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THE HYDROGRAPHY, FISH, AND TURTLE POPULATION OF LAKE WINGRA*

WAYLAND E. NOLAND

INTRODUCTION

Work on this paper was carried out in 1948 and 1949. It started as a paper dealing with a few of the aspects treated here when the writer was enrolled during the spring of 1948 in a one-credit course at the University of Wisconsin called "Zoology 224, Limnology Journal Club," given by Professor Arthur D. Hasler. Each student was expected to deliver a talk reviewing some publication in the field of limnology or discussing some original contribution in the field. The present writer, a native of Madison who has spent many pleasant hours fishing on Lake Wingra, chose it as his subject for discussion.

Lake Wingra is of particular interest because it is a small but heavily fished lake located at a population center (Madison) and is at the same time an integral part of the large outdoor laboratory known as the University of Wisconsin Arboretum. For these reasons it was felt that a detailed study and compilation of records of the lake, such as this paper, would be worth while.

In addition to the encouragement and large amount of data provided by Professor Hasler, a number of other persons have been very helpful in providing valuable data and the writer wishes to express his appreciation to Professors G. William Longenecker (Director of the Arboretum), the late Aldo Leopold, Lowell E. Noland, and Ernest F. Bean (State Geologist), all of the University of Wisconsin; Madison Park Superintendent James G. Marshall; Edward Schneberger, Lyle E. Dye, Elmer F. Herman, Charles Lloyd, and Clarence L. Cline of the Wisconsin Conservation Department; John C. Neess, Joseph W. Jackson, and to the many others whose assistance is acknowledged in the list of references. Furthermore, the writer would like to express his appreciation to his father and mother, Professor and Mrs.

* This paper is dated September 20, 1949 and has been amended to October 1, 1950.

Lowell E. Noland, and to his grandfather, Professor Wayland J. Chase, for reading and criticizing parts of the manuscript.

I. THE HYDROGRAPHY OF LAKE WINGRA

A. HYDROGRAPHIC HISTORY

The first hydrographic survey of Lake Wingra was made by E. A. Moritz in 1904 (M12). His map shows the lake in approximately its original contours, before any dredging or filling had been carried out. The map shows a maximum depth of 14 feet in the depression located south of what is now the center of the island shoreline of Vilas Park. South of the area of maximum depth and in the southeastern part of the clear-water area of the lake is a shoal which reaches a minimum depth of eight feet. A large part of the central portion of this clear-water area, lying along an approximately east-west axis, is within the 10-foot contour line, including the depression and shoal previously mentioned. Toward the western end of this large area are two more depressions, having east-west elongation and separated by a slight bar with a minimum depth of 12 feet. The northern depression has a maximum of 13.5 feet and the southern depression a maximum depth of 13 feet. The descent from the 2- to the 10-foot contour is relatively rapid on all sides of the lake, particularly on the northern and southern sides. All sides of the clear water are surrounded by marsh, particularly on the eastern and southeastern sides, where the marsh extends all the way to the bridge on the Fitchburg Road (also called the Fish Hatchery Road) from where it drains through Murphy's Creek into Lake Monona (S3), and on the northeastern side, where an extensive marsh covers what is now the lower part of Vilas Park.

The 1901 "Hydrographic Map of Lake Monona" by L. S. Smith (S3) shows a channel for Murphy's Creek originating along the southern part of the eastern side of the clear-water area of Lake Wingra and running in a rather direct line through the marsh to the bridge on the Fitchburg Road. Other references, however, refer to the lake prior to the dredging of Murphy's Creek as an undrained lake (H3) or as having no natural outlet (D2). Although a well-defined channel through the marsh was probably lacking prior to the dredging of Murphy's Creek, it is certain that Murphy's Creek served as the drainage outlet for Lake Wingra. Even the present shoreline has an appreciable indentation along the southern part of the eastern shore where the principal flow through the marsh to the beginning of the channel of Murphy's Creek must have occurred.

Beginning in 1905 and continuing in 1906 extensive dredging and filling operations were carried out in the northeastern marsh area in order to create Vilas Park (M3, M4). Edgewood Bay and Northeast Bay were created during the construction of the park (H5). Further dredging and filling operations were carried out there in 1913 (M6, M7). In 1905 the dredging of a channel for Murphy's Creek was begun through the eastern marsh, proceeding in an arc, concave southwestward, from the bridge on the Fitchburg Road northwestward to what was then the southern end of Warren Street (now called Randall Avenue, but no longer continuing to the lake as did Warren Street) (M2, M3, M12). Plans for the dredging of Murphy's Creek are shown on the 1904 "Hydrographic Map of Lake Wingra," previously described. In 1906 the dredging of this portion of Murphy's Creek was completed and a wooden lock was constructed a short distance above the bridge on the Fitchburg Road to maintain the lake at its original level (H5, M2, M3, M4, M5). The remaining dredging of Murphy's Creek, from the bridge to Lake Monona, was carried out in 1907 and 1908 (M4, M5). Previous to the dredging of Murphy's Creek, the water level dropped only a few inches between Warren Street and the bridge on the Fitchburg Road but fell about four feet between there and Lake Monona (M2).

The changes in the shoreline of the northeastern part of the lake as a result of the Vilas Park dredging and filling and the dredging of a new channel for Murphy's Creek are shown in the 1916 "Map of Lake Wingra" by P. H. Hintze (H5). In this map the 1916 shoreline appears to have been superimposed on the lake-depth contour lines of the 1904 "Hydrographic Map of Lake Wingra."

During the period from about 1914–1920 the Lake Forest Land Company undertook to drain and fill, with sediment dredged from the lake, the extensive areas of marsh and lowland east and southeast of the lake in order to develop residential land (B3, C1, J1, K1, M8, M9). A. S. Pearse refers to a hole about 30 feet deep, probably in the area of present maximum depth, present during the spring of 1917 and formed by the working of a hydraulic dredge during the preceding summer (P3). Drainage canals were constructed, one of which passed near the southeastern corner of the lake and was separated from it merely by a dike (H5, M8). During the summer of 1917 this dike was opened to permit the passage of a Lake Forest Land Company dredging barge which had been constructed on Lake Wingra (M8). Since the drainage canals emptied into Murphy's Creek between the lock and the bridge on the Fitchburg Road (H5), once the dike was opened, there was little to hold back the water of Lake Wingra and the level fell to 12–15 inches above the "normal level" of Lake Monona, which had been established by the Railroad Commission on June 28, 1917, as 844.65 feet above sea level (M8). On July 19, 1918, the Railroad Commission required the maintenance of a lock and spillway at the outlet of Lake Wingra, with the spillway level to be 847.68 feet above sea level (M8). The new lock and spillway were constructed in 1919 (M9) at their present location a short distance southeast of South Orchard Street, and the dike in the southeastern corner of the lake closed (M9). The construction of the new lock permitted the lowering of the entire length of Murphy's Creek to approximately the level of Lake Monona, facilitating the drainage of the marsh without maintaining Lake Wingra at the low level to which it had been temporarily reduced by the opening of the southeast dike. To provide fill for the newly drained marsh large quantities of sediment were dredged from Lake Wingra, particularly from along the eastern part of the south shore and from the area just above the new lock, producing Outlet Bay, as well as just below the lock, producing the Murphy's Creek widespread. In spite of the extensive drainage, dredging, and filling operations, the project failed to produce sufficiently dry land for residential use and the former marshland soon became known as the "Lost City."

In 1919 A. S. Pearse (P3) reported the following hydrographic data in English units and in 1920 A. S. Pearse and H. Achtenberg (P5) reported the same data in both English and metric units for Lake Wingra, except that the mean depth was listed as 5.3 feet:

Maximum Depth	Length	Width	Shoreline	Area	Mean Depth	
4.25 m.	2.6 km.	1.4 km.	7.3 km.	2.17 sq.km.	--	(1.6 m.)
14 ft.	1.6 mi.	.8 mi.	4.5 mi.	.79 sq.mi.	5.5 ft.	(5.3 ft.)

In 1921 A. S. Pearse reported Lake Wingra to have a volume of 2,761,000 cubic meters (P4).

In 1926 B. P. Domogalla and E. B. Fred (D4) reported the following hydrographic data in metric units and in 1935 B. P. Domogalla (D3) reported the same figures in English units for Lake Wingra:

Maximum Depth	Length	Width	Mean Depth	Volume
4.3 m.	1.60 km.	.60 km.	2.7 m.	5,600,000 cu.m.
14.1 ft.	1.00 mi.	.37 mi.	8.9 ft.	1,479.52 million gal.

With the exception of the figures for maximum depth for which there is close agreement and the figures for shoreline and area for which direct comparison is lacking, these data do not agree at all with those reported in the preceding paragraph. The fact that the figures of 14 and 14.1 feet, respectively, for the maximum depth are in close agreement with the maximum depth of 14 feet shown on the 1904 "Hydrographic Map of Lake Wingra," and that they do not reflect the considerably greater maximum depth resulting from the dredging of 1914–1920 leads to the belief that the figures for maximum depth, at least, were obtained in both cases from the 1904 map. Furthermore, in 1938 C. Juday stated (J2) that Lake Wingra had a maximum depth of 14 feet and an area of 200 acres.

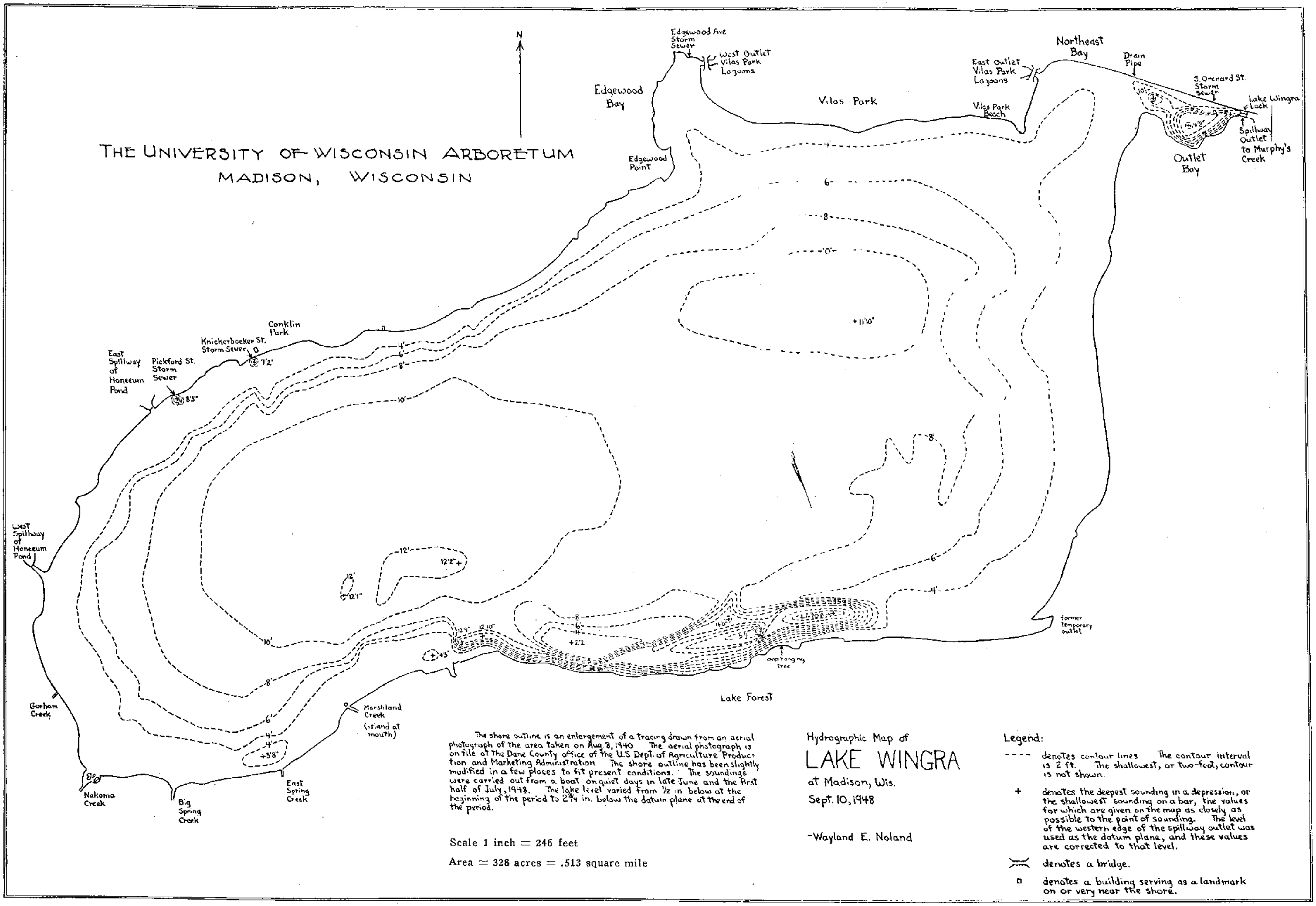
The second hydrographic survey of Lake Wingra appears to have been made by W. L. Tressler since the map appears in his Ph. D. thesis (T1a), which was written in 1930. The contour interval is 1 meter (3.3 feet) but the map is not drawn to scale. The two depressions in the western part of the lake which appeared in the 1904 map are also present in this map within 4-meter (13.1 foot) contour lines. The shoal in the southeastern part of the lake is missing and the depression south of the central portion of Vilas Park is shown within the 4-meter (13.1 foot) contour line to the east of where it should be because Vilas Park is drawn out of proportion to its size. The significantly new features of this map are the depth of Edgewood Bay, which has a 4-meter (13.1 foot) depression in the outer part of the bay, the 1-meter (3.3 foot) depth of Northeast Bay with the 2-meter (6.6 foot) and 3-meter (9.8 foot) contour lines bent in toward the bay, and the depth of Outlet Bay, which contains a 4-meter (13.1 foot) depression. This map cannot represent the result of a survey of the entire lake because it does not show the deep dredging channels present along the eastern part of the south shore at the time the map was made. It probably represents a redrawing of the 1904 map, embodying the results of soundings of Edgewood Bay, Northeast Bay, and Outlet Bay, which did not exist at the time the 1904 map was made.

During the winter of 1933–34 rocks were carried out on the ice in the western part of Lake Wingra where the water was about four feet deep with the intention of creating a bar where migratory geese could rest undisturbed (L3, P6). The first day after the ice went out in the spring the rocks had settled so that a bar remained about a foot above the water (P6). By the next morning the bar had disappeared completely into the soft bottom sediment (P6). A sounding made by the engineer, John F. Icke, where the bar had been, revealed solid bottom at a depth of 70 feet (P6).

In 1941 the Vilas Park Lagoons were redredged to restore the five-foot center depth (M10). The depth at the shore was made 15 inches with a slope of one foot downward for every four feet on the horizontal (M10). These operations did not affect Lake Wingra, since the dredging was confined solely to the lagoons, and the dredged sediment was deposited on the large island in the center of the lagoons.

It was reported in 1946 that Lake Wingra had received no treatment with copper compounds (N2). This fact was substantiated by chemical analyses of samples of bottom mud taken at three different points in the lake (N2).

The third hydrographic survey of Lake Wingra and the second survey of the entire lake was carried out in 1948 and the results are embodied in the "Hydrographic Map of Lake Wingra" by W. E. Noland, a full report of which appears below. The former area of maximum depth in the lake, 14 feet, south of the central portion of Vilas Park, now has a maximum depth of only 11 feet 10 inches at a point directly south of the small point at the center of the Vilas Park shoreline and is no longer the deepest area in the lake. The eight-foot shoal is still present in the southeastern part of the lake. The two east-west elongated depressions in the western part which formerly had a maximum depth of 13.5 feet on the north and 13 feet on the south now appear as a very large area along the axis of the lake within the


THE UNIVERSITY OF WISCONSIN ARBORETUM
MADISON, WISCONSIN
N
Edgewood Ave Storm Sewer
West Outlet Vilas Park Lagoons
Edgewood Bay
Edgewood Point
Vilas Park
Vilas Park Beach
East Outlet Vilas Park Lagoons
Northeast Bay
Drain Pipe
S. Orchard St. Storm Sewer
Lake Wingra Lock
Spillway Outlet to Murphy's Creek
Outlet Bay
Conklin Park
Knickerbocker St. Storm Sewer
East Spillway of Honeeum Pond
Pickford St. Storm Sewer
West Spillway of Honeeum Pond
Gorham Creek
Nakoma Creek
Big Spring Creek
East Spring Creek
Marshland Creek (island at mouth)
Lake Forest
overhanging tree
former temporary outlet
Hydrographic Map of
LAKE WINGRA
at Madison, Wis.
Sept. 10, 1948
-Wayland E. Noland
The shore outline is an enlargement of a tracing drawn from an aerial photograph of the area taken on Aug. 8, 1940. The aerial photograph is on file at the Dane County office of the U.S. Dept. of Agriculture Production and Marketing Administration. The shore outline has been slightly modified in a few places to fit present conditions. The soundings were carried out from a boat on quiet days in late June and the first half of July, 1948. The lake level varied from ½ in. below at the beginning of the period to 2¾ in. below the datum plane at the end of the period.
Scale 1 inch = 246 feet
Area = 328 acres = .513 square mile
Legend:
---- denotes contour lines. The contour interval is 2 ft. The shallowest, or two-foot, contour is not shown.
+ denotes the deepest sounding in a depression, or the shallowest sounding on a bar, the values for which are given on the map as closely as possible to the point of sounding. The level of the western edge of the spillway outlet was used as the datum plane, and these values are corrected to that level.
denotes a bridge.
denotes a building serving as a landmark on or very near the shore.

10-foot contour line. This area slopes gradually to a maximum depth of 12 feet 2 inches in the southern part of the area.

The dredging operations of the Lake Forest Land Company, which have already been referred to, have produced profound changes in the bottom contours along the south shore. A new area of maximum depth for the lake, 20 feet 8 inches, has been created in a dredging channel along the eastern part of the south shore. At one point along the Lake Forest shore a narrow bar lies between two dredging channels. The descent from the point of minimum depth, 5 feet 4 inches, at the eastern end of the small bar to the 16-foot depth of the shoreward dredging channel is extremely rapid.

Another area of relatively great depth for Lake Wingra was created by the dredging of Outlet Bay, which now has a maximum depth of 14 feet 8 inches, corresponding with the area of 4-meter (13.1 foot) depth in the map of W. L. Tressler (T1a). There is a second small depression just east of the western entrance to Outlet Bay, which has a maximum depth of 10 feet 1 inch. Northeast Bay is rather shallow, as was also shown on Tressler's map, since it is entered only by the 4-foot contour line. In Edgewood Bay only a vestige remains of the deep area shown on Tressler's map to have a depth of 4 meters (13.1 feet), since the 4-foot contour line enters the bay only for a short distance where the 4-meter (13.1 foot) depth used to be. Most of Edgewood Bay is, however, very shallow, and rapidly filling in with sediment eroded from the steep hill at the foot of which it lies.

The Knickerbocker Street and Pickford Street storm sewers have scoured out beyond their outlets small but relatively deep depressions, which at the time of the soundings were 7 feet 2 inches and 8 feet 5 inches in depth, respectively. The mud at the bottom of these depressions was heavily charged with sewer gases, particularly in the case of the Pickford Street storm sewer.

The depression just out from and to the west of East Spring Creek outlet was probably formed by pumping. Circumstantial evidence for this belief is the presence of a sizeable iron pipe lying on shore and projecting into the lake in the area.

B. Report of the Hydrographic Survey of Lake Wingra

(To accompany the hydrographic map of Lake Wingra)

Acknowledgments

The sounding was carried out by Wayland E. Noland, with the assistance of Professor Lowell E. Noland, Thomas L. Finch, and James P. Telford, using a round-bottom rowboat provided by the University of Wisconsin Department of Zoology. Thanks are due to John E. Bardach for assistance in providing the boat. The mapping was carried out by Wayland E. Noland, with the advice and assistance of Professor Lowell E. Noland. Financial support for the project was provided by the University of Wisconsin Arboretum Committee, arranged by Professor Arthur D. Hasler.

Procedure

The shore outline for the hydrographic map was obtained from a tracing drawn from an aerial photograph of the area taken on August 8, 1940. The aerial photograph is on file at the Dane County office of the United States Department of Agriculture Production and Marketing Administration, 353 West Johnson Street, in Madison. The tracing was enlarged to provide a map of convenient size with a scale of 1 inch = 246 feet. The shore outline was slightly modified in a few cases to fit present conditions. The area of Lake Wingra, as determined from the map with the use of a planimeter, was found to be 328 acres, or .513 square mile.

The soundings were carried out from a boat on calm or quiet days in late June and the first half of July, 1948. The period from dawn until 7:30–8:00 A.M. generally proved to be the best time from the standpoint of least wind and least disturbance to fishermen on the lake, since there were few at that time of day. The method of sounding was similar to that used by W. J. Chase and L. E. Noland in their hydrographic survey of Lake Ripley (C3). Landmarks were located on the map at various points along the shoreline. The sounding runs were made by starting at one of these points and heading across the area to be sounded toward another landmark. Two persons were always present on these sounding runs. One person was responsible for rowing and keeping the boat lined up on the landmark to the rear, and the other person was responsible at the beginning of the run for keeping the rower headed toward the forward landmark and for taking and recording the soundings. The rower kept his oar strokes as nearly uniform as possible, and stops were made for soundings at intervals of five or ten strokes. Immediately after the fifth or tenth stroke, as the case happened to be, the rower backwatered to bring the boat to a complete stop, or nearly so, so that the sounding line was vertical at the time of sounding.

The sounding operations were carried out as quickly as possible in order to keep the error caused by drifting of the boat off its course at a minimum. As soon as a sounding operation was well under way, no attempt was made to head the boat back toward the forward landmark if it had been blown off course, but at all times the boat was kept in line with the rear landmark, since the maintenance of as nearly straight a course as possible was more important than ending up at a given landmark. In a case where the end of the sounding run was not at the intended landmark, the distance to that landmark was measured in oar strokes taken in exactly the same manner as the strokes on the sounding run, with stops at five or ten stroke intervals. The sounding runs were plotted on the map as straight lines. The assumption was made that the lengths of the strokes on any one sounding run were all the same. This assumption permitted the location on the map of the sounding points and the endpoint of each run. The lengths of the strokes varied some from run to run depending on the rower and the presence of a breeze. From this description of the procedure it is evident that as nearly calm conditions as possible were required since a breeze blowing in any direction except parallel to the course would tend to make the course an arc instead of a straight line as depicted on the map, and a breeze of irregular velocity from any direction would cause the stroke lengths to be irregular rather than equal for a given run, as depicted on the map. In the presence of calm conditions, however, and over relatively short distances such as are found on a small lake like Lake Wingra this method of operation appears quite satisfactory, and has the advantage that a very large number of soundings can be made in a relatively short time. A total of 60 sounding runs were made across the various parts of the lake.

The plumb used for all of the soundings was made by pouring molten lead into a muffin tin which served as a mold. A rubber tube clamp was set in the lead to provide a place for attachment of the sounding line. The plumb weighed 1 pound 2½ ounces and had a bottom diameter of 1¾ inches.

The sounding line was made of strong wrapping twine which had been waterproofed by soaking in melted paraffin. It was calibrated by attaching markers of colored string to it at six-inch intervals. The calibrations were checked periodically against a steel tape, but the errors were so slight that corrections of the data were found to be unnecessary. The measurements were made in feet rather than in the scientifically preferred metric units in order to encourage greater popular use of the map.

The level of the western edge of the spillway outlet was used as the datum plane. Since the lake level varied from one-half inch below at the beginning of the sounding period to two inches below the datum plane at the end of the period, the values for the deepest soundings in the depressions and the shallowest soundings on the bars were corrected to the level of the datum plane. Since the variations in lake level below the datum plane were considered within the limits of error in making and plotting the soundings, however, the values for the soundings used only for drawing the contour lines were ordinarily not corrected to the level of the datum plane.

Because of the presence of numerous offshore bars, often covered with bulrushes, and of marsh growth in the southeastern corner of the lake, and because of the generally very irregular and probably rather temporary contour of the bottom area at a depth of less than four feet, the shallowest, or 2-foot, contour is not shown. Aside from surface run-off, all of the known tributary water sources of Lake Wingra are shown on the map.

In the dredging channels along the south shore of the lake the actual rate of drop-off is frequently much greater than the position of the contour lines would indicate, since the dredging channels are characterized by relatively flat, deep channels with very steep sides. In order to avoid the confusion resulting from allowing the contour lines to run together they have been allowed to encroach on the deeper parts of the channels. The shallowest part of the small Lake Forest Bar is very irregular, and in some places nearly vertical drops of as much as two feet were encountered.

Blackline copies of the map are now available for a nominal fee at the office of the State Geologist, Professor Ernest F. Bean.

C. Water Sources of Lake Wingra

Many of the springs which formerly provided Lake Wingra with a steady flow of water throughout the year no longer exist. Those which have ceased to flow were located on the north shore in the city of Madison. Many of these springs have been replaced as sources of water by storm sewers. Since the drainage from these storm sewers is dependent directly on rain or melting snow, their flow into the lake is very irregular, varying from none to a torrent, depending on the weather. Much of the rain water falling on the north shore of the Lake Wingra basin, which formerly in all likelihood reached the lake by percolating through the ground and then flowing along subsurface strata to reappear in the form of springs, now reaches the lake as direct runoff carried by storm sewers. To the extent that this change has occurred the character of the water supply of Lake Wingra has also changed. A fairly constant flow of clear, relatively hard, spring water has in considerable measure been replaced by a very irregular flow of soft rain water containing the dissolved and suspended dirt and oil of city streets.

1. Water Sources Which No Longer Exist

The list of such sources and their detailed description is as follows:

a. *The Reynolds Spring*

This spring (or springs) was located near the present Lake Wingra outlet at the edge of the marsh just south of the old Dividing Ridge on the north side of the lake (B4, B6c) and was probably on the east side of South Orchard Street just below the residence at 717 South Orchard Street. The creek which served as its outlet to Lake Wingra has been obliterated by filling (B6c).

b. *Marsh Spring 1*

This spring was located in the marsh which is now Vilas Park, about 225 feet south of the old lake bank and on a line extended midway between and parallel to Harrison and Van Buren Streets (M10a). The spring was obliterated in 1905 by the filling which was carried out to create Vilas Park (S2).

c. *Marsh Springs 2 and 3*

This pair of springs was located in the marsh which is now Vilas Park, about 100 feet out from the old lake bank and midway between lines continued from Van Buren and Lincoln Streets (M10a, S2). The springs were obliterated in 1906 either by the additional filling or by the landscaping which was carried out in Vilas Park (M4a).

d. *Marsh Springs 4 and 5*

These springs were located in the marsh which is now Vilas Park. They were, respectively, about 125 and 200 feet southwest of Marsh Spring 3 and about 100 feet out from the old lake bank (M10a). The westernmost of the two, Marsh Spring 5, was directly out from the foot of Lincoln Street. The springs were obliterated in 1905 by the filling which was carried out to create Vilas Park (S2).

e. *Edgewood Bay Springs*

This pair of springs was located in the old marsh, about 50 feet out from the old lake bank, and about 120 and 180 feet, respectively, southwest of a line continued from the center of Edgewood Avenue (M10a). This area was later dredged to form Edgewood Bay so that the spring which remained was located in open water. This spring was last reported in 1931 (T2).

f. *Big Fish Spring*

According to George J. Behrnd, this large spring was located at the border between the cattails and open water in a small bay about 300 feet southwest of Edgewood Point. The spring was about six feet deep and was a good fishing spot. It stopped flowing at least 15 years ago and rapidly filled in.

g. *East Edgewood Spring*

This small spring was located about 45 feet out from the old lake bank and about 210 feet northeastward along it from the big (eastern) gully on the Edgewood property (M10a).

h. *Edgewood Big Spring*

This large spring, also known as the Deep Hole (B4), was located by some large willow trees about 65 feet out from the old lake bank and about 75 feet southwest along it from the big (eastern) gully (B3, M10a). Two artificial rock-walled pools, which are still to be seen, were supplied by water from the spring (B4). As late as January 1924 there was sufficient seepage at the site of the old spring to keep one of the pools permanently filled with water (N4).

i. *West Edgewood Springs*

These four springs were located along the western part of the Edgewood shore about 60 feet out from the old lake bank and, respectively, 350 feet, 450 feet, 550 feet, and 730 feet southwest along the bank from the big (eastern) gully (M10a). Two artificial rock-walled pools which were supplied by water from at least two of these springs are still to be seen.

j. *The Chase Springs*

According to Dr. Samuel L. Chase there were once eight small springs on the old Chase property, which lies along the Lake Wingra shore between Woodrow Street and Conklin Park. As late as January, 1924, there was sufficient seepage from two of the old springs to maintain two small pools during the spring and much of the summer (N4).

k. *The White Rock Spring* (B4)

This spring, which was also known as the Willow Spring and the White Cross Spring (B3), was located on the southeast side of Monroe Street near the present site of the William Wolf and Son Hardware Company at 2611 Monroe Street. Its water was carried several hundred feet to the lake by a ditch.

As the result of draining and filling operations carried out from about 1914–1920 by the Lake Forest Land Company, the marsh south of the eastern part of Lake Wingra has been converted into land which now drains through a series of canals into Murphy's Creek. Consequently, a number of springs (Vilas Spring, Cow Spring, Gay Spring, and Silver Spring (B4)), which formerly flowed into the marsh, and which could then be considered a part of Lake Wingra, now flow directly to Murphy's Creek, and can no longer be considered as water sources of Lake Wingra.

The question as to what caused the springs in the area between Edgewood Avenue and Conklin Park to stop flowing is difficult to answer with certainty. One factor which undoubtedly contributed, and may have been the sole cause, is the construction of buildings, streets, and sidewalks, which has greatly increased the amount of surface run-off and correspondingly reduced the amount of water which can soak into the ground and replenish the ground water in the area which formerly supplied the springs.

Another possible cause which has been suggested is the drilling of Madison Unit Well No. 1 at 817 Knickerbocker Street. This well was completed on December 7, 1923, and put into operation on May 5, 1924. The shaft of the well is insulated to a depth of 126.5 feet below the surface so that no water can be drawn off above this level. It seems possible that the "cone" of this well might have taken in the water which formerly appeared in the form of springs in this region, but several facts oppose this argument. With the exceptions of the Edgewood Bay Spring and Big Fish Spring, all of the springs in this area appear to have been reduced to at best a seepage status before the city well was put into operation. Furthermore, because of an inefficient pump, the well has been only on an emergency standby basis for the past 10 years and the present water level in the well is only 3 feet below the level of 1924 (N6).

2. Present Water Sources

The present water supply of Lake Wingra is provided by surface drainage from the Lake Wingra watershed, from springs, and, along the City of Madison shore, from storm sewers. The water sources (listed in counterclockwise order starting from the Lake Wingra outlet at the northeastern corner of the lake) are listed below:

a. South Orchard Street storm sewer
b. Vilas Park Zoo drain pipe
c. Vilas Park Lagoons
    1) Campbell Street storm sewer
    2) Van Buren Street storm sewer
d. Edgewood Avenue storm sewer
e. Woodrow Street storm sewer
f. Knickerbocker Street storm sewer
g. Pickford Street storm sewer
h. Honeeum Pond
    1) Chapman Street storm sewer
    2) Council Ring Spring
    3) Honeeum Spring
i. Glenway Street storm sewer
j. Gorham Creek
    1) Gorham Spring and the Duck Pond
    2) Stevens Pond and Stevens Creek
k. Cherokee Drive storm sewer

l. Nakoma Creek
   1) Nakoma Golf Course Lagoons
   2) Nakoma Spring
   3) Manitou Way drainage ditch
      a) 3900 Manitou Way storm sewer
      b) 3910 Manitou Way storm sewer

m. Big Spring Creek
   1) Big Spring
   2) West Spring and West Spring Creek

n. East Spring and East Spring Creek

o. Marshland Creek
   1) Teal Marsh
   2) Marsh Springlets

A detailed description of these water sources follows:

A storm sewer outlet enters the lake at the foot of South Orchard Street.

A drain pipe, which runs along the eastern edge of the buffalo pen in the Vilas Park Zoo, drains part of the zoo yards, passes under the park drive, and enters the lake just opposite the point on the south shore at the western entrance to Outlet Bay.

The Vilas Park Lagoons, which were originally created by dredging in 1905–1906 (M3, M4), connect with Lake Wingra by outlets that lie beneath stone bridges at the eastern and western ends of the park outer drive. Two storm sewers drain into the lagoons. The first extends from the foot of Campbell Street south southwestward, passing under Vilas Park and beneath a large drinking fountain in the park, and emptying into the lagoons in the bay east of the big island. The second storm sewer continues from the foot of Van Buren Street southeastward under Vilas Park a short distance east of the tennis courts and enters the lagoons opposite the western edge of the big island.

A storm sewer outlet enters Edgewood Bay near the foot of Edgewood Avenue.

A storm sewer outlet enters the marsh at the foot of Woodrow Street.

A storm sewer which runs parallel to and just west of Knickerbocker Street enters the lake a few feet west of the Aberle Boat Livery.

A storm sewer continues southeastward underground from the intersection of Arbor Drive and Pickford Street and drains into Lake Wingra a short distance east of Honeeum Pond.

Honeeum Pond is an artificial pond in the University of Wisconsin Arboretum southeast of Monroe Street in an area bounded by lines continued from Pickford Street and Western Avenue. Work on the pond was started on March 15, 1938 and finished in October, 1939 (L3). The pond empties into Lake Wingra over two small dams about a foot above the lake level at each end of the pond. Honeeum Pond is supplied by water from one storm sewer and two springs. The storm sewer continues from the foot of Chapman Street under Monroe Street and a short distance along Arbor Drive from where it passes on and empties into the pond along the central part of the north shore. The Council Ring Spring and the Honeeum Spring, which are also known collectively as the Marston (B4), Topp (B1), or Lime Kiln Springs (B4, B5), are also located along the central part of the north shore of the pond a short distance west of the storm sewer outlet. The Council Ring Spring flows out from the base of the Kenneth Jensen Wheeler Memorial Council Ring. Honeeum Spring is located about 70 feet below and southwest of the Council Ring Spring and nearer to the pond.

A storm sewer outlet emerges from beneath the southeast side of Monroe Street a short distance southwest of Glenway Street and drains through an open ditch into the marsh.

The Gorham Spring is located in the University of Wisconsin Arboretum at the bend in Nakoma Road south of the intersection where Monroe Street becomes Nakoma Road. This spring, which really consists of five springs, is located on the southeast side of the street. The springs flow into a widespread known as the Duck Pond, which flows over a small dam into Gorham Creek, which then flows out through the marsh and into Lake Wingra. Stevens Pond is an artificial pond located in the Arboretum a few feet southwest of Gorham Spring. Work on the pond was started in 1935 and finished in the spring of 1936 (L3). The water supply of Stevens Pond is derived from springlets located near the western corner of the pond and from spring seepage, which, like the springlets, was opened up when the pond was dug, making it unnecessary to divert water into Stevens Pond from the Duck Pond as originally planned (L3). The water level of Stevens Pond is now above that of the Duck Pond (L3).

Stevens Pond empties over a dam into Stevens Creek, which joins Gorham Creek a short distance below the Duck Pond.

A ravine which runs along the southeast side of Cherokee Drive empties into the storm sewer at the intersection of Manitou Way, Nakoma Road, Cherokee Drive, and Huron Hill. This storm sewer emerges a short distance south of the intersection and drains through a meandering channel into the marsh south of Stevens Pond.

Nakoma Creek rises in two lagoons in the Nakoma Golf Course near Manitou Way. The lagoons are artificial, having been dug when the golf course was filled and developed about 1925 (D1). Their sources of water are numerous springlets located along their shores. A short distance downstream from where the lagoons join to form Nakoma Creek an underground pipe carries part of the water directly across the golf course to the northeastern corner where it drains into another small lagoon, which was dug in 1948. The remaining water of Nakoma Creek is augmented a few feet farther on by a sizable spring which rises in the stream bed. (It seems possible that this spring comes from the water source which formerly supplied Viall's Spring.) This spring was formerly located behind (southeast of) the residence at 3865 Nakoma Road (the rebuilt Viall home) on the marshy Lake Wingra flat (B4). The spring was obliterated by the grading of the land on which it was located and of the adjoining land now occupied by the Nakoma Golf Course (B5). Its water supply replenished by the spring rising in its stream bed, Nakoma Creek flows on northeastward to the edge of the golf course. There it is joined by a drainage ditch flowing eastward from Manitou Way. This drainage ditch originates near the intersection of Manitou Way and Iroquis Drive and runs along Manitou Way to a point across the street from 3910 Manitou Way. Here a pipe from a storm sewer across the street empties into the ditch at the point where the ditch makes a right-angle turn. Another storm sewer originating opposite 3900 Manitou Way empties into the ditch a short distance east of the right-angle turn. The ditch then continues eastward along the edge of the golf course and empties into Nakoma Creek. Nakoma Creek flows along the edge of the golf course to the northeastern corner where it is rejoined by the water from the small lagoon. Here Nakoma Creek turns to the northeast and meanders out through the marsh into Lake Wingra.

There are three large springs originating at the base of a hill along the western part of the southern shore of Lake Wingra. Arboretum West Spring, also known as Rowe's Spring (B4, B5), the westernmost of these three springs, is located near the western edge of the hill. Its water flows through a small creek northeastward to its junction with Big Spring Creek.

Arboretum Big Spring, the largest spring tributary to Lake Wingra, is the middle one of the springs. Its waters are carried northward through a sizable creek into Lake Wingra. Just to the east of Big Spring is a very small spring, commonly considered as a part of Big Spring.

Arboretum East Spring, also known as White Clay Spring (B4, B5) because of the prevalence of small white fossil clam shells in the marl through which it flows, drains through a small creek out into Lake Wingra.

Farther to the east, near the bend in the Arboretum Drive before it enters Lake Forest, is Marshland Creek. It originates in Teal Marsh, a large marsh fed by drainage, which lies a considerable distance to the south. Marshland Creek flows northeastward from Teal Marsh and passes through a culvert under the Arboretum Drive. Then it flows northwestward through a very marshy region. Between the point where the Arboretum footpath crosses the creek and about 100 feet upstream the marsh is filled with numerous springlets which provide most of the volume of the creek. Before entering Lake Wingra, Marshland Creek swings a considerable distance to the northwest.

D. Ice Season Records

The records of the closing and opening dates for the ice on Lake Wingra are incomplete but enough records are available to make their compilation worth while. All of the earlier records, which are not referred to by a reference mark, are taken from the journal (L1) of Walter H. Chase, who lived on the shore of Lake Wingra for many years.

Season	Closed	Opened	Number of Days Closed#
1877–78	Dec. 29	Mar. 9	70
1878–79	Dec. 6	Mar. 29	113
1879–80	Nov. 19	Mar. 23	125

A number of the values in the freezing and thawing record of Lake Wingra presented by L. Wing in Table 3, page 156 of his paper (W1) are in error since they do not check with the paper (L1) from which he obtained the closing and opening dates. For the winter 1888–89 the number of the day

Season	Closed	Opened	Number of Days Closed
1880–81	Nov. 16	Apr. 29	164
1881–82	Nov. 20	Mar. 2	102
1882–83	Dec. 2	Apr. 10	129
1883–84	Nov. 15	Apr. 13	150
1884–85	Nov. 24	Apr. 13	140
1885–86	Dec. 5	Apr. 15	131
1886–87	Nov. 24	---	---
1887–88	Nov. 20	Apr. 13	145
1888–89	Dec. 12	Mar. 24	102
1889–90	---	Mar. 24	---
1890–91	Dec. 4	---	---
1891–92	---	Apr. 2	---
1892–93	Nov. 18	Apr. 5	138
1893–94	Nov. 17	Mar. 10	113
1894–95	Nov. 15	---	---
1895–96	---	Mar. 30	---
---	---	---	---
1913–14	Nov. 2 (C1)[x]	---	---
1914–15	Nov. 29 (C1)	---	---
1915–16	---	Mar. 20 (P5)*	---
1916	Nov. 15 (P5)[z]	Nov. 28 (P5)[z]	13[z]
1916–17	Dec. 10 (P5)[z]	---	---

after October 31 on which the fall freeze occurred should be 42, not 32. For the winter 1885–86 the number of the day after February 28–29 on which the spring thaw occurred should be 46, not 45. The values for the length of the frozen period during the years 1877–1896, with the exception of the winter 1877–78, are all too low by the number of days in the month of February (28 or 29), with additional errors introduced by the two errors previously mentioned. Consequently, all new values obtained by smoothing processes involving these incorrect values, or by interpolation from them, are also in error.

[x] It seems doubtful that this date represents the final closing date for the season. Lake Monona did not close until December 27 and Lake Mendota closed on January 12 (U1). The monthly mean temperatures in Madison were 42° for November, 1913, and 32° for December, 1913 (U1). It appears quite probable from the daily temperature data for November and December, 1913, that Lake Wingra opened sometime in November and then reclosed on December 7 or 8 during a period of cold weather.

date	maximum (U1)	minimum (U1)
Dec. 6, 1913	43°	37°
Dec. 7, 1913	37°	14°
Dec. 8, 1913	31°	18°

Consequently, the closing date of November 2, 1913, has not been included in the calculation of the average closing date.

* Another paper by A. S. Pearse (P3) records the date as March 26. The date of March 20 has been arbitrarily chosen since it appeared in the more recent of the two publications.

[z] For use in calculating the average closing date November 27 has been taken as the closing date since this is the date obtained by adding the early 13-day closed period to the final closing date, December 10. The 13-day closed period has not, of course, been used in the calculation of the average number of days closed, nor has the opening date of the 13-day closed period, November 28, been used in the calculation of the average opening date.

Season		Closed	Opened	Number of Days Closed
---	---------------	---	---	---
1926–27	---------------	Nov. 20 (W5)	---	---
1927–28	---------------	---	Mar. 24 (T2)	---
1928–29	---------------	Nov. 29 (T2)	Mar. 25 (T2)	116
1929–30	---------------	Nov. 17 (T2)	---	---
---	---------------	---	---	---
1934–35	---------------	---	Mar. 25 (L2)	---
1935–36	---------------	---	Mar. 24 (L2)	---
1936–37	---------------	---	Apr. 10 (L2)	---
1937–38	---------------	---	Mar. 21 (L2)	---
1938–39	---------------	Nov. 25 (L2)	Mar. 25 (L2)	120
1939–40	---------------	---	Apr. 9 (L2)	---
1940–41	---------------	Nov. 13 (L2)	---	---
---	---------------	---	---	---
1943–44	---------------	---	Mar. 24 (L2)	---
1944–45	---------------	Dec. 2 (L2)	Mar. 17 (L2)	105
1945–46	---------------	Nov. 24 (L2)	Mar. 20 (C2)	116
---	---------------	---	---	---
1947–48	---------------	---	Mar. 26	---
1948–49	---------------	Dec. 7 (N3)	Mar. 27 (N3)	110
1949–50	---------------	Nov. 25 (N3)	Apr. 7	133
			Average	122

Average	Closed	Opened	Number of Days Closed
Lake Wingra ----------	Nov. 26	Mar. 29	123[y]

The long term averages for the much larger nearby lakes, Monona and Mendota, are presented for comparison:

Averages 1855–1949 (U1)	Closed	Opened	Number of Days Closed
Lake Monona ----------	Dec. 14	Apr. 4	111
Lake Mendota --------	Dec. 19	Apr. 6	108

II. Fish Population

A. Fish Population Data

1. Carp Seining Data

The most complete data on the present fish population of Lake Wingra, particularly with regard to the larger species, was obtained from the seinings conducted as a carp control measure by the Wisconsin Conservation Department. With the exception

[y] Calculated from the average opening and closing dates.

of the most recent seining on March 29, 1949, which was carried out by a commercial fisherman, S. M. Kernan, all of the seinings were conducted by the Wisconsin Conservation Department. The seinings comprised single hauls extending over most of the main part of the lake. The dates of the seinings and the reported sizes of the seines used are presented in the table below:

Reference Number	Date of Seining	Net Size: Wings: Stretch Measure	Net Size: Wings: Length	Net Size: Bag: Stretch Measure	Reference
1936–I	Nov. 14–15, 1936	4½ in. 3 in.	Total 7000 ft.	2 in.	(B2, D5)
1936–II	Nov. 18, 1936	4½ in. 3 in.	Total 7000 ft.	2 in.	(B2, D5)
1944	Oct. 26, 1944	4¼ in. 2½ in.	Total 7000 ft.[a]	....	(B2)
1945–I	Apr. 12–13, 1945	5½ in. 3¼ in.	1500 ft. 4500 ft.	2 in.	(B2, W2)
1945–II	Nov. 14, 1945	5 in. 3¼ in.	1000 ft. 5200 ft.	....	(W2)
1949	Mar. 29, 1949	5½ in. 3 in.	>5200 ft.[b] 600 ft.	3 in.	(K2)

[a]30 ft. depth (B2).
[b]15 ft. depth. (H1).

In the 1936–I seining, difficulties in operation of the net, such as bogging down in the marl, made it necessary to leave the net in the water overnight so that the fish were not removed until November 15, 1936 (W2). Because of adverse weather the 1945–I seining also required two days, resulting in the escape of most panfish as well as many larger fish (B2).

All of the carp and bowfin caught in each of the seinings were removed from the lake. In the first seining all of the buffalofish were also removed, but in all subsequent seinings the few which remained were returned to the lake. In the first three seinings all of the garfish were removed from the lake but in all subsequent seinings the garfish were turned over to Professor Arthur D. Hasler for study. The majority of them were tagged and returned to the lake. Except where otherwise noted, all other fish were returned to the lake except for the relatively small numbers which died during the seinings or were kept for scientific study.

It is evident from the records which follow that the estimated number and average weight of the fish vary widely in the various hauls. This appears to have been due primarily to differences in the mesh sizes of the seines used, apparently not always corresponding to the figures previously given, and secondarily to variations in the fish population.

The following records include all fish reported in the various seine hauls, except perhaps for the 1944 haul. With respect to the 1944 haul Professors Arthur D. Hasler and Aldo Leopold stated on October 30, 1944, in a letter to E. J. Vanderwall, then Director of the Wisconsin Conservation Department, "The seining was very carefully done until the onset of evening made it evident that the haul could not be finished during daylight. Up to that time Dr. Black had the opportunity to make a careful tally of all fish gilled in the net or released around the ends. With the onset of darkness, large groups of fish other than carp were allowed to go over the net, making continuation of the tally impossible. The haul was completed in darkness, with the net result that no census data were obtained except on carp." E. J. Vanderwall replied on November 4, 1944, "Had it not been for a tremendous population of crappies and game fish which was totally unexpected in such amounts, the haul could easily have been completed (in one) day."

Abbreviations: est. = estimated, av. = average.

CARP (Cyprinus carpio)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	4,850	1,150	5,275 (B2)	3,000 (B2)	1,200 (H1)	---
Est. av. wt. lb.	7 (J2)	7 (J2)	<8 (B2)	5	5 (H1)	---[a]
Est. wt. lb.	33,851 (W2)	8,000 (W2)	40,000 (W2)	15,000 (W2)	6,000 (W2)	13,685 (H1, W2)

Total est. wt. removed from the lake = 116,536 lb.

BIGMOUTH BUFFALOFISH (Megastomatobus cyprinella)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	326[b]	none	3 (B2)	24 (B2)	19 (W2)	5 (H1)
Est. av. wt. lb.	2 (J2)	---	15 (B2)	15	15 (H1)	large (H1)
Est. wt. lb.	652[b] (W2)	---	45	360 (W2)	285	---

Total est. wt. removed from the lake = 652 lb.

NORTHERN LONGNOSE GAR (Lepisosteus osseus oxyurus)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	1,429[b]	357[b]	1,000 (W2)	69 (H2)	85 (H2)	31 (N1)
Est. av. wt. lb.	1.4 (J2)	1.4 (J2)	3	3	2	2.95 (N1)
Est. wt. lb.	2,000[b] (W2)	500[b] (W2)	3,000 (W2)	210 (H2)	169 (H2)	91.6 (N1)

Total est. wt. removed from the lake = >5,500 lb.

BOWFIN (Amia calva)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	none	none	5 (B2)	10 (H1)	5 (H1)	6 (S1)
Est. av. wt. lb.	---	---	2 (B2)	3 (H1)	3 (H1)	5.61 (S1)
Est. wt. lb.	---	---	10	30	15	33.7 (S1)

Total est. wt. removed from the lake = 89 lb.

GOLDFISH (Carassius auratus)

One specimen having a weight estimated at 1 lb. was caught and removed from the lake in the 1944 seining (B2).

TROUT

Two specimens, not further identified, were reported in the 1936–II seining (W2).

COMMON WHITE SUCKER (Catostomus commersonii commersonii)

An estimated 75 specimens (B2, W2) with an average weight of 2.35 lb. (B2) were reported in the 1944 seining.

SUCKER

An estimated 120 specimens (W2), not further identified, with an average weight of 2 lb. (H1) were reported in the 1945–II seining.

SPOTTED SUCKER (Minytrema melanops)

One specimen was reported in the 1944 seining (B2).

CHANNEL CATFISH (Ictalurus lacustris punctatus)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	none	none	none	1 (B2)	none	3 (H1)
Est. av. wt. lb.	---	---	---	6 (B2)	---	---

BULLHEAD

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	none	none	5 (B2, W2)	none	2 (W2)	none
Est. av. wt. lb.	---	---	1.2 (B2)	---	---	---

NORTHERN PIKE (Esox lucius)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	4 (W2)	7 (W2)	100 (W2)	35 (W2)	35 (H1, W2)	none
Est. av. wt. lb.	---	---	3.33 (B2)	3.32 (B2)	3.5 (H1)	---

MUSKALONGE–NORTHERN PIKE HYBRID (Esox masquinongy immaculatus x Esox lucius)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	none	none	8 (W2)	1 (W2)	1 (W2)	16 (H1)
Est. av. wt. lb.	---	---	14 (B2)	14 (B2)	14 (H1)	31–35 in. (H1)

WHITE BASS (Lepibema chrysops)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	500[b] (W2)	1,000[b] (W2)	10,000 (B2)	344 (B2)	2 (W2)	none
Est. av. wt. lb.	1.26 (J2)	1.26 (J2)	.32 (B2)	.32 (B2)	---	---

YELLOW BASS (Morone interrupta)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	none	none	40,000 (B2)	215 (B2)	none	abundant (H1)
Est. av. wt. lb.	---	---	.22 (B2)	.22 (B2)	---	---

PERCH (Perca flavescens)

Two specimens having an average weight of 33 grams (1.2 oz.) were taken from the stomachs of walleyes caught in the 1944 seining (B2).

WALLEYE (Stizostedion vitreum vitreum)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	400[b] (W2)	600[b] (W2)	100 (B2, W2)	4 (W2)	58 (H1, W2)	25 (H1)
Est. av. wt. lb.	1.5 (J2)	1.5 (J2)	3.87 (B2)	3.75 (B2)	3.8 (H1)	large (H1)

NORTHERN SMALLMOUTH BASS (Micropterus dolomieu dolomieu)

Both largemouth and smallmouth bass were reported in the 1936 seinings but the former were a little more abundant than the latter (J2). Unfortunately, in the figures for the 1936 seinings the two species are grouped together under the term "black bass" (W2). No smallmouth bass were reported in the later seinings.

BLACK BASS	1936–I	1936–II
Est. no.	300[b] (W2)	800[b] (W2)
Est. av. wt. lb.	1.45 (J2)	1.45 (J2)

LARGEMOUTH BASS (Huro salmoides)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	(see above)		100 (B2, W2)	70 (H1, W2)	127 (H1, W2)	10 (H1)
Est. av. wt. lb.	---	---	2.89 (B2)	2.89 (B2)	---	---

SUNFISH (Lepomis gibbosus)

No figures are available for this species alone. When the term "sunfish" is used in the records, it also includes bluegills. In the 1936 seinings the sunfish group is reported to have been chiefly bluegills (J2).

SUNFISH

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	10,000[b] (W2)	10,000[b] (W2)	(see bluegill)		46 (H1, W2)	none
Est. av. wt. lb.	.33 (J2)	.33 (J2)	---	---	---	---

BLUEGILL (Lepomis macrochirus macrochirus)

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	(see sunfish)		50,000 (W2)	5,319 (W2)	(see sunfish)	none
Est. av. wt. lb.	---	---	.23 (B2)	.23 (B2)	---	---

WHITE CRAPPIE (Pomoxis annularis) and BLACK CRAPPIE (Pomoxis nigromaculatus)

With the exception of the 1944 seining no distinction is made between the two species in the records. For 1944 Dr. John D. Black broke the total estimated number down into 350,000 white crappies and 100,000 black crappies (B2).

	1936–I	1936–II	1944	1945–I	1945–II	1949
Est. no.	10,000[b] (W2)	30,000[b] (W2)	450,000 (W2)	4,214 (W2)	172 (H1, W2)	none
Est. av. wt. lb.	.33 (J2)	.33 (J2)	.16 (B2)	.34 (B2)	---	---

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[a] The catch was reported to be confined almost entirely to two sizes: 10 lb. or more and around 1½ lb. (P7).

[b] In a letter to Professor Chancey Juday, dated December 9, 1936, Robert A. Gray, then Superintendent of Contract and Commercial Fishing, Wisconsin Conservation Department, stated that the figures which he was presenting for the two 1936 seinings were for numbers of fish. This was true in the case of all fish except carp, buffalofish, and garfish. Unfortunately, however, the reports of the supervising warden for the two seinings indicate that in the latter three cases the figures were for *pounds* of fish removed, not *numbers* of fish (W2). When Professor Juday correctly assumed in the case of carp that the figures represented *pounds* but failed to do so in the cases of buffalofish and garfish he introduced an error in the figures given in his paper for buffalofish and garfish (J2).

Furthermore, since all kinds of fish except carp, buffalofish, and garfish appear to have been returned to the lake after each seining (W2), it appears unjustifiable to use the combined total figures for both seinings as was done in Professor Juday's

2. Small Net Operations

a. By A. S. Pearse and H. Achtenberg in 1916

In 1916 A. S. Pearse and H. Achtenberg carried out 194 gill-net sets at various depths in Lake Wingra, using nets varying between 1½ and 4 inches in stretch measure and 60 and 75 feet in length (P5). The numbers of fish of the different kinds listed were separately computed from Table 4 of their paper (P5). In order of abundance (the most numerous being listed first) they were:

1) perch
2) bluegill
3) northern pike
4) black crappie
5) sunfish
6) largemouth bass
7) carp
8) western golden shiner
9) bowfin
10) northern longnose gar
11) northern smallmouth bass
12) northern brown bullhead

b. Recent Test Nettings

Some information on the recent fish population of Lake Wingra is provided by the fyke net studies by Elmer F. Herman and Clarence Hageman of the Wisconsin Conservation Department (H4), and by the small gill-net operations of University of Wisconsin students.

Two fyke nets, each having a 75-foot lead and 4-foot depth, were set near the south shore of Lake Wingra on June 14, 1945. One net was lifted on June 15 and the other on June 16. The two catches were reported collectively as follows:

252 crappies
75 bluegills
6 sunfish
3 bullheads
3 white bass
3 snapping turtles
2 walleyes
1 redhorse
1 bowfin
1 golden shiner
1 yellow bass
1 perch

From scale sample records made available by Dr. John C. Neess of fish caught in 17 small gill-net sets the present writer has compiled the summary which follows. All but the first haul were made by Dr. Neess as part of a scientific study. He used

paper (J2), since a large proportion of the fish returned to the lake after the first seining may be assumed to have reappeared in the net during the second seining. If this is true, duplication is present in the figures given in Professor Juday's paper (J2) for the numbers of fish caught, and the figures for pounds of fish per acre which he then arrives at are much too high, both for this reason and because the figure used for the area was too low—200 acres, instead of the correct value of 328 acres.

the same gill net throughout. Its dimensions were 1¾ inches stretch measure, 300-foot length, and 4-foot depth. Sets were made in several locations in the lake. Northern pike and largemouth bass were returned to the water immediately whenever alive, without scale samples being taken, so that figures for these two species are incomplete. The records are useful in supplementing the data from the carp seinings, particularly in the case of small or elongated fish such as perch, western golden shiner, or yellow bass. The January 4, 1944, haul must have been made at the outlet of one of the spring streams, perhaps Big Spring Creek, because the main lake was frozen over.

Date	Yellow Bass	White Crappie	Perch	Bluegill	Carp	Black Crappie	Northern Pike	Largemouth Bass	White Bass	Sunfish	Golden Shiner	Yellow Bullhead	Longnose Gar	Bowfin	Total
Jan. 4, 1944	...	...	...	14	...	...	...	5	...	1	...	...	...	...	20
July 19, 1945	...	12	6	...	...	...	1	...	...	...	...	...	...	...	19
July 24, 1945	4	17	1	...	...	...	...	...	...	...	2	...	...	...	24
July 25, 1945	3	10	...	...	...	...	...	...	...	...	...	1	...	1	15
July 28, 1945	...	5	...	...	...	...	...	...	...	...	...	...	...	...	5
Sept. 30, 1945	1	24	...	3	...	...	...	...	2	...	...	...	...	...	30
Oct. 18, 1945	24	22	...	...	1	...	...	...	...	...	...	...	...	...	47
Oct. 27, 1945	13	3	...	...	...	...	...	...	...	...	...	...	...	...	16
Nov. 3, 1945	19	8	...	...	...	...	...	...	...	...	...	...	...	...	27
July 5, 1946	50	32	23	1	...	...	4	...	...	1	1	...	...	...	112
July 17, 1946	...	...	...	...	...	...	4	...	...	...	...	...	...	...	4
Aug. 3, 1946	23	10	9	2	...	6	...	...	2	...	...	...	...	...	52
Aug. 24, 1946	55	4	...	...	11	9	...	...	...	1	...	...	...	...	80
Nov. 1, 1946	40	...	1	...	5	...	2	...	...	...	...	...	...	...	48
Nov. 8, 1946	22	...	1	...	1	...	...	...	1	...	...	...	...	...	25
June 17, 1947	61	6	18	...	...	...	...	...	...	...	...	...	...	...	85
July 9, 1947	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
Total	315	153	59	20	18	15	11	5	5	3	3	1	1	1	610
No. days on which caught	12	12	7	4	4	2	4	1	3	3	2	1	1	1	17

3. Ice-Fishing Census

Beginning with the winter of 1945–1946 ice fishing for panfish has been permitted on Lake Wingra. In connection with their duties in patrolling the University Arboretum, Mr. Joseph Hammersley and other University policemen have stopped frequently and asked the ice fishermen what kinds of fish they caught, how many, and at what time of day they caught the most fish. This census was conducted from January 29–March 13, 1946, and from January 26–March 12, 1947. Since the census was not conducted every day, nor for the entire ice-fishing season, nor did it always include every ice fisherman on the lake, it does not indicate the total catch, but a tabulated summary of the results is significant in indicating the relative numbers of the different kinds of panfish taken from the lake during the ice-fishing season.

SEASON	"CRAPPIES"	PERCH	BLUEGILLS	"BULLHEADS"
1945–1946	947	22	4	2
1946–1947	528	3	none	none

The great predominance of crappies (both the white and black species) can be explained not only by the fact that they were among the most abundant panfish in the lake, and like perch are more active in the winter than other panfish, but by the fact that minnows, which, as well as some fish eyes, were ordinarily used for bait, are rarely taken by sunfish, bluegills, or bullheads. The fact that the catches contained both black and white crappies is not in agreement with the observation by A. S. Pearse in 1919 that adult black crappies do not appear to feed in the winter (P3). A. S. Pearse and H. Achtenberg observed in 1920 that Lake Wingra perch move about very little in the winter and hence feed less than those in Lake Mendota (P5), and this is in agreement with the small catches of perch reported here. The absence of yellow and white bass is difficult to explain, but probably can be ascribed to winter inactivity or to a greater wariness on their part.

4. Personal Observations

The personal fishing experiences of the writer provide considerable information on the fish population of Lake Wingra, particularly in the shallow, weedy portions. During the late summer and early fall of 1947 in the course of 16 trips to Lake Wingra some fish were caught on each occasion. The location was the same in each case: A stretch of shoreline about 60 feet wide on the north shore of Northeast Bay, opposite the small point which separates Northeast Bay from Outlet Bay, and opposite the bulrush bed just west of the point. The bottom was composed of rock fill and marl for a distance of about 10 feet from shore, and beyond that distance was entirely marl. The depth of the water fished was 1½–3¼ feet. During the earlier part of the period weeds were abundant and formed several large patches which reached the surface. The fishing was done entirely from shore with one or two cane poles, using on each line a small (#5) snelled hook and a cork and sinker balanced with respect to weight to give a high sensitivity to bites. Worms or nightcrawlers were used for bait throughout, except that on September 19 two of the yellow bullheads were caught on raw beef. Large worms or halves of nightcrawlers were found to be the best bait since it was easier to prevent "bait stealing" with the larger worms. Because there were no legal size limits on panfish and all fish were kept, regardless of size, the results give a fair estimate of the relative numbers of the kinds of fish present in the shallow, weedy areas which will take a worm bait. It should be added that the proportion of fish caught to those which took the bait was very small indeed.

RESULTS OF 16 FISHING TRIPS TO LAKE WINGRA IN 1947

DATE	SUN-FISH	PERCH	YEL-LOW BULL-HEAD	BLUE-GILL	CARP	SUN-FISH-BLUE-GILL HYBRID	MIR-ROR CARP	TOTAL
Sept. 10......	8	......	5	2	......	......	......	15
Sept. 11......	12	3	......	......	2	2	......	19
Sept. 12......	7	2	......	1	......	......	......	10
Sept. 15......	6	2	4	......	......	......	......	12
Sept. 17......	16	5	3	1	......	......	......	25
Sept. 19......	9	2	3	1	......	......	......	15
Sept. 20......	3	......	......	......	......	......	......	3
Sept. 21......	14	1	......	1	2	......	......	18
Sept. 26......	6	4	4	1	......	......	......	15
Sept. 28......	12*	15	......	2	......	1	......	30
Oct. 3.......	11	3	2	2	2	......	......	20
Oct. 5.......	6	5	2	2	......	......	1	16
Oct. 10.......	2	3	1	......	......	......	......	6
Oct. 11.......	3	5	1	......	......	......	......	9
Oct. 18.......	6	1	1	2	......	......	......	10
Nov. 1.......	......	......	1	......	......	......	......	1
Total........	121	51	27	15	6	3	1	224

*Does not include 6 sunfish returned to the water.

The fishing on September 20 and November 1 was carried on less than one hour, not sufficient time to make a representative catch. September 28 was one of those days when the weather conditions at the time, and probably those preceding, give the fish a stimulus causing them to bite far more vigorously and to be caught much more readily than on other days in the same period. Thirty-six panfish were caught in 2½ hours but since the legal mixed daily bag limit of 30 had been accidentally exceeded, it was necessary to return six sunfish, which were still alive, to the water. On this occasion the fishing was carried on from 2:00–4:30 P.M. It had rained the night before and that morning there had been a thunderstorm, but the rain ended in time to permit fishing. The sky was cloudy and during the time of fishing the wind was shifting from light southerly to moderate northwesterly and the barometer was beginning to rise slowly. Evidently a cold front had passed. The U. S. Weather Bureau office at North Hall in Madison reported temperature extremes of 63° and 47° with .64 inches of rain for the day.

SIZE RANGES OF THE FISH LISTED IN THE PRECEDING TABLE

KIND OF FISH	LENGTH IN INCHES	GREATEST WEIGHT
Sunfish	4–6	3 oz.
Perch	6–10	6 oz.
Yellow Bullhead	6–12	14 oz.
Bluegill	5–7	5 oz.
Carp	12–17	2 lb. 11 oz.
Sunfish-Bluegill Hybrid	5–6	3 oz.
Mirror Carp	14	1 lb. 3 oz.

