Carajou Point	1200	n.a.	Oak savanna	14
32. Burnt village	167	10 to 15 acres	Oak savanna	14
33. Site 3	21	n.a.	Oak savanna	14
34. Site 4	50[a]	n.a.	Oak savanna	14
Ojibawa				
Ozaukee County				
35. Port Washington	50[a]	n.a.	Sugar maple forest	1

[a] Populations estimated
n.a. Data not available

Tribal Totals

Potawatomi	8,900 to 8,690 people
Winnebago	6,034 to 5,734
Ojibawa	50
Total	14,984 to 14,474 people

References

1. Brown 1906
2. Brown 1916
3. Brown 1922
4. Brown 1923[a]
5. Brown 1923[b]
6. Brown 1926[b]
7. Brown 1926[c]
8. Brown and Brown 1928
9. General Land Office Surveyor's Notes, 1836
10. Haskins 1909
11. Lawson 1920
12. Porter 1902
13. Sohrweide 1926
14. Stout and Skavlen 1927
15. West 1903

able for 10 of the 35 villages. These data suggest ratios of 15.2 people/acre for village sites and 35.1 people/acre for agricultural fields. Thus, SE Wisconsin summer villages and fields occupied about 970 acres from 1820 to 1830. Winter camp acreages (for which no data are available) were estimated by subtracting the acreage of agricultural fields from that of summer villages. On this basis, about 1500 acres of land were cleared by Indians in SE Wisconsin just before settlement or about 0.06% of the region. These clearings were concentrated near Milwaukee (403 acres), Waukesha (370 acres) and Horicon Marsh (428 acres). About 80% of the population lived in these three areas.

Comparison of the presettlement vegetation and Indian settlement patterns (Fig's. 1 and 2) reveals little apparent tribal preference for major vegetation types. The Potawatomi lived mainly east of fire barriers in sugar maple-basswood-oak forest while the Winnebago lived chiefly in oak forest and savanna adjacent to fire barriers such as the Rock River. There were numerous exceptions (Table 1). Winnebago villages near Horicon Marsh were in sugar maple forest while the Potawatomi villages near Waukesha were in oak savanna and those in Racine County were in prairie. The most populous Winnebago and Potawatomi villages were in sugar maple-basswood forest near rivers or marshes. This probably reflects more available food resources in these sites than in oak forests and savannas. There was no association of Indian sites with disturbed vegetation types (such as brush or aspen forest) perhaps reflecting lack of detail available from the GLO surveyor notes. It is also possible that, since most of the regional vegetation reflected frequent disturbance by fire, the effect of Indian settlements was not as easily observable as it would have been in a less frequently disturbed area.

Indirect effects were probably more extensive than land clearing. Indians have been reported to set fires to maintain open lands, clear agricultural fields and modify wildlife habitat (Day 1953). There is no record of systematic fire-setting rituals in the Winnebago or Potawatomi cultural literature. This is in contrast to the practices of some western Canadian tribes who have an annual fire-setting ritual in the prairie (Lewis 1980). However, it appears that the Winnebago used fire to affect vegetation occasionally. Lathrop (1856) refers to a prairie fire in Racine County in 1835 blamed on the Indians. A prairie and woods fire in the Turkey River area near the Mississippi was set by Winnebago to drive game (Beltami 1828) and other Winnebago's used annual fires to clear brush for hunting (Schafer 1929). Other references to Indian fires in Wisconsin include a grass fire set in 1831 by the Menomini near Lake Butte des Morts (Porlier 1900).

Data on lightning fire frequency in southeastern Wisconsin are poor, since DNR records are based on information supplied irregularly by local fire departments (E. Trecker, personal communication). Data from northern Wisconsin are collected systematically and are more accurate. They indicate that lightning is a minor cause of forest fires. From 1970 to 1978, 97 lightning-caused fires occurred in northern Wisconsin yielding an average of twelve fires/year or 0.00000198 fires/mi^2/year (Wisconsin DNR 1970 to 1978). Thunderstorms are somewhat more frequent in southeastern Wisconsin than in the northern part of the state (U.S. Weather Bureau 1952) and a few lightning-caused forest fires have been reported in southeastern Wisconsin (Wisconsin DNR 1971 and 1977). Applying the northern Wisconsin lightning fire rate would produce an average of five lightning-caused fires per year in SE Wisconsin. The effective rate may have been somewhat lower in non-forested areas but even there lightning can be an important ignition source (Vogl 1974). Based on these data, one can conclude that lightning-caused fires were present in southeastern Wisconsin before European settlement.

There is evidence that Indians intentionally moved plants useful for medicinal and food purposes. Black (1978) discusses transport of sweet flag (*Acorus calamus*), butternut (*Juglans cinerea*), Canada plum (*Prunus nigra*), chokecherry (*Prunus virginiana*) and wild strawberry (*Fragaria virginiana*) by Algonquian tribes in Quebec. She also mentions gooseberry (*Ribes cynosbati*), *Amelanchier,* hawthorn (*Crataegus* sp.), and wild rice (*Zizania aquatica*) as possible candidates for Indian transport. Yarnell (1964) mentioned evidence for transport of chestnut (*Castanea dentata*), Canada plum, Kentucky coffee tree (*Gymnocladus dioicus*), *Nelumbo, Apocyanum androsaemifolium* and *A.cannabinum, Asclepias tuberosa* and *A. syriaca* and *Urtica gracilis* by New York and east coast tribes. Beltami (1828) observed a beech tree along the Mississippi River near Minneapolis. It was revered by local Indians and probably planted since this location is far beyond the range of beech. In Wisconsin, Curtis (1959) noted the association of Kentucky coffee trees with some Indian village sites. Smith (1923) mentioned the transport of *Ptelea trifoliata* by Menomini Indians into their reservation from Kansas. It appears likely that Indians moved valuable plants to fulfill their needs.

Plant harvesting must have produced a widespread effect. Apparently, there has been no attempt to estimate the amount of wood needed to cook and smoke fish and meat, boil maple syrup and warm wigwams, but it was probably considerable. Many native plants were gathered for food, medicine, dyes, cordage and smoking materials. Smith (1923 and 1933) examined the ethnobotany of several Wisconsin tribes and listed the uses of numerous species. Curtis (1959) believed that gathering had little effect on plant populations in the state with the possible exception of *Psoralea esculenta* which was prized for its fleshy root.

Hunting and trapping may have affected vegetation indirectly. There is good evidence that Wisconsin Indians overtrapped beaver, deer and otter (Kay 1977). The decrease in beaver dams probably reduced the sedge meadow habitat in the region. If deer populations were low, favored browse species (such as Canada yew-*Taxus canadensis*) may have benefited. Indians probably hunted local elk and bison to extinction along the Fox River in northeastern Wisconsin and elk were extirpated from the state before extensive European settlement began (Kay 1977). These indirect impacts probably had a negligible effect on the regional vegetation.

Conclusion

Several Midwestern studies have examined the settlement pattern of Indians in relation to vegetation. Dustin (1930) studied Indian sites in Saginaw County, Michigan, and concluded that most villages were near navigable water and marshes where game and food plants were abundant. Sugar maple forests were also favored. Jones and Kapp (1972) examined the relationship of presettlement forest pattern to Indian settlement in Bay County, Michigan. In a bog pollen profile, they found an increase in *Ambrosia, Populus* and *Typha* from 35 to 325 A.D. which may reflect an adjacent Indian site occupied at that time. The tribes living in Bay County at the time of European settlement were not discussed but from the maps of Jones and Kapp, it appears that dense sugar maple-beech-hemlock forest was avoided by the Indians in favor of oak-ash forest and proximity to major river valleys. Bowman (1974) working in southern Ontario determined that large white pines present at settlement had developed on abandoned Huron Indian agricultural fields.

In southeastern Wisconsin, most of the 35 villages were located near large rivers and marshes where travel was easy and food plentiful. Apparently, the tribes showed little preference for different vegetation types. Most Potawatomi villages were in sugar maple-basswood-oak forest but Waukesha area villages were in oak savanna. Winnebago villages were mostly in oak forest and savanna but the villages near Horicon Marsh were in sugar maple forest. The GLO surveyor's notes show no evidence of direct effects of a village on vegetation. However, this may be a reflection of the generally low level of detail available from this source.

Just before European settlement, there were about 15,000 Potawatomi and Winnebago Indians living in southeastern Wisconsin. It is estimated that these people cleared about 1500 acres of land or about 0.06% of the region. Clearings were concentrated near Milwaukee, Waukesha and Horicon Marsh. Although there was no observable relationship between disturbed vegetation and Indian sites, there is strong circumstantial evidence that fire was used especially by the Winnebago tribe. Likewise, the vegetation pattern provides strong evidence of frequent fires especially west of large river/marsh complexes. Other activities such as wood gathering, plant collecting and hunting probably had local impacts. There is also evidence for lightning-caused fires in the region. However, these were infrequent and probably not sufficient in themselves to account for the vegetation pattern. Since the largest villages were in sugar maple forest, this also indicates that Indians were not the sole cause of fire. Fire, the most important disturbance factor in the presettlement vegetation of southeastern Wisconsin, was probably caused by both Indians and lightning.

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References Cited

Barrett, S. W. 1980. Indians and Fire. Western Wildlands. Spring 1980:17-20.

Beltami, J. C. 1828. A Pilgrimage in Europe and America Leading to the Discovery of the Sources of the Mississippi and Bloody Rivers. Volume II. Hunt and Clarke, London.

Black, M. J. 1978. Plant Dispersal by Native North Americans in the Canadian Subarctic, in "Nature and Status of Ethnobotany" ed. R. I. Ford. Anthropological Papers 67. Museum of Anthropology. University of Michigan. Ann Arbor, Michigan.

Bowman, I. 1974. The Draper Site: White Pine Succession on an Abandoned Late Prehistoric Iroquoian Maize Field. Part II. Research Report 4. North Pickering Archaeology. Ministry of Natural Resources. Toronto, Ontario.

Brown, C. E. 1906. A Record of Wisconsin Antiquities. Wisconsin Archaeologist 5(¾), 289-429.

———. 1908. Additions to the Record of Wisconsin Antiquities: II. Wisconsin Archaeologist 7(1) new series:1-33.

———. 1909. Additions to the Record of Wisconsin Antiquities: III. Wisconsin Archaeologist 8(4) new series:113-118.

———. 1911. Fourth Addition to the Record of Wisconsin Antiquities. Wisconsin Archaeologist 10(4) new series:165-187.

———. 1916. Archaeological History of Milwaukee County. Wisconsin Archaeologist 15(2) new series:25-106.

———. 1922. Beaver Dam Lake. Wisconsin Archaeologist 1(1) new series:7-19.

———. 1923a. Waukesha County-Northern Townships. Wisconsin Archaeologist 2(2) new series:7-64.

———. 1923b. Waukesha County-Southern Townships. Wisconsin Archaeologist 2(2) new series:69-119.

———. 1925. Fifth Addition to a Record of Wisconsin Antiquities. Wisconsin Archaeologist 4(1): new series:9-25 and 4(2):86-114.

———. 1926a. Rock Lake. Wisconsin Archaeologist 5(4) new series:107-129.

———. 1926b. Delevan Lake. Wisconsin Archaeologist 6(2) new series:7-31.

———. 1926c. Pike Lake, Wisconsin Archaeologist 6(2) new series:41-47.

——— and T. T. Brown. 1928. Lake Geneva and Lake Como. Wisconsin Archaeologist 7(3) new series:129-205.

Curtis, J. T. 1959. The Vegetation of Wisconsin. University of Wisconsin Press. Madison, Wisconsin.

Day, G. 1953. The Indian as an Ecological Factor in the Northeastern Forest. Ecology 34(2):329-346.

Dorney, J. R. 1980. Presettlement Vegetation of Southeastern Wisconsin: Edaphic Relationships and Disturbance. M.S. Thesis. University of Wisconsin-Milwaukee.

Dustin, F. 1930. Some Ancient Indian Village Sites in Saginaw County, Michigan. Papers of the Michigan Academy of Science, Arts and Letters 12:75-89.

Finley, R. W. 1976. Original Vegetation Cover of Wisconsin from U.S. General Land Office Notes. USDA Forest Service. North Central Forest Experimental Station.

General Land Office Surveyors Field Notes: 1836. State of Wisconsin, Commissioner of Public Lands.

Haskins, S. G. 1909. Remains of Aboriginal Occupation in Pewaukee Township. Wisconsin Archaeologist 8(3) new series:81-92.

Hibbard, B. H. 1904. Indian Agriculture in Southern Wisconsin. Wisconsin Historical Society Proceedings 145-155.

Jones, J. A. 1974. Indians of Western Illinois and Southern Wisconsin. Anthropolgical Report on the Indian Occupancy of Royce Area 187. Garland Press Co. New York.

Jones, C. L. and R. O. Kapp. 1972. Relationship of Bay County, Michigan Presettlement Forest Patterns to Indian Cultures. Michigan Academician 5(1):17-28.

Kay, J. 1977. The Land of LaBaye: The Ecological Impact of the Green Bay Fur Trade, 1634-1836. Ph.D. Thesis. University of Wisconsin-Madison.

Lathrop, Rev. J. 1856. Historical Sketch of Kenosha County, Wisconsin. Wisconsin Historical Collections 2:460-479.

Lawson, P. V. 1920. The Potawatomi. Wisconsin Archaeologist 19(2) new series: 41-116.

Lewis, H. T. 1980. Indian Fires of Spring. Natural History 89(1):76-83.

Martin, C. 1973. Fire and Forest Structure in the Aboriginal Eastern Forest. The Indian Historian 6(3):23-26.

Porlier, L. B. 1900. Narrative by Louis B. Porlier in an Interview with the Editor (R. G. Thwaites). Wisconsin Historical Collections 15:439-447.

Porter, R. L. 1902. Aboriginal Mounds at Muckwanago in Waukesha County. Wisconsin Archaeologist 2(1):8-13.

Russell, E. W. B. 1981. Vegetation of Northern New Jersey Before European Settlement. American Midland Naturalist 105(1):1-12.

Schafer, J. 1929. Editorial Comment. Wisconsin Magazine of History 13:419.

Smith, H. 1923. Ethnobotany of the Menomini. Publications of the Milwaukee Public Museum 4(1).

———. 1933. Ethnobotany of the Forest Potawatomi Indians. Milwaukee Public Museum Bulletin 7(1):1-230.

Sohrweide, A. 1926. The Watertown Village Site. Wisconsin Archaeologist 19(2) new series:51-56.

Spector, A. B. and H. L. Skavlen. 1927. The Archaeology of the Lake Koshkonong Region. Wisconsin Archaeologist 7(2) new series:47-102.

Spector, J. D. 1974. Winnebago Indians, 1734-1829: An Archaeological and Ethnohistoric Investigation. Ph.D. Thesis. University of Wisconsin-Madison.

Stout, A. E. and H. L. Skavlen. 1927. The Archaeology of the Lake Koshkonong Region. Wisconsin Archaeologist 7(2) new series: 47-102.

Thwaites, R. G. undated. Notes on Winnebago Indians. Mss Manuscripts 7E. Folder 3. Wisconsin Historical Library Madison, Wisconsin.

U.S. Weather Bureau, Climatological Services Division. 1952. Mean Number of Thunderstorm Days in the United States. U.S. Dept. of Commerce, Weather Bureau. Washington, D.C.

Vogl, R. J. 1974. Effects of Fire on Grasslands, in "Fire and Ecosystems," ed. T. T. Kozlowski and C. E. Ahlgren. Academic Press. New York.

West, G. A. 1903. Summary of the Archaeology of Racine County, Wisconsin. Wisconsin Archaeologist 19(2) new series: 3-34.

Wisconsin Department of Natural Resources. 1970 to 1978. Wisconsin Forest Fire Reports. Madison, Wisconsin.

Yarnell, R. A. 1964. Aboriginal Relationships Between Culture and Plant Life in the Upper Great Lakes Region. Anthropological Papers No. 23. Museum of Anthropology University of Michigan. Ann Arbor, Michigan.

HYDROLOGY AND CHRONOLOGY OF A PEAT MOUND IN DANE COUNTY, SOUTHERN WISCONSIN

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Abstract

This study describes the hydrologic conditions that have caused the formation of a three hectare peat mound. This wetland is elevated two meters above the adjacent 100 hectare Waubesa Wetlands and has developed at the transition area between upland and lowland.

Results from 37 hydrologic stations located on the mound indicate the existence of an artesian source of water beneath the peat. Because of the ability of clay layers to confine an aquifer more than silt and sand layers, the stratigraphy of the mineral soil beneath the peat may dictate the amount of vertical flow of water and thus the height to which the peat can accumulate. The rate of groundwater flow and the topography of the artesian site determine whether peat will accumulate. The beginning of peat formation at the mound is dated at 7500 ±80 years before present (WIS-1265).

Introduction

The purpose of this study is to describe the hydrologic conditions that have caused the development of a peat mound, an elevated wetland which has formed at the transition between upland and lowland. The study site is a three hectare portion of the 100 hectare Waubesa Wetlands located in Dane County, southern Wisconsin (Figure 1). In southern Wisconsin peatlands are typically located in local depressions of the landscape where water levels are relatively high throughout the year (Bedford, *et al.* 1974). They often form in a manner similar to the way the majority of Waubesa Wetlands formed, by the accumulation of organic matter in a shallow lake bay or lake (Friedman, *et al.* 1979). The peat mound examined in this study is different from the more typical basin-filled peatlands of the region in several respects.

First, its surface is elevated two meters above the adjacent basin-filled wetland. This is remarkable because for peat to accumulate the water level must be at or near the surface of the peat throughout the year. The high water levels retard the rate of decomposition, so that rate of productivity of organic matter exceeds the rate of decomposition. The difference in elevation between the mound and the basin-filled wetland implies a dramatic change in the elevation of the water table over a relatively short distance in the peatland. The water table, and hence the surface elevation of the peat, drops nearly two meters in less than 40 meters of horizontal distance (Figure 2). This is an exceedingly steep slope for peatlands in this region. Only blanket bogs in Great Britain and Ireland exhibit steeper slopes (Moore and Bellamy 1974).

Secondly, the three-dimensional shape of the peatland is convex, not flat or concave like a typical basin-filled wetland. In this respect the mound is more similar to raised *Sphagnum* bogs that occur 800 km to the north (Heinselman 1970).

Finally, although lake sediments (gyttja) underlie the basin-filled portion of Waubesa Wetlands, no lake sediments underlie the

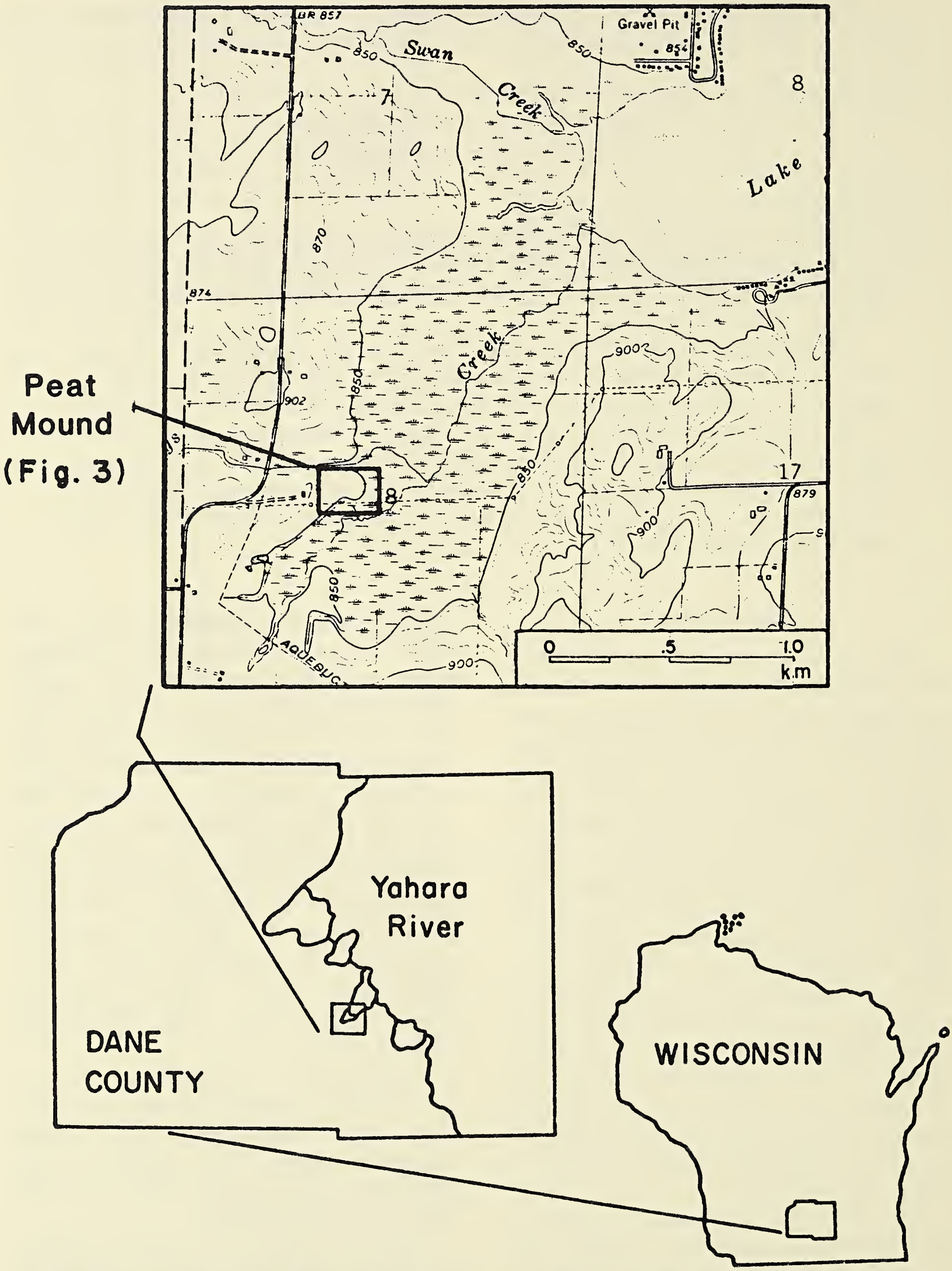

Fig. 1. Map of Waubesa Wetlands and its location in Wisconsin. The peat mound is shown in more detail in Figure 3.

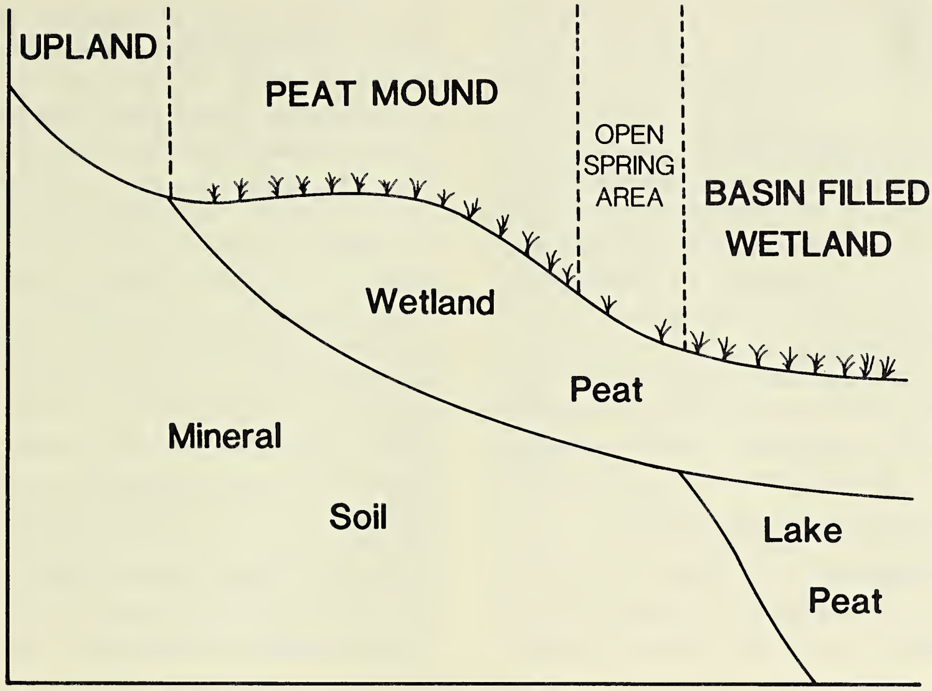

Fig. 2. Schematic diagram showing the relative positions of the peat mound and open spring area in relation to the upland and basin-filled wetland.

one to two meters of peat of the mound. The lack of underlying lake sediments implies that the peat did not form through a basin-filling process typical of many peatlands in the region.

This preliminary study provides a description of the physical conditions that have caused the development of the mound. Because the source, distribution, fluctuation and flow of water are central to the development of peatlands, we have taken a hydrological approach.

The Study Area

The site is near a terminal moraine that marks the extent of Wisconsin glaciation 13,000-17,000 years ago (Mickelson and McCartney 1979). A drumlin is located immediately next to the peat mound. Beneath the glacial till are layers of sandstone (Cline 1965). Artesian springs are common in the region, and occur at the base of the mound.

The vegetation was disturbed by plowing and the planting of reed canary grass, *Phalaris arundinacea,* about 50 years ago. The reed canary grass still dominates the site, and therefore the peatland is classified as a degraded fen (Curtis 1959). *Gentianopsis procera* occurs in comparative abundance in patches on the top of the peat mound (Burr 1980), and the groundwater is mineral rich. Other plants at the site which are characteristic of sedge meadows or wet prairies but are also found in fens are *Carex stricta, Andropogon gerardii,* and *Spartina pectinata* (Bedford, *et al.* 1974). *Cornus stolonifera* occurs in patches at both the top of the mound and in the basin-filled portion of the wetland, but not on the slopes, where *Phalaris* dominates.

One to two meters of fibrous sedge peat has accumulated in the study area. The top 50 cm is more decomposed than the deeper peat.

The site is owned by The Nature Conservancy.

Methods

Surveying. We established a 50 × 50 meter grid system on the mound using wooden stakes to mark the intersection of the grid. From this grid we defined a coordinate system to allow horizontal control at the site. All positions on the mound can be located by two coordinates.

To determine relative elevations of the surface of the mound, we leveled approximately 200 points using a Leitz automatic level. We produced a contour map with 40 cm contour intervals using computer assisted two-dimensional interpolation and smoothing routines (Figure 3). Back-checking with actual data showed the interpolation and smoothing routines did not distort the data. Smoothing was necessary because of the high degree of microrelief on the mound, caused by sedge tussocks and ant hills.

Hydrology. Thirty-seven hydrologic stations were established on the peat mound. Thirty are located on a 25 meter grid system (Figure 3). The other seven are located 10 meters apart on a transect from the top of the mound down to the basin-filled wetland. Each station has a shallow open well (about 50 cm deep) and a piezometer. Each piezometer is a 1.1 cm diameter titanium pipe open at both ends. To prevent the pipe from clogging while it was being pushed through the peat, we placed a loosely fitting bolt into the lower end of the piezometer so that the head of the bolt completely covered the lower opening. After driving the piezometer to the proper depth we lifted the pipe 2 cm, opening the lower end. The bottom

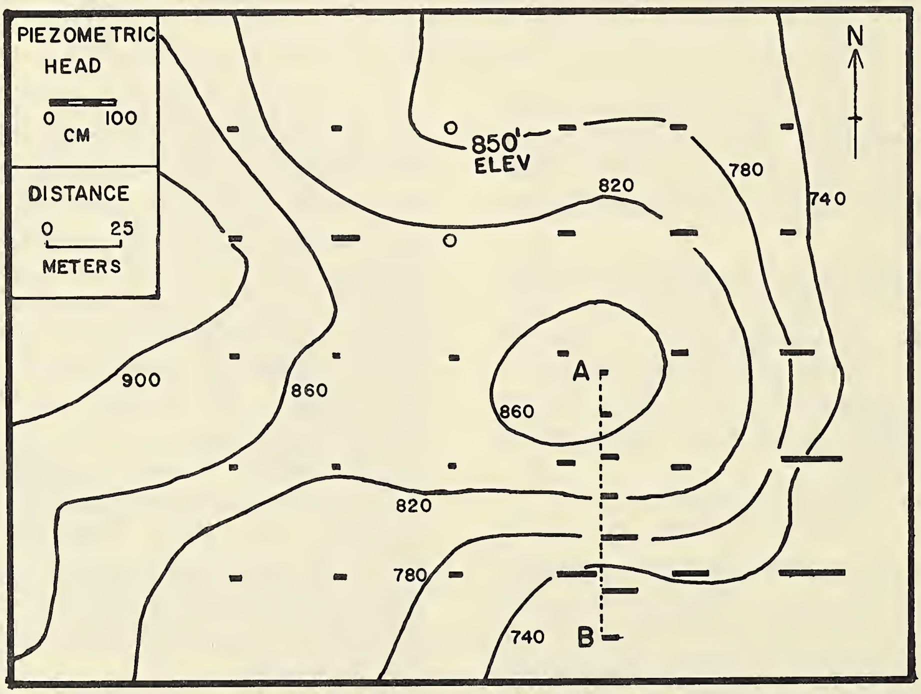

Fig. 3. Contour map of the peat mound showing the location of the piezometric head at the 37 hydrologic stations. Contour interval is 40 cm (relative to arbitrary base station); the 780 cm contour line coincides with the 850 ft. U.S.G.S. contour line (see Fig. 1). A-B marks the transect shown in Figure 4. Hollow circles indicate negative piezometric head (see text).

openings of the piezometers are in mineral soil three to four meters beneath the surface of the mound.

The level of the water in the piezometer measures the hydraulic head of the stratum at the bottom of the pipe. This was compared with the water level in the well. We call the difference between the two levels, the piezometric head. If the water level in the piezometer is higher than the water level in the open well, we arbitrarily called this a positive piezometric head. Water will tend to move upward. The surface elevation at each station is known and elevations are marked on each piezometer.

We measured the elevation of water in each well and piezometer using a wooden dipstick in a four hour period on 13 November 1979, and again on 25 October 1980. There were no substantial differences between the results. Our figures are based on the 13 November 1979 data. Dipstick displacement was calculated and accounted for in the results.

Stratigraphy. We determined the stratigraphy of the underlying sediments at several stations along the transect using Livingstone, Hiller, or Davis peat corers, as well as a standard soil auger.

Laboratory analysis. Pollen and charcoal analysis was done at the Center for Climatic Research. Pollen was scarce but at least 100 grains were counted at each level. Standard pollen analytical techniques were used (Faegri and Iverson 1964).

Results and Discussion

The contour map of surface elevations of the mound shows the existence of a raised dome of peat (indicated by A in Figure 3)

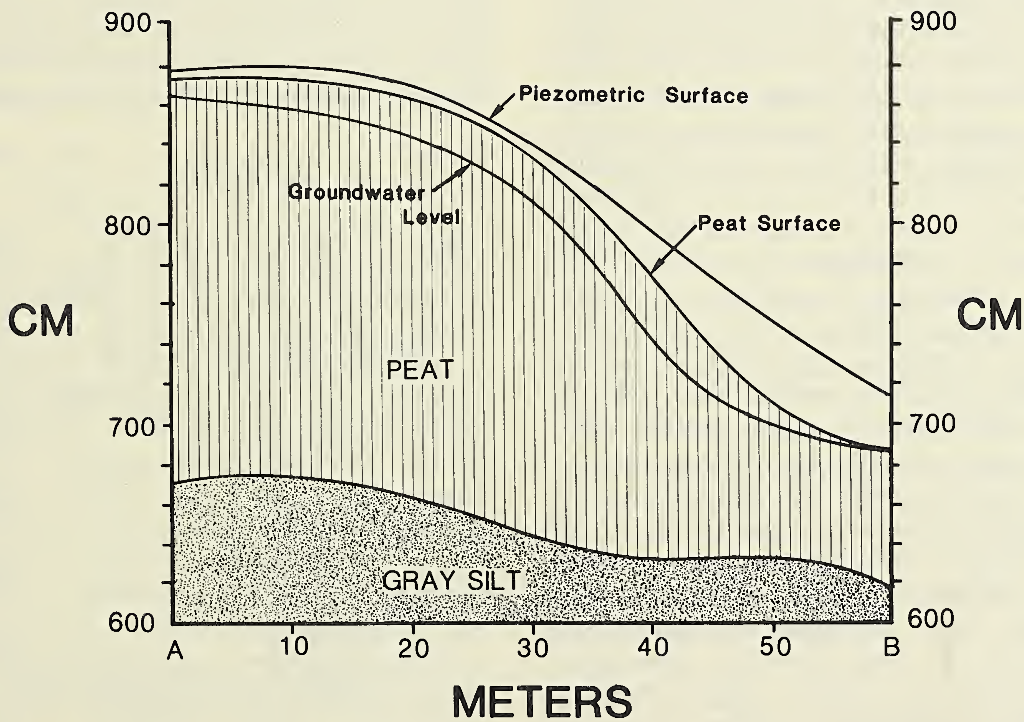

Fig. 4. Cross section of the peat mound, showing the relationship among the piezometric surface, peat surface, groundwater level, and mineral soil (gray silt). The location of the transect is shown in A-B in Figure 3.

nearly two meters above the surface of the basin-filled peatland. The water table closely follows the surface elevations, usually being within 30 cm of the surface. To determine the source of the water in the peat mound, we measured the piezometric head at 37 locations. Figure 3 shows that 35 of the 37 stations have a positive piezometric head, indicating an artesian source of water. We cannot fully explain the anomalous readings at the other two stations, although there may be a very localized perched water table near the two stations. In contrast to the positive piezometric head in the mound, a hydrologic station in the basin-filled portion of the wetland showed no difference in water levels between a piezometer and an open, shallow well. This indicates that the hydrology of the peat mound is qualitatively different than the hydrology of the basin-filled wetland.

The artesian source of water has allowed the peat to accumulate to an elevation nearly two meters above the surrounding basin-filled wetland. To investigate the reasons for the existence and location of the relatively steep slopes emanating in three directions from the raised dome of peat, we placed hydrologic stations ten meters apart along a transect from the top of the mound down to the basin-filled wetland (Figure 3). Figure 4 shows that although there is a good correlation among the piezometric surface, the surface of the peat, and the water table, the piezometric head is greater midway down the slope than on the top of the mound.

It might be expected that a region with a greater piezometric head would be able to supply water to a higher elevation, allowing the peat to accumulate to a greater height, than a region with a lesser piezometric head. The data refute this. Although the top of the mound has a high piezometric head, the slopes have higher heads. The highest piezometric heads are found at the base of the slopes near the open springs (Figure 3).

There are at least two reasons why the elevation of the peat is not positively correlated with the piezometric head. Under very high heads the vertical flow of water may be great enough to prevent any accumulation of peat. This would be the case if there were little resistance to flow in the substrate. Any excess organic matter is dislodged and washed away by the water. This is the most likely explanation of why the open spring area at the base of the mound (Figure 2) still exists after thousands of years of peat accumulation elsewhere in Waubesa Wetlands.

Secondly, if there is substantial resistance to vertical flow through the substrate, a high piezometric head need not be associated with an elevated water table and subsequent peat accumulation. To test this idea, we conducted a preliminary experiment to see if there is greater resistance on the top of the raised sedge meadow. Detailed stratigraphies were determined at both locations. In addition, at the midslope point seven piezometers were placed at various depths in various substrates according to the predetermined

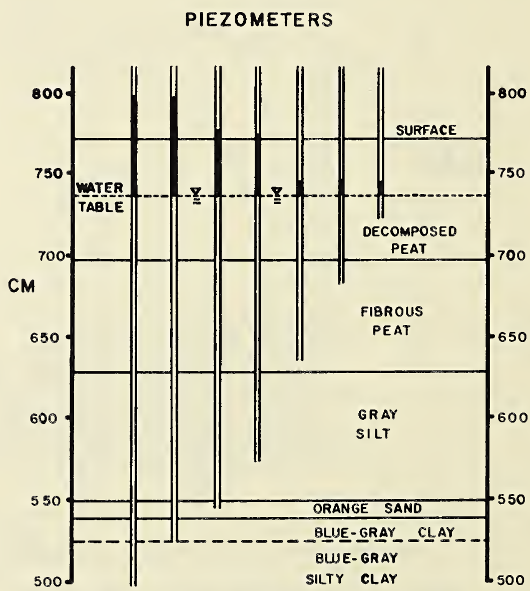

Fig. 5. Piezometric heads (dark lines) at seven levels in the stratigraphy at a midslope point. Note the three distinct levels of the piezometric heads.

stratigraphy. The results are shown in Figure 5.

Although the piezometers were placed at seven depths, there are only three distinct values of piezometric head. Two barriers to vertical flow are suggested by this result. The first is at the boundary between the blue-gray clay layer and the orange sand and the second is at the interface between the gray silt and the fibrous peat. The stratigraphy at the top of the mound differs from the stratigraphy midslope. At the top of the slope there is no blue-gray clay layer beneath the orange sand. Although we have not yet done the piezometric test, the lack of the clay layer probably affords greater vertical flow rates, allowing a higher water table and greater peat accumulation on the top of the mound. In addition, the sand lens may allow significant rates of horizontal flow from the mound to the basin-filled wetland, so that not only does vertical flow meet a greater resistance midslope, but horizontal flow is enhanced. The vertical extent of the water table is thus limited in the midslope region.

Chronology of the Peat Mound Development

The ages of the mineral soil strata and the peat underlying the top of the mound were estimated by correlating pollen spectra taken from various levels with published, radiocarbon-dated pollen diagrams (Friedman *et al.* 1979). The deposition of the mineral soil probably occurred rapidly after deglaciation. Although pollen grains are sparse, half of the grains counted from levels in the mineral soil are spruce. This suggests an age of about 12,500 years before present (L. Maher, Personal communication).

Peat sampled just above the mineral soil-peat interface from a core taken at the top of the mound has been radiocarbon dated at the University of Wisconsin-Madison (WIS-1265) by Dr. Margaret Bender. The date for the beginning of peat formation is 7500 ± 80 years before present. This date indicates the beginning of the postglacial warm period in southcentral Wisconsin and the extension of the prairie into this area. It is a minimum date because of the charcoal layer at the transition between inorganic and organic sediment indicating a possibility of burned peat and therefore a hiatus in the core.

A decrease in groundwater supplies caused by a decrease in precipitation and an increase in temperature during this time might have decreased the piezometric head enough to allow peat to be produced and to begin to accumulate. A higher piezometric head would wash sediment away and a smaller head would be too intermittent to give a favorable production/decomposition ratio for build-up of peat. Once the peat begins to build up it acts like a sponge—raising the water table, and the peat acts also as a cap—slowing down the flow of water. The peat, then, accentuates the peat forming conditions and accelerates the accumulation of peat.

Other charcoal layers are common in the peat, suggesting that fires have swept over the landscape and have maintained oak-deciduous forest and prairie vegetation in the region to the present day. The peat mound itself may have also burned during dry periods in the past.

The Significance of Peat Mounds

Because of the importance of artesian sources of water to the hydrology and development of peat mounds, the ecological properties of the mound may differ substantially from other types of peatlands. For example, nutrient cycling, vegetation dynamics, and water relations in a wetland are all dependent to some degree on the hydrological properties of the wetland. Yet very little is known about the ecosystem dynamics of spring-dependent peatlands.

The occurrence of spring induced peat mounds in Jefferson County, southern Wisconsin has been reported by Milfred and Hole (1970) and Ciolkosz (1965). Van der Valk (1975) and Holte (1966, cited in Van der Valk) describe similar systems in northwestern Iowa. Although the vegetation of the

Iowan fens is different from that of Waubesa, the hydrologic setting is similar.

In Europe several authors discuss springs and their effects on peatland development (Hafsten and Salem 1976; Holdgate 1955a, b; Kirchner 1975; Lahermo *et al.* 1977; Moore and Bellamy, 1974; Wickman 1951). But because of differences in water flow, topography, climate, and water chemistry, the peatlands described in these studies are similar to our site only because springs are important in their development.

There is little knowledge of the regional distribution and abundance of peat mounds, but the geologic condition giving rise to these peatlands may not be rare (Ciolkosz 1965; G. B. Lee and J. H. Zimmerman, personal communications). Because these peatlands may often occupy the transition area between upland and more extensive wetlands, they are more subject to agricultural disturbances such as runoff, drainage, and tillage. The vegetation differences between the Iowa fens and the mound at Waubesa Wetlands may be a function of the land use history of each area as well as the climatic and geochemical differences of the area. The Excelsior fen complex in Iowa which has more than eleven peat mounds and associated spring terraces is badly degraded by cattle pasturing although the wetter areas still have *Lobelia kalmii, Eupatorium perfoliatum,* and *Parnassia glauca; Gentianopsis procera* was found at the nearby Silver Lake fen which is an Iowa Natural Area Conservation site (M. Winkler, personal observation).

Ecological processes taking place in this intermediate position in the landscape are important in the coupling of land and water systems (Hasler 1975).

Conclusions

An artesian source of water has allowed vertical accumulation of peat and development of a peat mound. Stratigraphy of mineral soil beneath the peat influences the amount of vertical flow of water and ultimate height of the peat. The mound may be approaching (or may already be at) an equilibrium height.

The peat mound, because of its location between the upland and basin-filled wetland, may act as an important buffer, intercepting runoff of nutrients from the upland. Also, because of their location at the upland-wetland interface, many peat mounds have probably been eliminated or degraded in some way. Because the ecological processes occurring in this kind of peatland are not well known, more detailed research needs to be done before the complexities of this hydrologically interesting ecosystem are understood.

Acknowledgments

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References Cited

Bedford, B. L., E. H. Zimmerman, and J. H. Zimmerman. 1974. The Wetlands of Dane County, Wisconsin. Dane County Regional Planning Commission, 581 pp.

Burr, C. 1980. Lesser Fringed Gentians. *Wisconsin Natural Resources Magazine.* 4(5): 21.

Ciolkosz, E. J. 1965. Peat mounds of southeastern Wisconsin. *Soil Survey Horizons.* 6: 15-17.

Cline, D. 1965. Geology and Groundwater Resources of Dane County, Wisconsin. *U.S.G.S. Water Supply Paper* 1779-U.

Curtis, J. T. 1959. *The Vegetation of Wisconsin: An Ordination of Plant Communities.* Univ. of Wisconsin Press, Madison, 657 pp.

Faegri, K., and J. Iverson. 1964. *Textbook of Pollen Analysis.* Oxford.

Friedman, R. M., C. B. DeWitt, and T. K. Kratz. 1979. Simulating post-glacial wetland formation: a quantitative reconstruction of Waubesa Marsh. University of Wisconsin-Madison. Institute for Environmental Studies, *Report* #106, 60 pp.

Hafsten, U., and T. Solem. 1976. Age, origin and paleo-ecological evidence of blanket bogs in Nord-Trondelag, Norway. *Boreas* 5:119-141.

Hasler, A. D. 1975. Coupling of Land and Water Systems. Springer-Verlag. New York, 309 pp.

Heinselman, M. L. 1970. Landscape evolution, peatland types, and the environment in the Lake Agassiz Peatlands Natural Area, Minnesota. *Ecological Monographs* 40:235-261.

Holdgate, M. W. 1955a. The vegetation of some British upland fens. *J. Ecol.* 43:389-403.

Holdgate, M. W. 1955b. The vegetation of some springs and wet flushes on Tarn Moor near Orton, Westmoreland. *J. Ecol.* 43:80-89.

Holte, K. E. 1966. A floristic and ecological analysis of the Excelsior fen complex in northwest Iowa. Ph.D. Thesis, University of Iowa, Iowa City, 292 pp.

Kirchner, A. 1975. Zum Auftreten von Druckwasser in Niedermooren. *Arch. Acker- u. Pflanzenbau u. Bodenkd.* 19:613-617.

Lahermo, P., V. E. Valovirta, and A. Sarkioja. 1977. The geobotanical development of spring-fed mires in Finnish Lapland. Geological Survey of Finland. *Bulletin* 287, 44 pp.

Mickelson, D. M., and M. C. McCartney. 1979. Glacial geology of Dane County, Wisconsin. Map. University of Wisconsin Extension. Geol. and Nat. Hist. Survey.

Milfred, C. J., and F. D. Hole. 1970. Soils of Jefferson County, Wisconsin. University of Wisconsin Geological and Natural History Survey. *Bulletin* 86, Soil Series No. 61.

Moore, P. D., and D. J. Bellamy. 1974. *Peatlands.* Springer-Verlag. 221 pp.

Van Der Valk, A. G. 1975. Floristic composition and structure of fen communities in northwest Iowa. *Proc. Iowa Acad. Sci.* 82: 113-118.

Wickman, F. E. 1951. The maximum height of raised bogs. *Geol. Foren. Forhandl.* 73:413-422.

MEASURES OF SYMPATHETIC REACTIVITY IN THE INFANT: A PILOT STUDY TO ASSESS THEIR FEASIBILITY IN MASS SCREENING PROGRAMS

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Abstract

Autonomic nervous system instability has been implicated as a causal factor in the etiology of the Sudden Infant Death Syndrome (SIDS). Measures of sympathetic nervous system reactivity in the infant were therefore reviewed to decide upon a safe, easy and inexpensive method to assess this variable. We conclude that the galvanic skin response (GSR) is the most suitable measure and very amenable to mass screening programs. Difficulties in securing parental informed consent to the conventional method of measuring the GSR, however, necessitated the development of an alternative method which appears promising. While further studies will be required, we conclude that it will be highly feasible to add the GSR to other measures of SIDS susceptability in mass screening programs.

Our objective in this study was to determine whether existing methods for the assessment of sympathetic nervous system reactivity would be suitable for infant mass screening programs. We are most pleased to report that, by all indications, they will. We are confident that pilot programs can be instituted in the very near future.

Our primary intent has been to improve existing mass screening programs for possible susceptability to Sudden Infant Death Syndrome (SIDS). I strongly wish to emphasize at this point that SIDS or "crib death" remains, in the words of the National Sudden Infant Death Syndrome Foundation, "neither predictable nor preventable." Unfortunately, SIDS is still "a disease of theories" and still claims the lives of an estimated 7,500-10,000 babies per year in this country alone.

One theory which has been the subject of considerable recent research and has been well covered in the media is that of sleep apnea. In brief, this simply means that the baby repeatedly ceases to breathe during sleep and eventually never resumes respiration. These apneas have been observed in many SIDS infants prior to death (Steinschneider, 1972; Shannon, Kelly and O'Connell, 1977).

We should first summarize the characteristic epidemiologic aspects of the SIDS. Briefly, the incidence of the syndrome is highest in males, although sex by race interactions exist, in low birthweight infants and in non-caucasians (Bergman, Ray, Pomeroy, Wahl and Beckwith, 1972; Kraus and Borhani, 1972). The SIDS is rare in the neonatal period and after six months. Most deaths occur at two to three months of age (Bergman et al., 1972). Seasonal trends have also been demonstrated with most of the deaths occurring in the early winter months (Kraus and Borhani, 1972). Finally, death appears invariably to occur during sleep (Bergman *et al.*, 1972).

Bergman *et al.* (1972) have proposed that the SIDS results from a spasm of the muscles of the larynx. As evidence they cited the intrathoracic petechiae (small hemorrhages in the lungs and elsewhere) and the fluid blood observed upon autopsy in SIDS victims. These findings are consistent with death due to acute upper airway obstruction.

Our group now believes that multiple causes of SIDS probably exist but that respiratory failure is primary whatever the mechanism. The laryngospasm theory has been recently supported by Leape, Holder, Franklin, Amoury and Ashcroft (1977). These investigators observed respiratory arrest in infants secondary to gastroesophageal reflux. In other words, due to an anatomic malformation, gastric (or stomach) fluids reflux or flow back causing respiratory arrest. They suggested that these infants appear to be true SIDS cases and that the respiratory arrest may have resulted from laryngospasm. Other evidence supports this view (Beckwith, 1978).

The rationale for suspecting that sympathetic nervous system reactivity may be a major factor rests primarily upon the "drowning swimmer reflex." It has often been found that apparent drowning victims have no water in their lungs. It seems highly likely that laryngospasm accounts for these deaths (Wong and Grace, 1963). We further suggest that the high state of sympathetic nervous system arousal associated with the threat of drowning precipitates the spasm. Another reason for suspecting that sympathetic reactivity may be a critical factor in some SIDS cases is the autonomic nervous system instability characteristic of a particular phase of sleep (Hartmann, 1967).

It thus appears that relevant screening programs for SIDS should include a safe, easy and inexpensive test of sympathetic nervous system reactivity. We submit that the galvanic skin response (GSR) or, more properly, the electrodermal response will be most suitable. The GSR defines the state of arousal of the sympathetic nervous system by changes in the electrical conductivity of the skin produced by palmar sweating.

This index of, basically, emotionality or arousal is measured by passing a small electrical current (which can be provided by a six volt household battery) through electrodes placed upon the palms or the soles of the feet. A meter then registers changes in the conductance of the skin measured in mhos.

Weller and Bell (1965) have used the GSR to investigate sympathetic arousal in various behavioral states in 60-110 hour old neonates. They reported that, not only did this measure correlate significantly with several other indices of sympathetic arousal, but that their recordings were not contaminated by movement artifact.

The late Harold Schlosberg (1954) in a witty and delightful review of theories of emotion has emphasized several other attractive features of the GSR which are certainly relevant to mass screening programs. Basically, the device is easily and inexpensively constructed (to quote Dr. Schlosberg: "the whole gadget can be assembled for about $25 and is as portable as a box of cigars") and recordings can be obtained simultaneously from many subjects.

Although the GSR clearly appears to be the best measure of sympathetic nervous system activation in the infant, this method involves passing a small electrical current through the body and we encountered substantial problems in obtaining the informed content of parents. We therefore sought another method of assessing the GSR.

Silverman and Powell (1944) developed a colorimetric technique for the analysis of palmar sweating. They painted the skin with a 25% solution of ferric chloride in ethanol and allow it to dry. A small piece of paper was then saturated with a 5% solution of tannic acid in water and likewise allowed to dry. The GSR as measured by palmer perspiration was then assessed by placing the paper in contact with the skin for three minutes. If the skin is dry no reaction will occur but if perspiration is present the water-soluble ferric chloride will react with the tannic acid to form a blue spot on the paper. The spot ranges from blue-gray to deep blue and the hue is directly proportional to the amount of perspiration present. The intensity of the blue spot can be graded by a densitometer and/or human judges. Silverman and Powell noted that the method is very simple and economical and provides a permanent record which is unaffected by humidity. It thus appears to be a most suitable method for the assessment of the GSR in a mass screening program of the type described should problems of parental consent for the use of the conventional method arise.

We were quite excited when we discovered this system but our primary enthusiasm was short-lived. Tannic acid has recently been placed in category one on the list of known or suspected carcinogens by the Occupational Safety and Health Review Commission. Obviously it will be next to impossible to obtain informed consent for this method also.

It later occurred to us, however, that different chemicals might be used to produce a similar measure of the GSR. Since the reaction involves a salt and a weak acid we accordingly began to experiment with other weak acids. Two of our students performed a "lie detector" experiment using a weak solution of citric acid in place of tannic acid to measure the palmar sweating which accompanies lying. The results were encouraging although the blue spots were pale (Jones and Staples, 1979).

We are, therefore, continuing to explore the use of this method. As subjects become available we will increase the concentration of the ferric chloride solution and experiment with other weak acids to produce an optimal result. We are confident that in this manner we will develop another economical and non-invasive method for the assessment of the GSR in large-scale infant screening programs.

The GSR is, however, clearly only one of a battery of screening procedures necessary for the evaluation of an infant's risk for SIDS. Among others these include evaluation of the sleep respiratory pattern for the frequency and duration of apneas and apnea density by type (Guilleminault, Ariagno, Korobkin, Nagel, Baldwin, Coons and Owen, 1979) and the infant's responsivity to carbon dioxide during sleep (Shannon, Kelly and O'Connell, 1977). Other important measures have been discussed in a recent review (Guilleminault and Korobkin, 1979).

Such screening programs, perhaps coordinated through Wisconsin's excellent network of Regional Perinatal Centers (Graven, Howe and Callon, 1976), now appear to be highly feasible. Such a program appears most desirable also as it could provide vitally needed longitudinal data on the role of infant sleep respiratory patterns and autonomic nervous system instability in the mechanisms of the SIDS.

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References Cited

Beckwith, J. B. 1978. Personal communication.

Bergman, A. B., Ray, C. G., Pomeroy, M. A., Wahl, P. W. and Beckwith, J. B. 1972. Studies of sudden infant death syndrome in King County, Washington. III. Epidemiology. Pediatrics. 49:860-870.

Graven, S. N., Howe, G. and Callon, H. 1976. Perinatal health care studies and program results in Wisconsin 1964-1970. p. 39-57. *In* J. B. Stetson and P. R. Swyer (eds.) Neonatal intensive care. Green, St. Louis.

Guilleminault, C. and Korobkin, R. 1979. Sudden infant death: Near miss events and sleep research. Some recommendations to improve comparability of results among investigators. Sleep. 1:423-433.

———, Ariagno, R., Korobkin, R., Nagel, N., Baldwin, R., Coons, S. and Owen M. 1979.

Mixed and obstructive sleep apnea and near miss for sudden infant death syndrome: 2. Comparison of near miss and normal control infants by age. Pediatrics. 64:882-891.

Hartmann, E. 1967. The biology of dreaming. Charles C. Thomas, Springfield, 206 pp.

Jones, B. and Staples, R. 1979. Galvanic skin response. Paper submitted in partial fulfillment of the requirements of Psychology 110, Ripon College. Ripon, Wisconsin.

Kraus, J. F. and Borhani, N. O. 1972. Postneonatal sudden unexpected death in California: A cohort study. Am. J. Epidemiol. 95:497-510.

Leape, L. L., Holder, T. M., Franklin, J. D., Amoury, R. A. and Ashcroft, K. W. 1977. Respiratory arrest in infants secondary to gastroesophageal reflux. Pediatrics. 60:924-928.

Schlosberg, H. 1954. Three dimensions of emotion. Psychol. Rev. 61:81-88.

Shannon, D. C., Kelly, D. H. and O'Connell, K. 1977. Abnormal regulation of ventilation in infants at risk for sudden infant death syndrome. N. Engl. J. Med. 297:747-750.

Silverman, J. J. and Powell, V. E. 1944. Studies on palmar sweating. Am. J. Med. Sci. 208: 297-305.

Steinschneider, A. 1972. Prolonged apnea and the sudden infant death syndrome: Clinical and laboratory observations. Pediatrics. 50: 646-654.

Weller, G. M. and Bell, R. Q. 1965. Basal skin conductance and neonatal state. Child Develop. 36:647-657.

Wong, F. W. and Grace, W. J. 1963. Sudden death after near-drowning. J.A.M.A. 186: 724-726.

FOOD, POPULATION, ENERGY AND THE ENVIRONMENT

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"The third world cannot solve its food problems without solving its energy problems—and without solving both, the road ahead could lead to economic and human chaos. But pointing that road in a better direction will require a massive and well-planned international effort by both science and society." The United Nations University Newsletter, Vol. 5, No. 2, May, 1981.

"Developing country needs for commercial energy consumption in agriculture could jump by nearly five times in the next 20 years. . . . Of the total world commercial energy used in agriculture, the share of developing countries, including China, is about 18%—or the equivalent of 36.8 million tons of oil. But if agricultural production is to increase at target rates . . . energy use will have to expand to 174.5 million tons of oil equivalent by the year 2000, 94% of it in the form of fertilizers and fuel." FAO AT WORK, Feb. 1981, published by the FAO Liaison Office for North America, Washington, D.C.

"Our [the U.S.] ability both to meet domestic demand and to continue to export large amounts of agricultural products is in question because of major uncertainties about future conversion of farmland to nonfarm uses, possible longrun climate changes, future trends in agricultural productivity, future water and energy supplies and costs, and some uncertainty about how much unused cropland is actually available for crop use." The United States may already be sacrificing future yields "by exporting our topsoil to finance oil imports." Statement by Professor Richard Barrows, in *CALS Report,* January-February 1981, Vol. 18, No. 1, University of Wisconsin-Madison, College of Agricultural and Life Sciences.

It has taken 8,000-10,000 years from the beginning of a settled agriculture until the present to increase knowledge enough to produce food for the more than 4 billion people who now live on earth, and perhaps half a billion or more of these remain undernourished. At recent rates of population growth, the world could have another 4 billion people to feed in about 35 years. Does the world have the resources to feed its growing numbers?

There is obviously no simple answer to this question. The changing pattern of world grain exports (Table 1) over the past 40 years shows increasing deficits (i.e. imports) by growing numbers of developing countries. The traditional grain deficit region, Western Europe, has become more self-sufficient, the developing regions have all increased their dependence on grain imports (although there are a few surplus producing countries in these regions), while the only exporting regions are North America, Australia and New Zealand.

There is, however, a tremendous gap between yields in most developing countries and what they might be. That yield gap represents a tremendous potential food reserve which must be realized in the future. In 1935-39 average grain yields were the same in the industrial and the developing countries, but today there is a difference of 50 percent (Johnson, 1976).

The growing imports of grain by the de-

TABLE 1

(Taken from *To Feed This World* p. 22, by Sterling Wortman and Ralph W. Cumminggs, Jr.; the Johns Hopkins University Press, Baltimore, 1978)

The changing pattern of world grain exports

	Exports (million tons)[a]					
Region	1934–38	1948–52	1960	1966	1973[b]	1975[b]
North America	5	23	39	59	88	94
Latin America	9	1	0	5	−4	−3
Western Europe	−24	−22	−25	−27	−21	−17
Eastern Europe & U.S.S.R.	5	—	0	−4	−27	−25
Africa	1	0	−2	−7	−4	−10
Asia	2	−6	−17	−34	−39	−47
Australia & New Zealand	3	3	6	8	7	8

Sources: Lester Brown and Erik Eckholm, *By Bread Alone*; Lester Brown, *The Politics and Responsibility of the North American Breadbasket.*
[a] Minus sign indicates net imports.
[b] Fiscal year.

veloping countries does not mean that their agriculture has been stagnant. Also, most grain, by far, is still consumed within the same countries where it is produced—only around 10 percent of world grain production moves in international trade. In fact the food supply situation in developing countries of all regions except Africa has improved to some degree during the past three decades. Between the mid 1950s and the mid 1970s, food production in the less developed countries, taken as a group, actually increased at a rate equal to or slightly greater than that of the industrial or more developed countries. However, population growth rates have been, and continue to be, extremely high in the developing countries, recently averaging about 2½ percent per year versus less than 1 percent per year in the high-income, industrialized countries.

World food production has been increasing about .5 percent faster than annual rate of growth in the world's population. However, there is one major difference in the way this increased production was achieved. In the developing countries, expansion of cultivable area accounted for roughly half of the increase in output, and intensification of production on existing acres accounted for the other half. In contrast, in the developed countries almost all the increase resulted from intensification (greater output per acre).

Despite serious inequities in distribution, both approaches have helped world food production keep a few steps ahead of population growth, but both face significant obstacles. Bringing more and more land into agricultural production has, in many cases, created or worsened severe problems of wind and water erosion, soil destruction, overgrazing, desertification, and deforestation. There is more land that can be put into agricultural production (although often of a quality inferior to that already under cultivation). Before converting such land, however, we must recognize the potential consequences of soil and general environmental degradation. Estimates of the amount of land that can be brought into food production without serious environmental repercussions vary widely. Even if one discounts the potential for environmental damage, expansion of cultivable land is not an option available to many countries seeking to increase food production. Available croplands are not always located where population pressures are greatest. India, Bangladesh, and China, for example, certainly do not have a great deal of unused arable land.

The other route toward expanding food supplies is land use intensification, but efforts to make each acre yield more food also confront problems. Highly intensive land use demands great inputs of energy; much of that energy has come from fossil fuels (gas, coal and oil) and from electricity (often manufactured from fossil fuels).

So far, this approach to increasing production has depended on an energy subsidy to the food system: we supplement the sunlight, captured by plants, with stored solar energy captured millions of years ago and preserved in the forms of oil, coal, and gas (Steinhart and Steinhart, 1974). This method of subsidizing agriculture with energy from nonrenewable sources has come about through farm mechanization—the use of tractors, electric motors, and so on, and an ever-growing reliance on fertilizer and other chemicals that are very energy-intensive in their manufacture or, as in the case of nitrogen fertilizer, that depend on petroleum products as a raw material. Irrigation is another means of intensifying land use by providing and controlling water supplies, but irrigation, too, is usually energy-intensive in terms of construction of facilities and frequently in terms of pumping and distribution.

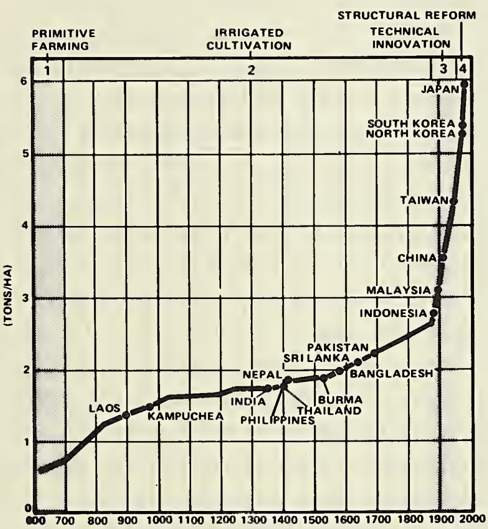
The U.S. now has less than 3 percent of its people actually engaged in farming (USDA Agriculture Handbook No. 561). Other industrialized countries also have witnessed sharp declines in the number of farmers over the past 30 to 40 years. We have replaced horses and mules and human labor with machines. Although these capital- and energy-intensive agricultural systems of the industrial nations have made possible a high standard of material well-being, the increasing cost of energy may require major adjustments in the years ahead.

Once the shift to a mechanized, energy-intensive agriculture has been made, as it has in the industrial countries, it is very difficult to turn back. According to a study by the U.S. Department of Agriculture (The Farm Index, August, 1975), if the U.S. were to return to the technology and the farming practices of 60 years ago, achieving the production totals of today would require about 61 million horses and mules. At present, of course, draft horses and mules are not widely available. The U.S. would also need about 27 million farm workers, nearly 24 million more than we now use. To feed the horses and mules, we would require the production from more than the 100 million acres of cropland currently devoted to the production of farm exports. Thirty percent or more of the population would be in farming, and average family incomes of farmers as well as nonfarmers would be much lower.

In other words, we have achieved our high level of living through the substitution of machines and fossil fuels—finite in amount—for human and animal power, through the intensive use of fertilizers, and through the advances in genetics, farm management, regional specialization in production (itself energy intensive since it increases the need for transportation in the food system), and so on. A return to the practices of 60 years ago would also spell starvation for many people in the world who now depend on U.S. food exports. But, one should add, the entire U.S. economic system is so energy-intensive that even with this energy-demanding agriculture, the entire food and fiber system accounts for only about 17 percent of all the energy used in the United States (USDA Agricultural Handbook No. 561). Personal automobiles, it is estimated, use 27 percent. Food *production* absorbs less than one-fifth of the total energy used in the food system (i.e., about 3.4 percent of all commercial energy used in the United States). More than two-fifths is used for food processing and distribution; homes and commercial eating establishments consume the other two-fifths (USDA Agriculture Handbook No. 561).

Japan also has a highly energy-intensive agricultural system, as do most industrial countries, but Japan has not matched the

U.S. system in terms of mechanization and fuel use. It has, instead, become more intensive than the U.S. in terms of irrigation and the use of fertilizers and other chemicals. Japan's farmers have registered remarkable achievements on the nation's small land area. China, in contrast, has pressed its agricultural output about as far as the use of human power and the recycling of organic matter will permit, and it is now seeking technology to intensify its agriculture in other ways—by producing nitrogen fertilizer domestically and developing its petroleum industry. There are limits to how much food an acre of farmland can produce without the heavy use of fertilizers and other chemicals. Those limits are illustrated in Figure 1, which compares current rice yields in selected Asian countries to the historical growth of rice yields in Japan.



Source: From W. David Hopper, "The Development of Agriculture in Developing Countries." Copyright © 1976 by Scientific American, Inc. All rights reserved.

Fig. 1. Intensification of farming: Current rice yields in selected Asian countries compared to the historical growth of rice yields in Japan (solid line).

(Taken from *To Feed This World* p. 48, by Sterling Wortman and Ralph Cummings, Jr.; the Johns Hopkins University Press, Baltimore, 1978)

As noted earlier, energy-intensive agricultural systems also face serious problems: fossil fuels are getting scarcer and ever more expensive, and the increased use of commercial fertilizers and other chemicals poses environmental risks. In the mid-1970s the world used about 40 million tons of nitrogen fertilizer annually; it is projected that in order to feed the world's population in the year 2000, we will need to use about 200 million tons of nitrogen fertilizer (Hardy and Havelka, 1975). Such increases, plus concomitant increases in the use of insecticides and herbicides, present a serious threat. We simply do not know enough about the consequent ecological imbalances that may result from such vast growth in the use of chemicals. Major problems have already developed. In the Philippines, for example, new high-yielding varieties of rice require a greater density of plants and high rates of fertilization which in turn lead to more weeds and insects. Controlling the pests requires using more chemicals. In wet-paddy rice culture, farmers used to raise fish along with rice in their paddies. Rice with fish plus some garden vegetables was, after all, a pretty good diet. But insecticides kill the fish in the rice paddies, and farmers are now trying to build separate ponds in order to preserve the fish harvest.

This case in the Philippines is simply an illustration of the kind of problems that can result from the increasing use of agricultural chemicals throughout the world. The consequences are sometimes severe and often unpredicted. Obviously, efforts to increase food production, whether through more intensive use of existing cropland or expansion of cultivable area, confront the obstacle of resource scarcity and pose major environmental risks. But just as obvious is the imperative to feed a growing population. What is to be done? This question defies simple solution. There is no easy choice between what is good and right and what is bad and wrong; all choices carry ill effects.

I do not wish to sound like an alarmist in these matters. The world is not, in my judgment, approaching some precipice over which it is about to plummet. Throughout history we find that human beings have proven to be very ingenious, inventive, and adaptive. We will likely create new means of production and new styles of life in response to the shortages that are developing as we pass from a global economy based on fossil fuels to one based on a greater reliance on alternative and renewable sources of energy. We have crossed such "bridges" in energy use before as Figure 2 shows. Past transitions of energy usage may appear to have been easier than the one in prospect because we always seem to have moved from a less compact and perhaps less functional form of energy to a more compact and more concentrated form. However, we are not certain what future sources of energy we will exploit and, when this transition is evaluated in retrospect, it may prove not to have been any more difficult than those of the past.

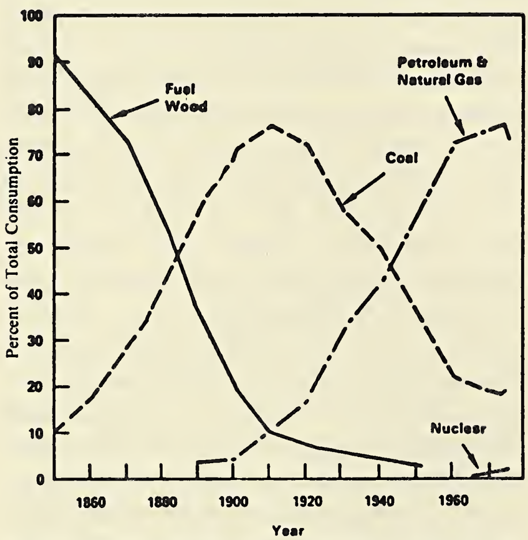


Fig. 2. U.S. Energy Consumption Patterns by Energy Source.*

(Taken from Purdue Farm Management Report, "The Potential for Producing Energy From Agriculture," by Wallace E. Tyner, Agricultural Economics Department, Purdue University, West Lafayette, Indiana)

* Source: Historical Statistics of the United States." Bureau of the Census. U.S. Bureau of Mines.

Regardless of how easy or how difficult this transition proves to be, we must take steps to address the complex problems associated with the interconnected issues of increased food production, rising energy costs, population growth and environmental protection. These steps can be divided into two categories—those that must be taken within the next 10 to 25 years and those that will be feasible only in 50 years or so.

In the short-to-medium term, we must control the rate of population growth. This rate must come down, substantially one would hope, within the next 20 years. The world cannot absorb many more doublings of population every 30 to 35 years, which has been the rate for about the past 30 years. There are, in fact, some encouraging signs that population growth rates are falling. They are already very low in the industrial countries (less than one percent per year, in some cases near zero), and substantial declines in growth rates have been registered in China, Indonesia, and some Latin American countries. Yet we also need to remind ourselves that the number of people is only one part of the issue. The other side of the coin is the per capita consumption rate. And people in the industrial countries, especially in the United States, use much more than their proportionate share of the earth's finite energy and mineral resources. People in the rich countries use almost 100 times as much commercial energy per person as do people in countries with the lowest per capita incomes (World Bank, 1978). We also consume a disproportionate share of grain resources, not directly as grain but as meat after grain has been fed to livestock.

One must be cautious, however, about criticizing the livestock enterprise. Some people tend to condemn all livestock as inefficient converters of grain, and it is quite possible that we will be feeding less grain to ruminants in the future. But livestock farming is essential since it allows humans to consume many plant materials which they cannot consume directly. Livestock can utilize forage grown on marginal lands where grains cannot (or should not) be grown. The emphasis should be on more forage and less grain, rather than eliminating livestock farming. Wisconsin is a leader in forage research, and its leadership has been strengthened by the recent opening of the USDA/North Central Regional Dairy Forage Research Laboratory.

Given the widely accepted view that we are approaching limits to the availability of some critical resources, it does not seem possible that the 70 percent of the world's people living in the developing countries can achieve the resource consumption levels of the 30 percent residing in the industrial countries. Beyond resource limits, the environmental consequences of pursuing such consumption levels worldwide would be disastrous. Therefore, when we urge population control for the poor, we must also urge consumption control and conservation for the rich. The poor people of this world must be given the opportunity to develop their human capacities and to provide for their basic needs of food, clothing, shelter, medical services, and education.

However, a curtailment of per capita resource consumption in the high-income countries does *not necessarily* mean a decline in living standards. Much of our consumption is wasteful. In the short term, for example, the best means for meeting the problem of high energy costs is *conservation*. And the people in the high-income countries, especially those in the United States, can cut energy use very substantially without a major alteration of life styles.

Beyond resource conservation and population control, however, there are a number of measures, now in various stages of research and development, that hold great promise for improving the world food situation. Innovations that produce more food but at the same time decrease the dependence on fossil fuels and minimize the chances for environmental damage are critically important to our future. One area of research involves increasing the capacity of legumes for utilizing atmospheric nitrogen, as well as transferring this capacity for nitrogen fixation to corn and cereal grains. One research team has already developed a corn variety that can capture some nitrogen from the atmosphere, albeit a small amount when compared to the plant's total needs. If this research is ultimately successful, fertilizer demands will fall. Research to increase the efficiency of photosynthesis, the process by which green plants utilize sunlight in the manufacture of organic matter, in order to accelerate plant growth, is also underway (Zelitch, 1975). Scientists have changed the structure of corn plants, for example, to expose more leaf area to the sun and improve photosynthesis. New varieties of barley and wheat with more erect leaves to improve interception of sunlight are already in wide use (USDA Farmline, September 1980). Still other research deals with the domestication of "wild" plant varieties. Of the 3,000 species of plants used for food in the world only about 150 are grown commercially, and of these, 20 supply almost all the food for the earth's more than 4 billion people. We use only a handful of available plants and animals for our food, and particularly all of these were demonstrated by our ancestors several thousand years ago. We have certainly improved upon the food-yielding capacity of these species, but we have not added to the stock.

Research on the development of plants that can grow in saline soils has produced impressive results. On irrigated desert farms in Mexico, a plant with the highest per acre yield of any halophytic (salt-adapted) species tested has a protein content higher than that of wheat. Plant-breeding programs

TABLE 2

(Taken from *To Feed This World* p. 79, by Sterling Wortman and Ralph Cummings, Jr.; The Johns Hopkins University Press, Baltimore, 1978)

Losses of potential crop production by region

Region	Value (million US$) Actual	Value (million US$) Potential	Losses (%) due to: Insect pests	Losses (%) due to: Dis-eases	Losses (%) due to: Weeds	Loss as % of potential value	Value of lost production (million US$)
North & Central America	24,392	34,229	9.4	11.3	8.0	28.7	9,837
South America	9,276	13,837	10.0	15.2	7.8	33.0	4,561
Europe	35,842	47,769	5.1	13.1	6.8	25.0	11,927
Africa	10,843	18,578	13.0	12.9	15.7	41.6	7,735
Asia	35,715	63,005	20.7	11.3	11.3	43.3	27,290
Oceania	1,231	1,707	7.0	12.6	8.3	27.9	476
U.S.S.R. & China	20,140	28,661	10.5	9.1	10.1	29.7	8,521
World	137,439	207,786	12.3	11.8	9.7	33.8	70,347

Source: Agricultural Research Policy Advisory Committee, *Research to Meet U.S. and World Food Needs.*

to select for greater resistance to insects and diseases and attempts to develop biological methods of insect control by the use of natural predators or pest-sterilization methods also promise to increase food supplies because about one-third of the world's potential harvest is lost to insects, diseases, and weeds (Table 2).

All these diverse lines of research carry major implications for saving fossil fuels and avoiding dangers from over-use of chemical fertilizers and pesticides. Even with research breakthroughs, of course, the world will continue to need inorganic fertilizers and some chemicals for pest control, but a lesser dependence on these chemcials would at least diminish the environmental burden now posed by ever-increasing applications, and it would decrease the demand for the energy needed in the manufacture of inorganic fertilizers and protective chemicals.

Research on better ways to apply available energy in agriculture, especially alternative sources of energy, is also in progress. Systems for producing bio-gas from waste materials, as well as some solar systems, can be used for crop drying, water heating and other purposes. Scientists are working on developing bacteria capable of breaking down tough plant materials such as cellulose and lignin. If their work is successful, it will be feasible to convert wood, cornstalks and other biomass into fuel alcohol. The ethanol currently produced from corn (or sugar cane juice in Brazil) or other substances high in carbohydrates, requires good land to produce the corn. The corn could be eaten directly or fed to livestock. It should be added, however, that the production of ethanol from corn yields a considerable quantity of high protein distillers' dried grains—an excellent feed supplement for livestock.

The promise of all this research does not provide a ready solution to the world's food production and distribution problems. Discoveries in the laboratory or in well-controlled field experiments must be adapted and developed in such a way that they prove practical for farmers. Successful research in biological, physical, and engineering sciences applicable to food production and the development of alternative energy sources may also require new production, distribution and consumption patterns, new property relations, changes in the socio-economic structure, modified financial and other institutions, and indeed entirely new theoretical conceptions of the economic, social, and political world. Institutional innovations and adjustments are imperative if the advantages of new technological developments are to be widely shared; research in economics and the other social sciences, both basic and applied, is strategic to such a transformation. Basic technological shifts in crop production will certainly require changes in farm management practices and quite possibly in the organizational structure of farms and farm businesses, large and small. Some fundamental issues of farm policy, both in the United States and in other countries, will have to be confronted. New issues may very well demand unique policy approaches.

Many of the projects underway on a variety of research fronts may well yield fruitful results within relatively few years. Some new techniques and practices are already being adopted ,and they simply require time to be perfected and applied on a larger scale. As for the more distant future, 50 or more years from now, the outlook can be optimistic *if* we can control growth in population and consumption in the shorter term, *if* the nations of the world can develop procedures to eliminate the constant threat of annihilating civilization with modern weapons of war, and *if* we, as a society, can provide sufficient support for scientific and humanistic research.

We will, I believe, eventually develop more abundant, more reliable, and less depletable sources of commercial energy, and it is unlikely that any one source will dominate the energy scene as petroleum has during the past 30 to 40 years. The "unlimited" prospects of nuclear fusion are still too remote and may not materialize within this period; more promising is the potential of solar energy. A variety of solar technologies are available now. These technologies are expensive, but as the costs of other types of energy increase, they will become more competitive. Mass production and widespread use of solar techniques will also reduce their costs. We need simply to look at what has happened to the real prices of computer technology during the past 20 years to recognize the implications of continued efforts to adapt ever more efficient engineering and production to a growing (and highly competitive) market. These gains in efficiency notwithstanding, however, it is a good bet that the real cost of energy in the future, irrespective of its source, will be higher than that of petroleum before 1973.

One solar technology that seems most intriguing is the photovoltaic cell which converts sunlight directly into electricity. Such cells are now used to power instruments on spacecraft; they could be used commercially, but their cost, although decreasing, is still prohibitive. Since photovoltaic cells can be made from a relatively abundant and nonpolluting element, silicon, the technology faces no major supply constraints and poses no environmental perils. One problem with the technology concerns "shipping" the electric energy from areas where it is produced (presumably in hot desert areas where a great deal of sunshine can be captured and transformed into electricity) to places where it is most needed. Transmitting electrical power by wire over long distances results in a substantial loss. To overcome such distribution problems, physical scientists and engineers plan to convert electrical energy into a chemical source of energy.

If the electric power can be transmitted by wire to a major water source (e.g. in the United States from the Southwest deserts to the Pacific Ocean) this electrical power can be used to decompose water into its elements and thus produce hydrogen gas. Methane can be produced from the hydrogen plus water and limestone. Or, if a liquid is preferable, methonal can also be produced from these same ingrediants. "These chemical vehicles avoid the difficulties not only of intermittent radiation, but also of long-distance transmission. If existent pipeline technology is used which is second only to water transportation in efficiency, fluids can be transported any required distance overland to centers of consumption" (Hubbert, 1978).

Abundant energy supplies do nothing to increase the globe's ultimate stock of mineral resources. Presumably, we can reduce our demands and stretch our supplies of minerals by improving recycling methods, by increasing production and manufacturing efficiency, by enhancing conservation efforts, by using lower-grade ores, and by mining the oceans. While some of these efforts are already underway, most will become more attractive and more feasible once alternative supplies of energy are available. More abundant and diverse energy supplies will also permit new types of agricultural production, including energy-intensive greenhouse production which will reduce our need for tillable agricultural lands and lessen our vulnerability to climatic fluctuations (USDA Farmline, September 1980). Again, such developments would not produce the environmental side effects associated with expansion of cultivable area and intensified production on existing farmlands.

This optimistic outlook seems nearly utopian, at least in physical terms. Are there no physical limits? It seems to me that there *is* an ultimate limit—the environment. We simply cannot keep on growing and doubling population *or* production *or* consumption for very many more generations. Without checks on population, the current population of more than 4 billion people could jump to 8 billion in 30 years and to 16 billion in 60 years, when today's teenagers are still alive. The potential for physical and social catastrophe would also seem to increase geometrically.

Doublings of production and consumption to stay even with or "get ahead" of the demands of a growing population (or the rising expectations of a stable population) also face inevitable limits. Petroleum production, for example, has doubled every ten years since 1900. In each decade, as much petroleum is pumped from the earth as has been extracted in all previous time. By the end of 1963, cumulative world crude oil production had amounted to 150 billion barrels. By the end of 1973 it had reached 299 billion barrels, double the grand total produced by 1963 (Hubbert, 1978). Doubling of production of a finite resource cannot go on many more decades.

Without question, population growth must level off; zero or even negative rates must be the goal. To correct severe inequities in the distribution of resources and income, high income societies must restrain their consumption and help to create opportunities for the poor to improve their standard of living. As we pass through this difficult period of major adjustments, we must support and rely on research and development of reliable knowledge aimed at long-run solutions to the problems of food, population, energy and the environment. All physical resources are finite and limited, but human creativity and intellectual capacity, so far as we know, are not. All other resources become scarcer with increased use, but human knowledge multiplies as a result of use. The ultimate challenge is to expand human knowledge, understanding, and tolerance so that we may have a world of peace and security, a world without hunger and fear.

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References Cited

Hardy, R. W. F., and U. D. Havelka. 1975. "Nitrogen Fixation Research: A Key to World Food?", *Science* 188.

Hubbert, M. King. 1978. "World Energy Resources." In *Proceedings of the Wisconsin Seminar on Natural Resource Policies in Relation to Economic Development and International Cooperation,* Vol. 1. Madison: Institute for Environmental Studies, University of Wisconsin.

Johnson, D. Gale. 1976. "Food for the Future: A Perspective," *Population and Development Review,* No. 2.

Steinhart, John S., and Carol E. Steinhart. 1974. "Energy Use in the U.S. Food System," *Science* 184.

Tyner, Wallace E. 1979. "The Potential for Producing Energy from Agriculture." Purdue University Farm Management Report (April, 1979).

U.S. Department of Agriculture. 1975. "Can 1918 Farming Feed 1975 People," *The Farm Index* (August 1975). Authored by Earle E. Gavett.

U.S. Department of Agriculture. 1979. *1979 Handbook of Agriculture Charts,* Agricultural Handbook No. 561.

U.S. Department of Agriculture. 1980. *Farmline,* Vol. 1, No. 6, September 1980.

World Bank. 1978. *World Development Report, 1978.* New York: Oxford University Press.

Wortman, Sterling and Ralph W. Cummings, Jr. 1978. *To Feed This World.* Baltimore: The Johns Hopkins University Press.

Zelitch, Israel. 1975. "Improving the Efficiency of Photosynthesis." *Science* 188.

THE FUEL GRADE ALCOHOL POTENTIAL OF WISCONSIN'S EXPORT GRAIN AND PROCESS VEGETABLE WASTES

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Abstract

Concentrated and inexpensive biomass in readily bioconvertible waste forms from two agribusiness sectors could be used to produce approximately 23.6 million gallons per year of competitively priced fuel grade alcohol. An additional 8.9 million gallons per year could be produced from these same two sources by the application of more vigorous bioconversion technology. These estimates are based on the quantities and fermentable carbohydrate contents of the Superior grain elevator and statewide vegetable processing industry wastes. Present-day technology appears equal to the task; Wisconsin's on-line fermentation and distillation capacity is large enough to utilize all the generated waste, and estimates of the economics of production present a favorable picture. In addition, both the environment and the waste generating industries would benefit by the elimination of a massive waste disposal problem. Commercial application of the findings reported in this communication could lead to the creation of a viable fuel grade alcohol program equivalent to 86 percent of Wisconsin's fermentation/distillation capacity projected to be on line by the end of 1982.

Introduction

Current fermentation/distillation practices aimed at the production of fuel grade alcohol from biomass rely almost exclusively on traditional grains (wheat and corn) as feedstock. However, at today's cash market grain prices, present-day technology is unable to support the production of a competitively priced product (Converse et al., 1979). Other less expensive feedstocks which are available in large quantities have been considered (wood chips, corn stover, etc.); however, the high degree of lignification of these biomass forms has thus far precluded their cost effective conversion to fermentable sugars (Kosaric et al., 1980). Only concentrated major sources of inexpensive biomass capable of efficient conversion to fermentable sugars can support an economically viable fuel grade alcohol production industry.

Two large-scale sources likely to meet these requirements in the State of Wisconsin are grain and seed dust generated and collected at the Port of Superior grain elevator facilities, and byproduct wastes generated during processing of specialty crop vegetables in the Wisconsin canning industry. The total biomass waste generated annually by these two industries in the State of Wisconsin is about 769,000 tons. The present communication addresses the fuel grade alcohol potential of these two biomass sources with emphasis on efficiency of bioconversion and cost-effectiveness of production.

Materials and Methods

Process vegetable waste samples were collected from the Waunakee plant of the Oconomowoc Canning Company during the 1980 pack. These were either frozen or flash sterilized and canned until use. Grain elevator dust samples were collected from bin toppings, add back chutes, and dust collector tank discharges in Superior, Wisconsin, and were stored at room temperature. Elevators sampled include Continental, Elevator M, Farmers Union, ADM, and Globe facilities. Grain dust samples whose particle size distribution appeared grossly heterogeneous (e.g., wheat dust) or highly aggregated (e.g., sunflower seed dust) were ground in a Wiley mill to pass a 1-mm screen prior to analysis. Portions of each process vegetable waste sample were freeze-dried and also Wiley milled to pass a 1-mm screen prior to analysis.

Moisture contents of grain dust samples were determined by the gravimetric method (Blondin and Green, 1970). Hexose/pentose ratios were determined by spectrophotometry (Scott, 1976). Lignin contents were determined by the spectrophotometric acetyl bromide method (Morrison, 1972). Starch bioconversion was carried out with alpha-amylase and amyloglucosidase according to procedures outlined in the technical information bulletins of the respective enzymes (Biocon [U.S.] Inc., 1981). Bioconversion of cellulose was carried out at 45°C for 48 hours in the presence of 0.5 percent (w/v) cellulase enzyme complex from *Trichoderma viride* (now *T. reesei*). The preparation used was obtained from the Enzyme Products Division of Miles Laboratories. Substrate concentrations were set at 4 to 5 percent (w/v). Fermentations were carried out at 30°C with distillers active dry yeast (*Saccharomyces cerevisiae*) obtained from Biocon (U.S.) Inc. Percent alcohol in the distillates was determined through the use of alcohol dehydrogenase and nicotinamide adenine dinucleotide (Bonnichsen and Theorell, 1951) or by specific gravity measurements.

Biomass Waste Origin and Inventory

The two biomass waste forms evaluated have a long history of embarassment to the respective waste-generating industries. Grain and seed dust in suspension in air is an excellent fuel which has been likened to gunpowder and is claimed to be responsible for many elevator explosions. As the industry responds to this hazard and modifies its practices in scheduled compliance with Federal Clean Air Act standards, each season witnesses the collection of greater quantities of grain dust at elevator facilities. This cleanup represents a severe economic loss to the elevator industry because of the high cost of air scrubbing equipment and poor marketability of the collected dust.

Most vegetable processing byproducts also have negligible economic value. In Wisconsin some waste solids from canneries processing vegetable crops are given away to farmers willing to collect and transport them for use as hog feed. The remainder must be dumped in landfill sites, a practice which is frowned upon by the Wisconsin Department of Natural Resources. The voluminous effluent streams from canneries represent high B.O.D. sugar solutions which cannot be released to surface waters and must therefore be spray irrigated on rented farmland or processed at high expense through private or municipal treatment plants. Accordingly, the vegetable processing industry in Wisconsin spends several millions of dollars annually to dispose of cannery effluent and solid wastes in a manner which will comply with environmental standards.

Grain and seed dust originates from constant abrasion of intact grain and seed during the high-speed handling required to move the commodities efficiently through the elevator facilities. Estimates of the amount of grain dust handled and collected in port elevators vary significantly. The picture is further clouded by the industry-wide trend to collect more and more dust as additional air scrubbing equipment is installed toward compliance with Clean Air Act standards. A high end limiting estimate of 2.6 percent dust per weight of grain or seed has recently been proposed (Schnake, 1981). Table 1 contains a summary, based on this estimate, of the annual elevator grain dust tonnage for the grain and seed storage facilities in the Superior-Duluth area. The data show that presently a maximum of approximately 232,000 tons of grain and seed dust is potentially collectable each year at these facilities. A more accurate estimate of this figure will be forthcoming as the Superior Harbor Commission plans to inventory dust collector discharges during the 1981 transshipment season (Olson, 1981). Scheduled new elevator construction and elimination of the embargo on the export of grain to Russia is likely substantially to increase the throughput of the Superior-Duluth grain elevators and hence the amount of grain dust generated.

TABLE 1. Estimated annual quantities of grain and seed dust at Superior-Duluth export elevators.

Commodity	*1980 transshipment tonnage*[a]	*Maximum estimated dust tonnage*[b]
Wheat	5,096,000	132,500
Corn	1,174,000	30,520
Sunflower seed	1,377,000	35,800
Other[c]	1,270,000	33,020
Total	8,917,000	231,840

[a] Port of Duluth-Superior 1980 Tonnage Report No. 9.
[b] Assumed to be 2.6 percent of transshipped grain and seed (Schnake, 1981).
[c] Includes barley, flax seed, oats, rye, and soybean.

TABLE 2. Estimated annual quantities of process vegetable waste.

Vegetable crop	*Input tonnage*[a]	*Process waste* %	*Tons*
Sweet corn	513,520	50[b]	256,760
Potato	259,875[c,d]	55[e]	142,930
Snap bean	211,184	21[f]	44,439
Green pea	153,670	22[b]	33,807
Beat	77,800	50[b]	38,900
Carrot	45,000[g]	44[b]	19,800
Lima bean	4,900	14[f]	686
Total	1,256,949		537,232

[a] Wisconsin Agricultural Statistics Bulletin, "Summary of 1980 Process Vegetable Crops."
[b] According to Wisconsin Canners and Freezers Association.
[c] 1979 Wisconsin Agricultural Statistics, Wisconsin Agricultural Service.
[d] Assumes that only 30 percent of harvested crop was processed.
[e] Personal communication from D. H. Penly, Oconomowoc Canning Co.
[f] Cooper (1976).
[g] Assumes that only 80 percent of harvested crop was processed.

Byproduct wastes from vegetable processing originate in canneries in two main forms: discrete solids and screened effluent. Discrete solids include leaves, trimmings, stems, peels, pods, husks, cobs, silk, and defective processed vegetables. Screened effluent contains leached starches and sugars carried in suspension or solution through 20-mesh screens. The vast volumes of screened effluent flow originate from water input at various stations during vegetable processing. Depending on the vegetable source, water is added at stations for washing, husking, desilking, blanching, cutting, peeling, slicing, clipping, screening, grading and inspection. Table 2 contains a summary of the total annual process byproducts wastes generated in Wisconsin canneries. The data include both discrete and screened effluent wastes and in general reflect the total weight decrement between canned product and vegetable crop input. Based on a total of approximately 537,000 tons of byproducts wastes, the weighted average byproducts wastes tonnage in Wisconsin canning industry is about 43 percent of the input crop.

ANALYSIS AND ALCOHOL POTENTIAL OF GRAIN AND SEED DUST

A previous study (Martin, 1978) of the composition of grain dust suggested that dust from specific grains have characteristics similar to the grain from which it came. Thus wheat and corn dust were reported to contain 80.2 percent and 96 percent, respectively, of the carbohydrate of intact wheat and corn. However, the fiber content of wheat dust (16.4 percent) was about 5.5 times higher than that found in intact wheat (3.0 percent), while that of corn dust (7.4 percent) was only thrice that found in intact corn (2.5 percent). These observations suggest that wheat dust may contain much more lignin and hemicellulose than intact wheat. If this is so, an appreciable fraction of the total carbohydrate of wheat dust might be "nonfermentable" five carbon sugars (pentoses) and lignocellulose complex. Since wheat dust is by far the major waste in the Superior-Duluth facilities (see Table 1), it was important to examine this question. The data shown in Table 3 clearly establish the high pentosan content of wheat dust. While the pentose fraction derived from intact wheat accounts for only 14.5 percent of the total carbohydrate, that from wheat dust accounts for 42 percent. Thus, while the total carbohydrate content of wheat dust was 71.3 percent of intact wheat, the readily fermentable carbohydrate (hexose) content was only 48.5 percent of that of intact wheat. The significant increase in lignin content (from 1.1 to 8.7 percent), an indicator of structural carbohydrate (hemicellulose/pentosan), found in wheat dust is in agreement with these findings.

Corn dust is remarkably different, having characteristics closely related to intact corn (Table 3). Commodities other than wheat, corn, and sunflower seed dust have not yet been examined by us. The values quoted in Table 3 for these commodities are assumed

TABLE 3. Analysis of elevator grain and seed dust.[a]

Commodity	*% total carbohydrate*	*% hexose*	*% pentose*	*% lignin*	*% moisture*
Wheat dust	44.2(5)	25.7(5)	18.5(5)	8.7(1)	7.65(2)
Wheat	62	53	9	1.1	nd[b]
Corn dust	70(3)	58.3(3)	11.7(3)	3.4(1)	9.3(2)
Corn	69	62	7	1.9	nd
Sunflower seed dust	36.3(3)	23(3)	13.3(3)	5.4(1)	8.0(2)
Other[c]	50	40	10	nd	nd

[a] The grain and seed dust are averages for the number of samples analyzed which is included in parentheses after each value.
[b] nd = not determined.
[c] Based in part on the data of Martin (1978).

TABLE 4. Alcohol potential of grain and seed dust.[a]

Dust commodity	*Gallons of 200 proof alcohol*					
	Hexose fermentable		*Pentose fermentable*		*Total fermentable*	
	Per ton	*Total*	*Per ton*	*Total*	*Per ton*	*Total*
Wheat	44.2	5,857,000	22.2	2,942,000	66.4	8,799,000
Corn	100.2	3,060,000	14.0	429,000	114.2	3,489,000
Sunflower	39.5	1,416,000	15.9	571,000	55.4	1,987,000
Other	68.8	2,272,000	12.0	396,000	80.8	2,668,000
Total	—	12,605,000	—	4,338,000	—	16,943,000
Average	54.4	—	18.7	—	73.1	—

[a] Based on analytical data of Table 3. Conversion factors used were (1) 172 gallons of alcohol per ton of starch (hexose) and (2) 120 gallons of alcohol per ton pentose assuming fermentation by a pentose utilizing organism such as *F. oxysporum* (Batter and Wilke, 1977).

TABLE 5. Carbohydrate content of process vegetable wastes.[a]

Vegetable byproducts	Extractable CBH[b] %	Extractable CBH[b] Tons	Crude-fiber CBH %	Crude-fiber CBH Tons
Sweet corn	16.4	42,109	8.0	20,541
Potato	15.8	22,583	1.4	2,001
Snap bean	6.1	2,705	1.0	444
Green pea	12.4	4,192	2.0	676
Beat	8.0	3,112	4.0	1,556
Carrot	7.0	1,386	2.5	495
Lima bean	20.3	139	1.0	7
Total		76,226		25,720

[a] Based on data of Table 2 and that of Cooper (1976).
[b] CBH = carbohydrate.

TABLE 6. Hexose/pentose analysis of extractable carbohydrate from process vegetable wastes.[a]

Vegetable byproducts	Hexose %	Hexose Tons	Pentose %	Pentose Tons
Sweet corn	98.6	41,519	1.4	590
Potato	86.9	19,625	13.1	2,958
Snap bean	85.7	2,318	14.3	387
Green pea	86.2	3,614	13.8	578
Beet	89.6	2,788	10.4	324
Carrot	86.5	1,199	13.5	187
Lima bean[b]	90	125	10	14
Total		71,188		5,038

[a] Based on analyses of data compiled in Table 5.
[b] Estimated.

TABLE 7. Hexose/pentose analysis of crude-fiber carbohydrate from process vegetable wastes.[a]

Vegetable byproducts	Hexose %	Hexose Tons	Pentose %	Pentose Tons
Sweet corn	63.9	13,126	36.1	7,415
Potato[b]	75	1,501	25	500
Snap bean	75.8	337	24.2	107
Green pea	72.1	487	27.9	189
Beet	71	1,105	29	451
Carrot	70.5	349	29.5	146
Lima bean[b]	70	5	30	2
Total		16,910		8,810

[a] Based on analyses of data compiled in Table 5.
[b] Estimated.

values based in part on previous data (Martin, 1978).

Estimates of the alcohol potential of grain and seed dust are contained in Table 4. The information is presented in three different formats representing (1) the alcohol potential based on standard fermentation technology using *S. cerevisiae,* which ferments only hexoses; (2) the incremental alcohol potential which would be obtained by fermentation with pentose utilizing microorganisms (e.g., *Fusarium oxysporum*) and (3) the theoretical total alcohol potential assuming fermentation of both hexose and pentose sugars. Since the probable input to fermentation facilities proposed for the Superior-Duluth area would be a proportioned mixture of dust from several grain and seed sources, the weighted average alcohol potential per ton is the most significant projection. Standard fermentation practices would be expected to yield an average of 54.4 gallons of 200 proof alcohol per ton of mixed grain and seed dust. This value can be compared with an industry-wide average value of 79 gallons per ton from several intact grain commodities (Mandeville, 1980). Improved technology aimed at complete hexose/pentose fermentation would raise this projection to 73.1 gallons per ton, very close to the yield expected from the parent grain and seed mixture.

Analysis and Alcohol Potential of Process Vegetable Wastes

If the discrete solids from vegetable wastes are pressed hydraulically an expressate, rich in soluble sugars, is obtained. The pressed residue contains the bulk of the crude fiber carbohydrate (cellulose and hemicellulose) wastes while the bulk of the soluble or extractable carbohydrate wastes is present in a mixture of the screened effluent and expressate. Estimates of the percent distribution of extractable and crude-fiber carbohydrate are available for each class of vegetable byproducts wastes. Table 5 shows a compilation of these estimates applied to the byproducts yields described in Table 2. These calculations provide a breakdown of the net extractable and crude fiber carbohydrate content for each of the vegetable crop byproduct wastes encountered in the Wisconsin canning industry. Thus, an annual total of approximately 76,000 tons of readily bioconvertible extractable carbohydrate is available from Wisconsin canneries, with an additional 26,000 tons potentially available depending on the efficiency and cost-effectiveness of bioconversion. Already the lower amounts of carbohydrate would suffice to produce a theoretical maximum of approximately 11.6 million gallons of 200 proof alcohol.

Since the hexose/pentose ratio of wastes determines in large measure the ultimate alcohol yield, each available vegetable byproducts sample was submitted to hexose/pentose analysis. The results for extractable and crude-fiber carbohydrate are described in Tables 6 and 7. As expected, crude-fiber carbohydrate contains more pentose (34 percent) than does extractable carbohydrate (6.6 percent). Surprisingly, extractable carbohydrate does contain an appreciable pentose component, but this is not expected to affect greatly the alcohol potential of this vegetable byproducts fraction. More importantly, the fermentable sugar (hexose) content data allow projections to be made with greater fidelity of alcohol yield obtainable by standard fermentation technology.

Estimates of the alcohol potential of process vegetable byproducts wastes are compiled in Tables 8 and 9 for extractable and crude-fiber carbohydrate. Again, the estimates are presented in three ways describing the alcohol potential based on (1) hexose fermentable sugars, (2) pentose fermentable sugars, and (3) total fermentable sugars.

In summary, standard fermentation practices applied to Wisconsin's vegetable byproducts wastes could be used to produce approximately 11 million gallons of 200 proof alcohol. Effective saccharification of cellulosics coupled to standard fermentation practices could generate an additional 2.9 million gallons for a total of 13.9 million gallons. Finally, improved fermentation technology aimed at the co-utilization of pentose sugars could produce an additional 1.66 million gallons for a grand total from vegetable byproducts wastes of 15.56 million gallons.

It is important to point out at this juncture that all of the estimates given assume

Table 8. Alcohol potential of extractable carbohydrate from process vegetable wastes.[a]

	Gallons of 200 proof alcohol		
Vegetable byproducts	*Hexose fermentation*	*Pentose fermentation*	*Total fermentation*
Sweet corn	6,435,000	70,800	6,505,800
Potato	3,042,000	354,960	3,396,960
Snap bean	359,300	46,440	405,740
Green pea	560,200	69,360	629,560
Beet	432,100	38,880	470,980
Carrot	185,800	22,440	208,240
Lima bean	19,400	1,680	21,080
Total	11,033,800	604,560	11,638,360

[a] Based on data compiled in Table 6 and the following bioconversion factors: 155 gallons per ton for hexose fermentation and 120 gallons per ton for pentose fermentation.

Table 9. Alcohol potential of crude-fiber carbohydrate from process vegetable wastes.[a]

	Gallons of 200 proof alcohol		
Vegetable byproducts	*Hexose fermentation*	*Pentose fermentation*	*Total fermentation*
Sweet corn	2,258,000	889,800	3,147,800
Potato	258,200	60,000	318,200
Snap bean	57,960	12,840	70,800
Green pea	83,760	22,680	106,440
Beet	190,100	54,120	244,220
Carrot	60,030	17,520	77,550
Lima bean	860	240	1,100
Total	2,908,910	1,057,200	3,966,110

[a] Based on data compiled in Table 7 and the following bioconversion factors: 172 gallons per ton for hexose fermentation and 120 gallons per ton for pentose fermentation.

theoretical yields which are seldom encountered at industrial levels. Cumulative bioconversion losses are routinely encountered during starch and cellulose saccharification as well as fermentation with *S. cerevesiae*. Losses encountered during mashing of grains are generally related to inefficient grain processing (grinding). This is unlikely to be a problem with grain and seed dust since the particle size distribution of the dust is considerably smaller than that of traditional ground grain input to fermentation vats (Martin, 1976). However, the trade-off with grain and seed dust comes from its higher level of structural carbohydrate, which may restrict access to saccharifying enzymes of a portion of the hexoses (Harkin, 1973).

Losses are also encountered during fermentation because a portion of the sugars is consumed in growth of the yeast necessary for the alcoholic fermentation, and products other than ethyl alcohol and carbon dioxide are produced in small quantities during fermentation. Finally, firm data are not yet available on the efficiency of recovery of dilute sugars from the extractable carbohydrate fraction of vegetable byproducts and on the efficiency of cellulosics saccharification. It is difficult at this time to put a precise figure on these losses; somewhere in the range of 8 to 12 percent of the overall quantity of wastes available from the two major sources under consideration seems a reasonable estimate. Some of these imponderables will be discussed in more detail in the following section.

Production Considerations

Since the bulk of the alcohol potential of cannery wastes and grain and seed wastes is derivable by traditional bioconversion technology, in the discussion of production considerations emphasis must be placed on readily fermentable feedstock fractions. Exploratory studies aimed at bioconversion of more intractable wastes (e.g., cannery wastes crude-fiber carbohydrate and wheat dust

Table 10. Wisconsin process vegetable wastes expressate volumes and carbohydrate concentrations.

Vegetable byproducts	*Carbohydrate in expressate (%)*	*Effluent volume[a] gallons × 1000*	*Volume normalized to 20 percent sugar* Factor	*Volume normalized to 20 percent sugar* gallons × 1000
Corn husk[b]	11.0	14,071[c]	1.82	7,731
Corn stream	2.68	314,626[d]	7.46	42,175
Potato	1.92	278,759	10.4	26,804
Snap bean	2.0	32,054	10.0	3,205
Green pea	4.45[e]	22,326	4.49	4,972
Beet	2.9	25,433	6.90	3,686
Carrot	2.52	13,035	7.94	1,642
Lima bean	2.0[f]	1,647	10.0	165
Total	—	701,951	—	90,380
Average	2.58	—	7.75	—

[a] Calculated by dividing the total extractable carbohydrate tonnage of Table 5 by the percent concentration of carbohydrate in the expressate, followed by multiplication of this number by 23,700.
[b] Includes husks, cobs, and silk cuttings.
[c] This source accounts for 6,531 tons of carbohydrate (Penly, 1981).
[d] Based on the estimate of carbohydrate remaining after removal of 6,531 tons.
[e] Based on dietetic pea pack expressate.
[f] Estimated.

pentosans) have been performed and will be described in future reports.

Cannery Wastes Extractable Carbohydrate

The major drawback to immediate utilization of extractable carbohydrate from process vegetable byproducts wastes is their excessive dilution, as can be inferred from B.O.D. values of cannery effluents (Weckel et al., 1968). While the precise carbohydrate concentrations of the screened effluents are not yet known, those of expressates have been determined and the data are compiled in Table 10. Since the screened effluents were formerly in solution equilibrium with the expressate solutions derived from the discrete wastes, the carbohydrate concentration in the former is likely less than that found in the expressates. However, for purposes of production considerations, the concentration of total extractable carbohydrate is assumed to be identical to that of the expressate solutions.[1] Except for expressates from corn and husk cuttings, the carbohydrate concentrations fall in the range of 1.92 to 4.45 percent (Table 10), values too low for efficient fermentation and subsequent alcohol recovery. Ideally, input sugar concentrations for fermentation should be in the range of 15 to 20 percent. Therefore, the problem is to concentrate at least 702 million gallons of process effluent soluble sugars containing an average of 2.58 percent by weight of fermentable sugar to a final concentration of at least 15 percent, preferably 20 percent, and a final volume of approximately 90 million gallons. To avoid excessive storage and transportation of the diluted stream, this task must be performed on site, within the span of the canning season (about 122 calendar days), and at a cost not to exceed 6¢ per pound of sugar for the concentrate to remain competitive with other fermentation feedstocks (Gregor, 1979).

For several years dilute sugar streams have been economically concentrated to 25 to 30 percent sugar by candy manufacturers in the U.S.A. and elsewhere, using commercially available reverse osmosis equipment (Spatz, 1974). Recent versions of such equipment have been in use for several months in different locations for the concentration of lactose from whey, for the concentration of beet sugars, and for the purification of water from low B.O.D. corn and potato waste streams (Friedlander, 1981). No significant membrane fouling problems have been encountered in these applications and routine membrane cleaning with detergents has proven an effective means of maintaining full operating efficiency. Thus reverse osmosis technology seems eminently applicable for concentrating vegetable process effluent soluble sugars to fermentable levels.

Economic analysis of unit costs suggests a favorable outlook for commercialization within the canning industry of the large-scale production of process effluent soluble sugar concentrates for fermentation feedstock. While sufficient data are not yet available for an in-depth analysis, the introduction of a few assumptions allows a reasonable estimate to be made of unit costs; these are summarized in Table 11. A commercial re-

TABLE 11. Cost analysis summary of process effluent soluble sugar concentration by reverse osmosis.

Item	*Contribution to annual costs*	*Cents per pound sugar*
A. Fixed costs		
Reverse osmosis equipment	$1,715,000	1.2
Membrane replacement	600,000	0.4
Stainless steel storage	962,000	0.6
Prefiltration equipment	600,000	0.4
Subtotal	$3,877,000	2.6
B. Operating costs		
Power	$ 300,000	0.2
Maintenance	200,000	0.13
RO membrane cleaner	239,000	0.16
Subtotal	$ 739,000	0.49
NET	$4,316,120	3.09

verse osmosis (RO) unit with a molecular weight cutoff limit of 300 would retain the bulk of the extractable carbohydrate. Such a system, operating for 20 hours per day at 400 psi, could process 14.35 million gallons of cannery effluent per season per unit (Friedlander, 1981). Thus a total of 49 units would be required to process approximately 702 million gallons of cannery effluent produced statewide. At a cost of $175,000.00 per unit, the total capital cost for RO equipment would be $8,575,000.00. If amortized over 5 years, the contribution to fixed costs would therefore be $1,715,000.00 per year. Since the useful life of the membranes is estimated at 2 to 3 years of continuous service, membrane replacement costs do not enter into the fixed costs during the period of equipment amortization because the canneries operate for only approximately ⅓ of the year. Thereafter, with membrane replacement every 6 calendar years, the costs should average only $12,200.00 per year per unit for a total annual contribution to fixed costs of $600,000.00.

On-site stainless steel equipment for storage of 2 to 3 days' supply of dilute effluent and concentrate would require an investment of approximately $9,620,000.00. Storage tanks are generally amortized over a long period of time; the annual contribution to fixed costs during a ten-year amortization period would be $962,000.00. Pre-reverse osmosis filtration equipment (e.g., a "Shriver" filter press or continuous discharge centrifuges and sterile filtration cartridges) would be expected to add an additional $3,000,000.00 which if amortized over a five-year period, would contribute $600,000.00 to the annual fixed costs estimate. The total statewide annual contribution to fixed costs would therefore be $3,877,000.00

The operating costs estimates compiled in Table 11 are all based on published estimates (Spatz, 1974) derived from the use of the same equipment used to estimate fixed costs. The figures quoted include both RO and prefiltration associated labor, maintenance, power, and chemical costs. The net annual operating costs amount to $739,000.00 for total statewide annual production cost estimate of $4,616,000.00. Since these costs would cover the production of approximately 76,226 tons of sugar concentrate, the production cost per pound of sugar would amount to approximately 3¢, a value well below the 6¢ per pound limit arbitrarily imposed above for cost-effective reasons. At 6¢ per pound of sugar, the feedstock cost contribution to 200 proof alcohol production is approximately 77¢ per gallon. Since production costs themselves (fermentation and distillation) are in the range of 35 to 45¢ per gallon depending on the value and marketability of distillers by-products, the net production costs for 200 proof alcohol would be approximately $1.17 per gallon, a figure well within the competitive range of gasoline costs today. These figures can be compared with a value of $1.29 for the feedstock share contribution alone of 200 proof alcohol produced from today's cash market grains. The 3¢ per pound difference between our estimate of sugar concentrate production cost and competitive upper limit creates flexibility to absorb other costs (e.g., equipment housing, transportation, syrup production option, incomplete membrane rejection of sugars, shortened membrane life, putrefaction losses, saccharification requirements, etc.) for which sufficient data are not yet available to derive reasonable estimates.

Canneries have two options to use or market their sugar concentrates. First, to avoid storage of 90 million gallons of sugar concentrate, the canneries could sell their fresh concentrates to nearby alcohol producers. The approximately 40.5 million gallons per year of fermentation/distillation capacity expected to be on line in Wisconsin by the end of 1982 (Plaza, 1981) could utilize all of the sugar concentrate from Wisconsin's canneries. Distilleries are presently located in Trempealeau, Marathon, Lincoln, Brown, Juneau, Fond du Lac, Columbia, Dane, Lafayette, Rock, and Walworth counties at sites which literally surround the state's major vegetable processing facilities. By operating for approximately one-third of the year with cannery sugar concentrates as inexpensive feedstock, distilleries could significantly reduce their high outlay for cash market grains as fermentation feedstock.

Second, canneries could run the 20 percent sugar concentrate solutions through scraped-surface heat exchanger evaporators to produce a syrup containing about 60 percent sugars. Normally the energy to evaporate approximately 60 million gallons of water to produce a 60 percent sugar syrup would add another 4¢ per pound to the cost of the sugar produced (assuming 4¢ per KW), exclusive of equipment requirements. However, canneries generate vast quantities of waste heat; the application of heat exchanger technology might contribute a major fraction of the heat required to operate scraped-surface evaporators. Three major benefits might accrue: transportation costs would be significantly reduced, storage facilities need not be so large, and the syrup is more amenable to long-term storage.

Also important is the form of the sugars in the extractable carbohydrate: mono-, di-, or trisaccharides are directly utilizable by yeast but polysaccharides are suitable for fermentation only after extensive enzymatic saccharification. Fermentation/distillation analysis of expressates from corn husk and cob cuttings has established that the yield of alcohol without enzymatic saccharification is 86.4 percent of that found after pretreatment with amylase enzyme. Thus, it is likely that the bulk of the process vegetable extractable carbohydrate is directly fermentable.

Recovery of Sugars from Cannery Wastes Crude-fiber Carbohydrate

Crude-fiber carbohydrate consists principally of cellulose, which must be degraded to simple sugars by chemical, microbiological, or enzymatic processes prior to fermentation. Naturally occurring cellulose is mostly associated with lignin which physically restricts access by enzymes or microorganisms to the glycosidic linkages which must be ruptured to generate simple sugars (Harkin, 1973). In general, the more lignin in a lignocellulosic biomass sample, the greater its resistance to enzymatic or microbiological saccharification. Woody lignocellulosics contain 25 to 30 percent lignin and offer the highest degree of resistance to bioconversion (Millett, 1979). Less than 5 percent of the lignocellulosic sugars of woody biomass are released (Humphrey, 1979) through the action of the cellulase enzyme complex from *T. viride* in the absence of expensive pretreatment processes (e.g., ball milling, explosive decompression).

Cannery wastes discrete solids are in general less highly lignified than woody lignocellulosics (Table 12), and consequently more amendable to enzymatic conversion to simple sugars. The mostly highly lignified vegetable byproduct discrete waste encountered was the solids portion of corn husk and cob cuttings. Despite their 9.7 percent lignin, the latter released 78.3 percent of their total carbohydrate in the form of simple sugars after 48 hours hydrolysis with 0.5 percent cellulase enzyme complex from *T. viride*.

Table 12. Lignin content and saccharification efficiency of cannery wastes crude-fiber carbohydrate.

Discrete wastes sample	*% lignin*	*% saccharification*[a]
Corn stover	14.4	41.3
Corn husk and cob cuttings	9.7	78.3
Snap bean	3.8	84
Beet	2.4	81.5
Pea	2.3	nd[b]

[a] Saccharification was carried out in the presence of Cellulase TV (Miles) for 48 hours at 45°C and at pH of 4.5. Substrate concentration was set at 4 percent and the enzyme concentration at 0.5 percent.

[b] nd = not determined.

All other cannery discrete wastes samples are less lignified and should afford good or better yields of sugar on cellulose hydrolysis than corn husk and cob cuttings. This is borne out by the saccharification results obtained with snap beans and beet discrete solids wastes.

Data for corn stover are included because this material has a lignin content intermediate between that of cannery wastes solids and that of woody biomass. The sharp decrease in the enzymatic release of simple sugars observed with this sample suggests a major structural impediment to enzymatic attack in going from 9.7 percent to 14.4 percent lignin. While other factors such as cellulose crystallinity and graft copolymerization (Harkin, 1973; Caulfield and Moore, 1974) could be partially responsible for this remarkable transition, the two key features of these data are that all cannery wastes discrete solids examined appear to contain less than 10 percent lignin and all appear to be efficiently degradable to simple sugars in yields greater than 78 percent with extracellular cellulase enzyme complex.

Recovery of fermentable sugars from cannery wastes crude-fiber carbohydrate is therefore a technically feasible endeavor. However, cost effectiveness of such a venture cannot be accurately assessed without additional data. The principal drawback to the use of commercially available cellulase enzyme complex is the long residence time (*circa* 48 hours) at 45°C required for complete conversion and the danger of putrefaction at these temperatures, which could add significantly to the cost of bioconversion. There are two alternatives open to cope with this problem: 1. Use of the thermotolerant cellulase enzyme complex from *Thielavia terrestris* (Tusé et al., 1980), which is active at or near conventional mashing temperatures, to effect a faster rate of cellulose hydrolysis per unit time; or 2. simultaneous enzymatic saccharification with commercially available thermolabile cellulase and fermentation, a strategy similar in concept to the Gulf Process (Emmert and Katzen, 1979). Both of these options are currently under investigation in our laboratory.

Bioconversion of Grain and Seed Dust

The key consideration relative to the bioconversion of grain and seed dust will probably be its market value to the graneries as feedstock for alcohol production. Presently, such wastes are sometimes sold for approximately $11.00 per ton for pelletizing and use as animal feed. This price is only about 10 percent of the market value of intact grain and seed. Because of the severe economic loss incurred in the removal of grain and seed dust, currently U.S. export elevators return some of the collected dust to export grain and seed; this practice lowers the quality of U.S. export commodities and is contrary to the recommendation of U.S. Government regulatory agencies, which have "requested" that grain dust removed not be returned to grain. Diversion of all collected dust to fermentation feedstock requires that a higher unit value than that at present be placed on grain and seed dust wastes.

Critical information required to estimate the potential value of grain and seed dust as fermentation feedstock includes the alcohol yield per ton, the production costs, and the market value of the product (200 proof alcohol). Data on the alcohol potential per ton are contained in Table 4. Since conventional fermentation practices do not currently utilize pentose sugars for the production of alcohol (see however, Batter and Wilke, 1977; Anonymous, 1981a), the most conservative estimate of alcohol potential must be based on the hexose content. On this basis, mixed grain and seed dust currently available from the Superior facilities should yield approximately 54.4 gallons of 200 proof alcohol per ton. Estimates of production costs (Katzen, 1980) for a 10 million gallon per year batch plant processing grain established a base conversion cost of

32.5¢ per gallon, exclusive of feedstock cost but including a distillers byproducts value equivalent to 38.6¢ per gallon. Since the June 15, 1981 price quotations (Anonymous, 1981b) for anhydrous alcohol averaged $1.80 per bulk f.o.b. gallon, the theoretical grain and seed dust value capable of being sustained would be $1.80 less production costs of 32.5¢ per gallon or $1.475 per gallon equivalent. Since each ton of grain and seed dust could be used to produce at least 54.4 gallons of alcohol, the maximum value per ton of feedstock would be $80.24, or 7.3 times the value afforded by diversion to animal feed and approximately 73 percent of the value of the intact commodity. Marketing practices aimed at competitiveness with current gasoline prices (approximately $1.30 per gallon) would reduce the value of $53.04 per ton or still 4.8 times the value afforded by diversion to animal feed. Finally, simultaneous bioconversion of the pentose fraction of grain and seed dust could convey maximum values of $107.80 to $171.30 per ton, respectively, depending on marketing practices. Studies are presently underway to determine the feasibility of pentose co-fermentation.

All of the above estimates are based on the production of anhydrous alcohol for blending to gasohol. Production of wet alcohol for a straight fuel market would be attended by a decrease in production costs, and decrease in alcohol value relative to the anhydrous alcohol market.

Summary

Grain elevator dust and process vegetable byproducts are good examples of economic liabilities which can be converted into assets through conversion to fuel-grade alcohol. The ability of these two biomass waste sources to support a viable fuel-grade alcohol production industry is intimately tied to the elimination of major costly industrial waste disposal problems. The vegetable processing industry in Wisconsin spends several millions of dollars annually to dispose of high B.O.D. cannery effluent and a major portion (greater than 30 percent) of the input crop as solid waste in a manner which will comply with environmental standards. Occupational Safety and Health Act, the requirements of the 1970 Clean Air Act, and the incidence of grain dust explosions are forcing grain elevator facilities to install expensive air scrubbing equipment to collect and dispose of grain and seed dust, currently a near valueless byproduct. Utilization of byproducts from these two sources as fuel-grade alcohol feedstock would therefore attenuate the burdens of waste disposal and regulatory compliance for the affected industries, in addition to sparing fossil fuel.

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References Cited

Anonymous. 1981a. USDA process converts xylose to ethanol. Chem. Engr. News 59(25):54-55.

———. 1981b. Price quotes. Gasohol U.S.A. 3(7): 3.

Batter, T. R. and C. R. Wilke. 1977. A study of the fermentation of xylose to ethanol by *Fusarium oxysporum*. Lawrence Berkeley Lab., Univ. of California. p. 160.