TIMES OF FISH ACTIVITY

Except for the yellow bullheads all of the fish listed on the preceding page were caught during daylight hours, which suggests that they become inactive at dusk, the perch being the last to become inactive. With two exceptions all of the yellow bullheads were caught at dusk or later, and on every occasion when the fishing was carried on after dusk, at least one yellow bullhead was caught. The yellow bullheads suddenly became active with noticeable regularity just after the other fish had stopped biting. An 11-inch yellow bullhead was caught at noon on September 17, a hot, sunny day, and on November 1 the yellow bullhead was caught at 4:30 P.M. when a thick cloud cover greatly reduced the light intensity. It may be concluded that yellow bullheads are inactive when the light intensity is equivalent to normal daylight at a depth of about two feet in Lake

Wingra, except when there is a tempting odor, such as that of a nightcrawler, in the vicinity of the spot where they are resting. At dusk, when the activity of the other panfish has ceased, the yellow bullheads become active with such regularity that the start of their biting is a measure of the decrease of light intensity to a certain point.

The larger predatory fish appeared to increase their activity about one hour before sunset, as indicated by the splashes they made when jumping at the surface of the water, probably in pursuit of other fish. The individual paths which some fish, presumed to be largemouth bass, took could be followed by noting the location of their successive splashes, which occurred every few minutes. When fishing was continued long after dark, a number of resounding splashes caused by very large fish were always observed, usually some distance off the south shore in the deeper portions of Outlet Bay. These splashes were taken to indicate that large fish, probably walleyes, did their feeding at night since these heavy splashes occurred only well after dark.

General Discussion by Species

Carp (Cyprinus carpio)

Except for the one mirror carp, the carp were caught in pairs, the second right after the first, and also from other characteristic carp bites it was evident that the carp travel in groups or schools and move very rapidly.

Northern Yellow Bullhead (Ameiurus natalis natalis)

Yellow bullheads are evidently abundant in Lake Wingra. No other species of bullhead has been seen in the lake by the present writer. There are apparently two color phases. The darker variety—the shade may be due simply to exposure to the air—is difficult to distinguish on the basis of color alone from the brown bullhead. The distinction is readily made, however, using as a criterion the characteristic white barbels under the jaw of the yellow bullhead (E1).

Northern Pike (Esox lucius)

Two specimens were seen, which appeared to be about 20 and 23 inches long, caught on what looked like a "Johnson Silver Minnow" in the bulrush bed about 200 feet south of the fishing location to which reference has already been made.

Perch (Perca flavescens)

Prior to September 26 the perch were caught by fishing near the bottom as far out as a cane pole would conveniently reach, and they were all small, ranging from 6–7 inches. When placed in a tub of water they would rest characteristically on the bottom supported on their pectoral fins, and, when disturbed, would dart around in a manner similar to that of a Johnny darter. As will be noted from the table, beginning on September 26 there was a marked increase in the ratio of perch to sunfish caught. At the same time the average size of the perch increased. The change was evidently due to the presence of perch around the fishing location which had not been present there before. The perch came in closer to shore than before and the fishing proceeded in "spells" with a constant succession of perch bites for 15–30 minutes followed by a slack period of equal or greater length when only sunfish and occasionally bluegills were present. The first heavy frost of the season occurred on September 25 and another on September 26 (U1a). From these observations it may be concluded that perch definitely prefer cool water and that the majority of them, particularly the larger ones, remain in the deeper portions of the lake where, except on very windy days, slight thermal stratification provides them with cooler water. [A. S. Pearse and H. Achtenberg reported (P5) that because of high water temperatures Lake Wingra perch pass through a period during August and September when little food is taken.] In the fall, as soon as the surface and shallow water is cooled to a more tolerable temperature, the perch enter shallow water in large, rapidly moving schools. Starting with September 26 there appeared to be a peak of activity on sunny days in late afternoon but on cloudy days, such as September 28, great activity of the schools was evident as early as 2:00 P.M.

Largemouth Bass (Huro salmoides)

On most of the 16 fishing days one and often more largemouth bass were caught which ranged in size from 3–9 inches but since the legal size limit was 10 inches, they were all returned to the water. If it had been permissible to keep the largemouth bass, they would have ranked in abundance in the catches between the yellow bullhead and the bluegill. Since two largemouth bass, estimated at 14 inches in length, were seen to be caught on what resembled an "Hawaiian Wiggler #1" spoon in the bulrush bed not over 200 feet to the south, it was evident that segregation according to size existed and the writer happened to be on the side where the "nursery school" bass gathered.

Sunfish (Lepomis gibbosus)

During the time of the year when weeds are abundant in the lake, sunfish are found in the shallow weed beds and immediately adjacent shallow areas, where they are very abundant and willing to bite. The main problem encountered in the fishing summarized in tabular form in the section on "Results of 16 Fishing Trips . . ." was to get the first bite, to attract the fish to the particular location where the fishing was being carried on. The location was usually chosen because there was a comfortable place to sit on the shoreline. It took anywhere from half an hour to an hour to get the first bite, but from then on there was little difficulty in keeping the fish around since a focus of activity had been created. The more lines in the water in a given area, the easier it was to keep the fish in that area. Sunfish are evidently gregarious and it seemed that the underwater commotion caused by the sunfish milling around the bait served to attract other fish to the area, probably by hastening the spread of the worm odor through the water. It is a curious fact that, in spite of considerable fishing in both areas, the writer has never seen a sunfish in the Vilas Park Lagoons or in Murphy's Creek just below the Lake Wingra outlet. This leads to the conclusion that sunfish constitute a stable resident population and are slow to populate new areas or to repopulate shallow areas with abundant organic decomposition where a probable oxygen deficiency under the ice has forced a migration away from the area.

Bluegill (Lepomis macrochirus macrochirus)

The habits of the bluegill contrast rather sharply with those of the sunfish in that they prefer the deeper portions of the lake and are much more migratory in nature. These facts are well borne out since they constitute the major and often the sole catch of worm fishermen using boats and they are generally caught by slow trolling. The bluegills which appeared in the catches summarized in tabular form in "Results of 16 Fishing Trips . . ." seemed to be on the shoreward edges of schools which did not long remain in the area at the fishing station, as is indicated by the fact that the catch on any one day never exceeded two. The bluegills were all caught by fishing as far out as a cane pole would conveniently reach. Earlier observations indicate that the place of the sunfish in such places as Murphy's Creek and the Vilas Park Lagoons is taken by small bluegills.

Sunfish-Bluegill Hybrids (Lepomis gibbosus x Lepomis macrochirus macrochirus)

The three specimens listed in "Results of 16 Fishing Trips . . ." were readily recognizable as sunfish-bluegill hybrids by their blue-black opercular flap and light olivaceous side having the banding but not the color of bluegills. The head region had markings resembling those of the sunfish. The hybrid designation was confirmed by Harold Elser, who has made extensive studies of the characteristics of natural sunfish-bluegill hybrids.

The absence in the catches of crappies, white bass, and presumably yellow bass can be explained by the fact that they rarely take a worm bait, except that in the spring, crappies are more frequently caught on worms. During the period when the fishing summarized in "Results of 16 Fishing Trips . . ." was carried out large numbers of crappies were seen to be caught by other fishermen trolling slowly with minnows in the deeper portions of Outlet Bay.

B. Fish-Planting Records

Prior to the dredging of a channel for Murphy's Creek in 1905–1908, free migration of fish between Lake Monona and Lake Wingra was probably impossible because of the lack of a well-defined channel through the marsh east of Lake Wingra, as has already been stated. Ever since the dredging of Murphy's Creek a lock has been present so that upstream migration apparently could occur only on occasions when the lock was opened, which have been rare in recent years, or when migrating fish were lifted over the lock or southeast dike by fishermen and game wardens. During 1917–1919, however, when the southeast dike was open, free migration of fish was probably possible between Lake Monona and Lake Wingra.

The earliest report of the planting of fish in Lake Wingra or its tributaries is the building of stone-walled pools about Edgewood Big Spring and Edgewood West Springs and the stocking of them with trout by Cadwallader C. Washburn, Governor of Wisconsin from 1872–1874, during the time when he owned and lived at Edgewood before giving the property to the Order of Dominican Sisters in 1881 (B3, B4, M1, R1). The pools were commonly referred to as "Governor Washburn's trout ponds" (B4, R1).

The remaining fish-planting records were provided by the Wisconsin Conservation Department, and are as complete as their data permit. The planting records include fish both from rescue and transfer operations and from hatcheries. Because of the nature of the methods used, particularly in the case of rescued and transferred fish, but also in the case of hatchery-raised fish, especially in earlier years, the likelihood is very great that fish of species other than those indicated in the records may have been accidentally planted along with the kinds recorded (L4). Many of the rescued and transferred fish have come from the Mississippi River (L4) and this fact probably explains the discovery in the 1944 carp seining of four species of fish and the discovery in the 1945 fyke-net studies of a fifth species, all found in the Mississippi River, but not previously reported from Lake Wingra: The spotted sucker, redhorse, channel catfish, white crappie, and yellow bass. The latter two have become the two most abundant species of panfish in the lake.

Prior to 1941 federal fish rescue and transfer and hatchery operations were carried out independently and usually without the knowledge of the Wisconsin Conservation Department. Fish were usually shipped upon application of private individuals and groups and the distribution of them was left to these private parties. Consequently, there was no assurance that the fish were actually planted in the waters for which they were designated (L4). In 1941 agreement was reached between the Wisconsin Conservation Department and the Federal Fish and Wildlife Service that thereafter all federal fish would be planted by the Wisconsin Conservation Department (H6).

Lastly it should be added that minnows have long been a popular bait for crappies in Lake Wingra. Since practically none of the minnows used were obtained from Lake Wingra itself, there is no telling what may have been introduced when Lake Wingra boat-livery operators released fish that didn't look like minnows found in their minnow shipments or when fishermen emptied their minnow buckets at the end of a day.

1. Brown Trout

year	adults
1934	500
1936	50
1937	100

2. Rainbow Trout

year	adults
1936	50
1937	75

3. Brook Trout

year	
1940	6,000 fingerlings in Gorham Creek
1941	400 yearlings in the Big Spring area

4. Sucker

year	adults
1940	6

5. Bullhead

year	fingerlings	yearlings	adults
1930	?	?	?
1939	---	10,000	---
1942	---	---	2,600
1943	35,000	---	---
1945	5,000	---	---

6. Northern Pike

year	fry	fingerlings	adults
1922	300,000	miscellaneous	
1940	---	---	5
1941	---	5,000	---
1942	546,198	---	---

7. Muskalonge-Northern Pike Hybrids

year	fingerlings	24 inches long
1940	258	---
1945	1,000	---
1946	1,843	---
1947	?	---
1948	---	120

8. White Bass

year	fingerlings
1917	900
1933	1,000
1940	15,000
1943	6,000

9. Perch

year	eyed eggs	fingerlings	adults
1915	---	960	---
1917	---	300	---
1938	2,903,040*	---	---
1939	---	16,000	---
1940	---	15,000	30

10. Walleye

year	miscellaneous	fry	adults
1900	350,000	---	---
1901	600,000	---	---
1902	375,000	---	---
1903	150,000	---	---
1905	300,000	---	---
1906	480,000	---	---
1907	400,000	---	---
1908	---	300,000	---
1909	---	420,000	---
1912	---	400,000	---
1916	---	320,000	---
1921	---	972,000	---
1922	---	650,000	---
1928	---	690,000	---
1929	---	902,500	---
1930	---	873,550	---
1940	---	---	15
1943	---	7,000,000	---

11. Black Bass

year	fry	advanced fry	fingerlings
1908	4,000	---	3,000
1910	7,500	---	400
1911	---	5,000	400
1913	22,000	---	---
1914	---	25,000	---
1916	---	---	10,000
1930	"bass miscellaneous"		

11a. Largemouth Bass

year	fingerlings	yearlings	adults
1937	2,000	---	---
1938	1,250	---	---
1939	8,600	---	---
1940	15,000	---	77
1941	10,000	1,000	---
1942	10,000	---	---
1943	12,000	---	---
1944	1,500	---	---

* Large quantities of perch eggs were transferred from Lac Vieux Desert and several other northern Wisconsin lakes to southern Wisconsin (L4).

12. Sunfish

year	
1930	"sunfish miscellaneous"
1940	10 adults

13. Bluegill

year	fingerlings	yearlings	adults
1939	4,000	---	---
1940	10,000	---	30
1941	10,000	4,800	400
1943	2,000	---	1,200
1944	---	3,000	---

14. Crappie

year	fingerlings	yearlings	adults
1940	15	---	---
1941	---	100	150
1943	---	---	200

C. Maximum Size Records

In the case of the common white sucker, carp, mirror carp, and walleye the information found does not give a fair indication of the largest specimens to be found in Lake Wingra. No size records were found for the spotted sucker or smallmouth bass.

Unless otherwise stated, the measurements of length refer to total length, measured from the tip of the mouth to the tip of the tail fin. When the original measurements were taken in English units, the values have been converted into metric units, and conversely, to aid in comparison. The calculated values are included in parentheses.

1. Northern Longnose Gar (Lepisosteus osseus oxyurus)
   length 122.0 cm. (48.0 in.); weight (5.0 kg.) 11 lb.
   Taken in the carp seine of S. M. Kernan on Mar. 29, 1949 (N1).

2. Bowfin (Amia calva)
   length 74 cm. (29 in.); weight (3.9 kg.) 8 lb. 10 oz.
   sex female.
   Taken in the carp seine of S. M. Kernan on Mar. 29, 1949 (S1).

3. Bigmouth Buffalofish (Megastomatobus cyprinella)
   The specimens taken in the Wisconsin Conservation Department carp seine in 1944 and 1945 were estimated to have had an average weight of 15 lb. (B2, H1, W2). No exact size records were found.

4. Common White Sucker (Catostomus commersonii commersonii)
   The specimens taken in the Wisconsin Conservation Department carp seine in 1944 were estimated to have had an average weight of 2.35 lb. (B2). No exact size records were found.

5. REDHORSE (Species not determined)

   length 47.4 cm. (18.6 in.); weight 1.585 kg. (3 lb. 8 oz.). age 7.

   Taken in a Wisconsin Conservation Department fyke net on June 15 or 16, 1945 (H4).

6. CARP (Cyprinus carpio)

   Unfortunately, exact size records for the large specimens taken in the Wisconsin Conservation Department carp seines are lacking. It can be said, however, that many of the carp fell into the class known commercially as jumbos, i.e., greater than 7 lb. (W2).

   Many of the carp in the 1949 haul were estimated to have had a weight of 10 lb. or more (P7). The best exact size record which was found is:

   length (43 cm.) 17 in.; weight (1.22 kg.) 2 lb. 11 oz.

   Caught by still-fishing with worms by Wayland E. Noland on Oct. 3, 1947 (N5).

7. MIRROR CARP (Cyprinus carpio, mirror variety)

   As in the preceding case, exact size records for the large specimens taken in the Wisconsin Conservation Department carp seines are lacking. The best exact size record which was found is:

   length (36 cm.) 14 in.; weight (.54 kg.) 1 lb. 3 oz.

   Caught by still-fishing with worms by Wayland E. Noland on Oct. 5, 1947 (N5).

8. GOLDFISH (Carassius auratus)

   The one specimen taken in the Wisconsin Conservation Department carp seine in 1944 had an estimated weight of 1 lb. (B2).

9. WESTERN GOLDEN SHINER (Notemigonus chrysoleucas auratus)

   length 19.8 cm. (7.8 in.); weight .094 kg. (3.3 oz.).

   Taken in a gill net by John C. Neess on July 5, 1946 (N1).

10. NORTHERN CHANNEL CATFISH (Ictalurus lacustris punctatus)

    The specimen taken in the Wisconsin Conservation Department carp seine in 1945–I had an estimated weight of 6 lb. (B2). No exact size records were found.

11. NORTHERN YELLOW BULLHEAD (Ameiurus natalis natalis)

    length 33.7 cm. (13.3 in.); weight .508 kg. (1 lb. 1.8 oz.).
    Taken in a gill net by John C. Neess on July 25, 1945 (N1).

12. WESTERN MUDMINNOW (Umbra limi)

    "standard" length (does not include tail fin) 17.9 cm. (7.1 in.).
    Collected by A. S. Pearse in Marshland Creek on June 12, 1915 (P2).

13. NORTHERN PIKE (Esox lucius)

A specimen reported to weigh 19¾ lb., dressed, was caught on a frog bait about 1902 by James A. Reynolds when he was 10 years old (B6a). The best exact size record which was found is:
length (104 cm.) 41 in.; weight (7.7 kg.) 17 lb.
Caught by bait-casting with a Johnson Silver Minnow spoon and pork rind by M. E. Weed on July 27, 1948 (W4).

14. MUSKALONGE–NORTHERN PIKE HYBRID (Esox masquinongy immaculatus x Esox lucius)

length (100 cm.) 39.5 in.; weight (4.45 kg.) 15.7 lb.
Taken in the Wisconsin Conservation Department carp seine on Oct. 26, 1944 (H1).

15. WESTERN BANDED KILLIFISH (Fundulus diaphanus menona)

"standard" length (does not include tail fin) 4.6 cm. (1.8 in.).
Collected by A. S. Pearse in Marshland Creek on April 28, 1915 (P2).

16. WHITE BASS (Lepibema chrysops)

length 37.1 cm. (14.6 in.); weight .483 kg. (1 lb. 1.0 oz.).
age 5.
Taken in a Wisconsin Conservation Department fyke net on June 15 or 16, 1945 (H4).

17. YELLOW BASS (Morone interrupta)

length 25.6 cm. (10.1 in.); weight .280 kg. (9.8 oz.).
sex male.
Taken in a gill net by John C. Neess on Nov. 1, 1946 (N1).

18. PERCH (Perca flavescens)

length (25 cm.) 10 in.; weight (.17 kg.) 6 oz.
Caught by still-fishing with a nightcrawler by Wayland E. Noland on Oct. 10, 1947 (N5).

19. WALLEYE (Stizostedion vitreum vitreum)

The specimens taken in the Wisconsin Conservation Department carp seine in 1944 and 1945–II were estimated to have had an average weight of 3.8 lb. (B2, H1). The best exact size record which was found is:
length 39.7 cm. (15.6 in.); weight .543 kg. (1 lb. 3.2 oz.).
age 5.
Taken in a Wisconsin Conservation Department fyke net on June 15 or 16, 1945 (H4).

20. LARGEMOUTH BASS (Huro salmoides)

Gilson Glasier is reported to have caught two or more bass in about 1914–1915 which weighed about 10 lb. (B6b). The best exact size record which was found is:
length (76 cm.) 24.9 in.; weight (3.29 kg.) 7 lb. 4 oz.
Caught by bait-casting with a Johnson Caper spoon by William Aberle on July 20, 1947 (W3).

21. SUNFISH (Lepomis gibbosus)
    length 17.0 cm. (6.7 in.); weight .145 kg. (5.1 oz.).
    Taken in a Wisconsin Conservation Department fyke net on June 15 or 16, 1945 (H4).

22. BLUEGILL (Lepomis macrochirus macrochirus)
    length 22.0 cm. (8.7 in.); weight .296 kg. (10.4 oz.).
    sex female (N1).
    Taken in the Wisconsin Conservation Department carp seine on Nov. 14, 1945 (H1).

23. SUNFISH–BLUEGILL HYBRID (Lepomis gibbosus x Lepomis macrochirus macrochirus)
    length (15 cm.) 6 in.; weight (.085 kg.) 3 oz.
    Caught by still-fishing with worms by Wayland E. Noland on Sept. 11, 1947 (N5).

24. WHITE CRAPPIE (Pomoxis annularis)
    length 30.0 cm. (11.8 in.); weight .344 kg. (12.0 oz.).
    Taken in the Wisconsin Conservation Department carp seine on Nov. 14, 1945 (H1).

25. BLACK CRAPPIE (Pomoxis nigro-maculatus)
    length (28 cm.) 11 in.; weight (.23 kg.) 8 oz.
    Caught by trolling with a T-4 frog Flatfish plug by Wayland E. Noland on June 27, 1942 (N5).

26. BROOK STICKLEBACK (Eucalia inconstans)
    length 5.87 cm. (2.3 in.).
    Taken in a dip net by A. S. Pearse in Marshland Creek on Oct. 6, 1914 (P1).

D. SUMMARY OF THE FISH POPULATION BY SPECIES

All references in this discussion to the plantings of fish refer to plantings made by the Wisconsin Conservation Department.

Northern Longnose Gar (Lepisosteus osseus oxyurus)

C. E. Brown reports that this species was very abundant in Lake Wingra about 1914 (B6b). An estimated 1¼ tons were removed from the lake in the two 1936 carp seinings. In the eight years intervening between 1936 and 1944 it appears to have made a complete recovery, since an estimated 1½ tons were removed from the lake in the 1944 carp seining and destroyed. Although the majority of the specimens caught in the carp seinings subsequent to 1944 were tagged and returned to the lake, this species does not yet appear to have returned to its former position of overwhelming abundance among the large predatory fish. Because of its elusiveness and the extreme difficulty of setting the hook in its long bony snout, this species is infrequently caught by fishermen.

Bowfin (Amia calva)

This species does not appear abundant but exists as a stable population whose members reach a large size. All of the bowfin caught in the carp seinings, an estimated total of 89 lb., were removed from the lake.

Trout

Although repeated attempts have been made to stock brown, rainbow, and brook trout in Lake Wingra and its tributary spring streams, none of these species has become established, but a number of the planted fish did survive (J3, L3). Any future attempts at establishing these fish may be similarly expected to end in failure because of the small size of the tributary streams and the lack of a suitable environment for natural reproduction.

Bigmouth Buffalofish (Megastomatobus cyprinella)

In 1936 this fish was fairly abundant and the 2-lb. average weight of the estimated 326 specimens removed from the lake in the 1936–I carp seining indicates that there had been a rather recent successful hatch. The 15-lb. average weight of the relatively few specimens taken in the subsequent carp seinings, all of which were returned to the lake, indicates that there has not been a successful hatch since before 1936. Apparently as far as reproductive potential is concerned this native species is unable to meet the competition of its close rival, the exotic carp, and is headed for ultimate extinction in Lake Wingra.

Common White Sucker (Catostomus commersonii commersonii)

No record of this species from Lake Wingra was found prior to the 1944 carp seining but it appeared then to be well established. Whether or not this is the result of the planting of six adult suckers (species unknown) in 1940 is interesting to speculate.

Spotted Sucker (Minytrema melanops)

This rather rare Mississippi River fish was reported from Lake Wingra only in the 1944 carp seining when one specimen was seen. It was probably introduced from fish rescue and transfer operations.

Redhorse (species not determined)

A single specimen was taken in a Wisconsin Conservation Department fyke net in 1945. It was probably also introduced from fish rescue and transfer operations.

Carp (Cyprinus carpio)

This is now by far the predominant large fish in Lake Wingra and an estimated total of 58¼ tons have been removed from the lake in the six carp seinings since 1936. Periodic cropping of the huge carp population by seining appears to be economically desirable as well as beneficial to other species of fish in the lake and to plants used as food by ducks. Carp are occasionally caught by fishermen using worms or nightcrawlers for bait.

Carp were first introduced into Wisconsin about 1879 (C4), but Dr. Samuel H. Chase did not notice them in Lake Wingra until the late 1890s (L1). A. R. Cahn reported that in 1913–1914 they abounded in Lake Wingra (C1).

Goldfish (Carassius auratus)

The only specimen reported was taken in the 1944 carp seining and removed from the lake. It probably was someone's pet which had been released and evidently had thrived on its Lake Wingra diet.

Western Golden Shiner (Notemigonus chrysoleucas auratus)

This large native minnow is and has been present in appreciable numbers in Lake Wingra. On account of its relatively small size and elongated shape, however, it has been completely missed in all of the carp seinings.

Channel Catfish (Ictalurus lacustris punctatus)

A specimen estimated at 6 lb. was seen in the 1945–I carp seining and three were seen in the 1949 carp seining. They were probably introduced from fish rescue and transfer operations.

Northern Black Bullhead (Ameiurus melas melas)

No reports of this species having been taken from Lake Wingra were found.*

* A. S. Pearse, in giving a summary (P3) of data presented in a subsequent paper (P5), reported the black bullhead, but this is obviously an error since the latter paper reports only the brown bullhead.

Northern Brown Bullhead (Ameiurus nebulosus nebulosus)

This species was reported by A. R. Cahn as one of the most common in the lake during 1913–1914 (C1). It was again reported as being caught in 1916 by A. S. Pearse and H. Achtenberg (P5). It is probable that both of these reports are the result of misidentification since the yellow bullhead and the brown bullhead are fairly easily confused when the white barbels under the lower jaw, which are the most prominent distinguishing characteristic of the yellow bullhead (E1), are overlooked. The present writer has never seen a brown bullhead from Lake Wingra.

Northern Yellow Bullhead (Ameiurus natalis natalis)

Around 1920 "big yellow bellies" were reported very common above and below the outlet of Lake Wingra and a lot of them were brought up with the marl in the dipper dredge when that area was being dredged (B6a). The personal fishing observations of the present writer indicate that yellow bullheads are also abundant at present. Their bottom feeding habits and shape probably account for the fact that they have usually escaped being caught in very great numbers in nets. In view of the excellent native population of yellow bullheads, planting of any species of bullhead appears unnecessary and undesirable.

Northern Pike (Esox lucius)

As far back as the records go Lake Wingra has supported an excellent population of this large predator, which was sought after by both commercial and sport fishermen (B6, B7). As the maximum-size records indicate, this fish reaches the largest size of any species in Lake Wingra. A limited amount of planting of this fish was carried out in 1922 and from 1940–1942. The most recent plantings may have had some influence on the great increase in the number of northern pike caught in the 1944 and 1945 carp seinings over the number caught in the 1936 carp seinings. The population of this fish seems to be somewhat depleted at present, probably as the result of the extremely heavy fishing pressure to which Lake Wingra is subjected. Continuous stocking of northern pike fingerlings seems desirable, both as a panfish and carp control measure, and to improve the game fishing.

Muskalonge-Northern Pike Hybrid (Esox masquinongy immaculatus x Esox lucius)

Beginning in 1940 and continuing through 1948 these hybrids have been planted in Lake Wingra as an experimental measure. Many have been caught by fishermen but those which were not immediately caught reached a large size, as indicated by the estimated sizes of those caught in the carp seinings beginning in 1944.

White Bass (Lepibema chrysops)

No evidence was found that white bass were present in Lake Wingra prior to the first planting of 900 fingerlings in 1917. Although no further plantings were made until 1933, W. L. Tressler reported in 1930 that perch and white bass were numerous in the waters of Lake Wingra (T1). The 1936 carp seinings revealed a substantial population of white bass.

Yellow Bass (Morone interrupta)

This Mississippi River species was reported from Lake Wingra for the first time in the 1944 carp seining where it ranked fourth in abundance among the panfish caught. It was probably introduced as the result of fish rescue and transfer operations. It rose rapidly in abundance and became by far the commonest panfish in Lake Wingra, although hook and line catches by fishermen give no indication of this fact.

Perch (Perca flavescens)

The extensive gill-net catches made by A. S. Pearse and H. Achtenberg in 1916 indicate that perch were then by far the most abundant panfish in the lake (P5). The perch were small in size, however, since the average "standard" length (does not include tail fin) was 14.16 cm. (5.6 in.) and the maximum was 18.0 cm. (7.1 in.) (P5). Again in 1930 W. L. Tressler reported that perch and white bass were numerous in the waters of Lake Wingra (T1). As in the case of the golden shiner, the far more abundant perch were also completely missed in all of the carp seinings on account of their relatively small size and elongated shape. Perch have now declined to the position of third most abundant panfish but the personal observations of the present writer indicate that the maximum size has increased above that reported by A. S. Pearse and H. Achtenberg for 1916. Whether or not this increase in size is due to the introduction of genetic "new blood" by the plantings made from 1938–1940 is interesting to speculate.

Walleye (Stizostedion vitreum vitreum)

This species was probably present in Lake Wingra before planting was started in 1900 (R1). A number of large plantings listed as "miscellaneous" walleyes were made from 1900–1907. Judging from the numbers of fish planted, "miscellaneous" must refer to fry, since a total of 2,655,000 were planted. From 1908–1943, 12,528,050 fry were planted, the most recent planting being of 7,000,000 in 1943. Fifteen adults were planted in 1940. The carp-seining data indicate that the walleye is one of the principal game fish in Lake Wingra and that it has been most abundant at times of northern pike scarcity, and conversely. Considering the substantial numbers of walleyes present, they are rather rarely encountered by fishermen.

Northern Smallmouth Bass (Micropterus dolomieu dolomieu)

This species is mentioned once in the early records under the local name of "yellow bass" (R1). It was reported from the gill-net catches of A. S. Pearse and H. Achtenberg in 1916 (P5). It was reported as a little less abundant than the largemouth bass in the 1936 carp seinings (J2), which indicates that it was present in fair abundance. None were reported in the 1944 carp seining or in any subsequent net hauls. Smallmouth bass may be considered absent from Lake Wingra at present.

What has caused the decline of the smallmouth bass is not clear. Flagrant law violations in the removal of bass during their spawning season from above the Lake Wingra lock, observed by the present writer, may have been a contributing factor. Since the planting records prior to 1937 refer only to "black bass" it is not known whether any smallmouth bass were planted under that designation. None have been planted since. The frequent presence of crayfish in the stomachs of the yellow bullheads caught by the writer indicates that the main source of food of adult smallmouths is not lacking. Consequently, it might be worthwhile to attempt to re-establish this popular game fish by a trial planting of fingerlings.

Largemouth Bass (Huro salmoides)

As far back as the records go Lake Wingra has, as in the case of the northern pike, supported an excellent population of this large predator, which was sought after by both commercial and sport fishermen (B6, B7). It has appeared in good numbers in all of the carp seinings and small specimens under the legal size of 10 inches have been abundant in the past few years. From 1937–1944 the lake was well stocked with fingerlings, as well as 1,000 yearlings in 1941 and 77 adults in 1940. If the present rate of natural reproduction continues, as evidenced by large numbers of small largemouth bass, further stocking seems unnecessary.

Sunfish (Lepomis gibbosus)

The sunfish is and has been one of the most abundant inhabitants of the shallow weedy areas of Lake Wingra and is frequently caught by fishermen. A. R. Cahn reports it as one of the most common species during 1913–1914 (C1) and A. S. Pearse and H. Achtenberg caught it rather frequently in their gill nets in 1916 (P5). In view of its small size and presence chiefly in the shore areas, it is understandable that it has not appeared abundant from the carp-seining data. The limited amount of sunfish-bluegill hybridization which occurs, as indicated by the three hybrids in the catches of the writer, is not surprising in view of the abundance of both parent species in the lake.

Bluegill (Lepomis macrochirus macrochirus)

This popular panfish is and has been the fish most sought after and most frequently caught by the majority of worm fishermen. It was reported in 1905 (M11) and A. R. Cahn described it as one of the commonest fish in the lake during 1913–1914 (C1). It was caught frequently in the gill nets of A. S. Pearse and H. Achtenberg in 1916 (P5). It has been well represented in the carp seinings. According to the most recent data it was the fourth most abundant species of panfish. From 1939–1944 the lake was well stocked with bluegills. There seems to be no indication at present of an overpopulation of bluegills.

Rock Bass (Ambloplites rupestris rupestris)

The only report of rock bass from Lake Wingra is that of A. R. Cahn for 1913–1914 (C1). A. S. Pearse reported in 1921 that the rock bass was absent from Lake Wingra (P4). It also appears to be completely absent at present. It might be reestablished by planting along the rocky part of the Edgewood shore and along the Vilas Park shore where the shore has been formed by an artificial rock fill. The frequent presence of crayfish in the stomachs of the yellow bullheads caught by the present writer indicates that the principal food of adult rock bass is not lacking, and in addition rock bass seem able to tolerate rather high temperatures.

White Crappie (Pomoxis annularis)

No evidence was found that the white crappie is native to Lake Wingra. A. S. Pearse devoted an entire paper (P3) to the black crappie in Lake Wingra but gave no indication of the presence of the white crappie during 1916–1917, and no white crappies were reported in the extensive gill net catches made by A. S. Pearse and H. Achtenberg in 1916 (P5). The first report of the white crappie was in the 1944 carp seining, where it appeared in tremendous numbers, indicating it to be the most abundant panfish in the lake, which position it continued to hold at least through 1946, as indicated by the gill-net catches of Dr. John C. Neess. It was probably introduced as the result of fish rescue and transfer operations.

Black Crappie (Pomoxis nigro-maculatus)

This popular panfish, frequently referred to locally as the "silver bass," is the native crappie of Lake Wingra. It was reported for 1902–1903 (M11) and A. R. Cahn described it as one of the commonest species during 1913–1914 (C1). A. S. Pearse described it as among the dominant species during 1916–1917 (P3). It ranked second in abundance among the panfish in the 1944 carp seining, overshadowed in a 3½ to 1 ratio by the white crappie. It ranked fifth in abundance among the panfish in the 1945–1947 gill-net catches of Dr. John C. Neess, overshadowed in a 10 to 1 ratio by the white crappie.

Forage Fish

In addition to the fish previously discussed in detail it should be mentioned that the following species have been reported from Lake Wingra or its tributaries:

Blackchin Shiner (Notropis heterodon)

Reported as one of the commonest species during 1913–1914 (C1).

(Notropis cayuga)

Reported during 1913–1914 (C1).

Blunt-Nosed Minnow (Hyborhynchus notatus)
Reported during 1916–1917 (P3).

Western Mudminnow (Umbra limi)
Reported during 1913–1914 (C1), 1914 (P1), and 1915 (P2).

Western Banded Killifish (Fundulus diaphanus menona)
Reported during 1913–1914 (C1), 1915 (P2), and 1916–1917 (P3).

Central Johnny Darter (Boleosoma nigrum nigrum)
Reported during 1913–1914 (C1).

Northern Silverside (Labidesthes sicculus sicculus)
Reported during 1913–1914 (C1) and 1916–1917 (P3).

Brook Stickleback (Eucalia inconstans)
Reported during 1913–1914 (C1), 1914 (P1), 1915 (P2), and 1916–1917 (P3).

E. CONCLUSION

In spite of its large carp population Lake Wingra is a good panfish lake. In the opinion of the present writer it might be even better if yellow bass and white bass, which are not caught by the majority of fishermen, had never been introduced, since they presumably compete directly for food with other more-sought-after panfish. Certainly it can be said that there is plenty of variety to be had among the species of panfish. The principal management problems seem to be (1) carp control and (2) encouragement of predation by all possible means as a carp- and panfish-control measure and to improve the game fishing. Carp control can be effected by frequent large-scale seinings and it is to be hoped that this measure will be used even more in the future than it has been in the past. Predation has been encouraged by the planting of muskalonge-northern pike hybrids, and this is to be commended, but it is suggested that the same effect might be created more economically by the planting of fingerlings of either or both species alone. The rate of natural reproduction of largemouth bass seems to be satisfactory.

III. THE TURTLE POPULATION OF LAKE WINGRA

In 1915 A. R. Cahn wrote (C1, p. 135), "The reptiles (of Lake Wingra) are represented by the painted turtle and the snapping turtle; the former is found quite often in the swamp, while the latter is more strictly limnetic, yet both may be said to be characteristically aquatic." The situation has changed little since that time because the present turtle population of Lake Wingra is predominantly composed of painted turtles (Chrysemys picta marginata) and snapping turtles (Chelydra serpentina serpentina). Professor Arthur D. Hasler reports that specimens of Blanding's turtle (Emys blandingii) have been collected by members of his field zoology classes in the Arboretum within one-half mile of Lake Wingra, and in June, 1947, the present writer observed a very large specimen two miles southwest of Lake Wingra at the pond along the Chicago and Northwestern Railway. The soft-shelled turtle (Amyda spinifera spinifera) is sparingly present in Lake Wingra. Dr. John C. Neess reports that two specimens, one a large one, were caught in the Wisconsin Conservation Department carp seine on October 26, 1944, and that the larger specimen is preserved in the University of Wisconsin Zoology Department collection. George J. Behrnd, who has fished the lake for many years, also told the writer that on a few occasions he has seen soft-shelled turtles in Lake Wingra.

On a number of occasions when fishing with worms in Lake Wingra, the writer has had a series of unexplained "bites" only to see the head of a painted turtle appear a minute later a foot or two away from the cork. This turtle is apparently quite cautious about taking the hook in its mouth since it is rather rarely caught by fishermen.

The snapping turtle, which reaches a large size in Lake Wingra, is frequently caught by fishermen. It serves as a very useful scavenger by consuming dead fish, which would otherwise rot along the shoreline and give off bad odors. Several times, just after dusk, the writer has observed a large snapping turtle, swimming slowly along the shoreline, removing dead fish, including some which were not freshly dead. The disappearance of quite a few fish from stringers left unattended in the water can be ascribed to similar causes, and occasionally the "snapper" has been caught in the act. When a fisherman realizes he has on his line a snapping turtle, which has not already swallowed the hook, he can usually avoid hooking it by not pulling too hard and by letting the turtle swim around until it gets tired or runs out of breath and lets go. The destruction of this splendid scavenger by thoughtless fishermen, or by drowning in nets, is indeed unfortunate.

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A CYTOLOGICAL STUDY OF THE ANTERIOR LOBE OF THE PITUITARY IN RELATION TO THE ESTROUS CYCLE IN VIRGIN HEIFERS*

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INTRODUCTION

The pituitary gland of the cow lies in the hypophyseal fossa and is bounded dorsally by the presphenoid cartilage of the basi-sphenoid bone. The gland is connected by the stalk or infundibulum to the brain. It is ovoid in shape and measures from 15 to 26 mm. long by 10 to 20 mm. wide by 8 to 16 mm. thick. The weight of the fresh gland ranges from 1.5 to 3 grams. The hypophysis consists of distinct anterior, intermediate and posterior lobes. The residual lumen or cleft separates the gland into two portions, one containing the anterior lobe and one containing the intermediate and posterior lobes. The anterior lobe with which we are concerned in this study is the largest portion of the gland and constitutes 70 per cent of the total weight. The anterior lobe ranges in weight in dairy breeds from 1.3 to 2.6 grams. Very little detailed information concerning the cytological picture of this gland in the cow in relation to the estrous cycle is available.

The present study was undertaken to consider critically the gross anatomy, histology and cytology of the anterior lobe of the pituitary gland during the estrous cycle in young virgin heifers. Information so derived may be of value in the further understanding of pathological changes of the pituitary induced by various causes and should represent a basic contribution to the knowledge of the physiology of bovine reproduction. This paper

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reports a continuation of research by Weber *et al.* (1948) and Reutner and Morgan (1948) on the histology of the bovine reproductive tract.

Review of the Literature

There is little information on the weight and measurements of the anterior lobe in virgin heifers. Peremenschko (1868), Dostojewsky (1886), Herring (1908), Trautman (1909), Lewis and Turner (1939) reported that the anterior lobe definitely constituted the larger portion of the gland. Although Gilmore *et al.* (1941) weighed a series of anterior lobes, the age range of the animals involved was not comparable to those represented in our study. In a group of 18 females and 1 male the average weight of the anterior lobe was 1.442 grams.

The histological structures of the bovine pituitary gland apparently was described first by Dostojewsky (1886) who observed acidophilic cells along the periphery, basophiles and chromophobes in the center of the gland. Trautman (1909) classified the cell types of the bovine pituitary gland which included strongly staining chromophile cells (acidophiles and basophiles), weakly staining chromophile cells (acidophiles and basophiles) and chromophobe cells. These findings were confirmed by other workers including Wulzen (1914), Herring (1914), Bell (1919), De Beer (1926), Cermak (1932), Soos (1934), Blickenstabb (1934), Beato (1935), Gilmore *et al.* (1941) and House (1942). Wittek (1913), Schonberg and Sakaguchi (1917) and Beato (1935) noted large numbers of eosinophiles and/or the low number of basophiles in the anterior lobe of the bovine pituitary. The differentiation of the basophilic cells was studied by Hall and Hunt (1938) and Hall (1938).

Confirmation of the occurrence of chromophobe cells in the bovine pituitary was made by Schonberg and Sakaguchi (1917), Smith and Smith (1923), Howes (1929) and Spaul and Howes (1930). In general, these cells are found to be more numerous in the central areas of the gland. Gilmore *et al.* (1941) were the first to make differential cell counts in the anterior lobe of the bovine pituitary. Their data were based on 12 cows of various ages and sexual stages. The average showed 44.27 per cent acidophiles (ranging from 17.69 to 60.4 per cent), 6.98 basophiles (ranging from 2.24 to 10.82 per cent) and 48.74 chromophobes (ranging from 33.36 to 72.69 per cent).

Although a considerable amount of work has been done on the cytological changes in the anterior lobe in relation to the estrous cycle in other species, especially in laboratory animals (guinea pig, rat, rabbit, pig, dog and cat) little information is available concerning the bovine. In the guinea pig Chadwick (1936) found that during the luteal phase of the estrous cycle there was a low level of chromophiles. After regression of the corpora lutea a rapid elevation of the levels of chromophile cells occurred while the degranulation of the basophiles took place in early estrus and that of the eosinophiles in late estrus. Hagquist (1938) noticed that the variations in the number of cells of the different types in relation to the cycle in the guinea pig were not statistically significant. He found the degree of granulation in basophiles and acidophiles increased during the first part of the cycle and decreased during heat. Kirkman (1937) observed a drop in the percentage of basophiles at the time of estrus in the guinea pig.

Charipper and Haterius (1930) found eosinophiles and basophiles in the rat pituitary during late diestrus; basophiles and a few faintly staining eosinophiles during late estrus. Reese (1932) observed in the rat that the eosinophilic cells were filled with intensively staining granules during estrus, while they were lightly stained during diestrus. Wolfe (1935) found no variations in the percentage of the different cell types in rat pituitaries during the various phases of the estrous cycle. During estrus the eosinophiles were filled with granules, in diestrus they were often stained lightly. The basophiles showed more definite variations; heavily granulated basophiles were at their highest level during proestrus. At the beginning of estrus and during estrus and metaestrus, they showed a marked loss of granules. Granulation was restored during diestrus.

Wolfe, Cleveland and Campbell (1932) studied the gland in the dog and found two differential staining types of cells instead of the single basophilic type. One type showed an increase in granulation, size and number during proestrus. The number of cells decreased before ovulation but became scarce during the luteal phase. The acidophile cells followed about the same pattern of behavior. Wolfe and Cleveland (1933) noticed in the albino rat a constant number of acidophiles throughout the cycle, the amount of granulation, however, being highest at the time of estrus. When the corpora lutea were active as in pseudopregnancy a drop occurred in the number of these cells. The basophilic cells became degranulated during diestrus.

Wolfe, Phelps and Cleveland (1934) found the percentage of chromophiles quite high in the rabbit at the time of estrus. When the doe was mated, a distinct drop in the number of basophiles followed and this figure was lowest point 5 days after copulation. Severinghaus (1939) noted the beginning of the degranulation of basophiles and increased secretory activity at one hour after coitus. In a comprehensive review of the subject he discussed the hypophyseal cytology in relation to the reproductive hormones.

Cleveland and Wolfe (1933) observed that the basophiles were maximal at proestrus and low during the luteal phase in the sow.

Materials and Methods

Fourteen clinically normal virgin heifers (Holstein–Friesian breed) ranging from 14 to 20 months of age were used in this study. All of the animals were obtained as calves and when used in the experiment were negative to the tuberculin tests and brucellosis agglutination tests. They were kept in ideal quarters, fed an adequate balanced ration and allowed to exercise. The animals were observed carefully for external signs of estrus. In addition, rectal palpations were made daily on each animal during at least three estrous cycles. The animals were slaughtered at various intervals (Table 1).

The pituitaries were removed as soon as possible and placed in Mossman's, Helly's or Regaud's fixative. The latter gave the most satisfactory results. Sections were cut at 5 microns beginning at the median sagittal plane proceeding toward the lateral sides of the gland. Approximately each 50th section was mounted and three slides were selected for study from each gland, including the first section obtained and one at each third of the distance from the middle to the side of the gland. Sections were stained with Ehrlich's hematoxylin, blued, postchromated and counterstained with erythrosin, orange G and aniline blue according to the method of Cleveland and Wolfe (1932).

Results

In general, the findings of others regarding the distribution of the several main cell types has been confirmed. The acidophilic cells were most numerous although the incidence of basophilic cells often equaled and sometimes surpassed that of the acidophilic cells in number. The nucleus showed a vesicular structure with a distinct nuclear membrane, 2 to 3 nucleoli and, except for chromatin masses and a fine network, a colorless nucleoplasm in most cells. The nucleus was slightly eccentric in position. The cytoplasm was closely packed with deep yellow staining granules. When less granules appeared a faint coloring developed and occasionally some cells were more orange-red rather than yellow. The acidophilic cells were ovoid in shape and varied in diameter from 8 to 14 microns.

TABLE 1

PROPORTION OF THE DIFFERENT CELL TYPES OF THE ANTERIOR LOBE OF THE PITUITARY GLAND OF 14 VIRGIN HEIFERS SACRIFICED AT VARIOUS INTERVALS OF THE ESTROUS CYCLE

Cow No.	Stage of Estrous Cycle	Per Cent Acidophilic Cells	Per Cent Basophilic Cells	Per Cent Chromophilic Cells	Number of Cells Counted
1	Estrus	47.3	2.1	50.6	3203
2	Estrus	62.8	11.0	26.2	1984
3	1 day postestrus	45.1	10.9	44.0	1894
4	1 day postestrus	44.4	11.2	44.4	2616
5	2 days postestrus	55.3	8.3	36.4	3243
6	2 days postestrus	48.2	8.1	43.7	2039
7	2 days postestrus	49.6	6.3	44.1	3390
8	2 days postestrus	36.7	2.5	60.8	1915
9	5 days postestrus	66.4	9.8	23.8	3054
10	6 days postestrus	46.9	4.1	49.0	2147
11	11 days postestrus	43.2	9.9	46.9	1412
12	15 days postestrus	53.7	10.8	35.5	1735
13	18 days postestrus	40.2	10.9	48.9	2024
14	19 days postestrus	59.6	7.3	33.1	3886
	Average	50.0	8.1	41.9	

The basophilic cells were of two forms or types. The cytoplasm of the smallest type measured 4 to 9 microns, was filled with blue staining material and the small nucleus appeared mostly as an eosinophilic mass. The cytoplasm of the larger cells, ranging from 9 to 14 microns, was more granular, the nucleus was of the vesicular type.

The chromophobe cells measured 10.17 microns, with a gray to faint blue staining cytoplasm. The nucleus was similar in size to that of the eosinophiles and larger basophiles, although sometimes a little larger and more irregular. The cell border could hardly be distinguished.

Mitosis of pituitary cells could not be observed in this work. Three slides from each gland were studied, including every fifth field in every fifth row, thus covering an area equivalent to about one-seventh of the section. Every cell with eosinophilic inclusions was considered to be an eosinophile and cells with the nucleus inside the area were counted. Results of these cell counts are given in Table 1.

The average for the 14 glands was 50.0 per cent acidophiles, 8.1 per cent basophiles and 41.9 per cent chromophobes. The amount of colloidal substance in the glands varied greatly. In two glands a few cavities were found, ranging from 50 to 450 microns in diameter, the lumen of which was covered with ciliated epithelium. Filling the lumen was an aniline blue staining colloidal material. According to Dostojewsky (1886) this structure was probably first observed by Luschka in 1860.

A study of Table 1 indicates a wide variation in the percentages of the different cell types in the glands studied. No correlation with cellular activity of the anterior lobe of the pituitary gland with the estrous cycle could be detected.

Summary

Counts of the cells of the anterior lobe of the pituitary gland of 14 virgin heifers showed an average percentage of 50.0 for the acidophiles, 8.1 per cent for the basophiles, 41.9 per cent for the chromophobes. A relationship of relative cell numbers to the stage of ovarian activity was not apparent.

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HISTORY AND PLATO'S MEDICINAL LIE

ROBERT K. RICHARDSON

In a collection of Mark Twain's pieces entitled *The Stolen White Elephant,* copyrighted 1882, is an essay "On the Decay of the Art of Lying." The subtitle indicates that it was read "at a meeting of the Historical and Antiquarian Club of Hartford, and offered for the Thirty-dollar Prize." A footnote facetiously adds: "Did not take the prize."

The essayist explained that he was not speaking about the "custom of lying," for, said he, "the Lie, as a Virtue, a Principle, is eternal," and drove home his point with the further words: "The Lie, as a recreation, a solace, a refuge in time of need, the fourth Grace, the tenth Muse, man's best and surest friend, is immortal, and cannot perish from the earth while this Club remains." He summarized his position early in the Address in the remark: "*Judicious* lying is what the world needs. I sometimes think it were even better and safer not to lie at all than to lie injudiciously. An awkward, unscientific lie is often as ineffectual as the truth." The sermonette ended with the exordium: "Joking aside, I think there is much need of wise examination into what sorts of lies are best and wholesomest to be indulged, seeing we *must* all lie and *do* all lie, and what sorts it may be best to avoid,—and this is a thing which I feel I can confidently put into the hands of this experienced Club,—a ripe body, who may be termed, in this regard, and without undue flattery, Old Masters."

Mark was, of course, jesting about what he called minor "deflections from the truth," and particularly about those associated, and still associated, with the social amenities. And yet what the humorist said about the lie as an eternal principle, what he dropped about the need of the world for judicious lying, were notably close to the content of one of Plato's most famous pages! Having, in the earlier part of the *Republic,* imagined a state, governed, doubtless, by the best for the good of all, but a state in which governors and soldiers alike are deprived of private property and are regimented in, or rather out of, family life like dogs in breeding kennels, while the masses take orders from the managing classes as Russian peasants accept the rule of commissars and soviets, Plato must at length raise and answer the question: How get this thing started? How induce these graded classes to accept their assigned rôles? His solution is the famous "medicinal lie," a well-begotten fiction.

> By what artifice then [says Socrates] may we devise one of those opportune falsehoods of which we were speaking a while back, something noble, whereby we may, above all, deceive the rulers and, in any case, the rest of the city?

Urged to explain himself he continues:

> Well, then, I will speak: and yet I really do not know how to muster the recklessness to begin or what words to use. I will try first to persuade the rulers themselves, and the soldiers, and then the rest of the city, that the education and training already received from us were illusions; they were but fancying, as in dreams, that they actually experienced these things, whereas, in reality, they were all that time being fashioned and nourished in the Earth, where they themselves, their weapons, and the rest of their equipment, were manufactured. And when everything was done, their mother, the Earth, sent them up: and so they must take thought for the country in which they live as for their mother and nurse, and must defend her if attacked, and must look upon the rest of the citizens as earth-born brothers. . . . "no doubt, all of you who dwell in the state are brothers," we shall say to them, keeping up the fiction, "but when the god formed you, he mingled gold in the composition of such of you as were suitable for ruling, wherefore they are most honored; and silver in those fit to be auxiliaries; and iron and brass in the farmers and the rest of the workers. As you are originally all of the same stock, you will commonly have children like yourselves."

Socrates concludes his imagined propaganda—which, like the Athenian in *The Laws,* he relates to the ancient tale of Cadmus and the Dragon's Teeth—by providing for a certain "circulation" from and into the élite in any instances where the gold and the brass are occasionally found misplaced, and by explaining that though an existing generation were beyond persuasion of these fictions, the belief might gradually lay hold of later generations.

Plato's is, of course, a magnificent lie, a lie, however artfully simple in tecture, of eminently wider scope than any associated with the afternoon calls of Mark Twain's Hartford ladies: but it does have this in common with its Connecticut kinsmen—it belongs to the class designated by the humorist as "judicious lying." Does it share the other characteristics of Twain's lie, necessity and eternity? Is it like those "impossible falsities" which Sir Thomas Browne declared "include wholesome moralities, and such as expiate the trespass of their absurdities?"[1]

Professor Fite, in his *Platonic Legend,* speaks ill of Socrates' device:

> And Plato [he writes] was not the last, nor probably the first, to think of the creation of a myth of "brotherhood" when policies of state call for a general sacrifice on the part of the people. Behind the words of the dialogue we can hear both Socrates and Glaucon laughing heartily at the thought of fooling the people by a device so transparently audacious. The universal kinship may at first be viewed with suspicion, Socrates explains, but with the lapse of a generation it will pass as gospel.[2]

Fite's criticism is compounded of dislike for the regime instituted and of contempt for the method of the institution. In this paper it is Plato's method of initiating his state that is under examination, not the quality of the proposed commonwealth. Was Plato in the passage referred to baldly proposing and approving falsehood in any ordinary sense of that term today?

He may receive interpretation both from the context of his own works and from the course of recorded history. It seems entirely congruous with his habit of thought elsewhere—his comment on his own myth at the end of the *Phaedo;* his contempt for matter-of-factness in the inspiring passage at the close of the Ninth Book of the *Republic;* the place assigned "fiction" in implanting sound suggestion in the mind of childhood in the Second Book of the *Laws;* the Charioteer myth of the *Phaedrus;* and the vision of judgment, predestination, free will and the moral blamelessness of God in the tale of Er, son of Armenius, in the Tenth Book of the *Republic*—to view the "medicinal lie" of the *Republic's* Third Book as ancillary to the same high purpose with respect to the realization of a social and political ideal as was served with regard to problems such as reality, life,

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[1] *Apud* Bergen Evans, *The Natural History of Nonsense* (1946), p. 29.
[2] W. Fite, *op. cit.* (1934), p. 29.

death, freedom, predestination, values and immortality by his enchantments, accepted hazards and myths, in other passages.

But the "medicinal lie" may receive interpretation and justification from outside Plato's writings. Despite his apparent naivété and simplicity—his shadows and reflections, for example, in pools of water in the story of the Den—he is but suggesting methods of the influencing of conduct, and modes of the rise and evolution of ideas, known to experience before and since his time. Four historical processes, at least, are comparable to the famous "lie"—and none involve deceit in any usual sense. After allowance for over-lapping of categories in specific cases, these processes may roughly be delimited as follows:

(I) The creation, or rise, of states of mind and opinion favorable to a given ethic or a desired social condition.

(II) The perpetuation or employment of a previously existent opinion.

(III) The rationalizing of opinion, old or new, a phase of (II).

(IV) The avoidance of the effect of some state of opinion for the time-being ineradicable—the legal fiction.

I. The Creation or Rise of States of Mind and Opinion Favorable to a Given Ethic or a Desired Social Condition

In this category, and closely akin to Plato's "lie," may be placed theories of government and society such as the "social contract"; self-evident "rights of man"; the "economic man"; the assumption that kings are, *ipso facto,* tyrants—or, contrariwise, doctrines of divine right and divine entail; in early cultures the identification of the virility and felicity of the chief or Pharoah with the welfare of the tribe or state; the psychology of the ordeal in times and places marked by a certain efficaciousness in that superstition. *Vox populi, vox Dei* may join the group, as also the mediaeval, and even surviving, doctrine that "law is found" and 17th and 18th century attempts, in England by parliamentarians and in France by judges, to give concrete meaning to the doctrine in the form of statements of "fundamental laws." Locke, Hobbes, Rousseau, Dante, Marsiglio, Hitler, all, however variant in purpose or morality, are associated in this same genus. Montesquieu's teachings, on the other hand, fall without the type.[3]

History and contemporary life abound in numerous minor illustrations. Polybius is quoted in a book of some years since on Scipio Africanus as maintaining that Lycurgus made his scheme of laws "more easily believed in" by the Spartans by asserting that he had been assisted in their compilation by the oracle; and as holding that "Scipio similarly made the men under his command more sanguine and more ready to face perilous enterprises by instilling into them the belief that his projects were divinely inspired." "But," adds Polybius, "that he invariably acted on calculation and foresight, and that the successful issue of his plans was always in accord with rational expectation, will be evident."[4]

Cicero, in his second book *On the Republic,* half apologizes for stating that Romulus was the son of Mars by saying that "we may grant that much to the popular tradition, especially as it is not only very ancient, but has been widely handed down by our ancestors, who desired that those who have deserved well of the commonwealth should be deemed actual descendents of the gods, as well as endowed with godlike qualities."[5] This is practically a case of Plato's "lie" become effective.

The rousing effects upon the knights of the First Crusade of finding the "holy lance" beneath a church pavement at Antioch —an obvious case of "planting"—is familiar. Well known, too, is the Conqueror's stretching out of his arms on stumbling at his landing in England and saving important appearances before his followers by declaring himself thus invested by God with the kingdom he had come to seize. Havelock Ellis, in his *Dance of Life,* relates how Foch, quoting De Maistre, lays down in his

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[3] Current "functional" propaganda in secondary schools, and creeping up into the collegiate level—in the latter case with more questionable justification—in the interest of democracy, seems to the writer to belong in the same list. Ideas planted so early that the mind can form no opposing judgments are dogmas, and dogmas, unsupported, play the part of Plato's myths and fictions. The point is that so far as these programs go behind the demonstrable, and especially beyond verifiability by those instructed, they are akin to Plato's enchantments and myths and fictions, and are, at the appropriate levels, neither to be more nor less condemned.

On the negative side, the veiling of unwanted attitudes, examples are to be found in any censureship, the best known being the Index of the Roman Church: and, in contrast and protest, the *Areopagitica.* On the other hand, how should be classified the practice of those who leave their children without religious instruction until, as the saying goes, "they can grow up and decide for themselves"?

[4] B. H. Liddell Hart, *A Greater Than Napoleon, Scipio Africanus* (1928), p. 6.

[5] Cicero, *op. cit.,* tr. Keyes (Loeb Clas. Lib.), II, p. 113.

Principes de guere the doctrine that "a lost battle is a battle one thinks one has lost." "The battle," comments Ellis, "is won by the fiction that it is won."[6] Virgil had been ahead of De Maistre and Foch by nineteen centuries: *Possunt, quia posse videntur.*[7]

All these incidents and sayings, like many more that might be cited, have this in common with the "medicinal lie" that, like Plato's audacious fiction, they tend to the creation of a state of mind or of opinion favorable to a given ethic and morale or a desired social and political condition.

II. The Perpetuation or Employment of a Previously Existent Opinion

Medicinal fiction has also been at work in the perpetuation of previously existent opinions or institutions. One form is the "catchy" slogan—such, for example, as "Rally round the Flag, boys, rally round the Flag!" The eagle-standard played a similar part for the legionary. "For King and Country" is an instance where the second half of the slogan appeals more to the reason while the first instills emotional punch. Thornton Wilder's *Our Town* furnishes a fine case in point.

> Over there [recites the Stage Director] are some Civil War veterans. Iron flags on their graves—New Hampshire boys—had a notion that the Union ought to be kept together, though they'd never seen fifty miles of it themselves. All they knew was the name, friends—the United States of America. The United States of America. And they went and died about it.

Other examples of the use of ancient states of opinion to buttress existing institutions have been the dogmas of the divine origin of the Japanese dynasty; of the deity of the Pharoahs and, later, of the Roman Emperors; of the springing of the Brahmins from the head of Brahma; of the mandate of Heaven granted to, or withdrawn from, the Emperors of China. Parson Weem's tales of the young Washington perhaps fall into an humble corner of the same ideology.

Far more important, as things appear to the writer, was the taking over by early Christianity of the Jewish apocalytical eschatology whence it so largely sprang and the subsequent

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[6] H. Ellis, *op. cit.* (Houghton, Mifflin, 1923), p. 103. *Cf.* chap. on "The Art of Living," in toto.

[7] *Aeneid,* V, 231.

adoption by this same Christianity, now become Gentile, of those Hellenistic viewpoints and attitudes that gave birth to the veneration of saints, the rise of a doctrine of Purgatory (quite Greek and Orphic) and, indeed, to not a little of that *schema salvationis* common to most Protestants and Catholics alike. The enlarging body of converts, attracted to the spiritual beauty of Jesus, took Him to themselves as certain of the Gnostics, even before Jesus' day, had taken Jewish Messianism to themselves; but they adopted Him because they could wrap Him in layers of fictional lore as old as, and older than, history itself. If this view of Christian history be sound, the perpetuation of the ancient as the price of the introduction and maintenance of the new, illustrates another angle of Plato's fiction: it is a mode of exhibiting the eternal tension of the stable and the flux, of inheritance and mutation.

III. The Rationalizing of Opinion, Old or New, A Phase of II

There have been occasions when men have deemed it desirable to defend old ways against new, or, on the other hand, to defend the new as not differing from the old or as developing out of the old.

Edmund Burke, a "traditionalist," "a Whig of the Revolution," was one who wanted to keep the old and who vented his fear and detestation of the French Revolution in his famous *Reflections*. In these he not only gives a quite fictional picture of the past, but goes further and defends fiction in itself. He loved the past and wrote of "all the pleasing illusions" whereby it had "made power gentle, and obedience liberal,"—"illusions," which, he feared, were "to be dissolved by this new conquering empire of light and reason" wherein "the decent drapery of life" itself was rudely to be torn off. The "drapery" is, of course, fiction.[8] "You see, Sir," he wrote the young Frenchman in the letter of which his book assumed the form,

> You see, Sir, that in this enlightened age I am bold enough to confess, that we [the English] are generally men of untaught feelings: that instead of casting away all our old prejudices, we cherish them to a very considerable degree, and, to take more shame to ourselves, we cherish them

[8] Reflections on the Revolution in France, in *Works*, II (London, 1894), p. 349.

> because they are prejudices; and the longer they have lasted, and the more generally they have prevailed, the more we cherish them. We are afraid to put men to live and trade each on his own private stock of reason; because we suspect that this stock in each man is small, and that the individuals would do better to avail themselves of the general bank and capital of nations, and of ages. Many of our men of speculation, instead of exploding general prejudices, employ their sagacity to discover the latent reason which prevails in them. If they find what they seek (and they seldom fail), they think it more wise to continue the prejudice, with the reason involved, than to cast away the coat of prejudice, and to leave nothing but the naked reason: because prejudice, with its reason, has a motive to give action to that reason and an affection which will give it permanence. . . . Prejudice renders a man's virtue his habit; and not a series of unconnected acts. Through just prejudice, his duty becomes a part of his nature.[9]

And here Plato and Burke are alike: each wishes men's duties to become parts of their natures, their habits! The difference is merely that in this instance Burke defends the "illusions," the "prejudices," of the past because he is nostalgic for the old, whereas Plato, with a playfulness quite superficial, creates fresh illusions, based on an ancient tale, because he is nostalgic for the new. Rousseau, in his paradoxical fashion, though really, in a way, on Plato's side, was doing much the same with his noble, never existent, naturally compassionate savage.

An instance, on the other hand, of what amounts to a medicinal lie to save the new from imputation of hostility to the old, a rationalizing method, is the allegory, a manner not of writing but of reading and interpretation. Popular among the Greeks, though meeting the disfavor of Plato (as in the *Phaedrus*), it enabled them to reconcile an improving moral sense with their Hesiod and Homer. From the Greeks this method of interpreting sacred writings passed to the Jews and the Christians, enabling men like Philo and Augustine to square their classical metaphysics with their Judaism or Christianity, and furnishing the Church a method of evading Jewish copyright on the Old Testament. What the "historical approach" to Scripture is today in the matter of resolving difficulties incident to higher criticism and a more advanced ethical sense, the "allegorical approach" was yesterday.

[9] Burke, *op. cit.*, p. 359.