Blondin, G. A. and D. E. Green. 1970. The mechanism of mitochondrial swelling. V. Permeability of mitochondria to alkali metal salts of strong acid anions. Bioenergetics 1: 193-213.

Bonnichsen, R. K. and H. Theorell. 1951. An enzymatic method for the microdetermination of ethanol. Scand. J. Clin. Lab. Invest. 3:58.

Caulfield, D. F. and W. E. Moore. 1974. Effect of varying crystallinity of cellulose on enzymatic hydrolysis. Wood Sci. 6(4):375-379.

Converse, J. C. 1979. Ethanol production from biomass with emphasis on corn. College of Agricultural and Life Sciences, Univ. of Wisconsin-Madison.

Cooper, J. L. 1976. The potential of food processing solid wastes as a source of cellulose for enzymatic conversion. Biotechnol. Bioengr. Symp. 6:251-271.

Emert, G. H. and R. Katzen. 1979. Chemicals from biomass by improved enzyme technology. Paper presented at 1979 ACS/CSJ Joint Chemical Congr., Honolulu, Hawaii, April 1-6.

Friedlander, R. 1981. Personal communication.

Gregor, H. P. and T. W. Jeffries. 1979. Ethanolic fuels from renewable resources in the solar age. Annals of the N.Y. Acad. Sci. 326:273-287.

Harkin, J. M. 1973. Lignins. p. 323-373. *In* R. W. Bailey and G. W. Butler (eds.) Chemistry and biochemistry of herbage, Vol. 1. Academic Press, New York.

Humphrey, A. E. 1979. The hydrolysis of cellulosic materials to useful products. p. 25-53. *In* R. D. Brown and L. Jurasek (eds.) Hydrolysis of cellulose: Mechanisms of enzymatic and acid catalysis, Vol. 181. American Chemical Society, Washington, D.C.

Katzen, R. 1980. Alcohol from corn. p. 123-127. *In* J. K. Paul (ed.) Large and small scale alcohol manufacturing processes from agricultural raw materials. Noyes Data Corp., Park Ridge, New Jersey.

Kosaric, N., D. C. M. Ng, I. Russell, and G. S. Stewart. 1980. Ethanol production by fermentation: An alternative liquid fuel. Adv. Appl. Microbiol. 26:147-227.

Mandeville, M. W. 1980. Solar alcohol: The fuel revolution. Ambix Press, Port Ludlow, Wash. p. 1-127.

Martin, C. R. 1978. Characterization of grain dust properties. Paper presented at 1978 Summer Mtg. ASAE, Logan, Utah, June 27-30.

Martin, C. R. and D. B. Sauer. 1976. Physical and biological characteristics of grain dust. Trans. ASAE 19:720-723.

Millett, M. A., M. J. Effland, and D. F. Caulfield. 1979. Influence of fine grinding on the hydrolysis of cellulosic materials—acid vs. enzymatic. p. 71-89. *In* R. D. Brown and L. Jurasek (eds.) Hydrolysis of cellulose: Mechanisms of enzymatic and acid catalysis, Vol. 181. American Chemical Society, Washington, D.C.

Morrison, I. M. 1972. A semi-micro method for the determination of lignin and its use in predicting the digestibility of forage crops. J. Sci. Food Agric. 23:455-463.

Olson, M. R. 1981. Personal communication.

Penly, D. H. 1981. Personal communication.

Plaza, G. 1981. Personal communication.

Schnake, L. D. 1981. Grain dust: problems and utilization. USDA, Economics and Statistics Serv. Report No. ESS-6. p. 1-17.

Scott, R. W. 1976. Combined determinations of glucose, mannose, and xylose by spectrophotometry. Anal. Chem. 48:1919.

Spatz, D. D. 1974. Reclamation of food waste products through membrane processes. Industrial Wastes Jan./Feb.:20-24.

Tusé, D., B. J. Mason, and W. A. Skinner. 1980. Comparative activity profiles of *Thielavia terrestris* and *Trichoderma reesei* cellulases. Biosources Digest 2(4):216-227.

Weckel, K. G., R. S. Rambo, H. Veloso, and J. H. von Elbe. 1968. Vegetable canning process wastes. College of Agricultural and Life Sciences, Univ. of Wisconsin-Madison, Research Report No. 38. p. 1-20.

Note

[1] An inventory of extractable carbohydrate carried out during the early part of the 1981 vegetable pack has thus far revealed two general trends: 1. The total amount of extractable carbohydrate wastes exceeds the estimates described herein by an average of 38 percent; and 2. the weighted average effluent carbohydrate concentration for both the green pea and snap bean pack is less than that of the expressate alone. Thus, while it is theoretically possible to recover more sugar than originally estimated, the reverse osmosis equipment requirements specified in this report are sufficient for the recovery of only 70 percent of projection.

MORAL ASPECTS OF THE ALLOCATION OF PUBLIC HEALTH CARE FUNDS

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When a society decides to devote some portion of its public resources to health care, significant questions about allocation arise. First of all, of course, there is the question of how much of the society's total resources ought to be allocated to health care—as opposed to defense, education, and so forth. That, however, is not the question with which this paper deals. For the purposes of the present inquiry, it will be assumed that the decision about what portion of resources to allocate to health care has already been made. The question here is how the resources made available for health care ought to be allocated to each of several possible areas.

This matter acquires considerable importance from the intimate connection between good health and the good life (as discussed by classical Greek philosophers). Whether one thinks in terms of designing a society in which individuals can achieve something approaching the good life, or in terms of evaluating existing societies with an eye to the individual's chance of attaining the good life in them, the individual's chance of enjoying good health must be taken into consideration. And the individual's chance of enjoying good health in a given society can certainly be affected by the way that public health-care funds are used in that society.

It should be kept clearly in mind that the problem at issue here is *not* that of the proper distribution of expensive medications and scarce medical equipment. That matter has been examined by a number of writers in recent years, and some of the most interesting articles—including Nicholas Rescher's "The Allocation of Exotic Medical Life-saving Therapy"—have recently been reprinted in Ronald Munson's excellent *Intervention and Reflection: Basic Issues in Medical Ethics.*[1] Such discussions, however, are basically concerned with the distribution of resources allocated for the *treatment* of ill health. And this question can be seen as subsidiary to the question at issue in this paper—that of the proper distribution of resources alloted to health care. Treatment is just one of several areas in which health-care funds can be spent, and part of the question to be discussed here is just how much of such funds ought to go for treatment in the first place.

I should like to suggest that by "stepping back" to consider this matter of the allocation of public resources among what must be acknowledged to be competing areas in health care, we may be able to see over the tangles of equipment-and-medication allocation difficulties to discover something of importance for future public policy decisions.

What kind of areas do I have in mind when I speak of competing areas of health care? Treatment is one, prevention is another, and research is a third. I do not mean to suggest that this is the only way in which the field of health care can be subdivided—or that there are no areas of overlap between these areas. I simply believe that for the purposes of discussing how public funds for health care are to be employed, it is important to consider this particular division. As a matter of fact, as will be seen shortly, one of these areas turns out to be of particular importance from a particular moral point of view.

I wish to begin by considering the "history" of a health problem, not as it affects any particular individual, but as it affects a whole society over a long period of time. One could, of course, speak in terms of actual examples, but I believe that the relevant points can be made most clearly in the abstract. Consider, then, some health problem that affects the members of some society. (I use the expression "health problem" because I wish to include functional disorders, injuries, and behavioral problems as well as diseases.) The problem may exist for many generations before anything effective is done about it, simply because the civilization does not have the knowledge or the materials to do anything about it. During this period of the problem's history, which for our purposes can be labelled "Stage One," individuals afflicted suffer—or at least experience discomfort—without recourse. From the point of view of a disease, Stage One is a time of flourishing. With respect to injuries, Stage One represents the period of most serious consequences for the injured parties. And in general, Stage One in the history of a health problem is the worst from the point of view of the individuals affected.

Eventually, if the society in question is fortunate, Stage One comes to an end: someone discovers something that effectively reduces the discomfort associated with the problem. A medicine is found that alleviates the symptoms of the disease, or that accelerates healing of the injury; or therapy is developed to improve the existence of persons with a particular emotional problem. Such developments usher in Stage Two in the history of the health problem—the period of the problem's containment and decline. The disease may continue to survive, but its ravages are reduced. The injuries or congenital defects may still occur, but the severity of their consequences is lessened. In Stage Two the society affected by the problem is fighting back with some success.

The duration of Stage Two is every bit as problematic as that of Stage One. Just as some societies may cease to exist before any effective treatment for certain health problems is found, so other societies may never get beyond Stage Two with respect to certain health problems. There is no guarantee that a particular society will ever go beyond "containing" a particular health problem. But there is always a possibility that the society may at length obtain the information and equipment that will permit it to control the problem so thoroughly that it might as well not exist. It is at this point that the problem can be said to pass into Stage Three of its history.

In Stage Three the problem is completely under control. The disease is entirely prevented—or it is completely cured if it does occur. The physical deformity is entirely repaired. The injury is induced to heal completely, and the emotional disorder is rectified once and for all. The society, in brief, no longer suffers from the problem because the problem has been overcome.

In some societies, people may regard Stage One as the unalterable *status quo* with respect to certain health problems—or even with respect to health problems in general. They may mistakenly assume that suffering caused by disease and deformity is an essential component of human existence. In other societies, people may suppose that certain health problems can be at most controlled, and that a diminution of the associated suffering is the best that can be hoped. They may, in other words, accept Stage Two as the unchangeable *status quo*. In our own civilization, however, by dint of good fortune and good work in recent centuries, we have come to appreciate the possibility of Stage Three. Indeed, with respect to certain health problems, we have actually witnessed the arrival of Stage Three. And we have come to look forward eagerly to its advent with respect to many other health problems.

As a matter of fact, indications are strong that there is literally no limit to the number of health problems that can eventually be ushered into Stage Three of their history. It may prove possible, in the course of time, to bring *all* diseases, both major and minor, under complete control. Colds and VD may become as much a thing of the past as smallpox. We may find sure ways of preventing mental illness. We may learn to regenerate major organs. And it may even become possible to eliminate the disorders associated with aging. We *may* that is, ultimately eliminate health problems altogether. Should this last possibility strike you as entirely without plausibility, may I simply invite you to reflect on the advances in medical knowledge that have been made in the last several hundred years. Is it really very likely that a thousand years from now—barring some untoward development that could stop the advance of knowledge—we will still be plagued by hemorrhoids and hay fever? At the very least, I think it must be admitted that in the light of previous progress in the containment and control of a wide range of health problems, it is entirely possible that Stage Three will come for the vast majority of the problems we know at present. And should new problems arise, there is no special reason to think that they will prove less tractable than those we have already overcome.

In order to appreciate an important ethical issue which arises when the three-stage history of a health problem is taken into consideration in a discussion of the allocation of public health-care resources, it will be necessary to focus on a particular facet of this history—the manner in which the suffering associated with a health problem varies from one stage to another. And in doing this it will be well, at least at the outset, to limit consideration to a hypothetical society in which population size does not vary significantly through the three stages of a problem's history. Assume, if you will, that factors entirely unrelated to the problem in question operate in such a way as to keep the size of the population constant.

Stage One, then, is likely to be that in which health problems occasion the greatest amount of suffering (per unit of time). When there is no effective means of prevention or treatment for a disease, an injury, a congenital deformity, or an emotional illness, it is likely to produce a maximum of pain, discomfort, and sorrow—both for the people directly affected and for those who love, depend upon, or take care of them. There may, of course, be exceptions. Some health problems may prove quickly terminal for the afflicted individual in Stage One and may drag on and on in Stage Two. In such cases, it is possible that the total suffering undergone by a given individual in Stage Two of a particular problem's history might be greater than that undergone by a similarly afflicted individual during Stage One. In general, however, it would seem that, other things being equal, it would be preferable to encounter a health problem in Stage Two rather than in Stage One of its history.

Accordingly, Stage Two can be accurately described as the period in a health problem's history in which it is responsible for the second greatest amount of suffering. Part of the control that people obtain over the problem in Stage Two may be control over the pain it causes to the person directly involved—or it may be of such a nature as to prevent the development of the problem into its most painful phases. To be sure, the original control attained over the problem *may* consist merely in the ability to limit the number of individuals stricken—and the severity of the problem for those who do encounter it. In any event, if one had to choose to live in a society in which a particular health problem *might* be encountered, one would still be well advised to elect the society in which the problem was in Stage Two. If the ravages connected with the problem are not reduced by that society's containment measures, at least the likelihood of having it in the first place may be less because of those measures.

Stage Three, quite naturally, stands out as the period in which a health problem causes virtually no suffering at all. No one dies from the problem; no one suffers extended pain from it; no one is even seriously inconvenienced by it. Most evidently, other things being equal, one should choose to live in the society in which a given health problem is in Stage Three of its history.

The suffering caused by a health problem over the course of its history can be represented as a curve. This curve, which will be referred to as the "total-suffering curve" for a health problem, shows the suffering produced by the problem as a function of time. During Stage One, the curve will typically be high and roughly parallel to the time axis, although there may be cyclic fluctuations. Seasonal diseases may be responsible for more suffering at certain times of the year than at others; congenital birth defects which prove quickly fatal may occasion more suffering at times of the year when more children are born, and certain injuries, with their associated suffering, may cluster around times of the year when certain activities are more popular. On the whole, however, the total suffering curve for a particular health problem will, in the stable-population society under consideration, run more or less parallel to the time axis during Stage One. At the onset of Stage Two, of course, the curve will drop as the total suffering occasioned by the problem is reduced through the development of means of containing the problem. Then, if those containment methods continue to be improved during Stage Two, the curve will slope generally downward. Finally, when Stage Three arrives and the problem is controlled to the point of nonexistence, its total-suffering curve will either level out just above the time axis or will come to coincide with the time axis at the zero suffering level.

(What sort of unit might be involved if the total-suffering function for a particular health problem were to be expressed precisely? The time could be measured in, say, days from an arbitrary point in time; but what about the suffering? Intuitively, the notion of the total amount of suffering caused by a problem is nonproblematic: for a given time, the more people that are suffering from the problem, and the more intensely they are suffering, the more total suffering there is. How this might actually be measured is another matter. Perhaps it will one day be possible to measure electrical activity in the brain that correlates with suffering—and to use *that* as a measure of the suffering experienced by the individual in question. Short of this, one might think in terms of something like "unpleasant minutes per day." Of course, one ought to make adjustments for the difference between really awful minutes and merely uncomfortable minutes caused by a health problem; but even if this were not done, one could obtain a quantitative indication of the suffering caused by a problem each day by adding up all the unpleasant minutes lived through by different people affected that day. Note that if two people suffered during the same minute, that would make *two* unpleasant minutes experienced for that day.)

Naturally, as the individual total-suffering curves for different health problems in a society "zero out," the curve representing the grand total of *all* suffering in that society will tend downward—so that, other factors being equal, it will become lower and lower as health problems move into Stage Three of their individual histories. And that, of course, is something consummately to be desired. The general notion of social progress is closely bound up with the idea of successive reductions in the height of the grand-total-suffering curve. As generally conceived, the ideal society—even if it is only a sort of Platonic limit to be approached but never reached—would have a grand-total-suffering curve running flat at zero.

It is at this point that the problem for policy makers entrusted with the allocation of public health-care funds becomes apparent. The society has, after all, other things to which it is going to devote part of its resources, so the funds available for all health-care activities are limited. The result is that certain of those activities will have to be restricted at the expense of others. And the problem is that the allocation of public resources to certain areas of health care appears likely to give better results, in terms of reduction of the total suffering associated with a health problem, than would the allocation of those funds to other areas of health care.

It should be evident that there is no point in discussing the allocation of public funds for health care during Stage One of a problem's history. During Stage One, either no funds at all are provided for the alleviation of the problem or else whatever resources are made available are expended in such a way that they produce no results at all. Perhaps time is devoted to incantations that have no effect at all on the health problem. Or perhaps money is spent on useless medications or fruitless therapy. In any case, no progress is made against the problem. In Stages Two and Three, on the other hand, the expenditure of resources on health problems does produce results; so it is here that the question of the proper allocation of public health-care resources arises.

In particular, the question is most pressing during Stage Two of the history of a health problem. In Stage Three, after all, the knowledge and material for complete control of the problem are at hand; and available resources are directed toward their application. (This is not to say, of course, that public resources will be sufficient for the continuing complete control of all health problems that can be controlled. Some problems may, under conditions of scarcity, slip back from Stage Three into Stage Two.) During Stage Two, however, a decision must be made as to what proportion of the available resources will be used for treatment of those already afflicted by a particular health problem, what proportion will be allocated for procedures designed to keep others from becoming afflicted, and what part will be reserved for research designed to move the problem into Stage Three of its history.

The effect of allocating public health-care funds to each of these three areas deserves careful attention. But let us, for the sake of clarity, begin by considering how the total-suffering curve for a particular health problem might behave if no public funds at all were allocated to *any* of the three. Suppose, that is, that all treatment, prevention, and research are left to the private means of individuals and organizations. It is, of course, safe to suppose that private resources will be expended in these areas. Most individuals, if they realize that effective means of prevention or treatment are available for a particular health problem, will choose to allocate some part of their own funds to these ends. And since people tend to place a high value on their own health and that of their loved ones, they may in fact be willing to allocate a fairly large part of their income or assets to treatment and prevention. This alone will often insure that the total suffering associated with a health problem will be kept fairly low in Stage Two. Moreover, if no public funds are available for prevention or treatment, private groups may organize for the express purpose of providing such funds. With respect to research, on the other hand, it may be *only* organizations (commercial or otherwise) that finance research activities when no public funding is forthcoming. Few individuals have the knowledge, funds, and inclination to do research on their own. It is important to realize, however, that research *can* be done—and the end of Stage Two brought about—without the use of public funds at all. It is unlikely, however, that under such conditions Stage Two will end as soon as it would if public funds were available.

Let us now consider the likely effect on the total-suffering curve for a particular health problem if public resources are alloted for dealing with that problem. Suppose, to begin with, that in Stage Two of the history of a particular health problem, public health-care funds are available and are concentrated in the area of prevention. In the case of disease, this might mean that most available funds would be earmarked for eradication of environmental conditions known to contribute to the spread of the disease and for the manufacture and administration of whatever immunizing agents might be known. Few if any public funds would be set aside for treatment of those who, in spite of the preventive measures, contracted the disease. And few public funds if any would be used for research into ways of eliminating the disease altogether. In the case of a type of injury, the prevention-centered approach would mean that available public resources would go toward avoiding injuries of that sort in the first place, through the use of existing techniques. Society's resources would not, in general, be used for the treatment of those who sustained such injuries—nor for research into new ways of preventing them or new ways of repairing the damage.

Because of the preventive measures in effect under this approach, the total-suffering curve for a particular health problem would be substantially lower during Stage Two than it would be without public funds. The definite integral of the total-suffering function for Stage Two, that is, would be smaller under this approach. Although no public resources were devoted to treatment, the mere fact that many fewer people would have the problem means that there would be less overall suffering. (The overall total of "unpleasant minutes" for the entirety of Stage Two would be less.)

The prevention-centered approach, however, has two saliently unattractive features. One, of course, is that members of the society are left more or less to fend for themselves when they encounter a health problem. The frequency of such encounters may indeed be drastically reduced by the publicly funded measures of prevention. There may be, in comparison either to Stage One or to Stage Two without public funds, a greatly reduced likelihood of contracting a particular handicap, or developing a given type of emotional problem. But for those who *do* have health problems in spite of the preventive measures in effect, the lack of public assistance may be painful. If they can obtain treatment through the private channels of the marketplace, they may have no cause for concern. But if treatment is unavailable —either because of cost or because effective methods have simply not been developed—their chances of completing a good life (again, in the classical Greek sense of that phrase) may be significantly diminished.

The other outstandingly unattractive feature of the prevention-centered approach is that, for any given health problem, Stage Three cannot be expected to arrive any sooner than it would if no public funds were allocated to the problem at all. It is most likely that the advance of knowledge relevant to the ultimate solution of the problem will be much slower in the absence of public resources for research than if they were available. True, advances may be achieved by organizations or individuals operating with their own means, but it is unlikely that such advances will come as soon without public funding for relevant research.

The upshot of this last point is absolutely crucial. Under a prevention-centered approach, the total-suffering curve for a given health problem will not "zero out" as soon as it would if public funds were alloted to research. More lives will be touched by the problem, and some lives will be touched by it more often. As long as Stage Two lasts, even those individuals who are not afflicted by the problem themselves run the risk of having their lives repeatedly saddened by the affiliction of people they love. Advances in knowledge are essential if the total-suffering curve for a given problem is to come down from its Stage-Two level to its Stage-Three level. And unless a society benefits serendipitously from a gift of knowledge from some external source, research will be required to obtain that new knowledge.

What if available public resources during Stage Two of a particular health problem's history are devoted primarily to the treatment of those who experience the problem, with little or nothing from public funds going for prevention and research? This could very well be the arrangement under which the greatest overall amount of suffering would occur before the onset of Stage Three. With no publicly funded preventive measures in place, a relatively large proportion of the population might be affected by the problem; and in the absence of publicly financed research, the problem might well continue for a relatively long time—perhaps even indefinitely. To be sure, the concentration of public resources on treatment would reduce the suffering of each afflicted individual. But some unhappiness would still be occasioned by each occurrence of the problem. And the *number* of occurrences could keep the total-suffering curve higher than it would have been if most or all available public resources had gone for prevention. Moreover, the treatment-centered approach does no more than the prevention-centered one to reduce the duration of Stage Two.

For obvious reasons, the approach to public health-care fund allocation that involves concentration on research is not without serious drawbacks either. If few public funds are expended on prevention during Stage Two of a problem's history, the number of occurrences of the problem will be relatively high. It will quite likely be as high as if no public funds were available for health care at all. In addition, the severity of the suffering connected with most health problems will, given the lack of public funds for treatment, be near a maximum. This might not, to be sure, hold for all types of health problems. Without publicly supported treatment, some problems might prove fatal in a relatively short time. And there might, because of this, be less suffering involved in each occurrence than there would have been if publicly funded treatment had been available. For many problems, however, this will not be the case. Lack of public resources for treatment will simply mean greater suffering for each occurrence of the problem.

There is, nevertheless, one point that can be urged in favor of the concentration of public funds in the area of research. And it is far from being an inconsequential point. If the society in question has research capabilities that insure results in proportion to resources allocated, then the concentration of funds in the area of research will have the effect of reducing the length of Stage Two for any given health problem. This will not occur, of course, when a society has only inefficient research systems that simply burn up resources without producing advances in relevant knowledge. But when public resources produce or accelerate successful research, they have the effect of reducing the amount of overall suffering a health problem can cause in a society before it is ushered into Stage Three. In fact, it may well be the research-centered approach that would minimize suffering from a given health problem in the long run. It is true that with minimal public funding for prevention and treatment, the total-suffering curve for a problem would remain high longer than it would under either of the other approaches already considered. But the total-suffering curve would also "zero out" sooner. And because of this, overall suffering during Stage Two could well be less than with either of the other two approaches. (There would be more "unpleasant minutes" per day in the early part of Stage Two, but Stage Two could well come to an earlier conclusion.)

So how are the policy makers who are to allocate public funds for health care to proceed? With respect to any given health problem that has not yet been conquered, they find themselves without any precise knowledge of how long Stage Two is going to last. They do have at their disposal information about the amount of suffering that the problem in question has been causing. They have some idea, that is, of how the total-suffering curve for that problem has behaved in the past, and so they may be able to make a reasonable guess at how the curve will run in the future. Perhaps the total-suffering curve for the health problem in question has been trending down during Stage Two, and perhaps there is no reason to suppose that this trend will change. In that case the allocaters may even be able to predict the time at which Stage Two will end, by projecting the past trend into the future. Or perhaps the total-suffering function has been running roughly parallel to the time axis. In this case, if there is no reason to expect a change, the allocaters can predict that Stage Two will continue indefinitely unless something is done. Similarly, if the total-suffering curve is actually trending *up* during Stage Two, it may be reasonable to expect a continuing increase, with no end to Stage Two in sight.

Obviously, the assumptions that the allocaters make about the future direction of the total-suffering curve will be of the greatest importance for their decision about how to use public health-care funds. If the trend is sharply down, there may be no reason to allocate public funds (or additional public funds) to the area of research. As long as past funding (whether public or private) continues, there may be every reason to suppose that Stage Three will arrive in an acceptably short period of time. On the other hand, if the total suffering curve has been holding steady or moving upward, then there is a strong argument for concentrating public funds—if that has not already been done—in the area of research. The allocaters would presumably like to minimize the overall suffering caused by the health problem during Stage Two of its history, and research may present the only real possibility of bringing Stage Two to an end at all. It is important to remember of course, that the concentration of public health-care funds in the area of research may involve removing public funds from the areas of prevention and treatment. If substantial amounts of public funds have been going into those areas in the past, this diversion may result in a *rise* in the total-suffering curve over the short run. The point, however, is that it can also be expected to lead to the end of Stage Two—and thus to the minimization of overall suffering from the problem during the course of its history.

Will the allocaters actually find many instances of health problems with steady or climbing total-suffering curves in Stage Two? It may very well be that they will. This is rendered much more likely by a fact which has not been taken into account so far—the fact of increasing populations. The previous discussion of the behavior of total-suffering curves under different allocation schemes was conducted with reference to a hypothetical society in which the population remained constant throughout the history of the health problem in question, In reality, allocaters of health-care funds in today's world have to deal with the fact that populations are growing rapidly. And this means, in the case of many health problems, that the total amount of suffering produced is growing too. If a problem affects a certain percentage of the population, then the more people there are, the more suffering (the more "unpleasant minutes") there will be. The health problem that had a nearly flat total-suffering curve in a society of constant size would have a rising total-suffering curve in a society with an increasing population. In times of rapidly increasing population, research concentration of public funds for certain health problems may be urgently required if overall suffering from those problems is to be kept to a minimum—or indeed to any finite amount.

(And what about approaches to the allocation of public health-care funds that would involve different "mixes" of prevention, treatment, and research? It might, in fact, be the case that some such "hybrid" approach to funding in connection with a particular problem would be the one that would turn out to minimize overall suffering. Ideally, what the allocaters want, we may presume, is the allocation scheme that will produce the total-suffering function with the smallest definite integral for Stage Two of the problem's history. Unfortunately, it may be difficult for the allocaters to predict with any accuracy what functions would result from different allocation "mixes." When this is the case, the relative dependability of research as a means of ultimately bringing down the total-suffering curve may argue strongly for the research-oriented approach.)

Thus—at least with respect to certain health problems—the allocaters of public health-care funds may have strong reasons for concentrating those funds in the area of research. This conclusion, however, immediately suggests certain ethical complications. On the one hand, from the point of view of (act) utilitarianism, the overall reduction in suffering likely to be obtained by favoring research would seem to make it *morally* incumbent upon the policy makers to allocate the funds in this way. On the other hand, numerous deontological theories of morality which recognize the existence of an independent principle of justice (in the sense of fair, impartial, or even-handed treatment) would appear to have difficulties with certain aspects of the research-centered allocation scheme.

Consider, to begin with, the utilitarian position, which declares the morally preferable course of action to be that which will, in the long run, keep the overall sum of happiness as far ahead of the overall sum of unhappiness as possible. Its analysis of the matters under consideration here is quite straightforward. If overall suffering from a particular health problem can only be minimized by a concentration of public health-care funds in the area of research, then that is what ought morally to be done. A careful utilitarian would have to inquire, of course, as to whether such a use of the funds might not cause enough suffering in some other area (unrelated to the health problem) to offset the suffering saved by the research concentration. This might rarely be the case. (An unexpected side effect of the research might, for example, be the development by one of the companies involved of a substance which would enable it to enslave the society.) I cannot, however, think of reasons for supposing this to be the case in general. Furthermore, it is highly likely that research funded in connection with one health problem will from time to time have results applicable to the elimination of other health problems. From the utilitarian point of view, this possibility of an additional contribution to the reduction of suffering in general certainly strengthens the moral case for the concentration of public health-care funds in the area of research. In short, with respect to many health problems, a utilitarian will want to hear very strong arguments if someone suggests that available public funding ought *not* to go for research.

Are there, in general, strong arguments against the sort of research concentration in question here? The answer would seem to be that there are not any that would impress a utilitarian. If, however, the ethical analysis of the matter at hand is conducted from the point of view of a deontological moral theory, then there may indeed be a reason for hesitancy about concentrating public health-care funds in the area of research. In particular, there is a possibility that there would be something *unfair* about the allocation of most such funds for this purpose. And on many theories, what is unfair is immoral.

Various nonteleological theories could serve as the basis for this sort of criticism.

What these theories have in common is their belief in the existence of a moral rule against unfair or partial distributions. Because of the existence of this rule, they maintain, unfair or biased distributions are immoral. The theories differ with regard to the origin of the rule: some think of it as existing of itself, independent of the reason or volition of any being; others hold it to be a necessary product of human reason; others believe it to have been laid down by a supreme ruler of the universe; and others think of it as a convention existing through the mutual agreement of a number of individuals. The ontological status of the rule is not, however, of the first importance for the present discussion. The important question here is whether, in fact, this commonly recognized principle of fair distribution *does* rule out the concentration of public health-care funds in the manner discussed.

It is undeniable that the research-centered approach to a health problem would, to a certain extent, sacrifice the interests of individuals afflicted at present to the interests of those who might be similarly afflicted in the future. Would this be unfair? Both the individuals suffering now and those who might suffer in the future are—or would be—interested in being free from discomfort caused by the health problem. And the allocation of funds provided for dealing with a particular health problem can be seen as the distribution of freedom from discomfort. Can it then be fair to spend public funds to benefit future victims at the expense of present victims?

Suppose a choice were made to expend public health-care funds for the benefit of people living in a certain part of the country at the expense of people with the same problem living in another part of the country. Here it would be difficult to claim that the funds were being spent impartially or evenhandedly. If they were being spent for medication, they ought—in the name of fairness—to be spent for medication for people in all parts of the country. And if the funds were insufficient to procure medication for everyone afflicted, then fairness would require that recipients be chosen in some random manner. Certainly, the earmarking of the treatment funds for just those people in a particular part of the country would be open to a charge of unfairness. Why then, should it be any more fair to earmark public health-care funds for expenditures that will benefit only those people living in the future?

The question is not an easy one to answer. There may not, in fact, be any entirely satisfactory answer. The situation *may* be one in which a choice simply has to be made between what would be completely fair and what would minimize suffering. However, some attempt can at least be made to defend the research-centered allocation scheme from the charge of gross injustice. It can, in particular, be suggested that the allocation of funds for research does in fact effect a sufficiently random distribution of benefits to be at least reasonably fair.

In the interest of clarifying this possibility, suppose for a moment that a king decides to distribute his remaining bottles of fine cognac among his people. There are, unfortunately, many more people in the kingdom than there are bottles in the cellar; and so, desirous of being fair about the business, the king has the lucky recipients chosen by lot. This procedure would in all probability pass muster from the point of view of the commonly recognized nonteleological principle of fairness. But what if the king decided to give *future* citizens a chance at the cognac as well? What if he had his minister decide by lot how many of the bottles should be given away now (by lot) and how many should be given away by lot in a hundred years. Would this be less fair? Perhaps one could not claim it to be any *more* fair, even though it would give a chance to more people. But one would, I think, be hard pressed to find it partial. (Notice that the question of whether a greater total of happiness might not result from the receipt by some people of bottles of a very great age is not really relevant to the question of the *fairness* of the scheme.)

In a similar manner, the research-centered approach to the allocation of public health-care funds can be said to be reasonably impartial in its distribution of benefits (freedom from discomfort). It is not a special pre-selected group of individuals that receive the benefits from the funds invested in research into a particular health problem. It is whoever happens to be around when that research finally effects the transition from Stage Two to Stage Three of the problem's history. And this may or may not include some of the people who are in existence when the funds are allocated—just as the recipients of the cognac under the doubly randomized distribution system might or might not include some who were alive when the scheme was established. To be sure, to the extent that the research-oriented approach can reasonably be expected to provide benefits preferentially to those living in the future, it can be said to be unfair. And indeed, it may always be the case that those living long after the allocation of certain funds for research will stand a better chance of benefitting from them than those who are very near the end of their lives at the time of the allocation. To this extent, the research-centered approach may always involve a residual amount of unfairness. It is, however, likely to be small. It would seem to be a part of the nature of research that its results are not predictable in any definite manner. Past experience may indicate that research pays off—without indicating just how soon any particular program of research is likely to do so. Thus at the time when certain public health-care funds are allocated for research (rather than for treatment or prevention), it will be impossible to say precisely how soon benefits will be derived by anyone. And because of this, the approach can be said to distribute benefits in a reasonably random way.

It thus appears that when a health problem displays a Stage-Two total-suffering curve that shows no sign of dropping, the allocaters of public health-care funds in today's societies—whether they are utilitarians or are simply interested in keeping overall suffering to a minimum—would be well advised to favor research over prevention and treatment. Such an approach would at least not be terribly immoral with respect to the commonly recognized rule of impartiality, and it would definitely offer the brightest prospect for the early advent of Stage Three.

Note

[1] (Belmont, California: Wadsworth, 1979). Rescher's article originally appeared in *Ethics*, 79 (April, 1969), 173-86. Also of interest is Leon R. Kass, "The New Biology: What Price Relieving Man's Estate?" *Science*, 174 (November 19, 1971), 779-88. The question of the relative importance of different health-care subfields *is* taken up by Alan Davis and Gordon Horobin in "The Problem of Priorities," *Journal of Medical Ethics*, 3 (September, 1977), 107-9. They argue that prevention should receive higher priority than treatment, with primary responsibility being placed on the individual.

A RECENT DIALECT SURVEY OF SOME TRAITS OF WISCONSINESE

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Students enrolled in Linguistics 101: *Human Language,* were sent out to interview speakers of English about a number of syntactic and lexical items. This paper represents the first tabulated data from such a series of interviews, collected over Thanksgiving vacation 1978.

The students were asked to interview one speaker from each of the following age groups; 15-25, 40-50, and 65 and older. This type of sample is extremely useful for showing language change, as well as being convenient for gatherers since they could interview a friend or sibling, a parent, and a grandparent. Of the 360 questionnaires returned, 204 were tabulated. These speakers were chosen because they had grown up in Wisconsin, both parents were from the Great Lakes or Upper Midwest States and their grandparents came either from these same states or a non-English speaking country. All the speakers were Caucasian. Speakers from the Chicago and Minneapolis areas were also tabulated for the sake of comparison. No attempt was made to differentiate socio-economic classes.

The first construction to be examined is the use of 'once' to mean 'right now' or 'right away'. The sentence presented to the speaker was, "Come here once, I gotta tell you something." 67% of the young group admitted using this construction, 45% of the middle-aged group, and 25% of the older group. When asked if they had heard the construction before, nearly 100% stated they had. Of the speakers in Chicago 20% used the construction. Of those in the Minneapolis area only 6% used sentences of this type. The majority of speakers in Chicago and in Minneapolis denied having heard this type of sentence before. So, we can see that this construction is spreading in Wisconsin. If we look at the statistics for the Milwaukee area, we find a higher percentage of speakers using sentences of this type: 56% of the young group, 83% of the middle-aged group and 33% of the older group. This is significant because people in the middle group are probably more conscious of styles of speech than the other two groups. The young group has not yet found a need to develop styles, since their life experiences have mostly been within the family and a closed circle of friends. The older group has cast off a variety of styles since they are no longer as interested in job advancement as they once were. The people in this middle category have a great deal of influence over the speech of the population as a whole via television, schooling, advertising, etc. Perhaps the reason we see such a high percentage of Wisconsin youth using this construction is that it is spreading from Milwaukee, as a focal area, to the developing speech of the young in the state as a whole.

The second construction to be examined is the use of 'already' to mean 'right away' as in the following sentence said of getting into a car, "Get in already." 43% of the young group admitted using this construction, 33% of the middle group and only 15% of the older group. Here again Milwaukee county had higher percentages; 70%, 67%, and 67%. Chicago had 100%, 56% and 0%; Minneapolis had 0%, 33% and 50%. So, both here in Wisconsin and in the Chicago area the construction seems to be spreading, while in Minneapolis it is dying out.

The third construction under discussion is the use of 'yet' to mean 'still'. The sentence used in the study was, "Is there turkey yet?" asked by someone arriving late to a Thanksgiving dinner who wants to know if some turkey remains to be eaten. The percentages for this construction remain relatively constant throughout the different groups: 31%, 29% and 25%. In Chicago only one speaker in fifteen used the construction and in Minneapolis only one in sixteen. This type of sentence is primarily used in rural counties across the central part of the state: Fond du Lac, La Crosse, Manitowoc, Sheboygan, Washara, and Winnebago.

Construction four dealt with sentences of the type, "Do you wanna come with?". This construction comes from the German verb 'mitkommen' 'to come with'. This construction can be found in all parts of the United States where German immigrants comprize a large percentage of the inhabitants and where the German heritage is strongly felt. In Wisconsin the percentages were 77%, 60% and 35%. In Chicago, where this construction is known to be wide-spread, the percentages were 100%, 75% and 100%. Minneapolis also had high percentages, 100%, 50%, and 100%. But the interesting fact about this construction is that 91% of the young women in Wisconsin used this construction as compared to 44% of the young men. This finding supports the sociolinguist William Labov's assertion that women are in the forefront of linguistic change. As the primary teacher of children both as mother and elementary instructor, women instigate and carry on linguistic change.[1]

The last construction looked at was the use of the phrase "come by me" to mean "visit." The example used was spoken by one friend to another over the telephone, "Come by me on your way home from work today." This usage comes from the construction in German, "Kommen Sie vorbei." The percentage of users of this construction was very small in Wisconsin and the construction seems to be dying out: 8%, 8%, and 22%. No speakers in Chicago or Minneapolis used this construction. The construction was recorded primarily in Fond du Lac, Ozaukee, Sheboygan, and Wood counties.

The most interesting lexical item studied was the word used for an apparatus which dispenses drinking water. We wanted primarily to study the percentage of speakers who used the word 'bubbler' compared to the words 'fountain', 'water fountain', and 'drinking fountain'. We found a significant difference in the percentage depending on whether the apparatus was indoors or outdoors. For indoors the percentages of speakers who said "bubbler" were 58%, 32%, and 33%. These increased to 76%, 59%, and 37% when the bubbler was outdoors. The percentage of speakers in Minneapolis and Chicago who used the word 'bubbler' was insignificant. A very interesting fact the indoor/outdoor distinction showed was that 34 people switched from some form of the word 'fountain' to 'bubbler' when going from indoors to outdoors, whereas only ten switched from 'bubbler' to some form of the word 'fountain'.

I have spent some time trying to track down the etymology of the word 'bubbler'. Ms. Marilyn Boeldt of the Kohler Company in Kohler, Wisconsin has assisted me by providing information from *Kohler of Kohler News,* the company newspaper of the Kohler Company. The first time the term 'bubbler' appeared was in 1914 when it occurred alongside, and meaning the same thing as, the technical term 'bubbling valve'. It seems as though the terms were in free variation, in other words, used interchangeably in Kohler's 1914 catalogue. By 1919, the word 'bubbler' seems to have gotten the upper hand as the primary word, replacing 'bubbling valve'. Since the type of porcelain fountain with the bubbler on it became popular for outdoor use, and the water cooler and other types of dispensers were still used indoors, it seems only logical that a significantly higher percentage of speakers would use 'bubbler' for the outdoor fountain.

We also looked at the various words for parents, considered as a collective unit. 13% used the word 'folks'. 1% used the word 'rents', presumedly a shortening of 'parents'. The rest of the responses were for the standard word 'parents'. 'Folks' is found primarily in rural areas.

We hope that by continuing this project we will be able to resolve some of the mysteries of Wisconsin dialect and arrive at a clearer picture of speech in our state.

Note

[1] Labov, William, *Sociolinguistic Patterns*, University of Pennsylvania Press, 1972, pp. 301-302.

THE CREATIVE ARTIST AS TRAVELER: ROBERT LOUIS STEVENSON IN AMERICA

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On August 7, 1879, the *S. S. Devonia* steamed down the Clyde carrying Robert Louis Stevenson second class to New York. *The Amateur Emigrant* is his record of his experience on the *Devonia* and on an immigrant train to California. Portions of *The Amateur Emigrant* deleted in earlier editions have been replaced in the collection *From Scotland to Silverado* edited by James D. Hart.[1] In his introduction, Hart points out the greater maturity of *The Amateur Emigrant* compared to Stevenson's earlier *Travels with a Donkey* and *An Inland Voyage* (pp. xxxvii-xxxix) and suggests that the deleted portions "deepen and extend the sense of Stevenson's second-class passage" (p. xl).

The sense of Stevenson's journey from Glasgow to Monterey is of an experience more meaningful, more universal, than simply an uncomfortable three weeks compounded of noisome smells. sickness, heat and vermin. The real journey that he records is a symbolic statement of progressive loss of identity. He is cut off and adrift in an uncharted void, traveling endlessly in a nightmare in which nothing is as it seems to be or as it should be until at last even the destination ceases to have significance. Throughout the work the images reinforce this alienation. Only on the last page, devoted to his eventual arrival at San Francisco, is there any feeling of fulfillment, any small sense of returning reality. Though he repeats the word "new," writing of "new creatures within and without" watching the sun rise on a "new day" in a "new country" (p. 146), the impression of the preceding hundred and forty-five pages is too strong to be dispelled.

The depth to which Stevenson was affected by his experience is evident in a letter written to Edmund Gosse about a month after his arrival.

> I fear this can hardly be called a letter. To say truth, I feel already a difficulty of approach; I do not know if I am the same man I was in Europe, perhaps I can hardly claim acquaintance with you. My head went round and looks another way now; for when I found myself over here in a new land, and all the past uprooted in the one tug, and I neither feeling glad nor sorry, I got my last lesson about mankind; I mean my latest lesson, for of course I do not know what surprises there are yet in store for me. But that I could have so felt astonished me beyond description. There is a wonderful callousness in human nature which enables us to live.[2]

It is the purpose of this paper to examine the images that contribute to Stevenson's symbolic statement, images that in their deeply ironic nature mark his increasing disorientation. Traditionally, the ocean voyage has been used as a symbolic projection into the unknown. To Stevenson the significance of his voyage must have been poignantly apparent. Already estranged from his family, he had been called to California because of the serious illness of Fanny Osbourne, his future wife. Unlike his companions on the voyage, though he has cut himself adrift from his past, his purpose in doing so has not been to find a new life of greater promise. In the title and throughout both parts of *The Amateur Emigrant* he consistently uses the word "emigrant." He never becomes an "immigrant." The usage implies an emphasis on the "going out" or cutting adrift rather than the "coming in" or arrival.

For Stevenson the ship is the last bond with the known, secure world of the land that he has left. As a small projection of the shore, it represents security in contrast to the unknown sea, the unknown future. Thus, it is described in terms of the known with images familiar to dwellers on the shore. The passengers belong for the space of the voyage "to one small iron country on the deep" (p. 10). They are a "little nationality" in an "iron world" (p. 17) in which at night they gather "at the aftermost limit of our domain, where it bordered on that of the saloon" (p. 15). So completely does Stevenson impress this image of ship as world that the substitution in the cliché, "And I would have gone to the ship's end and back again for an oyster or a chipped fruit" (p. 76) passes almost unnoticed.

On first seeing the *Devonia,* he describes it as "a wall of bulwark, a street of white deck houses, an aspiring forest of spars, larger than a church, and soon to be as populous as many an incorporated town in the land to which she was to bear us (p. 3). But beyond the known limits of this "parishful of people" (p. 26) stretches the sea and the unknown future. The end of the journey is an unidentified "land to which she was to bear us" rather than a destination specified by name.

David Daiches in his short study comments on Stevenson's use of the contrast between exterior and interior backgrounds, specifically in *Treasure Island.*[3] In *The Amateur Emigrant,* the small, enclosed areas of the ship are safe refuge from storms and danger as, according to Daiches, the parlor of the Admiral Benbow Inn would become later. Though much about the ship and particularly the steerage is offensive to Stevenson, even his cabin becomes a metaphorical "oasis" (p. 4).

Stevenson extends the sense of a small plot of humanity adrift in vast space with a parallel image. At night the steerage passengers gather in a sheltered area near the deckhouse to sing and link their arms to steady themselves against the movement of the ship. "It was a general embrace, both friendly and helpful, like what one imagines of old Christian Agapes. I turned many times to look behind me on the moving desert of seas, now cloud-canopied and lit with but a low nocturnal glimmer along the line of the horizon. It hemmed us in and cut us off in our swift-travelling oasis. . . . And small as was our iron world, it made yet a large and habitable place in the Atlantic, compared with our globe upon the seas of space" (p. 17).

The *Devonia* is adrift in time as well as space. Stevenson describes the futile attempt of one of the passengers to retain a sense of time. She was determined to keep her watch on Glasgow time—the only "time" she has ever known—until she reached New York.

> They had heard reports, her husband and she, of some unwarrantable disparity of hours between these two cities. . . . It was a good thing for the old lady; for she passed much leisure time in studying the watch. Once, when prostrated by sickness, she let it run down. It was inscribed on her harmless mind in letters of adamant that the hands of a watch must never be turned backwards; and so it behoved her to lie in wait for the exact moment ere she started it again. When she imagined this was about due, she sought out one of the young second-cabin Scotsmen, who was embarked on the same experiment as herself and had hitherto been less neglectful. She was in quest of two o'clock; and when she learned it was already seven on the shores of Clyde, she lifted up her voice and cried "Gravey!" (pp. 7-8)

Images of a world devoid of habitual reference points are even more marked in Part II of *The Amateur Emigrant.* Fleetingly in Pennsylvania the landscape reminds Stevenson of England but this is a world in which all markers have been reversed and "the sun rises with a different splendour" in America. "It may be from habit, but to me the coming of day is less fresh and inspiriting in the latter; it has a duskier glory and more nearly resembles sunset; it seems to fit some subsequential, evening epoch of the world" (p. 104).

In this brief lightening of his spirits, Stevenson makes explicit the contrast between the images of known land and unknown sea. "For we are creatures of the shore; and it is only on shore that our senses are supplied with a variety of matter, or that the heart can find her proper business. . . . If I must indeed look upon the ocean, let it be from along the seaboard . . . dotted at sundown with the clear lights that pilot home bound vessels" (pp. 105-106).

Unlike the ship, the train is never an oasis. He cannot turn from the endless wastes to its interior security. Perhaps, as a consequence, his descriptions of the Nebraska plains are particularly vivid. "It was a world almost without a feature; an empty sky, an empty earth; front and back, the line of the railway stretched from horizon to horizon, like a cue across a billiard-board; on either hand, the green plain ran till it touched the skirts of heaven" (p. 123). Though he is projecting the experience of the early settlers, the feelings are his own when he writes, "Yet one could not but reflect upon the weariness of those who passed by there in old days . . . with no landmark but that unattainable evening sun for which they steered, and which daily fled them by an equal stride. They had nothing, it would seem, to overtake; nothing by which to reckon their advance; no sight for repose or for encouragement; but stage after stage, only the dead green waste underfoot, and the mocking, fugitive horizon" (p. 124). He longs for the mountains, imagining, perhaps, the familiar shapes of the Highlands, but "Alas! and it was a worse country than the other. . . . Hour after hour it was the same unhomely and unkindly world about our onward path" (p. 127).

In addition to a diminished sense of time and place, there is a consistent distortion throughout the journey of the familiar bases of social interaction and each contact is fraught with an overwhelming irony. For example, Stevenson paints a glowing picture complete with battle metaphors of the popular concentration of the emigrant. But, he says, "This is the closest picture, and is found, on trial, to consist mostly of embellishments. . . ." The truth is that, "We were a shipful of failures, the broken men of England" (pp. 10-12).

When Stevenson tries to find help for a sick man lying on the deck, the crew members are concerned only over the possibility that he may be another seaman and the steward says, "That's none of my business . . . I don't care" (p. 47-48). On the immigrant train, the conductor refuses to answer a question and turns his back on Stevenson. Later he is heard to explain, "It was . . . his principle not to tell people where they were to dine; for one answer led to many other questions, as what o'clock it was; or, how soon should we be there? and he could not afford to be eternally worried" (pp. 120-121).

This kind of irony pervades the description of every one of Stevenson's encounters in Part II. From New York to Council Bluffs he is not on the immigrant train and thus has the comfort of a dining car. He asks the waiter if it is the custom in America to tip. "Certainly no, he told me. Never. It would not do. They considered themselves too highly to accept. They would even resent the offer." And still protesting, he pockets the tip (p. 108).

He meets a widow with children on the train who allows him "to buy her children fruit and candies; to carry all her parcels, and even to sleep upon the floor" so that she could have his empty seat. When she leaves she says, "I am sure . . . we all *ought* to be very obliged to you" (pp. 109-110).

A railway official at Council Bluffs sells, for his own profit, pillows and boards to be placed between the seats for sleeping. The price is two dollars but has fallen to one and a half before the train leaves. At the first stop, people come aboard selling the pillows at fifteen to twenty-five cents with no charge for the board (pp. 116-118).

When the train stops at Elco, Nevada, three men approach Stevenson and one offers him work saying, "I'm running a theatre here, and we're a little short in the orchestra. You're a musician, I guess?" When Stevenson says he is not, "He seemed much put out of countenance; and one of his taller companions asked him, on the nail, for five dollars." Though his fellow passengers are encouraged at this indication of an abundance of jobs, Stevenson says, "I am not so sure that the offer was in good faith. Indeed, I am more than half persuaded it was but a feeler to decide the bet" (pp. 144-145).

The climactic instance of the discrepancy between the seeming and the real is Stevenson's description of the passing of immigrant trains. "As we continued to steam westward toward the land of gold, we were continually passing other emigrant trains upon the journey east; and these were as crowded as our own. . . . Whenever we met them, the passengers ran on the platform and cried to us through the windows, in a kind of wailing chorus, to 'Come back.' On the plains of Nebraska, in the mountains of Wyoming, it was still the same cry, and dismal to my heart, 'Come back!' " (p. 137).

In a world in which all familiar signs and markers are missing, Stevenson loses his identity. He has witnessed the same loss in the steerage passengers. Stripped of individuality and dignity they are, as Hart mentions in his introduction (p. xl), "human animals" herded into "stalls" and "pens." Animal images are used throughout in descriptions of the immigrants. Waiting to board the boat for Jersey City they "stood like sheep, and . . . the porters charged among us like maddened sheep-dogs" (p. 101). On the train, "We pigged and stewed in one infamy" (p. 138), and as the cars approached, "there would come a whiff of pure menagerie" (p. 133).

Stevenson shares the loss of individuality with the immigrants. At Council Bluffs, he stands "in front of the Emigrant House with more than a hundred others, to be sorted and boxed for the journey" (p. 115). The process has begun on the ship on the superficial level of class distinction. He realizes that by traveling second class he is seen as lower class, treated by the steerage passengers as one of themselves and looked down upon by the first class travelers. "For here I was among my own countrymen, somewhat roughly clad, to be sure, but with every advantage of speech and manner; and I am bound to confess that I passed for nearly anything you please except an educated gentleman. The sailors called me 'mate,' the officers addressed me as 'my man,' my comrades accepted me without hesitation for a person of their own character and experience, but with some curious information" (p. 72).

With a touch of humor he introduces an image to which he returns throughout Part I.

> In the steerage there are males and females; in the second cabin ladies and gentlemen. For some time after I came aboard I thought I was only a male; but in the course of a voyage of discovery between decks, I came on a brass plate, and learned that I was still a gentleman. Nobody knew it, of course. I was lost in the crowd of males and females, and rigorously confined to the same quarter of the deck. . . . Still, I was like one with a patent of nobility in a drawer at home; and when I felt out of spirits I could go down and refresh myself with a look of that brass plate. (pp. 5-6)

Later he says, "I was taken for a steerage passenger . . . and there was nothing but the brass plate between decks to remind me that I had once been a gentleman" (p. 72). When a woman from steerage is taken ill beneath the gaze of the first class passengers on the hurricane deck, they assume Stevenson is her husband and he ruefully confesses, "I was chagrined at this. Now was the time for me to go and study the brass plate" (p. 74).

Next, his profession is called in doubt. "To such of the officers as knew about me . . . I appeared in the light of a broad joke. The fact that I spent the better part of my day in writing had gone abroad over the ship and tickled them all prodigiously. Whenever they met me they referred to my absurd occupation with familiarity and breadth of humorous intention. Their manner was well calculated to remind me of my fallen fortunes. You may be sincerely amused by the amateur literary efforts of a gentleman, but you scarce publish the feeling to his face" (p. 74).

Eventually this entropic process reaches to a basic level of his personality. "The steerage conquered me; I conformed more and more to the type of the place, not only in manner but at heart, growing hostile to the officers and cabin passengers who looked down upon me, and day by day greedier for small delicacies. . . . The offer of a little jelly from a fellow-passenger more provident than myself caused a marked elevation in my spirits" (pp. 75-76). There is a complaint about the food and Stevenson is asked to look over the bill of fare and each day as he leaves the steward fills his pockets with greengages. "I have not been in such a situation since I was a child and prowled upon the frontiers of a dinner party . . . and if I was still a gentleman on a brass plate, in relation to those greengages I may call myself a savage" (p. 77).

Stevenson is perfectly aware of the symbolic structure he is fashioning. He says, "Travel is of two kinds; and this voyage of mine across the ocean combined both. 'Out of my country and myself I go,' sings the old poet: and I was not only travelling out of my country in latitude and longitude, but out of myself in diet, associates and consideration" (p. 72).

Rain falls the whole time Stevenson is in New York. His clothes are soaked and he leaves them behind "for the benefit of New York city." He has mentioned clothes as reflections of identity several times and here he says, "With a heavy heart I said farewell to them as they lay a pulp in the middle of a pool upon the floor of Mitchell's kitchen. I wonder if they are dry by now" (p. 99).

Perhaps the most poignant statement Stevenson makes on his experience is his conclusion to a rather mundane event on the train. He says of a drunkard who has been thrown from the train, "He carried a red bundle . . . and he shook this menacingly in the air with one hand, while the other stole behind him to the region of his kidneys. It was the first indication that I had come among revolvers, and I observed it with some emotion" (p. 112). The drunkard, intimidated by the conductor, staggers off down the track followed by the laughter of the passengers. Unobtrusively, Stevenson makes the central statement of his odyssey in the next sentence. "They were speaking English all about me, but I knew I was in a foreign land" (p. 113).

Images of sickness and death, the final loss of identity, complete Stevenson's portrayal of the process of disorientation. In his hotel in New York, he can hear the men in the next room, and "the sound of their voices as they talked was low and moaning, like that of people watching by the sick." His companion "tumbled and murmured, and every now and then opened unconscious eyes upon me where I lay. I found myself growing eerier and eerier . . . and hurried to dress and get downstairs" (p. 96). Later, on the train, he says, "the shadows were con-founded together in the long hollow box of the car. The sleepers lay in uneasy attitudes . . . flat upon their backs like dead folk" (p. 128).

Stevenson has, indeed, come a long way out of his country and himself. As he shapes the scenes and events of the physical journey from the Clyde to Monterey, they become increasingly significant of his interior journey—a journey of the spirit which left him, as he wrote to Gosse, with his head turned around and looking the other way.

Notes

[1] Cambridge, Mass., 1966. All quotations from *The Amateur Emigrant* are from this edition.

[2] Sidney Colvin, ed. *The Letters of Robert Louis Stevenson* (New York, 1911), I, 289.

[3] *Robert Louis Stevenson* (Norfolk, Conn., 1947), p. 38.

RICHARDSON'S ARISTOCRATS: A STUDY IN THE LIMITS OF FREEDOM

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Samuel Richardson's fascination with freedom and his fascination with the figure of the aristocrat are closely related. As Richardson conceives him, the aristocratic man is, at least potentially, the freest of all human creatures.[1] Free from the pressures which generally circumscribe conduct—discipline in childhood, financial necessity, and the social and legal sanctions which punish anti-social behavior—the aristocrat can define his selfhood and choose his own destiny in a way that enthralled Richardson's imagination. His social position not only liberates the English aristocrat from control by others, but also offers him an opportunity to govern the lives, and even the physical reality, around him. To a great degree, he can create his own world and his liberty at times seems to be that of a God.

All Richardson's major characters demand freedom and fight for it with desperate tenacity. But characters like Pamela and Clarissa ask only the irreducible minimum of freedom: the liberty to obey God's laws as they themselves interpret them. They may desire, but they would never demand, control of their time, their employments, the fates of those around them—or even of their own fates where moral imperatives are not involved. That Pamela and Clarissa expect so little liberty—and that their world attempts to deny them even that little—is a function partly of sex and partly, in Pamela's case, of class. At one extreme of Richardson's world, then, are powerless women, struggling for the basic freedom of moral choice without which they will be less than fully human and, at the other, are aristocratic men like Mr. B and Lovelace, demanding the right to impose all their impulsive desires upon the reality around them.

The education of the gentleman was a popular topic in conduct books of the seventeenth and eighteenth centuries. An unpublished work of Defoe's, *The Compleat English Gentleman,* discusses the absence of discipline characterizing the usual gentleman's upbringing in a way that is close to the view of the subject which Richardson's novels express. The indulgent mother of a son born to inherit a great estate will be unwilling, Defoe asserts, to subject him to the discipline of his social inferiors in a public school. Such a mother will yield to her natural fondness and to her pride in her son's social superiority and will engage a tutor willing to be no more than a toady to her heir. The son himself will early understand his importance as the future representative of a great family and the power that his position gives him over his parents. Thus he will be deprived of the discipline which most children receive at school *and* at home.[2] Similar criticisms of aristocratic education appear in other conduct books of the period, such as Richard Allestree's *The Gentleman's Calling* (1679) and Clement Allis's *The Gentile Sinner* (1660). Both Richardson's libertine villain/heroes, Mr. B and Lovelace, fit the pattern traced by Defoe and other conduct book writers: they have been raised primarily by mothers who could not bear to see them contradicted or corrected. And each boy is the only male representative of an ancient family and the heir to a great estate.

In adulthood, Richardson's aristocrats prove to be even freer from coercive pressures than they were as children. Provided they are minimally careful not to injure their estates, they need not worry about money. Their peers in the aristocracy and gentry will accept them on the basis of their social position and will regard a hefty amount of misconduct as appropriate to, or at the very least tolerable in, someone of their status. The idea that the aristocrat is born for pleasure, not duty, was an all too common one, both Richardson and many writers of conduct books felt. This point could hardly be made more emphatically than in the scenes in *Pamela* where Mr. Williams tries to get one of the neighboring gentry to intervene on behalf of the imprisoned girl and encounters in succession apathy, mild sympathy overruled by an unwillingness to antagonize so powerful a man as Mr. B, and finally, on the part of Sir Simon Darnford, the feeling that B's treatment of his servant is quite acceptable since he is merely exercising a modified *droit du seigneur.* " 'He hurts no family by this' " Sir Simon comments (p. 138), while the parish minister remarks tolerantly that " 'Tis what all young gentlemen will do' " (p. 139).[3]

If neither the conscience implanted by a strict upbringing, financial necessity, nor social pressure, provide effective checks on the aristocrat's freedom of action, that leaves only the coercive power of the law as a possible limiting force. But Richardson makes it clear that the determined aristocrat has little reason to fear legal punishment for even the most heinous behavior. The aristocrat's role as local Justice of the Peace, ideally a duty he owes to society, if abused becomes a means of escaping punishment, or even of furthering his own wickedness. Mr. B issues a warrant for Pamela's arrest, which he intends to use should she manage to escape him. Indeed, the many mock trial scenes in the two parts of *Pamela* poignantly emphasize the abuse of authority of which B is guilty. Pamela, the innocent party, must play the culprit, while the guilty B, with all the power of society to back him, usurps the roles of accuser and judge. Lovelace reflects cynically on his chances of escaping punishment for the rape of Clarissa and concludes, quite accurately, that between Clarissa's natural disinclination to air the matter in court, the sympathy his connections and good looks would procure from any jury, and the readiness of juries to believe that a rape victim must have encouraged her assailant, he is quite secure. Lovelace considers a variety of audacious crimes, including murder, in the course of *Clarissa,* and if in end he decides not to commit most of them, it is not fear of the law that stops him.

The theory upon which England's constitution is based, that an aristocrat's stake in the country is a sufficient guarantee for his good behavior, since it would be irrational for him to do anything either to injure the nation or imperil his own share in it, is one which Richardson finds laughably simplistic. It is cited several times by Lovelace's acquaintances as a reason why Lovelace surely will not commit this or that enormity (eg. Vol. IV, p. 144, p. 253).[4] Such reasoners, Lovelace notes, are definitely wrong to assume that he must always "prefer his interest to his pleasure" (Vol. IV, p. 248). In fact, his stake in the country actually makes Lovelace more willing to defy the law than a poorer man would be—for he can always flee to the continent and live there comfortably on what he can salvage of his fortune. "All countries of the world are alike to me," he claims (Vol. II, p. 39). The code of honour, which might be regarded as a survival of an earlier age's system of enforcing justice, though it threatens sanctions for bad behavior, is not much feared by aristocrats who, like B, choose their victims from the lower classes, or who, like Lovelace, are masters of all offensive weapons.

Freedom from fear, from want, from the coercion of other men, in both childhood and maturity—what sort of personality will such a situation produce? Richardson's paradoxical answer is that too much freedom creates a personality which will enslave itself far more effectively than it could be enslaved by any outside force. The process can be seen in a mild form in Mr. B, far more dramatically in Lovelace—of Richardson's major aristocratic characters only Sir Charles Grandison escapes unscathed.

Pride—the need to respect oneself and to be respected by others—is one of the strongest human drives in the world of Richardson's novels. But the need for respect can assume a multitude of shapes and align itself with a dazzling variety of ideas and emotions. Pamela, having no social status to be proud of, glories in her honesty and repeatedly reminds Mr. B that, though not his social equal, she is his superior in the eye of God. It is pleasantly ironic that after she becomes Mr. B's wife, the nature of Pamela's pride changes and she remarks that her only source of self-congratulation is that "I have been raised to a condition where I have power to do good"—for "what am I in myself to be proud of?" (p. 528). The alliance between Pamela's strict moral standards and her need for self-respect is clearly demonstrated by this shift. The prostitutes in *Clarissa* are also motivated by pride in their almost frantic desire to see "the divine Clarissa" brought down to their own level. Her degradation will prove "the sex's" universal frailty and will thus excuse their own weaknesses.

The eldest son of an ancient family, raised in an environment where everyone around him is his inferior and his slave, develops a distinctive type of pride. He has never been forced to live up to a demanding moral code and hence cannot pride himself on his successes as a moral agent. Totally undisciplined, he has never developed a conscience and so cannot derive self-respect—as Pamela and Clarissa do—from his consistency in obeying its orders. But he *has* received constant deference and submission from those around him, and it is natural that his pride will be gratified only so long as he continues to receive such tokens; tokens which, as he well knows, are tributes paid to his social position, rather than to his individual merit. So the aristocrat will be proud not of what he is, but of the way other people treat him.

Lovelace displays the most radical disjunction imaginable between his own consciousness of inner moral value and the outward deference he exacts. Lovelace's pride is always of the bottom line variety: if he can gain deference and submission in the end, he does not care how much he need lie, cheat, or abase himself along the way, as his treatment of Clarissa demonstrates. In his attempts to make her his pliant and deferential mistress, Lovelace is not merely guilty of the most varied and despicable misconduct, but further, Clarissa continually catches him misbehaving and responds with heartfelt contempt. But Lovelace perseveres, for he believes that his final triumph over Clarissa will cancel all intervening humiliations, though he is keenly aware of the ridiculous, degraded figure he often cuts in her eyes. Deference is more important to Lovelace than any of life's more solid pleasures. He feels no desire to seduce Rosebud once his power over her has been acknowledged.

Lovelace's pride feeds on the degradation of others and in the process degrades Lovelace himself—yet this destructive pride is a direct result of Lovelace's extreme, but characteristic, aristocratic childhood. And the characteristic freedom of the aristocrat has molded Lovelace's personality in ways that are even more dramatic. Because Lovelace has never been forced to obey any rule except that of his own desires, he finds the idea that his freedom should be circumscribed in any way both humiliating and intolerable. Lovelace does not merely refuse to obey the laws of morality or the laws of England, he refuses to be bound by any rules of thought or language which might impede him in his endeavor to make the world around him conform to his desires.[5]

Perhaps the most striking of the freedoms which Lovelace demands is his tacit refusal to be bound by the "laws" of empirical evidence. Lovelace likes to describe himself as an empiricist who bases his generalizations on his own wide experience and on a series of "experiments" which he has carefully performed. But as *Clarissa* progresses it becomes clear that Lovelace is simply a special pleader trying to prove the premise that Clarissa's morals can be corrupted and not, as he likes to think, an unbiased experimenter testing the limits of virtue as a participant/observer. Lovelace's pride is largely responsible for his tenacious commitment to the idea that all virtue is a sham and that every woman has her price. For if all virtue is a sham, Lovelace, like the prostitutes who share his desire to degrade Clarissa, need feel no shame about his own lack of virtue. Thus Lovelace goes on "trying" Clarissa even after he has collected an overwhelming amount of evidence that her resistance is as sincere as it is violent and that her health is crumbling under the strain of her fear. Quite early in the novel, when Lovelace is still using adjectives like "blooming" and "glowing" to describe Clarissa, Belford is shocked by her weak and haggard appearance. (Vol. IV, p. 94) Clearly Lovelace must ignore the physical damage to Clarissa if he is to continue his attempt to make the bottom line of their relationship come out as he wishes. What he pretends is an empirical generalization about the universal corruptibility of women, is really an ideological position to which he is so deeply committed that he will ignore any amount of evidence suggesting its falsehood, in his desperate attempt to *make* it true. Lovelace's interpretations of the events he observes become ever more bizarre and strained as the novel progresses and perhaps his attitude toward evidence is most clearly shown by his request that Belford pretend to him that the dying Clarissa is recovering: "I will go abroad rejoicing and believing it and my wishes and imaginations shall make out the rest." (Vol. VIII, p. 321) Thus, by the end of the novel, Lovelace acknowledges that he is not an empiricist, but an artist determined to make the visions of his imagination a reality.

Lovelace does not allow his thought processes to be restricted by the rules of logical, consistent reasoning any more than he allows them to be trammeled by the demands of empirical evidence. "Regardless shall I be in all I write of connection, accuracy, or of anything but my own imperial will and pleasure," he tells Belford (Vol. III, p. 63). Up to a point this is playfulness on Lovelaces 'part, but beyond that point he becomes quite serious in his refusal to accept an unpalatable conclusion merely because it follows logically from valid premises. In such a situation, Lovelace is always prepared to take elaborate evasive action. His letters are filled with the most maddeningly perverse arguments, always bolstering the conclusion to which he is emotionally committed. Concerning the basic question of whether he *must* continue his attempts on Clarissa, Lovelace sometimes argues that because Clarissa does not love him, it is necessary that he punish her by seducing her. But at other times her attitude seems more favorable and at those times Lovelace tells himself that if Clarissa does love him, then he must seduce her because he has a good chance of getting away with it. Lovelace never admits these two arguments cannot, simultaneously, be true—nor does he admit that each argument undercuts the other. If Clarissa loves him there is no reason for punishment, and if she doesn't, his seductive wiles are unlikely to succeed. He continues to use the two arguments in all their logical incompatibility as supports to the conclusion at which he has already arrived.

Lovelace often defines a category most perversely in order to bolster his decision that a particular individual must be treated as Lovelace wishes to treat him, because he is a member of that category. When he wants to strengthen his resolutions against Clarissa —and that is most of the time—Lovelace likes to remind himself that a "triumph" over her will be a "triumph over the sex," which once wounded him in the person of the "quality jilt" who played him false, and secondarily a triumph over his enemies the Harlowes. (Vol. III, p. 83) It is true that Clarissa *is* a woman and a Harlowe, but by defining her in terms of those crude categories, Lovelace ignores both her extraordinary qualities as an individual and the unpalatable fact that mistreating her will, as Belford repeatedly points out, serve, rather than frustrate, James Harlowe's purposes. The categories Lovelace chooses are not those which best describe Clarissa or her situation, but they are the ones which most effectually bolster his resentful attitude and this is what he is after.

Lovelace's attitude toward language is nearly as libertarian as his attitudes toward evidence and logical reasoning. Lovelace seems to find restrictive and humiliating the idea that he ought to be satisfied to follow the linguistic conventions within which most people confine their communications. Thus he invents the Roman style for writing to his fellow rakes—and stipulates that they cannot take offense at anything written in that style. The Roman style thus permits Lovelace to use words freely without being affected by the usual consequences of such a practice. Nor does Lovelace care to be bound by the vocabulary of standard English. His neologisms are numerous; clearly he thinks that he can create a language fit to express his thought. Lovelace's constant, dazzling use of figurative language strains against the rules of both logic and language. Through the force of his bizarre metaphors, his refusal to confine himself to the literal meanings of words, Lovelace hopes to prove that reality is what it appears to him to be. His frequent descriptions of Clarissa as a bird seem intended to demonstrate—to himself and Belford—not merely that she is basically animal, though she seems to soar angelically, but also that what he is doing to her is not important. These metaphors are an attempt to escape the conclusions which would have to follow logically if he described her in standard English, as a woman possessing an immortal soul.

The freedoms which Lovelace demands for himself are complex, varied, and radical, and include a refusal to be bound by the commonly held "laws" of identity. We have seen that Richardson's aristocrats are generally treated with a consistent respect that is unaffected by the nature of their behavior. Perhaps as a result of this, Lovelace has come to believe that he possesses a self, to which other people respond, that is somehow completely separable from the personality he manifests in his actions. When his feigned illness succeeds in upsetting Clarissa, Lovelace is convinced that her love for him has not been affected by his past misbehavior and that he therefore has "credit for a new score" of misconduct. (Vol. V, p. 1) He thinks, in other words, that there is an inner, essential Lovelace whom Clarissa adores—and that her image of that Lovelace cannot be destroyed by anything the outer Lovelace may do. This idea is consistent with the exemption from consequences which Lovelace has always experienced, but it is not true of Clarissa's feelings for him. As Lovelace's behavior cumulatively and unmistakeably demonstrates his violence and sadism, Clarissa realizes that the man who attracted her is not the "real" Lovelace and her feelings readjust themselves accordingly. To the moment of her death, Lovelace cannot believe that this process has actually occurred, that it is irrevocable, and that the "self" he has in Clarissa's eyes is now based on the evidence of his actions. Lovelace's delight in disguises suggests his plastic approach to the idea of personal identity: he can temporarily become whomever it suits his purposes to be, without compromising that inner, essential Lovelace.

Lovelace believes that he has the power to influence, indeed create, both the world Clarissa perceives and the world that actually surrounds her. Lovelace has tricked Clarissa into taking up residence in Mrs. Sinclair's brothel, he has arranged to have accomplices impersonate various emissaries from Clarissa's family, he has invented elaborate circumstantial tales concerning a house which must be ready for occupancy before he and Clarissa can marry—yet he feels sure that he can keep the evidence of all these deceptions secret as long as he wants, that the reality he has created for Clarissa and the world he wants her to perceive can be kept separate and that he can control both. But Lovelace overestimates the plasticity of empirical fact even in the hands of a master deceiver. Clarissa gradually, by bits and pieces, picks up the evidence Lovelace's schemes would deny her and when she realizes that she is imprisoned in a brothel, she can successfully apply her superior wit to the problem of escape.

And this is what happens with all the excessive freedoms which Lovelace claims: moral truths and empirical facts reassert their primacy in the teeth of his most determined efforts to prove that he has the power and will to set them aside. The aristocratic claim of total liberty overreaches itself and produces total enslavement, a situation in which no effective courses of action are open. Lovelace's greatest problem stems from the fact that what he thinks of as empirically based generalizations which he is testing—"once subdued, always subdued," and the like—but which are really cynical axioms to which his pride is deeply committed, are simply not true in the theistic world of *Clarissa*. Lovelace is trying to create a debased, animalistic reality which sets God's law aside and Richardson believes that God will not let this happen: the divine spark of real virtue that never deserts Clarissa results from the mission and teachings of Christ and is stronger than Lovelace's best efforts to eradicate it. As Belford points out repeatedly, toward the close of the novel, the hand of Providence can be clearly seen punishing all those who have played roles in Clarissa's downfall. If a man is trying to remake God's world in his own evil image, to prove the truth of falsehoods, he will naturally fail, as Lovelace does. The evidence of his misconduct will accumulate in spite of his attempts to conceal it, the good in men will assert itself no matter how hard he tries to make universal corruption the order of the day.

Nor is Lovelace's boasted freedom circumscribed only by God's laws; he also finds that his own past actions acquire a momentum which, to his surprise, severely limits his present freedom of action. For example, in his war against the idea of virtue, Lovelace seduced and degraded Sally Martin and Polly Horton, who subsequently became prostitutes and partners in Mrs. Sinclair's brothel. During the period when Clarissa is residing at Mrs. Sinclair's, Lovelace is often inclined to acknowledge the hopelessness of his designs on her, to do her justice, and marry her. But Sally and Polly never permit Lovelace to retreat from his worst purposes—their pride, as we have seen, is involved in seeing Clarissa reduced to their own level. They ridicule Lovelace's best and most intelligent impulses as unmanly weakness and effectually prevent him from changing his mind in time. Yet Sally and Polly are what Lovelace has made them and the strong and evil influence they exercise is the direct result of his past actions.[6] Further, since Lovelace's pride is fed on the outward respect he receives from others, he is peculiarly susceptible to the influence of different companies: he is eager to earn the prostitutes' applause by displays of cynical machismo, but occasionally he is just as moved, in Clarissa's presence, by an impulse toward the virtue which will earn *her* approval. A man whose pride is of this externalized sort, will have less control over his actions than the man who cares only for the approval of his own conscience.

Lovelace's seduction attempts acquire a forward motion which also limits his freedom: each failed attempt is a humiliation to be redressed only by success on the next attempt, which therefore must be made. This means that the final attempt to subdue Clarissa, the rape, is virtually inevitable from the start. And the rape shows Lovelace to Clarissa in his true colors, thus destroying any possibility that she will become either his wife or his mistress. Lovelace's oft-repeated belief that he can have a wife at any time proves false, and he finds himself totally cut off from Clarissa, even before she makes her final escape in death. Lovelace suspects this, wondering if he has "put it . . . out of my own power to be honest. I hate compulsion in all forms; and cannot bear, even to be compelled to be the wretch my choice has made me . . . I am a machine at last and no free agent." (Vol. VI, p. 4) By claiming excessive freedom and letting his own lawless desires rule his behavior, Lovelace maneuvers himself into a position where all options are closed to him, where he lacks the power even to obey his own impulse to reform. In *Clarissa,* the truest freedom is the freedom the heroine finds at the end: to live by God's laws and to achieve a perfect union with God's goodness in death. The total freedom of the aristocrat is not merely an illusion, but an illusion which enslaves.

If Richardson is, in part, using Lovelace to demonstrate that the quintessential aristocratic upbringing censured by Defoe, Allestree, and other writers of conduct books does indeed produce a lawless and destructive personality, how does it happen that his remaining aristocratic protagonists, Mr. B and Sir Charles Grandison, are ultimately able to lead lives of happiness and social utility? In Mr. B's case it seems clear that his education differed somewhat from the conduct book paradigm and provided a foundation on which a reformation could later be based. Like the mothers in *The Compleat English Gentleman,* B's mother could not bear to see him (or, for that matter, his sister the future Lady Davers) thwarted. But where Lovelace's mother seems to have been motivated in her indulgence by her snobbish sense of her son's social superiority, B's mother, Pamela tells us, was a true Christian with a sense of duty to inferiors, who overindulged her children through mistaken impulses of kindness. The fact that she spoiled her daughter as thoroughly as she spoiled the male heir to the family name and possessions does indeed suggest that her motive was squeamishness, rather than pure snobbery. B was apparently influenced by his mother's sincere commitment to Christianity, even as he tried to reject it. Though the indulgence and deference which characterized his upbringing produced in B the typical sort of aristocratic pride, B feels, unlike Lovelace, that the Christian standard of moral judgement really does matter. He is uneasy when he knows himself to be morally wrong, and particularly so when others tell him of it. B's basic commitment to Christian moral standards, in conjunction with the love he feels for Pamela—a love which is far more sincere and less physical then he will admit to himself—makes him a peculiarly half-hearted and inefficient seducer and rapist.

A part of B wants, Lovelace-like, simply to dominate Pamela and to bring her down to his own moral level, but another part of B responds to Pamela's repeated charge that his immoral behavior has destroyed his dignity in her eyes, with a wish to earn Pamela's approval by deserving it. Under Pamela's tutelage, B finally comes to realize the truth which always evaded Lovelace: that obedience to God's laws earns one maximum respect from others, and from oneself, and eliminates the discrepancy between one's sense of inner deficiency and the outward respect necessary to one's pride, that plagues the rakish aristocrat. At the end of the novel, B is happy in Pamela's almost slavish deference, in the chorus of adulation his generous behavior and good taste gain him, and in the conviction that he is now on fine terms with God. The sense of superiority which Lovelace vainly sought by degrading others, B finds by elevating himself.

Nonetheless, the reader may find that there are difficulties raised by the almost effortless way B's problems are resolved and these difficulties are perhaps clues to the depth of Richardson's distrust of aristocrats. The first difficulty is B's mother. How could a truly Christian woman possibly allow her children to have their own way in everything, knowing what all Christians know about man's innate sinfulness and the need for control? Second, there is the problem raised by B's pride. Clearly, Richardson finds the idea of an aristocrat whose pride is not one of his strongest passions to be unthinkable and B and Sir Charles Grandison are every bit as proud as Lovelace himself. Therefore Richardson is afraid to trust the permanence of B's reformation to such a feeble reinforcement as the approbation of his own conscience. B needs Pamela's passionate adoration and the approbation of his social equals thrown into the scale if his pride is to fight on the side of his reformation. It is easy enough to see why B's reformation would earn Pamela's approval, but the chorus of admiration with which B's neighbors greet his behavior is hard to credit. The same snobbish attitudes which make it so hard for B to admit to himself that he is truly in love with a servant have been shown throughout the novel to be the predominant social values held by the gentry. If B's original reluctance to marry Pamela is as strong as we have been led to believe, then surely his neighbors, actuated by the same feelings, would not receive the match so warmly. B's pride is gratified and the novel's moral—that virtue is rewarded—is driven home by their warmth, but at the expense of consistency.

Some of the other ways B's marriage to Pamela gratifies his pride and his feeling that as an aristocrat he ought to be freer than other people, are more skillfully managed. Marriage to a social inferior assures B of a degree of submission, deference, and gratitude almost unthinkable in a woman of his own class. Further, it is rather charming to see B take advantage of his marriage to a servant to order the government of his family according to his own notions and to make it stricter and more moral than the families of his neighbors. Like Pamela earlier in the novel, B senses that he can redress any social disadvantages which his wife's lack of birth and wealth may have laid him under, by compensatory superiority in the moral sphere. B is convinced that he has gained not merely respect, but also aristocratic distinction and true freedom—the freedom to behave better than his neighbors; the only freedom to differ which does not offend God—from his decision to marry Pamela. But Richardson's reluctance to test B's reformation in the fire of unpleasant consequences suggests a conviction that the aristocrat, raised in pride and liberty, must be bribed to behave. Like those of the exemplary little girls in the nursery stories Pamela later tells her children, B's virtues bring social success too mechanically. Richardson can't convincingly imagine the upbringing which made B reclaimable and he can't quite trust B's reformation without stacking the cards in its favor.

In Sir Charles Grandison, Richardson presents his readers with an aristocrat who certainly has no need to reform. Even confirmed lovers of Richardson find Sir Charles a bit difficult to swallow—and the reason for this is not only the fact that Sir Charles is so perfect that he cannot grow or learn. Clarissa is nearly as exemplary as Sir Charles and if readers find her a much livelier and more convincing character, the explanation cannot simply be Sir Charles's marginally greater moral excellence. The problems with Sir Charles seem to arise from the complex and sometimes contradictory virtues he must embody, the sheer number of thematic functions he is expected to perform, for these varied functions create tensions within his character from which Clarissa's is relatively free. In order to embody completely Richardson's conception of the ideal gentleman, as it is his function to do, Sir Charles must at once be the proud aristocrat and the humble Christian, the man of action and the man of accurate self-awareness, the idol of women and the devotee of the virtue of chastity, the accomplished swordsman and the convinced pacifist, and so forth. No wonder his character seems to buckle beneath the weight of these contradictory virtues.

Sir Charles's character must be impossibly complex because he embodies the aristocratic ideal at a time of transition. As Margaret Doody puts it, "The rejection of the old ideal of the noble warrior hero in favor of the ideal of benevolent gentleman may be regarded as a part of a concerted effort of a whole society to make adjustment to a kind of communal life other than that of the small, self-contained unit, protected by the leader who can wield a sword."[7] Lovelace is a sword-wielding aristocrat of the old sort trying unsuccessfully to exercise domineering power in a peaceful modern society. B is an aristocrat who shifts, fairly painlessly, from the old to the new style. But in creating the character of Sir Charles, Richardson tried to guard his exemplary gentleman from criticism by proponents of either style of aristocrat—to give Sir Charles the military skill, the pride, passion, and style of the old warrior hero, but to make it quite clear that his commitment to the Christian ideals of benevolence and social duty is so strong that his "warrior" traits stand no chance of controlling his actions.

Like B and Lovelace, Sir Charles is clearly shown to be the product of his upbringing. Only son and favorite child of a selfish, careless, amoral father and a responsible, self-disciplined, Christian mother, Sir Charles received a moral education which was probably more effective than it would have been had both his parents been decent people. His mother provided not merely the discipline, but also the example, while his father's life was a tacit warning of what to avoid. Schooled in the art of self-defense by his father, Sir Charles also learned a truly Christian abhorrence of the code of honor from his mother. The respect in which his mother was held, her effectiveness in keeping the family running smoothly, proved to her son the value of the feminine virtues and prevented him from taking his father as a model, though his strong sense of filial duty forbade him to reject his father's masculine values completely. Sir Charles's youth was not free from the valuable lessons of affliction which, in Richardson's view, too many aristocrats escape altogether. Sir Charles lost his beloved mother when he was only sixteen and at that time was sent into prolonged exile on the continent, for his father did not want the heir at home to witness his own misbehavior.

As usual, Richardson has carefully provided his character with an education which accounts for his most prominent traits. Unlike Richardson's other aristocrats Sir Charles has always known discipline and frustration, so we have a legitimate reason for the fact that he prides himself more on the inner moral rectitude he has developed, than on the deference he receives. Nonetheless, the very elaborateness of the explanation offered for this phoenix of an aristocrat suggests that Richardson finds in him something very odd, in need of more than the usual amount of discussion. Such an education as his—an aristocratic mother so free from snobbery or laxity, an aristocratic father setting so unattractive an example, nature providing the afflictions which wealth can frequently spare a child—is an anomaly very different from the typical aristocrat's education discussed in the conduct books.

Carefully and elaborately as Richardson has accounted for Sir Charles's commitment to Christian values, he is almost as unwilling to try Sir Charles's virtue, as he was to try Mr. B's reformation, in the fire of unpleasant consequences. Although Sir Charles is occasionally treated cruelly and contemptuously by the old fashioned sort of arrogant aristocrat—like General Della Porretta—the self-controlled dignity with which he bears and reproves affronts always ends by winning him greater admiration and deference than he could have earned by any other method. And since this usually happens with almost magical speed, Sir Charles is never forced to choose between satisfying the demands of his conscience and gratifying his desire for respect, except for vanishingly brief periods. Richardson tells us repeatedly that Sir Charles is a proud man, but that his is a proper pride, which can only be gratified by consciousness of internal worth and which can stand against any amount of outward discouragement—the opposite of the pride produced by the typical aristocratic childhood. We also learn that Sir Charles is too proud to owe an obligation and that his pride receives its greatest satisfaction from his own consciousness of his great social utility: "My chief glory will be, to behave commendably in the private life," he tells Harriet when they discuss their plans for the future. He does not need public notice to bolster his sense of worth. Clearly Richardson's point is that there are many sorts of pride and that those who have been properly educated do not need deference in order to have self-respect. But after making this point, Richardson gives Sir Charles enough deference to satisfy even a Lovelace. It is probably not Sir Charles whom Richardson distrusts here, but rather his own readers, who, not possessing Sir Charles's firm moral standards, may need a great deal of encouragement to follow his example of good conduct.

Like all of Richardson's main characters, Sir Charles values his freedom highly. But for him, as a conscientious man, aristocracy means the freedom to behave better than his neighbors, to be more generous, to obey the laws of morality more consistently and strictly. And these things his wealth and liberal education enable him to do. This sort of freedom is social, for the man who values it is a benefit to all his fellows. And it is real freedom, because it is based on a realistic understanding of what a rich, good and determined man can, with God's aid, accomplish. Sir Charles is not an impulsive do-gooder, but an empirical scientist—of the sort Lovelace falsely claimed to be—who studies situations before he acts and who judges in terms of valid moral standards. Where Lovelace could only dream of possessing the freedom and power to reduce the reality around him to his own moral level, Sir Charles actually can raise the moral quality of the society around him through example, encouragement, and judicious aid. Where Lovelace boxes himself into a corner by claiming excessive, impious freedoms, Sir Charles, through his benevolence, continually extends the circle of his influence and power. More and more people fall under his spell, emulate his virtues, leave him their property, and thus his scope for changing the world around him is ever on the increase. Paradoxically, the aristocrat who voluntarily obeys the laws of God and man proves freer than the aristocrat who claims that, "The law was not made for such a man as me." (*Clarissa* Vol. IV, p. 109)

The egalitarianism of Richardson's novels disturbed many of his contemporaries. His claim that in a Christian world the soul of a servant like Pamela is every bit as important as the soul of her master, seemed radical and dangerous. *Sir Charles Grandison* is the most conservative of Richardson's novels, for its moral scheme is not the Christian egalitarianism of *Pamela* and *Clarissa,* but rather the notion of the Great Chain of Being, which is repeatedly discussed by the novel's characters. If one thinks of reality as a great chain, then all creatures are essential to God's plan, but some are clearly higher than others. And this is the moral idea that stands behind Grandison's social conservatism. Only those who are free from sordid compulsion, and who are well educated, can reach the greatest heights of moral discrimination and action of which humanity is capable. Such people need not be of the highest branches of the aristocracy—indeed we have seen that Richardson is deeply distrustful of an aristocratic education, and neither Sir Charles nor Harriet comes from a really great family, as Lovelace does—but they must at least be well-off and well-taught. Sir Charles and Harriet, with their incredible power to make the finest moral distinctions and their almost super-human ability to live up to their convictions, represent the top rung on a moral ladder. In *Grandison* Richardson develops an idea which was to become important in the work of later eighteenth and early nineteenth century novelists like Fanny Burney and Maria Edgeworth: that the aristocrat can, because of his greater opportunities to act and learn, become a better man than any member of the working or middle classes. But even in *Grandison,* his most conservative work, Richardson's suspicion of the aristocracy prevents him from arguing this proposition wholeheartedly and convincingly. Richardson's distrust of aristocrats impels him to hedge his ideal gentleman with a dizzying number of special conditions, explanations, qualifications—so many that they begin to undercut each other and to destroy the credibility of Sir Charles's character.

The importance of Richardson's work for the way aristocrats are treated in later novels cannot be overestimated. The two types of aristocratic characters which, in a multiude of varying forms, reappear in novels throughout the late eighteenth and nineteenth centuries first find novelistic expression in Richardson's work. The dark aristocrat, whose moral character has been destroyed by privilege, and the exemplary aristocrat, whose great opportunities have enabled him to reach a standard of excellence beyond the reach of ordinary mortals, have prototypes in other literary genres and in social theory, but as far as the novel goes, they are both Richardson's creations. Richardson liked the idea of an ideal gentleman but he was never really able to evade his conviction that the freedom of the essential aristocrat was a dangerous and destructive state of being. This conviction underlies the characterizations of B and Sir Charles and undermines the reader's belief in their virtues.

Notes

[1] In Britain the term "aristocrat" has never been completely clear in its application, for the British aristocracy is not a closed caste. I am using the term loosely here, to mean a man who has, or will inherit, a peerage, *or* who possesses, or will inherit, a great landed estate. B and Sir Charles fall into the latter category.

[2] Daniel Defoe, *The Compleat English Gentleman* (London, David Nutt, 1890).

[3] All references to Pamela incorporated in the text are taken from: Samuel Richardson, *Pamela or Virtue Rewarded* (New York, W. W. Norton and Company, 1958).

[4] All references to Clarissa incorporated in the text are taken from: Samuel Richardson, *Clarissa Harlowe: or The History of a Young Lady,* 9 vols. (Philadelphia, J. B. Lippincott Co., 1902).

[5] See John Carroll, "Lovelace as Tragic Hero," *University of Toronto Quarterly,* 42 (1973), pp. 21-24, for a similar, but abbreviated, discussion of the excessive freedoms Lovelace claims.

[6] For a more extended discussion of the evil influence that the women of the brothel have upon Lovelace, see: Judith Wilt, "He Could Go No Farther: A Modest Proposal about Lovelace and Clarissa," *PMLA,* 92 (1977), pp. 19-33.

[7] Margaret Doody, *A Natural Passion: A Study of the Novels of Samuel Richardson* (Oxford, The Clarendon Press, 1974) p. 242.

[8] Samuel Richardson, *Sir Charles Grandison* (London, Oxford University Press, 1972) Vol. III, p. 99.

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In the "Proteus" section of *Ulysses,* there is a clear and precise reference to Jacob Boehme and to his book, *The Signature of All Things.* Boehme's name is still somewhat familiar to students of theology and philosophy. He is said to have influenced philosophers from Hegel to Heidegger and theologians down to Tillich, Berdyaev, and Marcel. But he has been better known in earlier ages than our own. For those who may not be familiar with Boehme, here is a brief life of this writer in whom Joyce was very interested, and to whom he therefore referred rather more widely in his writings than is generally realized.

Jacob Boehme was born near Görlitz in what is now East Germany in 1575, and lived in that town most of his life. He was a shoemaker by trade, who later sold his shoemaking business to become a draper, and dealer in woolen articles.

Boehme was always very religious, and in his maturity he had two religious experiences which not only colored, but really shaped the rest of his life. Under the influence of these experiences, he felt compelled by God to write down what had been revealed to him, and he wrote so rapidly and compulsively that he has been considered by some critics the first of the "automatic" writers.

As an untrained theologian, however, Boehme got into a great deal of trouble with his pastor and other religious leaders, so eventually he wrote some of his works in the language of alchemy. As Evelyn Underhill puts it, some ancient religious writers used the language of alchemy to convey religious "secrets to the elect, whilst most certainly concealing them from the crowd."[1]

It can already be seen, that Joyce would have found a writer like Boehme interesting because of his hermetic writings as well as his sometimes strange philosophy. Joyce would have seen similarities between Boehme and that old favorite of Joyce's, Giordano Bruno. There were also aspects of Boehme's life as religious rebel, and martyr of a kind, which must have attracted Joyce. So it is no wonder that we find Stephen musing upon Boehme as he says in "Proteus," "Signatures of all things I am here to read . . . ," and goes on to meditate on particular signs as he sees them along the strand.

Stephen's reflections in this section mirror the thoughts of other philosophers besides Boehme. Aristotle is one of these. It is not surprising that this is so, because Boehme's philosophy in his *Signature of All Things* is very similar to Aristotle's. The thinking in "Proteus" is united by many links of associative logic. As the section continues and we see Stephen meditating on Proteus or a Protean God, we go even deeper into Boehme's theories. For the most striking of all Boehme's theories and the one which most interests modern philosophers is that of the evolutionary nature of God.

Boehme actually taught that the Godhead evolved, and in fact, is eternally evolving. This theory seems to be evidenced in Stephen's thinking in this section because no matter what trend his thoughts take, still, by associative logic, he keeps coming back to thoughts of the Godhead, which he thinks of as a kind of Proteus. He muses: "God becomes man becomes fish becomes barnacle goose becomes featherbed mountain." (50:13-14)

Stephen also refers to the Godhead as "Mananaan," the old Irish sea god, and finally as the Demiurge. These references, too, are very much in line with the nature of Boehme's version of God. Mananaan, like Proteus, is a changing God. The term "Demiurge" comes from Gnosticism, and this is related to Boehme because many of his doctrines reflect Gnostic doctrines, just as they do Cabalistic teachings.

There are other aspects of Boehme's doctrines present in the "Proteus" section, such as his ideas of Adam Kadmon, of Lucifer, and so on. The more one knows of Boehme's writings, the more one can see reflected in this episode. Some of these doctrines have implications which continue throughout *Ulysses.* It is, however, in *Finnegans Wake* that one finds the most frequent references to Jacob Boehme.

The Boehme allusions in *Finnegans Wake* are done somewhat in the same manner as Joyce's many allusions to Giordano Bruno. The Boehme usages are part of intricate and amusing wordplays, yet often they are also thematically linked. For instance, one of the main ideas in *Finnegans Wake* is the fall of HCE or Finnegan, which has also been interpreted by many critics as Adam's fall or the fall of Everyman. However, there have been some critics who have seen this as the fall of divinity itself. Atherton, for example, sees it thus.[2] William York Tindall identifies HCE as the God of the Cabala.[3]

Now the idea of a God falling into nature is a Gnostic idea which looms large in the works of Boehme, which is very likely where Joyce met it. There was also a phase of Boehme's development in which he was rather pantheistic. For him, nature was God's body. So HCE's body, scattered all over the landscape fits very well with this conception.

There are a number of symbols which Boehme uses in connection with God that are in turn used by Joyce in marvellous types of word play connected with HCE or with Shaun, HCE's son who seems to supplant or become his own father in some sense, thus becoming God himself. These symbols are the rainbow, flowers, creative thunder, and the number "7".

In Boehme's symbology the rainbow was the throne of God as well as a part of his body. In the *Wake,* too, in the very first pages, we find the "regginbrow ringsome on the aquaface." This is probably a reflection in water of the rainbow, or a reflection of the eyebrow of God, or a reflection of the eyebrow of HCE who is God. There are also the rainbow girls who surround Shaun as he grows in importance. Their presence seems to indicate his growing divinity.

The rainbow girls and Shaun also play the game of "Angels, Devils and Colours." This is very significant because flowers were symbolic of angels in Boehme's theology. Each color revealed the nature it signified. The rainbow girls in this chapter are both angels and flowers.

Boehme also used thunder as a creative symbol in his writings, and said, for instance, that it occurred when the Father first recognized Himself (during the evolutionary process) and then also when the Father recognized His Son. The thunderclap is, of course, also extremely significant in the *Wake.*

"Seven" is an old mystic number which Boehme uses frequently in regard to God, and he uses it in especially significant ways. One of these is the number of emanations in his evolutionary God. Joyce uses the number frequently when referring to HCE and also to Shaun as he seems to become HCE. In one place, HCE is attired in seven articles of clothing.[4] In Chapter 13 Shaun also wears seven articles of clothing.[5] These references all strengthen the claims to divinity of HCE and his son.

There are many other word clues that Joyce makes use of when he embellishes a Boehme theme and even employs in groups by themselves. Such words usually occur within restricted passages or are scattered over no more than a page or two. The kinds of words are all associated with Boehme's life or works. (Incidentally, these symbols can all be found neatly grouped in the Introduction to the Law edition of Boehme's works which was published in England between 1764 and 1781, and which remains the most famous English edition of Boehme's works.)

One of the most important of the symbols just mentioned is the lily. The lily above all is Boehme's sign. Boehme compared union with the Divine to "the scent of the lily," and "the blossoming of the lily." He had a lily engraved on his own signet ring, and a lily also appeared on his grave marker.

Another clue word is ladder. Boehme spoke often of having climbed up a ladder in his soul to where he found his God. The Trinity, the word "three," and even the word "four" are also associated with Boehme. The Trinity is used because Boehme wrote so much about the origins of God, and "four" is used because in his theologizing Boehme was said to have discovered a fourth person in God, a discovery which was always vehemently denied by Boehme. Wool, gloves, shoes, boots, hammering, etc., are all frequent clues, and obviously are all connected with Boehme's trades.

There are also a great many word plays on Boehme's own name. The name is also correctly spelled "Böhme," and in England it sometimes appears as "Boehm." The name is also frequently mispronounced. Joyce naturally makes the most of this, making the name appear as "Bohemia," "Beam," "Bean," and in many other variations. Thus, the words "Lily of Bohemey" which appear in the *Wake* (246:18) and have been taken to mean "The Bohemian Girl," are also a reference to Boehme and his lily. Similar clues can be easily multiplied. These terms, or word clues, are usually employed when Boehme is tied to a theme. So with the HCE/God theme already described, many of these terms also occur.

There are several other themes in the *Wake* to which the Boehme word clues are tied, and other kinds of clues, such as Boehme's given name, Jacob (which is also James and is therefore also Shem) which could be explored more fully. One final point is still to be made. In pointing out Joyce's frequent use of Jacob Boehme in his works, I do not wish to imply that Joyce subscribed to Boehme's doctrines. In Joyce's younger days, when he discovered some of his other favorites—Vico and Bruno, he may have come across Boehme also. At this stage of Joyce's life, he may have been interested in the mystical aspects of Boehme's writings. The young Stephen of *Portrait* exhibits a definite interest in mysticism, however much he may or may not mirror Joyce's own early interests. As a mature adult, Joyce seems to have been interested in mysticism only in so far as he was interested in the arcane, hermetical, or the extremely unusual. Joyce was interested in Jacob Boehme. His interest, however, was as he himself said in regard to Vico, to "use him for all he was worth." Such use, like so many other Joyce uses, has forever enriched *Finnegans Wake* as well as our enjoyment of it.

Notes

[1] Evelyn Underhill, *Mysticism* (New York: E. P. Dutton and Co., Inc., 1961), p. 142.

[2] James Atherton, *Books at the Wake* (New York: Viking Press, 1974), p. 31.

[3] William York Tindall, *A Reader's Guide to Finnegans Wake* (New York: Farrar, Straus & Giroux, 1972), p. 174.

[4] James Joyce, *Finnegans Wake* (New York: Viking Press, 1971), p. 30.

[5] *Ibid.*, p. 404.

THE LABYRINTH: A FOUNDATION OF CHURCH AND CITY SYMBOLISM

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Novelists commonly describe the city in labyrinthine terms. The changing definition of the term is significant. To the ancients, the labyrinth connoted paths of intricate deviation leading eventually to a center for the initiated from which demons were excluded by the very device of the labyrinth. In the Middle Ages that center still held in the guise of walled towns with a centrally-located church giving order to the whole complex. In the nineteenth century that center begins to be eclipsed by secular institutions and by the twentieth century, novels question even the validity of presupposing that a center exists to be found. Consequently, in considering the interrelationship of church and city, one is led to consider the labyrinth with its circular core as symbolic foundation of the city. Before considering the correspondence between center and periphery, it will be necessary to consider each concept separately in its symbolic uses and meaning. Correlations between the dynamics of the labyrinth and those of the city will then be more apparent.

According to anthropologists, geographers, and psychoanalysts, the geometric concept of circularity is one of the most universal and basic to men's understanding of the world. Universally it is a symbol of wholeness and harmony. It is, according to Yi-Fu Tuan, "a recurrent motif in the arts of ancient eastern civilizations, in the thinking of ancient Greece, in Christian art, in the alchemical practices of the Middle Ages, and in the healing rites of some nonliterate peoples." As an archetypal image of the reconciliation of opposites, the circle also appears in the design of traditional and idealized cities. People everywhere show evidence of structuring space by placing themselves at the center "with concentric zones . . . of decreasing value beyond"; illustrating thereby the universality of center and periphery as organizational concepts. Related to circularity, according to Tuan, are the concepts of open and enclosed. Whereas openness often signifies freedom, adventure, light, and society, closure suggests the womb, security, darkness, and privacy. When one or the other becomes threatening, however, the victim experiences either agoraphobia or claustrophobia.[1]

One of the most ancient uses of the circular as symbol remains even today in the visible traces of burial grounds. As a consequence of studies conducted particularly in England and the British Isles, A Hadrian Allcroft has cited evidence which demonstrates that architectural features of burial grounds for dawn man were most frequently circular. As containers of the bones of the venerated dead, these grounds took on a religious character. Another feature of these circular burial grounds was a vertical image located at the center. Whether tree, rock, or pole, this vertical object served symbolically as a link between heaven and earth, between the mcirocosm of man and the macrocosm of the universe. In short, "religion and burial being inseparable, the same circularity which marked the burial place marked also the *temenos;* tomb and temple had one common plan."[2] Because these grounds became temple sites, the cemetery served as the foundation of the city with the temple as religious and legal center of authority.

The circular burial ground with vertical dimensions, then, was a place of ritual veneration with cosmic orientation. And as such, it represents the bare bones of an architecural structure which eventually received the name church. The word *church* itself shows in its etymology this connection between circularity and consecration. In Old English, *church* is derived from "cirice" meaning circle. Just as burial grounds were set aside, i.e., consecrated for religious ritual by the presence of bones, so too the church altarstone used for the ritual sacrifice of the death-resurrection mystery must contain the bones of a venerated, deceased member. The idea of a plot of ground taking on a sacred character is developed by Mircea Eliade in *The Sacred and the Profane*. According to his thesis, man encountered the world as differentiated: land from sea, and sky from both, for instance. But ways of imposing meaning by categorizing were invented only as part of an historic process. Until these ways of imposing significance evolved, the earth was amorphous, or to use Eliade's term, profane. What designated certain times and places as sacred in opposition to profane, then, was their being differentiated from the mass, set aside or consecrated, as the word sacred implies. Consequently, meaningful assembly with the presiding presence of ancestors in consecrated burial ground came to be seen as a sacred act. Furthermore, since scientific findings have established the circular burial ground as the first meeting place chosen because of its sacred character, burial ground bears a real relationship to the structure later known as the church. Even after circularity disappeared as a common feature of burial grounds the dead continued for some time to occupy the area immediately surrounding the church. This practice remains even today in country churches. Similarly cathedrals entomb their venerated dead beneath the nave. The practice of burying the dead around city churches was discontinued for practical rather than symbolic reasons. There simply was not enough land available and people recognized the danger to their health. Nevertheless, the notions of church and cemetery remain closely associated culturally even today. For modern churches without crypts still have bones in their altarstones and often in their cornerstones.

Because circularity has always been associated symbolically with perfection and the vertical with transcendence, it is appropriate that these geometric shapes be incorporated into the church with its orientation in the supernatural and absolute.

Circularity is associated symbolically with the ideal city as well as the ideal church, however. And in fact, the two are often associated together as one large circle: the church as the center, the city organized concentrically around it. According to Lewis Mumford, the city had its birth in the burial ground, just as the church did. "Urban life," he writes, "spans the historic space between the earliest burial ground for dawn man and the final cemetery, the Necropolis, in which one civilization after another has met its end."[3] Like the church, then, the ancient city received its birth and special character from the burial ground that constituted its center.

Examples of circular cities founded on burial sites are still with us in the world of fact as well as fiction. Rome, for example, was supposedly circular at its founding "with the *mundus* (the place of departed souls) at the center."[4] Even today Rome is called the Eternal City because it is the reputed seat of Christ's vicar on earth and capital of Christendom. This city derives its greatest significance, then, from its being the center of the universal church. Moreover, St. Peter's Basilica was built on a cemetery; and tradition has it that the basilica was built over St. Peter's tomb.[5]

One must also consider Jerusalem, which was placed at the center of the world in medieval maps. The wheel maps of the Middle Ages, with Jerusalem located at the hub of the wheel, "expressed the beliefs and experiences of a theological culture."[6] This city, like Rome, is also envisioned as a church in its designations as "Heavenly Jerusalem," "New Jerusalem," and "City of God." Moreover, medieval man depicted the temple of Jerusalem at the center of a circular walled city.

Circular models also guided the founding of relatively recent cities in history. Paris, for example, was "concentric in pattern and focused on the Cathedral of Notre Dame on the Isle de la Cite."[7] Other medieval cities circular in topographical orientation and in which the cathedral occupies a central location include the following: Toulouse and Limoges in France; Cologne, Hanover, and Frankfort-am-Main in Germany; and the cities of Buda in Hungary and Vienna in Austria. In most instances, the medieval city core included the presence of a cathedral or church. For the word "cite" or city "referred to the initial ecclesiastical nucleus."[8] These churches, in turn, were either founded on burial sites or enclosed relics of the dead after the structures were completed. Although the foundations of London, laid before the Middle Ages, are not circular, St. Paul's original cathedral was built on a Roman burial site as a matter of intent rather than convenience, according to Tuan.[9]

In the world of philosophical and theological speculation, Plato's utopia as well as St. Augustine's City of God are based on circular plans. The former combines the circle with the square, while the latter is purely radial. Literary cities portrayed as circular, often with church as center, expressed man's desire to translate heaven to earth. For example, in Marcel Proust's *Remembrance of Things Past,* the town of his childhood is remembered as resembling a medieval town "as scrupulously circular as that of a little town in a primitive painting."[10] Patterned on the image of perfection, the city ideally was to transcend the vagaries of life and reflect the predictability of the cosmos.

Often, too, these cities were surrounded by circular walls which, before they were used for defenses, were designed to suggest completeness. While signifying wholeness, walls also served to fix the limits of the city. Within these walls, man's life acquired a sense of direction and purpose. According to Yi Fu Tuan, "the wall was the clearest expression of what the city builders took to be the limits of their domain."[11] Mumford also emphasizes that walls were used as constructions for defense purposes only late in their history. He also cites the importance of church bells in determining the city's limits. Beyond their sound, one was also beyond the city's boundaries and in that area designated as profane.

Contrary to present day attitudes that idealize the country, medieval conceptions idealized the city. According to a German proverb of the Middle Ages, " 'City air sets a man free.' " To philosophers of Aristotle's time and after, the city stood for a perfect society. Heathens lived in the country or on the heath; peasants (pagus) or pagans lived in the rural districts.[12]

Combining the horizontal and the vertical, the circular city aspired toward an order based on the vault of heaven itself, and in its aspiration came to symbolize that order. In the same way, the church was also viewed as image of the cosmic order. In Byzantine church architecture, for example, the vault of the church was an image of heaven with the floor as paradisiacal earth. The dome as vault of heaven was preserved through Renaissance and into modern times. Public gestures of man's desire for the transcendent, expressed by the church in ziggurat, pyramid, steeple or temple, has its counterpart first in the church as the center, then in its monument and fountain at lesser "centers." With their vertical-horizontal tension united in the circle construct, city and church symbolize the "antithesis between transcendence and immanence, between the ideal of disembodied consciousness (a skyward spirituality) and the idea of earth-bound identification."[13] A sense of vertical striving is tempered by a horizontal call to rest.

Both church and city, then, acquired their rudimentary beginnings within the circular burial ground as place of religious ritual and communal assembly. The labyrinth stands in conjunction with circularity as well in its combination of the vertical and horizontal, signifying perfection. Although not all labyrinths of fact or fiction are circular in shape, the ritual dance associated with them always includes circular movement, indicating their basically circular nature. The general construction of the labyrinth consists of a central area circular in form surrounded by a series of concentric, winding paths intended to confuse the uninitiated.

According to the myth of Theseus,[14] which expresses the mythico-religious significance of the labyrinth, the center was a sacred space. Within it, the Minotaur (half-man, half-bull) signified the union of mortality and immortality (the bull being a symbol of divinity for the ancients). In slaying it, Theseus performed an act of defiance even while fulfilling a requirement of a religious cult. According to this cult, it was necessary that the bull, surrogate for the king-god, be slain in the king's stead, thus insuring the king's continued life as well as the lives of his subjects. Like the ambiguous nature of the Minotaur (god-man) as well as the labrys (double-bladed axe) with which Minotaur was slain, the myth has a double interpretation. According to one theory, Theseus performed a saving act by slaying the Minotaur because in doing so he guaranteed the peoples' lives.[15] In another interpretation, however, Theseus was a usurper in that he embodied the Greeks' hatred of the Cretan bull-cult.[16] By slaying the Minotaur he symbolically destroyed that cult, displacing it and substituting that of Athena and the cult of the ram.

Whatever the correct interpretation, it is clear that the labyrinth itself was a center of religious ritual; that it was circular in structural orientation; and that it celebrated the death-resurrection mystery in a fertility cult. In all these elements it resembles in nature and function a role later played by church and city. Like the church as locus of the celebration of life and death mysteries, the labyrinth was the locus of man's attempt to "overcome death and renew life." According to C. N. Deedes, it was in the labyrinth that "the living king-god went to renew and strengthen his own vitality by association with the immortal lives of his dead ancestors."[17] Communion with the dead was also the purpose behind burial rites celebrated on burial sites. Evidence in the remains of stone circles in England and the Scandinavian countries demonstrates the relationship between circular burial ground and labyrinth: "When we come to examine some of the stone circles of Scandinavia," writes Deedes, "we find that they are actual labyrinths, conforming in design to the plan of those on the coins of Knossos."[18]

While burial ground and labyrinth are clearly related as just demonstrated, city and labyrinth are also closely related conceptually as well as actually. These relationships are the links of a chain, then, joining labyrinth to church and church to city, circularity being the common feature uniting all three. One link, however, remains dangling by itself unless the following question is answered: what is the relationship between city and labyrinth?

The labyrinth, related as it is to church through its association with burial ground, has a more direct relationship to church as well as city in its medieval representation in cathedrals themselves. As W. H. Matthews has pointed out, medieval churches contain labyrinths in art on floors and walls. While some are called "ways," others have the name "Jerusalem" inscribed at their centers. A labyrinth has also been found with the words "Sancta Ecclesia" at its center. Conjecture is that these labyrinths served as miniature pilgrimages to holy cities for those who could not make the actual trip. A "Chemin de Jerusalem" could be walked with one's index finger on the wall if one could not traverse the roads on foot.[19] Not only the church, but the city as well began as a magnet drawing people together to celebrate mystery; the city, too, was "the goal of pilgrimage."[20]

Various pseudonyms for labyrinths also establish a connection between them and cities; "Ruins of Jerusalem," "City of Nineveh," "Walls of Jericho," and "Babylon" are some of the names given to labyrinths.[21] According to legend, Ariadne's dance was performed in Troy, and in fact was responsible for the city's fall in that, while the dance was being performed around the walls, the Greeks wheeled their wooden horse through its gates. The notion of troia ("a winding") was then carried as far north as Scandinavia where it survives as a labyrinthine maze in earthworks and stone circles. Labyrinth and city are notions related to each other, then, through Troy, a city whose name indicates the labyrinthine.

Not only are labyrinth and city joined by historical evidence; the two are related conceptually as well. A tension between exclusion and inclusion characterizes both labyrinth and city. While the labyrinth's inner winding passageways promise the possibility of extension, its external windings protect the center from violation by the uninitiated in the same way that the burial place was protected from grave-robbers by intricate passages. According to Paul Kuntz, "the labyrinth was able to protect a city, a tomb or sanctuary, but in every case, it protected a magical-religious area which excluded those not invited or initiated."[23] The center was a place secluded, while the periphery protected it from invasion.

Besides the tension between exclusion and inclusion, labyrinth and city embody a similar tension between injunction and permission. While injunctions take shape as laws designed to protect the community and regularize worship, permissions contain the more vital designation of possibilities and freedom. Exposure and seclusion, permission and injunction, then, are some of the psychological dynamics of the architectural construct of both city and labyrinth, each with its sacred core surrounded by peripheral deviations.

For the city this core often took the shape of a citadel with its law court and temple; for the labyrinth, it was bull-ring of ritual celebration. Just as cities often had circular walls enclosing them, the labyrinth had "a circular crenelated enclosure."[24] Related to both city and labyrinth, the injunctive nature of laws as reflected in visible walls, served to define the interior space of city and labyrinth as sacred or set apart. Citadel and center asserted symbolically man's desire to overcome death, to unite heaven and earth, to join the transcendent and the immanent. In their life-giving powers labyrinth and city were a common "means of bringing heaven to earth."[25]

Notes

[1] Yi-Fu-Tuan, Topophilia: *A Study of Environmental Perception, Attitudes, and Values* (Englewood Cliffs: Prentice-Hall, 1974), p. 17.

[2] Hadrian Allcroft, *The Circle and the Cross* (London: Macmillan, 1930), I, p. 22.

[3] Lewis Mumford, *The City in History: Its Origins, Its Transformations, and its Prospects* (New York: Harcourt, Brace, and World, 1961), p. 7.

[4] Tuan, p. 153.

[5] *Encyclopedia of World Art, VIII* (London: McGraw-Hill, 1962), pp. 324-349; 527.

[6] Tuan, p. 41.

[7] Tuan, p. 159. For geometric significance in town planning see John Archer, "Puritan Town Planning in New Haven," *Journal of the Society of Architectural Historians*, 34 (May 1975), pp. 140-149.

[8] Robert Dickinson, *The West European City: A Geographical Interpretation* (London: Routledge and Kegan Paul, 1951), p. 252.

[9] T. G. Bonney, *Cathedrals, Abbeys, and Churches of England and Wales* (London: Cassell and Co. 1891), p. 44.

[10] Marcel Proust, *Swann's Way,* trans. C. K. Scott Moncrieff (New York: Modern Library, 1928), p. 59.

[11] Tuan, p. 230.

[12] Tuan, p. 150.

[13] Tuan, p. 28.

[14] Works consulted regarding the myth of Theseus and the Minotaur include the following:
Apollodorus, The Library, 2 vols., trans., James Frazer (London: William Heinemann, 1921).
Michael Ayrton, *The Maze Maker* (London: Longmans, Green, and Co., 1967).
Ronald Burrows, *The Discoveries in Crete* (London: John Murray, 1908).
Diane De Turo Fortuna, "The Labyrinth of Art," Diss. Johns Hopkins Univ., 1967.
Edith Hamilton, *Mythology* (New York: New American Library, 1942).
Ovidus, *Metamorphoses,* trans., Sir Samuel Garth (New York: Heritage Press, 1961).
Plutarch, *The Lives of the Noble Grecians and Romans,* Vol. I, trans. Thomas North (Oxford: Basil Blackwell Press, 1928).
Louis Herbert, ed. *Mythology of All Races* (New York: Cooper Square Publishers, 1964).

[15] Phillippe Borgeaud, "The Open Entrance to the Closed Palace of the King: The Greek Labyrinth," in Context," *History of Religions,* 14 (August 1974), p. 1-27. Also, S. H. Hooke, ed., *The Labyrinth: Further Studies in the Relations Between Myth and Ritual in the Ancient World* (New York: Macmillan, 1935), ix.

[16] C. N. Deedes, "The Labyrinth," in *The Labyrinth,* ed. S. H. Hooke, p. 29.

[17] Deedes, p. 42.

[18] Deedes, p. 38.

[19] W. H. Matthews, *Mazes and Labyrinths: A General Account of Their History and Development* (London: Longmans, Green, and Co., 1922).

[20] Mumford, p. 10.

[21] Matthews, p. 56.

[22] Deedes, p. 6.

[23] Paul Kuntz, "The Labyrinth," *Thought: A Review of Culture and Idea,* 47 (Spring 1972), p. 11.

[24] Deedes, p. 6.

[25] Mumford, p. 31.

AFRO-AMERICANS IN EARLY WISCONSIN

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The Upper Great Lakes Territory, later to evolve into the states of Wisconsin, Michigan, Illinois, Indiana, Ohio, and part of Minnesota, became a home for Africans and their descendants almost from the time of its discovery. In their efforts to develop this territory, the French established trading posts as well as military and religious settlements. Their purpose, like that of the English to the South, was to establish a source of economic resources that would be channelled back to the coffers of Europe.

Soon after their entry into the territory, the French added to the soldiers, missionaries and envoys some 500 Africans from Guinea, West Africa.[1] These Africans constituted a substantial portion of pioneers as the French moved deeper into the Mississippi Valley. Within five French settlements along the Mississippi, i.e., Kaskaskia, Kaaki, Fort Chartres, Saint Phillipi, and Prairie de Roche, well over 300 Africans were counted along with the 1100 Europeans, indicating that Africans comprised nearly twenty percent of the population in the Mississippi territory.[2]

While Africans served as sources of population and labor for the New World, the French had apparently not concluded that Africans were to be treated solely as property with little ability to make decisions over their lives. Therefore, Africans functioned in many of the same capacities as the French. Records indicate that Africans, like the French, served as fur trappers and traders, as packhorsemen, cooks, and voyageurs. According to the hierarchy among the French, groups of traders were formed with a chief trader responsible for collecting the goods and furs and seeing that these were transported to New France and Canada for exchange. A number of these chief traders and entrepreneurs were known to be Africans.[3]

Although Africans were accepted as free agents in trading roles, they were also used as slaves, especially by those who appeared to be of some social importance. For example, in the early 1700's a French priest recorded the baptism of Charles, a Negro slave of M. de Vercheres, the commandant of one of the military posts established by the French within the territory.[4] Similar records note the presence of other slaves in the homes of wealthy traders.

Exactly how the French were able to reconcile the contradictory roles assigned to Africans in the same territory is not clear. From all indications, however, they did not appear to limit contact between the two groups, for records indicate several instances of independent voyageurs and fur traders marrying slaves. One such incident is that of Bon Coeur, a French-American fur trader, who married Marguerite, also known to be of African descent.