IV. The Avoidance of the Effect of Some State of Opinion for the Time-Being, at Least, Ineradicable—The Legal Fiction

A fourth type of historical medicinal lie is first cousin to Plato's, the conscious legal fiction, the pretense by the courts that something is objectively true which all parties concerned, surely all legalists concerned, know to be false. It differs from Plato's fiction only in its naked and avowed contempt for fact. Legal fiction has, in historic times, been a chief means of equating the administration of law with developing equitable standards while at the same time conserving wholesome reverence for stability. Examples are liberalization of the *jus civile* under the influence of *jus gentium* through the channel of the praetorian edict; the allegation of breach of the king's peace in private accusations or grand jury presentments, and the partial avoidance of restraints on free trade in land by the procedure known as "suffering a recovery." A renowned and most happy illustration is the open contempt for logic and legal fact in the obvious subterfuge which enabled the Whigs and Tories to combine (each remaining true to their differentiating principles) in ousting the Stuarts from the throne of England—the agreement of both parties to the formula: "the said late King James the Second having abdicated the government, and the throne being thereby vacant." And a still more famous instance is that judicial, fictional interpretation of Magna Carta which makes its 39th article guarantee jury trial at a date before the petty criminal jury had even come into existence.[10]

It may be just worth while, in bringing this paper to a close, and as a friendly gesture in Plato's direction, to point out that more than once the lack of some mediating device has put a check on sound reforms. Three instances come to mind off-hand: the frailty of the parliamentary achievements of the 14th and 15th centuries incident to their slight grip on contemporary mindedness and their failure to have developed a parliamentary "habit" or "prejudice"; the premature radicalism of the ecclesiastical policies of Edward VI; and the failure of the too unsympathetically pressed reforms of the Emperor Joseph II. In our own time the non-enforcement and fate of the Eighteenth

[10] In Wisconsin history the judicial interpretation of the State Constitution in the *Edgerton School Case* falls within the type.

Amendment may perhaps point a moral. A favorable state of opinion, however arrived at, is requisite to the successful launching of reforms and of institutions. Gestation must precede birth.

So, putting two and two together, Mark Twain may really have "said something" when he spoke of the lie as an "eternal principle," and of "judicious lying being what the world needs"! And we may perhaps credit Plato as dealing, after his whimsical fashion, not with demagogic and Fascistic deceit of the unsuspecting masses, but with those enchantments, those fictions, those unverifiable presuppositions and intuitions, those ultimate mental foundations on which the life of man, individually and in society, has so largely rested. Plato was not concocting a lie: he was taking account of an ever-living fact.

FUNCTIONAL HOUSING IN THE MIDDLE AGES

SVEND RIEMER

Housing conditions of the Middle Ages were just about close enough to the contemporary scene to be referred to by planners and architects with either envy or contempt. The city of the Middle Ages has been glorified by the architect from the esthetic point of view. Its so-called organic qualities have been praised. But the city of the Middle Ages has also been sneered at by the engineer who contemplates with bewilderment a street pattern that seems to have been laid out by cows being driven home from pasture.

Neither envy nor contempt, however, can do justice to the historical past. We must try to give a functional interpretation to medieval construction and city planning, understand the purposes for which these medieval cities and homes were built. We cannot remain satisfied with off-hand remarks explaining that medieval cities were placed on mountain peaks, on islands or peninsulae for defensive purposes etc. We must consider the peculiar medieval needs for family living. We must realize that the city, the residence, and the furniture of the Middle Ages can be fully appreciated only if we abstract our own ideas of comfort and propriety. We must realize, particularly, that our way of life is set apart from that of the Middle Ages by an increased emphasis upon the desire for privacy.

Such functional analysis must get at the core of medieval housing attitudes. The home life of the early Middle Ages lacked privacy to an extent unimaginable to even the poorer classes in modern society. What is more remarkable, this lack of privacy did not cause much suffering or frustration since the desire for it was highly undeveloped. There was no indication in that world of the "invisible wall" which in our present civilization separates human beings from each other;[1] which makes them shrink at close bodily contact and turn from observation of intimate bodily functions.

Eating habits can be used to illustrate the point. It was quite customary, up to the 15th century, to dine from a limited num-

[1] Norbert Elias. Ueber den Prozess der Zivilization. Basel, 1939, p. 89.

ber of table settings, with several people using the same plate, the same cup, and the same knife. This sharing of the same table setting was not induced by the lack of utensils. On the contrary, the late Middle Ages displayed a considerable amount of luxury at the table in the use of various bowls, vessels of all sorts, plates and service dishes. There was simply no attempt to provide for nicety in eating habits. The wealthy merchants of the 13th century, for example, used different knives and spoons at different seasons; they used ebony handles at Fast, ivory work at Easter, and inlay work at Lent. These tools then were obviously supplied up to the level of luxurious consumption. But the possibility of providing separate tools for the individual guests at the dinner table did not even dawn upon a people adapted to a low threshold of shame, a people with little desire for immaculate privacy.[2]

This trait had its implications in the housing and city planning of the Middle Ages. Bedroom behavior was free from shame. Nightgowns came into use only as late as the 15th and 16th centuries. People slept in the nude or in their clothes. The display of the naked body was not frowned upon. Sleeping quarters were not isolated but were readily shared by all members of the family as well as their servants and their guests. Beds were shared at all ages by non-married members of the two sexes. Matters of intimate hygiene, moreover, were to a large extent transferred from the individual home to the community bathhouse. With regard to requirements for tub bath and steam bath, the standard of living in the Middle Ages was by no means low. But at the occasion of the weekly bath the entire family might have been seen parading through the city streets in a state of almost complete undress protected possibly by only a loin cloth.

The frank manner in which Erasmus of Rotterdam, at the very end of the Middle Ages, discussed matters of sex in a book of manners designed for an eight-year-old school boy indicates an absence of shame and protective secrecy as far as all elementary bodily functions were concerned.[3]

This desire for privacy, unique to our modern civilization, first appeared with the development of the small family which threw a circle of in-group out-group relations around parents and off-spring. It was unknown to a pattern of family life which

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[2] *Ibid.*, p. 85.
[3] *Ibid.*, pp. 230 ff.

overflowed into a wider circle of servants, friends, relatives, and members of the community.

The sex mores of the Middle Ages were "up to the point";[4] they were naive and free from that refined stimulation of the sex drive which has permeated our culture since the days of the Renaissance. Illegitimate children, to be sure, were in abundance, and there was a definite place for them in society. There was prestige in being the bastard child of a high-ranking father. Sex activities were considered the normal share of any adult's life. As far as women were concerned, presupposing a possible later marriage, only the premium upon virginity which guaranteed to the father the legitimate birth of his own children put a barrier to sexual relations. Bachelors were more or less expected to take advantage of the brothel. At the same time, the married man had to sneak into the Red Light district of the medieval city; his sexual adventures outside marriage were frowned upon or even punished because they infringed upon the right of his spouse to marital relations.

Weddings were community affairs; and the visual participation of friends and relatives did not stop at the threshold of the bridal chamber. Dances and games were occasions for frank sexual solicitation. They were aimed at physical contact and occasions for denudements. Sexual stimulation, on the other hand, was more strictly limited to such definite occasions than in our own times.

We may ask whether we are at all entitled to talk about the "private lives" of the Middle Ages. The life of the family flowed over its boundaries and mingled with that of the wider community. The portals of the private houses in the medieval cities were thrown open. In the narrow streets of the residential sections practically all traffic was barred. These streets were not designed for traffic; they were merely extensions of the family abode and the workshops of the different craftsmen. In fact, there was no separation between a man's place of work and his private dwelling; nor was there any clear-cut distinction between leisure time and time for gainful employment.

It is wrong, furthermore, to assume that the lives of the citizens were more or less confined to the "residential" sections of town. We carry a false image in our minds if we visualize

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[4] Louis Mumford. The Condition of Man. New York, 1944. p. 114.

these old cities as a composite of primarily church and cathedral, and then private dwellings. This is the picture of many of these cities which has come to us in our times. Actually, the civic center—as we might call it today—formed a small town of its own, located adjacent to or in the immediate vicinity of the central market place. Later, as the private lives withdrew within the small family circle and more and more activities were taken out of public circulation, many of these public buildings lost their functions. They were turned into private homes, or they stood unused, or they were entirely torn down and replaced by residential construction.

The citizens of the Middle Ages participated in a never-ending round of social occasions. They were well provided for with the necessary community facilities. They had not one, but many, buildings available for a rampant club life and for active leisure-time activities. Leisure, to be sure, was not indulged in every single day or for definitely set hours as in our culture. The allotment of leisure time followed a different principle. Some one hundred days or so of the year were dedicated to different saints and set apart for rest and merry-making.

Needless to say, there were also public buildings designed for administrative and commercial functions, and in the late Middle Ages, perhaps even to industrial functions. But these buildings, in one form or another, were made available to all citizens by the fusion of work and play, of informal social gatherings and purposeful occupational endeavors, and by the lack of distinction between different types of activities which later were to become clearly segregated from each other with the spread of division of labor. They constituted truly a part of the living space of the entire urban population. They were places in which to walk around and meet friends for a chat or, possibly, a business deal.

Then, there was the city hall, equipped for administrative and judiciary purposes as well as for dances and festivals. There was the market place into which, in the more agreeable seasons, intra-mural activities easily overflowed. These activities were facilitated by galleries and colonnades crowded with peddlers and farmers and urbanites selling their goods. The spectacle of public punishments took place in front of the city hall. Here also, celebrated visitors were entertained with food and drink. Frequently, city halls were extended in size to accommodate the increasing amount of community activities. Special dance houses were built and made available for private weddings, for citizen groups, or, on special occasions, for the entire citizenry. The bath-houses also served as places of entertainment, as did the brothels where the unmarried male population spent the evening.

There were the armories, the store houses; there were special buildings for the various guilds equipped for trade as well as drinking and club activities. There were the cloth-houses, the cheese-houses, the wine-houses, the butcher-markets, and the exchange. There were the saloons for wine and beer; and there were inns where the transients crowded, washed their clothes, bathed and dressed, and ate and drank in one large living space on the ground floor, retiring for the night into large, barrack-like bedrooms.

There were hospitals for different types of diseases, many of them charitable foundations sponsored by the nobility or wealthy merchants. Ball-houses were available for the games of the time. Homes for the aged accommodated those without family assistance at a time of need. An entire subsidized "housing project" with rent-free private dwellings as well as community facilities was donated by the Fuggers, a wealthy merchant family in Augsburg.

An appraisal of housing conditions in the Middle Ages has to consider this emphasis upon communal living. The entire city, with all its private as well as public buildings, must be the unit of observation for any attempt at a truly functional analysis.

We know very little about the individual dwelling unit of the Middle Ages. Information about residential housing of the early Middle Ages is distorted by repeated processes of remodeling which were carried out to accommodate changing needs and to house the population increase which thronged the limited space available inside the city fortifications. Although we know more about the late than about the early Middle Ages, documentary materials lend us some help in the reconstruction of the early dwelling units. These materials, however, are available not in the form of floor plans but in the form of descriptive statements. And even these are rare because the private lives of the era did not hold the center of the stage. The interest in objective environmental description arose much later, possibly during the late Middle Ages and the Renaissance; and for earlier information, therefore, we have to remain satisfied with passing remarks.

The early burghs of the Middle Ages—dwelling units and defensive shelters of the feudal nobility—contained many features that were to influence the urban residence for centuries to come. The choice of location, naturally, was entirely dominated by the need for defense against enemy raids. They towered on mountain cliffs or were protected by island or peninsular positions. They nestled in swamps or selected open spaces where a minimum of protection was offered to the approaching enemy.

The differentiation between shelter inside the moat or behind protective walls was not devoted to the needs arising in connection with the private lives of the noble family, but rather to the many special requirements for the defense and sustenance of the large feudal household which included servants, knights, pages, managers, clerks, cooks, stable grooms, and others. Between the inner and the outer wall, if two defensive walls were provided to increase the safety of the burgh, were the stables for the horses, the chicken coops, and the various other structures necessary to retain sufficient livestock in case of a siege. In the main building there was an armory, cellar, and a grain house. There was a chapel also where services were held for the servants and the noble family alike. Clerk, manager, and cellar official might have been provided for with special rooms of their own. There was, of course, a kitchen, and frequently a special baking room as well. It is only when we come to a consideration of the general living space and the rooms which held the private or social lives of the noble family and its entourage that we are struck by an amazing lack of differentiation.

If we glance at the floor plan of a medieval burgh[5] we are bewildered by the complete lack of any system of communication which we have learned to consider a necessary prerequisite of even the most modest family dwelling of the present ages. There were no halls which made the individual rooms directly accessible without passing through other rooms located closer to the entrance door or to the stairway. As a matter of fact, the flight of rooms on the second floor—which generally contained the living quarters—was strung up in a row very similar to the arrangement of the railroad flats in cheap tenement houses in our metropolitan centers. The galleries which appeared in the later Middle Ages—viewed as an element of esthetic embellish-

[5] Alwin Schultz. Deutches Leben im XIV. und XV. Jahrhundert, Wien, 1892. p. 11.

ment or as a stand for spectators engaged in watching the tournaments in the court of burgh or castle—may have been even more important at the time of their introduction because of the privacy which they provided. They were the forerunners of interior halls and corridors. Originally, there was only a directly interconnected sequence of rooms.[6]

Privacy was obtainable, under these conditions, only in those rooms most remote from either entrance or stairs. Thus, there entered into the assignment of the available rooms for specific purposes a hierarchical arrangement which, very naturally, reserved the remote quarters for the most privileged inhabitants, i.e., the lord of the burgh, his family, and especially honored guests. Adjacent rooms served as anti-chambers, such as the knight-chamber, and as general living space or possibly servants' quarters. Those rooms closer to the entrance or stairs were increasingly public in character. Alcoves and bay-windows, which we associate with life in burgh or castle or even the medieval city residence, may not have held, for the contemporaries, what seems to us the primary advantage of a pleasant view on the surrounding landscape, but may have served, rather, as a refuge from the humdrum of the social life to which small groups might retire for purposes of at least relative privacy.[7]

Life in the burghs of the Middle Ages was far from solitary. There was a constant coming and going, and while there were few complaints that these roaming strangers interfered with the privacy of the residents of the burgh, we find comments about the actual danger involved in the penetration of the fortifications by unknown men who might easily defeat the purpose of defense against the outside world. Under ordinary circumstances, the feudal residence was open to anybody. Thieves and robbers as well as hold-up men might enter. And they could remain unobserved in the turmoil of various activities which continuously linked the open spaces, the court of the castle, and the residence proper. The burgh was filled with all the noises of the farmyard. There were cattle in the stables as well as sheep, horses, and other livestock. Riders went out to supervise the peasants, and they returned to report to the feudal lord in his private chambers. Wagons with supplies crossed the drawbridge and rattled

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[6] Alwin Schultz. Das haeusliche Leben der Europaeischen Kulturvoelker. Berlin, 1903. p. 10.

[7] *Ibid.*, pp. 12, 13.

into the court. There was little occasion, indeed, for quiet solitude.

Nor was the need for it felt. The active life was spent in the open spaces. The burgh provided a refuge only, against the enemy as well as against the extremities of an unfriendly climate. Winters, needless to say, inflicted severe suffering. The heating facilities were totally inadequate. The open fireplace provided relief only to those seated in its immediate vicinity while the less-honored guests, knights, pages and servants, froze in the expanse of the wide rooms or halls. There was no window glass in the early Middle Ages, and wind, rain, sleet, and snow were kept out by wooden shutters which left the interior in complete darkness. Winter was a time for hibernation. Life literally stood still and was awakened only when the spring breezes invited a closer relationship with the out-doors. We have to realize that certain wants—requirements which seem indispensible to us—were not even experienced as such in the Middle Ages. It would be wrong to try to understand through our perspective of the 20th century the functional relationship between technical means for providing them and the demand for improvements.

The desire for privacy, particularly, is a late flower in the progress of our civilization. We are not as much astonished at the fact that the citizen of the Middle Ages was technically and economically limited in his ability to satisfy his demands for privacy, for separate rooms to accommodate activities that were apt to interfere with each other, or for secluded chambers to shelter the intimate life of the family in retirement, as we are at the fact that he did not take full advantage of even the limited resources available to him. Life, in the Middle Ages, organized itself in a qualitatively different pattern. Ambitions and feelings of achievement took a different turn and became established within a different system of satisfactions.

The floor plan without a system of communications is one of the most striking symptoms to indicate the presence of a qualitatively different pattern of needs. There is no doubt that arrangements could have been made for connecting halls or for the grouping of individual rooms around the general entrance on each floor. Yet, the "railroad" or "shotgun" arrangement of rooms was obviously not considered a nuisance. Moreover, there was a feeling of comfort connected with close human crowding, the comfort that went with the assurance of safety within a group held together by bonds of loyalty or solidarity. The feudal lord and his family, in particular, were stowed away behind barriers of various categories of subjects committed to the defense of life and safety of their superiors. Even outside the remote private chambers, the feudal lord was continuously surrounded by a bodyguard of servants, pages and knights which, under the circumstances of a hazardous struggle for survival, could scarcely be resented as an infringement upon his privacy. The times were not safe for relaxed leisure in isolated quarters.

Privacy can be enjoyed only where the intimate life of the small family is inviolate by taboos that pervade the entire culture. Only where a feeling of shame is internalized by all members of a civilization, and where the intruder is just as much pained by the disturbance he causes as the one that is intruded upon, is there any meaning in staking out clearly the realm of our intimate and private lives against the sphere of social interaction.

Life in a medieval burgh, thus, was quite similar to that in a temporary camp where the call to arms might sound at any minute. At night, only a privileged few were able to withdraw to separate quarters. The rest prepared their beds wherever a suitable bench could be found. They made themselves comfortable with furs or blankets or pillows, but frequently refrained from undressing completely. Usually, they arranged themselves in status groups for the night, guarding the line of attack against the sanctum of the private chambers of the ruling family.

Under the circumstances, the differentiation of rooms in the burgh made very little progress. All rooms were used as "double-purpose" rooms. Furniture was carried in and out according to the demands of the immediate situation. The dining table was carried into the largest hall or room whenever the entire household assembled at meal times. It frequently consisted of boards placed on supports, barrels or similar contraptions. Benches and chairs were arranged to accommodate a social gathering around the open fireplace. A rearrangement, again, had to be made when the armed guard or the servants prepared themselves for a night's rest.

The housing investment went into the crude shell of the structure itself, with a flight of rooms available alternately for different purposes. It went further into the utensils required both for everyday living and for the luxury of special entertaining. The furniture was modest, however, and there was not very much of it. There were curtained beds with canopies to provide a semblance of privacy in rooms otherwise easily accessible to outsiders. There was a decided lack, on the other hand, of permanent installments or fixtures which would have assigned a room to a more or less definite purpose.

It was an easy task, therefore, to prepare an empty burgh rapidly for a princely visit or for occupancy after years of abandonment. Whatever comforts the times provided were quickly moved into the crude shell of a shelter. The burgh, as such, presented itself as an advantageous camping ground, safe against hostile attacks, and relatively protected against the extreme vicissitudes of the climate.

In the medieval cities the private family was sheltered in a great variety of structures. There was a close relationship, particularly in the earlier days, between the house of the peasant and the house of the city dweller. Within the expanse enclosed by the city walls, soon after the foundation and the first layout of the city plan, peasant dwelling and urban residence must, in fact, have been identical in many instances. Farmsteads were part of the urban community. But even the houses of the peasants varied greatly, from simple one-room straw-thatched dirt huts to elevations of several floors, with an entrance door wide and high enough to permit horse-drawn wagons to drive right into the building for purposes of unloading.

This latter feature was retained in the merchant's house of the late Middle Ages. The main entrance, however, which formerly opened sideways to the farmyard, was shifted around to the street front. This was essential to aid transportation in a growing urban environment.[8]

In addition to the isolated structures, we have to consider the typical row house of the late Middle Ages which allowed for efficient utilization of valuable land. By means of vertical partition, many isolated structures were converted to half-houses, some of which were still retained after complete deterioration or demolition of the other half. These half-houses deserve some further comment.[9] That dwelling units should have been divided

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[8] Rudolf Eberstadt. Handbuch des Wohnungswesens und der Wohnungsfrage. Jena, 1910. p. 87.

[9] *Ibid.*, p. 39.

under the pressure of continuous population increase is well understandable. With modern conditions in mind, however, it will appear to us that a horizontal division should have been preferred, separating different floors from each other and making flats or apartments available to different renters just as in the tenement house of the industrialization period.

For an explanation, we must consider, first, the complex role of the family house in medieval urban society. Inhabited by independent craftsmen, it served in most cases simultaneously as a workshop and domicile. The workshop required direct access to the street for purposes of trade, barter, and transportation. One or several upper floors would never have provided for these needs. Where upper floors were made available for a separate household, they accommodated families of married apprentices. Due to severe restrictions on apprentice marriages, these were exceedingly rare.

We must also consider another reason for the avoidance of house partitions by different floor levels. The medieval house completely lacked any unified system of stairs connecting clearly separated floors from each other. The height of individual rooms was not standardized. Ceilings might have been arbitrarily high or low according to the preference of either builder or owner. Thus, floor levels were not nearly as apparent as they are in our modern structures. Nor was access to the higher levels of the house gained by a system of stairs running through the entire structure. From the ground floor to the room on top there might have been some simple steps in one part of the building. The uppermost rooms, however, might just as well have been reached from a room on the middle level not directly connected with the ground floor. Vertical communications wound somewhat awkwardly through various rooms on different levels of the entire structure. Thus, any horizontal division of the structure would have meant an intolerable impasse upon family privacy.

Needless to say, the floor plan of the medieval city house was characterized by a crude and elementary set of interior subdivisions. The floor plans of one one-story and one two-story house show these houses to have been about 17 feet wide at the street front.[10] The two-story house extended deeper into the backyard. The most striking feature of the plan was the hall-kitchen com-

[10] *Ibid.*, p. 91.

bination into which one entered directly from the outside. The kitchen was indicated only by the open fireplace which was contained in an alcove-like arrangement off a long hall which extended through the entire length of the building. Later on, there was a tendency to close off the kitchen from the relatively spacious entrance hall. Apart from kitchen and hall, there was one large room on the ground floor, available for general living purposes (Stube), and a smaller room (Kammer), used primarily for sleeping purposes. While these floor plans constituted a first improvement beyond the one-room shacks of poor city dwellers in the early phases of the Middle Ages, they did not measure up to the more intricate and elaborate arrangements of the patrician homes which were located closer to the center of town, and which came into their prime toward the end of medieval urban culture.

These simple abodes extended the institution of home ownership through wide strata of the city population. While ownership was confined, in most cases, to ownership of the building and other improvements, the rent to be paid for the "eternal" lease of the land never attained the exploitative character of apartment rentals in the cities of late antiquity. There was, of course, a class of servants and apprentices and other individuals without property. They were deprived of the privilege of forming households and had to live as best they could in the anti-chambers, the attic rooms, or the special wings given to the servants in the homes of full-fledged citizens.

The wealthy merchants owned the most luxurious city residences. Through a huge portal, large enough to let wagons laden with goods pass, one entered into a tremendous hall which served as a temporary storage space for various commodities which were piled high awaiting either distribution into cellars or special storerooms or preparation for shipment to other cities or the market place. The ground floor, furthermore, contained office space. A counter separated the entrance hall from both storeroom and office, and here goods were checked in or out. The living quarters were confined to the upper floors.

A special wing of the house might have been projected into the courtyard. Here, the ground floor was taken up by the stables. Otherwise, the "back-house" contained the servants' quarters, possibly kitchen or bath-house. The toilet also, if we want to apply this term to the so-called "stink-hole" frequently not emptied for a decade or more, was often located in the rear of the main house. The living quarters proper consisted of smaller or larger rooms, connected with each other in a somewhat haphazard manner, and assigned to specific uses by the scanty furniture of the period. There were no fixtures which committed individual rooms to specific purposes, however, and the entire problem of communications was not systematically planned so as to provide a maximum of privacy where such might have been needed. Rearrangements in the use of rooms easily accommodated changes in family composition.

Domestic luxury of the Middle Ages led to the installment of a bathroom and an adjacent dressing room. These rooms, according to the customs of the times, had a relatively public rather than a private character. Thus we find them frequently on the ground floor where the problem of drainage could be solved more easily. The wine cellar, also, formed an important part of the house. It was accessible through a special entrance from the outside rather than by stairs in the interior of the building. The kitchen, generally, faced the yard and was located on the ground floor at the back of the main structure.

In these patrician mansions, then, we observe some differentiation. The assignment of specific rooms to specific purposes, however, was limited to those parts of the house that provided some sort of public service, in either work or recreation. The living quarters offered an undifferentiated shell—so many rooms of varying size that could be used, like the living space in the early burghs—for different needs.

It is not possible to overemphasize the lack of internalized controls guarding the intimate aspects of family life. The avoidance of cross-traffic through rooms was rarely a matter of serious concern. Genre pictures of the times show us congregations of family members, guests and servants, all in a more or less advanced stage of undress. Doors were flung wide open to any possible intruder. Through the master bedroom one could look into the hall and other chambers. Outsiders could enter the room where the family members were asleep, and, naturally, the simple beds of the servants were frequently located at the foot of the family bedstead.

The furniture was scanty and of a very modest type. Compared with modern conditions, only the beds were more elaborately equipped. This was due to the lack of shelter against intrusions. In bed, at least, the curtains kept the sleeping family out of sight. The canopy had the additional function of protecting the bed against stucco, or possibly vermin, falling from the ceiling. A wash-stand, a low chest, and possibly a chair or two were frequently all the furniture provided in the bedroom. Clothing and linen were stored in a large chest in the hall.

Wood panelling tended to be replaced, toward the end of the Middle Ages, by tapestry for mainly sanitary reasons. While tapestry could be removed and cleaned from time to time, the wood panelling served as a refuge for vermin unless it was ripped out and completely replaced. Glass windows, also, were introduced in the late Middle Ages, but were an expensive luxury item even then. Only shutters, with possibly parchment or paper or oiled linen windows, were available as a protection against the cold. The inadequate heat from the open fireplace was gradually replaced by tile stoves which kept the house comfortably warm even during winter time. In study and library, chairs and desks made their appearance. An important storage space for small utensils was the mantel of the wood panelling. In the window nooks there were bookshelves and simple benches covered with pillows for comfort. All in all, however, the housing luxuries of the times were not aimed at increasing the comforts and conveniences for everyday living; they were dedicated rather to artistic display, to elaborate ornamentation of the limited stock of available furniture, and to the embellishment of plates, utensils, and vessels.

Where wealth permitted, the city dweller provided the family with a garden house outside the walls of the city. There the summers were spent in a relatively pleasant environment far from the heat as well as the stench and the filth of the congested city street.

Progress in living standards advanced all through the course of the Middle Ages, but more so with regard to public rather than to the private aspects of life. To be sure, public needs may have been more urgent. The population pressure of the late Middle Ages, combined with inadequate provisions for sanitary water supply and for the elimination of waste products, caused blatantly intolerable conditions. Thus, from the gradual paving of the streets to restrictions of sewage disposal, to the installment of public toilets, to the elimination of pig-stys from the narrow city streets, to the installment of a plumbing system that piped running water into the individual dwellings, to city ordinances which safeguarded the need for sunlight in the side alleys and to the installation, furthermore, of a system of street lighting, and to the organization of a more efficient machinery for the fighting of fires, the citizenry at least kept in step with some of the needs growing out of the cumulative process of congestion.

We venture to suggest, however, that the direction of improvements was influenced more by the emphasis on public relations rather than the protection of private family interaction. We are confronted with a different culture than our own. Its system of shelter can be fully appreciated only by the consideration of preferences that show a surprising disregard of modern "essentials." The individual arranged himself and his way of life under technological, economic, and social conditions so remote from the contemporary scene as to furnish the foundation of a personality structure that must appear as "strange" to the superficial observer.

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. XXXIII. NAJADACEAE

JAMES G. ROSS AND BARBARA M. CALHOUN

This report is based on specimens from the herbaria of the University of Wisconsin and of the Milwaukee Museum, and from collections by the United States Fish and Wildlife Service as reported by Mr. Neil Hotchkiss. Reports by Mr. Hotchkiss, not supported by specimens, are indicated on the maps by open circles. The authors acknowledge the kindness of Mr. A. M. Fuller of the Milwaukee Museum and Mr. Neil Hotchkiss of the United States Fish and Wildlife Service in providing specimens and data and also express their gratitude to Dr. N. C. Fassett for his help and supervision. Notes on water preference were taken from the "Land Economic Inventory of Northern Wisconsin, Sawyer County," Wisconsin Department of Agriculture and Markets Bulletin, No. 138. 1932. The treatment of linear-leaved and broad-leaved species of Potamogeton follow that of Fernald[1] and Ogden[2] respectively.

Physiographic features controlling distribution of aquatic plants are indicated on Map 22. The solid line encloses the Driftless Area where little standing water occurs except along the Mississippi and the Wisconsin Rivers. The stippled area is the bed of Glacial Lake Wisconsin, where are found many slow streams, reservoirs, etc. The rest of Wisconsin is glaciated, and therefore abounds with small lakes, especially in areas centering on Waukesha County, Vilas County, and Washburn County. Some of these lakes are very limy while others contain very soft water. Therefore a great diversity of species occurs in these areas.

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[1] Fernald, M. L. Mem. Amer. Acad. Arts and Sci. 17 : 1–183. 1932.
[2] Ogden, E. C. Rhodora 45 : 57–105, 119–163, 171–214. 1943.

KEY TO GENERA

1. Leaves alternate, except the uppermost; flowers and fruits in spikes or heads..*Potamogeton.*
1. Leaves opposite; flowers not in spikes or heads.
   2. Seeds tapered to each end and enclosed in a papery envelope....*Najas.*
   2. Seeds enclosed in a fruit coat which is narrowed to a stipe at one end and a slender style at the other end is toothed down one side..*Zannichellia.*

POTAMOGETON

1. Floating leaves usually heart-shaped at base, jointed at attachment to petiole so that they lie flat on the water surface; submersed leaves thickened, semi-terete, narrowly linear
   2. Submersed leaves 0.8–2 mm. wide; fruits with concave sides; spikes 3–6 cm. long; floating leaves mostly 3–10 cm. long. ....23. *P. natans.*
   2. Submersed leaves 0.3–1 mm. wide; fruits with plane sides; spikes 1–3 cm. long; floating leaves 2–5 cm. long....24. *P. Oakesianus.*
1. Floating leaves tapered or rounded at base or absent; submersed leaves flattened or thread-like
   3. Submersed leaves with parallel edges
      4. Stipules fused with the lower part of the leaf to form a sheath
         5. Leaves auricled at base, 3–7 mm. wide and arranged in two ranks as a rigid, flat spray......................4. *P. Robbinsii.*
         5. Leaves not auricled at base, 0.2–3.0 mm. wide, and arranged in a lax, diffuse, branched spray
            6. Sheath formed by fused stipule and leaf at least 1 cm. long; fruit without dorsal keel, the outline of the embryo not visible
               7. Leaves not filiform, 1.0–3.0 mm. wide........2. *P. vaginatus.*
               7. Leaves filiform, 0.2–1.0 mm. wide
                  8. Leaf tips of lower leaves with long tapering points; fruits with a short beak.................3. *P. pectinatus.*
                  8. Leaf tips of lower leaves blunt or rounded; fruits without beaks
                     9. Stems 0.5–1.5 mm. thick; sheaths tight around stem; leaves 3–6 cm. long; flowers in 2–5 whorls ....1. *P. filiformis.*
                     9. Stems 2–3 mm. thick; sheaths large, loose, inflated; leaves 8–18 cm. long; flowers in 4–12 whorls ....2. *P. vaginatus.*
            6. Sheath formed by fused stipule and leaf base not more than 5 mm. long; fruit with more or less prominent dorsal keel, the outline of the embryo plainly visible

10. Submersed leaves linear, 0.5–2 mm. wide, obtuse or acute
    11. Adnate leaf sheath longer than free stipular end ....15. *P. Spirillus.*
    11. Adnate leaf sheath about half the length of free stipular end.........................16. *P. diversifolius.*
10. Submersed leaves setaceous or linear-filiform, 0.1–0.6 mm. wide; adnate leaf sheath less than half the length of the free stipular end..................17. *P. capillaceus.*

4. Stipules free from the leaf
    12. Submersed leaves 0.1–5.0 mm. wide, with cellular-reticulation between inner nerves absent or inconspicuous
        13. Leaves flaccid, linear-setaceous
            14. Stem arising from delicate and branching rootstocks, filiform or slightly compressed, very low and bushy-branched or elongating to 1 m. or more and then remotely branched chiefly below the middle; dimorphic; dilated leaves (when present) coriaceous, from lance- to oval-elliptic in shape..................17. *P. capillaceus.*
            14. Stem arising from filiform extensively creeping rootstock, filiform, freely and repeatedly forking, 1–8 dm. long; not dimorphic....................6. *P. confervoides.*
        13. Leaves not flaccid, though sometimes linear-setaceous
            15. Submersed leaves 9–35-nerved; stem strongly flattened, 0.7–3.2 mm. broad; stipules 1.5–3.5 cm. long. ....7. *P. zosteriformis.*
            15. Submersed leaves 1–7-nerved
                16. Basal glands 0.6–1.2 mm. broad; fruit 2.0–2.3 mm. broad; leaves 2–5 mm. wide, rounded at tip. ....12. *P. obtusifolius.*
                16. Basal glands, if present, 0.2–0.4 mm. broad; fruit 1.2–2.0 mm. broad, leaves 0.1–2.4 mm. wide
                    17. Stipules strongly fibrous, becoming whitish
                        18. Leaves thin, 5–7-nerved, 1.5–3.5 mm. broad, obtuse or rounded and mucronate at tip; stipules 7–11 mm. long; peduncles flattened, 1.5–5 cm. long.........................9. *P. Friesii.*
                        18. Leaves firm, often revolute, 3 (rarely 5)-nerved, 0.5–2.5 mm. broad, obtuse to sharply attenuate; stipules 0.8–2 cm. long; peduncles filiform, enlarged at tip, 1–9 cm. long
                            19. Leaves mostly rigid, obtuse or abruptly contracted to mucronate tips ....10. *P. strictifolius* var. *typicus.*
                            19. Leaves firm, scarcely rigid, very gradually tapering to a slender tip; stipules less strongly fibrous..10. *P. strictifolius* var. *rutiloides.*

17. Stipules soft, greenish, membraneous to subherbaceous
  20. Primary submersed leaves 0.1–0.5 mm. wide, without lacunae bordering midrib, the two lateral nerves visible only under high magnification; plants dimorphic; fruiting plants with upper floating dilated leaves elliptic or narrowly obovate; sterile plants with only linear-filiform submersed leaves..............14. *P. Vaseyi.*
  20. Primary submersed leaves 0.3–2.4 mm. wide, with one or more rows of lacunae bordering the midrib, except in *P. foliosus*, 1–3 nerves plainly visible; plants not dimorphic
    21. Leaf bases usually without glands; leaves without lacunae bordering the midrib, except sometimes near the base; sepaloid connectives 0.4–1.0 mm. long; fruit with rather coarse dentate sometimes prominent keels
      22. Stems 0.2–1 m. long, subsimple to loosely branched; leaves deep green to bronze; the primary leaves 4–10 cm. long, 1.4–2.8 mm. broad, 3–5 nerved....8. *P. foliosus* var. *genuinus.*
      22. Stems 0.6–6 dm. long, commonly bush-branched; leaves bright green, the primary leaves 1–8 cm. long, 0.3–1.5 mm. broad, 1–3 nerved..........8. *P. foliosus* var. *macellus.*
    21. Leaf bases commonly with a pair of glands; the leaves usually with 1–several rows of lacunae bordering the midrib; sepaloid connectives 1–2 mm. long; fruit rounded on the back or obscurely keeled
      23. Stipules connate, forming cylinders with margins united at least below the middle, in age rupturing and often shredded at tip; lacunae absent or nearly so in all but upper leaves; spikes interrupted, 6–12 mm. long with 3–5 whorls; winter buds both axillary and terminal............11. *P. pusillus.*
      23. Stipules not connate, tending to be flat toward tip, convolute; lacunae bordering midrib well-developed; spike continuous, 2–8 mm. long, of 1–3 whorls; winter buds all at the tips of branches
        24. Leaf tips subacute to sharply pointed
          25. Midrib of principal leaves (below the involucral leaves) bordered on each side by 1 or 2 rows of lacunae

26. Primary leaves of the principal stems 0.5–1.5 mm. wide, with well-defined lacunae often in rows each side of the midrib in the lower half of the leaf.............13. *P. Berchtoldi.*
26. Primary leaves 0.3–1 mm. wide, with a single row of frequently evanescent lacunae each side of the midrib..13. *P. Berchtoldi* var. *tenuissimus.*
25. Midrib of principal leaves bordered on each side by 3–5 bands of coarse lacunae.....13. *P. Berchtoldi* var. *lacunatus.*
24. Leaf tips mostly rounded or obtuse, midrib bordered on each side by 1 row (sometimes 2 at base) of lacunae; foliage mostly dark to light green
27. Principal leaves 3–7 cm. long. ....13. *P. Berchtoldi* var. *mucronatus.*
27. Principal leaves 0.8–2.5 cm. long. ....13. *P. Berchtoldi* var. *polyphyllus.*
12. Submersed leaves 1–10 mm. wide, delicate and ribbon-like, more or less distichous, the broad space between the inner nerves conspicuously cellular-reticulate
28. Submersed leaves 0.5–10 mm. wide, 7–13-nerved, not conspicuously distichous........18. *P. epihydrus* var. *typicus.*
28. Submersed leaves 0.2–0.8 mm. wide, (3-) 5–7-nerved, strongly distichous and rather crowded on new shoots. ....18. *P. epihydrus* var. *Nuttallii.*
3. Submersed leaves lanceolate, elliptical to ovate
29. Floating leaves with 30–50 nerves, or rarely absent; submersed leaves arcuate, 0.8–2 dm. long and 2.5–7 cm. broad; petioles of submersed leaves 1–6 cm. long; endodermis of O-cells....................................21. *P. amplifolius.*
29. Floating leaves with less than 30 nerves, or absent; submersed leaves smaller
30. Margins of leaves dentate........................5. *P. crispus.*
30. Margins of leaves entire
31. Base of leaf clasping stem; endocarp loop with cavity; leaves all submersed
32. Stipules whitish, inconspicuous, disintegrating to stringy fibers; endodermis of O-cells....28. *P. Richardsonii.*
32. Stipules whitish, conspicuous, persistent, rounded at tip; endodermis of U-cells..............27. *P. praelongus.*
31. Base of submersed leaf not clasping stem; endocarp loop solid; leaves both floating and submersed

33. Flowers on short pedicels 0.5–1 mm. long; apex of submersed leaves obtuse, never sharp-pointed, usually with 7 prominent nerves; endodermis of O-cells; floating leaves tapering to petioles 1–3 cm. long; stipules of submersed leaves thin and membranous, becoming shredded, although base is quite persistent; dorsal keel of fruit thin, well-developed upward, and lateral keel none or very low

34. Submersed leaves oblong-linear to linear-lanceolate, 7–25 cm. long, usually more than 8 times as long as broad, tapering to an obtuse or acutish apex ....19. *P. alpinus* var. *tenuifolius.*

34. Submersed leaves oblong to ovate-oblong, 4–10 cm. long, usually less than 8 times as long as broad, apex rounded and sometimes slightly cucullate ....19. *P. alpinus* var. *subellipticus.*

33. Flowers sessile; apex of submersed leaves usually acute, sharp-pointed to mucronate; bases of floating leaves rounded or cuneate; keel of fruit strongly prominent grey-green to olive-green

35. Stipules of submersed leaves firm, persistent; endodermis of U-cells

36. Petioles of floating leaves 2–9 cm. long, shorter than blade; submersed leaves 9–17-nerved, with lacunae in 2–5 rows along midrib.....25. *P. illinoensis.*

36. Petioles of floating leaves 2–10 (–15) cm. long, mostly longer than blade; submersed leaves with 3–9 nerves, with lacunae in 1–2 rows, mostly obscure

37. Principal submersed leaves narrowly elliptic to oblanceolate, (1–) 1.5–9 (–13) cm. long, 0.2–1 (–1.5) cm. wide, 5–10 times as long as broad, or if more than 10 times, then not less than 6 cm. long, sides not parallel; nerves (3–) 5–9

38. Principal submersed leaves (1–) 1.5–4.5 (6.5) cm. long, 0.2–0.6 (–0.8) cm. wide; 5–7-nerved..........26. *P. gramineus* var. *typicus.*

38. Principal submersed leaves (3–) 6–9 (–13) cm. long, 0.6–1 (–1.5) cm. wide; nerves 7–9 (–11).............26. *P. gramineus* var. *maximus.*

37. Principal submersed leaves linear, (1–) 1.5–3.5 (–5.5) cm. long, 0.1–0.25 (–0.3) cm. wide, 10–20 (–30) times as long as broad, sides essentially parallel for most of their length, tapering at apex to an acute tip; nerves 3 ....26. *P. gramineus* var. *myriophyllus.*

35. Stipules of submersed leaves decaying early, except sometimes semi-persistent in *P. nodosus;* endodermis of O-cells
    39. Stem without conspicuous spots; floating leaves elliptical; submersed leaves 7–15-nerved, with lacunae of 2–5 rows along midrib, petioles 2–13 cm. long; stipules brown and linear.....22. *P. nodosus.*
    39. Stem conspicuously spotted; floating leaves more rotund and ovate; submersed leaves (9–) 11–21-nerved with petioles up to 1.5 cm. long; stipules of floating leaves persistent, triangular..20. *P. pulcher.*

1. P. FILIFORMIS Pers. var. BOREALIS (Raf.) St. J. Map 1.

Collected in Wisconsin at only three stations always in very shallow water: near Oconomowoc in Waukesha County, Kangaroo Lake in Door County, and Trout Lake in Vilas County.

2. P. VAGINATUS Turcz. Map 2.

Collected in shallow water of Lake Mendota in University Bay and also in Marquette County near Montello.

3. P. PECTINATUS L. Map 3.

Widely distributed in southeastern, eastern central, and in the northwestern parts of the state, in shallow water of medium-hard and hard-water lakes and streams. Its abundant fruits form a valuable food for water-fowl.

4. P. ROBBINSII Oakes. Map 4, dots.

Abundant in the northern part of the state and occurring occasionally in the eastern half in either hard or soft water.

P. ROBBINSII Oakes. f. CULTELLATUS Fassett. Map 4, crosses.

Collected at only two points, in Douglas and Waukesha Counties. This form differs from *P. Robbinsii* in having non-serrate leaf margins. See Fassett, Rhodora 35 : 388–389. 1933.

5. P. CRISPUS L. Map 5.

Introduced from Europe, found only in Walworth, Dane, and Trempealeau counties in Wisconsin, collected first in 1905.

6. P. CONFERVOIDES Reichenb. Map 5, cross.

Collected once in Wisconsin, in Langlade County in a lake lying in drift of Fourth Wisconsin glaciation.[8] It occurs other-

[8] Fassett, N. C. Rhodora 36 : 349. 1934.

wise only in the area extending from Newfoundland south to New York, New Jersey and Pennsylvania. See Fernald, Rhodora 33 : 44–46. 1931, and Mem. Gray Herbarium 3 : 32–36, 1932.

7. P. ZOSTERIFORMIS Fern. Map 6.

Locally abundant in ponds and quiet streams of eastern and northern Wisconsin.

8. P. FOLIOSUS Raf. var. GENUINUS Fern. Map 7, crosses.

In medium hard, fresh or brackish water, occurring sparsely in eastern and northern Wisconsin.

P. FOLIOSUS Raf. var. MACELLUS Fern. Map 7, dots.

Chiefly in calcareous waters, abundant in the south-central area and sparsely in the north.

9. P. FRIESII Rupr. Map 8.

Fairly frequently found in calcareous or brackish water in southeastern Wisconsin; also collected in Brown and Door counties as well as northwestward in Forest and Douglas counties.

10. P. STRICTIFOLIUS Ar. Benn. var. TYPICUS Fern. Map 9, dots.

In calcareous waters; collected only once in each of Douglas, Bayfield and Door counties.

P. STRICTIFOLIUS Ar. Benn. var. RUTILOIDES Fern. Map 9, crosses.

Rare throughout southeastern and northeastern Wisconsin, mainly in alkaline waters.

11. P. PUSILLUS L. *P. panormitanus* Biv.; see Dandy and Taylor, Journ. Bot. 76 : 90–92. 1938. Map 10.

Prefers slightly alkaline waters; occurs occasionally in eastern and northern Wisconsin.

12. P. OBTUSIFOLIUS Mert. and Koch. Map 11, dots.

In cold streams and lakes of northeastern Wisconsin. Collected in Oneida, Sawyer, Douglas and Bayfield counties.

13. P. BERCHTOLDI Fieber. *P. pusillus* of authors; see Fernald. Rhodora 42 : 246. 1940. Map 13.

Occurs throughout northern Wisconsin, occasionally in hardwater lakes.

P. BERCHTOLDI var. TENUISSIMUS (Mert. and Koch) Fern. Map 14.

Grows in soft to hard water; occurs in Lake Mendota, Dane County, and occasionally northward through the middle of Wisconsin, also in the northwest.

P. BERCHTOLDI var. LACUNATUS (Hagström) Fern. Map 15.

Collected at three points in northern Wisconsin.

P. BERCHTOLDI var. MUCRONATUS Fieber. Map 16.

Fairly abundant in the northwestern area, collected once in Crawford County in the southwest.

P. BERCHTOLDI var. POLYPHYLLUS (Morong) Fern. Map 17.

Rare, collected only in Douglas, Washburn, Langlade and in Jefferson counties. These varieties of *P. Berchtoldi* have the essentially same range in Wisconsin and very similar general ranges.

14. P. VASEYI Robbins. Map 11, crosses.

Rare, along the Wisconsin River basin in lakes whose waters flow into that river or were at one time connected with it. A species closely related to *P. Vaseyi* occurs both in Michigan and in Minnesota but is not known in Wisconsin. This is *P. lateralis* Morong, differing from *P. Vaseyi* in having fruiting plants with linear submersed leaves and sterile (but often flowering) plants with floating leaves, the opposite of the case in *P. Vaseyi.* The leaves of *P. lateralis* are 0.4–1 mm. wide while the leaf width of *P. Vaseyi* varies from 0.3–0.5 mm. More detailed differences are given by Fernald in his monograph of linear-leaved species.

15. P. SPIRILLUS Tuckerm. Map 18, dots.

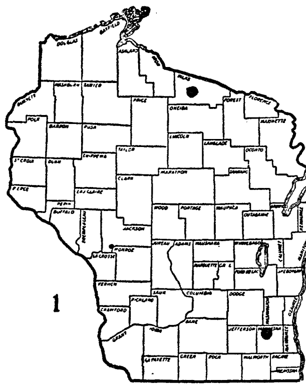
Along the Wisconsin River in Portage and Lincoln Counties and northwestward in shallow waters of ponds, lakes, and quiet streams.

16. P. DIVERSIFOLIUS Raf. Map 18, crosses.

A southern species, found chiefly along the Mississippi and Chippewa rivers.

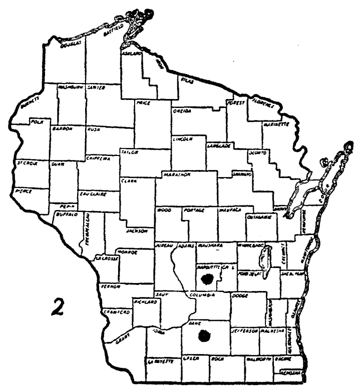
17. P. CAPILLACEOUS Poir. Map 12.

A coastal plain, shallow-water species. Rare in Wisconsin, found occasionally in soft water lakes of Adams, Juneau, Jackson and Sawyer counties.



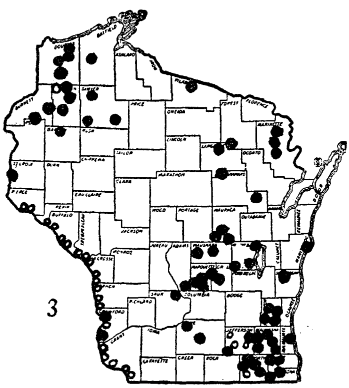
1

Potamogeton filiformis var. borealis



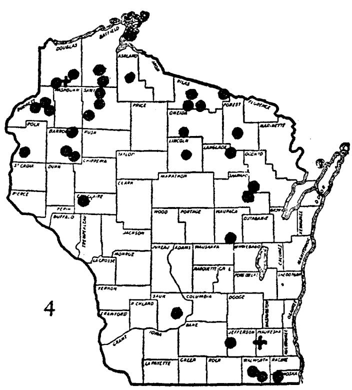
2

Potamogeton vaginatus



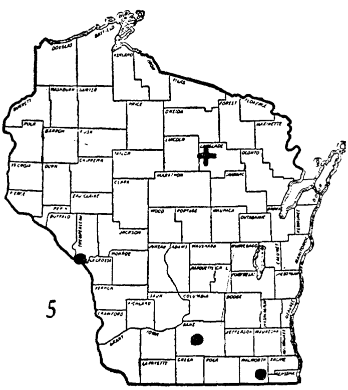
3

Potamogeton pectinatus



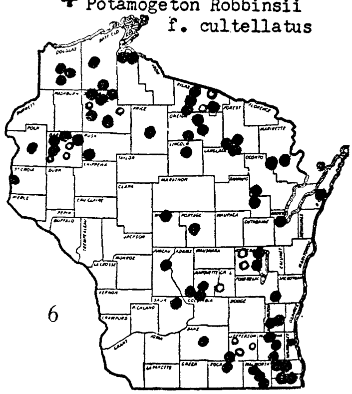
4

● Potamogeton Robbinsii
✚ Potamogeton Robbinsii f. cultellatus



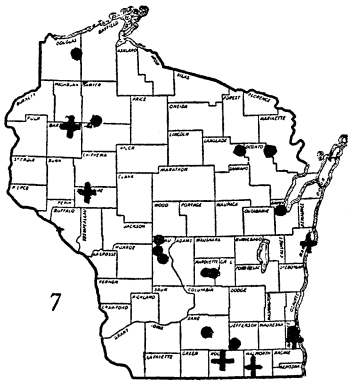
5

● Potamogeton crispus
✚ Potamogeton confervoides



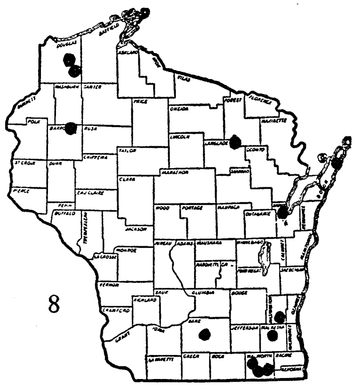
6

Potamogeton zosteriformis



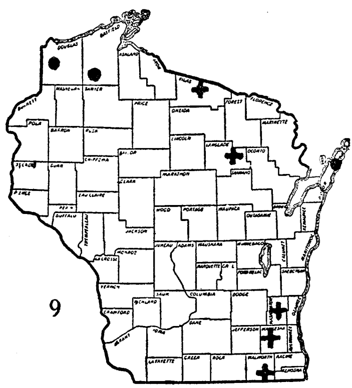
7

✚ Potamogeton foliosus var. genuinus
● Potamogeton foliosus var. macellus



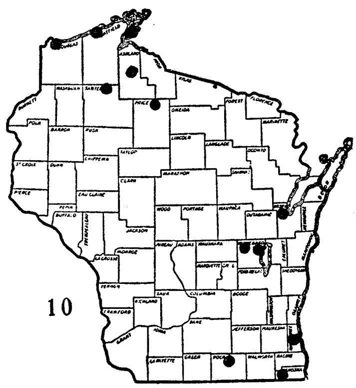
8

Potamogeton Friesii



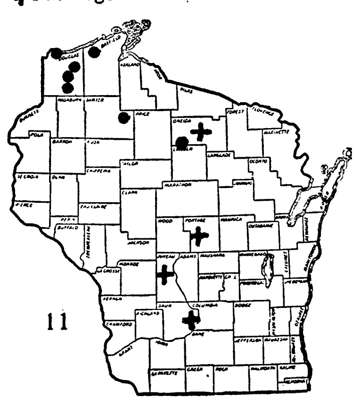
9

● Potamogeton strictifolius var. typicus
✚ Potamogeton strictifolius var. rutiloides



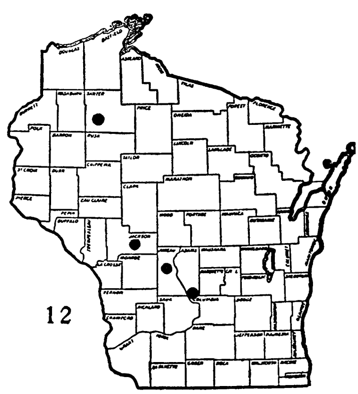
10

Potamogeton pusillus



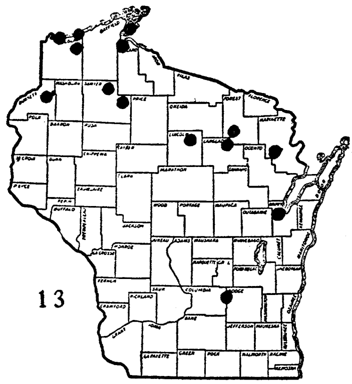
11

● Potamogeton obtusifolius
✚ Potamogeton Vaseyi



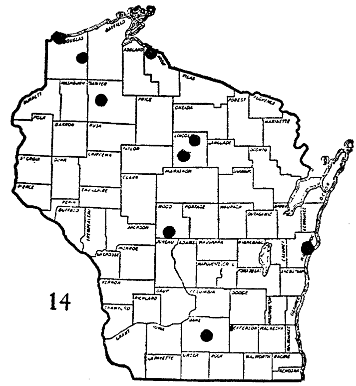
12

Potamogeton capillaceus



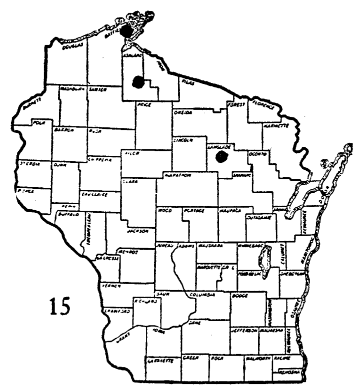
13

Potamogeton Berchtoldi



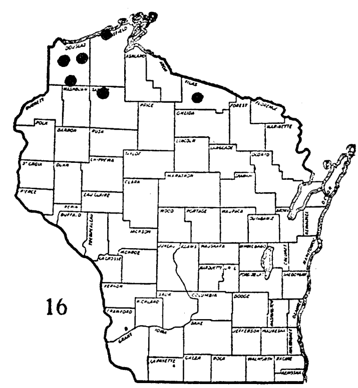
14

Potamogeton Berchtoldi
var. tenuissimus



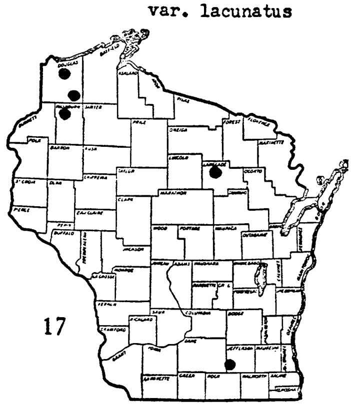
15

Potamogeton Berchtoldi
var. lacunatus



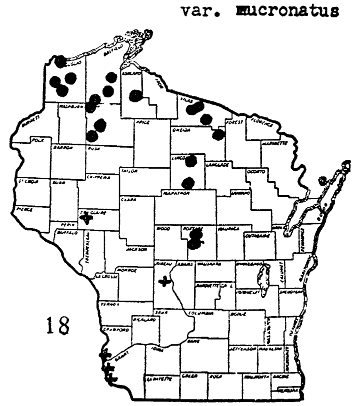
16

Potamogeton Berchtoldi
var. mucronatus



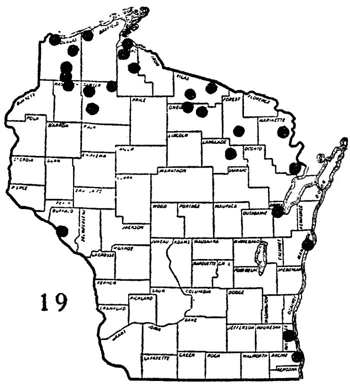
17

Potamogeton Berchtoldi
var. polyphyllus



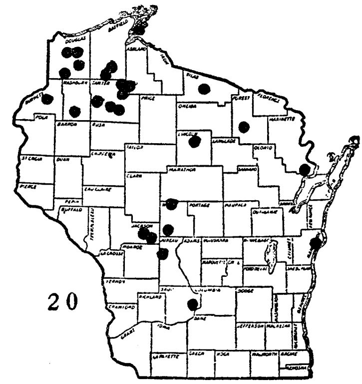
18

✚ Potamogeton diversifolius
● Potamogeton Spirillus



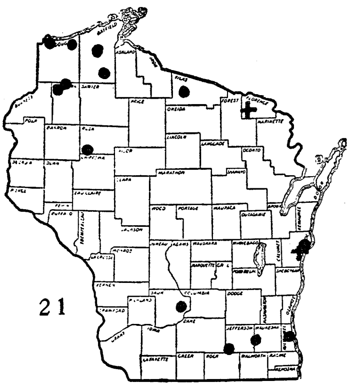
19

Potamogeton epihydrus var. typicus



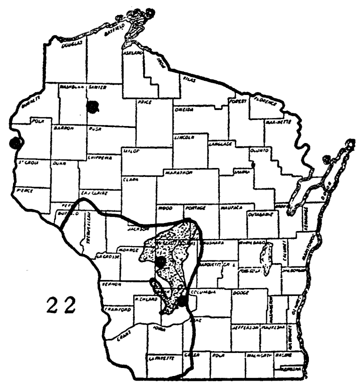
20

Potamogeton epihydrus var. Nutallii



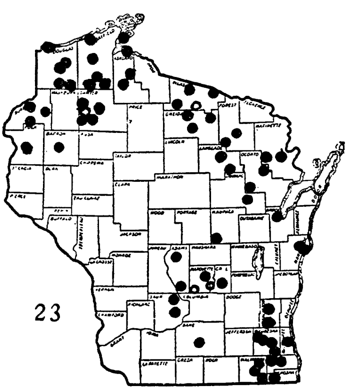
21

● Potamogeton alpinus var. tenuifolius
✚ Potamogeton alpinus var. subellipticus



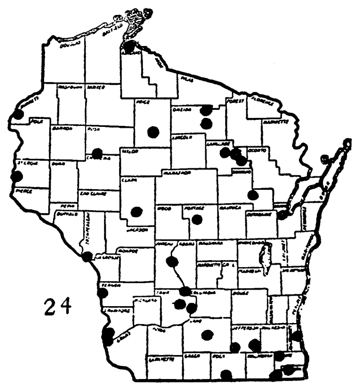
22

Potamogeton pulcher



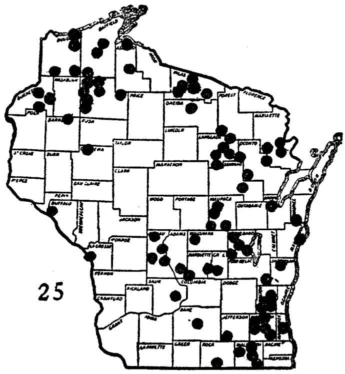
23

Potamogeton amplifolius



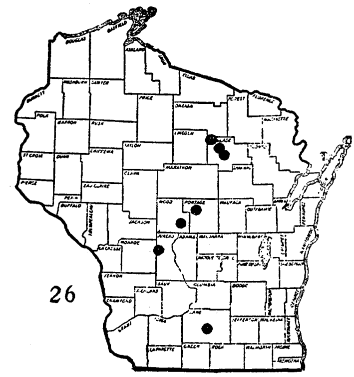
24

Potamogeton nodosus



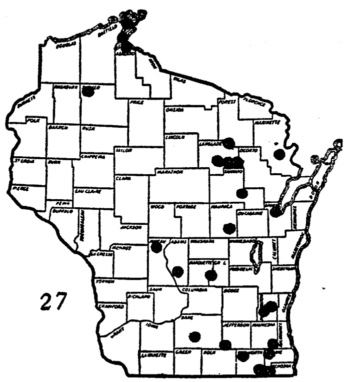
25

Potamogeton natans



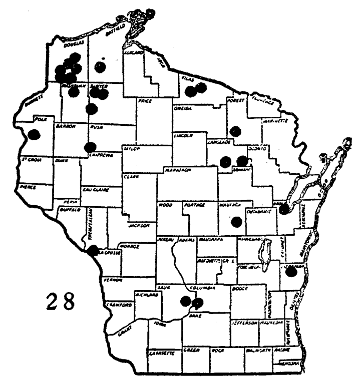
26

Potamogeton Oakesianus



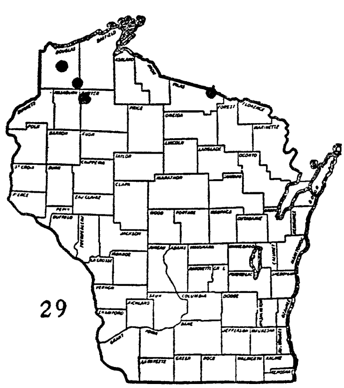
27

Potamogeton illinoensis



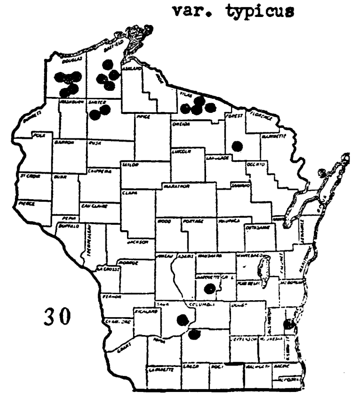
28

Potamogeton gramineus var. typicus



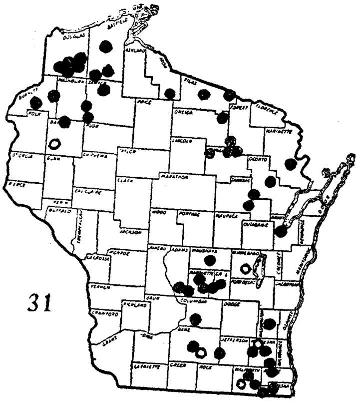
29

Potamogeton gramineus var. maximus



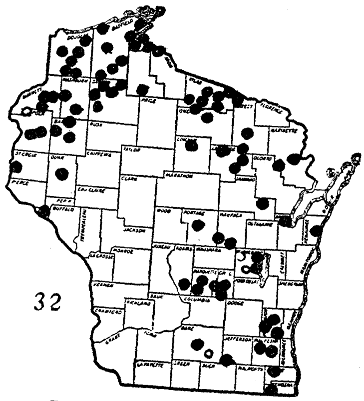
30

Potamogeton gramineus var. myriophyllus



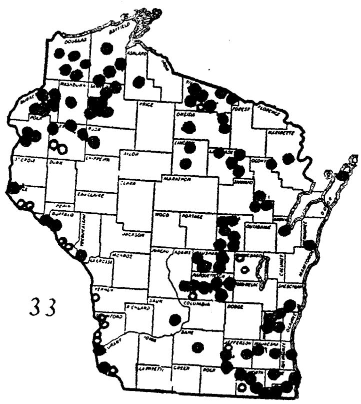
31

Potamogeton praelongus



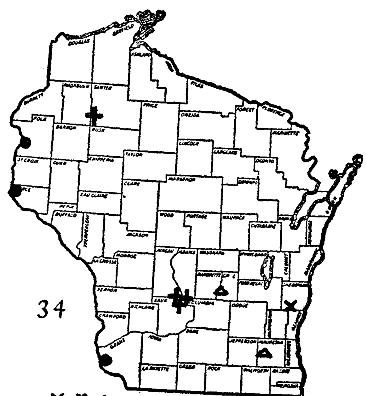
32

Potamogeton Richardsonii



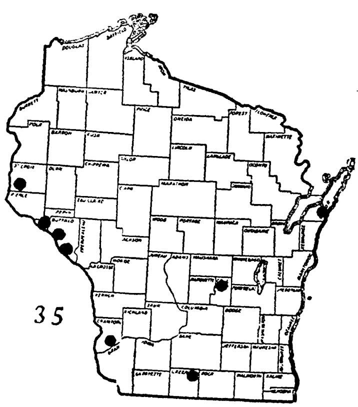
33

Najas flexilis



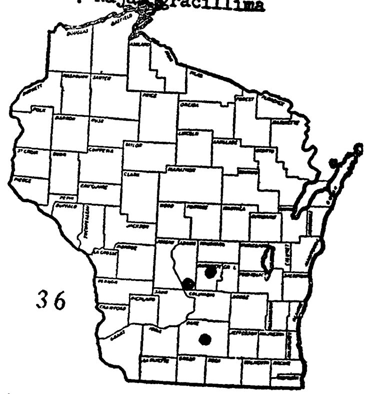
34

× Najas marina
△ Najas olivacea
● Najas guadalupensis
+ Najas gracillima



35

Zannichellia palustris



36

Zannichellia palustris var. major

18. P. EPIHYDRUS Raf. var. TYPICUS Fern. Map 19.

Common in the north and occasionally in the east near the Lake Michigan shore, also collected in Sauk and Buffalo counties. This species grows both in soft and hard water lakes.

P. EPIHYDRUS Raf. var. NUTALLII (C. and S.) Fern. Map 20.
Common in north and occasionally in central Wisconsin.

19. P. ALPINUS var. TENUIFOLIUS Raf. Map 21, dots.

Sparsely distributed in northwestern and southeastern parts of the state.

P. ALPINUS var. SUBELLIPTICUS (Fern.) Ogden. Map 21, crosses.
Collected only in Florence and Manitowoc counties.

20. P. PULCHER Tuckerm. Map 22.

This species is not cited from Wisconsin by Ogden, Rhodora 45 : 121–122. 1943, although the dot on Map 6 of his paper (page 127) representing Taylors Falls, Minnesota, appears as if in Wisconsin. This station is indicated on our Map 22 just east of Polk County.

The range of *P. pulcher* in Wisconsin (and in eastern Minnesota) appears to be related in some way to preglacial and early post glacial history. Its occurrence in company with other uncommon species in Holly Lake, Sawyer County has already been discussed.[4] It occurs in Sauk County in the bed of Glacial Lake Wisconsin, in a stream in Baxter's Hollow, in the unglaciated portion of the Baraboo Hills. In Juneau County it is found in the bed of Glacial Lake Wisconsin, in reservoirs maintained for cranberry culture.[5] The possibility of its introduction with cranberry stock from the east appears remote in light of the rest of its distribution in Wisconsin.

21. P. AMPLIFOLIUS Tuckerm. Map 23.

Usually in deep, hard water, common and abundant in eastern and northern Wisconsin.

22. P. NODOSUS Poir. Map 24.

Also known as *P. americanus* C. and S. Usually in flowing water; common along the Mississippi and Wisconsin Rivers and occasionally elsewhere throughout the state.

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[4] Fassett, N. C. Rhodora 36 : 350–351. 1934.
[5] Catenhusen, John. Trans. Wis. Acad. 36 : 165. 1944.

23. P. NATANS L. Map 25.

Tolerant of waters with a large range of pH; abundant in shallow waters of lakes and streams throughout eastern and northern Wisconsin, also at two points near the Mississippi, at La Crosse and near the mouth of the Chippewa River. Because of its tendency to fruit freely it is one of the primary foods for water-fowl.

24. P. OAKESIANUS Robbins. Map 26.

Not widely distributed, found in shallow water of stream near Madison, Dane County and at one point in each of Wood, Juneau, Portage and Langlade counties.

25. P. ILLINOENSIS Morong. Map 27.

Including *P. lucens* and *P. angustifolia* of American authors. Sparsely scattered throughout eastern and northern Wisconsin.

26. P. GRAMINEUS L. var. TYPICUS Ogden. Map 28.

Fairly abundant in the north but very rare elsewhere.

P. GRAMINEUS var. MAXIMUS Robbins. Map 29.

Very rare in northern Wisconsin.

P. GRAMINEUS var. MYRIOPHYLLUS Robbins. Map 30.

Moderately abundant in some areas in the north but found only at one station in each of Marquette, Sauk, Dane and Ozaukee counties in the south.

27. P. PRAELONGUS Wulfen. Map 31.

Usually in medium-hard water; fairly common in eastern and northern Wisconsin.

28. P. RICHARDSONII Ar. Benn. Map 32.

Commonly found in medium-hard-water lakes in eastern and northern Wisconsin. *P. bupleuroides* was reported from northern Wisconsin by Fassett, Rhodora 29 : 228. 1927, but the material seems rather to belong with *P. Richardsonii.*

NAJAS

1. Leaves coarsely toothed, the teeth visible to the naked eye; backs of leaves often spiny; fruits 4–5 mm. long.................. *N. marina.*
1. Leaves with fine teeth, usually visible only under a lens; backs of leaves not spiny; fruits 2–3.5 (–4.5) mm. long
   2. Widenings of leaf bases tapered

3. Style 1 mm. or more long; seed very finely and obscurely marked with 30–40 rows of pits across the middle, usually shining
    4. Leaves 1.5–4 cm. long, 0.5–1 mm. wide at base above the lobes, gradually tapered to the tip; seed shining....... *N. flexilis.*
    4. Leaves 9–18 mm. long, 1.2–2 mm. wide, abruptly pointed; seed dull.. *N. olivacea.*
3. Style 0.5 mm. or less long; seed dull, coarsely and deeply pitted with 10–20 rows of pits across the middle... *N. guadalupensis.*

2. Widenings of leaf bases lobe-like, wedge-shaped and coarsely jagged, leaf blades thread-like, finely toothed........... *N. gracillima.*

1. N. MARINA L. Map 34, X.

Collected at one station in Wisconsin, Random Lake, Sheboygan County.

2. N. FLEXILIS (Willd.) Rostk. and Schmidt. Map 33.

Common in the shallows of medium to hard water lakes in the eastern and northern areas of Wisconsin.

3. N. OLIVACEA Rosendahl and Butters. Map 34.

Two collections in Wisconsin have been identified by Professor Rosendahl as probably belonging to this species. Since mature fruit is not present, identification could not be made with certainty.

4. N. GUADALUPENSIS (Spreng.) Morong. Map 34, dots.

In Wisconsin this species has been collected at only three stations along the Mississippi River. These are either in the shallows or in adjacent lakes.

5. N. GRACILLIMA (A. Br.) Morong. Map 34, crosses.

Collected near Wisconsin Dells and once in Sawyer County. See Fassett, Rhodora 38 : 348–350. 1934.

ZANNICHELLIA

1. Z. PALUSTRIS L. Map 35.

Stems numerous and thread-like, from extensively creeping root-stocks; fruits in bunches of 2–5, scarcely stalked, the body 2–2.5 mm. long. Hard to brackish water; along the Mississippi and Wisconsin river basins, not common.

2. Z. PALUSTRIS var. MAJOR (Boenn.) Koch. Map 36.

Fruit longer stalked, the body 2.5–3 mm. long. Though found chiefly along the Atlantic Coast, it has been collected in Adams, Marquette, and Dane counties in Wisconsin.

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. XXXVI. SCROPHULARIACEAE

PETER J. SALAMUN

The following maps were compiled from the material in the herbaria of the Milwaukee Public Museum and the University of Wisconsin, together with supplementary specimens collected during the past year. Grateful acknowledgment is made to Mr. Albert M. Fuller, curator of the herbarium of the Milwaukee Public Museum; to Mr. James H. Zimmerman and Mr. Robert S. Ellarson for their contributions of flowering specimens; to Mr. James G. Ross for his assistance in the field; to Mrs. Margaret S. Bergseng for her criticisms and suggestions regarding the report; and to Dr. N. C. Fassett for his assistance and advice in the preparation of this report as well as for his critical reading of the manuscript. This paper is incidental to the work of the writer as a research assistant under a grant from the Wisconsin Alumni Research Foundation.

The nomenclature of genera and species is, with few exceptions, that of the Scrophulariaceae of Eastern Temperate North America, by Dr. Francis W. Pennell.[1] Although Dr. Pennell's monograph has been used extensively in the preparation of this report, it has seemed preferable to use the term "variety" for a geographic subdivision of a species rather than the term "subspecies." Where authorities other than those mentioned in this book are used, reference to them has been included in the text. Additional specimens which were cited by Dr. Pennell are also included in the maps, but the symbols used are plotted in outline only. Also included are habitats and the dates of flowering in Wisconsin.

[1] The Academy of Natural Sciences of Philadelphia. Monographs Number 1, 1935.

KEY TO GENERA

(Specimens with Flowers)

a. Fertile stamens *5* .... 1. *Verbascum.*
a. Fertile stamens *2* or *4*
  b. Corolla spurred on lower side at the base
    c. Leaves narrowly linear to lanceolate or spatulate-linear, entire; plants erect
      d. Leaves narrowly linear to lanceolate, alternate, sessile; pedicels 2–6 mm. long .... 2. *Linaria.*
      d. Leaves spatulate-linear, opposite, with short petioles; pedicels about 1 cm. long .... 4. *Chaenorrhinum.*
    c. Leaves reniform-orbicular, toothed or lobed; plant climbing or trailing .... 3. *Cymbalaria.*
  b. Corolla not spurred on lower side at the base
    e. Fertile stamens *2*
      f. Stamens exserted; corolla rotate or salver-form; capsule somewhat flattened
        g. Corolla-lobes much shorter than the tube; capsule acute, much longer than wide; leaves in whorls of 3–6. .... 12. *Veronicastrum.*
        g. Corolla-lobes nearly as long or longer than the tube; capsule rounded or notched, slightly if at all longer than wide; leaves opposite, rarely ternate, or alternate
          h. Plants with a basal rosette of large, long-petioled leaves; corolla yellow, lobes projecting; cauline leaves alternate .... 14. *Besseya.*
          h. Plants without a basal rosette of long-petioled leaves; corolla purplish or white, lobes spreading; cauline leaves opposite (bract-leaves in upper portion of stem sometimes alternate) .... 13. *Veronica.*
      f. Stamens included; corolla definitely 2-lipped; capsule not flattened
        i. Sterile filaments short or lacking; calyx usually subtended by 2 bracts, exceeding in length the calyx-lobes; leaves lanceolate, narrowed to the base, or if broad at the base, with minute dots .... 11. *Gratiola.*
        i. Sterile filaments nearly equalling the fertile pair in length; calyx not subtended by long bracts; leaves mostly ovate, broadest usually at the base and without minute dots .... 10. *Lindernia.*
    e. Fertile stamens *4*
      j. Leaves alternate
        k. Galea short or absent; cauline leaves sessile
          l. Stem-leaves bract-like; basal leaves oval to orbicular, on long petioles .... 14. *Besseya.*
          l. Stem-leaves with long ribbon-like lobes; basal leaves, if present, lobed, sessile .... 19. *Castilleja.*

k. Lateral lobes of corolla fused into a galea, exceeding in length the lower lobes; cauline leaves petioled..21. *Pedicularis.*

j. Leaves opposite or whorled

m. Leaves and bracts narrowly linear or linear-lanceolate to filiform, entire..............................17. *Gerardia.*

m. Leaves broad and flat, toothed or lobed

n. Calyx prismatic, 5-angled......................9. *Mimulus.*

n. Calyx not as above

o. Margins of leaves serrate, toothed, or sometimes entire to slightly fringed at the base, never pinnatifid or lobed

p. At least the uppermost stem-leaves sessile and clasping by a broad base

q. Sterile stamen conspicuous, as long or longer than the fertile ones; bearded; all stem-leaves sessile and clasping...................7. *Penstemon.*

q. Sterile stamen inconspicuous, not bearded; lowermost stem-leaves narrowed to the base or petioled...............................5. *Collinsia.*

p. All stem-leaves petioled, or, if sessile, narrowed to the base

r. Leaves and bracts entire or with a few bristly teeth at the base..................20. *Melampyrum.*

r. Leaves toothed

s. Corolla maroon; leaves ovate-lanceolate, coarsely toothed....................6. *Scrophularia.*

s. Corolla white or rose-purple; leaves lanceolate, serrate; corolla imbricated with rounded overlapping concave bracts.................8. *Chelone.*

o. At least some of the cauline leaves lobed

t. Lateral lobes of the corolla fused into a galea, exceeding in length the lower lobes.........21. *Pedicularis.*

t. Corolla-lobes not as above, or if a galea present, not exceeding the lower lobes

u. Upper stem-leaves with a few basal lobes

v. Corolla purple; leaves sessile, with lobes oblong-lanceolate..................18. *Tomanthera.*

v. Corolla white with yellow palate; leaves petioled, with lobes tooth-like or long-pointed. ....20. *Melampyrum.*

u. Upper stem-leaves without lobes, or all pinnately lobed

w. Anthers glabrous; both anterior and posterior stamens of nearly equal length; upper stem-leaves ovate-lanceolate, entire to serrate, lower ones lobed...................16. *Dasistoma.*

w. Anthers villose; posterior stamens exceeding anterior stamens in length; upper and lower stem-leaves more or less pinnately lobed. ....15. *Aureolaria.*

KEY TO GENERA

(Based on Vegetative Characters)

a. Cauline leaves alternate
  b. Leaves narrowly linear to lanceolate, entire..............2. *Linaria.*
  b. Leaves lanceolate to oblong-lanceolate, toothed or lobed, or if entire more than 1 cm. wide
    c. Cauline leaves sessile (basal leaves sometimes petioled)
      d. Leaves with ribbon-like lobes....................19. *Castilleja.*
      d. Leaves toothed or shallowly lobed
        e. Plants usually 1–4 dm. tall; cauline leaves bract-like, less than 2.5 cm. long................................14. *Besseya.*
        e. Plants usually 0.5–1.5 m. tall; cauline leaves lanceolate to oblong-lanceolate, usually more than 3 cm. long..1. *Verbascum.*
    c. Cauline leaves petioled
      f. Plants erect; leaves lanceolate...................21. *Pedicularis.*
      f. Plants climbing or trailing; leaves reniform-orbicular. ....3. *Cymbalaria.*
a. Cauline leaves opposite or whorled (upper bract-leaves sometimes alternate)
  g. Leaves narrowly linear to spatulate-linear, entire, usually less than 5 mm. wide
    h. Leaves with short petioles, spatulate-linear; stem with gland-tipped hairs.................................4. *Chaenorrhinum.*
    h. Leaves sessile, narrowly linear to linear-lanceolate or tapered toward the tip; stem glabrous to scabrous
      i. Leaves usually less than 5 mm. long, clasping by a broad base and tapered toward the tip; plants wholly submersed. ....11. *Gratiola.*
      i. Leaves usually 1 cm. or more long, linear to linear-lanceolate, not clasping; plants emersed or terrestrial.....17. *Gerardia.*
  g. Leaves linear-lanceolate, sometimes ribbon-like, to orbicular, toothed or lobed, or if entire more than 5 mm. wide
    j. Cauline leaves toothed, sometimes entire or undulate, but never lobed
      k. Leaves 3–6 in a whorl.......................12. *Veronicastrum.*
      k. Leaves opposite or rarely ternate
        l. Upper bract-leaves alternate....................13. *Veronica.*
        l. Upper bract-leaves opposite
          m. Stems prostrate except near the tip; leaves oval to nearly reniform, wavy-margined..............9. *Mimulus.*
          m. Stems erect; leaves usually linear-lanceolate to ovate, remotely toothed
            n. Leaves sessile at least in the upper portion of the stem, sometimes petioled or nearly so in the lower portion

o. Leaves, at least in the lower portion of the stem, with narrow bases or petioled; those in the upper portion sometimes with broad clasping bases
p. Upper stem-leaves with broad and more or less clasping bases
q. Lowermost leaves, including the petioles, usually more than 2.0 cm. long, ovate, long-petioled, to cuneate....................5. *Collinsia.*
q. Lowermost leaves, including the petioles, usually less than 2.0 cm. long, ovate, short-petioled.............................10. *Lindernia.*
p. Upper and lower stem-leaves with narrow bases
r. Leaves lanceolate, less than 5 times as long as broad................................11. *Gratiola.*
r. Leaves narrowly linear or linear-lanceolate, more than 5 times as long as broad....13. *Veronica.*
o. All stem-leaves with broad and more or less clasping bases
s. Leaves covered with minute glandular dots. ....11. *Gratiola.*
s. Leaves without glandular dots
t. Leaves ovate, usually less than 2.5 cm. long. ....10. *Lindernia.*
t. Leaves lanceolate to lanceolate ovate, usually more than 3 cm. long
u. Stems 4-angled.....................9. *Mimulus.*
u. Stems terete
v. Basal leaves present, with long petioles; plants terrestrial................7. *Penstemon.*
v. Basal leaves usually absent, or if present sessile; plants partially or wholly submersed.........................13. *Veronica.*
n. Leaves petioled throughout the stem
w. Leaves evidently toothed throughout
x. Leaves acuminate at the tip
y. Leaves linear-lanceolate or lanceolate, bases narrow..............................8. *Chelone.*
y. Leaves lanceolate ovate to ovate, bases broad. ....6. *Scrophularia.*
x. Leaves acute to obtuse at the tip........13. *Veronica.*
w. Leaves and bracts entire, uppermost sometimes with a few bristly teeth at the base...20. *Melampyrum.*
j. At least some of the cauline leaves lobed
z. Upper stem-leaves slightly lobed at the base
aa. Leaves sessile; lobes oblong-lanceolate.......18. *Tomanthera.*
aa. Leaves petioled; lobes tooth-like, or long-pointed. ....20. *Melampyrum.*

z. Lower stem-leaves more evidently lobed

bb. Lower stem-leaves lobed, upper leaves entire or serrate. ....16. *Dasistoma.*

bb. Stem-leaves all lobed

cc. Leaves oblong-lanceolate; lobes cut less than half the distance to the mid-rib.....................21. *Pedicularis.*

cc. Leaves ovate-lanceolate; lobes cut more than half the distance to the mid-rib.....................15. *Aureolaria.*

1. VERBASCUM [Bauhin] L. Mullein

a. Plants pubescent with gland-tipped hairs; leaves only slightly pubescent; pedicels 1–2.5 cm. long.....................1. *V. Blattaria.*

a. Plants with branching glandless pubescence; leaves tomentose at least beneath; pedicels usually less than 1 cm. long

b. Filaments of the two longest stamens twice as long as the anthers; at least the lower clusters of the inflorescence somewhat remote; leaves only slightly decurrent on the stem; leaves of winter rosette with short petioles which are hidden at the base of the rosette, and acute tips; pubescence silvery..2. *V. phlomoides.*

b. Filaments of the two longest stamens four times as long as the anthers; inflorescence densely crowded; leaves long-decurrent on the stem; leaves of winter rosette with more evident petioles, and more nearly obtuse at the tip; pubescence yellowish...2. *V. Thapsus.*

1. V. BLATTARIA L. Moth Mullein. Map 1.

Naturalized from Europe and found only occasionally in the state in dry fields, roadsides, and waste places; collected to date only from Dane, Jefferson and Milwaukee counties. Flowering June to September.

A white-flowered form has been described as f. ALBIFLORA (Don) House, but as yet has not been reported in the state.

2. V. PHLOMOIDES L., including *V. thapsiforme* Schrader; see Rhodora 49 : 67–68. 1947.

Collected only from La Crosse and Dane counties where it was reported growing in disturbed fields. Introduced from Europe, and now spreading in waste places, waysides and disturbed areas. Flowering July to September.

3. V. THAPSUS L. Common Mullein.

Common everywhere in the state, especially in disturbed fields, waysides, along railroad tracks and waste places. Introduced from Europe. Flowering July to November.

2. LINARIA [Bauhin] Miller Toadflax

a. Corolla yellow; leaves usually 2–5 cm. long, 2–10 mm. broad
  b. Corolla 16–22 mm. long excluding spur, pale sulfur-yellow with orange-yellow palate; leaves linear to linear-lanceolate; capsule greatly exceeding the calyx lobes......................1. *L. vulgaris.*
  b. Corolla 6–8 mm. long excluding spur, lemon-yellow with darker palate; leaves lanceolate to ovate-lanceolate; capsule equalling or slightly exceeding the calyx lobes................2. *L. genistifolia.*
a. Corolla blue; leaves usually 1–3.5 cm. long, and less than 2 mm. broad...3. *L. canadensis.*

1. L. VULGARIS Hill. Butter and Eggs. Map 2.

Common in pastures, waste fields, and roadsides throughout the state. Flowering May to September. Introduced from Europe.

2. L. GENISTIFOLIA (L.) Mill. Broom-leaved Toadflax.

Introduced from Europe, and occasionally escaping from gardens. One specimen was collected adjacent to the sidewalk on the northeast corner of Agricultural Hall, University of Wisconsin, July, 1947.

3. L. CANADENSIS (L.) Dumont. Blue Toadflax. Map 3.

Prefers sandy plains, bars, bluffs and hillsides; Green County to Outagamie County, westward. Dr. Pennell suggests that this species may have survived glaciation in the Driftless Area, and since has migrated outward slightly on sandy soils. Flowering May to August.

3. CYMBALARIA [Bauhin] Hill

1. C. MURALIS Gaertn., Mey. & Scherb. Kenilworth or Coliseum Ivy.

Collected only from Dane and Milwaukee counties where it has probably escaped from cultivation. Introduced from Europe.

4. CHAENORRHINUM Reichenb.

1. C. MINUS (L.) Lange. Small Snap-dragon. Map 4.

Locally abundant in cinders along railroad tracks; largely in the eastern part of the state from Brown County to Walworth County, westward to Outagamie, Winnebago and Dane counties. Introduced from Europe.

5. COLLINSIA Nutt.

1. C. VERNA Nutt. Blue-eyed Mary.

This species reaches the northern limits of its range in southern Wisconsin, having been collected near Janesville, Rock County, on a wooded hillside. Collected in May.

6. SCROPHULARIA [Bauhin] L. Figwort

a. Sterile stamen greenish; panicle narrowly elongate, 4–8 cm. wide, its branches relatively stout and ascending; capsules dull, 6–9 mm. long..1. *S. lanceolata.*

a. Sterile stamen purplish; panicle usually broad, 5–18 cm. wide, its branches usually spreading; capsules usually glossy, 4–7 mm. long. ....2. *S. marilandica.*

1. S. LANCEOLATA Pursh. Map 5.

Locally abundant in open woods, dry meadows, pastured areas and along railroad tracks throughout the state. Flowering mid-May to early August.

2. S. MARILANDICA L. Map 6, dots.

Locally abundant in open woods, along wooded river banks and at the foot of bluffs, largely in the southern half of the state, with one reported as far north as Oneida County. Flowering early July to late August.

There is considerable variation in the pubescence of the leaves; the most pubescent type is designated f. NEGLECTA (Rydb.) Pennell. Reported only from Grant County. Map 6, crosses.

7. PENSTEMON Mitchell Beard-tongue

a. Stem-leaves toothed
  b. Lower lobes of the corolla scarcely exceeding the upper; middle and lower portions of the stem glabrous, glaucous......1. *P. Digitalis.*
  b. Lower lobes of the corolla considerably exceeding the upper; middle and lower portions of the stem more or less pubescent
    c. Lower lip of the corolla projecting forward; middle and lower portion of the stem minutely granular-pubescent; corolla 15–25 mm. long
      d. All stem-leaves except the uppermost pair glabrous..2. *P. gracilis.*
      d. All stem- and basal leaves minutely pubescent on under side........................3. *P. gracilis* var. *wisconsinensis.*

c. Lower lip of the corolla upcurved so as to close the orifice to the throat; middle and lower portions of the stem and the leaves loosely pubescent with long crinkly hairs; corolla 20–30 mm. long .... 4. *P. hirsutus.*

a. Stem-leaves entire or obscurely undulate

e. Corolla white, 15–20 mm. long, glandular-puberulent within on all sides; stem-leaves ovate to lanceolate .... 5. *P. tubaeflorus.*

e. Corolla purplish, 35–50 mm. long, glandless-pubescent within; stem-leaves oval to orbicular, acute to acuminate at the tip. .... 6. *P. grandiflorus.*

1. P. DIGITALIS Nutt. Map 7.

Occurs in open woodlands, fields and occasionally roadsides, mostly in the southern half of the state, but extends northeastward to Marinette and Door counties. Flowering early June to July.

2. P. GRACILIS Nutt. Map 8.

This species in its typical phase has been most frequently collected in the western portion of the state, from Columbia County northwestward and westward, in open fields on prairie and sandy soils. Flowering late May to August.

3. P. GRACILIS var. WISCONSINENSIS (Pennell) Fassett, Rhodora 49 : 293. 1947. Map 9.

This variety is confined almost entirely to the Driftless Area, in open woods, fields and occasionally roadsides. Sometimes grows with typical *P. gracilis* and grades into it. Flowering late May to August.

4. P. HIRSUTUS (L.) Willd. Map 10.

Confined largely to the eastern portion of the state, extending westward to Green Lake and Rock counties. Occurrence usually in open areas on sandy and gravelly soils, along railroad tracks and slopes of ravines. Flowering late May to July.

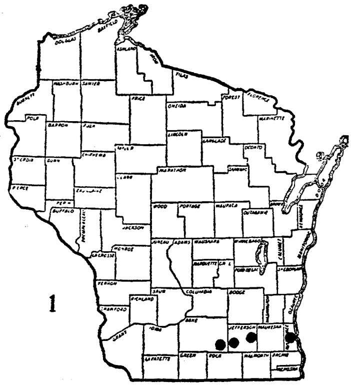
5. P. TUBAEFLORUS Nutt. Map 11.

Rare in Wisconsin; collected only in Burnett, Crawford and Dane counties, where it is reported in fallow fields, roadsides and along river banks. Flowering early June to August.

6. P. GRANDIFLORUS Nutt. Map 12.

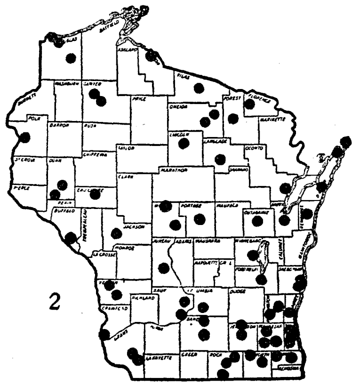
A prairie species entering the state from the west and extending to Wood and Juneau counties, with a single specimen from Sheboygan County. Confined largely to prairies, sandy soils and barrens. Flowering early June to July.

1



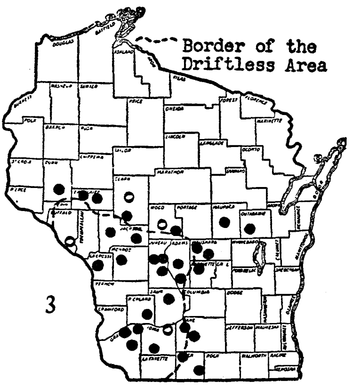
Verbascum Blattaria

2



Linaria vulgaris

3



Linaria canadensis

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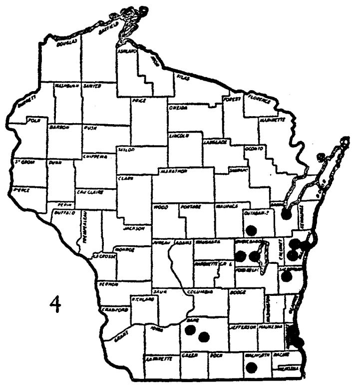
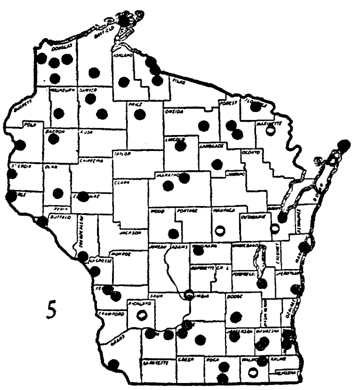


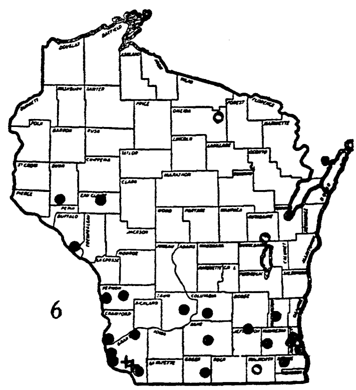
Chaenorrhinum minus

5

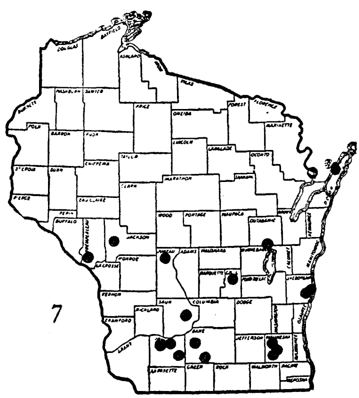


Scrophularia lanceolata

6

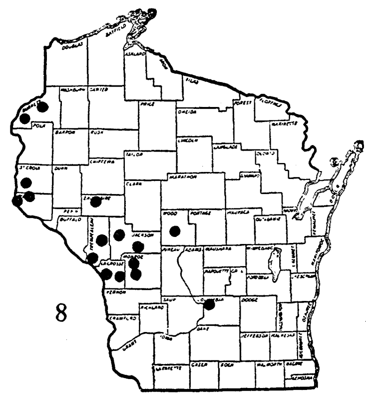


● Scrophularia marilandica
\+ f. neglecta



7

Penstemon Digitalis



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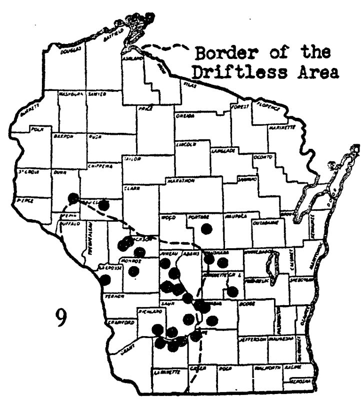
Penstemon gracilis



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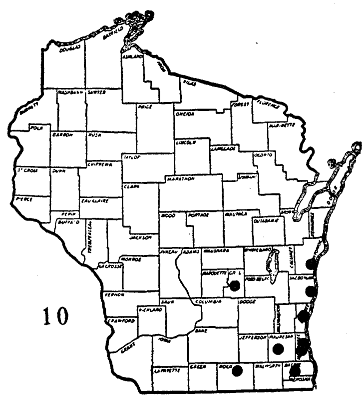
Penstemon gracilis var. wisconsinensis



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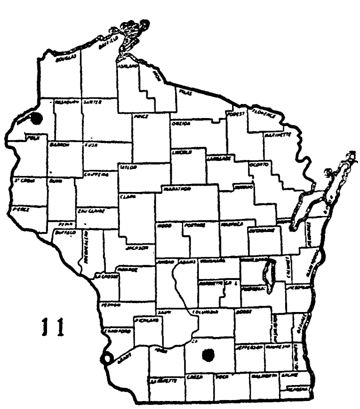
Penstemon hirsutus



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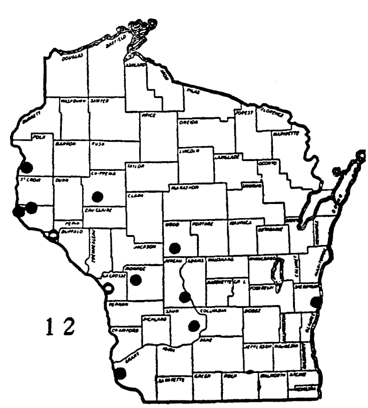
Penstemon tubaeflorus



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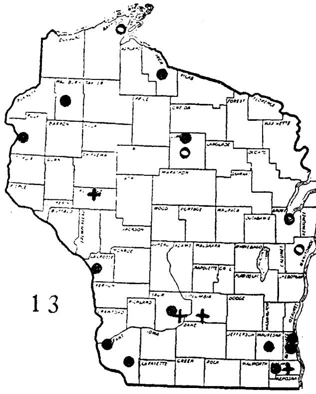
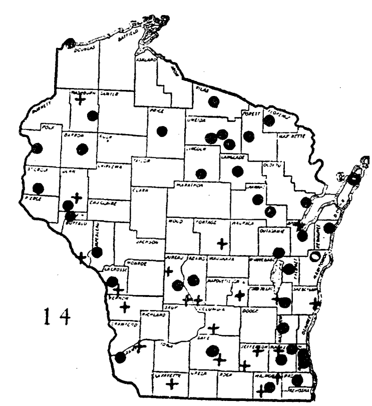
Penstemon grandiflorus



13

● Chelone glabra var. typica
+ f. tomentosa



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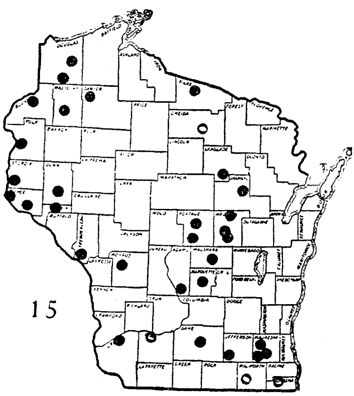
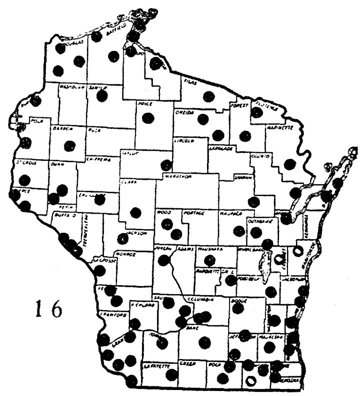
● Chelone glabra var. linifolia
+ f. velutina



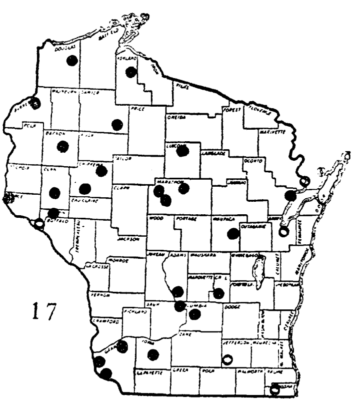
15

Mimulus glabratus var. Fremontii



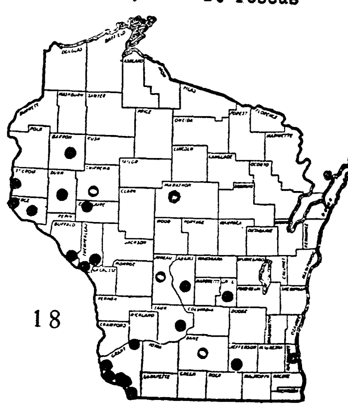
16

● Mimulus ringens
+ f. roseus



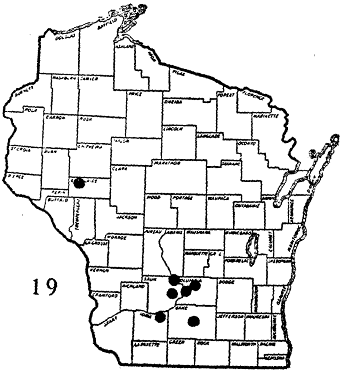
17

Lindernia dubia



18

Lindernia dubia var. riparia



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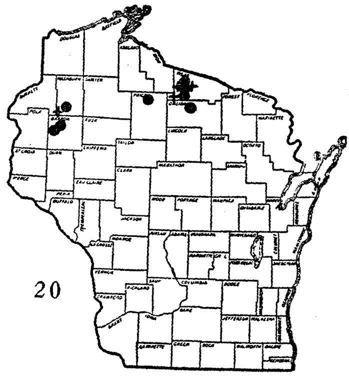
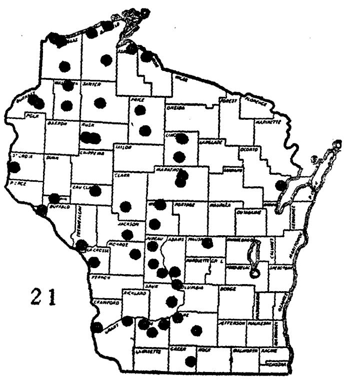
Lindernia anagallidea



20

● Gratiola lutea
\+ f. pusilla



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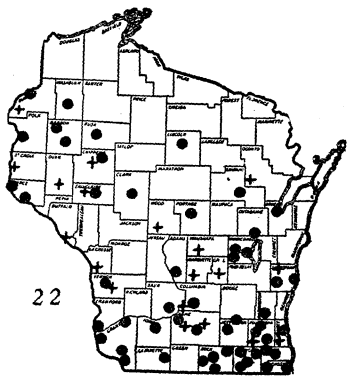
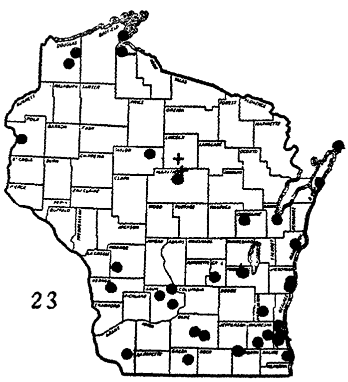
Gratiola neglecta



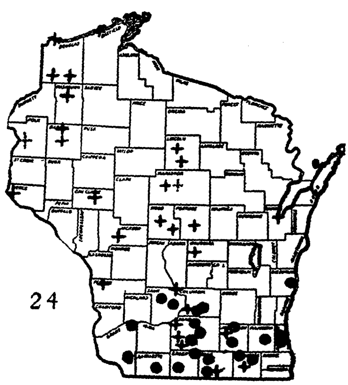
22

● Veronicastrum virginicum
\+ f. villosum



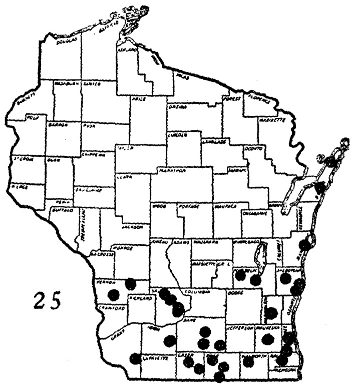
23

● Veronica serpyllifolia
\+ Veronica humifusa



24

● Veronica peregrina var. typica
\+ Veronica peregrina var. xalapensis



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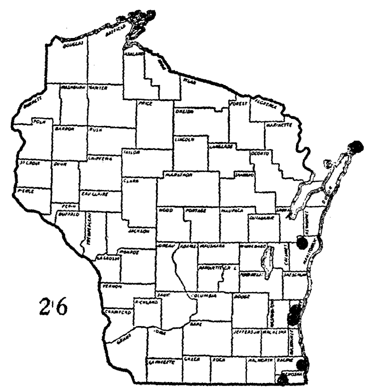
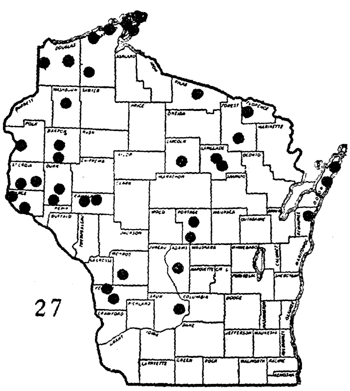
Veronica arvensis



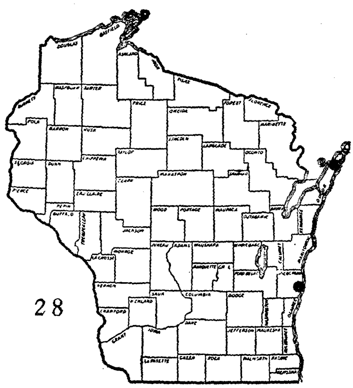
26

Veronica officinalis



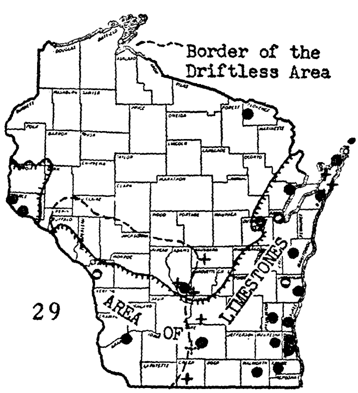
27

Veronica americana



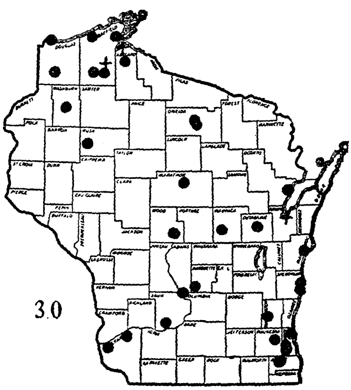
28

Veronica Anagallis-aquatica



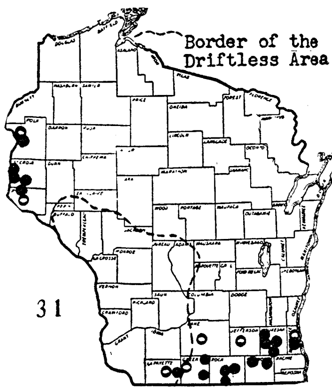
29

● Veronica connata var. typica
+ Veronica connata var. glaberrima



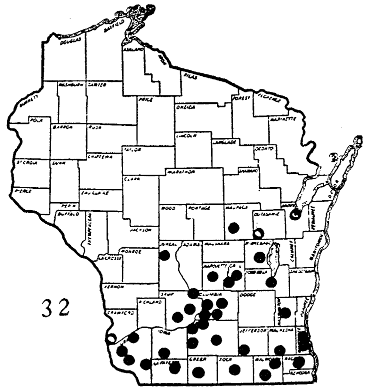
30

● Veronica scutellata
+ f. villosa



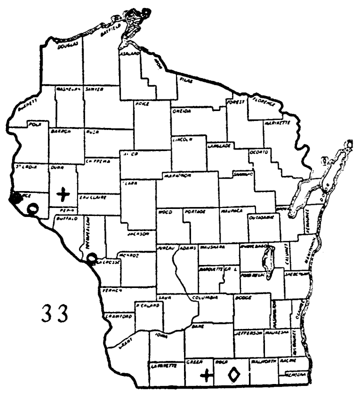
31

Besseya Bullii



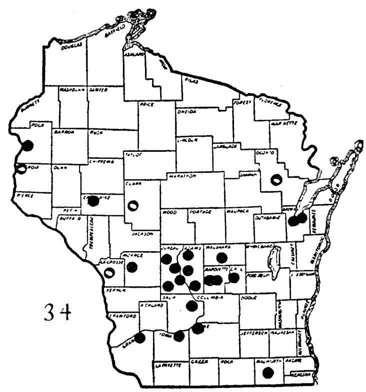
32

Aureolaria grandiflora
var. pulchra



33

◊ Aureolaria flava var. typica
● Aureolaria pedicularia var. typica
✚ Aureolaria pedicularia var. intercedens



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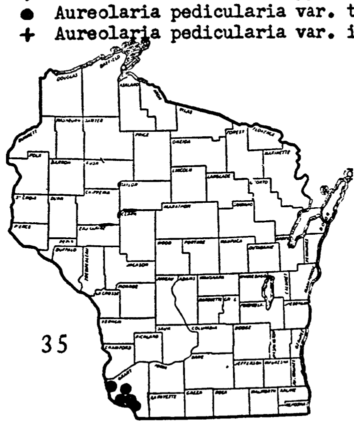
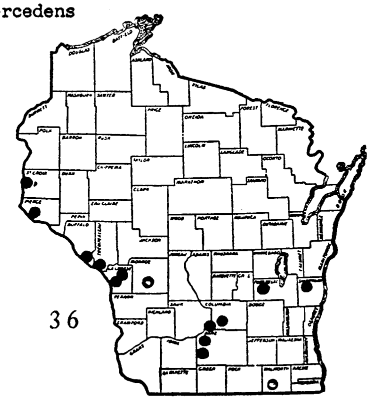
Aureolaria pedicularia
var. ambigens



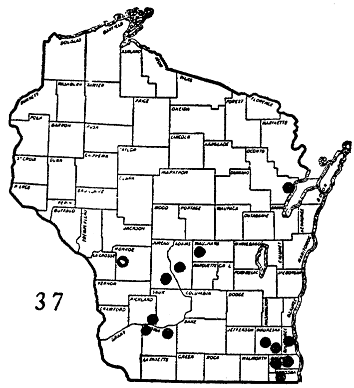
35

Dasistoma macrophylla



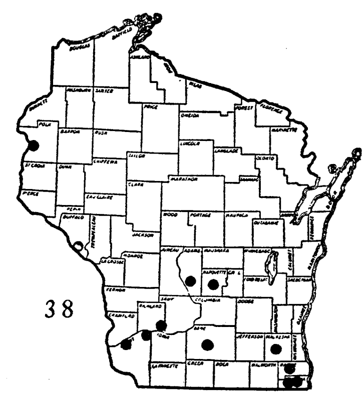
36

Gerardia aspera



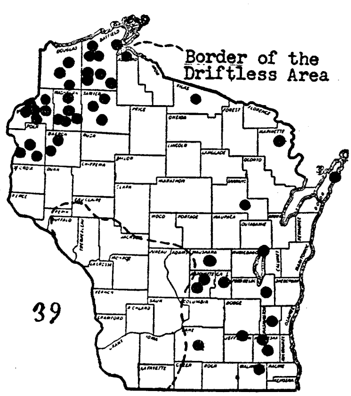
37

Gerardia purpurea



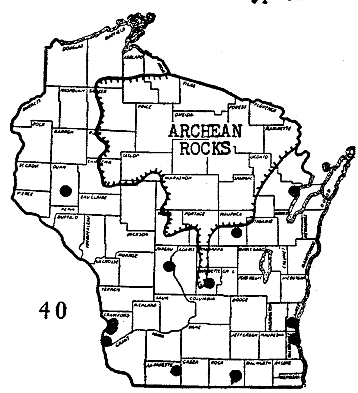
38

Gerardia paupercula var. typica



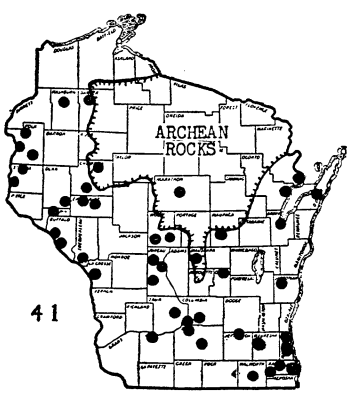
39

Gerardia paupercula var. borealis



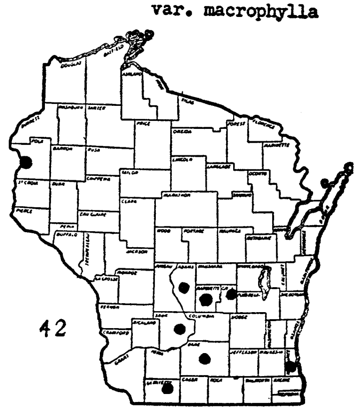
40

Gerardia tenuifolia var. macrophylla



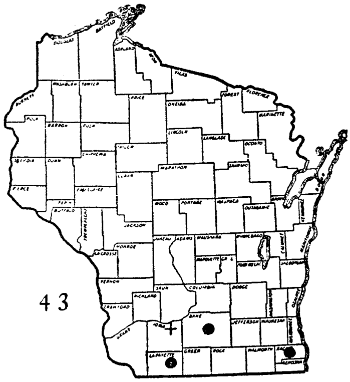
41

Gerardia tenuifolia var. parviflora



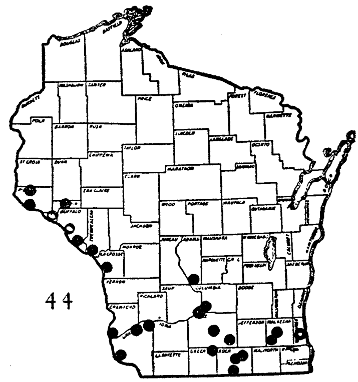
42

Gerardia Gattingeri



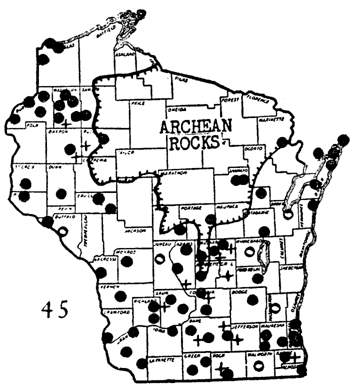
43

+ Gerardia Skinneriana
● Tomanthera auriculata



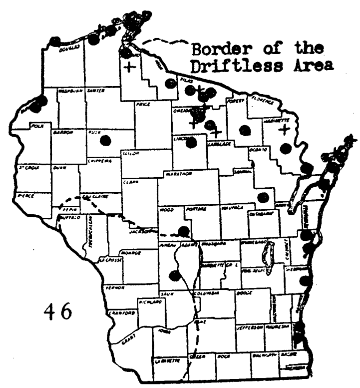
44

Castilleja sessiliflora



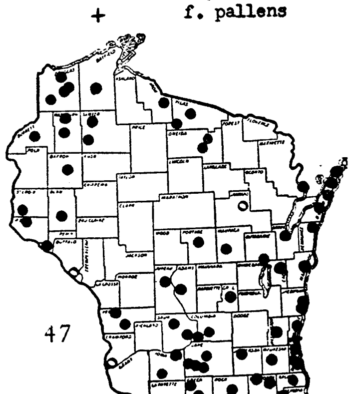
45

● Castilleja coccinea
+ f. pallens



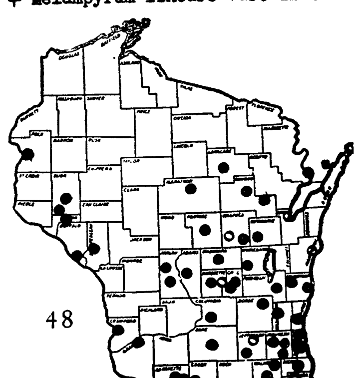
46

● Melampyrum lineare var. americanum
+ Melampyrum lineare var. lineare



47

● Pedicularis canadensis
+ f. praeclara



48

Pedicularis lanceolata

8. CHELONE [Tourn.] L. Turtlehead

a. Corolla externally white, lips rose-purplish within; leaves lanceolate or elliptic, 2–4 cm. wide....................1. *C. glabra* var. *typica.*
a. Corolla externally greenish yellow, lips white within; leaves linear to narrowly lanceolate, mostly 1–2 cm. wide...2. *C. glabra* var. *linifolia.*

1. C. GLABRA L. var. TYPICA (Pennell) Deam, Fl. Ind. 838. 1940. Balmony. Map 13, dots.

Occurs throughout the state along river bottoms, swamps and other moist places, but is less abundant than var. *linifolia.* Flowering early July to September.

Plants with leaves densely tomentose on the under side have been described as f. TOMENTOSA Pennell. Map 13, crosses.

2. C. GLABRA var. LINIFOLIA Coleman. Map 14, dots.

Locally abundant in swamps, bogs and moist shores of lakes and streams throughout the state. Flowering mid-July to early October.

Plants with leaves densely pubescent beneath have been designated f. VELUTINA Pennell & Wherry. Map 14, crosses.

9. MIMULUS L. Monkey Flower

a. Corolla lemon-yellow; leaves reniform, nearly sessile to petioled. ....1. *M. glabratus* var. *Fremontii.*
a. Corolla purplish; leaves oblong to lanceolate, sessile, clasping by a heart-shaped base..................................2. *M. ringens.*

1. M. GLABRATUS HBK. var. FREMONTII (Benth.) Grant. Map 15.

Moist places about springs, shores of lakes, cold streams and ponds throughout the state. Flowering June to September.

2. M. RINGENS L. Map 16.

Common along moist banks of streams, in swales and marshy meadows throughout the state. Flowering June to September.

An individual with a pink corolla has been collected in Burnett county and has been described as f. ROSEUS Fassett, Torreya 42 : 181. 1943. Map 16, cross.

10. LINDERNIA All. False Pimpernel

a. Lower pedicels shorter than the subtending leaves; upper pedicels shorter or only slightly exceeding the subtending leaves; leaf blades 1–3 cm. long, lower ones obviously narrowed at the base
  b. Pedicels in upper portion of stem shorter than the subtending bract-leaves, ascending...............................1. *L. dubia.*

b. Pedicels in upper portion of the stem exceeding the subtending leaves, more or less divaricately spreading....2. *L. dubia* var. *riparia.*

a. Both lower and upper pedicels obviously exceeding their subtending leaves; leaves 0.5–1.5 cm. long, nearly all widest near the base and somewhat clasping............................3. *L. anagallidea.*

1. L. DUBIA (L.) Pennell. *L. dubia* subsp. *major* Pennell; see Rhodora 44 : 441–446. 1942. Map 17.

Locally common along sandy and muddy shores and banks of rivers, lakes and ditches throughout the state. Flowering July to September.

2. L. DUBIA var. RIPARIA (Raf.) Fern., Rhodora 44 : 444. 1942. *L. dubia* subsp. *typica* Pennell. Map 18.

Sandy and muddy shores of lakes, streams; moist ditches and sandy places, largely in the southern half of the state, extending northward to St. Croix and Marathon counties. Flowering July to September.

3. L. ANAGALLIDEA (Michx.) Pennell. Map 19.

Edges of streams, ponds and moist places, usually on sandy soil; Dane, Iowa, Sauk, Columbia and Eau Claire counties. Flowering July to September.

11. GRATIOLA [Bauhin] L. Hedge Hyssop

a. Corolla golden-yellow; leaves clasping stem by a broad base, with many dark glandular dots (submersed form lacks the glandular dots)...1. *G. lutea.*

a. Corolla greenish-yellow; leaves narrowed to a sessile or scarcely clasping base, without glandular dots...................2. *G. neglecta.*

1. G. LUTEA Raf.[2] Map 20, dots.

Collected only in the north-part of the state, in Barron, Washburn, Price, Oneida and Vilas counties, where it is reported along sandy, peaty and muddy lake shores. Flowering July to September.

Forma PUSILLA (Fassett) Pennell, a submersed sterile state, occurs in soft water lakes with sandy bottoms at depths of 1–4 meters. Map 20, crosses.

2. G. NEGLECTA Torr. Map 21.

Frequently occurring along margins of lakes, ponds, kettleholes, ditches and drying depressions, mostly throughout the

[2] *G. aurea* Muhl. in Gray's Man. ed. 8, p. 1276. 1950.

western half of the state, extending eastward to Oconto and Fond du Lac counties. Flowering June to September.

12. VERONICASTRUM [Heister] Fabr.

1. V. VIRGINICUM (L.) Farw. Culver's Root; Culver's Physic. *Veronica virginica* L. Gray's Manual, ed. 7. Map 22, dots.

Fairly common along roadsides and railroad right-of-ways, wet meadows, prairies, sandy places and open woods throughout the state, except in the northernmost tier of counties. Flowering late June to August.

There is considerable variation in the pubescence of the lower surfaces of the leaves, and the most hairy form has been described as f. VILLOSUM Pennell. Map 22, crosses. Distribution as above.

13. VERONICA [Bauhin] L. Speedwell

a. Main stem terminating in an inflorescence, its flowers either densely crowded in the terminal portion or remote and axillary; upper bract-leaves alternate

b. Stem leaves lanceolate, at least twice as long as broad

c. Plants 0.5–2 m. tall; leaves evidently dentate-serrate, acute to acuminate, short-petioled; inflorescence in a dense terminal raceme..1. *V. longifolia.*

c. Plants less than 0.5 m. tall; leaves remotely finely serrate to nearly entire, obtuse, sessile; flowers more remote, in axils of upper bract-leaves

d. Plants glabrous....................4. *V. peregrina* var. *typica.*

d. Plants with gland-tipped hairs...5. *V. peregrina* var. *xalapensis.*

b. Stem leaves ovate, only slightly longer than broad

e. Pedicels 1–2 cm. long, usually exceeding the leaves....7. *V. persica.*

e. Pedicels less than 1 cm. long, usually shorter than the leaves

f. Pedicels shorter than the sepals, less than 2 mm. long. ....6. *V. arvensis.*

f. Pedicels mostly equalling or longer than the sepals, usually 2 mm. or more long

g. Corolla 3–4 mm. broad, whitish or pale blue with darker stripes; pedicels and rhachis appressed-puberulent; capsule 3–4 mm. broad........................2. *V. serpyllifolia.*

g. Corolla 0.5–1 cm. broad, deep blue; pedicels and rhachis pubescent with spreading viscid or gland-tipped hairs; capsule 4–6 mm. broad......................3. *V. humifusa.*

a. Flowers in axillary racemes; main stem never terminating in an inflorescence; stem-leaves all opposite
  h. Stem-leaves with short petioles, or if sessile narrowed to the base
    i. Leaves ribbon-like, very long and narrowed to the base, sessile, remotely toothed; sepals rarely more than half the length of the capsule....................................13. *V. scutellata.*
    i. Leaves lanceolate to ovate, more closely serrate, evidently petioled; sepals nearly equal in length to the capsule
      j. Plants glabrous or with a few gland-tipped hairs; capsules glabrous......................................9. *V. americana.*
      j. Plants densely pubescent; capsules pubescent.....8. *V. officinalis.*
  h. Stem leaves sessile and clasping by a broad base
    k. Racemes 30–60-flowered at maturity; pedicels 4–8 mm. long, with a few gland-tipped hairs; racemes and pedicels strongly ascending; sepals acute to acuminate; plants wholly or partially emergent aquatics................10. *V. Anagallis-aquatica.*
    k. Racemes mostly 5–35-flowered at maturity; pedicels 3–6 mm. long; racemes and pedicels more loose and divergent; sepals more nearly acute; pedicels and distal portions of the stem evidently glandular-pubescent or wholly glabrous; plants frequently wholly submerged
      l. Distal portions of stem and pedicels with gland-tipped hairs. ....11. *V. connata* var. *typica.*
      l. Distal portion of stem and pedicels wholly glabrous. ....12. *V. connata* var. *glaberrima.*

1. V. LONGIFOLIA L.

Introduced from Europe, but occasionally escaping from cultivation to waste places, roadsides and along railroad tracks. Collected only from Dane and Milwaukee counties.

2. V. SERPYLLIFOLIA L. Thyme-leaved Speedwell. Map 23, dots.

Occurs throughout the state in pastures, waysides, open woods and along river bottoms. Introduced from Eurasia. Flowering May to July.

3. V. HUMIFUSA Dickson. Map 23, crosses.

An alpine species that is found occasionally in the northern part of the state, especially in moist springy places. Collected only from Lincoln and Marathon counties.

4. V. PEREGRINA L. var. TYPICA (Pennell) Deam, Fl. Ind., 847. 1940. Neckweed; Purslane Speedwell. Map 24, dots.

Fairly common in the southern part of the state, frequenting cultivated gardens, abandoned fields and moist open places where it usually occurs with the next. Flowering May to June.

5. V. PEREGRINA var. XALAPENSIS (HBK.) St. John & Warren, Northwest Sci. 2, No. 3 : 90. 1928. Map 24, crosses.

A more widespread variety than the typical, especially in the western U. S. In the state it occurs in moist places, usually along streams, depressions, along railroad embankments and especially cultivated and pastured areas; becoming quite an aggressive weed. Flowering May to June.

6. V. ARVENSIS L. Corn Speedwell. Map 25.

Locally common in dry fields, pastures and cultivated areas; Vernon County to Door County, southward. Flowering May to June. Introduced from Europe.

7. V. PERSICA Poir. *V. Tournefortii* C.C. Gmel; *V. Buxbaumii* Tenore; and *V. Byzantina* (Smith) BSP.

Introduced from Europe, and now occurring along roadsides, fields and other waste places. Collected in Marathon, Sheboygan and Milwaukee counties.

8. V. OFFICINALIS L. Common Speedwell. Map 26.

This species is confined to the Lake Michigan shore from Kenosha to Door County, where it occurs in ravines, open woods and dry places. Introduced from Europe. Flowering late May to August.

9. V. AMERICANA (Raf.) Schwein. American Brooklime. Map 27.

Occurs in stream beds, roadside ditches, along ponds, swamps and other moist places throughout most of the state, except in the southern and southeastern portions. Flowering late May to early September.

10. V. ANAGALLIS-AQUATICA L. Water Speedwell. Map 28.

Collected only from Sheboygan and Door counties. Inhabits ditches, ponds and slow moving streams. Flowering June to September. Naturalized from Europe.

11. V. CONNATA Raf. var. TYPICA (Pennell) Deam,[3] Fl. Ind., 849. 1940. Map 29, dots.

Frequent in slow moving streams, shaded ditches, sloughs and brooks, largely in the limestone areas. Flowering late May to October.

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[3] *V. comosa* Richter, *ibid.*, p. 1284.

12. V. CONNATA var. GLABERRIMA (Pennell) Fassett, Rhodora 41 : 525. 1939. Map 29, crosses.

Apparently much more local along the eastern border of the Driftless Area and in Door County. This variety and the typical are often wholly submersed and cannot be distinguished except by a comparison with emersed plants of the region.

13. V. SCUTELLATA L. Marsh Speedwell. Map 30, dots.

Locally common throughout the state in marshy places, river bottoms, roadside ditches and depressions. Flowering late May to September.

Plants with white hairs throughout the stem and leaves have been described as f. VILLOSA (Schumacher) Pennell. Map 30, crosses.

14. BESSEYA Rydberg[4]

1. B. BULLII (Eaton) Rydb. *Synthris Bullii* (Eaton) Heller, Gray's Manual, ed. 7. Map 31.

Locally common on sandy and gravelly ridges, knolls, open woods and prairies; southernmost counties, northward to Dane and Milwaukee counties; along St. Croix River, Pierce to Polk counties. The two apparently separated regions are shown by Dr. Pennell's map actually to be connected by stations in Iowa and Minnesota. Flowering May to August.

15. AUREOLARIA Rafinesque[5] Foxglove

a. Stems glabrous, more or less glaucous .... 1. *A. flava* var. *typica.*
a. Stems more or less puberulent or pubescent
  b. Pubescence glandless .... 2. *A. grandiflora* var. *pulchra.*
  b. Pubescence more or less glandular
    c. Distal portion of stem closely pubescent, only slightly glandular; pubescence of leaves scarcely or not glandular; capsule usually 9–11 mm. long .... 3. *A. pedicularia* var. *typica.*
    c. Distal portion of stem glandular-pubescent to hirsute; pubescence of leaves more evidently glandular; capsule usually 11–15 mm. long
      d. Glands scattered throughout the distal portions of the stem. .... 4. *A. pedicularia* var. *intercedens.*
      d. Glands crowded throughout the distal portions of the stem. .... 5. *A. pedicularia* var. *ambigens.*

[4] *Wulfenia* Jacq., *ibid.*, p. 1280.
[5] Considered with *Tomanthera* under *Gerardia, ibid.*, p. 1285.

1. A. FLAVA (L.) Farw. var. TYPICA (Pennell) Deam, Fl. Ind., 854. 1940. Smooth Foxglove. Map 33, diamond.

Open oak woods on sandy or light loam soils. Reported by Pennell from southern Wisconsin, presumably Walworth County. Flowering late July to late September.

2. A. GRANDIFLORA (Benth.) Pennell var. PULCHRA Pennell. Map 32.

Largely in the southern part of the state, northeastward to Waupaca and Brown counties. Prefers open oak woods. Flowering late July to mid-October.

3. A. PEDICULARIA (L.) Raf. var. TYPICA (Pennell) Deam, Fl. Ind., 855. 1940. Map 33, dots.

Reported by Pennell as collected in Trempealeau and Pierce counties. Occurs in dry oak woods. Flowering mid-August to late September.

4. A. PEDICULARIA var. INTERCEDENS Pennell. Map 33, crosses.

Collected in Dunn and Green counties; growing in sandy open oak woods. Flowering early August to late September.

5. A. PEDICULARIA var. AMBIGENS (Fern.) Farw. Map 34.

Occurs largely in the sandstone areas of the central and northeastern portion of the state, and along rivers northwestward to Polk County, and southeastward to Walworth County. Dry sandy oak woods and wooded sand dunes. Flowering late July to early October.