According to the records, Marguerite was travelling through the Great Lakes territory with her master, Sieur Boutin, on their way to one of the settlements in Illinois, when she met Bon Coeur. As love would have it, they were soon married by a French priest and a year later had a daughter, Veronique, who was baptized in 1743. Exactly how this marriage affected the slave status of Marguerite is open to speculation. The baptismal records seem to indicate that all three members of the Bon Coeur family became the slaves of Sieur Boutin; however, there is also evidence that Bon Coeur remained a fur trader and continued his work among the Indians.[5]

The population of the Upper Great Lakes area did not remain stable. Although the French were the dominant residents of the territory between 1687 and 1763, numbers of British fur traders and settlers also resided in the area. During the French & Indian War, the French and British fought numerous battles over the right to control the territory. By the treaty which ended the war in 1763, the British gained control of the area, Canada and the upper Mississippi. Unwilling to become British subjects, many of the French settlers and their African counterparts migrated down the Mississippi and established a fur trading post around the St. Louis area. According to Moses Strong, this migration consisted of approximately 2500 people, of which 900 were Africans.[6]

This rather large emigration from the territory left few African-Americans; not many more were to come with the British. This was but the first of several population drops during the development of Wisconsin which helped generate the myths that: (1) African-Americans could not tolerate the climate of these extreme northern states, and (2) Wisconsin has not had a sufficient African-American population to warrant investigation of their historical contributions.

Those African-Americans who remained in the territory were independent fur traders who lived and worked among the Indian tribes, slaves of Frenchmen who chose to stay, and Africans who had intermarried with French settlers. Among these French African-Americans who remained in the territory were two individuals who later figured prominently in the settlement and development of Wisconsin, Illinois, and Minnesota. They were Joas (Jean) Bonga and Jean Baptiste Point de Sable.

Joas (Jean) Bonga or Bunga, though later listed as free, was said to be a slave of Captain Daniel Robertson, the British officer in command at Mackinac between 1782 and 1787. There are indications that the French chose to sell their slaves to the British, but historians have speculated that Bonga was acquired by the British officer from Indian traders who had previously captured him from the French around Missouri during the Revolutionary War.

Upon joining the Robertson household, Joas met and married another Robertson slave, Marie Jeanne, also of African descent. To Marie Jeanne and Joas were born two daughters, Rosalie in 1786 and Charlotte in 1782.[7] Historians have placed a great deal of emphasis on the fact that Joas and Marie Jeanne did not marry until 1794, which meant that their children were illegitimate.[8] It should be noted, however, that the relationship between Joas Bonga and his wife was not very different from those of other fur traders in the area, British and French included. As pointed out by Louise Kellogg, fur traders were required to live far from the posts to carry on their business with the Indians.[9] Within the territory surrounding the trading posts, there were few priests, and it was not until one became available that a couple chose to repeat their vows of marriage—often after years of living as man and wife. This may very well have been the case with the Bongas.

Bonga descendants became prominent in the development of Wisconsin, Michigan, and Minnesota. A son of Joas and Marie Jeanne, Pierre Bonga, followed his father's footsteps and became a successful trader among the Chippewas, as did the grandson, George Bonga. It was apparently this George Bonga who served as an interpreter to Governor Lewis Cass in the treaty negotiations with the Indians at Fond du Lac in 1820.[10]

Among those free Americans of African descent living with the Indians in the territory was Jean Baptiste Point de Sable. De Sable came to the Northwest Territory and established himself as an independent fur trader. There are various theories about his point of origin, some claiming that he came from the West Indies, others suggesting that he was a runaway slave from Kentucky. As an independent trader, he set up a trading post among the Indians in 1779 on the site that was to become Chicago, Illinois.

By 1783, the newly formed federal government of the United States had obtained control of the territory around the Great Lakes and had taken over the fur trading industry. Because the numbers of Africans, both West Indies and native born, had increased to the point where half of the population of some southern states had become African-American, and because the issue of slavery was becoming a rather complex problem that the new government did not wish to deal with, some consideration was given to colonizing the new territory with the new African immigrants.[11] This idea was abandoned when the states decided it would be better to contain the people of color and slavery in the southern region. Apparently it was assumed that transportation of the Africans would mean the establishment of the institution of slavery in the north. Thus, in the ordinance establishing the Northwest Territory a clause was included prohibiting slavery or involuntary servitude of any type. This must also have meant that there were to be no Africans, for a few years later the congress passed the Fugitive Slave Act of 1793 which forced the return of slaves reaching the territory on their way to Canada and freedom.

The effort to exclude African-Americans from the Northwest Territory was not successful. There were, of course, some Africans still residing in the territory, having come with the French. Others arrived as runaways and to avoid recapture found it often to their advantage to settle with the Indians in the area. As had occurred during the French regime, many interracial marriages took place and, finally, cultural absorption. One of the best examples of this is the LeBuche-Duchouquette-Gagnier-Menard family.

In the early years of the Northwest Territory, two settlements existed in the area that was to become Wisconsin—Prairie du Chien and Green Bay. These two settlements developed largely because they were close to the military posts established to help settlers in the area, to fight Indians, and to maintain control over the fur traders remaining in the region. Of the two, Prairie du Chien was apparently the larger. In his recollection of the early days at this settlement, James Lockwood wrote:

> Among the other inhabitants of notoriety at that time was a Mrs. Menard, of mixed African and white blood. She came from one of the French villages below and then married to Charles Menard, a Canadian of French extraction. She had been married twice previously. . . .[13]

Mary Ann LeBuche, or Aunt Mary Ann, as she was known, served as a midwife, nurse and healer. From all indications, her obvious African features created no difficuly for her. During her lifetime, she bore 13 children to three husbands. She and her first husband, Duchouquette, a Frenchman, had two sons. Of the sons, Francois DuChouquette is mentioned in historical notes of John Jacob Astor's expedition to the mouth of the Columbia River. After DuChouquette, Aunt Mary Ann married Claude Gagnier, also French, by whom she had three sons and three daughters.[14]

The Gagnier children evidently became respected citizens of Prairie du Chien and participated in the community with little difficulty and little discrimination. It was recorded that one of the boys was a blacksmith while the others became wealthy farmers.

Registre Gagnier, one of these latter sons, figured in a significant historical event of the time. He resided on his farm approximately three miles from Prairie du Chien, together with his wife, two children, and a hired man by the name of Lipcap. As the story goes, Chief Red Bird of the Winnebagoes arrived at Fort Crawford in Prairie du Chien, determined to avenge some insults suffered by members of his tribe. When his efforts to provoke a fight were not successful at the Lockwood trading post, Red Bird and his companions went to visit the Gagniers, friends of his for many years. After accepting Gagnier's hospitality, Red Bird surprised his host and shot him. At the same time, Wekuw, another Winnebago, shot the hired hand. Mrs. Gagnier and her ten-year-old son managed to get away, but the 18-month-old daughter was captured, stabbed and scalped. Surprisingly, the child lived.[15]

Red Bird and his associates were pursued by Colonel Henry Dodge, who later became the territorial governor of Wisconsin, and by soldiers from Fort Howard. Although Red Bird died in prison, his associates were tried, sentenced and afterward pardoned on condition that the Winnebagoes would turn over to the United States their rights in the lead mining area—the land that was to figure prominently in the economic development of the State of Wisconsin.

Gagnier was not the only African-American to die in this uprising. After killing Gagnier, Red Bird and his companions returned to a small settlement of Winnebagoes who had camped at the mouth of the Bad Ax River. During the celebration which followed, several keel boats came by on the way to Prairie du Chien with supplies. The keel boats were attacked by the Winnebagoes and one man was killed—". . . a little Negro named Peter."[16]

The most hostile, conflict-ridden and perhaps most emotional period in the history of America occurred between 1800 and 1865. For African-Americans it was a period in which their difficulties intensified, the search for freedom became an obsession and the institution of slavery was finally abolished. It was during these years that Wisconsin moved from frontier to territorial status and finally became a state. For Wisconsin, as for the rest of the nation, the need to make decisions about citizens of African descent was a major consideration, and led to some of the state's most important moments in history.

With the opening of the Erie Canal and the promise of fertile land for farming, settlers from New York, Maryland, Vermont and other Northeastern states joined foreign immigrants in the Northwest Territory. They brought their belief in the need for an open-labor market with free labor, and the associated view that slavery should be abolished. These individuals settled primarily in the Eastern part of the state. At the same time, from the states of Missouri, Kentucky, Tennessee and Virginia came another group of migrants interested not only in farming, but also in the wealth of the mines. These settlers brought their human chattels and a different set of beliefs about people of color. The largest number of slaveholders and others sympathetic to slavery settled in Western Wisconsin.

The census of Wisconsin Territory in 1840 listed 185 free African-Americans and eleven slaves. At this time the original four-county census had grown to thirty-two counties, with African-Americans residing in sixteen of them.[17] The majority of free African-Americans lived in Grant, Iowa, Milwaukee, Calumet, and Brown counties. The slave population was found in Grant County, where ten slaves—three males and seven females—resided, and in Iowa County, where there was one male slave.

The presence of these slaves stimulated a statewide controversy. Those who favored slavery continued to maintain their property in spite of the fact that to do so was considered illegal under the Northwest Ordinance. Slaveholders included such prominent men as territorial Governor Henry Dodge, his son-in-law William Madden (Chaplain of the territorial legislature), James Morrison, George W. Jones, and James Mitchell.[18] Those who opposed slavery were led by the crusader Reverend Edward Mathews, representative of the American Baptist Home Mission Society. The pressure applied by Reverend Mathews and his followers stimulated all the slaveholders in the state with the exception of James Mitchell, a Methodist minister, to emancipate their slaves, but in name only. Thus, by May of 1848, all slavery was abolished and Wisconsin was admitted to the Union as a free state.

Elimination of slavery, however, did not insure full citizenship to African-Americans in Wisconsin. The state constitution, developed at a convention with no African-American delegates, granted the right to vote to all citizens who were male, twenty-one years of age or older, and residents of the state for one year. This ruling was interpreted as designating only those males who were foreign or native-born Europeans and those Indians who were citizens of the United States but not members of a tribe. Voting rights would be granted to other citizens, namely African-Americans, only if Wisconsin voters agreed.[19]

In addition to those denying the African-American the right to vote prior to the civil war, laws were also passed excluding anyone of African descent from serving in the state or community militia or on neighborhood road crews. According to the Highway Act of 1849, a poll tax payable in labor was required of all male inhabitants of the state except those of color and paupers, idiots and lunatics.[20]

African-Americans in Wisconsin, were however, accorded some legal rights, among them the right to: 1) hold private or public meetings; 2) testify in courts against whites; 3) seek redress of grievances through the courts; 4) own or purchase property; 5) travel without restrictions; 6) seek a free public education; 7) serve on juries; 8) marry interracially; and 9) work in an occupation.[21] When compared with the laws of the surrounding states, Wisconsin's acceptance of African-Americans appeared to be liberal. Ohio, Indiana, Illinois and Iowa, for example, had developed laws governing African-Americans that closely resembled the Black Codes in the South. Although they fared better in Wisconsin, the African-Americans of the state decided that they must have the right to vote and, with the assistance of members of the Euro-American community, set about to obtain it.

Securing the right to vote for citizens of African descent required several state-wide referenda and finally a court suit. The first referendum on the issue, held in 1847, was defeated by the exclusively European-American electorate by a two-to-one margin. As might be expected, the largest number of votes in favor of granting the right to vote to ctizens of African descent was cast in the state's eastern countries and most opposing votes came from the western portion of the state. Citizens of the Madison and Dane County area voted overwhelmingly against granting suffrage.[22]

In 1849, another referendum on the issue was held. After some rather emotional debates, the Second State Constitutional Convention in Madison empowered a new state legislature to grant "colored persons" the right to vote. There was, however, a stipulation that this could be done only if a majority of the votes cast in the particular election were in favor of the proposal. This stipulation proved to be a tremendous barrier, since the vote in favor of granting suffrage to African-Americans was only 5265 out of a total of 31,000 votes cast in the election. The State Board of Examiners, therefore, declared the issue defeated.[23]

The issue was again an important question for voters in the 1857 general election; and again it was defeated. The disenfrancisement of the African-American citizen continued until 1866, when a court suit initiated by Eziekiel Gillepsie, a Milwaukee citizen, resulted in declaration of the election results of 1849 as valid.[24]

The questions surrounding the role of

citizens of African descent in American states and cities created the same emotional fervor and divisiveness in Wisconsin as it did in other geographical regions. For the most part, the division appeared to have regional and geographical bases. Those in favor of full equality were located largely in the eastern portion of the state, where immigrants from non-slaveholding states had settled; and those who held the most ardent anti-black views were found in the western counties. The philosophical differences on the issue became even more pronounced as the debate on slavery and equality reached a fevered pitch throughout the country.

Euro-American rejection of the African-American as a social being and citizen heightened in 1861. As the Civil War loomed, white Wisconsinites, and Dane County residents in particular, became increasingly concerned about the possibility of African-Americans migrating to their cities and farms in greater numbers than ever before. This concern soon generated several attempts to pass laws similar to those of Ohio, Indiana and Illinois that would exclude, or at least restrict, the migration of African-Americans in Wisconsin.[25]

The first effort in this area was the introduction of a Negro Exclusion Bill in 1862 by Saterlee Clark, a Democratic senator from Dodge County. This bill would have dictated that: "(1) no blacks would be permitted to enter Wisconsin after August 1, 1862; (2) circuit courts would have to register blacks already residing in Wisconsin; (3) those blacks already residents would have to carry a certificate which proved they resided in Wisconsin prior to the August 1 deadline; (4) no one could contract for any additional blacks or mulattos to come into Wisconsin to work; and (5) a $50 fine would be levied against any black who arrived illegally or any person who hired them."

The bill, as proposed, was defeated. However, in October, 1862, as refugees from the South began to arrive in Wisconsin from camps in Illinois, the issue was again joined, and noted white Madisonians led the fight. Among these leaders were the editors of the Wisconsin *Daily Patriot,* S. D. Carpenter and Horace A. Tenney. These gentlemen contended that Wisconsin must forestall the migration of the African-Americans, for they would come into the state, take jobs as laborers or domestics, and soon consider themselves equal to white laborers. If this happened, they claimed, Negroes would "eat the bread of whites and white trash would end up standing aside for the 'colored gentry.' " Such a situation was seen as absolutely untenable. Such equal treatment, according to Edward G. Ryan, leader of the Wisconsin Democratic party, went against the principles on which America was founded. As far as he was concerned, America was in the possession of the "white race," and the government of the country was designed to be carried on by "white men for white men."

The dangers of "black migration" to Wisconsin became so controversial that Peter Deuster, a German immigrant and the editor of the *Milwaukee Seebote* used the issue in his campaign and was elected to the State Assembly because of his promise to see that African-Americans were not allowed into Wisconsin. Soon after his election, he introduced a resolution that called for their exclusion. His reasons for asking for this restriction were that:

1. Blacks coming to Wisconsin would end up being injurious to white labor in that they would take jobs white men should have.
2. Blacks given such jobs would take positions from whites who had gone off to fight for the Union; therefore, it was the duty of the legislature to protect the jobs and homes of those soldiers.
3. Blacks should also be excluded because, if permitted to migrate to Wisconsin, they would soon become destitute and end up in the poor house or jail.

Although the Deuster resolution was killed by being sent to a committee which refused to report it on the floor, its language and presentation represented the mind set that was to deny African-American equality again and again.

In 1863, the state legislature began to receive petitions asking it to act again on a Negro exclusion bill. As a result, the third attempt was made through a legislative committee formed to study the issue. In his account of this incident, Edward Noyes suggests that the petition campaign that prompted this third effort was connected to the formation of Democratic Clubs across the state under the auspices of the Knights of the Golden Circle. But regardless of their origin, the petitions came into the legislature and contained the names of prominent citizens of Wisconsin as well as those of poor and recent foreign-born immigrants. One signer was George William Featherstonhaugh, Jr. who was the first signer of the Wisconsin Constitution in 1848—a constitution which had as its first article that all citizens of Wisconsin were free and equal. Dane County and Madison, in particular, presented the second largest number of petitions, only slightly fewer than Dodge County.

The legislative committee responsible for reporting on exclusion suggested that, in the interest of fairness and equality, nothing should be done. In their opinion, all individuals had a right to be judged on their own merits and to move about America as they pleased. In spite of their report, a minority opinion was issued by Oscar F. Jones from Dodge County and a third Negro Exclusion Bill was introduced. The provisions of this bill would: (1) make the exclusion act not applicable to *bona fide* African-American residents of the state; (2) fine any person or corporation bringing an African-American into the state a sum of $200; (3) make all employers of African-Americans furnish a surety bond. The bill also specified that if an African-American became needy or a public charge, the employer would have to forfeit a total of $500 to the city or village in which the African-American lived.

The bill and its substitute was tabled in the Assembly; in the Senate, it was sent to the Committee of Benevolent Institutions where Senators Miles Young of Grant County S. S. Wilkinson of Sauk County led the opposition that resulted in its defeat. Although no further efforts were made to prohibit their immigration, the African-American population of Wisconsin had been served a warning that their presence was unwelcome.

Notes

[1] Woodson, Carter G. *A Century of Negro Migration,* Washington, D.C.: Association for the Study of Negro Life and History, 1918.

[2] Woodson, Carter G. *Ibid.*

[3] Porter, Kenneth. *The Negro on the American Frontiers.* Wisconsin Historical Collections, Volume 11, 207.

[4] Wisconsin Historical Collections, Volume 19, page 11.

[5] Wisconsin Historical Collections, Volume 19, page 9, page 67. Wisconsin Historical Collection, Volume 11, page 204.

[6] Strong, Moses. History of Wisconsin Territory, 1836-1848. Madison: State Printers, 1885.

[7] Wisconsin Historical Collections, Volume 19, pages 83, 91, 97, 157.

[8] Wisconsin Historical Collections, Volume 18, page 497. Porter, Kenneth, *op. cit.,* page 82.

[9] Kellogg, Louise, *The French Regime in Wisconsin.* Wisconsin Historical Collections, Volume 1.

[10] Bennett, Lerone. *The Shaping of Black America.* Chicago: Johnson Publishing Co., 1975.

[11] Woodson, Carter G., *op. cit.*

[12] Gordon, Milton. "Assimilation" in Greer, Colin, Ethnic Experiences in America.

[13] Lockwood, James. *Early times and events in Wisconsin.* Wisconsin Historical Collections, 1903, Volume 2, pages 98-196.

[14] Lockwood, *Ibid.* Porter, Kenneth, *Ibid.*

[15] Wisconsin Territorial Census, 1850. Lockwood's Narratives (1816). Although other individuals of French-African descent intermarried with Indians, the Gagnier-Menard families seemed to marry Europeans in the area, a practice which,

though infusing African blood, soon led to the absence of African identity and color in later generations. In fact, in later census records, the members of the family previously identified as having African blood were listed as European Americans or were not given a race identity at all.

[16] Lockwood, James, *Ibid.* Snelling, William M. *Early Days at Prairie Du Chein, and the Winnebago Outbreak* (1867). Wisconsin State Historical Society Collections, Volume 5, pages 146-147.

[17] Wisconsin Territorial Census, 1840.

[18] Carter Clarence, Edwin (Ed), An Abolitionist in Territorial Wisconsin, *Wisconsin Magazine of History,* Volume 52, 1968-69. 3-17.

[19] Fischel, Leslie. Wisconsin and Negro Suffrage, *Wisconsin Magazine of History,* 46, 1963, pages 180-187.

[20] Fischel, Leslie, *Ibid.*

[21] Current, Richard, *History of Wisconsin,* Volume 2, page 146. 1976.

[22] Molstad, John. Wisconsin Attitude Toward Negro Suffrage, Bachelors Thesis, University of Wisconsin, 1900.

[23] Fischel, Leslie, *Ibid.*

[24] Fischel, Leslie, *Ibid.*

[25] Noyes, Edward. "White Opposition to Black Migration Into Civil War Wisconsin," *Lincoln Herald,* 1971, 73, 181-193.

EARLY PROBLEMS WITH LITTORAL DRIFT AT SHORELINE HARBORS ON THE GREAT LAKES

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Abstract

In the mid-1800's, surveys on the Great Lakes documented and commented upon the shoreline changes caused as newly constructed harbor jetties began to interfere with the littoral drift. These jetties caused a predictable pattern of updrift accretion, downdrift erosion, and bar formation at the harbor mouth.

This early work can provide a gauge, or control, of the effects of an isolated littoral barrier on an otherwise natural shoreline. In many areas, modern controls are not available, because shorelines are now extensively modified by engineering works.

INTRODUCTION

At a shoreline harbor, breakwaters and jetties interfere with the normal littoral drift, causing changes in shoreline configuration. The beach commonly advances along the area updrift from the structure; a bar usually forms at the harbor entrance; downdrift shoreline erosion increases so that the shoreline will recede. These problems began to be widely discussed in engineering journals in the last quarter of the nineteenth century (Johnson, 1957). The history of the harbor breakwater at Madras, India, was among the earliest to receive widespread attention (Vernon-Harcourt, 1882; Spring, 1912-1913). However, this paper will show that as early as the 1830's, surveys made along the shorelines of the Great Lakes documented and discussed shoreline changes that were caused by breakwater and pier[1] construction. It is the author's impression that many of these early surveys have been overlooked, possibly because their publication was limited to early government documents.

As settlement progressed along the Great Lakes, it became apparent that there were few satisfactory natural harbors. In most southern areas, the shoreline is regular and smoothly curved. Rivers and estuaries that drain into the lakes were commonly separated from the lake by spits (Eaton, 1828; Stockton, 1838; Cram, 1839). Entrance channels were dredged through the spits, their sides stabilized by jetties, whereupon the littoral drift promptly extended the shoreline lakeward on the updrift side of the jetties and deposited shoals at the channel mouth. Erosion appeared along the downdrift shoreline. Engineers were primarily interested in the maintenance of a navigable channel, so their work on the littoral drift problem was mainly concerned with shoaling and bar formation at the harbor mouth. Engineers debated whether it was feasible to prevent bar formation by extending the piers farther lakeward, or by orienting the piers in a special way, or whether the bar should simply be removed by regular dredging (Graham, 1858a; Cram, 1839). However, some of the shoreline surveys extended for considerable distances updrift and downdrift of the harbor structures, and show an awareness of the effects of harbor structures on littoral processes of the neighboring shoreline. This early work is compatible with

[1] Technically, a pier may be either of open framework or of solid rock, rubble, etc.; the term jetty is more precise in this context, i.e. a solid barrier extended outward from shore into navigable water. However, these were usually called piers on the Great Lakes and that term is used in this paper as synonymous with jetty.

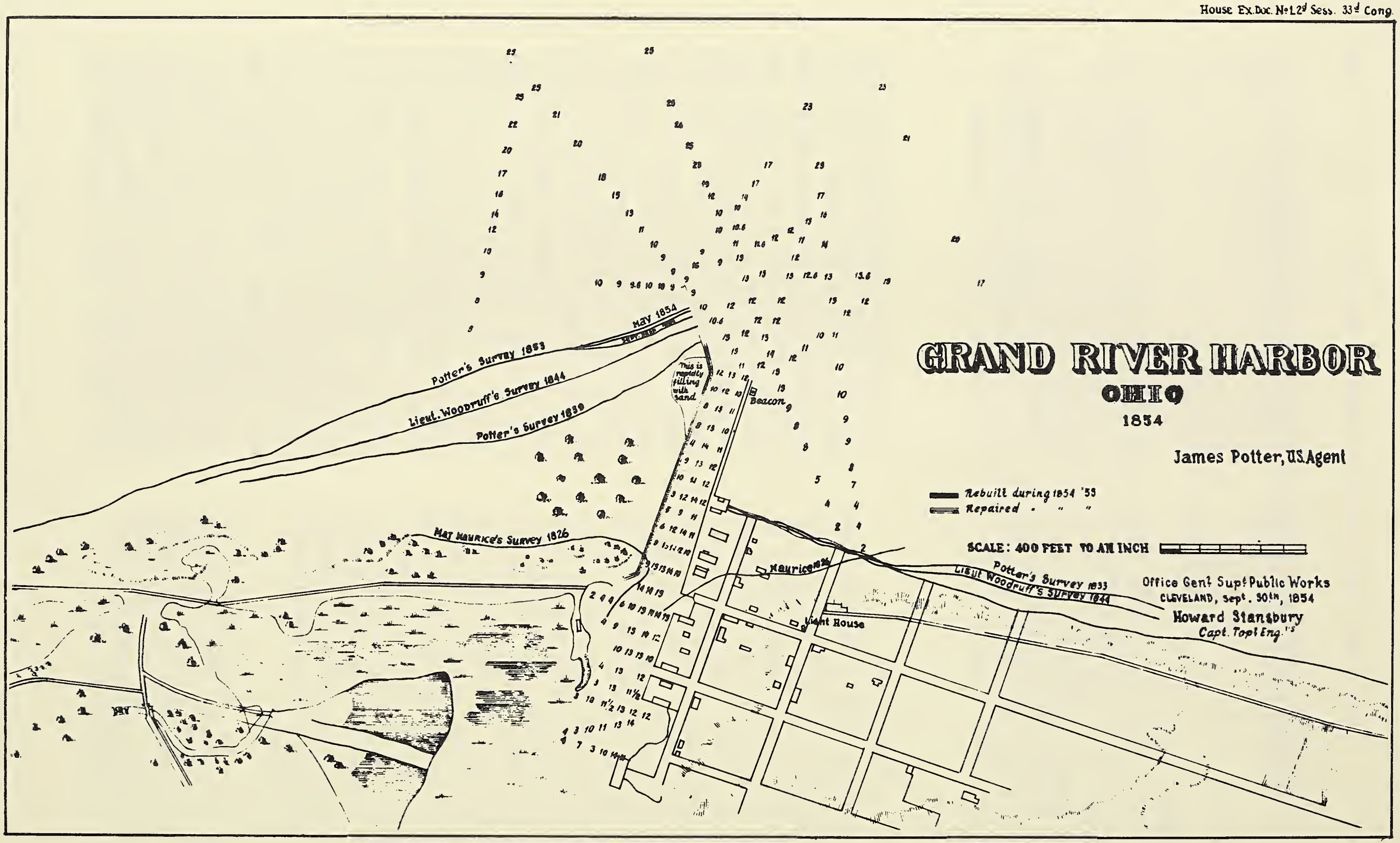

Fig. 1. Grand River harbor, Ohio, 1854 (redrafted from Potter, 1854a). The successive surveys, made from 1826 through 1854, document progressive shore accretion updrift of the piers. Downdrift, a minor zone of accretion trends into a zone of progressive erosion. The full extent of the zone of erosion is not shown.

contemporary understanding of the effects of shoreline structures (e.g. Johnson and Eagleson, 1966; King, 1972; Rosenbaum, 1976), so most of the observations cited will not require extensive comment.

The Surveys

The following surveys were selected for their early date, for their coverage or discussion of the shoreline updrift and downdrift of the harbor structures, or for their depiction of a large number of successive shorelines.

Harbors on the South Shore of Lake Erie:

In a report on harbors along the Ohio and Michigan shore of Lake Erie (Kearney and others, 1839), it was observed that the harbor piers:

> "were commenced within the line of the shore, as it stood when the piers were begun; since which, in nearly every case, the shore has advanced in the direction of the length of the piers-in some cases to no great extent, while in others, especially the more eastwardly of the harbor, the beach has increased very much." (pp. 147-148).

At Grand River, Ohio, the piers:

> "extend beyond the present shore, the west pier 555 feet, and the east pier 635 feet, the beach having advanced, since commencement of the work, 1,180 feet on the west, and 440 feet on the east side of the piers." (p. 180).

and it was noticed that

> "A sand shoal has formed here as at Conneaut and Ashtabula, in advance of the piers, and it has continued to progress with the extension of the work." (p. 180).

First appropriations for harbor improvement at Grand River were made by the Federal government in 1825 (Abert, 1846). A map published in 1854, of successive shoreline surveys (Potter, 1854a), provides a record of progressive effects of the harbor piers (Fig. 1). Surveys were made in 1826, 1833, 1839, 1844, 1853, and 1854. A bar, with depths as little as 2.5 m (7.6 ft.) had formed at the head of the piers. A large area of accretion formed to the west of the piers. A much smaller area of accretion formed to the east, in an area that had been a reentrant near the end of a spit. Farther east, downdrift, the shoreline progressively eroded over the period of record. This zone of erosion apparently extended far beyond the limits of the survey, since the progressive landward displacement of the shorelines is constant, or increasing, at the downdrift limits of the map. Similarly situated zones of accretion and erosion are shown on maps of the harbors of Ashtabula (Potter, 1854b), Conneaut (Potter, 1854c), Buffalo (Pettes, 1854), and Presqu'ile (Williams, 1838). It is interesting that another map of Grand River harbor (Potter, 1854d) is identical to that in Fig. 1, except that the notations "Potter's Survey 1833" and "Lieut. Woodruff's Survey 1844" have been deleted. These notations identify previous shorelines in the area downdrift of the jetties, in which there had been shoreline recession. Conceivably, this omission was an effort to direct attention away from unfortunate consequences of breakwater construction.

Another description of problems with littoral drift is presented in a report of Black Rock harbor (Brown, 1837). This harbor is now a northern extension of Buffalo harbor.

> "The pier which projects from the main shore for the purpose of arresting the sand in its progressive motion along the beach, and preventing it from accumulating in the Black Rock basin, has received no injury. The accumulation of sand against the south side of it, has, however, been so great, that it begins to pass around the outer extremity of the work, and the pier must be extended, or, which could perhaps be more economical, a new one constructed, about 300 yards to the south of it, as was recommended last year, in order to accomplish the object in view. The cause, however, which produced this motion of the sand, is constant and uniform in its action, and I believe that nothing will effectually remedy the evil short of entirely protecting the shore between Buffalo

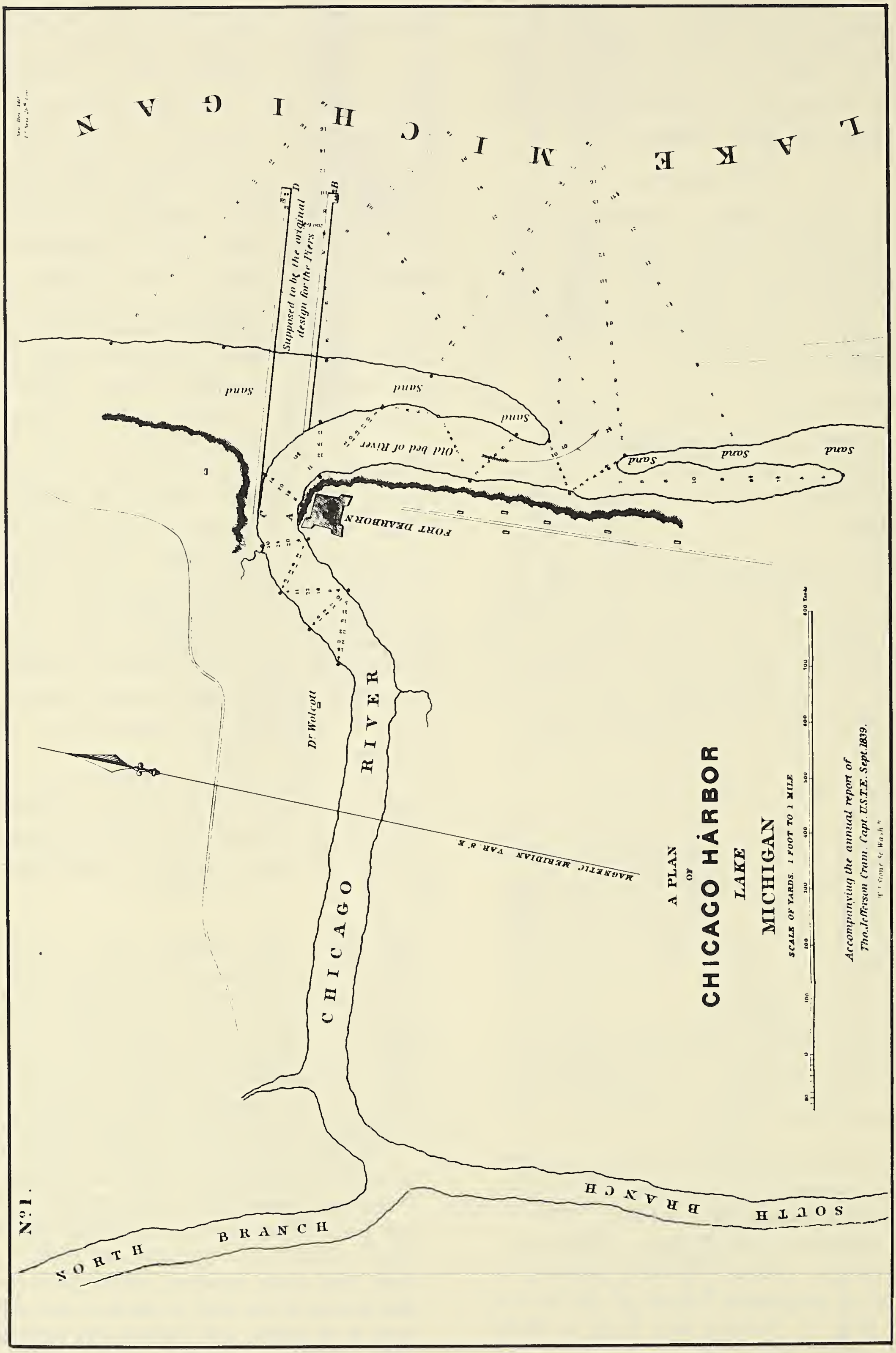

Fig. 2. Chicago harbor (Cram, 1839) before first pier construction.

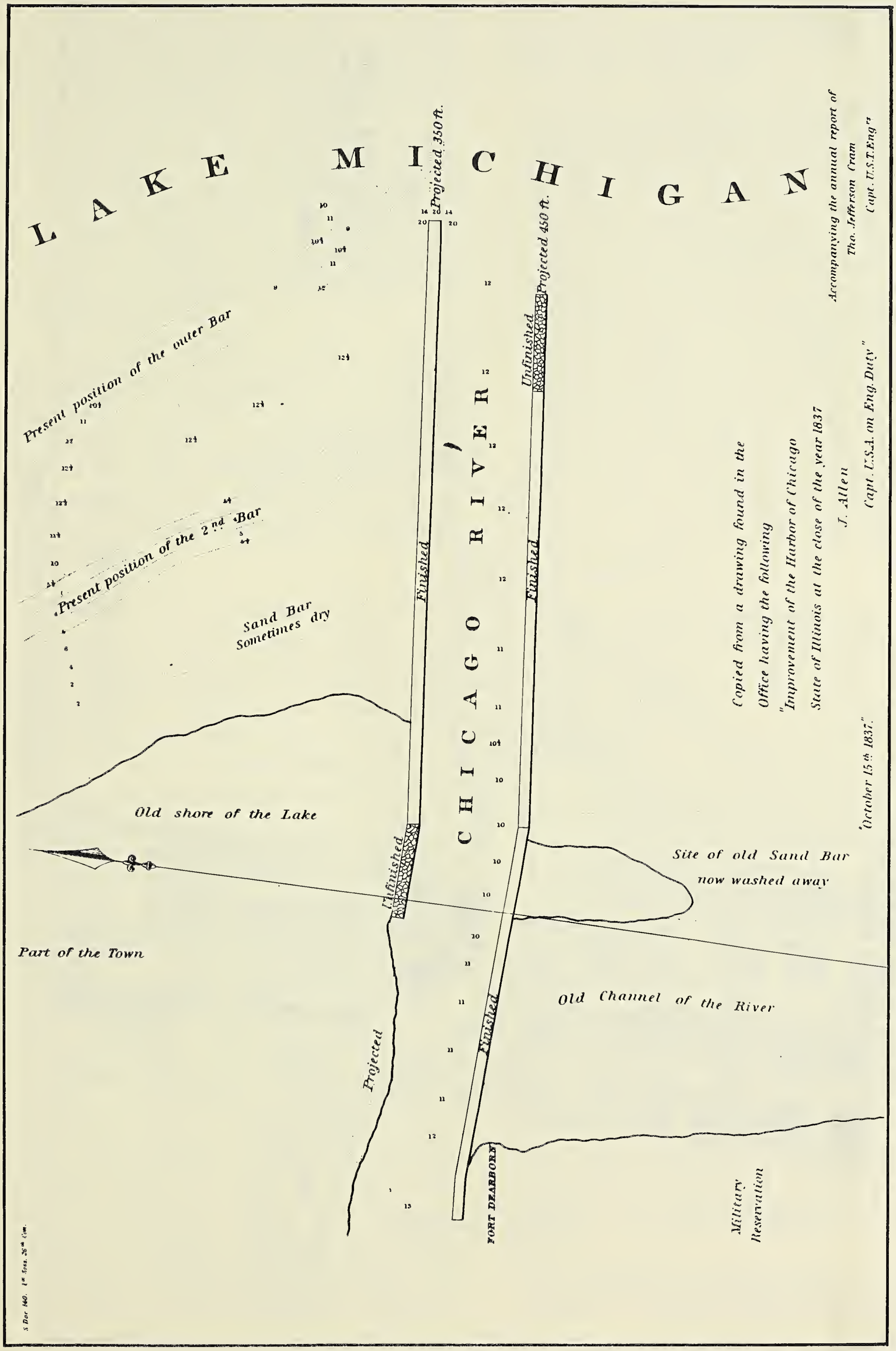

Fig. 3. Chicago harbor, 1837 (Cram, 1839), showing early effects of the harbor piers in blocking the littoral drift.

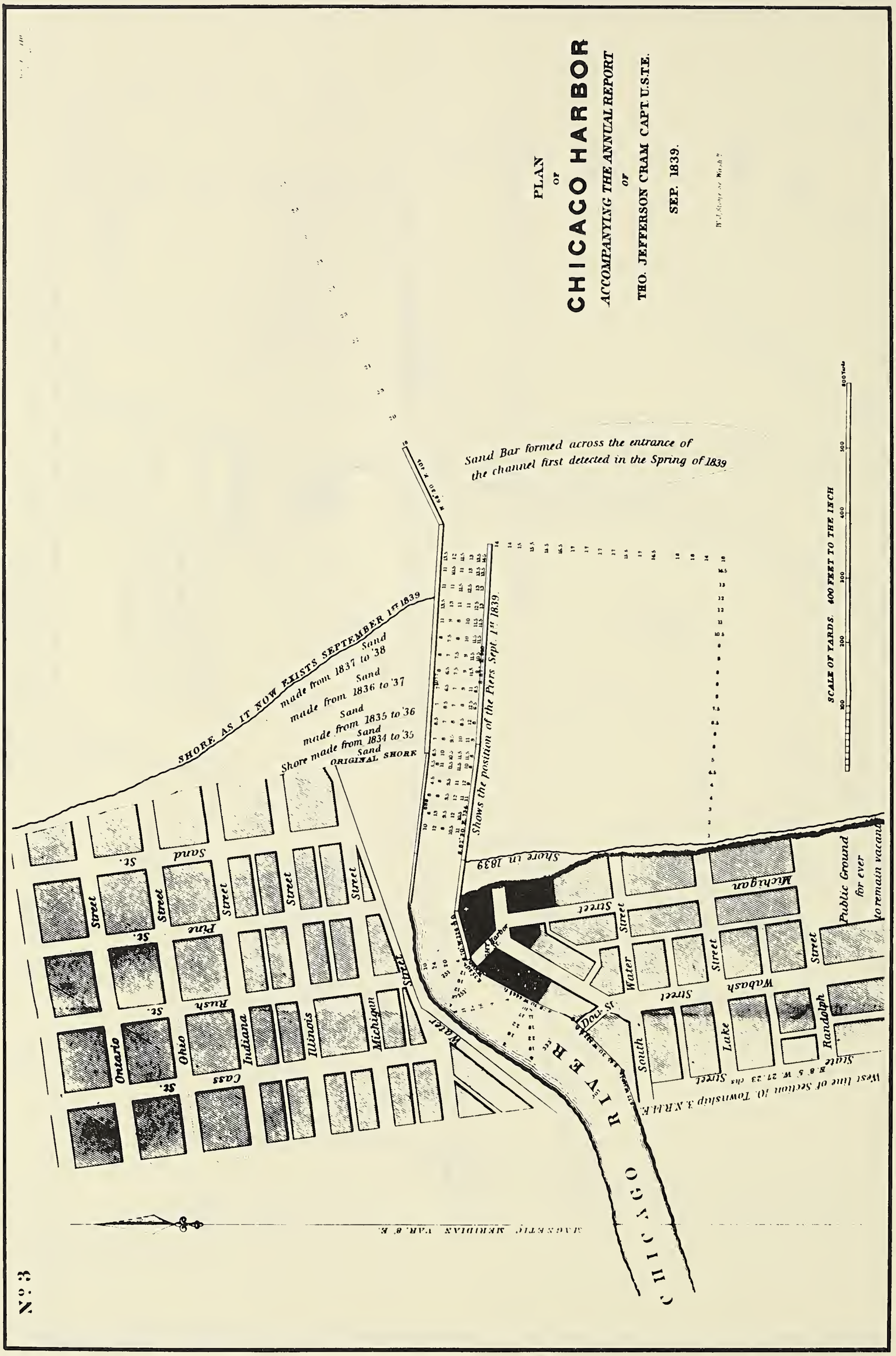

Fig. 4. Chicago harbor, 1839 (Cram, 1839).

and Black Rock from the surf of Lake Erie, or confining the sand in its place by a series of parallel piers projecting from the beach at suitable intervals, over nearly the whole of the distance included between the present pier and Buffalo Creek. The effect of this latter mode would be to cut this beach into small portions, each of which would assume such a direction that the surf caused by the prevailing westerly winds would no longer produce a progressive motion towards the north, in the particles of sand of which the beach is composed. . . ."

A year later, Williams (1839) repeated his concern that "the sands are accumulating opposite the existing Black Rock pierhead to an alarming degree . . . ," tending to fill up the harbor, and also expressed alarm over the recession of the shore to the north of the pier, where the Erie canal was becoming endangered.

Chicago Harbor, Lake Michigan

Figures 2, 3, and 4 (Cram, 1839) show the progressive changes of the mouth of the Chicago River following pier construction. The precise date of the survey for Fig. 2 is unknown, but is evidently before pier construction, the first appropriation for which was made in 1833 (Abert, 1846). Figure 3, dated October 15, 1837, exhibits a lakeward shift of both the shoreline and sand bars updrift of the piers, and a diminution of the sand bar and retreat of the shoreline downdrift of the piers. Figure 4, dated September, 1839, shows the piers to have been extended, and the updrift shoreline accumulation to have been enlarged.

Although Figs. 2-4 document updrift shoreline accretion, bar formation at the harbor mouth, and downdrift shoreline recession, the first specific comments on the latter problem appear in a letter of February 17, 1840, in which the Mayor and Common Council of Chicago petitioned the Federal government to protect the city from the "encroachments of Lake Michigan," encroachments that were caused by effects of the harbor piers (Raymond and others, 1840). The officials maintained:

> "That the construction and extension of the piers forming the harbor at this place, having caused such a change in the action and effect of the waters on this shore of Lake Michigan, that immediately on the north side of said piers land is gradually forming, while on the south side thereof, it is rapidly disappearing. That, on the south side, this encroachment of the lake has progressed to an alarming extent, as will appear from the diagram hereto annexed. That, unless it be speedily arrested, a large portion of the best part of our city will soon be overwhelmed. That the cost of erecting a permanent barrier against this invasion will be great; that our city is poor, its revenues are scarcely adequate to meet its current expenses, much less to undertake a work of this magnitude and expense."

A map, Fig. 5, accompanied this letter. The line surveyed in 1821 probably corresponds to the edge of higher ground shown in Fig. 2, rather than to the shoreline of the spit; maximum retreat of the shoreline between 1821 and 1840 was at least 61 m (200 ft.). A notation on the copy of this map at the office of the Corps of Engineers in Chicago indicates that first work on the harbor piers was done in 1833, not in 1836, as indicated on the published version. It is possible that existing work was rebuilt in 1836, accounting for the discrepancy.

Further comment on the littoral processes causing bar formation at the Chicago harbor mouth was given by Col. J. D. Graham of the United States Army Topographical Engineers, who, beginning in 1854, supervised detailed surveys that included yearly positions of the accreting shoreline in the area to the north of the piers (Graham, 1857, 1858b). In a report (Graham, 1858a) he advised:

> "A reference to the six maps of Chicago Harbor . . . will be sufficient to convince any

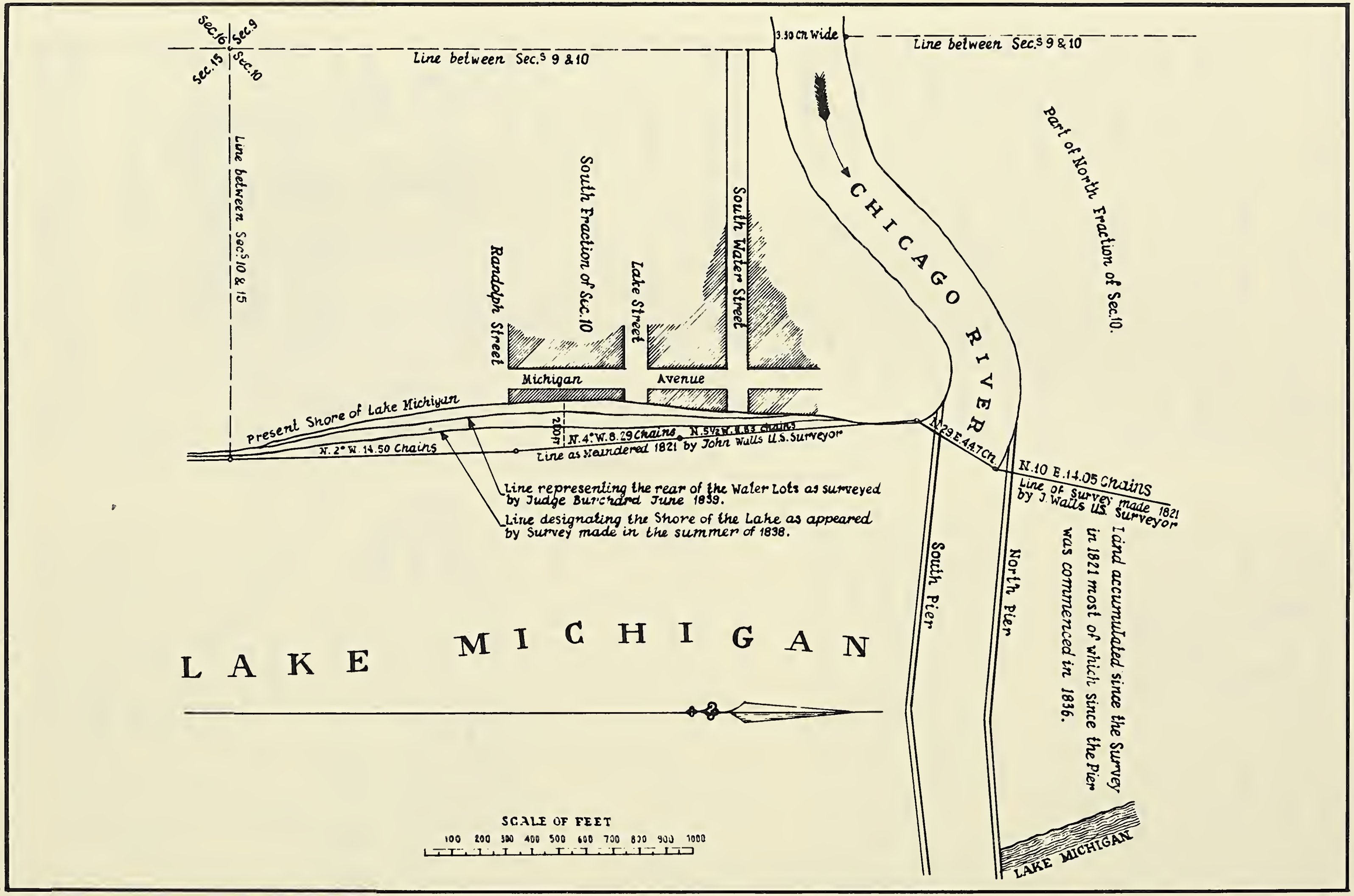

Fig. 5. Chicago harbor, 1840 (redrafted from Raymond and others, 1840). A notation on the copy of this map at the Chicago office of the United States Army Corps of Engineers indicates that first pier work, done on the south pier, was commenced in 1833, not in 1836, as here indicated. The earlier date coincides with the earliest appropriation (Albert, 1846).

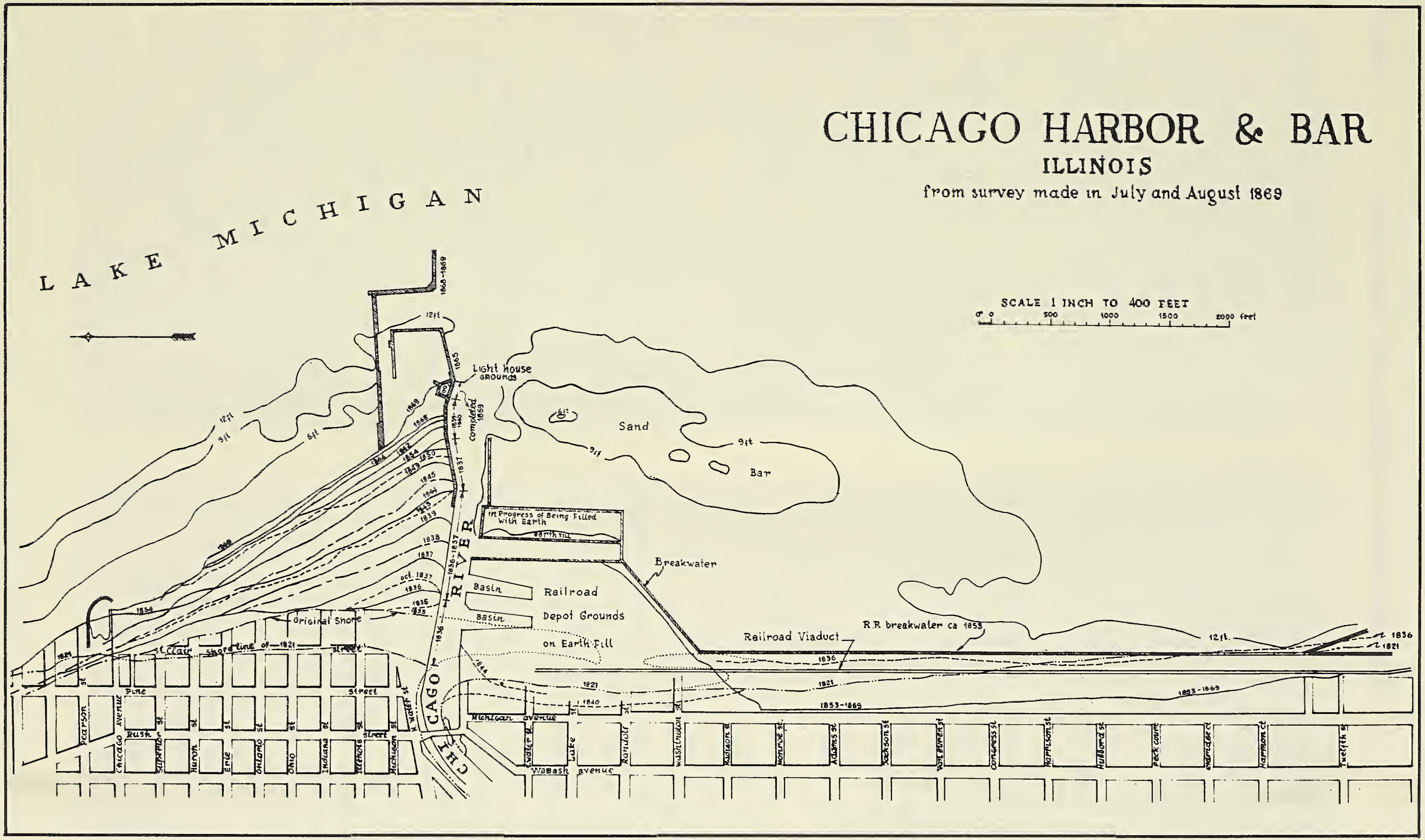

Fig. 6. Successive shorelines from 1833 to 1869 at the Chicago harbor (adapted from Wheeler, 1869). The line surveyed in 1821 probably corresponds to the edge of higher ground shown in Fig. 2.

one that however often this bar may be removed by dredging, it will re-form itself by the deposits caused by the meeting of the littoral or shore current of the lake with the obstruction of the east end of the north pier; and, moreover, that it will always assume identically the same direction, shape, and dimensions, as to width, which it had before being cut away by dredging. . . . Here, then, we have the uniform effect of a fixed hydraulic law. . . ." (p. 1103).

Shoreline changes at Chicago from 1833 to 1869 have been summarized in Fig. 6, which is based on an unpublished map by Wheeler (1869). Similar published maps are those by Graham (1857, 1858b). The outline of the spits has been manually transferred from Fig. 2, and the 1840 shoreline south of the river has been transferred from Fig. 5. The 1836 shoreline south of the river is that shown on Chicago Harbor Auxiliary Map A32 (Anon., n.d.). Dates entered parallel to the north jetty indicate the year of construction of the respective jetty segment, and were obtained from Reynolds (1865) and Chicago Harbor Auxiliary map A74 (Anon., n.d.). Wheeler's map and the Auxiliary Maps are in the collection of the Chicago District Office, U.S. Army Corps of Engineers.

To the north of the harbor jetties, yearly changes in shoreline position following jetty construction are indicated. The original shore presumably corresponds to the water's edge of the sandy area shown in Fig. 2. The shore of 1821 may represent the edge of higher ground, also indicated in Fig. 2.

The position of the paired spits has been approximated from Fig. 2. The approximate position of these spits was also shown by Alden (1902). In that work, the river mouth between the spits falls along a line between Madison and Washington Street, rather than east of Randolph Street, as indicated here. Alden also positioned the spits about 100 m (300 ft.) farther lakeward than shown here.

In Fig. 6, the position of the sand bar is after Wheeler (1869). The 12 ft. bottom contour is hardly affected by the jetty work of 1868 and 1869, suggesting that the bar's position was determined by littoral conditions that prevailed before the addition of those outermost jetty segments.

South of the harbor jetties, shorelines of 1821, 1836, 1840, 1844, and 1853-1869 are indicated. If the 1821 shoreline represents the edge of high ground, a narrow band of low riverbank probably separated it from the Chicago River, as indicated on Fig. 2. However, this low ground is not shown in Fig. 6.

It is evident that by 1853 there had been substantial retreat of almost the entire shoreline downdrift of the jetties. In that year, or in 1852, railroad track was laid south of the Chicago River along a right-of-way granted in 1852 (Hart, 1853). This grant required that the railroad construct a breakwater to protect the eroding shoreline south of the Chicago River (Brownson, 1915, p. 55). Track was laid on a trestle in shallow water, the trestle being protected by a shore-parallel breakwater. The natural shoreline, which had advanced to Michigan Avenue, was thus made part of a lagoon, and erosion in this area was halted, although it is likely that such relief was at the expense of areas downdrift of the breakwater's termination.

As at Grand River, Ohio, the zone of erosion downdrift of the harbor jetties apparently extended well beyond the downdrift limits of the surveyed area. Near the survey's limits, at Twelfth Street, the 1853-1869 shoreline is 77 m (235 ft.) landward from the 1821 shoreline, and 99 m (300 ft.) inland from the 1836 shore.

The survey of 1844 is the last record of the natural shoreline in the area between the Chicago River and Madison Street. This area became the site for landfill, on which the railroad yards were later constructed.

In 1871, Col. D. C. Houston compared the erosion problem at Chicago to that occurring at Minnesota Point, Duluth-Superior, on Lake Superior, noting that:

> "at Chicago and vicinity, where the lake drift caused by northeasterly storms is southward, that when a pier is built out into the lake and the drift arrested, the shore to the south is cut away, and works of some kind are necessary to protect it. Large amounts of money have been expended in such protections on the lake front of Chicago, south of the harbor." (Newton, 1872).

Discussion

Figures 1-6 depict situations in which harbor piers acted as littoral barriers, causing accretion along the updrift shoreline, recession along the downdrift shoreline, and deposition on the lake bottom near the piers' entrance. Unfortunately, with the possible exception of Fig. 5, these surveys do not extend far enough downdrift to enable one to determine the limits of the zone of shoreline recession. Fig. 6 suggests that this zone is very large.

The surveys demonstrate that there is a progressive reduction in the rate of advance of the shoreline updrift of newly constructed piers. Graham (1858a) noted this trend in suggesting that:

> "in proportion as the general direction of this new shore line approaches to a coincidence with the direction or thread of this littoral current, the increase is much less rapid, nearly in the inverse ratio of the elapsed time." (p. 1104).

The advance of the shoreline into the lake presumably allows a progressively larger portion of the littoral drift to migrate past the piers. It is also conceivable that the rate of the shoreline advance is slowed due to the geometry of the area of accretion, in which the accretion takes place along the hypotenuse of similar triangles, so that the available drift material must be distributed over an ever larger area. One must be cautious, however, in considering relationships between the length of the piers and the rate of change of successive shorelines shown on these maps, since the piers were built in stages. The piers shown were usually more extensive than the initial piers which first impeded the littoral drift at each site.

Lake level changes cannot account for rapid local variations of either the rate or direction of shoreline change shown on these maps. Records show that the shoreline in the areas updrift of the piers advanced at the same time that downdrift shores retreated. The map of Grand River harbor (Fig. 1), records the shoreline in 1826, 1833, 1839, 1844, 1853, and 1854, periods of both rising and falling lake levels (Williams and others, 1838; Whipple, 1859?; Henry and Lamson, 1861), yet it shows progressive accretion updrift of the harbor piers, and progressive erosion over most of the area downdrift of the piers.

Some of the surveys show little shoreline change, or even slight accretion, along the shoreline immediately downdrift of the downdrift pier (Kearney and others, 1839; and Figs. 1, 4, 5, and 6). When present, these accretions are smaller than those occurring updrift of the piers, and are succeeded downdrift by an extensive area of erosion. The piers apparently cause a local reversal of the littoral drift along a small part of the downdrift shoreline (Sato and Irie, 1970; Johnson and Eagleson, 1966), thus causing the minor accretion along the piers' downdrift flank.

These surveys provide a guage of the effects of an isolated littoral barrier on an otherwise natural shoreline. Today, various groins, seawalls, rubble mounds, and revetments line large sections of the shore, and make it difficult to evaluate the effects of a single structure. The individual or cumulative effect of the proliferation of modern structures may interfere with the normal littoral drift, and thus mask or reinforce the effect of any particular structure under consideration. In the early case histories just discussed, there are few, if any, smaller structures to complicate the interpretation.

Conclusions

In the 1830's, survey on the Great Lakes began to document the problems caused by littoral drift at shoreline harbor works. Most of these surveys were performed by the United States Army Topographical Engineers. The surveys found a recurring pattern of beach accretion along the shoreline that was updrift of the harbor piers, sediment deposition on the lake bottom near the harbor entrance, and beach erosion and shoreline retreat along the downdrift shoreline, problems that began to receive a great deal of attention half a century later (Vernon-Harcourt, 1882; Spring, 1913-1914), and which have continued to plague breakwater and pier construction to the present.

Acknowledgments

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References Cited

Abert, J. J. 1846. Report of the Secretary of War, in answer to a resolution of the Senate, calling for a statement of appropriations for construction and repair of roads, fortifications, and harbors, and for the improvement of rivers. Bureau Corps of Topographical Engineers, House Reports v.4, n.741, 30th Cong., 1st Sess., 1847-1848, Serial-527, pp. 283-305.

Alden, W. C. 1902. Chicago Folio, No. 81, Geol. Atlas of the U.S. U.S. Geol. Survey. Washington, D.C. 14 pp.

Anonymous. n.d. Chicago Harbor Auxiliary Map A32. Collection of the Chicago District, U.S. Army Corps of Eng. Also Map A74, same source.

Brown, T. S. 1837. Documents accompanying the report of the Chief Engineer—B. Senate Docs. v.1, n.1, 25th Cong., 2nd Sess., 1837-1838, Serial 314, p. 319-325.

Brownson, H. G. 1915. History of the Illinois Central Railroad. University of Illinois Studies in the Social Sciences, v.4, nos. 3-4, 182 pp.

Claussen, M. P., and Friis, H. R. 1941. Descriptive Catalogue of Maps published by Congress 1817-1843. Washington, D.C., 104 pp.

Cram, T. J. 1839. Report on harbor improvements on Lake Michigan, by Captain T. J. Cram, Captain Topographical Engineers, *in* Report from The Secretary of War, transmitting copies of reports of the Topographical Bureau in relation to internal improvements in the Territory of Wisconsin, in obediance to a resolution of the Senate of the 15th instant, January 31, 1840. Senate Docs., v.4, n.140 26th Cong., 1st Sess., 1839-1840. Serial 357, pp. 16-21.

Eaton, J. H. 1828. Letter from the Secretary of War, transmitting a survey and estimate for the improvement of the Harbor of Chicago on Lake Michigan. House Docs. v.3, n.69, 21st Cong., 1st Sess., 1829-1830, Serial 197, 3 pp.

Graham, J. D. 1856. Map G. No. 44 Chicago Harbor & Bar Illinois. From survey made 11-14 Nov., 1856. Nat'l. Archives Collection, Washington, D.C. Scale 1:2400.

——— 1857. Map G. No. 52 Chicago Harbor & Bar Illinois. From survey made in April, 1857. Senate Doc. No. 1, House Doc. No. 2, 35th Cong., 2nd Sess., 1858-1859, Serial 978, scale 1:2400.

——— 1858a. Lieutenant Colonel J. D. Graham's report (No. 230) on the Lake harbor works under his direction, for the year 1858. Office, General Superintendence of Lake Harbor works, Chicago. Senate Ex. Docs. v.3, n.1, 35th Cong., 2nd Sess., 1858-1859, Serial 976, pp. 1099-1192.

——— 1858b. Map G. No. 58, Chicago Harbor & Bar, Illinois, from survey made between the 7th of August and the 2nd of September 1858. Senate Ex. Docs. v.4, 36th Cong., 1st Sess., 1859-1860, Serial 1026. Scale 1:2400.

Hart, H. 1853. City of Chicago, Cook Co., Illinois. Chicago Hist. Soc. Collection. Scale 1:4800.

Henry, D. F., and Lamson, A. C. 1861. Table #3, Profile of the Curves of the Annual Oscillations in the Five Great Lakes and Detroit River, for the Years, from 1851 to 1861, compiled from data in the office of the Survey of the North and North West Lakes under the direction of Captain George G. Meade. Senate Ex. Docs., v.3, n.1, 36th Cong., 2nd Sess., 1860-1861, Serial 1081.

Houston, D. C. 1871. Official letter, quoted in W. H. Newton, Report of W. H. Newton, C.E., to the Governor of Wisconsin for Special Survey of Superior Harbor, November 22, 1872. Madison, Wis. 29 pp.

Johnson, J. W. 1957. The littoral drift problem at shoreline harbors. Journal of the Waterways and Harbors Division, American Society of Civil Engineers, v.83, n.WW1, paper 1211, 37 pp.

———, and Eagleson, P. S. 1966, Coastal Processes, *in* Ippen, A. T., ed., Estuary and Coastline Hydrodynamics. New York, McGraw-Hill, pp. 404-492.

Kearney, J., Smith, H., and Bowes, J. R. 1838. Message from the President of the United States, showing the operations of the Topographical Bureau during the year 1839; Appendix D, Report of the Board of Inspection of Lake Harbors, Detroit, July, 1839. Senate Docs. v.1, n.58, 26th Cong., 1st Sess., 1839-1840, Serial 355, pp. 146-271.

King, C. A. M. 1972. Beaches and Coasts (second edition). London, Edward Arnold, 570 pp.

Pettes, W. H. 1854. Map of the Buffalo Harbor, N.Y., Topographical Bureau: labelled Senate Ex. Doc. n.1, 2nd Sess., 33rd Cong.; bound in House Docs. v.1, pt.3, 33rd Cong., 2nd Sess., 1854-1855, Serial 779, and in Senate Ex. Docs. v.3, 33rd Cong., 2nd Sess., 1854-1855, Serial 748, scale 1:3600.

Potter, J. 1854a. Grand River Harbor, Ohio. House Ex. Doc. No. 1, 2nd Sess., 33rd Cong., scale 1:4800.

1854b. Ashtabula Harbor, Ohio. Senate Ex. Doc. n.1, 2nd Sess., 33rd Cong., scale 1:2400.

1854c. Conneaut Harbor, Ohio. Senate Ex. Doc. n.1, 2nd Sess., 33rd Cong., scale 1:4800.

The above three maps made under auspices of Office General Superintendent of Public Works, Cleveland. Howard Stansbury, Capt. Top'l Engrs. in Senate Ex. Docs. v.3, 33rd Cong., 2nd Sess. 1854-1855, Serial 748. (b) and (c) are also in House Ex. Doc. v.1, pt.3, 33rd Cong., 2nd Sess., Serial 779, In the latter volume, (a) has been slightly altered, see Potter, 1854d.

———. 1854d. Grand River Harbor, Ohio. Senate Ex. Doc. n.1, 2nd Sess., 33rd Cong., in House Ex. Doc. v.1, pt.3, 33rd Cong., 2nd Sess., Serial 779, scale 1:4800.

Raymond, B. W., and others. 1840. Petition of the Mayor and Common Council of the City of Chicago, praying an appropriation to protect that city from the encroachments of Lake Michigan. Senate Docs., v.4, n.195, 26th Cong., 1st Sess., 1839-1840, Serial 357, 4 pp. with map, approx. scale 1:4800.

Reynolds, W. F. 1865. The main part of the harbor of Chicago, Ill., Surveyed July-Sept., 1865. Colln. Chi. Distr., U.S. Army Corps Engrs. Scale 1:3600.

Rosenbaum, J. G. 1976. Shoreline structures as a cause of shoreline erosion: a review, *in* Tank, R. W., ed., Focus on Environmental Geology: a collection of case histories and readings from original sources (second edition). New York, Oxford University Press, pp. 166-179.

Sato, S., and Irie, I. 1970. Variation of topography of sea-bed caused by the construction of breakwaters. Proceedings of the Twelfth Coastal Engineering Conference, American Society of Civil Engineers, pp. 1301-1319.

Spring, F. J. E. 1913. Coastal Sand-travel near Madras harbour. Minutes Proceedings Institution of Civil Engineers, v.194, 1914, pp. 153-246.

Stockton, T. B. W. 1838. Report from the Secretary of War, in compliance with a resolution of the Senate of the 14th instant, transmitting a copy of the survey of the harbor of City West. Senate Docs., v.3, n.225, 25th Cong., 2nd Sess., 1837-1838, Serial 316, 3 pp.

Vernon-Harcoart, L. F. 1881-1882. Harbors and estuaries on sandy coasts. Minutes Proceedings Institution of Civil Engineers, v.70, 1881-1882, pp. 1-32.

Wheeler, J. B. 1869. Chicago Harbor and Bar, Illinois, from survey 20 July-30 Aug., 1869. Colln. Chi. Distr., U.S. Army Corps of Engrs. Scale 1:4800.

Whipple, A. 1859? Chart A, chart of annual oscillations of lake surface. Senate Ex. Doc. n.2, 36th Cong., 1st Sess., bound in Senate Ex. Docs. v.4, 36th Cong., 1st Sess., 1859-1860, Serial 1026.

Williams, W. G., and others. 1838. Harbor Improvements on Lake Erie, *in* Documents accompanying the Report of the Topographical Engineer. Senate Docs. v.1, n.1, 25th Cong., 3rd Sess., 1838-1839, Serial 338, pp. 373-395. Includes four maps; two Presqu'ile harbor, one each of Dunkirk and Cataraugus harbors.

———. 1839. Appendix B: Annual report of Captain W. G. Williams, U.S. Topographical Engineer and General Superintendent of Harbor Improvements, on the southeast shore of Lake Erie. Submitted September 30, 1839, *in* Message from the President of the United States showing the operations of the topographical Bureau during the year 1839. Sen. Doc. v.1, n.58, 26th Cong., 1st Sess., 1839-1840, Serial 355, pp. 107-139.

CHEMISTRY AT THE UNIVERSITY OF WISCONSIN, 1848-1980

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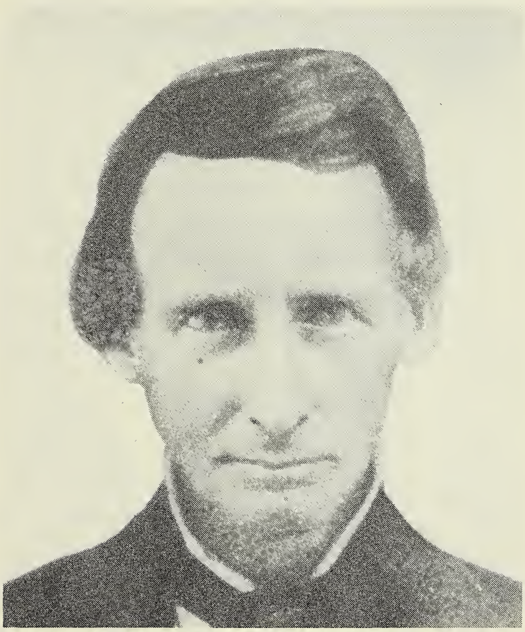
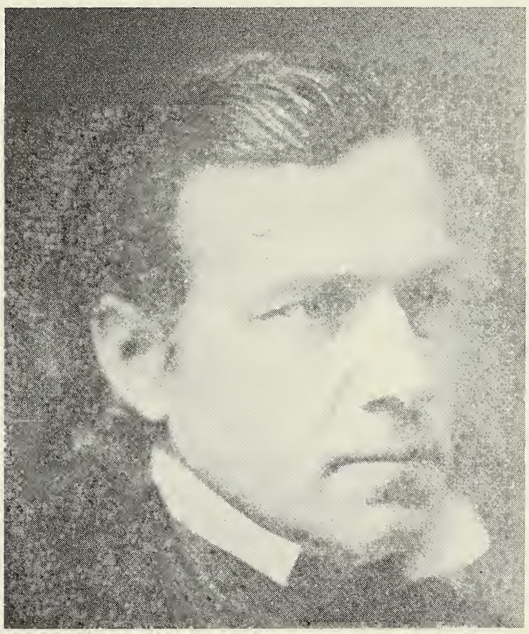
Despite the enthusiasm of proponents for the new university created when Wisconsin became a state in 1848, the fledgling institution got off to an inauspicious start. It appeared improbable, during its first quarter-century, that a hundred years later it would rank among the top dozen universities in the country, with strong faculties in more than a score of academic fields, including chemistry, biochemistry, and chemical engineering.[1] When Professor John Sterling met 17 students for the first preparatory class on February 5, 1849, chemistry was not even a part of the curriculum. It was not until May, 1854, that S. P. Lathrop joined the faculty in time to teach chemistry to the two students who soon became the first graduates of the university.[2]

During the next 25 years chemistry had little prominence in the curriculum. The professor of chemistry was also professor of natural history, or of agriculture. Lathrop, the first professor, died before the end of 1854. His successor, Ezra S. Carr, did not appear in Madison until January, 1856. While some of the students found him a worthy teacher, he expended much energy on campus politics and resigned in 1867, just prior to being discharged. His professorship of chemistry and natural history went to a recent graduate of Lawrence University and the Chicago Medical College, John Da-



S. Pearl Lathrop (1816-1854)
Prof. of Chemistry and Natural History, 1854



Ezra S. Carr (1819-1894)
Prof. of Chemistry and Natural History, 1856-1868

vies, the third occupant of the chemistry chair to come out of the medical profession.[3]

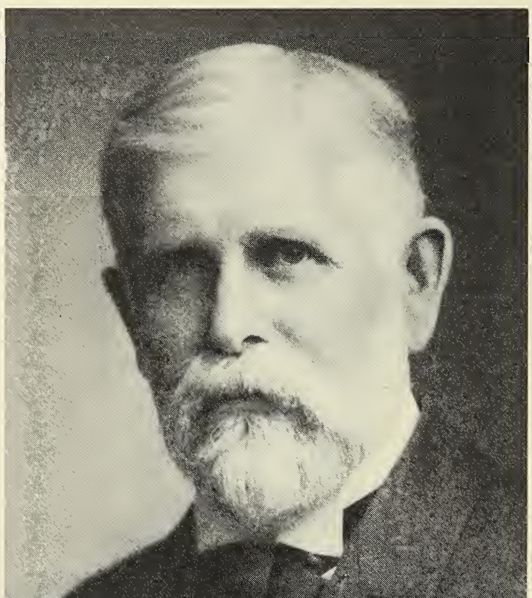
The coming of Davies was coincident with the beginning of better days for the university. It had barely survived its first decade because of financial problems. The second decade was hardly better since the Civil War decimated enrollments, causing further problems which were only partially resolved by admission of women to the normal department, set up for the training of schoolteachers.

The post-war years, however, were good ones for higher education in America. Passage of the Morrill Act provided land grants by which the federal government encouraged the states to establish colleges of agriculture and mechanic arts. Wisconsin did not follow the paths of Ohio, Indiana, Michigan, Iowa, California, and other states who set aside their land grants for state colleges of agriculture and engineering. Instead, the Wisconsin legislature, in spite of considerable opposition, assigned its land grant to the existing university. While this may have delayed the growth of a viable agricultural college, it injected strength into the existing university without preventing the ultimate development of a leading agricultural program.[4]

In line with the mandate to provide instruction in agriculture, the university brought W. W. Daniells to the campus in early 1868 as the first professor of agriculture. A graduate of the Michigan Agricultural College (present Michigan State U), he had just spent a year in Harvard's Lawrence Scientific School studying chemistry with O. Wolcott Gibbs. Since Wisconsin farm boys stayed away from the new agricultural department in droves, Daniells' principal activity was teaching chemistry and managing the college farm. During his first year in Madison his title became Professor of Agriculture and Analytical Chemistry. Even in his first term he taught chemical analysis to a single student, using a carpenter's bench in the basement of University Hall (Bascom) as a work table.[5]

During the next decade Davies' work focused more and more on physics and astronomy while Daniells took over great responsibility for chemistry. The agricultural program was a disappointment, whether because of or in spite of Daniells is unclear. At any rate, 'book larnin' was unpopular with Wisconsin farmers and their sons stayed home or enrolled in other courses. Meanwhile Daniells became disenchanted with management of the university farm, which was expected to show a profit. In 1880 when the chemistry program was given departmental status with Daniells as its first chairman and sole professor, he was happy to turn the agricultural program over to William Henry, the new botany professor.

The university had reached the point where professors were expected to be specialists in a single discipline. Davies had already abandoned chemistry and was now the chairman



W. W. Daniells (1840-1911)
Prof. of Agriculture and Chemistry, 1868-1880
Prof. of Chemistry and Chairman, 1880-1907

of the physics department. In addition, Roland Irving was professor of geology, Edward Holden of astronomy, William Henry of botany (and agriculture), E. A. Birge of zoology, and Sterling of mathematics.

The eighties was a decade of rapid growth in enrollment and faculty size. It was during this decade that Thomas Chrowder Chamberlin took over the presidency from John Bascom. Since 1874 Bascom had directed the growth of the university and overseen the separation of clustered disciplines into departments and the expansion of these departments. He had engaged in a renewed building program which included a Science Hall and an Observatory outfitted with an excellent 15-inch refractor. An engineering program had been stabilized, a pharmacy course initiated under the guidance of the talented plant chemist, Frederick Power, and agriculture given an investigatory mission even though there were no students. Scholarly investigation had begun to emerge, most notably in the work of historian William F. Allen and geologist Roland Irving.[6]

Chamberlin continued the momentum generated under Bascom. A leading American geologist who had been prominently associated with the Wisconsin Geological Survey, Chamberlin recognized those moves which were essential to change the parochial image which had characterized the university in the past. Henry was encouraged to build the agriculture department into an activity having interest to Wisconsin's farmers. A short course was opened during the winter months when farm work was minimal. If farm boys would not enter the university for a complete education, they might at least spend the winter in Madison gaining knowledge of new ideas in farm practice. The experiment was a success. A few years later, after S. M. Babcock perfected the famous test for butterfat in milk, a short course for cheesemakers was created.[7]

Perhaps most important in the Chamberlin presidency was the evolution of a serious graduate program under the direction of astronomer George Comstock. Masters degrees had been granted from 1856 but they, like masters degrees granted by many American colleges in the nineteenth century, were more nearly representative of good behavior for a few years following receipt of the baccalaureate degree, than of a serious intellectual input. In 1874, during Bascom's presidency, the first M.S. degrees in course, were granted. The graduate program escalated during the Chamberlin period with the first Ph.D. being granted in 1892 for studies in geology. The recipient was Richard Van Hise, who stayed as Professor of Geology and in 1903 became the University's eighth president. Van Hise, following receipt of his B.S. in 1879, had served Daniells as an assistant in chemistry.[8]

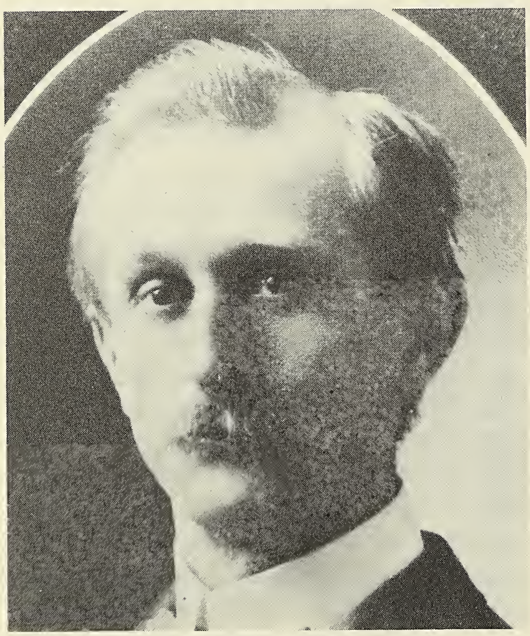
Chamberlin left Madison in 1892 to become a professor of geology at Chicago where Rockefeller money had just created a vigorous university with a strong faculty attracted from less affluent institutions. The new president, Charles Kendall Adams, was a man of repute in educational circles who, despite poor health, continued the momentum established under Bascom and Chamberlin.

The chemistry department continued the growth that had started under Bascom and Chamberlin. Daniells, while not a brilliant chemist or teacher, was nevertheless a conscientious, hardworking professor who was not afraid to hire faculty members whose qualifications exceeded his own. Homer Hillyer came in 1885, fresh from a Ph.D. under Ira Remsen at Johns Hopkins. He took over and expanded the work in organic chemistry. Although he never became a leader in this field, he developed a modest research program and served as advisor for those chemistry majors doing work toward senior and masters' theses.[9] Among these students was a second generation German-American from Two Rivers, Louis Kahlenberg.

In 1892, following completion of his B.S., Kahlenberg was made a fellow in chemistry while he completed work for his master's degree under Hillyer. At that point, he became an instructor in the department.

During this period Kahlenberg was hearing about the work in the new area of physical chemistry which was developing in Germany. He resigned his instructorship in 1894 and embarked for Leipzig to study under Wilhelm Ostwald, the recognized master of the new discipline. His Ph.D. was granted, *summa cum laude,* in 1895. Kahlenberg headed back to America, enthusiastic about the new physical chemistry being created by Arrhenius, van't Hoff, and Ostwald.

Upon arrival in Madison Kahlenberg learned that the chemistry department had hired Arthur P. Saunders, a recent Ph.D. from Johns Hopkins. There was no room for another man on the staff. Thereupon, Kahlenberg called upon Edward Kremers, director of the pharmacy program, who hired him as instructor of pharmaceutical technique



Louis Kahlenberg (1870-1941)
U.W. Chemistry Faculty, 1896-1940
Chairman, 1907-1919

and physical chemistry. Thus, physical chemistry had its origins at Wisconsin in the school of pharmacy, not in the department of chemistry. The absurdity of the situation was rectified a year later when Saunders resigned to take a *Wanderjahre* in Germany and Kahlenberg was appointed instructor in physical chemistry.[10]

Immediately after returning to Wisconsin Kahlenberg initiated a research program in chemistry of solutions. He was soon joined by a few undergraduates and graduate students. The first Ph.D. in chemistry was conferred upon Azariah T. Lincoln in 1899 for research on solutions done under Kahlenberg's direction, the second, in 1901, on Kahlenberg's boyhood friend, Herman Schlundt. Both of these men went on the respected careers as academic chemists, Lincoln as chairman of the chemistry department for many years at Carleton College, Schlundt holding a similar position at the University of Missouri.[11]

From the early years of the twentieth century, the chemistry department began to acquire visibility, not only in the university but on the national chemical scene. This was coincident with a vigorous period of development under President Van Hise (1903-1918) when the university acquired a unique image in the educational world. Van Hise had entered the presidency as a respected leader in stratigraphic geology. He knew, from his involvement in the development of mineral deposits, the potential for successful interplay between academicians and those in practical endeavors. During his presidency that potential was exploited, particularly in the interface between education and government, in the form of what became known as The Wisconsin Idea. Van Hise believed that "The boundaries of the University are the boundaries of the State."[12]

The circumstances were propitious since Robert M. LaFollette had been elected Governor in 1900. He and the university developed a symbiotic relationship whereby university professors were used as advisors in developing those governmental innovations which came to be known as the Progressive Movement. At the same time, the university found at the Capitol end of State Street a more sympathetic attitude than during its first half century.

During the period between 1900 and the end of World War I the chemistry department grew rapidly, not only in enrollment in courses and size of faculty, but in national recognition. While only a handful of graduate students were enrolled in 1900, there were 42 in 1920. Some of this increase is attributable to the post-war enthusiasm for chemistry in all graduate schools, but even before the war there had been a steady growth in the number of students who selected Wisconsin for graduate study in chemistry.[13]

Victor Lenher was added to the chemistry staff in 1900, very largely to strengthen the program in analytical and inorganic chemistry. He had taken a Ph.D. with Edgar Fahs Smith at Pennsylvania in 1898. Lenher initiated a research program in the chemistry of the lesser-known elements and, at the time of his death in 1927, probably from toxic metal poisoning, he was widely recognized for his work on selenium and tellurium.[14]

Hillyer, who was pushed out of the department in 1905, joined the National Chemical Co.; he was replaced by a promising young organic chemist, Frederick Koelker, who had just completed his Ph.D. with Emil Fischer in Berlin. Koelker's career was short-lived; he entered a mental institution in 1909 and died two years later. Responsibilities for organic chemistry were taken over by Richard Fischer, a member of the pharmacy faculty, when Koelker became ill. Fischer had, following degrees in pharmacy and chemistry at Michigan, been an instructor in pharmacy at Wisconsin. In 1898 he started graduate work in Germany, spending a term with Emil Fischer in Berlin, then migrating to Marburg where he completed the Ph.D. under Ernst Schmidt, authority on alkaloids, in 1900. He immediately returned to Wisconsin as assistant professor of pharmacy and in 1903, took on the added duties of State Chemist, responsible for enforcement of the dairy and food laws. Soon after taking over Koelker's courses he was made a permanent member of the chemistry department.[15]

When Daniells approached retirement in 1907, Kahlenberg was the obvious choice for chairman. His teaching style had given him an awed, but admiring, following. His research had gained him international, albeit contentious, attention. Although he had returned to America with great enthusiasm for the new theory of solutions, as had other American boys who studied in Ostwald's laboratory, Kahlenberg's research program at Wisconsin soon recognized shortcomings in the official dogma of ionization theory. Studies on nonaqueous solvents, as well as work on concentrated solutions, convinced Kahlenberg that supporters of the theories of Arrhenius and van't Hoff were extending the power of those theories beyond the dictates of good sense. Never one to retire from an area of contention, Kahlenberg opened a lifelong attack on the theory of ionization. This earned him the enmity of most physical chemists but there is evidence that he gloried in their disapproval. At any rate, it did not deter his superiors from appointing him to the departmental chairmanship. He entered into the work with enthusiasm. Staff expansion was quickly made and the department created the Chemistry Course.[16]

James H. Walton, with a doctorate under Georg Bredig in Heidelberg, was brought into the faculty in 1907, in part to spread the responsibility for the growing freshman chemistry instruction, in part to introduce a new dimension into the research program. At about the same time Francis Krauskopf, still a graduate student at Cornell, was brought in to help with the freshman program. Upon the strong recommendation of Cornell's Wilder D. Bancroft, under whom Krauskopf was studying, he was invited to take an instructorship at Wisconsin. There he completed his Ph.D. under Kahlenberg and became a permanent member of the faculty. During their first decade at Wisconsin he and Walton played a very secondary role to Kahlenberg in the freshman chemistry program but after the post-war reorganization they took over full responsibility for all general chemistry students except the engineers. Despite a marked difference in personality, they complemented each other and made an effective team. Walton was an austere New Englander of forbidding physical physique who disliked detail, but had a compulsive drive to make policy; Krauskopf was a gentle soul with enormous patience for detail, but an intolerance for fools and the irresponsible. Both were talented teachers who, for four decades, orchestrated the evergrowing service course with remarkable effectiveness. Each pursued a modest research program, but their real forte was in the classroom. They died within six months of one another, a year short of retirement, in 1947.[17]

Except for a few instructors whose association with the department was transient, the pre-war faculty was completed with the return of J. Howard Mathews and the advancement of H. A. Schuette. Both had been undergraduates in the department. After Mathews finished his M.S. under Kahlenberg he continued his graduate studies under T. W. Richards at Harvard. Richards had an international reputation as a result of his accurate work on atomic weights and, in 1914, became the first American Nobel laureate in chemistry. In 1908, upon completion of his Ph.D., Mathews joined the Wisconsin faculty. Schuette, a bit younger, completed his B.S. in 1910 and stayed on for graduate work with Professor Fischer. In 1914, two years before completing his doctorate, he took over Fischer's courses in food analysis and developed that area during the remainder of his career.

The pre-war faculty represented a diversity of fields and presented a program of broad appeal. Graduate students were attracted from a wide geographic base and by 1910 several Ph.D.'s were being awarded annually. Still, all was not harmonious. Kahlenberg monopolized the graduate students and his autocratic behavior as chairman led to factionalism in the department. His effectiveness was further jeopardized by the manner in which he was becoming isolated from the mainstream of American chemistry because of his opposition to ions. Nevertheless he had the firm support of President Van Hise; the chemistry department was looked upon favorably by the university community.[18]

During the war years the strains within the department were exacerbated. Wisconsin, with a large German ethnic population, was suspect with regard to loyalty to the American cause. Senator La Follette, because of his questioning of President Wilson's policies, which he considered likely to involve the United States in war, was receiving severe criticism around the country and in his own state.[19] Extreme polarization took place, even in the university community. Kahlenberg, never one to hide his views, spoke out in opposition to the direction the country appeared to be taking. Although there is no sound evidence to question his loyalty, Kahlenberg was vigorously denounced. The department's other professors with German doctorates showed opposing reactions: mild-mannered Richard Fischer made no statements, but, since he failed to sign the faculty round robin denouncing Senator La Follette, he was suspect; James Walton quickly offered his expertise to the government for research on chemical warfare and his loyalty was never questioned.[20]

Once the United States became a belligerent, the university's program went on a wartime basis. Many male students enlisted or were drafted. Military training programs appeared on campus. As faculty members left to become involved in wartime projects, the teaching loads of those remaining behind became heavier. The chemistry department lost the services of Lenher, Walton, Mathews, and instructor Carleton. There was suspicion about the Americanism of those remaining behind to teach the classes: Kahlenberg, Fischer, Krauskopf, and Schuette.

Even before the war ended, a Palace Revolt was generating. President Van Hise was sent notice by Harold Bradley, professor of physiological chemistry in the medical school and a chemical warfare service volunteer, that the Wisconsin chemistry faculty in service would probably not return if Kahlenberg remained chairman. Van Hise never received the letter since he died the day it was written; Dean Birge, as Acting President, took action. Birge had always been cool toward Kahlenberg and, as early as 1900, had brought Lenher into the department as a counterbalance. Van Hise, who respected Kahlenberg as a chemist, had also begun to have reservations in his last years. At any rate, Birge sought and found support from other campus scientists; Kahlenberg received the axe. He was permitted to retain his professorship, but lost his chairmanship and the physical chemistry course he prized. He remained a popular teacher of freshman engineers for another twenty years, but found himself without influence in the department and remained outside the mainstream of American chemistry as a consequence of his opposition to ions.[21]

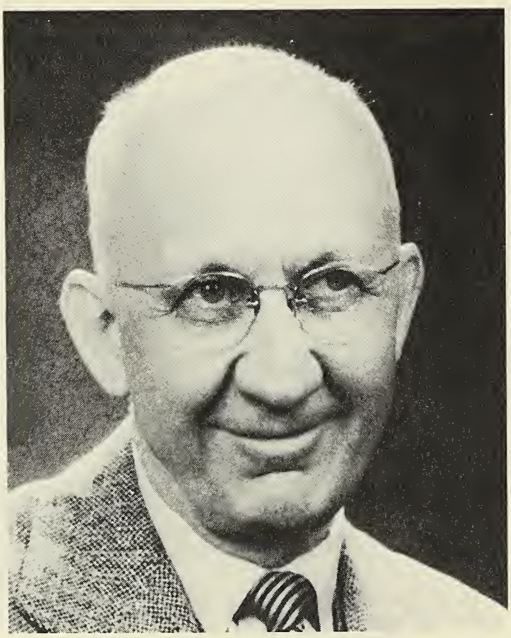
As the university prepared itself for vigorous post-war activity the problem of the chairmanship of the chemistry department was resolved, although not without considerable internal strain even if that strain was not obvious to the general public. Of the rebel faction, Lenher was the one member with a national reputation and he coveted the chairmanship. However, his popularity in the department, and even in the camp of the rebels, was insufficient to bring about his selection. The strategy of the dissident group, therefore, became one of attacking Fischer's failure to have developed an organic research program of broad visibility. Birge was informed that organic chemistry would be particularly attractive in post-war America, where the country would wish to attain international leadership in its chemical industry. Therefore it would be desirable to bring in a widely recognized organic chemist who might bring luster to that division of chemistry and, at the same time, take over the chairmanship. Marston T. Bogert of Columbia was suggested.

Discreet inquiries were made in the East about Bogert. The reports were not favorable and the suggestion was not pursued. It became obvious that a chairman must be selected, at least for the present, from the inner circle. The choice fell on J. Howard Mathews, the youngest of the returning rebels, who took office in summer, 1919. The

J. Howard Mathews (1881-1970)
U.W. Chemistry Faculty, 1908-1952
Chairman, 1919-1952

choice proved to be a fortunate one, and Mathews retained the chairmanship up to the time of his retirement 33 years later.

Mathews quickly demonstrated a flair for administration. Deeply devoted to the success of the chemistry department, he worked untiringly for its welfare. The momentum the department had gained during the Kahlenberg chairmanship was given an additional thrust early in the Mathews period. Of particular significance was the fact that Mathews, in contrast to Kahlenberg who sought greatest visibility for himself, was not afraid to surround himself with chemists who were better scientists than himself. Mathews was an excellent judge of men and repeatedly succeeded in bringing promising young men into the faculty. He was prone to provide all possible support for development of their programs as soon as he was convinced they understood their objectives. At the same time, he never hesitated to terminate a man whose performance failed to measure up to expectations. He was not loved by his faculty, but he was deeply respected.[22]



Homer Adkins (1892-1949)
U.W. Chemistry Faculty, 1919-1949

During Mathews' very first year, the organic program was stimulated by the hiring of Homer Adkins, a recent Ph.D. from Ohio State. Adkins proved to be a hard-driving investigator who quickly became a natural leader in the department. His research soon attracted national attention and, well before his untimely death in 1949, he was ranked alongside Roger Adams, Frank Whitmore, and James B. Conant as an American leader in organic chemistry.[23]

In 1923, S. M. McElvain completed his Ph.D. under Roger Adams at Illinois and joined the organic group at Wisconsin. McElvain also proved to be a blue ribbon selection whose research quickly gained visibility.[24] Graduate students of high quality were soon coming in large numbers to study under Adkins or McElvain. Both were challenging teachers of advanced material and both were effective guides of graduate students.

Richard Fischer, although overshadowed by his younger colleagues, still held an important role in the department where he and one of his last graduate students, Michael Klein, carried the major responsibility for the undergraduate organic courses. Enrollment in these courses increased rapidly during the twenties, partly because of the increasing numbers of chemistry majors and partially because of the importance of elementary organic chemistry as a service course for students headed for medicine, pharmacy, engineering, and agriculture. Had Fischer and Klein not had a deep interest in elementary students, coupled with only a casual interest in research, the research programs of Adkins and McElvain might not have developed as smoothly.[25]

Mathews also took initiative in improving the physical chemistry program. Farrington Daniels, a 1914 Ph.D. with T. W. Richards, left the U.S. Nitrogen Fixation Laboratory in 1920 to join the department at Wisconsin. He quickly made his mark on both instructional and research programs. Daniels' suggestions for improvements in the textbook used in the physical chemistry course led its author, Frederick Getman of Mount Holyoke College, to invite him to become a coauthor. Daniels soon became a major author and the book became the standard textbook in American colleges for three decades. He also authored a text on mathematical preparation for physical chemistry and led a team of Wisconsin physical chemists in writing a laboratory manual which became widely used throughout the country.

Daniels continued research begun at the Nitrogen Fixation Laboratory and became a leading authority on the properties and reactions of oxides of nitrogen. These studies ultimately diverged, as Daniels became deeply interested in chemical kinetics on one hand and large scale nitrogen fixation on the other. Around 1940 he became involved in the direct combination of nitrogen and oxygen in a gas-fired, regenerative furnace. Although the process was developed through the pilot plant stage, it never quite became competitive with the Haber process. Daniels also contributed extensively in the field of photochemistry during these early years.[26]

Chairman Mathews was always active in developing promising new areas of chemistry. In 1923 he brought The Svedberg from Uppsala in order to focus attention on the field of colloid chemistry. Svedberg, with the assistance of a group of graduate students, built and tested a new device, an optical centrifuge, which served as a precursor of the ultracentrifuge designed and built at the University of Uppsala upon his return.

The Svedberg visit produced several developments at Wisconsin. Most immediate was Mathews' organization of a National Colloid Symposium, which brought together most American chemists interested in colloid chemistry at a summertime conference in Madison. The Colloid Symposium became an annual affair, with every tenth meeting returning to Madison. Mathews' dream of a National Colloid Institute to be housed on the campus in Madison failed to receive funding with the onset of the Depression and had to be abandoned.

He was more successful in creating an ongoing program in colloid chemistry within the department, however. After John W. Williams completed his Ph.D. under Daniels in 1925, he was brought into the faculty and encouraged to pursue studies in colloid chemistry.[27] In the late thirties, the program received a significant stimulus when a Svedberg ultracentrifuge was given to the department. This became the focal point for studies of sedimentation characteristics of complex systems such as proteins.

Instrumentation also received attention in the analytical division. Mathews, like his mentor T. W. Richards, had a compulsive interest in instruments. He was a talented photographer and was at his best in the classroom when he was describing instruments for studying chemical phenomena. He recognized earlier than most of his peers the power which instruments might have for the unravelling of chemical problems. When an addition to the Chemistry Building was completed in 1929, it contained a sizeable instrumental laboratory which soon contained the most recent spectrographs, colorimeters, pH meters, and polarographs. The laboratory was placed under the direction of Villiers W. Meloche, who was retained on the faculty after completion of his Ph.D. under Lenher in 1925.[28] The Instrumental Laboratory served not only as a teaching laboratory for instrumental analysis, but as a service laboratory for research within the department and in laboratories in other parts of the university. The chemistry department was well known around the campus for its willingness to provide assistance to others involved in chemical problems.

Although Mathews was not looked upon as a great teacher, he was nevertheless supportive of good teaching in the department and frequently fought with deans and presidents for greater support in getting instructional work done. His success in this direction was no doubt aided by the fact that his superiors in the administration knew that he was tight-fisted with money. He was trustworthy in budget planning, and consequently, administrators were inclined to meet his demands if the money could be found. As a result, he was successful in obtaining appropriations for substantial additions to the Chemistry Building in 1928 and again in 1938. He was also reasonably successful in adding teaching staff when enrollment in service courses became tight. This was true, not only in providing adequate funding for teaching assistants from the corps of graduate students, but in adding instructors, some of whom were later moved up to tenured professorial status. C. Harvey Sorum was retained, after completing his Ph.D. with Krauskopf in 1927, to become a part of the Walton-Krauskopf team.[29] Later the chemistry majors and chemical engineers were split from the general survey courses and Sorum developed a special course for these students. His problem book, his manual for semimicro qualitative analysis, and his textbook became widely used in American institutions. M. L. Holt was similarly retained, upon completion of his doctorate with Kahlenberg in 1930, to work with his mentor in the course for freshman engineers. Holt took over that course upon Kahlenberg's retirement in 1940.[30]

By the end of the twenties the department had expanded and reached a state of apparent stability. The void left in analytical chemistry by Lenher's death in 1927 was widened by the sudden death of George Kemmerer, a Pennsylvania Ph.D. who moved from Carroll College to Wisconsin in 1920.[31] Professor Meloche, who stepped in valiantly to keep the analytical chemistry program going, was finally joined in 1929 by Norris F. Hall, who became the third Richards Ph.D. on the professorial staff.[32]

In summarizing the personnel of the department at the end of the twenties decade, mention must be made of Professor Schuette who had been responsible for organic analysis and food chemistry since 1914. His role in the department always remained somewhat ambiguous, since quantitative organic analysis was hardly accepted in the mainstream of the organic program, and was not looked upon with enthusiasm by the analytical chemists, who were all concerned with the analysis of inorganic substances. Schuette's field, therefore, developed very largely as a separate program which, nevertheless, attracted a strong following among students.[33]

With the onset of the economic depression in the last days of 1929, the chemistry department, along with the rest of the university, entered into a long period of financial stringency. There were no further additions to the faculty after Hall and Holt were brought in until 1937, when John Willard, a Daniels Ph.D. in 1935, was added to the general chemistry group.[34] The enrollment decreases in the early thirties were soon slowed, partially as a consequence of government aid to students. The science departments at Wisconsin were more fortunate than their counterparts elsewhere, because of research grants originating from the Wisconsin Alumni Research Foundation (WARF). Professor Harry Steenbock of the agricultural chemistry department had discovered in 1924 that exposure of food to ultraviolet light led to fortification of the food with vitamin D. Patents on the process were assigned to the newly formed Foundation for management. Income from the arrangement began to be funneled into the Graduate School at the time of the Depression. This enabled the university to retain faculty members who might otherwise have been released. It also enabled science departments to provide fellowships for graduate students and even for students who were unemployed after completing their degrees.[35] Among those benefitted by fellowship aid was Stanford Moore, Ph.D. 1938 under Adkins and agricultural chemist, K. P. Link; Moore's later research at Rockefeller University led to the 1972 Nobel Prize in Chemistry.[36] Link's research on naturally-occurring anticoagulants later led to patents whose income added substantially to the WARF fund.[37]

By the end of the thirties the economy had not fully recovered, but circumstances had improved to the point that the department might undertake projects which had been delayed. The addition to the building in 1939 has been mentioned, as has the hiring of Willard. Joseph Hirschfelder was moved up to an instructorship in 1940. He had taken a double major for the Ph.D. at Princeton in 1936, working in chemistry under Henry Eyring and in physics under Eugene Wigner. After another year at Princeton in the Institute for Advanced Study he came to Wisconsin as a research fellow supported by WARF until 1939 when he was given a faculty appointment. Hirschfelder took leave soon after involvement of the U.S. in World War II and returned after the war as a full professor. At that time he established a Theoretical Chemistry Institute, enabling him to build a unique staff for the study of theoretical problems related to flame propagation, equations of state, and molecular quantum mechanics.[38]

The year 1940 also saw the coming of two promising young organic chemists, A. L. Wilds and William S. Johnson. Wilds had just had a major role in the successful synthesis of equilenin in Werner Bachmann's laboratory at Michigan.[39] Johnson had also worked on steroid chemistry as a graduate student under Louis Fieser at Harvard. Both quickly attracted an enthusiastic group of graduate students as they continued their research on steroids. Johnson left Wisconsin in 1960 to become chairman of the chemistry department at Stanford.[40]

The last faculty additions in the early forties occurred in 1942, when Paul Bender, Aaron Ihde and Edwin Larsen joined the faculty. Bender, who joined the physical group, had just completed his doctorate at Yale under G. Ackerlov. He was a talented instrumentalist and quickly became involved in the expansion of the instrumental holdings and shop facilities. For many years he was chairman of the shop committee.[41] For Larsen and Ihde it was a return to alma mater in order to work with the freshman chemistry program, which had just lost three instructors. Ihde had completed his doctorate in 1941, working in food chemistry under Schuette. Larsen had taken his B.S. at Wisconsin, then gone to Ohio State for a 1942 doctorate under W. C. Fernelius. He became associated with Holt's course for the freshmen engineers and instituted a research program which dealt with the chemistry of the less familiar elements.[42] Ihde became deeply involved with the Walton-Krauskopf team. After the wartime urgencies abated he turned part of his attention to science in the new program of Integrated Liberal Studies and also began the development of his work in the history of chemistry.[43]

The wartime years saw a badly strained department. The program which became known as the Manhattan Project drew off Daniels, Willard and Larsen. Hirschfielder joined the National Defense Research Committee as a consultant on interior ballistics of guns and rockets and as group leader of the geophysics laboratory. He later served with the Naval Ordnance Test Station, and in 1946 was assigned chief phenomenologist for the Bikini atom bomb test. McElvain served as consultant to the NDRC and Adkins was deeply involved in mission oriented research for the Office of Scientific Research and Development which led to 8 restricted reports dealing with chemical warfare agents and defense against them. In addition, his laboratory at Wisconsin investigated the synthesis of antimalarial agents. Wilds also served as an investigator for the NDRC and Williams became deeply involved in government research on blood plasma proteins and blood plasma extenders.

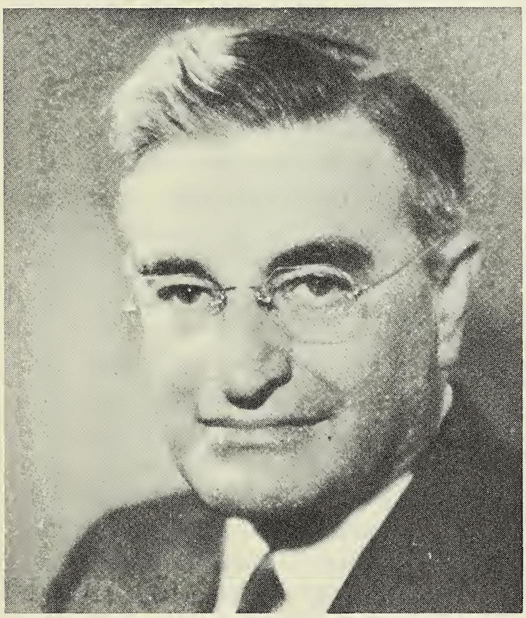
Teaching responsibilities remained heavy during the war years, despite student enlistments and losses through the draft. The military based a number of special training programs on the campus and instruction of such courses was frequently out of step with the academic calendar, thereby necessitating complex teaching arrangements for the faculty. Once the war ended, enrollment mushroomed as discharged military personnel returned to civilian life. The GI Bill of Rights enabled many such persons to embark upon a college education and the faculty at Madison was willing, as usual, to take aboard all qualified comers (as well as some not so qualified).

Freshman chemistry courses, which were required in many areas outside chemistry itself (agriculture, engineering, medicine pharmacy, home economics, nursing, medical technology, and even physical education), presented a critical problem, even during the war years. A major innovation was introduced in 1944 when Odell Taliaferro was appointed a full-time lecture assistant, largely through the leadership of Professor Walton who had, for more than two decades, taken great pride in the success of the large introductory lectures. From the beginning of the century, and even before, lecture demonstrations had had an important role in clarification of the subject. At first, professors like Carr and Daniells had prepared their own demonstrations. Later, when graduate students appeared, individual teaching assistants were assigned to particular lecturers to prepare demonstration materials. The system never worked satisfactorily since, unless professors worked closely with the lecture assistant, apparatus was missing when needed, materials were not checked properly before class, and demonstrations frequently failed. The appointment of Taliaferro, a former chemistry major in the department, proved a striking factor in maintaining the quality of the instructional program in the decades which followed.[44]

The freshman chemistry problem was exacerbated in 1947 by the deaths of Walton and Krauskopf, but helped by the recent return of Willard and Larsen. A heavy hiring program brought in seven recent Ph.D's as instructors between 1946 and 1950. These men were supplemented by several temporary instructors drawn from available personnel, mostly advanced graduate students. Laboratory sections were scheduled on Saturday mornings and in the evenings. Since teaching assistants from graduate student ranks were in short supply, their numbers were supplemented with seniors from the Chemistry Course. Somehow, the freshman courses were taught. Professors Willard and Larsen even managed to resume and expand their research programs in radiochemistry and lesser-known elements. Edward King and John Margrave, who arrived as instructors during the expansion period, contributed impressively both in the classroom and in developing a research program. They were quickly promoted to tenure.[45]

Work in more advanced levels also suffered from growing pains, with similar expansions being only slightly delayed. The analytical division added Walter Blaedel,[46] a recent Ph.D. under Leighton at Stanford, in 1947, and Irving Shain,[47] Ph.D. 1952 at University of Washington under Crittenden, in 1952. Organic added Harlan Goering, a student of S. J. Crystol at Colorado and Eugene van Tamelen, who had just taken his doctorate at Harvard under Gilbert Storck (Wisconsin '45 under McElvain). Both came in 1950 and immediately contributed significantly to the organic program, which had recently suffered the untimely death of Adkins. Despite that loss, the organic division remained an attractive one.[48]

The physical division was also showing a concern for the future. John Ferry came in 1945 as a young chemist with an established reputation in high polymers. Following receipt of a Stanford Ph.D. under George Parks, he had spent nine years at Harvard as instructor, member of the Harvard Society of Fellows, and associate chemist at Woods Hole. In 1959 he became the department's fifth chairman.[49] Robert Alberty was made an instructor in 1947, upon completing his doctorate under Professor Williams. Another Wisconsin Ph.D., Charles Curtiss, was added to the faculty the next year. He had studied with Hirschfelder and held a joint appointment with the Theoretical Chemistry Institute. Mathews' final appointments to the faculty before his retirement in 1952 were Shain, mentioned above, and C. Daniel Cornwell, who was a student with E. Bright Wilson at Harvard.[50]



Farrington Daniels (1889-1972)
U.W. Chemistry Faculty, 1920-1959
Chairman, 1952-1959

Mathews' success in building a widely-recognized department was unusual. Yet, even he made mistakes. Perhaps the most conspicuous was sacking Henry Eyring in 1928. On the whole, however, his record was unusual. He became chairman of a seven-man department in 1919; he retired from a 25-man department. He took over a building constructed in 1905 and substantially enlarged in 1913, but shared with the School of Pharmacy and the State Chemist's Laboratory. He retired from the same building (still shared with pharmacy and the state chemist), but with substantial additions made in 1929 and 1939. Following retirement he became involved in planning further enlargements.

Farrington Daniels took over the chairmanship and continued until retirement in 1959. His administration saw little change in permanent faculty; Hall and Schuette retired in 1955; Robert West and Lawrence Dahl were added.[51] Daniels' regime was plagued, nevertheless, with threats of losses of key professors to other institutions. He was successful in fending off all such raids except for Professor Johnson, who made the decision to become head of the department at Stanford in 1960.

Daniels was also faced with a critical shortage of space and expended much energy toward funding further expansion and seeking ground for such expansion. Building was delayed beyond the end of his chairmanship, but the fundamental problems were becoming resolved by then. The department ultimately abandoned the building it had occupied since 1905 and started a new unit in the block across the street. Ground was broken in 1960 and the unit, later christened the J. Howard Mathews Chemical Laboratory, was occupied in 1962. A major high-rise addition, occupying a substantial portion of the remainder of the block, was completed in 1967. It is named the Farrington Daniels Chemistry Building. The 1905 part of the vacated building was razed and replaced by modern construction by the department of physics. The modified structure, now named Chamberlin Hall, is occupied by the physics department and the Pharmacy School.

Daniels' chairmanship was characterized by his intense activity outside departmental administration. In 1953 he served as President of the American Chemical Society. He also maintained his heavy program of research which involved, in the years following the end of the war, the development of nuclear reactors for power production and a survey of mineralogical sources of fissionable materials. He soon became disenchanted with nuclear energy as a stable source of energy for the future when his survey showed that uranium sources in the earth's crust were limited. He then turned his enthusiasm toward solar energy as a limitless energy source. During his retirement he continued his investigations of solar energy problems to within a few weeks of his death in 1972.

When Daniels took the chairmanship he did so only on condition that the duties not seriously interfere with his scientific program. A precedent was set in the university at that time by permitting him to appoint an associate chairman to relieve him of some of the administrative duties, a policy which has been followed ever since in the department and which has been copied in certain other departments. Professor Holt served as associate chairman during the Daniels chairmanship and the following one of Ferry. When Shain took the chairmanship in 1967 he brought Alex Kotch into the department as associate chairman.[52] Kotch, with an organic Ph.D. under Carl S. Marvel at Illinois, had recently served in Washington as a grant administrator with the National Science Foundation. Kotch continued as associate chairman when Shain became Vice-Chancellor of the Madison unit of the University in 1970. He served successively under three chairmen, Shain, Willard (1970-72), and Fenske (1972-77).

Richard Fenske had joined the inorganic and physical divisions in 1961, fresh from a Ph.D. at Iowa State where he worked on energy levels of platinum under Donald S. Martin. Fenske, who was involved in the freshman chemistry program, also pursued an active research program involving calculation of energy levels and electronic transitions in transition-metal complexes. After ten years at Wisconsin he was chosen for the chairmanship.

When Fenske left the chairmanship, Kotch also resigned the associate chairmanship to take an administrative position with the newly formed Solar Energy Research Institute in Golden, Colorado. Thereupon, the new chairman, Dennis Evans who had joined the analytical division in 1966, selected Professor Larsen for the associate chairmanship. Larsen continued in this position when Barry Trost became chairman in 1980.[53]

As the present is approached, an in-depth examination of the development of the chemistry department will not be continued. Suffice it to say that the decade of the sixties was characterized at first by rapid growth in personnel and activities consistent with a period of a strong economy which stimulated college enrollments all over America, and followed by a collapse which forced colleges everywhere to engage in a holding action which would enable them to at least maintain the position they had attained. This pattern was to continue through the seventies.

The story in the chemistry department at Wisconsin paralleled the pattern within other U.W. departments and in universities elsewhere. A rapid expansion in personnel and space took place in the sixties; a holding action characterized the seventies.

In the period between 1960 and 1969 the chemistry department added 25 men who attained tenured professorial status. Several of them came at tenure level to strengthen areas in the program, a departure from the long and successful tradition of bringing in promising young men in the hope that they would develop into leaders in the profession. Howard Zimmerman, a Yale Ph.D. in organic, was brought in from a tenured position at Northwestern in 1960; Richard Bernstein (physical and theoretical) was attracted from Michigan in 1963 (but was later attracted to Texas and then, Columbia); Emory Fisher (extension and general) returned to his doctoral alma mater from the Missouri School of Mines to take over supervision of chemistry and physics in the Extension Centers while helping in Madison with the freshman program; and Kotch (organic) came from the National Science Foundation.[54] During the sixties 14 professors were lost, one by death, four by retirement and nine to other universities. During the next decade, only 7 new men attained tenure and 5 tenured members were lost, two of these by retirement.

The chairmanship, following Daniels' retirement, turned over at fairly short intervals. The first three chairmen served a total of 72 years; the next five served 25. All of them were able men, but times had changed. The job of administering a department had become vastly more demanding by 1950 than it had been even in 1919, when Mathews became chairman. Further, all of the chairmen since Mathews were chemists with vigorous research programs who were unwilling to see their discipline pass them by, as had happened to Kahlenberg and Mathews.

The year 1980, which marked the department's one hundredth year as an administrative entity, was strikingly in contrast with 1880 when the discipline was given independent status. In 1880, all branches of chemistry were taught by a single professor, W. W. Daniells, who emphasized classical analytical methods in a building constructed to serve all the sciences. When he turned over the chairmanship to Louis Kahlenberg in 1907, the department had a faculty of four professors, several instructors and teaching assistants, a handful of graduate students, and a small but healthy research program. Kahlenberg clearly changed the department from one that was teaching-oriented to one that also emphasized research. This trend was continued under the Mathews' chairmanship and those that followed. In 1980 Trost became chairman of a department with 40 professors, a group of technicians and specialists, several hundred graduate students and postdoctoral fellows from most states of the union and numerous foreign countries, and several thousand undergraduate students. Bachelors' degrees have been granted in chemistry to more than 2250 students; Ph.D.'s number about 1675 since the first in 1899. The department graduates 30 to 50 undergraduate majors per year, many of whom go elsewhere for graduate studies while many go into industry or turn to medicine, or sometimes law. About half of the Ph.D.'s go into industry while many of the rest go into academic work, either directly or after a year or two of postdoctoral work elsewhere. By contrast, in

Barry Trost (b. 1941)
U.W. Chemistry Faculty, 1965-
Chairman, 1980-

1880 there was virtually no demand for chemists since chemical industry was barely emerging as a business field.

Acknowledgment

This paper has been drawn from material in the published literature, from the University of Wisconsin Archives and the Archives of the State Historical Society of Wisconsin, and from personal observations, first as a chemistry course student beginning in 1927, and later as a faculty member beginning in 1942. I am particularly indebted to many individuals who, over a half century, have passed on oral information, provided interpretation, and provided references to documentary sources. To them I am eternally grateful, and apologetic for any misinterpretation I may unwittingly have introduced.

To Henry A. Schuette I am most deeply indebted since he laid the foundations of my interest in the history of the department and, had it not been for a breakdown in health, expected to write this story. I also owe much to J. Howard Mathews, Farrington Daniels, F. C. Krauskopf, V. W. Meloche, J. W. Williams, E. B. Fred, Otto Kowalke, Homer Adkins, Richard Fischer, and Mark Ingraham. Others who have been helpful in settling various points include S. M. McElvain, Louis Kahlenberg, J. H. Walton, M. L. Holt, E. M. Larsen, Emory Fisher, Odell Taliaferro, Bette Germann, Harold Schimming, Edmund Fitchett, Fredus N. Peters, Jr., and Marion Veazey.

There are four histories of the university which also proved very useful for general background as well as certain specifics. They are: C. W. Butterfield, *History of the University of Wisconsin* (Madison, 1879), R. G. Thwaites, ed., *The University of Wisconsin. Its History and Its Alumni* (Madison, 1900); J. F. A. Pyre, *Wisconsin* (New York, 1920); M. Curti and V. Carstensen, *The University of Wisconsin,* 1848-1925, 2 vols. (Madison, 1949). In addition there were several less comprehensive works which were useful: Robert E. Gard, *University Madison U.S.A.* (Madison, 1970) has a wealth of nostalgia and anecdotal material; A. G. Bogue and Robert Taylor, eds., *The University of Wisconsin. One Hundred and Twenty-five Years* (Madison, 1975), contains chapters dealing with various aspects of the university, especially programs, mostly since 1949; *A Resourceful University. The University of Wisconsin-Madison in its 125th Year* (Madison, 1975) also deals with university programs with emphasis on recent developments.

Notes

[1] There have been four major evaluations of quality of graduate education in the U.S.; the first in 1925, the most recent in 1969. The U.W. chemistry department was ranked 13th in 1925, 5th in 1957, tied for 7th with Columbia in 1964, and tied for 8th with Chicago, and Cornell in 1969. Wisconsin biochemistry ranked 4th with Rockefeller U and MIT in 1964, 5th in 1969, in the only reports which ranked biochemistry and chemical engineering. In the latter field Wisconsin was ranked in a first place tie with MIT in 1964, and held first place alone in 1969. For the full reports see: R. Hughes, *Quality of Graduate Education in Thirty-eight Universities* (Washington: Am. Council on Educ., 1928); H. Keniston, *Graduate Study in the Arts and Sciences at the University of Pennsylvania* (Philadelphia: U of Pennsylvania, 1959); A. M. Cartter (Washington: Am. Council on Educ,. 1966); K. D. Roose and C. J. Anderson, *Rating of Graduate Programs* (Washington: Am. Council on Educ., 1970); for summary see A. J. Ihde, "Chemistry in the Old Northwest," *Ohio Journal of Science,* 78:59-69 (1978).

[2] Merle Curti and Vernon Carstensen, *The University of Wisconsin. A History, 1848-1925,* 2 vols. (Madison, 1949), 1:70-86. This reference will be cited hereafter as Curti-Carstensen with volume and page. Also see A. J. Ihde and H. A. Schuette, "The Early Days of Chemistry at the University of Wisconsin," *J. Chem. Educ.,* 29:65-72 (1952). Cited hereafter as Ihde-Schuette with page.

[3] On Lathrop see P. W. Boutwell, "Stephen Pearl Lathrop," *Trans. Wis. Acad.* 41:95-116 (1952). On Carr see Curti-Carstensen, 1:83-114, 177, 180-81; J. F. A. Pyre, *Wisconsin* (New York, 1920), 133-36. On Davies see Curti-Carstensen, 1:335, 355; and J. F. Parkinson, "John Eugene Davies," *Trans. Wis. Acad.,* 13:614-18 (1901).

[4] Curti-Carstensen, 1:172-73, 207 ff, 296.

[5] W. H. Glover, *Farm and College. The College of Agriculture of the University of Wisconsin. A History* (Madison, 1952), 30-31 and *passim;* Curti-Carstensen, 1:335, 352-53, 461-65; *Dictionary of Wisconsin Biography* (Madison, 1960), 94; Ihde-Schuette, 66-67.

[6] Curti-Carstensen, 1:246-74, 327-63, 439-75.

[7] W. H. Glover, *Farm and College* (Madison, 1952), 113-32, 160-86; Curti-Carstensen, 1:475 ff, 546-47, 11:386-94.

[8] Curti-Carstensen, 1:501-60.

[9] Ihde-Schuette, 67; *American Men of Science,* 1st edn., 1906: 148; 7th edn., 1944: 814; Chemistry Dept. files.

[10] N. F. Hall, "A Wisconsin Chemical Pioneer—The Scientific Work of Louis Kahlenberg," *Trans. Wis. Acad.,* 39:83-96 (1949) and 40:336-37 (1950); A. J. Ihde, *Dictionary of Scientific Biography,* 7: 208 (1973); A. J. Ihde, *American Chemists and Chemical Engineers,* W. D. Miles, ed. (Washington, 1976), 259. This work will be cited hereafter as Miles, *American Chemists.*

[11] Ihde-Schuette, 67; *American Men of Science,* 5th edn., 1933:676, 981.

[12] M. M. Vance, *Charles Richard Van Hise. Scientist Progressive,* (Madison, 1960), 91-136; Curti-Carstensen, 11:3-122.

[13] University of Wisconsin Catalogs, 1900-1920.

[14] "Faculty Resolution on the Death of Victor Lenher," U.W. Faculty Min. for June 17, 1927; *Ind. Engr. Chem.,* News Edn., 13:5 (1927); *Wis. State J.,* June 13, 1927 and June 14, 1927.

[15] Ihde-Schuette, 67-68.

[16] A. J. Ihde, "Kahlenberg's Opposition to the Theory of Electrolytic Dissociation," *Selected Topics in the History of Electrochemistry,* Geo. Dubpernell, *et al.,* eds., *Proceedings of the Electrochemical Society,* 78-6:299-312 (1978); R. G. A. Dolby, "Debates Over the Theory of Solution," *Hist. Studies in the Physical Sciences,* 7:297-404 (1976).

[17] On Walton see U.W. Faculty Resolution on Death of James H. Walton, Document 818, Oct. 6, 1947; *Capital Times,* June 7, 1947, June 8, 1947. On Krauskopf see U.W. Faculty Resolution on the Death of Francis C. Krauskopf, Document 835, Jan. 12, 1948. *Capital Times,* Oct. 16, 1947.

[18] Curti-Carstensen, 1:630; 11, 311, 348-51.

[19] Robert C. Nesbit, *Wisconsin. A History* (Madison, 1973), 435-55; Wm. F. Raney, *Wisconsin. A Story of Progress* (New York, 1940), 300-05, 308-16; Richard N. Current, *Wisconsin. A Bicentennial History* (New York, 1977), 54, 198-200.

[20] U.W. Archives, 4/0/3, box 76, "Round Robin"; Curti-Carstensen, 11, 311, 348-51.

[21] Curti-Carstensen, 11:349-51; H. C. Bradley to Van Hise, Nov. 18, 1918, presidential papers

[22] Miles, *American Chemists,* 5-7, and *Badger Chemist,* No. 4, p. 15; No. 10, p. 5; No. 14, p. 11; No. 16, p. 1; No. 17, pp. 1-2; No. 18, pp. 1, 3-6. Badger Chemist, which will be cited frequently hereafter, needs a bit of clarification. It is a printed newsletter of the U.W. Department of Chemistry in Madison which is prepared annually for alumni and friends of the department. As such it seldom finds its way into permanent repositories. A full set is on file in the Archives of the U.W. in Madison, in the Chemistry Department, and in the library of the author. It was edited from 1953 (No. 1) through 1964 (No. 11) by Henry A. Schuette, from 1965 (No. 12) through 1969 (No. 16) by Emory D. Fisher, and from 1970 (No. 17) through 1980 (No. 27) by Aaron J. Ihde. Issues carry news of the department, faculty, and alumni, including pictures. Nos. 1, 2, 16, 17, and 20 carry pictures of faculty groups and No. 4 has pictures and biographical profiles of each faculty member. As new persons joined the faculty, the next newsletter carried a picture and brief biography. This reference will be cited hereafter as *Badger Chemist,* with issue number and page. There have been annual issues except in 1962. Attention is also called to Alan J. Rocke and A. J. Ihde, "A Badger Chemist Genealogy," *J. Chem. Educ.,* 56:93-95 (1979), which traces the intellectual lineage of tenured professors back to C. L. Berthollet, A. F. Fourcroy, and J. J. Berzelius.

[23] F. Daniels, "Homer Burton Adkins," *Biog. Memoirs, Nat'l. Acad. Sciences,* 27:293-317 (1952); A. J. Ihde, *Dict. Amer. Biog.,* Fourth Suppl., 1946-1950 (1974), 5-7; Ihde in Miles, *American Chemists,* 5-7; Memorial Resolution, U.W. Faculty, Document 918, Nov. 7, 1949.

[24] *Badger Chemist,* No. 20, pp. 5-6; No. 22, p. 13; No. 26, p. 13.

[25] On Fischer see E. R. Schierz in Miles, *American Chemists,* 154-155 and *Badger Chemist,* No. 3, p. 5. On Klein see *Badger Chemist,* No. 4, p. 13; No. 8, p. 5; No. 12, p. 7.

[26] Olive Bell Daniels, *Farrington Daniels. Chemist and Prophet of the Solar Age* (Madison, 1978). Privately printed by the author. Also see A. J. Ihde in Miles, *American Chemists,* 319-20; *Badger Chemist,* No. 1, p. 1; No. 2, p. 1; No. 4, p. 6; No. 20, pp. 1, 3-4, 8-9.

[27] *Badger Chemist,* No. 4, p. 24; No. 16, pp. 10-11; No. 17, pp. 2-4; No. 24, p. 15.

[28] *Ibid.,* No. 4, p. 18; No. 7, p. 4; No. 20, p. 13.

[29] *Ibid.,* No. 4, p. 21; No. 5, p. 17; No. 9, p. 5; No. 15, p. 12; No. 18, pp. 19-20.

[30] *Ibid.,* No. 4, p. 10; No. 19, pp. 1, 3-4.

[31] *Ibid.*, No. 22, p. 14.

[32] *Ibid.*, No. 3, pp. 1-3; No. 4, p. 8; No. 10, p. 8.

[33] *Ibid.*, No. 3, pp. 1, 3; No. 4, p. 19; No. 5, p. 15; No. 15, pp. 1-2; No. 25, 1, 4-6.

[34] *Ibid.*, No. 4, p. 24; No. 6, p. 9; No. 9, p. 16; No. 18, p. 8; No. 26, pp. 1, 7, 19-20.

[35] Harold Schneider, "Harry Steenbock (1886-1967)—A Biographical Sketch," *J. Nutrition*, 103: 1235-47 (1973); A. J. Ihde, "Harry Steenbock-Student and Humanist," *Wis. Acad. Rev.*, 26/1: 15-17 (1979); H. F. DeLuca, "The Vitamin D Story," *ibid.*, 18-24; Memorial Resolution . . . on the death of Harry Steenbock, U.W. Faculty Document 186, March 4, 1968.

[36] *Badger Chemist*, No. 20, p. 11; No. 21, p. 11.

[37] *Ibid.*, No. 21, p. 4; No. 26, pp.11-12; Memorial Resolution . . . on the death of Karl Paul Link, U.W. Faculty Document 399, May 5, 1980.

[38] *Badger Chemist*, No. 4, p. 9; No. 9, p. 16; No. 13, pp. 15-16; No. 23, p. 5.

[39] *Ibid.*, No. 4, p. 23.

[40] *Ibid.*, No. 4, p. 12.

[41] *Ibid.*, No. 4, p. 2; No. 24, p. 2; No. 26, pp. 1, 5, 15-16.

[42] *Ibid.*, No. 4, p. 14; No. 15, p. 8; No. 23, p. 10; No. 27, p. 5.

[43] *Ibid.*, No. 4, p. 11; No. 14, pp. 14-16; No. 16, pp. 13-16; No. 27, pp. 15-17.

[44] *Ibid.*, No. 21, pp. 1, 3; No. 22, p. 19.

[45] On King see *ibid.*, No. 4, p. 12. On Margrave see *ibid.*, No. 4, p. 17; No. 10, p. 1; No. 27, p. 19.

[46] *Ibid.*, No. 4, p. 3; No. 25, p. 19; No. 26, p. 14; No. 27, p. 12.

[47] *Ibid.*, No. 4, p. 20; No. 15, p. 3; No. 16, p. 1; No. 18, p. 28; No. 22, p. 7; No. 24, p. 20; No. 25, p. 10.

[48] On Goering, see *ibid.*, No. 4, p. 8; No. 19, p. 12. On van Tamelen see *ibid.*, No. 4, p. 22.

[49] *Ibid.*, No. 4, p. 7; No. 7, p. 3; No. 16, p. 1; No. 19, p. 3.

[50] On Alberty, see *ibid.*, No. 4, p. 1; No. 14, p. 3. On Curtiss, *ibid.*, No. 4, p. 4. On Cornwell, *ibid.*, No. 4, p. 1.

[51] On Dahl, see *ibid.*, No. 7, p. 5; No. 25, p. 19. On West, see *ibid.*, No. 5, p. 5; No. 18, p. 15; No. 27, p. 13.

[52] *Ibid.*, No. 15, p. 7; No. 24, p. 10.

[53] On Fenske, see *ibid.*, No. 11, p. 8; No. 19, p. 12; No. 23, p. 5. On Evans, see *ibid.*, No. 14, p. 7; No. 23, p. 5. On Trost, see *ibid.*, No. 13, p. 7; No. 23, p. 12; No. 27, pp. 1, 8.

[54] The running record in the sixties is covered in *Badger Chemist*, Nos. 9-17 while Nos. 18-27 cover the decade of the seventies. On Zimmerman, see *ibid.*, No. 9; p. 4; No. 21, pp. 6-7; No. 23, p. 7; No. 27, p. 1. On Fisher see *ibid.*, No. 11, p. 9; No. 17, pp. 3-4. On Bernstein, see No. 10, p. 4; No. 21, p. 12.

FURTHER LINKS IN THE CALIFORNIA-WISCONSIN ASTRONOMICAL CONNECTION

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There are numerous astronomical links between California and Wisconsin, probably more than between any other two states. Many of them I outlined in a paper previously published in these Transactions,[1] but I have since learned of still more connections which are described in the present paper.

It all began with Lick Observatory, the first large research observatory in California. Its first Director, Edward S. Holden, came from the University of Wisconsin to Lick and thus started the California-Wisconsin axis. Holden was tentatively selected as Director of Lick Observatory in 1874, many years before it was built on Mount Hamilton, while he was still a young astronomer at the Naval Observatory in Washington. Holden left the Naval Observatory to become Director of the Washburn Observatory on the Madison campus of the University of Wisconsin in 1881 when James Watson, its first Director, died unexpectedly of pneumonia.

At Washburn, with the 15½-inch refractor and the meridian circle, Holden observed positions of nebulae, stars and comets—the old astronomy of position. In 1883 he headed a government-sponsored eclipse expedition to Caroline Island, a tiny atoll in the Pacific Ocean between Tahiti and Hawaii. It was a three-month trip, in which he and the other astronomers travelled over 12,000 miles by ship and railroad. They had to cross the Isthmus of Panama and change ships in those days long before the canal had been built. At the eclipse Holden searched visually for a planet closer to the sun than Mercury, but found none.[2]

Holden advised Nils P. Haugen, then Wisconsin Commissioner of Railroads, on introducing a bill in the legislature to require the railroads to use Central Standard Time in the state.[3] Up until then there was a twenty-minute difference between Chicago and St. Paul times, and the railroads changed time at Elroy. Holden was one of the professors who approached T. C. Chamberlin, then with the United States Geological Survey, about succeeding John Bascom as President of the University of Wisconsin. Chamberlin was interested in the position, but did not want to force Bascom out, and therefore did not actually become President until after Holden had left for California.[4]

Holden was a member of the Wisconsin Academy of Sciences, Arts, and Letters, and gave a paper on the Caroline Island eclipse expedition at the W.A.S.A.L. meeting in Madison on December 28, 1883. After he departed for California, he became a corresponding member of the Academy.[5] When he left Wisconsin, Holden presented several books and pamphlets to the State Historical Society of Wisconsin, and also "a maro, or covering of the loins, used by natives of Tahiti . . . of both sexes, usually their only garment."[6]

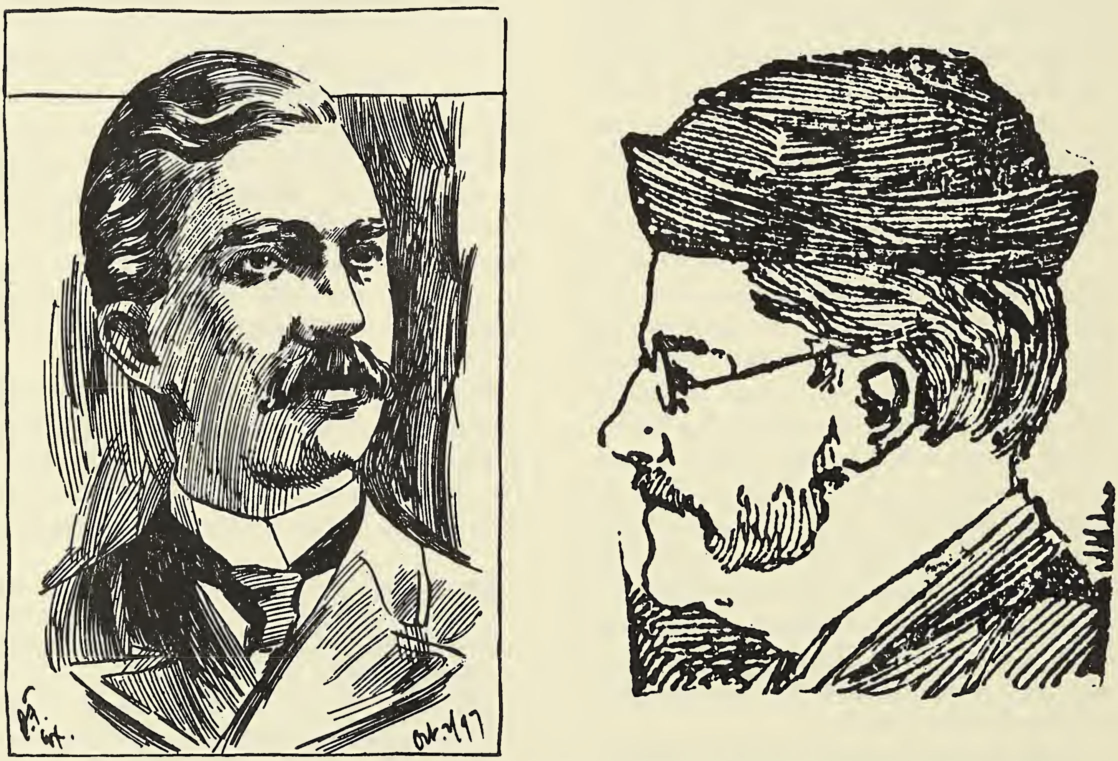
Holden enjoyed life in Madison and left only because of the outstanding astronomical opportunity at the new Lick Observatory. He wrote to B. A. Gould, a prospective successor in his job as Director at Washburn:[7]

> Let me ask you to consider this letter as strictly confidential. I expect to resign my position here on Jan 1/86, to take the L[ick] O[bservatory]. I wish to know if you have any desire to take this Observatory. If you would be willing I shd. like to be the means of having it offered to you. With the exception of the H[arvard] C[ollege] O[bservatory]. I regard it as the most desirable college Obs.

in the U.S. The salary is $3000 with a beautiful house (fifteen rooms) near the O. with every possible convenience. The O. itself is completely fitted for ast'y of position. The state publishes the obsns. The college duties are 50 lectures of 1 hour, April-June. The observatory income is 1500 (app'n) 175 (lib'y) 600 (time service). Out of this I pay a fair asst (720) computer (360) janitor (420), and meteor. obsr. (quarters) & all expenses. The site of the Obsy & of the House is extremely beautiful. The town itself is very pretty. There is no reason why your children could not get all the Essentials of education here. The liberty of the Astromr. is absolute. I am well aware that you deserve something more than this Obsy. But I know that if you took it you wd. make it what you deserve. I am not willing that it should go to another if you are willing to take it. May I ask you for a word to express your wishes on this?

In California as Lick Observatory approached completion, Holden was brought out as President of the University, a job that was often open in those years. He started as President in January 1886 and served until the observatory was finished and ready for use in 1888, at which time he stepped up to its directorship. Holden received an honorary LL.D. degree from the University of Wisconsin in 1886, just after he left for California, thus enabling his friends from then on to address him as "Doctor."[2]

A considerable amount of planning for Lick Observatory had been done under Holden's recommendations while he was at Madison. He did much of it himself, particularly on the library and on the smaller astronomical instruments, but other parts of it were done by his colleagues on the University of Wisconsin faculty. The report on the



1. Newspaper drawings of James E. Keeler (left) and Edward S. Holden (right), second and first Directors of Lick Observatory, respectively. Holden began and Keeler nurtured the California-Wisconsin astronomical connection. Lick Observatory Archives.

geology of Mount Hamilton, published in Volume I of the Lick Observatory Publications, is signed by Roland D. Irving, Professor of Geology at the University of Wisconsin and United States Geologist in Madison.[8] This report was drawn up by his assistant, young Charles Van Hise, later the recipient in 1892 of the first earned Ph.D. degree ever granted by the University of Wisconsin. Van Hise succeeded Irving as Professor of Geology at Madison, and still later became President of the University of Wisconsin from 1903 until his death in 1918. He was the popularizer of "the Wisconsin idea" of the university as the practical servant of the state.[9]

The detailed design of the dome for the Lick Observatory 36-inch telescope, a large and very unusual building for its time, was provided by Storm Bull of the University of Wisconsin Mechanical Engineering Department. He also designed the focal plane baseplate for the telescope, used for mounting the eyepieces and the spectrograph.[10] Born in Norway, Bull was trained at the Swiss Polytechnic Institute in Zurich. He emigrated to Madison in 1879, where his uncle, Ole Bull, the famous violinist, was then living, and joined the University of Wisconsin faculty. Throughout his career Bull did outside consulting and also served as a full-time engineering faculty member. He charged the Lick Trustees 75¢ an hour for his services, which he regarded as a mean between the $1.00 per hour that would be a fair price and the 50¢ per hour Holden wanted to pay him.[11] As a University of Wisconsin faculty member, Bull was elected to the Madison City Council and was Mayor of Madison for one term.[12]

George C. Comstock was with Holden one of the early prime movers in the California-Wisconsin axis. Comstock was born in Madison and studied astronomy at the University of Michigan, where he received his B.S. degree in 1879. When Watson moved from Michigan to the University of Wisconsin as first Director of its Washburn Observatory, Comstock went with him and after Watson's death, Comstock stayed on as Holden's assistant. At Madison he calculated under Holden's supervision many of the tables to be used later at Lick Observatory for the reduction of star positions, the determination of time, etc. In 1885 Comstock left Madison to become Professor of Mathematics and Astronomy at Ohio State University, but he spent the summer of 1886 at Lick Observatory, working with the meridian circle before the 36-inch refractor was completed. Holden thought very highly of Comstock's scientific abilities and wanted to hire him on the Lick staff,[13] but Comstock preferred the job as Holden's successor at Madison.

When he accepted the Presidency of the University of California, Holden had first thought of his friend Samuel P. Langley, a pioneer astrophysicist then at Allegheny Observatory near Pittsburgh, as his successor as Director at Washburn. Langley had visited Madison and appreciated it greatly, writing Holden, "I look back to Madison as a home in sunshine, part of whose joys have been intercalated into my bachelor existence, and I shall long remember my visit, which was not only so pleasant at the time but which has done me good since. . . ."[14] Langley, however, declined to be considered for the directorship at Washburn Observatory, telling Holden that he did so for only one reason. He said he was over fifty and wanted to keep working, "but I yearn—it is the word—for a larger companionship, and for the society of the East which you are—with wife and children *and* your work able to leave for a larger scientific field."[15] Holden next offered to recommend for the job in succession two friends of his own generation, B. A. Gould and William A. Rogers. Gould declined,[16] but Rogers wanted the job, as long as he did not have to appear as a candidate for it. He was actually recommended for the position by President John Bascom, who however was himself nearing the end

2. Four important figures in the California-Wisconsin astronomical network. George C. Comstock (upper left), Storm Bull (upper right), Sidney D. Townley (lower left), Charles R. Van Hise (lower right). Lick Observatory Archives.

of his reign and was under pressure to resign. The Board of Regents did not accept the recommendation, but instead put Physics Professor John E. Davies in temporary charge of the observatory. Rogers then accepted a position at Colby College in Maine.[17] A year later Comstock was appointed Director, but because of his relative youth, he was saddled by the Regents for the first few years with a "consulting director," Asaph Hall of the Naval Observatory. Hall would come to Wisconsin for just a few weeks each year, but this awkward arrangement soon ended when Comstock had gained the Regents' confidence.[18] Hall, the discoverer of Deimos and Phobos, the two satellites of Mars, himself had an earlier Wisconsin connection. He and his wife had been married at Elkhorn in 1856, while she was looking for a job as a school teacher.[19]

All Comstock's research was in positional astronomy. He was the first Wisconsin faculty member elected to the National Academy of Sciences for work done at Madison, and became the first Dean of the University of Wisconsin Graduate School, appointed by Van Hise in 1904. Comstock built up research at Madison over the years until he retired in 1920. As an assistant at Washburn Observatory, uncertain about his future, he had gone to law school and had entered the bar, but had never practiced. He always said that law school was the best training he ever had; possibly he meant for being a dean.[20]

Armin O. Leuschner was a California astronomer who did not quite make the Wisconsin connection. He became the first graduate student at Lick Observatory in 1888, after earning his B.S. at Michigan. But one year later when A. V. Egbert, Comstock's assistant at Washburn Observatory, left to take a position on the faculty of a small church college in northern Ohio, Comstock wrote Holden to ask if he could recommend a replacement.[21] Holden strongly recommended Leuschner, who wanted to come to Madison and spend a year away from Lick.[22] But by the time Holden's letter had arrived Comstock had opened negotiations with Albert S. Flint, an older, more experienced man from the Naval Observatory, and he hired him. Thus to California's good fortune Leuschner stayed in the West and ultimately became long-term Chairman of the Berkeley Astronomy Department, and for several years Dean of the University of California Graduate School.[23]

Sidney D. Townley, a native of Waukesha, received the first graduate fellowship at Lick Observatory, the Phoebe Hearst Fellowship, worth $360 a year. He did his undergraduate degree at Wisconsin, followed by two years of graduate work, leading to an M.S., all under Comstock. As an undergraduate Townley took part in all the student activities, including not only oratorical contests and class elections, but also hunting in the woods west of the city—now the West High School area—and rowing out to the University Farm to steal apples—near the present site of Eagle Heights. In his sophomore year Townley heard a lecture by a visiting English astronomer, Richard A. Proctor. It inspired him to take an astronomy course from Comstock, and the course interested him so much that in his junior year he got a job as Comstock's student observing assistant. This job paid 20¢ an hour and gave Townley the privilege of living in a furnished room at the Observatory, for which he paid $4 a month. As a senior he earned a little more by running the Observatory time service, which furnished the time to the railroads in Madison. His parents let him take the family horse to the University, since as part of his job he was allowed to keep it in the Observatory barn. The time service job tied him down in Madison so that he could not go home to Waukesha for vacations except for a few days at a time.

After finishing his B.S., Townley received one of four graduate fellowships at the University of Wisconsin, for which he taught one section of an algebra class supervised by Charles D. Slichter and continued to help at the Observatory. In the summer of 1891 Townley went to Oregon for a working visit with one of his brothers, and took the opportunity to make a quick tour of northern California. He visited Lick Observatory where he met several of the staff and watched them observe one night. He also stopped at Stanford University, which was still under construction but due to open that fall. Townley admired the handsome buildings and gave his opinion that "[t]his is the beginning of a fine University and will probably some day rank among the leading institutions of the land." Finally he visited Berkeley where he was less impressed: "The University has a nice location and some fine buildings but in neither respect does it come up to the U.W." After two years of graduate work at Madison, Townley received his M.S. and then on Comstock's recommendation went to Lick on the first fellowship, which paid $40 a year less than the fellowship he had held at Wisconsin.

According to Townley, he arrived at Mount Hamilton on the noon stage on July 1, 1892, the day his fellowship began, only to be reprimanded by Holden for not coming the day before so that he could begin work promptly at 9 A.M.[24] This is a good story, but actually Townley's diary showed that he was nearly three weeks late in addition to the half day he mentions. But once there he got right down to work and was able to spend much of the time in the summer and fall in research on variable stars, the subject of his Madison thesis. In addition, at Lick he had the duties of running the time service and of assisting Astronomer W. W. Campbell observe spectroscopically two nights each week. In the winter semester Townley moved to Berkeley and took formal classes, and then returned to Mount Hamilton in May and June to complete his observing project.[25]

The next year his fellowship was not renewed; Holden preferred to spend the money that Mrs. Hearst gave the Observatory to finance an eclipse expedition to Chile and to buy a new spectroscope for the Observatory.[26] In desperation Townley wrote Comstock asking if there was any possibility of a job at Wisconsin, or if he knew of any other jobs at other observatories: "I have got to strike something before long or else go to sawing wood for a living."[27] He literally dreamt of Madison.[28] Townley did get a low-paying instructorship at Michigan, and with one year of graduate study in Germany along the way ultimately received his Sc.D. at Ann Arbor in 1897.

Jobs were hard to come by; for instance as the directorship changed hands at Lick Observatory, Townley wrote five different letters of application for a position there within one two-and-a-half-year period.[29] He held an instructorship at Berkeley for several years, then became the one-man staff of a geodetic observatory at Ukiah, California and then at last became a long-time professor at Stanford, which had indeed turned out to be a fine university.[24]

One of the most famous scientists from the University of Wisconsin, Robert W. Wood, a physicist universally regarded as one of the world's experts in light, came to Lick Observatory as a guest investigator in the summer of 1900. He was then a young assistant professor and was introduced to James E. Keeler, Holden's successor as Director, in a letter from Benjamin W. Snow, Keeler's old friend and schoolmate.[30] Snow described Wood as "a thoroughly jolly and companionable man, and one who has won for himself a very enviable place among the investigators of our faculty."[31] Wood, after observing the solar corona at the 1900 eclipse, had conceived a scheme of detecting the faint corona without an eclipse. He

3. The University of Wisconsin baseball team of 1891. Sidney D. Townley, the manager, is in the back row, second from left, wearing a dark derby hat and light suit. Then an astronomy graduate student at Wisconsin, he later became a graduate student at Lick Observatory, and still later a professor at Stanford. Photograph courtesy of the Townley Family.

planned to take advantage of the fact that the coronal light is polarized and contains no absorption lines to enhance its contrast with the scattered sunlight.[32] Keeler died unexpectedly of a stroke just a few days after inviting Wood to bring his apparatus to Lick, and W. W. Campbell was actually in charge when he arrived. The corona, even in polarized light in the deepest solar absorption lines, proved too faint for Wood's method, as he had feared it might.[33] Nevertheless, the experiment at Lick was useful in evaluating the method, and Wood remained interested in astronomy and full of suggestions for further observational research. A year after his visit to Mount Hamilton Wood left Wisconsin when he was appointed a full professor at Johns Hopkins, in the vacancy created by Henry A. Rowland's death.[34]

Joel Stebbins, Professor of Astronomy at the University of Wisconsin from 1922 until 1948, earned the third Ph.D. ever awarded by Lick Observatory. He had been an undergraduate at the University of Nebraska, and spent one further year as a graduate student there, then another year at Wisconsin with Comstock who recommended he go to Lick to learn "the new astronomy" or astrophysical research. In California, in alternate semesters Stebbins participated in observational research at Mount Hamilton and took formal courses in Berkeley. During his second year at Lick, Stebbins began observing with the 36-inch refractor and did the first thesis assigned by Campbell, a busy research worker with many observational projects. Stebbins' thesis was on the long-period variable Mira. He followed its spectral changes and correctly concluded that it must be an intrinsic variable star, physically pulsating, and not a system of two stars revolving about each other.[35]

Stebbins had quickly learned that the California atmosphere was much better for astronomy than Wisconsin's when he saw a double star resolved with the small 12-inch refractor on Mount Hamilton that had seemed an elongated blob, only suspected of being double, with the giant Yerkes 40-inch refractor.[36] As Keeler had earlier written when he thought the 40-inch was going to be erected in Chicago, rather than in Williams Bay as it was, "Our Chicago friends will have a larger telescope, but 36 inches on Mt. Hamilton will beat 40 inches in Chicago."[37] And like many another Midwesterner, Stebbins thought California was beautiful in the spring when the mountains are sparkling green and the valleys are covered with flowers, but in late summer when the hills dried up and turned brown he wrote: "I can't make up my mind to think that this place is as pretty as Madison. Everything is so different."[38] In 1903, after only two years as a graduate student at the University of California, Stebbins earned his Ph.D. degree and then went on to a long and successful career in photoelectric research at Illinois and Wisconsin.[35]

Although Sebastian Albrecht was not a famous scientist, he holds the distinction of being the first astronomer ever married at Lick Observatory. Born in Milwaukee, he graduated from the University of Wisconsin in 1900, taught high school in West Bend for two years, then returned to Madison to begin graduate work in astronomy and mathematics. After one year as a graduate student, he was awarded a Lick Observatory fellowship on Comstock's recommendation.[39] For the next three years he divided his time between observational work at Lick and classes at Berkeley. He did his thesis, a spectroscopic study of Cepheid variable stars, under the supervision of W. W. Campbell, who was by then the third Director of Lick Observatory. (Campbell received an honorary LL.D. degree from the University of Wisconsin in 1902, as Holden had earlier.)[40]

Albrecht was appointed to the Lick staff after receiving his Ph.D. in 1906. He worked closely with Campbell taking spectroscopic measurements with the 36-inch refractor. They were trying to detect the presence of water vapor in Mars' atmosphere, or at least set an upper limit to its amount. Albrecht observed at Mount Hamilton and also accompanied Campbell on his expedition to Mount Whitney in the late summer of 1909. The party of six people included a doctor, a carpenter, and a meteorological expert from the Weather Bureau in addition to the astronomers and a guide. They took a 16-inch reflecting telescope, a prism spectroscope, and the associated optics to the 14,565 foot summit. After a few days of acclimatization for themselves and their horses at an intermediate altitude, in two nights at the summit they obtained several good spectra of Mars and the Moon, and although they did not detect water vapor, they set a firm upper limit to the amount of it in Mars' atmosphere.[41]

In 1910, Albrecht accepted a job at the Argentine National Observatory in Cordoba. Before his departure, Albrecht married Violet Standen, a Lick Observatory secretary. The wedding was held in the Director's house on Mount Hamilton with fifty members of the Observatory community in attendance. A minister from Saratoga, California, performed the ceremony under crossed flags of the United States and Argentina, the latter a flag borrowed by Campbell from the Consulate in San Francisco. The Albrechts left Mount Hamilton a week later for Argentina with intermediate stops at his family home on Forest Home Avenue in Milwaukee, and in New York.[42] Unfortunately, the job in Argentina did not work out, and Albrecht returned to the United States in 1912, working briefly at the University of Michigan and then for many years at Dudley Observatory in Albany, New York.[43]

In conclusion, there were and still are many close astronomical ties between Wisconsin and California, probably more than between any two states. In part, they came about because of the demand for astronomers in California—beginning in 1888 with the completion of the Lick Observatory—and because of the source of astronomers at the University of Wisconsin—from early on a strong research-oriented institution. But in part they also came about because of personal contacts and relationships dating back to Holden and Comstock—and those personal contacts were and are important too.

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References Cited

1. Osterbrock, D. E. 1978. Trans. W.A.S.A.L. 66:1-24.
2. Campbell, W. W. 1919. Bio. Mem. N.A.S. 8:347-372.
3. Letter, Haugen to Holden, Feb. 7, 1885, Archives, College of Letters and Sciences, Department of Astronomy, University of Wisconsin, Madison, Memorial Library, hereafter cited as UW.
4. Letters, Chamberlin to Holden, May 16, 1885, Holden to Chamberlin, May 17, 1885, Lick Observatory Archives, University of California, Santa Cruz, McHenry Library, hereafter cited as LOA.
5. Trans. W.A.S.A.L. 7, unpaged, 1883-1887.
6. Letter, D. S. Durie to Holden, Oct. 22, 1885, UW; Collections State Hist. Soc. Wis. 10: 37-38, 1885.
7. Letter, Holden to Gould, Oct. 5, 1885, UW.
8. Irving, R. D. 1887. Pub. L.O. 1:55-58.
9. Vance, M. M. 1960. *Charles Richard Van Hise, Scientist Progressive.* Madison, State Historical Society.
10. Letters, Bull to Holden, Dec. 16, 1885, July 20, 1887, LOA.
11. Letter, Bull to Holden, Apr. 16, 1885, LOA.
12. Thorkelson, H. J. 1907. Wis Engineer 12: 1-4; Turneaure, F. E. 1908. Jour. Western Soc. Engineers 13:453-454.
13. Letters, Holden to W. H. Scott, May 14, 1885, to Comstock, June 17, Dec. 15, 1886, LOA.
14. Letter, Langley to Holden, Dec. 12, 1884, LOA.
15. Letter, Langley to Holden, Oct. 2, 1885, LOA.
16. Letter, Gould to Holden, Oct. 6, 1885, LOA.
17. Letters, Rogers to Holden, Oct. 16, Oct. 26, 1885, July 18, Aug. 6, Sep. 14, 1886, Nov. 7, 1887, LOA.
18. Letter, Comstock to Holden, Sep. 6, 1887, LOA.
19. Hill, G. W. 1908. Bio. Mem. N.A.S. 6: 241-309.
20. Townley, S. D. 1934. Pub. A.S.P. 46:171-176; Stebbins, J. 1939. Bio. Mem. N.A.S. 20:161-182.
21. Letter, Comstock to Holden, Sep. 2, 1889, LOA.
22. Letters, Holden to Comstock, Sep. 10, 1889, Leuschner to Holden, Sep. 20, Sep. 25, 1889, LOA.
23. Alter, D. 1953. Pub. A.S.P. 65:269-273; Herget, P. 1978. Bio. Mem. N.A.S. 49: 129-147.

24. Aitken, R. G. 1946. Pub. A.S.P. 58:193-195.
25. Townley, S. D. 1885-1893, Diary. Parts of this diary are published as Townley, S. D. 1940, *Diary of a Student of the University of Wisconsin 1886 to 1892,* Palo Alto; the entire diary is in the possession of Mrs. Lucile Townley Clark.
26. Letters, Holden to J. C. Stump, Oct. 27, 1892, to P. A. Hearst, Jan. 30, 1893, LOA.
27. Letter, Townley to Comstock, Mar. 21, 1893, UW.
28. Letter, Townley to Comstock, Feb. 6, 1897, UW.
29. Letters, Townley to Holden, Aug. 28, 1897, to J. M. Schaeberle, Dec. 18, 1897, to W. W. Campbell, June 4, 1898, to J. E. Keeler, June 21, 1898, to W. W. Campbell, Dec. 13, 1900, LOA.
30. Letter, Comstock to Holden, Apr. 25, 1887, LOA.
31. Letter, Snow to Keeler, July 2, 1900, LOA.
32. Letters, Wood to Campbell, July 15, 1900, to Keeler, July 22, 1900, LOA.
33. Letters, Wood to Campbell, Aug. 23, 1900, Jan. 20, 1901, LOA.
34. Seabrook, W. 1941. *Doctor Wood, Modern Wizard of the Laboratory.* New York, Harcourt, Brace.
35. Whitford, A. E. 1978. Bio. Mem. N.A.S. 49:293-316.
36. Letter, Stebbins to H[ome] F[olks], Oct. 28, 1901, LOA.
37. Letter, Keeler, to H. E. Mathews, Dec. 20, 1892, Allegheny Observatory Archives, Hillman Library, University of Pittsburgh.
38. Letters, Stebbins to H[ome] F[olks], May 19, June 1, 1902, LOA.
39. Letters, Albrecht to Campbell, Feb. 25, 1903, Comstock to Campbell, Feb. 24, 1903, LOA.
40. Wright, W. H. 1949. Bio. Mem. N.A.S. 25:35-74.
41. Campbell, W. W. 1909. L.O. Bull. 5:149-164.
42. San Jose Mercury, July 3, 1910.
43. Letter, C. D. Perrine to Campbell, July 6, 1912, LOA.

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Theodore N. Savides
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PRESIDENTIAL ADDRESS

Theodore N. Savides

April 1982

For a very long time now we and the rest of this nervous world's industrialized nations have become mesmerized by the notion of calculating national wealth by the size of the gross national product and a favorable balance of trade. Not content with our questionable ability to estimate the *present* state of our economic health by these narrow measures we also base our prognosis of *future* health on whether the GNP is rising or falling and whether the balance of trade seems likely to tip for us or against us. For thoughtful men and women both of these somewhat suspect measures are very weak reeds indeed upon which to base predictions regarding the future of our posterity.

Although these brief remarks should in no way be construed as a sermon, they do have a text of sorts, or really two texts. The first is Aristotle's well-known observation that "educated men are as much superior to uneducated men as the living are to the dead." Parenthetically one might observe that given the man's world in which he lived, it is highly unlikely that Aristotle intended to include women in his use of the word "men." Modern society, of course, is quite a different matter, and the inclusion of women in the generic "mankind" is taken for granted. In 1870, however, the year this institution was founded, the status of women was perhaps most aptly described by Friedrich Nietzsche who suggested that woman existed for the amusement of the warrior, that all else was folly. On the long list of distinguished persons consulted in the matter of establishing this very academy, one finds not a single female, and an enormous volume of social conflict and pain lay ahead before women achieved even their present somewhat unsatisfactory status.

The second text is from Cicero, and in the simplest language possible the great Roman stated a universal truth equally true for every normal member of our species, a truth obvious to everyone of us here: "to think is to live." One need only call to mind the thousands of our kind described in the cruelest language we know as being simply "institutionalized vegetables" to understand the priceless value of the ability to reason, an ability infinitely reduced even in the highest of the other primates.

But merely because we can out-reason the great apes hardly means that our problems are ephemeral and will shortly evaporate like so much mist. Terribly complex social, political, moral and economic dilemmas face our nation and our world for the foreseeable future, which future, by the way, is rarely as foreseeable as the term suggests and might more accurately be described as the unforeseeable future.

Each year a new generation of youth arrives, seeking to make its place in society and the world of work. Opportunities must be provided lest we squander the most precious of our resources, human talent. Historically our economy has usually managed to solve this perennial problem simply by expanding our production of material goods and refining the provision of human services. For some years now considerably more Americans have been employed in the service areas than in the manufacturing industries. Notwithstanding this happy development, we still lead the world in the production of junk, and the safe disposal of this enormous and ubiquitous volume of refuse constitutes a major problem for virtually every American community.

But the difficulties confronting us in recycling or otherwise safely disposing of our material debris are dwarfed by the growing size of our social debris, the human flotsam and jetsam of a great and affluent nation which in recent years seems at least temporarily to have lost its sense of direction. On the positive side, however, what used to be known as our sense of manifest destiny has finally given way to a more realistic view of the tragic consequences of rapidly depleting our irreplaceable natural resources. Clearly the provision of food, clothing and shelter for the impoverished ones of this world is a global problem far exceeding the ability of any one or two or three of the most prosperous nations to solve, alone or in combination.

And then among a host of acute internal problems is the increasing level of gratuitous violence and outrage which we commit upon each other. Such aberrant behaviour is by now so pervasive as to have made the manufacture and installation of security systems both in places of business and personal residence one of the fastest-growing industries we have, an ironic paradox in a nation which from its beginnings has prided itself on being an open society.

Many millions of our fellow citizens suffer from the twin plagues of alcoholism and chemical dependency both of which cross lines of age, sex, education and economic status.

The immense social costs of widespread unemployment, personal and business bankruptcies, steeply diminishing levels of support for artistic, cultural and scientific endeavors, in short of the entire educational enterprise, cast deep shadows over the present and the future as well. Each of us is hard-pressed to maintain perspective and a sense of optimism in the face of the continuing gloom which overhangs so many important sectors of society today.

But if we as a proud and productive people continue indefinitely to flounder around in a trough of despondency and defeat, it will be because we have lost sight of the true source of wealth which resides where it has always resided, in the educated skills of our people, in their almost incredible faculty for problem-solving.

The spectacular flowering of genius which so marked Periclean Greece and Elizabethan England may never be achieved again, but we can be quite confident that the grand total of our natural and intellectual resources far exceeds those of ancient Greece and Medieval Britain combined. They will, at last, when deliberately focussed on our national dilemmas carry us forward into a future far brighter than our present. If so, that happy outcome will be accomplished by close and continuing attention to the earlier texts of these remarks, namely Aristotle's advice that educated men are far superior to uneducated men as the living are to the dead and Cicero's equally perceptive observation that to think is to live.

I may say in conclusion that thanks to the dedicated efforts of Academy administrations both in the recent and not so recent past, your academy is both alive and well. I am confident that within the gradually expanding boundaries of its resources it will as before continue to support and encourage the sciences, arts and letters in full adherance to the sacred dictum of its venerable charter.

THE MAKING OF *A SAND COUNTY ALMANAC*

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A Sand County Almanac by Aldo Leopold needs no introduction in our time. Few books have had as much influence on America's growing ecological awareness. *A Sand County Almanac* is praised as the right mix of nature observation and ecological thought, of field experience and philosophical reflection, of scientific fact and aesthetic delight and ethical value. In fact this collection of essays—so diverse and yet unified in perspective, material, and treatment—has become the model for contemporary nature writing. But for all that the book has been given little critical literary attention. What textual analysis there has been has only considered the 1949 edition of *A Sand County Almanac.* No study of the earlier manuscript versions of the essays has been made. No one has traced the evolution of the text or of Leopold's thinking about the substance and structure of the text during its lengthy gestation from November, 1941, to April, 1948. This essay proposes to do those things, based on an examination of correspondence, essay drafts, and other manuscripts contained in the Leopold archives at the University of Wisconsin-Madison. Especially in the letters between Leopold and his publishers and his friends one can trace the evolution of the concept of the book. In them one finds the debate over what constitutes a nature book, the debate about the right interplay between nature observation and ecological preachment. In them one observes Leopold working out his own answers to these questions. The major part of this essay will examine the period during which *A Sand County Almanac* evolved both as concept and structure in order to discover the evolution of Leopold's thinking about what a nature book should be. As an after note this essay will also briefly comment on some of the mechanical aspects of writing, revising, and editing the work: changes within the essays, changes in the type of essays, changes in titles, and changes in organization.

Prior to 1941 Leopold had published essays in many journals, some as early as the 1910's. For example, the most discussed of all the essays in *A Sand County Almanac,* "The Land Ethic," first appeared in 1933 as "Conservation Ethic." "Conservation Esthetic" first appeared in 1937. Most of Leopold's early essays were either technical or, like the two cited, overtly conservationist exhortation—philosophic essays Leopold called them. It is important to keep in mind the kind of essays Leopold wrote before 1941 if one is to understand the controversy within Leopold himself and between Leopold and his correspondents during the 1941-1947 period during which the book was shaped. A few of the 1930's essays like "Guacamaja" (1937) and "Marshland Elegy" (1937) shared with the philosophic essays their conservationist/ecological purpose, but were presented more nearly in descriptive/narrative terms. Event in part substituted for reason as ecological argument. None of these essays, however, were intended to be primarily narrative descriptions. Several essays which appeared in 1941 and which were later incorporated into *A Sand County Almanac,* anticipate the kind of essays Leopold was later to write. The only pre-November, 1941, essay to use the shack experience was "65287," later changed to "65290" (why, I cannot say). "Bur Oak is Badge in Wisconsin" (*Wisconsin Agriculturalist and Farmer,* April, 1941), an early and shortened version of "Bur Oak," and "The Geese Return" (manuscripts dated September, 1941) both predate Leopold's thinking about *A Sand County Almanac.* Although in their early versions both anticipate the tone of the later shack essays and were revised in that direction in the middle 1940's, they were, in 1941, basically conservation/ecology essays.

A letter from Knopf publishers written to Leopold on November 26, 1941, begins the period of Leopold's serious consideration of the kind of nature essays he should write and of how they might be coherently organized. That letter begins the making of *A Sand County Almanac.* In it Knopf told Leopold that they sought someone to write "a personal book recounting adventures in the field . . . warmly, evocatively, and vividly written . . . a book for the layman . . . [with] room for the author's opinions on ecology and conservation . . . worked into a framework of actual field experience." Notice that at the very outset of the Knopf/Leopold correspondence the fundamental variables which make up nature writing not only were identified but also were couched within their inevitable tension. On the one hand, the Knopf letter says a nature book must be personal, narrative, a recounting of field adventures and experiences, informed, warm, evocative. But beyond such narrative observation, a nature book might contain the author's opinions, his considered analysis of nature, his comment about natural events and man's place in them. It might address ecological and conservationist matters. And notice too Knopf's insistence that such ecological considerations be "worked into a framework of actual field experience," not the reverse. That was not the approach Leopold's essays had been taking up to that time. Conservation issues, not descriptions of nature, were the controlling element in his essays. Ironically had Knopf held to its desire to mold ecological considerations into field experience, it would have judged Leopold's essays more favorably in 1944 and in 1947. Leopold's responding letter (December 3, 1941) addresses this issue which was to separate them for the next six years. In it Leopold also questioned "how far into ecology (that is, how far beyond *mere natural history*) such a book should attempt to go. . . . I am convinced that the book should go part way into ecological observation" (italics mine).

This matter of what constitutes a nature book, of what is the right mix of nature observation and conservation exposition received little attention from Leopold during the next two or more years. On December 29, 1941, Leopold wrote Knopf, "I am out as sole author for a year or two." He claimed to be writing "a series of ecological essays . . . as a Christmas book." I have uncovered no other reference to this unusual Christmas book idea. It is worth noting that Leopold describes what he was writing in 1941 as "ecological essays," a term appropriate for the largely non-narrative exhortative conservation pieces written before that time. In fact the title he probably would have chosen for the essays at that time was *Conservation Ecology.* In January of 1942 Knopf asked to see some of these ecological essays. Leopold pleaded that upon closer consideration he found the essays not to be ready. In April of 1943 Knopf again asked how the essays were progressing. Leopold responded that that he would get to them in the next year or two. In January of 1944 Knopf once again inquired about the essays. This time Leopold was able to say, "I have been working steadily" (January 28, 1944). And he had been. Of the thirty-seven datable manuscript drafts of the essays from *A Sand County Almanac* which are included in "Drafts of Essays in Sand County Almanac" (Writings, Box 5) in the Leopold archives of the University of Wisconsin, twenty-one date from 1943 and the first half of 1944, especially from September of 1943 through June of 1944. Probably eight of the book's forty-one essays were written during that period.

That period is also rich in Leopold's correspondence with his friend H. Albert Hochbaum, artist and wildfowl expert. Their letters to one another reveal what essays Leopold was then working on, what tone and content he sought for the essays, and especially what overall effect Leopold wanted the collection of essays to have. As early as May 7, 1943, in a letter to Hochbaum Leopold spoke of "our joint venture." "Let's by all means reinstate the original plan and keep sending each other whatever materials we manage to bring together." Regarding the book and its drawings Leopold was to say, "This is a personal venture, and I take special pride in its 'home-made' aspect" (June 18, 1944). Later of Hochbaum's critical advice Leopold said, "I am learning alot from your letters" (June 3, 1944). "[O]ur intellectual partnership is one of the anchors of my ship. Without it I would be adrift" (October 17, 1947). On September 23, 1943, Leopold could say that "for the moment I have my hands more than full with the book. Perhaps I had not told you that I had spent the summer at it. I think I will call it 'Land Ecology' instead of 'Conservation Ecology.' " Leopold expressed concern over what he called the "literary effect" of the essays. Regarding his effort to reconcile the need to provide enough environmental data to permit ethical judgment and on the other hand achieving a satisfactory artistic or literary effect, Leopold wrote at length in his letter of March 1, 1944.

> When you paint a picture, it conveys a single idea, and not all of the ideas pertinent to the particular landscape or action. If you inserted all of the ideas of your picture, it would spoil it.
>
> In order to arrive at an ethical judgment, however, about any question raised by the picture, you need to consider all pertinent ideas, including those which changed in time. It seems to me, therefore, that any artistic effort, whether a picture or an essay, most often contains less than is needed for an ethical judgment. That is approximately what I meant when I said I intended to revise the essays insofar as could be done without spoiling the literary effect. . . . I do know that the essays can give a more accurate judgment, particularly in reference to my own changes of attitude in time without hurting literary effect, and possibly improving the literary effect.

These 1943 and early 1944 letters refer to "Green Lagoons," "Too Early," "Illinois Bus Ride," "Draba," "Marshland Elegy," "Escudilla," "sketch of the chickadees," "The Flambeau," "Odyssey," "Great Possessions," "Thinking Like a Mountain," and "Pines Above the Snow." Hochbaum, in a letter Leopold marked "important letter," combined praise and criticism of the essays, and encouraged Leopold to worry less about "literary effects." "Since you can give a lilt to the deadest subject, it seems to me that [the quality of the essays] is in what you are writing about, not in your technique" (March 11, 1944). Moreover, Hochbaum was able to identify precisely those issues of unity, tone, and emphasis that were to plague Leopold and his prospective publishers for years. He found the overarching theme of the essays hard to uncover. He considered Leopold's tone elitist and cynical, and encouraged Leopold to write more simply, personally, optimistically. He further suggested that Leopold, in his struggle to get the right mix of natural facts and "ethical judgment" (March 11, 1944) think of the series of essays as a self-portrait, and that the Leopold depicted be "less a person than he is a Standard" (March 11, 1944), but a standard which finds lessons in his own life as well as in the lives of others. As Hochbaum wrote on February 4, 1944:

> The lesson you wish to put across is the lesson that must be taught—preservation of the natural. Yet it is not easily taught if you put yourself above other men. That is why I mentioned your earlier attitude toward the wolf. The Bureau Chief had as much right to believe we should be rid of the Escudilla bear, or the government crews to plan roads for the crane marsh, as you had the right to plan the extermination of wolves in New Mexico. One gathers from parts of Escudilla and Marshland Elegy that you bear a grudge

> against these fellows for not thinking as you when, in your own writings, you show that you once followed a similar pattern of thought. Your lesson is much stronger, then, if you try to show how your own attitude towards your environment has changed." (February 4, 1944)

Leopold himself had earlier acknowledged that "about the question of attitude in the essays—we all go through the wringer at one time or another" (January 29, 1944). A month later on the same matter, Hochbaum said, "you have sometimes followed trails like anyone else that lead you up wrong alleys. That is why I suggested the wolf business." "I hope you will have at least one piece on wolves alone" (March 11, 1944). On March 21, Leopold said he planned to write a wolf essay soon. On April 14, he wrote, "I am roughing out an essay or two, working toward your idea of a shack series." Leopold also enclosed a draft of "Thinking Like a Mountain," an essay which blends personal experience and universal environmental statement, an essay of confession to match the diatribe of his 1930's ecological essays. Said Hochbaum, " 'Thinking Like a Mountain' fills the bill perfectly" (April 15, 1944).

On June 6, 1944, Leopold sent thirteen essays both to Macmillan, who had by then also contacted Leopold, and to Knopf. Much can be learned from a close examination of that list and of Leopold's comments about it.

1. Marshland Elegy
2. Song of the Gavilan
3. Guacamaja
4. Escudilla
5. Smoky Gold
6. Odyssey
7. Draba
8. Great Possessions
9. The Green Lagoons
10. Illinois Bus Ride
11. Pines Above the Snow
12. Thinking Like a Mountain
13. The Geese Return

[14. The Flambeau]
[15. Clandeboye]

In his cover letter Leopold said, "The object, which should need no elaboration if the essays are any good, is to convey an ecological view of land and conservation." Knopf had initially asked for "a personal book recounting adventure in the field" (November 26, 1941). At first glance one might conclude that Leopold had attempted no accommodation between philosophical ecological essays and mere natural history. Such is, however, by no means the case. Conspicuously absent from the list are three nonnarrative ecological essays from the 1930's: "Conservation Esthetic," "The Conservation Ethic," and "Wildlife in American Culture." Clearly Leopold's purpose in these thirteen essays (to which two more were added in August of 1944) upon which no organizational structure had yet been imposed, was to popularize and to dramatize through actual events, in some cases through his own personal experiences, those same ecological and conservation issues which he had addressed in the earlier philosophic essays. But if on the one hand the more philosophical essays do not appear, neither on the other hand except incidentally do the essays based on shack experiences. It is interesting to note that after ten years at the shack and after two and a half years of serious thought about nature essays, Leopold used the shack experience in only two of the fifteen essays, "Great Possessions" and "Pines Above the Snow." Unlike the 1947 draft, the 1944 draft of "The Geese Return" contained no shack reference. Ecological preachment, made accessible to the public by means of described events and experiences, is the dominant essay type by 1944. "Draba" is the most notable exception, a gentle, elegant description and implicit ecological argument.

This change in the perspective of Leopold's essays is evident in what he said in his cover letter about a title for the book. I once thought to call it "Marshland Elegy —And Other Essays," but "Thinking Like a Mountain—And Other Essays," now strikes me as better" (June 6, 1944). Up to the summer of 1943 Leopold thought of the title as *Conservation Ecology*. After giving his first real attention to the essays in the summer of 1943, *Land Ecology* seemed a more appropriate title. The change points to a greater interest in natural fact and a lesser interest in human conservation activities. But as Leopold continued his work on the book, particular essays embodying the idea of land ecology seemed apt to name the book by, first "Marshland Elegy" and by June, 1944, "Thinking Like a Mountain." "Marshland Elegy" which dates from 1937 begins with an exquisitely poetic portrayal of a marsh dawn, and ends with a harsh attack on governmental conservation blundering and the prospect of an ecological doomsday. Leopold's place in the piece is that of aloof critic, the judge of what is right. By contrast "Thinking Like a Mountain" is personal, experiential, humble, even confessional. It records Leopold's own ecological blunders. More profound than "Elegy," it quietly speaks of individual attitude, of Leopold's own change in attitude. In place of the doomsday ending in "Elegy" it concludes with Thoreau's hopeful dictum, "In wildness is the salvation of the world."

This combining in the same essay of wolf description, personal experience, attitude change, and ecological comment troubled the editors of Knopf. Their letter of rejection of July 24, 1944 (Macmillan had rejected the essays with virtually no comment a few days earlier) triggered Leopold's struggle for the next three and a half years to define to his own satisfaction what a nature book should be. The 1944 Knopf rejection comments and Leopold's response to them are critical to an understanding of the concept and structure of *A Sand County Almanac*, the prototype for all contemporary nature writing. For that reason I include Knopf's entire July 24, 1944, letter.

Dear Professor Leopold,

We have discussed your essays here and find that, while we like your writing, they do not seem altogether suitable for book publication in their present form. One reason is that they are so scattered in subject matter, and it also seems to us that the point of view and even the style varies from one essay to another. Pieces of only a page or two in length are also rather difficult to put into a book. And of course the dozen articles submitted would make a very slim volume indeed. I am sure you plan these as only part of a volume.

I wonder if you would consider making a book purely of nature observations, with less emphasis on the ecological ideas which you have incorporated into your present manuscript? It seems to us that these ecological theories are very difficult indeed to present successfully for the layman. Certainly, the repetition in chapter after chapter of a book, of the idea that the various elements and forces of nature should be kept in balance would end by becoming monotonous. Would it not be better to make the greater part of the book observation of wild life in narrative form, such as your pieces on "Great Possessions" and the "Green Lagoons," adding a chapter developing the ecological interpretations?

Such a book should, we feel, be based on your own experiences and if possible should be limited to one region of the country. In the present collection, we feel a distinct break between the middlewestern and southwestern essays, because of the completely different conditions existing in the two regions. Some sort of unifying theme or principals must be found for a book of this sort, we think, and perhaps it would hold together better if it were limited to a single part of the country.

One reason the ideas about the balance of nature, as embodied in these essays, do not seem successfully presented is, I feel, that the reader is apt to get a confused picture of what you advocate. Sometimes it seems that

> you want more intelligent planning, but you point out that nature's balance was upset with the coming of civilization, and you certainly do not seem to like the ordinary brand of conservationists and government planners. I think the average reader would be left somewhat uncertain as to what you propose. Perhaps in a single essay, all these ideas could be related so that your basic theme would become clearer.
>
> I should add that we are impressed with your writing, with the freshness of observation which it reflects, and the skill of phrase. We believe that readers who like nature will enjoy such writing and hope that we can work out with you a successful plan for a volume. I would appreciate hearing your reaction to the above, and will hold the essays until you tell me what to do with them.
>
> Yours sincerely,
> Clinton Simpson

That the essays were yet not developed into a book form is true. But the more basic issue remained the direction Leopold's essays took, their effort to combine narrative and exposition. Not surprisingly Knopf liked "Green Lagoons" and "Great Possessions." The editors still preferred "a book purely of nature observations, with less emphasis on ecological ideas." The heart of the Knopf/Leopold debate was the perceived conflict between observation of nature and comment about nature, between aesthetic response and ethical insight, between nature as other and man/land interaction. Knopf wanted the "what-I-saw-while-in-the-woods" sort of nature book. Leopold's concerns by contrast were planetary and ethical as well as provincial and descriptive. In a letter dated August 24, 1944, Knopf after seeking the judgment of two unnamed professional writers, dropped its concern for regional focus, but persisted in demanding more essays, longer essays, elimination of repetitive ecological arguments, and the addition of a chapter "which sums up the argument for the forces of nature." Leopold's reply to Knopf's rejection letter made clear that his agenda was "conservation in continental rather than in local terms" (July 27, 1944). But he agreed with Knopf that the essays should, whenever possible be presented in narrative form. Hochbaum's immediate response to the Knopf letter Leopold at once shared with him, pointed out the similarities between Knopf's and his own previous criticisms, and urged Leopold to recast the entire book around the shack experience*—something narrative, closer to nature, more hopeful in tone (July 31, 1944). Leopold admitted that "the shack essays . . . are of a different cast than [sic] the others" (August 17, 1944). By the end of the summer Leopold pledged to redo the essays along the lines Knopf suggested—longer essays with a discernible difference between the body of natural observation and the final section on ecological matters.

But apparently much time elapsed before Leopold worked on the book. To Hochbaum on December 4, 1944, Leopold wrote, "I'm saying nothing of the essays because I've not yet tackled them." Heavy correspondence continued between them, but no references to the essays are to be found during 1945-1947. Knopf continued to check periodically with Leopold on how the work was progressing. Little was being done. At the urging of some of his friends Leopold sent some of his earlier "philosophical" essays to Knopf. Returning them, Clinton Simpson again expressed concern over what he considered thematic and stylistic disunity. As encouragement he added, "I find whatever you write full of interest and vitality, and it seems to me our only problem is one of fitting together the pieces in a way that will not seem haphazard or annoying to the reader" (April 29, 1946). Said Leopold in reply, "I entirely agree with you that I can see no easy way of getting unity between the philosophical pa-

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* A rejection letter from the University of Minnesota Press dated January 31, 1946, suggested that in his essays Leopold "introduce more of himself, so that his personal experience becomes the thread on which the essays are strung."

pers and the descriptive essays" (May 10, 1946). No issue was the object of more of Leopold's literary attention than this matter of unifying natural description and ecological exhortation. He saw "Draba" and "The Land Ethic" as of one piece. Knopf did not.

Much writing and revising took place from the last half of 1946 up to the time the manuscript was submitted in 1947. Leopold's correspondence reveals his determination to get the essays published one way or another. Eleven of the thirty-seven dated essays included in "Drafts of Essays in Sand County Almanac" (Writings, Box 5) in the University of Wisconsin Leopold archives fall into this period. (Twenty-one fall into the earlier 1943-44 productive period.) Many of these later essays growing out of Leopold's shack experiences and reflecting his intention to include more personal narrative, are privately held and unavailable for examination. Probably about nine of the forty-one essays were written during this period.

The results of Leopold's 1946-47 literary work appear in the manuscript of *A Sand County Almanac,* then entitled *Great Possessions,* sent to Knopf on September 5, 1947. It is important to note that Leopold explicitly stated that he put together this manuscript (essentially the same as the published book) in a deliberate effort to meet the objections Knopf raised in their three letters of July 24, 1944; August 24, 1944; and April 29, 1946. *A Sand County Almanac* as we have it today was Leopold's best effort to combine narrative and exposition, natural fact and conservation value, joy and concern, the particular and the universal, the scientist and the poet and the philosopher. Knopf saw it otherwise. The book, they said, "is far from being satisfactorily organized. . . . What we like best is the nature observations, and the more objective narratives and essays. We like less the subjective parts—that is, the philosophical reflections which are less fresh, and which one reader finds sometimes 'fatuous.' The ecological argument everyone finds unconvincing; and as in previous drafts, it is not tied up with the rest of the book." As final advice Clinton Simpson suggested to Leopold that "instead of trying to cover so much territory, you might concentrate on the 120 acres of woodland you bought" (November 5, 1947). By this time Leopold was less ready to accept Knopf's judgment on a matter that had received so much of his attention. Regarding the essays he said in his letter of reply, "I still think that they have a unity as they are" (November 18, 1947). Five months later on April 14, 1948, Oxford University Press agreed and accepted the same manuscript without critical comment. (Sloane was also looking favorably at the manuscript at that time.)

It is important to examine what was included in the final manuscript, the one that evolved over six years of debate over its contents, the one in which Leopold properly unified the elements of natural description and ecological concerns, of field and contemplation, of dawn at his Wisconsin River shack and his analysis of environmental history. A comparison of the table of contents of the 1947 manuscript with the 1944 list demonstrates change in two directions. In the first place many more essays by 1947 are based on the shack experience. Leopold called these personal narratives "Sauk County Almanac." In them emerges Leopold the man, the participant observer, the Standard as Hochbaum would have it. The arguments of the earlier ecological essays and philosophical essays are demonstrated in the personal experiences recorded in these late essays. Fact and value appear in all three essay types: one merely gains access through a different door.

Leopold's late attention to essays based on his shack experience is beyond doubt. It is reasonable to assume that the focus grew out of Knopf's and Hochbaum's urging. The 1947 manuscript includes twenty-one essays in Part I "Sauk County Almanac," only seven of which had appeared earlier as articles, one of them "Pines Above the Snow" in a version so different that one may conclude that fifteen of the twenty-one Part I essays are new to the book. Essay manuscript dates and the 1944 list of fifteen essays demonstrate that most of the essays in Part I, "Sauk County Almanac" date from Leopold's last few years and reflect his turning to personal experience and to nature description as a vehicle for conservation thinking. Observed meadow mice replaced criticized road builders.

By contrast only six of the sixteen essays in Part II had not been previously published. Ten of these sixteen essays were among the fifteen included on the 1944 list. Probably only two of the essays in the manuscript Part II were written after mid-1944. Clearly the ecological essays included in Part II reflect Leopold's 1941-1945 sense of what nature writing should be. "Marshland Elegy" and "Thinking Like a Mountain" cover the range of such ecological essays. Any reading which attempts to reconstruct the making of *A Sand County Almanac* must begin with Part II. Parts I and III come later in Leopold's thinking and reflect his final conviction that personal descriptive essays on the one hand, experience based ecological essays in the converging middle, and philosophic essays on the other hand all have their place in a book about nature.

If it is true that Leopold gave late attention to personal narrative in the shack essays, it is also true that he only late determined to include four philosophical essays, three of them essentially unchanged from their first appearances between 1933 and 1941. Clearly Leopold considered what he had said about a conservation ethic in 1933 to be no less important in 1947. Of even more importance for this investigation of the conceptual evolution of *A Sand County Almanac,* Leopold to the end saw a unity in "Draba" and "The Land Ethic." Thus the book in its final form acquired a greater range in style and point of view than it had had in the earlier years of its making. Thematically it remained complexly tight.

Throughout the writing of the book Leopold was concerned about unity of tone, "literary effect" as he described it to Hochbaum. That he was consciously concerned about textual balance is evident from a handwritten, undated sheet (in Robert McCabe's Leopold file) entitled "Notes for Paper Writing." On it Leopold argued the need to set forth at the outset the facts and descriptions related to the matter. This process he called "exposition." Only upon its completion ought one move on to what he called "commentary," that is discussion, appraisal, and interpretation. That organization is certainly reflected in the three-part division of *A Sand County Almanac:* I. Sauk County Almanac, II. Sketches Here and There, III. The Upshot. Lest there be any doubt, Leopold carefully spelled out their relationship in the "Foreword," that section of the book I am certain Leopold wrote with Knopf's previous objections in mind. Part I, he said, tells what his family sees and does at its week-end refuge—personal observation. Part II he described as episodes in his life bearing on conservation issues—experientially based conservation commentary. The essays of Part III he said deal with "philosophical questions." And notice how Leopold had been conditioned to assume very few were interested in such essays. How wrong Knopf was to want them out; how right Leopold was to insist on their presence. *A Sand County Almanac* is a working out of what "Notes For Paper Writing" says about composition and argument. It begins with the facts and descriptions of land and man at the shack. Only then does it move on to discussion, appraisal, and interpretation.

The evolution of Leopold's thinking about his book, which he never thought of by the publisher's title *A Sand County Almanac,* is epitomized in his changing choice of title. Before mid-1943 *Conservation Ecology* was his choice. Around that time he turned to

Land Ecology (See earlier comments). In early 1944 he preferred as title essay "Marshland Elegy"—a lovely but devastating ecological essay, one in which Leopold does not himself appear. By mid-1944 Leopold considered "Thinking Like a Mountain" a better choice—a more personal and thoughtful essay. The title essay Leopold chose for the 1947 manuscript was "Great Possessions," the essay he thought his best (October 31, 1944), one which depends on Leopold the man, the phenologist, the lover of land, the man in search for harmony with his world. This last title choice reflects Leopold's last and deepest sense of the book—a book which ironically assesses man's great possessions; a book which through narrative and exposition, both implicitly and explicitly, set up Aldo Leopold as Standard. As his essays evolved, Leopold added Leopold an example to Leopold the preceptor. Only then did he become Leopold as Standard.

A reading of *A Sand County Almanac* benefits not only from an understanding of its conceptual and structural evolution, but also from an awareness of how Leopold wrote and revised, and of how the book was edited. Important as these matters are, they have not thus far been made accessible to Leopold's readers. My brief comments are to be construed as introductory to the more complete study which has yet to be made.

Those who have studied the literary process are familiar with the personal journal extracted and reshaped into essays and finally into books. John Muir and Henry Thoreau wrote that way. Aldo Leopold did not. It was habit for Leopold to take a small pocket notebook with him into the field. The plaid-covered notebook found in his pocket at his death, written in scratched script and cryptic style, contained records of temperatures, shopping lists, correlations of bird songs and candle power, and flower blooming dates. All is factual and quantitative. The last line in the fire-scorched notebook reads "lilac shoots 2″ long." These field notes were promptly recorded in what is called "The Shack Journal," the several volumes of which are to be found in the University of Wisconsin Leopold archives. The journal entries, consisting entirely of listings and descriptions of natural events, were made by different members of the Leopold family, but primarily by Aldo himself. The journal, carefully done and without erasures, is divided into sections with recurring headings such as "Phenology, Mammals, Broken Candle, First Bloom, Out of Bloom, Last Bloom, and so on." This journal, containing only natural description with no value or delight response, is neither a Leopold, nor a family, nor a shack journal. It is a land journal. The Leopold children used it as a data base for later technical articles. But the journal is no way the basis for the essays in *A Sand County Almanac*. A search of journal entries on, for example, woodcocks as indexed by Leopold's wife (interestingly Leopold had suggested to Knopf that *Great Possessions* be indexed) demonstrates beyond doubt that the journal is not the literary source of "Sky Dance."

Leopold's initial literary unit was the draft essay, written neither at home nor at the shack but in his office early in the morning. Nor did I find indication that Leopold wrote from extensive preparatory notes. To the contrary, in several drafts I found blank spaces where exact numbers and technical terms were to be added later. An examination of Leopold's neat pencil drafts reveals writing that is skillful, colorful, natural. Leopold's first draft language was metaphoric, balanced, poetic. There can be no doubt about Leopold's literary gift. Revision followed, mostly deletion and tightening, but occasionally large portions were added, like the Jonathan Carver and John Muir sections of "Bur Oak" and the accounts of geese near the shack in "The Geese Return." Perspective revisions occur. For example, the first draft of "January Thaw" speaks of "the naturalist." The next draft replaces "the naturalist" with "you." Only in the final version does the personalized, Leopold "I" appear.

Leopold actively sought critical comment on his writing from friends, family, and colleagues. Dozens of people at one time or other examined and critiqued Leopold's essays. One of the very last notes before his death requested eleven of his friends to read his manuscript with an eye for unity, style, and balance between description and commentary—matters which concerned him to the end. After his death Leopold's son Luna headed a team responsible for the book's final editing. The Hamerstroms wisely argued that the work be as Leopold left it. Others suggested changes, some of which were made. Oxford considered the title *Great Possessions* unsellable. Worse titles were suggested: *Fast Losing Ground, Last Call, Two Steps Backward, This We lose,* and others (July 19, 1948). One of the editorial team, Alfred Etter, found either "Sand Country Almanac" or "Seasons in the Sand Country" a better rubric for Part I than Leopold's choice "Sauk County Almanac" (June 10, 1948). Possibly the most important change to the manuscript after Leopold's death was the climax-altering decision to shift "The Land Ethic" from its original first placement in Part III to its present final position. Many lesser changes were also made. "'The Alder Fork" was changed from Part II to Part I. "Ave Maria" was changed a bit and retitled "Choral Copse," although Leopold's wife preferred the original title. "Prairie Birthday," not in the original manuscript, was added to Part I. "The White Mountain" was renamed "On Top." Opinions of the essays differed widely. One of the editorial team thought all of Part I was weak. Bill Vogt considered the essay "Draba" to be "as insignificant as the plant itself." The first sentence of this essay drafted on March 16, 1943, was cut. "During this the longest winter, of the biggest war, in this month of the big tax, it is salutary to think upon Draba." Whether that deletion improved the piece, you may judge. A reference to Gabriel Heater was dropped from "Too Early." Several of the editorial team objected to language here and there which they considered "too sweet" and not in character for Leopold. But beyond other small changes, the manuscript remained intact.

A Sand County Almanac in the making had a long and interesting history. Any serious study of this work, and certainly any attempt to analyze it as *genre exemplar* can no longer be content with the 1949 published edition, but must also take into account how Leopold wrote and revised, and especially how the concept of the book evolved. Leopold's attitude toward writing was no less ecological than was his attitude toward land.

THE PRE-EUROPEAN SETTLEMENT VEGETATION OF THE ALDO LEOPOLD MEMORIAL RESERVE

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Abstract

From the original land survey notes of the eight sections surrounding and including the Aldo Leopold Memorial Reserve in Sauk County, Wisconsin, qualitative data were used to determine plant community types present prior to European settlement. They included savannas, upland forests, floodplain forests, tamarack swamps, and marshes. Through correlation with soils information and comparison with the pre-European settlement vegetation maps of Columbia and Sauk Counties and with the present vegetation of the Reserve, a more detailed pre-settlement vegetation map was prepared. Ten plant communities were distinguished: oak openings, oak barrens, dry upland forest, mixed hardwood forest, mixed floodplain forest, wet floodplain forest, tamarack swamp, low prairie, sedge meadow, and marsh. These communities were related to discontinuous gradients of fire stress, fluctuating water-levels, and siltation levels. Prevailing climate, regional geology, and local topography were the main factors responsible for the environmental gradients.

INTRODUCTION

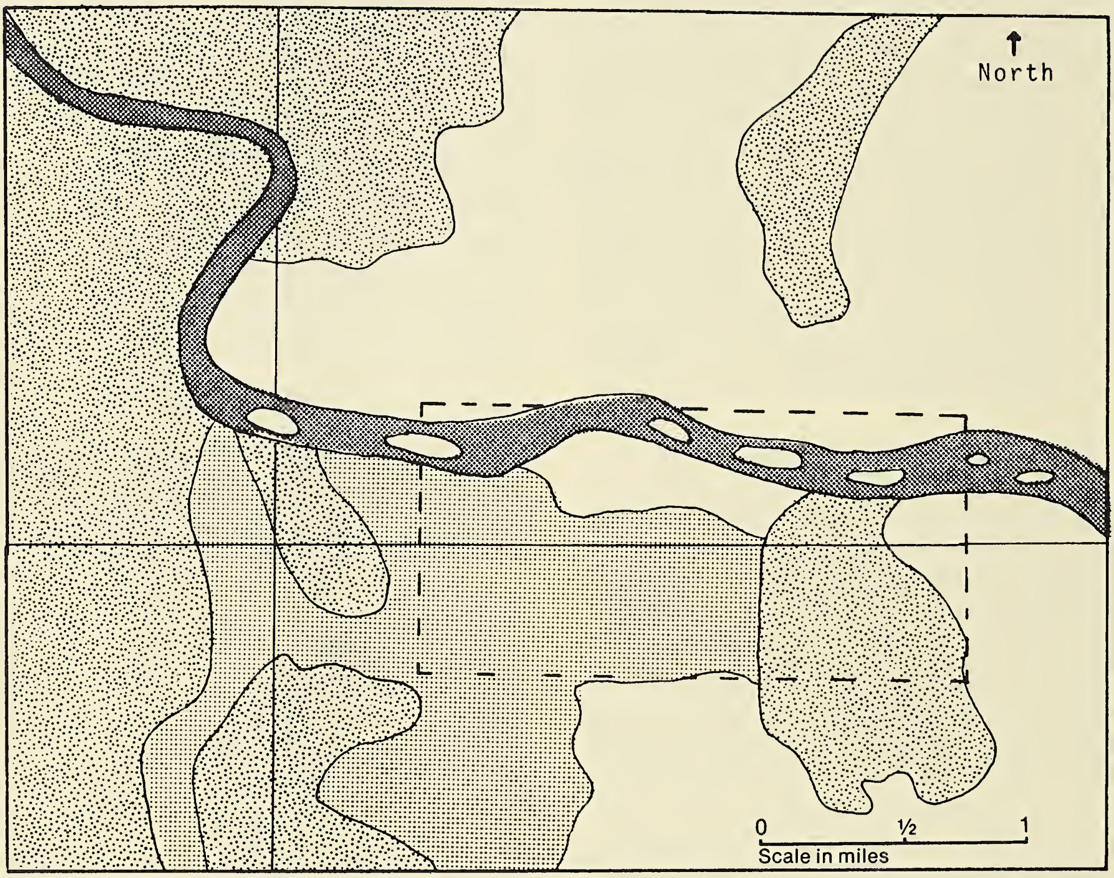
The vegetation of Wisconsin has been thoroughly modified through European settlement and subsequent land-use. Frequent fires maintained many of the plant communities of Wisconsin prior to settlement. In the absence of fire, the sunny oak openings of southern Wisconsin grew up into the oak woodlots of today, while shrub-carr and aspen invaded the sedge meadows and low prairies. Lumbering and farming transformed most of the remaining expanses of prairie, savanna, marsh, and forest into today's fields of corn and hay (Curtis 1959).

The Aldo Leopold Memorial Reserve is located in Fairfield Township, Sauk County, Wisconsin (R7E, T12N, Sec. 2, 3, 4, 5; R7E, T13N Sec. 32, 33, 34, 35) (Fig. 1). This area is the "sand country" of Aldo Leopold where he and his family spent their weekends and vacations in the 1930's and 1940's. The property had been devastated by early settlers, and Leopold spent much of his time nurturing the land back to a healthy state. Today, the Reserve encompasses a great diversity of plant communities, ranging from floodplain forest, marshes and

Fig. 1. Location of the Aldo Leopold Memorial Reserve, Sauk County, Wisconsin.

prairies to upland woodlands and cultivated fields (Luthin 1978).

A goal of current research on the Reserve is to acquire an understanding of the ecology, environment, and history of the Reserve as a guide to the management of the area, as well as to increase our capacity for land rehabilitation and management. The purposes of my study were to identify the major presettlement plant community types of the Aldo Leopold Memorial Reserve and their species composition, and to relate their occurrence and distribution to environmental factors. This, in turn, will facilitate comparison of the presettlement plant community types with those of Aldo Leopold's time and



LEGEND

END MORAINES

GROUND MORAINE

(Mecan & Wyocena loamy sand and sandy loam, Plainfield and Gotham loamy sand and sand)

LAKE BASIN (Wauseon, Keowns, Tustin and Rimer loams and sandy loam; and peat soils)

---- Borders of the study area

Fig. 2. Glacial deposits and generalized soils of the area surrounding and including the Aldo Leopold Memorial Reserve, Sauk Co., Wisconsin. (Adapted from Wisconsin Geological and Natural History Survey 1976, Glacial Deposits of Wisconsin Map and from Hole *et al.* 1968, Overlay Soil Map of Wisconsin.)

of the present to emphasize the degree to which the landscape has been modified following European settlement.

Description of the Study Area

The study area lies in northeastern Sauk County, Wisconsin, south of the tension zone which separates the Northern Hardwoods floristic province to the northeast from the Prairie-Forest province to the southwest (Curtis 1959). The study area includes the eight sections surrounding the Aldo Leopold Memorial Reserve. It is bounded to the north by the Wisconsin River and to the south by a large marsh. The marsh has recently been drained and is now farmed.

The surface features have been influenced primarily by glaciation, subsequent erosion, and the pervasive influence of the Wisconsin River. The study area is covered with a mantle of deposits laid down by a series of glacial advances, the last being the Green Bay Lobe of the late Woodfordian age (Black & Rubin 1967-68) approximately 12,000 years ago. During glaciation, ice dammed the river in the vicinity of the study area. Subsequently, the retreating glacier deposited debris between 100 and 300 feet in depth within the area (Borman 1971). In the process, the river was diverted from its present location along the north end of the study area (Alden 1918). Temporary ponding occurred until the swollen waters broke through the resistant morainal deposits (Columbia County Planning Department 1970).

At the time of European settlement, the glacial lake basin with its characteristically broad and flat expanse occupied the central part of the study area (Columbia County Planning Department 1970). A rolling terrain composed of morainal hills (Socha, pers. comm., 1981) rising 50 to 170 feet above the lake basin lay to the south, west and east and a floodplain to the north (Fig. 2).

Original Land Survey Records

There are several historical sources for a description of the pre-settlement vegetation of a given area. One primary source is traveller and settler accounts in local, county, and state historical societies and histories. The Wisconsin River was the principal means of transportation in the study area prior to settlement. One traveller wrote of it:

> The chanel is subject to change, from the numerous bars of sand which lie in it, and frequently alter their position. In this river are numerous islands, in which grow the principal timber of the country. The banks are generally low and sandy. (Tanner 1908)

Another described the river as passing between "forests of oak" (Marryat 1839) and yet another remarked about numerous tall pines on the islands near the present city of Portage (Turner 1898). William Toole, a pioneer farmer in a neighboring township, meanwhile, described the interior country as composed of

> exclusively oak in the several varieties of black, red, white, and burr oak, with an occasional hickery or aspen poplar, and very rarely a black cherry, irregularly scattered apart and seldom near enough together to be called a grove or more commonly a growth of oak brush, with dwarf willows, poplar, hazel, and a few other kinds of shrubs. (Cole 1918)

Reflecting over her childhood in the same township as the study area, Mrs. John Luce wrote:

> Fairfield in pioneer days was a veritable flower garden. Wherever the sod was unbroken the ground was literally covered with flowers. (Luce 1912)

Not everyone was so delighted with what they found, though. While surveying about two miles east of the study area, Theodore Conkey wrote in his field notes: "They call this barrens and barren it is" (Conkey 1845).

In areas where they are available, however, the records of the original U.S. Government land surveyors are most frequently used to reconstruct the past vegetation of a particular region.

The data for the original land survey of the study area were collected in 1845 by Theodore Conkey and John Brink and in 1851 by Henry J. Howell. At each section and quarter section corner along the survey lines, i.e., at ½ mile intervals, corner posts were set. From each post, these surveyors measured the distance* and angle to the two closest trees in different quadrants, blazed the trees to facilitate relocation, and recorded the tree species and diameter. In addition, line trees, those intersected by survey lines, were recorded by species and diameter. The location of springs, ponds, streams, prairies, marshes, bottoms and other features encountered along the survey lines were recorded, and after each mile and township, the Deputy Surveyor completed a brief summary of the land surveyed. Upon completion of the survey, plat maps were prepared for each township and range (Dodds *et al.* 1943, and Tans 1976).

Evidence of fraud and bias has been found in the original land survey records for some areas (Bourdo 1956), but there is no evidence indicating fraud in the data for the Reserve (McConaghy, 1979, pers. comm.).

The original land survey records do have their limitations. The survey was conducted under less than ideal conditions. Furthermore, instructions to the surveyors frequently varied; surveys were conducted in different months; different crews surveyed the interior and exterior lines of a township; the survey crews were not always literate, and the gathering of ecological data was not a stated goal of the survey (Tans 1976).

The major limitation of the survey in the study area, however, is its scale. The Reserve is small—under 1200 acres—and geologically complex. The survey records only provide information along the four sides of each square mile. By themselves, they are not capable of the fine resolution necessary in this diverse landscape. Some lowland communities, such as sedge meadows, low prairies, and emergent aquatic marsh known to be present in the Reserve, were not separated in the land survey records (Leopold 1935-48, and Luthin 1978). Other plant communities were overlooked because they occupied too small an area to be present on one of the survey lines. Even with topographical information, vegetation types from the GLO data are generalized and boundaries between them arbitrary.

Finally, the relatively few corners present (35 within the study area) are not enough to justify a quantitative treatment of the survey data. Within each community type, the number of trees of each species is less than 10 and usually less than 5. Thus, a statistical treatment of the results may be more confusing than illuminating. Quantitative analyses of vegetational composition, spatial relationships, and structure, which are useful in mapping community types, are therefore not attempted here.

Soils: Another Historical Record?

Soils are an additional source of information for reconstructing the pre-settlement vegetation of a particular region. A soil is a three dimensional body of mineral and organic matter that reflects conditions at the site where it is found (SCS Soil Survey Manual 1951). The biota is particularly important in influencing the development of characteristic horizons within the soil body (Jenny 1958, and Hole 1976). Plant communities will occur with correspondingly distinct soil profiles (Buol, Hole, and McCracken 1973). For example in a forested area in Menominee County that escaped clear-cutting in logging days three major forest communities, with correspondingly distinct soil profiles, occur within a distance of 40 kilometers: (1) hemlock forest (Spodosol soil), (2) hemlock-northern hardwood

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* Surveyors measured distances in units of chains (66 ft.) and links (.66 ft. or 7.92 in.); 80 chains = 1 mile. Survey posts were set at the 40 and 80 chain points on the four sides of each section.

forest (double profile soil—weak Spodosol over weak Alfisol soil), and (3) northern hardwood forest (weakly developed Alfisol soil) (Milfred, Olson, and Hole 1967).

Soils respond slowly to vegetative shifts. In southern Wisconsin, for instance, Van Rooyen (1973) estimated that about 400 years are required to form a mollic epipedon (a characteristic prairie surface horizon) in a well-drained site and 200 years where drainage is impeded. An ochric epipedon (a characteristic forest surface horizon) may form in 300 years under a nearby deciduous forest. This time lapse, called "pedologic lag," between change of vegetation and that of the soil profile allows one to reconstruct the presettlement vegetation of a given region long after settlement.

Soil survey maps (SCS 1951) based on small-scale aerial photographs are very useful in reconstructing the pre-settlement vegetation of locations like the Aldo Leopold Memorial Reserve that are too small to be analyzed using surveyors' data alone. They indicate the probable distribution of plant communities not intersected by the survey lines. They help sharpen delineation of boundaries between community types and help to differentiate certain lowland plant communities, such as sedge meadows, low prairies, and emergent aquatic types, that cannot be determined from the land survey records. When accompanied by field investigations of vegetation and soils, as in the Menominee Tribal Lands of Wisconsin study (Milfred, Olson, & Hole 1967), they can help determine successional relationships among vegetation types and the importance and extent of environmental factors operating in the area.

There are limitations in the soil approach to reconstructing past vegetation patterns. In mapping the soils of Wisconsin, the SCS indicated the pre-settlement vegetation type associated with each soil series. They performed the bulk of their mapping, however, prior to Curtis's studies on the vegetation of Wisconsin (1959) and to Findley's map of the pre-settlement vegetation of Wisconsin (1976). Their terminology, therefore, is not directly comparable to that of Curtis (Hole, 1980, pers. comm.).

Furthermore, our understanding of the processes of soil formation under specific biotic regimes is incomplete and, in some cases, very general. It is consequently difficult to be certain of the vegetation type associated with a given soil profile and for a given soil series. There may be two (or more) vegetation types associated with a particular series. For example, Curtis noted (1959) that the very ancient maple forests of Green County, Wisconsin occurred on soils mapped in the early reconnaissance soil surveys as prairie soils. A later soil survey of Grant County, Wisconsin (Robinson & Klingelhoets 1961) made the same ecological error (see Hole, 1976). Like typical prairie soil profiles, these soils had a nearly black A_1 layer, enriched in humus, extending to a depth of 7 to 9 inches. Most likely, this so-called "prairie horizon" was not the result of former prairie occupation as originally believed, but instead was caused by the "nutrient-pumping" ability of sugar maple and basswood.

Soil profiles also may reflect conditions that existed a hundred or more years prior to the time of European settlement and not those at the time of settlement. There has been a vegetative shift in the last few thousand years from grassland to encroaching forest (Curtis 1959). Because of the process of pedologic lag, one would expect the deep dark mineral soils to be more extensive in Wisconsin than the actual prairie that European settlers found there. This may be the real explanation for the fact that the soil map shows more of the state occupied by prairie soils than was occupied by prairie a century ago (Hole 1976).

Finally, soil series maps are themselves generalized and do not always include the soil series corresponding to particular vegetative types found in a given area. On extinct lake beds, for example, wet prairie is often a minor component in the moisture gradient from oak uplands through wet prairie, sedge meadows and marsh. Hence it typically does not appear in the generalized soil maps (Hole, 1980, pers. comm.).

Methods

Keeping these limitations in mind, one can construct a more detailed and accurate pre-settlement vegetation map for small study areas by utilizing both the original land survey records and the soil survey maps than by using either alone.

From the original land survey field books on file at the Division of Trust Lands and Investments (DNR, Madison, Wisconsin), the surveyors' notes from all of the interior and exterior lines of each section surrounding and including the Aldo Leopold Memorial Reserve were examined. The species and size of each bearing tree, the species and size of each line tree, the distance from tree to survey post, the description of each section, and the field notes on the meanders of the Wisconsin River were tabulated. This information was summarized and transferred to blank section outline forms. As data from the original survey records were transposed, each section and quarter section point was coded according to the nature of the plant community.

The determinants of the plant community types were similar to those utilized by Tans (1976) in his study of the pre-settlement vegetation of Columbia County, Wisconsin: the dominant tree species, if any, at the point, characteristics of the landscape from the surveyors' comments, and density of tree canopy as indicated by the distance from surveyor post to tree. A measure of density is possible because the mean of the two distances in links from survey post to tree corresponds well to the mean distance between trees in feet in a natural situation (Cottam and Curtis 1956).

The major groupings of plant community types in the presettlement landscape surrounding and including the Aldo Leopold Memorial Reserve were: savanna, upland forest, floodplain forest, tamarack swamp, and marsh.

After delineating these groups, soil types were utilized to distinguish between oak barrens and oak openings, between dry upland forest and mixed hardwood forest, between mixed floodplain forest and wet floodplain forest, and between low prairie, sedge meadow and emergent aquatic marsh. Determinations of the pre-settlement vegetational associates for the soil series present in the study area (Table 1) were based upon descriptions of the properties of the soil series found in Hole (1976) and in the records of the SCS and upon field evaluations of the present vegetational associates for each soil series.

An example will illustrate the procedure adopted here. Areas occupied by the Adrian soil series were characterized in the GLO survey notes as marsh and for the Granby soil series as marsh and floodplain forest. In Hole (1976), the vegetational associates for Adrian muck were sedge meadow or shrub carr and for Granby sandy loam swamp hardwoods or conifers. Since there was no evidence of shrubs in the GLO account for areas occupied by Adrian muck and no evidence of other natural plant communities in field investigations in the study area, it was classified as sedge meadow. Both swamp hardwoods and wet prairie were noted in field investigations, on the other hand, for areas occupied by the Granby soil series. I decided, therefore, that the vegetational associates found in Hole (1976) for Granby were not quite complete and mapped areas described as marsh in the GLO accounts and containing prairie species in the groundlayer at the present time as wet prairie. Two other soil series, Marshan and Rimer (Table 1), also had incomplete vegetational associates in Hole (1976).

TABLE 1. Soil types and their pre-European settlement vegetational associates.

Soil Types	*Vegetational Associates*
I. *Entisols* (recently formed soils)	
Typic Udipsamment—Plainfield*	Oak Barrens[1,2,4]/Dry Upland Forest[1,4]
Aquic Udipsamment—Brems*	Mixed Floodplain Forest[3,4]
Wet Alluvial*	Wet Floodplain Forest[3,4]
Alluvial*	Mixed Floodplain Forest[3,4]
II. *Mollisols* (prairie soils)	
Typic Argiudoll—Ringwood	Dry-Mesic Prairie[2]
Typic Haplaquoll—Granby*	Low Prairie[1,4]/Wet Floodplain Forest[1,2,4]
Gilford	Low Prairie[3]
Colwood	Low Prairie[3]
Marshan	Low Prairie[1]/Sedge Meadow[2]
III. *Alfisols* (high base status forest soils)	
Psammentic Hapludalf—Gotham*	Oak Opening[1,2,4]/Dry Upland Forest[1,2,4]
Typic Hapludalf—Wyocena*	Oak Opening[1,2]/Dry Upland Forest[1,2]
McHenry	Oak Opening[1,2]
Sisson	Mixed Hardwood Forest[2]
Fox	Oak Opening[1,2]/Dry Upland Forest[1,2]
Briggsville	Oak Opening[1,2]/Dry Upland Forest[1,2]
Arenic Hapludalf—Tustin*	Upland Forest[1,2]
Mollic Hapludalf—Billett	Oak Opening[1,3]
Aquic Hapludalf—Rimer*	Lowland Oak Opening[1]
Aquollic Hapludalf—Mosel	Oak Opening[1,3]
Shiffer*	Mixed Hardwood Forest[2,4]
IV. *Entisols* (organic soils)	
Terric Medisaprist—Adrian*	Sedge Meadow[2,4]
Palms	Sedge Meadow[2,4]
Typic Medisaprist—Houghton*	Emergent Aquatic[2,4]/Sedge Meadow[2,4]

* Found in Aldo Leopold Memorial Reserve.

Sources: [1] GLO Survey Notes
[2] Hole (1976)
[3] Soil Conservation Service Reports
[4] Field Investigations

The completed township maps coded to identify the major vegetation types, together with the surveyors' maps, U.S. Geological Survey topographic map, the soils map of the county (Gundlach 1980), the pre-settlement vegetation maps of Sauk (Lange 1973 & 1976) and Columbia Counties (Tans 1976), the vegetation map of the Aldo Leopold Memorial Reserve (Luthin 1978), and field inspections were utilized in preparation of the final map of the pre-settlement vegetation of the Aldo Leopold Memorial Reserve (Fig. 3). Where the boundary line between two communities was not evident by inspection, the boundary line was refined to correspond to the nearest topographic line.

RESULTS AND DISCUSSION

Ten vegetation types were identified as comprising the vegetation of the study area in the 1840's (Fig. 3). The relative area

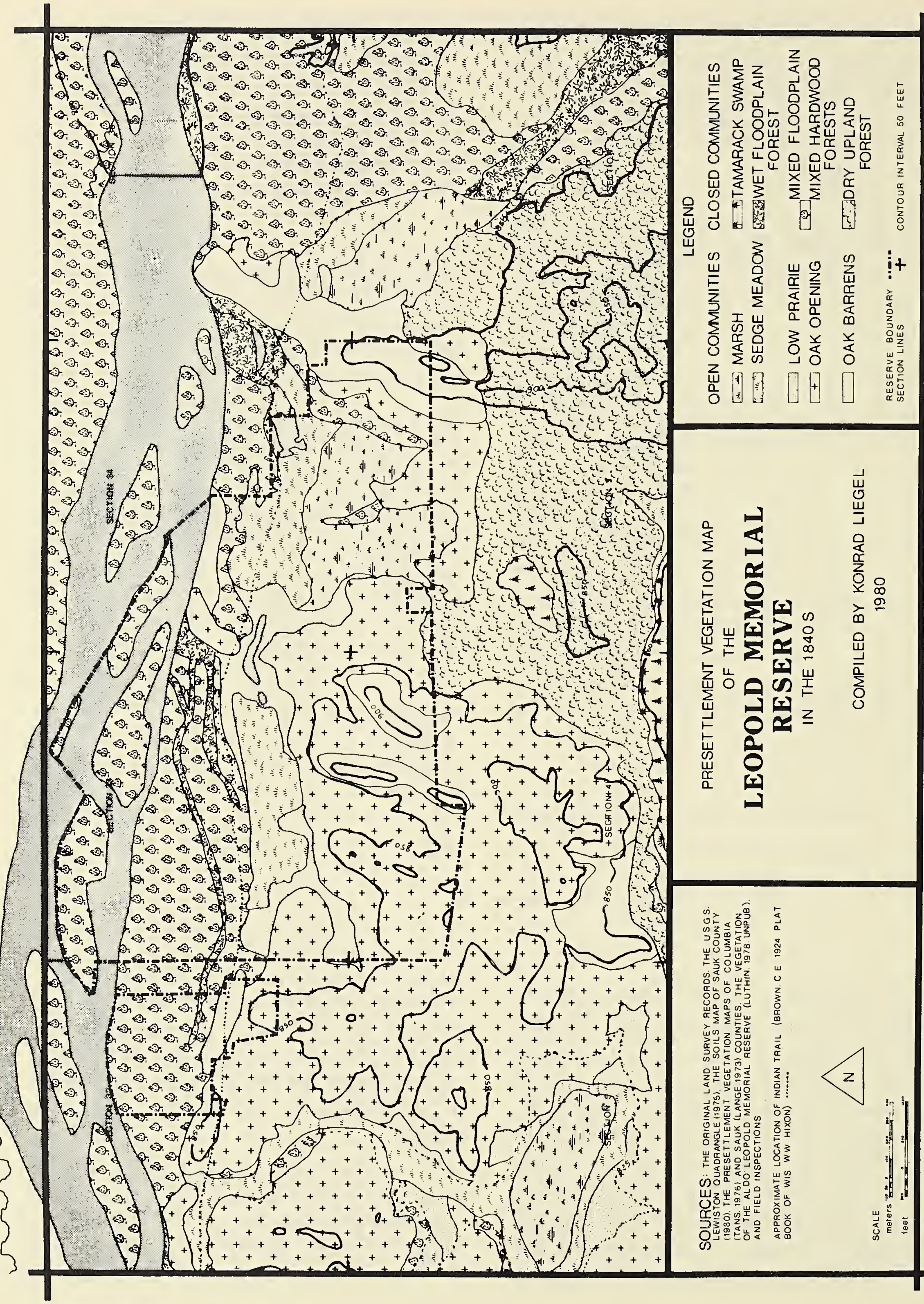
PRESETTLEMENT VEGETATION MAP
OF THE
LEOPOLD MEMORIAL
RESERVE
IN THE 1840 S
COMPILED BY KONRAD LIEGEL
1980
LEGEND
OPEN COMMUNITIES
MARSH
SEDGE MEADOW
LOW PRAIRIE
OAK OPENING
OAK BARRENS
CLOSED COMMUNITIES
TAMARACK SWAMP
WET FLOODPLAIN FOREST
MIXED FLOODPLAIN
MIXED HARDWOOD FORESTS
DRY UPLAND FOREST
RESERVE BOUNDARY
SECTION LINES
CONTOUR INTERVAL 50 FEET
SOURCES: THE ORIGINAL LAND SURVEY RECORDS. THE USGS LEWISTON QUADRANGLE (1975), THE SOILS MAP OF SAUK COUNTY (1980), THE PRESETTLEMENT VEGETATION MAPS OF COLUMBIA (TANS, 1976) AND SAUK (LANGE,1973) COUNTIES, THE VEGETATION OF THE ALDO LEOPOLD MEMORIAL RESERVE (LUTHIN 1978, UNPUB), AND FIELD INSPECTIONS
APPROXIMATE LOCATION OF INDIAN TRAIL (BROWN, C E 1924 PLAT BOOK OF WIS WW HIXON)
N
SCALE
meters
feet
SECTION 34
SECTION 35
SECTION 3
SECTION 4
SECTION 5
850
900

Fig. 3.

TABLE 2. Relative area coverage of the pre-European settlement plant community types in the eight sections surrounding and including the Aldo Leopold Memorial Reserve, Sauk County, Wisconsin.

Community	*% of total land surface*	*Community*	*% of total land surface*
Savanna	31	Marsh	17
Oak Opening	(26)	Sedge Meadow	(8)
Oak Barrens	(5)	Marsh (Emergent Aquatic/ Sedge Meadow)	(5)
Floodplain Forest	25	Low Prairie	(4)
Mixed F. Forest	(23)	Upland Forest	16
Wet F. Forest	(2)	Dry Upland Forest	(15)
		Mixed Hard. Forest	(1)
		Open Water	10
		Tamarack Swamp	1

covered by each vegetation type is given in Table 2. Size class distribution for line, bearing, and meander trees indicates that the median size tree was in the 10-inch diameter class. Table 3 lists the line, bearing, and meander tree species found within the study area. Almost 85 percent of the bearing trees were oaks. Oaks were found in virtually all of the vegetation types. It is possible, as Tans suggests (1976), that this reflects the surveyor's bias towards selecting oaks as bearing trees. When line and bearing trees are compared for differences in the relative abundance of species, however, no significant difference is found except, perhaps, for the bur oak. It is evident, therefore, that the pre-settlement landscape of the study area was dominated by oaks.

Three interdependent factors seem to have been crucial in influencing the pattern and composition of the pre-settlement vegetation types in the study area: topography, hydrol-

TABLE 3. Line, bearing, and meander trees from the Original Land Survey of the eight sections surrounding the Aldo Leopold Memorial Reserve, Sauk County, Wisconsin. Common names are those given by the surveyors.

Common Name	*Scientific Name*	*Number of Trees*	*Percent of Total*
Black Oak	*Quercus velutina* L., *Q. ellipsoidalis* E. J. Hill, or *Q. rubra* L.	34	26.8
White Oak	*Quercus alba* L.	19	14.9
Birch	*Betula nigra* L.	19	14.9
Bur Oak	*Quercus macrocarpa* Michx.	18	14.2
Yellow Oak	*Quercus ellipsoidalis* E. J. Hill	12	9.4
Maple	*Acer saccharinum* L.	8	6.3
Tamarack	*Larix laricina* (DuRoi) K. Koch	5	3.9
Ash	*Fraxinus* spp.	3	2.4
Willow	*Salix* spp.	2	1.6
Cottonwood	*Populus deltoides* Marsh.	2	1.6
Swamp White Oak	*Quercus bicolor* Willd.	1	0.8
Aspen	*Populus* spp.	1	0.8
Elm	*Ulmus* spp.	1	0.8
Hickory	*Carya ovata* (Mill.) K. Koch	1	0.8
Pine	*Pinus strobus* L.	1	0.8
TOTAL		127	100.0

ogy, and fire. The probable role of each will be discussed for each vegetation type. Microclimate and soil type probably are also important but their effects are best understood in terms of topography and hydrology.

Savanna

Savannas were defined by section and quarter section points where the range of the mean distance between survey post and tree was 209-50 links, which corresponds to a range in density of 1-17.4 trees per acre, well within Curtis' definition of a savanna (Curtis 1959, Anderson and Anderson 1975). The mean distance from survey post to tree was 87.3 links, equal to a $\bar{x}$ density of 5.7 trees per acre. Median tree size in the savannas was 12 inches in diameter.

Dominant tree species, soil type, topography, and exposure were used to distinguish between oak barrens and oak openings. Oak barrens were savannas dominated by black oak (*Quercus velutina* L., *Q. ellipsoidalis* E. J. Hill, or *Q. rubra* L.). They were restricted to the droughty Plainfield loamy sand and sand. Oak openings, on the other hand, were savannas dominated by white (*Q. alba* L.) or bur oak (*Q. macrocarpa* Michx.). They occurred on a variety of soil types, including Gotham, Wyocena, McHenry, Fox, Briggsville, Billett, Dresden, Rimer, and Mosel. Within the savanna community the witness trees were always of the same species at any one corner whereas in the floodplain forest and upland forest they were often of different species.

At the time of settlement, a traveller going from east to west across the uplands of the Reserve would have passed through thinly-treed savannas of black oak on the ridge tops and white oak in the valleys, then onto a rolling parklike plain of scattered groves of bur oak immediately to the west of the Reserve. This pattern may reflect a differential response among the oaks to topographically-induced moisture and fire gradients. The land west of the Reserve is gently rolling, unlike the broken hilly landscape within the Reserve. Under prevailing westerlies, the potential exists there for frequent fires, which would favor fire tolerant and shade intolerant species such as bur oak. The presence there of several areas of the Ringwood soil series, a prairie soil with too small an area to be mapped in this study, also supports this line of reasoning.

Upland Forest

Upland forests were mapped at upland sites where the mean distance between the survey post and tree was 50 links or less, i.e. a density of 17.4 or more trees per acre. The mean distance for all upland forest sites was 37.2 links, a density of 31.5 trees per acre.

Upland forests were subdivided on the basis of dominant tree species and soil type. Dry upland forests were plant communities dominated by several species of oaks, most notably black, white, and bur oak, and found on a variety of soil types (Table 1). Mixed hardwood forests were found on the Sisson and Shiffer soil types, generally restricted to fire-protected, north-facing, and mesic to wet-mesic sites. In spite of their distinct soil types and upland location, mixed hardwood forests closely resemble the mixed floodplain forests of the Reserve at the present time and are likely not a distinct type (Luthin 1980). They may be kept wet periodically due to surface runoff or seepage from adjacent higher ground (Luthin 1980). In addition, they include several tree and ground-layer species with northern lowland affinities such as tamarack (*Larix laricina* (DuRoi) K. Koch), huckleberry (*Gaylussacia baccata*), blueberry (*Vaccinium* spp.), and dwarf raspberry (*Rubus pubescens*). Mixed hardwood forests, hence, are mapped together with mixed floodplain forests (Fig. 3).

Unlike other surveyors in the area, John Brink distinguished between yellow oak and black oak in his field notes for the forest community. What Brink listed as yellow oak in the study area is probably Hill's oak (*Q. ellipsoidalis* E. J. Hill) since it was more commonly found in dry woods or barrens on the very poor Plainfield soil type.

All of the witness trees in the dry upland forest community were oaks although a hickory was recorded as a line tree. The presence of redroot (*Ceanothus americana*) and prairie grass in the understory was noted. These results suggest that the upland forest was simply a former oak savanna closed by the development of root sprouts and/or oak seedlings. If this were the case, the median tree size of the oak forests, composed of numerous young trees crowding the older, savanna-grown trees, would be less than that of the oak savanna (Tans 1976). As expected, the median diameter of the oak forest trees was 10 inches but for oak savanna trees, 12 inches.

Prior to settlement upland forests typically occurred in areas adjacent to natural fire barriers, i.e. in areas of irregular topography, extensive wetlands, and between branching streams (Tans 1976). A large marsh and tamarack swamp immediately south of the study area (Lange 1976) may have been responsible for protecting the forests south of the Reserve from frequent and/or intense fires.

Since both oak forest and savanna occurred on the same soil series, it was impossible to distinguish them by soil type (Table 1). Curtis thought (1959) that oak savannas originated from the degradation of preexisting forests by fire. Pedologic lag could then account for the similarity in soil types between the two communities. This may be too simplistic, however, for in the study area, forest probably has recently replaced savanna. An alternative explanation (Hole, 1979, pers. comm.) is that only a few trees per acre are enough to prevent the development of a prairie soil. Shade may suppress the prairie vegetation so that less of it is incorporated into the soil and/or tannic acids released by the decaying oak leaves may change the pH and mineral content of the soil.

Floodplain Forest

Floodplain forest included those points along the survey lines in lowlands where the mean distance between the survey post and tree was 50 links or less, corresponding to a density of 17.4 or more trees per acre; the mean distance was 41.2 links, density 25.7 trees per acre. Median diameter of the trees was 10 inches. The surveyors called these areas "bottoms" and indicated their position when entering and leaving. This information was useful in separating the river bottom types from those adjacent to them.

Floodplain forests were subdivided on the basis of dominant tree species and soil type. The mixed floodplain forests were plant communities restricted to the Brems and alluvial soils where the dominant tree species included river birch (*Betula nigra* L.), ash (*Fraxinus* spp.), and different species of oak previously mentioned. The wet floodplain forests were plant communities restricted to the Granby and wet alluvial soils where the dominant tree species in the Reserve today is silver maple (*Acer saccharinum* L.). Although less common, aspen (*Populus* spp.), swamp white oak (*Q. bicolor* Willd.), willow (*Salix* spp.), elm (*Ulmus* spp.), and pine (*Pinus strobus* L.) were also present in the floodplain forests. The surveyors also frequently commented on the undergrowth of vines, briars, alder, prickly ash (*Xanthoxylum americanum* Mill.) and occasional small oaks and grass.

The vegetational complexity of the mixed floodplain and wet floodplain forests reflects the varied environments of old channels, sand bars, and levees, created by a constantly shifting river channel. Although frequently inundated during spring flood, the bars and levees quickly warm up when the flood waters subside and during low water may be somewhat droughty. The drought-tolerant black oak and pine find a suitable medium for growth and may eventually form extensive stands. Meanwhile, the water-tolerant silver maple colonizes the edges of old sloughs and abandoned channels.

Tamarack Swamp

Tamarack swamp was defined as wetlands where tamarack was the dominant tree. These communities developed in low-lying pockets over peat where the drainage was stagnant and where the likelihood of fire was low (Tans 1976).

Marsh

The surveyors made no distinction between marsh, sedge meadow, or low prairie, calling all treeless lowlands marsh. Soil types were used to distinguish among these three communities. Low prairies were mapped in areas of mineral soils with high organic content, including the Granby, Gilford, and Colwood series. An exception was the Marshan series which Hole (1976) associated with swamp hardwoods and sedge meadows. In areas within the study site where the vegetation is largely unaltered, this soil type is associated with sedge meadows with a low prairie border and is transitional between these communities. Sedge meadows were mapped in areas of organic soil with some mineral content, including the Adrian and Palms peats. Emergent aquatic marsh was mapped in areas of Houghton peat although sedge meadow is also found on that soil type. Noteworthy is the occurrence of low prairie on the Granby series. In the floodplain forest, silver maple sloughs occurred on this same soil type. As in the mesic forests of Green County, Wisconsin, this joint occurrence may be due to the similarity in "nutrient-pumping" ability between prairie forbs and grasses and maples.

The several wetland communities within the former glacial lake basin are affected by action of the Wisconsin River. The floodplain forests are found in areas characterized by widely and rapidly fluctuating water levels, heavy siltation and erosion, prolonged spring flooding, and a much lower summer water table. Further inland, where conditions are less variable, are found the low prairie, sedge meadow, and marsh. Here, there is little to no siltation, ground-water is always near or above the surface, and water-levels shift gradually.

Low prairie, sedge meadow, and marsh are found along an environmental gradient of increasing water-levels. Low prairie is a fire-swept community usually located on lowlands subject to inundation by heavy rains or by floodwaters from nearby streams (Curtis 1959). The presence of low prairie in the study area is probably due to frequent fires originating from the west and possibly to occasional flooding. Sedge meadows, on the other hand, are characterized by steady ground-water discharge throughout the year and a water table at or immediately below the soil surface. The waterlogging of the soil prevents the total decomposition of plant material produced each year. This material, the peat, builds up slowly and in some areas may be many feet deep. Marshes are found within depressions in the peat where the water tables lie above the surface of the peat. Here, emergent aquatic vegetation, including cattails (*Typha* spp.) and reeds (*Scirpus* spp.), are found among the sedges (*Carex* spp.).

Conclusions

1. In study areas too small in size for quantitative analyses, one can construct a more detailed and accurate pre-European settlement vegetation map by utilizing both the original land survey records and the soil survey maps than by using either alone.

2. In the eight sections surrounding and including the Aldo Leopold Memorial Reserve, Sauk County, Wisconsin, two savanna, five tree-dominated, and three wetland herb communities existed at the time of European settlement. These communities were related to discontinuous gradients of fire stress, fluctuating water-levels, and siltation levels. Prevailing climate, regional geology, and local

topography were the main factors responsible for these environmental gradients.

Acknowledgments

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Literature Cited

Alden, W. C. 1918. The quaternary geology of southeastern Wisconsin. U.S. Geol. Surv. Prof. Paper 106. 356 pp.

Anderson, R. C., and M. R. Anderson. 1975. The presettlement vegetation of Williamson County, Illinois. Castanea 40:345-363.

Black, R. F., and M. Rubin. 1967-68. Radiocarbon dates of Wisconsin. Trans. Wis. Acad. Sci., Arts and Lett. 56:99-115.

Borman, R. G. 1971. Preliminary map showing thickness of glacial deposits in Wisconsin. *In:* Finley, R. W., 1975. Geography of Wisconsin. Univ. of Wis. Press, Madison, Wis. 472 pp.

Bourdo, E. A., Jr. 1956. A review of the general land office survey and of its use in quantitative studies of former forests. Ecology 37:754-768.

Buol, S. A., F. D. Hole, and R. J. McCracken. 1973. Soil genesis and classification. Iowa State University Press, Ames, Iowa. 360 pp.

Cole, H. E. 1918. A history of Sauk County. Vol. 1. Lewis Publ. Co., Chicago, Ill. 566 pp.

Columbia County Planning Department. 1970. Physical features analysis. Columbia County Prelim. Rep. No. 1. 55 pp.

Conkey, T. 1845. GLO survey field notes.

Cottam, G. 1949. The phytosociology of an oak woods in southwestern Wisconsin. Ecology 30: 271-287.

Cottam, G. and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37:451-460.

Curtis, J. T. 1959. The vegetation of Wisconsin. Univ. of Wis. Press, Madison, Wis. 657 pp.

Dodds, J. S., J. P. McKean, L. O. Stewart, and G. F. Tiggs. 1943. Original instructions governing public land surveys of Iowa. Iowa Engineering Society, Ames, Iowa. 565 pp.

Findley, R. W. 1976. Original vegetation cover of Wisconsin. Map. University of Wisconsin Extension, Madison, Wis.

Gundlach, H. F. 1980. Soil survey of Sauk County, Wisconsin. Soil Conservation Service. 248 pp. + Maps.

Hole, F. 1976. Soils of Wisconsin. Univ. of Wis. Press, Madison, Wis. 223 pp.

Hole, Francis. 1979 & 1980. Personal communication.

Jenny, H. 1958. Role of the plant factor in the pedogenic functions. Ecology 39:5-16.

Lange, K. 1973, unpubl. Presettlement vegetation of Sauk County, Wisconsin. Map.

Lange, K. 1976. A county called Sauk: a human history of Sauk County, Wisconsin. Sauk County Historical Society. 168 pp.

Leopold, A. 1935-1948, unpubl. "Shack journals."

Luce, Mrs. J. 1912. Fairfield in the fifties. Baraboo Weekly News. May 2, 1912.

Luthin, C. 1978, unpubl. Vegetation map of the Aldo Leopold Memorial Reserve, Sauk County, Wisconsin.

Luthin, C. 1979, unpubl. Herbarium of the Aldo Leopold Memorial Reserve, Sauk County, Wisconsin. 47 pp.

Luthin, C. 1980, unpubl. Plant communities of the Aldo Leopold Memorial Reserve, Sauk County, Wisconsin. 33 pp.

Marryat, F. 1839. A diary of America, with remarks on its institutions. Edited by Jules Zanger. 1960. Indiana Univ. Press, Bloomington, Ind. 342 pp.

McConaghy, Donald. 1979. Personal communication. Sauk County surveyor.

Milfred, C. J., C. W. Olson, and F. D. Hole. 1967. Soil resources and forest ecology of Menominee County, Wisconsin. Wis. Geol. Nat. Hist. Surv. Bull. 85, Soil Ser. No. 60. 203 pp. + 3 maps.

Robinson, G. H., and A. J. Klingelhoets. 1961. Soil survey of Grant County, Wisconsin. U.S. Dept. Agr. Soil Conservation Series, 1951, No. 10, 98 pp. + 72 map sheets.

Socha, Betty. 1981. Personal communication. 1981 Glacial Geology Leopold Fellow.

Soil Conservation Service. 1951. Soil survey manual. U.S. Dept. Soil Conservation Service Handbook No. 18. 503 pp.

Tanner, E. 1908. Wisconsin in 1818. Wisconsin Historical Society Collections 8:287-292.

Tans, W. 1976. The presettlement vegetation of Columbia County, Wisconsin, in the 1830's. DNR Tech. Bull. No. 90, Madison, Wis. 19 pp.

Turner, A. J. 1898. The history of Fort Winnebago, Wisconsin Historical Society Collections 14:65-102.

Van Rooyen, D. J. 1973. I. Organic carbon and nitrogen status in two Hapludalfs under prairie and deciduous forest, as related to moisture regime, some morphological features, and response to manipulation. II. Comparison of the hydrologic regimes of adjacent virgin and cultivated pedons at two sites. Ph.D. Thesis. Univ. of Wis., Madison, Wis. 176 pp.

SOME HISTORICAL ASPECTS OF RUFFED GROUSE HARVESTS AND HUNTING REGULATIONS IN WISCONSIN

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Abstract

Closed hunting seasons for ruffed grouse were first instituted in Wisconsin in 1851, partly as a response to intense market hunting. The open seasons in the early 1850s were about 4 months long, but by 1921 were shortened to 4 days. This conservative period lasted for about 20 years before hunting seasons were gradually lengthened. Today, hunting seasons are as long as they were in the 1850s and ruffed grouse harvests are at record highs. These facts, coupled with an increase in hunters concentrated on public wildlife areas have warranted an examination of how modern-day harvests effect local populations of ruffed grouse. The role of research in the management of this important game species is also discussed.

In 1949, Aldo Leopold expressed the feelings of many hunters when he wrote, "There are two kinds of hunting: ordinary hunting, and ruffed-grouse hunting." In Wisconsin, the ruffed grouse was avidly sought by almost 200,000 hunters each year during the 1970s (Wis. Dept. of Natural Resour., unpubl. rep., Ruffed grouse management plan, Madison, Wis., 1978). It was the subject of several research projects and dozens of popular articles. Thousands of acres were managed in an attempt to increase grouse densities and in the late 1970s over 1 million participant days (no. hunters × no. days hunted) annually were spent in the pursuit of "partridge" (Wis. Dept. of Natural Resour., unpubl. rep., Ruffed grouse management plan, Madison, Wis., 1978).

This paper examines the lengthy record of ruffed grouse harvests in Wisconsin, the trend in ruffed grouse hunting regulations, and the impact of research on grouse management strategies. We speculate on the possible effects of harvests on local grouse populations under modern circumstances.

This paper was prepared as an adjunct to a ruffed grouse field study funded by the Wisconsin Department of Natural Resources, the Department of Wildlife Ecology of the University of Wisconsin-Madison, the U.S. Fish and Wildlife Service, and the Ruffed Grouse Society of North America. We thank L. Keith, R. McCabe, Doris Rusch and C. Swanberg for reviewing the manuscript. However, the interpretations made in this paper are the sole responsibility of the authors.

THE EARLY YEARS

Early travelers in northern Wisconsin rarely noted the ruffed grouse as abundant (Schorger 1945). The forests in the northern half of the state generally lacked the understory cover needed to support high grouse densities. In the southern half of the state, open deciduous woodlands provided heavy brush cover that supported large grouse populations (Schorger 1945).

The lumber industry soon changed the structure of the northern forests and consequent grouse abundance. Logging began around 1840, and by 1870 it was Wis-

[1] In cooperation with University of Wisconsin-Madison, U.S. Fish and Wildlife Service, Wisconsin Department of Natural Resources, and Wildlife Management Institute.

consin's leading industry (McCabe 1964). Second-growth forest, interspersed with clearings created by logging and periodic fires, provided ruffed grouse with near ideal habitat. Currently, ruffed grouse are considered most abundant in the north and west-central parts of the state, common in east-central, and scarce in the southeast where there is little good habitat (Wis. Dept. of Natural Resour., unpubl. rep., Game harvest trends, Madison, Wis., 1968).

Schorger (1945) believed that the general lack of early references to ruffed grouse in Wisconsin indicated that it was not a favorite game species until other upland game birds, notably the prairie chicken (*Tympanuchus cupido*) and sharp-tailed grouse (*Pedioecetes phasianellus*), became less plentiful. However, by 1845 market hunters were getting as much as $1.25 per dozen ruffed grouse, and by 1898 up to 600 birds a day during the fall were being shipped to cities (Schorger 1945). The market shipments of ruffed grouse apparently never reached the magnitude of those of prairie chickens and sharptails.