16. DASISTOMA Rafinesque[6]

1. D. MACROPHYLLA (Nutt.) Raf. Map 35.

This species seems to be entering the state from the southwest along rivers and streams, known in Wisconsin only from Grant County, occurring on lightly wooded hillsides. Flowering late June to early September.

17. GERARDIA L. Gerardia

a. Pedicels short, slightly if at all exceeding the calyx and capsule

b. Upper lobes of corolla only slightly spreading; capsule cylindric, decidedly longer than wide; upper surface of leaves and stem very scabrous; branches and pedicels strongly ascending. .... 1. *G. aspera.*

[6] *Seymeria* Pursh, *ibid.*

b. Corolla-lobes reflexed spreading; capsule globose to globose-ovoid; upper surface of leaves less scabrous and stem smooth; pedicels and branches more spreading
c. Corolla 20–35 mm. long..........................2. *G. purpurea.*
c. Corolla 10–20 mm. long
d. Corolla 15–20 mm. long, campanulate; anthers rather densely white-villose..............3. *G. paupercula* var. *typica.*
d. Corolla 10–17 mm. long, tubular-campanulate; anthers sparingly villose-pubescent with pale brownish or white hairs...........................4. *G. paupercula* var. *borealis.*

a. Pedicels long, usually exceeding the corolla, at least longer than the calyx and capsule
e. Stem-leaves usually 2–4 mm. broad; plants relatively dark green or purplish, tending to blacken in drying; seeds dark brown or blackish
f. Anthers densely villose; leaves and branches spreading; axillary fascicles not or only slightly developed.
..............................5. *G. tenuifolia* var. *macrophylla.*
f. Anthers sparingly villose; leaves and branches ascending; axillary fascicles usually conspicuously developed.
................................6. *G. tenuifolia* var. *parviflora.*
e. Stem-leaves usually less than 2 mm. broad, narrowly linear to filiform; plants yellowish green, not tending to blacken in drying; seeds yellow or yellowish brown
g. Stem-leaves narrowly linear, 2–3 cm. long; stem terete, only slightly striate, much branched; corolla-lobes somewhat emarginate; calyx-lobes not whitened at tip...........7. *G. Gattingeri.*
g. Stem-leaves linear to nearly filiform, 1–2.5 cm. long; stem conspicuously striate-angled, simple or moderately branched; corolla-lobes truncate; calyx-lobes whitened at tip..8. *G. Skinneriana.*

1. G. ASPERA Dougl. Map 36.

Locally common on prairies, dry sandy hills and southerly exposed bluffs; Sheboygan County to St. Croix County, and southward. Flowering mid-July to mid-September.

2. G. PURPUREA L. Map 37.

Mostly in the southern part of the state, extending northward to Monroe and Waushara counties, and northeastward to Oconto County. Prefers moist sandy areas, frequently along the edges of streams, rivers and lakes, and occasionally on dry soil. Flowering early August to September.

3. G. PAUPERCULA (Gray) Britt. var. TYPICA (Pennell) Deam, Fl. Ind., 852. 1940. Map 38.

Occurs usually along shores of lakes, rivers, moist ditches, marshes and infrequently on prairies and bluffs, largely in the southern half of the state, extending northward to Polk County along the Mississippi and St. Croix rivers. Flowering late July to September.

4. G. PAUPERCULA var. BOREALIS (Pennell) Deam, Fl. Ind., 852. 1940. Map 39.

Distribution appears to be wholly within the glaciated portion of the state, occurring along sandy shores of lakes and streams in the northern part, and in bogs and marshy places in the southern part. Extensive collections have been made in the northwestern part of the state, and Mr. W. T. McLaughlin, in Ecol. Mono. 2 : 344, 1932, has described the probable reasons for its presence along the shores of practically all the sandy lakes in this area. Flowering July to September.

5. G. TENUIFOLIA Vahl var. MACROPHYLLA Benth. Map 40.

Habits loam or clay soils along river bottoms, swales and ditches. Largely in the southern portion of the state, extending northeastward to Oconto County and northwestward to Dunn County. Flowering mid-August to mid-October.

6. G. TENUIFOLIA var. PARVIFLORA Nutt. Map 41.

Locally common along river banks, lake shores, moist fields and depressions, usually on sandy soil. Appears to be largely absent from the granitic rocks of the north central portion of the state. An apparent exception is a specimen in the Milwaukee Public Museum which was collected near Wausau, Marathon County. However a geological map of the region discloses an outcrop of basic igneous rock in this area which may explain this occurrence. It is suggested that a watch be kept for this plant on similar outcrops in this area. Flowering mid-August to October.

7. G. GATTINGERI Small. Map 42.

Occurs on dry knolls, bluffs and open oak woods; Marquette and Green Lake counties southward, with a collection from Polk County. These two apparently separate areas are probably connected through Iowa and Minnesota. Flowering mid-August to early October.

8. G. SKINNERIANA Wood. Map 43, cross.

Rare in the state, having been collected only from the vicinity of Arena, Iowa County. Prefers open sandy areas, bluffs, dunes and prairies. Flowering mid-August to September.

18. TOMANTHERA Rafinesque

1. T. AURICULATA (Michx.) Raf. Map 43, dots.

Collected in Dane, Lafayette and Racine counties where it occurs in prairies, old fields or rarely open woodlands. Flowering August to September.

19. CASTILLEJA Mutis Painted Cup

a. Bracts and leaves pale green, numerous; corolla 3–4 cm. long. ....1. *C. sessiliflora.*

a. Bracts scarlet, yellow or whitish-tipped; corolla 1.5–2.5 cm. long. ....2. *C. coccinea.*

1. C. SESSILIFLORA Pursh. Map 44.

Locally common in prairies, and sandy and limestone ridges and knolls, from Milwaukee County diagonally across the state to Pierce County, thence southward and westward; often an indicator of undisturbed high prairie. Flowering May to late July.

2. C. COCCINEA (L.) Spreng. Scarlet Painted Cup. Map 45, dots.

Locally abundant throughout the state, but largely absent from the north central portion. Usually occurring in moist meadows, sandy areas and moist open woods and roadsides. Flowering May to early September.

Plants with whitish or yellowish-tipped bracts have been described as f. PALLENS (Michx.) Pennell (including both f. *alba* Farw. and f. *lutescens* Far. in Amer. Midl. Nat. 8 : 276. 1923). Map 45, crosses.

20. MELAMPYRUM [Bauhin] L. Cow Wheat

a. Foliage leaves and bracts linear, 1–4 (–6) mm. broad, all entire or the uppermost bracts rarely toothed at the base; stem simple, or loosely few-branched, 0.5–2 dm. high, the simple branches only 1–10 cm. long; mature capsules 3–5 mm. broad...1. *M. lineare* var. *lineare.*

a. Foliage leaves linear to lanceolate, 2–10 mm. wide; larger bracts linear-lanceolate to lanceolate-ovate, 3–20 mm. broad, some or all of them sharply toothed at the base; stem usually bushy branched (exceptionally unbranched), 2–5 dm. high; branches in well developed plants 0.2–2.5 dm. long; mature capsules 3.5–6 mm. broad. ....2. *M. lineare* var. *americanum.*

1. M. LINEARE Desr. var. LINEARE (Desr.) Beauv.; Fernald, Rhodora 44 : 450. 1942. Map 46, crosses.

Occurs in bogs and in sandy areas beneath coniferous trees in the northernmost tier of counties, including the tip of Door County. Flowering June to August.

2. M. LINEARE var. AMERICANUM (Michx.) Beauv.; Fernald, Rhodora 44 : 451. 1942. Map 46, dots.

Collected largely in the northern portion of the state, extending southward in the central part to Juneau County, and in the eastern part to Milwaukee County; occurs in bogs, Jack Pine barrens and open sandy areas. Prefers acid conditions. Flowering June to August.

21. PEDICULARIS [Bauhin] L. Lousewort; Wood Betony

a. Stem-leaves alternate, with long petioles, deeply lobed; galea with two short spurs........1. *P. canadensis.*
a. Stem-leaves opposite, with short petioles, pinnatifid; galea without spurs........2. *P. lanceolata.*

1. P. CANADENSIS L. Wood Betony; Woolly Lousewort. Map 47, dots.

Locally abundant throughout the state in dry open woods and fields, usually on sandy soils, and occasionally on light loam soils. Flowering May to June.

The red-flowered plant, f. PRAECLARA A. H. Moore, Rhodora 16 : 128. 1914, has been collected in red clay along the bluff sides of Lake Michigan near the town of Mequon, Ozaukee County. This form has been reported as being locally abundant in some areas of the New England States. Map 47, cross.

Var. *Dobbsii* Fern., Rhodora 48 : 59, 1946, has been described as having a stoloniferous habit and an apparently less cespitose tendency. An examination of the specimens in the two herbaria, as well as extensive collections during the past summer has failed to distinguish any appreciable differences to warrant distinction at this time.

2. P. LANCEOLATA Michx. Betony. Map 48.

Distributed mostly in the southern portion of the state, extending northward to Polk, Langlade and Marinette counties. Prefers moist woods, tamarack bogs and low places, usually on loam soils. Flowering early August to October.

PROBLEMS, PRINCIPLES, AND POLICIES IN WILDLIFE-CONSERVATION JOURNALISM

CLARENCE A. SCHOENFELD

PART I

WILDLIFE CONSERVATION AS A JOURNALISTIC PROBLEM

INTRODUCTION

The area in which wildlife conservation and journalism impinge upon each other is the subject of this paper. It is largely a frontier area which has only recently been discovered in all its ramifications, which is occupied by numerous savages and only a handful of skilled pioneers, and which is waiting to be explored by such expeditions as this thesis represents.

Were the subject-area to be classified in a biological fashion, its taxonomy would appear to be something like this:

Phylum: Communications
  Order: Education
    Family: Science Education
      Genus: Science Journalism
        Species: Conservation Journalism
          Variety: Wildlife Management Reporting

While the overtones of this study involve fundamental considerations in the broad fields of journalism, public relations, public administration, education, and scientific investigation, the focus of the study itself is limited to the interpretation of wildlife conservation (with special emphasis, where applicable, to the state of Wisconsin). There are two reasons for this truncated approach. First, the interpretation of the science of wildlife management presents a clear and present problem in itself. Second, it is probable that in journalism, as in ecology, the mechanisms of a complex society will become understandable only when the mechanics of a relatively simple segment is fully analyzed.

DISCUSSION

For purposes of this study, the *Webster's* definition of "journalism" will suffice: "The business of managing, editing, or writing for journals or newspapers."[1] "Wildlife management," or "wildlife conservation," needs more documentation.

Narrowly applied, it means "the art of making land produce sustained animal crops of wild game for recreational use."[2] Used more broadly, it involves man-to-land conduct, and "putting the sciences and arts together for the purpose of understanding our environment."[3, 4] The term is conveniently, if not correctly, used herein to include fish as well as game.

And the point might as well be made here and now, that one cannot rightfully separate wildlife from the land, or them from people. We are all of one piece.[5] This fact has long had its biological implications and will be seen to be the very basis of the problems—and the possibilities—in wildlife-conservation journalism.

It is not the purpose, nor should it be necessary, for this study to do anything more than mention the importance of all natural-resources conservation today in general and the importance of wildlife conservation in particular.[6] One timely and pertinent statement will be sufficient—from the preamble to the program for a conference on "Conservation of Wisconsin's Nat-

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[1] N. Webster, *Collegiate Dictionary* (Springfield, Mass., V, 1947), 545.

[2] Aldo Leopold, *Game Management* (New York, 1933), 4.

[3] *Ibid.*

[4] "Twenty centuries of 'progress' have brought the average citizen a vote, a national anthem, a Ford, a bank account, and a high opinion of himself, but not the capacity to live in high density without befouling and denuding his environment, nor a conviction that such capacity, rather than such density, is the true test of whether he is civilized. The practice of game management may be one of the means of developing a culture which will meet this test."—*Ibid.*, 416.

[5] "We find that we cannot produce much to shoot until the landowner changes his ways of using land, and he in turn cannot change his ways until his teachers, bankers, customers, editors, governors, and trespassers change their ideas about what land is for. To change ideas about what land is for is to change ideas about what anything is for. Thus we started to move a straw, and end up with the job of moving a mountain."—Aldo Leopold, "The State of the Profession," *The Journal of Wildlife Management,* Vol. 4, No. 3, July, 1940. 346.

[6] "Conservation is not just something it would be nice to have. It is not just something that would make life a little more pleasant and perhaps a bit more profitable. Conservation is a matter of life and death. In spite of civilization, in spite of great material achievements, like the release of atomic energy, people are today more than ever faced with elemental demands, such as the need for food, water, and shelter."—Edward H. Graham, "Flashbacks from the St. Louis Conference," *Outdoors Unlimited,* June, 1948. 1.

ural Resources" held on the University of Wisconsin campus, June 30–July 1, 1949:

> Conservation has been defined broadly as the efficient and intelligent use of natural resources. Conservation means not hoarding, but wise utilization, both in peace and war, without exploitation of either the physical resources themselves or of the human elements involved. The record of the past hundred years shows wasteful practices that should be corrected. It shows an alarming depletion of resources, not all necessarily wasteful. It calls for intensified study of the possibilities of utilizing marginal nonrenewable resources, as well as conservation of renewable heritages. The depletion of Wisconsin's natural wealth is a matter of public knowledge. Its great pineries have been replaced by aspen scrub; its superb rivers have been silted and polluted; many of its fauna have been extinguished or converted into pests; six million of its acres have lost five inches or more of top soil. Our aspirations to wiser resource use, collectively called conservation, have been slow to stem destructive forces.[7]

The calling of such a conference itself is indicative of the importance of the subject. As is the fact that two of the most popular and—fortunately—most-discussed postwar non-fiction books are Fairfield Osborn's *Our Plundered Planet* and William Vogt's *Road to Survival,* both of them trumpeting the call for more and better conservation.

Of course, neither such conferences nor such books are either new or necessarily worthwhile. Conservation has been, by common consent, a good thing for a good many years. Barring love and war, few enterprises are talked about or toyed with in so many diverse ways and places, by such a mixture of groups and persons, as conservation. But the net total of all this effort has been something only slightly more than zero. We have accumulated pledges and societies, but we have not conserved.

As the late Aldo Leopold put it:

> Everyone ought to be dissatisfied with the slow spread of conservation to the land. Our "programs" still consist largely of letterhead pieties and convention oratory. The only progress that counts is that on the actual landscape of the back forty, and here we are still slipping two steps backward for each forward stride.[8]

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[7] University of Wisconsin, "An Introduction," *Preliminary Program,* Centennial Conference on Conservation of Wisconsin's Natural Resources, (Madison, 1949), 2.

[8] Aldo Leopold, "The Ecological Conscience," *Wisconsin Conservation Bulletin,* Vol. XII, No. 12, December, 1947, 7.

But, as we have said, it is not the purpose of this study to document either the necessity for all types of conservation or the current lack of it. It is the purpose of this study to reconnoiter the journalistic no-man's-land where wildlife conservation falters.

A generation ago, wildlife managers began with the job of producing something to shoot or catch. It seemed to them that once they collected a body of scientific knowledge about wildlife crops and cropping, all would be well. They initially reckoned not with the land nor, more important, with the landowner. Now they are face to face with the fact that wildlife conservation is not so much management of game as management of public opinion.[9]

The realization is catching on.

Seth Gordon, for many years executive director of the Pennsylvania Game Commission, is on record as saying that "the human element—the public relations problem—is always more difficult to handle than is the management of wild creatures."[10]

Something of the same sentiment is voiced by Ira N. Gabrielson, president of the Wildlife Management Institute, in his book, *Wildlife Conservation:*

> The most uncertain factor is not management (of game) itself but public support for a suitable and effective program that may be neither a spectacular performance nor a crusade.[11]

I take it that the late Professor Leopold of the University of Wisconsin (and the Wisconsin Conservation Commission) had a similar idea in mind when he told the 1946 Midwest Wildlife Conference at Columbia, Mo.:

> A conservation commission can operate up to the level of public opinion, but finds a drag when it attempts to proceed beyond that point. A commission cannot build a program without public support.

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[9] "Quite as necessary as research is education. . . . Effective conservation has been made impossible in many parts of the world by man's failure to recognize the indispensability of scientific treatment. . . . The education of conservation workers is not enough. The leaders in all countries must understand the ecological imperative, and in the democracies this understanding should reach all the people." —William Vogt, *Road to Survival,* New York, 1948, 175.

[10] Seth Gordon, "Pennsylvania Bags 700,000 Deer in Ten Years," *Our Deer—Past, Present and Future,* Harrisburg, 1944, 22.

[11] Ira N. Gabrielson, *Wildlife Conservation,* (New York, 1941), 313.

To borrow a term from the game managers themselves, public opinion constitutes a *threshold* which effectively controls the application of game-management techniques to public conservation problems. The woods are strewn with the skeletons of conservation projects which have died, not because of any genetic flaw, but through lack of sufficient discriminating public interest and support.[12]

Biologists, in short, once dreamed of solving wildlife problems while the galleries cheered. Wiser now, they see need for "human engineering" as well as better research. So it was that H. Albert Hochbaum of the Delta (Manitoba) Waterfowl Research Station, speaking at the Ninth Midwest Wildlife Conference at Purdue University in December, 1947, addressed his fellow ecologists, not on the management of wildlife, but on "The Management of Man." It is becoming increasingly apparent, he said, that the knowledge and co-operation of the public is of fundamental importance in carrying out a well-rounded conservation program[13].

Mr. Hochbaum's thesis was echoed by Frank H. King, regional co-operative wildlife manager, Horicon, Wis., in a recent issue of the *Wisconsin Conservation Bulletin:*

> The real core of the trouble seems to be that the public does not understand our program and so is not ready to adopt it.[14]

This low public-opinion threshold has been responsible, in the words of Ira N. Gabrielson, "for an appalling waste of conservation funds and effort."[15]

The most common form of this waste is sportsmen's pressure for greater and more liberal harvesting privileges than the con-

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[12] A National Conservation Education Workshop, held June 14 through June 17, 1948, at the Cook County Forest Preserve District, Illinois, under the auspices of the National Committee on Policies in Conservation Education, could come only to this conclusion: "At the present time there is failure on the part of the average citizen to understand the basic facts concerning the wise use of our natural resources, coupled with an individual sense of futility and consequent irresponsibility. This constitutes a serious threat to individual welfare and national survival." *Proceedings of the National Conservation Education Workshop,* Chicago, 1948, 17.

[13] "Most of the resistance to intelligent game conservation programs has come from those who hunt and fish."—Gabrielson, *Wildlife Conservation,* 227.

[14] Frank King, "The Management of Man," *Wisconsin Conservation Bulletin,* August, 1948, 9.

[15] Ira N. Gabrielson, "What Is Wrong With Wildlife Administration?", *Sports Afield,* July, 1948, 40.

dition of the stock will allow;[16] or, contrariwise, sportsmen's opposition to more liberal cropping when ranges become patently over-stocked with ungulates.[17]

Another great waste has come from sportsmen's pressure for indiscriminate artificial propagation and restocking programs which wildlife science has shown in many cases to be uneconomical if not downright dangerous.[18] Wanton predator control is another favorite phobia of sportsmen.[19] Tolerance of incompetent state conservation commissions is another shortcoming.[20]

E. Sydney Stephens, late chairman of the Missouri Conservation Commission, once charged:

> Conservation is a sissy, with ruffled pantalettes, a May basket in her hand, and a yellow ribbon in her hair. The weakness lies primarily with state administration. It's not a pretty picture; in too many cases it's ugly as hell! Of 65 departments in 48 states, only five have a "passing" grade.[21]

The Wisconsin situation was highlighted recently by Gordon MacQuarrie, outdoor editor of the *Milwaukee Journal,* in these words:

> We do wondrous things in Wisconsin. We've got a conservation director responsible for a $6,000,000 budget whom we pay $6,500 a year, less than the salaries of his two

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[16] "A difficulty in the proper handling and utilization of wildlife is often found in the attitude of hunters and fishermen who desire to take more game or fish than the crop available for harvest, regardless of the condition of the breeding stock. . . . It is too common in the abstract to be all for conservation and wise use but in practice to be only for self at the other fellow's expense."—Gabrielson, *Wildlife Conservation,* 126.

[17] "It is my considered opinion that excess deer have, during the past decade, cancelled out all the forestry program of all agencies working in Wisconsin."—Aldo Leopold, "The Deer Dilema," *Wisconsin Conservation Bulletin,* September, 1947, 3.

[18] "All evidence leads to the conclusion that much stocking is unnecessary, uneconomical, or even harmful if the species suited to the environment are already present."—F. A. Westerman and Albert S. Hazzard, *For Better Fishing,* (East Lansing, Mich., 1945), 7.

[19] "Unless the predator scourge and its effect on present game conditions is recognized, we will never again see good hunting. Predator control, and especially a drastic reduction of the fox horde, is the prime factor in any game restoration program. Without it all efforts will fail miserably."—Leo A. Wincowski, "Are Our Wildlife Sanctuaries Simply Free Lunch Counters?", *Outdoors Unlimited,* January, 1949, 1.

[20] "The citizen makes increasing demands for services from his government to help him exist in a 20th century world, and yet his connection with and interest in that same government tends to recede more and more into apathetic separation."—Fred E. Merwin, *Public Relations in Selected Wisconsin Administrative Departments,* unpublished thesis, (Library, University of Wisconsin, 1937), 4.

[21] E. Sydney Stephens, "Where Are We and What Time Is It?", Address, North American Wildlife Conference, St. Louis, 1946.

> assistants. We are losing bright young men in forestry and biology departments of the state because private industry pays them better. We were the last important fishing state in the Union to pass a universal fishing license law. We, the people, persist in a kibitzing program of advising expert game managers that is comparable with a sick person indulging in self-medication. We spend around $50,000 a year trying to feed deer artificially, despite the fact that every other important deer state found out years ago it was money wasted, and quit it. We decline to learn from the experiences of other states. We set up our conservation commission and its department as a convenient whipping boy. We pay bounties amounting in some years (county and state) to about a quarter million dollars on predatory animals, when the truth is that no reputable game man in the country will endorse such expenditure. They all know it is no good. . . . It comes down to this: There are too many self-avowed experts in the Wisconsin conservation picture and the real experts, the trained men, are doing things they do not want to do but are forced to do.[22]

To summarize, it is virtually self-evident that the bottleneck in the conservation of American wildlife today is increasingly less an insufficient research base for operations and increasingly more an insufficient public support of sound management practices.

Fortunately, the public-opinion threshold is not so static as the many thresholds in nature. It is conditioned by the emotion and intelligence of the public.[23] Consequently the opinion threshold can be raised by stimulating the public's awareness and increasing the public's fund of information. In short, by education.[24]

As Chester S. Wilson of the Minnesota Conservation Department has said:

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[22] Gordon MacQuarrie, "Right Off the Reel," *Milwaukee Journal,* January 6, 1948, 34.

[23] "Behind every human act lies an 'emotion' that sets the act going; and behind the 'emotion' lies a 'thought' or an 'idea'. If such survival-emotions as the desire for conservation are to become part of our daily existence, they must be based on knowledge and the thought that stems from it. If we are to make peace with the forces of the earth, that peace must begin in our minds—and we must seek, and accept, many new ideas. We must reject many old ones."—William Vogt, *Road to Survival,* (New York, 1948), 210.

[24] " 'Conservation' has been so long sterilized by isolation from 'education'—when they are in reality inseparable—that many Ph.D.'s are ignoramuses in questions having to do with the land; and a shocking proportion of our State Conservation Commissions are guided by traditions that should have disappeared with the Model T."—*Ibid.,* 313.

> Conservation education will get more results per dollar spent than any other conservation activity.[25]

But what kind of education? The teaching of wildlife conservation in every grade from first to 16th is of course an obvious necessity. Such a course of action will, however, bring results only in the next generation. For results in the present it is the adult population which must be educated, and this can primarily be done only through the public press.

It was E. W. Scripps who wrote:

> It is only through the press—mainly the daily press—of the country that the vast majority of the people of this country receive any information or education at all. It is, therefore, only through the press that the public can be quickly and well instructed on matters of its greatest interest.[26]

The daily newspaper, in other words, is a main channel to the public's thought stream. Stimulation of public awareness and increase of public information through the newspaper—and its attendant magazines and journals—presupposes an ability to write about significant subjects in terms which the public can understand. Unfortunately the situation today in conservation journalism seems to be one in which we have a plethora of journalists with nothing to write about and a paucity of technicians who can write in the popular vein.

On the one hand are the so-called "outdoor writers." E. Sydney Stephens bitingly characterized "98 per cent of them" in these words:

> They apparently don't know what it's all about. They either clip or paste, or they write glowing accounts and publish pictures of what Joe Doakes killed or caught last weekend, which only invites and incites millions of others to go and do likewise. But nary a word about what it takes to put fish in streams or birds in fields.[27]

G. G. Simpson of the American Museum of Natural History has documented the case history of a scientific news story which originated in his office.

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[25] Chester S. Wilson, "New Step in Conservation Education," *Eighth Biennial Report of the Minnesota Department of Conservation,* (Minneapolis, 1948), 32.

[26] E. W. Scripps, quoted in "The Rise of Science Understanding," *Science,* Vol. 108, September 3, 1948, 243.

[27] E. Sydney Stephens, "Where Are We and What Time Is It?", Address, North American Wildlife Conference, St. Louis, 1946.

Out of nearly 100 papers whose stories finally come back to him, only about one-tenth had reports that were neither seriously wrong scientifically nor obnoxious to him personally.[28]

He comments:

> In view of the great need for popular presentation of the results of research, and in view of the mechanisms set up for this purpose and used in this case, this is a serious matter despite its humorous side. It is fairly typical of what still happens to scientific news.

On the other hand are the conservation experts, most of whom, according to Russell Lord, editor of *The Land,* write in "a rather spurious or pretended jargon of objectivity which they impose upon themselves as a mark of scientific respectability."[29]

Clarence Cottam of the U. S. Fish and Wildlife Service put it this way at a recent Midwest Wildlife Conference:

> Research reports are too often written in a lingo the public cannot understand and in such a manner that they are worthless unless interpreted by someone else capable of writing and speaking to the public. . . . We need better public appreciation of the importance of research as a foundation for practical information and management. The results of technical research should be popularized.[30]

Perhaps one telling example of what Mr. Cottam is talking about might well be cited. Prof. Paul L. Errington of Iowa State College last year wrote a prize-winning learned paper on "Predation and Vertebrate Populations." Mr. Errington's theme should come to the immediate attention of the sporting public, since he pooh-poohs the popular conception that predator control is the alpha and omega of game management. Yet here is the conclusion of Errington's essay, couched in such diverse terminology that I suspect even some experts are probably hard-pressed to follow it:

> On the whole, in view of the human tendencies to overestimate the population effects of conspicuous or demonstrably heavy predation, something of a scaling down of emphasis should well be in order, notably in appraising the

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[28] G. G. Simpson, "The Case History of a Scientific News Story," *Science,* Vol. 92, August 16, 1940, 150.

[29] Russell Lord, quoted in "Technical Journalists Wanted, Survey Shows," *The Quill,* September–October, 1946, 10.

[30] Clarence Cottam, quoted in "The Management of Man," *Wisconsin Conservation Bulletin,* August, 1948, 9.

> role of direct predation in the population mechanics of higher vertebrates. Thresholds of security and their associated inverse relationships between the numbers of adults resident and the numbers of young produced or tolerated are frequently suggested by the published data, and these in turn quite evidently operate in conjunction with characteristics of habitat and with "cyclic" and other depression phases; but the patterns revealed may look remarkably little influenced by variations in kinds and numbers of predators. Even in equations depicting predator-prey interactions in lower vertebrates, loss types may substitute naturally for each other instead of pyramiding, and compensatory reproduction should not be ignored when a resilient instead of a rigid fecundity is indicated.[31]

Dr. Errington, in other words, needs a translator just as much as if he were writing in Arabic. And it would not be amiss to point out here that Dr. Errington does have a translator. The Conservation Commission with which he works, through illustrated weekly releases and spot news stories to the press, reaches thousands of people daily. *The Iowa Conservationist,* a monthly magazine with an issue of 22,000 copies, is sent free to all county superintendents of public schools for distribution to rural schools, free to many libraries and other public places, and by cost-subscription to many citizens. Certainly this program of public education has had a part in making possible a unique Iowa legislative act embodying the principle of biological balance as applied to wildlife.[32]

What is here implied is that the key public support for wildlife conservation can be enhanced by a combination of bringing the ideas of the experts down to the level of the sportsman's grasp and bringing the sentiments of the sportsman up to the plane of management's possibilities. This meeting of minds can be substantially aided by a wildlife story translator, he being either a journalist with a technical background or a biologist with a flair for popular writing.[33]

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[31] Paul L. Errington, "Predation and Vertebrate Populations," *The Quarterly Review of Biology,* Vol. 24, No. 2, June, 1946, 177.

[32] George Hendrickson, "Some Accomplishments of Conservation Education in an Intensively Agricultural State," *Transactions of the Ninth North American Wildlife Conference,* (Washington, 1944), 345.

[33] "Is there a great need for writers who have both journalistic ability and the proper training in the technical fields? An emphatic 'yes' was given by the editors of 31 of the nation's leading agricultural and conservation magazines in their answer to this question in a survey of 50 periodicals made by the author last summer."—Robert W. Shaw, "Technical Journalists Wanted, Survey Shows," *The Quill,* September–October, 1946, 10.

That such combinations are within the realm of possibility is testified by present evidences in the public prints. Certainly Harold Titus' "Old Warden" series in past *Field & Streams* and the "Running Sores on the Land" series in 1948 issues of *Sports Afield* are prime examples of the journalist turned scientist. On the other hand, in the profession of wildlife management, and on its fringes, are a growing number of scientists with literary bents; Frazier Darling, Durward Allen, D. C. Peattie, Albert Hazzard, for instance.

"These intergrades in human taxonomy," wrote Aldo Leopold, "are perhaps more important than those which so perplex the mammalogists and ornithologists. Their skulls are not yet available to the museums, but even a layman can see that their brains are distinctive."[34]

SUMMARY

If, then, wildlife conservation is in large measure a problem in the management of man,[35] and if the management of man involves the successful translation of the message of wildlife science into the jargon of the sportsman, what are some of the fundamental problems in wildlife-conservation journalism?

They seem to me to include these two:

First, what are some of the principles which should underly the interpretation of wildlife science?

Second, what is a sound wildlife-conservation journalism policy for the future?

To the answering of these questions this paper is devoted.

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[34] Leopold, "The State of the Profession," *The Journal of Wildlife Management,* 233.

[35] This is not to say, of course, that all wildlife research knots are tied. For example:

"We patrol the air and the earth, but we do not keep filth out of our creeks and rivers. We stand guard over works of art, but species representing the work of aeons are stolen under our noses. In a certain sense we know more about the fires that burn in the spiral nebulae than those that burn in our forests. We aspire to build a mechanical cow before we know how to build a fishway, or control a flood, or handle a woodlot so it will produce a covey of grouse."—Leopold, *Game Management,* 7.

PART II

WILDLIFE-CONSERVATION JOURNALISM PRINCIPLES

INTRODUCTION

Newspapers of Friday, January 10, 1947, carried a United Press dispatch datelined Washington, D. C., which read in part:

> An army of more than 12,000,000 hunters and fishermen is rapidly depleting some species of wildlife, the Fish and Wildlife Service warned today. In its annual report on wildlife conditions, the Service called for "the most careful planning and the most unremitting effort," to prevent serious damage to the nation's fish, fowl and wild animals.[1]

Thus are we of the "enlightened" 20th century well on the way to seeing repeated on a grand and terrible scale the mass murder of bison and passenger pigeons.

There is only one thing that will save American wildlife as we know it and that is nothing less fundamental than a revolution in the spirit of the American outdoorman, a revolution which will change every American hunter and fisherman from a consumer of wildlife goods to a producer of wildlife appreciation, a revolution which increases his perception and decreases his trigger-itch.[2]

This job of remaking the American sportsman is a tough assignment. It is a job in which the wildlife-conservation journalist must play an important part. Because it is such a grass-roots proposition, it involves more than a mere facility with the techniques of interpretation.[3] It involves at least a vague idea of what the mission is all about; a conservation philosophy, if you please.[4]

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[1](Madison), *Wisconsin State Journal,* Jan. 10, 1947, 1.

[2]"Conservation must exist in the mind before it exists on the land."—Ollie E. Fink, *The Gateway to Conservation,* (Columbus, Ohio, 1946), 9.

[3]"In self-education, in the schools, in the public forum, and in the whole communication process of our time it is essential that the wise use of natural resources becomes more than a catch-phrase, more than a byword, more than a 'subject' of study. . . . Conservation must now enter the required core of human experience." —Association for Supervision and Curriculum Development of the National Education Assn., *Large Was Our Bounty,* 1948 Yearbook, (Washington, D. C.), 146.

[4]"Uses to which man puts the environment are determined not alone by his skills. Even more those uses are determined by what he believes, and thinks, to be valuable. If we consider that our own generation is the ultimate value, we will have little concern for the future, even for the future of our own children. If we consider that our own individual good is the chief good, we shall attempt to

What are the principles which must motivate and make up any real conservation journalism program? To the answering of that question this chapter is devoted.

DISCUSSION

Conservation Perspective. Conservation has three prime facets—public administration, biology, journalism. Conservation has a history. For the wildlife-conservation journalist in Wisconsin, for instance, these facts should shape up into the following outline:

I. Conservation history as a political scientist sees it.

1838 Fishways required in all dams "except mill dams." Probably first conservation law.
1851 First closed seasons (on deer, prairie chicken, quail, woodcock, and ruffed grouse).
1867 Commission appointed to investigate forestry conditions.
1891 Office of State Game Warden established.
1893 Prohibition of spring shooting made conditional upon like action by adjacent states (which was never taken).
1895 Office of Commissioner of Fish and Fisheries established.
1897 Resident and non-resident licenses required.
1901 First state park purchased in Polk County.
1901 Passed Audubon Society "model law" protecting non-game birds.
1907 State Park Board established.
1911 First Conservation Commission established.
1912 Buck law passed.
1915 Federal migratory bird regulations in effect.
1927 Commission reorganized on "commissioner-director" plan.
1927 First national forest purchase area set up in Wisconsin.
1933 Commission given power to set all game open season dates.
1934 Conservation Congress organized.
1938 Federal aid for wildlife becomes available through Pittman-Robertson Act.
1939 State Planning Board issues study on Horicon Marsh.[5]

II. Conservation history as a biologist sees it.

1832 Last buffalo east of Mississippi killed in Trempealeau County.
1840 Sharptails "extremely abundant" in southern Wisconsin.

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accumulate wealth, or money, and therefore power clear beyond any needs of our own, largely for the purpose of satisfying our urge for dominance by controlling the destiny and lives of others. Ultimately, the wise use of resources depends upon the creed we live by, the ethics that guide our conduct, our essential sense of stewardship."—Edward G. Olson, "Educating for Social Perspective," *NEA Journal*, Vol. 31, No. 9, December, 1942, 277.

[5] Aldo Leopold, "Wisconsin Wildlife Chronology," *Publication 301*, Wisconsin Conservation Department, (Madison, 1940).

1856 Last Wisconsin turkey killed in Grant County.
1871 Last great Wisconsin meeting of passenger pigeon; covered 850 square miles and contained 136 million pigeons.
1875 First state fish hatchery.
1876 Barbed wire fencing first available in quantity.
1878 Dr. E. A. Birge started his study of Wisconsin lakes.
1879 Carp introduced into Wisconsin by U. S. Fish Commission.
1897 Wisconsin Geological and Natural History Survey established.
1899 Last Wisconsin passenger pigeon shot in Wood County.
1910 Gustav Pabst began planting pheasants and Hungarian partridge in Waukesha County.
1921 H. L. Stoddard employed by Milwaukee Public Museum.
1928 Conservation Commission started game farm and began statewide public planting of pheasants.
1928 Research committee appointed by Conservation Commission and prairie chicken investigation gets underway.
1929 Sporting Arms and Ammunition Institute started game survey of Wisconsin.
1933 AAA and CCC start soil conservation and stream improvement work.
1933 Chair of game management established at University of Wisconsin.
1940 State takes 95-year lease on Central Wisconsin Conservation Area.
1941 Conservation Department, with federal-aid funds, begins research projects on deer, pheasant, grouse, and waterfowl.[6]

III. Conservation history as a journalist sees it.

1867 Statute requiring county treasurers to publish the game laws yearly in local papers.
1873 First state association for preservation of game.
1910 Van Hise published *Conservation of Natural Resources*.
1910 Dean Russell instituted forestry-game course in University of Wisconsin short course.
1920 Friends of Our Native Landscape organized.
1922 First Izaak Walton League chapters founded at Milwaukee and Fond du Lac.
1929 State Federation of Women's Clubs start conservation work.
1935 Teaching of conservation made compulsory in public schools.
1936 *Wisconsin Conservation Bulletin* first published by Conservation Department.
1939 Wisconsin Society of Ornithology organized.
1946 Four-year conservation course for teachers set up at Central State Teachers College, Stevens Point.
1947 Conservation major established at University of Wisconsin.[7]

One-World Conservation. The subject of conservation means one thing here and another thing there. To the hunter it means

[6] Aldo Leopold, *op. cit.*
[7] Aldo Leopold, *op. cit.*

simply stocking pheasants on barren uplands. To the farmer it means drawing a check for not planting corn on a slope. To the botanist it means protecting a last stand of ladyslippers.

Actually, conservation is one of the all-embracing words in the richest of all languages, and a crying need in wildlife-conservation journalism is to get across the universal one-world concept of conservation.[8]

Let us see how the National Committee on Policies in Conservation Education defines the term.

"Conservation," says the Committee, "is the use of natural resources in such a way as to contribute to the best possible future welfare of mankind. Essentially it is good citizenship applied to the use of natural resources. It must deal with soil, water, forests, grasses and other vegetation, all wild animals, minerals, and scenic resources."[9]

Conservation was at one time synonymous with preservation —"thou shalt not." Then it came to mean planting a tree on Arbor Day or hatching fish to be placed in muddy and polluted streams. Today conservation means predominantly "wise use." It means the "preservation and restoration of our forests, control and augmentation of our water supply, and the preservation and restoration of our soil," according to Louis Bromfield.[10]

The soil is basic. Sportsmen, particularly, are prone to ignore this fact. Yet hunting and fishing, as such, are strictly secondary.

"We know that if we are to have a strong, healthy, and prosperous America," says William Voight, Jr., of the Izaak League, "we must take proper care of our soil, its beneficial vegetation, water, and other renewable resources. Without these, the whole country will be reduced to helplessness in no time. With them in good shape, we will also have decent hunting and fishing as welcome by-products."[11]

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[8] "The whole meaning of the American problem will be missed unless all resources are studied, and then not only as separate areas but also in their functional interflow. That is why the integrated approaches of both science and social studies are essential to the development of social perspective in children and adults alike."—Edward G. Olson, "Educating for Social Perspective," *NEA Journal*, Vol. 31, No. 9, December, 1942, 278.

[9] National Committee on Policies in Conservation Education, *Report*, (Chicago, 1948), 2.

[10] Louis Bromfield, "A Primer of Conservation," *Bulletin of the Garden Club of America*, November, 1942, 7.

[11] William Voight, Jr., Personal Communication to Author, November 12, 1948.

To say that wildlife cannot be managed properly except as it relates to land use is but another way of stressing the dependence of wildlife upon environment. The way we manage the land determines whether wildlife shall have a place.

In the words of the Soil Conservation Service's Edward H. Graham, "When we have accomplished land conservation, we shall have gone a long way toward achieving wildlife conservation."[12]

This is the Number One conservation lesson for America's sportsmen to learn.

The cause needs a discussion and analysis of what constitutes whole conservation, not in terms of duck hunters, or fishermen, or bird lovers, or foresters, but in simple, general terms of man's existence in relation to soil, water, and vegetation.

The editor of the *Journal of Forestry* writes in a recent editorial of "One Forest World."[13] But our world is not alone "One Forest World;" it is also "One Wildlife World," "One Soils World," or better than all of these simply "One World," having regard for all resources, organic and inorganic, and all the people.

Even the Congress of the United States has had this universal aspect of conservation called to its attention in 1948 by Bill HR 6054, introduced by Chairman Clifford R. Hope of the House Committee on Agriculture.[14]

The bill would centralize and integrate all federal conservation activities.

"The economy of nature," declares Representative Hope, "is not divided into parts labeled 'soil conservation,' 'forestation,' 'watershed protection' and 'agricultural production'. It is one big proposition."

What this means in terms of conservation journalism is that the subject should be presented in terms of its total and not in terms of its details. The objective is to teach the reader to see the land, to understand what he sees, and enjoy what he understands. Wildlife, for instance, cannot be understood without understanding the landscape as a whole. The sciences and arts of conservation must not be discussed as if they were separate.

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[12] Edward H. Graham, *Land and Wildlife*, (New York, 1943), p. 219.
[13] Editorial, "One Forest World," *Journal of Forestry*, 43, 1945, 469.
[14] "Bill HR 6054," *Outdoors Unlimited*, April, 1948, 7.

The one-world nature of conservation also means that the subject cannot be presented in a vacuum. It should be integrated throughout other news, not presented as a separate package.[15]

Conservation Citizenship. A basic defect in current conservation journalism is that we have not asked the citizen to assume any real responsibility, to display any personal code of ethics. We have told him that if he will vote right, obey the law, join some organizations, and practice what conservation is profitable on his own land, that everything will be lovely; the government will do the rest.

This formula is too easy to accomplish anything worth while. It calls for no effort or sacrifice, no change in our philosophy of values.

Leopold called what is lacking "the ecological conscience."[16] Biology is the science of communities, he said, and the ecological conscience is the ethics of community life. It is citizenship applied to conservation.

This simply means that the practice of conservation must spring from a conviction of what is ethically and esthetically right, as well as what is economically expedient. A thing is right only when it tends to preserve the integrity, stability, and beauty of the community, and the community includes the soil, waters, fauna, and flora, as well as people.

Simply put, we need a code of decency for man-to-land conduct.

"We must cease being intimidated," declared Leopold, "by the argument that a right action is impossible because it does not yield maximum profits, or that a wrong action is to be condoned because it pays. That philosophy is dead in human relations, and its funeral in land-relations is overdue."[17]

Thus, agrees Professor Howard Michaud of Purdue, the primary objective of conservation education is to develop "a conservation consciousness" that will safeguard the resources upon which this nation depends for its high standards of democratic living.[18]

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[15] Izaak Walton League of America, *Education in Conservation,* (Chicago, 1944), 9.

[16] Aldo Leopold, "The Ecological Conscience," *Wisconsin Conservation Bulletin,* Vol. XII, No. 12, December, 1947, 15.

[17] Aldo Leopold, *op. cit.*

[18] Howard H. Michaud, "The Indiana Conservation Education Camp for Teachers," *School Science and Mathematics,* Feb. 1947, 141.

In other words, the end purpose of conservation journalism must be to show the citizen that conservation is impossible so long as land-utility is given blanket priority over land-integrity. It will be his personal philosophy of land use, as well as his vote and his dollar, which will ultimately determine the degree to which the conservation idea is converted from preachment into practice.

Vital Nature of Conservation. "Conservation," says E. Sydney Stephens of Missouri, "is a sissy, with ruffled pantalettes, a May basket in her hand, and a yellow ribbon in her hair."[19]

We must begin to emphasize the life-and-death nature of conservation. Against a background of war, we must prove that democracy can use its land decently.

The high standard of living that exists in the United States today is based on an unparalleled abundance of natural resources and partly on their irrational and irresponsible exploitation. These capital assets are being dissipated at an alarming rate. History records many peoples that have been reduced to poverty or obliterated because of exploitation of natural resources. Nature does not issue a blank check.

These are the hard facts of life that must be presented as conservation. Milk-and-water bird studies, flower-pressing, and hunting and fishing chit-chat are not enough.

"The public has been misled by constant emphasis on the inexhaustible magnitude of the riches of our continent and the wisdom of getting a share at once," says the National Wildlife Federation. "The folly of such a policy is already demonstrated by the rapid exhaustion of valuable resources and by the waste due to lack of proper management."[20]

"Go and use carefully" must replace "Come and get it" as our national motto.

Conservation Simplicity. Conservation, at heart, is not technically complicated. Any attempt to make it so defeats the purpose of conservative journalism. Conservation should be presented in terms of simple interests, skills, morals, and psychology.

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[19] E. Sydney Stephens, "Where Are We and What Time Is It?", Address, North American Wildlife Conference, St. Louis, 1946.

[20] National Wildlife Federation, *Conference on Education in Conservation*, (Washington, D. C., 1939), Foreword.

Conservation is best born of curiosity and pride. The 4-H boy who becomes curious about why red pines need more acid than white is closer to conservation than he who writes a prize essay on the dangers of timber famine.[21]

Conservation journalism must deal with local situations. John Caldwell of the Tennessee Department of Conservation tells this story:

> Here is a picture which I wish all of you could see. It is a little country schoolhouse with three rooms, and in the front you see the land cut up with gullies. One day not long ago I stopped by that school and asked the teacher if she taught conservation. She was rather apologetic. She replied in the negative, saying that she did not teach it as she did not have any materials. Yet there were the materials right outside the school door, a whole laboratory for the children.[22]

Indiana provides another example of the laboratory-at-hand. It is the Wabash Valley. Any child can understand that the song, "On the Banks of the Wabash," must have been written long ago when the cornfield and the pasture and the pig pen did not crowd the very underbrush off the banks and spill earth and manure into the water itself.[23]

Conservation education must deal with living nature. The great naturalist Agassiz was fond of admonishing his students to "study nature and not books." In too many schools today, students learn from picture books of plants and animals, or in labs from dead and distorted specimens. The need is to turn back to the outdoors.

Professor E. Lawrence Palmer of Cornell tells of a young man who had been offered a position as a biology teacher in a normal school and came back thoroughly disgusted because the school had only nineteen compound microscopes. The young Ph.D. was appalled by the suggestion that the students might get better training in practical biology if the whole nineteen microscopes were thrown out the window and the students went outside, too.[24]

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[21] Aldo Leopold, "The Role of Wildlife in a Liberal Education," *Transactions of the Seventh North American Wildlife Conference,* (Washington, D. C., 1942), 485.

[22] John Caldwell, "Conservation Education in Tennessee," *Conference on Education in Conservation,* (Washington, D. C., 1939), 28.

[23] Clement T. Malan, *Conservation of Water,* (Lafayette, Ind., 1946), Foreword.

[24] E. Lawrence Palmer, *More Outdoor Education,* (Ithaca, N. Y., 1947), 39.

Conservation journalism must be liberal as well as technical. We have about enough conservation experts. We need many more conservation laymen.

Conservation journalism ought to begin at the bottom. The chances are almost one hundred to one that even today's experts arrived at their present stage through a long, slow process starting from a casual acquaintance with some minor, non-technical phase of conservation. The next decade's conservationists are seeded with scrapbooks and cane poles, and not with graphs and high-powered binoculars.[25] The difference between the hunter and the ecologist is one of degree and not of kind. Trigger-itch is the raw material out of which outdoor perception is built.

The Wisconsin teacher's guide to conservation has summed these principles of elementary ecology up very nicely:

> Conservation is not a single subject. It is an area of learning, and a way of living. Its facts are found in the sciences, and its applications extend into all fields of study. That instruction which contributes to good citizenship will contribute most to conservation. The involved and specialized aspects of such a vast area of learning cannot be grasped by children. The teacher must so present the work that the pupils will see in their communities and their daily living the facts for the principles of conservation. They must so teach that the pupils will see the effects of soil erosion in the muddy water of the stream, and the gully on the hillside. Here is an opportunity to develop an appreciation and an understanding of national problems from the local experiences of the pupils.[26]

Conservation Facts. Here are some of the formulas which must take precedence in any conservation arithmetic lessons:

1. An understanding of the fundamental concepts of the conservation movement.[27]
   a. That, as we have already said, soil, water, forest, and wildlife conservation are all parts of one inseparable program.
   b. That wildlife must have an environment suited to its needs if it is to survive.

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[25] Curtis L. Newcombe, "The Study of Conservation," *The Journal of Higher Education,* Vol. XVI, No. 6, June, 1945, 299.

[26] Wisconsin Department of Public Instruction, *Helps in Teaching Conservation in Wisconsin Schools,* (Madison, 1938), 11.

[27] Michigan State College Extension Division, *Wildlife Conservation,* (East Lansing, 1942), 7.

   c. That any use that is made of any living resource must be limited to not more than the net annual increase if the essential seed stock is to be continually available.

2. A knowledge of the conservation program in general.[28]
   a. That these facts are self-evident — (1) primitive America was richly endowed with natural resources; (2) in the process of economic development, a part of this great stockpile is being destroyed.
   b. That these facts are demonstrable—(1) many kinds of wildlife, for instance, can be made to thrive on land in economic use; (2) many more can be accommodated on land not needed for economic use; (3) the ways to dovetail economic use with conservation can be found by research and made known by education; (4) the time for action is now.

3. An appreciation of the fact that the primitive conditions of the America of 1500 cannot be restored and that the job now is to repair the damage as far as possible and put natural constructive processes back to work.[29]

4. A belief that to promote perception is the only truly creative part of recreational development in America.[30]

5. A realization that we can only co-operate with nature, not conquer, if we are to survive in a world where the land is the most precious and most fundamental basis of our economy.[31] Civilization is not an enslavement of a constant and stable earth. We cannot pacify the earth. She will not be "occupied." We can only strive to enter into harmonious relationship with her.

   The natural resources of our country are like money in the bank. They may be:

   a. Hoarded without benefit to commerce.
   b. Expended unwisely, resulting in economic chaos.
   c. Used to enrich a few at the expense of many.
   d. The primary cause of national and international strife.

   Or:

   a. "Developed" for the benefit of commerce.
   b. "Distributed" equitably and carefully.

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[28] University of Wisconsin, *Conservation of Wisconsin Wildlife,* (Madison, 1937), 5.

[29] *Ibid.*

[30] Aldo Leopold, "Conservation Esthetic," *Bird-Lore,* March–April, 1938, 101.

[31] U. S. Office of Education, *Conservation in the Education Program,* (Washington, 1937), 18, 19.

c. Considered, as far as possible, the heritage of all the people.
d. Used in such a way as to alleviate, if not abolish, national and international strife.

Upon the solution of these problems depends the spiritual as well as the material welfare of the people of the United States.

6. A conviction that conservation is not alone something we do; it is something we feel. When conservation becomes a kind of thinking, a way of life, it takes on real and substantial meaning.[32]

"Conservation education," wrote Aldo Leopold shortly before his death, "reminds me of my dog when he faces another dog too big for him. Instead of dealing with the dog, he deals with a tree bearing his trade-mark. Thus he assuages his ego without exposing himself to danger.

"Just so we deal with bureaus, policies, laws, and programs, which are the symbols of our problem, instead of with resources, products, and land-uses which *are* the problems."[33]

Conservation journalism is a matter of survival. Humanity must produce and conserve, or starve. It is conservation or catastrophe.

Conservation journalism is a matter of the good life. Wise use of natural resources is essential to the health, wealth, and happiness of people everywhere.

Conservation journalism is a matter of our natural heritage. Our duty is to repair, maintain, and improve the natural endowment intended for future generations.

Time is running out. For educators, scientists, clergymen, writers, sportsmen, businessmen, politicians, and laymen everywhere, conservation journalism in sufficient volume and of discriminating content is a "must" project.[34]

SUMMARY

The real future of American wildlife lies not in patching up an ailing environment, in mammoth restocking enterprises, nor in helter-skelter game laws, but in so reshaping the American

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[32] Fairfield Osborn, *Our Plundered Planet,* (New York, 1948), 256.

[33] Aldo Leopold, "Land-Use and Democracy," *Audubon Magazine,* September–October, 1942, 313.

[34] Clay Schoenfeld, "Reading, Writing, and Resources," *Hunting and Fishing,* March, 1949, 13.

sportsman's sense of values that he will go afield to give instead of take, to produce a new perception of his surroundings rather than to consume its crops. Conventional conservation techniques can be only a stop-gap. They will not long withstand the onslaught of 12,000,000 gunners and anglers. Only a reorientation of the sporting spirit will save our wildlife.[35] To say that such a reorientation involves a whole change in the American approach to life does not erase the necessity of the revolution. The immensity of the job is equalled only by the need.

Only the wildlife-conservation journalist motivated by a sound philosophy can make a worthwhile contribution to conservation. He should see that the net purpose of all conservation writing is not the bulging creel nor the motorized conquest of the corners of the country, but is a veritable revolution which will change every American hunter and fisherman from a consumer of wildlife goods to a producer of wildlife appreciation—a revolution which increases his perception and decreases his trigger-itch.

PART III

WILDLIFE-CONSERVATION JOURNALISM POLICIES

INTRODUCTION

So far, we have seen wildlife conservation defined as in large part a journalistic problem. We have outlined principles for wildlife-conservation journalism. What is the upshot? What course of action does this situation-estimate suggest? This chapter presents a point-by-point recapitulation of the case to date and a list of recommended policies for the future.

DISCUSSION

1. Wildlife conservation, wise wildlife-resource use, fish and game management—call it what you will—is essentially the art-science of growing wildlife crops for recreational purposes.[1]

2. Wildlife conservation techniques differ widely in detail, but all are bent to two ends: the preservation of an adequate

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[35] Fallsburgh Central Schools, *A Course in Angling* (Fallsburgh, N. Y., 1948), 3.

[1] Aldo Leopold, "Game Management," *Encyclopaedia Britannica,* (New York, 1947), reprinted.

breeding stock, and the creation of a favorable habitat in which the stock may multiply.[2]

3. Since favorable wildlife habitat naturally involves soil, water, flora, and other fauna, all renewable natural resources must here be considered in unity rather than as entirely separate categories.[3]

4. Man is also a part of the wildlife environment, and since his role is anything but passive, the management of fish and game inevitably involves the management of man.

5. In the era in which wildlife conservation was limited largely to the restriction of take of naturally propagated fish and game, this management of man consisted almost entirely of laws prohibiting excessive hunting and fishing. As wildlife conservation moved into the stage of artificial propagation, the management of man came to include the encouragement of various stocking enterprises. Today the wildlife conservation scientists know that laws and restocking are either without fundamental value or are in themselves not enough to conserve fish and game.

6. Consequently, the management of man must now take on new ramifications. It must develop (a) a deep sense of wildlife husbandry on the part of the landowner and/or the land-controller, (b) the perceptive faculty in all Americans and particularly in consuming sportsmen,[4] and (c) the receptivity of landowners and land-users alike to scientifically sound, albeit at times traditionally puzzling, techniques of wildlife management.[5]

7. Hence the conservation of wildlife and its attendant management of man have passed to a considerable extent out of the exclusive realm of the law courts and the laboratory and into the realm of education.

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[2] *Ibid.*

[3] Fairfield Osborn, *Our Plundered Planet,* (New York, 1948), 60.

[4] "The only true development of American . . . resources is the development of the perceptive faculty in Americans. . . . Let no man jump to the conclusion that Babbitt must take his Ph.D. in ecology before he can 'see' his country. On the contrary, the Ph.D. may become as callous as an undertaker to the mysteries at which he officiates. . . . The farmer may see in his cow-pasture what may not be vouchsafed to the scientist adventuring in the South Seas."—Aldo Leopold, "Conservation Esthetic," *Bird Lore,* March–April, 1938, 103.

[5] "There is need for wider diffusion of scientific knowledge, scientific appreciations, and scientific attitudes among all classes of the population. . . . The need is to sell science to the public, to convince the public that science is important and valuable, and to help people assimilate whatever benefits scientific attitudes and practices may yield, through the acceptance and use of science in daily thinking." —Benjamin G. Gruenberg, *Science and the Public Mind,* (New York, 1935), 180.

8. Wildlife-conservation education can be conducted at the youth level principally in school and college classrooms and at the adult level principally through the public prints.

9. In both cases, although particularly in the latter, there is a transcendant need for the interpreter, who can translate the message of wildlife science into the idiom of the layman,[6] and for abundant vehicles for his output.[7]

10. It is apparent from past experiences that this successful wildlife-conservation translator cannot, except in rare cases, himself be a practicing scientist with no training or prior experience in the techniques and demands of popular writing.[8, 9]

11. It is equally apparent from past experience that this successful wildlife-conservation translator cannot, again except in rare cases, himself be a practicing journalist with no technical background.

12. There is, however, evidence that, by what might be called natural propagation in the wild, it has been possible to produce educators (using the term broadly) possessing that happy combination of scientific knowledge and journalistic proficiency.

13. But such purely fortuitous production of wildlife-conservation interpreters is not sufficient to meet modern needs. How, then, are we, by what might be termed artificial propagation in

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[6] ". . . The preparation of information for popular use requires the services of a trained specialist—a specialist not only with a facility for explaining scientific facts in plain readable, accurate language, but with breadth of view, an aptitude for organization, and a keen and accurate understanding of human nature."—C. W. Warburton, "The Agricultural College Editor," *Extension Service Circular* 131, (Washington, D. C., 1930), 1.

[7] Of the 32 articles on science in *Saturday Evening Post* issues for the year 1947, not one had even the remotest connection with wildlife science.

[8] "The proper appreciation and application of new discoveries is being hindered at present by increasing specialization, employing a terminology and a mathematic apparatus which are intelligible only to a few specialists in some one subject. Anyone who has completed a piece of research may think it necessary to set out his facts for the use of the expert who is working in the same subject, and is familiar with the technical terms and hidden difficulties. Yet such writings make dull and difficult reading for the great majority of those who are interested in scientific study."—Sir William Bragg, "The Unity of Knowledge," *Nature,* March, 1939, 392.

[9] "The failings of scientists in regard to the effective popularization of science are these:

"1. Most investigators do not write effectively, either because they cannot or because for various reasons they will not use a style that appeals to the masses.

"2. Scientists as a class regard with anxiety and distrust the efforts of laymen to present the findings of science in popular fashion, and some go so far as to refuse altogether to co-operate with newspapermen.

"3. A minority of researchers care little what the public thinks of their work, have no faith that the masses can be instilled with appreciation for science, and consequently are out of sympathy with efforts to popularize it."—Nieman Hoveland, *Popularizing Science,* unpublished thesis, Library, University of Wisconsin, 1947, 18.

confinement, to produce wildlife-conservation interpreters in adequate volume and quality?

14. The possibilities, it seems to me, are fourfold:

a. For going outdoor writers, we can set up in strategic spots around the country special institutes, seminars, and conferences which will offer—in capsule form, it is true—courses in the basic and applied sciences of fish and game management.

b. For going wildlife scientists and administrators, we can likewise offer introductory courses in journalism and public relations.

c. For student journalists, we can provide both general curricula in conservation sciences and specific courses or phases of courses in science reporting.

d. For student biologists, we can provide custom-built courses in popular writing and public administration.

15. The net effect of such a dual approach should be to develop journalists with something scientific to write about and scientists with at least some ability to write in the popular vein; and who can co-operate with each other.[10]

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[10] A good summary of the matters that must be borne in mind in order to achieve co-operation between journalists and scientists is made by the managing editor of the *Buffalo Evening News* (who undeniably is somewhat biased in favor of the press):

"The first thing we must recognize is that, in spite of the progress which has been made in more accurate reporting of scientific, educational, and allied activities, there are many in these fields who give little or no credit to the newspapers for what has been accomplished, and by their critical attitude toward newspapers as a whole, without being specific in their objections, make for misunderstanding rather than the co-operation which is essential to still more accurate and sympathetic reflection of the view-points of the specialists.

"It is equally true that, under the sting of some of this lament and criticism, there are newspapermen who demonstrate their impatience by an aloof attitude, so that the net result is to create an atmosphere in which it is impossible to carry on constructive work. We must have tolerance, patience, and understanding on each side. I am certain that you will find newspapermen ready to respond to any reasonable overtures. I think there is work to be done in both fields to bring about a clearer understanding of our respective view-points and aspirations, as well as limitations.

"Many, if not most, newspapermen are socially minded; they sympathize keenly with the scientist who wants his work and that of his associates intelligently interpreted to the public, but in making that possible the scientific group must come out of their shells; they must take a human as well as a scientific view-point; they should have some insight into the newspaper outlook and at least give the newspaper credit, until he proves otherwise, for knowing something about his own job.

"The scientist frequently would appear just as ridiculous if he attempted either to write a newspaper story or operate a paper as the newspaperman often appears to him, when he attempts to explain for the benefit of the lay reader some of the things which even scientists do not understand or about which they disagree. Nevertheless, I observe that some scientists think they know all about newspaper

16. The number of American institutions where such a program could be effectively initiated is limited in all probability to those which have on one campus a reputable school of journalism and a recognized department of wildlife management. The University of Wisconsin is a convenient example.

17. To be specific, I propose the following wildlife-conservation journalism policy for the University of Wisconsin:

a. An annual two-week summer institute for outdoor writers of the Middlewest (possibly in conjunction with an institution for teachers), staffed by experts in the fields of soil, water, flora, forest, fish, and game conservation.
b. A continuing series of late-afternoon or night conferences for the professors in the conservation sciences, conducted by experts in the fields of science reporting and public relations.
c. A double-major sequence leading to the degree of B.S. in Science–Journalism for a select number of students, combining the present journalism curriculum with the present major in the biological aspects of conservation,[11] to include an undergraduate seminar in wildlife-science reporting.
d. A share of the journalism course in advanced feature writing (Journalism 105b) devoted to science interpretation.
e. A share of the journalism courses in public relations (Journalism 125 and 221) devoted to science public relations.
f. A share of the journalism course-phase in sports writing (Journalism 2) devoted to outdoor writing.
g. A share of a projected course in advanced reporting devoted to science writing.
h. A share of the journalism course in trade journals and house organs (Journalism 117) devoted to the federal and state bulletin.

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work as well as their own. My experience has indicated that the man who is willing to take time and patience to explain a story to a reporter, who is not a specialist in the same field, usually fares very well in having it reported as he would like to have it presented to the public.

"Too often the scientific man thinks wholly in terms unrelated to those in which he is approached by a reporter who wants a story about the matter in hand. The problem is to reconcile divergent view-points; to force both from a high-horse attitude; to bring about mutual respect. Surely, the scientist knows his subject better than the reporter. On the other hand, the reporter knows his limitations of time and space under which he has to work, and should have a clearer idea of how to explain what he has learned to the public."—A. H. Kirchofer, *Science,* 76 : 1964, Aug. 19, 1932.

[11] University of Wisconsin, *Bulletin,* "College of Letters and Science, Announcement of Courses, 1948–1950," (Madison, 1948), 62.

i. A continuation of the present School of Journalism fellowship in science reporting with occasional encouragement given to the applicant who wishes to specialize in the interpretation of wildlife conservation.
j. Encouragement of continued graduate research in the field of wildlife-conservation journalism.[12]
k. A course in popular writing and public relations for majors in the biological sciences.
l. A series of publications, suitable for school, press, library, and controlled distribution, on the conservation of Wissin's natural resources.
m. An expansion of the wildlife-management section in the semi-annual report of the Agricultural Experiment Station.[13]

18. Undergirding such a strictly wildlife-conservation journalism policy would of course be an expansion of teaching, research, and public service in all lines of the conservation sciences.

19. Underlying the instruction in all conservation-journalism courses should be this philosophy: that there is no such thing as good English in the abstract, but that there are kinds of English that are good for specific occasions, and that the prime requirement of writing is that it be understood and that it provoke action. The test of every word or phrase in an article should be: "Does this word or phrase give the clearest meaning and set the most appropriate tone for the purpose of the communication?"[14]

20. Underlying the instruction in all conservation-science courses should be this philosophy: that there is an "I" in conservation; that we must hitch conservation directly to the producer-consumer relationship, instead of to the government; that we must cease being intimidated by the argument that a right action is impossible because it doesn't yield maximum

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[12] "I quarrel with the uniform dullness of American scholarly writing today. I quarrel with the system that enslaves the scholarly author and prevents him from being an individual, writing for other than his professional colleagues. And the system that forces scholars into frequently meaningless research projects and further compels the scholar to write of the results, if he is to have promotion and pay, is not only stultifying but a real danger to our intellectual life."—Joseph A. Brandt, "Intellectual Slave Market," *The Saturday Review of Literature,* June 5, 1948, 20.