It is probable that the first restrictions on ruffed grouse hunting were incidental to restrictions intended primarily for prairie chickens and sharptails. Market hunting and loss of habitat in the early 1800s caused dramatic declines in prairie chicken and sharptail populations (Schorger 1944, McCabe 1964), and in 1851 Wisconsin responded by passing its first game law which not only protected prairie chickens but also ruffed grouse, bobwhite quail (*Colinus virginianus*), and woodcock (*Philohela minor*)

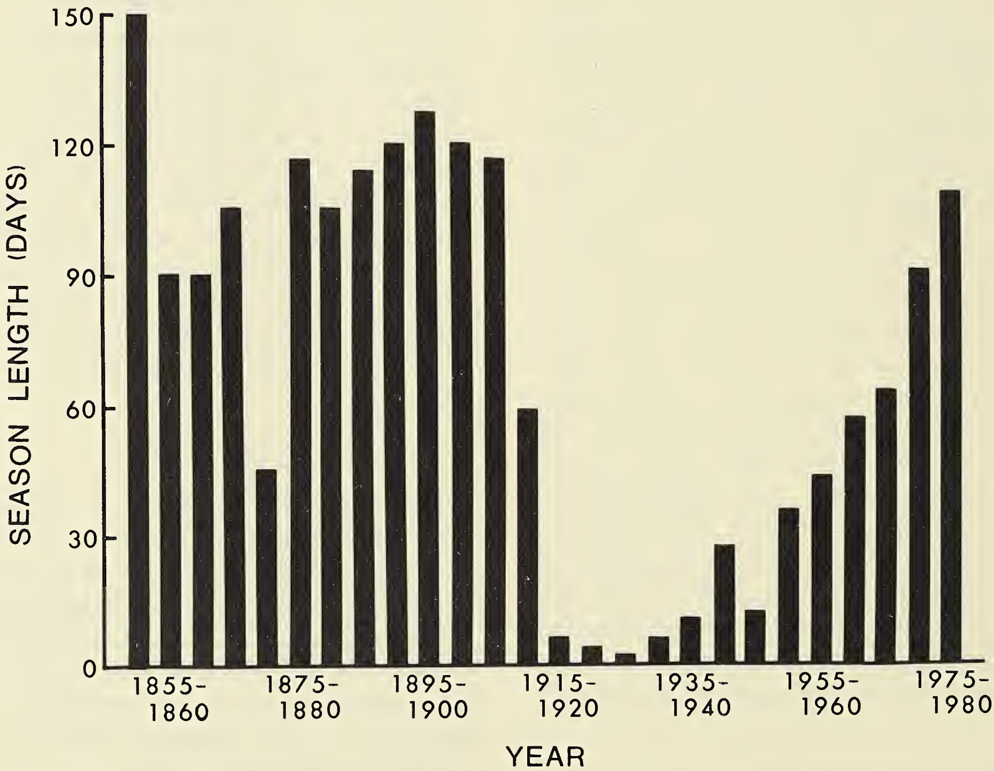

Fig. 1. Five-year averages (1851-55 to 1975-80) of season lengths for ruffed grouse hunting in Wisconsin. Open seasons were first instituted in 1851 and were usually within September-January. Year-long closed seasons were 1917-20), 1929-30, 1936-37, and 1945-47, all inclusive. Data were compiled from Wisconsin Department of Natural Resources Hunting Regulations and Scott (1937*a-d*, 1938).

from 1 February to 1 August (Scott 1937*a*, Schorger 1944). The idea of closed hunting seasons[2] for ruffed grouse was not new; New York had closed seasons as early as 1708, and Massachusetts in 1818 (Schorger 1945).

The Trend Towards Conservative Game Laws

Since the first closed season for ruffed grouse in 1851, hunting season lengths have undergone frequent, sometimes annual changes. During the first 2 decades following 1851, open seasons varied between 90 and 150 days annually, but were shortened to 45 days in 1871. By 1880 the open season was lengthened to about 120 days, and season duration remained relatively stable for almost 2 decades before the first statewide, year-long closed season was abruptly instituted in 1917 (Fig. 1).

During the last half of the 19th century and the first few decades of the 20th century, several other laws were enacted partly on behalf of the ruffed grouse. The sale of upland game birds was made illegal in 1853, became legal shortly thereafter, and was again made illegal in 1903 (Scott 1937*a,d*). Exportation of ruffed grouse from the state was prohibited in 1878, 1883, and for the final time in 1887, with periods of unprohibited interstate shipment in between (Scott 1937*b,c*). The legal methods by which these birds could be "reduced to possession" were often amended: game bird nests were protected in 1867; nets, traps, and snares were outlawed for all gamebirds in 1874; and by 1878 the use of firearms for hunting was restricted to guns which were discharged from the shoulder (Scott 1937*a,b*). Even the use of dogs for hunting upland game birds was briefly prohibited from 1891 to 1893 (Scott 1937*c*).

[2] "Closed seasons" in this paper refers to hunting seasons closed for part of a year, whereas "year-long closed seasons" are closed to hunting for an entire 12 months.

The first Wisconsin daily bag limit, set at 25 in 1905, was reduced to 15 in 1907, 10 in 1913, and 5 in 1921 (Scott 1937*d,e*). Since 1921 the limit has ranged from 3 to 5, and presently stands at 5 (Scott 1937*a-d*, 1938).

The Conservative Period

It is probable that the fluctuations in early game laws were a reflection of fluctuations in ruffed grouse populations. The fluctuations of ruffed grouse populations were not well documented, much less understood. Abrupt and dramatic natural declines were often attributed to the gun, and season closures were the logical management remedies. Certain counties in Wisconsin had prohibited ruffed grouse hunting for an entire year as early as 1873, e.g., Sauk County; but 1917 was the first year of a statewide, year-long closed season (Scott 1937*a*). In 1921, the season was reopened, but only from 4 October to 8 October. The 4-day season was in effect for 8 years. In 1929, the season was again closed for 2 entire years, reopened in 1931 for 5 years of abbreviated seasons, and in 1936 and 1937, closed for the third time in 20 years (Fig. 1).

Just as decreases in grouse numbers were attributed to overhunting, the periodic increases in the Wisconsin ruffed grouse population during the early decades of this century were often attributed to a decrease in hunting pressure. In 1922, Commissioner Barber of the Wisconsin Conservation Department wrote: "The closed season provided by the legislature for prairie chickens and partridge extending from 1916 to 1921 has brought marvelous results in the increase of these birds. Never have the results of protection of any species of wild animal been more clearly demonstrated than in this instance. At the close of the hunting season in 1915, it seemed that these birds were doomed to extermination, but the closed season and the cooperative efforts of the warden force and sportsmen in suppressing law violation brought the birds back again more plentiful than our most optimistic hopes could anticipate . . ." (Scott 1938:33-34). His conclusion was a logical one. At that time little was known of the natural fluctuations of ruffed grouse populations, and wildlife managers did not have the benefit of the research on population ecology that would be conducted in later years. Apparently, few people believed that the periods of grouse scarcity and abundance might occur regardless of the presence or absence of sport hunting.

The Wisconsin Department of Natural Resources, then called the Wisconsin Conservation Department, began estimating annual grouse kills from hunter questionnaires in 1931, after the second period of closed seasons had ended in Wisconsin (Wis. Dept. of Natural Resour., unpubl. rep., Wisconsin game and fur harvests, a summary 1930-75, Madison, Wis., 1976). The 1931 harvest was small, but sharply increased in 1932 (Fig. 2). The grouse harvest in 1933 was similar, but the kill plummeted, and by 1935 it was at the same low level as in 1931. Consequently, the season was again closed for 2 years—1936 and 1937.

This pattern was repeated when hunting was reopened in 1938. The harvest rose sharply in the early 1940s, but subsequently crashed later that same decade. Again the season was closed, this time from 1945 to 1947 (Fig. 2). For a third time the pattern was repeated: a sharp rise in total harvest occurred in the early 1950s, but by 1960 harvests had gradually dropped to the same low level that was reported in 1935 and 1944. In the past, low harvest years had preceded closed seasons, but this time the management response to a low grouse harvest was different. The succeeding hunting season was not closed, nor even shortened. In spite of this radical departure from conservative regulations and management tra-

Fig. 2. Annual harvest estimates of Wisconsin ruffed grouse compiled by the Wisconsin Department of Natural Resources. Estimates were derived from voluntary game census cards from 1930 to 1958, from returned questionnaires sent to random samples of hunters from 1959 to 1969, and from returned questionnaires distributed to counties in proportion to the number of hunting licenses sold in the county from 1970 to present. All estimates are subject to nonresponse, prestige and memory bias, but do reflect general harvest trends (Wis. Dept. Natural Resour., unpubl. rep., Wisconsin game and fur harvests, a summary 1930-75, Madison, Wis., 1976).

dition, the kill in 1961 rose, and in 1962 the kill rose again. Harvests fluctuated in the late 1960s, but seasons were maintained or even liberalized; by the 1970s, season lengths were longer than they had been for almost 100 years and estimates of grouse harvests were at record highs (Figs. 1, 2). A change in management policy had clearly taken place.

The Trend Toward Liberal Game Laws

The first major study of the life history, ecology, and management of ruffed grouse began in New York in 1930. The primary goal of the New York "Ruffed Grouse Investigation" was "to find ways and means of assuring the future of the ruffed grouse," and an evaluation of hunting was among the first assignments (Bump et al. 1947:372). They found that about 17% of the preseason population was harvested and, because of this relatively low harvest rate, concluded that "the general effect of man's hunting on grouse, as currently practiced, is not detrimental . . ." (Bump et al. 1947:370).

Research on many other game species was conducted in many parts of North America in the 1930s and 1940s. Data from these studies (e.g., Errington and Hamerstrom 1935) provided impetus for development of the principle of compensatory mortality. In "Our Wildlife Legacy," a popular textbook in wildlife management curricula of the day, Allen (1954) cited work on ring-necked pheasants (*Phasianus colchicus*) and cottontail rabbits (*Sylvilagus floridanus*) in Michigan, ruffed grouse in Minnesota (King 1937), bobwhite quail in Oklahoma (Baumgartner 1944), and the findings of the New York Ruffed Grouse Investigation and went on to state the compensation principle in simple terms: "if we fail to take a hunting harvest, Nature does it for us" (Allen 1954: 131). Generations of students digested the principle, and most biologists came to accept the idea that most game animals present in summer and fall would succumb to late fall and overwinter mortality, and that fall hunting would mainly harvest these surplus animals that would otherwise die of natural causes.

Data on ruffed grouse population dynamics were also beginning to accumulate. By the 1940s, many authors began to believe that the lows and highs in the population cycle were natural events, and that hunting had little or no effect on the frequency or amplitude of the fluctuations (Schorger 1945, Bump et al. 1947). In fact, many biologists believed the fluctuations in numbers of hunters and grouse harvests were a result rather than a cause of fluctuations in game abundance.

The idea that sport hunting may not be detrimental to ruffed grouse populations was further supported by evidence in the 1940s. Ruffed grouse populations in Michigan, Minnesota, and Wisconsin were at low levels during the early part of that decade (Erickson 1951). Minnesota responded by closing the season in 1944, and Wisconsin followed suit in 1945. Michigan held out, and in 1948, when the seasons in Minnesota and Wisconsin were again opened, the estimated grouse harvests for all 3 states were very similar, and a year later the harvests for all 3 were virtually identical. Minnesota and Wisconsin had apparently given up hundreds of hours of grouse hunting and gained nothing. The ruffed grouse populations rose and fell as they always had, and were apparently little affected by the presence or absence of hunters.

The research continued. Palmer (1956) monitored and compared ruffed grouse populations on hunted and unhunted areas in Michigan during a decline in numbers from 1950 to 1954. He found that spring and pre-hunting season populations were similar on both the hunted and unhunted areas, even though an estimated 30% of the pre-season population on the hunted area was harvested each year. Dorney and Kabat (1960) and Fischer and Keith (1974) also found no detectable relationship between hunting and subsequent populations, and suggested that

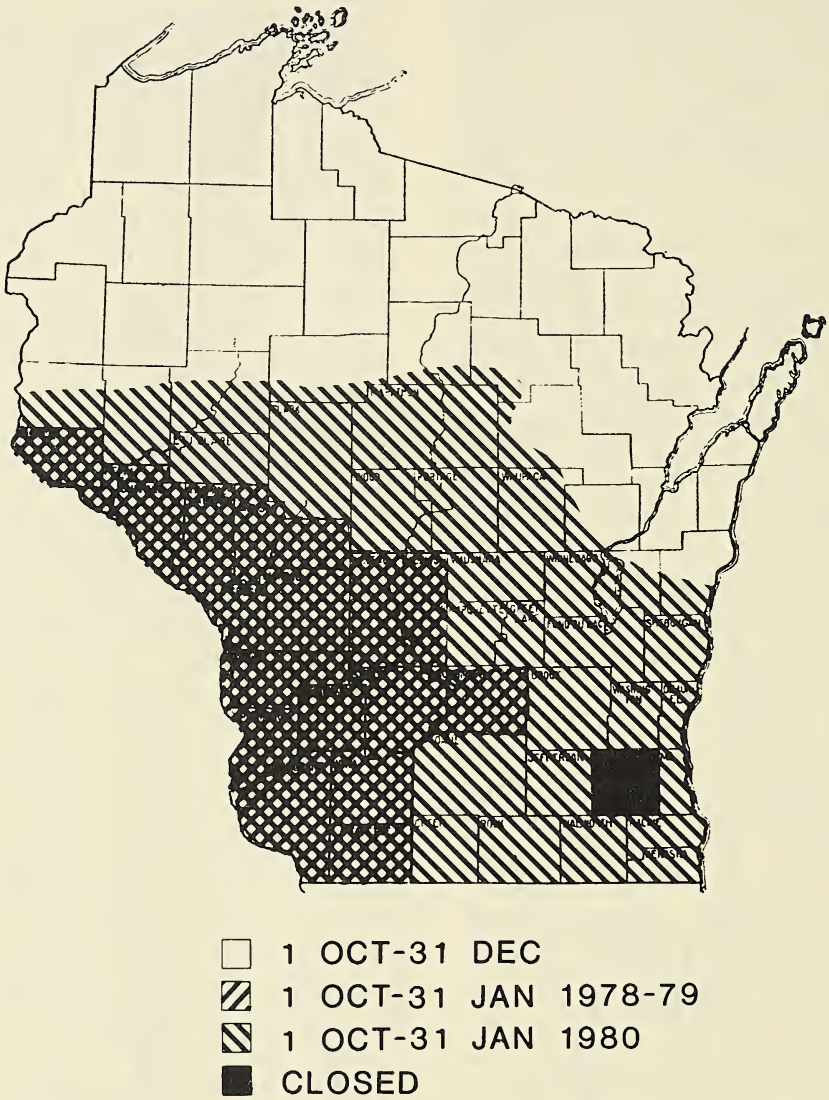

Fig. 3. Since 1925, Wisconsin has been divided into 2 or more zones with different ruffed grouse hunting seasons. From 1973 to 1979, 17 counties had roughly 1 October-31 January hunting seasons (cross-hatched area), and the rest of the state had 1 October-31 December seasons (diagonal lines and clear area). In 1980, the 4 month hunting zone was extended to include all or parts of 31 additional counties (cross-hatched and diagonal line areas) while the remaining northern third of the state retained the 3 month season (clear area). Ruffed grouse hunting has been closed in Waukesha County since 1978 because of the low grouse population in that area. Data were compiled from Wisconsin Department of Natural Resources Hunting Regulations.

ruffed grouse populations in Wisconsin and Alberta could withstand higher harvest rates.

Other researchers, working on bobwhite quail in Texas (Parmalee 1953), Gambel's quail (*Lophortyx gambelii*) in Arizona (Swank and Gallizioli 1954), and wild turkeys (*Meleagris gallopavo*) in Virginia (Weaver and Mosby 1979) came to similar conclusions.

On the basis of research and general acceptance of the principle of compensatory mortality, game managers concluded that hunting had no effect on grouse numbers from year to year. Attitudes of game managers thus changed from concern about "over-hunting" in the early part of this century to acceptance of the generalization that "hunting has no effect." Changes in Wisconsin ruffed grouse hunting regulations reflected this change in attitude. Season lengths have grown steadily since the late 1940s, and further increases in the hunting season have been instituted as recently as 1980 (Fig. 1).

Modern Ruffed Grouse Harvest

In 1980 Wisconsin sportsmen could hunt ruffed grouse for 4 months in the southern half of the state and 3 months in the north (Fig. 3). Sales of small game and sportsmen's licenses have been generally increasing since 1935 (Fig. 4). In our opinion, extended hunting seasons, growing numbers of hunters, heavy concentrations of hunters on some lands, and the anticipated increase in demand for ruffed grouse hunting in Wisconsin (Wis. Dept. of Natural Resour., unpubl. rep., Ruffed grouse management plan, Madison, Wis., 1978) warrant continued scrutiny and study of population dynamics and annual harvests of Wisconsin's ruffed grouse.

Earlier studies on ruffed grouse harvests were often conducted on very large, inaccessible tracts of land. Also, relatively little was known about movements of grouse until recent years. They were assumed to be relatively sedentary, and the magnitude of dispersal was not fully appreciated. Later research (Chambers and Sharp 1958, Godfrey and Marshall 1969, Hale and Dorney 1963, Rusch and Keith 1971) has shown that dispersal, which occurs in fall and spring, is important to the dynamics of ruffed grouse populations, and involves large segments of the grouse population and movements of several kilometers in young grouse. Grouse may move from unhunted to hunted areas in fall and spring, thus partially obscuring or alleviating the effects of hunting on certain population segments. Scattered public wildlife areas or isolated woodlots which are not surrounded by good ruffed grouse habitat may not have a reserve of grouse to replace those shot in the fall.

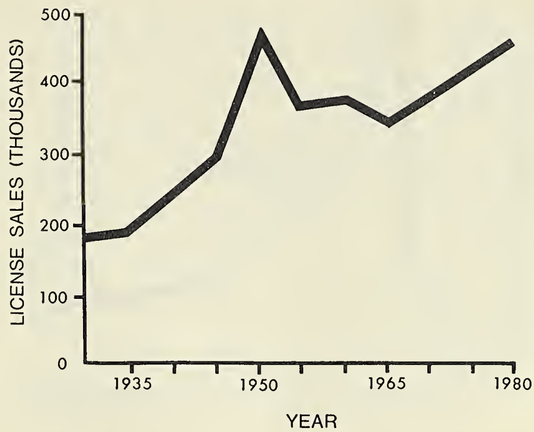

Fig. 4. Sales of small game and sportsmen's licenses in Wisconsin, 1930-80. Not all license buyers hunt ruffed grouse. Approximately 177,000 license holders hunted ruffed grouse annually in the late 1970s (Wis. Dept. Natural Resour., unpubl. rep., Ruffed grouse management plan, Madison, Wis., 1978).

Further consideration and reexamination of the idea of compensatory mortality in ruffed grouse is also warranted. It is possible that hunting in late summer or early fall, when annual grouse numbers are relatively high, would merely take birds which would otherwise suffer late fall or winter mortality. In Alberta, Rusch and Keith (1971) found

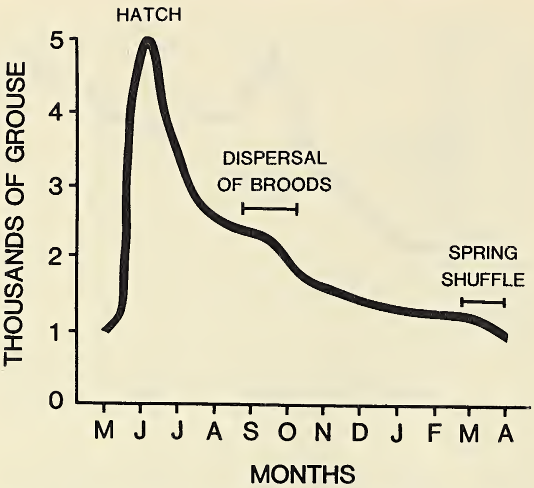

Fig. 5. Theoretical changes in numbers of a population of Wisconsin ruffed grouse over 1 year. Peak hatch for ruffed grouse in Wisconsin is approximately 1 June (Hale and Wendt, 1951). The population probably then quickly declines in early summer and levels off in late summer, after the chicks have grown and juvenile survival improves. During the fall dispersal period mortality probably again increases because grouse, especially the young of the year, move into unfamiliar and insecure areas where they are vulnerable to predation and accidents. When the dispersal period ends in late fall, the population probably levels off and remains stable until the spring breeding season. A lesser amount of movement and dispersal may also occur in the spring. Population curve was generalized from estimates of density of ruffed grouse on study areas in Alberta (Rusch and Keith 1971) and Manitoba (Rusch et al. 1978). Comparable data were not available for populations of ruffed grouse in Wisconsin.

that ruffed grouse populations declined rather rapidly in mid-fall to late fall and remained stable over winter. If our generalized annual population curve for ruffed grouse (Fig. 5) is accurate, grouse that survive the fall dispersal period have a good chance of surviving to the breeding season. Substantial and successful late season hunting—November through January, for example—may remove birds from the population that would otherwise survive to breed in the spring.

It is probable that ruffed grouse populations in Wisconsin have not yet been measurably affected by sport hunting. Yet the ideas described in this paper, like others in the past, raise questions that need to be addressed by additional research. Do ruffed grouse in Wisconsin follow the same annual population curve as that generalized for grouse in Alberta? Is late-season hunting pressure moderate or heavy in some areas of Wisconsin? Is spring dispersal adequate to replace stock taken from populations of ruffed grouse that are heavily hunted? Answers to questions like these may help managers develop new strategies for grouse harvests which will maximize or optimize breeding grouse numbers in managed and unmanaged habitats throughout the state. The ultimate goal is a management plan which will maximize harvests without adversely affecting ruffed grouse populations.

Literature Cited

Allen, D. L. 1954. Our Wildlife Legacy. Funk and Wagnalls, New York. 422 pp.

Baumgartner, F. M. 1944. Bobwhite quail populations on hunted vs. protected areas. J. Wildl. Manage. 8:259-260.

Bump, G., R. W. Darrow, F. C. Edminster, and W. F. Crissey. 1947. The Ruffed Grouse: life history, propagation and management. N.Y. State Conserv. Dept. 915 pp.

Chambers, R. E., and W. M. Sharp. 1958. Movement and dispersal within a population of ruffed grouse. J. Wildl. Manage. 22:231-239.

Dorney, R. S., and C. Kabat. 1960. Relation of weather, parasitic disease and hunting to Wisconsin ruffed grouse populations. Wis. Conserv. Dept. Tech. Bull. No. 20. 64 pp.

Erickson, A. B. 1951. Closed season no boon to ruffed grouse. Conserv. Volunteer 14:34-36.

Errington, P. L., and F. N. Hamerstrom, Jr. 1935. Bob-white winter survival on experimentally shot and unshot areas. Iowa St. College. J. Science 9:625-639.

Fischer, C. A., and L. B. Keith. 1974. Population responses of central Alberta ruffed grouse to hunting. J. Wildl. Manage. 38:585-600.

Godfrey, G. A., and W. H. Marshall. 1969. Brood break-up and dispersal of ruffed grouse. J. Wildl. Manage. 33:609-620.

Hale, J. B., and R. S. Dorney. 1963. Seasonal movements of ruffed grouse in Wisconsin. J. Wildl. Manage. 27:648-656.

———, and R. F. Wendt. 1951. Ruffed grouse hatching dates in Wisconsin. J. Wildl. Manage. 15:195-199.

King, R. T. 1937. Ruffed grouse management. J. Forestry 35:523-532.

Leopold, A. 1949. A Sand County Almanac. Oxford Univ. Press. 269 pp.

McCabe, R. A. 1964. Some aspects of wildlife and hunting in northern Wisconsin. Trans. Wis. Acad. 53:57-65.

Palmer, W. L. 1956. Ruffed grouse population studies on hunted and unhunted areas. Trans. N. Am. Wildl. Conf. 21:338-345.

Parmalee, P. W. 1953. Hunting pressure and its effect on bobwhite quail populations in east-central Texas. J. Wildl. Manage. 17: 341-345.

Rusch, D. H., and L. B. Keith. 1971. Seasonal and annual trends in numbers of Alberta ruffed grouse. J. Wildl. Manage. 35:803-822.

———, M. M. Gillespie, and D. I. McKay. 1978. Decline of a ruffed grouse population in Manitoba. Can. Field-Nat. 92:123-127.

Schorger, A. W. 1944. The prairie chicken and sharp-tailed grouse in early Wisconsin. Trans. Wis. Acad. 35:1-59.

———. 1945. The ruffed grouse in early Wisconsin. Trans. Wis. Acad. 37:35-90.

Scott, W. E. 1937a-e. Conservation history. Wis. Conserv. Bull. a, 2(3):10-15; b, 2(4): 14-20; c, 2(5):23-30; d, 2(6):27-37; e, 2(9):26-31.

———. 1938. Conservation history. Wis. Conserv. Bull. 3(4):26-37.

Swank, W. G., and S. Gallizioli. 1954. The influence of hunting and of rainfall upon Gambel's quail populations. Trans. N. Amer. Wildl. Conf. 19:283-297.

Weaver, J. K., and H. S. Mosby. 1979. Influence of hunting regulations on Virginia wild turkey populations. J. Wildl. Manage. 43: 128-135.

EVALUATION OF INGESTED SHOT LEVELS IN WATERFOWL HARVESTED IN WISCONSIN IN 1980

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Abstract

A topic of current concern in wildlife biology is the poisoning of waterfowl due to ingestion of waste lead shot. In 1980, citizens of Wisconsin took political action which resulted in a legislative mandate to halt lead shot restriction and to require investigations that would determine whether such restriction was, in fact, appropriate. A Toxic Shot Evaluation Committee was formed of eight persons knowledgeable and concerned about the problem, and representative of its various points of view. The recommendations eventually offered to the Department of Natural Resources and the Natural Resources Board were based on a survey of past research from Wisconsin and throughout the nation, and on an investigation that the Committee itself performed. In five representative regions of the state, hunters were asked to contribute the gizzards of waterfowl from their hunting bag. A total of 3,801 was received. Analysis of their contents was then performed by volunteers from the hunting and non-hunting public, supervised by committee members and observed by DNR personnel. Quantitative data on total occurrence of shot, geographic and species variation in occurrence, and relative amounts of lead vs. steel shot were obtained.

Introduction

Although fatal lead-poisoning due to the ingestion of waste lead gun-shot is estimated to kill more than 1,000,000 birds annually, there has been no practical alternative to lead shot until recently. In 1977 lead shot was prohibited for waterfowl hunting with twelve gauge guns in five southeastern Wisconsin counties and along the Mississippi shoreline of six other counties. Steel shot was the required alternative in those areas. The basis for selecting these counties was the waterfowl harvest level of 20 or more waterfowl per square mile. The rationale of this restriction was that high harvest resulted from heavy hunting pressure which deposited large amounts of waste shot in those wetlands. The greater the deposition, other factors being equal, the greater the probability of lead-poisoning originating in those areas. In 1978 and 1979 the critical harvest level was amended to ten per square mile and the no-lead (steel) "zone" expanded to include 21 counties in southeastern Wisconsin and eight along the Mississippi River.

In early 1980 political action by a number of Wisconsin citizens, both hunters and non-hunters, led to legislation which canceled, for that year, the prohibition of lead shot, on the ground there was insufficient information to demonstrate that a lead-poisoning problem occurred in Wisconsin, and that the harvest index did not validly represent geographic "hotspots."

The 1980 legislation, therefore, required formation of a citizens' advisory committee which would investigate these concerns and determine what criteria would best answer them and what specific procedures were needed to provide data. These criteria and procedures were then to be recommended to the Department of Natural Resources.

The Toxic Shot Evaluation Committee was comprised of eight members: Dr. Vern

Larsen of Shiocton, Harold McEuen of Onalaska, Charles Morgan of La Crosse, William Peterburs of Mequon, James Rehbein of Beloit, Jeff Renard of Neenah, Herb Theisen of Friendship and David Strohmeyer, representing the Oshkosh area and serving as chairman. In a series of meetings during late 1980 the committee soon discovered that documentation pertaining to lead-poisoning was actually quite abundant. Appraisal of approximately 140 references indicated that recent studies had become very specialized. Furthermore, basic information on lead-poisoning, such as places of occurrence and numbers dying, tended to remain in files and unpublished reports, apparently viewed as being too repetitious to warrant conventional publication. A substantial amount of the documentation applied to the Wisconsin situation (19 references dating from 1937 to 1980); Wisconsin had been a forerunner in the study of lead-poisoning and continues to be a focal area for many of the studies relating to lead-poisoning. The Wisconsin records supported the use of harvest levels for determining lead-restriction zones in that the locations of previous die-offs coincided very closely with the high-harvest counties.

The Committee, in concurrence with the U.S. Fish and Wildlife Service Final Environmental Impact Statement (1976), felt that steel-shot zones should be rather specifically determined. It therefore suggested a three-year program for sampling waterfowl gizzards and wetland sediments, both to update the data and to identify "hotspot" areas. Rather than delay until a recommendation for data collection could be made to the Department of Natural Resources and processed through legislative channels, the committee decided to organize its own study of the frequency of occurrence of shot in the gizzards of waterfowl harvested during the 1980 hunting season.

Methods

The members of the Toxic Shot Evaluation Committee represented the major waterfowl hunting regions of Wisconsin which are, essentially, the southeast quarter of the state and the Mississippi River area. The Committee members asked hunters in their areas to save gizzards from the waterfowl they shot, and to provide data regarding the locale, species and date, and to participate in regular inspection sessions at some convenient time and place. At these sessions each gizzard was opened and its contents washed into a white enamel tray and searched for shot. Shot which had been largely eroded by the gizzard's grinding action might remain as a mere fleck of metal and was difficult to detect. If any shot was found in a gizzard, the organ was inspected carefully for entrance holes that would indicate whether an uneroded shot had been fired into the gizzard when the bird was killed. Any such shot were recorded separately and not included in the ingested category. Data on species, hunting locale, date, presence-absence of shot, number of shot present, whether steel or lead, and whether eroded or not were recorded for each gizzard. The data from the various locations throughout the state were sent to David L. Strohmeyer and assembled for presentation to the Natural Resources Board and for this paper.

Results

A total of 3801 gizzards was collected from 30 counties in Wisconsin (Table 1). Twelve of the counties provided very few gizzards (total of 46) and are included as a collective unit. The 3755 gizzards from the other 18 counties represent 1.5% of their annual harvest (as estimated from the 10-year mean, 1966-1975) and would seem to be an adequate sample. Some counties were more thoroughly sampled than others, perhaps even excessively so. One objective of the continuation of this study will be a more balanced distribution of samples from the various counties. One intangible in sample collection, however, is the level of cooperation by hunters from those areas.

Overall, 10.6% of the 3801 gizzards con-

TABLE 1. County Comparison of Gizzard Data, 1980.

County	*1966-1975 Harvest (per sq. mi.)*	*Total gizzards inspected*	*No. with shot*	*% of sample with shot*
Adams	8.7	165	11	6.7
Calumet*	11.4	11	2	—
Dodge*	54.0	159	18	11.3
Fond du Lac*	27.5	160	18	11.3
Green Lake*	36.4	380	34	8.9
Jefferson*	19.6	129	10	7.7
Juneau	9.9	18	4	—
Kenosha*	21.1	69	3	4.3
Manitowoc*	19.4	26	4	—
Marquette*	30.0	84	6	7.1
Outagamie*	20.5	742	70	9.4
Racine*	14.5	70	1	1.4
Shawano	6.7	87	1	1.1
Walworth*	15.8	100	4	4.0
Waukesha*	16.9	156	12	7.7
Waupaca*	20.2	219	41	18.7
Waushara*	15.3	20	2	—
Winnebago*	52.4	864	138	16.2
LaCrosse area		296	16	5.4
12 other counties with small samples		46	9	—
Total		3801	404	10.6

* Counties in 1978, 1979 no-lead zone.

TABLE 2. Occurrence of Shot in Waterfowl Harvested From Specific Wetland Areas.

County	*Wetland*	*% Occurrence/Sample*
Shawano	Shawano Lake	0 of 66
Waupaca	White Lake	23.4 of 137
	Partridge Lake	8.5 of 59
Outagamie	Black Slough Conservation Club	9.3 of 269
	Wilderness, K & S Gun Clubs	9.5 of 442
Winnebago	L. Buttes des Morts	21.0 of 334
	L. Poygan	19.5 of 169
	Rush Lake	12.0 of 67
	L. Winnebago	9.1 of 287
Fond du Lac	Eldorado Marsh	13.9 of 108
Green Lake	Grand River Marsh	8.2 of 291
Marquette	Buffalo Lake	7.0 of 82
Adams	One mile segment of Wisconsin River	7.0 of 140
Dodge	Horicon Marsh	8.4 of 95
Jefferson	L. Koshkonong	7.8 of 129
Waukesha	Big Muskego Lake	8.0 of 103
Walworth	L. Como	8.0 of 52
Racine	L. Tichigan	2.0 of 47
Kenosha	Camp Lake	6.0 of 49

tained at least one shot at the time the bird was killed. This is a minimum value as some shot may have gone undetected and it omits all shot considered to have been fired-in. An additional 184 gizzards (5.5% of the 3361 gizzards evaluated for this condition) contained fired-in shot.

The '78 and '79 steel shot zone included 21 southeastern counties which harvested more than 10 birds per square mile. The present study provides adequate ingestion data for 12 of those 21 counties, and for two counties with a harvest of less than 10 birds per square mile (Table 1). The ingestion rates for the former counties range from 1.4 to 18.7% (median = 9.4), while for the latter two counties they range from 1.1 to 67%. Only in four counties, Adams, Kenosha, Racine and Walworth, does the ingestion level not agree well with the harvest index.

Twenty specific wetland areas contributed sufficient gizzards to permit an estimate of the extent of shot ingestion in birds harvested there (Table 2). The fewest gizzards from a single area included in this summary are the 47 from Lake Tichigan, while the largest number was the 334 from Lake Butte des Morts. Most of these areas show rather high percentages of shot. It is reasonable that those areas which can supply large numbers of gizzards are heavily hunted, and therefore are areas of high shot deposition and high potential for shot ingestion.

Wisconsin waterfowl hunters take most of their harvest from rather few species of birds. Sixty-one percent of the annual bag is comprised of just three species; adding the next six species raises the total to 88% of the annual harvest. These species do not show equal frequencies of ingestion of waste shot (Table 3). The mallard shows a high rate, while the ringneck and scaup show very high rates. The widgeon, black duck and Canada goose are all high, and all of these species are among the nine most harvested. Only the number two, three and four species (see Table 3) in the statewide bag fall below the five percent level which has been identified by the U.S. Fish and Wildlife Service as a limit critical to the reduction of large-scale lead-poisoning. Several of the less hunted species, such as the pintail and the redhead, also show high rates of ingestion.

Different counties show different rates of harvest for various species. Certainly the lesser scaup is more heavily represented in the harvest on Lake Winnebago than in most other areas of the state. The three most commonly harvested species (or species groups) for each adequately sampled county are presented in Table 4. Adams county, for example, harvests mostly mallards, secondly, other dabblers and thirdly, geese. Very few divers are shot there in spite of the proximity of the large pools on the Wisconsin River.

TABLE 3. Species Occurrence of Shot in Gizzards.

Species	*% of annual harvest*	*Total inspected*	*% with shot*
mallard	34	1405	11.3
wood duck	15	118	4.2
blue-winged teal	12	283	2.8
green-winged teal	7	201	1.5
ringneck	6	307	22.1
lesser scaup	5.5	360	15.0
widgeon	5.5	156	7.7
black duck	2.5	58	8.6
Canada goose	—	141	10.6
pintail	—	68	10.3
shoveler	—	28	0
gadwall	—	24	0
greater scaup	—	10	50.0
redhead	—	110	23.6
canvasback	—	18	5.5
ruddy	—	27	11.1
hooded merganser	—	15	6.6
common and red-breasted merganser	—	4	25.0
bufflehead	—	47	2.1
goldeneye	—	13	7.7
scoters	—	13	0
snow goose	—	12	8.3
unknown	—	87	13.6
LaCrosse area*	—	296	5.6
TOTAL		3801	10.6

* Not separated by species.

TABLE 4. Percent Shot Ingestion in the Three Most-Harvested Species Per County.

County	*First in harvest*	*Second in harvest*	*Third in harvest*
Adams	mallard — 3	dabblers* — 15	geese** — 14
Dodge	mallard — 13	dabblers — 9	geese — 24
Fond du Lac	mallard — 17	greenwing — 2	geese — 10
Green Lake	mallard — 13	dabblers — 5	geese — 7
Jefferson	mallard — 9	dabblers — 4	1. scaup — 0
Kenosha	ringneck — 13	redneck — 8	mallard — 0
Marquette	mallard — 6	ringneck — 14	dabblers — 0
Outagamie	mallard — 12	bluewing — 3	dabblers — 11
Racine	mallard — 0	sea ducks† — 0	woodduck — 0
Shawano	mallard — 0	scaup — 6	ringneck — 0
Walworth	dabbler — 0	bluewing — 0	mallard — 13
Waukesha	mallard — 16	woodduck — 4	bluewing — 0
Waupaca	ringneck — 30	mallard — 10	1. scaup — 21
Winnebago	1. scaup — 16	mallard — 14	ringneck — 33

* = All but mallard, bluewing and greenwing
** = Both Canada and snow
† = Mergansers, bufflehead, goldeneye and scoters

This table also shows the percent occurrence of ingested shot for those species *in that county*. For example, only 3% of the mallards killed in Adams county contained shot, although 11.3% of the state total of harvested mallards did so. Fifteen percent of the dabbler category and 14% of the geese harvested in Adams county contained ingested shot. Numerous other comparisons of this type are possible. Kenosha ringnecks show 13% occurrence, but Winnebago ringnecks show 33%. Shawano county scaup show 6% occurrence, but in Waupaca county, the next one south, the scaup show 21% occurrence of shot. Walworth and Racine counties harvest mostly low shot-occurrence species, hence their low overall ingestion levels in spite of their 10+ harvest level.

One interpretation which can be made of the different levels of occurrence between counties is that most shot is not being brought in from other areas. If it were, there would be less variation in occurrence along north-south migration routes. These regionally different levels suggest local origin of shot for certain species. For example, the Winnebago county ringnecks seem to be getting their shot from Lake Butte des Morts (70 of 97 ringnecks came from Butte des Morts, and 21 of them contained shot). These data also suggest areas which do *not* seem to be shot sources for some or all species. As more data accumulate it may become possible to identify specific problem areas within counties.

Table 5 presents the number and type of shot found. Considering the number of giz-

TABLE 5. Number and Type of Ingested Shot.

No. of shot	*No. of gizzards*	*Type of shot*	*No. of gizzards*
1	252	lead	298
2	67		
3	31	steel	69
4	15		
5	5	both	21
6-10	11		
11-20	2	TOTAL	388*
21-30	2		
30+	3		
TOTAL	388*		

* 388 plus 16 unspecified from LaCrosse = 404.

zards collected in counties with lead shot restriction in 1977, '78 and '79, the amount of steel shot is rather low. This could be evidence of ingestion of the current year's supply of shot, or, possibly, of ingestion in other areas of the state. It could also suggest violation of the restriction, widespread use of 20 gauge guns (in which lead use was permitted) or long-term availability of lead shot from years prior to the restriction. Data from 1981 and '82 will help in determining which of these alternatives is correct.

The great majority of gizzards contained only one shot. The percentages of birds with various numbers of shot agree very well with those found in the Bellrose (1959) study which summarized data on 35,000 gizzards, and with a study done in England (Thomas, 1978). It would seem, then, that a typical occurrence pattern exists. It is appropriate to mention that not all birds which ingested lead shot would have died. The chances of death increase, though, as the number of ingested shot increases (Bellrose, 1959). Recent studies, especially one by Dieter and Finley (1979), show that even partial absorption of a single pellet can cause metabolic disorders sufficient to kill a bird or make it much more vulnerable to natural predators or to hunters.

Literature Cited

Bellrose, F. C. 1959. Lead poisoning as a mortality factor in waterfowl populations. Ill. Nat. Hist. Surv. Bull. 27(3):235-288.

Dieter, M. P. and M. T. Finley. 1979. Aminolevulinic acid dehydratase enzyme activity in blood, brain and liver of lead-dosed ducks. Environ. Res. 19:127-135.

Thomas, G. J. 1978. Lead poisoning in waterfowl and ways of reducing it. Internat. Waterfowl Res. Bureau Bull. 45:27-31.

U.S. Fish and Wildlife Service. 1976. Steel: Final Environmental Statement. Proposed use of steel shot for hunting waterfowl in the United States. U.S. Government Printing Office, Washington, D.C. 276 pp.

VEGETATIONAL CHANGE IN UNIVERSITY BAY FROM 1966 TO 1980

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Abstract

The aquatic macrophytes of University Bay, Lake Mendota, Dane Co., Wisconsin, were sampled using the line transect method. Twenty-one lines were sampled, and all plants intercepting every 5th meter segment of each line were recorded. Data were used to construct a contour map of the vegetated zone of the bay, delimit plant communities, and determine species composition. Marked vegetative changes have occurred since Lind and Cottam studied the bay in 1966. The most pronounced changes were, (1) the decline of an exotic, *Myriophyllum spicatum,* which had become the dominant species, (2) the decline of *Vallisneria americana* and *Ceratophyllum demersum,* (3) the increase in importance of *Potamogeton pectinatus,* (4) a 30% reduction in littoral zone area, and (5) reduction of large continuous stands to scattered plants. The vegetative decline in University Bay paralleled similar declines in other Dane Co. lakes.

Introduction

Many investigators have documented aquatic macrophyte change over the last century, accompanying eutrophication of lakes in North America (e.g. Lind and Cottam 1969, Harman and Doane 1970, Nichols and Mori 1971, Stuckey 1971, Crum and Bachmann 1973, Bumby 1977). An exotic, *Myriophyllum spicatum,* has invaded many eutrophic waters in the eastern U.S., including the Madison, Wisconsin lakes (Nichols 1975). In the Madison lakes, *M. spicatum* replaced *Vallisneria americana* and several *Potamogeton* species as the dominant species (Lind and Cottam 1969, Nichols and Mori 1971). Lind and Cottam (1969) reported dominance of *Myriophyllum exalbescens,* but they evidently misidentified *M. spicatum* (Nichols 1971). *M. spicatum* has since declined in the Madison lakes (Carpenter 1979). The purpose of this study was to provide a current description of the aquatic vegetation of University Bay, Lake Mendota, extending the vegetation record for this bay to a 70 year period. Results of this study will be useful in a concurrent study of changes in value of University Bay as a waterfowl refuge. This paper describes changes in the drainage basin with consequent nutrient and sediment input, changes in distribution of rooted vegetation, species composition changes, community change, and apparent changes in aquatic macrophyte density.

Study Area

The study area was located within the Yahara River basin system of lakes in south-central Wisconsin. The 106 ha University Bay is a small bay on the south side of Lake Mendota, bounded by the University of Wisconsin-Madison campus to the south and the Picnic Point peninsula to the north (Fig. 1). The hydrography is characterized by a sand bar extending from Willow Point to Picnic Point. A large shallow flat (<1.5 m) occurs west of the bar and depth reaches 16 m to the east. A more complete description of the study area was provided by Dillon (1956).

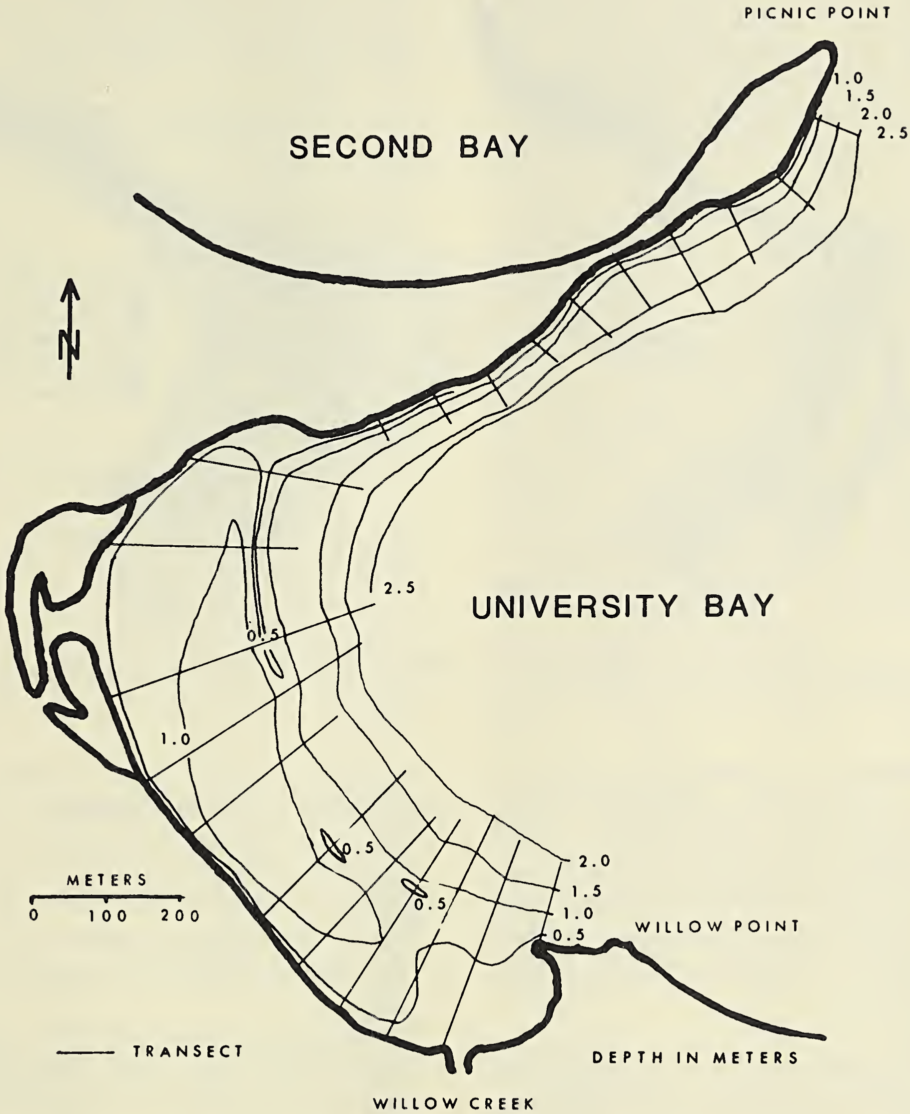

Fig. 1. Map of University Bay showing depth contours to the limit of growth of submerged aquatic plants. Transects ended where vegetation ended.

Methods

Sampling

Sampling of vegetation in University Bay in 1980 was designed to be directly comparable with that of Lind and Cottam (1969), i.e. 21 transects were positioned in the same locations as those of Lind and Cottam. I sampled vegetation between 28 July and 11 August, 1980, using a length of polypropylene rope, held at each end by an anchored buoy, as a transect line. Vegetation below every 5th meter segment of this line was sampled with a garden rake modified with ¼ inch wire mesh attached to the teeth. Each quadrat was, in essence, 1 m by 1 rake width (i.e. 36 cm). Depth at each quadrat was measured with a weighted line marked at 0.5 m intervals. The density of vegetation

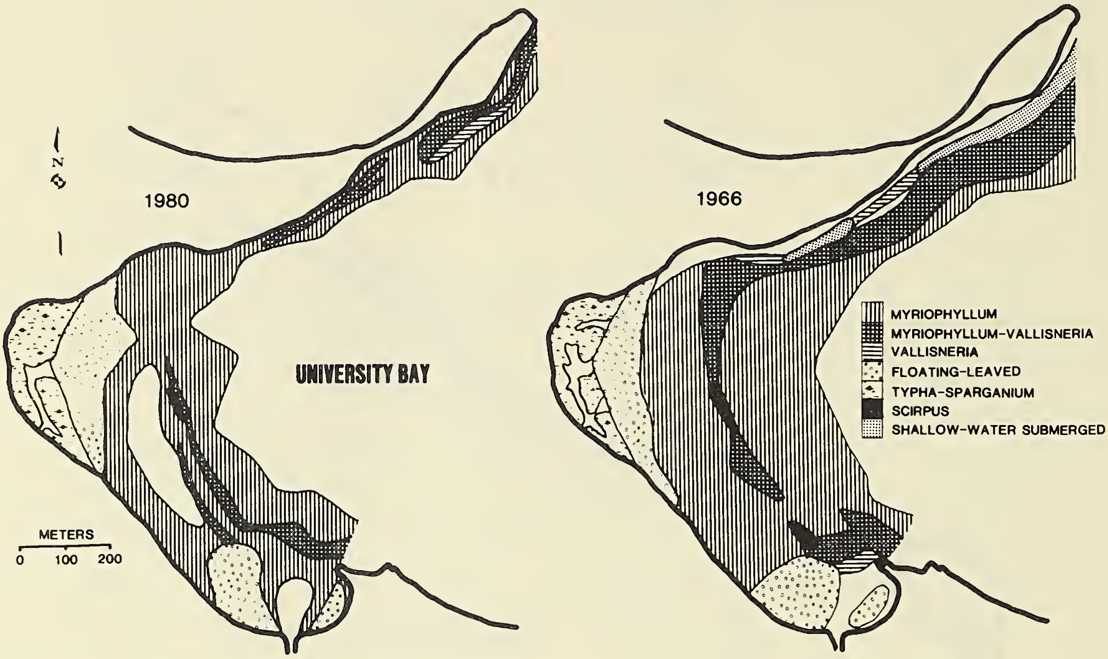

Fig. 2. Map of communities of University Bay in 1980 and 1966 (adapted from Lind and Cottam, 1969).

in each quadrat was recorded as present (1 plant), scattered (discontinuous), or continuous (solid stand). Each transect was terminated at the point beyond which no vegetation was found in five consecutive quadrats. Nomenclature of plant species follows that of Fassett (1960) as revised by Ogden.

Analysis of Data

Quadrat data from all transects in this study were combined to determine frequency and relative frequency based on the percentage of quadrats containing each species. The depth and species occurring at each quadrat were used to develop hydrographic and plant community maps of the vegetated area of University Bay (Figs. 1 and 2). Communities were delimited in the same manner as those of Lind and Cottam (1969). The floating-leaved and emergent communities were delimited on the basis of physiognomy. The remaining three communities consisted entirely of submerged plant species. These aggregations were a *Myriophyllum* community, a *Vallisneria* community and a joint *Myriophyllum-Vallisneria* community. The demarcation of community boundaries was made at the point where the distribution of the dominant species became discontinuous as recorded from transect quadrat data, not at the point where the species ceased to exist.

Total transect length in 1966 was approximately 40% longer than in 1980 due to the presence of vegetation in deeper water. In order that percent presence (frequency) be directly comparable with that in 1966, 1980 frequency data were corrected by dividing by 1.4. With this correction, actual change in area of presence can easily be ascertained. Without the correction, a species with the same distribution in each study would have a higher frequency in 1980 than in 1966.

Results

Vegetation grew to a greater depth along Picnic Point than in the southwest section of the bay (Fig. 1 and 2). Very little vege-

TABLE 1. Comparison of depths at which growth of submerged aquatics ceased in 1966 (Lind and Cottam 1969) and the present study. Depth at end of transect marks depth at which no more plants were found.

Depth limit interval (m)	*No. transects ending* 1966	1980
1.0–1.4	0	2
1.5–1.9	0	10
2.0–2.4	0	7
2.5–2.9	6	2
3.0–3.4	6	0
3.5–3.9	7	0
4.0–4.4	2	0

tation was found in water depths greater than 2.5 m (Table 1).

Submergent vegetation was generally sparse over most of the bay. Solid, continuous stands were found only in a narrow band along the eastern edge of the gravel bar, in a narrow band along Picnic Point, and in small scattered beds west of the bar. Vegetation was absent in 25% of the quadrats.

University Bay contained 14 submerged and floating-leaved plant species in 1980; only *Myriophyllum spicatum, Potamogeton pectinatus* and *Vallisneria americana* were common (Table 2). The other species present each had a relative frequency less than 4%.

Myriophyllum spicatum occurred in nearly all of the eulittoral zone of the bay, except on the delta at the mouth of Willow Creek and an area nearly devoid of vegetation west of the bar (Fig. 2). *M. spicatum* grew on organic and silt bottoms primarily. It was the only species commonly occurring in water deeper than 1.5 m. It occurred in greatest density along Picnic Point in water 1.0-1.5 m deep and along the eastern slope of the bar in water 0.8-1.5 m deep. Dense mats of filamentous algae (*Mougeotia* sp. and *Rhizoclonium* sp.) were present on these dense stands of *M. spicatum*.

Potamogeton pectinatus, the second most frequent species, was found in scattered

TABLE 2. Changes in aquatic macrophyte species composition in University Bay.

Species	*1966 Frequency (%)*	*1980 Frequency (%)*	*1966 Relative Frequency (%)*	*1980 Relative Frequency (%)*
Ceratophyllum demersum	18.1	4.2(3.0)[b]	13.6	3.7
Chara sp.	0.0[c]	0.0	0.0[c]	0.0
Elodea canadensis	0.4	2.8(2.0)	0.3	2.5
Heteranthera dubia	1.6	1.1(0.8)	1.2	1.0
Myriophyllum spicatum[a]	74.2	52.0(37.1)	55.6	45.4
Najas flexilis	0.1	1.1(0.8)	0.1	1.0
Nelumbo lutea	0.5	1.4(1.0)	0.4	1.2
Nymphaea tuberosa	9.4	6.0(4.3)	7.1	5.3
Potamogeton crispus	0.0[c]	1.7(1.2)	0.0[c]	1.5
Potamogeton foliosus	0.5	2.4(1.7)	0.0[c]	2.0
Potamogeton nodosus	0.8	0.3(0.2)	0.6	0.2
Potamogeton pectinatus	1.4	22.5(16.1)	1.1	19.6
Potamogeton richardsonii	2.2	1.0(0.7)	1.7	0.9
Potamogeton zosteriformis	0.2	0.0	0.1	0.0
Ranunculus trichophyllus	2.0	0.0	1.5	0.0
Vallisneria americana	21.0	16.3(11.6)	15.7	14.2
Zannichellia palustris	0.0[c]	1.4(1.0)	0.0[c]	1.2

[a] Reported as *Myriophyllum exalbescens* by Lind and Cottam (1969).

[b] Numbers in parentheses are percent frequencies corrected for a 40% greater total transect length in 1966 than 1980, for comparison with 1966 frequency data.

[c] Less than 0.05.

solid stands just north of the delta, at the north end of the bar, and near Willow Point, in addition to scattered plants elsewhere. This species was primarily located on or west of the bar. There was no pattern to distribution with respect to depth or bottom type, and few fruiting plants were found. It was not as continuous as *Myriophyllum spicatum,* but grew with it in all water less than 1.5 m deep except near the tip of Picnic Point.

Vallisneria americana was limited to sandy bottom areas near Willow Point, along both sides of the bar and along Picnic Point (Fig. 2). As with the vegetation in general, *V. americana* was present in greater depths along Picnic Point than near the Willow Creek delta. The depth to which *V. americana* grew ranged from 1.5-1.9 m. It was in poorest condition west of the bar where it was silt-covered and rotting. Healthy, flowering stands were present along Picnic Point where relatively little silt was found on the plants.

The *Myriophyllum* community was most prominent in the bay (Fig. 2) and was nearly monotypic in the deeper areas. *M. spicatum* became codominant with *V. americana* forming *Myriophyllum-Vallisneria* communities on sandy bottom along the bar and Picnic Point (Fig. 2). The community dominated by *V. americana* alone was found only in a narrow strip at the distal end of Picnic Point in water depths of 1.6-1.8 m.

Two emergent communities were recorded, a large *Typha-Sparganium* marsh on the mudflats in the northwest corner of the bay and a small bed of *Scirpus validus* on the bar (Fig. 2). The former was very dense whereas the latter was sparse.

Floating-leaved communities consisting of *Nymphaea tuberosa* and *Nelumbo lutea* were situated at the northwest and southwest corners of the bay (Fig. 2). *Myriophyllum spicatum* and *Ceratophyllum demersum* were the predominant submerged species below the floating-leaved plants. Silt and marl bottoms were characteristic of these communities.

The continually forming sand delta at the mouth of Willow Creek and a large portion of the deeper water west of the bar (Fig. 2) were nearly devoid of vegetation.

Discussion

Bay Area Changes and Nutrient and Sediment Input

In order to understand the vegetational changes in University Bay, changes in nutrient and particulate matter input should be known. Until 1910, University Bay was bounded to the west by a 53 ha marsh which undoubtedly trapped large amounts of nutrients and silt that would otherwise have entered the bay. In 1910, the marsh was drained and planted to corn. Thereafter, fertilizer-enriched water was pumped into the bay. From 1940 to 1980, the Madison population increased from 67,000 to 171,000, increasing the input of urban pollution, especially with the onset of the "detergent era." In addition, the rapidly growing communities upriver from Lake Mendota dumped treated sewage into the Yahara River until 1971. Probably the major contributor of nutrient and particulate matter to University Bay during the last 30 years has been Willow Creek (also known as University Creek), which wound through a marsh until the early 1950's. This creek was channelized, and the storm sewer outfall of the Hilldale area was placed at the head of the creek. This rapidly growing residential and commercial area increased in size from less than 8 km^2 to greater than 15 km^2 during the 1950's and early 1960's (Sterrett, 1975). This, together with increased building density and pavement surface, greatly increased runoff and thus nutrient and particulate loading to University Bay.

Ahern (1976) estimated that 922 kg of total phosphorous and 353,000 kg of particulate matter entered University Bay via

Willow Creek in 1972 alone. High sedimentation is evidenced by the delta forming at the mouth of the creek including an expanding, willow covered, island. Further evidence that nutrient loading has been most prominent since the early 1940's was provided by Bortleson and Lee (1972) when they found drastically increased phosphorous and nitrogen concentrations in the top 15 cm of the marl, representing the period of 1940 on.

Maximum Depth of Rooted Vegetation

Denniston (1921) and Andrews (1946) found rooted vegetation common to water depths of 5-7 m in University Bay. Indeed, some of the long-stem pondweeds grew profusely east of the bar to these depths. However, in 1966, most of the 21 transects ended in depths of 2.5-4.0 m, and by 1980, vegetation depth was further restricted, most of the transects ending between 1.5 and 2.5 m (Table 1). This change from 1966 to 1980 resulted in a littoral zone reduction of approximately 30%.

West of the bar, a large area of water where dense growths had occurred in 1966 was largely devoid of vegetation in 1980. This area coincides with water depths between 1.0 and 1.5 m (Figs. 1 and 2). On days when a high particulate load was carried by Willow Creek, it was evident that the current carried and deposited silt and sand primarily west of the bar. Wave action and carp activity in this shallow area further increased turbidity, preventing plants from growing in water as shallow as 1.0 m. Turbidity and silt resulting from Willow Creek also explains the shallower maximum depth of rooted vegetation found in 1966 (Lind and Cottam) and 1980 on this side of the bay (Fig. 1). It appears that factors causing major changes in maximum depth of vegetation have occurred since the early 1940s and continue to affect vegetation. Similar reductions in deep zone vegetation following eutrophication and siltation with related turbidity, have been reported elsewhere (Harman and Doane 1970, Morgan 1970, Felstehausen and Rabl 1973, Bumby 1977). Turbidity reduces light penetration and thus the depth at which plants can grow.

Cover Changes

Rickett (1921:509) stated, "In University Bay, almost all of the species found in the lake are present in a dense tangled growth." Andrews (1946:8) observed that "at each end of the bay aquatics with floating leaves become so abundant that large mats of floating algae and plant fragments are held in place permitting growths of duckweed in open water." Lind and Cottam (1969) suggested that the vegetation was dense enough to impede human use. Upon casual observation, it became obvious that such dense growths of vegetation did not occur in 1980. As mentioned earlier, the area of solid, continuous stands of vegetation was very limited. Moreover, the fact that in 25% of the quadrats not even 1 plant was found implies discontinuity.

There were also indications that the floating-leaved communities have thinned. *Myriophyllum spicatum* was infrequently found in the floating-leaved communities by Lind and Cottam in 1966. Further, in Lake Wingra, *M. spicatum* occurred in the floating-leaved communities only where *Nymphaea tuberosa* leaves were widely scattered. In 1980, the corrected frequency for *N. tuberosa* was half that in 1966 (Table 2), and *M. spicatum* was the dominant submerged species in this community.

Species Composition

Extensive beds of *Vallisneria americana, Potamogeton* species, and *Chara* sp. found in 1921 and 1946 were replaced by *Myriophyllum spicatum* by 1966 (Lind and Cottam 1969). Whether *M. spicatum* caused the decline of these species or invaded following the decline is not known. However, other lakes, having become eutrophic yet lacking exotic species, also have experienced a decline in native species (Stuckey 1971, Crum and Bachmann 1973). Moreover, weedy species usually require disturbance or reduction in vigor of native species before explosive growth occurs.

The greatest change in vegetation of University Bay between 1966 and 1980 has been the decline of *M. spicatum*. Corrected frequency data show a decline from 74.2 to 36.1% in 1980. *M. spicatum* was still the most abundant species with a relative frequency of 45.4% in 1980. The deep water zone of *M. spicatum* has disappeared as well as a large area west of the bar (Fig. 2). This decline was most noticeable in Lake Mendota between 1974 and 1975, and it had occurred in the other 4 Madison area lakes by 1978 (Carpenter 1979). This pattern of invasion, abundance, and decline has been typical of most *M. spicatum* invasions (Carpenter 1979).

Phillips et al. (1978) presented a mechanism for vegetative decline, whereby increasing nutrient levels result in increasing growth of filamentous algae and other epiphytes. These epiphytes shade and, consequently, reduce the growth of macrophytes. Reduction in competition and in secretion of phytoplanktonic suppressants from macrophytes then results in increased phytoplankton biomass, further shading the macrophytes. Although filamentous algae were very abundant in 1966 and 1980, they could not, alone, account for the reduction in *M. spicatum* in University Bay; the disparity in loss between different parts of the bay would not be explained.

Carpenter (1979) discounted toxic metals, harvesting, herbicides, climatic variables, and nutrient levels as the cause of decline. Carpenter (1979:57) suggested that the decline ". . . was a result of synergistically interacting factors, perhaps including nutrients, epiphytes, competitors, and parasites or pathogens." Competition was not likely a factor in University Bay, because all of the common species except *Potamageton pectinatus* also declined (Table 2); *P. pectinatus* was not dense enough to cause competition with *M. spicatum* over most of the bay. It is likely that seston and epiphytes contributed to the decline; however, something more was involved since the decline occurs with most invasions of *M. spicatum*. Bayley et al. (1978) described a disease which could be spread from one plant to another under low light conditions, such as occurs with turbidity. Perhaps this is occurring in the Madison area.

The frequency of *Ceratophyllum demersum* increased 8-fold with the first year of decline of *Myriophyllum spicatum* in Lake Wingra; it is rated highly tolerant of turbidity (Davis and Brinson 1980). *C. demersum* was described as being very abundant everywhere west of the bar in University Bay in 1970 (Gillette unpubl. rept.). However, in 1980 *C. demersum* abundance was much reduced (Table 2). I searched for this species in 1981, finding few plants; these were in the most protected areas of the bay.

Carpenter (1979) suggested the reduction in density of *M. spicatum* in 1977 reduced competition with *C. demersum*. Perhaps this was occurring in University Bay in 1970. The reduction in density of *M. spicatum* from solid stands to scattered plants since 1970, together with decreased distribution, has likely led to increased wave action and turbulence in University Bay. This would adversely affect *C. demersum* (non-rooted) and may explain its current distribution and low abundance.

Vallisneria americana frequency decreased by almost one-half from 1966 to 1980 (Table 2). It was restricted to the coarsest bottoms. Perhaps siltation or resuspension of sediments was less there. Healthy plants were most abundant east of the bar, along Picnic Point, far from the silt source, Willow Creek. Perhaps, also, *Myriophyllum spicatum* could not have competed with *V. americana* on this substrate as it has an affinity for fine organic substrates (Patten 1956).

Most other species remained in low abundance. By 1980, *Potamageton zosteriformis, Chara* sp., and *Ranunculus trichophyllus* had disappeared.

The one species that has significantly increased in importance since 1966 (Table 2), *Potamogeton pectinatus,* has survived high levels of urban pollution elsewhere (Butcher 1933, Haslam 1978, Ozimek 1978). It also doubled in frequency in L. Wingra (Carpenter 1979). The linear leaves of *P. pectinatus* remain relatively free of settling particles (Sculthorpe 1967, Sheimer and Prosser 1976). Moreover, the filamentous algae so abundant on *Myriophyllum spicatum* in University Bay were negligible on *P. pectinatus. P. pectinatus* is, however, very susceptible to shading in its early period of growth (Anderson 1978). These properties may have allowed *P. pectinatus* to persist and increase while other species have declined.

Community Changes

The northern pondweed communities have disappeared. The *Scirpus validus* bed has been reduced from a strip across the bar (Rickett 1921) to 3 separate beds in 1966 and to 1 bed by 1980 (Fig. 2). A delta of sand now lies where a diverse community occurred in 1950 at the mouth of the creek (White unpubl. rept.). Furthermore, there are no longer beds of shallow water communities dominated by *Elodea canadensis, Najas flexilis, Chara sp.* and *Zannichellia palustris* (Fig. 2). Now, the *Myriophyllum* community of 1966 could be better called the *Myriophyllum-P. pectinatus* community, and *Myriophyllum spicatum* has replaced *Ceratophyllum demersum* as the dominant submerged species in the floating-leaved community. Finally, the *Vallisneria* community has been reduced from near uniform distribution (Andrews 1946) to a few strips on sandy substrates by 1966 and reduced even further by 1980 (Fig. 2).

Conclusions

There has been an obvious decline in the macrophyte vegetation of University Bay between 1966 and 1980. The maximum depth of rooted vegetation has been reduced; a 30% reduction in littoral zone area has resulted. The continuity or density of vegetation has been reduced considerably. The pattern of abundance and decline of *Myriophyllum spicatum* followed that of invasions of this species elsewhere in North America and invasions of *Elodea canadensis* in Europe (Sculthorpe 1967). However, the vegetative decline in University Bay was not limited to *M. spicatum.* Other species, common in 1966, have decreased considerably; some species have vanished. Only one native species, known to be relatively tolerant of urban pollution, increased significantly in importance from 1966 to 1980. Whether the factors which affected the abundance of native species also led to the decline of *M. spicatum* is not known. However, it was obvious that turbidity and siltation from Willow Creek effluent did have an effect on *M. spicatum,* because the condition of these beds differed between areas near and far from the creek mouth. As Carpenter (1979) suggested, it is likely that many factors led to its decline in the Madison lakes.

The future of the vegetation in University Bay is, of course, uncertain. The decline of *M. spicatum* has been apparent for 6 years, and only 1 native species has increased. There is considerable space where macrophytes could grow without competition from other macrophytes; however they will not likely increase in abundance if nutrients and particulate matter continue to enter Lake Mendota from its watershed. Experiments in British lakes revealed that isolation of areas from nutrients and silt resulted in a positive response from native vegetation (Phillips et al. 1978). Although the state of

Wisconsin has been addressing watershed management, it is not likely that growth of macrophytes will be actively encouraged; the state is also responsible for macrophyte control.

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Literature Cited

Ahern, J. 1976. Impact and management of urban runoff. M. S. Thesis. Univ. of Wis.-Madison. 207 pp.

Anderson, M. G. 1978. Distribution and production of sago pondweed (*Potamogeton pectinatus* L.) on a northern prairie marsh. Ecology 59:154-160.

Andrews, J. D. 1946. The macroscopic invertebrate populations of the larger aquatic plants in Lake Mendota. Ph.D. thesis, Univ. of Wis. 104 pp.

Bayley, S., V. D. Stotts, P. F. Springer, and J. Steenis. 1978. Changes in submerged aquatic macrophyte populations at the head of Chesapeake Bay, 1958-1975. Estuaries 1:171-182.

Bortleson, G. G. and G. F. Lee. 1972. Recent sediment history of Lake Mendota, Wisconsin. Env. Sci. and Tech. 6:799-808.

Bumby, M. J. 1977. Changes in submerged macrophytes in Green Lake, Wisconsin, from 1921 to 1971. Trans. Wis. Acad. Sci., Arts and Lett. 65:120-151.

Butcher, R. W. 1933. Studies on the ecology of rivers. I. On the distribution of macrophytic vegetation in the rivers of Britain. J. Ecol. 21:58-91.

Carpenter, S. R. 1979. The invasion and decline of *Myyriophyllum spicatum* in an eutrophic Wisconsin lake. P. 11-32. *In:* Aquatic Plants, Lake Management and Ecosystem Consequences of Lake Harvesting. Institute of Environmental Studies, U.W.-Madison. 435 pp.

Crum, G. H. and R. W. Bachmann. 1973. Submerged aquatic plants of the Iowa Great Lakes region. Iowa State J. Res. 48:147-173.

Davis, G. J. and M. M. Brinson. 1980. Responses of submersed vascular plant communities to environmental change. U.S. Fish and Wild. Serv. Biol. Serv. Prog. FWS/OBS-79/33.

Denniston, R. H. 1921. A survey of the larger aquatic plants in Lake Mendota. Trans. Wis. Acad. Sci., Arts and Lett. 20:495-500.

Dillon, S. T. 1956. A nine-year study of fall waterfowl migration on University Bay, Madison, Wisconsin. Trans. Wis. Acad. Sci., Arts and Lett. 45:31-57.

Fassett, N. C. 1957. A Manual of Aquatic Plants. (Revised Edition; E. C. Ogden, Ed.). Univ. Wis. Press. Madison. 405 pp.

Felstehausen, H., and N. Rabl. 1973. Lake Koshkonong improvement: problems and possibilities. Proceedings of the Water Resources Management Workshop. Univ. of Wis.-Madison. 28 pp.

Gillette, L. N. 1970. University Bay waterfowl census report. Unpubl. Rept. at Univ. Wis.-Madison Wildl. Ecol. Dept.

Harman, W. N., and T. R. Doane. 1970. Changes in the aquatic flora of Otsego Lake between 1935 and 1969. N.Y. Fish and Game J. 17:121-123.

Haslam, S. M. 1978. River plants: The macrophytic vegetation of watercourses. Cambridge Univ. Press, Cambridge, 396 pp.

Lind, C. T. and G. Cottam. 1969. The submerged aquatics of University Bay: A study in eutrophication. Amer. Midl. Nat. 81:353-369.

Morgan, N. C. 1970. Changes in the fauna and flora of a nutrient enriched lake. Hydrobiologia 35:545-553.

Nichols, S. A. 1971. The distribution and control of macrophyte biomass in Lake Wingra. Ph.D. Thesis. Univ. of Wis.-Madison. 111 pp.

Nichols, S. A. 1975. Identification and management of Eurasian watermilfoil in Wisconsin. Trans. Wis. Acad. Sci., Arts and Lett. 63:116-128.

Nichols, S. A. and S. Mori. 1971. The littoral macrophyte vegetation of Lake Wingra. Trans. Wis. Acad. Sci., Arts and Lett. 20: 501-527.

Ozimek, T. 1978. Effect of municipal sewage on the submerged macrophytes of a lake littoral. Ekol. Pol. 26:3-39.

Patten, B. C. 1956. Notes on the biology of *Myriophyllum spicatum* L. in a New Jersey lake. Bull. Torrey Bot. Club 83:5-18.

Phillips, G. L., D. Eminson, and B. Moss. 1978. A mechanism to account for macrophyte decline in progressively eutrophicated freshwaters. Aquatic Bot. 4:103-126.

Ricket, W. H. 1921. A quantitative study of the large aquatic plants of Lake Mendota. Trans. Wis. Acad. Sci., Arts and Lett. 20:501-527.

Scheimer, F. and M. Prosser. 1976. Distribution and biomass of submerged plants in Neusiedlersee. Aquatic Bot. 2:289-307.

Sculthorpe, C. D. 1967. The biology of aquatic vascular plants. Edward Arnold Ltd., London. 610 pp.

Sterrett, R. J. 1975. The geology and hydrogeology of University Bay, Madison, Wisconsin. M.S. Thesis. Univ. of Wis.-Madison. 162 pp.

Stuckey, R. L. 1971. Changes of vascular aquatic flowering plants during 70 years in Put-in-Bay Harbor, Lake Erie, Ohio. Ohio J. Sci. 71:321-342.

White, K. 1950. Fall migration and sex ratios of waterfowl on University Bay. Unpubl. rept. at Univ. Wis.-Madison Wildl. Ecol. Dept.

SUCCESSION AND ELM REPLACEMENT IN THE DUNNVILLE BOTTOMS

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Abstract

Six forest stands were sampled in the flood plain forests of the Dunnville Bottoms. Present composition of the trees was determined and the composition of the next generation was predicted from sapling data. Elm is presently an extremely important tree in these bottoms, and Dutch elm disease will reduce its numbers and average size. Its present associates, especially hackberry and ash, will likely increase in numbers and, in some cases, in size owing to canopy gaps created by dying elms. The more open nature of the canopy may persist in places because of the occasional development of dense thickets of shrubs.

INTRODUCTION

Elm is a dominant in the bottomland forests of eastern North America, and may comprise 25% to 75% of the trees present (Fowells, 1965). The loss of elm, because of Dutch elm disease, will greatly affect the composition of these river bottom forests. Presently, elm is the most abundant and one of the largest trees in the flood plain forests of the Dunnville Bottoms. However, since Dutch elm disease entered this stand about 15 years ago, about one-third of the elms have died. This study attempts to predict the successional changes that will take place.

STUDY AREA

The Dunnville Bottoms is an extensive river bottom flood plain located at the confluence of the Red Cedar and Chippewa Rivers in southeastern Dunn County, Wisconsin (Figure 1). The bottoms are about four miles (6.4 km) long and from about one-half (0.8 km) to two and one-half miles (4.0 km) wide (Figure 2). Several small ponds occur, as well as substantial areas that are low and marshy. Several sloughs carry water in times of flooding or intensive rainfall. Much of this area was acquired by the State of Wisconsin in the 1940's, and has been managed by the Department of Natural Resources primarily as a hunting area. Portions of these bottoms were once farmed, with the now vacant fields scattered throughout the area.

The Dunnville Bottoms is located within the Central Plains Geographic Province of Wisconsin, entirely within the older glacial drift area (Pre-Wisconsin drift). The alluvial soil is composed of nearly level sandy loams to silt loams, and nearly level poorly drained soils that have a silty clay-loam subsoil (Wing, 1969). The elevation in the bottoms ranges from 700 to 730 feet (220 to 223 meters) above sea level, and areas less than 720 feet are probably flooded annually or nearly that often. Most flooding occurs in the spring months, with April having the highest average water levels (U.S. Geological Survey, 1961-79).

The vegetation is predominantly bottomland hardwoods with silver maple and species of elm and ash as the dominants.

METHODS

Six wooded stands of at least 5 acres (2 Hectares) were selected for study (Figure 2). All occur on low, relatively level land that is subject to flooding. The six stands were very similar in composition, with elm, ash and silver maple as dominants. No evidence of recent disturbance by fire, grazing or cutting occurs in any of the stands.

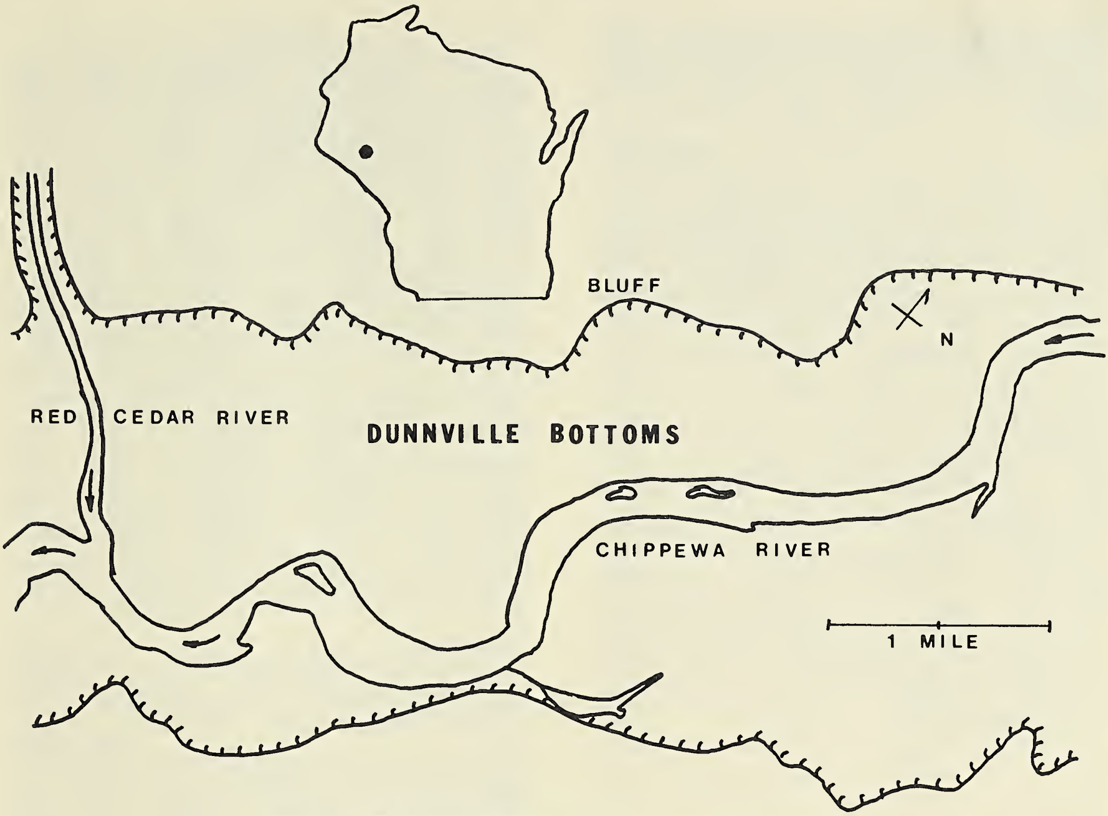

Fig. 1. The Dunnville Bottoms and its geographic setting.

Trees were sampled during September and October of 1980 using the Quarter Method (Cottam and Curtis, 1956) at 300 randomly selected points in the six stands. A total of 1200 trees were recorded, which included both live and dead elm. The names of trees whose crowns overlapped the sampled trees were also recorded.

No distinction is made between species of elm in this study because of the difficulty in identifying dead elms and reaching the branches of live elms to obtain distinguishing characteristics. Almost all of the elms that were examined were *Ulmus americana;* although individuals of *U. thomasii* and *U. rubra* also occur. Also, almost all of the trees recorded as ash were *Fraxinus pennsylvanica,* although *F. nigra* did occur in some samples. Bur oak (*Quercus macrocarpa* Michx.) is a common species throughout the bottoms. The study area is at the

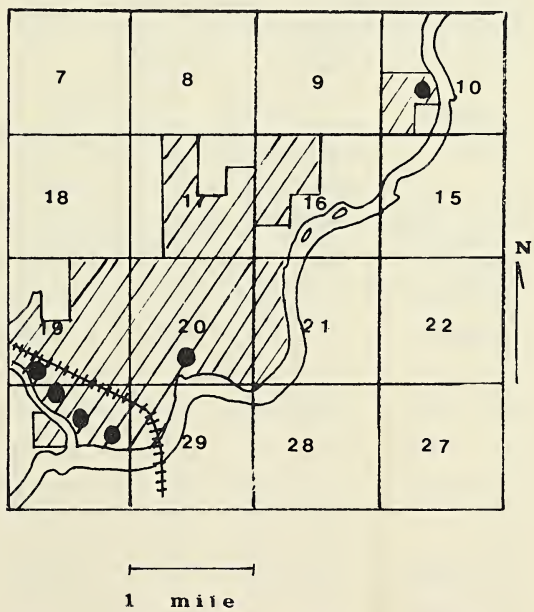

Fig. 2. Extent of the study area and the location of the six stands. Diagonal hatching indicates DNR management area.

northern limit of the range of swamp white oak (*Q. bicolor* Willd.); however, no individuals of this species were noted in the sample.

The number of individuals of each species of sapling beneath the crowns of sampled trees was also recorded. Saplings are defined as any potential overstory tree that is less than 4 inches (101.6 mm) diameter at breast height (dbh), but at least 1 inch (25.4 mm) diameter at ground level. Saplings beneath live and dead elms were recorded separately. Wedges were cut from randomly selected saplings beneath live and dead elms to observe diameter growth rates. Height growth was also observed by noting the growth increments between terminal bud scale scars for the most recent two years (1979 and 1980). The species and number of seedlings were recorded in a 39.37 inch (1 meter) diameter circular plot centered at each quarter point.

TABLE 1. Some standard phytosociological parameters for the combined data of the six stands. Two sets of data are presented for comparing the effects of Dutch elm disease on the composition of these stands.

Species	Including Dead Elm				Excluding Dead Elm			
	RF	RD	RDo	IV	RF	RD	RDo	IV
ELM	30.3	34.5	36.7	33.8	23.8	25.7	25.3	24.9
SILVER MAPLE	18.9	20.9	32.1	24.0	20.6	23.8	37.9	27.4
ASH	19.9	18.5	11.1	16.5	21.7	20.9	13.1	18.6
BASSWOOD	10.5	9.9	9.5	9.9	11.5	11.3	11.1	11.3
HACKBERRY	8.9	7.9	5.4	7.4	9.7	8.9	6.3	8.3
BUR OAK	5.1	4.0	3.2	4.1	5.5	4.5	3.8	4.6
BOX ELDER	2.2	1.5	0.7	1.5	2.4	1.7	0.9	1.7
RIVER BIRCH	1.8	1.3	0.3	1.1	1.9	1.4	0.3	1.2
Y. HICKORY	1.0	0.6	0.2	0.6	1.0	0.7	0.2	0.6
RED OAK	0.7	0.4	0.4	0.5	0.8	0.5	0.5	0.6
BUTTERNUT	0.4	0.2	0.3	0.3	0.5	0.3	0.2	0.3
COTTONWOOD	0.1	0.1	0.0	0.1	0.2	0.1	0.1	0.1
WILLOW	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2
BLUE BEECH	0.1	0.1	0.0	0.1	0.2	0.1	0.1	0.1

RESULTS

More than fifteen species of trees were found in the six stands. Of these, elm (*Ulmus* spp.), ash (*Fraxinus* spp.) and silver maple (*Acer saccharinum* L.) were the most abundant (Table 1). Basswood (*Tilia americana* L.), hackberry (*Celtis occidentalis* L.), river birch (*Betula nigra* L.), bur oak (*Quercus macrocarpa* Michx.), and box elder (*Acer negundo* L.) occurred quite frequently. The remaining species, bitternut hickory (*Carya cordiformis* (Wang) Koch.), butternut (*Juglans cinerea* L.), red oak (*Quercus borealis* Michx.), jack oak (*Quercus ellipsoidalis* Hill.), cottonwood (*Populus deltoides* Marsh.), blue beech (*Carpinus caroliniana* Walt.) and willow (*Salix* spp.) occurred infrequently (Table 1).

Elm, silver maple and ash are the dominant trees based on their importance value for the combined data and were, in fact, dominant species in all of the 6 stands. The effect of excluding dead elm from the data summary is of course an increase in the importance values of the remaining species.

The average basal area for all six stands is 92 square feet/acre (20.7 m^2/HA), which is somewhat less than the 100 square feet/acre (22.5 m^2/HA) reported for southern Wisconsin flood plain forests by Curtis (1959). The loss of some elm, because of Dutch elm disease, may be partly responsible for this difference. The average Compositional Index (Curtis, 1959) of the six stands is about 540, quite similar to the 560 reported by Curtis (1959) for southern Wisconsin flood plain forests.

Elm is presently the most abundant tree in the Dunnville Bottoms, and was even more abundant prior to the death of large numbers of individuals. Approximately 34% of all elms sampled were dead, with a range of 21% to 53% in the 6 stands. Dutch elm disease apparently affected the larger elms to a greater extent than the smaller trees, as a greater percentage of the larger trees were dead.

Size class distribution of the more abundant trees is illustrated in Figure 3. Live elm and ash have their maximum densities in the smaller size classes; while silver maple is well represented in the largest size classes. The largest silver maple recorded had a dbh over 40 inches (100 cm) and many individuals occurred that were over 24 inches (60 cm). Some very large elm trees also occurred, the largest being a live elm of more than 50 inches (127 cm) dbh.

Hackberry is the most abundant sapling (37.1% of all saplings), while ash (17.2%), elm (15.4%) and bitternut hickory (13.9%) are also quite abundant. A fairly large number of basswood saplings (11.1%) were also recorded; however, these were almost all basal sprouts of mature trees. Silver maple is also a prolific sprouter; however, it accounted for only 3.4% of all saplings, despite being one of the most abundant trees in the mature size classes.

The kinds and numbers of saplings beneath each species of tree are illustrated in Table 2. Each entry in a row is the percent of the total number of saplings found under a canopy tree of the species listed. Canopy trees of elm include both live and dead individuals.

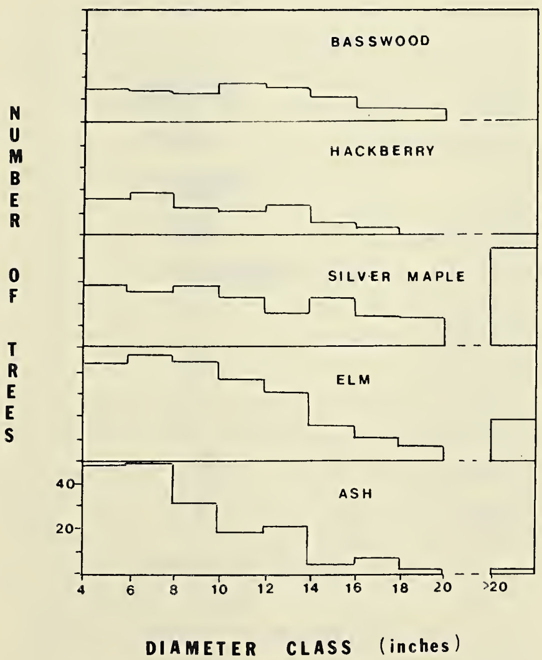

Fig. 3. Size class distribution of trees.

TABLE 2. Number of saplings beneath different species of canopy trees. Each entry in a row is the percent of the total number of saplings found under a canopy tree of the species listed. Canopy trees of elm include both live and dead individuals.

	SAPLINGS								
CANOPY TREES	ELM	ASH	S. MAPLE	BASSWOOD	HACKBERRY	BUR OAK	BOX ELDER	B. HICKORY	OTHERS
ELM (live+dead)	15	22	5	1	45	0	2	10	0
ASH	26	13	2	2	44	0	3	10	0
S. MAPLE	22	29	8	0	36	0	1	4	0
BASSWOOD	4	4	0	60	16	0	1	15	0
HACKBERRY	16	24	0	1	36	2	0	20	1
BUR OAK	18	8	0	23	23	7	4	17	0
BOX ELDER	2	17	0	22	30	0	29	0	0
RIVER BIRCH	26	53	7	0	7	0	0	7	0
B. HICKORY	13	8	0	0	13	1	20	45	0
OTHERS	29	1	0	0	34	0	0	29	7

TABLE 3. Radial growth, in inches/year, of saplings below live and dead elms.

SAPLINGS	beneath live elm	beneath dead elm
hackberry	0.04	0.06
b. hickory	0.05	0.09
ash	0.07	0.06
elm	0.03	0.09
basswood	0.06	0.07

The average radial growth rates for the last 4 years of saplings beneath live and dead elm are illustrated in Table 3. These data are based on at least 15 samples each for all species except basswood where only 5 samples were obtained from under dead elm. Except for basswood, all differences in radial growth beneath live and dead elm were found to be statistically significant ($p. < 0.001$) with a *t* test. All except ash exhibited greater radial growth rates beneath dead elm. Mean height growth for the last 2 years beneath live and dead elm is illustrated in Table 4. At least 15 samples each were taken for all species except basswood, where only 5 samples were obtained from under dead elm. All differences in height growth beneath live and dead elm were found to be statistically significant ($p. < 0.05$) using a *t* test. Hackberry, ash and bitternut hickory had greater height growth rates beneath the dead elms. These data suggest that hackberry and bitternut hickory respond well to release from suppression with both radial and height growth. Ash responds with enhanced height growth; while elm and basswood respond with enhanced radial growth.

Only three species have produced relatively large numbers of seedlings in recent years. These are ash (32.2% of all seedlings), hackberry (30.2%) and elm (27.8%).

Table 4. Height growth, in inches/year, of saplings below live and dead elms.

SAPLINGS	beneath live elm	beneath dead elm
hackberry	7.6	11.0
b. hickory	15.0	16.5
ash	19.6	21.1
elm	10.3	9.6
basswood	9.6	4.9

Discussion

Succession

The future composition of the forest community can be predicted by using the relative number of each species of sapling found beneath the individual mature trees (Horn, 1975). This is done by multiplying the proportion of each species of sapling below each species of canopy tree by the relative density of the canopy trees. The assumption is made that each species of sapling under the canopy of a tree has a probability of replacing that tree proportional to its numbers.

This tree-by-tree replacement model was used to predict the composition of the next generation of trees in the Dunnville Bottoms. Canopy tree data (including dead elm) and sapling data from Table 2, were used to generate the present and predicted composition values illustrated in Figure 4.

Fig. 4. Present and predicted composition of the six stands in the Dunnville Bottoms.

A system of rating trees according to age class profiles was also devised by Horn (1975) for use in successional studies. An "invading" species is defined as one with many seedlings and saplings, but only small trees. A "locally reproducing" species has individuals in all size classes, with a substantial number of young trees and saplings. A "senile" species occurs only as larger trees with few, if any, seedlings and saplings.

Silver maple is predicted to decline from its present relative density of 21.0% to 4.4% in the next generation. It is an example of a "senile" species, as many of the individuals are in the larger size classes and there is a paucity of the relatively shade intolerant seedlings and saplings. Silver maple stands usually develop on low areas at the river bank where new alluvium has been deposited. Physiographic events of this nature have not occurred in these six stands in recent years, and no new stands of silver maple are present. The location of silver maple stands in these low, frequently flooded areas, and its tolerance to flooding, may be important modifying factors in predicting its density in the next generation. Because it is more tolerant of flooding than many of the other species, and because of the probable high survival rates of basal sprouts, silver maple may be more successful in the next generation than this model predicts.

River birch, box elder, and bur oak are shade intolerant "senile" species whose densities are predicted to decline in the next generation. However, unlike silver maple, none of them is presently very abundant, with relative densities of only 1.4, 1.7, and 4.5% respectively. Bur oak occurs at higher elevations where conditions are apparently no longer conducive to its reproduction. River birch and box elder are both tolerant of flooding and usually become established on newly deposited alluvium, often as associates of silver maple.

Elm, basswood, and bitternut hickory are classified as "locally reproducing" species, although elm and basswood are predicted to decline somewhat in density, while an increase is predicted for bitternut hickory. These three species are represented in the understory by relatively large numbers of saplings and small trees which should respond well to openings created by the death of large elms.

Basswood and bitternut hickory are both intolerant of flooding, and thus are restricted to the higher elevations in these bottoms. No seedlings of basswood were recorded and almost all saplings were of sprout origin. All basswood trees were sprouting, and it seems likely that these sprouts, with their large root systems, have a greater chance of replacing the mature stem than saplings of other species. If so, basswood density should change very little in the future. Bitternut hickory seedlings were quite sparse, although saplings were common. Good seed production in bitternut hickory occurs approximately every three to five years (Fowells, 1965), and several recent low production years could explain the present lack of seedlings. Ware (1955) found that bitternut hickory is a minor component of the flood plain forests of southern Wisconsin, and it will probably continue to be so in the Dunnville Bottoms.

Elm is more flood tolerant than basswood and bitternut hickory, and occurs on a greater variety of sites. Elm produces abundant seed, and large numbers of seedlings and saplings occur throughout the bottoms. Dutch elm disease is likely to affect the future of this species, as high mortality rates occur especially in the larger mature trees. Thus, it is expected that a general decline in the average size and number of seed-bearing individuals will occur.

Ash and hackberry are considered to be "invading" species in these bottoms. Ash trees are abundant (relative density of 21.0%), but the vast majority of trees are small (average dbh of 9.6 inches is the smallest among the six most common species). Ash is capable of producing fruit when only 3 to 4 inches dbh (Fowells, 1965), as illustrated by the presence of large numbers of seedlings and saplings. Ash is quite flood tolerant and should succeed on a variety of sites. Although it is not especially shade tolerant, it grows rapidly following release from suppression. Gaps created by dead elms should provide an excellent opportunity for this species.

Large numbers of hackberry seedlings and saplings occur in the Dunnville Bottoms, although mature trees are not common. Ware (1955) found this species to be a minor component of flood plain forests in southern Wisconsin. Other studies have found it to be abundant in the sapling sizes, but limited in the number of mature trees (Lindsey et al., 1961, Bell, 1974). Hackberry is a prolific "seed" (drupe) producer, and avian and mammalian dispersal is common (Krajicek, 1958). It is quite shade tolerant, and some saplings in this study were found to be over 35 years old. Height and diameter growth of this species is generally slow (Putnam, 1951). Thus, it appears that a combination of very high reproductive rates, but very slow growth rates results in proportionately more saplings and small trees and fewer large individuals. Hackberry is not very tolerant of flooding, and thus is restricted to the higher elevations.

Elm Replacement

Elm is the most abundant tree in the Dunnville Bottoms and is presently classified as a "locally reproducing" tree. Dutch elm disease entered this stand about 15 years ago, and the subsequent loss of large seed-bearing trees will ultimately reduce the number of seedlings and saplings as well as mature trees.

A clear replacement sequence of elm is not yet apparent; although some predictions can be made on the basis of the saplings now present under live and dead elm. A statistically significant difference was found ($p. < 0.01$, 8 df using a Chi square test on a 2×9 contingency table) between the kinds of saplings under live and dead elm (Table 5). This difference is due primarily to the greater number of elm saplings observed under elm trees than was expected on the basis of chance, and to the greater observed number of silver maple saplings under dead elm than was expected. Presently 45% of all saplings under elm (both live and dead) are hackberry; while 22% are ash. Elm (15%), bitternut hickory (10%), silver maple (4%) and basswood (2%) account for most of the rest of the saplings.

TABLE 5. The numbers of saplings of different species that occurred under live and dead elm trees.

Sapling	BENEATH LIVE ELM	BENEATH DEAD ELM
HACKBERRY	472	189
ASH	182	98
ELM	173	33
Y. HICKORY	137	53
SILVER MAPLE	19	35
BASSWOOD	15	10
BOX ELDER	7	2
BUR OAK	6	2
BUTTERNUT	2	0
TOTAL	1013	422

Other recent studies have predicted hackberry to increase in numbers with the death of elm (Pelz and Rolfe, 1977; Micelli et al., 1977; McBride, 1974). Hackberry is a slow-growing tree and not very tolerant of flooding, thus its future domination in these stands is probably overestimated by the techniques used in this study. Nevertheless, it possesses opportunistic characteristics such as widespread seed dispersal and flexible seedbed requirements. These attributes, along with relatively high shade tolerance, enable it to maintain large populations of seedlings and saplings. These large numbers of young hackberry under elm should ultimately result in some successful replacements. Only 6.1% of the trees that overlapped the crowns of elm were hackberry. Thus, lateral growth of this species into the openings created by the dead elms is probably not of much significance.

Replacement of elm by its former associates, especially species of ash, was observed by Grittinger (1978) in some lowlands of eastern Wisconsin. Ash is the second most abundant sapling below both live and dead elm in the Dunnville Bottoms, and its crown was found to overlap with 12.8% of the elms. This tree exhibits rapid height growth when released from suppression, which may permit it to reach the canopy before other species upon the death of elms. Also, mature trees may exhibit enhanced growth as their canopies take advantage of the openings created by the dying elms.

The remaining species had relatively few saplings present under elm. Bitternut hickory and basswood crowns overlapped with the crowns of elm only 0.4 and 4.8% of the time. However, these two species are quite shade tolerant, which may permit their saplings to persist under elm until opportunity presents itself. Silver maple crowns overlapped with 24.9% of the elm crowns. The death of elms at the lower elevations, where silver maple is abundant, may result in enhanced lateral and sprout growth by this species.

Saplings were absent beneath 25% of the dead elms. A heavy cover of shrubs, especially prickly ash (*Xanthoxylum americanum* Mill.), grey dogwood (*Cornus racemosa* Lam.), chokecherry (*Prunus virginiana* L.) and brambles (*Rubus* spp.) occurred in most such cases. The shade cast by the shrubs may preclude establishment of trees, although it is possible that more tolerant species such as basswood and yellowbud hickory may eventually become established and grow through the shrub canopy. Barnes (1976), working in southeastern Michigan, and McBride (1973), working in southeastern Iowa, also found a substantial number of sites where a dense cover of shrubs developed below dead elm trees. McBride states that inhibition of tree reproduction by the dense shrub cover will result in a more open nature of the forest.

In summary, it appears that elm will remain a component of the forests of the Dunnville Bottoms for the immediate future. However, it will be greatly reduced in numbers and in average size. Present associates of elm are likely to increase in abundance in most of the gaps created by the dying elms; while the remaining gaps may be occupied by persistent stands of shrubs. Based on sapling density under both live and dead elm, hackberry and ash are predicted to be the trees that will realize the greatest increase in abundance.

Literature Cited

Barnes, B. V. 1976. Succession in deciduous swamp communities of southeastern Michigan formerly dominated by American elm. Can. J. Bot. 54:19-24.

Bell, D. T. 1974. Tree stratum composition and distribution in the streamside forest. Amer. Midl. Nat. 92(1):35-46.

Cottam, G. and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37:451-460.

Curtis, J. T. 1959. The Vegetation of Wisconsin. Univ. of Wis. Press, Madison, Wisconsin 657 p.

Fowells, H. A. 1965. Silvics of Forest Trees of the United States. U.S.D.A. For. Serv. Handb. 271, Washington, D.C. 762 p.

Grittinger, J. F. 1978. Loss of elm from some lowland forests in eastern Wisconsin. Trans. Wisc. Acad. of Sci., Arts and Lett. 66:195-205.

Horn, H. S. 1975. Forest Succession. Scientific American 232:90-98.

Krajicek, J. E. 1958. Silvical characteristics of hackberry. U.S. For. Serv. Central States Expt. Sta. Misc. Release 31:1-11.

Lindsey, A. A., R. D. Petty, D. K. Sterling and W. van Asdall. 1961. Vegetation and environment along the Wabash and Tippecanoe Rivers. Ecol. Monogr. 31(2):105-156.

McBride, J. 1973. Natural replacement of disease-killed elms. Amer. Midl. Nat. 90(2): 301-306.

Micelli, J. C., G. L. Rolfe, D. R. Pelz and J. M. Edington. 1977. Brownfield woods, woody vegetation and changes since 1960. Amer. Midl. Nat. 98(2):469-475.

Pelz, D. R. and G. L. Rolfe. 1977. Stand structure and composition of a natural mixed hardwood forest. Trans. Ill. State Acad. of Sci. 69(4):446-454.

Putnam, J. A. 1951. Management of bottomland hardwoods. U.S. For. Serv. South. Forest Expt. Sta. Occas. Paper 16. 60 p.

Sather, L. M. and C. W. Threinen. 1962. Surface water resources of Dunn County, Wisconsin. Conservation Department, Madison, Wisc.

U.S. Geological Survey. 1961-1979. Water resource data for Wisconsin. Madison, Wisconsin.

Ware, G. W. 1955. A Phytosociological Study of the Lowland Forests in Southern Wisconsin. Ph.D. Thesis. Univ. of Wis.-Madison 115 p.

Wing, G. N. 1969. Soil Survey of Dunn County, Wisconsin. U.S.D.A. Soil Conservation Service.

THE WITCH TREE COMPLEX

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In an American Indian settlement[1] on the northwest shore of Lake Superior there exists a belief system which has successfully withstood the ravages of time and history. Both of its religious and socio-cultural practices are centered upon a sacred tree, and the legends, beliefs, and practices surrounding this particular tree play an integral part in the belief system.

Based upon the oral history narratives obtained from local Indian informants,[2] it is clear that this particular belief system developed in accordance with the unique life style of the natives who reside on the Minnesota shore of Lake Superior—a way of life characteristic of a hunting, fishing, and gathering society. The lives of these people are directly related to this belief system. Their success in hunting and fishing, their safety on, or near, the water, and sometimes the safety of their families, depends upon their knowledge and understanding of the interrelationships between the tree and the other spirits of the region. I shall examine these operational components, their relationship and interdependence in the following order: the Witch Tree and man; man, water spirits and the spirit tree; Nanabojou and the water spirits; celestial spirits and man; the Little People and man; wigwam shakers, the oracles; the Sugar Bush Rock and the Little People; and traditional rituals vs. Christian religions.

In view of related data on Ojibwa culture gathered by other writers, this study deals with a local variant of the Ojibwa Grand Medicine Lodge.[3] Furthermore, due to its esoteric nature, this study describes and examines the working components according to an emic approach.[4] For this purpose I have developed an emic model (see appendix A) in order to more clearly present the major-factors which comprise this belief system.

Each element in this belief system can operate as an independent unit; however, within the system each element is interdependent with others, and they in turn, are related to the core of the complex —the beliefs that are centered around the Witch Tree. The knowledge of the functions of these units in relation to the Witch Tree complex is dependent upon the oral transmission of information by natives of the area who understand the inter-acting complex of this belief system. In essence, this emic model is used as a vehicle to apply cognitive theory which basically seeks to view the dynamics of culture through the eyes of those who are regarded as members of that culture.

The Witch Tree and Man

The so-called Witch Tree stands within the Grand Portage, Minnesota, area which comprises the greater part of the Ojibwa Indian reservation—the Grand Portage band of Chippewa. Its geographic location is approximately four miles north of the community of Grand Portage, an area which still abounds in wilderness land. The geological formations are the remains of the keweenawan volcanic period when molten lava poured over the region. The glacial period is represented all along the shore of Lake Superior with abundant evidence of the great ice sheets.[5] The forests are composed of birch, aspen, mountain ash and many varieties of fir, spruce and pine. The western shore of Lake Superior is rugged and as one travels north the rocky cliffs become increasingly high. The Witch Tree, itself, is located on Hat Point which escaped the glaciers and has never been burned over. Upon it may be found preglacial formations, rare ferns and mosses.[6] Hat Point is located between Was-WahGonig Bay, which means "spear fishing by torchlight," and Grand Portage Bay.

This tree is centuries old and quite unlike the massive and majestic white cedars which are indigenous to this particular geographic area. The tree is a small, gnarled, and bristly red cedar. The trunk is contorted, grey with age and the ceaseless buffeting of the elements. It has a stoic appearance, as if it were made of stone. The natives say that neither the trunk nor the branches of the tree sway even with the strongest winds.[7] It grows out of a rock separated from the main body of land by a few inches of water. There is no visible means of sustenance for the tree and the Indian people of this region consider its growth miraculous.[8] Furthermore, red cedar is an unusual species to this area. All of these factors contribute to the mystical qualities perceived by the supporters of this belief system.

The local name of this tree was popularized either by white men who misunderstood its significance, or by local Indians who had converted to Catholicism and were led to believe that the tree and its powers were evil.[9] Elizabeth Thbault and Peg Henderson, two of the more traditional inhabitants of Grand Portage, feel that the English name for this magnificent tree had its origin with the artist Dewey Albinson, who was instrumental in bringing the tree to the attention of the general public.

The tree is believed to have the power to influence unseen spirits and thus the ordering of natural events. It has been incorrectly reported by non-Indian writers that in the old days the Indians would make roundabout portages to avoid passing the tree. It is said they dared approach it only in large groups, drumming and singing and bearing gifts of tobacco and vermillion.[10] It is true that then, as now, offerings were made, but Celia Hendrickson and Elizabeth Thbault state that it is erroneous to say that the Indian people avoided the tree.

In Ojibwa the tree is called "manido gishigence," manido meaning spirit and gishigence meaning small cedar. Billy Blackwell informed me that natives of this area also refer to it as "the cedar" or "the old cedar." Indian people view cedar boughs as symbols of a life giving source. Cedar boughs are also used by Indians for medicinal purposes. Both red and white cedar have been used by Indians in the Southwest as well as in the Great Lakes area as sacred incense in their ceremonies.[11] The importance of the Witch Tree, however, lies not only in the boughs but within the tree itself. In essence, the tree is a manifestation of a land phenomenon which is directly related to the world of the water spirits and therefore, the tree is employed as an intermediary between man and the water spirits. In local native beliefs and practices, the tree is directly associated with the water and is a symbolic representative to man of that world.

From a practical point of view, since the 19th century this tree has been used as a landmark by the people of this area.[12] Fur traders, voyageurs and Indian fishermen were, and are, better able to navigate the treacherous shifting waters of Lake Superior by taking their bearing from this cedar tree.

Man, Water Spirits and the Spirit Tree

For many centuries as Indian people passed Hat Point they would stop and place offerings at the base of the tree and in the nearby waters. These offerings consisted mainly of tobacco since it is a general belief of most traditional Indians that tobacco is a special gift of the Great Spirit to be offered when praying for compassion or favor.[13] Billy Blackwell stated that around the Grand Portage area it is believed that Indians should not take tobacco on the waters or in the air while crossing a body of water without thinking of the waters or offering tobacco to them. They believe that the water spirits are anthropomorphic and, like man, appreciate the pleasure of smoking tobacco. Therefore, if one does not offer them tobacco or at least think about doing so, the water spirits erroneously believe the tobacco is being brought to them, and in an attempt to obtain it, they may cause the man carrying the tobacco to drown. This is not considered a maleovolent act, but an error on the part of the spirits for there is no way they can know the tobacco is not meant for them. In such circumstances the tree growing between water and land is used as an intermediary between man and the water spirits.

The Grand Portage people, like other traditional Ojibwa, believe that there is a great spirit or manido above but also many other spirits who watch over and take care of the areas they inhabit and that some of these spirits are treacherous if not treated properly.[14] Billy indicated that the Ojibwa know what these beings look like because some of the old people have seen them or dreamed of them. Their appearances have been described and passed down for as long as these Indians have lived in this area. Some of these water spirits, or manidos, are described as underwater serpents with one, two, or three horns, or as underwater panthers.[15] Traditional natives of the area believe that the water manidos can act alone, as invisible spirits, and that they can appear as manifestations of the water panthers or horned serpents. My informants never specified whether or not the water panthers and serpents can exist when not possessed by the water spirits; however Billy Blackwell and Mark Naganub told me that they are inseparable, yet separable, depending upon the conditions under which they appear.

In examining the nature of the belief system involving the Witch Tree it is important to keep in mind that the elements can operate independently, as well as being directly and indirectly related, when assuming a major role in man's ordering of his world.[16] The Witch Tree becomes a significant source of power in man's attempt to order his world as it helps him to maintain an adequate means of subsistence, establish safety, and create stability. Let us see how the outlying components which surround the Witch Tree affect this particular belief system.

Nanabozo and the Water Spirits

Nanabozo, an outlying component of the Witch Tree complex, is an Ojibwa culture hero.[17] He has no power to give to these people when they are in need and although there is no evidence that the Grand Portage people recognize a direct relationship between the Witch Tree and Nanabozo, in their legends Nanabozo is seen as having encounters with the water manidos. These encounter tales, as told by Billy Blackwell and Mark Naganub, illustrate the power of the water spirits when in combat with Nanabozo. Despite the intensity of the battles between the two, neither destroys the other. Nanabozo as a culture hero has the power to combat the spirits, but he can never transfer this power to man because the great spirit has not endowed him with this power. As a demigod he has the power to encounter the elements and adequately defend himself against evil manidos, but he cannot transfer this power to man. Nanabozo is important in this belief system only because it is through his encounters with the water spirits that the people measure the power of the water spirits since, in the main, they themselves have no direct contact with them (See Appendix A).

Although the water spirits are generally evil and injurious to man, they also have the ability to grant mystical gifts of power to man. When the people deal with the water manidos, either to appease their wrath or for permission to travel the waters, they act through the Witch Tree, as intermediary, leaving tobacco at its base as a sacrificial offering to both land and water elements.

Celestial Spirits and Man

A covert relationship exists between the Ojibwa believers, the celestial beings, and the Witch Tree. Prayers are directed to the intermediary powers of the Witch Tree, which extend not only to the water spirits but also to the celestial beings such as the Thunderbirds, who control the thunderstorms and winds. Both elements are a threat to those who travel by water and air. The natives recognize the tree's power to withstand these elements which in turn is interpreted as strength to deal with the water and with the celestial manidos.

The Little People and Man

The Little People, Maymaygwaysiwuk,[18] are somewhat like the manidos, but their ability to grant power to man should not be confused with that of the manidos. Their role in this belief system is more analogous to that of the mystical "little people" of the Irish who mischievously create havoc in man's life and on rare occasions bestow supernatural gifts of power upon him.

The natives of Grand Portage accept the Little People as an integral part of an interrelated belief system of invisible power sources. These Indian people feel that they must contend with the Little People when they encounter those particular elements which relate to their survival. Those who believe in the Little People also believe in the Witch Tree. When my informants spoke of the Witch Tree in general, or of specific occurrences related to it, they also brought up stories concerning the Little People.

In their tales about the Little People these Ojibwa Indians indicate that these supernatural beings have mystical powers which can be used to either help or hinder man, though they do not make specific reference to the use of these powers. The Indians at Grand Portage hunt and fish in the area they believe to be the land base of the Little People. This area includes the waters and nearby shoreline which are believed to be under the power of the Witch Tree. The local Ojibwa believe that the Little People occupied this particular geographic region prior to their own arrival and therefore the Ojibwa feel this area belongs to the Little People. WasWahGonig Bay is a major hunting ground which belongs to the Little People. Here, and in adjacent areas, the Little People play tricks on man to discourage him from hunting and fishing, but on rare occasions they perform acts of kindness to man. Jennie Hietok told me a story about a man who was having a hard time catching enough fish in WasWahGonig Bay to feed his family. He left his canoe, and when he returned found it filled with fish. He saw little foot prints on the ground and around the canoe which gave him reason to believe that the Little People had magically filled his canoe. Elizabeth Thbault told me another story, not as positive, about a man who was fishing in WasWahGonig Bay and had his canoe filled with more fish than he needed. He landed his canoe and went inland to gather firewood to cook his noon meal. When he returned there were no fish in his canoe, but there were little foot tracks around it. As he looked toward the Witch Tree he saw several stone canoes manned by the Little People.[19]

In general, the Grand Portage people believe the Little People resent human beings, especially when they enter the Little People's domain. They feel that because man cannot predict the Little People's behavior they should supplicate the power of the Witch Tree when entering these particular areas to hunt or fish. In doing so they believe that if the Little People are encountered they will be compassionate and refrain from playing tricks which would prevent the Indian people from successfully hunting or fishing.[20]

The Little People apparently respond favorably to small children. Peg Henderson told me tales in which the Little People steal children, play with them, treat them to a special banquet, and then return them unharmed. It is believed that the Little People hypnotize the children, for when the children are found they are in a state of suspended animation. When asked where they have been, they will not respond for hours or days. With the exception of a few cases in which the children related that they have been with the Little People, the adults do not know where they have been. The major source of information concerning the whereabouts of these children is gained through the wigwam shakers.[21]

Wigwam Shakers: Oracles

The Ojibwa of Grand Portage view wigwam shakers as Indian oracles. Help is sought from these people in order to locate children who cannot be found, or after the children have returned to determine what happened to them while they were gone. There are several stories concerning encounters with the wigwam shakers. Elizabeth Thbault told me that there was once a little girl who had been lost for a considerable time. In order to learn her whereabouts her parents went to a wigwam shaker who said that she had been taken by the Little People. After she was found she bore witness to the divination of the wigwam shaker. Another more sorrowful story, involves a child who was lost and when her parents went to the wigwam shaker he told them specifically where they would find her—in an underwater cave off the shore of Lake Superior. They followed his directions and found her, dead, exactly where he said she would be—in an underwater cave. (In this case it is believed that through carelessness, when the parents became absorbed in berry picking and forgot to watch over the girl, the water spirits claimed her.) The local Ojibwa fear both the water spirits and the Little People. The natives who live on or near the lakeshore recognize the danger of leaving a child by the water's edge. They fear that either the water spirits or the Little People may snatch up the youngster.

The Sugar Bush Rock and the Little People

Although the wigwam shaker divines the deeds of the Little People he cannot control them. Some measure of control however, is associated with the Sugar Bush Rock which functions in much the same way that the Witch Tree does. Elizabeth Thbault and Mark Naganub told me that Indians have heard the Little People drumming and singing close to the base of the rock and some have even claimed to see the Little People in this area. To protect themselves against the wrath of these supernatural beings, these natives supplicate the intermediary powers of the Sugar Bush Rock for a bountiful harvest of maple sugar and berries and for assurance of success in their hunting. If they offer tobacco to the Sugar Bush Rock and the Witch Tree, then the people feel they will be safe whenever they travel in any of the areas occupied by the water spirits or Little People.

Old Traditional Rituals vs. Christian Religions

Within the last decade the younger generation of Indian people at Grand Portage have begun a revival of old traditional rituals. Billy Blackwell explained one such ritual—that of offering a sacred bundle to the waters of Lake Superior. Associated with this ritual is the belief that by making such a physical religious offering the attention of both the water spirits and the Witch Tree will be gained. Since they have revived this ritual, the traditional natives of Grand Portage believe that their world has become more orderly. They feel that in the past too many Indians were giving too much attention to Christian religions and because of this their world order tended to become disrupted. Hence, by reinstating this particular ritual the Witch Tree becomes more active in helping with those ventures involving the nearby waters.

The local Roman Catholic priest, Father Jude Koll, feels that with the revitalization of old traditional rituals, the practice of attending Christian church services has begun to wane significantly. Many Ojibwa under the age of 35 feel that Christianity has not helped their people, and has, in fact, actually hindered them. John Flatt and several other older members of this Indian community stated that the Christian religion has not been the answer for their people and therefore, they feel it is a good thing that the younger generation is returning to the old Indian religious practices and beliefs.

In this analysis I have examined the nature of the belief complex surrounding the Witch Tree. I have noted that the tree itself does not have any particular physical interaction with man. It can however, respond in a mystical way to man's supplication through his prayers and gifts. Therefore, as an intermediary between the other elements in the model it is evident that it can and does use its supernatural powers to help man successfully order his world. Man is successful in fishing, crossing the waters, hunting, and navigating the air as long as he invokes the intermediary powers of the Witch Tree.

In sum, according to the analytical model, it is evident that the Witch Tree is a particular entity upon and around which the other entities revolve and respond both directly and indirectly. Not only do they operate in such a fashion, but their interaction with each other is based on an initial action and reaction relationship to this particular entity, the Witch Tree. From a structured point of view, this phenomenon is not necessarily the core of the belief system for the system does not have a nucleus. The Witch Tree acts as a focal point and dominating entity in the interaction between the outlying elements in this belief system.

Notes

[1] For the purpose of this paper the following terms will be used interchangably: American Indian, Indian, Ojibwa, Indian people, native, traditional inhabitants, and Chippewa.

[2] I interviewed the following informants during the summer of 1976 as part of a study sponsored by a joint grant from the Minnesota American Revolution Bicentennial Commission and the Graduate School at the University of Wisconsin-Milwaukee.

Billy Blackwell, age 28, Ojibwa/French Canadian
Mark Naganub, age 60, Ojibwa
Elizabeth Thbault, age 78, Ojibwa
Wilfred Montefraud, age 75, Ojibwa
Celia Hendrickson, age 75, Ojibwa
Herman Henderson, age 45, Ojibwa
Peg Henderson, age 40, Ojibwa
John Flatt, age 70, Ojibwa
Jennie Hietok, age 81, Ojibwa
Henry Flatt Peterson, age 71, Ojibwa
Father Jude Koll, age 60, Anglo-Saxon

[3] Selwyn Dewdney, *The Sacred Scrolls of the Southern Ojibway* (Toronto: University of Toronto Press, 1975); Carolissa M. Levi, *Chippewa Indians of Yesterday and Today* (New York Pageant Press, 1956); Sister Bernard Coleman, "The Religion of the Ojibwa of Northern Minnesota," *Primitive Man*, (July and October, 1937), 1ff; and Ruth Landes, *Ojibway Religion and the Midewiwin* (Madison: University of Wisconsin Press, 1968). These sources provide information concerning Ojibwa religion.

[4] R. W. Burchfield, Editor, *A Supplement to the Oxford English Dictionary* (Oxford: Clarendon Press, 1972), p. 934. The following is a definition of emic: ". . . in contrast to the etic approach, an emic one is in essence valid for only one language or one culture at a time; it is an attempt to discover and to describe the pattern of that particular language or culture in reference to the way in which the various elements of that culture are related to each other in the functioning of that particular pattern, rather than an attempt to describe them in reference to a general classification derived in advance of the study of that particular culture."

[5] Elizabeth Bachmann, "Our Legendary Witch Tree," *The Conservation Volunteer* (Nov.-Dec. 1966), 43.

[6] Ibid., 44.

[7] All informants reported this fact about the Witch Tree.

[8] This was the consensus of all informants.

[9] Rev. Peter Jones (Kahkewaquonaby), *History of the Ojibway Indians; with Especial Reference to their Conversion to Christianity* (London: A. W. Bennett, 1861). This book deals with conversion methods.

[10] Elizabeth Bachman, "Our Legendary Witch Tree," *The Conservation Volunteer* (Nov.-Dec. 1966), p. 41.

[11] H. B. Alexander, *The World's Rim: Great Mysteries of the Native American Indians* (Lincoln: University of Nebraska Press, 1970). See this source for more information.

[12] Bachmann, p. 42.

[13] Ruth Underhill, *Red Man's Religion* (Chicago: University of Chicago Press, 1965). See this source for further information.

[14] Gerald Vizenor, *Anishenabe Adisokan; Tales of the People* (Minneapolis: Nodin Press, 1965). This book contains many tales relating to this subject.

[15] Norval Morriseau, Selwyn H. Dewdney, editor. *Legends of My People the Great Ojibway* (Toronto: The Ryerson Press, 1965), pp. 37-40.

[16] Arnold Van Gennep, *Rites of Passage* (Chicago: University of Chicago Press, 1975). See this source for further information.

[17] Richard M. Dorson, *Bloodstoppers and Bearwalkers* (Cambridge: Harvard University Press, 1972), pp. 41-51.

[18] Morriseau, pp. 75-78.

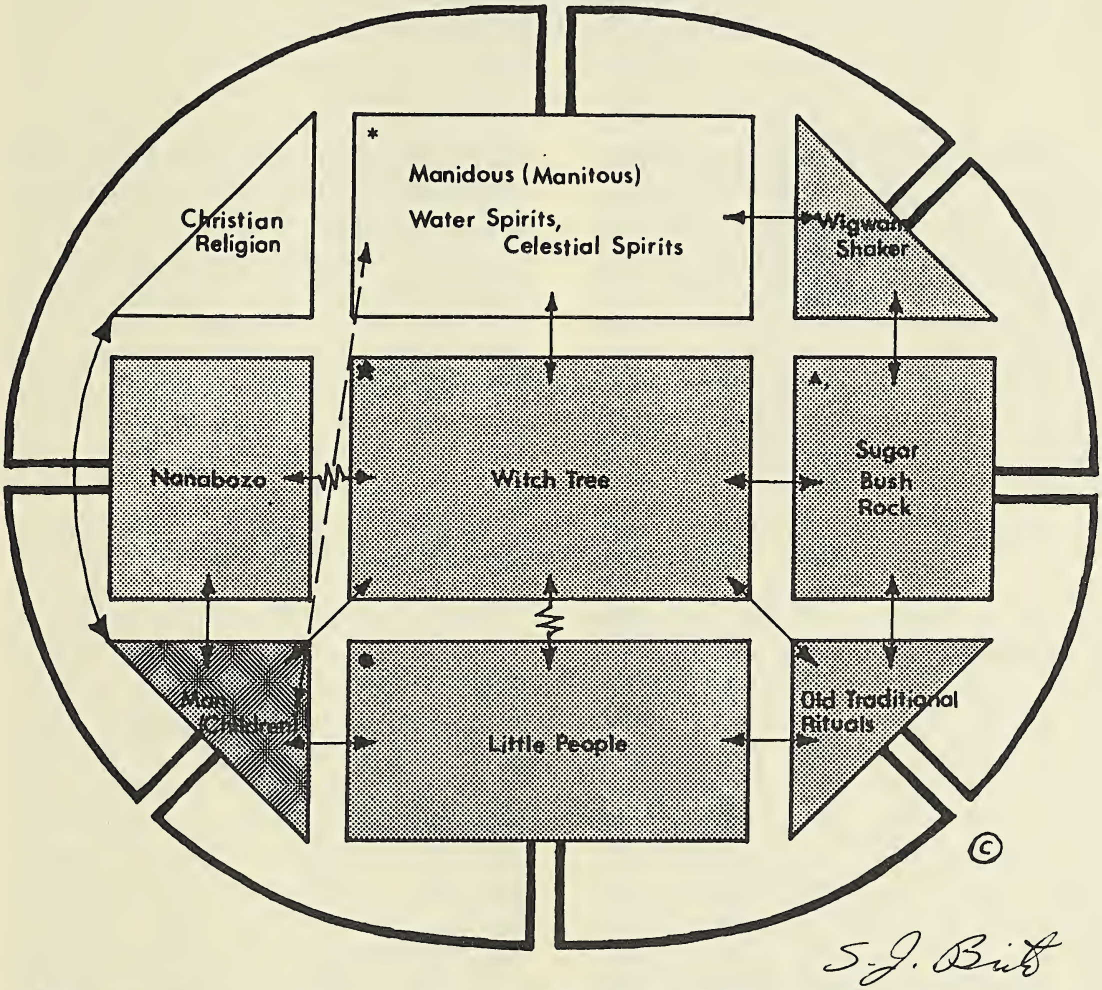
[19] Morriseau, pp. 79-80, records the use of stone

canoes by supernatural beings.

[20] Informants: Billy Blackwell and Elizabeth Thbault.

[21] Morriseau, pp. 85-88; A. K. Black, "Shaking the Wigwam," *The Beaver* (Dec., Outfit 265), pp. 13-34. See these sources for more information.

APPENDIX A



Legend: **Emic Model of Witch Tree Complex**

Triangular elements depict variable behavior

Rectangular elements depict more consistant behavior

Metaphysical-Physical Physical-Metaphysical Physical

Direct Physical or Metaphysical interaction

Relationships between Elements: Indirect or Direct

Direct Understood, not logically rational

● Affects Fishing, Hunting, Gathering, and Child Stealing
★ Affects Fishing (Hunting), Gathering, and Navigation
* Affects Fishing, Navigation
▲ Affects Gathering, Hunting

ANIMALS AND ANTHROPOMORPHISM IN CHILDREN'S LITERATURE

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Animals have long been popular subjects in literature, especially children's literature. However, they have often been treated anthropomorphically, to the dismay of biologists who feel that endowing animals with human emotions and motives presents misguiding pictures of such creatures and may lead children to false impressions and expectations of real life animals. After all, biologists could point to a period only a few hundred years ago when animals as well as men could be brought to trial for moral derelictions. A dog could be solemnly condemned for killing sheep, or a cat as the accessory to witchcraft. There are people who continue to hold a cat morally responsible for stalking birds and wolves for killing deer, as though these were decisions made by the individual creatures. One woman I know deeply disapproves of mourning doves because they make nests so shallow that their eggs are easily lost over the edge. Biologists argue that childrens' literature devoted to anthropomorphic creatures encourages the tendency to judge animals by human standards. Sometimes such judgments are legislated; laws require that the cat be belled and other laws promise a bounty for wolves or coyotes even in areas where they are no direct threat to domestic animals. In more peaceful settings a woman may be appalled that her cat doesn't recognize her own kitten of several years previous. The cat has failed to live up to the sentimental expectations of human motherhood.

Alternatively, many biologists feel that the "Bambi syndrome" resulting from anthropomorphic treatment of animals is dangerous, both to humans and to the animals, since most children (and many adults) come to view animals as cuddly, soft, friendly creatures which they can treat as pets. In reality, of course, even squirrels and rabbits can inflict severe wounds, and many animals carry lice, ticks, rabies and other diseases and parasites. Baby animals, especially, may be picked up and carried home as "pets," where they either succumb to improper care or become a nuisance and a hazard as they get older. The Bambi syndrome is also scored by wildlife biologists as a source of pressures against rational management of wildlife populations through hunting and trapping.

Despite such well-founded uneasiness by biologists, childrens' stories continue to abound with anthropomorphic animals. Snakes got a bad press in the Bible and no author seems to have tried to endear a snake to young readers. However spiders, mice, water rats and other unlikely small creatures have shared childrens' affections with kittens, dogs, horses, pigs, and such wild creatures as raccoons, deer, bears, and foxes. Anthropomorphism is too deeply embedded in our literature, and not only childrens' literature, to be easily eliminated even if it proved desirable to eliminate it.

Aesops *Fables* illustrates one use which has been made of anthropomorphism. The didactic stories provide a means of conveying both practical and moral judgments without pointing to specific people. The creatures in these stories talk as humans do and evince human emotions including regret in "The Sick Lion," a story in which other animals insult a dying lion who now wishes that he had treated them less arrogantly in the past. Vanity is castigated in "The Fox and the Crow" in which a fox flatters a crow into singing and therefore dropping its food. The cautionary tales were intended for adults as well as children and adults were also the original audience for animal stories such as those collected by the brothers Grimm, as well as for the tales of Reynard the Fox. In fact, there was almost no literature designed exclusively for children until the 18th century. But the 19th century produced a flood of literature for the children of the increasingly literate and education-oriented middle class. Animal stories increased dramatically in the latter half of the century, and Magee (p. 221) has suggested a connection between the emergence of Darwinism and the increased interest in animals. However that may be, the production of animal stories for children has increased with the ensuing years. During 1980-81 over 1000 children's animal books were in print in America. The books exhibit degrees of anthropomorphism ranging from the almost totally anthropomorphic to the entirely realistic. In general, the books for younger children are the most anthropomorphic and are the most likely to continue the cautionary tradition begun by Aesop's *Fables*. The books for older children are the most realistic and are often designed to teach readers about the instincts, habits and life cycles of wild and domestic animals. Thus the books for older readers, at their best, serve to counter the possible misconceptions gained from early exposure to anthropomorphic tales.

Animal stories for children can be defended on the ground that they have positive impact on children's behavior. Pet stories bring out children's desire to nurture and protect, while the vulnerability of wild creatures encourages a sense of compassionate kinship. Since many animals, particularly the wild ones, are unfamiliar to young readers, giving them human characteristics can make them seem less alien (Markowsky, p. 460) and thus engage the reader's interest and sympathy. Moreover, "talking beast stories are perhaps the first kind of fantasy that younger children encounter" (Sutherland, p. 222). Anthropomorphic animal books may also be a child's introduction to humor in literature. Children too young to have seen any of the animals represented seem to be amused by pictures of animals wearing clothes, not because they know that animals don't wear clothes but because they are familiar with clothing on people and a kitten's face and paws peeking out of the garb they associate with themselves or their parents strikes them as funny. At a somewhat more sosphisticated level the discrepancy between the animal and its actions and clothes may be a source of humor. At a still higher level of sophistication the anthropomorphic animals can become caricatures of tradesmen, grumbling grandfathers, or fearful children. The child is amused by the recognizing the types while the text is simultaneously suggesting methods for dealing with such people.

Animal stories can be divided into three broad categories based on the degree of anthropomorphism present: 1) those in which animals behave like human beings; 2) those in which animals behave like animals except that they talk and may wear clothes; and 3) those in which they behave entirely like animals (Sutherland, p. 341). It has been suggested that these categories represent the chronology of a child's reading. However, adults also enjoy anthropomorphic animal tales, particularly in satire, and children of any age often enjoy both realistic and fanciful animal stories, alternately.

The three categories of animal stories can be illustrated best by examining one or two of the best known stories in each category.

In the category of complete anthropomorphism *Little Bear* and subsequent books in the series by Else Homelund Minarik are widely available in bookstores and libraries. Little Bear is a child with childlike feelings and experiences, with whom child readers can identify. He and his friends entertain themselves by trying to stop his hiccups. They discover their imaginative capacities when he and Owl pretend that a log is their boat for a fishing expedition, and when they imagine that they find a mermaid in the river near where they are picnicking. Little Bear consciously plans his future—he will be a fisherman some day. He also learns to write a letter to his friend Emily who has gone away to school. Little Bear appears to be a biological bear—meaning that he has fur and looks like a bear, but he really is only a nominal bear. He lives in a house with furniture with father Bear, who wears suits, and mother Bear, who wears dresses and cooks dinner. Family relationships and the imaginative play of childhood form the basis of the stories.

A more complex story in which the characters are animals dressed and acting like human beings is the childhood classic, *The Wind in the Willows* by Kenneth Grahame. Each chapter tells a complete story of the four friends: reflective Mole, kindly Water Rat, shy Badger and rich, conceited, troublesome Toad. The characters assume quite different traits from those commonly associated with their species. Their thoughts, personalities and actions are clearly those of children rather than animals. When Mole was lost in the deep wood, Rat became alarmed. "The rat looked very grave, and stood deep in thought for a minute or two." He armed himself with pistols to look for his friend and as he passed through the wood, "wicked little faces . . . vanished immediately at the sight of the valorous animal." Rat brought "a fat, wicker luncheon basket" on a fishing expedition. When Rat offered to teach Mole to swim, "Mole was so touched by this kind manner of speaking that he had to brush away a tear or two." In a burst of creativity Rat composed poetry.

The friends and other creatures owned property that only humans have. Toad's house was grand, with stables, a boathouse, and a banquet hall. "Toad is rather rich, you know, and this is really one of the nicest houses in these parts, though we never admit as much to Toad." Toad prepared a caravan for his friends and himself so that they could travel.

The friends are overtly kind to each other in human manner. Toad, according to Rat, "is indeed the best of animals . . . [although] he is both boastful and conceited." Badger had a fire and a fine dinner prepared for his friends who had just come in from a frightening night in the deep wood. Toad loved cars, but was a careless driver so that Rat and Badger tried to figure out a way to keep him from being killed by accident.

The equally classic tale of *Winnie the Pooh,* while superficially belonging to the class of anthropomorphic animal tales, is technically a tale of anthropomorphic dolls, since these are stuffed toy animals and, unlike Little Bear, must first be endowed with life and only then with characteristics either bear-like or human.

The category of partially anthropomorphic stories is in some ways the most complex. The animals in such tales usually behave like animals except that they talk. They may also have some human characteristics which provide a familiar footing for the reader, but "the secret of the good 'dressed animal' is that it never loses its believability as an animal, even though it wears clothes and talks" (Sutherland, p. 97).

The stories which are partially anthropomorphic are those which are most altered by illustrations. "Goldilocks and the Three Bears" has been reprinted for a hundred years and in that time has had dozens of illustrators. The bears' house is more or less tree-like depending upon the illustrator's vision. The bears' beds may be nests of leaves or four posters. The chairs and the cooked porridge as well as the conversation make the story partly anthropomorphic, but as other household details and clothing are depicted by the illustrator the story can seem much more anthropomorphic than the text warrants. Southey's bears were still bears and Goldilocks prudently fled for her life. (I have heard rumors of a modern version of the story in which Goldilocks is invited to stay for breakfast and accepts—an alteration which makes Southey's 'dressed animals' nearly the equivalent of Little Bear and his family.)

Peter, in Beatrix Potter's classic *Tale of Peter Rabbit* is another dressed animal. Although the animals wear clothes, talk and go to the market, they never lose their believability as animals. They live in a hole in the ground and eat what rabbits normally eat. Peter stole vegetables from a garden, which is what rabbits often do. When he was chased and again when he was lost, he was frightened, but no human motives or thoughts are attributed to him. He and his family continue to live rabbit-like lives despite their clothes and language. Death occurs, as it does in nature, but is treated in a matter of fact way. Children can identify with Peter, who is much like a child, except that his basic rabbit nature is not changed.

E. B. White's masterpiece, *Charlotte's Web* contains barnyard animals who look and act just like ordinary animals to everyone except the little girl, Fern, but who can communicate with each other remarkably. Wilbur, the runt pig who was raised on a doll bottle, is the focal point of the story. His banishment to the barnyard starts the amazing fantasy in which animals understand each other and are understood by Fern. Charlotte, the aloof, intelligent spider, feels sorry for Wilbur, who has been marked for butchering, and weaves messages into her webs which eventually save him. The fact that Charlotte can write and Wilbur can mourn his own demise mark the animals as having human characteristics. Wilbur is a child needing affection, "Wilbur didn't want food, he wanted love"; he is also a true pig who loves to roll in the muck, "So he pushed the straw aside and stretched out in the manure," and would love to be "in a forest . . . searching and sniffling along the ground, smelling, smelling, smelling." Charlotte lives like a spider, "I drink them—drink their blood. I love blood," yet feels emotions, as she said to Wilbur, "You're my best friend, and I think you're sensational." She was at once a believable spider and a feeling being, as she sat ". . . moodily eating a horsefly and thinking about the future." Templeton, the rat, ". . . had no morals, no conscience, no scruples . . ." He said of himself, "I prefer to spend my time eating, gnawing, spying, and hiding." He also took frequent trips to the dump. The animals, who remain true to the characteristic of their species (Charlotte dies after laying her eggs), speak and show emotion in a story that is a believable fantasy.

Partially anthropomorphic animals are human enough through their dress and speech to enable children to identify with them. Yet despite their appearance, each remains true to the basic biological pattern of his or her species.

The third category of animal stories is limited to tales in which animals both look and act like animals. However they often display characteristics which children admire in human beings. There is greater variety in these stories than in those in the other two categories. Realistic stories for young children are usually cheerful, while the tragedy which occurs in the lives of many animals is more often portrayed in the stories for older readers.

The primary criterion for realistic stories about animals is that the animals be portrayed objectively. If there is conjecture about motives it should agree with interpretations recorded by animal behaviorists. Sentimentality and melodrama should be used very sparingly.

The well known author, Marguerite Henry, specialized in horse stories. Her *Misty of Chincoteague* portrays the lives of two captured wild ponies, Misty and her mother Phantom. The story is realistic throughout. Both ponies act as ponies normally do. Phantom never lost her wildness although she had been captured and became well trained. Misty loved attention and did pony-like pranks to obtain it. As Misty gave the boy, Paul, a great swipe with her tongue, "it was as if she had said, 'Why is everyone so quiet? I'm here! Me! Misty!' " Both ponies nuzzled for sugar and loved treats. Throughout the book when the animals are credited with emotions, it is clear that the interpretations are being made by people. During a hard rain after they had been caught, "Misty's head fell across Paul's lap, not because she wanted human comfort but because she was tired from the hard drive and the rain." As Phantom ran back to her island after being freed, she turned once to look back to her people. " 'Take good care of my baby,' she *seemed* to say. 'She belongs to the world of men, but I—I belong to the world of wild things!' " Motives are never imputed directly to the horses and the animals are never sentimentalized.

Realistic stories designed to teach children about pets and to counter the sentimentalized animals and the "dressed animals" they may have encountered in earlier reading have begun to appear in recent years. Stories of children overreacting to their pets and their assumed needs are among the fine realistic stories to be published in the past decade. None of these has the classic reputation of the books previously discussed, but they deserve mention because they are representative of a modern approach to animal stories. . . . A boy believes that a baby bird he has rescued needs help in learning to fly in the book *Bird* by Liesel Skorpen. . . . Dick Gackenrack's *Do You Love Me?* is the story of a small boy with no playmates who accidentally kills a bird he had found by too much fondling. He later discovers that his new puppy enjoys cuddling as much as he does. *Leave Herbert Alone,* by Alma Whitney, is amusing in a wry way. A girl is so eager to show her love for a cat that she frightens him and must learn gentler methods in her approach.

Perhaps the problem of anthropomorphism in childrens' animal stories is less important than it has been made to appear. Certainly anthropomorphism has literary and practical virtues of engaging the attention of young readers, serving as a vehicle for slightly veiled teaching about social relationships, and introducing young readers to fantasy and to humor in books. Moreover, there are so many excellent animal stories in print that as readers become older they will inevitably be exposed to realistic animal stories, some of them deliberately designed to correct more fanciful representations of animals and many of them designed to provide biologically accurate accounts of the lives of wild and domestic animals.

Literature Cited

Magee, William H., "The Animal Story: A Challenge in Technique," in *Only Connect: Readings on Children's Literature.* Ed. by Sheila Egoff, G. T. Stubbs and L. F. Ashley. Oxford Univ. Press, Toronto. 1969.

Markowsky, Juliet Kellogg, "Why Anthropomorphism in Children's Literature?", *Elementary English* 52:460-462. 1975.

Sutherland, Zena, and May Hill Arbuthnot, *Children and Books,* (5th Edition) Scott, Foresman and Co., Glenview. 1977.

BODY LENGTHS, BODY WEIGHTS AND FECUNDITY OF SEA LAMPREYS (*PETROMYZON MARINUS*) FROM GREEN BAY, LAKE MICHIGAN

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Abstract

This paper describes the results of measurements of body length, body weights and egg counts of ovarian samples in a representative collection of female sea lampreys from the Peshtigo River, and compares these data to other published regional sea lamprey studies. Specimens were collected during spring spawning runs of 1979 and 1980. Fecundity was determined by counting the number of eggs in one gram samples from each of 14 ovaries, and then multiplying by the total ovarian weight. For each of these parameters, our samples showed means of body length, 484.5 mm; body weight, 267.4 grams, and eggs per female, 97,016. These mean values were greater than any yet published for landlocked Great Lakes sea lamprey populations. Green Bay and its tributaries appear to be highly productive sea lamprey habitat.

This study compares morphological and fecundity data of Green Bay samples with data from selected sea lamprey studies from other Great Lakes sites and an original anadromous population.

The sea lamprey (*Petromyzon marinus* L.) is a primitive vertebrate belonging to the Class Agnatha. It is characterized by having no jaws or paired fins, seven gill pouches and a slender eel-like body form. There are well developed dorsal and caudal fins and a single median nostril. The oral disk has many strong, sharp, horny teeth which with a rasping tongue are used to break the skin of prey and allow the parasite to feed on the body juices.

The species has a nonparasitic larval, or ammocoete, stage that lasts for several years (3-10) before they metamorphose and become parasitic on fish. After 12-20 months as adults (Applegate, 1950), they migrate in the spring into fresh-water streams to spawn and die. The species is native to the Atlantic coasts of North America and Europe, but has invaded the Great Lakes in recent times.

The history of the progress of the sea lamprey through the Great Lakes has been well documented by fisheries biologists (Applegate, 1950; Smith, 1971). It has been an aggressive colonizer and rapidly increased in numbers in this new and rich habitat. Control programs began in Lake Michigan in the 1950's and have continued to the present in various degrees of intensity and with different methods. Initial control used mechanical traps, then electrical weirs and finally chemical agents that kill ammocoetes in the spawning streams. The selective lampricide, 3-trifluoromethyl-4-nitrophenol (TFM) has been dramatically effective although streams have to be treated periodically to guard against reestablishment of the population. Complete eradication appears impossible due to difficulty in the treatment of certain streams and the possibility that some lampreys are spawning in Green Bay itself.

PROCEDURE AND METHODS

Although collections have been made during the spawning runs on the Menominee and Peshtigo Rivers each year since 1978, specimens for this study were collected pri-

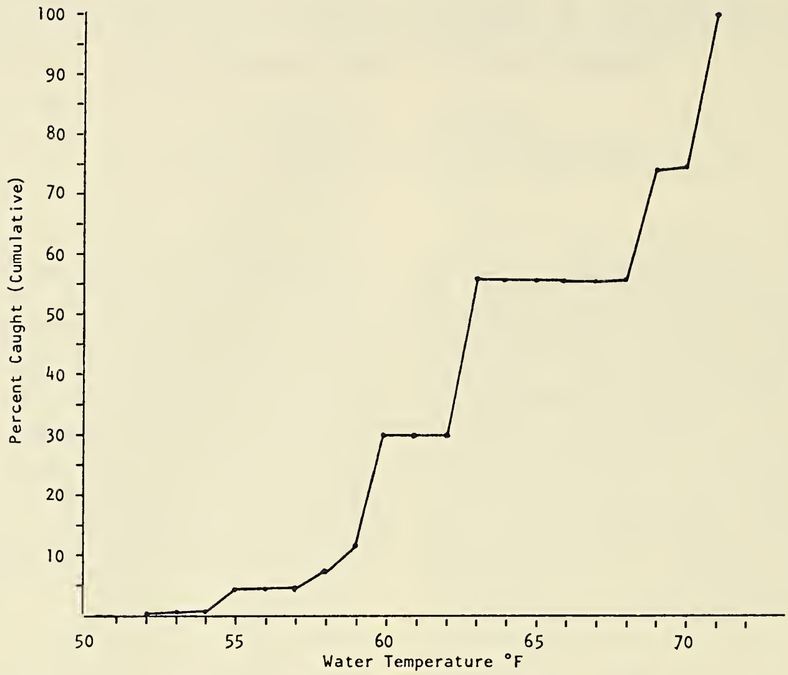

Fig. 1. Captured Peshtigo River Sea Lampreys—1980. (n = 300)

TABLE 1. Sizes of Peshtigo River Sea Lampreys—1980

	Body Length (mm.)		*Body Weight (gms.)*	
Captured Dates	*Males*	*Females*	*Males*	*Females*
May 1-15	n = 29	n = 48		
	$\bar{x}$ = 485.4	$\bar{x}$ = 471.4	$\bar{x}$ = 264.9	$\bar{x}$ = 241.2
	s = 42.9	s = 39.5	s = 76.2	s = 66.3
	r = 391-565	r = 403-545	r = 134-391	r = 136-391
May 16-31	n = 93	n = 121		
	$\bar{x}$ = 470.5	$\bar{x}$ = 489.2	$\bar{x}$ = 220.8	$\bar{x}$ = 240.4
	s = 36.4	s = 36.6	s = 46.2	s = 52.7
	r = 400-538	r = 380-569	r = 121-350	r = 134-381
June 1-20	n = 3	n = 6		
	$\bar{x}$ = 426.3	$\bar{x}$ = 480.0	$\bar{x}$ = 192.3	$\bar{x}$ = 234.8
	s = 4.6	s = 17.2	s = 22.8	s = 20.7
	r = 421-429	r = 461-504	r = 172-217	r = 204-267
Total	n = 125	n = 175		
	$\bar{x}$ = 473.3	$\bar{x}$ = 481.8	$\bar{x}$ = 230.8	$\bar{x}$ = 241.0
	s = 38.5	s = 42.8	s = 58.2	s = 55.6
	r = 391-565	r = 380-569	r = 121-391	r = 134-391

s—standard deviation calculated as $\sqrt{\frac{\Sigma (x - \bar{x})^2}{n - 1}}$

marily during the 1980 run. Five female lampreys from 1979 were also used in the egg counts.

Three small (2 × 4 × 1½′) mechanical traps designed to catch spawning sea lampreys were operated for approximately eight weeks from late April to mid-June. Traps were checked five days per week and reset according to water levels. All sea lampreys were kept in our laboratory, weighed, measured and the sex determined. All lampreys and ovaries were preserved in a ten percent formaldehyde solution.

Total body length was measured to the nearest millimeter and body weight was taken to the nearest gram.

The fecundity methodology used was pioneered by Vladykov (1951), where because of the extremely large number of eggs, number of eggs in a one gram unit was determined and then the total egg number was estimated by multiplying eggs/gram × total ovarian weight. Adult females have only one ovary.

The ovary was removed from each female, dried on paper toweling and weighed to the nearest gram. A one gram sample was then removed from the central region of the elongated ovary and all eggs were counted in that sample. Counting was done using a Bausch and Lomb binocular zoom microscope.

This method of determining the fecundity of lampreys is tedious but fairly accurate. Lampreys spawn only once so approximately one-half of the primary ova are developing into mature eggs (Hardisty, 1964), which are all the same size. The weight of the ovary consists mainly of the eggs, while connective tissue accounts for only a small percent of the weight.

Results

Time of Spawning Run

Sea lampreys began entering our traps when the river water temperatures reached about 10°C (50°F). However, as is shown in Figure 1, the peak spawning period was between 15.6 to 21.1°C (60° to 70°F) when 50 percent of the Peshtigo River specimens were taken. Trap catches rapidly drop off once the water temperatures pass 21°C (70°F).

Body Length

As indicated in Table 1, Peshtigo River adult female sea lampreys were longer than males; females = 481.8 mm. (±42.8), males 473.3 mm. (±38.5). In Table 1 the spawning run is divided into three periods; early (May 1-15), middle (May 16-31) and late (June 1-15). The middle period could probably be considered the peak spawning period.

Body Weights

This sexual dimorphism continues with body weights as the females in the samples had approximately a four percent heavier mean body weight of 241.0 gm. (±55.6). However, males apparently enter the rivers heavier (note May 1-15 subsample), but lose weight more rapidly than females. With both sexes, the heaviest weights were from individuals in the first subsamples. Applegate (1950) suggests that the larger size of early migrants may be due to an earlier attainment of sexual maturity among larger specimens than among the smaller ones. Neither sex feeds during the spawning run (Applegate 1950) and, therefore, they are utilizing stored energy.

Fecundity

Fourteen adult sea lampreys, five from 1979 and nine from 1980, were used to obtain representative samples of ovarian weights, eggs per gram sample and extrapolated total egg counts. Mean value for these three parameters were 48.8 g (±18.6), 2141.4 (±416) and 97,016.4 (±29,398.1) respectively. As can be seen in Table 2, there is a great deal of variability between samples. There does not seem to be a directly linear relationship between lamprey lengths and ovarian weight or total egg counts

TABLE 2. Fecundity of Green Bay Sea Lampreys (n = 14)

	Lamprey Length (mm.)	*Lamprey Weight (gm.)*	*Ovarian Weight (gm.)*	*Eggs/ Gram*	*Eggs/ Ovary*
Mean	484.5	267.4	48.8	2,141.5	97,016.4
Standard Deviation	41.8	67.7	18.6	416.0	29,398.1
Variance	1,626	4,255	322	160,709	802,518,601
Range	410-560	169-378	22-83	1,404-2,795	48,974-146,132

although larger females tended to have higher egg counts. Egg diameters were also measured with the mean value (0.98 mm.) very close to one millimeter.

DISCUSSION

The purpose of this study was to compare morphological and fecundity data between the Green Bay samples and selected published sea lamprey studies from other Great Lakes sites and an original anadromous population. Table 3 illustrates these comparisons and shows the distinctively longer, heavier body and greater absolute fecundity of the anadromous form from Quebec in contrast to the land-locked forms which have been referred to as a dwarf race (Vladykov, 1951). Although individuals in the present Green Bay samples are larger than in any of the other reported Great Lakes studies, our specimens are still much more diminutive than the marine samples. Smith (1971) earlier found that among males, Green Bay samples from Michigan rivers were generally

TABLE 3. Comparative Body Lengths, Body Weights and Eggs Per Ovary Among Selected Sea Lamprey Populations.

Location	*Mean Body Length (mm.)*	*Mean Body Weight (gm.)*	*Mean Eggs per Ovary**
Lake Michigan			
Green Bay	482	249.9	97,016
range	(380–569)	(134–391)	(48,974–146,132)
n	189	189	14
Door County (Vladykov, 1951)	359	127	62,870
range	(291–439)	(59–208)	(38,678–85,712)
n	10	10	10
Lake Superior (Manion, 1972)			
Marquette County (Chocolay River)	406	158	68,599
range	(340–511)	(85–315)	(43,977–101,932)
n	29	29	29
Lake Huron			
Ocqueoc River, MI	440	—	61,500
Carp Creek (Applegate, 1950)	—	186.6	
range	(320–536)	(61–436)	(21,000–107,000)
n	10,411		
Anadromous Population			
Quebec (Vladykov, 1951)	742.9	842.0	171,589
range	(666–841)	(560–1,145)	(123,873–258,874)
n	10	10	10

* estimated number of eggs

larger than lampreys from the main lakes. He suggested the difference in size may have been caused by differences in food supply, in the environments, or in the timing of establishment and decline of the lamprey populations. Since the last treatment of the Menominee and Peshtigo Rivers, the U.S. Fish and Wildlife Service has noted a slight decline in lamprey size (John Heinrich, Pers. Comm.).

Vladykov noted that fewer oocytes matured in the dwarf forms and suggested this was due to their reduced body size. Hardisty (1964) suggests a possible theory for the origin of the land-locked race is that those individuals with low reproductive fecundity, reduced body size and ill-equipped physiologically for life in the sea tended to remain in lakes and upper reaches of the river systems after metamorphosis throughout the trophic period.

However, among the Great Lakes populations, the Green Bay samples appear to be representative of a rich and productive habitat. Presently, the tributaries of Green Bay, i.e. the Menominee and Peshtigo Rivers, are carefully monitored and periodically treated with a lampricide (TFM) to destroy ammocoetes in the sediment of the stream bottom. Despite the reduction in adult lamprey in the spawning runs of 1979 and 1980, the sea lamprey because of its tremendous egg production, maintains a potential to rapidly reinfest suitable streams. The sex ratios on the Menominee and Peshtigo Rivers are skewed toward females with the percentage of males being 45.8 in 1977, 48.9 in 1978, 53.8 in 1979 and 42 in 1980. This preponderance of females suggests a population declining and under stress (i.e. from the lampricide) as has been reported by Heinrich et al. (1980). This shift to female dominance has been recorded earlier in Lakes Michigan and Superior as lamprey populations decrease in numbers from peak levels (Smith, 1971). Monitoring the Menominee and Peshtigo Rivers will continue for the next several years.

Acknowledgments

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Literature Cited

Applegate, V. C. 1950. Natural History of the Sea Lamprey, *Petromyzon marinus,* in Michigan. U.S. Fish and Wildlife Serv., Special Sci. Rep. Fish. 55'237 p.

Hardisty, M. W. 1964. The fecundity of lampreys. Arch Hydrobiol. 60(3):340-357.

Heinrich, J. W., J. G. Weise and B. R. Smith. 1980. Changes in biological characteristics of the sea lamprey (*Petromyzon marinus*) as related to lamprey abundance, prey abundance, and sea lamprey control. Can. J. Fish. & Aquat. Sci. Vol. 37:1861-1871.

Manion, P. J. 1972. Fecundity of the sea lamprey (*Petromyzon marinus*) in Lake Superior. Trans. Amer. Fish Soc., No. 4:718-720.

Smith, B. R. 1971. Sea lampreys in the Great Lakes. Pg. 207-247, in M. W. Hardisty and I. C. Potter, Eds. The biology of lampreys. Vol. I. Acad. Press, N.Y.

Vladykov, V. D. 1951. Fecundity of Quebec Lampreys. The Can. Fish Culturist, No. 10, 1-14.

A NEW DISTRIBUTION RECORD FOR A WISCONSIN CRAYFISH (*ORCONECTES IMMUNIS*)

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Little has been written in Wisconsin about the distribution and abundance of the various crayfish species. Yet, interest in the status of the various species has heightened with the rapid spread of a newly encountered species for Wisconsin, namely *Orconectes rusticus*. This report concerns a seldom encountered species, *Orconectes immunis* (Hagen), which was reported in Creaser's 1932 original distribution work but has not been reported since.

In September of 1981, I visited a minnow dealer, Mr. James Larson, in the northwestern part of Wisconsin near New Richmond. He had a collection of crayfish from Fish Lake in Polk County that appeared to have much different characteristics than other common Wisconsin species. He graciously gave me four specimens—two males and two females—for identification.

The specimens were identified as *Orconectes immunis* with the use of Hobb's (1976) general reference on crayfish and Creaser's (1932) reference for Wisconsin. The males were clearly I Form (sexually mature) and had the usual characteristics of the genus *Orconectes*. The distinguishing character for the genus is a two-pointed gonopod. Vital measurements on all four specimens appear in Table 1.

Identifying characteristics were as follows: The carapace had no lateral spines on it and was relatively smooth. The acumen was relatively short, flat, and blunt, the tip being about as long as the width. There were no upturning or lateral spines such as are characteristic of some other species. The cheliped of the males was distinctly larger than that of the females—a characteristic of most crayfish species. *O. immunis* is characterized by a tooth in the middle of the lower digit or, as described by Creaser in 1932, an indentation at the base of a movable finger which creates the impression of having a tooth.

The male gonopods (I Form) were two-pointed and had a distinctly downward turn from the normal horizontal position. This bend amounted to a full 90° from horizontal —much more of a bend than is typical of other *Orconectes* species, in which the gonopods are either straight or gently curved. The presence of I Form males is suggestive of late summer and early fall mating for the species.

The female orifice or *annulus ventralis* had shoulders, a mesiad rise and a depression to the left. In this respect, it is unique among the other Wisconsin *Orconectes* species which have a valley in the middle.

Normally, color is not a reliable characteristic of crayfish species, but it is unique enough to be distinctive for *O. immunis*. The overall body color is greenish-brown to olivaceous with no distinct marks. However, the chelipeds are very strikingly colored a reddish-purple which tends to merge with the olivaceous color on the outside but is quite bright to the interior. This characteristic was reported for *O. immunis* in New York as well (Crocker, 1957).

Fish Lake is a 56-acre winterkill lake with a four foot maximum depth (Sather and Threinen, 1961). Thus, it must be assumed that the species will prosper in adverse environmental conditions. This record confirms the presence of *Orconectes immunis* in northwestern Wisconsin. The nearest and only previous reported Wisconsin records were for the shores of Lake Pepin and Milwaukee County (Creaser, 1932). Given its entry into the bait distribution

TABLE 1. Sizes of four specimens of *Orconectes immunis* from Fish Lake, Polk County.

	♂ *I Form*	♂ *I Form*	♀	♀
Total length (cm)	7.8	8.0	8.5	9.5
Carapace length (cm)	3.7	4.1	4.1	4.3
Cheliped length (cm)	3.8	3.5	3.0	3.0

circles with widespread markets, an expanding distribution can be expected.

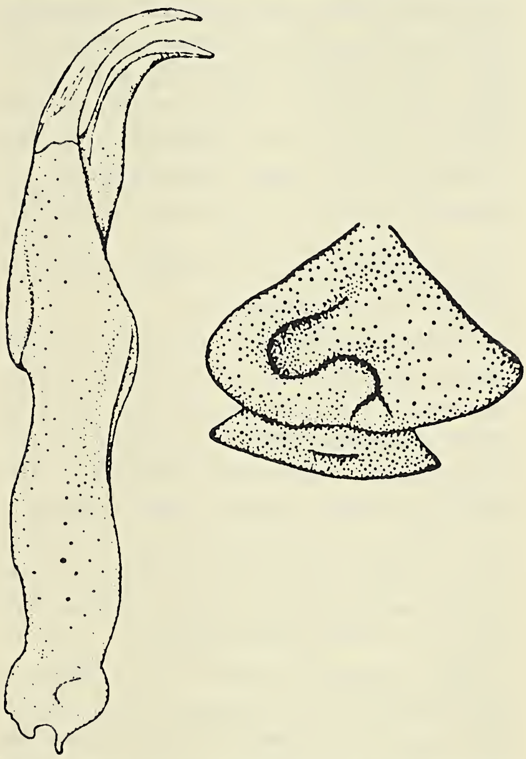

Fig. 1. The gonopod and annulus ventralis of the crayfish *Orconectes immunis* (from Crocker, 1957).

The national distribution is reported as being from New England to Wyoming in the north, southward to Alabama. This distribution record for Wisconsin would fall well within that area. As Creaser (1932) noted, the species is probably more abundant than indicated by isolated encounters. The species was also reported in 1981 in the muskellunge rearing ponds at the Spooner Fish Hatchery, although not yet formally confirmed.

Bibliography

Creaser, Edwin P. 1932. The decapod crustacea of Wisconsin. Trans. Wisconsin Acad. Sci., Arts and Letters. 27:321-338.

Crocker, Denton W. 1957. The crayfishes of New York State (Decapoda, Astacidae). Bull. N.Y. State Museum and Science Service. No. 355, 97 ppp.

Hobbs, Horton H., Jr. 1976. Crayfishes of North and Middle America. Env. Prot. Agency (Water Pollution Control) Res. series 18050 Eldo 5/72, 173 pp.

Sather, La Verne M. and C. W. Threinen. 1961. Surface water resources of Polk County. Wis. Cons. Dept. 143 pp.

OUR LANGUAGE — A SMORGASBORD OF TONGUES: THE SCANDINAVIAN INFLUENCE

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"I am of this opinion that our own tung should be written cleane and pure, unmixt and unmingled with borrowings from other tunges,"[1] so wrote Sir John Cheke (1514-57), Regius Professor of Greek at Cambridge University, in the latter years of his life. Such an opinion was not restricted to a commentator of the sixteenth century. The nineteenth century English historian, Edward A. Freeman, while working on his five volume History of the Norman Conquest, saw as one result of the Norman Conquest the abiding corruption of our language. Both men would rather have seen an "English" term used instead of borrowing from Latin and French as English did extensively throughout the centuries after 1066. Thus, one would say crossed for crucified, mooned for lunatic. Both would have preferred more use of the process of word creation as was used by the Anglo-Saxon writers, by German and Icelandic even today. Thus, for example, one would say foresayer for prophet, likejamme for parallelogram, and leechcraft for medicine. Neither of these writers was fully aware that, "of all the aspects of a language, vocabulary and meaning are the most sensitive to the external social and historical forces that determine which words a culture preserves and which it borrows from another."[2]

Our tongue has become, one might say, a smorgasbord of tongues. It has not remained "unmixt and unmingled with borrowings of other tunges," but has borrowed from many and varied languages over the centuries. Let it suffice to list here in the interests of space: million and rocket from Italian; barbecue and cigarette from Spanish; smuggle and hustle from the Low German Languages (Dutch, Frisian, Plattdeutsch, Afrikaans); plunder and zither from High German; mammoth and polka from the Slavic languages; assassin and gazelle from Arabic; amen, Sabbath and cabal from Hebrew; spinach and shawl from Persian; horde and vampire from Turkic; nabob and pajamas from Sanskrit and Hindi; calico and atoll from Dravidian; silk and ketchup from Tibeto-Chinese; tycoon and geisha from Japanese; amok and kangaroo from Malay-Polynesian and Australian Aborigine.

And the Scandinavian influence? It began long before any of the words just cited were borrowed. Alas, Cheke's and Freeman's desire to return to what they considered native English words was doomed even before 1066 and the Norman Conquest. The language of the seaborne invaders from the North, the Danish tongue (ON *dönsk tunga,* Sw. *dansk tunga*) had begun to penetrate almost every domain of the English language.

These seaborne invaders, the Vikings, all called *Dene* by the English, raided and settled England for almost 300 years. First they came as roving bands, raided on a small scale and left, then they came with large armies, invaded and began to establish settlements in that area of England later appropriately named the Danelaw. Finally they deposed the English King Ethelred the Unready and became rulers of England, Norway, and Denmark. The Scandinavians had come to England along two main routes: the Danes accompanied by some Swedes came directly across the North Sea to Yorkshire and East Anglia; the Norwegians came by stages. They had settled the Shetland Islands, the Orkney Islands, and the Western Isles off the cost of the North of Scotland. They had settled, too, in Northern Ireland and the Isle of Man in the Irish Sea. From these places they sailed to the northwest of England and established permanent colonies in Cumberland, Westmorland, North Lancashire and West Yorkshire.

It is not known how many Vikings came and settled but since more than 1400 places in England, particularly in the areas mentioned above, the East and the North, bear Scandinavian names, the number was considerable and their influence on English vernacular speech was not small. It has been said that Scandinavian vocabulary was ubiquitous in the English language. We use many Scandinavian words in our standard English and many remain in English dialects.

We first obtain a clear picture of Scandinavian loan words in English in the writings of the thirteenth century. Hundreds of Scandinavian words appear and we know that they are Scandinavian loan words because we cannot trace them to an OE source, we know that an Old Norse original exists, and further most of these texts were written in areas where the Scandinavians settled. We are often helped in our proof when we have strong evidence that the word is used in present day dialects. Examples of this latter phenomenon will be given later in this paper. In some instances we can tell that words are borrowed from Scandinavian because of differences in the development of certain sounds in North Germanic and West Germanic. For example, the sound *sk*. In OE, this became *sh* as in ship, shall, fish. In ON it remained *sk* (ON *skip, skal, fisk*). Thus we have a word from OE meaning *shirt* and one from ON meaning *skirt* yet both come from the same Germanic word. Sky, skin, scrape, scrub and "scot" in scotfree (scot meaning tax) are examples of borrowed Scandinavian words beginning with *sk*. Similarly, words retaining the hard pronunciation of *k* and *g* which became *ch* and *y* in OE are of Scandinavian origin. *Kid* (as in kidgloves), *dike, get, give,* and *egg* are all Scandinavian, as are *kirk* for *church* and *brig* for *bridge*. The latter two are evident in place names quite frequently. *Aye, nay* and *hale* as in "hale and hearty" are borrowed words that also show a difference in sound development. English has *no* and *whole* for the latter two.

Here we see both the English and Scandinavian words retained and there are other examples of this phenomenon. (The English word is given first): Rear—raise, from—fro, craft—skill, hide—skin, sick—ill. Nearly all the examples given are common words yet they are not necessarily used by us all in the same way. In England sick and ill mean two different things, here they mean the same. Sometimes the ON word prevailed over the English word so that we use anger (ON *angr*) rather than the original English words, *torn* or *grama,* wing rather than *feðra,* sky for *wolcen,* boon for *ben,* bark for *rind,* take for *nima,* sister for *sweoster,* window (*vind auga*) instead of "eye thurl," plow as a verb rather than as a noun meaning "a measure of land," holm meaning islet or watery meadow not ocean. The Old English word *dream* meant joy, the Old Norse, vision in sleep. Thus "dream" as we use it is Norse in origin. It will perhaps surprise the reader that the pronouns "they," "their," and "them" are all of ON origin and yet we assume such words are English words. To these we can add "both," "same," "though," and "till."

Who would think that "law," "outlaw," "flat," "loose," "low," "odd,", "tight," "awkward," "rotten," "tattered," and "to die" are Scandinavian words? They are, and there are many more common words too numerous to mention here. Of course many also have faded from common use and other words (from French, Latin and other sources) have prevailed. Earlier the number of place names of Scandinavian origin and the locations in which most of them occur were mentioned. The Scandinavian origin of these place names is shown usually by a suffix, sometimes by a prefix. For example, *by* meaning a "farmstead" or "town." There are 600 place names ending like this in the East and Northeast. Grimsby, Derby, Newby, Rugby, and Thoresby are but a few. We also retain the meaning "town" in our word "by-law," i.e., town law. Other words used to form place names are *beck* (ON *bekkr*) meaning stream, *brig* (ON *bryggja*) meaning bridge, *holme* (ON *holm*) meaning watery meadow, *lathe* (ON *hlatha*) meaning barn, *thorpe* (ON *þorp*) meaning village, *thwaite* (ON *þveit*) meaning an isolated piece of land, *toft* (ON *toft*) meaning a piece of land. Some examples are: Drybeck, Brighouse, Lindholme, Silloth, Scunthorpe, Braithwaite, Micklethwaite, Lowestoft. There are 300 names like Scunthorpe, almost 300 like Braithwaite, and 100 like Lowestoft. The largest group of the 1400 Scandinavian place names is found in the county of York and county of Lincoln. These are the areas settled predominantly by Danes and some Swedes. The second largest group is in Cumberland and Westmorland, those areas settled by the Norwegians. In some districts of Yorkshire over 75% of the place names are of Norse origin.

This county, Yorkshire, was divided by its Viking settlers into three parts which they called *þriðjungr,* a word which subsequently became "thriding," a thirding so to speak. Later this became "riding" and hence we had the West Riding, the East Riding, and the North Riding (the latter made known to Americans by James Herriott's novels). In these ridings and the surrounding areas it is common to find natural features bearing Norse names. People walk up banks in North England, that is, up hills, and ants live in banks (ON *bakki*—elevation). They climb in gills (small ravines, ON *gil*), walk through carrs (marshes, ON *kjarr*), down into slacks (hollows, ON *slakki*), along riggs (ridges, ON *hryggr*), may have fellwalking (fell, ON *fjall*—hillside) as a hobby and, on walks, may view a large force (waterfall, ON *fors*), watch the trout swim in a beck (stream, ON *bekkr*), and fish in the rivers of the Yorkshire dales (valleys, ON *dalr*).

In the areas settled by the Vikings dialects are preserved, particularly in the farming communities, and much of Northern England is farmed in one way or another. Traditional regional dialects are best preserved in such communities, and farming—a universal industry—provides us with a large scale of material from Old Norse. Thus we have *lea* for scythe (ON *le*), *garth* for croft (an enclosed pasture for sick animals—ON *garðr*), *midden* for bin (a place to put ashes—ON *mydding*), *gesling* for gosling (ON *gæslingr*), *steg* for gander (ON *steggi*), *stithy* for anvil (ON *steði*), *stee* for ladder (ON *stige*), *stack* for cock as in haystack. (To the author, Little Boy Blue slept under a haystack, not a haycock, ON *stakkr*). The people *clip* sheep not shear them (ON *klippa*), a farmer plows his field *athwart* (diagonally, from ON *um þvert*), calls *giss* to his pigs (cf. Norwegian *gis*), addles his money (from ON *oðlast*—to acquire property, later meaning earn), perhaps keeps a *clatch* of chickens (ON *klekja*) and calls the farm equipment for his horses *gear* (ON *görvi*). This last word came to be used in a general way for equipment. As boys, Yorkshiremen among others say "get your gear" before they go to play soccer or rugby.

Since games have been mentioned, let it be said that, in parts of Northern England, boys lake (*leik* from ON *leika*) football, not play it and the game the bairns, i.e., children (ON *börn*), play here called "tag" is "tig" (from the Old Norse word *tjuga* meaning to touch) to children in Northern England. The boys are called "lads" and a daughter "our lass," both lads and lass being most likely of Norse origin. It is hoped one's children do not grow up to be gormless, i.e., silly, dumb (from ON *gaumr*—wit/sense), or gowks (fools from ON *gaukr*—cuckoo), that, when they are playing with wood they don't get spells in their finger (ON *spjölr*—splinter/sliver), that while they are outside, the rain does not teem down (ON *toema*—

to pour), that their families don't *flit* (ON *flitja*—move), and we readily accept it if some have big lugs (ears, c.f. Norwegian *lugga*—to pull by the ears) and are kay-fisted (ON *kei*—left). All of the examples given here are current words and place-names, some to be sure only in dialects but many in our standard language and all from the Viking settlers.

It is surprising that our stock of Scandinavian words contains very few recent loan words from the modern Scandinavian languages. "Rug," "muggy," and "ski" came into use in the late nineteenth century. "Skol" is a much more recent addition to frequent use, although it was used in Scotland in the sixteenth century. "Geyser," "rune," "skald," and "saga" all came from Icelandic in the eighteenth century, and in this century we have borrowed "ombudsman" from Swedish and lest it be forgotten "smorgasbord"!

This paper has been written by a Yorkshire *tyke,* the name of which all Yorkshiremen are proud. Little did he know that it came from ON *tik* and meant originally a dog, a low fellow. He, like Cheke and Freeman, was not totally aware of which words a language would borrow and why.

Notes

[1] Quoted from Joseph M. Williams, *Origins of the English Language: A Social and Linguistic History* (New York: The Free Press, 1975) p. 88.

[2] Op. cit., p. 41.

MORE WISCONSINESE

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This paper represents a continuation of the material I have collected about Wisconsin speech. Previous findings have been published in *Transactions* of the Wisconsin Academy of Sciences, Arts, and Letters, Vol. 69, 1981. The data for this paper was collected in a similar manner as the material for the last paper. Students from Linguistics 101: *An Introduction to Human Language,* an introductory-level course for non-majors at the University of Wisconsin-Madison were sent out over Thanksgiving vacation 1980 and Easter break 1981 to interview speakers of English about some aspects of Wisconsin speech. Each student was to interview a person 15-25 years of age, one 40-50 years of age, and one 65 years old or older. In the first group, 191 questionnaires were tabulated; in the second, 77. All the speakers were Caucasian or Semitic except for five Blacks from Milwaukee.

The first construction I will look at is the use of *by* to mean "to," as in the sentence: "Let's go by John's this evening." This sentence was accepted by 93 percent of the informants, with nearly unanimous approval by speakers along Lake Michigan. Speakers in Sheboygan, Calumet, Manitowoc, and Milwaukee counties would even accept the sentence, "Let's go by John this evening" where no possessive is marking the Proper Noun. This expression comes from German *bei,* which when construed with the dative case means "near" or "at."

The next construction I will examine is *aft* as a shortening for *afternoon.* Informants were asked if they would say the sentence "What are you doing this aft?". Thirty-two percent said they would say the sentence; 27 percent of the young, 45 percent of the middle-aged group, and 26 percent of the oldest group. This form seems to have stabilized among all age groups, show no particular geographical distribution, and be a relatively stable lexical item.

Speakers were asked if they would say, "It's a nice day, in so." This use of *in so* as a tag would be equivalent to standard English *isn't it* in this particular sentence, but in negative sentence this tag is positive; for example, "It isn't a nice day, is it?". The tag rule for English is *extremely* complicated. The verb in the tag must agree with the verb in the main sentence in tense, number and the opposite of positive or negative. In addition, the speaker must know what the expected answer will be. Negative tags usually elicit a positive answer; positive tags a negative answer. Most languages have much simpler all-purpose tags. German has *nicht wahr,* literally "not true," or *gel,* short for "Ist es geltig?" ("Is it valid?"). French uses *n'est ce pas* "is it not." Canadian English has the simple tag *eh?,* as in a sentence my bridge partner, who is from Toronto said to me the other day, "You would have led a spade, eh?". The implication, of course, was that I should have since the verb of the sentence was positive. Eight percent of the speakers interviewed admitted using the construction *in so.* These responses were from the counties of Dane, Door, and Sheboygan.

We asked our informants what they called athletic shoes made of canvas. The overwhelming reply was *tennis shoes.* Six percent called them *sneakers,* which is still used in the urban areas of the East Coast. All the speakers in our survey who said *sneakers* were from the more urban areas of our state —Green Bay, Madison, and Milwaukee.

Sneakers was used by more older informants than younger speakers. We did not collect a single instance of *tennies*. This is probably due to our lack of informants under the age of 15, since this word seems to be popular among school-aged children.

An item which amused me when I moved to Wisconsin seven years ago from California was the period in school when one exercises. In Junior High School, we called it *gym* and in High School *P.E.* No one here in Wisconsin seems to call it *P.E.* I said to a group of new-found Wisconsin friends, "Are you going to take any P.E. this semester?" and all I received were puzzled looks, no answers. Then one woman, who must have done some travelling to another area of the country, said "Oh, you mean Phy. Ed." Sure enough, 39 percent said *Phy. Ed.*, 10 percent said *Phys. Ed.* and 51 percent said *Gym*. But the expression does seem to be changing over time; *Phy. Ed.* is gaining currency among the young, *gym* is losing it, and *Phys. Ed.* is remaining the same. The statistics are, for the young: 50 percent *Phy. Ed.*, 10 percent *Phys. Ed.*, 40 percent *Gym;* for the middle-aged: 30 percent *Phy. Ed.*, 10 percent *Phys. Ed.*, 60 percent *Gym;* for the oldest group: 35 percent *Phy. Ed.*, 6 percent *Phys. Ed.*, 59 percent *Gym.*

We found a very interesting distribution for the lexical item for *soft drink*. Among the young and the middle group, pop was preferred by the majority of the state with a noteworthy pattern of exception. From Manitowoc County to Racine County on Lake Michigan with the inland county of Waukesha, part of the greater Milwaukee area, all speakers prefer "soda." There were examples of *soda* and *soft drink* scattered throughout the state, most usually in the older age group.

In Calumet, Manitowoc, and Sheboygan counties, residents *fry out* rather than "cook out," when cooking bratwursts over coals. There exists the corresponding noun *A fry out,* to which one may be invited to fry out these brats. I would venture to say this is a direct translation of the German verb *braten,* used for frying rather than *kochen,* used for cooking generally and boiling in particular. This is the same verb stem seen in the word *Bratwurst* itself. Calumet, Manitowoc, and Sheboygan counties were settled by a large percentage of German immigrants.

About half the informants surveyed syllabified *Wisconsin* as [wI·skɔn·sn̩] rather than the standard [wIs·kɔn·sn̩]. This distinction, however, is somewhat muddled by the fact that most speakers use extremely heavy stress on the second syllable. I have been unable to hypothesize a reason for this phenomenon. It does give a particular quality to a native's speech when he says, "I'm from Wis*con*sin." I might add that in casual speech the word is often shortened to [skɔnsn].

Of the informants surveyed, 10 percent said the name of the largest city in the state is [mwɔ·ki] in two syllables, 25 percent said [mi·wɔ·ki] without the [l] and 65 percent said [mIl·wɔ·ki] in three. Since [m I w l] are all sonorants, it is rather a simple matter of assimilation to come out with [mwɔ·ki]. Note that this does not happen, however, to Pewaukee, a city 25 miles to the west of Milwaukee. [pwɔ·ki] seems odd and unnatural. [p] is not a sonorant and cannot be easily merged or assimilated with neighboring sounds.

DISCOVERING THE BEST OF BOTH WORLDS: A LOOK AT ENGLISH TEACHING IN GERMANY AND AMERICA

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When one has spent years teaching lower-division composition and literature in the United States and then teaches essentially the same courses in the English Department of a German university, comparisons between the two academic systems become inevitable. Such a comparison will discover the advantages of both systems: "In America you can assume that the students will actually read the texts" or "Germans believe human beings have a *right* to a paid vacation!" Some of the contrasts between the two systems are amusing. Others are instructive: for example, the differences in course loads, in the students' background, in methods of evaluating students' progress, in curriculum, and in departmental structure. The following discussion of English teaching at one particular German university will by no means be an indictment of American English departments. On the contrary, my experience in Germany has taught me—believe it or not—that we Americans do many things right at our universities.

First, the reader should know several facts about the English Department at the Justus Liebig University in Giessen, Germany, where I taught for two years, and the corresponding department at the University of Wisconsin-Milwaukee, where I had previously taught for eleven years. In the late 60's and early 70's the UWM English Program had about one hundred staff members (including 40-50 teaching assistants, as well as lecturers who concentrated on composition and lower-division literature courses). There were several hundred majors, and in addition, the department served the entire university as instructors of literature and basic writing. The department at Giessen also has several hundred "majors," although it does not serve the entire university as do American English departments. This is one reason why the faculty is relatively small: seven professors, five tenured faculty of lower rank, half-a-dozen graduate assistants (who teach only one literature seminar per semester), nine lecturers, and three or four part-time instructors. The department has its own "teacher-training" institute; it does not deal with a separate education department. It should be remembered that the *German* department at Giessen would be equivalent to an American *English* department, while English is part of the foreign language program (although it is the most popular foreign language, which accounts for the large number of majors). The courses taught by lecturers like myself include essay writing, translation, phonetics, grammar, American, British, and Canadian studies, and an amorphous course called "Listening and Comprehension."

I first learned of the vacant position at the Justus Liebig University through Professor Ihab Hassan, who has many friends at German universities. Giessen was trying to build a partnership with UWM (Wisconsin is the sister-state of Hessen, where Giessen is located). The Giessen English department in particular wished to establish relationships with English-speaking universities for the sake of both student and faculty exchanges, since it is essential to have a certain number of native speakers teaching university-level English in Germany. I was not only qualified to handle the teaching assignments, but could also speak and read German fluently as the result of a year's study in Berlin; thus, I was an obvious candidate for the two-year lecturer's position. Naturally, the thought of returning to Germany as a teacher instead of a student was enormously appealing. Just as appealing was the salary, which was double that of my lecturer's pay in Milwaukee. Even with the higher prices in Germany, it represented a substantial salary boost. It was paid over twelve months, with a Christmas bonus of one month's pay. True, these lucrative pay scales are a factor in the financial problems which German universities are also suffering. Still, for the first time in my life, I was being paid what I thought I was worth.

The English program as it existed at the time I began teaching in Giessen (September, 1979) allowed the individual instructor a great deal of freedom in selecting topics for courses in American and British studies (called *Landeskunde*). I was scheduled to teach three of these courses; my orientation in teaching them came mainly from the other instructors. First, there was the question of specific subject matter. *Landeskunde* classes are intended to give students a broad understanding of culture, society, and government in the English-speaking countries. On the whole, German school classes about America focus on a narrow range of topics, particularly the problems of blacks and Indians. Without downplaying the racial problems in the United States, I tried to introduce my students to other aspects of American civilization.

At first I picked impossibly broad topics: American institutions, social relationships, arts and culture. My best inspiration was a course on the American frontier, which I taught a second time because it was so popular. Germans are extremely interested in cowboys and Indians; in fact, the whole complex of images associated with the Wild West signifies "America" to the average German. Later I taught courses on protest movements and on religion in America. I knew the tormer topic would be a sure-fire student draw. The latter topic attracted more interest than I had expected. Germans seem both repelled and fascinated by the enthusiasm for, and commercialization of, religion in the United States. Church attendance in Germany is very low (although most people still belong officially to a church). The Protestant churches, in particular, have rather unexciting services and their programs have little popular appeal. Moreover, some people feel the churches compromised themselves by not opposing the rise of Nazism in the 1930's. Interestingly, many clergymen today are vocal opponents of nuclear armament, perhaps in an effort to promote the Church as an anti-establishment force.

My essay writing classes were much like similar classes in the United States, focussing on themes drawn largely from personal experiences and opinions. In retrospect, I believe I should have required at least one research project, since the students did not understand research concepts and often showed little imagination when writing from their own experience. For instance, given an assignment on comparison, almost half of the students compared country life to city life. This apparently is a hot topic in Germany, but the papers it inspired were dismayingly dull, repetitious, and generalized. Technically, the students' errors were mainly in vocabulary, spelling, and idiom usage. There were few of the gross errors in grammar, syntax, or sentence completeness which frustrate English teachers in America, which testifies to the quality of basic English instruction in Germany.

The "Listening and Comprehension" course was both the despair and delight of the lecturers. No two people ever seemed to be able to agree on just what its goals and methods were supposed to be. In theory, it was supposed to give the students their main opportunity to hear and speak English. In fact, since there were no limits on class size, it was almost impossible to get even most of the students to talk in one class period. I also learned, to my surprise, that many English majors avoided actually speaking English if at all possible. On the other hand, the looseness and vagueness of the course allowed for all kinds of experimentation, as well as providing a chance to really know one's students. I used a variety of material: newspaper reports, tapes, music, jokes, simulations, games, films, and video tapes ("Laverne and Shirley" got mixed reviews). At the time I considered the course fun and hoped the students were learning something; in retrospect, I realize that *I* learned more about teaching language from this course than from any of the others I conducted in Germany.

In preparation for my *Landeskunde* courses, I drew up reading lists based on the books available in the departmental library (something worth initiating in America, by the way). Although instructors of literature courses usually expect their students to procure copies of the basic texts, most language instructors do not require students to buy books, relying instead on handouts and copies (copiers and ditto machines are even more important at German universities than in the States). There are no university bookstores as we know them, so that required texts must be ordered through private bookstores; as a result (and also because of the expense of buying books for every class), far fewer textbooks are required.

All the instructors as well as the full professors, complained of the students' unwillingness to read, and indeed, very few of my students seemed to derive much pleasure from actually reading English. There are several reasons for this. Most students take ten or twelve different two-hour courses per week. It would be impossible for a student to do the amount of reading and writing that the typical American instructor would expect for each of these courses. A student is only required to do written work or heavy reading for a few classes each semester. He need only attend the rest of his classes, and at the end of the semester will receive the signature of the instructor on his class list to certify his attendance.

A second reason for the lack of interest in reading is, unfortunately, more basic: many of the students just don't enjoy reading English and are not highly motivated to study the language. One explanation I heard was that many would-be doctors who couldn't get into medical school decide to major in English instead, reasoning that their nine years of secondary school English would provide the basis for a major. As in the United States, English Departments in Germany are refuges for students who are not exactly sure what they wish to do for a career. In the past, most of these English majors ended teaching in the high schools, but since these job opportunities have almost dried up, the Giessen English faculty has tried, with mixed success, to develop programs to train English majors as something other than teachers. Unfortunately, as in the states, there are large numbers of students who must be pushed, pulled, and cajoled through their "chosen" program of study.

Nevertheless, most students in all areas of study come to the university with an enviable knowledge of English and with generally strong academic backgrounds. There are only about forty universities in Germany (for a population of 60 million) and they must accept a much more elite group of students than American universities. The students are somewhat older than American undergraduates, since they leave the *Gymnasium* (the most demanding level of secondary school) at the age of nineteen, after which the men must serve fifteen months in the armed forces before beginning their studies. I found the students intelligent and generally well-prepared for university work. My essay writing students were not used to writing themes in the form which I demanded but they quickly adapted to my requirements. A more serious problem, for students who had learned British English in the schools, was my American accent; although this, too, was only a temporary obstacle. Most of my students were well-informed about current affairs and surprisingly knowledgeable about American politics. On the other hand, I missed that touch of goofiness which characterizes American students, that willingness to say something outrageous to stimulate discussion or just to show off.

Under the German system there is no limit on the sizes of classes. Typically, in the first week or two of the term, students visit many courses and then pick out the ones they want to attend for the rest of the semester. Thus, new teachers have significantly fewer students than instructors who are better known. By the same token, notoriously poor teachers get very few students. Classes offered at favorable times are always overcrowded. Moreover, students may take required courses repeatedly in order to raise their grades in these subjects. At the same time, at least when I started teaching, there was very little monitoring by the administration of *when* classes were scheduled by the lecturers. Lecturers were not supposed to schedule courses on Wednesdays or on Tuesday or Thursday mornings, since these time slots were reserved for the required courses taught by the professors. Aside from that, instructors had great freedom in scheduling; after a semester one learned that certain times would draw fewer students. For example, although five of my courses were always packed, the sixth, a "Listening and Comprehension" section at 2:00 p.m. on Friday, never had more than ten students. This I regarded as my "fun" class. Other lecturers were less scrupulous about the timing of their classes. The system insured that favorably scheduled courses would be overcrowded, resulting in a lack of individual attention from the instructor. This freedom to choose whatever classes they want, without enrollment restrictions, is jealously guarded by the students and is not likely to change. It leads to composition classes of forty or fifty students and to "discussion" sections of thirty. In this light, regulation of class sizes and scheduling by American universities appears sensible and justified. I should mention that at Giessen, at least, attempts are being made to regulate the lecturers' course loads and class schedules.

Another problem related to class scheduling is the academic calendar itself. The winter semester lasts from the middle of October until the middle of February, sixteen weeks in all. There is then a break until the beginning of April when the summer semester starts; this lasts thirteen weeks, until the beginning of July. The disparity in semester lengths is increased because there are many one-day holidays during the summer semester. Thus, a course scheduled on a day when classes are often cancelled may meet only ten times. This usually requires extensive reorganization of syllabuses from one semester to another, since the amount of material which can be presented to the students in the summer is much less than can be handled during the winter.

After two years, I still do not entirely understand the grading system at German universities, and there seems to be some confusion about it among Germans themselves. Our students were supposed to gather a certain number of certificates, called *Scheine,* from their instructors. On each certificate is written the course title, the instructor's name, the work which was done for the grade, and the grade itself. The grading scale goes from "1" (the highest) to "6" (total failure). A "4" was the lowest passing grade, but in fact was considered a disgrace. These grades are not recorded on any permanent record, only on the *Schein* itself, which is kept by the student.

The real determinants of a student's progress are the intermediate examinations and the state (final) examinations, which in the English Department consist of an essay, a translation, and an oral test. A student has three chances to pass each of these examinations. Although students must earn a given number of *Scheine* before taking these examinations, only the grades on the examinations actually determine whether a student will pass. Thus, the grades for the individual courses do not count in a students' final evaluation, serving the students mainly as clues to their own progress and ability. The major examinations are graded like the separate courses, with "4" being a passing grade, but in fact the kiss of death for future job prospects. Worse, a "4" test cannot be retaken for a better mark. The American system, where good grades mathematically compensate for poor ones, is far less traumatic than the German system, where, as you can imagine, each examination is preceded by a period of incredible anxiety to the student.

One of the hardest things for an American instructor to adjust to is the hierarchy of a German university department. Because there are fewer professors in the typical German academic department than in the typical American one, and because it is more difficult to become a professor in a German university, the professors have more prestige. Even within the professorial ranks there are gradations which determine salary size, the number of student assistants one gets, and whether one deserves a personal secretary or not. The professors determine the policy in every department, despite the token presence of representatives of students and lower-level faculty in the Departmental Council. There is no "junior faculty" in the American sense, that is, assistant professors who may have been lecturers the year before and who will work their way up to a full professorship within the same department. In practice, the distance between professors and lecturers is very great and communication is difficult and hedged about by formalities. The German language contributes to the problem as well. People of higher rank are always addressed as "Mister" or "Mrs." (*Herr* and *Frau*) plus the surname, or with the formal form of "you" (*Sie*). This contrasts with the American situation, where full professors are typically on a first-name basis with most of the staff, and sometimes even with students.

The departmental structure and the accompanying formalities have, inevitably, a strong effect on the way programs are developed and taught, because they tend to impede direct consultation. Programs of study are developed with minimal input from the lecturers who may be doing the actual teaching. There are few of the informal discussions between high-ranking and low-ranking instructors so frequent in American colleges and universities, which often alert administrators that a course of study is running into trouble. Few German professors have had the extensive experience teaching lower-division courses, especially composition, which fosters understanding of what a composition teacher really faces in the classroom.

One of the new programs created by the Giessen English Department is the "Foreign Language English Major" (the actual name has undergone several changes). This program, which went into effect shortly before I began teaching at Giessen, is a response to the declining market for English teachers in Germany, the consequent threat of declining enrollments in the English department, and cuts in departmental funding and personnel. The goal of the program is to train students in English, a second foreign language, and a subject such as economics or agricultural science. After completing the program the students are supposed to have the competence to work for international corporations, the government, airlines, etc. The program has been criticized because the administration had not determined whether there was actually a demand for people with this kind of specialty. Until now, however, there have not been enough graduates from the program to test the market.

An important part of this new foreign language program is the "Intensive Course," a mini-course meeting three hours a day during the last two weeks of February, that is, just after the formal end of the semester. The exact content of this class is still being debated. Some feel it should concentrate on the spoken language, others believe it should be a review of writing, translating, and reading as well as speaking; still others feel there should be an extended written and oral examination at the end to determine whether students should be allowed to continue in the program. This very basic question of content has been complicated by the lack of coordination between professors and lecturers in planning the course. The expectations of the professors have changed several times, as have the testing procedures for the course, and as a result, many instructors have come to regard the course as a futile exercise. Before I left, there were earnest efforts on both sides to produce a sensible course plan, but this was occuring only after long delays. Ironically, most of the students would benefit from a two-week immersion in spoken English, as this is the area where most of them are weakest.

I mention the difficulties with the Intensive Course because it was one of the most unfortunate examples of the lack of communication among instructors and professors. Without giving exhaustive details of other controversies, I will simply state that the lack of a forum for sitting down and hashing out problems on a basis of equality contributed to many of these conflicts. The problem of reconciling the objectives of a program with what can actually be done in the classroom is a very familiar one on American campuses. Many people in the UWM English Department will recall the confusion a few years ago when the College of Letters and Sciences decided to require that every student pass a test on grammar and essay writing before he or she could become a junior. Nevertheless, once this policy was decreed, the composition staff itself was given the responsibility for developing a new program to meet the requirement. Moreover, the looser hierarchy of the typical American academic department makes it easier to thrash out these problems.

Compounding these difficulties is the fact that bureaucrats in the Hessian educational ministry have great power and sometimes exercise it in unpredictable ways. This was brought home to the entire staff several years ago, when there was a sudden rumor that lecturers' teaching loads were about to be increased to 24 hours per semester. Technically, the loads are 16 hours, which works out to six two-hour courses per week, the other hours being accounted for by the intensive course and time spent grading the various examinations. However, some bureaucrat had noticed that, for salary purposes, most language courses only counted one-half (like laboratory courses in the United States), meaning that lecturers might have to put in as many as 24 classroom hours to receive credit for 12 teaching hours. The rationale behind this system was that language courses require little or no preparation, an obvious absurdity to anyone who has ever taught any language class. In the course of discussions the University president admitted that he thought language classes consisted largely of rote drills from workbooks. On this issue, both lecturers and professors were united in their opposition, and, as of this writing, course loads have not been raised. However, the "half-credit" rule is still the official standard for calculating course loads.

The attitude toward pedagogical technique shown by these rules suggests another difference between American and German universities. There is, I believe, less appreciation in Germany for the art and technique of teaching than in the United States. This may be a holdover from the days when German universities were much more elite and students were highly motivated and more capable of learning on their own, regardless of whether the professors were capable *teachers*. Now the universities have more students who are there simply because they do not know what else to do. Particularly in the English Department, there are many students who need to do "catch-up" work in writing, speaking, or translation. All this requires that instructors think carefully about how they teach, organize their classes methodically, use a variety of techniques, bring in films and tapes, and stay alert for signs that students are bored or incomprehending. Especially in the area of language and composition, Americans are continually experimenting and exploring the "how" of teaching. No one assumes that language courses can be taught simply by means of written or spoken drills taken from a book. There is a growing awareness of this fact in Germany as well, although respect for university pedagogy is still not as widespread as in America.

The last few pages have been critical of some practices at German universities. Let me emphasize that the years I spent at the Justus Liebig University were enjoyable and rewarding. I made many friendships, learned a great deal about teaching, and acquired an admiration for my colleagues and my students as well. My criticisms are not made from an attitude of superiority but from a sense of frustration that many capable people had so much difficulty communicating and cooperating.

It was also a pleasure and a challenge to instruct students with such solid training behind them. Few of my colleagues had had any experience teaching at an American university, and they frequently groused about the abilities of the German students. I could never be as critical as they were. Most college instructors in the United States would envy the intelligence, ability, and motivation of the students at Giessen. Although I was teaching English as a foreign language, I learned a great deal about teaching literature and composition to native speakers as well. Explaining the peculiarities of English grammar and sentence structure to German students forced me to consider why these features had been bedeviling my American students. I became a more sensitive, thorough teacher as a result. In addition, I was able to counter or at least balance out some of the German stereotypes about the United States, while becoming aware of the German point of view on other matters: their frustration with our simplistic attitudes towards the Soviet Union, their perception of our personal shallowness, their disgust with the cheapness of much of our culture, symbolized for them by the MacDonald's restaurants proliferating across Germany. Still, many Germans, even those who are anti-American, are fascinated by the United States; the harshest criticism of our country is often the sign of a profound interest.

American universities have much to offer those in Germany, especially in the areas of course structure, registration, and teaching technique, while Germany can show us the value of high standards, the importance of foreign language training, and the need for solid high school instruction as a preparation for college. Yet for all the differences between the two systems, I came to realize that some basic concerns are identical. The problems of decision-making responsibility, instructional freedom, and the sharing of authority are common to universities in both nations. Moreover, the financial crunch has come at last to German schools. Everyone is preoccupied with retaining teaching positions, keeping up salary levels, maintaining enrollments, fending off massive increases in teaching loads, and trying to prove that one's own department is useful at a time of high deficits and falling birth rates. Germany and the United States can both take pride in some aspects of their university systems. Yet sometimes the issues of class scheduling, course loads, even pedagogical methods and authority seem minor in comparison to the survival of the universities in anything like their present form.

My experience in Germany helped me see the strengths and weaknesses of the American system more clearly. But ultimately, my stay in Germany was valuable because it showed me that certain problems are common to all universities, perhaps even inherent in the very structure of a university. I became a better teacher not only because of what I learned in the classroom, but because I deepened my understanding of the position of universities in the 1980's.

THE HOUSE OF THE SEVEN GABLES: CLASSICAL MYTH AND THE ALLEGORY OF REDEMPTION

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It is a commonplace in Hawthorne criticism that his works have been influenced by such great English writers as Bunyan, Milton, and Spenser. Not much has been written, however, about ancient classic influences on his art. No one seems to have been sufficiently intrigued by the classical references in *The House of the Seven Gables*[1] to analyze the book in terms of classical influences. Perhaps the reason for this neglect is that direct, patent references to the classics are rare in the Hawthorne romances, In *The House* there are only four. But this sparing use of references is important because it indicates that Hawthorne chose carefully and did not employ them lightly. Investigation of these references reveals that three of the four come from *The Aeneid,* which suggests that Virgil's epic was either one of Hawthorne's favorite books, or that it was simply much on his mind at the time he wrote *The House.* Whichever conclusion is correct, it seems only logical to look for echoes of *The Aeneid* in *The House.*

Another reason for suspecting the influence of the classics in *The House* is that Hawthorne wrote two children's books, *The Wonder Book* (1851) and *Tanglewood Tales* (1853), in which he retold the classic myths of Greece and Rome. Shortly after publishing *The House,* Hawthorne began *The Wonder Book* and finished it in less than two months.[2] The manuscript, according to his son-in-law, has few corrections and no extensive revisions. These facts give evidence of familiarity with the myths and indicate that they had occupied Hawthorne's mind for some time.[3] The classical myths, it would seem, were not only a part of Hawthorne's general cultural heritage, but conscious objects of his art and thought during the years of his greatest productivity. Therefore it does not seem unreasonable to speculate about their influence on his fiction.

Even more important to any theorizing about the influence of classical myth on Hawthorne's art is his statement about the enduring value of myth and its use. In his preface to *The Wonder Book* he states:

> No epoch of time can claim a copyright in these immortal fables. They seem never to have been made; and certainly, so long as man exists, they can never perish; but, by their indestructibility itself, they are legitimate subjects for every age to clothe with its own garniture of manners and sentiment, and to imbue with its own morality.[4]

These words, written on July 15, 1851, not long after the publication of *The House of the Seven Gables,* are sufficient cause in themselves for the curious critic to ask if, beneath the "garniture of manners and sentiment" of Hawthorne's romance, there might not be a myth.

The text of *The House of the Seven Gables,* I believe, affords ample evidence that echoes of *The Aeneid* are present in the romance. Of the four direct references to classical myth found in the book, the reference to Midas[5] in association with Judge Pyncheon is the only one not connected with *The Aeneid.* The meaning of the reference is obvious and commonplace. The judge, like Midas, is foolish in his greed. Hawthorne, however, also associates the judge with another, more obscure legend, the myth of Ixion. In the myth Ixion committed a murder but was pardoned by Zeus. Ixion then became arrogant and even sought to win the love of Hera. Zeus, therefore, formed a phantom Hera from clouds to which Ixion made love and boasted that he had won the real Hera's affection. Zeus finally condemned Ixion to Hades where, tied to a wheel, he must revolve endlessly. When Judge Pyncheon tried to kiss Phoebe and she instinctively turns away, he is said to be "a modern parallel to the case of Ixion embracing a cloud, and was so much the more ridiculous. . . ."[6] In book six of *The Aeneid* (line 484) the hero, on his journey through the Underworld, meets Ixion spinning on his wheel of torture.

A third classical reference is associated with Hepzibah. It occurs early in the book and has no particular thematic value but does indicate that Hawthorne had *The Aeneid* in mind. As Hepzibah awaits her first customers "her breast was a very cave of Aeolus."[7] Aeolus is the god of the winds and keeps them penned up in his cave where they race about frantically until he lets them loose on the earth. Aeolus figures prominently in the first book of *The Aeneid* (lines 52 through 141).

The final direct classical reference is associated with the Pyncheon elm, which is certainly one of the main symbolic elements in *The House*. Without detracting from the common interpretation of the tree as the cosmic force of nature straining to reclaim for itself the artificial domain of the house, I would like to suggest that the tree-symbol contains still another level of meaning. Because of other echoes of *The Aeneid* and because of Hawthorne's concern with myth during this period of his life, I think the tree can also be seen as a mythical tree found in *The Aeneid*. In introducing us to the Pyncheon elm, Hawthorne writes: "In front . . . grew the Pyncheon elm, which, in reference to such trees as one usually meets with, might well be termed gigantic."[8] The rhetoric here is strange enough to make one think that Hawthorne is giving the reader a clue that this elm is a very strange and special tree. He does not simply compare the elm and its size to other trees. He writes "which, in reference to" as if to indicate that we cannot really compare this tree to others, but only make reference to it in relationship to "such trees as we usually meet with." This may seem to be slight evidence for the point I am going to make, but it becomes significant in view of the final classical reference. In the chapter "Alice's Posies," Hawthorne describes the elm as it appeared on the morning after the Judge Pyncheon's death.

> This aged tree appeared to have suffered nothing from the gale. It had kept its boughs unshattered, and its full complement of leaves; and the whole in perfect verdure, except a single branch, that, by the earlier change with which the elm-tree sometimes prophesies the autumn, had been transmuted to a bright gold. It was like the golden branch that gained Aeneas and the Sybil admittance in Hades.
>
> This one mystic branch hung down before the main entrance of the Seven Gables so nigh the ground that any passer-by might have stood on tiptoe and plucked it off. Presented at the door, it would have been a symbol of his right to enter and be made acquainted with all the secrets in the house.[9]

Aeneas and the Sybil, referred to in this passage, are found in the sixth book of *The Aeneid,* the account of the hero's journey through the Underworld to visit his father. The Golden Branch, which enables him to pass unharmed through the Underworld, and return to the land of the living, was taken, not from an elm, but from a holm-oak.[10] Hawthorne, of course, knew this but still made the strange imagistic connection. He did it, perhaps, because he wanted to clearly associate the Pyncheon elm with that sixth book of Virgil's epic and the congeries of images which that association would evoke. For in that section of *The Aeneid* there is a vast and shadowy elm beneath which Aeneas and the Sybil, bearing their golden passport, must travel. It stands in the ante-chamber to Hades in front of the main entrance. False dreams cling to all its branches. Beneath it are the beds of Grief, Resentful Care, Ugly Poverty, and Forlorn Old Age. Around it lurk the Harpies, the Furies, and other monsters symbolic of guilt, evil, and pursuing Fate (LL. 263-289).

The Pyncheon elm is meant to be associated with this mythic tree. It towers over the house "sweeping the whole black roof with its pendent foliage." Beneath its leaves dwell Hepzibah and Clifford, forlorn in their old age, victimized by false dreams, threatened by ugly poverty, torn by resentful care, and haunted by evil. In the shadow of the elm stands the main entrance to the house, the passport to which is the golden branch. Considering these parallels between the Pyncheon elm and Virgil's Underground with its mythic elm, it seems logical that the house can be seen as Hades, or at least its antechamber with all its attendant miseries.

The house is also described as a human heart because so much of mankind's varied experience has passed there, "so much had been suffered, and something, too, enjoyed—that the very timbers were oozy, as with the moisture of a heart. It was itself like a great human heart, with a life of its own, and full of rich and sombre reminiscences."[11]

In another context the house is said to be the emblem of many a human heart that is surrounded by the roar of life but is itself gloomy and desolate.[12] The outward imagery of the house reflects the somber inward state of its old inhabitants' hearts. Hepzibah's heart is a dungeon in which joy lies enchained.[13] Clifford is a material ghost, a dark and ruinous mansion in which the heart's hearth-fire is cold and the light of intellect darkened.[14] Both are prisoners of the house, ghosts doomed to haunt it; and they cannot even follow Phoebe to church.[15] But, the authorial voice makes clear, the prison-house simply reflects the fact that no "dungeon is so dark as one's heart" and no "jailor so inexorable as one's self."[16] Hepzibah and Clifford are Shades who dwell in a twilight Hades, and their exile from life can never be ended until their hearts can be exorcised. They must be freed from the terrors that bind their own hearts.

Hawthorne once described the human condition in terms of the human heart visualized as a dark cavern.

> At the entrance there is sunshine, and flowers growing about it. You step within, but a short distance, and begin to find yourself surrounded with a terrible gloom, and monsters of diverse kinds; it seems like Hell itself. You are bewildered, and wander long without hope. At last a light strikes upon you. You peep towards it, and find yourself in a region that seems, in some sort, to reproduce the flowers and sunny beauty of the entrance, but all perfect. These are the depths of the heart, or of human nature, bright and peaceful; the gloom and terror may lie deep; but deeper still is the eternal beauty.[17]

The problem of human life is to get beyond the depths where gloom and terror lie, to break out of the private hell of the human heart chained by its own obsession with evil. Clifford and Hepzibah cannot escape because they have inherited the burden of the Pyncheon past and have been absorbed into the life of the house with its reiterated pattern of "perpetual remorse of conscience, a constantly defeated hope, strife amongst kindred, various misery, a strange form of death, dark suspicion, unspeakable disgrace."[18] This psychological, moral, spiritual trap, embodied in the hell of the great heart-house and its inhabitants' imprisoned hearts, is Hawthorne's poetic statement of the problem of evil. His solution, at least in *The House of the Seven Gables,* is his poetic statement of the mode of human redemption.

For Hawthorne there is no cosmic, social or religious scheme that will solve this problem of evil. "Earth's Holocaust" rejects such schemes, and Hawthorne's conclusion in that sketch is: "Purify that inward sphere [the human heart], and the many shapes of evil that haunt the outward, and which now seem almost our only realities, will turn to shadowy phantoms and vanish of their own accord. . . ."[19] There is no cosmic human heart to be purified, and so redemption must come to each individual through the gift of human love. Hawthorne's theory is based on his one great emotional experience, giving himself in love to Sophia Peabody. In knowing himself to be the object of her love, he felt such an acute awareness of being freed from the prison of himself that he wrote, with a fervor rare for him, "We are not endowed with real life . . . till the heart is touched. That touch creates us,—then we begin to be."[20] Out of this deep, real-life experience grew Hawthorne's conviction that the work of redemption, the work of Christ himself, belonged to women because of woman's greater tenderness and ability to touch other hearts with her love. In *The Blithedale Romance* Coverdale states:

> Heaven grant that the ministry of souls may be left in charge of women . . . God meant it for her. He has endowed her with the religious sentiment its utmost depth and purity, refined from that gross, intellectual alloy with which every masculine theologist —save only One, who merely veiled himself in mortal and masculine shape, but was in truth, divine—has been prone to mingle it.[21]

Coverdale goes on to cite the Virgin Mother as an example of how divine love can be more fittingly received by mankind since it is filtered through the medium of a woman's tenderness.[22] In *The Scarlet Letter* Hawthorne introduces the same theme again when he writes that "The angel and apostle of the coming revelation must be a woman indeed, but lofty, pure, and beautiful . . . the ethereal medium of joy . . . showing how sacred love should make us happy. . . ."[23] Hawthorne's redeemer is a woman, and the grace she brings is her ability to love.

When composing *The House of the Seven Gables,* his most obvious allegory of redemption, Hawthorne faced a gigantic problem. He had to redeem Clifford and Hepzibah and exorcise the house. But his Puritan conscience would not allow him to create a female Christ[24] nor could he "impale the story with its moral as with an iron rod."[25] He made his female redeemer a pagan goddess, a source of life and fertility.

In creating Phoebe as the redeemer-figure of *The House,* Hawthorne wisely chose her name. The Phoebe of mythology was a latecomer to the mythological scene. Consequently she was identified with many other goddesses. One of these was Proserpina, part-time goddess of fertility and young maidenhood, and part-time Queen of Hades.[26] Though gloomy Pluto's partner in ruling the dead, Proserpina seems to have been a benign influence in the dread kingdom of Hades. The Golden Branch of *The Aeneid,* for example, is Proserpina's privileged passport for heroes, plucked from her sacred grove and brought to her in the Underworld as a gift. (Bk, VI, Ll. 139-42) In Hawthorne's version of the Prosperpina myth[27] the goddess is an even more benign figure. Abducted by Pluto and imprisoned in the Underworld, the child goddess of sunshine and flowers carried nature and sunlight with her to the dark kingdom. As she walked through Pluto's palace, the eternal gloom fled before her. She so warmed the hearts of the King and all his subjects that the dark kingdom was never the same again.

The parallels between Phoebe of *The House* and the child goddess of sunshine and flowers, who brings light and warmth to the Underworld, are unmistakable. When Phoebe comes to the house of the Seven Gables, she stands in the shadow of the mythic elm before the house's "antique portal" and we are told:

> The sordid and ugly luxuriance of gigantic weeds that grew in the angle of the house, and the heavy projection that overshadowed her, and the time-worn framework of the door,—none of these things belonged to her sphere. But, even as a ray of sunshine, fall

> into what dismal place it may, instantaneously creates for itself a propriety in being there, so did it seem altogether fit that the girl should be standing at the threshold.[28]

Phoebe spends one night in a musty, long-unused bedroom and her mere presence exorcises the gloom and purifies it of all former sorrow and evil.[29] Clifford immediately sees Phoebe as the essence of sunshine and flowers in a much more agreeable form of manifestation.[30] The old house itself, the Hades-like prison, is changed by Phoebe's presence. From the time of her appearance in the house the grime and sordidness of the old dungeon seemed to disappear. The dry-rot of its timber skeleton ceases its gnawing process. The shadows of gloomy events and the scent of death yield to the power of her presence.[31] As the house, which objectifies the inward state of its aged inhabitants' hearts, yields to the young "goddess's" influence, the hearts of the old people also begin to open. Joy escapes the chains around Hepzibah's heart.[32] Clifford, from her presence, breathes in harmonious life.[33] Phoebe is also angel,[34] a prayer,[35] a religion in herself,[36] the ideal woman,[37] exorcising evil from house and heart.

When she is about to leave, both Holgrave and Venner tell her that she is the source of all blessings.[38] When she has gone, evil and gloom creep back into the dark realm of the house. Weeds overtake the garden around the house and all living creatures forsake the garden.[39] The Grimalkin waits on the window sill like a devil waiting to clutch a human soul.[40] Judge Pyncheon enters the house with his evil scheme. Death follows in his footsteps, and the old people are gripped in terror.

Just as evil had closed in on the house when Phoebe departed, it must flee as she approaches again. During her absence of five days nature had been unkind. The sun had refused to shine. But the young nature goddess's return, heralded by the appearance of the golden branch, is a signal for nature to make amends. The sky puts on an aspect of benediction and the street is genial with sunshine. "Vegetable productions, of whatever kind, seemed more than negatively happy, in the juicy warmth and abundance of their life."[41] Even the old house seems to have gained a kind of familiarity and sisterhood with this renewed luxuriance of nature. When Phoebe arrives and enters the garden, the demon-like Grimalkin flees before her. The garden, devoid of all other living things, suddenly becomes alive with the Pyncheon fowl.[42]

Before Phoebe enters the house, Hawthorne, as if to make sure that the reader will not miss the point of his imagery, asks if "her healthful presence" is "Potent enough to chase away the crowd of pale, hideous, and sinful phantoms, that have gained admittance there since her departure."[43] Within the house broods the corpse of Judge Pyncheon, symbol of generations of accumulated evil. Fortuitous as his death may seem, it too is connected with Phoebe. She, the golden branch of the Pyncheon family, and also the goddess-redeemer of the old Hades-house, was absent when he forced his way into the Underworld. But he who enters the Underworld without the protection of the golden branch can never exit. Like Ixion chasing the phantom Hera, the judge has pursued the phantom Pyncheon fortune. Like Ixion he received a fitting punishment and died in the old oaken chair in which so many other stern Pyncheon masters had hugged the same delusion. It remains for Phoebe to exorcise the aura of gloom with which his presence fills the house. When Phoebe enters the house and meets Holgrave, the descendent of old Maule gives us the answer to Hawthorne's question about the effect of Phoebe's redemptive presence.

> Could you but know, Phoebe, how it was with me the hour before you came! . . . The presence of yonder dead man threw a great black shadow over everything; he made the universe . . . a scene of guilt and of retri-

bution more dreadful than the guilt. . . . The world looked strange, wild, evil, hostile; my past life, so lonesome and dreary; my future, a shapeless gloom, which must mold into gloomy shapes! But, Phoebe, you crossed the threshold; and hope, warmth, and joy came in with you.[44]

Because of Phoebe's presence, the final remnants of evil have been exorcised from the old house and when Clifford and Hepzibah return, filled with dread, they too are released from their burden of gloom by her simple, loving presence. The allegory of redemption is complete.

Notes

[1] For the sake of brevity the title is often abbreviated to *The House.* All references to Hawthorne's works are to the tenth Riverside edition of *The Complete Works of Nathaniel Hawthorne,* 12 vols. (Boston: Houghton Mifflin & Co., 1883). Documentation in this text will be to volumes and pages in this edition.

[2] *Works,* Vol. IV, p. 10.

[3] *Ibid.,* p. 11.

[4] *Ibid,* p. 13.

[5] *Works,* Vol. III, p. 77.

[6] *Ibid.,* p. 145.

[7] *Ibid.,* p. 53.

[8] *Ibid.,* p. 43.

[9] *Ibid.,* p. 337.

[10] Virgil, *The Aeneid,* translated by H. Rushton Fairelough. (The Loeb Classical Library, no. 63.) (Cambridge: Harvard University Press, 1967), Book VI, line 209.

[11] *Works,* Vol. III, pp. 42-43

[12] *Ibid.,* p. 348.

[13] *Ibid.,* p. 127.

[14] *Ibid.,* p. 131.

[15] *Ibid.,* p. 204.

[16] *Loc. cit.*

[17] Nathaniel Hawthorne, *The American Notebooks,* ed. Randall Stewart (New Haven: Yale University Press, 1932), p. 98.

[18] *Works,* Vol. III, p. 222.

[19] *Works,* Vol. II, p. 455.

[20] *Works,* Vol. IX, p. 223.

[21] *Works,* Vol. V, p. 458.

[22] *Loc. cit.*

[23] *Ibid.,* p. 311.

[24] Jean Norman, *Nathaniel Hawthorne: An approach to an Analysis of Artistic Creation,* trans. from the French by Derek Coltman (Cleveland and London: Case Western Reserve University Press, 1970), p. 208.

[25] *Works,* Vol. III, pp. 14-15.

[26] Oskar Seyffert, *Dictionary of Classical Antiquities,* ed. and rev. by Henry Nettleship and J. E. Sandys (New York: Meridian Books, 1957). cf. entries, Artemis, Diana, Persephone, Phoebe, Proserpina.

[27] *Works,* Vol. IV, pp. 341-378.

[28] *Works,* Vol. III, pp. 90-91.

[29] *Ibid.,* p. 95.

[30] *Ibid.,* p. 135.

[31] *Ibid.,* p. 166.

[32] *Ibid.,* p. 127.

[33] *Ibid.,* p. 172.

[34] *Ibid.,* p. 106.

[35] *Ibid.,* p. 202.

[36] *Ibid.,* p. 202.

[37] *Ibid.,* p. 171.

[38] *Ibid.,* p. 257 (Holgrave) and p. 264 (Venner).

[39] *Ibid.,* p. 295.

[40] *Ibid.,* p. 332.

[41] *Ibid.,* p. 336.

[42] *Ibid.,* p. 353.

[43] *Ibid.,* p. 351.

[44] *Ibid.,* p. 362.

THE VORTEX OF TIME: POUND AND HIS *CANTOS*

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One of the most revolutionary concepts implicit in *The Cantos* of Ezra Pound is the configuration of time as a spinning gyre: a VORTEX. The image of a vortex is an ancient one, but in Pound's era it began to crop up more frequently as a kind of generator to make things happen in art, hence the "Vorticist" movement. It was a situation of Vortex vs. Vulgarity. At least this is the twist Yeats gave to the matter when he said that "great art, now that vulgarity has armed itself and multiplied itself, is perhaps dead in England."[1] Yeats's concept of the vortex, inherited from Empedocles and conditioned by Blake, is a paradigm of intersecting vortices (cones), one within the other, turning in opposite directions. This paradigm signifies a contradiction of opposites (Concord/ Discord, Objectivity/Subjectivity, Primary/ Antithetical).[2] Pound's concept of vortex, however, is more complicated. A single cone or series of cones (vortices) arranged circularly or linearly, depending on one's point of reference, seems to be the best model.

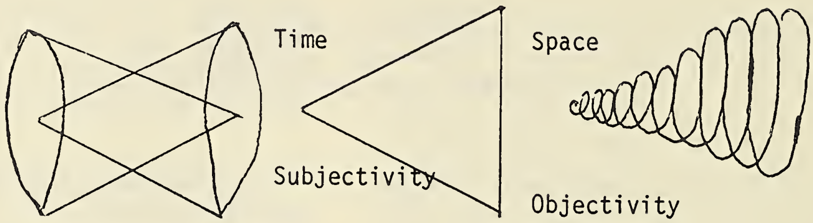
Time is a VORTEX, or series of vortices joined by a single axis, the base of each vortex being a supreme concentration of energy, a point of Infinite Density, which sets into motion ever-widening circles of energy which become entropic at their widest circumference: the principle of convergence and dissipation.

Energy was a key word for the Vorticists. A favorite text of Pound's was *The New Word,* in which its author Allen Upward speaks of the double vortex as a waterspout expressing "the true beat of strength, the first beat . . . which we feel in all things that come within our measure, in ourselves, and in our starry world."[3] In his *Essays* Pound insisted that energy is the motive force of art and "the point of maximum energy may be called the vortex."[4]

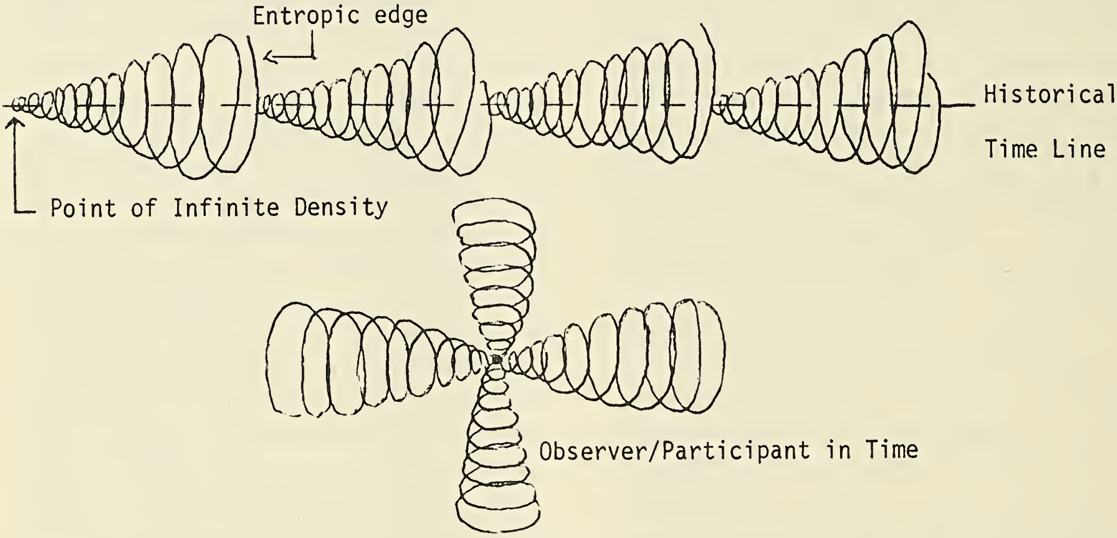
Time as process is linked to continuous shaping and unshaping, forming and deforming patterns. Under this rubric of energy, matter is "Irritable and unstable,/Is formed, is destroyed,/Recomposes to be once more decomposed . . ." (Canto 37).[5] Pound's understanding of creative energy combined with the principle of the instability of matter led him to search for new patterns in the making of poetry. His openness to the non-literary arts, particularly sculpture and painting, allowed him to incorporate the ideas of such artists as Gaudier-Brzeska, Wyndham Lewis, and Brancusi, in his own work.[6] Cubism, anti-naturalism, and possibly futurism[7] were more than catch words for Pound; they were working principles to be transposed into poetry—"(to break the pentameter, that was the first heave)" (Canto 81)—in order to break up traditional poetic grammar with its logical connections and parallelisms. It was a credo of the Vorticists to juxtapose images which do not coincide in the perceptual world to keep their art from becoming adversely mimetic, and to uncover the truth in appearances. The sources of the poem are found in the shapes and sounds of the world, they become energized in the vortex of the poet's mind, and they are given back to the world as "patterned messages."

Whether or not these patterned messages are "true" messages, or "good" art time will reveal. Time as a revelatory medium is the arbitrator of truth and the discoverer of good. When a poem reports the truth, it stands a chance of being considered good art, in time, whereas bad art is "inaccurate art." It makes "false reports" about existence.[8]

Yeats's vortex:



Pound's vortex:



Only poems which have enduring value are carried through the vortex of time. Only poems which transcend the time in which they were created give a sense of freedom from time/space limitations. We may go as far as to say with one contemporary poet, Octavio Paz, that "the poem is a means of access to pure time, an immersion in the original waters of existence. Poetry is nothing but time, rhythm perpetually creative."[9]

The vortex of time, as both idea and image, permits the interpenetration of past, present, and future as given in the data of consciousness, and it accommodates the Bergsonian notions of duration and intensity. "We do not know the past in chronological sequence . . . what we know we know by ripples and spirals eddying out from us and from our own time," Pound says, confirming the configuration.[10] When the flux of time—Heraclitean flow—is perceived both linearly and circularly, "messages" from recorded history, and the historical process itself, exert immense pressure on the creation of a literary text, even to the extreme of becoming, in Pound's case, a philosophical and structural principle. Being-in-the-world means being fixed in a historical time through birth/death and being unfixed by the waves of the past and thrust toward the future. Heidegger says, "Each man is in each instance in dialogue with his forebears and perhaps even more and in a more hidden manner with those who will come after him."[11] Pound, perhaps, would not deny this supposition, for he sought to make his *Cantos* a kind of secular Bible to instruct his own and future generations in aesthetic, ethical, political and economic conduct. He believed that humankind neither progresses nor regresses—though he did entertain utopian dreams—but experiences periods of high-energy levels that correspond to what he called "The Great Ages of Kulchur."[12]

While it is relatively easy to agree with Pound's thesis on the relationship of energy to art, and even his concept of high and low creative periods, it is more difficult to accept his judgment as to what constitutes a great age of culture. Pound had an obvious need to shore himself up with the Myth of Utopia, to cling to the notion of a dream society wherein beauty, order, harmony and good will are inviolable. So it was that he selected certain epochs for eulogization, epochs which signified for him not only the flourishing of great art, but also harmonious relationships between man and nature, between just words and moral action ("Get the mot just before action"—Canto 85), between polity and economy. The epochs of "the Gods," of ancient Egypt, of certain Chinese Dynasties, of Homer's Greece, of Quattrocento art, and Jefferson and Adams' America, to name the most striking examples, were imbued with this utopian gloss, and chosen to be transmitted, through poetic text, as paradigmatic societies.

Pound's vision is highly personal and unmediated by empiricism. All the intercultural borrowings are governed by the boundaries of his aesthetic and socio-economic taste: "I have seen what I have seen" (Canto 1), he says in the persona of Odysseus, his literary alter-ego. Yet, a quest for a personal truth with a possible universal application shines through this Pound-Odysseus linkage. In this quest—questioning?—transformed into text, Pound sees himself engaged in the practice of "weaving an endless sentence," that is, a sentence that never resolves itself, a perpetually spinning gyre (the vortex of time), a continual questioning, and a "knocking at empty rooms, seeking for buried beauty" (Canto 7). His engagement carries echoes of the divine injunction, "Ask . . . seek . . . knock" (Matthew 7:7). We could say, figuratively, that in the process of writing his *Cantos,* Pound went about knocking on doors of rooms which contained segments of former civilizations, in order to recoup those elements of the tradition which were still viable for contemporary and future life. Rooms which rendered buried beauty were restored, since "tradition is a beauty which we preserve and not a set of fetters to bind us,"[13] and rooms which emitted mildew and "old men's voices" were sealed off with ridicule.

It is time to listen to the text. Light and water are the two elements necessary for creation, i.e., the creative act. The fundamental model is given in Genesis I:2-3: ". . . the Spirit of God moved upon the face of the waters. And God said, "Let there be light." Pound speaks of an *a priori* light, in the infinite domain of pre-life:

> Gods float in the azure air,
> Bright gods and Tuscan, back before dew
> was shed.
> Light: and the first light,
> before ever dew was fallen.
> (Canton 3)

The "first light" is the point of Infinite Density, the dynamic concentration of energy, "the white light that is allness" (Canto 36), emanation before differentiation. It is the "light that sings eternal" (Canto 115)—timeless, but not static. It is erratic light, spinning in the center of the vortex. Then, light and water join to create life—"rain also is part of the process" (Canto 74). While Pound does not specifically associate light with the masculine principle and water with the feminine principle—he does present Aphrodite, the feminine symbol of erotic energy and transformation, in association with some form of water, such as cloud or "tide's change."

> "I am the torch" wrote Arthur "she saith"
> in the moon barge βϱοδοδάϰτυλος Ἠώς
> [rosy-fingered Dawn]
> with the veil of faint cloud before her
> [Aphrodite] Κύθηϱα δεινὰ as a leaf borne
> in the current/pale eyes as if without fire
> (Canto 80)[14]

In the above passage, torch(light), moon (light), and dawn(light) are carried in the divine form of Aphrodite who moves across the water, veiled with faint cloud, directionless as a leaf on the water. She is a symbol of creative power which is unwilled and natural, without artifice. Notice that both light and water are conjoined in her, yet her light is pale: the "torch" is diffused by the cloud before it; the moon is a weak light in comparison with the sun; the light of dawn is fainter than the light of midday. Her "pale eyes as if without fire" also suggest that her "fire" is tempered with water so as not to turn destructive—as in the sacrificial pyres, firearms and artillery, hellfire, and "cigar-butts" of the "monopolists, obstructors of knowledge" (Canto 14) and other manifestations of the fire-that-destroys found throughout the *Cantos.*

In the same way that Aphrodite contains both creative elements within herself, the great civilizations are depicted with an interplay of light and water:

> and North was Egypt
> the celestial Nile, blue deep,
> cutting low barren land
> Old men and camels
> working the water wheels;
> Measureless seas and stars,
> Iamblichus' light,
> the souls ascending . . .
> (Canto 5)

Clarity of form (the Nile cutting through the land), fecundity (the Nile), unity of man and nature (men and camels), work for one's own sake and not for power over others (working the water wheels), and the absence of calculation (measureless seas and stars) are the components of a sane society, in Pound's opinion. His rosy view of Egyptian civilization was partially conditioned by his friend, Gaudier-Brzeska, who called Egypt one of "the three primary civilizations": "The *hamite vortex* of Egypt, the land of plenty—"[15]

Pound and Gaudier-Brzeska are also in agreement regarding the convergence of energy in the Age of the Five Rulers and the Hsia Dynasty and its eventual dissipation in the lesser dynasties of Han, T'ang, and Ming.

Gaudier-Brzeska's text:

The blackhaired men who wandered through the pass of Khotan into the valley of the *Yellow River* lived peacefully tilling their lands, and they grew prosperous.

Their paleolithic feeling was intensified. As gods they had themselves in the persons of their human ancestors—and of the spirits of the horse and of the land and the grain.

The sphere swayed.

The vortex was absolute.

The Shang and Chow dynasties produced the convex bronze vases. . . .

The vortex was intense maturity. Maturity is fecundity—they grew numerous and it lasted for six thousand years.

The force relapsed and they accumulated wealth, forsook their work, and after losing their form-understanding through the Han and T'ang dynasties, they founded the Ming and found artistic ruin and sterility.[16]

Pound's text:

> YAO like the sun and rain,
> saw what star is at solstice
> saw what star marks midsummer
> YU, leader of waters,
> black earth is fertile, wild silk still is from Shantung
> (Canto 53)

YAO, CHUN, YU controller of waters
Bridge builders, contrivers of roads
gave grain to the people
kept down the taxes
(Canto 56)

Exchange brought abundance,
the prisons were empty.
'Yao and Chun have returned'
sang the farmers
'Peace and abundance bring virtue.' I am
'pro-Tcheou' said Confucious five centuries later,
With his mind on this age.
(Canto 53)

YAO and CHUN (Age of Five Rulers) and YU (Hsia Dynasty) rule societies characterized by creative thought, civil order, high productivity in the labor force, and the absence of exploitation and usury. Peace and harmony in the State were revered, but

Then came little dynasties, came by murder, by treason,
with/ the Prince of TçIn rising
. . .
Thus came TçIn into Empire
called themselves later TANG
hunters and jongleurs. Comedians were the king's eyes
but unstable.
. . .
Dry spring, a dry summer
locusts and rain in autumn
and beyond that, lack of specie
tax collectors inhuman.
(Canto 55/292)

Came Ming slowly, a thousand, an hundred thousand
the pirate Kouetchin came to him
At court, eunuchs and grafters
(Canto 56)

and south Ming had to fear more from rottenness inside
than from the Manchu north and north east.
(Canto 58)

We can begin to see, in the dissolution of the Chinese dynasties, that what Pound was seeking, in his long trek through the vortices of time, was ever eluding him. "Totalitarian" vision, the holistic dream, paradise on earth, is a mirage which flashes enticingly on the horizon of the mind. The patterns of verse in the later cantos become more fragmented as Pound strives to adjust his desire for wholeness with historical facticity:

Le Paradis n'est artificiel
but it is jagged,
For a flash
for an hour.
Then agony, then an hour,
then agony,
Hilary stumbles, but the Divine Mind is abundant
unceasing
improvisatore
Omniformis
unstill;
(Canto 92)

At best, he could present in his poetry those "hours of history" which seemed to him most closely linked with the abundance of Divine Mind, as a counterthrust to his perception of sterility and fragmentation in his own time.

"God is concentrated attention; a work of art is someone's act of attention, evoking ours,"[17] and so Pound directs our attention to Homer's Greece, to reestablish the importance of erotic energy and fecundity.

Scilla's dogs snarl at the cliff's base,
The white teeth gnaw in under the crag,
But in the pale night the small lamps float seaward
. . .
The sea is streaked red with Adonis,
The lights flicker red in small jars,
Wheat shoots rise new by the altar,
flower from the swift seed.
(Canto 47)

Despite the bestiality and violence all around (Scilla's dogs), requiring the sacrifice of Adonis, the conjunction of light and water, in the small lamps floating seaward, gives rise to new life. The act of plowing is necessary, not only for planting the land—"Two oxen are yoked for plowing" (Canto 47)—but also for sexual planting, which is a form of organic renewal.

> By prong have I entered these hills:
> That the grass grow from my body,
> That I hear the roots speaking together,
> The air is new on my leaf . . . (Canto 47)

The instruction to "Think thus of thy plowing" in Canto 47 is not given to satisfy technological purposes or hedonistic needs. It is to remind us of our deep rootedness in nature and our interconnection with all forms of being, a divine vision advanced throughout the canto by the poet's "naming" of the gods. Pound evokes the divine names of Prosperine, Tamuz, Adonis and Tellus, divinities of fertility and sacrifice, over against the preponderance of scientific and rational thought governing 20th-century behavior. He seems to say that in our reliance on scientific knowledge, our confidence in a power no higher than ourselves, we run the risk of "knowing less than drugged beasts," the risk of our own extinction. The exclamatory naming of the gods and the ecstatic atmosphere of the canto jars us into a way of knowing that is both sexual and spiritual: "The light has entered the cave. Io! Io!/ The light has gone down into the cave,/ Splendour on splendour!" (Canto 47). The light in the cave symbolizes, first, the union of man/woman, a holy microcosm ("sacrum, sacrum, inluminatio coitu"—Canto 36) within a holistic macrocosm (in contrast to the eunuchs who represent de-holification), and secondly, Platonic enlightenment, knowledge of things as they are in totality. The healing power for a broken world resides both in human nature and in transcendent nature:

> KAI MOIRAI' ADONIN
> that hath the gift of healing,
> that hath the power over wild beasts.
> (Canto 47)

At this nearly half-way mark in the *Cantos,* Pound has enlarged his quest by moving out of the corridor of culture, with its many diversified "rooms," into the natural world, into the space where "the roots are speaking together." Yet, in order for him to experience the "truth" of nature, "First must thou go the road/ to hell" (Canto 47). On this road to hell, the poet comes face to face with the knowledge that man cannot dwell as a "root," that he cannot step outside his own awareness of himself as a self, and exist "unknowingly." Also on this road to hell, the poet comes to realize that the gods come and go, even if, paradoxically, they are always-there.

> The hells move in cycles,
> No man can see his own end.
> The Gods have not returned. "They have never left us."
> They have not returned.
> (Canto 113/ 787)

Man is "sentenced" to exist between nature and divinity, and the tension of this "betweenness" often produces overwhelming anxiety. The poet in an anxious state can no longer hear the voices of the gods and the voices of nature, as he could previously:

> Through all the wood, and the leaves are full of voices,
> A-whisper, and the clouds bowe over the lake,
> And there are gods upon them,
> (Canto 3/11)

nor can he enter the "rooms of culture" to find redress, since anxiety tends to be a-historical in that it obliterates all that is not anxious. This is the state Pound is describing when he says

> no Empire handle
> Twists for the knocker's fall, no voice to answer.
> . . .
> Damn the partition! Paper, dark brown and stretched,
> Flimsy and damned partition.
> Ione, dead the long year
> My lintel, and Liu Ch'e's lintel.
> Time blacked out with the rubber.
> (Canto 7/25)

Anxiety is the barrier, the "flimsy and damned partition" that separates the poet from the presence of the gods, from the speaking voices of nature, and from the messages of history. The "Time" that is "blacked out" is organic and historical time, upon which all enduring poetry is structured. All that remains is clock-ticking time, which Heidegger calls "ravenous time,"[18] which Pound calls "the evil Evil/A day, and a day" (Canto 30/147). When "(Clock-tick pierces the vision)"—(Canto 5/18) the poet becomes so disordered and displaced that he can no longer *see* with clarity, or *hear* the totality of mediations. He characteristically views the world with dis-trust.

To understand Pound's eventual breakdown, we must rid ourselves of the notion of nature as a balanced system. Artemis, who appears sporadically in *The Cantos,* is the goddess of the hunt and of nature. In Canto 30, she sings a song against pity:

> Pity causeth the forests to fail,
> Pity slayeth my nymphs,
> Pity spareth so many an evil thing.
> Pity befouleth April,
> Pity is the root and the spring.
> Now if no fayre creature followeth me
> It is on account of Pity,
> It is on account that Pity forbideth them
> slaye.
> All things are made foul in this season,
> This is the reason, none may seek purity
> Having for foulnesse pity
> And things growne awry;
> No more do my shaftes fly
> To slay. Nothing is now clean slayne
> But rotteth away.
> (Canto 30/147)

Pity is, essentially, failure of will. It is false sentiment for that which should be cut away, the emotion which prevents man from acting ruthlessly to rectify wrongs. Pity is the desire for comfort and consolation at the expense of truth. Pity operates in a context of clock-time or mechanical time, in the dull regularity of "a day and a day," forgetful of organic time. Those who are susceptible to pity have impaired vision, in that they refuse to see ruthlessness in nature itself, which allows for seasonal change. Daniel Pearlman, in his interpretation of Canto 30, gives lip service to the need for ruthlessness in man, yet, curiously, he sees nature as otherwise. He claims Artemis "is symbolic of the self-regulatory principle in nature, the ecological balance by which nature maintains itself in a sort of timeless perfection."[19] This "reasonable" view of nature is not Pound's view at all. Throughout *The Canto*s nature is depicted dynamically as fertility, force, energy, the continual upheaval of life-forms, the surging of seas, storms, earthquakes, the slaying of beasts and men: alternating construction and deconstruction. Nature is, by its very nature, imbalanced.

Though Pound, in the beginning, desired to create a work of "timeless perfection," approximating the ordered harmony of a Bach fugue or Dante's *Divine Comedy,*[20] in the course of his lifetime, which paralleled the creation of *The Cantos,* his lifework, he encountered such a turmoil of new ideas and creative strife, that he had to give up his first desire, lest he make a "false report." He was ahead of his time in his willingness to see truth emerging as relative and uncertain, and nature as disruptive and disjunct.

> Jungle:
> Glaze green and red feathers, jungle,
> Basis of renewal, renewals:
> Rising over the soul, green virid, of the
> jungle,
> Lozenge of the pavement, clear shapes,
> Broken, disrupted, body eternal . . .
> (Canto 20)

Always Pound was "Willing man look into that formed trace in his mind/ and with such uneasiness as rouseth the flame" (Canto 36). The disjunctive and fragmentary patterns of verse in the *Cantos* mirror the process of nature and the breakdown of civilizations as Pound actually conceived them. But it is clear that his willingness to confront the world "wide-open" drove him toward such mental disorder that he had to search again for an idea of order, hence his misguided move towards Mussolini.

The tragedy of Pound lies in the fact that he did not recognize he had lost the poetic totality of mediations. He entered into a period of dis-trust, instead of breaking vision, i.e., the ability to see and hear through the barrier of his anxiety, which was "Paper, dark brown and stretched," that is, a "paper tiger," dangerous to life, but defeatable. He chose to speak with an evil and ravenous tongue as a means of combatting anxiety. Specifically, he used the Jews as a scapegoat, epoused the destructive totalitarianism of Mussolini, and finally, blamed his friends for the failing of his creative energy—"Their asperities diverted me in my green time" (Canto 115). Nor could he understand why those messages which had risen out of his deep frustration were not tolerated.

> in short/ the descent
> has not been of advantage either
> to the Senate or to "society"
> or to the people
> (Canto 83)

As I have indicated, it is the poet's mission to bring the messages of the gods, and of nature, to the people, to con-verse with the people,

> Sd Mr. Yeats (W.B.) "Nothing affects
> these people
> Except our conversation.
> (Canto 83)

But the poet who has lost a holistic vision of the world, who succumbs to distrust of and alienation from the people, is the poet who should remain silent. "Tempus loquendi,/ Tempus tacendi" (Canto 31). Pound's most redeeming moment came near the end of his life when he questioned where he had "gone wrong? What had been his root error? 'That stupid, suburban anti-semitic prejudice?' "[21]

Pound suffered, in the vortex of time, the dissipation of creative energy, the mental entropy, the "beclouding" leading to sectarianism and obscurantism, common to most sentient beings. We can emphathize and learn from his sufferings, but more importantly, he deserves to be remembered for his moments of force and clarity, the converging lines of holistic vision which rise to majestic word-peaks in *The Cantos*. He sought with passion to speak of what is constant and abiding amidst a background of confusion and disorder, and he "gathered from the air/ a live tradition" (Canto 81).

The poet is the person who "lays hold of something permanent in ravenous time". . . . [T]he permanent must be fixed so that it will not be carried away, the simple must be wrested from confusion, proportion must be set before what lacks proportion. . . ."[22] Pound attempted to fulfill this large task. The most permanent, simple, and finely-proportioned image in *The Cantos* is the *con*joining of light and water, already alluded to in the figure of Aphrodite. This combination of basic elements signifies creativity and the renewal of life, and in addition, carries the promise of intermittent peace:

> With clouds over Taishan-Chocorua
> when the blackberry ripens
> and now the new moon faces Taishan
> one must count by the dawn star
> Dryad, thy peace is like water
> There is September sun on the pools
> (Canto 83)

In such imagery, nature and the word become one vast single text.[23] The "poet is he who, beneath the named, constantly expected differences, rediscovers the buried kinships, between things, their scattered resemblances."[24] Pound takes the focus off time as a "sequence of nows" unrelated to future and past, and redirects our attention to the importance of kinships, historicity, and "the tradition." In this sense *The Cantos* strive toward the Heideggarian concept of time in relation to being, i.e., the verse contains a "rendering present" which is "anticipating" (future) and "bearing in mind" (past) at the same time.[25]

Was Pound's failure to summon up the energy to hold fast to a holistic poetic vision the fault of his historical existence in a fragmented and uncentered world, or is the holistic poetic vision merely a myth of the imagination? The answer to this question is one the reader must seek out for himself. In a time characterized by "God's self-withholding,"[26] we have lost the ground of certainty. Foucault's observation that "the age of resemblance is drawing to a close . . . leaving nothing behind it but games," troubles us. Yet, in the absence of God (gods), nature's presence remains as the source of the poet's affirmation:

How drawn, O GEA TERRA,
what draws as thou drawest
till one sink into thee by an arm's width
embracing thee. Drawest,
truly thou drawest.
Wisdom lies next thee,
simply, past metaphor.
Where I lie let the thyme rise
and basilicum
let the herbs rise in April abundant
(Canto 82)

Pound's text is in con-text with all previous and contemporaneous texts which carried positive or negative significance for him, and his text projects "messianic" words on yet-to-be-created texts. Explication of these matters of vortex, time, history, and intertextuality open up *The Cantos* to new understandings.