[13] University of Wisconsin, *What's New in Farm Science.*

[14] "Our task is to develop a sensitivity to the appropriateness of language in various types of social and personal situations."—Robert C. Pooley, "The Language of Adults," *Chicago Schools Journal,* Vol. XXX, Nos. 5 and 6, January–February, 1949, 136.

profits, or that a wrong action is "OK" because it pays; that it is conscience, in the end, that is the beginning of real conservation.

SUMMARY

No more fitting nor more succinct parable of the problems, principles, and policies in wildlife-conservation journalism could be set down than these words of the late Aldo Leopold:

> The (passenger) pigeon lived by his desire for clustered grape and bursting beechnut, and by his contempt of miles and seasons. Things that Wisconsin did not offer him today he sought and found tomorrow in Michigan, or Labrador, or Tennessee; to find them required only the free sky, and the will to ply his wings. But there are fruits in this land unknown to pigeons, and as yet to most men. Perhaps we too can live by our desires to find them, and by a contempt for miles and seasons, a love of free sky, and a will to ply our wings.[15]

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[15] Aldo Leopold, "On a Monument to the Pigeon," *Silent Wings,* (Madison, Wis., 1947), 3.

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A BRIEF HISTORY OF THE STEEL TRAP AND ITS USE IN NORTH AMERICA

A. W. SCHORGER

All this is pleasure; but a Man of Sense,
Looks to his Traps; 'tis they bring in the Pence.
The Otter-season's short; and soon the frost
Will freeze your Traps, then all your Labour's lost.
—CAPT. CARTWRIGHT (1784)

The exploration and development of North America were due primarily to the activities of trappers. Furs were easily transported great distances and had high value for the weight represented. Of these, beaver pelts were the most desirable in the European markets. The Indians took the beaver by netting, shooting, spearing, and with deadfalls. The Colonials of Virginia and the Carolinas used steel traps rather extensively from 1700 onwards; however, until the beginning of the nineteenth century, the bulk of the furs were taken by the Indians by primitive means. The use of steel traps did not become important until about 1750 when white trappers began taking beaver west of the Alleghanies, and eventually on the Missouri and the shore of the Pacific.

There is a paucity of information on the development of the steel trap and its use in the fur trade in North America in spite of its importance. Much useful data must rest in the records of the early fur companies, particularly the Hudson's Bay Company, London, which were not examined.

There is general agreement that the steel trap was a refinement on the various types of torsion traps, some of which are of ancient origin.[1*] According to Larouse[2] the modern steel trap was developed from the *traquenard,* a trap used preeminently for taking beasts of prey. This trap was in use in the Middle Ages and is mentioned by even more ancient writers. It consisted essentially of two boards with teeth on one edge, kept apart by a stick serving as a trigger, and held under high ten-

* All numbered references are listed at the end of this article starting on page 196.

sion by means of a spring, or more often twisted double cords. The animal in trying to reach the bait stepped on a treadle which displaced the stick and allowed the two boards to close firmly over the neck of the victim. Some of the early steel traps were also designed to catch the animal by the neck rather than by the foot (Fig. 6). In some traps the tension was supplied by a strong bow made of holly or whalebone.[3]

Steel traps were long in coming into common use. Aside from torsion traps, pens, deadfalls, and pits were used for taking wolves and other animals. The monks of Melrose, during the reign of William I (1165–1175), had a provision in their charter permitting the trapping of wolves.[4] There is nothing in the grant* to indicate that steel traps were used. The *piege* of du Fouilloux[5] for taking wolves was a pit. Nor are steel traps mentioned for the taking of wolves in Ireland in 1584.[6]

Early Designs

Traps made in whole or in part from iron may be very old. Crescentiis[7] describes an iron trap as follows:

> Foxes and wolves are captured especially with an iron trap, which has about it many sharp barbs, and these have about them a ring on which they are hinged, to which is attached a piece of meat. Everything is firmly fastened to the ground except the meat. Whenever the wolf lifts the attached meat with his teeth, the ring lifts the barbs around the head and neck of the wolf and the more strongly he tries to get away, the more strongly he is held. Also they make other traps by which, by the feet or legs, all sorts of animals generally may be taken, which are hidden in the paths which they use. These traps are of such a shape or form that unless they have been seen they cannot be understood.*

The trap described by Crescentiis does not contain a spring. The description indicates that the mechanism (Fig. 2) consists

* Excepto quod non venabuntur ibi cum motis et cordis nec alios ducent ad venandum nec pedicas ibi ponent nec ad capiendos lupos neque accipient infra has divisas accipitrum et spervariorum nidos.

* Uvlpes et lupi precipue capiuntur quadam taiola ferrea. que circa se multas habet rampones acutos. et ipsi habent circa se annulum. prope se vbi annexi voluuntur. ad quem annectitur frustum carnis. omniaque occultata preter carnem in terra firmata iacent, Cum autem lupus carnem dentibus captam eleuat annulus eleuat rampiones circa caput et collum lupi qui cum forcius trahit. et recidere nititur forcius stringitur et tentur, Item fiunt alie taiole quibus in pedibus siue cruribus omnes generaliter bestie capi possunt que occultantur in itineribus quibus vtuntur. que sunt talis figure aut forme quod non nisi oculata fide intelligi posset.

of a ring, pinned or otherwise securely anchored to the ground, on which are hinged a number of iron rods barbed at the tip. These rods radiate like the spokes of a wheel. Surrounding the base ring is a second ring on which the rods rest. The second ring has cross bars to which the bait is attached. The trap when set lies flat on the ground and is easily concealed with crumbled

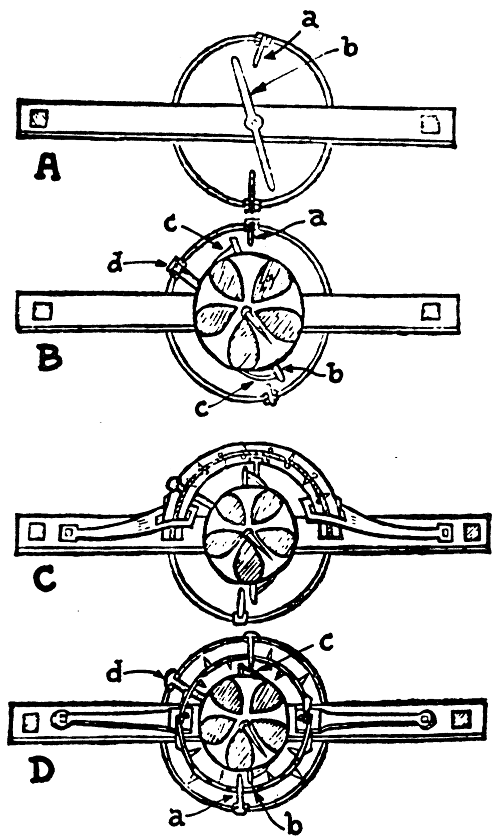

FIGURE 1. Spring trap after Mascall (1590). The letters have been added.

earth. When the wolf jerks the bait, the outer ring rises carrying with it the barbed rods which quickly surround the head of the wolf.

The first dated edition of the work of Crescentiis, of Bologna, was published in 1471; however, it was completed about 1305.

A cut (Fig. 1) of a steel trap with springs was published by Mascall[8] in 1590. His description follows:

> The griping trappe made all of yrne, the lowest barre, and the ring or hoope, with two clickets, and a turning pinne, which ring is set fast to the sides of the lowest barre.
>
> More unto it is, a plate round in the middest, with five holes cut out, and a sharpe yrne pinne in the middest, which plate hath a spring on both sides under the edge of the plate, and they stirre not of joyntes up and down, as the other doth but standes fast in touching the crosse pinne under the plate.
>
> Here is more with two springs untylde on both sides, in holding together the two hoopes with nayles.
>
> Now when the two springes are opened abroade and holde downe, here it is to be shewed as hee standeth tyled with the two springes, downe flat to the long barre on both sides, which springes are made of good steele, and as soone as the clickets which holde them downe under the plate when both the outward clickets be stirde. The two springes shuts them suddenly together and there is in the two shutting hoopes sharpe pinnes of yrne set one contrary to the other, with holes made for those pinnes to goe thorough and shut close together, that it will holde any thing, if it be but a rush or straw, so close they shut together. The two hoopes on both sides outward are made bigger and bigger upwarde, to hold more close when they come together, as ye may perceive by the hoopes within the springs, on both sides. Then there is at the ends of the long barres two square holes, which holes are made to pinne the long barre fast to the ground, when yee set or tyle him in any place at your pleasure. His clickets may so be made, that if any Otter, Foxe, or other, doe but tread thereon he shall be soone taken. This ye must binde a piece of meate in the middest, and put it on the pricke, and so binde it fast, and in pulling the baite, the clickets will slippe and the springes will rise, and so will take him. Thus much for this kind of trappe shall be sufficient to understand the order thereof.

The figures and description do not explain adequately the construction of the trap and its operation. Apparently the plate with the "pricke" fastened rigidly to it was free. Probably the trap (Fig. 2, B and D) functioned as follows: the springs *c* were pressed against the "turning pinne" *b* by forcing the set screw *d* against the edge of the plate. The more the screw was turned the more the springs were forced outward so that eventually one or both "clickets," resting over the jaws of the trap, would be held by the tip under the small springs. A slight displacement of the plate would cause it to slip above or below the end of the set screw. This would release the pressure on the small springs which would move toward the plate, thus releasing the "clicket" *a* and permitting the jaws of the trap to close. It will be noted that in C and D the springs of the plate are on the opposite side of the "turning pinne" to that in B, in which case it would be impossible to hold the plate against the "pinne" by means of the set screw.

A single spring trap of simpler design (Fig. 3) is given by Fortin[8a] (1660). That shown by Liger[9] (1709) seems to be identical.

It is stated by Lagercrantz[10] that jaw traps are first mentioned in the Swedish hunting literature by Risingh[11] (1671). A steel trap of the "hoop" type, designed to catch the animal by the neck, was in use in Finland by 1642. The Statens Historika Museet, Stockholm, contains a manuscript dating from 1642 which has a drawing of a Lappish drum on which are various figures including a trap and a fox. A version of 1645 in the library of Upsala University lacks the drawing. The drawing as well as both manuscripts have been published.[12] A photograph of the drum was obtained through the courtesy of Dr. Ernst Manker, Stockholm. Only that portion showing the trap and the fox is reproduced (Fig. 5). The manuscripts state that figure number twelve represents a "fox-iron" (räfjern). A more detailed drawing of a similar fox trap is given by Fleming[13] (1724) (Fig. 6). Various designs are figured and described by Doebel[14] (1754).

The design of the traps used by the English at the beginning of the eighteenth century is not known. Worlidge[15] (1704) wrote: "Pole-cats, Wheasels, &c. these Animals are very injurious to Warrens, Dove-houses, Hen-roosts, &c. but the method to take them in Hatches and small Iron-gins like those made for Foxes, are so very well known, that nothing need be said of them." The same statement of the common knowledge of iron traps is made by Mortimer[16] (1707), who recommends the steel trap for taking the fox and badger. At this time the use of a steel trap for taking rats is not mentioned.

It is of interest that while the inhabitants of northern Europe had such cumbersome and inefficient traps, the English, at least by 1768, had developed a model (Fig. 4) that does not differ essentially from that in use today. Robert Smith,[17] late ratcatcher to the Princess Amelia, warns against the use of too wide a pan (bridge) as a fox may spring it without being caught. He continues:

> But in order to prevent any such disappointment, I would advise that your steel traps for the Fox should be square in the jaw, and not round as the common traps are usually made, and strike but five inches high, and seven inches long in the jaw, with saw-teeth, and let the tail of the trap be two feet from the tail end of the spring, for they are generally made too short, from whence this inconvenience arises, that when a trap stands for some time in warrens or parks, the spring gives out, the purchase being so quick, whereas, were the traps formed on the principle above laid down, the spring would remain for a considerable time without giving way; and lastly, let the bridge of the trap be four square inches.

The identity of the springing mechanism with that of the modern trap is shown clearly by Cartwright's description of the "tongue" of a trap:

> A small bar of iron, which is placed on one-side of the bed of a trap, and turns upon a pin: it passes over one of the jaws and the end of it is fixed under the heel of the bridge, which it supports until that is pressed upon; when, being set at liberty, the jaws fly up.[18]

A trap in Newfoundland was called a "slip." Rev. Anspach, who lived on the island from 1799–1812, wrote: "Another sort of trap or snare used chiefly for catching deer, bear, or other large animals, is the *slip,* which is composed of different materials, according to the circumstances of the hunter, but mostly of iron."[19] The remainder of the description is an almost verbatim copy of the above quotation from Cartwright.

There are some differences between present American terminology and that of Cartwright.[18a] He uses bridge for pan, and tongue for dog. It is explained that to "tail a trap" is to fix it properly for catching an animal. This harks back to Mascall[8] who uses the expression "set or tyle."

The similarity of the steel trap used by the Indians in Canada to the English rat trap, with the exception that the former had smooth jaws and double springs, is mentioned by Ballantyne,[20] and Milton.[21] It should not be inferred in consequence that the beaver and similar traps were developed from the rat trap. All the information available shows that the steel trap was designed

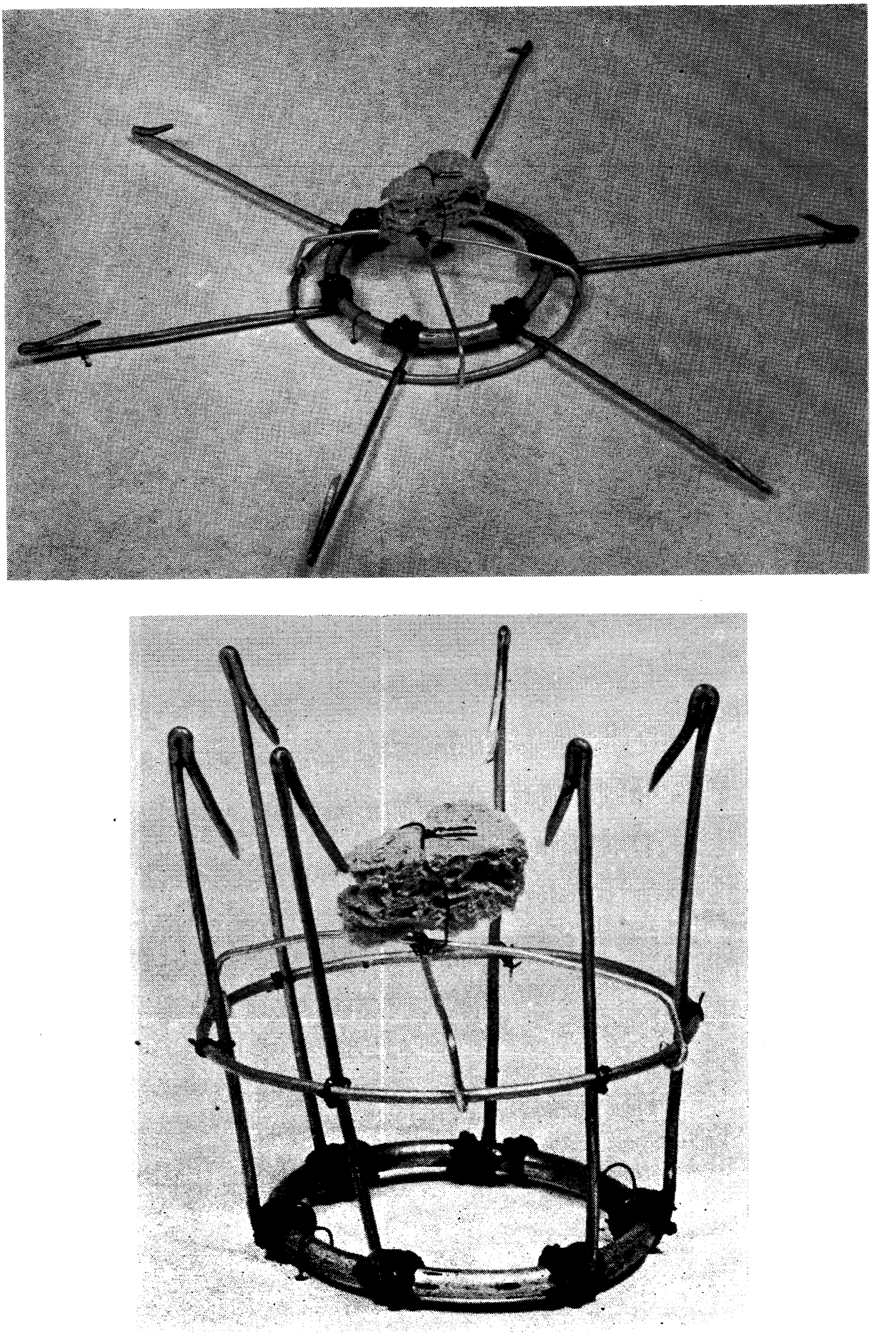

FIGURE 2. Model of trap after Crescentiis. Upper figure represents the trap set and lower figure the trap closed.

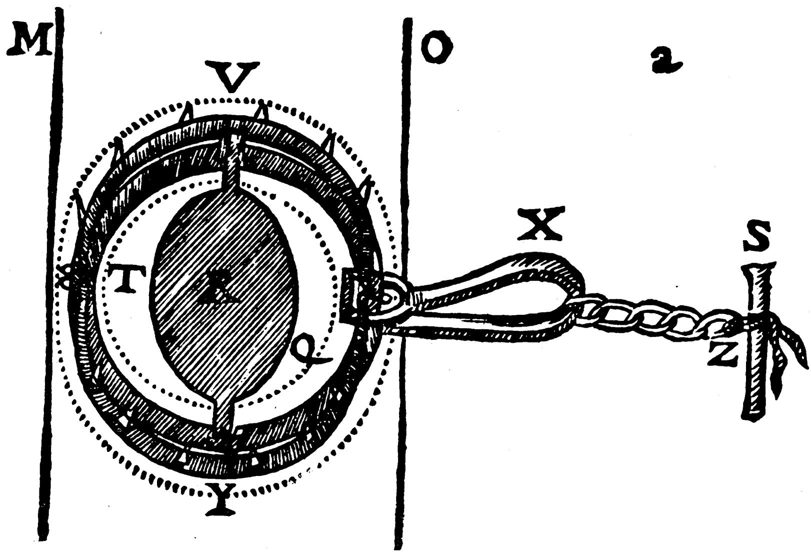

FIGURE 3. (Top) Spring trap after Fortin (1660).

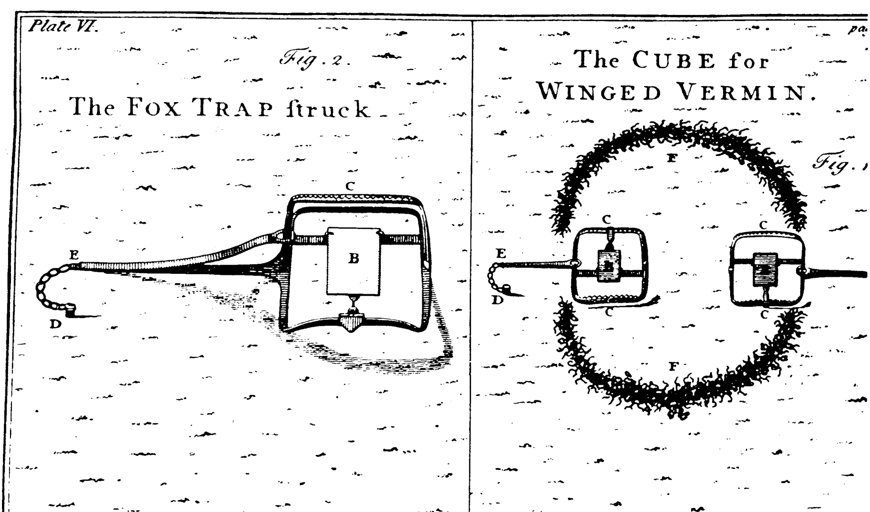

FIGURE 4. English trap after Smith (1768).

FIGURE 5. (Top) Lappish trap with approaching fox (1642).

FIGURE 6. Fox trap after Fleming (1724).

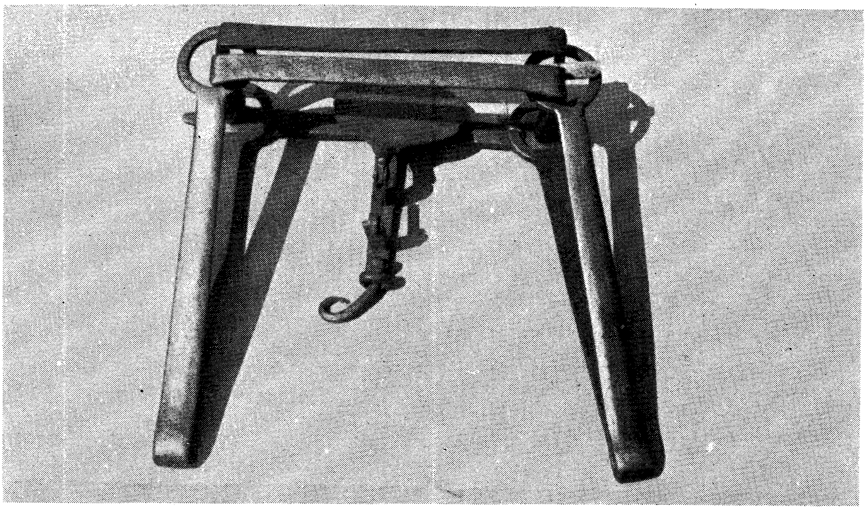

FIGURE 7. (Top) Trap alleged to have been used by Daniel Boone. Photograph by George H. Breiding.

FIGURE 8. Trap of native manufacture from the Tangier Zone, Morocco, owned by William D. Schorger.

and used for large predators, e.g., the fox, before being made sufficiently small to take the rat.

There are over a hundred United States patents covering "freak" traps and modifications of the ordinary steel trap. The first important departure from the design of the English trap was the "jump" trap, for which Dr. A. S. Blake of Waterbury, Connecticut, was granted U. S. patent number 23,750 on April 26, 1859. In this trap the springs are placed in the base, making the trap short and compact. The name of the trap is derived from the tendency of the trap to jump when sprung. This style is still preferred for small mammals by many trappers. The advantages, according to Woodcock,[22] are ease of concealment and the ability to set it in certain places where the trap with long springs is impracticable.

A trap of native manufacture, purchased in the Tangier Zone, Morocco, on March 25, 1949, by William D. Schorger, is shown in Figure 8. The rectangular base is 6.25 by 4.5 inches; length of jaws 5.9 inches; and length of spring 6.6 inches. The weight is 1.58 pounds. A piece of burlap is sewed over the base with palmetto fiber. In the middle is attached a strip of cane 3.75 inches in length that serves as a pan, but potentially a large portion of the area of the burlap may function in this capacity. The dog consists of a twig with a flattened tip which is attached to the base by a palmetto cord 1.25 inches in length. In setting the trap the "dog" is placed over a jaw and the tip inserted beneath the cane. The spring is attached at a right angle to the jaws. The trap is obviously copied from a European model. The crude springing mechanism may be due to economy or to the smith's lack of skill in making the finer parts of metal.

Use in the United States

The early literature contains numerous references to the making of "traps" to take wolves and other animals. These were usually pits or deadfalls, and it is unsafe to assume that they were made of iron or steel. The records of Massachusetts Bay and New Plymouth Colonies contain ordinances governing the taking of wolves in "traps or other engines."[23] In 1642 a law was passed that the various towns should make, bait, and attend daily a total of 27 traps.[23a] The scarcity and value of iron in the colonies precludes the probability that these traps were made of metal. Iron traps, however, were in use, for it was enacted in 1633 that no "guns or Iron traps" could be set unless protected by an enclosure and not placed near any highway.[23b]

The settlers in Virginia and the Carolinas were more venturesome than the other colonists and competed with the Indians in the taking of furs. It was in this region that the use of steel traps became common, and from whence it spread northward to Canada and down the Ohio Valley through the agency of "Kentucky" hunters. They seem to have been in wide use at the beginning of the eighteenth century. Byrd[24] wrote in 1728 that the Indians had scarcely any other way of taking the beaver than with snares, but the English used a steel trap. He remarked also: "Both Beavers and Wolves, we know, when one of their Legs is caught in a Steel Trap, will bite it off, and they may escape with the rest."

The loose terminology of the time makes it impossible in many cases to determine the nature of the mechanism employed in capturing animals. A snare was not only a noose, but a "trap," or "gin." Lawson[25] in 1700 visited the Saponas in North Carolina when the King "went to look after his Beaver-Traps." It is not certain that these were steel traps. However, Brickell[26] wrote in 1737:

> They [beavers] are sometimes shot, but are taken most commonly after the following manner. The Planters break down part of their Dams, and lay Traps in those places, which the Beavers attempting to repair and mend at Night, are caught in them.

Only a steel trap could have been used in the swift water with any degree of success. The Moravians "set" traps and caught beaver near Salem, North Carolina, in 1753.[27]

The use of steel traps by both whites and Indians was extensive after 1750. Smith, a captive of the Indians, wrote that in the winter of 1756–57 in eastern Ohio: "Near this pond, beaver was the principal game. Before the waters froze up, we caught a great many with wooden and steel traps: but after that, we hunted the beaver on the ice."[28]

In 1794 Loskiel[29] wrote that the Indians captured beaver in iron traps. Still earlier, 1779, Zeisberger[30] stated that since the Indians had learned the use of the steel trap from the whites, the beaver had been almost exterminated along the Muskingum River in Ohio.

A curious use of beaver traps was made by Captain Simeon Ecuyer at the siege of Fort Pitt by the Indians in 1763. On June 2 of that year he wrote to Colonel Henry Boquet: "I have distributed tomahawks to the inhabitants; I have also gathered up all of their beaver traps which are arranged along the rampart that is not finished." His misplaced confidence in the power of the beaver trap is shown in his letter of June 16: "I have collected all the beaver traps which could be found with our merchants and they were placed in the evening outside the palisades. I would be pleased to send you one with the leg of a savage, but they have not given me this satisfaction."[31]

The "Long Hunters" who went into Kentucky in 1770 were equipped with steel traps.[32] Daniel Boone returned to North Carolina during the year to obtain additional traps.[33] William Sudduth set his beaver traps in Saltlick Creek, Kentucky, in March, 1788;[34] and in 1792 James Miller of Knoxville, Tennessee, advertised steel traps for sale.[35]

The West Virginia Historical Society has a trap (Fig. 7) which is stated to have been used by Daniel Boone to take beaver. It was presented by the Huddlestone family.[36] Bakeless[37] says that Boone gave the trap to the Huddlestones. Boone settled at Point Pleasant about 1788–89 and about 1790 stopped over night at the home of Daniel Huddlestone below Kanawha Falls, near the present site of Boone, West Virginia. The original account is by Hale[38] who obtained his information about 1840 from Jared Huddlestone, son of John Paddy Huddlestone (1771–1862). Boone having noticed fresh beaver sign in the river inquired for beaver traps. When informed that they had a steel trap for taking foxes, but no beaver traps, Boone set the fox trap in the stream in the presence of Paddy. Five beavers were caught the first day and the colony was soon exterminated. The taking of five beavers in one day with one trap using the customary set would be little short of miraculous.

I am indebted to Mr. George H. Breiding for the photograph of this old, hand-made trap and the following data: weight 5 pounds and 10 ounces; total length 31 inches; and length of jaws 9⅜ inches.

Just when the New York Indians began to use steel traps is uncertain. On February 12, 1761, Sir William Johnson[39] wrote to Jeffrey Amherst that "Beaver & Fox Traps" were commonly sold to the Indians. He estimated on October 8, 1764, that the Indian Trade would require 5000 beaver traps annually.[39a]

Steel traps were used in the Indian trade in New England in 1747. On November 28 of this year J. Bradbury was credited by the province of Maine for the payment for three wolf traps at fifty shillings each. The provinces licensed the traders and furnished goods. On October 27, 1749, John Popkins was paid £9–13–0 for "cleansing" traps and on May 15, 1750, William Lithgow was given credit for seven beaver traps returned.[40]

Alexander Henry spent the winter of 1763–64 in Michigan hunting with the Indians. He wrote: "The usual method of taking these [beavers] is by traps, formed of iron or logs, and baited with branches of poplar."[41] The Indians of the Michigan area were supplied in part with traps from New York by Sir William Johnson. The inventory of goods for Indian presents in the King's Store at Detroit on July 17, 1781, mentions 38 beaver traps, and it was estimated that 60 traps would be required to August 20, 1782.[42] The estimate for the year ending August 20, 1783, was 100 traps.[42a]

On July 6, 1774, Richard Wright of Detroit wrote to Hayman Levy regarding an order of trade goods which included 20 beaver traps.[42b] It was stated by Thomas Ainslie in 1788 that most of the furs were collected at Mackinac where the Indians exchanged them for goods such as "Traps for catching the Animals."[43]

The Philadelphia firm of Baynton and Wharton began trading with the Indians in 1754. In the fall of 1763 George Morgan became a partner. The new firm of Baynton, Wharton, and Morgan continued in operation until 1776. Samuel Wharton and George Croghan in 1764 concocted the plan of sending goods to Illinois.[44] Morgan went to a post at Kaskaskia from which he wrote in February, 1768, that too great a quantity of beaver traps could not be sent.[45]

The French–Canadian literature is almost completely silent on steel traps, but there appears to be one example of use. Beauharnois, Governor of New France, gave permission in 1727 to a party of traders to build a fort in the Sioux country. In the fall of this year Fort Beauharnois was built on the Mississippi on the western shore of Lake Pepin. One of the signators to the articles of agreement was Francois Campeau, a blacksmith. It was stipulated that he was at liberty to work at his trade for anyone who wished to employ and pay him, in consideration of which he was to fulfill certain obligations to the Company.[46] In September, 1729, Beauharnois sent to the French Minister a report on the fort which contained the following:

> Some days later a Chief Püant came to the fort of the French to see a man named Gigner who was there; he invited him to come and see him at his lodge, which he did, in spite of the representations of the other Frenchmen, where he was hardly come with a trap which he had with him when the Püants seized it, when he would have run at the risk of his life if some Foxes had not hindered him. Finally he had to make a bargain and give presents to get it back.[47]

It is inconceivable that so much value would be placed on a trap by both Frenchman and Indian unless it were made of steel.

The manufacture of traps by French smiths in Wisconsin is first mentioned by Augustin Grignon.[48] According to his earliest recollections (c. 1785) his father always employed a blacksmith at Green Bay to make traps and do other smith work. The trader Jacob Franks had a blacksmith shop at Green Bay prior to 1798 but it is not definitely stated that traps were made. In 1818 he obtained traps from Canada. He wrote to John Lawe from Montreal on March 11: "I have already 300 Beavor Traps Baled up . . . so that you see some Exertion must be made next fall to get the Followines up to the Missisipii."[49]

Curot[50] was in charge of a trading post on the Yellow River, Wisconsin, the winter of 1803–04, where the Indians were using traps. Evidently the traps were provided by the post since there was a threat to take them from one Corbeau. The winter of 1804–05, Malhiot[51] had twelve traps among the goods to be traded with the Indians at Lac du Flambeau. Dubuque,[52] in the fall of 1806, sent an outfit to trap on the Missouri. The men squandered their time on the Des Moines River and when they returned in the spring he refused to accept what remained of their "guns, traps, and Kettles."

Among the goods taken by Perrault's[53] party to Fond du Lac (Duluth–Superior region) the summer of 1790 were "some traps and kettles." Anderson[54] was in charge of a post on the Minnesota River the winter of 1807–08, at which time he outwitted a fox by the use of six steel traps. At this time, if not long before, steel traps were in common use in Minnesota. Pike[55] states that the Northwest Company bartered a beaver trap for four beaver skins, the equivalent of $8.00 in money.

The earliest use of the steel trap on the Missouri and westward has not been determined. It is known that traps were carried in stock in southern Illinois in 1768. Before this time Kentucky trappers were active across the Mississippi. Daniel Boone moved to Missouri in 1799 and was soon engaged in trapping beaver. One cold day the winter of 1802–03 Boone had his hand caught in a trap and had to return with it to camp where he was released by his negro Deny.[33a]

Traps formed part of the equipment of the Lewis and Clark Expedition of 1804–06.[56] In North Dakota on April 10, 1805, they overtook three Frenchmen trapping beaver. Lewis in a footnote expresses the opinion that they were the first trappers on the river.[56a] This is doubtful since the French had been exploring the Missouri River region for over half a century. Again in North Dakota on August 12, 1806, they met two American trappers going up the Missouri with "20 odd good traps."[56b]

The early trading companies depended on the Indians for their furs and do not seem to have included traps in their merchandise. Truteau[57] was stopped on the Missouri in 1794 by the importunate Sioux. Traps are not mentioned among the articles which he was forced to give as presents.

The Indians were so troublesome and unreliable that at the turn of the century it became customary for the traders to hire white "hunters." Pierre Menard, writing from the Three Forks of the Missouri on April 21, 1810, informed Pierre Chouteau that a party of their hunters had been defeated by the Blackfoot. Many of their traps were lost but 40 had been recovered.[58]

Most of the subsequent expeditions mention traps as part of the equipment. Luttig[59] states that on May 11, 1812, some traps were taken on board at St. Charles, Missouri; and that on September 24, at the post on the boundary between North and South Dakota, four men went hunting taking with them ten traps.

Loaning Traps

The fur companies found that there were advantages in loaning traps to the Indians. This was a lien on their furs and the traps had a recovery value. Godman says:

> The Indians inhabiting the countries watered by the tributaries of the Missouri and Mississippi, take the beavers

principally by trapping, and are generally supplied with steel-traps by the traders, who do not sell, but lend or hire them, in order to keep the Indians dependent upon themselves, and also to lay claim to the furs which they may procure. The name of the trader being stamped on the trap, it is equal to a certificate of enlistment, and indicates, when an Indian carries his furs to another trading establishment, that the individual wishes to avoid the payment of his debts.[60]

The custom of loaning or leasing traps may have originated in the rivalry between trading companies. The X Y Company was founded in 1801 by dissenters from the North West Company. Curot, who was in charge of the X Y post on the Yellow River, wrote on March 4, 1804: "Smith arrived at one Oclock this afternoon with 3 Men that Mr. Sayer had sent off This morning For Corbeau's lodge, in order to take away *His* traps and skinning knives, in case Corbeau should give any plus to Smith. . . ."[50a] John Sayer was with the North West Company. Used traps appear frequently in the inventories of the American Fur Company. The practise was followed by the United States Factories. Manuel Lisa, sub-agent for the Indians, wrote to Governor Clark at St. Louis on July 1, 1817: "I lend them traps, only demanding preference in their trade."[61]

Loaning was not confined to the Indians. Daniel Boone and Matthias Van Bibber were trapping on the Grand River, Missouri, the fall of 1804, when they were robbed of their traps and pelts by the Osage Indians. When the Indians were shown that the marks on the traps and pelts proved that they belonged to Chouteau, a St. Louis trader, they said that Chouteau must send to their towns to get possession.[33b]

Use in Canada

General use of the steel trap in Canada came considerably later than in the United States. This was due in part to the confinement of transportation in Canada mainly to water. Traps were bulky, heavy, and expensive. The American trapper could use horses for carrying his equipment in nearly all sections of the country. None of the numerous early lists of trade goods examined mentions traps. As late as 1772 Cocking[62] was "building traps for wolves."

The beginning of the use of the steel trap for taking beaver is discussed by Thompson: "Some three years ago [1794] the Indians of Canada and New Brunswick, on seeing the Steel Traps so successful in catching Foxes and other animals, thought of applying it to the Beaver, instead of the awkward traps they made, which often failed."[63]

Some steel traps were in use by 1762 for on June 5 of that year traders going to Toronto were given a pass permitting them to take, among other goods, 41 steel traps.[39b] Steel traps, some of which were double-spring, were used almost exclusively by Cartwright[18b] who in 1770 began a long period of trapping in Labrador. Some of his traps were sufficiently large to be used for bear. He informs us that the Esqimaux did not have traps. On May 28, 1779, he mentions that 96 foxes were caught during the season, and

> . . . had the traps not been so very old and bad we should nearly have doubled the above number. What I have now, are only the worst of my old stock; for the [American] privateer not only carried away six dozen of new ones, which had never been opened, but also what good ones they found in use.[18c]

The Sauteaux Indians, about 1804, were using steel traps and the Indians of Labrador had them in 1808.[64] Innis[65] has expressed the opinion that the use of steel traps spread slowly in western Canada and stated as an example that only two pieces of traps (180 pounds) were sent to the Northern districts in 1818. However, Harmon wrote in 1820: "The greater part of the Indians, on the east side of the Rocky Mountain, now take the beaver in steel traps, which we sell them."[66] According to Milton[21a] the steel trap for taking small mammals was still somewhat of a luxury as late as 1862. The trapper, "if he is rich," has some steel traps.

Number of Traps Used

It is not possible to give statistics on the growth in use of steel traps. Sir William Johnson[39a] in 1764 estimated that 5000 beaver traps would be required annually.

The records of the American Fur Company do not show clearly how many traps were traded annually. On April 22, 1820, Ramsay Crooks wrote to Robert Stuart at Mackinac that he was obtaining 300 beaver traps from Canada.[67] Crooks on December 22, 1821, ordered from W. W. Matthews, Montreal, 320 beaver traps to be sent to New York, and 350 beaver and 240 muskrat traps for the Mackinac post for the trade of 1822. Again on October 20, 1823, Stuart ordered from Montreal 600 beaver and 450 muskrat traps for Mackinac.[67]

An estimate of the number of traps required by the Outfits (Great Lakes) of 1835, sent on December 4, 1834, to R. Crooks by S. Abbott of Mackinac, is given below:[68]

Outfit	Traps	
	Beaver	Muskrat
Grand River	40	400
Chicago and Milwaukee	20	400
Green Bay	40	130
Biddle and Drews	20	100
Fond du Lac	240	250
Warrens	60	..
Lac du Flambeau	20	..
Ance	40	20
Chippewa	20	..
	500	1300
On hand 1st. December	153	382
To be made by blacksmiths at Mackinac prior to June 1	347	600
	500	982
Have made at Detroit for safety	100	318
Total	600	1300

The inventory of 1833 shows that the Upper Mississippi Outfit had at St. Peters, Minnesota, 378 beaver and 1099 rat traps.[69]

The equipment of a trapper of the Missouri Fur Company in 1809 included six beaver traps.[70] This also is the number given by Osborne[71] for the period 1834–43. Irving[72] states that each man had seven traps, while Ross[73] mentions that though six was the usual number, ten were frequently taken to guard against wear.

On June 22, 1833, Wyeth[74] wrote to Bonneville suggesting a joint trapping expedition in which the former would furnish 20 traps and the latter 40 for a party of twelve men.

MANUFACTURE

It is probable that a considerable number of the traps used in colonial times was imported from England. The latter country's main interest in the colonies was a market for its manufactures. However, no information on imports was found. The greater number of the traps was made by local smiths. The blacksmith was one of the important persons at the trading posts and one of the requirements for employment was that he be skilful in making traps. Mass production did not begin until the middle of the nineteenth century. Ignatius Wetzel began to work as a smith on the Menominee Indian Reservation, Keshena, Wisconsin, in 1854. As late as 1859 he reported that he had made "from 60 to 70 spring traps."[75] Woodcock[22a] had muskrat traps made by a smith in Potter County, Pennsylvania, in the 1850's and bear traps in 1871 or 1872.

The names of the individuals manufacturing traps are sometimes given. The firm of Baynton, Wharton, and Morgan[76] purchased beaver traps in 1768 from Baltzer Geer, whose residence has not been discovered. At this time trappers and traders were furnished with guns and other iron articles from Philadelphia and Lancaster.

Following arrival in Missouri, Daniel Boone[33c] built a shop and secured a set of blacksmith's tools. Here he made and repaired traps.

The trade west of the Mississippi after 1800 was supplied largely from St. Louis, the goods being obtained from Philadelphia. Leber Pepin was sent from St. Louis to Philadelphia to learn their methods of making guns and hardware.[59a] In 1817 Lewis Newell arrived in St. Louis and began the manufacture of edge tools and other hardware. The quality of his work was so good that he acquired a great reputation for his wolf and beaver traps, and squaw axes.[77]

The Missouri Fur Company's agent, Joshua Pilcher, testified in 1824 that his company always maintained blacksmith shops on the Missouri for making traps and other hardware. At that time it had two shops in the neighborhood of Council Bluffs, one at the Big Bend of the Missouri, and another among the Mandans.[78]

The Newhouse trap was the first in America to be standardized and manufactured on an extensive scale.[79] Sewell Newhouse was born at Brattleboro, Vermont, in 1806. In 1820 his family moved from Colerain, Massachusetts, to Oneida County, New York. He began making traps for his own use at the age of seventeen. The springs were forged from the blades of old axes. These traps after a season's use were sold to the Indians at $.62 apiece.

The Newhouse family in 1849 joined the Oneida Community which had been founded the year previously at Oneida. Newhouse made only a small number of traps during the next few years. In 1855, due to requests for traps from Chicago and New York, he established a shop for making them. Three men were employed using the customary blacksmith's tools. This was followed by the installation of power machinery.

The plant in 1872 employed nearly one hundred people and made six sizes of traps.[80] Three years later the annual capacity was stated to be 300,000 traps.[81] However, during the eight years ending in 1874, only about 750,000 traps were made.[79a] Over 300,000 pounds of iron and steel were used annually.

The Newhouse traps established and maintained an excellent reputation. The tale is related that Newhouse set and sprung his traps in ice-water to demonstrate their quality to the Indians. They were astonished that the springs did not break. When the Oneida Indians removed to Green Bay, Wisconsin, in 1846, they are reputed to have taken Newhouse traps with them and spread their fame in the West.[82]

The manufacture of traps by the Oneida Community was discontinued in 1925 and certain assets were acquired by the Animal Trap Company, Lititz, Pennsylvania.

The firm of Blake, Lamb, and Company was organized in Waterbury, Connecticut, in 1865 to make the Blake "jump" trap.[83] It was incorporated in 1867. The founders were Dr. Amos S. Blake, born in Vermont in 1812, and William Lamb, born in Jewett City, Connecticut, in 1805. The business is at present conducted by the Hawkins Company, South Britain, Connecticut.

Steel Used

A constant difficulty in the manufacture of traps in the early days was the quality of the steel. Most of the steel was obtained from England, but some from Sweden and Germany. On February 27, 1820, R. Crooks wrote to W. W. Matthews, Montreal:

> The 7 Cwt. Steel we want is (Sylvester says) Crawley or Crawley No. 1—the bars are perhaps rather over ¾ inch wide by ¼ inch thick.—It is the kind Maçon the Trapmaker always used, and I dare say you know the article well. There is plenty of German Steel in New York, but *none* of the description we require.[67]

Also Stuart wrote from Mackinac to Crooks on November 19, 1820: "The steel you sent will not answer for the traps. . . . The Steel wanted is Crawley No. 1, ⅝ in. and ¼ in. thick.

Some domestic material was used. Crooks on December 27, 1822, objected to paying $140 per ton for iron from the Juniata Works.[67]

A cheaper but undivulged method of making traps was developed at Mackinac. Stuart wrote to J. J. Astor on March 11, 1827:

> Have the goodness to add to the general order for this place 1000# nail plate Iron 2¾ inches wide (if not to be had exactly of this dimension, better a little wider than narrower) it is for Rat-Traps which we have devised a way of making at ⅔ the labor heretofore attending them but it can be effected only by having this Iron . . . want of it would be a most serious disappointment.[67]

The quantity and quality of the metal used at Mackinac is given in the letter of June 29, 1827, from Stuart to Astor:

> Have the goodness to send up at your early convenience 800# Millington–Crawley steel No. 1¼ by ¾ Inch for Beaver Traps—1000# half inch square Iron—2 bunches faggot Iron (1 inch) 300# nail rod Iron ⅜ In: 400# Millington–Crawley steel No. 1 2/8 by ⅝ inch for Rat Traps—These articles we must have before the close of the navigation—for I must get our traps made here, else we shall I am afraid be always imposed upon.[67]

Nail rods were used to make the jaws. Stuart wrote to John Lawe at Green Bay on September 8, 1826, regarding a shipment of iron and steel: "The Hoop Iron is for the plates of the Traps —& the Horse Nail Rods for the Jaws."[84]

The German steel caused difficulty. Abbott wrote to Crooks on December 4, 1834: "Our German Steel turns out very bad, in making 200 Beaver trap Springs the loss was 44. would it not therefore be well to have made in New York this winter 200 Pairs Beaver Trap Springs & 100 Pairs Rat trap Springs?"[68]

Quality and Specifications of Traps

The quality of the early hand-made traps was generally poor. In 1811 Macdonell[85] complained that in England the manufacture of edged tools for cold countries was not understood. The great defect in traps was the snapping of the springs when set at low temperatures. Simpson wrote on May 18, 1821:

> The supplies of this Department [Athabasca] generally speaking are of good quality, the Ironmongery excepted, which is really a disgrace to the Tradesmen who furnish it. On our Axes Beaver Traps and Guns the existence of the people and Trade in a great measure depends, therefore the utmost attention should be paid to the manufacture of those articles. The Beaver Traps (marked MS on the Bait plate) are too weak and made of the worst British Iron, whereas they should be the best Swedish: the Cross plate is too slight and should be fastened by a Screw and Nut instead of a Clenched Nail. The Traps are now packed up as required for use whereas the pieces should be packed up seperately in order to be put together at pleasure, which would prevent breakage in the transport hither: the Indians complain that the Traps are altogether too slight, so weak as not to hold a full grown Beaver. The NW traps are much stronger, and the Indians frequently retain part of their hunts for the purpose of trading their Traps with our opponents.[86]

On January 11, 1834, John Rowand, Fort Des Prairies, wrote to James Hargrave, York Factory, in the same vein:

> . . . and while I think of it allow me to remind you that the Beaver & Rat Trap springs we got from you are the worst articles you can imagine every one we got this last summer cannot endure the cold weather & less the cold water before they broke in two & the Natives bring them all back to us in pieces do my friend give your Blacksmiths a lesson we lose a great deal by it.[87]

The objective of our government to protect the Indians from the rapacity of the traders by the establishment of factories was never realized. This was due in part to the poor quality of the trade goods. On September 30, 1810, J. B. Varnum, U. S. Factor at Mackinac, wrote to Gen. John Mason, Superintendent of Indian Trade:

> Our Steel Traps are also an article so miserably made that they never will sell for one half what they first cost; I have offered them at that, and have not been able to vend

one of them; in fact they are not worth any thing more than so many pounds of old Iron Hoops; of which they are in part manufactured.[88]

The correspondence of the American Fur Company contains an occasional letter of commendation, but mainly lamentations, on the quality of the traps. Ramsay Crooks wrote to W. W. Matthews on January 10, 1818, that "Jean Baptiste Maçon is the Trapmaker"; and on February 14 of this year: "Maçon's Beaver Traps of last year were so good that we would have preferred getting them of him again but by Superintending occasionally the persons you now employ, we will get work nearly if not quite as good."[67]

The Company showed constant solicitude over the quality of its ironware. On December 5, 1821, Crooks wrote to Russell Farnham, Des Moines River: ". . . care will be taken that both your Axes & Traps are good, for I feel very anxious that the Indians learn to pay their credits—and we can at least try to do away [with] the usual pretence of the articles being bad."[67]

Anxiety over the traps continued. Stuart wrote to Crooks on October 17, 1822: "Some complaints have reached me of the Montreal traps: I hope Mr. Matthews will look well after *old square toes,* who makes them."[67] On the same date he wrote to Matthews to improve the quality of the springs. The following year, December 14, 1823, Matthews was again reminded that the traps were "very bad."

Miles Standish, a trapmaker of Montreal, rose and fell in grace. Stuart wrote to Crooks at St. Louis on May 16, 1822: "You did not ask for Beaver Traps, but I send you 25 to show you the Superior Style of Standish's work, a few of them are made large and almost square, this I had done to see which are preferred in that quarter."[67]

The work of Standish may have been satisfactory for the next few years, but on June 29, 1827, Stuart wrote to Astor:

> We have just examined the Traps you had made by Standish and I am sorry to say that they are literally good for nothing, which will be of most serious consequence to our next year's business—his conduct in imposing such trumpery on the Company, is most disgraceful,—after having charged about 50 cts too much, we certainly had reason to expect good and faithful work if I could now purchase other Traps, I would not send one of his into the Indian Country.[67]

Stuart continued devastatingly on August 10, 1827:

> In consequence of what Mr. Clapp remarked about Standish's Traps, I re-examined them, but I found them no better than before—indeed some of the Traders preferred going without, than to take them, what they required. Mr. Clapp seems to think it is with the filing & polishing we quarrel, but that *altho' desirable* is of minor consideration —The *Springs* are so bad and weak, that some of the Traps can be opened by drawing the Jaws apart with the Fingers —the Jaws of all come very badly together; and as conclusive evidence of their want of Strength and Solidity, they weigh but from 1¾ @ 2 lbs—whereas Mr. Standish must recollect that the Contract I entered into with him fall of 1823 required that each should weigh 3 lbs.—this with good workmanship would prevent their having the *rickets,* as they now have. . . .[67]

Stuart on August 18, 1827, informed Astor that he was sending him one of the worst and one of the best of Standish's traps, between which there was little difference. He also forwarded a trap of the kind desired and such as Standish used to make when employed at Mackinac. In addition there was included a trap sent by Standish the year preceding as a sample for fulfillment of the contract. Stuart adds: "The trap I send you as sample, is not filed at all, because I wish to show it in the natural state—but those you may contract for should be filed because it gives them a handsome polish &c, which much pleases the eye of the Indians."[67]

The purchase of traps was based usually on a sample submitted to the smith. The American Fur Company had specifications but a copy could not be located.

In preparation for his western expedition, Capt. Wyeth[74a] on February 13, 1832, ordered from Davenport and Byron, New York, "20 Doz of the traps such as you name and such as used by Mr. Astor." Prior to this time, January 28, he inquired of his brother Leonard if beaver traps could be purchased in New York. The trap should have double springs, jaws without teeth, a chain six feet long with two swivels, and weigh five pounds.

Samuel Abbott, Mackinac, specified on April 9, 1835, that the springs for beaver traps should be 8¼ inches in length and those for muskrat traps 6 inches in length "to the bend of the Spring."[68a]

Wyeth's letter of February 4, 1834, to Tucker and Williams, Boston, contains the method of testing a trap:

> I do not think the traps will be according to sample therefore it will be requisite to examine them carefully and compare them with the patern, which is in Brainerds possession. They should be equally well finished with the patern and by contract are to be set for one week and then rejected if the springs do not come up fair or are broken. I have agreed, if he would have all of them finished by 7th Feb. to give him $15 over and above the contract. If Brainerd will not agree to have them set on board the Packett and take back all that do not prove good on their arrival in Baltimore, it will be requisite to retain them in Boston one week in order to try them by setting at the end of which time, if the springs are unbroken and come up fair and they are as well finished as the sample he will be entitled to $165 for one Hundred traps, this provided they are delivered to you on the 7th inst but if delivered after that time he is only entitled to 150$.[74b]

Chief Factor John Lee Lewes, Cumberland House, Saskatchewan River, on February 5, 1839, ordered ten large beaver traps to be used in taking foxes. They were to be

> . . . of the following dimentions extreme length of the jaws' of the trap when open 10 Inches. the Iron supporter on which the bait plate works 2 Inches high, the plates to be very light, and nearly to fill the whole interior of the trap when sett. the springs' strong. with good swivel chains 3 feet long.[87a]

An old beaver trap found near the site of Fort Hall, Idaho, an early Hudson's Bay post, has been described by Young.[89] It has a length of 23½ inches. The length of each spring is 7⅛ inches and the spread of the jaws is 6 inches. In its present condition the weight is 2¼ pounds. Allowing for the missing chain and pan, and loss by rusting, the original weight was probably about 4 pounds.

Cost

The cost of traps varied considerably. Their value increased with the distance from the source of manufacture due to the expense of transportation. In 1764 and 1769 Sir William Johnson,[39c] Johnson Hall, New York, purchased beaver traps at 10 shillings New York currency or 6s/8d sterling. This is $1.42

based on sterling. A bill to him from Duncan, Phyn, and Ellice,[39d] Schenectady, dated July 2, 1766, covers 57 steel traps at 9s.*

The invoice book[76] of Baynton, Morgan, and Wharton shows payment of 50 pounds to Geer on July 20, 1768, for 100 beaver traps. The cost per trap was therefore $1.30. A wolf trap in Maine[40a] in 1747 was valued at 50s ($8.05).

The inventories of two estates in Jefferson County, Kentucky, in 1782 list one "steel trap" at 25 shillings and three at 3 pounds 15 shillings.[90]

A requisition for presents to the Indians at Amherstburg, Canada, in 1798 called for 50 beaver traps at 10s. Another from the Indian Department, La Chine, dated October 2, 1799, listed 100 beaver traps with chains at 6s. The 20 beaver traps wanted in 1809, in case of war with the United States, were priced at 8s/6d.[42c]

The traps purchased by the Indian Office of the United States were not only poor in quality but very high in price. Varnum at Mackinac, on September 12, 1810, made this complaint: "The price of a first rate Trap in Montreal is generally seven to eight shillings Halifax currency; more than one hundred per cent less than ours cost in the States, consequently they would not sell even if they were of good quality, much less in their present state."[91] An inventory of goods on hand at the Mackinac Factory on December 31, 1809, has an entry of 110 beaver traps valued at $342.10, or $3.11 each. There remained in stock on September 30, 1811, 12 "superior beaver traps" valued at $66.00, or $5.50 each.[91]

The traps carried at the Fort Wayne, Indiana, Factory of the Indian Office showed considerable differences in value. In 1803, 1805, and 1806 beaver and other traps were carried in the in-

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* It is very difficult to follow the gyrations of the colonial currencies and that of the United States, and give the value of the traps based on the purchasing power of the present-day dollar. There is lack of agreement among scholars on the values of the colonial currencies. Taking the table given by J. Wright (The American Negotiator, 2nd ed., London, 1763 : p. vi), the values of the various shillings would be:

One shilling	sterling	21.4 cts.
" "	New England	16.1 "
" "	New York	12.2 "
" "	Pennsylvania	13.0 "

The Halifax currency was the same as New York. The above values were calculated to the Spanish dollar on which our currency was subsequently based. It was worth 4s/8d (*l.c.* p. 7). Johnson's traps cost accordingly $1.22 New York currency and $1.42 sterling, a considerable discrepancy.

ventory at $1.67 each. However, the prices of beaver traps from 1806–09 ranged from $2.25 to $3.00.[92] In 1820, Lewis Cass, Governor of Michigan, as Superintendent of Indian Affairs disbursed four beaver traps at $2.50 each and one at $4.12½.[78a]

The American Fur Company secured beaver traps at a very low cost. On October 20, 1823, Robert Stuart, Mackinac, wrote to Ramsay Crooks:

> I have entered into a contract with Mr. Standish to furnish us here 600 Beaver Traps (in Boxes of 20) at $1.00 and 450 rat traps viz. 300 with two Springs at $1 & 150 of one Spring at 75 cents, also 50 prs. Beaver Trap Springs at 50 cents—the Rat Traps are to be in Boxes of 40—& no charge for Boxes,—terms of payment 60 days from 1 Oct. after delivery—We are to furnish him say the 1100 lb. Steel ordered in General order, at cost and charges—He is bound to come up in the spring to deliver the Traps . . . and the terms are I think so favorable, that you will probably add what traps will be required at St. Louis and Detroit.[67]

On June 20, 1826, Stuart asked James Abbott, Detroit, to procure and forward 150 muskrat traps at a cost not to exceed 80 cents; and on July 24 of this year he wrote that he was informed that rat traps could be obtained in Detroit for 4s/6d.[67]

Costs were watched in a miserly fashion. Stuart wrote to Astor on June 15, 1827:

> By the invoice I perceive that you pay Mr. Standish $1.85 for Beaver traps, and 85 cts. for Rat traps, this is entirely too much, the most he should get for Beaver traps is $1.50, and for Rat traps of two springs 75 cts. Two years ago when everything was much higher than it is now he delivered me the Beaver traps here (in Boxes free of every charge) at $1.60 payable say in 6 mos. and last year he made them in Montreal at $1. and we could have got them made at 80 cts.—Please let me know if your arrangement with him is for any definite period or quantity of work.[67]

One reason for the cheapness of these beaver traps was that they weighed only two pounds or less. Stuart wrote to Astor on August 10, 1827, that $1.25 was a fair price for a beaver trap. A rat trap with one spring should cost 50 cents and one with two springs 75 cents. In 1834 the cost of making a beaver trap at Mackinac was a little over $2.00;[68] and in April, 1835, it was $1.58.

The inventory of the blacksmith shop at Mackinac in 1834 showed the following articles and their values:[69]

61	lbs. German steel for beaver trap springs @...	.12½	$ 7.62
170	lbs. blistered steel	.14½	24.65
12	pr. beaver trap springs	.65	7.80
1½	pr. rat trap springs	.44	.66
381	beaver traps	2.00	762.00
401	rat traps, one spring	.81	324.81
121	beaver traps, unfinished, ½ price	1.00	120.00(?)
4	trap swaging (?) moulds	1.00	4.00

The inventory of the Upper Mississippi Outfit of 1833 remaining at St. Peters includes the novel item of 18 house rat traps at 50 cents each.

An entry dated July 19, 1822, St. Louis, records the shipment of 30 beaver traps at $2.72 each to George Davenport at Fort Armstrong on the Mississippi. In September of this year Louis Penconneau, Sr. was charged for 19 beaver traps at $2.80 each.[93] On November 10, 1835, Joseph Villandre purchased 6 beaver traps at $10.00 each.[94] In view of the price this transaction must have occurred on the Upper Missouri.

The contract between Capt. Wyeth and Mr. Brainerd, a blacksmith of Boston, in 1834 called for beaver traps at $1.50.[74b]

The cost of a trap to the Indians was high even after taking into consideration the expense of transportation and the risk. In 1805, in Minnesota, the North West Company charged $8.00 for a beaver trap. The price was the same in 1820.[95]

The winter of 1843–44 an Indian took from Bunnell's store at La Crosse, Wisconsin, "ten good otter traps, worth in those times, in choice furs, at least two dollars and a half apiece."[96]

A trap became very valuable when it reached the Rockies. A party of trappers belonging to the Missouri Fur Company was defeated in battle with the Indians in 1810. Menard wrote that the thirty men being sent to the place of the defeat would be given "only three traps each, not deeming it prudent to risk more. . . ."[58]

While at a Gros Ventres village in 1810, Gen. James[70a] purchased from the famous mountain man, John Colter, a set of six beaver traps for the price of $120.00. Gen. William Ashley transferred his outfit near present Salt Lake City, to the firm of Smith, Jackson, and Sublette on July 18, 1826. Beaver traps were entered on the bill of sale at $9.00 each.[58a] The accounts of the American Fur Company for 1832 and 1833 at Fort Union show that beaver traps were carried at $12.00 and the springs at $2.00 each.[58b]

The winters of 1879–80 and 1880–81 were spent by Baillie-Grohman in the Rockies. He remarks that though beaver traps could be purchased for about eighty shillings a dozen in the western towns, they were "worth five or ten times that in the wilds."[97]

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METHODS AND AIMS OF A SURVEY OF THE GERMAN SPOKEN IN WISCONSIN

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Some of you remember that I read a paper on "The Problem of Speech-Mixture in the German Spoken in Northwestern Dane County, Wisconsin" at last year's meeting of the Academy. Since that time, a number of people have asked for a more detailed exposition of the methods I use in collecting speech-specimens. Usually there is a query coupled with this request, a query about the ultimate aims of this entire project, taking for granted that there are any aims beyond the joy of merely collecting material. Since it seemed that the reactions and criticisms of a group composed largely of non-linguists might be helpful, I shall briefly state what I have so far done and what I hope to do. I therefore want to thank the Program Committee of the Academy for giving me this opportunity. A few things presented in last year's paper will necessarily be repeated here in order to give the complete picture.

Before we proceed with this paper, another word of thanks must be expressed. This survey of the German spoken in Wisconsin would have been impossible without the encouragement and very liberal financial aid of the University of Wisconsin through its Committee on Research and the Department of German, especially Professor R–M. S. Heffner. The University granted me a Post-Doctoral Research Fellowship plus an expense-fund from November 1945 to September 1946, then research leave of absence from teaching duties plus a travel-fund from September 1947 to February 1948, and another research grant plus a travel-fund has been given for this coming summer. Any gratitude that I can express must of necessity be quite inadequate.

The survey of the German spoken in Wisconsin has proceeded according to the following plan. The first step is the collection of a body of linguistic data; such collections are here called speech-records or simply records. The second step consists of the analysis of the records. In the third step, conclusions are then drawn from the collected data. As in any scientific research, the more extensive the data, the more precise, the more certain are the conclusions. Frequently the analysis of the records is carried on simultaneously with the collecting, but the analysis is in all cases a much more time-consuming task. At times also, preliminary conclusions may be drawn not from the entire body of linguistic data but only from a selected list of records.

Accordingly, I have gone to different bilingual communities in Wisconsin and have recorded specimens of the German spoken by certain individuals who shall be referred to hereafter as informants. Speech-specimens of 62 such informants have so far been recorded, chiefly in Dane, Jefferson, Milwaukee, Sauk, Columbia, Dodge, Washington, Sheboygan and Manitowoc counties. It is hoped that the usage of more informants can be recorded in the near future (some will definitely be done this coming summer), especially in such important German areas as Green, Ozaukee, Fond du Lac, Shawano, Marathon and Buffalo counties. But even in some parts of the counties first mentioned additional records ought to be made, especially in such key centers as Watertown, Milwaukee and Sheboygan.

Since it is impossible to record the speech of all the people of a given locality, the choice of informants is of prime importance. The fundamental requisite, of course, is that the informant speak German or a German dialect natively, not as a language acquired in school, but this does not mean that the informant had to be born in Germany. In order to find out whether or not there is a definable rate of progression in speech-mixture, records were made of some first-generation German-born informants and of some second-, third- and even fourth-generation Wisconsin-born informants. This inevitably leads to a check on differences in usage for the different age groups. The oldest informant was 83 years of age, the youngest only 17 years. In the selection of informants, care must be exercised to secure individuals who are truly representative of the locality in which they live. This means that they must have spent most of their lives in the locality and that they have a certain amount of communication with the other members of their community.

The good informant has certain other qualifications. He should have at least average native intelligence, but not necessarily much formal education. He should be interested in things beyond the sphere of his everyday activities. He should have the power of sustained mental concentration for extended periods of time. He should be friendly, frank, open-minded, easy to meet and not too self-conscious; and last, but hardly least, he should hear well and speak clearly. Women are often excellent informants, if their initial suspicion and reticence can be overcome. On the whole, it is not easy to find people who are such paragons of virtue.

It is well known that the Germans who settled in Wisconsin came from all parts of Germany, though not in equal numbers. It was therefore necessary to choose some informants who speak different German dialects, especially in those Wisconsin communities which were predominantly settled by people from one specific part of Germany; an example is Dodge County with its predominance of settlers from Pommerania and Brandenburg. Thus records have been made not only of several varieties of Standard German but also of the following dialects with sub-varieties: Pommeranian, Brandenburger, Mecklenburger, Cologne and Bernese. To omit these dialects would convey an entirely false picture of the status of the German language in Wisconsin. It will also be interesting to see whether or not the processes of speech-mixture follow the same patterns in all these dialects, but the records have not yet been analyzed from this viewpoint.