Notes

[1] W. B. Yeats, "Symbolism in Poetry," *Essays and Introductions* (New York: Collier Books, 1968), p. 154.

[2] W. B. Yeats, *A Vision* (New York: Collier Books, 1966), pp. 67-79.

[3] Allen Upward, *The New Word* (London: A. C. Fifield, 1908), p. 195.

[4] Ezra Pound, "The Serious Artist," in his *Literary Essays,* ed. T. S. Eliot (New York: New York: New Directions, 1954), p. 49.

[5] Ezra Pound, *The Cantos* (New York: New Directions, 1948). All further references to this work will be cited within the text.

[6] Timothy Materer, *Vortex: Pound, Eliot, and Lewis* (Ithaca: Cornell Univ. Press, 1979).

[7] Robert H. Ross, "Sound and Fury: Realism, Futurism, Vorticism, Imagism, Early in the Second Decade," *Backgrounds to Modern Literature,* John Oliver Perry (San Francisco: Chandler, 1968), pp. 39-46.

In 1909 a Milanese painter named Marinetti published the first Futurist "Manifesto," which, among other things, called for a new poetic movement:

> The foundations of our poetry shall be courage, audacity and revolt.
>
> We announce that the splendor of earth has become enriched by a new beauty, the beauty of Speed . . .
>
> All beauty is based on strife. There can be no masterpiece otherwise than aggressive in character. Poetry must be a violent assault against unknown forces to overwhelm them into obedience to man . . .

Pound seems to have been attracted initially to the tenets of Marinetti for he introduced the loquacious painter to London artistic circles. In 1914, Pound wrote to Joyce that Lewis was "starting a new Futurist, Cubist, Imagiste Quarterly . . . mostly a painter's magazine with me to do the poems." Later the Vorticists "disowned Futurism because it denied tradition, and were wary of Cubism because it seemed indifferent to personality." See Kenner, *The Pound Era,* p. 236-8.

[8] Pound, "The Serious Artist," p. 43.

[9] Octavio Paz, The Bow and the Lyre, trans. Ruth L. C. Simms (Mexico, D.F.: McGraw-Hill, 1975), p. 15.

[10] Ezra Pound, *Guide to Kulchur* (New York: New Directions, n.d.), p. 60.

[11] Martin Heidegger, *On the Way to Language,* trans. Peter D. Hertz and Joan Stambaugh, 1st. ed. (New York: Harper & Row, 1971), p. 31.

[12] Pound, *Guide to Kulchur,* see especially Part I, Section II; Part II, Section III; Part III, Section VI; Part IV, Section VIII.

[13] Pound, "The Tradition," *L.E.,* p. 91.

[14] Transcriptions of the Greek are taken from John Hamilton Edwards and William W. Vasse's *Annotated Index to the Cantos of Ezra Pound: Cantos I-LXXXIV* (Berkeley: Univ. of California Press, 1957. Κύθηρα δελνά literally means "dread (or fearful) Cythera," another name for Aphrodite. I have taken the liberty to render the Greek as "Aphrodite" in my text for the purpose of consistency.

[15] Pound, *Guide to Kulchur,* p. 64.

[16] *Ibid.,* pp. 65-66.

[17] Kenner, p. 53.

[18] Martin Heidegger, "Holderlin and the Essence of Poetry," *Existence and Being,* intro. and analysis by Werner Brock, Gateway Edition (Chicago: Henry Regnery, 1949), p. 279.

[19] Daniel Pearlman, *The Barb of Time: On the Unity of Ezra Pound's Cantos* (New York: Oxford Univ. Press, 1969), p. 118.

[20] *Ibid.,* pp. 11-14.

[21] Kenner, p. 556.

[22] Heidegger, "Holderlin and the Essence of Poetry," p. 280-1.

[23] Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (New York: Vintage-Random House, 1973), p. 34.

[24] *Ibid.*, p. 49.

[25] Martin Heidegger, *Being and Time,* trans. John Macquarrie & Edward Robinson (New York: Harper & Row, 1962).

For a full explication of this concept of time see Division Two: Dasein and Temporality.

[26] Werner Brock, "An Account of 'The Four Essays'," *Existence and Being,* Martin Heidegger, Gateway Edition (Chicago: Henry Regnery, 1949), p. 175.

[27] Foucault, p. 51.

Bibliography

Bergson, Henri. *Time and Free Will: An Essay on the Immediate Data of Consciousness.* Harper Torchbooks. The Academy Library. New York: Harper & Brothers, 1960.

Davie, Donald. *Ezra Pound: Poet as Sculptor.* New York: Oxford University Press, 1964.

Edwards, John Hamilton and William W. Vasse. *Annotated Index to the Cantos of Ezra Pound: Cantos I-LXXXIV.* Berkeley: Univ. of California Press, 1957.

Foucault, Michel. *The Order of Things: An Archaeology of the Human Sciences.* New York: Vintage-Random House, 1973.

Harmon, William. *Time in Ezra Pound's Work.* Chapel Hill: The Univ. of North Carolina Press, 1977.

Heidegger, Martin. *Basic Writings.* Ed. David Farrell Krell. New York: Harper & Row, 1977.

———. *Being and Time.* Trans. John Macquarrie & Edward Robinson. New York: Harper & Row, 1962.

———. *Existence and Being.* Intro. and Analysis by Werner Brock. A Gateway Edition. Chicago: Henry Regnery, 1949.

———. *On the Way to Language.* Trans. Peter D. Hertz and Joan Stambaugh. 1st. ed. New York: Harper & Row, 1971.

Kenner, Hugh. *The Pound Era.* Berkeley: Univ. of California Press, 1971.

Lewis, Wyndham. *Time and Western Man.* New York: Harcourt, 1928.

Materer, Timothy. *Vortex: Pound, Eliot, and Lewis.* Ithaca: Cornell Univ. Press, 1979.

Neumann, Erich. *Art and the Creative Unconscious.* Four Essays. Trans. Ralph Manheim. Bollingen Series LXI. Princeton: Princeton Univ. Press, 1971.

The Odyssey of Homer. Trans. Herbert Bates. New York: McGraw-Hill, 1929.

Ortega y Gasset, Jose. *The Dehumanization of Art, and Other Essays on Art, Culture, and Literature.* Princeton: Princeton Univ. Press, 1968.

Paz, Octavio. *The Bow and the Lyre (El arco y la lira): The Poem. The Poetic Revelation. Poetry and History.* Trans. Ruth L. C. Simms Mexico, D. F.: McGraw-Hill, 1975.

Pearlman, Daniel. *The Barb of Time: On the Unity of Ezra Pound's Cantos.* New York: Oxford Univ. Press, 1969.

Pound, Ezra. *The Cantos.* New York: New Directions, 1948.

———. *Drafts & Fragments of Cantos CX-CXVII.*

———. *Guide to Kulchur.* New York: New Directions, n. d.

———.*Literary Essays.* Ed. T. S. Eliot. New York: New Directions, 1954.

———. *Make It New.* New Haven: Yale Univ. Press, 1935.

———. *Section: Rock-Drill: 85-95 de los cantares.* New York: New Directions, 1956.

———. *Selected Poems.* New York: New Directions, 1957.

Ross, Robert H. "Sound and Fury: Realism, Futurism, Vorticism, Imagism, Early in the Second Decade." *Background to Modern Literature.* John Oliver Perry. San Francisco: Chandler, 1968.

Teilhard de Chardin, Pierre. *The Phenomenon of Man.* Intro. Julian Huxley. Harper Colophon Books. New York: Harper & Row, 1961.

Upward, Allen. *The New Word.* London: A. C. Fifield, 1908.

Wilhelm, James J. *The Later Cantos of Ezra Pound.* New York: Walker, 1977.

Yeats, W. B. *Essays and Introductions.* New York: Collier Books, 1968.

Yeats, W. B. *A Vision.* A Reissue with the Author's Final Revisions. New York: Collier Books, 1956.

TO POLISH A CROWN: SHAKESPEAREAN DIALECTIC

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It is sometimes said, by T. S. Eliot for instance, that Shakespeare has no meaning, no thought.[1] One variation of this idea is that Shakespeare himself never "says" anything, but only presents voices on a variety of questions. If one traces the concept of voices to its relationship with "votes,"[2] then one might argue that Shakespeare presents various votes on an issue—such as nature in *King Lear*—but never tells which side won the election, or which side should have done. Perhaps Shakespeare dramatizes the questions but never the answers.

Certainly Shakespeare is no Plato. Shakespeare has no Socrates to speak for him, no Socrates to define a system of metaphysics from which may come a theory of ethics, knowledge, or politics. If Plato is a metaphysician of nature—or if Kant is—then Shakespeare represents with language the nature of which Plato and Kant try to make sense. But language—including rhyme, meter, diction, thought, and metaphor—constitutes only one of Shakespeare's strong suits. There is also psychology—the relationship between varieties of action and the characteristics of the soul; and there is playwrighting, which is what Shakespeare's contemporaries thought he did for a living.

As a playwright, Shakespeare is a playbuilder, even as an arkwright in his day built arks. The English Renaissance (this is now a commonplace) had a highly-developed sense of craft. In Shakespeare's craft the basic unit of construction is the scene. Thus, were Shakespeare to "say" anything—were he to suggest an issue, raise a question, voice a debate, even make an argument—he would do so partly by placing scenes together in a certain order. In this sense the affinities between him and Plato become greater, for both, in different ways, are dialecticians. Shakespeare the Dialectician writes a scene in which subjects are voiced, then follows that scene with the same subjects voiced in different ways, and so on. The result is a dramatic debate. But the order in which the topics are voiced may provide clues, to the attentive listener, about what Shakespeare is saying.

The example I have chosen to illustrate these assumptions and methods is the first act (or first three scenes) of *Henry IV, part 1*. I have selected a chronicle play partly because any examination of "dialectical argument" in a comedy or tragedy would have much tougher going in a brief essay. The generosity of viewpoint in Shakespearean comedy—and mystery of viewpoint in his tragedy—make clear dialectical argument harder to find. But a chronicle play addresses the issue of political power, so arguments become naturally inherent as to how power is acquired, used, and lost. Although this "argument of history" is treated in different ways by Christians and Machiavellians,[3] an argument it is: more susceptible to dialectical clarity than are comic festivals or tragic riddles.

In the first three scenes of the first part of *Henry IV,* Shakespearean voices are heard on four topics: theft, penance, rebellion, and parenthood. In the first scene the topics are presented in just that order. As to theft, Henry Bolingbroke sits in his London throne room, there state business to do, with a stolen crown on his head. Of course the crown had been stolen from a politically inept king, and political necessity would well argue that Richard had to go. But Henry has gone counter to a myth of legitimacy-by-primogeniture. Whether such a myth be Christian natural law or Machiavellian fraud is beside the main point, which is that a stolen crown is hard to keep.

But Henry's penance—to send a crusading English legion to rescue from infidels those "holy fields" (I.i.24)[4] over which Christ Himself had walked—is an attempt to meet at once the Christian and Machiavellian objections to his crown. Such a crusade would signal personal penance to God, and Machiavelli himself would approve such a united English diversion from the fact of Henry's theft. It is a bright idea from a king both politic and penitent. But Rebellion says no. Owen Glendower has defeated the Crown's forces led by Mortimer; and although Henry Percy has defeated on the king's behalf a variety of rebellious Scots, even Percy himself is rebellious in refusing to turn over all his prisoners to the Crown. Such impudence is blamed on Percy's uncle Worcester—which is even worse since Worcester would be a rebel of significant power against the king.

Henry is therefore back to penance again, but not the bright executive penance of the planned crusade, which must now be postponed. Henry's new penance means that all is to be endured and nothing to be done. Such penance is related to parenthood, the fourth topic: Henry fears he is to be punished for his stolen crown by the rebellion of his own son, Hal Bolingbroke, Prince of Wales. Toward the end of the scene, when Henry wishes that Henry Percy, not Henry Bolingbroke, were his son, the King reflects on all four topics at once. In his utterance of regret mixed with wish-fulfillment this player-king has just performed a Shakespearean synthesis of four great themes, each of them a burden to him. In effect, he who had robbed the firstborn fears that his own firstborn will punish him.

But Henry is hardly to be kept down for long. At the very end of his scene he is ever the doer and commander, giving orders about the next council (to be held on the next Wednesday at Windsor) and urging his lieutenants on to efficient action. For Henry time is important—he will race it hard to outrun the twin bugbears of suffering penance and fearful rebellion. Henry would never be caught asking the question posed to his son in the next scene by Sir John Falstaff: "Now, Hal, what time of day is it, lad?" (I.ii.1)

In this scene the four topics are voiced in a different order: rebellion, theft, parenthood, and penance. Thus, the order of topics in the second scene is in good part the reverse of the first. What the first scene approaches rather late—because Henry would forget about rebellion for as long as possible—the second scene starts with as a *given,* because rebellion comes naturally to the prince and his unreliable companion. And what Henry has immediately on his mind as cure for the rebellion he might otherwise wish away—penance—Hal and Falstaff get to only later in the scene; and even then Falstaff's vow that he will "give over" (81) his "wicked" (81) life is but one more moment in a kidding career. Henry is immediately penitent; Falstaff and Hal approach it, jokingly, rather later, as an implicit comment on the sincerity of any conventional penance in this play.

As for parenthood, the king comes to that topic fairly late. Henry dwells late on his son partly because Hal too is one of those unpleasant subjects better left alone. But Hal seems to think on his father not at all—as though he has no concern for his father's fears. It is only Falstaff, rather early in the scene, who reminds Hal that it's "here apparent" that "thou art heir apparent" (48-49); and Falstaff's begging point is that Hal use his parental inheritance to good advantage by giving thieves complete license. What Henry would forget about his son, the son's new patrimony—represented by the king of Eastcheap Tavern[5]—underlines pointedly: that the heir of a stolen crown would not wish to discourage theft.

Finally, there is theft itself. In the first scene, before the scene itself opens, *it* is the given. In the second scene, what was unmentionable in the first is mentioned with abandon. Falstaff and Hal kid early and profusely about their thefts, past and future. The bulk of the scene is given over to plans for the robbery of the travellers at Gadshill, and to Poins' and the prince's plans to rob Falstaff and company after they have robbed the travellers. It is as though the king's worst fears about realm and son have come true. What he would avoid—various rebellion and regretful parenthood—this second scene presents with immediacy and abundance: a wayward, impenitent son planning a rebellious theft of respectable pilgrims, and then planning a further theft of the thieves themselves. Could Henry see this scene with *its* order of topics, he would see his own son perform an analogy of the king's own likely and fearful situations: rebellious thieves stealing from those who had earlier stolen—in the instance of Henry IV, stolen a crown.

But in this dialectical allegory if Theft and Rebellion are to be the king's foes, unknown to him Parenthood and Penance will be his friends. Parenthood and Penance have the last vote in this scene: when Hal confides to listeners and readers that, when the time is most to be redeemed, he will repent and pay the debt consistent with his true parental heritage. Hal will steal—but only from those unsuspecting among his father's foes who think him a failure. And he will rebel—but only against those who would rebel against his father. Hal will put together the four topics in a unique equation. Later in the play he will become the full player-prince,[6] and the topics will dance to the order of his choreography. He plans to be in the play yet outside it.

But first we must encounter those who, on both sides of the conflict, manage only to be trapped in the play and in history. In retrospect it is a shrill and desperate Henry whom we meet, along with a voluble and unknowing Henry (Hotspur) Percy, plus a priggish and scheming Worcester who clumsily makes self-survival the occasion for conspiracy against the king. Relative to Hal's announced gambit, confined only to us, these (partly excepting energetic Hotspur) are a diminished lot.

If unmentionable theft, mounting rebellion, and flawed parenthood are the subjects of King Henry's trepidation in the first scene, and if the prince and Falstaff approach these very subjects without fear in the second, then the third scene is different still. Naturally, as in the previous scene, it presents rebellion first; but this time the rebellion is seemingly directed straight to the king's face—for the first time. Here is not merely the sign of rebellion, as were the loquacious quibbles on thievery in the last scene. Here, to Henry's mind, is rebellion itself: the refusal of Hotspur to give up his prisoners. Nor will a worried regal "we" accept Hotspur's insistence that he did so because the crown sent a regular sissy to request the prisoners. For Hotspur the king's related accusation of Hotspur's brother-in-law Mortimer turns Hotspur's apparent rebellion into a real one. Hotspur's honor, however much rooted in glands rather than reason, is offended. This king is dishonorable, so he will get all the rebellion the fighting Hotspur has to offer. A king, because oversensitive to rebellion, acts to provide himself even more of it.

The balance of the scene, after this obvious analogy between the small-time rebellion of the Gadshill kids and the big-time one of the London adults, may be called "The Political Education of Henry Hotspur." As such, this education fleshes out the other three themes: in order of presentation they are theft, penance, and parenthood. Hotspur hears for the first time that King Henry slanders Edmund Mortimer because King Richard had declared that only Mortimer could rightfully receive his crown. Thus Hotspur realizes now that Henry had stolen it. Thus also Hotspur vows to defeat Henry as penance for his own family's role in helping Bolingbroke rob the crown from its rightful owner—Hotspur's own brother-in-law the Earl of March.[7] Finally, there is the theme of parenthood, for Northumberland can do little more with young Hotspur than the King with young Hal. Henry wants Hal to reform and act as though he is Prince of Wales. Northumberland wants something simpler from the ranting Hotspur: he wants Hotspur to shut up. That Hotspur has known little of the theft by which Henry has taken the crown, that his rebellion and penance are rooted entirely in personal slights against himself and his brother-in-law, and that he can barely conquer garrulity enough to listen to a complex plot against the king he hates—these are signs that events are in the saddle and will ride Hotspur. In sum, although this is Hotspur's scene his opposition and remorse are pubescent, his knowledge of political theft shallow, and his relations with father and uncle both cantankerous and inconstant. His apparent union with them against Henry, given the background of Hal's confidential soliloquy, may well be no match for Hal's promised union with Henry against them all. Already Hal is one-up because of his superior stealth. If Hotspur approaches theft, rebellion, and penance as elements in a first-reader political education, then Hal seems already to have advanced knowledge in these subjects, which he will redefine from the roots up.

The crown has been stolen, and so it is tarnished. Henry tries to polish it by the diversion of the crusade, which simultaneously defines penance with the two great metaphors of his time, one religious and one political. In theory it is a wonderful idea to give mischievous minds the business of fighting infidel Turks instead of Henry or each other. But the rebellion has gone too far, so no crusade can polish the crown. And both Henry's worries at the end of the first scene, and Hal's comportment through most of the second, would seem to confirm that Henry's firstborn (should he get the crown at all) will only tarnish it further. Nor would the rebels of the third scene seem to have much promise of polishing this crown, since they helped tarnish it, show no disposition to get it for the apparent proper heir Mortimer, and have as their noblest pretender only the impetuous and inept Hotspur. That leaves in reality, as crown-polisher-to-be, only Hal the Prince of Wales. He would inherit a tarnished crown, but he announces secretly his plans to polish it. He will do so by giving rebellion, theft, penance, and parenthood fresh cordons in new places. Here, roughly, would be his new meanings:

Rebellion: not the conventional act of opposing a king vulnerable because of how he acquired sovereignty, but rather a new opposition to the primogenitive myth itself. The new, substitute myth would be acquired by a new political fraud of exquisite timing: the sudden admiration which accrues to one "Redeeming time when men least think I will" (I.ii.187).[8]

Theft: not the conventional concept of stealing a crown from a firstborn king, but rather a new concept: that a stolen crown is up-for-grabs to anyone who can take it and confer upon it a new legitimacy. Much to the point are Hal's robbing the robbers at Gadshill, and his overeagerness to take the crown from his sleeping, seemingly dead father in *Henry IV, part 2*.[9]

Penance: not the bright but finally traditional idea of his father—the pious crusade to busy abroad scheming minds—but rather the penance of success: defeat of the "illegitimate" rebels, expansion of the realm into France, and (for even Hal conventionally obeys God) many almhouses at state expense in Richard's memory. The true penitent, then, both polishes a tarnished crown and makes it brighter than ever. The name of Richard may take care of beggars, but the true salvation of men lies in the brilliantly sovereign state.

Parenthood: not merely the conventional fealty owed to the father-king, but also a dual loyalty to a dual fatherhood. Hal is finally loyal to the historic father who holds the crown and can give it to the prince for polishing. But the princely dialectician is typically loyal—for a while—to an alternate patrimony: his inheritance of the corpulent companion who professes indifference to history. Whether Falstaff is a seductive sophist or a Christian parable[10] is beside the real point, which is that he stands outside Machiavellian history, drinks sack while immensely concerned with survival to drink more, and ribs both sides as thieves jousting over a dirty crown. The agile Hal needs such a friend in part when he paradoxically leaves him, for maximum political surprise. But Hal needs Falstaff also to practice the juggling of opposites, and to learn, like Falstaff, to bide his time outside history until he is ready to join and direct it. Of course, unlike Falstaff—who knows that "To the latter end of a fray and the beginning of a feast/Fits a dull fighter and a keen guest" (IV.ii.67-68)—Hal knows contrarily that one joins a fray only when it needs one most. But if Falstaff times to survive, it is no accident that his princely chum times to win. His ultimate duelling victory over Hotspur, deserted by his own father in battle, only confirms by ritual the political suppleness of Hal's dual parentage.

So the old notions of power attached to the crown are tarnished beyond any polishing that even Prince Hal could do. This crown can only be polished by brilliance—by the new man of new meanings: rebellion against the hackneyed ideas of rebellion; audacious theft of an already-stolen crown; contrition that drives the quest for victory; and parenthood that stands both in and out of history.

A few plays later the crown of Henry V becomes dazzling indeed.

Notes

[1] See "Shakespeare and the Stoicism of Seneca," *Elizabethan Essays* (New York, 1964), pp. 46-47.

[2] Compare D. J. Gordon's implicit tracing of the voices/votes connection in "Name and Fame: Shakespeare's *Coriolanus*," *Papers Mainly Shakespearean*, ed. G. I. Duthie (Edinburgh, 1964), p. 55.

[3] The single best interpretation I know of the contrast between Christianity and Machiavelli is Isaiah Berlin's "The Question of Machiavelli," *New York Review of Books*, XVII (4 November 1971). The same basic essay is in Berlin's *Against the Current* (New York, 1980) as "The Originality of Machiavelli."

[4] All quotations from the play are from *The Complete Works of Shakespeare*, ed. David Bevington (Glenview, Illinois 1980).

[5] One does not have to resort to the crudest Freudian conceptions in order to see that Hal has two patrimonies in this play. It would be inaccurate and simplistic to say that Falstaff represents an "id-father," and Henry a "superego-father." For one thing, Hal has never really given up his fealty to King Henry. For another, Falstaff is much too shrewd a survivalist to have quite the self-destructive riot of the id. But Falstaff is definitely "king" of his world—the green world of play and historical indifference—even as Henry is king of his: the red-and-white world of political consequence. For a fuller exposition of these two worlds see Northrop Frye's "The Argument of Comedy," *English Institute Essays, 1948*, ed. D. A. Robertson (New York, 1949), pp. 58-73.

[6] For a full analysis of the Shakespearean *player-king* see Eilleen Allman's *Player-King and Adversary* (Baton Rouge, 1980).

[7] Indeed, a point sometimes overlooked about Hotspur's early professions of "honor" in attacking Henry is that much more important to Hotspur than the historical robbery of Richard is the slight to his brother-in-law Mortimer, which he takes as a personal offense. Here is another example of Hotspur's incessant present-mindedness and unfitness to rule. Such present-mindedness in a different theme—not in honor but poetry—led to the downfall of Richard himself.

[8] At the same time Hal gives a new twist, obviously, to the Christian doctrine of "redemption." In this new Machiavellian context redemption is mixed up with proper timing. An implicit theme of *The Prince* is that timing is all. One must know *when*, for instance, to be good and when to seem so (chapter XV).

[9] See Act IV, scene v. Of course there is a lot of predictable human nature in this scene: Henry, dying, is predictably upset that Hal has taken the crown from Henry's only-sleeping, not-yet-dead, side. And Hal is predictably penitent when he discovers that Henry is still alive. But human terms aside, the event also suggests the extent to which stealing seems still associated with the crown which once belonged to Richard.

[10] For classic, representative, but diverse views of Falstaff see Samuel Johnson's edition of Shakespeare, introductory headnote to the first and second parts of *Henry IV;* and W. H. Auden's "The Prince's Dog" in his *Dyer's Hand* (New York, 1968). A more accessible source of Johnson's headnote is *Johnson on Shakespeare*, ed. Walter Raleigh (London, 1908), especially p. 125.

TEXTUAL POLITICS: THE USES OF IMAGINATION IN JOANNA RUSS'S *THE FEMALE MAN*

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It is a commonplace in SF (science fiction) today that most of the best younger writers are women. One of the most admired —and controversial—is Joanna Russ. In the five novels, numerous short stories, reviews and critical essays that she has produced since 1959, the acuteness of Russ's analytical powers and the virtuosity of her technical range have won many readers—and confused or angered others. *The Female Man* (written in the Sixties but not published until 1975) is a particularly good example of her work and the uses of SF.

The Female Man (hereafter *TFM*) has always disturbed a lot of people. In Section Seven of the novel, Russ herself anticipates some of their responses:

> Shrill . . . vituperative . . . no concern for the future of society . . . maunderings of an antiquated feminism . . . this shapeless book . . . twisted, neurotic . . . some truth buried in a largely hysterical . . . of very limited interest . . . no characterization, no plot . . . really important issues are neglected . . . a not very appealing aggressiveness . . . another shrill polemic which . . . the tired tricks of the anti-novelists. . . . (Seven:III)[1]

When I have taught the novel, a typical series of reactions goes like this:

> So far I don't like reading this book; I'm confused . . . I'm starting to enjoy it . . . it's venting some of my anger . . . I don't know whether to cry or yell . . . It's as if Russ has been bugging scenes from my own life . . . very motivating . . . told me *I* have to do what I want; no one will do it for me.

This set, of course, is from women. But in either set, the first problem for readers is the fact that *TFM* is hardly constructed in conventional novel form. Form it does have, however: a very carefully considered one.

What kind of form? One useful answer is to say that the novel is not a work but a "Text." Roland Barthes, one of the first to stress this distinction, reminds us that any time we write (anything), we offer others the last word, whether we will it or not. In the particular case of literature, a writer is concerned to multiply meanings without "filling" or "closing" them.[2] The writer, Barthes says, uses language to shape a world "which is emphatically signifying but never fully signified"[3]: that is, we know that what we read is meaningful, but the meaning is not complete or certain.

But writers differ in how complete they intend their meanings to be and in how much of the "last word" they want readers to have. In Barthes' distinction, a *work* is an object, a thing, whose meaning readers consume or "get." A *text* is an activity, a production, of both work and reader together. To make room for readers to create with authors, texts often test conventional limits of rationality or readability: they don't follow our conventional expectations about plot and characterization. Instead of packaging a meaning for us to get, texts keeping deferring a final or single meaning; they aim for multiple, even conflicting, meanings which can't be reduced to a single, "author's" meaning. In short, texts *play*. By delaying and shifting meanings, a text plays within a field with potentially infinite patterns that vary with each reader and even each reading by one reader. Readers play the game of text by experimenting to produce the experience for themselves. They perform and interpret instead of passively imitating or consuming what they experience as they read. That is why Barthes claims that a text "participates in its own way in a social utopia . . . the space in which no language [writer's or reader's] has a hold over any other, where languages circulate."[4]

Texts are also what Jerome McGann called "visionary art": art that is a vehicle of our perception (not an object of it). Such art "would urge no programs and offer no systems," but would provide a method to help us deliver ourselves from systems. Whichever term we use, the point is that we are challenged to choose between the responsibility for constructing our own "systems" of meaning as we read or the abdication of responsibility.[5] The pleasures and perils of texts are simply a specialized form of what is the game of life for human beings: the creatures who have the unique freedom to make meanings. As Hayden White points out, we have the ambiguous power to shape ourselves and our worlds through our languages—although human language has the power both to create meaning and to frustrate all our efforts to express definitive, unambiguous meanings.[6]

In defining visionary art, McGann was talking of William Blake, who had his own vivid description of what happens in the experience of a text. Blake's image was the apocalyptic moment when the fourfold "Human Form Divine" wakes in an individual or a culture: for, according to Blake, what we call God *is* the Human Imagination. This description of the moment when it fully wakes also dramatizes how a text, its readers and its infinite number of meanings interact:

> And they conversed together in Visionary Forms dramatic which bright/ Rebounded from their Tongues in thunderous majesty, in Visions/ In new Expanses, creating exemplars of Memory and of Intellect/ Creating Space, Creating Time according to the Wonders Divine/Of Human Imagination. . . .
>
> (*Jerusalem* 98:28-31)[7]

In a word, Blake's synonym for what texts and readers engage in is "conversation."

In *TFM,* the character Jael herself uses a Blake quotation to help explain her actions, a quotation which again describes how texts operate:

> . . . as Blake says, the path of Excess leads to the Palace of Wisdom, to that place where all things converge, but up high, up unbearably high, that mental success which leads you into yourself under the aspect of eternity. . . . (Eight:IX)[8]

Or, as one of the other narrators says, "You never know what is enough until you know what is more than enough" (Three:VI).

Russ's work has many allusions to Blake, which is logical enough. For although 150 years separate them, Blake and Russ shared a common problem: how to respond directly to a political situation with a work of art. Blake's *Jerusalem* took on the Napoleonic wars that marked the failure of the apocalyptic hopes which so many people had of the French Revolution. *TFM* takes on not only sexual politics, but the underlying assumptions and conditions of our culture that produce those politics.

Russ's alternatives are not Blake's. But, like Blake, she aims to liberate, not enslave, the reader's imagination. Both believe that to achieve that aim, art must somehow "trouble what exists"[9] in our world in order to make us re-imagine it. If we do shape ourselves and our worlds through our languages, then our human problem is how to be both free and responsible manipulators of language. For an artist, there is an added problem: how to induce others to be so as well.

When an artist speaks for or from an "oppressed" group (some group always is in any culture we've known so far), this emphasis on liberating the imaginations of both artist and audience is hardly surprising. Russ writes from the periphery of American culture, as an "outsider" in a literary, economic, social and sexual sense. From that position, in *TFM* she undertakes a journey within herself and throughout her universe: the interrelationship is a significant part of the point.

Russ also undertakes a solution to the problem of teaching freedom or of providing an opportunity for the reader to exercise freedom.

To do that, Russ chose to write SF, a form which can re-envision or re-write the novel (and its world) as Blake did with the Bible and Milton (and their worlds). Novels, what fans love to call "mundane fiction," take the world and its systems as given; they reflect the world that is. Against that constant background, the only thing that a novel can change or vary is the human figure we focus on. Novels can warn you what the world will do to you, advise you to escape a particular social group, tell you how to behave in order to be what the world calls successful. But novels can't *re-imagine* the world and its systems.[10]

Science fiction can, and often does. It can present a possibility of difference, a created and not-yet-existent world or systems or institution. That is important because our experience of that nonexistent world in SF like *TFM* provokes a dialogue, a conversation, with the world we know.

Joanna Russ is not the first SF writer to do a SF novel with more than one protagonist, shifting points of view, or an amazing variety of forms. She's not the first to construct a non-linear plot or to use SF to explore the kind of fundamental philosophical and social issues raised in *TFM*. The point is that like any writer of texts, she aims to disturb our expectations of form, to trouble our notions of what we and the world are, in order to encourage *us* to re-envision both what is and what could be: to liberate our own imaginative energy.

For these reasons, *TFM* presents (to the readers) and allows (for the narrators) a journey inward to our own inner condition *in relation to* the conditions of our world. As Jael says, the text operates through *excess:* it isolates, exaggerates, reconnects, *plays* with certain personality components under varying conditions. In this novel, Russ shapes aspects of her own psyche as characters: one characterized by narcissism, fear, hatred, masochism, passivity and dependence (Jeannine); one characterized by strength, intelligence, imagination, adaptability and self-love (Janet); a third, characterized by fierce independence, cunning, power, savage wit and anger (Jael). The fourth character, torn among these three is Joanna.[11] Joanna, who says she is the author of the novel, isolates each of these potentialities within herself and pushes them to excess by gradually building up a picture of the kind of world, the kind of technological and economic state, the kind of culture that would be most likely to evoke each potentiality. And she does all this to envision how all four operate in relation to each other, interplay, in Joanna and in Joanna's/our world.

But our question is what kind of form the novel has. Each of *TFM*'s nine parts is further subdivided into segments, some of which are only a sentence or phrase long. The point of view shifts back and forth from third- to first person narration, and among first-person narrators. The sequence of events is not linear: it makes sudden, disorienting leaps, often circling back to continue or revise an earlier segment. Some segments do have topical connections: e.g., Part One:IX shifts from Jeannine's attitude toward work to the Whileawayan one. Yet focussing on the fact that Joanna makes herself increasingly conspicuous as an author, the maker of a fiction we're reading, makes it possible to sort the novel's nine Parts into four main divisions: (A) Parts One to Four, (B) Parts Five and Six, (C) Parts Seven and Eight, (D) Part Nine. After a relatively detailed look at the first section to see how the pattern of Joanna's inward journey emerges, the significance of the other three can be perceived more quickly.

(A) A Choice of Evils: Fear and Fantasy (Parts One to Four)

TFM opens with the character Janet Evason's introduction of herself. Born "on Whileaway," she obviously comes from a planet and a culture radically different from ours. Janet's 187 I.Q. and her work history may not seem so alien, but her references to Whileawayan childhood experiences like stalking wolves, or wandering in bands to visit the North Polar Station, are; most alien of all are her mention of "my mother" and "my other mother," her "Wife," Vittoria, and her family of nineteen. The "tripods of computer beacons everywhere" indicate an advanced technology. In little more than a page, Janet presents life on Whileaway as freer, more varied, more *interesting* than it is for most of us.

The second segment shifts to a third-person narrator (unidentified) who introduces Jeannine Dadier; her character and world contrast highly with Janet's. SF readers can quickly add up the details of this segment to conclude that Jeannine comes from an alternate or parallel world. The year is 1969, but World War II has never occurred (war with Japan is being discussed) and the U.S. is still in the grips of the Great Depression; this world's 1969 technology is behind ours. Where Janet is active, adventurous, emotionally fulfilled, Jeannine is passive and daydreamy, tied to a dreary part-time job at a library and to a "lover" whose presence she can hardly bear. The reader eventually notices that Jeannine is the only "J" who never relates her own tale: the narrative of Jeannine is always someone else's.

In the next two segments, the third-person narrator tells how Janet appeared in our world; this narrative becomes Joanna's first-person introduction of herself, an inhabitant of our world and time. As Janet returns to Whileaway after her first brief appearance, Joanna remarks that she has "just turned into a man, me, Joanna. I mean a female man, of course; my body and soul were exactly the same" (One:IV).[12]

Continuing with these kinds of shifts, Part One serves to introduce these three protagonists, to explain the device of "probability universes" (One:VI) and to expand on the opening views of Janet's and Jeannine's worlds. Whileaway, in the portrait that gradually emerges, is over 900 years ahead of us in another probability. Before the "catastrophe" that produced the current women-only culture, both technology and ecological thinking had achieved the re-formation of the earth itself into two large continents and had established colonies within the solar system. The society which has slowly been built up since the men disappeared is small in numbers, decentralized and agrarian, but technologically sophisticated: they've developed biological engineering, matter-antimatter reactors, induction helmets that permit direct human-computer interaction, space travel and the probability mechanics that sends Janet to Joanna's world. Thanks to the computers, there is a small administration, a geographical parliament and a guilds council. The legal system is even more minimal: one of the reasons Janet is chosen is that as a Safety and Peace Officer, she can be spared. (She has that job, we'll find, because her I.Q. is lower than most Whileawayans': " 'I am stupid,' " she says in Seven:IV.) Only social and personal relations are complex, given their family and clan systems. Whileawayans work very, very hard, we are told—16 hours a week is typical.

Presuming some knowledge of American history, Part One presents less detail about Jeannine's world; Jael will later state that Joanna's and Jeannine's worlds are "almost the same moment of time" (Eight:V). In her 1969, there is no television, only radio; presumably other forms of technological lag contribute to the shortage of full-time jobs and the low pay for existing ones. The federal government plays a large role: we hear of the WPA, rationing and government vs. free market stores. The tension that results from the profound contrast between this world and Whileaway intensifies throughout the novel. Running through the views of these worlds and, later, of Joanna's and Jael's, are recurrent thematic links: the question of self-image and the "female man" concept, as well as ideas of work and pleasure, and varieties of aggressive behavior on both personal and social levels.

Despite what we learn about probability

universes and how the Whileawayans sent Janet off as ambassador, two puzzles emerge about how all the protagonists move from one probability to another. Jeannine's arrival on Joanna's world is presented very ambiguously. While watching Janet on TV in a cocktail lounge, Joanna meets Jeannine, looking "very much out of place" (Jeannine agrees) and comments, "I can't imagine how she got there, except by accident" (One: VII). Joanna will still be insisting that she doesn't know how she's gotten "stuck with Jeannine" when all three of them are transported to Whileaway (Five:I)—where Jeannine will feel even more out of place, repeatedly muttering, "I'm not here" (One: XIV). The opening of Part Two presents an even bigger puzzle: a new and nameless "I" who says explicitly that she is not any of the other three. " 'You'll meet me later,' " she says, and apparently disappears until Part Eight.[13] But this mysterious "blond Halloween ghoul" with a face that scares children asks a question that is central to the novel:

> Who am I?
> I know who I am, but what's my brand name? (Two:I)

It seems a cryptic question, but think of what a brand name tells us: what the "product" is; who "makes" it and how; who "sells" it and how; who profits from it in a particular method of distribution and exchange; what it's *for,* both in terms of literal use and in terms of the desires which having it is supposed to fulfill (economic status? sexual attractiveness? etc.). In short, who *uses* it? *How? Why?*

Except, that the "it," the "product," here is a woman.

Think, too, of the fact that brand names imply some kind of capitalist economy—and that such an economy does not exist in Janet's world, though it does on Joanna's, Jeannine's and, we'll discover, on the world of Jael, the mystery voice.

The question, of course, is ultimately Joanna's. *TFM* explores how and why women's lives are shaped in our society; therefore, it explores the nature of our society, period, for women and men. But in this reading of the novel, we also note the fact that Joanna's questions erupt out of nowhere at this point: displaced in an unrecognized voice, unconscious, just as her reason for being "stuck with" Jeannine is also unconscious.

It is right after Jael/Joanna's question that Joanna reminds us that she turned into a man on Feb. 7, 1969 (Two:II). "What's my brand name?" is an angry question. When Joanna finally details her transformation into "the female man" (to a person with full status) in Part Seven, it becomes clear that the essential catalyst is her anger. Only then do Jael and her world appear, and only then do we see that Jael has in fact been the agent who brought all three J's together and to Womanland.

Part Two, then, primarily concerns how Janet, Joanna and Jeannine come together, although some segments continue the narrative of Janet's dealing with our military and the police (III, V, VI, IX) and her TV interview (VII). There are scenes of Janet collecting Joanna and Jeannine (in a stolen car) or picking them up at the Chinese New Year Festival (where Jeannine's boyfriend Cal sees her go off with *three* other people). Joanna's narrative again uses ambiguities that play upon her authorial role. In segment VIII, she remarks that Janet "lived with me for a month. I don't mean in my house," mentioning Janet's ubiquitous media presence [to sell what?]; however, Part Three will focus on the six months that Janet does live with her. Joanna then adds, "With somebody I suspect was Miss Dadier appearing in my bedroom late one night," saying " 'I'm lost.' " Jeannine disappears, but Joanna says, "In my dream somebody [Jael?] wanted to know where Miss Dadier was"; when she wakes, Jeannine is on the other side of Joanna's mirror, "Semaphoring frantically." When Joanna tries to remove this presence by turning out the light, Jeannine "remained lit up. Dismissing the whole thing as the world's aberration, not mine," Joanna goes back to bed while Jeannine calls, " 'Janet?' " As Jael later remarks, "people don't recognize themselves except in mirrors, and sometimes not even then" (Eight:V).

If Jeannine's world contrasts painfully with Whileaway, so does Joanna's; they are, as we noted, close. Part Three ("This is the lecture. If you don't like it, you can skip to the next chapter.") divides between scenes of life on our world, especially the notorious party, and scenes of life on Whileaway, especially the extended summary of Whileawayan life and character.

In segment I of Part Three, Joanna refers to herself as author as well as character even more blatantly. Before Janet, she admits, all she did was:

> dress for The Man
> smile for The Man
> talk wittily to The Man
> sympathize with The Man
> flatter The Man
> understand The Man
> defer to The Man
> entertain The Man
> keep The Man
> live for The Man (Three:I)

However, Joanna goes on, "After I called up Janet, out of nothing, or she called up me (don't read between the lines; there's nothing there)," not only her zest for life but her physical health improved. Ambiguous tags like "I made that woman up" or "I imagine her" recur frequently.

One thing Joanna imagines is what would happen to Janet on our world *if s*he followed "the opera scenario that governs our lives": she sketches how Janet would meet a man at a party and charts the course of the romance, culminating in Janet's avowal that "I Am In Love With That Man. That Is The Meaning Of Life." But what really happens in Joanna's tale is that Janet spends six months with her, devouring information of all sorts and driving Joanna crazy by going naked, dialling phones with her feet, dropping into judo crouches while dressed in acceptable feminine style, and commenting about sex with men: ". . . to me they are a particularly alien species; one can make love with a dog, yes? But not with something so uncomfortably close to oneself" (Three:II).

But then Joanna and Janet do go to a party (Three:II), Joanna obsessed but dissatisfied with her appearance and physically miserable, Janet pleased, excited and cheerfully unconcerned about her "Disappearing Lipstick." The party is such a formally brilliant capsule satire of male-female relationships in our society, and such a perfect exemplar of the tension between how Joanna has been trained to behave and how she'd like to, that it's hard to resist quoting it all, though of course we must.

But every reader of the novel remembers the climax. As Joanna and Janet try to leave, their host tells them they're *not* going. If we watch the pronouns here, we see a clear little model of Joanna as the locus of the multiple J's. "He took *us* by the wrist," Joanna says.

> "Let me go," said Janet.
> *Say it loud. Somebody will come to rescue you.*
> *Can't I rescue myself?*
> *No.*
> *Why not?*
> All this time he was nuzzling *her* ear and *I* was showing my distaste by shrinking terrified into a corner, one eye on the party. Everyone seemed amused.
> "Give us a goodbye kiss," said the host, who might have been attractive under other circumstances, a giant Marine, so to speak. *I* pushed him away.
> "What'sa matter, you some kinda prude?" he said and enfolding *us* in how powerful arms et cetera. . . . [pronoun italics mine]
> (Three:II)

"Shrinking terrified into a corner" is the hallmark of *Jeannine's* behavior, the passive persona whose labels are "vanishing," "shrinking," "disappearing." What we are seeing at this moment is Joanna's split between the passive, helpless self that she still can't escape, but hates, and the active, competent self that she can imagine and desires to be. Joanna spends the entire party being placating to the men who insult them and begging Janet to be "polite." The only moment of anger she allows herself (the only hint of Jael's repressed presence) is directed *at Janet* for daring to argue—and is only a fantasy act: "(Picture me on the back of the couch, clinging to her hair like a homuncula, battering her on top of the head until she doesn't dare to open her mouth.)"

In contrast, the free citizen of Whileaway resists the host's aggression with a control and competence appropriate to each stage of provocation. When words fail to deter the host and he invites her to *make* him let go, Janet "dumps" him once. The host escalates to obscene and violent insults. Janet is unmoved until he hits the one that is meaningful to a Whileawayan: "a Goddamned scared little baby virgin." (The key word is "baby.") At that point, Janet gives him "a big stinging theatrical come-on-get-your-guard" slap. When "the Marine" attacks in earnest, Janet "deflects" him twice until she gets him in a "cool and technical" hold, warning him that he'll break his arm if he moves. He does. With "astonished good humor," Janet asks, " 'But why do you want to fight when you do not know how?' " (Three:II). In Segment III, Janet extends the point about "all this uneasy aggression" that she's encountered here: "for the temperamental thing, sometimes you can't stand another person," the only cure is "distance." When it comes to physical conflict, "For sport, yes, okay, for hatred, no. Separate them." So is she sorry she hurt the host? "Not me."

At this dramatic moment, then, let me anticipate the final shape of the novelistic structure I'm proposing.

Joanna's increasingly overt and frequent references to herself as the source and manipulator of her characters and fiction focus our attention on her, on a women considering her situation and her own history in contemporary American society. The first fact about that situation is an internal conflict between what she is or has been and what she wishes she could be; and the conflict brings dissatisfaction, unease. That impels analysis, but Joanna turns to fantasy and imagination as her methods to isolate and model (ultimately) four characters, or aspects of herself, and the environments that would produce the clearest form of each.

At this stage of her inward journey, Joanna most clearly pictures only two of these aspects, Janet and Jeannine, and she's caught between them, unable to detach herself from Jeannine or to become Janet. We could, therefore, say that although Janet is using her imagination—being active, creating—she is also merely fantasizing—being relatively passive, unable yet to fully direct and control her creations in relation to herself or to make them active in reality. Although they seem fully-imagined, Janet and Jeannine remain "fantasies" for three reasons. First, Joanna can't see why she's stuck with Jeannine, this model of the worst she could be, whose world is so close to her own. Second, Janet is only an alien, a temporary visitor to our world. Even when Joanna, Janet and Jeannine physically come together, there is no agreement, no harmony, no *connection* among them yet. Joanna can't *see,* by which I mean *imagine,* what possible connections could exist. She merely pictures herself travelling with two other characters, one of whom represents everything she's afraid she'll become, and one of whom represents everything she desires to be, could be, if only the world were different.

Third, there is one aspect of herself that Joanna doesn't see yet, because her socialization impels her to repress it. That aspect, her justified frustration and anger, does find outlets long before she can recognize and portray it as Jael. The voice of anger and frustrated desire erupts with increasing frequency in the voices of Joanna and Jeannine from Part Four on, in comments that don't sound like either character or that the reader can't ascribe to any one character for sure.

This gradual emergence of Jael's voice makes perfect sense, just as the later revelation that Jael is the agent who brought the J's together does. However hidden she is from Joanna's consciousness in the novel's early stages, it is precisely this force of frustration becoming anger that motivates Joanna's exercise of fantasy and imagination to begin with. Russ herself has commented on how hard, and important, it is to get that anger articulated. At that stage of her career, she says, it was easy to write the scene (Part Eight) where Jael actually kills a Manlander, but the one where Janet breaks the host's arm was "very difficult": "The taboo here, I think, is the same one that makes 'man-hater' such a dirty word. It is the abandonment of passivity, the vehement assertion that I Come First, Not You, and all this through the release of perfectly justified anger." For, Russ says, Jael, "with her claws, her teeth, and her ferocious adrenalin highs is . . . Anger"; and "It is Anger that mediates between Oppression and Freedom."[14]

The fact that Joanna is still stuck somewhere between fantasy and full imagination in Part Three does not mean that her efforts are useless; on the contrary. It's true that by the end of Part One, Joanna has reached a static opposition of extremes. After the party, Part Three turns by contrast to social life on Whileaway. Part Four turns the contrast again as Joanna relates Janet's experiences with an American family and her love affair with Laura Rose. But pursuing these contraries to their painful extremes will at last produce the mirrors or foils, the dialogue with what is, that allow Joanna to examine herself and to articulate her anger at what is. Thus in Part Five, the novel further examines the freedom of Whileaway in Joanna's account of her "actual" trip there with Jeannine; in Part Six, we return to the oppression of Jeannine's world.

And *then* Joanna's use of fantasy and imagination makes her able to see and speak *her* self, *her* world, in Part Seven: "Let me tell you how I turned into a man." But Joanna's journey is not then over. Expressing anger is a step, not a solution—but to what? Is anger the same as aggression? How should either be expressed?

For the answers, Joanna will return to the methods that have brought her this far, now with even more conscious self-involvement, more active imagining instead of passive fantasizing. In the remainder of Part Seven, Joanna will return her text to Janet, finally telling the story of how and why Janet's duty as Safety and Peace Officer led her to shoot the old woman Elena Twason. But Joanna also allows herself to imagine desiring Elena, conceiving a desire doubly taboo on the grounds of age and gender (IV). Part Seven ends with the three J's summarizing their outlooks on life (V).

With Part Eight, Joanna has moved almost completely from fantasizing to fully imagining, creating an image that changes herself and her world. Two of the opposites are nearly fused: Jael and her world blend the worst-case environment we connect with Jeannine and the freedom and energy of action we identify with Janet. But Jael is another instance of "excess," a hypothesis that allows Janet to explore and play with—to *use,* not be used by—new images of desire, including aggression.

Joanna's imagination becomes fully active in the here and now with the novel's last section. Part Nine, "The Book of Joanna," fuses not only all four J's but also inner journey with outward act. At the conclusion of *TFM,* Joanna reveals a reshaping of both aggression and sexual desire in her own behavior and then relates the final meeting of all four characters in our world. Even then, she is not finished with her exercise in imaginative discovery and creation: Jael's last revelation will call the whole model of Joanna's desire, Whileaway, into question. But her final act in her text is to make her exercise in imagination into ours. Reclaiming the characters as her personae, Joanna formally bids farewell to her book. Through this concluding gesture, Joanna acknowledges and thus shapes her community—those whose lives she has shared in person and as a reader—and extends that community by inviting her readers to share and transform her experiences into their own. Because this text, an act aimed at and shared with her community, images the worst women and men can be, it is aggressive, a challenge. Because it images more mutually satisfying ways we could be, and because its very form invites us to share in its creation, the text is also an act of unselfish desire.

With this overall pattern in mind, we can note a few of the specific ways in which the rest of *TFM* develops it, focussing especially on details concerning the formation of self, self-image, and desire.

The rest of Part Three, as noted above, shifts to an extended description of how very different it is to grow up and live on Whileaway. In Part Four, the text gathers up all these issues and again pictures how a Whileawayan deals with our handling of them when Janet stays with the Wildings.

Laura Rose Wilding illustrates how a female child grows up and learns to see herself in our society. Among the things she learns, by her own account, are that she's a victim of penis envy and can't lead a happy or normal life, but that being a girl is wonderful "because you can wear pretty clothes and you don't have to do anything; the men will do it for you," so that she can "conquer the conqueror of Everest" instead of climbing it herself. However, men don't want to "make it" with aggressive girls: "Either they try to dominate you, which is revolting, or they turn into babies." She couldn't sleep with a girl because it's "abnormal" (Four: XI). How could Laur not fall in love with the woman from Whileaway? In her society, men and women define themselves only in the mirror of the other: women by what they *lack*, men by what they *have*. In Janet, Laur finds not a mere mirror of her desire to be a "human being," but a window onto new possibilities of how to be.

The multiple narrator of Part Four has far more difficulty with Janet. The voice of Jael—who will later announce that she is the "plague" of murder and revolt that exterminated Whileawayan men (Nine:VII) and repeat insistently that she's "an old-fashioned girl" (Eight:IX,X,XI)—gets even stronger as the J's confront a new model of desire. The "I" who describes Janet's arrival says, "I drifted into the attic; my spirit seized possession of the old four-poster bed . . . and slowly, slowly, I infected the whole house" (Four:II); a later "I" calls herself "the plague system" trying to keep Janet from Laur (Four:X). When Janet and Laur begin to act on their desire, the other three J's both share in and fear Janet's feelings, being bound by taboo. Janet breaks the Whileawayan taboo against sex with someone a generation younger, not for selfish reasons, but because of Laur's need. As the narrator relates it, "Janet—I—held her, her odor flooding my skin, cold woman, grinning at my own desire because we are still trying to be good," but when Laur kisses "Miss Evason," the narrator's had enough: "Janet's rid of me. I sprang away and hung by one claw from the window curtain" (Four:XIII).[15] When Laur and Janet make love, the narrator is presumably involved with Janet until near the climax, but then flees, "shrieking": "There's no excuse for putting my fact between someone else's columnar thighs," yet her desire shows in her appreciation of "the cool smoothness . . . the *architectura,* the heavenly technical cunning of those limbs."

Janet takes over in segment XVI to tell Laur the story of how she first "fell in love" with her wife Vittoria, an experience Whileawayans see as a "sickness," a painful obsession that merely projects self onto the whole world. "Romantic love" (not love) is seated in the solar plexus, a "radiation disease" that they are "mean and mocking" about because of "the self-consequence that comes with romantic passion," that "parasite." Unlike the "friendly" and non-possessive love that sustains their marriage, Janet says, "the operatic kind" or "that abyss opening on nothing" comes and goes; "I run away usually."

(B) Without Contraries, No Progression: The World Re-Imagined and The World Reflected (Parts Five and Six)

In Part Five, the trip to Whileaway (engineered by the unseen Jael, motivated by Joanna's inability to escape Jeannine) begins in Jeannine's world as she and Joanna meet Janet. Joanna perceives Janet as "our only savior," but Jeannine "did not want to admit that Janet existed" (Five:I). A clue to Jael's presence is the narrator of segment VI, who "has never visited Whileaway in my own person" and who relates how Janet, Jeannine and Joanna arrive there. Jeannine can't believe in Whileaway because she's sure it can be destroyed. Jeannine's world has taught her a simple lesson. Somebody will always get you: invade, "infect you with plague," "infiltrate," or "corrupt"; life is "just horrors. Horrors!" (Five:VII). But Joanna gets angrier on Whileaway, tartly noting in the next section that Jeannine "loves to be sat on" and basically wants to be "relieved of personality forever" (Five: VIII). The growing anger strengthens both the need for and the ability to continue imagining (travelling on) Whileaway. Along the way, "I" notices that, unlike the worlds where there are brand names, advertising, and other male mirrors and representations of women, on Whileaway, "there are no pictures made out of anybody or anything" (Five:XI).

The trip to Whileaway is useful only if it helps Joanna to deal with the Jeannine-potential. Thus in Part Six, it is Jeannine who "wakes from a dream of Whileaway," feeling that "everything in the world . . . makes her cry, . . . seems to say to her, 'You can't.' " Jeannine dismisses the recurrent dreams, defining Whileaway as "To while away the time. That means it's just a pastime" that "would sound pretty silly" if she told anyone. Where Jael asks, "What's my brand name?" Jeannine sees herself in the mirror and wonders "who is to use all this loveliness, who is to recognize it, make it public, make it available?" Not Jeannine, says the narrator; "Jeannine is not available to Jeannine" (Six:I).

But the energetic J's emerge in Jeannine, too. "I" has two arguments with Jeannine over what she wants. Playing devil's advocate, "I" argues for the status quo, but two voices give contrary answers for Jeannine. When her brother grabs Jeannine, he finds Janet in his grasp; *"Touch me again and I'll knock your teeth out!"* someone says (Six: IV). During the second argument, Jeannine looks in a mirror and jumps—"Who's that!" ("Was it Janet? Me?" the narrator asks.) Momentarily "shocked right out of her sorrow," Jeannine demands "with unwonted energy" to know what her sister-in-law wants out of life (Six:VII).

But Jeannine can't sustain this energy; she flees "from the unspeakableness of her own wishes" to land "in the lap of the possible" (marriage). Having said *yes* to Cal (she dialled his number without realizing it), Jeannine has one moment of self-love in her family's approval, while the narrator stands compassionately "with my arm around the shadow of her dead self"—and why not? For ". . . there but for the grace of God go I" (Six:IX).

(C) The Uses of Imagination: Liberating Anger and Desire (Parts Seven and Eight)

With those words, Joanna turns her attention and her text to herself (Part Seven). To become a female man, Joanna first had to become a woman: "someone automatically not above reproach . . . mirror and honeypot, servant and judge"—until you're 45 and "disgusting." When she rebels in rage against the suppression of all her own desires, the self-image her world gives back is: "I'm a sick woman, a madwoman, a ball-breaker, a man-eater," who doesn't "consume men gracefully," as a seductress, but cracks their joints "with these filthy ghoul's claws." Against the mirror-image set up by advertising, Joanna sees "my matted hair, my filthy skin, my flat plaques of green bloody teeth. I don't think my body would sell anything. O of all diseases self-hate is the worst and I don't mean for the one who suffers it!" (Seven:I). Eventually, the suffering of experiencing everything "through two systems of value, two habits of expectation," drives Joanna to her one choice: "To resolve contrarieties, resolve them in your own person." Picking up the mirror image, she cites Plato's statement that "we love . . . that in which we are defective," having learned that we pursue "our magical Self in the mirror of another," but "how on earth can one then possess it? Fucking, if you will forgive the pun, is an anti-climax." There is only one way to possess what we lack, need, want: "Become it." Joanna concludes, then, that "I am a man (And you are a woman.)," demanding "Move over"—or else, "By God and all the Saints, I'll break your neck" (Seven:II).

This conclusion, however, simply reverses what is; still self-centered, it leads only to vengeance. Again Joanna turns to Janet and Whileaway (Seven:IV), imagining what grounds would justify violence there (Elena Twason apparently was executed because her assertion that no one else exists is a denial of/attack on society and life itself) and imagining how she'd like to break both Whileawayan and our taboos with Elena.

This doesn't solve the problems with Joanna's conclusion, so she deals with them imaginatively in Part Eight, Jael and her world. In Jael's world, men and women have literally been at war; Jael herself illustrates what kind of "female man" results from simply reversing and extrapolating from the problems of our world: an assassin whose "own erection" is her unsheathing of hidden talons and teeth, whose last effort at diplomacy ends with her murder of a Manlander, who keeps a computerized male android as a sexual toy, who wants to reopen and *win* the war.

Joanna calls Jael "The Woman Who Has No Brand Name" (Eight:II) because Jael is something new, a woman who won't be used: who has the strength born of anger and near-despair to follow the path of Excess and find "the One Genuine Thing" possible *within the circumstances of her world.* In this gender-role reversal, Joanna pictures a woman defining herself as men do, by violence to others. The blood Jael sheds is "restitution," a "truthful reflection in the eyes of a dying man" that makes her existence a little more real in a world that taught her that to be a woman at all was already to be "guilty" (Eight:X).

In Jael's world, human(e) love and desire are impossible: "How can you love anyone who is a castrated You?" she asks of men. Yet since she still defines herself by Manland concepts, her observation that "Real homosexuality would blow Manland to pieces" is true of Womanland as well (Eight:VIII). In her world, violence—war—is the only form of desire left. She asks the other three J's to act on that desire with her, to provide bases for the war: " 'Do we do business?' " (Eight:XV).

(D) Uniting "Contrarieties": The Book of Joanna (Part Nine)

Jeannine (life is "just Horrors") is all for *Jael's* use of her world, not her own: "take the whole place over; I wish you would" (Nine:VII); Janet disapproves; Joanna does not answer directly.

So Jael is not The Answer for Joanna, but her equation of "Who am I?" with "What's my brand name?" has helped to lay open the fault in all the non-Whileawayan worlds. When we take our perception of a barrier or void between "I" and "Object" and assume it can't be crossed (though we desire to), it's "natural" to give primacy to this isolated "I." When we then use these assumptions to structure all the forms of our desire and all our social roles and institutions, sexism, racism, nationalism, capitalism, and so on are equally "natural" results. In a system where "I" is always defined *against,* excluding, the other, there can always and only be user and used, dominator and dominated; every "I" is a potential commodity to every other.

Whileaway is also not The Answer, only an alternative, the imagination of a better life and the conditions that might allow it.

By Part Nine, however, Joanna's imagination has freed her to begin committing "revolutionary" acts: breaking a man's thumb (IV) or "bringing my fantasies into the real world" in her own love affair with Laura Rose (VI), but then inviting us to join and reshape her "revolution" with the book itself.

What should be stressed here is that it is *questions* which effect the last fusion of the four J's and involve Joanna and her readers in *ongoing,* communal, action. Jael fuses the other three worlds to Whileaway, the dream of unselfish desire, by raising a fundamental question about how it evolved. According to Jael's last revelation, there was no "plague" that killed the men on Whileaway, only "I and those like me" who gave peace to Whileaway with "the bones of the men we have slain" (Nine:VII). Janet, however, refuses to believe that. In Joanna's and our "probable universe," will we make a world of unselfish desire through slow historical progress or violent revolution? Joanna's text excludes neither possibility, just as Joanna excludes none of her *personae* at this moment, knowing Jeannine to be her past, liking Jael best ("when I stop to think about it, which is not often"), disbelieving in Janet but recognizing her as "our savior from utter despair" (Nine:VII). From start to finish, therefore, Joanna's "little book" has called itself into question through both its structure and content. Her farewell to it suggests that we will do the same as we use her imaginative creation, so that our action will hasten the day when it is "quaint and old-fashioned" and "no longer understood": when "we will be free" (Nine: VII). *TFM*'s structure as a text liberates our imaginations without violence, offering us the experience of a process that we might learn to enact on a social level, too.

Notes

[1] Joanna Russ, *The Female Man* (New York: Bantam Books, 1975). For the convenience of readers with other editions, Part and segment numbers are substituted for page numbers and are indicated in the essay.

[2] Roland Barthes, Preface to *Critical Essays* (Evanston: Northwestern University Press, 1972), p. 267.

[3] Barthes, "Literature and Signification," Ibid., p. 268.

[4] This paragraph summarizes Barthes' "From Work to Text" in *Image, Music, Text,* trans. Stephen Heath (New York: Hill and Wong, 1977), pp. 155-64.

[5] Jerome McGann, "The Aims of Blake's Prophecies and The Uses of Blake Criticism" in *Blake's Sublime Allegory,* ed. Stuart Curran and Anthony A. Wittreich (Madison: University of Wisconsin Press, 1973), pp. 8-11.

[6] Hayden White *Topics of Discourse* (Baltimore: Johns Hopkins University Press, 1978), p. 276.

[7] William Blake, *Jerusalem* in *The Poetry and Prose of William Blake,* ed. David V. Erdman (New York: Doubleday and Co., 1970).

[8] The quotation is from "The Proverbs of Hell," *The Marriage of Heaven and Hell* 7:3.

[9] Barthes, "Literature and Signification," p. 267.

[10] See, for example, the transcription of Samuel R. Delany's 1977 speech, "The Word Is Not The Thing," in *Janus IV* (Summer/Autumn, 1978), pp. 5-8.

[11] "Joanna," I wish to stress, is the fictional character, including the *fictional author,* the authorial persona who comments about herself in the novel. The historical person is always referred to as *Russ* or *Joanna Russ.*

[12] Careful readers will have noted that Joanna's first account (One:IV) said that she was at a Manhattan party, while here the party is in Los Angeles: another playful device to remind us of author-Joanna's presence.

[13] The paperback editions of the novel give a clue to the presence of a fourth speaker. The first-page blurb on all the editions I have seen is the section of Jael's speech in Eight:V where she describes finding the other three J's.

[14] "Creating Positive Images of Women: A Writer's Perspective," Forum on Women and Literature, Cornell University, n.d., p. 5. I am indebted to Dr. Beverly Friend of Oakton Community College for a copy of this speech.

[15] It is the "old-fashioned" Jael who literally has claws.

THE SEARCH FOR EQUALITY IN WISCONSIN

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In the twilight of the struggle for woman's enfranchisement, Robert M. La Follette, progressive senator from Wisconsin, sat in California, attending his eldest son who was recovering from a serious illness. Upon receiving word that the Nineteenth Amendment, giving women the ballot, was up for a vote, he dashed back to Washington. There he was joined by his wife Belle, a feminist and ardent suffrage worker. On June 4, 1919, with his wife looking on from the balcony above the Senate floor, La Follette voted for enfranchisement. Immediately after the victory, Belle Case La Follette wired her husband's colleagues in the Wisconsin legislature, urging prompt ratification of the new federal amendment. Within days the men in Madison responded and Wisconsin added ratification to its list of progressive accomplishments.[1]

The passage and ratification of the amendment marked the culmination of an effort which began with the 1848 Seneca Falls Conventions and carried American suffragists through seventy-two years of debate and sacrifice. In the course of the struggle, the founding generation of Elizabeth Cady Stanton, Susan B. Anthony, Lucretia Mott and Lucy Stone gave way to another, Carrie Chapman Catt, Alice Stone Blackwell, Anna Howard Shaw, Alice Paul and Jane Addams. The original movement fractured in the 1860's over issues of strategy, leadership and priorities, only to be reassembled as the National American Woman Suffrage Association in 1890.[2] Even after the new organization was formed, incipient divisions existed among the women. On the one hand stood the feminists who advocated equal rights as well as the vote, while on the other were the social reformers, women who perceived the ballot as a tool for moral betterment.

Though such differences predated passage of the suffrage amendment, it was not until after the victory that they threatened to sunder the movement. Then, in the afterglow of their greatest success, the women split over issues of strategy and social reform gains. The gulf widened when the National Woman's Party introduced its national Equal Rights Amendment in the 1920's. The controversy centered around the issue of protective labor legislation for women. Social reform groups such as the League of Women Voters and the National Consumers' League emphasized the need to safeguard such hard-won advances as minimum wage laws, maximum hour laws and protective legislation for women and children. In short, they believed women deserved special consideration because of their weaker physical state and their roles as mothers. As May Dean Smith, a reformer and writer, stated, "to deny that women require care and protection is equal to a denial of her physical mission of motherhood."[3]

The Woman's Party, by contrast, felt that protective legislation grouped women with children, an admission of inferiority and dependence. Progressive judge Ben Lindsey stated, "What is known as special legislation for women is in fact not for women at all, but for children."[4] The NWP felt that protective legislation was acceptable only if instituted for both men and women. Gail Laughlin, a Woman's Party officer, explained the Party's position in this way;

> "The so-called eight hour laws for women, glibly called 'protective,' mean the shutting of the door of opportunity to women. If we are to have legislation concerning hours of labor—and I believe we should have that legislation—it should be based along the lines of industry, not along the lines of sex."[5]

Many feminists claimed that whenever protective laws had been enforced, women had lost their jobs to men. The Woman's Party felt that laws containing blatant discriminations should be abolished.

The argument over the constitutionality of protective legislation had raged throughout the progressive era, finally receiving judicial resolution in the famous case of *Muller v. Oregon.* In response to a challenge to the state of Oregon's ten-hour work day restriction on women, the social reformers had recruited Louis D. Brandeis to prepare the brief in behalf of special legislation. Relying primarily on European sources and statistics, he had persuaded the Supreme Court to uphold the state's practice. He asserted that "women are fundamentally weaker than men in all that makes for endurance; in muscular strength, in nervous energy and in the power of persistant application and attention."[6] In short, Brandeis chose a social defense of Oregon's statute. Yet from the standpoint of the more radical feminists, such laws violated the concept of gender equality; women could not seek status comparable to that of men while at the same time benefiting from special governmental favors. Thus in the 1920's only years after the suffrage victory, the women's movement faltered and splintered. By the middle of the decade, it was clear that the gulf could not be bridged and passage of an equal rights amendment would await the action of future generations.

It was against this backdrop of controversy and division at the national level that the members of the Wisconsin state legislature met to consider an equal rights law in 1921. Since the 1890's, Wisconsin had been the leader in progressive reform, due largely to the political devotion of Robert M. La Follette and his wife Belle. During the La Follette years Wisconsin went from a backward, politically corrupt state to one which emphasized democracy and reform. During his several terms as governor, La Follette broke trusts, regulated railroad companies and big business, instituted the direct primary and defeated the Republican party machine. He created a progressive coalition of his own, a machine which placed progressive men in government positions throughout the state. Moreover, La Follette stressed the need for cooperation between the University of Wisconsin and the state government. The alliance between the capitol in Madison and the University, "the Wisconsin Idea," resulted in thorough and lasting reform.[7] With the assistance of his family, La Follette also created a progressive journal, *La Follette's Magazine,* which took the progressive message to the homes of constituents.

Wisconsin women had been involved in the progressive movement from the beginning. Throughout the state's history, they had been politically active and by 1890 had won equal property rights, the right to practice law, and suffrage in school elections. The first woman was appointed to the Milwaukee school board in 1895.[8] As the Wisconsin progressive movement matured, many women became dedicated social reformers, participating in labor and prison reform efforts. Later they championed city improvement programs through which they developed playgrounds, libraries and kindergartens, as well as manual training programs.[9]

Woman suffrage was, therefore, an obvious item on the progressive agenda in Wisconsin. In 1912, Robert La Follette himself directed the effort for statewide enfranchisement, while Belle traveled extensively, speaking for the cause. She even utilized the family's mailing lists to send pamphlets and leaflets to potential allies.[10] When the votes were tallied, however, the issue was defeated by a two-to-one margin.[11] By 1921, having ratified the Nineteenth Amendment, they were again ready for action, this time banding together to move their representatives in Madison to support equal rights for women. The legislators, meanwhile, now regarded the women as potential constituents and openly courted their favor. The state Republican platform observed that women had "come into full partnership with men in the conduct of the affairs of government." As a consequence the party endorsed revision of laws "to the end that in all matters men and women should be upon a basis of equality."[12] On that platform John J. Blaine was elected governor.

With Blaine's pro-feminist administration in power, the Wisconsin chapter of the National Woman's Party felt that an equal rights law was attainable. Mabel Raef Putnam, the state chairman of the Woman's Party, explored the possibility by traveling to the state capitol where she met with feminist author Zona Gale and Ada James, the former president of the Political Equality League of Wisconsin. Both women were friends of the La Follette family and were active in the progressive movement. The three women addressed the Wisconsin Senate Judiciary Committee concerning the feasibility of an equal rights bill.[13] A few members of the committee expressed interest in such legislation but others voiced violent opposition.

The women realized that a strong force of dedicated workers would be needed to successfully institute such a law. Mabel Putnam met with the members of state women's organizations, and found that nearly every organization was willing to assist in the effort.

Next, Putnam called on Governor Blaine, who indicated his support and suggested a visit to Charles Crownhart, the Revisor of Statutes. Crownhart was a dedicated progressive, who had been Robert La Follette's campaign manager for many years. He agreed to draw up the equal rights bill. Although at first Crownhart suggested that the bill should provide only for choice of voting residence and jury service, he soon realized that an inclusive law would be more practical. He favored a "woman's bill of rights" which would "remove every disability" appearing "in the statutes. . . ."[14] a proposal the women heartily endorsed.

The Equal Rights Law was introduced into committee in May 1921. The bill stated:

> "Women shall have the same rights and privileges under the law as men in the exercise of suffrage, freedom of contract, choice of residence for voting purposes, jury service, holding office, holding and conveying property, care and custody of children, and in all other respects. The various courts, executive and administrative officers shall construe the statutes where the masculine gender is used to include the feminine gender unless such construction will deny to females the special protection and privileges which they now enjoy for the general welfare."[15]

The special protection clause was inserted in the bill as a compromise between the feminists and the reformers.

Mabel Putnam immediately wrote to United States Senators La Follette and Irvine Lenroot encouraging them to aid in passing the bill. She noted that; "Wisconsin women's organizations want Wisconsin to be first state thus to complete the grant of equal suffrage. We want you to urge your friends in Senate and Assembly to work and vote for this bill."[16] Lenroot sent back a short letter of approval, while La Follette responded by telegram, stating,

> "You doubtless are aware of the fact that the reactionaries are in control of the legislature, but I have today taken this matter up with friends at Madison, and I am certain they will be glad to give their co-operation."[17]

With the support of the La Follette progressives, the women gained needed political allies and awaited the debate on the bill.

Assemblyman Alexander Matheson led the opposition against equal rights, contending that the bill was a threat to the home. In debate he declared, "This bill will result in coarsening the fiber of woman—it takes her out of her proper sphere."[18] Many other reactionary members agreed with him. Senator Claire Bird felt that an amendment striking out "freedom of contract, choice of residence for voting purposes" and "in all other respects" was needed. The Senate voted and the Bird amendment was passed. The conservative sector supported the amendment, explaining, "Why, a woman could establish her residence separate and apart from that of her husband, and continue to live away from him forever while he would have to support her and could never divorce her."[19] The women felt that this amendment legalized slavery. One of their advisors typified their viewpoint:

> "It is a relic of barbarism that leads some to believe that a husband, no matter how great a tramp he may be, should start out on a vague quest and call upon his wife like a squaw to pack her papoose on her back and follow."[20]

The women's associations threatened to use the La Follette tactic of reading the roll call vote, and in that way oust any reactionary legislator who dared to vote against equal rights or for the Bird amendment.[21] Putnam and her legal advisors discussed the amendment with progressive members of the Assembly and agreed that the omitted parts must be restored to the bill's text. The Assembly complied by voting to discard the Senate's amendment.

The Wisconsin Equal Rights Law was passed in its entirety in June, 1921 and was signed by Governor John J. Blaine a month later. Although the bill had met with some opposition, careful politicking and the support of progressive congressmen and United States Senator Robert M. La Follette propelled the bill through the legislature in an amazingly short period of time. From Washington came the joyous reaction of the National Woman's Party. Wisconsin, they observed, had become "the first state in the Union to remove women from a subject position in the law." It was "the only place in the English-speaking world where women had equal rights with men."[22]

While the rift in the national woman's movement stifled any hope for an equal rights amendment at the federal level, Wisconsin had triumphantly passed its Equal Rights Law, the only state to accomplish such a feat during the post-suffrage period. Hence, it is apparent that Wisconsin's progressive environment was hospitable to feminist victory. Unlike the national women's organizations, Wisconsin's associations, both feminist and reform oriented, were not hostile toward each other. Most of these women had grown up in the progressive movement and were acquainted through this common experience. This fact enabled them to compromise their differences and work toward equality in Wisconsin. They subordinated ideological and tactical differences to rally around a common progressive cause and work toward gender equality. The result was a powerful coalition of dissimilar groups, including the Daughters of the American Revolution, the Polish Housewives League, the State Association of Catholic Women's Clubs, The Wisconsin League of Woman Voters, the Young Women's Christian Association and the Wisconsin Consumers League, as well as the Wisconsin Women's Progressive Association, the Wisconsin Federation of Business and Professional Women and the state chapter of the National Woman's Party.[23] The alliance between traditional reform and feminist organizations was sealed when both agreed to support the special legislation clause of the Equal Rights Law, which promised women the protection and privileges granted in prior statutes. Hence, the Wisconsin law protected special legislation for women in addition to guaranteeing them equal rights. The women thus avoided the divisive debate which characterized national efforts to reach agreement on the issue of protective legislation.

While the women did most of the footwork required to present the bill, male members of the legislature provided needed support and state court members later upheld the Equal Rights Law in several vital court cases. In addition, Governor John Blaine and the bill's author, Charles Crownhart, aided the women with advice and assistance. Like the women, male advocates of the bill were overwhelmingly progressive in political outlook. Too often in the past, male involvement in the women's movement had stifled genuine progress. In Wisconsin, on the other hand, the male-dominated Progressive Party had championed enfranchisement long before the Republicans or Democrats took up the cry.[24]

Wisconsin's unique brand of progressivism was largely the creation of Robert and Belle Case La Follette; the passage of the Equal Rights Law was a mark of their political acumen. By the time the bill was introduced the Senator was viewed as the champion of America's common men and women. Earlier in his career he had spoken ardently for woman suffrage, in the small towns which dotted the Chautauqua circuit. When American suffragists marched to Capitol Hill with their petitions, La Follette had been among the group of officials who greeted them in the rotunda. There he welcomed his daughter Fola, the carrier of Wisconsin's suffrage petition.[25] Later in his presentation of the memorial to a Senate committee, La Follette expressed his convictions stating; "I cannot remember a time when I was not in favor of extending the suffrage to women. I have always believed in co-suffrage," as well as "coeducation, equality of property rights," and "equality of opportunity for men and women alike."[26] True to his convictions, La Follette had often advocated enfranchisement on the floor of the Senate and opposed all efforts to modify the suffrage amendment.[27] He later explained the historic passage of the Nineteenth Amendment in a letter to his sons:

> "Mamma sat in the gallery all day and was rewarded, as were the other fighters for suffrage and equal rights, by seeing the Susan B. Anthony Amendment pass by 56 to 25—after a 70 year struggle. Six votes to spare. I started the applause on the floor and it swept the galleries again and again without any rebuke from the Chair, President Cummins presiding. All felt that it was a great victory."[28]

Above all, according to the Senator, it was a triumph for democracy.

With the vote secured, he turned his attention to the equal rights issue, a decision which culminated in his active endorsement of the Wisconsin bill. When that campaign reached its successful conclusion, La Follette wired his congratulations to Mabel Putnam. "I am deeply gratified to learn that the Wisconsin legislature has passed the bill granting equal rights to women, for which they have been fighting for so many years."[29] La Follette acted from conviction, but also from political expediency. He recognized that women had been active in the progressive movement long before they had gained the ballot, particularly in the area of social reform. Within his own political organization women had played a crucial role. Hence with enfranchisement a reality, the Senator courted the woman's vote, especially as he turned his eyes toward the Presidency in 1924.

He formulated a new strategy which relied in part on capturing a substantial portion of women's ballots. In fact, the candidate continued to depend on numerous women volunteers, many of whom were members of the Wisconsin Women's Progressive Association. In addition he recruited the support of such well-known figures as Jane Addams, Helen Keller, Florence Kelley, Rose Schneiderman, Zona Gale and Alice Stone Blackwell.[30] During the autumn of 1924, the campaign sponsored a series of articles by such distinguished women in the *New Republic* and the *Woman Citizen*, each treating a matter of particular concern to the nation's women voters. The candidate's platform was especially attractive to the newly enfranchised bloc. Often it reflected the agenda established by such organizations as the League of Woman Voters. La Follette embraced the standards of peace, disarmament, conservation, labor, wage and benefit improvement, child labor reform and equal rights. Alternatively, he condemned trusts, big business and political machines. To these stands, the Senator added a ringing endorsement of progressive hopefuls throughout the country, many of whom were also pledged to support an Equal Rights Amendment to the Constitution.[31]

La Follette clearly valued women as an addition to his political constituency, but he also was responding to strong sentiment within his own family. Both his wife Belle and daughter Fola were zealous proponents of feminist causes. Even the Senator's sons were active in behalf of women's rights. Once when their mother was unable to attend a suffrage parade in Washington, they marched in her stead. Of all the children, Fola was the most active advocate of women's causes. She was a frequent speaker and marcher in suffrage campaigns and refused to abandon her maiden name when she married George Middleton. Often Fola and her husband worked together in the movement. Family friends were also active participants in the campaign for the vote and equal rights. In a household frequently buzzing with discussion of pertinent issues and controversies, women's concerns received high priority.

The La Follette machine was staffed almost completely by friends and family who shared like views and loyalties. It was distinguished also by the number of women who occupied key positions. Above them all stood Belle Case La Follette. No single woman did more to advance Wisconsin progressivism. Although raised in an era when women were expected to be quiet and passive, Belle's early life on a pioneer farm produced an independent spirit. She was brought up under the tutelage of progressive parents, who had always sympathized with the woman's movement.[32] At the age of sixteen Belle Case enrolled at the University of Wisconsin where she met Robert La Follette. Belle finished near the top of her class and at graduation she won the Lewis Prize for the best commencement oration.[33] Belle Case and Robert La Follette married soon after graduation. Before the ceremony Belle aired her feminist views by asking the minister to delete the words "to obey" from her vows.[34] In 1885, at the age of 26, Belle Case La Follette became the first woman to graduate from the University of Wisconsin Law School. Although she never practiced law, Belle aided her husband with his law work, often writing his briefs.[35]

She also pursued her own endeavors. Her first major project was woman suffrage. Belle Case La Follette was a member of both the National Woman's Party and the National American Woman Suffrage Association.[36] Like her husband, Belle was a skillful speaker. She was a diligent supporter of the Wisconsin effort to enfranchise women in 1912, barnstorming across the state, making from five to seven speeches in a single day.[37] Belle also contributed to campaigns for the ballot in Ohio, Oregon and Michigan.[38] In addition she participated in marches and parades, and wrote on the suffrage topic. In 1913 she presented her arguments to the Senate Committee on Woman Suffrage.

While residing in Washington, D.C. Belle was alarmed by the appalling effects of racism in that city, and became a supporter of the black rights movement. Soon after, she joined the National Association for the Advancement of Colored People. She denounced lynching, segregation and the disenfranchisement of black voters in the south.[39] Furthermore she was one of the few suffragists who urged black women to join in the "traditionally" white cause of equal suffrage. James Weldon Johnson, a black author, wrote of her:

> "Belle Case La Follette believed not only in justice for the Negro, she believed in the Negro. She believed in his powers, his capabilities and in his innate gifts. She believed in his ability to make vital contributions to our national well-being and to our common cultural store."[40]

Unlike many women reformers, Belle Case La Follette favored equal rights with men. Belle urged wives to free themselves from their parasitic dependence on their spouses, to develop their own talents and be of service to humanity.[41] She drew on her own experiences and attempted to educate women to their potential for good. Belle felt that equality should come in three areas; "political—the right to vote; economic—the right to work; and legal equality—the removal of all discriminations against women under the old common law."[42] She also stressed that women should not be afraid to step into the political arena, or compete in other predominantly male occupations.

After the ratification of the suffrage amendment, Belle supported the equal rights work of the National Woman's Party, and in 1921 attended the party convention as a delegate of Wisconsin. She believed that the NWP should concentrate specifically on equal rights, leaving other organizations to deal with the remaining reform causes.[43] Always the arbitrator, she felt that reformers like Jane Addams and Florence Kelley did not understand the women of the NWP, explaining: "I have been assured by those who are active and have strong influence among the leaders that there is no intention of abandoning the ground gained by women's welfare work."[44] Even after the Woman's Party denounced labor legislation for women, Belle never wavered from her original equal rights stance.

The Wisconsin Equal Rights Law was heartily endorsed by Belle Case La Follette. When women's reformers sought her opinion on this topic, she explained: "The Wisconsin law expressly provides that it shall not be construed to deny women the special protection and privileges which they now enjoy for the general welfare. In this respect it furnishes a safe and conservative model."[45] Belle Case La Follette devoted continuous attention and energy to the woman's movement, participating in the campaign for suffrage at the national and state levels, writing articles in support of the ballot and championing the Equal Rights Law in Wisconsin. In the view of feminist leader Alice Paul, "Belle La Follette was the most consistant supporter of equal rights of all the women of her time."[46]

Belle served as counselor and advisor to her husband and two sons, Robert Jr., who succeeded his father in the Senate, and Philip, who served as governor of Wisconsin. She believed that women were particularly effective when working with male allies; hence she used her family's political position to further her own special projects. Often standing beyond the limelight, she allowed other family members to receive acclaim for work she had performed. Burton K. Wheeler, the Senator's 1924 running mate, explained Belle's lack of popular recognition in this way; "She was free of personal ambition and never sought political office or social position for herself, but was contented to remain in the background."[47] Still her influence on La Follette's career is undeniable. She affected his policy positions, took care of his correspondence, attended important debates and conferences, participated in speaking tours and edited a department of *La Follette's Magazine*.[48] Although not technically editor of the magazine until the Senator's death in 1925, La Follette's frequent absences often placed the burden of chief editor upon his wife. La Follette went for long periods without writing for the journal, and Belle often signed his name to articles which she herself had written.[49] She was also rumored to be the author of her husband's speeches.[50] In turn, La Follette recognized his wife's essential contribution. He once commented that she was "altogether the brainiest member of my family. . . . Her grasp of the great problems, sociological and economic, is unsurpassed by any of the strong men who have been associated with me in my work."[51] Others were even more open about Belle's role in the political partnership. When asked about her father, Fola La Follette wrote: "To write of my father without writing of my mother is an impossible task. . . . Their relation has always made our home and not father's office the center for all important conferences and discussions."[52]

The woman's movement did not produce many women as dedicated as Belle Case La Follette. Zona Gale, friend and author, commented: "Belle Case La Follette will stand as one who, ambitious for her husband and sons, was ambitious first of all that their ideals of social justice, which were also her ideals, should prevail."[53] In short, "Battling Bob" La Follette did not climb the political ladder himself, but alongside his partner. To a significant extent, the progressive tradition in Wisconsin was their joint creation. This reform climate was essential to the success of the Wisconsin Equal Rights Law, dwarfing all other contributing factors. Neither the remaining states nor the federal government had created a similar progressive machine. President of the National Woman's Party, Alice Paul, herself admitted that Wisconsin was able to pass its Equal Rights Law due to the progressive influence of the La Follette team.[54]

Eventually Alice Paul and the other members of the National Woman's Party would denounce the Wisconsin Equal Rights Law, particularly its protective legislation clause. Their rejection was precipitated by a 1923 ruling by the state attorney general that Wisconsin women could not become legislative employees due to the law's unique protective provision. In fact, the statute did yield mixed results for the women of the Badger State. Between 1921 and 1933 the Wisconsin Supreme Court used the Equal Rights Law to protect women in six test cases. Three of the cases involved women's employment, while two concerned a married woman's voting residence.[55] All of the decisions upheld the statute and protected the rights of these women. The ruling by the state attorney general was the exception in this list of feminist achievements. In 1923 the special protection clause was tested when a statute, written in 1905, was brought before the court. The law excluded women from legislative employee positions because such employees worked "long and unreasonable hours."[56] The earlier statute was declared legal, due to the protective provision of the Equal Rights Law. For such reasons women in Wisconsin had mixed feelings about the bill and watched it closely. The Wisconsin State Federation of Women's Clubs created a committee of women from various organizations to study the effects of the law. They found that, "The law had worked for a greater degree of justice and greater equality of women with men than they had before the passage of the law."[57] Other women felt that the Equal Rights Law was not sufficient. Zona Gale, for instance, regarded the law as a single step toward total equality for women. She wrote, "The status of women in Wisconsin even under our Equal Rights Law is but a stage in that long march."[58] Although the law gave Wisconsin women equal rights with men in most cases, the special legislation clause provided a loophole which would be used against feminist reform. Nevertheless, the Equal Rights Law effectively eliminated many inequalities under the old common law and provided a valuable precedent for future reform.

Notes

[1] Belle and Fola La Follette, *Robert M. La Follette* (The Macmillan Co., 1953), 891.

[2] See Eleanor Flexner's definitive *Century of Struggle*, rev. ed. (Harvard Press, 1975), and Ellen C. DuBois, *Feminism and Suffrage* (Cornell University Press, 1978) for accounts of the early movement.

[3] "Should Women Have Equal Rights?," *The Forum* (1927), 421.

[4] "A Telegram from Judge Ben B. Lindsey," *Equal Rights* (March 8, 1924), 27.

[5] William L. O'Neill, *Everyone Was Brave* (Quadrangle Books, Inc., 1969).

[6] Flexner, *Century*, 220-21.

[7] James I. Clark, *Chronicles of Wisconsin* (The State Historical Society of Wisconsin, 1955), 19.

[8] David P. Thelen, *The New Citizenship* (University of Missouri Press, 1972), 86-91.

[9] *Ibid.*, 92-98.

[10] Clark, *Chronicles,* 11.

[11] Herbert F. Margulies, *The Decline of the Progressive Movement in Wisconsin, 1890-1920* (The State Historical Society of Wisconsin, 1968), 142.

[12] Mabel Raef Putnam, *The Winning of the First Bill of Rights for American Women* (Frank Putnam, 1924), 23.

[13] *Ibid.*, 12.

[14] *Ibid.*, 24.

[15] Zona Gale, "What Women Won in Wisconsin," *Nation* (1922), 184.

[16] Putnam, *The Winning,* 25.

[17] *Ibid.*, 37.

[18] *Ibid.*, 49.

[19] *Ibid.*, 29.

[20] *Ibid.*, 30.

[21] *Ibid.*, 25.

[22] *Ibid.*, 9.

[23] Stanley J. Lemons, *The Woman Citizen* (University of Illinois Press, 1973) 187-88 and Putnam, *The Winning,* 70.

[24] Zona Gale, "Why I Shall Vote for La Follette III," *New Republic* (October 1, 1924), 116.

[25] La Follette, *Robert M. La Follette,* 477.

[26] *Ibid.*, 478.

[27] *Ibid.*, 891.

[28] *Ibid.*, 963.

[29] Putnam, *The Winning,* 67.

[30] Jane Addams, "Why I Shall Vote for La Follette I," *New Republic* (September 10, 1924), 36-7; Alice Stone Blackwell, "What La Follette Will Do and Has Done." *Woman Citizen* (October 18, 1924), 15; Gale, "Why I Shall," 115-16; "The La Follette Record of Achievement," *Woman Citizen* (September 20, 1924), 14.

[31] O'Neill, *Everyone,* 281.

[32] Dee Ann Montgomery, "An Intellectual Profile of Belle Case La Follette: Progressive Editor, Political Strategist and Feminist," (Indiana University Ph.D. Dissertation, 1975), 12-15.

[33] Patrick J. Maney, *"Young Bob" La Follette* (University of Missouri Press, 1978), 8-9.

[34] *Ibid.*, 9.

[35] *Ibid.*, 9.

[36] Montgomery, "An Intellectual," 83.

[37] *Ibid.*, 85.

[38] *Ibid.*, 84.

[39] Maney, *"Young Bob,"* 9 and Montgomery, "An Intellectual," 112.

[40] James Weldon Johnson, "Belle Case La Follette Believed in the Negro," *The Progressive* (November 7, 1931), 9.

[41] Maney, *"Young Bob,"* 10.

[42] Montgomery, "An Intellectual," 51.

[43] Belle Case La Follette, "National Convention of the National Woman's Party," *La Follette's Magazine* (March 1921), 42-3.

[44] Montgomery, "An Intellectual," 68.

[45] *Ibid.*, 67.

[46] *Ibid.*, 225.

[47] Burton K. Wheeler, "A Great Mother to the Human Family," *The Progressive* (November 7, 1931), 2.

[48] La Follette, *Robert M. La Follette,* 313-14.

[49] Montgomery, "An Intellectual," 43.

[50] La Follette, *Robert M. La Follette,* 313-14.

[51] Russell H. Austin, *The Wisconsin Story* (The Journal Company, 1948), 257.

[52] Montgomery, "An Intellectual," 169.

[53] Zona Gale, "Brotherhood: It Was as Simple as That," *The Progressive* (November 7, 1931), 2.

[54] Montgomery, "An Intellectual," 225.

[55] Gale, "What Women Won," 184.

[56] Lemons, *The Woman,* 189.

[57] *Ibid.*, 188-89.

[58] Gale, "What Women Won," 185.

THE FORMATION AND PROBLEMS OF THE FRENCH-INDIAN ALLIANCE, 1748-1758

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As a result of the loss of their naval base on Cape Breton Island during King George's War (1744-1748), the French in Canada were subjected to a naval blockade by England that deprived New France's trading posts of essential goods for the Indian trade. Due partly to the influence of English traders, the Indians in the French alliance system rebelled in 1747, causing the alliance to collapse.

When the peace of Aix-la-Chapelle ended the war in 1748, New France regained her naval base on Cape Breton Island, which seemed to insure New France's supply lines in any future war. With new trade goods arriving in Canada, order and control were again imposed upon the interior Indian tribes. New France's efforts in rebuilding their alliance were concentrated upon the Great Lakes, Ohio Valley, and Iroquois nations. This paper will deal with the first two Indian groups, and will explore both the problems and the ultimate failure of the French-Indian alliance.

The empire of New France had undergone a severe strain during King George's War (1744-1748). England, with her naval and economic strength, had tested the defenses of Canada almost to their limits. These Canadian defenses depended heavily on the support of many Indian tribes in eastern Canada and the Great Lakes region.

It is almost impossible to estimate accurately the numerical strength of these potential French allies. However, according to one 1736 source, 16,323 warriors were available in the Great Lakes area alone.[1] Colonel Henry Bouquet gives a total of 56,500 fighting men for all Indian nations then known. If the fighting men of the western and southern Indian tribes are subtracted, an estimated 35,600 warriors potentially could be gathered from Canada, the Great Lakes area, and the Ohio Valley.[2]

Clearly, whether the preceding estimates are accurate or not, whoever controlled these Indian tribes had a considerable source of power at his disposal. France's involvement with the Indians had begun in the sixteenth century, but its control of the west was challenged after 1642 by the New York Iroquois, supported by their Dutch and English trading partners. In the 1690's, French control was temporarily re-established through a rebuilt fort system. In 1696, King Louis XIV, at the urging of the Jesuits, closed all the western posts, withdrew the garrisons, and ordered the traders out of the lake country. As a result, traders from New York, Pennsylvania, Virginia, and Charleston invaded the west to trade with Indians previously allied with the French. During Queen Anne's War (1702-1713), British privateers created a shortage of trade goods in Canada, and further disadvantaged the French. It was not until after 1716, following the death of Louis XIV, that the French began to consolidate their holds on the lands and Indians of the Great Lakes by constructing a series of forts and posts throughout the interior regions and garrisoning them with soldiers and traders. These posts served several purposes: they were visible symbols of the French King's right to rule and control this part of North America; they were "recognized agencies" for keeping peace between tribes; they blocked English expansion into the area; they served as centers for receiving furs; they served as a "point of departure for expeditions seeking to uncover mines . . . [and an] approach to the Western Sea."[3]

The post commanders were not only to keep peace between the Indian tribes, but they were also to convince the Indians to join the French both in the fur trade or in war.[4] However, as the eighteenth century progressed, this became more difficult due to increasing numbers of English traders entering the Ohio Valley and eastern Great Lakes area. The English traders paid higher prices for the Indians' furs, did not discriminate between "good" furs and "bad" furs, and their trade goods were much cheaper. English traders, in an attempt to gain more furs spared little expense to woo the Indians away from the French posts. The English told the Indians that the French were not fair traders; that they attempted to rob the Indians by offering very little for even high grade furs.[5] Consequently the Indians became resentful and threatened to leave their French "fathers."

The French were well aware of the disparity in prices between the British and themselves. As early as 1689, the Governor of Montreal, made a table entitled "Differences in the Indian Trade between Montreal in Canada and Orange in New England, 1689."[6] The following are a few examples from his table:

The Indian pay for	*At Orange*	*At Montreal*
8 pounds of powder	One beaver	Four
A gun	Two beavers	Five
40 pounds of lead	One beaver	Three
A blanket of red cloth	One beaver	Two

The French, however, paid more for the furs of cats, fox, and wolves, and were competitive for mink, marten, fisher, otter, and weasel. The Indian therefore took one type of pelt to the English, and another to the French. Yet, because of the strength of the English industrial system, and the greater distance the French had to carry goods in order to reach their posts,[7] there was little that could be done to lower prices other than subsidize traders with monies from the home government.

By the 1740's the Indian's dependence on European goods was very great. When King George's War began in 1744, the disparity in the price of trade goods became even more acute. In 1745, the British captured the strategic fort and naval base of Louisbourg, located on Cape Breton Island at the mouth of the St. Lawrence River.[8] Louisbourg had served as a base for the French warships guarding the supply routes from France to Canada. Deprived of this base French supply ships were prevented from sailing up the St. Lawrence to Quebec. And the stock of supplies in store houses was rapidly depleted due to unusually large consumptions of goods for war purposes. From that point onward, the French position with the interior Indian tribes steadily declined. Because the French were without the means to supply the Indian's wants and needs,[9] many of the nations rebelled, or simply turned to the English for goods.[10]

This situation peaked during the years 1744-1747, when many of the Great Lakes and northern Ohio Valley tribes entered a conspiracy to destroy the French trading centers around the Great Lakes.[11] The Huron chief Nicholas instigated the plot. Nicholas and his band had moved from Detroit in 1738 after becoming dissatisfied with the French and their goods; he also feared the other tribes gathered around Detroit. The French attempted to persuade Nicholas to move back to Detroit, but instead Nicholas and his followers remained at Sandusky Bay with other bands similarly dissatisfied with the French.[12]

At Sandusky, English traders from Pennsylvania had erected a blockhouse in 1745. These traders persuaded Nicholas to break with the French and destroy all the French posts during the holidays of Pentecost. Nicholas' plan called for widespread destruction and participation by a total of 17 tribes.[13] Nicholas' Hurons were to destroy the French at Detroit; the Potawatomi were to kill the Frenchmen at Bois Blanc Island at the mouth of the Detroit River; the Miamis were to seize Fort Miami; the Fox were to take Green Bay, the Sioux and Sauk had plans to destroy Michilimackinac, and the Shawnee, Ottawa, and Chippewa were also to assist.[14] However, the conspirator's plans went wrong, and the French, on their guard, thwarted the rebellion. Even though the uprising failed to accomplish its goals, it succeeded in disrupting not only the fur trade of the Great Lakes but also the system of alliances that the French had cultivated.

With the collapse of his efforts, Chief Nicholas and his followers moved to the Illinois country, where Nicholas died in the autumn of 1748.[15] Some of the other "rebel" Indian bands that had been at Sandusky joined the group of Miamis led by La Demoiselle and immediately established another center for English traders, called Pickawillany.[16]

The French blamed the English for the collapse of their Indian alliance, claiming that the English "have succeeded . . . well in making them [the Indians] their devoted Creatures."[17] Indeed, the French felt that if something was not done quickly, the Indian's dissatisfaction would surely grow. One Frenchman wrote gloomily, "I hope the evil [of the English traders] will not become greater, but I should not Be Surprised if it did."[18] This same Frenchman felt that

> The only way to remedy it [the situation of the English encroachments] and to secure the fidelity of all the Savages, the peaceful and Complete possession of all the upper country, and the Entire Trade . . . Is . . . to deprive them [the Indians] of all Communications with the English. To succeed in this, and to Establish a lasting peace in the whole of the upper country, let Your Grace make England Agree in the next treaty of peace with This Crown, that the English shall abandon and Give up to the King for ever the Complete possession of the fort of Chouegen [Oswego]; that they Renounce having any relation with the Five yrocoisses [Iroquois] nations, . . . that they shall carry on no Trade either directly or indirectly throughout the territory Around lakes hontario, lake herrier, lake huron [lakes Ontario, Erie and Huron], Riviere Blanche and Belle Riviere [the Ohio Valley area]; that all the English Traders . . . shall Withdraw to their own country for ever Without ever being allowed to Return and carry on any Trade, or even Under any pretext whatsoever. . . .[19]

The English, of course, did not see themselves as being that influential with the Indians. One Englishman protested that the French

> . . . know all that affair [dealing with the Indians] better than we do Their Ministers are well inform'd which I doubt ours are not They take much pains to be inform'd & never fail to incourage such as can give information or any way improve their Trade & Interest & they constantly employ men of sufficient abilities for that purpose while we take no pains & know little else besides what we learn from their books.[20]

Another fact that the Englishmen were quick to point out was that New France's one significant source of income, the fur trade, gave her an immense advantage in dealing with the Indians. Not only were there trading posts throughout the interior, but as one Englishman complained, the French traders "live and mary among them, in short are as one people which last is not Comendable [*sic*] but gains their affection. . . .[21]

However by 1748 the French alliance system needed more than fraternizing traders; it had utterly collapsed. Nor did the peace of Aix-la-Chapelle (1748) bring relief to the two warring countries, for it was looked upon as "a temporary halt to the general struggle, and both sides began at once to prepare for the early reopening of hostilities."[22] For France, this meant reorganizing and strengthening their Indian alliance. This would prove to be a very great undertaking, for the rebellion of 1747 had not only disrupted the organization of the fur trade, but it had also cost the French government heavily.

The Governor-General of Canada, Comte de la Galissoniere, accurately evaluated the situation shortly after the rebellion. Galissoniere felt that as a result of the Indian disturbance, the fur trade had been so disruped "that far from The Posts yielding any Revenues, they have been the cause of considerable expenditure."[23] He doubted "whether the proceeds of the most profitable ten years of the posts could have paid the expenses of the last two years."[24]

La Galissoniere also realized that the loss of Newfoundland and Acadia (by the treaty of Aix-la-Chapelle), coupled with an aggressive English policy in the Ohio Valley, meant any new war could easily be lost by France if something was not done to strengthen Canada. Consequently, orders were issued to increase Canada's permanent military establishment, build new fortifications in the Ohio and Illinois area as barriers to British expansion, insure the alliance or neutrality of the various Indian nations, and if possible, destroy the harmful English trading post at Oswego.[25]

Yet another critical aspect for the French was their loss of prestige among the western tribes. Again, the French blamed the English almost entirely. And, although the French realized that the only way of insuring that the Indians would remain loyal was to keep English goods out of their hands, they had first to restore tranquility among the rebellious tribes. In February 1748, Galissoniere received a letter from the French Minister stating that a convoy of trade goods should arrive shortly for distribution at Detroit and Michilimakinac, and that:

> The goods transported there by them [voyageurs], and also what the nations have heard concerning the supplies the colony has received, must have enabled them to see what little foundation there was for the rumors carefully spread by the enemy regarding its alleged state of exhaustion.[26]

The minister suggested that after tranquility was brought by the trade goods, the Great Lakes tribes might be coerced by "inflicting signal punishment on the Sauteux [Chippewa]," whom he believed had instigated the rebellion.[27]

However, Canada, was in no position to pursue and crush the rebels. Therefore, although the French officials would have liked to see the disobedient Indians punished, it appeared the French would have to adapt a policy of conciliation. Far from aiding in the restoration of French prestige, the lack of force shown by the French served further to undermine their authority.

In an attempt to impress the tribes with New France's power, two strong detachments of troops were sent to Detroit and Michilimakinac in 1749.[28] Also, post officers were instructed to "inspire in them [the Indians] proper dispositions, and break the intrigues that the English only too often put in practice to attach these savages to themselves."[29] But, should the Indians' dispositions be "bad or wavering," then they must be dealt with severely.

The general order for Detroit, June 2, 1748, read:

> Should any Huron or other rebel be so daring as to enter the fort without a pass, through sheer bravade 'twould be proper to arrest him and put him to death on the spot.[30]

The instruction to use force upon "bad" Indians was seldom adhered to. It was far more common to give the "bad" Indian a stern lecture about the evils of the English, and then send him on his way with a gift.

These measures still did not get to the heart of the problem. The end of the war had brought back trade goods, but they were not of pre-war quality or price. Beauharnois claimed that "the goods there [at the posts] are at such a price as to Completely disgust the savages."[31] Therefore, the French sought to strengthen their fur trade through closer regulation. This, they felt, would not only endear them to the Indians but also secure the French traders from the harmful English competition.[32]

The French exploited their posts under three systems: farming out, the license system, and exploitation by the post commander. Under the system of farms, the right to trade at a certain post was sold to the highest bidder. Not only was the initial cost of obtaining the post expensive (especially for lucrative posts such as Green Bay), but also the farmer was required to pay a specified amount every year to the government. This cost, in turn, was passed on to the Indians. Farmers were assured that once they obtained a post, they would have sole trading rights there. However, in return for this protection, the farmer was required to provide services and aid to the post commander. Also, the farmer's cargo was strictly regulated, especially in regard to the amount of liquor he could carry.[33]

When a private merchant was given the right to carry on trade at a specific post, he was said to be licensed. The usual process for obtaining a license was simply to apply to the Governor-General for one. Supposedly, the Governor-General issued the licenses as a form of pension to needy officers or their families. This license then allowed the merchant to trade without paying the government for the right to do so. However, this system, like the farms, was often abused by profiteering traders and government officials. In addition to the benefits of trading under the license system, there were obvious disadvantages. For one thing, the trader was again strictly controlled as to the content of his cargo, the number of men he could employ, and the route he was to take to his post. Also, the licensee was required to carry as a part of his cargo a certain percentage of goods for the king, such as gifts that the post commandants distributed yearly. The last system of exploitation, trade by the post commander, was carried out much like the system of farms.[34]

Galissoniere and his Indentant, Bigot, argued that the lack of trade regulation during the war years, and the resulting confusion, had caused the trade to be exploited by the farmers and post commanders. They felt a return to a single license system, would stimulate competition between traders, and that, coupled with a return to lower prices as a result of peace, would be attractive to the Indians.[35] Galissoniere's replacement, Pierre-Jacque de Taffenel, Marquis de la Jonquiere, echoed these opinions. Because of the fear that the Indians would "carry their trade entirely to the English," the minister felt that the license system was one way in which the French could once more attach the Indians to themselves.[36]

The license system to be re-established at the various posts was connected to yet another stipulation. The officers in charge of the posts were given orders not to exploit their posts by selling the most coveted trade goods at very high prices, with the officer collecting the rewards. The order read that post officers should "enjoy only the allowances . . . according to their rank and to the expense . . . of the post."[37]

The trade that the Great Lakes tribes had been carrying on with the British at Oswego, on the southeastern shore of Lake Ontario, badly hurt New France's fur trade economy and the attempts at forming an alliance. In an effort to put an end to this "illegal" trade, La Jonquiere ordered that a post be built between the French posts of Fort Frontenac and Niagara. This new post, named Fort Rouille (Toronto), would block the Indian route from the upper country to Oswego. La Jonquier carefully explained to the minister that Ft. Rouille would be licensed, and that it would not be very expensive to build or maintain since he ordered it constructed of logs instead of stone. In addition, Fort Rouille would be manned by only one officer and fifteen soldiers.[38]

Oswego had been a thorn in the French side since its construction in 1724. Because it deprived the principal French trading post of Niagara of valuable furs, the French had always sought ways to destroy it or at least reduce its attractiveness. However, Oswego stood on Iroquois lands, and the French did not wish to anger such a powerful nation. By the 1730's Indians from many French areas were making the long journey to Oswego to take advantage of the high fur prices there.[39] By 1749, the situation was not as acute as formerly, but it still concerned the French. Their attempts at rebuilding the Indian alliance would suffer should the tribes continue to trade with the English.

La Jonquiere felt he could undermine Oswego's influence by providing cheap goods at Detroit and Niagara. Traders and merchants, he ordered, were to "sell their goods for two or three years in the future [i.e., on a type of credit], at the same prices as the English. . . ." This, he felt, would greatly help influence the tribes toward the French (in April, 1748, the Ottawa, Potawatomie, Huron, and Chippewa returned to the French alliance).[40]

At the same time that the French were trying to undercut Oswego's power by lowering prices on their goods, they also appealed to the Iroquois. Writing to La Jonquiere in May 1749, the minister stated that

> . . . if, on account of what may have occurred between them [Iroquois] and the English, they could be induced to destroy the post of Choueguen [Oswego] standing on their lands, it would be obtaining from them a service most useful in every respect.[41]

The Iroquois never destroyed Oswego. The benefits that they and other tribes reaped from the English there far outweighed what the French offered in return.

The Governor-General also determined on the rigid enforcement of orders forbidding all trade with the English. The order was meant

> . . . to put an end to the infringements on the prohibitions inserted in the licenses, to prevent the farmers and voyageurs encroaching upon one another's rights, to stop the coureurs de bois, to forbid the trade carried on by certain voyageurs with the English, and finally to divert the savage nations from the said trade.[42]

The problem of the *coureurs de bois* that La Jonquiere mentioned in the above order had always been a serious one. These illegal traders (men who traded without government authority and with complete disregard for trade regulations) had become numerous during the war, and despite constant orders for their arrest, siphoned off unaccountable quantities of furs. Taking them to the English traders, the *coureurs de bois* brought back to the Indians English goods, which only served to whet the Indians' appetite for the high quality British wares.[43]

La Jonquiere, like many of Canada's Governor-Generals, wished to stop this illegal trade. Not only did La Jonquiere order post commanders to assist in this effort, but also the numerous and powerful Chippewa were to be employed. If the Indians would denounce these smugglers, they would be assured a "good reward" if they handed over the confiscated material. La Jonquiere added, however, that he did not trust the Indians to keep their promise to apprehend such smugglers, and he instituted a watch as a precaution.[44]

One of the last actions La Jonquiere took before his death in 1752 was to send Sieur Chevalier de Repentigny to Sault Ste. Marie to "establish a post there at his own expense." This new post would lie astride yet another Indian trade route, and La Jonquiere believed it would inhibit the northern Indians' use of that trail in their journeys southward to the English. La Jonquiere wrote that this new post will

> . . . stop and forestall the consequences of the messages and presents that the English send to those nations that they may corrupt and win them completely over to their interests, and inspire them with feelings of hatred and aversion to the French.[45]

Governor-General La Jonquiere's attempts at making the Great Lakes Indians a strong ally of New France were generally successful. When the French and Indian War broke out between New France and the English colonies in 1754, the upper country Indians could be counted on as the most loyal and dependable Indian force that the French had. Like other tribes, the Great Lakes Indians needed goods, gifts, and inspiring speeches to prod them into military action. However, one weapon that the French held over the upper country inhabitants was the fear of resisting the French, and hence being destroyed as the Fox had been twenty-five years earlier.[46] Even though these northern allies traded at times with the English, they may have been moved by the better quality of the English goods, and not by a wish to see the French replaced by the British.

Another important aspect of the French ability to maintain their ascendancy over the tribes was their systematic way of handling both the fur trade and the Indian nations. Whereas the English were independent traders competing for the Indian trade, the French traders were, as a rule, under orders from the government. This government, unlike that of the English colonies, spoke and acted in a unified manner. And, although it was generally the post commanders who had the task of keeping peace among the tribes and subjecting them to French control, it was the Governor-General who sought to impress them at the annual spring meetings in Montreal. It was also the Governor-General's duty to direct the overall Indian policy so that it conformed not only to the desires of the fur trade, but also to the military aims of the government of New France.[47]

New France's attitude was hardening in relation to the growing competition from the British traders. When La Jonquiere died in 1752, the temporary Governor-General, Longueil, echoed the opinion of many of the post commanders that the whole upper country was "menaced by a general conspiracy."[48] In fact, Longueil decided to make his position quite clear, "There is no doubt, my Lord, but 'tis the English who are inducing the savages to destroy Fort Toronto, on account of the essential injury it does their trade at Choueguen."[49] This attitude was taken wholeheartedly by the newly arriving Governor-General Sieur de Menneville, Ange de Quesne. A foresighted man, he immediately began reinforcing Canada's military position in the Ohio Valley.

While the French had been securing the trade and alliance of the Great Lakes tribes, they had neglected the Ohio Valley. Although the Ohio region was less populous than the upper country, its tribes were important to both England and France. France was particularly worried that England might utilize the Ohio nations to sever communications between Canada and Louisiana and to isolate such major trading centers as Detroit. As a result of France's negligence, English traders were firmly established there. The French were aware that they could not control the Indian nations of the Ohio area unless they also controlled the trade there. Yet, it was not really the furs of the Ohio Valley that drew the French. Although the Ohio was rich in mammals, the milder climate yielded furs of lesser quality than the colder Great Lakes region. These furs, racoon, fox, marten, and to a lesser extent, beaver, were all placed below the medium of exchange in the Ohio area—buckskin.[50] This buckskin, although not so valuable as northern beaver, found a nearby market with the English.[51] The French saw that they must break this trade.

Lewis Evans' 1755 map of the Ohio Valley and Great Lakes area, entitled "A General Map of the Middle British Colonies," amply demonstrates English penetration and knowledge of the Ohio region. Evans illustrated all French and English trading centers, forts, the various Indian tribes, and the principle trade routes. It is quite apparent from that map and others that the English were in an excellent position to take "proper Step towards checking the Encroachments of the French by interrupting part of

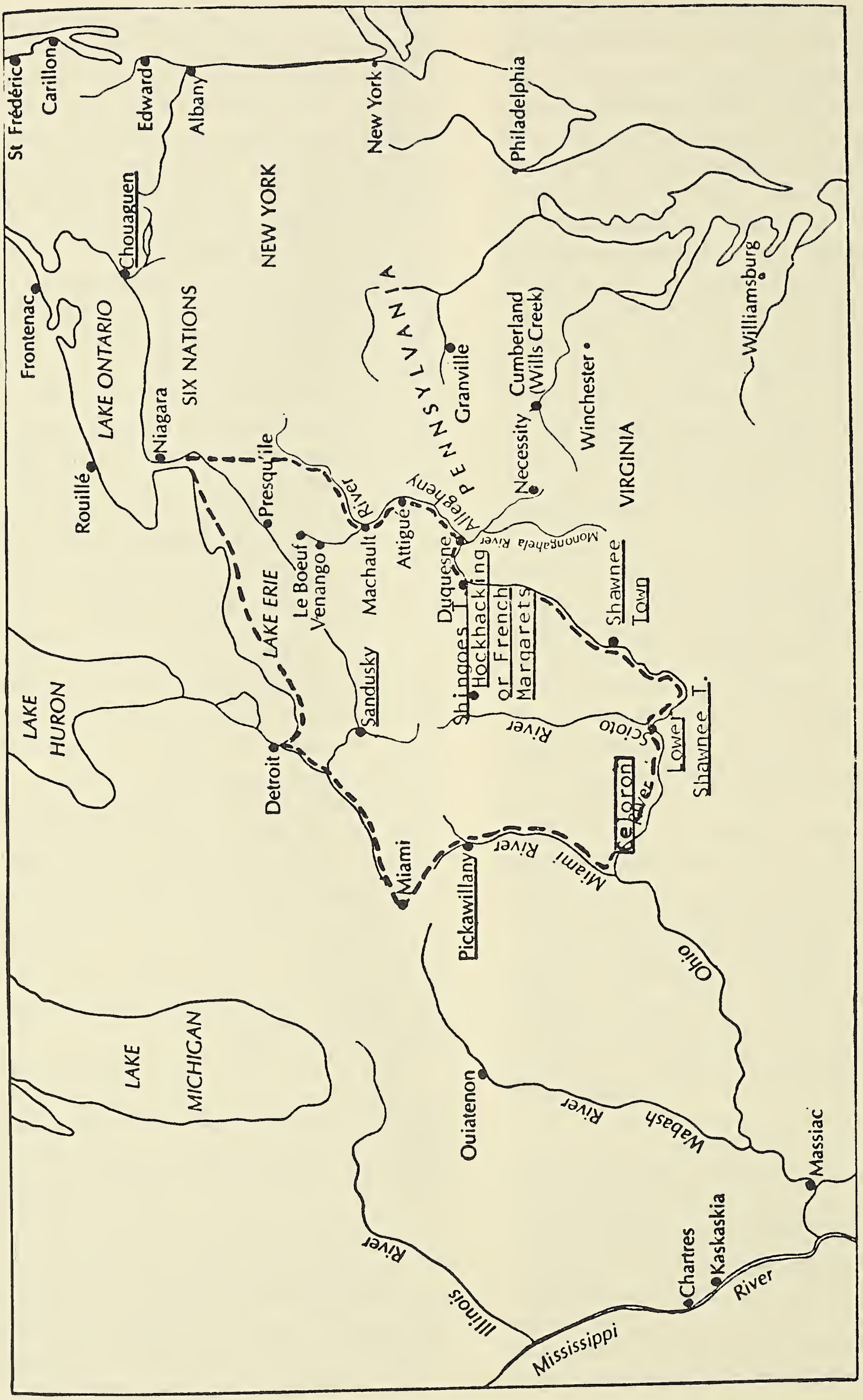

Fig. 1. Celoron's expedition of 1749. The principal English trading centers are underlined. Logstown was located at the letter "s" in Duquene.

their Communication from their Lodgements upon the great Lakes to the River Mississippi."[52]

Many Indian tribes claimed domination or rights over the Ohio Valley: the Catawba, Cherokee, Erie, the Iroquois Confederacy, Miamis, Mingos, Shawnees, and the Wyandots. However, the only group able to exert any degree of power was the Iroquois, which largely dominated the northern Ohio Valley tribes and lands.[53] All of these groups, especially the Miami, had been trading with the English from the Carolinas since approximately 1715.[54] The French had planned to drive the English traders from the Ohio in 1744, but the wartime lack of trade goods had lost them the support of the northern tribes. As a result they were forced to give up the plan.

The English, of course, denied that they controlled the Ohio, although it was quite apparent that they did. In 1748, a large number of gifts, supplied by Pennsylvania and Virginia, had been distributed at Logstown by English traders. Mingo, Delaware, Shawnee, and Wyandot tribes had then pledged their loyalty to the English.[55] The English, with their established trading areas, were in a very good position to refute the French claims to the Ohio. France, in control of the western areas of the Ohio Valley, felt deeply threatened, especially after the Ohio Company was chartered in 1748.

The Ohio Company, with funds provided by such families as the Lees, Washingtons, and Fairfaxes, as well as London merchants, had obtained a half million acres in the Ohio Valley. However, before the company could begin to realize profits from land sales, the area had to be surveyed, forts had to be constructed, and the Indians had to be solidly pro-English.[56] The company, determined that nothing should stand in its way, also attempted to pacify the powerful Iroquois nation. Meeting again in Logstown in June 1752, the English stressed friendship because they also desired "to protect and secure a peaceable Possession [of the Ohio Valley] to the Ohio Company."[57]

Fearing what the British could do with the Ohio nations, as demonstrated by the 1747 uprising, the French wished to know the status of the Ohio area, as well as the disposition of the tribes toward them. In June 1749, Pierre-Joseph de Celoron de Blainville left Canada accompanied by 15 officers, 20 French regulars, and approximately 200 French-Canadians and Indians under orders from La Galissoniere to claim the lands of the Ohio for the King of France (see map). Celoron was to warn any English traders he might encounter that they would henceforth not be tolerated in the Ohio area. If necessary, he was to use force. Celoron was also to instruct the Indians that the government of New France intended to take control.[58]

When Celoron reached the English center at Logstown, he ordered the British flag lowered and the flag of France raised in its place. He told the English traders operating there to leave, and he sent warnings by them to the colonial governments. The Indians were hostile toward Celoron, but they dared not attack so large a force. Although Celoron attempted to impress upon the Indians that the French were their new leaders, his diplomacy was weakened by the fact that he carried few trade goods for distribution. At Pickawillany, Celoron confronted La Demoiselle, a pro-English leader, and secured La Demoiselle's promise to move his band (largely Miamis) back to the Miami post on the Maumee River. It was a hollow promise. At all of the villages that Celoron visited, he found the Indians cool or hostile toward French overtures. In fact, Celoron shortened his expedition to avoid a possible engagement with these unruly Indians. Although he was under orders to drive the English traders from the valley of the Ohio, he found he was not sufficiently strong to accomplish this due to the attachment of the Indians to the English. (There were pro-French factions within some of the tribes, but generally speaking, they tended to be pro-British.)