After an informant has been chosen and has consented to serve, it is still impossible to record the totality of his speech. Even if it were possible, no one would consent to it. Since we can hope to record only a relatively small part of each informant's entire speech, it seems sensible to get the most important elements of his speech, elements which by their very nature, and by the very nature of the fact that the informant is speaking German, occur again and again in the totality of his speech. Moreover, we are interested not in the speech of a single informant but of many informants. In order to have comparable material for all the informants, the course of each interview must in large part be rigidly directed. There is only one practical way to meet all these conditions: a questionnaire must be used.

This is not the place, nor do we have the time, to discuss the way in which my questionnaire was built up. Let it be enough to say that it contains better than a thousand items—I have never counted the exact number. There are items to cover all the significant sounds of German; items to exemplify the grammatical and syntactical structure; and a very considerable sampling of the most common vocabulary, since almost all the items deal with situations out of everyday life. In the choice of items, rural life was rather heavily accented, first because German has retained greater vigor in rural communities and secondly because it is usually easier to get rural people to serve as informants. The items finally chosen were then arranged topically. This arrangement makes it somewhat easier for the informant in that it gives a certain continuity of thought; it also makes the responses more reliable in that it directs the informant's attention away from purely linguistic matters to the situations themselves. By and large, the topical arrangement used by the *Linguistic Atlas of the United States and Canada* was followed:

House and Home	Trees and Flowers	The Family
Dishes and Utensils	Small Life	Social Affairs
Farm and Buildings	Topography	The Emotions
Crops and Implements	Store and Business	The Weather
Animals and Fowl	The Body	Time
Vegetables and Fruits	Clothing	Numerals
Meals and Meats	Sickness	Miscellany
Foods and Drinks	Personal Attributes	

The interview proper is begun with an introductory statement, such as: "How do you say in German 'This is the kitchen', 'Our house has two kitchens', 'The stove is in the kitchen'?" and goes on in this way. It takes from four to eight hours to go through the entire questionnaire, depending upon the quickness of the informant and the frequency with which he goes off into discussions of other matters. With one informant the questionnaire was finished in one sitting, but usually it is better to stop after two or three hours, for the informant then gets tired, even cranky, and his responses are slower and less natural.

This is, of course, a translation method which has certain inherent weaknesses. First, it presupposes that the informant has a fairly good knowledge of English and this is not always a valid supposition. Secondly, the possibility of suggestion through the use of English is undeniable. Certainly some of the informants used the English word *beef* instead of the German *Rindfleisch* because of the English influence of the way in which this item was posed: "This is good beef". Others may have used *Feuerfliege* for *fire-fly* because they could not think of one of the

German names for this insect and therefore merely translated the components of the English name. The practiced ear is usually able to spot the difference between natural and unnatural responses.

Nevertheless, the use of English seemed unavoidable. With informants who give their responses in Standard German, I could use German in the interview and elicit the responses by the somewhat tedious methods of circumlocution and description and in part by using pictures, for the field-worker must be careful not to put words into the informant's mouth. With speakers of certain North German dialects I could use the dialect we speak at home. But no one would be able to use all the different German dialects spoken in Wisconsin, and in such cases the use of Standard German by the field-worker would lead the informant farther away from his dialect than the use of English.

To check the over-all reliability of the responses, I have tried to record a considerable piece of free conversation for each informant. This attempt was not always successful, because some informants were either not talkative enough to keep on speaking of their own accord, even for a couple of minutes, or else they closed up tightly, when the direct stimulus of specific questions was lacking. But the amount of free conversation recorded is still very considerable and more than enough to convince me of the reliability of the method used.

Two methods of recording were used—the one by hand in a rather close phonetic transcription, the other by machine with a small but good portable recording device made by the Sound-Scriber Company of New Haven, Conn. The attempt was made to do both hand and machine recording with each informant, but for various reasons was not always successful. In the beginning of the project a machine was not always available, but later the Research Committee authorized the purchase of one. The voices of a few otherwise good informants were not suitable for making good, clear machine records. A couple of informants were also averse to having machine records made of themselves. For recording free conversation the machine is indispensable and I also use it for recording part of the questionnaire in conjunction with hand-recording. There is no better check on one's accuracy of transcription. On the whole, the two methods of recording can be used very successfully in conjunction, as complementary and supplementary to each other.

And now the question: What is the purpose of all this work? The sociological, historical and folkloristic value of this collection is fairly evident and I hope to discuss these matters upon another occasion. But since I am primarily a linguist, I shall today deal only with the linguistic aspects of the collection.

The chief aim of the entire project is to throw light upon the problems of speech-mixture. A good deal has been written about these problems, much of it anecdotal and dilletante in nature, but some of it has true scientific worth. Even in the latter, the conclusions reached are at times contradictory, at times open to serious question, and at times merely insufficient. A couple of examples will make this clear. The late Professor A. W. Aron said that "Every English noun is a potential loan-word in colloquial American German" (*Curme Volume of Linguistic Studies —Language Monograph No. VII,* 1930, p. 11). In the light of my material, this is certainly an overstatement, for certain German nouns are never replaced by English nouns. At the same time this is then an insufficient conclusion, because it gives us no insight into what type of nouns are actually borrowed from English. Or again, when Professor Aron ascribed the assignment of grammatical gender to English loan-words chiefly to mechanical reasons (*ibid.,* pp. 11–28) and Professor O. Springer, on the other hand, chiefly to psychological reasons (*Journal of English and Germanic Philology,* vol. 42, 1943, pp. 22–25), we are here confronted with a contradiction which is hard to reconcile. The cause for this state of affairs perhaps lies in the fact that scholars have drawn conclusions from an insufficient body of linguistic data or from data which are in some way biased.

Our first task, then, is to establish what lexical, morphological, syntactical and phonological features are taken over from English. Next we must establish which English words and speech-patterns are used frequently, perhaps even exclusively, and which only sporadically. Thus of my 62 informants all use *der Pie* and *die Car* for the well-known pastry and vehicle respectively. Most of the informants use the English word *die* or *der Floor* instead of the German words *die Diele* (dialect) or *der Fussboden;* or the English *die* or *der Box* instead of the German *die Kiste, die Schachtel* or *der Kasten.* Use of English *der Keg* and German *das Fass* is about evenly divided; the same holds for English *der Suit* and German *der Anzug.* In other instances the English word is used only sporadically, even rarely, instead of the corresponding German word, e.g., English *der Rooster* versus German *der Hahn.* And finally, it is of equal importance to establish the fact that with certain concepts the English words never substitute for the German; e.g., *horse* is never used for the German words *Pferd, Gaul* and *Ross.*

This brings us face to face with the question: Why are certain words (as well as other linguistic features) borrowed from English whereas others are not? It is this question which rises like a spectre in the night and disturbs the usual calm of my spirits. The best answer so far has been given by Professor Leonard Bloomfield in his book *Language,* pp. 444–475. He speaks of cultural borrowings, intimate borrowings and aberrant mixture. Cultural borrowings occur when the speakers of one language suddenly come into contact with the cultural objects and habits of a different language group. This process goes on continuously and is multi-lateral. Intimate borrowings occur when two languages are spoken in the same community, in which case the one language is usually dominant, the other lower. Such a situation arises either through conquest or migration. This process is largely uni-lateral in that the lower language usually borrows from the dominant. Whatever does not fit into these two categories is aberrant mixture; extreme cases of such mixture result in the various "pidgins" spoken in different parts of the world.

Valuable and valid as the above classifications are, we run into trouble when we apply them to the material in our records. We find some clear-cut examples of cultural borrowing in the following English nouns now commonly used in Wisconsin German; they are taken from my records, but the list is not complete:

der Pie
der Cake
der Renter
der Pasture
der Counter (in the store)
die Condensery
die Creamery
die Fence
die Car
die, der or *das Sink* (in the kitchen)
das Loghaus
das Framehaus

These words symbolize items which were new to the Germans when they came to Wisconsin, or at least the American item was somewhat different from the corresponding item in Germany. It was therefore a simple matter to take over the English name together with the object. But in applying this principle we soon run into doubtful cases.

The sphere of intimate borrowing is more extensive. Despite the great number of Germans who settled in Wisconsin, English always has been the dominant language in the state as a whole, although this was not the case in a good number of communities some decades ago, and in a few communities the struggle is not ended even today. Thus even in German-speaking families, English personal names have largely replaced the German; *Henry, John* and *William* have crowded out *Heinrich, Johann* and *Wilhelm.* In my records there are many English words used which can safely be classed as intimate borrowings, e.g.:

die or *der Box*
die or *der Candy*
die or *der Handle*
der or *das Buggy*
der, die or *das Waist* (of the dress)
der, die or *das Match*
der, die or *das Heifer*
der Pail (and compounds)
der Bug (and compounds)
der Boar
der Suit (of clothes)
die Whip
die Ceiling
das Baby

One thing strikes us immediately about these words. All of them refer to common, everyday things with which the speakers are (or were) in constant contact and which are therefore apt to have emotional connotations, but for which there also are good, native, German words which are usually used side by side with the borrowed words. Originally the use of these English words may have been playful or emphatic and only with much use did they become habitual. We sometimes find German words used in the same way by our bilingual speakers when using English, e.g., speaking of *the old Hengst* instead of *the old stallion* or *I'm all ausgespielt* instead of *I'm all worn out.* But again, and in a very high percentage of the total borrowings, it is hard to decide whether or not they are the result of intimate borrowing. Just a few examples will make this clear:

die or *der Marsh*
die or *der Station*
die or *der Lake*
der or *das Butcher-shop*
der Depot
der River
die Print
die Cornice

Or are all such words to be looked upon as aberrant borrowings? And here too we would have to put almost all the borrowings in the fields of pronunciation, morphology and syntax. In the last analysis this, of course, is no solution of the problem.

The concept of intimate borrowing also fails to answer the question: How are we to account for the existence of loan-translations, such as:

der Fettkuchen 'fat-cake' (dialect)
der Fussstuhl 'foot-stool'
der Pferdsrettich 'horse-radish'
die Butterfliege 'butter-fly'

Or of hybrid compounds, such as:

der Ueber-coat 'over-coat'
die Vieh-yard 'cattle-yard'
der Dish-lappen 'dish-cloth'
die Smoke-wurst 'smoke-sausage'

These are evidently forms of borrowing, but neither cultural nor intimate.

On the whole, it is fairly clear that we run into difficulties in applying the two principles of cultural and intimate borrowings. It therefore seems necessary to make an entirely different attack upon the problem. To indicate this new approach, I have decided to use two descriptive terms which still do not entirely satisfy me: mechanical borrowing and psychological borrowing. Mechanical borrowing includes Bloomfield's classification of cultural borrowing but also embraces a good deal more. Wisconsin German has no word for an hitherto unknown object and mechanically accepts the English name of the object. Or Wisconsin German mechanically follows the patterns of English in pronunciation, word-formation (e.g., loan-translations), morphology and syntax. Psychological borrowing includes Bloomfield's intimate borrowing but again is more inclusive. It is not only operative in the case of the nouns and verbs referring to things and actions close to the speaker; we must rather take into account the entire scale of man's emotions with all his likes and dislikes; yes, we must even investigate the entire psychological motivation of speech. In psychological borrowings it will hardly be possible to decide precisely what factor was operative in each single instance, but a very careful examination of the informants' background may solve many doubtful cases. A fuller presentation of these two complex types of borrowing, supported by more material from my records, must wait for another occasion, but I did want to indicate the lines along which I have been working and along which I propose to continue working, if for no other reason than to find out where they lead us.

One other purpose of this survey of the German spoken in Wisconsin must be mentioned: To ascertain the extent of dialect borrowing. It seems safe to assume that the German language will not survive long enough for complete dialect-leveling to take place or for the emergence of a new, rather homogeneous Wisconsin German dialect as was the case with Pennsylvania German. The beginnings of this process are certainly here; I have noticed it especially in the Sheboygan–Manitowoc area, where the different dialects are no longer very active and where those who speak German use a variety of Standard German with many dialect remnants. But we do want to find out before it is too late, exactly how far this process has gone, how much influence the dialects have exerted upon Standard German and vice versa in areas where dialects are still active, and finally what influence the dialects have had upon each other in areas where more than one dialect is spoken.

In the last analysis, all the problems of speech-mixture and of dialect-mixture can be subsumed under one head: To throw light upon the problems of linguistic structure and linguistic change and thereby to advance linguistic science.

ACIDITY OF SOIL AND WATER USED IN CRANBERRY CULTURE

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That cranberries are grown in Wisconsin under a much wider variety of conditions than in the eastern states has long been recognized. In no way is this more strikingly evidenced than by the range in the acidity of the soil and water used in their culture. This is clearly shown in Figure 1 which is based in part on data assembled by L. M. Rogers. The readings given are averages of all those made in each location. The marshes represented on this chart comprised over three fourths of the acreage in production during the years 1930–1944. It will be noted that the pH of soil planted to cranberries ranges from 3.6 to 6.8 and that of the water used in flooding from 5.0 to 8.3. The chart also shows that while in general acid soil and acid water tend to be found together, there are some exceptions. In one case a marsh having soil of pH 4.0 used water with pH 7.8. Another marsh (only a few years old) having soil with pH slightly over 5.0 uses water with a pH above 7.5.

In striking contrast to this C. S. Beckwith, who was for many years in charge of the Cranberry Substation of the New Jersey Experiment Station, informed me in a personal conversation in April, 1943, that the pH of 90 per cent of New Jersey's cranberry soils is between 4.0 and 5.0 with a maximum of about 5.5 and that the water used for flooding cranberries in that state is very uniform at about 4.5.

As yet no comparable information is available regarding the soils of southeastern Massachusetts, by far the most important cranberry producing region in the world. Readings on pH and alkalinity of many water supplies used in flooding cranberries in Massachusetts were made during July and August, 1945 and 1946. Through the generous assistance of the workers at the Cranberry Station, H. F. Bergman, H. J. Franklin, and J. L. Kelley, and of the officers of the New England Cranberry Sales Company, it was possible to reach bogs widely scattered through-

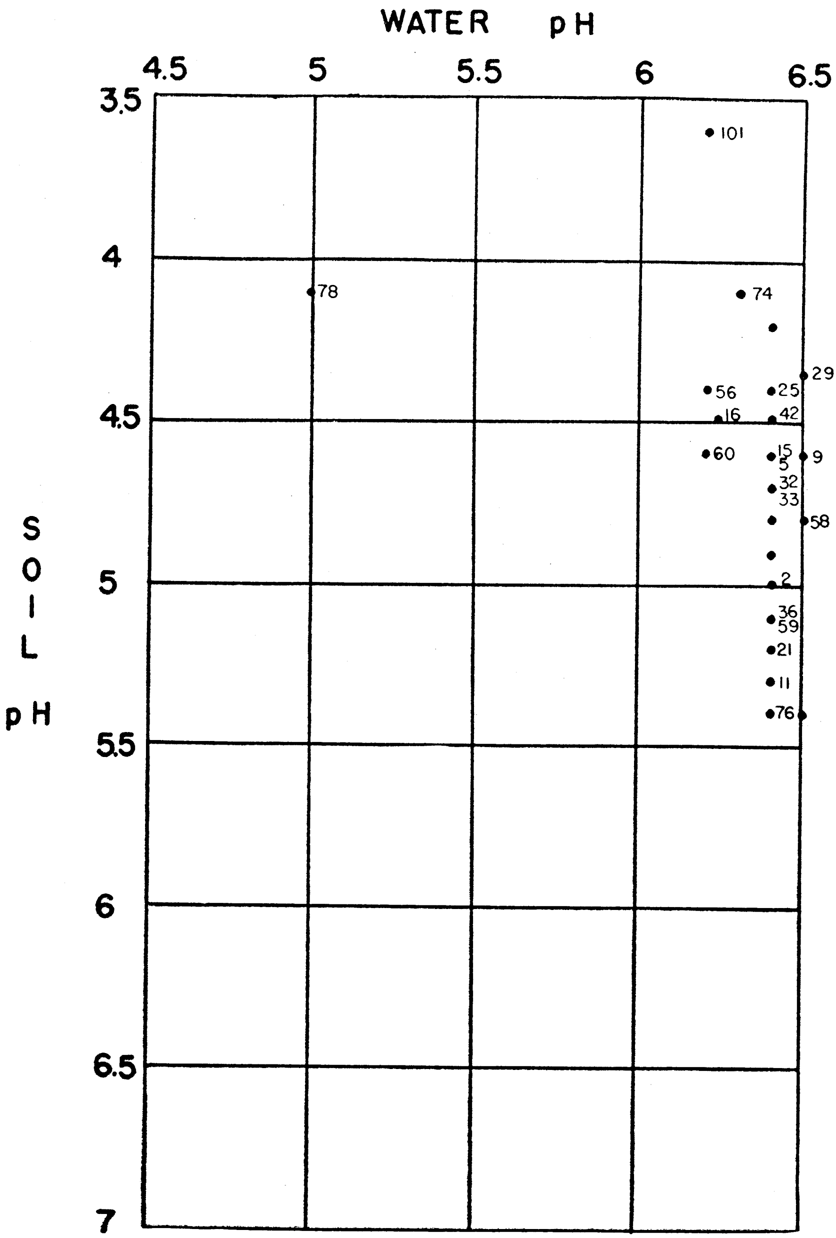
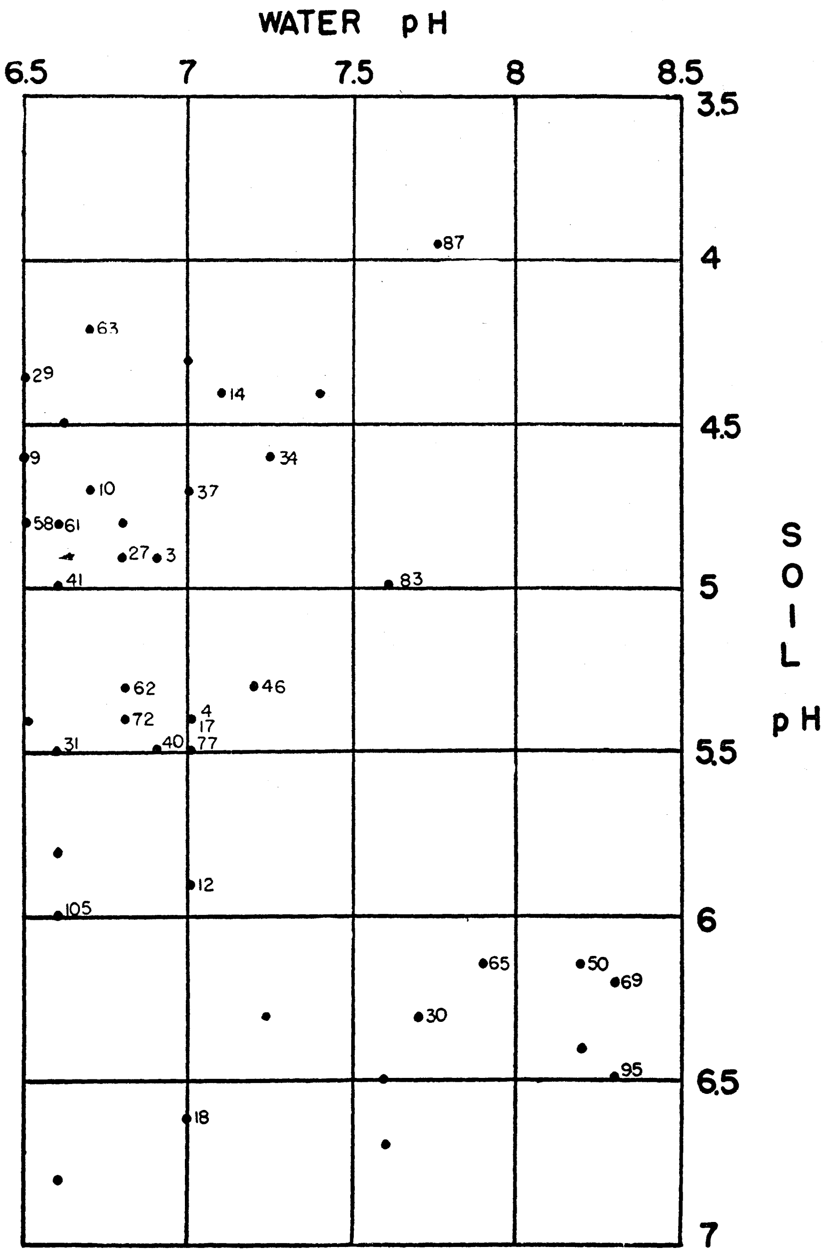


FIGURE 1. Each dot represents a single cultivated Wisconsin cranberry marsh.


WATER pH
6.5
7
7.5
8
8.5
3.5
4
4.5
5
5.5
6
6.5
7
SOIL pH
87
63
29
14
9
34
10
37
58
61
27
3
41
83
62
46
72
4
17
31
40
77
12
105
65
50
69
30
95
18

out the cranberry growing area. In all, water from at least 200 sources was tested. The number of cranberry bogs on which the water is used would be much larger since water from certain ponds and streams is used on several different bogs.

The contrast in water between eastern Massachusetts and Wisconsin is striking. All but four of the samples of water used in flooding cranberries in Massachusetts had a pH of 7.0 or below. It is also obvious that all the flooding water thus far tested in southeastern Massachusetts is very low in carbonates. Exactly one half of the first 100 water supplies on which these Massachusetts data are based showed a bound carbon dioxide content of three parts or less per million. All except 11 had five parts per million or less and would thus fall in the category "very soft" as set up by Birge and Juday[1] and widely used in Wisconsin. The highest reading for any cranberry water supply in Plymouth or Barnstable counties was 6.5 p.p.m. bound CO_2.

Water sources falling in Juday's classes "medium hard" and "hard" were found in southern Vermont as well as in western Massachusetts and Connecticut, but so far as could be learned these have never been used in cranberry culture. The foregoing information tends to show why none of the cranberry problems which are believed to be associated with the use of hard water in Wisconsin have been recognized in Massachusetts.

[1] Birge, E. A. and Chancey Juday. 1911. The Inland Lakes of Wisconsin. Wisconsin Geological & Natural History Survey. Bull. 22, 259 pp.

RECENT ADDITIONS TO THE RECORDS OF THE DISTRIBUTION OF THE AMPHIBIANS IN WISCONSIN*

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INTRODUCTION

In recent years there has been an increasingly large amount of work done on the herpetofauna of various states. Although there has been a few scattered regional Wisconsin notes on the subject, no comprehensive work has been done since Pope and Dickinson's monograph (1928). However, their publication was restricted to the taxonomy and distribution of the amphibians and reptiles of the state. A need for an up-to-date report on the herpetology of Wisconsin was recognized. To meet this need, a handbook on the Wisconsin lizards and snakes by Mr. W. E. Dickinson of the Milwaukee Public Museum has recently been published. In order to help complete the herpetological studies, a survey on the amphibians was started some three years ago. The final objective of the survey is to publish a treatise on the natural history of the amphibians of the state.

The purpose of this paper, however, is to set forth the present status of the distribution of the amphibians in Wisconsin. In addition, problems concerning subspecies are discussed. The distribution of eighteen species is tabulated. Furthermore, one new subspecies identification has been changed, and six species mentioned by Pope and Dickinson (1928) have been placed in a supplementary list.

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Materials and Method

Specimen records were obtained by personal field trips, aid solicited from schools and other interested people, by listing, and actual specimens of Wisconsin amphibians procured from various museums and universities in the adjacent states. The compilation of the maps are based on previous published records, unpublished records, and 877 specimens obtained during the past three years as a result of the survey. The amphibians collected for the present study have been deposited with the Marquette University Museum.

New County Records

The following abbreviations are being used to indicate in the species tabulation the various universities, museums, or individuals who have new records of Wisconsin amphibians.

CCM	Carroll College Museum
CNHM	Chicago Natural History Museum
RE	Richard A. Edgren, Jr. of Northwestern University
MMNH	Minnesota Museum of Natural History
MPM	Milwaukee Public Museum
MU	Marquette University
UI	University of Illinois
UMMZ	University of Michigan Museum of Zoology
UW	University of Wisconsin
USNM	United States National Museum

ORDER CAUDATA (URODELA)

Family Proteidae

Necturus maculosus maculosus (Rafinesque)

Common Mudpuppy

Map 1

County	Locality	Source and Cat. No.
Chippewa	Boyd	MU 1583
Door	Sturgeon Bay	MU 1018, 1769
Door	Sand Bay	UW 4054, 4056–7
Juneau	Mauston	MPM uncatalogued
Kewaunee	Dykesville	MU 1785–86
Manitowoc	Two Rivers	MU 1262
Washburn	Little Horseshoe Lake	MU 1019–21
Washburn	Spooner	UMMZ 69624

Necturus maculosus stictus Bishop

Wisconsin Mudpuppy

Map 1

Bishop (1941) described a new subspecies which he called the *N.m. stictus.* The range given by Bishop (1943), extends from Lake Winnebago to Mackinac County on the upper peninsula of Michigan. In the present study no additional specimens have been caught.

Family Salamandridae

Triturus viridescens louisianensis (Wolterstorff)

Louisiana Newt

Map 2

County	Locality	Source and Cat. No.
Ashland	Butternut	CNHM 35830
Dodge	Fox Lake	UI 1404–06
Jefferson	Palmyra	MU uncatalogued
Kenosha	Bristol	MU 1023–24
Marinette	Crivitz	MU uncatalogued
Waukesha	Waukesha	MPM 2415

Pope and Dickinson (1928) listed the newt found in Wisconsin as *T.v. viridescens* (Rafinesque). Fifty-one specimen records were examined and it was found that all of the salamanders fit the description of the *T.v. louisianensis*. The sizes of all of the aquatic newts ranged from 47 to 90 mm. in length with the average size of 64.5 mm. Seventeen red efts varied in length from 42 to 60 mm. with an average length of 51.5 mm. Of the seventeen efts, 2 red land newts have been found near Bristol in Kenosha County. This is a further verification of William's report (1947).

Family Ambystomidae

Ambystoma jeffersonianum (Green)

Jefferson's Salamander

Map 3

County	Locality	Source and Cat. No.
Columbia	Poynette	UW uncatalogued
Door	Jackson	UW 4348–52
Douglas	Tomahawk Is.	UW 6163
Douglas	Gordon	MMNH 516–7
Forest	Metonga Lake	MPM 2558
Fond du Lac	?	MPM 2590
Green Lake	Markesan	UI 1410
Kewaunee	Kewaunee	MU 1062
Manitowoc	Point Beach St. Park	MU 1319–20
Marathon	Hatley	MU 1612
Oconto	?	UNMZ 85566
Sauk	Reedsburg	MPM 2403
Sawyer	Loretta	UMMZ 77131
Vilas	Trout Lake	UW 6673
Waushara	Saxesville	UW 9688
Waushara	Silver Lake	RE 457–59, 751–91
Wood	Wisconsin Rapids	MPM 2347

Breckenridge (1944) states that "Minnesota specimens of this salamander are definitely smaller than those from farther east." Bishop (1943) gives the average eastern form size as 162 mm. The largest Wisconsin specimen examined is 119 mm.; the average size is 86 mm.

Ambystoma maculatum (Shaw)

Spotted Salamander

Map 4

COUNTY	LOCALITY	SOURCE AND CAT. NO.
Oconto	?	UMMZ 85569
Manitowoc	Point Beach State Forest	MU 1316

A salamander only occasionally found in the state. Not enough specimens of this form have been found to make any evaluation of its distribution in Wisconsin. Only one representative of this species has been caught by me; it was discovered under a decayed coniferous log in the south end of Point Beach State Forest. Several *Plethodon cinereus cinereus* (Green) were found in close proximity to the *Ambystoma maculatum,* yet they did not seem to disturb each other. It should be added, however, that the lack of records of this species does not necessarily imply that it is rare in the state.

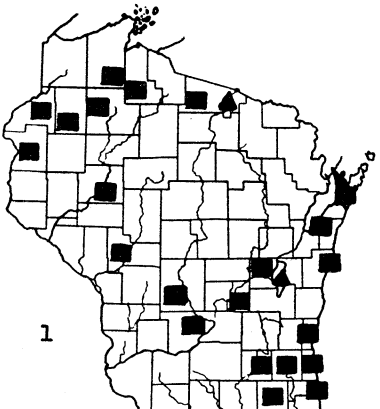
Ambystoma tigrinum tigrinum (Green)

Eastern Tiger Salamander

Map 5

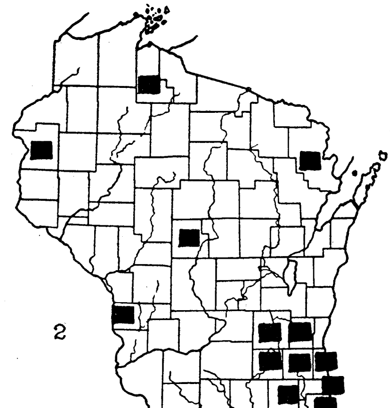
COUNTY	LOCALITY	SOURCE AND CAT. NO.
Dodge	Beaver Dam	UI 271–73, 275, 1412–18
Eau Claire	Eau Claire	MU 1619
Marathon	Hatley	MU 1611
Pierce	Hager City	MMNH 963–65
Waushara	Silver Lake	RE 873
Waushara	Wild Rose	UW 9916

These salamanders have been caught during the spring breeding season in a dirty drainage ditch in one of the industrial areas of Milwaukee. In 1949, however, a modern drainage system was installed; consequently, the water in the ditch was no longer present. Therefore, it seems likely that in several years the present population will die off, and with no prospect of the procreation of further progeny in that area.



1

■ NECTURUS MACULOSUS MACULOSUS
▲ NECTURUS MACULOSUS STICTUS



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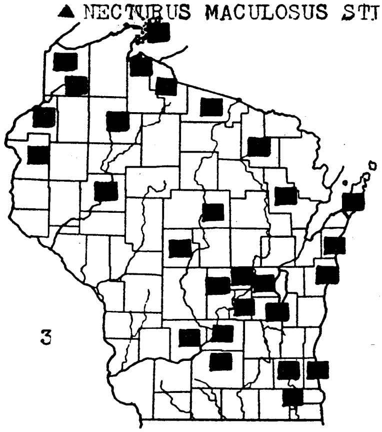

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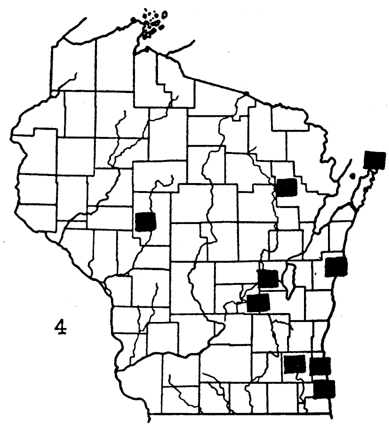
AMBYSTOMA JEFFERSONIANUM



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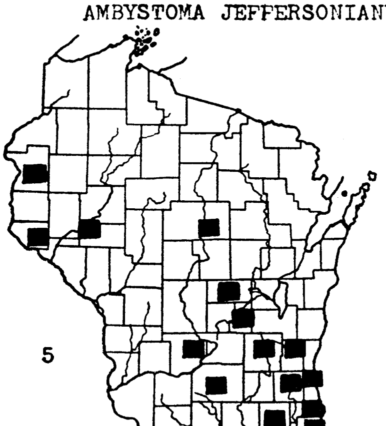
AMBYSTOMA MACULATUM



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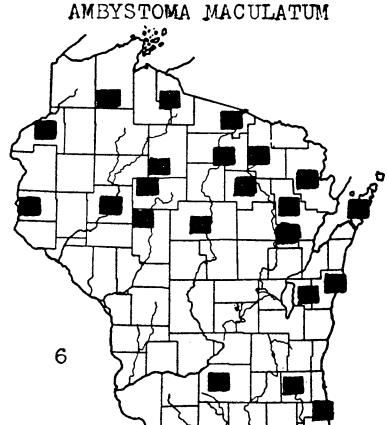
AMBYSTOMA TIGRINUM



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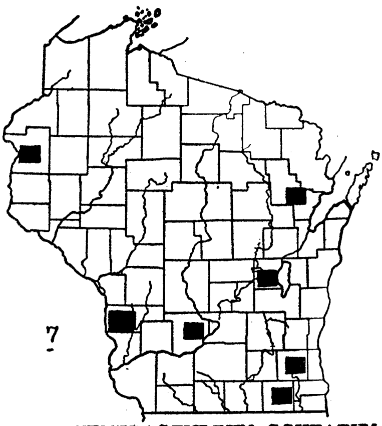
PLETHODON CINEREUS



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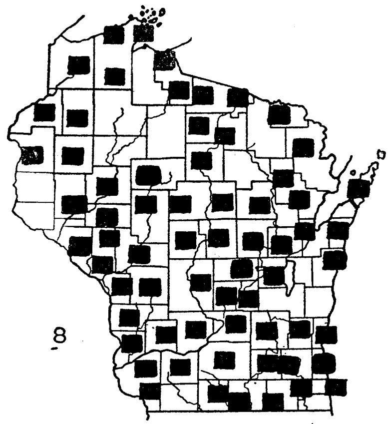
HEMIDACTYLIUM SCUTATUM



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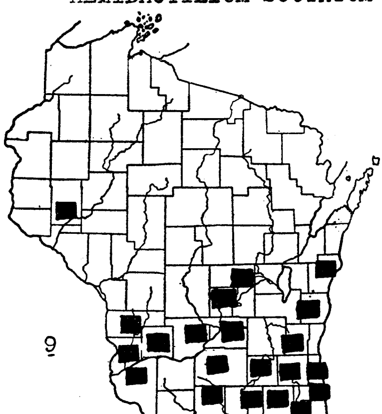
BUFO TERRESTRIS AMERICANUS



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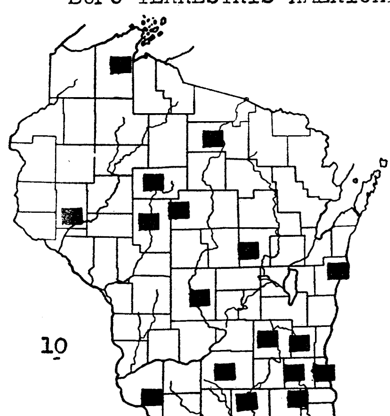
ACRIS GRYLLUS



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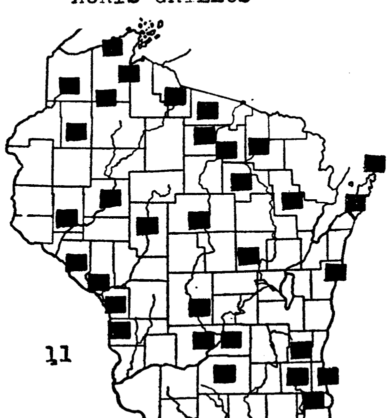
PSEUDACRIS NIGRITA



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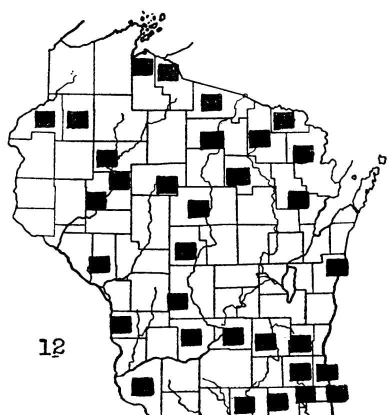
HYLA CRUCIFER CRUCIFER



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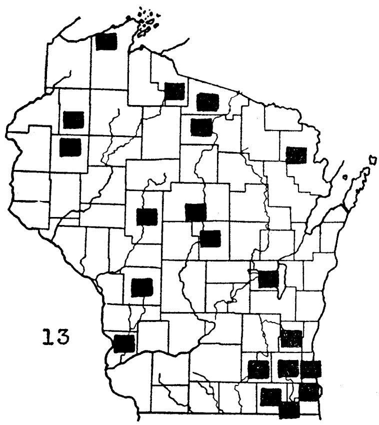

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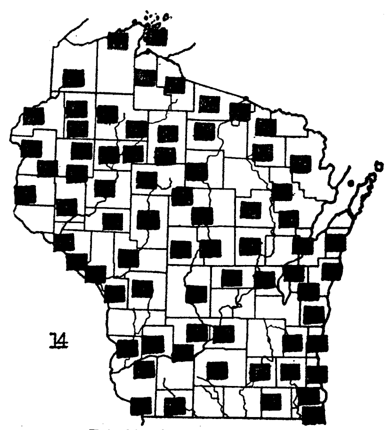
RANA CATESBEIANA



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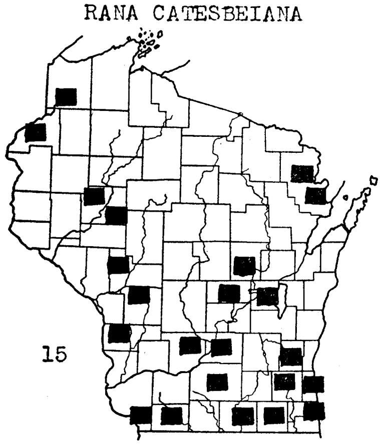
RANA CLAMITANS



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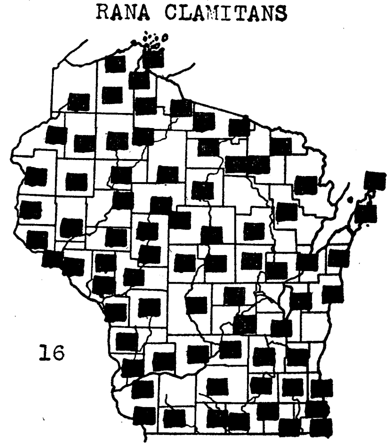
RANA PALUSTRIS



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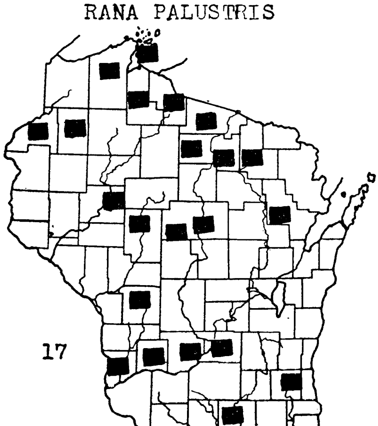
RANA PIPIENS



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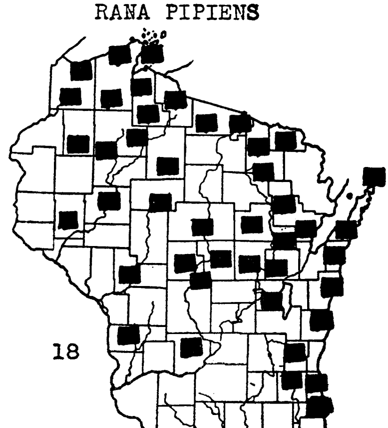
RANA SEPTENTRIONALIS



18

RANA SYLVATICA

Family Plethodontidae

Plethodon cinereus cinereus (Green)

Redbacked Salamander

County	Locality	Source and Cat. No.
Bayfield	Calbe	UW uncatalogued
Chippewa	Brunet Is. State Park	UW uncatalogued
Door	Garrett Bay, Bartlet Lake	MPM 2593–94
Douglas	Brule	UW uncatalogued
Douglas	Pattison State Park	UW uncatalogued
Forest	Metonga Lake	MPM 2569
Manitowoc	Point Beach State Park	MU 1788–89
Marathon	Rib Mountain State Park	RE 874–75
Marinette	Lake Hilbert	MPM 2667
Oconto	?	UMMZ 85567
Polk	St. Croix Falls	MMNH 386–90
Price	Chequamegon National Forest	US uncatalogued
Vilas	Phelps	MU 1268–69
Taylor	Chequamegon National Forest	UW uncatalogued

During the past twenty years, no specimens have been found south of Manitowoc County. Many of these salamanders were found within and under rotten logs in the Point Beach State Forest. In the early part of June 1948, we found five females encircled around their individual clusters of eggs within rotten logs. No eggs were found underneath the logs.

Hemidactylium scutatum (Schlegel)

Four-toed Salamander

Map 7

At the present time three records have been added to the reports of previous investigators. On May 8, 1949, two specimens were caught by Dr. Herbert Levi of the University of Wisconsin in Madison. These salamanders were found in Baxter's Hollow, which is near the Badger Village, in Sauk County. Upon corresponding with Dr. Levi, he wrote, "They were found in logs in relatively dry places in a maple-yellow birch forest and some were seen in a stand of witchhazel." The second specimen record was found by Dr. Levi in the Interstate Park in Polk County on July 18, 1949. These specimens are now placed in the University of Wisconsin Museum of Zoology. The third specimen was found by me near Stiles in Oconto County on August 26, 1949. It was found in a log in a beech-maple forest.

The salamander found in the Interstate Park extends this species to a probable state-wide distribution. Previously Bishop (1943) reported that the most northwesternly distribution extended from Vernon to Lincoln Counties in Wisconsin. The new Wisconsin record extends the distribution approximately 130 miles west of Lincoln County. Pope and Dickinson (1928) stated that the occurrence of this species was rare in this state. The probable reason for their conclusion is its secretive habits; however, I do not believe that they are as rare as previously believed.

ORDER ANURA (SALIENTIA)

Family Bufonidae

Bufo terrestris americanus (Holbrook)

American Toad

Map 8

County	Locality	Source and Cat. No.
Ashland	Ashland	MU 1384–97
Barron	Rice Lake	MU 1398
Brown	Suamico	UMMZ 72584
Dodge	Beaver Dam	UI 1438–40
Green	?	UMMZ 66728
Green Lake	Berlin	MU 1081–82
Jefferson–Dodge	Watertown	MU 1545–71
La Crosse	La Crosse	MU uncatalogued
Kewaunee	Kewaunee	MU 1640–41
Manitowoc	Kiel	MU 1601–61
Manitowoc	Whitelaw	MU 1327
Marinette	Crivitz	MU 1000
Outagamie	Appleton	MU 1466
Outagamie	Bear Creek	MU 1143, 1766–68
Ozaukee	Thiensville	MU 1037
Trempealeau	Dodge	MU 1219
Washington	Hartford	MU 1728
Waupaca	Waupaca	MU 1277–78

This is the only representative of the Family Bufonidae now known to be found in Wisconsin. It is one of the most common species of woodland amphibians in the state, and it has a state-wide distribution.

Family Hylidae

Acris crepitans Baird

Swamp Cricket Frog

Map 9

County	Locality	Source and Cat. No.
Crawford	Prairie du Chien	MU 1329–32
Dodge	Beaver Dam	UI 1447–48
Juneau	Mauston	MPM uncatalogued
Kenosha	Wheatland	UMMZ 67882
Manitowoc	Point Beach State Park	MU 1043
Sheboygan	Little Elkart Lake	CCM uncatalogued
Washington	Hubertus	MU 1013
Waupaca	St. Lawrence	CNHM 14729–30

This is a small rough skinned tree frog found near quiet ponds and lakes in the southern half of the state. Although Wright and Wright (1949) report that this species is distributed throughout most of Wisconsin, the present records show that they are limited to the southern half of the state. However, Creaser (1944) reports this amphibian as being taken in the northern part of the lower peninsula and also in Delta County in the upper peninsula of Michigan. Upon corresponding with Dr. Norman Hartweg of the UMMZ, he informed me that the Delta County record was a misidentification and should be disregarded. Breckenridge (1944) states that it is found in the SW and SE corner of Minnesota, and this corresponds to the northern limits of the Wisconsin records. The status of a new subspecies *A.g. blanchardii* (Harper) in Wisconsin described by Harper (1947) will be reserved for another paper.

Pseudacris nigrita triseriata (Wied)

Striped Tree Frog

Map 10

County	Locality	Source and Cat. No.
Adams	Friendship	UW 3856–62
Clark–Marathon	Dorchester	MU 1200
Dane	Madison	UW 6505
Dodge	Beaver Dam	UI 1452–71
Manitowoc	Two Rivers	MU 1016
Oneida	Bradley	UW 6755–67
Rock	Milton	UW 9514

County	Locality	Source and Cat. No.
Taylor	Medford	UMMZ 69623
Waukesha	Waukesha	UW 9521
Waupaca	Waupaca	MU 1276

This tree frog has been taken only infrequently in this state, but is widely dispersed throughout Wisconsin. Its habitat is similar to that of *Hyla crucifer.*

Hyla crucifer crucifer Wied

Spring Peeper

Map 11

County	Locality	Source and Cat. No.
Buffalo	Waumandee	MU 1132
Manitowoc	Point Beach State Park	MU 1322
Ozaukee	Cedarburg Swamps	MU 1321
Sawyer	Hayward	UMMZ 71437
Trempealeau	Perott State Park	RE 892
Vernon	Wildcat Mountain State Park	UW uncatalogued
Washington	Holy Hill	MPM 2561
Waupaca	Waupaca	MU 1275
Waushara	Wautoma	RE 887–90

This species is a small delicate tree frog found on moist floors of mixed deciduous-coniferous forests throughout the state. The present records show scattered distribution in the entire state.

Hyla versicolor versicolor (Le Conte)

Common Tree Frog

Map 12

County	Locality	Source and Cat. No.
Columbia	Portage	MU 1451
Dodge	Beaver Dam	UI 1476–79
Forest	Metonga Lake	MPM 2562
Iron	Hurley	MU 1434
Manitowoc	Two Rivers	MU 1263–64
Marinette	Crivitz	MU 1015
Oconto	Oconto	MU 1060
Rusk	Ladysmith	UW uncatalogued
Taylor	Medford	UMMZ 69623
Trempealeau	Arcadia	MU 1225
Trempealeau	Perott State Park	RE 884
Walworth	Whitewater	MPM 2454
Washburn	Little Horseshoe Lake	MU 1014

Family Ranidae

Rana catesbeiana Shaw

Bullfrog

Map 13

County	Locality	Source and Cat. No.
Barron	Barronett	RE 916–26
Kenosha	Bristol	MU 1260–61
Marinette	Crivitz	MU 1272

Rana clamitans Latreille

Green Frog

Map 14

County	Locality	Source and Cat. No.
Barron	Rice Lake	MU 1621–28
Calumet	near Kiel	MU 1066
Kewaunee	Kewaunee	MU 1639
La Crosse	La Crosse	MU uncatalogued
Lafayette	Darlington	MU 1678–79
Manitowoc	Kiel and Cleveland	MU 1600, 1755
Marinette	Crivitz	MU 1312–13
Outagamie	Bear Creek	MU 1756–61
Price	Phillips	UMMZ 69588
Rusk	Glena Flora, Bruce	UMMZ 69592–96
St. Croix	Willow River, Hudson	MMNH 843–53
Sheboygan	Sheboygan	UW 1976–77
Taylor	Medford	UMMZ 1976–77
Vernon	Wildcat Mtn. Sta. Park	UW uncatalogued
Waupaca	Waupaca	MU 1284–88, 1309
Waushara	Silver Lake	RE 462–6, 365–66, 897–905

Rana palustris Le Conte

Pickerel-Frog

Map 15

County	Locality	Source and Cat. No.
Chippewa	Cadott	MU 1480
Chippewa	Jim Falls	UMMZ 69605
Columbia	Poynette	UW uncatalogued
Marinette	Crivitz	MU 1273–74
Washington	Hartford	MU 1723–26
Waupaca	Waupaca	MU 1289–95
Waushara	Silver Lake	RE 460–61

Rana pipiens Schreber

Leopard-Frog

Map 16

COUNTY	LOCALITY	SOURCE AND CAT. NO.
Barron	Rice Lake	MU 1629–37
Brown	West Wrightstown	MU 1355–62
Calumet	near Kiel	MU 1065
Dodge	Beaver Dam	UI 1488–91
Dodge	Columbus	RE 896
Forest	Metonga Lake	MPM 2565
Green	Monticello, Brownstown	UMMZ 69631–32
Green Lake	Berlin	MU 1218
Jefferson	Watertown	MU 1543–44
La Crosse	La Crosse	MU uncatalogued
Kewaunee	Kewaunee	MU 1067–70
Lafayette	Argyle	UMMZ 69629
Manitowoc	Whitelaw, Kiel, Cleveland	MU 1325–26, 1592–99, 1754
Marinette	Crivitz	MU 1314–15
Outagamie	Bear Creek, Appleton, Kaukauna	MU 1762–65, 1442–45, 1340–54
Rusk	Ladysmith	UMMZ 64608
Taylor	Medford	UMMZ 69630–37
Waupaca	Waupaca	MU 1296–1308
Waushara	Silver Lake	RE 893–94

Breckenridge (1944) states that there are two mutant strains, *R.p. burnsi* and *R.p. kandiyohi,* found in Minnesota and which extend to the Wisconsin border. Wright and Wright's (1949) general distributional map shows these strains extending into Wisconsin between Pierce and La Crosse Counties. Recently, Moore (1942) made extensive studies on the genetics of *R.p. burnsi* and he concluded that "*Rana burnsi* differs from *Rana pipiens* by one dominant gene that influences pigmentation. . . . *Rana burnsi* should not have the status of a species or subspecies but should be reduced to synonymy with *Rana pipiens* and be referred to as the 'burnsi mutant.' " Furthermore, Moore (1944) investigated the taxonomy of *R. pipiens* Schreber, *R. sphenocephala* (Cope), and *R. brachycephala* (Cope), and he concluded that "it does not appear possible to recognize the three species or subspecies of meadow frogs on the basis of differences in body proportions or pigmentation." Therefore, he stated they "should be reduced to synonyms of *Rana pipiens* Schreber." Since in the present survey no mutant forms were caught in Wisconsin, and because of the complexity of this species, all of our forms will be referred to as *Rana pipiens* Schreber.

Rana septentrionalis Baird

Mink Frog

Map 17

County	Locality	Source and Cat. No.
Burnett	Meenon Twp.	CNHM 11075, 14749–62, 16355
Forest	Metonga Lake	MPM 2566
Rock	Milton	UW 9672
Wood	Wisconsin Rapids	MPM 2533

Rana sylvatica Le Conte

Wood Frog

Map 18

County	Locality	Source and Cat. No.
Jackson	Alma Center	UW uncatalogued
Kewaunee	Kewaunee	UW uncatalogued
Lincoln	Merrill, Copper River	UMMZ 64808–09
Manitowoc	Point Beach State Park	MU 1323
Outagamie	Appleton Junction	UI 1495–96
Rusk	Ladysmith, Hawkins	UMMZ 69619–20
Sheboygan	Terry Andrae Park	MPM 2413
Taylor	Medford	UMMZ 69621

Wright and Wright (1949) divide the Wood Frog into two subspecies, *R.s. cantabrigensis* Baird, which is a variety distributed in the northern half of the state (44 to 47 degrees N. Lat.), and *R.s. sylvatica* (Le Conte), which is a variety distributed in the southern half of the state (42.2 to 44 degrees N. Lat.).

288 specimens placed in the Marquette University Museum, Milwaukee Public Museum, and University of Wisconsin Museum of Zoology were measured for the body/tibia ratio. I arbitrarily classified as immature all frogs with body lengths less than 30 mm.; consequently, 61 specimens of the total number were placed in this category. Moore (1944) defined the body length as that distance from the snout to the cloacal opening, and tibia length as that distance between the knee and ankle joints when the leg of the frog was flexed. His definitions were

followed. Wright and Wright (1949) designated the body/tibia ratio range of 1.93–2.30 for *R.s. cantabrigensis,* and 1.60–1.88 for *R.s. sylvatica.*

TABLE 1

Rana sylvatica sylvatica (Le Conte)

Location	Size	No. of Specimens	Range of B/T Ratio	Av. B/T Ratio
Northern half............	mature	83	1.56–1.89	1.75
Southern half............	mature	68	1.40–1.89	1.76
Northern half............	immature	16	1.72–1.88	1.80
Southern half............	immature	18	1.63–1.86	1.72

TABLE 2

Rana sylvatica cantabrigensis Baird

Location	Size	No. of Specimens	Range of B/T Ratio	Av. B/T Ratio
Northern half............	mature	41	1.90–2.25	1.98
Southern half............	mature	5	1.90–1.96	1.92
Northern half............	immature	20	1.92–2.45	2.05
Southern half............	immature	7	2.09–2.42	2.26

Of the 124 mature specimens from the northern part of the state, 83 appeared to be *R.s. sylvatica,* the "southern form", while 41 fit the description of *R.s. cantabrigensis,* the "northern form." Of the 73 mature southern specimens, 68 were found to fit *R.s. sylvatica* characteristics, while only 5 fit *R.s. cantabrigensis* characteristics. (See Tables 1 and 2). In general, the tibia in immature specimens was shorter in proportion to the body than in the mature frogs. Those with *R.s. sylvatica* characteristics are widely distributed throughout the state; whereas, those characteristic of *R.s. cantabrigensis* are more prevalent in the northern half of the state. However, a complication arises when one considers that Wisconsin is probably in an area of intergradation of the two subspecies.

Supplementary List

The following group of amphibians have been included in the Wisconsin herpetofauna in other publications, but since no further specimen records have been found, it was decided to put them in a supplementary list.

A. A species that may be present in Wisconsin.

Bufo woodhousii fowleri (Hinckley)

One doubtful record is in the University of Wisconsin Museum of Zoology. Of the several hundred toads caught in the recent study, none of them fit the description of the Fowler's Toad. Edgren and Stille (1948), however, reported the presence of this species in Cook, Grundy, Kankakee, and Lake Counties in Illinois. Creaser (1944) states that the most northern record of the *B.w. fowleri* in Michigan is along Lake Michigan sand dunes in Mason County. Therefore, there is a possibility that this species may be found in the sand dune areas along the Wisconsin shores of Lake Michigan.

B. Species that should be omitted from the Wisconsin herpetofauna.

1. *Ambystoma opacum* (Gravenhorst)

Hoy (1883) reported finding this species under logs a few miles from Racine. Furthermore, Cahn (1929) noted, "Rare. Two specimens both from under rotten logs are all I have seen; one from near Oconomowoc Lake, the other near Dutchman's lake."

2. *Plethodon glutinosus glutinosus* (Green)

The National Museum has in their possession five specimens of *P. glutinosus* (USNM 3789) caught by some unknown person or persons. Hoy (1883) reported the presence of this species in Racine. Higley (1889) stated that this salamander was "not common in Wisconsin." Cahn (1929) also found "five specimens taken from under moist logs in swamps. Rare." Stille and Edgren (1948) reported what "seems to be the first authentic record for the slimy salamander in the Chicago Region." It was caught in Indiana in 1939.

3. *Pseudotriton ruber ruber* (Sonnini)

Higley (1889) reported that this salamander was found "in damp and unfrequented swamps in southern half of state; not rare." Hoy (1883) also noted its presence near Racine.

4. *Eurycea bislineata bislineata* (Green)

Higley (1889) stated "two or three specimens have been reported from southern Wisconsin. Racine, Hoy, rare." Upon corresponding with Dr. Doris M. Cochran of the U. S. National Museum, she informed me that the only specimen recorded (USNM 3747) was destroyed.

5. *Eurycea longicauda longicauda* (Green)

Hoy (1883) reported this species is "found at Racine." Higley (1889) stated that it was also found in Walworth County and was considered rare.

DISCUSSION

The development of suburban areas of cities and the cultivation of lands which were previously not affected by man have radically changed the natural habitations of many animals. As a consequence some species have become isolated, others may have increased in population due to man's influence. The urbanization of Milwaukee County can serve to illustrate the isolation of amphibians in a particular area. The example of *Ambystoma tigrinum* was cited previously in this article. *Necturus maculosus, Rana catesbeiana, Rana sylvatica,* and *Triturus viridescens* can be found only in a few isolated areas in Milwaukee County, although they were once widely distributed in that area.

On the other hand, specimen records caught in the present survey have shown that certain species are not as rare as previously reported. In recent years studies in the life histories of various species of amphibians have clarified possible habitats of these animals. With this in mind, new records of formerly rare amphibians have been found. Both *Triturus viridescens* and *Hemidactylium scutatum* belong in this category. In the past nine years five new widely scattered county records of *Triturus* have been found. Of *Hemidactylium,* three out of a total of seven county records have been found in 1949.

The problem of subspecies complex in the state should be more thoroughly studied. At the present time, the problem concerns *Necturus maculosus, Acris crepitans, Rana pipiens,* and *Rana sylvatica* complex. In those species, Wisconsin is in the intergradation area.

SUMMARY

Many new county distributional records have been added. *Bufo terrestris, Rana clamitans,* and *Rana pipiens* have been recorded in all but a few counties, and there is little doubt that they are found in those areas also. *Hemidactylium scutatum* and *Triturus viridescens* have been found to be more common than previously believed. *Necturus maculosus* is probably found in most of the larger lakes and waterways of the state, but due to its aquatic habitat has not been easily caught. On the other hand, certain salamanders have not been found for a number of years and may have disappeared in this area.

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NOTES ON SOME WISCONSIN FUNGI

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During the course of studies of the parasitic fungi of Wisconsin as represented around Madison and Sturgeon Bay, several forms were collected which proved to be of special interest either because they had not been collected previously in Wisconsin, or they were collected on new sucepts for Wisconsin. Cultural studies of two of the fungi were made and are presented briefly in this paper.

(I) *Venturia Clintonii* Peck.

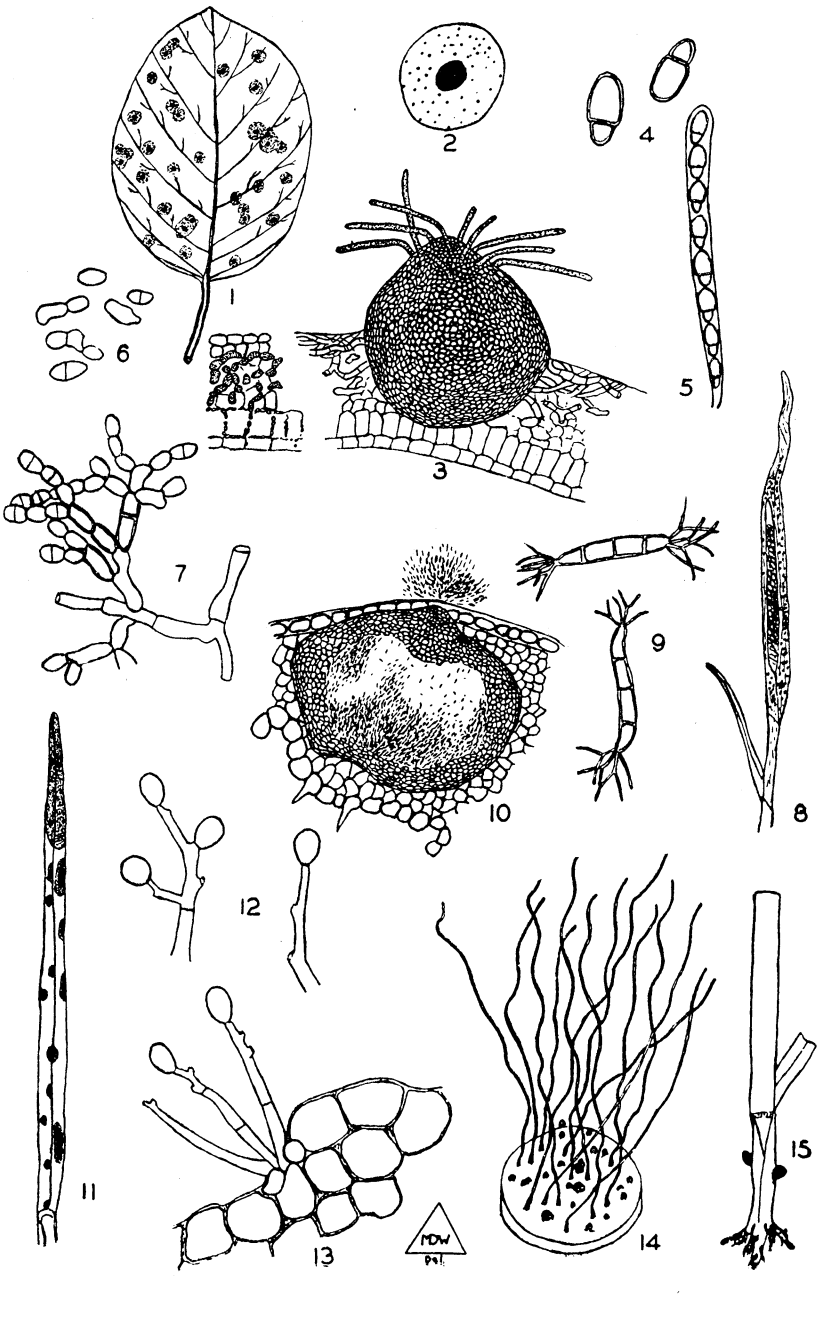
On the leaves of *Cornus* sp., leg. J. S. Boyle, Sturgeon Bay, Wis. Sept. 30, 1947 and April 25, 1948.

A leaf spot fungus on *Cornus* sp. was collected near Sturgeon Bay in the fall of 1947. The infection spots were circular, 3 to 5 mm. in diameter, brownish-black and often coalescing (Fig. 1). The center in each infection spot was jet-black, giving a characteristic frog-eye appearance. Microscopic examination revealed yellowish-brown hyphae massed in a stromatic layer beneath the cuticle. The strands of hyphae pushed between the epidermis and the intercellular spaces of the leaf tissue. In sections through the dark center portion of the infection spot, the hyphae were yellowish-brown, grouped in large masses as swollen hyphal cells, giving the appearance of chlamydospore-like structures (Fig. 3). No conidial stages were observed on leaves collected in the fall. In the spring of 1948, leaves with infection spots produced the previous season were collected on the ground to secure the overwintering stages of the fungus. The infection spots with their dark centers were clearly demarcated in the old leaves, with the perithecial stage of a *Venturia* sp. apparent in the light coloured area (Fig. 2). The perithecia were superficial, developing from the mass of hyphae in the leaf tissue (Fig. 3). The ascospores were uniseriate, yellowish-brown, ovate-ellipsoid, with the apical cell the larger of the two (Figs. 4 and 5).

The ascospores germinated readily when placed on water agar, and developed long germ tubes. Some of the germinating

EXPLANATION OF FIGURES

Fig. 1. Leaf of *Cornus* sp. showing infection spots x ½ nat. size.
Fig. 2. Enlarged view of infection spot x 5.
Fig. 3. Perithecium of *Venturia Clintonii* x 300.
Fig. 4. Ascospores x 1500.
Fig. 5. Ascus with ascospores x 800.
Fig. 6. Conidia of the *Cladosporium* stage x 1500.
Fig. 7. Showing the catenations of the conidia x 1320.
Fig. 8. Showing infection of *Dilophospora alopecuri* x 2.
Fig. 9. Spores of the same.
Fig. 10. Pycnidium of *Dilophospora alopecuri* x 300.
Fig. 11. Showing infection spots of *Ovularia pulchella* on red top, x 1.
Fig. 12. Conidiophores and conidia of same x 1320.
Fig. 13. Showing tufts of conidiophores x 1320.
Fig. 14. Sclerotia and sporophores of *Typhula phacorrhiza* x ½ nat. size.
Fig. 15. Showing the sclerotia on the overwintered culms of sudan grass x 1.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ascospores were picked out aseptically and transferred to potato dextrose agar. Colonies developing from the single ascospores were olive-green with a blackish tinge. The mycelium was creeping and branched, the conidiophores were erect and septate. Mature conidia were olive-green in mass, borne on the conidiophores in chains, of variable shape, sub-cylindric, ovate or ellipsoid, 0 to 1-septate and measuring 8–12 by 4–5 μ. Detailed examination of the imperfect stage of the fungus revealed it to be a species of *Cladosporium* (Figs. 6 and 7).

The *Venturia* species under study was similar to *Venturia Clintonii* Peck, described by Peck (1874) on *Cornus circinata* collected near Buffalo, New York. The ascospores were stated to measure 10 μ long and arranged in an uniseriate manner within the ascus. In the *Venturia* species under study, collected on *Cornus* sp., the ascospores were uniseriate and measured 10 x 5–5.5 μ. Since we had no authentic specimen of *V. Clintonii* for comparison, the identification of the fungus under study was based upon the description given by Peck.