Upon his return to Canada, Celoron noted that although "a solid establishment [in the Ohio] would be useful," he doubted it would be possible to obtain. He went on to state that

> All that I can say is that the tribes of those localities are very badly disposed toward the French and entirely devoted to the English. I do not know by what means they can be brought back. If force is employed they will be notified and will take flight. They have a great refuge among the Testes plates from whom they are not so very far away. If we send to them for trade, our traders can never give our merchandise at English prices on account of the costs that they are obliged to incur. Besides I think it would be dangerous to make conditions easier [he is probably speaking of subsidizing the traders] for those who inhabit the Beautiful River [Ohio] than for those of the posts of Detroit, Miamis, and others. It would depopulate our ancient posts and perpetuate the tribes on the Beautiful River, which are convenient to the English governments.[60]

La Galissoniere's replacement, La Jonquiere, had been informed upon assuming office in 1749, that of all his duties, "that which demands the most exacting care . . . is the government of the savages."[61] La Jonquiere felt that rather than build expensive posts in the Ohio, he would try bribery and the lavish use of gifts first.

Like most Indian nations, the Ohio tribes wanted neither side to dominate them, but if they had to choose, it would be the side that supplied their wants, and that appeared to be the most powerful. In 1749, it was clear to the Ohio nations that the English had the advantage.[62] A large part of the Ohio Indian's unwillingness to join the French alliance was the very poor quality and selection of French trade goods in relation to the finer, less expensive English items. These items were goods such as the following: calicos, bed gowns, broad and narrow ribbon, silk handkerchiefs, silver brooches and hair plates, wrist bands and rings, Holland ruffled skirts, embossed flannels, gartering, bed lace, brass penknives, strouds, duffels, and the like.[63] The French failed in their efforts to woo the Indians away from the British through the use of trade goods. At the time of La Jonquiere's death in 1752, the Ohio was still heavily British.

When Du Quesne assumed the leadership of New France in 1752, he reasserted that the valley of the Ohio must be held and be made part of New France's North American empire. Furthermore, Du Quesne felt that the Indians there should be able to cross the mountains to trade with the British any time they wished, but that no English trader should ever establish himself on French territory. Considering La Jonquiere's failure using bribery, Du Quesne's policy stressed action. In June 1752, a French-Canadian officer, Charles-Michel Langlade, led 240 Chippewa and Ottawa warriors to La Demoiselle's village of Pickawillany, which had been a growing center of English influence. Langlade's party plundered the village, captured or forced out the English traders operating there, and seized an estimated £3,000 sterling of furs and goods. To demonstrate French brutality, Langlade and his warriors killed and ate one of the British traders, as well as the pro-British chief La Demoiselle. Writing to the minister, Du Quesne said, ". . . I hope that my action in the Belle Riviere [Ohio area] country will awe all the Nations."[64]

Because of Pickawillany's importance to the Indians and the English as a trading center, its fall was significant. Not only did the destruction of Pickawillany remove one of the barriers to French control over the region, it also removed the leader that had inspired the others to resist going over to the French. After Pickawillany's fall, tribes such as the Mingo, Miami, Shawnee, and Wyandot felt that they could not defend themselves against the savage, French-led

Great Lakes tribes. This weakened their pro-English stance and unwillingly impelled them into the French alliance.

English influence in the Ohio Valley immediately began to wane, for Langlade's attack demonstrated to the Ohio Indians that France was able to muster a powerful force, transport it over a considerable distance, and destroy those who opposed French rule. Shortly after Langlade's venture, Du Quesne sent Pierre-Paul de la Malque, Sieur de Marin, to establish fortifications in the Ohio area. Throughout the summer of 1753, Marin drove his men hard, losing many. However, he succeeded in establishing Fort Presqu'ile on the southern shore of Lake Erie, and Fort le Boeuf farther south, on the banks of the Riviere aux Boeufs.[65] Although Marin's expedition did not enter the Ohio Valley proper, Du Quesne was anxious that French posts and forts be started there. In the spring of 1754, Du Quesne sent Pierre Claude de Contrecoeur with 1,000 men to pick up where Marin had left off. Reaching the forks of the Ohio, Contrecoeur's men drove away a smaller English force and began construction of what was to become powerful Fort Du Quesne. This action on the part of the French destroyed the remaining hold the English had on the valley of the Ohio.[66]

Governor-General Du Quesne realized that it was not enough to make a show of strength without doing something to reinforce French sovereignty. If the Indians were to back French military expeditions, French influence would have to be much stronger than it was. This increase in influence could come only through French traders and voyageurs. However, Du Quesne soon found that Canadian traders were unwilling—even fearful—to venture into the Ohio Valley because of the closeness of the British and the possibility of Indian hostility. Besides, it was profitable to stay with the already established trade at the safer posts of the upper Great Lakes region.

To lure French traders and merchants into the Ohio Valley, Du Quesne offered 1) that they would be aided in every conceivable way by the commandants at the various posts; 2) that their trade goods would be carried over portages without charge by garrison troops; 3) that if the traders ran out of goods, they would be able to obtain them from the post storehouses at low prices. In addition, Du Quesne also imposed restrictions. The staples of the trade, powder, lead, blankets, brandy, and firearms, had to be offered at only slightly higher prices than at Montreal, with the French government subsidizing the traders for any losses they might incur by this practice. Merchandise other than necessities could be sold for whatever the trade would bear. Du Quesne felt that by offering staples as low as possible, he would remove some of the reasons that the Ohio Indians might give for resuming trade with the English, as well as preventing the Indians from being cheated by overzealous merchants. As essential as the Ohio tribes were to the defense of New France, Du Quesne realized that their allegiance would be costly.[67]

England reacted predictably to French actions in the Ohio region. By the summer of 1754, France was engaged in the French and Indian War (1754-1763). New France and her Indian allies held the advantage initially. However, they recognized that the Anglo-Americans, with their superior population and industry, would benefit from a long war. Therefore, France's policy was geared toward a short, decisive, and highly offensive war, with her Indian allies carrying the bulk of the fighting. By the end of 1755, France had gathered virtually every upper country and Ohio Valley tribe into her alliance.[68] About this time, as New France's post commanders were encouraging the Indian nations to ravage the outlying English settlements, the lesson of English naval superiority taught during King George's War was retaught to the French.

In June 1755, a squadron of French ships carrying soldiers and supplies to Canada was intercepted by British Admiral Boscawen, and although only two of the ships were captured, it illustrated the tenuous military position of New France. It also demonstrated the importance of having secure lines of supply and communication to France. Shortly thereafter, 300 French vessels and approximately 6,000 French seamen (roughly the number required to man ten ships-of-the-line) were seized either on the high seas or in English ports.[69] This left France a total of 62 ships-of-the-line, with about 45 fit to sail immediately, against England's 130.[70]

Although Du Quesne's successor, Pierre Francois Rigaud de Cavagnial, Marquis de Vaudreuil, was a Canadian who knew North American style warfare very well, it was the French general, Montcalm, who dictated New France's war policy. Vaudreuil urged that the few French regulars available (probably close to 4,000 men) be used to guard the central approaches to Quebec. The colonial regulars, the militia, and the Indians, would then be free to devastate the English frontier from Massachusetts to the Carolinas. Montcalm's attitude was one of defeat: that Canada was in reality already lost. He wanted to wage war in the European style, relying heavily on the French regulars, and very little on the detested Canadians and Indians. Despite Vaudreuil's knowledge of the Indians, Montcalm's strategy prevailed.[71]

In spite of Montcalm's attitude, Vaudreuil felt it was necessary to use the Indian alliance to the utmost while it was still possible. One of his first objectives was the destruction of Oswego. Recognizing Du Quesne's neglect of the upper country, he believed that if Oswego fell, New France would finally achieve "the perfect attachment of all the Upper Country Indians."[72] Oswego continued to draw the Indian trade regardless of the undeclared war raging in North America. (Britain and France did not officially declare war until May 18, 1756.)

Under the command of Montcalm, a force of French regulars, Canadians, and Indians succeeded in capturing Oswego in August 1756. News of its fall created enthusiasm for the French cause among north country nations. Believing France to be the ultimate victor, almost eighteen hundred Indians volunteered for campaigns in the upcoming year.[73] In Ohio country the Indians did not take the news of Oswego's fall lightly. The commandant of Ft. Du Quesne, writing shortly after the fall of Oswego, remarked that the Indians of his region "appear glad that Chouaguen has fallen, but at the bottom of their hearts they are not satisfied."[74] This was probably because French goods were still very expensive for the Ohio tribes, who had long experience with the cheaper English items. Montcalm let his defeatist attitude show when he said that the taking of Oswego had a worthy effect upon the courage of Indians "belonging" to the French (i.e., the upper Great Lakes tribes). However, the courage "of those, who were like the Huron of Detroit in the depths of their hearts on the side of the English," lowered considerably when they found that strong Oswego had fallen.[75]

Although Indians were essential to the French for scouting and reporting on British military activities, keeping the British on the defensive, spreading fear, and keeping the enemy guessing as to France's true strength, they were also a colossal, seemingly unsolvable problem. For one thing, few of the Indians in the alliance kept their courage when facing disciplined fire from the Anglo-Americans. Likewise, they could not be depended upon to face an enemy using artillery, and virtually all major and minor English strongpoints had artillery of some type. When military affairs were going well for the French, Indian support was very good. However, when the French were faced with an equal number of British troops, or forced to retreat, the Indian support melted away as the Indians simply went home.[76]

Another problem was the regular officers from France. Aside from their obvious dislike of Canadian officers, the Frenchmen looked upon Indians with great contempt. Louis Antoine Bouganville, Montcalm's aide, claimed that Indians in the service of France are "naked, black, red, howling, bellowing, dancing, singing the war song, getting drunk, yelling for 'broth,' that is to say blood, drawn from 500 leagues by the smell of human flesh."[77] Furthermore, Bouganville felt it was next to impossible to utilize the Indians efficiently and in their fullest military capacity.

> We now have six hundred Indians, and hold a council to send them off in detachments, but it is a long job to get them to make up their minds. It requires authority, brandy, equipment, food and such. The job never ends and is very irksome.[78]

Bouganville also wrote that once the Indians had finally been prodded to action, the trouble was not ended.

> At last they get started, and once they have struck, have taken only a single scalp or one prisoner, back they come and are off again for their villages. Then for a considerable time the army is without Indians. Each one does well for himself, but the operation of the war suffers, for in the end they are a necessary evil.[79]

And yet Bouganville was not shortsighted enough to completely discount the importance of New France's Indian alliance. When after the defeat of Fort William Henry by Montcalm's forces in 1757, Montcalm was forced to counsel with the Indian chiefs on the warriors' brutality toward captured prisoners, Bouganville stated, "One sees by this action of the Marquis de Montcalm to what point one is a slave to Indians in this country. They are a necessary evil."[80] Indeed, military plans often had to be altered or postponed in accordance with the availability of sufficient numbers of warriors from the alliance. Also, French officers feared insulting the Indians lest they decide to go home.

Strategic Louisbourg on Cape Breton Island once again fell to the English in 1758. The few supplies and men that had been reaching Quebec via French ships diminished.[81] Any goods the French received had to come, for the most part, from the New England smugglers who operated with such audacity for much of the colonial period.[82] Shortly after Louisbourg fell, another French outpost, Fort Frontenac, surrendered to the British. The Indian nations sensed the shifting tide of battle and grew more receptive to English peace appeals. In the autumn of 1758, the French were forced to destroy their fort at the forks of the Ohio to prevent its falling into the hands of an approaching English army. This, coupled with renewed and vigorous appeals for peace by English officials, caused the Ohio nations to largely abandon the French alliance of 1759.[83]

The upper country Indians remained loyal to the French longer than the Ohio Indians. As late as the summer of 1759, Langlade was still able to bring approximately 1,000 Indians to Montreal.[84] Montcalm very early felt that the upper country was already lost. Writing early in 1758, Montcalm felt that "the war, rendering merchandise dear, has made these posts worth little or nothing."[85] Although he was here speaking about the economic value of the posts to New France, he implied that the terrible expenses involved were not worth the meager return in furs and Indian aid. Seventeen fifty-nine saw the French defeated before Quebec, and by the following year, the Indians of the upper country, despite their "good dispositions" toward the French, were "repairing to the English" in very significant numbers. Governor-General Vaudreuil summed up the French-Indian alliance, as well as the whole Indian situation, when he wrote in June 1760, "The English . . . profit by our scarcity of goods."[86]

France's North American position was never as strong as that of the English colonies. Indeed, Canada not only had a small population unable to defend itself against the powerful English colonies, but it was actually a financial liability to the French

Crown. As Lawrence H. Gipson points out in his multi-volume work on colonial North America, New France's income was almost totally dependent on the fur trade. As a result, France was forced to continually subsidize her North American colony, at a great drain on her own economy. For example, in 1749 the total expenditures for maintaining New France amounted to 2,031,199 livres, while the total income received from Canada was but 233,016 livres. These expenses, due largely to the ineptitude of the indentant Francois Bigot, and the increased efforts to win the Indian tribes, rose dramatically during the 1750's. In 1753, the expenses of New France amounted to 3,495,675 livres, far above the total Canada exported.[87]

France, then, realized that Canada was not a profitable colony. But she also felt that it was essential to keep Canada to prevent further commercial and military expansion of England. (And perhaps because of plain stubbornness and pride.) However, to stockpile arms, ammunition, and supplies and keep a force of French regulars in Canada would have been far too costly. French officials saw an Indian alliance as the answer to their financial and military problems. But the question still arises as to why the Indian alliance, after such strenuous efforts to form it, was not more effective.

The two previous wars fought in eighteenth century North America, Queen Anne's (1702-1716) and King George's (1744-1748), apparently did not teach the French government any useful lessons about either the use of their allies or its own tenuous position. Quite true, the Indians were very important to any engagement in North America simply because of their numbers and their knowledge of the land. To discount them altogether seems foolish, but then so does basing a whole country's defense on them, especially when seen in the light of prior experience. But then, the French and Indian War did not develop into the type of war France anticipated. Perhaps this is the key to understanding the French Indian policy.

France was weak on the North American continent. This fact was recognized both in France and in Canada, as was the financial drain the colonies imposed. It was far cheaper to base the defense on Indians rather than on conventional troops when the war was expected to be short and fought mainly in the wilderness, and not to escalate past the colonies. England realized how important the tribes were and sought to deprive France of them. England succeeded in doing so not by the use of land forces or trade, but by striking at France's navy.

A weak navy, more than the lack of money or of high quality goods, caused the alliance and hence New France to fall. When it was realized in 1760 that a strong navy was needed if Britain was ever to be defeated, it was already too late. The vital lessons of King George's War had been ignored. Canada's defeat was foretold as early as June 1755, when French transports and warships were seized by the Royal Navy. The Indian alliance was only as strong as the stock of French goods at the various posts, and the display of military strength that Canada could muster, and both of these were tied to the success of French armies and fleets back in Europe.

Notes

[1] Extract from an enumeration by an unknown person, October 12, 1736, in Wisconsin State Historical Society, *Collections of the State Historical Society of Wisconsin*, 21 vols. (Madison: State Historical Society, 1854-1931), vol. 17: *The French Regime in Wisconsin-II, 1727-1748*, edited by Reuben G. Thwaites, pp. 245-252. Hereafter cited as *Wisconsin Collections*.

[2] Colonel Henry Bouquet, 1764. "Names of different Indian Nations in North America, with the Numbers of their Fighting Men. Historical Account of the Expedition against the Ohio Indians in 1764," London and Philadelphia, 1766, cited in U.S. Bureau of Indian Affairs, *Information Respecting the History, Condition and Prospects of the Indian Tribes of the United States*, by Henry

R. Schoolcraft, *Ethnological Researches Respecting The Red Man of America,* 6 parts (Philadelphia: Lippincott, Grambo and Co., 1853; reprint ed., Ann Arbor, Michigan: Xerox University Microfilms, 1974), 3:559.

[3] Lawrence H. Gipson, *The British Empire Before the American Revolution,* vol. 5: *Zones of International Friction, The Great Lakes Frontier, Canada, the West Indies, India, 1748-1754;* 16 vols. (New York: Alfred A. Knopf, 1942), pp. 50-51.

[4] Lawrence H. Gipson, *The British Empire Before the American Revolution,* vol. 4: *Zones of International Friction, North America South of the Great Lakes Region, 1744-1754;* 16 vols. (New York: Alfred A. Knopf, 1939), p. 146.

[5] *Ibid.,* p. 147.

[6] New York Colonial Documents, IX, 404-409, quoted in Gipson, vol. 5: *The Great Lakes Frontier,* p. 45.

[7] Norman W. Caldwell, *The French in the Mississippi, 1740-1750,* Perspectives in American History Series, no. 2 (Urbana, Illinois: University of Illinois Press, 1941; reprint ed., Philadelphia: Porcupine Press, 1974), p. 51.

[8] George F. G. Stanley, *New France, The Last Phase, 1744-1760* (Toronto, Canada: McClelland and Steward Limited, 1968), p. 76.

[9] Pouchot, *Memoir on the Late War,* II, p. 49, as cited by Caldwell, *French in the Mississippi Valley,* p. 47 n. 33, lists the following as common trade articles at the posts: hunting guns, lead, balls, powder, steel for striking fire, gun-flints, gun screws, knives, hatchets, kettles, beads, men's shirts, cloth (red and blue) for blankets and petticoats, vermillion and verdigris, tallow, blue and green ribbon of English weaving, needles, thread, awls, blue, white and red rateen for making moccasins, woolen blankets of three points and a half, three, two and one and a half of Leon cloth, mirrors framed in wood, hats trimmed fine, and in imitation, with variegated plumes or in red, yellow, blue and green, hoods for men and children of fringed rateen, galloons, real and imitation, brandy, tobacco, razors for the head, glass in beads made after the fashion, wampum, black wines, and paints.

[10] W. J. Eccles, *The Canadian Frontier, 1534-1760* (New York: Holt, Rinehart, and Winston, Inc., 1969), p. 151.

[11] Captain William Trent, *Journal of Captain William Trent from Logstown to Pickawillany, A.D. 1752.* Edited by Alfred T. Goodman (Cincinnati: R. Clarke and Co. for W. Dodge, 1871; Microfiche, Library of American Civilization, LAC 16624, n.d.), p. 15.

[12] Gipson, vol. 4, *North America South of the Great Lakes,* p. 174.

[13] Trent, *Journal of William Trent,* p. 15.

[14] See Memoir of Raymond to the French Minister, November 2, 1747, in *Wisconsin Collections,* 17:474-475; and Trent, *Journal of William Trent,* pp. 17-18. Trent recounted the tribes and conspiracy in an extended footnote.

[15] Trent, *Journal of William Trent,* p. 21 n. Nicholas was pardoned for his part in the rebellion provided he help maintain peace. However, he soon began to invite English traders back to his village. When the French heard of this, they ordered punitive measures be taken; Nicholas then decided to leave for the west.

[16] Thwaites, *Wisconsin Collections,* p. xvii.

[17] Memoir of Raymond to the French Minister, November 2, 1747, in *Wisconsin Collections,* 17: 475. Although the French blamed all the English in general, the rebellion was aided by independent English traders and was not officially sanctioned by the colonial governments. What aid there was to the Indians was too little too late.

[18] *Ibid.,* p. 476.

[19] *Ibid.*

[20] Colden to Peter Collinson, December ?, 1743, The Colden Papers, New York Historical Society Collections, 1919, III, pp. 42-44, quoted in Caldwell, *French in the Mississippi Valley,* p. 51.

[21] Philip Livingston to Storke and Gainsborough, 31 October, 1734, Manuscripts Miscellaneous, V. New York State Library, as quoted in Douglas E. Leach, *Arms for Empire, A Military History of the British Colonies in North America, 1607-1763* (New York: Macmillan Co., 1973), p. 177.

[22] Caldwell, *French in the Mississippi Valley,* p. 5.

[23] La Galissoniere and Hocquart to the French Minister, October 7, 1747, in *Wisconsin Collections,* 17:470.

[24] La Galissoniere to the French Minister, October 23, 1748, in *Wisconsin Collections,* 17:503.

[25] W. J. Eccles, *France in America.* The New American Nation Series, edited by Henry S. Commager and Richard B. Morris (New York: Harper and Row Publishers, Inc., 1972), p. 179.

[26] French minister to La Galissoniere, 12 February 1748, in *Wisconsin Collections,* vol. 18: *The French Regime in Wisconsin, 1743-1760, The British Regime in Wisconsin, 1760-1800. The Mackinac Register of Marriages, 1725-1821,* edited by Reuben G. Thwaites, p. 11.

[27] *Ibid.* Chippewa bands had attacked French boats on Lake St. Clair.

[28] French minister to La Jonquiere, May 4, 1749, in *Wisconsin Collections,* 18:22. This letter was

written to new Governor-General, La Jonquiere, but it refers to Galissoniere's requests and actions.

[29] Memoir of the king, April 30, 1749, in *Wisconsin Collections,* 18:19.

[30] New York Colonial Documents and Colonial Records of Pennsylvania, as quoted in Trent, *Journal of William Trent,* p. 22 n.

[31] Beauharnois to the French minister, October 9, 1744, in *Wisconsin Collections,* 17:443. Although this statement is attributed to Beauharnois, the previous Governor-General, it applies to the situation as Galissoniere found it in 1748-1749.

[32] Caldwell, *French in the Mississippi Valley,* p. 63.

[33] *Ibid.,* p. 52.

[34] *Ibid.,* p. 53.

[35] Bigot to the French minister, October 22, 1748, in *Wisconsin Collections,* 17:502.

[36] French minister to La Jonquiere and Bigot, May 4, 1749, in *Wisconsin Collections,* 18:26.

[37] *Ibid.*

[38] La Jonquiere and Bigot to the French minister, October 9, 1749, in *Wisconsin Collections,* 18:34.

[39] Gipson, vol. 5, *International Friction, The Great Lakes Frontier,* p. 62, gives an excellent example of the great price disparity in the period 1734 to 1748. The English offered 92 sols for any grade beaver skin, whereas the French offered 55 sols a pound for winter grade skins.

[40] La Jonquiere and Bigot to the French minister, October 9, 1749, in *Wisconsin Collections,* 18:34.

[41] French minister to La Jonquiere, May 4, 1749, in *Wisconsin Collections,* 18:23-24.

[42] La Jonquiere to the French minister, September 27, 1750, in *Wisconsin Collections,* 18:70.

[43] Caldwell, *French in the Mississippi Valley,* pp. 55-56. Caldwell presents some interesting examples of how the French sought to deal with the *coureurs de bois;* deportation and use as privateers.

[44] La Jonquiere to the French minister, September 29, 1750, in *Wisconsin Collections,* 18:73.

[45] La Jonquiere to the French minister, October 5, 1751, in *Wisconsin Collections,* 18:99.

[46] From 1730-1734, the French had attempted to destroy the Fox nation, who were an obstacle to their fur trade. They ruthlessly pursued the Fox far beyond what would have been necessary, despite pleas by other tribes to stop. This made the Indians not only fear what the French could do, but it also made the tribes very apprehensive of them.

[47] Caldwell, *French in the Mississippi Valley,* pp. 64-65.

[48] Longueil to the French minister, April 25, 1752, in *Wisconsin Collections,* 18:116.

[49] *Ibid.,* p. 112.

[50] Gipson, vol. 4, *International Friction, South of the Great Lakes,* pp. 188-189.

[51] Anderson, *Scraps,* Du Semetiere Papers, Library Company of Philadelphia, quoted in Gipson, *International Friction, South of the Great Lakes,* pp. 188-189 n.2, gives the following table of the value of deer skins:

A Buck is a Buck-skin
A Buck is equal to hundred grains of black wampum
A d° . . . to two hundred grains of white wampum
A d° . . . to two doe skins
A d° . . . to one otter skin
A d° . . . to one Beaver skin
A d° . . . to two Small Beaver skins
A d° . . . to five foxes skins
A d° . . . to six raccoons skins

[52] Lords to Gooch, March 4, 1748/9, Virginia Correspondence, 439-443, Public Records Office, Colonial Office, 5 V. 1366, quoted in Caldwell, *French in the Mississippi Valley,* p. 96 n. 44.

[53] Gipson, vol. 4, *International Friction, South of the Great Lakes,* pp. 153-154.

[54] Trent, *Journal of William Trent,* p. 11.

[55] Gipson, vol. 4, *International Friction, South of the Great Lakes,* pp. 184-185.

[56] See Eccles, *The Canadian Frontier,* p. 156; and Reuben Gold Thwaites, *France in America, 1497-1763* (New York: Harper and Brothers Publishers, 1905; reprint ed., Westport, Conn.: Greenwood Press, 1970), pp. 152-153.

[57] Instructions to the commissioners, Virginia Magazine of History and Biography, XIII, pp. 147-152, quoted in Gipson, vol. 4, *International Friction, South of the Great Lakes,* p. 253 n. 69.

[58] Journal of Celoron, 1749, in *Wisconsin Collections,* 18:36, 39.

[59] *Ibid.,* pp. 42-56.

[60] *Ibid.,* p. 57.

[61] Memoir of the King, April 30, 1749, in *Wisconsin Collections,* 18:17.

[62] Eccles, *The Canadian Frontier,* p. 159.

[63] Ohio Company Papers, I, pp. 7, 17, cited in Gipson, vol. 4, *International Friction, South of the Great Lakes,* p. 207.

[64] See Du Quesne to the French minister, October 25, 1752, in *Wisconsin Collections,* 18:129 n. 67; and Gipson, vol. 4, *International Friction South of the Great Lakes,* pp. 222-223.

[65] Eccles, *The Canadian Frontier,* p. 162.

[66] Gipson, vol. 4, *International Friction, South of the Great Lakes,* pp. 307-310.

[67] Eccles, *The Canadian Frontier,* p. 166.

[68] Lawrence H. Gipson, *The British Empire Before the American Revolution,* vol. 7: *The Vic-*

torious Years, 1758-1760; 16 vols. (New York: Alfred A. Knopf, 1949), pp. 63-64.

[69] See Alfred T. Mahan, *The Influence of Sea Power Upon History,* 12th ed. (Boston: Little, Brown and Co., 1947), pp. 284-285; and William M. James, *The Influence of Sea Power on the History of the British People,* The Les Knowles Lecture on Military History for 1947 (Cambridge: The University Press, 1948), p. 14.

[70] Mahan, *Influence of Sea Power Upon History,* p. 291. Spain joined the war on France's side in January 1762, adding 46 ships-of-the-line. However, to quote Mahan, ". . . it may well be doubted if its worth were equal to its numbers."

[71] Eccles, *France in America,* pp. 188-190. Montcalm and Vaudreuil eventually became very bitter enemies, which did not help the war effort.

[72] New York Colonial Documents, X, p. 309, quoted in Stanley, *New France, The Last Phase,* p. 97.

[73] New York Colonial Documents, X, p. 630; and "Journal of Levis," in Levis MSS., i, pp. 89-91, cited in Thwaites, *Wisconsin Collections,* 18: 196 n. 49.

[74] M. Dumas to M. de Makarty, August, 1756, in *Wisconsin Collections,* 18:164.

[75] Journal of Montcalm, November 21, 1756, in Casgrain, Levis Manuscripts, in *Wisconsin Collections,* 18:164 n. 6.

[76] Stanley, *New France, The Last Phase,* pp. 98-99.

[77] Louis Antoine de Bouganville, *Adventure in the Wilderness: The American Journals of Louis Antoine de Bouganville, 1756-1760,* trans. and ed. Edward P. Hamilton (Norman, OK: University of Oklahoma Press, 1964), p. 331.

[78] *Ibid.,* p. 36.

[79] *Ibid.,* p. 60.

[80] *Ibid.,* p. 170.

[81] See Mahan, *Influence of Sea Power Upon History,* p. 294; and Leach, *Arms for Empire,* p. 419. France did not make the mistake of neglecting her navy after 1760. By then, however, it was too late. By the outbreak of the American Revolution, many historians have felt France's rebuilt navy equalled or surpassed Britain's.

[82] Lawrence H. Gipson, *The Coming of the American Revolution,* ed. Henry S. Commager and Richard B. Morris, New American Nation Series (New York: Harper and Row, 1954), p. 28.

[83] Idem, vol. 7, *Victorious Years, 1758-1760,* pp. 278-279, 283-284.

[84] Memoir of Pouchot, May, 1759, in *Wisconsin Collections,* 18:211.

[85] Extract from Montcalm's journal, December 10, 1758, in *Wisconsin Collections,* 18:206.

[86] Vaudreuil to the French minister, June 24, 1760, in *Wisconsin Collections,* 18:217.

[87] Gipson, vol. 5, *International Friction, The Great Lakes Frontier,* pp. 25-27.

RICHARD T. ELY AND THE DEVELOPMENT OF THE EUROPEAN SOCIALIST AND LABOR COLLECTIONS AT THE UNIVERSITY OF WISCONSIN-MADISON

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In 1890 the University of Wisconsin was an aspiring but undistinguished school with a modest program of instruction and a library of 19,000 volumes. During the next decade a dramatic transformation of its educational program took place, "in intellectual as well as in material terms, in direction as well as in organization."[1] Inevitably, this rapid but necessarily uneven expansion was accompanied by academic growing pains in curriculum planning and in library development. It became a matter of concern to the university administration that the natural and physical sciences were assuming a disproportionate role in the curriculum and in the disposition of research funds. To achieve a more equitable balance of faculty interests, President Thomas C. Chamberlin, though a geologist, decided to build up the social sciences at Wisconsin by recruiting research scholars trained at the leading universities in the East.

Two years later, in 1892, President Chamberlin announced the formation of a School of Economics, Political Science, and History which would offer practical training in citizenship as well as advanced work in public administration. Its instructional program would aspire to do "for civic life what West Point did for the military."[2] Chamberlin's proposal evoked a quick and favorable response from the local newspapers, from the alumni of the university, and especially from the faculty. Frederick Jackson Turner, then a young history professor, warmly supported this new school "which would allow Wisconsin to build a graduate program in the social sciences more prestigious than Chicago's. It will be the center of post-graduate work in the Northwest."[3]

As the Director of this newly organized school, Chamberlin appointed one of the country's leading economists, Professor Richard T. Ely of Johns Hopkins University, who had taught John R. Commons, Frederick Jackson Turner, and Woodrow Wilson, among others. Ely immediately became Wisconsin's most distinguished faculty member and retained this position for 33 years until his retirement in 1925.[4] He was induced to leave the East by an offer of $3500 a year, a substantial salary for those days, and the unprecedented sum of $5000 for the purchase of library materials. This sum represented a considerable outlay of public funds since the entire library book budget was then $3000 annually. A decade later another $2500 was made available to Ely for special purchases in the social sciences. "Without a good library," the Board of Visitors noted approvingly, "you cannot possibly have a first class university."[5]

Since his main interest was then in the labor movement and in economic reform, Professor Ely confined his purchases largely to books in these fields. "The labor movement in its broadest sense" he wrote, "is the effort of men to live the life of men. It is the systematic organized struggle of the masses to attain, primarily, more leisure and larger economic resources.—Man shall never become truly prosperous so long as any class of the population is materially wretched."[6] At Johns Hopkins, Ely had championed gas-and-water socialism and strict Federal management of the country's mineral and forest reserves. He had made many friends among middle class reformers and Christian socialists in the East whose financial assistance he now sought for the acquisition of research materials. He was later assisted in this endeavor by John R. Commons who joined his faculty in 1904 and took over Ely's project of collecting documents on American labor history.

"I am a firm believer in the principle of state universities," Ely informed President Chamberlin, "but I think that private philanthropy should cooperate within the state in their development."[7] In 1900, a favorable opportunity to stimulate private contributions occurred when an important collection of the works of Robert Owen was offered for sale by an English bookseller. Ely immediately wrote to a number of prominent Wisconsinites of Scottish descent asking them to underwrite the cost of the works of the "Sage of New Lanark." Robert Owen was, of course, a Welshman, but his most significant reforms were carried on in Scotland, and he had become a beloved figure there. Ely was successful in this nationalistic approach, the required sum was soon subscribed and the collection purchased. That same year he raised $2000 from the German community in Milwaukee for the purchase of German language books on European economic problems. A few years later Ely's close friend William Dodge, a railroad tycoon from New York City, added $500 to the fund for the new school.

In the East, Ely had pioneered in the seminar method of graduate instruction, which he continued at Wisconsin. Over the years he offered seminars on such professional topics as Economic Theory, Economic History, and German Socialism.[8] They included research reports as well as general discussion of current literature.

While still at Johns Hopkins, Professor Ely had written a history of French and German socialism and had lectured widely on this subject. In the course of a series of Chautaqua appearances, he met William English Walling, a wealthy social reformer "who was then perhaps the most provocative mind in American socialism."[9] Walling was a founder of the NAACP and a charter member of the League of Industrial Democracy. Through Walling's generosity, several hundred books on European economic thought were presented to the University library in 1907. Approximately 200 of these volumes were kept in Madison, and the duplicates sold to the University of Illinois for $1500.[10] In the following year Walling purchased over eight hundred volumes from the personal library of Herman Schlueter, the veteran editor of the socialist *New Yorker Volkszeitung*. Walling gave the American titles to the Wisconsin State Historical Society, and the European portion, consisting of some 600 titles, to the University library. These works were welcome additions to both libraries. Thanks to Milwaukee's Victor Berger, socialism enjoyed greater public esteem in Wisconsin than it did in most other midwestern states. It had, in fact, become "synonymous with honest, humane municipal government."[11]

The European portion of the Schlueter collection pertained largely to German socialism and to the First International. The most important single item was unquestionably Friedrick A. Sorge's manuscript report on the Amsterdam meeting of the First International in 1872, which was published much later by the University of Wisconsin Press.

> There was also a wealth of material on the German Social-Democratic Party, including minutes of meetings and election handbills and posters. On the revolution of 1848 there is a considerable body of contemporary pamphlets, books and periodicals. Also impressive were the periodicals of later years, particularly those published in the seventies and eighties, which, like those of the forties, are to be found in few American libraries. Of the books written by important socialist and labor leaders of Germany there was a gratifying array. A group of socialist song books was also in the collection. And as a dash of spice, there were the books of about seventy literary figures whose novels, essays, and poetry could be characterized as socially progressive. But one would search in vain for

materials pertaining to individual labor unions, for seemingly Schlueter was interested only in books that dealt with theory and the problems of political organization.[12]

Walling's donations formed the nucleus of the European socialist collections in the University Library. His influence and his interest in Wisconsin did not stop there, however. Later, in 1909, it was Walling who sent the then nineteen year old Selig Perlman to Madison to study under John R. Commons.[13] Perlman was to become a distinguished member of the Wisconsin Economics faculty and the library collections were to benefit greatly from his wide knowledge of the European scene. Other Wisconsin scholars whose work touched on aspects of socialism included William Scott, Edward A. Ross, and Frederick Ogg.

In the summer of 1913 Richard T. Ely made a trip to Ireland in order to study a development which he believed to be unique in history, the transfer of ownership of a large part of the island from one economic class to another.[14] He decided to collect materials for the study of Irish history, its economic problems and culture. Back in Madison, Ely sought the help of Monsignor Patrick B. Knox, a Catholic priest who passed on Ely's request for funds to several prominent Irishmen. A generous gift was then made by the Ancient Order of Hibernians for the purchase of books which were presented on March 14, 1914 at a special ceremony in the State Historical Society Building. Most of these materials were added to the Historical Library at that time but were later transferred to the University Library when the division of fields was established.

Meanwhile despite Ely's efforts the library was not keeping abreast of other state universities with "which Wisconsin was fond of comparing itself."[15] By 1920 the University of Wisconsin Library had only 480,000 volumes, ranking well below such comparable midwestern institutions as Michigan, Minnesota, Illinois, and Chicago. Housed with the State Historical Society in a building completed in 1900, its physical quarters were already congested and "disgracefully overcrowded."[16] Enrollments rose steadily from seven to twelve thousand undergraduates while appropriations for books and periodicals stagnated. Although the librarians complained constantly of the shortage of book funds and the "painfully inadequate" provisions for undergraduates, little was done to improve this situation. Temporary relief was secured by the establishment of branch libraries and the removal of the reserve collections to the basement of Bascom Hall, but the stacks soon became crowded again.[17] In the 1930's the idea of a separate undergraduate library was briefly considered and rejected.[18] It was apparent after this rebuff that "the library was not particularly well thought of in university circles."[19] Consequently, building collections of specialized materials for intensive use by a few researchers was out of the question. It appears that faculty members of this period relied heavily on their own private libraries and a liberal leave policy in order to carry on their research projects.

In September, 1937, Louis Kaplan, a recent graduate of the University of Illinois Library School with a Ph.D. in European history from Ohio State, was named chief of reference at the university library. He brought to this newly created position a mind trained for scholarly research, and consequently a comprehension of the needs of scholars.[20] Kaplan began his long tenure at Wisconsin by building up a reference collection through purchases, stack transfers, and the creation of special files. He also formed a wide acquaintance with the faculty who kept him appraised of their research needs and interests. In 1949 Kaplan was appointed Associate Director for Public Services, assuming a heavy responsibility for collection development. In this capacity, he became the prototype of all the later subject bibliographers at Wisconsin.[21]

Wisconsin's socialist collections, established by Ely, presented a rare opportunity to build on existing resources. Prices were still relatively low for many books in this field, and inexpensive copies of early imprints frequently came on the market. Kaplan gradually identified the gaps in Wisconsin's collections and built up an extensive want list on the back of old catalog cards. Dealers' prices for books purchased and for books missed were recorded along with Kaplan's bibliographic notes on editions and rarities. He purchased mainly periodical runs, trade union publications, tracts, and specialized monographs. Many of the important works were acquired from Hugo Streisand in Berlin and from H. P. Kraus in New York. To supplement this historical collection with more recent titles Kaplan reacommended that Wisconsin assume original responsibility for the Farmington Plan's coverage of Social Reform Communism, anarchism, Socialism, and nihilism (LC categories HN and HX). From their specialized dealers a steady flow of these publications now began to enter the university library. A new building, completed in 1953, solved the storage problem for the time being.[22]

Believing strongly that source materials of this quality ought to be known and used by the national and even the international community of scholars, Kaplan set out to publicize Wisconsin's holdings of "socialistica." In 1953 he wrote a bibliographical essay for *College and Research Libraries* on socialist rarities, "their prices on the current market, and (the holdings) of leading library collections."[23] Four years later he published a descriptive article on Wisconsin's collection of books, periodicals, newspapers, and labor party reports.[24] When Kaplan became Director of the University Libraries in the late fifties, he turned over his "want file" of socialist titles to the newly appointed Social Studies librarian who continued to select heavily in this field. At Kaplan's suggestion the Social Studies librarian located and acquired copies, mostly on microfilm, of most of the stenographic reports of the early French Socialist Congresses, bringing together at Madison the most complete sets of these reports in North America.[25] Also about this time Kaplan, through the auspices of Professor Perlman, acquired for the university the personal papers of the late William English Walling.[26]

In succeeding years, Wisconsin's socialist collections continued to grow and prosper, partly through a standing order with the West German dealer Harrassowitz for "underground literature" and partly through the selection of the library's bibliographers. Richard T. Ely's modest initial investment in socialism has doubled and tripled in value. Today, these extensive holdings are recognized as a major international resource of interest to scholars in many fields of study.

Notes

[1] Merle Curti and Vernon Carstenson, *The University of Wisconsin: A History 1848–1925*. (2 vols., Madison: University of Wisconsin Press, 1949):I., 501.

[2] Benjamin G. Rader, *The Academic Mind and Reform: The Influence of Richard T. Ely*. Lexington, Kentucky: University of Kentucky Press, 1966. p. 112.

[3] Ray Billington, *Frederick Jackson Turner, Historian, Scholar, Teacher*. New York, Oxford, 1973. p. 91.

[4] "Inventory," Richard T. Ely, Papers *Wisconsin State Historical Society*.

[5] Elsie A. Fansler, The University of Wisconsin Library: A History (1848-1953) M.S. Thesis. University of Wisconsin, 1953, p. 25.

[6] Richard T. Ely, *Ground Under Our Feet: An Autobiography*. New York: Macmillan, 1938. p. 607.

[7] Richard T. Ely to President Chamberlin. January 11, 1892 in Ely Correspondence *Wisconsin State Historical Society* MS., 1892, Box 8.

[8] On this point see Wisconsin State Historical Society MSS 411. Ely Papers. Box 35-36. 3M/29 L-2-H6, particularly the file on 1900-01. German Socialism.

[9] Donald G. Egbert, ed. *Socialism and American Life*. 2 vols., Princeton, 1952. I., 312.

[10] Richard T. Ely, "Additional Statement in the Matter of John R. Commons, and the Work of the American Bureau of Industrial Research, April

1, 1909," *University Archives,* Presidents' Papers. General Subject Files (B Series) 1893-1949. Miscellaneous, 1906-1923 4/0/1. Box 21.

[11] Robert C. Nesbit, *Wisconsin: A History.* Madison: University of Wisconsin Press, 1973. p. 390.

[12] Louis Kaplan, "The William English Walling Collection (The Herman Schlueter Collection)," *U. W. Library Staff News,* vol. V. (1960), no. 1, p. 1.

[13] Thomas W. Gaveth, "Some Early Labor Economists: Richard Theodore Ely, John Rogers Commons, Jacob Harry Hollander, George Ernest Barnett, Robert Franklin Horie," M.S. Thesis, University of Wisconsin, 1954, p. 39.

[14] Lloyd W. Griffin. "Library of Irish History and Literature," *U. W. Library News.* February, 1959. IV no. 2, *Milwaukee Sentinel* March 8, 1914.

[15] Curti and Carstenson. *The University of Wisconsin.* II, 308; See also George Alan Works. *College and University Library Problems* Chicago, ALA, 1927. p. 125-26.

[16] Wisconsin University. Regents Business Report for 1918-20. p. 230. *University Archives.;* Clifford L. Lord and Carl Ubbelohde. *Clio's Servant: The State Historical Society of Wisconsin* (Madison: State Historical Society, 1967.) p. 123ff.

[17] L. C. Burke, Compiler. "Some Notes on the History of the University of Wisconsin Library—Its Branches and Collections." Madison: 1946. Rare Books Room, MS. p. 1.

[18] Wisconsin University. Faculty Minutes, Monday, December 7, 1936, p. 15-16. *University Archives.*

[19] Theodore Blegen and Keyes Metcalfe, "A Survey of the Libraries of the State Historical Society of Wisconsin and the University of Wisconsin," Summer, 1943, p. 3. Alan Bogue and Robert Taylor, eds. *The University of Wisconsin: One Hundred and Twenty-Five Years.* Madison: University of Wisconsin Press, 1975, p. 75.

[20] Wisconsin University. Libraries. Annual Reports 1937-1938, *University Archives* 22/1/1, box 1.

[21] Interview with Louis Kaplan, February, 1976.

[22] Gerhard B. Naeseth. "The Libraries Grow and Expand," *A Resourceful University. The University of Wisconsin-Madison In Its 125th Year.* Madison: University of Wisconsin Press, 1975. p. 209.

[23] Louis Kaplan, "Socialistica of 1800-1850: Rarities and Leading Collections," *College and University Libraries,* October, 1953.

[24] Louis Kaplan, "Sources For the Study of European Labor and Socialism (1840-1914) at Wisconsin." *College and Research Libraries,* March, 1957.

[25] Jack A. Clarke, "French Socialist Congresses, 1876-1914," *Journal of Modern History,* June, 1959.

[26] Louis Kaplan to Alfred W. Peterson, December 9, 1956, Manuscript Collections. Rare Book Room.

THE INFLUENCE OF REGULATION ON TOP LEVEL EXECUTIVE COMPENSATION FOR LARGE CORPORATIONS

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Abstract

Recently, attention has been focused upon studies of individual decision makers in the organizational setting. This study concerns the compensation of the chief executives of large corporations as it is influenced by regulation. In contrast to most other studies, executive compensation in this study includes gains from stock options as well as salary and bonuses. This empirical research demonstrates a difference in levels of executive compensation between large utilities and large industrial corporations and suggests an explanation for this difference.

Introduction

The chief executive officer is at the apex of the organizational structure. He is a key decision maker affecting the firm's behavior. The factors that motivate him influence his role as a decision maker. Of many such factors, compensation is an important one. Much of the current theoretical work places great emphasis on internal decision processes and motivation and behavior of executives. Assumptions about the effects of compensation upon these decision processes are often critical. Recently, Harvey Leibenstein suggested an alternative to the traditional micro theory called micro-micro theory. He differentiated his theory from the well known "complex objective function" theories: those associated with the names Tibor Scitovsky, William J. Baumol, Robin Marris, Herbert Simon and Oliver E. Williamson. The common element in the property rights approach, managerial theories and micro-micro theory is that they all study individuals within organizational contexts. This study concerns the compensation of the chief executives of large corporations as it is influenced by regulation. Empirical studies of chief executives' compensation are not new, however, empirical studies of the influence of regulation on chief executive compensation for large corporations are new. Also in this study gains from stock options are included as part of total compensation.

Background of the Study

The chief executive maximizes his utility subject to the limits established by the existing organizational structure. The rates that a public utility is permitted to charge are set at levels which are intended to allow the utility to cover its costs and earn a fair rate of return. In effect, regulation imposes a ceiling on the profits a regulated firm can earn.

The property rights theories offer explanations of the behavior of executives working for firms under regulation. Because of regulation, there is attenuation of the rights of chief executives over the residual profits. Thus executives will have incentives to strive for profits above the legal limit provided they can conceal such profits from the regulators and capture them, which to some extent they can do. Better offices, more congenial colleagues, and more relaxed business operations with shorter hours, for example, are means of "converting" potential profits into "higher cost" activities. The foregoing

TABLE 1. Summary Results of the Tests for Hypothesis.

Year 1976	Year 1977	Year 1978
$\bar{X}^1_{TCOMP_1} = 532.98; S_1 = 299.42; n_1 = 114;$	$\bar{X}^1_{TCOMP_1} = 530.96; S_1 = 228.28; n_1 = 107;$	$\bar{X}^1_{TCOMP_1} = 649.54; S_1 = 450.00; n_1 = 103;$
$\bar{X}^2_{TCOMP_2} = 189.85; S_2 = 85.61; n_2 = 34;$	$\bar{X}^2_{TCOMP_2} = 202.72; S_2 = 87.21; n_2 = 32;$	$\bar{X}^2_{TCOMP_2} = 230.97; S_2 = 96.85; n_2 = 31;$
$s_{\bar{x}_1-\bar{x}_2} = \sqrt{\frac{(299.42)^2}{114} + \frac{(85.61)^2}{34}} = 31.65$	$s_{\bar{x}_1-\bar{x}_2} = \sqrt{\frac{(288.28)^2}{107} + \frac{(87.21)^2}{32}} = 26.92$	$s_{\bar{x}_1-\bar{x}_2} = \sqrt{\frac{(450.00)^2}{103} + \frac{(96.85)^2}{31}} = 47.63$
$z = \frac{(532.98 - 189.85)}{31.65} = 10.84;$	$z = \frac{(530.96 - 202.72)}{26.92} = 12.19;$	$z = \frac{(649.60 - 230.97)}{47.63} = 8.79;$

Reject the Null Hypothesis at %5 level of significance; in otherwords the Alternate Hypothesis is accepted

[1] Mean executive compensation (including stock option gains) for the non-regulated firms.
[2] Mean executive compensation (including stock option gains) for the regulated firms.
(s = standard deviation; n = sample size)

analysis can be stated as a hypothesis: Executive compensation is higher for non-regulated firms than for regulated firms.

Methodology

Data were divided into large industrial corporations and the large utilities: over 100 large industrial corporations were compared with over 30 large utilities. This research is cross-sectional in character and the years chosen for the study were 1976, 1977, and 1978. Major sources of data were, *Fortune, Business Week,* proxies filed with the Security Exchange Commission and COMPUSTAT tapes.

The method uses traditional hypothesis testing of the null hypothesis. The basic format is as follows:

1) Null hypothesis H_0: $\mu_1 - \mu_2 \leq 0$

2) Alternate hypothesis H_1: $\mu_1 - \mu_2 > 0$

where μ_1 is defined as the population mean compensation of chief executive officers of all the firms in the non-regulated industries and μ_2 is the population mean compensation of chief executives of all the firms in the regulated industries. The alternate hypothesis states that executive compensation is higher for non-regulated firms than for regulated firms. The rationale for this hypothesis is described above. Further, since corporation assets may influence compensation, a similar calculation was run using the mean of compensation divided by assets for each corporation, to correct for differences in assets.

Empirical Results

In order to test for the hypothesis, the statistical test using equations 1) and 2) above was calculated, as shown in Tables 1 and 2. The sample size varied somewhat from year to year, but for the non-regulated firms *n* was around 100 and for the regulated firms *n* was a little over 30 each year.

From the results as shown in Table 1, based on 1976, 1977 and 1978 data, the null hypothesis is rejected; therefore the alternate hypothesis is accepted.

A similar test was conducted combining the data for all 3 years of 1976, 1977, and 1978. The combined sample size of non-regulated firms was more than 300 and for regulated firms was nearly 100. Table 2,

Table 2. Summary Results of the Tests for Hypothesis.
(Combined data, 3-year means for 1976, 1977, and 1978)

(A)	(B)
$\bar{X}^1_{TCOMP_1} = 569.49;\ S_1 = 345.39;\ n_1 = 313;$	$\bar{X}^3_{1Y1} = 0.238;\ S_1 = 0.215;\ n_1 = 313;$
$\bar{X}^2_{TCOMP_2} = 207.24;\ S_1 = 90.57; n_2 = 97;$	$\bar{X}^4_{2Y1} = 0.056;\ S_2 = 0.034;\ n_2 = 97;$
$s_{\bar{x}_1-\bar{x}_2} = \sqrt{\frac{(345.39)^2}{313} + \frac{(90.57)^2}{97}} = 21.58$	$s_{\bar{x}_1-\bar{x}_2} = \sqrt{\frac{(.215)^2}{313} + \frac{(0.034)^2}{97}} = 0.012$
$z = \frac{(569.49 - 207.24)}{21.58} = 16.79;$	$z = \frac{(0.238 - 0.056)}{0.012} = 14.96;$

Reject the Null Hypothesis at 5% level of significance; in other words the Alternate Hypothesis is accepted.

[1] Mean executive compensation (including stock option gains) for the non-regulated firms.
[2] Mean executive compensation (including stock option gains) for the regulated firms.
[3] $\bar{X}_{1Y1}$ is the mean of compensation ÷ assets for non-regulated firms.
[4] $\bar{X}_{2Y1}$ is the mean of compensation ÷ assets for regulated firms.

(s = standard deviation; n = sample size) part A is based on total compensation, which includes salary, bonus and stock option gains. Means of executives' compensation ($\bar{x}_{Tcomp}$), their standard deviation (S) and sample size (n) are presented. From the results of this table, the null hypothesis is rejected, which also means the alternate hypothesis is accepted.

Table 2, part B contains the results of compensation which includes salary, bonus and stock option gains, but for each corporation these values are deflated by the assets. Means of executives' compensation deflated by assets, their standard deviation and sample sizes are presented. From the results of this table, once again, it is seen that the null hypothesis is rejected.

Overall, these tests provided conclusive evidence for accepting the alternate hypothesis developed in this paper: i.e. executive compensation is higher for non-regulated firms than for regulated firms.

Conclusions

This research is focused on the individual, the chief executive officer of the large corporation. From the empirical evidence based on the sample, this research shows that the executives (individuals) can be studied in the organizational context. The theory of property rights explains the differences in regulated and non-regulated property organizations. Because of these differences, it is probable that the executives of regulated corporations compensate for lower monetary rewards by more comfortable surroundings shorter hours, and perquisites, which are not budgeted as compensation and are not taxable to the individual.

This study differs from most of the earlier studies in the following aspects: inclusion of the gains from stock options, the influence of regulations on executive compensation, the influence of corporate assets and the use of more recent data from 1976, 1977 and 1978. It brings out the role of regulation which may have policy implications for management and ownership of the large corporations.

References

Alchian, A. and H. Demsetz, "Production Information Costs, and Economic Organization," *American Economic Review,* December 1972.

Baumol, W. J., *Business Behavior, Value and Growth,* Revised Edition, Harcourt Brace and World, Inc., New York, 1967.

Coase, R. H., "The Nature of the Firm," *Economica,* November 1937.

Demsetz, H., "Toward a Theory of Property Rights," *American Economic Review,* Vol. 57, May 1967.

Leibenstein, Harvey, "A Branch of Economics Is Missing: Micro-Micro Theory," *The Journal of Economic Literature,* Vol. XVII, June 1979.

Marris, Robin, *The Economic Theory of Managerial Capitalism,* The Free Press of Glencoe, 1964.

Scitovsky, Tibor, "A Note on Profit Maximisation and Its Implication," *Review of Economic Studies,* Vol. II, 1943-44.

Simon, Herbert, "The Compensation of Executives," *Sociometry,* March 1957.

Williamson, Oliver E., *The Economics of Discretionary Behavior: Managerial Objectives in Theory of the Firm,* Prentice-Hall, Englewood Cliffs, New Jersey, 1964.

REDISTRIBUTION OF FALLOUT ^{137}CS IN BRUNNER CREEK WATERSHED IN WISCONSIN

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Abstract

The distribution of fallout ^{137}Cs was studied in Brunner Creek watershed, Wisconsin. In noncultivated areas, the highest concentration of ^{137}Cs was in the upper 5 cm of the soil profile and decreased with depth; whereas in cultivated areas, ^{137}Cs was distributed uniformly in the upper 25 cm. Losses of about 12 percent of the input of ^{137}Cs were occurring from the cultivated soils. The marshy area around White Clay Lake, into which Brunner Creek drains, had 1.5 times more ^{137}Cs than the forested areas in the watershed. The marsh area appears to be acting as a filter, removing both particulate matter and ^{137}Cs moving in the runoff water from the upland area to White Clay Lake. Sediment accumulation has averaged 11.5 cm between 1964 and 1975 in the marsh area.

Key words: fallout, ^{137}Cs, ecosystems, watersheds, radionuclides, runoff distribution, White Clay Lake

INTRODUCTION

Man, in his efforts to develop nuclear weapons and to control nuclear fission, has released many radionuclides into the atmosphere. These radionuclides are deposited on the earth's surface from the atmosphere either as dry fallout or in rainfall (Klement, 1965; Engelmann and Slinn, 1970). The amount and type of radionuclide fallout is monitored at several locations within the United States (Hardy, 1975).

With its long half-life, 30 years, and an energetic gamma ray, 0.662 mev, ^{137}Cs is an important radionuclide, radiologically and biologically, and is relatively easy to detect in environmental samples. Once in contact with the soil, ^{137}Cs is tightly bound by the clay-size soil fraction and organic matter, and its further movement by natural chemical processes in the environment is limited (Davis, 1963; Durrsma and Gross, 1971; Tamura, 1964). Therefore, the movement of fallout ^{137}Cs after it reaches the soil, is mainly associated with physical processes such as plowing, erosion, or deposition (Rogowski and Tamura, 1970; Ritchie, *et al.*, 1970, 1974).

A study was made on Brunner Creek watershed, which drains into the southeast side of White Clay Lake in Shawano County, Wisconsin (Figure 1), to determine the distribution and movement of fallout ^{137}Cs in the watershed.

METHODS AND MATERIALS

Soil samples, including all organic matter on the surface, were collected under the different land uses in the Brunner Creek watershed in 1974 and 1975. Major soil types in the watershed are Onaway loam, Salona loam, and Shiocton silt loam. Land use types sampled were from a 40- to 50-year old upland oak-maple forest that showed no evidence of soil erosion, from corn and alfalfa fields, from pastures, and from a low marshy area where Brunner Creek enters White Clay Lake. Samples of the sediment in the delta area where Brunner Creek enters White Clay Lake were also collected. Sample sites were chosen that

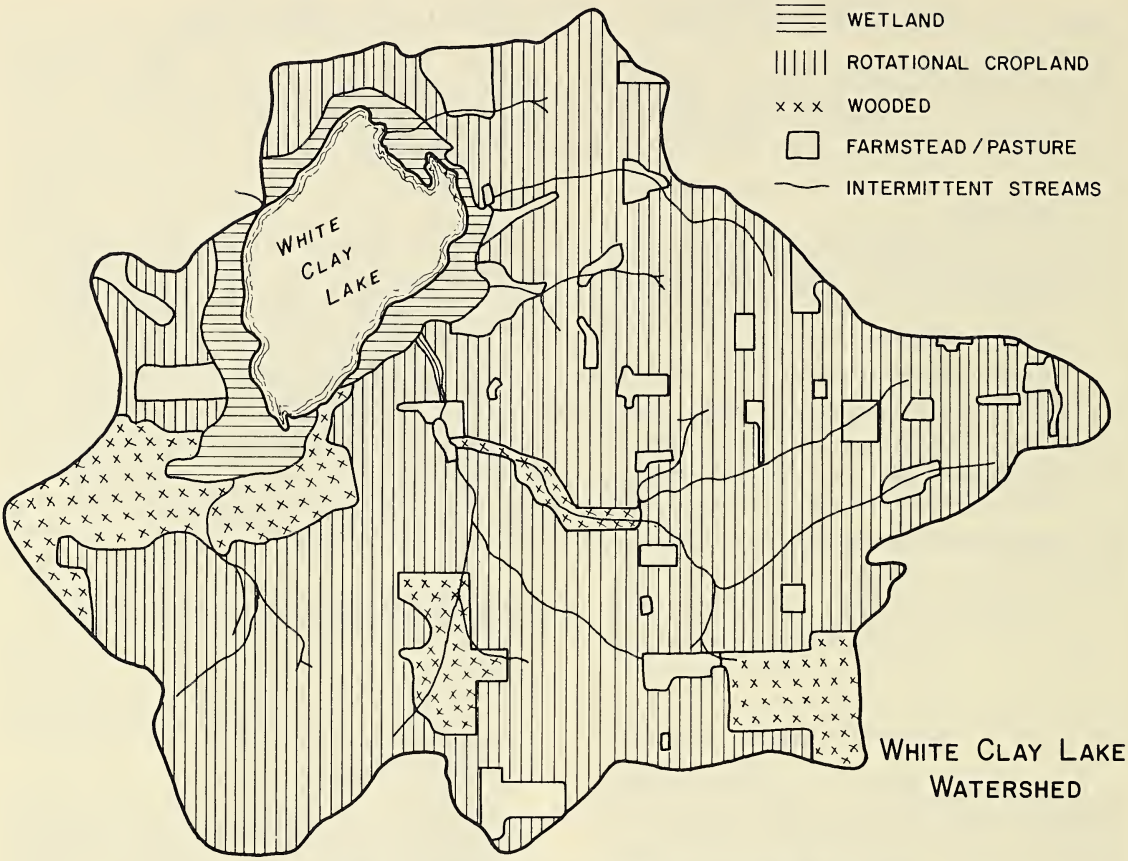

Fig. 1. Land use types in the Brunner Creek study area.

TABLE 1. Average concentrations and standard error of the mean of ^{137}Cs (nCi/m^2) in soil profiles under different land use types in Brunner Creek watershed, White Clay Lake, Wisconsin.

Depth	*Land Use Types*					*Sediment*
cm	*Oak-Maple*	*Pasture*	*Corn*	*Alfalfa*	*Marsh*	
0– 5	53.7 ± 2.0	54.9 ± 3.5	19.3 ± 0.8	18.7 ± 0.8	38.6 ± 4.0	51.8 ± 11.5
5–10	41.6 ± 2.8	40.0 ± 0.8	19.8 ± 0.8	20.2 ± 0.8	45.0 ± 4.7	17.3 ± 5.0
10–15	18.1 ± 2.7	14.3 ± 0.1	19.5 ± 0.6	19.8 ± 0.8	33.2 ± 5.8	3.0 ± 1.3
15–20	6.6 ± 0.9	3.6 ± 1.6	19.4 ± 0.5	18.1 ± 0.9	28.7 ± 7.0	3.0 ± 1.3
20–25	3.1 ± 1.1	2.5 ± 0.4	17.5 ± 0.9	14.7 ± 1.4	29.2 ± 8.2	0.8 ± 0.5
25–30	ND	ND	9.6 ± 1.4	9.8 ± 1.5	9.1 ± 2.8	0.8 ± 0.5
30–35	ND	ND	7.6 ± 1.6	9.0 ± 1.2	ND	ND
35–40	ND	ND	3.2 ± 0.8	3.4 ± 0.7	ND	ND
40–45	ND	ND	1.6 ± 0.8	0.9 ± 0.2	ND	ND
Total**	123.6 ± 5.1	115.2 ± 0.5	110.0 ± 4.1	107.8 ± 5.1	184.0 ± 17.6	69.9 ± 16.7
Range**	102–141	114–116	88–128	68–141	89–256	31–176
N***	6	2	23	23	7	9

* ND No samples collected.
** Total and Range are based on the summarization totals for each sample site.
*** Number of samples per depth and number of sample sites per vegetation type.

were representative of the major land use types and soils in the watershed. At least two sites, and as many as 23 sites, were sampled from each land use type. Samples were collected by 5-cm layers at each sample site. Each 5-cm layer sample was sieved through a 12-mm screen to ensure uniform aggregate size and dried at 105°C for 48 hours. About 3,000 g of the dried samples were put into Marinelli beakers and stored 3 to 4 weeks before gamma ray analyses were made using a 1024 multichannel analyzer with 10- × 12.5-cm thallium activated sodium iodide crystal (Ritchie and McHenry, 1973a). Counting time of each sample was sufficient to limit counting and machine errors to less than 1 percent. The complex gamma ray spectra were reduced to give ^{137}Cs and associated natural gamma ray-emitting radionuclide concentrations, using a least squares routine (Schonfeld, 1966). Cesium-137 is expressed in nanocuries per square meter (nCi/m^2) or in picocuries per gram (pCi/g). Average and standard error of the means of the concentration of ^{137}Cs were calculated for each land use type by 5-cm layer and for the total profile (Table 1). Concentration of ^{137}Cs in the total profile at each sample site was calculated by summing the concentration of ^{137}Cs of the 5-cm layers at the site. A budget accounting for the distribution of ^{137}Cs in the watershed was prepared showing the gains and losses of ^{137}Cs from each land use type. Cesium-137 is expressed in millicuries (mCi) in this budget.

Results and Discussion

The concentration of ^{137}Cs in soils varied among land use types (Table 1). The concentration of ^{137}Cs was highest in the marsh community where concentrations up to 256 nCi/m^2 was measured. This is a deposition area of soil particles eroded from the upland. Concentrations of ^{137}Cs were lowest in the alfalfa and corn fields where erosion had occurred, removing some soil and its associated ^{137}Cs.

The highest concentration of ^{137}Cs by weight was 7.7 pCi/g measured in a sample from the upper 5 cm in the marsh. A number of samples had concentrations of ^{137}Cs below detection limits of 0.05 pCi/g. These samples were considered to have zero concentration of ^{137}Cs in the analysis. These samples were always at the lower depths of the profile.

The vertical distribution of ^{137}Cs in the soil profiles under the upland oak-maple forest exhibited a pattern similar to that found in other studies (Gersper, 1970; Ritchie, *et al.,* 1972), with concentrations of ^{137}Cs highest in the upper 5 cm; however, a greater depth of penetration of ^{137}Cs was found in these oak-maple soils. Still, 75 percent of the ^{137}Cs in the forest soil profile was in the upper 10 cm. The total amount of ^{137}Cs in the forest profiles agreed with the concentration of fallout radionuclides measured at Green Bay, Wisconsin (Hardy, 1975). The concentration of ^{137}Cs per unit area under the oak-maple forest is used in this study as an indication of the total input of ^{137}Cs fallout deposited on the watershed.

The vertical distribution of ^{137}Cs in the soils under the pasture showed the same pattern as under the forest cover. This vertical distribution pattern would indicate that the pastures have been stable for many years. These pastures showed no visible signs of overgrazing or soil erosion. However, their slightly lower concentration of ^{137}Cs was probably caused by erosion and grazing loss.

The vertical distribution of ^{137}Cs in the soil profiles under the corn and alfalfa differed from that under the oak-maple forest and the pasture. In these cultivated soils, ^{137}Cs was uniformly distributed within the upper 25 cm of the soil profile. This layer represents the plow layer mechanically mixed by tillage operations. Other studies (Cline and Rickard, 1972; Ritchie and McHenry, 1973b) on the distribution of ^{137}Cs in cultivated and disturbed soils have shown similar vertical distributions.

The total amount of ^{137}Cs (nCi/m^2) in the soil under the corn and alfalfa was less than that measured under the forest sites, indicating that ^{137}Cs is being lost from these areas. Studies have shown that the loss of ^{137}Cs for an area in a watershed can be related to the amount of erosion (Ritchie, *et al.,* 1974). Some ^{137}Cs has moved from these cultivated fields and some has been redistributed within the fields as shown in other studies (McHenry, *et al.,* 1978; Mitchell, *et al.,* 1980).

Some of the ^{137}Cs moved from the original deposition site and was deposited within the marshy area surrounding White Clay Lake. The marsh averaged 1.5 times more ^{137}Cs than the oak-maple forest and 1.6 times more than the pasture. This indicated that the marsh was filtering soil particles and ^{137}Cs from the water passing through and was acting as a sink or trap for some of the ^{137}Cs moving from the cultivated areas within the watershed.

The depth of maximum concentration of ^{137}Cs in a sediment deposition profile can be related to the ^{137}Cs deposited in 1964 when the amount of atmospheric radioactive fallout was maximum (Ritchie, *et al.,* 1973c; Pennington, 1974; Robbins and Edgington, 1975; Ritchie, *et al.,* 1975; McHenry, *et al.,* 1978). Using this concept and studying the individual marsh site profiles, the amount of sediment accumulation in the marsh since 1964 has ranged from 2.5 to 22.5 cm in the seven marsh sample sites. The average deposition was 11.5 cm from 1964 to 1975, indicating that the marsh was an active filter for trapping the erosional particles as well as the attached ^{137}Cs lost from upland.

Highest concentration of ^{137}Cs was always in the upper 5 cm of the sediment profile samples collected from the delta of Brunner Creek in White Clay Lake, which indicates little deposition of recently eroded soil in this area of White Clay Lake. This also indicates that the marsh area was acting as an effective filter, removing some of the particulate matter and ^{137}Cs from the water moving in Brunner Creek before it entered White Clay Lake. Other nonpoint source pollutants attached to soil particles may have similar movement patterns.

A budget calculated to summarize the distribution and movement of ^{137}Cs in the watershed (Table 2) showed that 91 percent of the input fallout ^{137}Cs remained within the watershed. Only 10 percent of the ^{137}Cs input had moved from the area where it was originally deposited. The calculated loss of ^{137}Cs per unit area was greatest for the cultivated land.

The ^{137}Cs movement was assumed to have been associated with the finer soil and organic particles contained in runoff water from the watershed. Some of the ^{137}Cs movement could have been in solution, but this amount would have been small (Tamura, 1964). Seven percent of the ^{137}Cs that

TABLE 2. Watershed budget for ^{137}Cs calculated for Brunner Creek watershed.

Cover	*Area (ha)*	*Ca-137 nCi/m²*	*Input**	*Existing levels***	*Loss or gain*	*Loss or gain/ha*
			mCi	mCi	mCi	mCi/ha
Forest	84.6	123.6	104.6	104.6	0.0	0.0
Pasture	15.2	115.2	18.8	17.5	− 1.3	−0.09
Cultivated	420.1	109.1	519.2	458.3	−60.9	−0.14
Marsh	6.9	184.0	8.5	12.7	+ 4.2	+0.61
Totals	526.8	531.9***	651.1	593.1	−58.0	−0.11

* Atmospheric input of ^{137}Cs.

** Measured ^{137}Cs concentrated under each land use type times area of each type.

*** Weighted total based on area in each cover type.

moved from the watershed was deposited in the marshy area around the lake.

Fifty-eight mCi of ^{137}Cs was not accounted for in the ^{137}Cs budget. There are at least three possible explanations. Some of this ^{137}Cs could be accounted for in the milk that was produced by the cows feeding on forage and grain grown in the watershed. Milk is the only product that is removed in major amounts from the watershed. It is estimated, based on ^{137}Cs concentration in Chicago milk (Hardy, 1975), that less than lmCi of ^{137}Cs was removed from the watershed in the milk. Some ^{137}Cs may have also been removed by the selling of the older cows; however, this would also be a very small amount of ^{137}Cs.

Some of the ^{137}Cs probably moved through the marsh into White Clay Lake and was deposited in the deeper part of the lake or moved through the lake and downstream. Our data indicated that very little, if any, of this material was deposited in the delta area of Brunner Creek in White Clay Lake. Additional sampling would be necessary to determine deposition in the deeper part of the lake. This pattern of deposition was expected since any particles moving out of the marsh would be small, light-weight soil or organic particles that would not be readily deposited, but could be deposited in deeper parts of the lake or would remain suspended and pass through the system. It is difficult to estimate how much ^{137}Cs would move from the watershed and pass through the lake attached to fine soil and organic particles.

Most of the unaccounted for 58 mCi of ^{137}Cs probably remains in the watershed in locations that were not sampled or could be accounted for by sampling errors and variations. Statistical analyses indicated little significant difference between the ^{137}Cs concentrations in the different land use types. Areas not sampled would include forests located in lowland areas near the stream channel that would act as a buffer to the stream removing some of the radioactive material before it entered the stream. Cesium-137, in addition to being deposited in the marsh, is probably also deposited in these riparian vegetation areas and in the grass areas of the edge of the fields. Two samples, taken from fence rows at the edge of cultivated fields, had an average ^{137}Cs concentration of 156 nCi/m^2. Also, a small pond on Brunner Creek, which was not sampled, would have also trapped some of the sediment and ^{137}Cs. These areas could be deposition sites for much of the unaccounted for 58 mCi of ^{137}Cs.

This study showed that some of the ^{137}Cs has been redistributed in the Brunner Creek watershed. However, most ^{137}Cs remained near the site of the deposition from fallout. The marsh has acted as a filter to remove some particulates and ^{137}Cs from the runoff water before it entered White Clay Lake. Most of the ^{137}Cs which did move seems to be related to the erosion process within the watershed.

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Literature Cited

Cline, J. F., and W. H. Rickard. 1972. Radioactive strontium and cesium in cultivated and abandoned field plots. Health Physics 23:317-324.

Davis, J. J. 1963. Cesium and its relationship to potassium in ecology. *In* Radioecology (edited by) V. Schultz and A. W. Klement, Jr., pp. 539-556. (New York, USA, Reinhold).

Durrsma, E. K., and M. C. Gross. 1971. Marine sediment and radioactivities. *In* National Academy of Science, Radioactivity in Marine Environment, pp. 147-160. National Academy of Sciences, Washington, D.C., USA.

Engelmann, R. J., and W. G. N. Slinn. 1970. Precipitation scavenging (1970). U.S. Atomic Energy Commission Report CONF-70061, USA. 499 pp.

Gersper, P. L. 1970. Effect of American beech trees on the gamma radioactivity of soils. Soil Science Society of America Proc. 34: 318-323.

Hardy, E. P., Jr. 1975. Health and Safety Laboratory Environmental Quarterly, June 1, 1975 through September 1, 1975. Health and Safety Lab. Report HASL-297 and Appendix, USA.

Klement, A. W., Jr. (editor). 1965. Radioactive fallout from nuclear weapons. U.S. Atomic Energy Commission Report CONF-765, USA. 953 pp.

McHenry, J. R., J. C. Ritchie, and G. D. Bubenzer. 1978. Redistribution of cesium-137 due to erosional processes in a Wisconsin watershed. *In* Environmental Chemistry and Cycling Processes, (edited by) D. C. Adriano and I. L. Brisbin, Jr. U.S. Dept. of Energy, Washington, D.C., USA. Publ. CONF-760429. pp. 495-503.

Mitchell, J. K., G. D. Bubenzer, J. R. McHenry, and J. C. Ritchie. 1980. Soil loss estimations from fallout cesium-137 measurements. *In* Assessment of Erosion (edited by) M. deBoodt and D. Grabriel, J. Wiley & Sons, New York. pp. 393-401.

Pennington, W. 1974. Seston and sediment formation in five district lakes. Journal of Ecology 62:215-251.

Ritchie, J. C., P. H. Hawks, and J. R. McHenry. 1975. Deposition rates in valleys determined using fallout Cs-137. Geological Society of America Bul. 86:1128-1130.

Ritchie, J. C., and J. R. McHenry. 1973a. Determination of fallout Cs-137 and natural gamma-ray emitting radionuclides in sediments. International Journal of Applied Radiation and Isotopes 24:575-578.

Ritchie, J. C., and J. R. McHenry. 1973b. Vertical distribution of fallout Cs-137 in cultivated soils. Radiation Data and Reports 12:727-728.

Ritchie, J. C., J. R. McHenry, and A. C. Gill. 1972. The distribution of Cs-137 in the litter and upper 10 centimeters of soil under different cover types in northern Mississippi. Health Physics 22:197.

Ritchie, J. C., J. R. McHenry, and A. C. Gill. 1973c. Dating recent reservoir sediment. Limnology and Oceanography 18:254-263.

Ritchie, J. C., J. R. McHenry, A. C. Gill, and P. H. Hawks. 1970. The use of fallout cesium-137 as a tracer of sediment movement and deposition. Proc. Mississippi Water Resources Conf. 1970. pp. 149-163.

Ritchie, J. C., J. A. Spraberry, and J. R. McHenry. 1974. Estimating soil erosion from the redistribution of fallout Cs-137. Soil Science Society of America Proc. 38:137-139.

Robbins, J. A., and D. N. Edgington. 1975. Determination of recent sedimentation rates in Lake Michigan using Pb-210 and Cs-137. Geochemica et Cosmochima Acta 39:285-300.

Rogowski, A. S., and T. Tamura. 1970. Erosional behavior of cesium-137. Health Physics 18:467-477.

Schonfeld, E. 1966. Alpha-M—An improved computer program for determining radioisotopes by least squares resolution of the gamma ray spectra. Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA. ORNL-3975.

Tamura, T. 1964. Selective sorption reaction of cesium with mineral soil. Nuclear Safety 5: 262-268.

WISCONSIN'S GREATEST HEAT WAVE

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Abstract

Record making cold and very snowy winters in recent years have overshadowed memory of the intense and extended heat waves during the Dust Bowl Years, 1930-1936. Many temperature records established in 1934 and 1936 still stand unequalled; during one period lasting eight days in July, 1936, almost the entire state experienced afternoon readings of 100°F or higher. On July 13, 1936 Wisconsin's highest official reading, 114°, was recorded at Wisconsin Dells, and the entire state averaged 106° for the maximum value.

Introduction

The middle of a severe winter in Wisconsin is apt to conjure up two visions—one expensive and the other requiring patience alone. The expensive vision is Hawaii, Florida, or Southern California; the vision requiring patience is the conviction that in six months a considerably longer day (ca. 15 hours) and a noon sun much higher above the south horizon (ca. 70°) will guarantee that below zero temperatures and snowfall are virtually impossible.

Recent winters have been extraordinary: 1976-7, 1977-8, and 1978-9 each made records in terms of average monthly temperatures, the number of below zero days, the number of consecutive days without an above freezing reading, total snowfall, or combinations thereof. As recently as January, 1982, temperatures averaged nearly two standard deviations below normal in most parts of the state, and Milwaukee first equaled (−25°F) and then established a new all-time minimum temperature (−26°). Winters in recent decades have not been much more pleasant: representing two different winters, January 1963 and December 1963 each had an extraordinary number of below zero days, and on January 30, 1951 Madison established its coldest-ever reading, −37°.

Wisconsin has an invigorating quality of marked seasonality; summers generally average 50° warmer than winters in sharp contrast to Hawaii, Florida, and Southern California where the difference is closer to 5°, 25°, and 15° respectively. Extremes in summer in Wisconsin are likely to have even more disastrous impact on the economy than in winter as the Dust Bowl Years demonstrate.

Dust Bowl Years and Heat

Digging through the record books one must go back nearly half a century to the early 1930's to find temperatures as spectacularly above normal as winters recently have been below normal. The Dust Bowl Years 1930-1936 were remarkable for the number of heat records established. Wisconsin's two largest cities, for example, one along the moderating shoreline of Lake Michigan and the other well inland, established many daily record maximum temperatures from April through September 1930-1936; most of these records still stand unsurpassed by ensuing summers (Table 1). It is clear that two months contributed the largest number of heat records, June and July. Of the 75 records established in these

[1] This paper was written while on leave, Jan. 1-May 15, 1982, as Visiting Honorary Fellow, Dept. of Geography, UW-Madison.

TABLE 1. Daily Heat Records Established 1930-1936 and Still Standing.

	Madison	*Milwaukee*
April	1	1
May	7	6
June	9	12
July	13	14
August	3	2
September	3	4

Source: Unpublished data, National Weather Service, Madison and Milwaukee.

TABLE 2. Official Climatological Stations: July 7-14, 1936.

Date	*Total*	*Number with 100° or higher*	*Statewide average*
July 7	40	34	102°
8	40	35	101°
9	40	30	101°
10	40	29	101°
11	40	33	103°
12	39	34	104°
13	39	36	106°
14	39	29	104°

Source: *Climatological Data for the United States,* 1936.

two cities during the period considered, 15 were in the month of July, 1936.

That month is worth examining more closely because of eight consecutive days from the 7th through the 14th; these days are likely to live in climatological infamy. The *average* daily maximum temperature in Wisconsin during that period, based upon data from 39-40 official climatological stations, was 103°, and each day during the period averaged at least 101° (Table 2).

Most outstanding was July 13, 1936. On this date Wisconsin's highest official reading, 114°, occurred at Wisconsin Dells; 36 of 39 official climatological stations reported 100° or higher, and the state wide *average* high was 106°. Distribution of the afternoon maximum temperatures on July 13 is shown on Figure 1; added to the data for the 39 reporting official climatological stations is data for 20 cooperative stations from the archives in the State Climatologist's Office. It is interesting to note that only immediately adjacent to Lake Michigan were maximum reading below 100°: Kewaunee 92°, Sheboygan 98°, Milwaukee 95°, and Racine 99°.

On the next day when slightly cooler air started to move into northern Wisconsin, Madison climaxed its heat wave with an all-time high 107° and the Milwaukee Airport —now General Mitchell Field and the official weather station only since 1940—recorded 106°. The official reading from Milwaukee on that day was taken at the Federal Building on East Wisconsin Avenue very near the lake: 98°.

Earlier in the heat wave on July 8 nearly as many official climatological stations recorded 100° or higher, but a larger area scattered in the north and central parts of the state, was short of the century mark than was the case on July 13. Big St. Germain, Brule Island, Marshfield, Medford, and P. K. Reservoir were in this "cooler" category (96°-98°); however, on that day the entire Lake Michigan shoreline was hot: Kewaunee 104°, Sheboygan 103°, Milwaukee 101°, Racine 100°.

Data for the average maximum and minimum temperatures during the July 7-14 period are mapped on Figure 2. Only 5 stations did not average maxima of at least 100°: Superior 94°, Antigo 99°, Leona 97°, Kewaunee 97°; and Milwaukee 99°. Highest was a sizzling 108° at Eau Claire.

Examination of the "average low" readings demonstrates that minimum temperatures were also high during the heat wave; in some cases the average low temperature exceeded the normal daily mean temperature expected at that time of year: Antigo, Green Bay, Manitowoc, River Falls, Sheboygan, and Milwaukee are examples.

In addition to the 114° reading at Wisconsin Dells, which still stands as Wisconsin's hottest official reading, Madison and Milwaukee established unsurpassed records during this period (Table 3).

Significance of the 1930's in terms of *frequency* of drought years is demonstrated

Fig. 1. Maximum Temperatures, July 13, 1936. Official and cooperative stations.

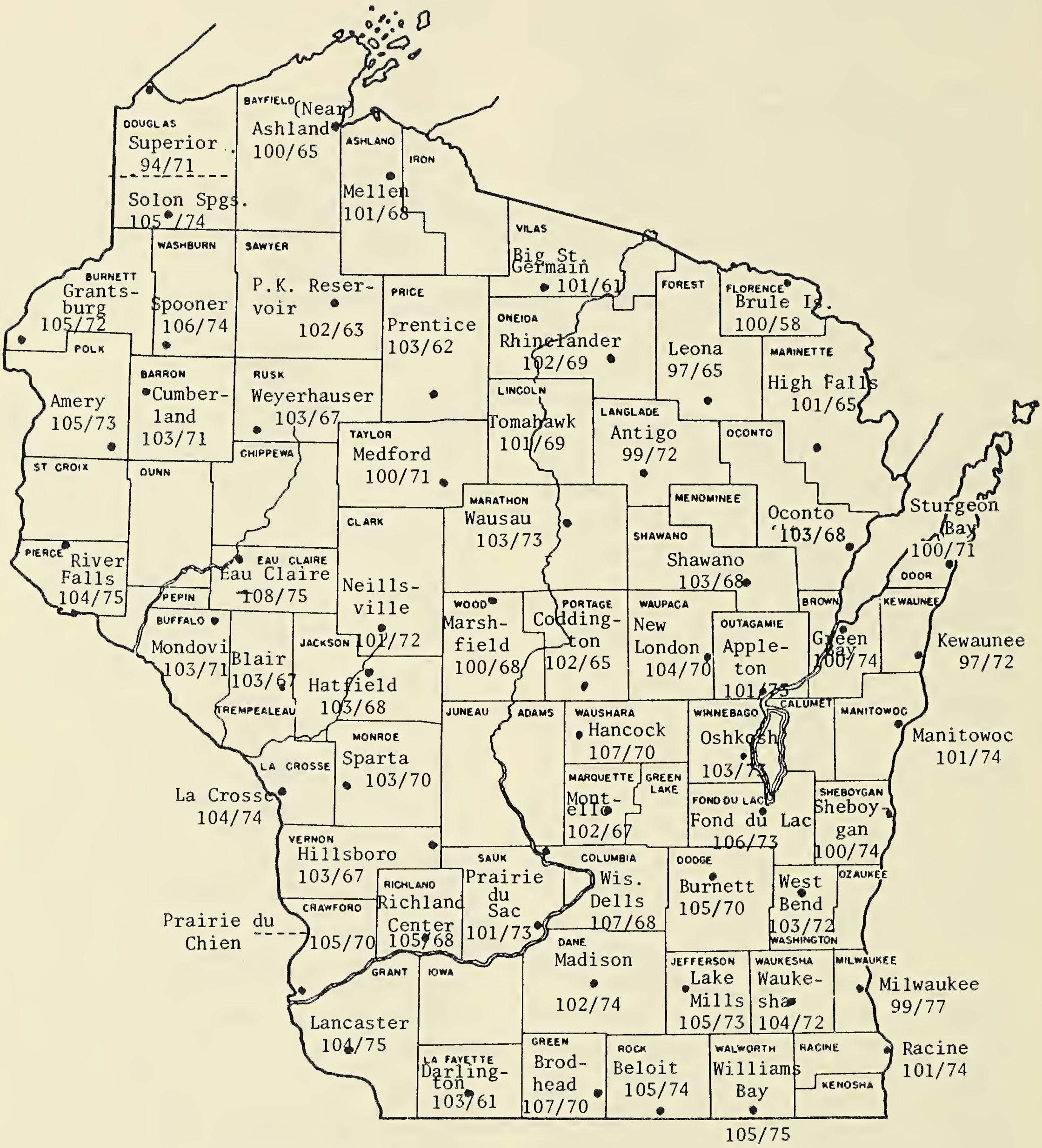

Fig. 2. Average Maximum/Minimum Temperatures, July 7-14, 1936.
Official and cooperative stations.

TABLE 3. All-Time Record Highs for the Calendar Day.

Date	*Madison*	*Milwaukee*
July 7, 1936	102°	98°
8	100°	101°
9	98°	101°
10	—	100°
11	100°	100*
12	104°	—
13	106°	95°
14	107°	98°

* The only time Milwaukee has ever had 4 consecutive 100° readings.

Source: Unpublished data, National Weather Service, Madison and Milwaukee.

in a climatology/vegetation analysis (Borchert, 1950); between the advent of record keeping and 1950 nine years were classified as major drought years: 1889, 1890, 1906, 1910, 1917, 1930, 1931, 1934, and 1936. That four of the nine were in the Dust Bowl Years, and more particularly, that the grand finale of drought *and* heat should occur in the last named year is no coincidence. Borchert clearly demonstrated the close relationship of major drought years with maximum positive departure of temperature. An updated study suggests that drought is probably more common in Wisconsin than the prosperous agriculture and colorful vegetation might lead the casual observer to believe (Mitchell, 1979).

Immediately prior to the period examined in this analysis, two separate high pressure systems moved from north of Lake Superior southeastward toward Georgia and then recurved westward to a position over Tennessee; there they reinforced the western arm of the Bermuda High to provide a steady source of very warm and extremely dry weather for the Middle West. This subtropical high was centered farther west than normal insuring the tropical continental air from the Great American Desert rather than tropical maritime air from the Gulf of Mexico would dominate the interior lowland (Monthly Weather Review, 1936).

Uniqueness of This Period/Conclusions

There have been other very hot spells of weather in Wisconsin, but none as long nor as intense as the July 7-14, 1936 period, although *individual* days have approached the character of these eight days in 1936. On June 1, 1934, for example, 24 out of the 42 official reporting stations registered 100° or higher; and on July 23, 1934, 28 of the 41 official reporting stations recorded 100° or higher. Reference to the standard for defining meteorological events, the prestigious *Glossary of Meteorology,* discloses that a heat wave is "a period of abnormally and uncomfortably hot and unusually humid weather. To be a 'heat wave' such a period should last at least one day, but conventionally it lasts from several days to several weeks . . . a spell of three or more days on each of which the maximum shade temperature reaches or exceeds 90°F." There is no doubt that early July, 1936 saw Wisconsin's greatest heat wave.

Acknowledgment

The cooperative spirit of the State Climatologist's Office, and its Director, Val L. Mitchell, in particular, is deeply appreciated. Citizens are encouraged to direct inquiries or visit their office; a wealth of data is available about all parts of this state.

Literature Cited

John Borchert, "The Climate of the North American Grassland," *Annals,* Association of American Geographers, Volume XL, March 1950, No. 1, pp. 1-39.

Climatological Data for the United States by Sections. Volume XXII. 1936. Part 3. July-September. U.S. Department of Agriculture. Weather Bureau, p. 28.

Glossary of Meteorology edited by Ralph E. Huschke. American Meteorological Society. 1959. p. 25.

Val L. Mitchell, "Drought in Wisconsin," *Transactions of the Wisconsin Academy,* Volume 67, 1979, pp. 130-134.

Monthly Weather Review, Volume 64, 1936, LXIV-63, U.S. Department of Agriculture, Weather Bureau.

WISCONSIN'S COLDEST FIVE WEEKS

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Abstract

The problem of the calendar month as a time standard to measure winter weather is addressed. Although January 1912 was Wisconsin's coldest calendar month on record, −2.5°F, the period January 19-February 22, 1936 averaged −3.5° statewide. Average daily minimum temperatures in the state were below zero during this 35 day period, dropping to −25° on seven days, and reached a bottom value of −29.1° on February 16. Distribution and timing of Zero Days are briefly analyzed; finally, the surface Arctic air mass outbreaks are correlated with the several periods of most intense cold.

INTRODUCTION

Three winters in the late 1970s will long be reference points for the citizens of Wisconsin in terms of severe cold, prolonged periods with temperatures below freezing, and depth of snow. However, none of the calendar months during those Arctic-like winters equalled the month of January 1912 when the state wide average temperature was −2.5°; in fact there was no 31 day period of time during the winters of the late 1970s equivalent to the average temperature of January 1912, but there was a *longer* period of time, during the winter of 1935-1936, when statewide temperatures were even lower than they had been in 1912. Since the 1936 cold wave occupied parts of two months, no single month had the statistical credit for the coldest-ever calendar month. "There was a period of severe cold, wind, and snow lasting from about January 18 to February 22 (1936). The temperature average for this period was the lowest on record for so long a period" (*Climatological Data,* 1936).

Comparison of January 1912 with the cold wave of January-February 1936 reveals the following: the entire state averaged −2.5° in January 1912, and −3.5° for the thirty-five consecutive days straddling two calendar months in 1936. Superior in the far north averaged −6.0° 1912, and −12.9° in 1936 (Unpublished Climatological Data); Milwaukee averaged 5.6° in 1912, and only 2.5° in 1936; and Madison had 1.2° in 1912 and −2.5° in 1936.

The analysis which follows defines the duration of the cold wave as that period of time during which the daily minimum temperature of the entire state averaged below zero—starting January 19 and terminating with February 22, 1936. (Table 1.)

THE COLD WAVE ANALYZED

Analysis of this data (Figure 1) reveals that within this time frame of thirty-five days there were distinct sub-periods: general deterioration of minimum temperatures from the 19th of January through the 24th, with the 5 days from the 22nd through the 26th averaging a frigid −25.1°; brief milder period followed, climaxing with −5.0° on the 29th; progressively colder temperatures developed after the 29th through February 2nd when the average again fell below −20°; a brief two day milder period was followed abruptly by intense cold, when,

[1] This paper was written while on leave Jan. 1-May 15, 1982, as Visiting Honorary Fellow, Dept. of Geography, UW-Madison. Prof. Villmow died following surgery for brain tumor in September, 1982.

TABLE 1. Average Daily Minimum Temperature in Wisconsin, January 19–February 22, 1936

January 19	− 9.2°	February 1	−17.0°
20	−11.2	2	−20.4
21	−12.3	3	− 1.7
22	−25.4	4	− 8.4
23	−26.8	5	−25.3
24	−28.3	6	−25.6
25	−24.5	7	−18.0
26	−20.4	8	− 3.1
27	−10.8	9	−13.6
29	− 5.0	10	− 6.9
30	−12.3	11	−12.5
31	−13.5	12	− 6.4
		13	− 0.6
		14	− 8.5
		15	−17.7
		16	−29.1
		17	−15.1
		18	−23.3
		19	−17.1
		20	−21.9
		21	−19.9
		22	−22.0
		Average	−15.6°

Source: *Climatological Date for the United States by Sections, Wisconsin.* 1936.

from the 5th through the 7th, the average minimum was −22.9°; alternating periods of cold and milder weather occurred during the 8th through the 14th, followed by the longest period of intense cold from February 15 through the 22nd; −20.6° was the average state minimum during these eight days, and the coldest night of the entire 35 days saw an average of −29.1° on February 16th.

If the distribution of average minimum temperatures throughout the state is examined, a range of 20° is noted (Figure 2). The 20° range is represented at its end points by Grantsburg (−25°), Burnett County and P.K. Reservoir (−25°), Sawyer County, both in northwestern Wisconsin on the one hand, and Milwaukee −5°), Milwaukee County and Racine (−5°), Racine County on the other. Note that even as far south as Hillsboro, Vernon County, the *average* minimum temperature for 35 consecutive days was −20°! The state wide average of −15.6° essentially divides the area down the middle between a western portion with values below −15° and an eastern portion with values above −15°.

The number of Zero Days, i.e., days on which the *maximum* temperature did not exceed 0°, is also mapped as the denominator on Figure 1. This term was extensively used by David Ludlum in his classic *History of American Weather* (Ludlum, 1966, 1968).

Zero Days are more erratically distributed than the average minimum temperature. The absolute range here is 12, from a maximum of 15 at Downing, Dunn County to a minimum of 3 at Racine, Racine County. However, Burnett, Dodge County in the southeast had 11, but Solon Springs, Douglas County in the northwest had only 6. In compiling the data it was noted that the Zero Days

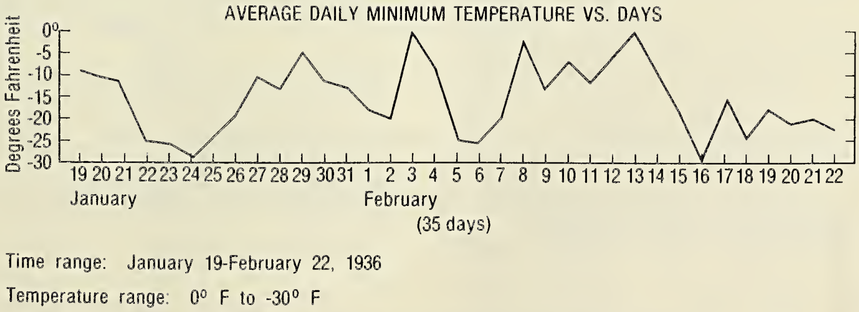

Fig. 1. Average Daily Minimum by Calendar Days.

Source: *Climatological Data for the United States by Sections. Wisconsin*, 1936.

Fig. 2. Average Minimum Temperature January 19-February 22, 1936/Number of "Zero Days" (*Maximum* did not Exceed Zero)

TABLE 2. Zero Days

Number of Official Stations Reporting *Maximum* Temperatures Zero or Below: Total Stations—40

Janaury 19, 1936	0	February 1, 1936	13
20	6	2	0
21	3	3	0
22	18	4	2
23	36	5	31
24	37	6	23
25	14	7	1
26	25	8	0
27	1	9	7
28	0	10	0
29	0	11	1
30	1	12	7
31	3	13	0
		14	0
		15	30
		16	22
		17	27
		18	29
		19	1
		20	0
		21	0
		22	0

Source: *Climatological Date for the United States by Sections, Wisconsin.* 1936.

generally occurred in sequence during three periods: (a) January 22-26, (b) February 5-6, and (c) February 15-18; in fact, nearly 90% of the state wide total were on these eleven days (Table 2). As an extreme example of prolonged frigidity, Downing, Dunn County had nearly seven consecutive 24-hour periods *without* an above zero reading!

Weather map analysis makes clear *why* the cold was so persistent and so intense (*Monthly Weather Review*). In January four massive Arctic air masses plunged southeastward from northwestern Canada toward the Middle West.

I—The first began in the Yukon Territory on the 14th of January. This high was centered over Minnesota/North Dakota on the 18th with central pressure of 30.56″, and on the 19th it was just north of Lake Superior at 30.40″, thereby initiating the cold spell to Wisconsin.

II—A second massive Arctic air mass moved more rapidly southeastward. lying along the western edge of Hudson Bay on the 22nd with central pressure of 30.54″ and two days later was centered over Indiana maintaining a central pressure of 30.40″—this was the start of five consecutive days which averaged below −20° minimum over the state.

III—On the 24th and 25th a third high pressure area over northwestern Canada, central pressure 30.80″, moved rapidly south to North Dakota on the 26th, and to Iowa on the 27th where its central pressure was still 30.78″, and on to southern Illinois the next day remaining strong at 30.58″.

IV—The last of the Arctic air masses of January moved out of Montana on the 27th with pressures of 30.78″, southward to Nebraska the next day and then on to Texas on the 30th.

February saw a larger number of Arctic air mass outbreaks than January, but it should be recalled that only thirteen days of the cold wave were in January, and twenty-two were in February.

I—On the first of the month a high over South Dakota with central pressure of 30.46″ moved southeast to a position over Iowa, then on to Wisconsin on the 2nd as temperatures plummeted to a state wide average of −20°.

II—On the 2nd, another Arctic air mass over northwestern Canada moved south to a position just north of Lake Superior where its pressure was a modest 30.32″. Wisconsin was therefore in a position between two frigid air masses early in February as temperatures over the state averaged −25° on the 5th and 6th.

III—On the 10th of the month another northwest Canada air mass moved south toward Montana, thence east to Hudson Bay by the 12th as temperatures dipped to −12.5°.

IV, V—In rapid succession, two massive Arctic thrusts now followed—one over North Dakota on the 15th with central pressure of 30.50″ moved east to Wisconsin, and the second over Montana on the 17th, with pressures equal to III in January, 30.80″, moved southeast maintaining its vigor as it moved toward Wisconsin. This combination plunged temperatures to the coldest of the entire period −29.1° on the 16th followed closely by four more days averaging about −20°.

VI—Finally, an Arctic high over Iowa on the 21st moved toward Michigan with central pressures of 30.42″ providing the last frigid day to the state before surface and, undoubtedly, upper air patterns, changed abruptly, ending Wisconsin's most severe cold wave.

Conclusions

January and February 1936 were very cold months in Wisconsin: temperatures averaged from 2° to 7° below normal over the state in January, and 11° to 15° below normal in February. For most of the state February 1936 was the coldest February in history, but not as cold as January 1912. In fact February 1936 averaged 2.8° state wide, 5.3° warmer than January 1912. When calendar month limits are ignored a period longer than a calendar month from January 19 through February 22, 1936 is discovered to be Wisconsin's coldest period.

Literature Cited

Climatological Data for the United States by Sections. Wisconsin. Volume XXIII. 1936. Part 1. U.S. Department of Agriculture. Weather Bureau, p. 49.

David M. Ludlum, *The History of American Weather: Early American Winters I 1604-1820,* American Meteorological Society, Boston, 1966, 285 pp.; *Early American Winters II 1821-1870,* American Meteorological Society, Boston, 1968, 257 pp.

Monthly Weather Review, Volume 64, 1936, U.S. Department of Agriculture, Weather Bureau, LXIV-2, LXIV-12.

Unpublished Climatological Data, Cooperative Weather Stations (Superior), State Climatologist's Office, Madison, Wisconsin.

ACADEMIA AND THE SEARCH FOR PEACE

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History provides examples of how different academic communities responded, or failed to respond, to the grave problems and tensions in other times. Some aggravated, intentionally or not, the conflicts in their society. Others withdraw and left society to its fate. Still others helped in the search for solutions. America's research universities, with their tradition of involvement with society, have overwhelmingly followed this last pattern (Saxon 1981).

With respect to many problems, Saxon's points are well taken. However, America's great research universities have seemed hesitant in undertaking work directly related to the search for a just and stable peace. Only recently have many faculty become concerned with research in the area of international conflict and its resolution by nonviolent means. There has been a trend toward professionalization of the peace movement. Several quarterly journals are now devoted to the field: the *Journal of Conflict Resolution* developed at the Center for Conflict Resolution at the University of Michigan, and the *Journal of Peace Research* from the International Peace Research Institute in Oslo. Some significant work on the problem of nuclear weapons proliferation has been done at Harvard's Center for Science and International Affairs (established in the mid-1970s). That Center publishes the *International Security* journal.

But the efforts are still fragmentary given the magnitude and the urgency of the task. "In an era when decisions taken by leaders of the Soviet Union or the United States can literally mean the death of hundreds of millions of Russians, Americans, and Europeans as well as additional deaths from secondary effects throughout the Northern Hemisphere, nuclear war is *the* problem with which we must cope successfully if we are to address any other" (John F. Kennedy School of Government Bulletin). We have courses in military science, why not in peace science? There is no question that the issues are of the most critical importance; the very survival of human civilization may be at stake. So why has "peace research" not become more prominent in the agendas of America's great research universities? Several possible reasons are worth considering.

First, researchable questions are not easily formulated and the issues cut across traditional university disciplines and departments. However, many policy-oriented research institutes on university campuses already bring together professionals from a number of disciplines to cooperate in the study of major issues in public policy. The ability of the University of Wisconsin-Madison to organize its diverse resources for the study of public questions is well demonstrated by existing Centers and Institutes such as the Industrial Relations Research Institute, the Institute for Research on Poverty, the Institute for Environmental Studies, the Land Tenure Center, and others. The Wisconsin Seminar on Natural Resource Policies in Relation to Economic Development and International Cooperation held at Madison in 1977-78 is one good example of special short-term programs that draw on staff from many traditional departments. Participants included faculty and students from economics, engineering, agriculture, geophysics, and law, as well as professionals in complimentary fields from several Arab nations (Dorner and El-Shafie, 1980).

Second, there is perhaps still too little recognition that we live in a world of growing interdependence among nations. Individual nations have worked out internal procedures (imperfect to be sure) for handling the interdependencies among peoples and groups *within* their jurisdictions. Although we now take it for granted, the idea of a "nation" with a "national government" was a major institutional innovation of an earlier time. Those rules for fostering mutually beneficial arrangements in national life took a long time to develop, and they continue to change and evolve. Today the nations of the world are groping for procedures by which the self-interested calculations of individual countries will take the interests of other countries into account. They are, in other words, searching for a set of mutually agreeable rules for institutionalizing the growing interdependence among nations. This is no simple quest, and it is one in which universities must play a major role.

Some of the insights developed by Wisconsin's great institutional economist John R. Commons may be relevant (Commons, 1957). Although Commons was concerned with institutions internal to a nation state, some of the procedural suggestions can be carried over to issues at the international level. Commons defined "institutions" as collective action in restraint, liberation, and expansion of individual action. This is what the world must seek in developing new institutions and new international procedures based on cooperation rather than confrontation among nations. Such new institutional arrangements will restrain and curtail certain acts of individual nations, but these very restraints, *if all are subject to them,* will serve to liberate and expand the opportunities of all nations.

We will return to interdependence later, but a third possible reason universities have not taken leadership in "peace research" may be the opinion expressed by some that war is part of human nature and that nothing much can be done about it: "We've always had wars and," some say, "we always will." However, just because wars have always existed is no reason to believe that they must continue to be fought. At least some military confrontations have clearly exhausted their potential for settling differences between nations. That potential has been destroyed by nuclear weapons.

We must distinguish between human conflict and the violent resolution of conflict. The first may indeed be inevitable, but it does not follow that the second is so. Nonviolent ways to settle conflicts are put into practice every day and every where. Is it unreasonable to assume that future conflicts between nations cannot be resolved by means other than war? I have to believe that it is not unreasonable. We cannot escape the burden of nuclear armaments, and universities have a special responsibility in lifting that burden. Most scholars recognize that it is impossible to separate domestic issues from global issues of resource scarcities, trade and monetary instabilities, proliferating weapons of war, and the unrelieved poverty of a quarter of the world's people. Problems of food production and distribution, environmental protection. energy supplies, and a reasonable chance for all people to lead a decent life simply cannot be confined within national boundaries. But it is precisely with respect to these kinds of issues that new rules governing international relations must be developed in order to reduce the scope of conflicts and to settle them by non-violent methods.

A fourth reason why universities have not embraced the concept of "peace research" may be the many meanings associated with the word "peace." Boulding (1978) puts the case well:

> On the positive side, peace signifies a condition of good management, orderly resolution of conflict, harmony associated with mature relationships, gentleness, and love. On the negative side, it is conceived as the absence of something—the absence of turmoil, tension, conflict, and war.
>
> A negative evaluation of peace is reflected in certain connotations of words like pacify,

> pacification, and appeasement. . . . On an even more negative set of values, peace is rated with death . . . the peace of mind that is a withdrawal from reality, the peace of catatonic trance have much in common with the peace of death. It is not surprising that we are suspicious of these negative forms of peace. The human race has often put a high value on struggle, strife, turmoil, excitement. We identify vigor with stress, with triumph. Our sports ritualize the value of striving in what I have called a ritual dialectic, in which winning is valued for its own sake. Perhaps the greatest enemy of peace is the perception that it is dull.

I would add that the term "peace" was given a doctrinal coloration by the manipulative use of the term by various Soviet-oriented movements, especially at the height of the cold war era.

The fifth and perhaps most important reason why more scholars have not committed themselves to peace research may well be a fear of being identified with the self-righteous moral posturing so frequently characteristic of "protest" movements. There is a major role for many of these movements. Dismaying as their rhetoric may be to researchers, marches and protests do force issues to the attention of both government and the general public. I suspect that no movement of this kind can get off the ground without leaders willing to dramatize a legitimate point of concern. While this is not to say that every popular movement is in the public interest, these movements can serve an important function. At the same time, this role is not necessarily suited to scholars who must retain a sense of proportion, see the issues in all their complexities, and provide a fair-minded perspective not only for themselves but for the public at large.

The problems with "peace research" provide some legitimate ground for concern: the questions are broad, researchable issues hard to formulate, empirical evidence difficult to assemble, and measurement and quantification often beyond reach. There is a natural, and perhaps inevitable, tendency to get lost on the abstract sea of high purpose when the imagination is freed from the stabilizing influence of empirical evidence developed by well-focused inquiries. No one is immune to this tendency. The intricate political nature of many of the issues (often global in scope) and the impossibility of understanding in any fundamental sense the social, economic, cultural, and political conditions guiding other people's and other nations' lives suggest a course of caution and humility. But they most emphatically *do not* suggest a course of academic withdrawal—of choosing not to engage in research on the basic questions of peace and disarmament and conflict management.

> As long as we think solely in terms of winning fights instead of managing conflict, our agenda can only lead to catastrophe. . . . We do not necessarily have to do away with fights altogether, but they must be highly limited and hedged with taboo. We do not have to pretend that hostility or even conflicts do not exist, but we must turn enemies into opponents. . . . (Boulding, 1981).

An acquiescent academic community has too long allowed the word "peace" largely to be appropriated by the far left and the utopians for their own purposes. This neglect has too often raised suspicions that "peace movements"—and by extension "peace research"—may be ploys of "enemies" who want to weaken Western resolve and promote unilateral disarmament in the name of "peace." The community of research scholars must reverse this neglect. A topic so important must not be stricken from research agendas simply because some who espouse peace have naive or hypocritical motives. A commitment to research does not involve prejudgments about the best ways to avoid or reduce conflicts and prevent wars. It is not a commitment to appeasement. These issues demand serious and unbiased scholarly investigation, because:

> We can expect little from a 'peace' movement that challenges only American military programs and presents itself as an attack upon, rather than an expression of, Ameri-

> can society. . . . Similarly we cannot expect much from those who cry the horror of nuclear war, but offer no feasible proposals for progress toward the legal and political processes that can replace it, or even a sensible perspective on what policies are most likely to prevent it. . . . Nor can we expect answers from those 'realists' who seek to apply traditional military and policy approaches to a radically changed world environment (Pickus, 1981).

Powerful nations were once fairly unrestrained in acting to achieve what they saw as their own interests. The weak had to depend on the goodwill and the self-imposed forbearance of the powerful; they had to rely on the strong to refrain voluntarily from using their power to its limit. For the weak, freedom of action was a privilege granted them by the more powerful. A half-century ago, transnational corporations, too, were more or less able to do what they wished ". . . introducing 'gunboat diplomacy' and 'market forces' and setting royalties. It took challenges—expropriations and other products of evolving 'national unity,' 'strong government,' and 'local experience and expertise'—before multinational operations became a matter of negotiation" (Kanel, 1978).

None of these expressions of power on the international scene have disappeared. In the past 30 years, however, there have been substantial changes in the exercise of such power. The nations of the world have become increasingly interdependent, and even the most powerful actors are often restrained in their acts and find it necessary to include in their calculation of self-interest the interests of other actors. No nation is immune to the adverse consequences of its own acts, and too narrow a view of self-interest in today's interdependent world can prove disastrous.

The problem, of course, is not with power *per se.* Any system needs power to drive it —physical, economic, political, and moral power. A more peaceful world will not arise from good intentions alone. The problem with power is to prevent its abuses without destroying its necessary functions, and this is the role of new institutional rules and procedures. When these new rules are applied to all, they must serve not only to restrain but also to liberate and make more secure the rights and opportunities of the weak as well as the strong.

The obstacles to achieving new rules and procedures are, however, very great. The international system is not simply a larger version of the national one. There are no common and universally accepted procedures for defining the public interest for the world at large. There is no hierarchical structure of power and no sovereign authority at the world level. Authority at the international level is horizontal—distributed among equally sovereign (although not equally powerful) nations. Perhaps current relations among the world's sovereign states are at a point not unlike the pre-nation "estate stage" of 14th century England: "Contesting interest groups had no clear powerful sovereign center. The 'estate stage' exhibits contractual, not constitutional relations and 'peace' by exercise of forbearance" (Parsons, 1978).

This non-hierarchical authority structure is unable to sustain agreements that might govern the behavior of nations in our increasingly interdependent world. Are nations ready to accept a "clear powerful sovereign center" at the international level? Not likely. True, there are more and more international agencies within the United Nations system. Those international bodies serve important functions—they can influence the global agenda, internationalize subjects formerly considered purely domestic matters, and provide a forum for debating alternative approaches. But so far, nations have been unwilling to invest these agencies with much policy-making or enforcement authority. The international system lacks the highly developed legal institutions of our familiar national systems (Bilder, 1980, p. 386).

Nevertheless, there are a variety of ways for working out bilateral and multilateral agreements. The lack of an international police force doesn't mean that nations will deliberately break their commitments; many international agreements are strictly honored by nations out of self interest. Disputes between neighboring nations are not uncommon, yet for the most part borders are respected and common resources are shared by mutual agreements that meet the interests of all parties. A recent climate of hostility may have dimmed the public luster of agreements between the United States and the Soviet Union; the terms of Salt I have expired and those of Salt II have never come into effect; yet:

> Except for the dismantling provisions, both Governments are respecting these terms. Even nonbinding norms can establish a *modus vivendi.* As with an unmarried couple sharing an apartment, it may be easier for both countries to live together than to enter into major commitments (Fisher, 1981).

Some Research Suggestions in Search of a More Peaceful World

The current system is not without hope. Many incentives can be written into international agreements to encourage (if not assure) compliance. But scholarly research must help define alternatives and prospects. And there is no single discipline that covers all facets of these complicated problems. The study of peace and conflict resolution cannot be abstracted from other aspects of world affairs including economics, history, culture, development, psychology, and communications, as well as politics. All disciplines across the spectrum of sciences and humanities can and must contribute. What follows is a brief outline of several broad research categories.

1. Research focused directly on peaceful means of conflict resolution. In 1975 Galtung presented a typology of peace research with an emphasis on what appeared (at that time) to be important gaps in knowledge. These gaps range from disarmament processes in history and the structure of disarmament negotiations to nonmilitary defense, the international implications of increasing scientific capability, and the role of positive sanctions in the international system (see also Weston *et. al.* 1978).
2. Research focused on international law and international mediation. University lawyers and labor economists have developed research and practical experience on mediating and settling disputes between management and labor. The application of these skills to the critical issues of international peace and disarmament (and especially nuclear arms reductions by the two super powers) is not nearly so well developed. There are good beginnings, yet much remains to be done (see Fisher 1978 and 1981; Bilder 1980 and 1981; Schachter 1976 and 1977).
3. Research focused on new international economic problems and relations. International monetary instabilities are directly related to the arms race. A Wall Street analyst contends that:

   > The U.S. banking establishment is concerned over the U.S. policy of deliberate confrontation with the Soviet Union. The escalation of the armaments race threatens to create worldwide chaos. . . . The economies of Russia and the U.S. are being ruined by the costs of the arms race. Surplus capital created for reinvestment is being eaten up by the demands of the arms race (Steel, 1981).

   Military spending does not "cure" economic ills; in fact it worsens them both nationally and internationally. Greater military spending, inflation, and cutbacks in social programs all produce inequities, reduce living standards for large parts of the population, and tend to "heighten hostilities at home" (Kopkind, 1981, p. 227).

   Discouragement at the 1980 annual meeting of the American Economics Association was read by one analyst as an international issue:

   > A growing number of leaders of the economics profession feel that their discipline in its present condition is of little use in solving the greatest danger

that now threatens humanity: the breakdown of the economic and social order on which the lives of more than four billion people depend (Silk, 1980).

4. Research focused on international aspects of environmental problems. The environment is a system that binds nations and peoples together in interdependent relationships made more binding because of technological developments in production, transport, and communication. Air pollution, degradation of international waters, weather modification, deforestation and desertification are global problems that can be attacked only by international negotiation, agreement, and action. There has been research in all these areas, but few attempts have been made to relate research results to the political process in international affairs.
5. Research focused on international issues of developing, pricing, conserving, and trading natural resources, including energy resources. Natural resources are invested with an inherent public interest because they are finite in quantity or require major public investments to maintain their renewability or quality. Differences in evaluation between buyers and sellers of resource commodities and the frequent divergence between national and international benefits and costs of resource use or exploitation give rise to disputes that have sometimes led to war. Again, research on these questions is common, but it should be specifically designed to provide insight into international negotiations on the issues so frequently threatening to world peace (Dorner and El-Shafie 1980, p. 26).
6. Research focused on the problems and the suffering of the 12 million refugees in the world (an estimate by the U.N. High Commissioner for Refugees). These are people who have fled their homes because of wars and conflicts, or the violation or threatened violation of fundamental human rights. Of the emergency food aid channeled through the UN/FAO World Food Programme in 1981, almost 75 percent went to support people in need as a result of man-made disasters—refugees, displaced persons and others affected by civil disturbances. Many of these people became refugees because of the rivalry and competition between the two super powers in the Third World. Thus research must be directed at this rivalry. Research must provide new alternatives for negotiations and agreements that will reduce the fears, the insecurity and the neurosis which each of these powers now seems to feel and project.
7. Research focused on the non-military aspects of our national security: continued efforts better to understand other cultures and social systems (to be shared widely with the general population through educational programs). Cyrus Vance may well be right in suggesting that U.S. security depends more on helping Third World nations out of their poverty and despair than on billions spent on new weapons systems. This approach too requires continuing research to help shape U.S. policies so that such assistance can contribute to national security by promoting a just and stable peace and thereby greater stability in the world.

This brief list is certainly not an exhaustive account of the research (and classroom teaching) that deserve more attention from university scholars and students in the search for a less dangerous and a more peaceful world. We must rethink our research efforts in light of the evolving and increasing interdependence and interconnectedness of nations. The key issues of equity in international trade and other relations among the world's nations and peoples may not be definable outside the actual process of negotiation, but equity must very definitely be addressed.

These are not tasks for scholars of a single university nor for scholars of a single country. But I am interested in seeing that the University of Wisconsin-Madison undertake a major research effort on some of these issues. It is most fitting for this great university to make that effort to extend the Wisconsin Idea of public service to the global community.

The 1981 report of a Commission appointed by former President Carter has called for the establishment of a National Peace Academy. That report has gone to the President and the Congress. Legislation to establish a United States Academy of Peace and Conflict Resolution has been introduced in the House with 69 co-sponsors. A similar bill introduced in the Senate has 50 co-sponsors. The idea may or may not bear fruit under current budget constraints, but it shows that at least some policy makers are seeking help from academia on these pressing issues.

Many universities, including Wisconsin, have been accused by their students of involvement in the "war system." Whether or not those charges are valid, we do owe it to our students to develop the courses and the research work that will meet the vital concerns of arms control, interdependence, and a more peaceful world.

Literature Cited

Bilder, Richard B. 1980. "International Law and Natural Resource Policies" in Dorner and El-Shafie eds. *Resources and Development: Natural Resource Policies and Economic Development in an Interdependent World.* Madison: The University of Wisconsin Press.

———, 1981. *Managing The Risks of International Agreement.* Madison: The University of Wisconsin Press.

Boulding, Kenneth E. 1978. *Stable Peace.* Austin: University of Texas Press.

———, 1981. "Survival at Gunpoint," *Technology Review,* August/September, p. 6.

Commons, John R. 1957. *Legal Foundations of Capitalism.* Madison: University of Wisconsin Press; originally published in 1924 by the MacMillan Company.

Dorner, Peter and El-Shafie, Mahmoud A. 1980. *Resources and Development: Natural Resource Policies and Economic Development in an Interdependent World.* Madison: The University of Wisconsin Press.

Fisher, Roger (with the help of William Ury). 1978. *International Mediation: A Working Guide.* New York: International Peace Academy.

Fisher, Roger. 1981. Three articles in the *New York Times* dated September 24, 25, and 26.

Galtung, Johan. 1975. *Peace: Research Education Action Essays in Peace Research Volume I.* Copenhagen: Christian Ejlers.

John F. Kennedy School of Government. Winter 1982. *Bulletin.* Harvard University, pp. 4-21.

Kanel, Don. 1978. "Power and Property as Issues in Institutional Economics and Economic Development." In *Proceedings of the Wisconsin Seminar on Natural Resource Policies in Relation to Economic Development and International Cooperation,* Vol. 2. Madison: Institute for Environmental Studies, University of Wisconsin.

Kopkind, Andrew. 1981. "Maddening, Not Madness" in *The Nation* March 7, pp. 227 and 280. [review of Ruth Leger Sivard. *World Military and Social Expenditures 1980.* World Priorities: Leesburg, Virginia].

Parsons, Kenneth H. 1978. "Public Policy on Natural Resources, Economic Development, and International Cooperation." In *Proceedings of the Wisconsin Seminar on Natural Resource Policies in Relation to Economic Development and International Cooperation,* Vol. 2. Madison: Institute for Environmental Studies, University of Wisconsin.

Pickus, Robert. 1981. "Introduction" to *American and World Affairs Directory,* Berkeley, California, World Without War Council of Northern California.

Saxon, David S. 1981. "A Role for Universities in Ending the Arms Race." *Chronicle of Higher Education,* July 6.

Schachter, Oscar. 1976. "The Evolving Law of International Development," *Columbia Journal of Transnational Law* 15:1-16.

———. 1977. *Sharing the World's Resources.* New York: Columbia University Press.

Steel, Johannes. 1981. "Arms Race Promises Economic Chaos," *The Capital Times,* September 24, Madison, Wisconsin, p. 13.

Silk, Leonard. 1980. *New York Times,* September 24, p. D-2.

Weston, Burns H., Sherle R. Schwenninger and Diane E. Shamis, eds. 1978. *Peace and World Order Studies: A Curriculum Guide.* New York: Institute for World Order.

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