The development of the *Cladosporium* stage of the fungus in culture from the ascosporic cultures of *Venturia* adds another instance of the connection of species in these genera, although the conidial stage has not been observed in nature. Aderhold (1901) showed that the conidial stage of *Venturia cerasi* (Rabenh.) Aderh., inciting the cherry scab, was a *Cladosporium* and not a *Fusicladium* as was originally assumed. Plakidas (1942) showed that *Cladosporium humile* Davis, described by J. J. Davis in Wisconsin on *Acer rubrum* L. and *A. saccharinum* L. was the conidial stage of *Venturia acerina* Plakidas.

(II) *Dilophospora alopecuri* (Fr.) Fr.

On the leaves and inflorescence of *Festuca ovina* L., leg. M. J. Thirumalachar, Columbus County, Wis. May 8, 1948.

Dilophospora alopecuri was first recorded in the United States by Bessey (1906) on the basis of material collected on *Calamogrostis canadensis* (Michx.) Beauv. by J. J. Davis in Wisconsin. The fungus was recorded on *Poa secunda* Preal. by Fisher (1940), on *Sitanion jubatum* J. G. Smith by Sprague (1942), and Greene (1948) collected the fungus on *Leersia oryzoides* L. and *Phalaris arundinacea* L. in Wisconsin. Atanasoff (1925), who studied the fungus in detail, showed the role of nematodes in the transport of the disease. The fungus has been recorded on a large number of hosts in Europe which includes species of *Festuca.*

(III) *Ovularia pulchella* (Ces.) Sacc.

On the leaves of *Agrostis gigantea* Roth., leg. M. J. Thirumlachar and J. S. Boyle, Aug. 7, 1948. Madison, Wis.

The fungus was described by Saccardo as parasitising orchard grass in Italy. Davis (1919) collected the fungus near Hixton, Wisconsin on *Agropyron tenerum* Vasey and described it as var. *Agropyri* Davis. The conidiophores of *O. pulchella* were stated to be simple or rarely branched, geniculate, bearing ovate, hyaline conidia which measured 8–12 μ long. In *O. pulchella* var. *Agropyri,* Davis (1919) described the conidiophores as straight or geniculate, 40–65 x 2–3 μ, and conidia 9–12 x 6–9 μ.

The infection spots on *Agrostis gigantea* were ovate to oblong, reddish-brown, surrounded by a pale margin, often coalescing to form large patches of 15 to 20 mm. long and 2–3 mm. broad (Fig. 11). Tufts of hyaline conidiophores, 40–50 x 3–4 μ, bearing terminally ovate, hyaline conidia measuring 10–13.5 x 6–8.5 μ were abundant on the material. Conidia were borne successively by sympodial branching of the conidiophore (Figs. 12 and 13). The older conidia, therefore, were pushed aside and appeared to be borne laterally on short branches. This conidiophore branching was similar to that described in *O. pulchella.* In the absence of any detailed comparative studies, we propose to place the *Ovularia* species on *Agrostis gigantea* under *O. pulchella* rather than assigning varietal status.

(IV) *Typhula phacorrhiza* Reichard ex Fries.

On the overwintered culms of oats, leg. M. D. Whitehead, Cross Plains, Wis., May 1, 1948, on culms of sudan grass, leg. M. J. Thirumalachar, Madison, Wis., April 10, 1948.

Cinnamon-brown sclerotia of *Typhula* were collected on overwintering stalks of oats and sudan grass in the early spring of 1948 (Fig. 15). The sclerotia were surface sterilized, plated on potato dextrose agar and incubated at temperatures between 8 and 12 degrees C. The mycelium developed rapidly from the sclerotia and produced more sclerotia on the surface of the medium. Sporophores were formed from the sclerotia which elongated rapidly as filiform structures. The sporophores were twanny in color and 100 to 180 mm. long (Fig. 14). The structure of the sclerotium and the characters of the sporophores of the *Typhula* under study compared very well with *T. phacorrhiza* given by Remsberg (1940).

(V) *Claviceps junci* Adams.

On *Juncus* sp., Lake Wingra, Madison, Wis., leg. M. J. Thirumlachar, Sept. 15th, 1946.

The ergot on *Juncus nodosus* L. was reported in Wisconsin by Davis on a single collection of the fungus comprising sclerotia. In the present collection several infloresences of *Juncus* sp. with ergot sclerotia were secured.

(VI) *Entyloma crastophilum* Sacc.

On the leaves of *Agrostis gigantea* Roth., leg. James G. Dickson et al, Aug. 8th, 1948.

The leaf smut on red top incited by *Entyloma crastophilum* was recorded for Wisconsin by Clinton (1906) but was not included by Davis (1942) in the "Parasitic Fungi of Wisconsin." The sori were minute and black and incited the yellowing and browning of the leaf tissue.

In conclusion the authors wish to acknowledge their indebtedness to Dr. James G. Dickson, Professor of Plant Pathology, University of Wisconsin, for the benefit of valuable advice and suggestions.

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CAUSES OF INJURY TO CONIFERS DURING THE WINTER OF 1947–1948 IN WISCONSIN[1]

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During the winter of 1947–1948 many conifers in the Lake States region were severely damaged by adverse climatic conditions. The injury affected native stands, plantations, nurseries, and ornamental stock. A survey revealed that losses in Wisconsin alone amounted to several hundreds of thousands of dollars. While the injury was sustained by nearly all species of conifers, it was most prominent on Scotch pine *(Pinus silvestris)*, red pine *(P. resinosa)*, and jack pine *(P. banksiana)*, in order of decreasing severity.

The needles of damaged trees showed a complete or partial characteristic browning. The injury was largely confined to the exposed portion of the crown. On some smaller trees, there was a sharp line of demarcation, indicating the depth to which snow had covered the needles. Complete defoliation as well as death of the buds occurred in many instances.

The event was preceded by a prolonged fall drought in which fairly high temperatures prevailed. In January, when the injury took place, there occurred several bright, unseasonably warm, days with strong southerly winds followed by very cold nights.

The injury has been generally attributed to three different causes: frost, sunscald, and drought or "winterkill." The term "frost injury" implies either intracellular or extracellular formation of ice crystals which causes the death of the protoplasm (5). Sunscald is a temperature effect in which the heat of direct sunlight leads to a dehydration of the tissues and irreversible coagulation of the protoplasm. The effect of the sunlight is often reenforced by reflection from the snow. Winter drought is the direct result of transpiration at a time when water is not available because of the frozen soil. The present investigation pro-

[1] The study was supported in part by the Wisconsin Conservation Department. Publication was approved by the director of the Wisconsin Agricultural Experiment Station.

[2] The author is indebted to Dr. S. A. Wilde for his helpful suggestions.

vided strong evidence that winter drought was the cause of the injury.

Observations throughout central and northern Wisconsin indicated that the damage was prevalent on the dry uplands, but not on lowlands with an accessible ground-water table. This disfavors the likelihood of damage by frost, which is more apt to occur on the sheltered lowlands. Moreover, the injury was confined to the portions of the trees most exposed to the warm southerly winds, and hence subject to increased transpiration. This also contradicts the probability of frost injury. In several instances, trees were injured which had been covered with burlap wrapping, which excludes damage by direct sunscald.

Examination of soil in several injured plantations in central Wisconsin revealed that fall drought had brought about a pronounced deficiency of soil moisture to a depth of nearly five feet. This deficiency was undoubtedly amplified by the effect of freezing. On the other hand, it is known that conifers lose about 8 per cent of their total annual transpirational water during the winter months. The winter consumption of water was greatly increased by the unusually high temperatures and southerly winds which occurred in January. The combination of all these conditions suggests that the trees were damaged by winter drought (2, 3, 7).

From a silvicultural standpoint, the greatest puzzle in the entire event was the damage of Scotch pine to an extent which far exceeded that of jack pine and red pine. Scotch pine is a species noted for its hardiness or frost resistance. In order to determine whether there were any differences in the anatomic characteristics of the injured pine species, specimens were collected from various areas. Cross sections of damaged and undamaged needles were made for a microscopic study (Plate I). This investigation showed there was no marked correlation between the degree of injury and the structural features of the needles. In general, however, jack and red pine had a slightly thicker cuticular layer which might have retarded the transpirational loss (6). Moreover, jack pine had the fewest stomatal openings per cross section, and red pine showed the greatest degree of thickening of the endodermal cell walls. These characteristics of leaf structure may also be of importance in the drought resistance of a species (4). There was no apparent difference in structure between the damaged and undamaged needles, other than the breakdown of mesophyll in the discolored

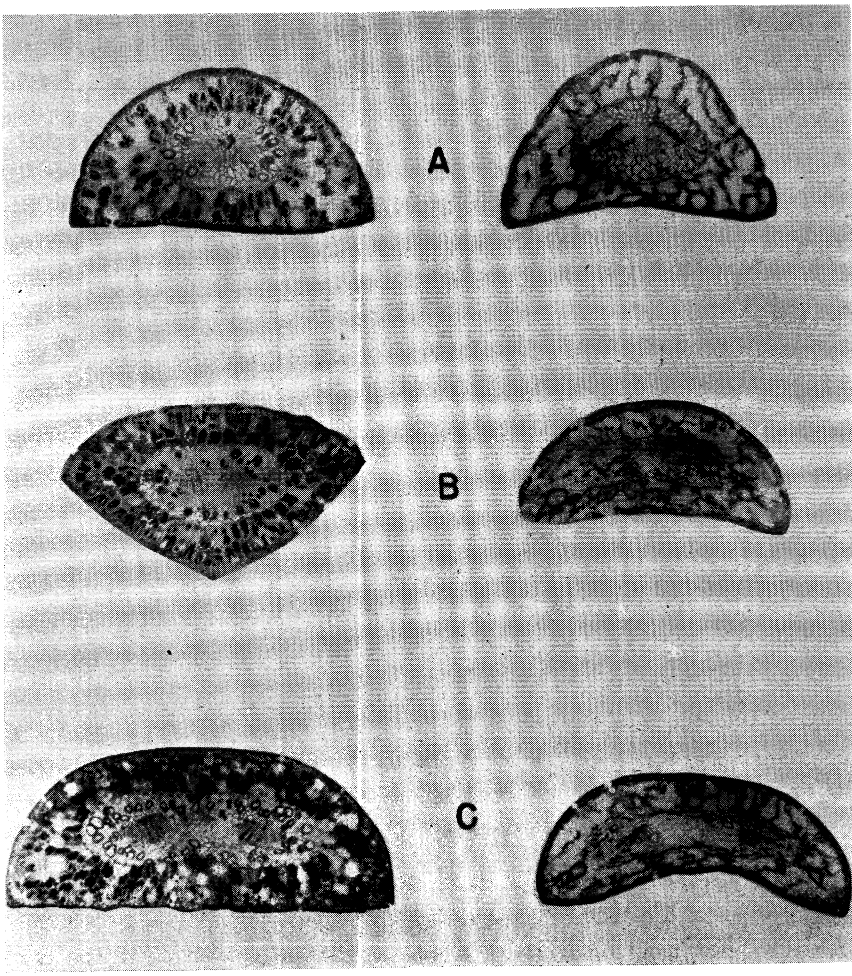

PLATE I. Cross sections of normal and injured pine needles: (A) *Pinus resinosa;* (B) *P. banksiana;* (C) *P. silvestris.* The left column presents uninjured needles; the right column, needles with damaged mesophyll.

needles. No sign of tissue destruction by ice formation was detected.

A survey of the literature brought to light one important condition which may be responsible for Scotch pine sustaining much greater injury than native species. It has long been known by European foresters that the roots of Scotch pine have a very restricted ability to penetrate soils of cut-over lands in which root channels have undergone deterioration (1). This shallowness of the root system of Scotch pine was substantiated by occasional observations, and most likely was the major cause for its extensive damage by winter drought.

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RATE OF GROWTH AND COMPOSITION OF WOOD OF QUAKING AND LARGETOOTH ASPEN IN RELATION TO SOIL FERTILITY[1]

S. A. WILDE AND BENSON H. PAUL[2]

The growing shortage of wood has recently created considerable interest in the silvicultural possibilities of aspen species. Both *Populus tremuloides* and *Populus grandidentata* show definite preference for the moist soils of lowlands and swamp borders. Therefore, it has been repeatedly suggested that these trees may serve as a suitable crop for the immense acreage of poorly drained deforested lands of central Wisconsin. The materialization of such a plan, however, requires knowledge of the minimum soil-fertility level which would assure a reasonably high rate of growth of aspen and the production of pulpwood of satisfactory quality. This problem was investigated during the summer of 1948 in Adams and Wood counties, Wisconsin. The unusual uniformity of siliceous substratum and the frequent occurrence of a favorably located ground-water table in this area provided conditions ideal for study of the growth effects of soil nutrients. In order to minimize the modifying influence of light, the investigation was confined largely to well-stocked semimature stands ranging in age from 20 to 29 years. In view of previously gained experience (6), particular attention in this study was devoted to the determination of alpha-cellulose in wood and trace elements in soils.

Eight sample plots of quaking aspen were located on soils which exhibited different degrees of depletion by fire and cultivation, and hence promised to have a wide range of fertility.

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[1] Contribution from the U. S. Forest Products Laboratory in cooperation with the Soils Department, U. W., Wisconsin Conservation Department, and the Institute of Paper Chemistry, Appleton, Wis. The study was supported in part by the Nekoosa–Edwards Paper Company, Port Edwards, Wisconsin.

[2] Professor of Soils, University of Wisconsin, and Chief, Division of Silvicultural Relations, U. S. Forest Products Laboratory, respectively. The writers acknowledge the wholehearted cooperation of Mr. F. G. Kilp and Dr. T. A. Pascoe of the Nekoosa–Edwards Paper Company. Credit is due to the Institute of Paper Chemistry for the determination of alpha-cellulose in wood samples. Messrs. D. T. Pronin, S. F. Peterson and R. Wittenkamp were engaged in field and laboratory investigations.

Only two sample plots were taken in stands of largetooth aspen because of the scarcity of this species in the area studied. For the same reason, one of the plots was located in a mature (40 years) stand. The size of sample plots varied between ½ and ¾ of an acre.

Soils investigated were derived from siliceous sandy deposits which originally formed the bottom of the extinct glacial Lake Wisconsin. These soils genetically belong to the type of gley-podzolic sands, and are underlain by a ground-water table accessible to the roots of trees. Because of the nutrient uniformity of siliceous substrata, the analyses were confined to the surface seven-inch layers, sampled by means of a tube. Two compound samples were collected from each plot and determinations were made in duplicate. The methods of Muensell (4), Ouellette (5), A. O. A. C. (2), and the Wisconsin State Soils Laboratory were used. Results of determinations of fertility factors are given in Table 1. The analyses for trace elements were limited to boron and manganese, the important representatives of this group of plant nutrients.

On the basis of nutrient content, the soils studied were roughly classified into three groups: "reasonably fertile," "marginal," and "infertile." The latter group included soils whose content of nutrients did not exceed the following levels: total nitrogen—0.052 per cent; available P_2O_5—46 pounds per acre; available K_2O—80 pounds per acre; replaceable bases—1.8 m. e. per 100 g.; available Mn—2.0 pounds per acre; and available B—0.34 pound per acre.

The determination of the average age, height, and diameter of stands was greatly facilitated by the simultaneous origin and uniformity of the young stands investigated. The site index was established on the basis of a nomograph constructed for young aspen stands of central Wisconsin by Wilde and Pronin (7). The study of wood properties was limited to five codominant trees on each sample plot. From these, one-foot sections between five and six feet above the ground were taken for analyses. Determinations of specific gravity were made on oven-dry weight and green-volume basis, using the Bruil volumeter (1). The content of alpha-cellulose was determined on chlorite holo-cellulose by the Institute of Paper Chemistry Methods (3), and crude protein by the standard Kjeldahl method. The results representing average of five determinations are given in Table 2.

TABLE 1

GROWTH OF ASPEN AND STATE OF FERTILITY IN THE 7 INCH SURFACE LAYERS OF SUPPORTING SANDY SOILS IN CENTRAL WISCONSIN

No. of Sample Plot, Age of Stand, Site Index, and Depth to Gr. Water	Reaction pH	Total N p.ct.	Total Repl. Bases ME/100 g.	Available Nutrients Lbs./A P_2O_5	Available Nutrients Lbs./A K_2O	Available Nutrients Lbs./A Mn	Available Nutrients Lbs./A B
Quaking aspen, reasonably fertile soils Av. exchange capacity 4.8 ME/100 g. and av. specific conductance, mhos 21.2							
SP. 1, 20 yrs., SI. 70, Gr. W. 21″	4.60	.092	2.4	126	140	3.7	1.50
SP. 3, 25 yrs., SI. 65 Gr. W. 19″	4.52	.073	2.2	92	160	1.5	1.40
SP. 4, 27 yrs., SI. 70+ Gr. W. 32″	5.03	.120	3.1	120	160	16.7	1.31
Average	4.71	.095	2.6	112	153	2.6	1.43
Quaking aspen, marginal soils Av. exchange capacity 3.8 ME/100 g., and av. specific conductance, mhos 13.9							
SP. 2, 23 yrs., SI. 60 Gr. W. 20″	4.38	.068	1.9	92	100	8.5	1.50
SP. 6, 24 yrs., SI. 60 Gr. W. 38″	4.86	.076	1.9	70	110	5.1	.85
SP. 7, 27 yrs., SI. 60 Gr. W. 37″	4.62	.078	2.1	130	120	3.2	.65
Average	4.62	.074	2.0	97	110	4.2	1.00
Quaking aspen, infertile soils Av. exchange capacity 3.5 ME/100 g. and av. specific conductance, mhos 10.6							
SP. 8, 23 yrs., SI. 50 Gr. W. 20″	5.12	.052	1.8	46	80	1.5	.34
SP. 9, 23 yrs., SI. 45 Gr. W. 28″	4.81	.042	1.3	46	70	2.0	.20
Average	4.96	.047	1.6	46	75	1.7	.27
Largetooth aspen, reasonably fertile soils Av. exchange capacity 4.6 ME/100 g. and av. specific conductance, mhos 14.4							
SP. 5, 29 yrs., SI. 55 Gr. W. 52″	4.82	.102	3.0	130	140	3.3	1.05
SP. 10, 40 yrs., SI. 55 Gr. W. 72″	5.28	.078	2.6	185	115	3.6	1.05
Average	5.05	.090	2.8	157	127	3.4	1.05

TABLE 2

RATE OF GROWTH AND PROPERTIES OF WOOD OF ASPEN PRODUCED ON SANDY SOILS OF DIFFERENT FERTILITY LEVELS IN CENTRAL WISCONSIN

No. of Sample Plot, Av. Age, Height, and Diameter of Stands	Site Index	Specific Gravity	Shrinkage by Volume p.ct.	Crude Protein p.ct.	Alpha-Cellulose p.ct.
Quaking aspen, reasonably fertile soils					
SP. 1, 20 yrs., h—36.6′ d—4.6″	70	.37	12.3	.74	47.3
SP. 3, 25 yrs., h—46.6′ d—5.3″	65	.43	12.9	.81	48.9
SP. 4, 27 yrs., h—62.7′ d—5.7″	70+	.44	13.3	.62	48.6
Average	70	.41	12.8	.72	48.3
Quaking aspen, marginal soils					
SP. 2, 23 yrs., h—41.3′ d—4.5″	60	.40	13.7	.56	46.2
SP. 6, 24 yrs., h—40.0′ d—4.6″	60	.40	12.9	.31	47.2
SP. 7, 27 yrs., h—45.0′ d—4.5″	60	.36	13.0	.56	47.6
Average	60	.38	13.2	.47	47.2
Quaking aspen, infertile soils					
SP. 8, 23 yrs., h—37.6′ d—3.8″	50	.36	12.3	.44	44.4
SP. 9, 23 yrs., h—30.6′ d—2.6″	45	.40	13.1	.44	44.0
Average	45+	.38	12.7	.44	44.2
Largetooth aspen, reasonably fertile soils					
SP. 5, 29 yrs., h—46.1′ d—5.0″	55	.34	12.0	.62	42.5
SP. 10, 40 yrs., h—54.3′ d—5.3″	55	.40	13.6	.37	44.4
Average	55	.37	12.8	.49	43.4

CONCLUSIONS

Results of investigations reveal a close correlation between the rate of growth of quaking aspen and nutrient content of supporting soils. Reasonably fertile soils were found to support stands of site index 65 to 70 plus, corresponding to an average annual height growth of about 24 inches. Marginal soils supported stands of site index 60, growing in height at an approximate annual rate of 20 inches. Infertile soils produced trembling aspen of site index 50 or 45 with average height growth of about 16 inches per year.

Quaking aspen on reasonably fertile soils produced wood having a rather high content of protein (0.72 per cent) and alpha-cellulose (48 per cent). The same species on infertile soils produced wood with a low content of protein (0.44 per cent) and alpha-cellulose (44 per cent). The inferior quality of wood produced on infertile soils was still further lowered by activity of parasitic fungi, particularly *Hypoxylon.*

The results of wood analyses were not free from erratic values which may have been caused by local variations in the composition of soil or wood (knots, decay, one-sided growth).

In agreement with previous observations (6), specific gravity of quaking aspen was found to be the highest on reasonably fertile soils (average 0.41), and the lowest on soils deficient in nutrients (average 0.38). However, this relationship did not hold true in all instances.

In spite of a comparatively high content of soil nutrients, largetooth aspen showed a low site index of 55, corresponding to average annual height growth of 19 inches. Moreover, it produced wood of the lowest specific gravity (.37) and of the lowest content of alpha-cellulose (43 per cent). These results, though limited, strongly suggest that largetooth aspen is by far more exacting in respect to soil fertility than quaking aspen.

Because of the purely reconnaissance nature of the study and insufficient number of samples, no attempt is made to attach statistical significance to the results of wood analyses.

SUMMARY

The growth and composition of wood of semi-mature aspen stands were investigated on sandy soils in central Wisconsin. The growth of quaking aspen on soils with a reasonably high

level of fertility was found to vary within site indexes 65 and 70; on such sites the specific gravity of wood and the content of alpha cellulose averaged .41 and 48.3 per cent, respectively. In spite of the accessible ground-water table, aspen growth on impoverished soils varied within site indexes 45 and 55, and trees showed a high percentage of decay caused by *Hypoxylon.* The low rate of growth was paralleled by an average specific gravity of .38 and content of alpha cellulose of 44.2 per cent. The pronounced deficiency of manganese and boron may have been partly responsible for deterioration of aspen on these sites. Because of good stocking of stands and uniform conditions of light, the wood of semimature stands was found to be much less heterogenous than that of the old stands. Therefore, the analysis of younger stands is suggested for all investigations dealing with the influence of environmental factors on the quantitative and qualitative productivity of the forest. The study indicated that on similar sites, largetooth aspen produces wood of a lower specific gravity and content of alpha cellulose than does quaking aspen. Moreover, largetooth aspen was found to be more exacting in respect to soil nutrients than quaking aspen.

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CHEMICAL CHARACTERISTICS OF GROUND WATER IN FOREST AND MARSH SOILS OF WISCONSIN[1]

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The chemical composition of ground water is a growth factor that has received in the past little attention from students of environment. Several reports have mentioned the ecological effects of "hard" or minerally rich, and "stagnant" or deoxidized ground water, but only in few instances were these terms supported by data of chemical analysis (Hesselman, 1910; Kopecký, 1928; Hartmann, 1928; Fehér, 1933; Laatsch, 1944).

During recent studies of poorly drained soils in central Wisconsin (Wilde and Zicker, 1948), markedly different growth of aspen and pine stands was observed on sites with seemingly identical conditions of soil profile and water table. Further investigations disclosed that the unexpectedly high rate of tree growth was due to the presence of ground water which was enriched in nutrients through its contact with lenses of lacustrine clay. These observations served as an impulse for a general survey of the chemical properties of ground water in four geological regions of Wisconsin: namely, northern granitic moraine, northeastern drift enriched in calcareous material, fluvial siliceous deposits of the central area, and southwestern eroded peneplain of residual limestone (Martin, 1932). The analyses were limited to the following five characteristics which appeared to be of greatest significance: reaction, specific conductivity, total alkalinity, content of dissolved oxygen, and oxidation-reduction potential. The determinations of total acidity, hydrogen sulfide, ferrous iron, nitrogen, and phosphorus, provided information of dubious importance and were discontinued.

Since the investigation of chemical properties of ground water in soils is a pioneering effort, the adapted methods of analysis are described in detail.

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METHODS OF ANALYSIS

Sampling: The water was allowed to accumulate at the bottom of the excavated trench in a sheet exceeding 4 inches. The sampling was accomplished by means of a foot suction pump connected with a double flask receiver, including a 200 ml. container (A) and a 900 ml. container (B). The rubber tube of the receiving 200 ml. vessel terminated in a weighted metal tube with a screened slit (Figure 1). After both flasks were filled with

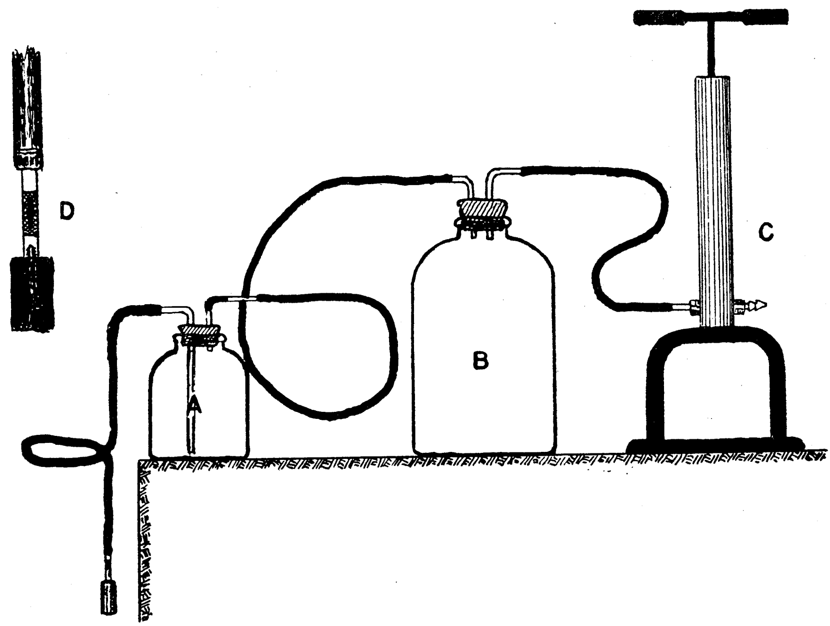

FIGURE 1. Apparatus for sampling ground water: A—200 ml. receiver; B—900 ml. receiver; C—foot suction pump; D—weighted metal tube with a screened slit shown in detail.

water, the water in receptacle "A" was used for instant determination of oxygen. The water in receptacle "B" was transferred into a 600 ml. flask to be taken to the laboratory for other analyses. Because of the great difference in temperature during the summer period, flasks with water samples often crack in transportation. Therefore, particular care should be used in both the selection of reliable containers and in careful preservation of water samples at a reasonably low temperature. The latter can be best accomplished by packing the containers in wet *Sphagnum* moss.

Determination of Reaction: The pH value of ground water was determined by means of the Beckman Potentiometer with a sleeve-type calomel and glass electrode unit. A standard buffering solution was used to calibrate the meter at pH 7.0, and the calibration was checked every fifth determination. The determinations were made on 200 ml. aliquots placed in a 250 ml. beaker. After each determination, the electrode unit was carefully washed with distilled water.

Determination of Specific Conductivity: Ground water was allowed to settle overnight, and a sample of 50 ml. was placed in a 1 x 6 inch test tube. The temperature of the sample was brought to about 77° F, and the conductivity determined by platinum electrodes connected with the Solu bridge, i.e., a type of Wheatstone bridge provided with a cathode-ray tube (magic eye). The reading of conductivity, expressing the total content of electrolytes, was taken instantly.

Determination of Total Alkalinity: A 100 ml. water sample was placed into a white casserole with three drops of brom cresol green indicator. The contents were titrated with .02 *N* sulphuric acid with constant stirring until the blue color was changed to yellow. Milliliters of H_2SO_4 used in titration, multiplied by 1,000 and divided by the milliliters of the titrated sample, give the total alkalinity in parts per million.

Reagents:

.02 *N sulfuric acid:* Approximately 1 *N* H_2SO_4 is prepared by diluting 27 ml. of acid with distilled water to 1 liter volume. Then 20 ml. of the stock solution are diluted with distilled water to 1 liter volume and solution is standardized against .02 *N* Na_2CO_3.

.02 *N sodium carbonate:* 1.060 g. of oven-dry Na_2CO_3 are dissolved in 1 liter of distilled water.

Brom cresol green indicator: .1 g. of indicator is dissolved in 100 ml. of distilled water.

Determination of Dissolved Oxygen: This was accomplished by using Winkler's method. The water sample in receptacle "A" was treated with 1 ml. of magnesium sulfate and 1 ml. of potassium hydroxide and potassium iodide mixture, using calibrated pipettes. The contents of the flask were shaken a dozen times. After the precipitate was settled, 1 ml. of concentrated sulfuric acid was added, thereby fixing the oxygen in an insoluble form. The sample was transferred into a white casserole. A few drops of starch solution were added and the sample was titrated with sodium thiosulfate until the blue color disappeared. The content of dissolved oxygen (O_2) is equal to milliliters of sodium thiosulfate used in titration.

Reagents:

Solution of magnesium sulfate: 480 g. of $MnSO_4 \cdot 4H_2O$, c.p. grade are dissolved in 1 liter of distilled water.

Solution of potassium hydroxide and potassium iodide: 700 g. of KOH and 150 g. of KI, c.p. grade are dissolved in 1 liter of distilled water.

Sulphuric acid: Concentrated H_2SO_4 c.p. grade.

Starch indicator: 2 g. of starch are dissolved in 1 liter of distilled water, and 2 ml. of CH_3Cl are added.

N/40 *sodium thiosulfate:* 6.205 g. of $Na_2S_2O_3 \cdot 5H_2O$ are dissolved in 1 liter of freshly boiled distilled water, and 5 ml. of $CHCl_3$ are added. Solution is standardized against N/40 $K_2Cr_2O_7$.

N/40 *potassium dichromate:* 1.226 g. of $K_2Cr_2O_7$ are dissolved in 1 liter of distilled water.

The determination of oxygen in ground water by the described standard Winkler's method provides data which have only relative significance. For the determination of oxygen in the presence of reducing substances, modifications of the standard procedure should be used (1). It should be pointed out that occasional slight contamination of the sample by oxygen is difficult to avoid in work with ground water.

Determination of Oxidation-Reduction Potential: A water sample of 200 ml. was placed in a 250 ml. beaker and brought in contact with a calomel and platinum electrode unit of Beckman Potentiometer. After 30 seconds the system attained equilibrium, and the reading was taken. The results were recalculated to the same level of pH 7.0, using the formula: $Eh = (Eo - 0.246) + 0.06(R - 7.0)$, where Eh is oxidation-reduction potential in volts at pH 7.0, Eo is positive or negative value of potential determined, and R is pH of water samples.

The negative values of Eh indicate that the water has a tendency to reduce dissolved or suspended compounds to a lower valence than has the calomel electrode. If Eh is positive, the water has an oxidizing tendency. It should be noted that the calomel cell has a potential of —.285; therefore, the determinations made with a *N* hydrogen gas cell give results that are .285 volt lower. Essentials of oxidation-reduction potential and important analytical precautions are discussed by Hood (1948) and Rohlich (1948).

SOIL-VEGETATION TYPES INVESTIGATED AND RESULTS OBTAINED

The diversified geology of the areas studied allowed observation of the extremes in the composition of ground water produced by its contact with residual limestone, calcareous lacustrine clays, strongly podzolized granitic drift, and deposits of pure siliceous sand. Within these geological regions, ground water was analyzed in seven broad types of poorly drained soils, as follows:

1. *Moss peat,* supporting open and slow-growing stands of black spruce and tamarack with ground cover of *Ledum-Chamaedaphne* type.

2. *Wood peat,* formed under dense stands of white cedar, balsam fir, and white spruce, characterized by a fair rate of growth and ground cover of *Oxalis-Coptis* type.

3. *Sedge peat,* occupied by marsh vegetation, predominantly of *Carex* spp.

4. *Muck,* i.e., semi-organic soils formed by sedimentation of clay and humus in the areas subject to overflow, and supporting largely tag alder, willows, and shrubs common to *Alnetum* and *Salicetum* types.

5. *Alluvial soils,* humus-enriched deposits in inundated areas, occupied by elm, black ash, river birch, oaks, red or silver maple, other lowland hardwoods, and occasionally white pine, with ground cover of *Urtica-Thalictrum* or *Urtica-Vernonia-Cephalanthus* types; the growth of stands on these soils varies greatly depending upon the depth to the ground water table and the proximity of the stream.

6. *Insufficiently drained non-alluvial sandy soils,* supporting mixed stands of pines, paper birch, and aspen, with ground cover of *Vaccinium-Cornus-Rubus* type, of either very good or very poor growth.

7. *Insufficiently drained non-alluvial loam soils,* supporting mixed hardwoods, hemlock, balsam fir, and white spruce in northern Wisconsin, or stands of lowland hardwoods in southern Wisconsin, with ground cover characterized by the presence of *Galium, Equisetum, Impatiens,* and *Ranunculus* spp. The rate of growth of these stands is subject to wide variation.

The results of analyses of ground water underlying these soils are presented in Table 1.

Relation Between the Chemical Properties of Ground Water and Vegetative Cover

The analyses of randomly selected samples indicated that a close correlation exists between the chemical properties of ground water and growth of vegetative cover. This is especially true of forest swamps and alluvial lowlands.

TABLE 1

CHEMICAL PROPERTIES OF SURFACE AND GROUND WATERS IN FOREST SOILS OF WISCONSIN

Description of Water Samples and Areas Studied	Depth to Ground Water Ins.	T°F	Reaction pH	Spec. Cond. Mhos 10^{-5}	Total Alkalinity ppm	Free Dissolved O_2 ppm	Redox Potential Eh,mv
Surface Waters							
Creek draining cedar swamp. Vilas Co.*	....	68	6.91	19.5	98	8.50	85
Beaver flowage run-off. Marinette Co.*	....	65	7.39	19.9	115	6.00	163
Well in Cranberry Creek Drainage Distr. Wood Co.	....	60	6.50	11.5	19	3.30	95
Pine River. Richland Co.*	....	68	8.29	43.0	244	8.90	174
Bear Creek. Richland Co.*	....	....	8.31	42.5	226	....	190
Cazanovia Spring. Richland Co.	....	60	7.69	32.0	159	8.30	129
Henrietta Spring. Richland Co.	....	....	8.11	28.0	148	7.50	161
Slough Water. Richland Co.	....	68	6.95	35.0	194	....	18
Ground Waters							
Moss peat; bl. spruce–tamarack muskeg. Forest Co.	4	62	3.54	5.0	None	None	—364
Moss peat; bl. spruce–tamarack muskeg. Oneida Co.	12	52	3.91	5.7	None	None	—335
Moss peat; muskeg with chlorotic sedges. Marinette Co.	6	56	4.23	6.1	None	0.20	—153
Moss peat; originally flooded muskeg with dead spruce. Marinette Co.	18	55	4.98	5.1	None	0.07	—95
Woody peat; white cedar and ba. fir. Marinette Co.	4	61	6.50	20.9	83	0.45	69
Woody peat; white cedar and ba. fir. Price Co.	6	62	6.19	7.5	24	None	—42
Woody peat; white cedar and ba. fir. Forest Co.	4	51	7.29	24.0	134	2.00	75
Sedge peat; marsh. Marinette Co.	16	54	6.40	38.0	144	1.50	74
Sedge peat; marsh. Marinette Co.	12	57	6.79	48.5	180	0.45	126
Sedge peat; marsh. Richland Co.	5	62	6.95	65.0	332	0.10	31
Muck; tag elder. Price Co.	30	58	7.68	14.2	75	5.40	89
Muck; elm, alder, sedges. Forest Co.	12	62	7.10	21.0	98	None	49
Alluvial silt loam; wh. pine, elm, ha. maple, aspen. Forest Co.	24	60	6.77	21.0	97	0.20	18

TABLE 1—*(Continued)*

CHEMICAL PROPERTIES OF SURFACE AND GROUND WATERS IN FOREST SOILS OF WISCONSIN

Description of Water Samples and Areas Studied	Depth to Ground Water Ins.	T°F	Reaction pH	Spec. Cond. Mhos 10^{-5}	Total Alkalinity ppm	Free Dissolved O_2 ppm	Redox Potential Eh,mv
Alluvial sand; aspen; good growth. Marinette Co.	30	60	6.39	17.7	75	1.50	74
Alluvial sandy loam; willows. Richland Co.	30	62	7.56	55.0	303	0.30	103
Alluvial sandy loam; lowland hardwoods, fair growth. Richland Co.	28	....	8.30	53.0	174	0.80	165
Alluvial sand; lowland hardwoods, fair growth. Richland Co.	24	60	8.21	28.0	107	0.40	161
Gley-podzolic sand; red pine, good growth. Marinette Co.	42	52	5.80	4.8	14	2.00	—30
Gley-podzolic sand; aspen, good growth. Marinette Co.	60	55	5.73	4.2	14	2.70	—5
Gley-podzolic sand; red and wh. pine, very good growth. Wood Co.	72	50	7.75	15.0	25	3.30	95
Gley-podzolic sand; aspen, poor growth. Wood Co.	37	56	5.54	6.1	16	0.80	—131
Gley-podzolic sand; aspen, very poor. Wood Co.	20	56	4.20	14.0	10	0.30	—305
Gley-podzolic loam; hemlock, hard maple, elm. ba. fir; fair growth. Langlade Co.	30	51	6.78	9.8	34	5.6	—2
Gley-podzolic loam; hemlock, wh. cedar, ba. fir, hardwoods; poor growth. Forest Co.	33	56	6.55	17.5	55	0.2	—26
Gley-podzolic loam; lowland hardwoods; poor growth. Langlade Co.	6	62	6.02	10.0	36	None	—81
Gley-grood loam; lowland hardwoods; poor growth. Richland Co.	12	64	6.80	26.0	10	0.10	28
Over-washed moss peat; tamarack, willows and poison sumac; poor growth. Richland Co.	12	58	7.35	30.0	179	0.10	76

*Average of three or more determinations.

Ground water of moss peat bogs, or "muskegs," presents an extreme condition of deoxidation and impoverishment; such water is characterized by a strongly acid reaction, an absence of oxygen and carbonates, a low specific conductivity, and a very low negative oxidation-reduction potential.

In comparison, water of wood peat shows a striking drop in acidity resulting from an increased supply of electrolytes; the frequent presence of free oxygen and a positive oxidation-reduction potential indicate that ground water of these sites is in a state of constant horizontal movement. Ground water of sedge peat has a nearly neutral reaction, high specific conductivity, and usually an appreciable content of free oxygen; the positive oxidation-reduction potential occasionally reaches a very high level.

Muck soils are underlain by water which reflects conspicuously the fertilizing effect of inundation; alkaline reaction, high content of carbonates, and high specific conductivity are outstanding features. In the proximity of the stream, ground water of muck soils shows a high content of free oxygen and a high oxidation-reduction potential. With certain variations, the same characteristics are observed in ground water of all alluvial deposits, provided the water is not sampled from the distant borders of the inundated zone where internal drainage is sluggish.

The ground water of poorly drained sandy soils, outside of the alluvial zone, is generally characterized by acid reaction, low content of carbonates, and low specific conductivity; its content of oxygen and oxidation-reduction potential vary considerably depending upon the depth of well-aerated soil and internal relief. Ground water underlying heavy gley soils possesses slightly alkaline reaction; other properties vary within wide limits. Contrary to expectations, the content of carbonates and conductivity of ground water underlying heavy gley soils outside of the alluvial zone proved to be at a low level.

The results suggest that a poor growth of both deciduous and coniferous trees is correlated with ground water which is deficient in oxygen and shows a very low *negative* oxidation-reduction potential. The very high content of carbonates, as found in water of some alluvial deposits, also appears to be responsible for a depressed growth of hardwood stands and their premature deterioration. The rapid growth of pine and aspen stands on sandy soils coincides with the presence of circumneutral ground water enriched in electrolytes and oxygen and possessing a high oxidation-reduction potential. A fair supply of electrolytes, expressed by a reasonably high specific conductivity, is likely to be a condition associated with a satisfactory growth of exacting climax species.

The results of further studies should formulate the relationship between the chemical properties of ground water and forest growth in more specific terms.

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ELECTROSTATIC EFFECTS PRODUCED IN DUST CLOUDS MADE WITH FINELY GROUND MINERALS OF VARIOUS COMPOSITION[1]

H. F. WILSON AND M. L. JACKSON[2]

During an investigation of rotenone dusts at this Station for control of the pea aphid, it was found that there was a wide variation in the results obtained in field experiments with dusts containing similar concentrations of rotenone. One of the causes for these variations has been traced to differences in the characteristics of different mineral dispersants used. One difference seemed to be related to dust dispersion on plants and insects which, in turn, seemed to be influenced by electrostatic charge effects produced in applying rotenone-bearing dusts.

When pea plants infested with aphids were dusted in the greenhouse with dusts producing variable charges, it was found that a wide difference in the dispersion of dust particles occurred which could be correlated with electrostatic charges. In testing the electrostatic effects, standard quantities (0.5 gms.) of dust were blown through an insulated copper tube connected to an electrostatic voltmeter. The total electrical capacity of the system employed was 17 MMF, so that each 1,000 volts registered on the voltmeter was equivalent to a net charge on the dust cloud of 1.7×10^{-8} coulombs or 5 e.s.u. of charge. On the basis of preliminary observations, a hypothesis was established to the effect that the net electrostatic charge in the dust cloud has the combined effect of (a) preventing flocculation of particles and (b) promoting dispersion onto the stems and underleaf as well as on the upper leaf surfaces. In applying this hypothesis, three general conditions developed: (1) If the average size of the particles of the dispersant was approximately 2 microns or less, as fre-

[1] Contribution from Wis. Agr. Exp. Sta. Published by permission of the Director.

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quently happens with materials ground to a clay fineness, a hanging cloud was produced with most of the particles forming as aggregates on the upper leaf surface, and electrostatic charges varied from 0 to 500 volts. Little or no dust settled on the under leaf surface and the control was poor; (2) If the average particle size was 50 to 100 microns, no dust cloud developed. Charges of 3,000 to 4,000 volts were produced if the mineral composition of the sample was satisfactory but, because of too few particles in a given amount of dust, there were few particles on the under leaf surface and the control was poor; (3) When the average particle size was from 10 to 30 microns, charges from 1,500 to 3,000 volts were developed and the dispersion on both the upper and lower leaf surfaces was approximately equal with from 5 to 10 particles per square millimeter of leaf surface and the control was good.

A similar variation in dust coverage was found with aphids on the dusted plants. Under some conditions the aphids would have many dust particles on them, while under other conditions some aphids would not be touched with a single particle. In the case of clay dispersants (fine particles), aphids in exposed positions might be heavily covered with a deposit of dust, but the dust did not seem to be highly effective. Therefore, two questions had to be answered:

(a) Can particles of rotenone be so thickly covered with minute particles of a dispersant that it does not come in contact with the insect?

(b) Are electrostatic charge effects important in causing a separation and wide dispersion of dust particles to all parts of the plant and to insects on the under leaf surfaces?

In a preliminary study of a few dispersants it was observed that, when two chemically different dispersants of opposite charge were mixed, the charge for the combined materials was less than that of each material taken separately. When different materials were tested for sign of charge it was found that (+) or (—) charges were developed according to the mineral composition of the material. Additional observations led to the conclusion that the mineral composition of a dust determines the sign of the charge and that the magnitude of the net charge per gram of material developed is determined largely by particle size. Preliminary observations have been reported from this Station (15, 16).

Review of Literature

A number of investigators report observations on the behavior of electrostatic effects in dust clouds which indicate that electrostatic charge effects might have an important influence on the dispersion of insecticidal and fungicidal dusts and sprays.

As early as 1776 (8) Lichtenberg discovered that dust shaken through a cloth bag became charged with (+) or (—) electricity, depending upon the nature of the dust. In 1806, Davy (3) found that dry solid acids in contact with metal plates charged the latter (+) and that alkaline substances charged them (—).

According to Guest (5) little if any additional information was added until Knoblauch (7) made a report in 1901 on a series of some 2,500 tests made in the same direction. He obtained results similar to those of Davy but decided that sulphur was negatively charged from contact with most materials with the exception of a few acids which were able to impart a positive charge to it. Glass was usually (+) but with a few alkalies (—). Rudge (10), through a series of observations on the electrification of dust storms, determined that in South Africa, where observations on atmospheric electricity were suitable because of the dryness of the air, the normal positive potential gradient of the atmosphere (100–200 volts per meter) might be reversed during storms and display negative values exceeding 500 volts per meter (—). Contrary to expectations, both the dust particles and the earth's surface at the place were charged (—). In England (11) he found that the dust, usually of a calcareous nature, imparted an additional (+) charge to the atmosphere.

Boning (2) found that "charges could be produced by like particles striking against each other when the particles differed in size." His experiments showed that regardless of the material used, collision between particles of the same material imparted a positive charge to the smaller particles. He attributed this to the fact that in a collision between two particles of different mass, the change of velocity of the smaller particle is greater than that of the larger particle, so that inertia would tend to transfer a few free electrons from the smaller to the larger particle.

Rudge (12) also concluded that the charge was carried by the dust particles and not by the air and that no charges were developed by the air. He further observed that the nature of the material from which, or upon which, the dust was blown did not affect the charge.

Stager (13), studying the electrification of dust clouds, decided that the distribution of the charges, at least in part, varies with the distribution of particle size.

Whitman (14) in 1926, with the use of a particle "polarity recorder," photographed individual particles in a dust cloud as they fell between electrically charged plates. These photographs showed the presence of positive, negative and neutral particles in all dust clouds even of very pure substances.

McLeod and Smith (9) constructed a unit with which they were able to study the effect of electrostatic charges of insecticidal dusts when blown through the unit. They determined the amount of dust deposited on electrodes charged (—) and (+) for a series of common insecticides and dispersants. Their findings summarized are:

"In general, powders of plant origin gave heavy deposits on the negatively charged plate." Dust particles (+).

"Diatomites and clays gave heavy deposits on the positively charged plate." Dust particles (—).

"All other materials were variously distributed, a feature which was apparently influenced by the composition of the particular dust." A variable combination of neutral, (+) and (—) dust particles.

"An addition of 1 per cent of one powder to another increased the major deposit in four out of eight cases studied."

Johnson (6), who was interested in commercial separation of ground minerals by selective electrostatic methods, undertook to study what he called the electrostatic conductivity of a series of minerals in terms of voltage—or, as he added, "the relative susceptibility of the minerals to being affected by a static charge or field."

Without going into the details of Johnson's method, it can be said that many of the minerals tested showed an intrinsic sign of charge. These particular materials were interesting to us because, using an entirely different technique, we observed that the sign of charge obtained for minerals of similar composition were in agreement with those obtained by Johnson. Only two exceptions were noted; bauxite ($Al_2O_3 \cdot 2\ H_2O$) and Smithsonite ($ZnCO_3$). These were found to respond in reverse order. Quartz and minerals relatively high in silica were attracted with a positive charge and repelled with a negative charge, showing these minerals to be (—). Calcite was affected in reverse order, as were most minerals not high in SiO_2 thus showing a (+) charge.

Fraas and Ralston (3a), working with several types of electrostatic separators employing purely frictive or contact charging, have obtained results which should be quite comparable to ours, except that there is little overlap in the materials. Fraas and Ralston were able to reverse the sign of charge in certain cases by changing the material against which the dust was contacted, but in our tests so far, changing the material of the nozzle has failed to change the sign of charge on any dust.

In the main, the observations reported by various workers were in agreement with those found in this laboratory, and, on the basis of these observations, the following theory on the dispersion of dust particles on plants is advanced by the authors.

Effect of Electrostatics in Obtaining Fine Dispersion of Insecticidal Dusts on Plants and Insects

If an insecticidal dust produces or acquires an electrostatic charge when blown through a dust blower, it is to be expected that each dust particle having the same charge will tend to be repelled from all particles of the same charge. When the dust cloud first breaks from the nozzle end of the dust blower, the momentum of the air stream will tend to hold the dust cloud together. But as the velocity of the air stream diminishes, the particles separate or disperse and move more independently. If the developed charge is weak, the repulsion between particles will be small and little or no dispersion of dust particles occurs. If the charge is strong, dispersion will be increased and the dust particles are made to strike a plant or insect singly rather than in aggregates. Theoretically, as the dust cloud approaches a plant, a charge opposite that of the dust cloud is induced on the plants and insects. This in turn causes the dust particles to be attracted to both plants and insects and causes the particles to cling more closely after contact. A diagrammatic representation of this phenomenon is shown in Figure 1. The passage of electrons down the plant stem during the dusting of its upper leaves was verified by registration of charges on an electrostatic voltmeter attached to the base of the plant (insulated from ground).

To study the factors involved in the production of electrostatic charge effects in dust streams, it seemed necessary to determine the behavior of different minerals and combinations of minerals. A collection of samples containing the materials commonly found in insecticidal and fungicidal dusts was then obtained and examined for electrostatic effects.

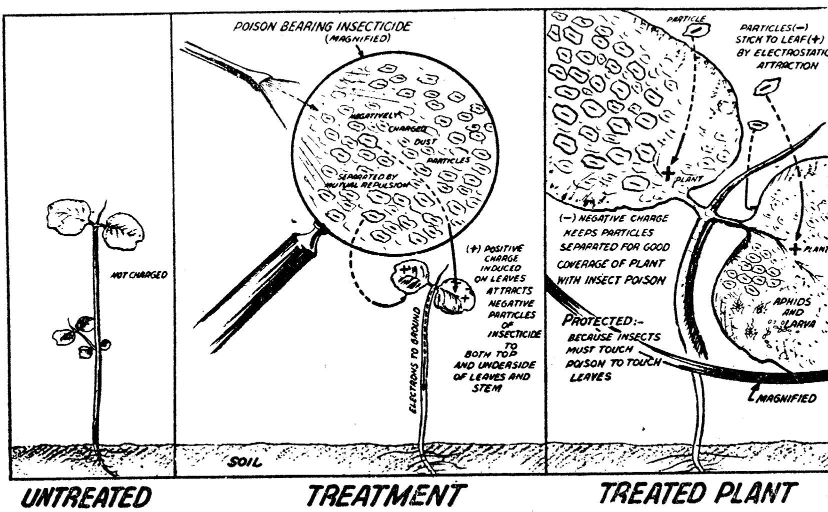

FIGURE 1. Showing the action of electrostatics in dispersing insecticidal dusts on plants and insects.

In making this study, it was found that each mineral or combination of minerals always produced characteristic measurable electrostatic charge effects in dust clouds when blown through a dust blower unit.

With standardized conditions of measurement employed, the magnitude of charges obtained depended upon the material, the size of grinding, and upon the conditioning treatment. The potentials registered varied from 0 to an estimated 50,000 volts or more (0 to 5,000 e.s.u. of charge per gram of dust).

SOURCE OF SAMPLES

The materials tested were in part purchased from Ward's Natural Science Establishment and others came from departmental collections. A few standard U.S.P. chemicals are included as indicated.

Equipment and Method of Procedure

In studying the electrostatic effects of the different materials tested, the same equipment and method of procedure were used as described by Wilson, Janes, and Campau (17). The method consists of blowing a standardized volume of dust through a specially constructed copper dust blower shown in Figure 2. The charges imparted to the blower were determined by the readings of an electrostatic voltmeter recording from 0 to approximately 14,000 volts.[3] Humidity of the air was found to affect the degree of electrification to such an extent that samples giving readings up to 8,000 volts might produce only 4,000 volts at 50 per cent relative humidity and drop to zero when the humidity increased to 75 per cent. Blactin and Robinson (2) in a study of electric charges in coal dust found that their apparatus became completely dead if the relative humidity rose above about 65 per cent. All readings reported were made with room temperatures between 80 and 85° F. and relative humidity between 30 and 40 per cent. In most cases readings were obtained with samples ground to pass through a 325-mesh screen. In a few cases where charges could not be obtained with 325-mesh samples, somewhat larger particles were used.

Fine powdered materials, for which the sign of charge had been previously established, were used as reference materials, namely: an impure pyrophyllite (commercially known as Pyrax),[4] quartz (SiO_2 crystals), and pure talc ($Mg_3\,Si_4O_{10}\,(OH)_2$) all with (—) charges, and calcite, $CaCO_3$ and a micaceous mineral designated commercially as "AA Mica" both with (+) charges.

In the apparatus used, it was possible to hold the charge on the voltmeter after a dust charge measurement, and then to place an additional charge on the dust tube by dispersing a second sample and transmit it additively to the voltmeter. If the second sample gave the same sign of charge as the first, the charge on

[3] As previously noted, all voltage readings quoted in this paper refer to 0.5 gm. samples and a 17 MMF system. If V is voltmeter reading (volts), the equivalent charge per gram of dust is therefore $(34 \times 10^{-12}\ V)\ \frac{\text{coulombs}}{\text{gm.}}$ or $(102 \times 10^{-3}\ V)\ \frac{\text{e.s.u.}}{\text{gm.}}$ (approximately $\frac{1}{10}\ V\ (\frac{\text{e.s.u.}}{\text{gm.}})$).

[4] Mineralogical characterization reported by Wilson, H. F., and Jackson, M. L. "Mineral Composition and Particle Size of Insecticidal Dispersants and Their Influence on Toxicity of Rotenone Dusts." *Jour. Econ. Ent.* 39, pp. 290–295, 1946.

the voltmeter was increased. But if the charge on the second material was of the opposite sign as the first, the charge on the voltmeter was reduced. By alternating one or several of the five reference dusts with the test sample, it was possible to determine the sign of charge for a wide variety of materials tested.

EXPERIMENTAL OBSERVATIONS AND RESULTS

Electrostatic Charge of Different Minerals and Mechanical Mixtures

A list of the minerals acquiring the sign of charge (—) or (+) and the amount obtained with the samples tested is shown in Table 1 and the electrostatic charges obtained with mechanical mixtures of two components are recorded in Table 2. As a general trend, when two minerals displaying the same sign of charge were mixed together the accumulation of charge for the mixture was higher than for either material alone.[5] If two materials displaying opposite sign were mixed, then the charge was reduced because of a neutralizing effect; with suitable proportions of the two materials, the charges of both were completely neutralized. By changing the proportions of two materials of unlike charging tendency, the sign of charge generated by the mixture could be varied from (—) to (+) or (+) to (—), Table 2. However, as exceptions, peculiarities developed with albite, almandite, hornblende, and rhodenite. These materials singly all became positively charged, but when combined with Pyrax they actually augmented its (—) charge. Likewise, when mixed with "AA Mica" they reduced the (+) charge of "AA Mica."

Trends which appear rather definitely established by the data in Tables 1 and 2 may be summarized as follows:

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[5] Mr. Ralston suggests a possible explanation of how additive effect of two minerals taking the same sign of charge is greater than the potential of either. "Under the conditions of operation of the nozzle one mineral can be charged to potential P_1 the other to P_2 by impact and separation from the nozzle wall. The effects average up to an arithmetic summation. However, if both particles are dielectrics they also impact each other in a turbulent stream of air and one will be charged (+) and the other (—). Assuming that the two minerals each took on (—) from impact with the nozzle walls, the (+) charged particles are a minority in the mixture and quickly meet and neutralize (—) particles of both minerals. These neutrals have new opportunities to impact the wall and become (—) again. Also, (—) charged particles of each mineral on impact may part with one higher in negative potential and the other much lower (equivalent to becoming (+) to the average atmosphere in the nozzle). By whatever mechanism, the additional potential is that added by impact of the two minerals against each other."

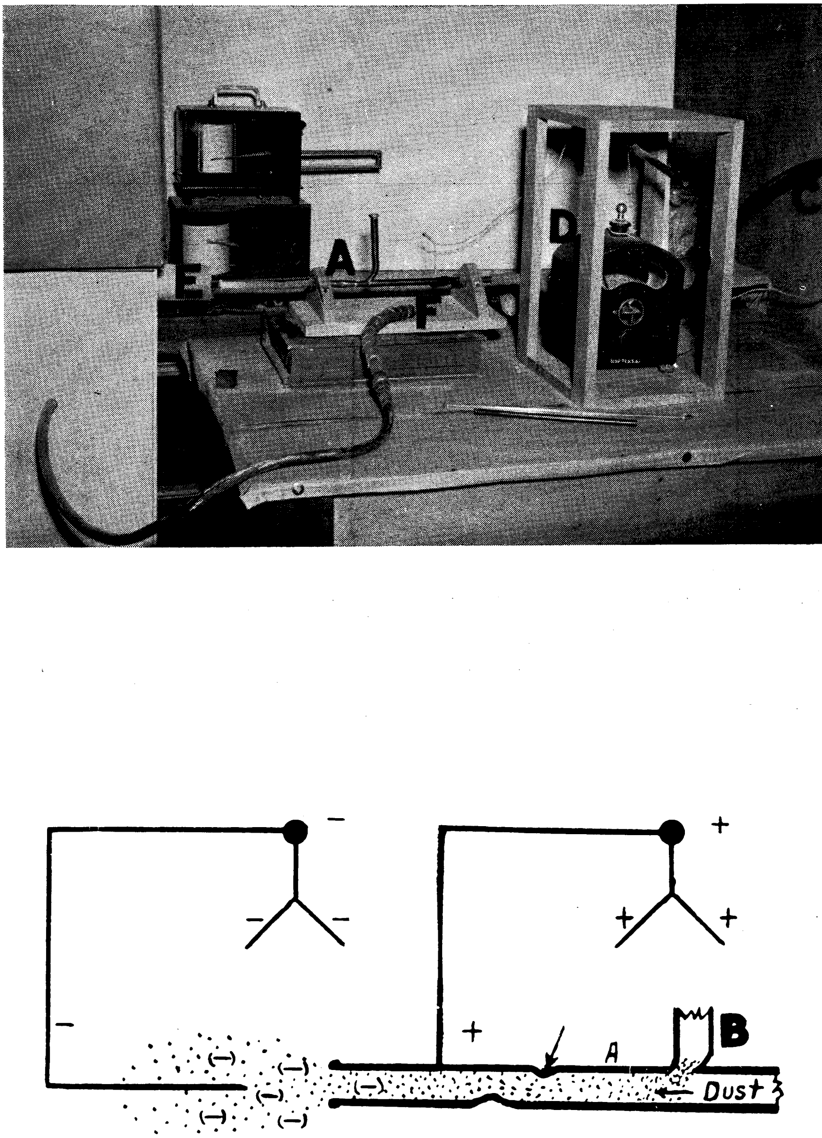

FIGURE 2. Apparatus for recording electrostatic charge effects of finely ground substances. A—Dust blower tube with indentations. B—Dust hopper. C—Air source. D—Electrostatic voltmeter. E—Dust collecting chamber. F—Tube fitted over hopper in cleansing operation by back pressure.

1. Three native ores common to insecticide dispersants developed (+) charges.
2. Three sulphides of metals used in insecticidal dusts as carriers for toxic metals developed no charges on the dust but were shown to be (+) in reaction because they depressed the negative reference material, quartz. One mineral sphalerite (ZnS) developed (—) charges.
3. Six minerals of the haloid group in which the fluoride compounds occur were found to be weakly positive in reaction. Cuprichloride appeared in additive tests to be (—) in reaction.
4. Carbonates and oxides of metals all became positively charged.
5. The oxides of silicon were found to be the main source of (—) charges in minerals. However, with the silicates, the charge developed was (+) or (—), probably depending upon crystal lattice factors and the balance between the silica component and the basic components Na_2O, CaO, MaO, MgO, and other oxides. The micas in highly pure forms, muscovite and biotite, were weakly (+) but a sample of commercial mica which may have contained small amounts of impurities was strongly (+) as was the micaceous reference material "AA Mica."
6. The sulphate group was found difficult to characterize because no direct charges could be obtained except for gypsum. The charge for this material was definitely (+). A sample of Glauber's salts gave no sign in itself but appeared to be negative in mixtures with calcite or quartz.
7. The acidic materials tend to develop (—) charge, as exemplified by the two alums, the two types of organic acid crystals, and by silicon dioxide as already mentioned.

Mineral samples of a same general composition consistently produced the same sign of charge even though the proportions of the different components in different samples varied as much as 20 per cent or more. For example, Pyrax has three component minerals, pyrophyllite, quartz, and mica. The mica content varies only to a slight degree, varying from 10 to 15 per cent but the pyrophyllite may range from 30 to 90 per cent and the quartz from 10 to 60 per cent, yet the charge in the dust cloud is always (—). While the charge per gram for various samples varied considerably, it was found that any particular sample gave about the same average charge under similar conditions in tests extending over a period of three years.

Samples of different types of talc showed a wide variation in the development of charge, some samples developing (—) charges, and others (+), possibly owing to a widely varying crystal structure in different members of the talc group, and also to content of mineral impurities, especially chlorites. Samples of steatite talc (soapstone) were quite variable, some samples produced (—) charges while the charge produced by the sample reported here was distinctly (+) as shown by the data obtained when mixed in different proportions with Wisconsin talc which is distinctly negative (Table 2). The sample of serpentine (magnesium analogue of kaolinite, sometimes included with the commercial talcs) was weakly (+).

A sample of tremolite talc (fibrous) did not produce a charge when tested alone; in equal portions with Pyrax or "AA Mica" this material completely neutralized the respective (—) or (+) materials, Table 2. Smithsonite (zinc carbonate) was shown to be strongly (+) because only one part in fifty greatly reduced the charge of Pyrax and the (+) charge was maintained when equal parts of this material were combined with "AA Mica." Sulphur which generates no charge, markedly depressed the (—) charge of Pyrax. Manganite, sulphur, and barium carbonate all had particles of very small size.

Repeated tests showed that, when some samples of material giving high charges were ground and reground, the charge potential decreased as the particle size was reduced by each succeeding grinding. When all materials were ground to clay fineness the charges were comparatively low and in some cases reduced to zero. Where tests were made with different particle sizes as obtained by screening it was found, even when a relatively limited size range is considered, that particle size greatly affected the magnitude (but not the sign) of the dust charge, Table 3. It will be noted that some materials gave increased charges while other materials gave markedly decreased charges as the particle size was reduced. These conditions may offer a partial explanation of the variable control obtained with insecticidal dusts compounded with the same minerals. It is interesting to note that in a similar relationship the coercive force of magnetic powders also increases with decrease of particle size (4).

TABLE 1

ELECTROSTATIC PROPERTIES OF VARIOUS FINELY POWDERED MATERIALS WHICH HAVE BEEN INCLUDED IN INSECTICIDAL DUST MIXTURES

Hardness	Material		Charge on Tube and Sign of Mineral (Volts)	Electrostatic Effect of Mineral Tested with Respect to Standard Minerals of Known Charge	
				Depresses Charge	Accelerates Charge
	Native Elements				
3.5	Arsenic	As	+5000	Quartz (—)	Calcite (+)
4–5	Iron in basalt	Fe	+2200	"	"
1.5–2.5	Sulphur	S	0 (+)	"	"
	Sulphides of Metals				
3.5–4	Chalcopyrite	$CuFeS_2$	0 (+)	Quarts (—)	Calcite (+)
2.5–2.75	Galena	PbS	0 (+)	"	"
6–6.5	Pyrite	FeS_2	0 (+)	"	"
3.5–4	Sphalerite	ZnS	—3000	Calcite (+)	Quartz (—)
	Haloids				
	Barium fluosilicate	$BaSiF_6$	+200	Quartz (—)	Calcite (+)
2.5	Cryolite	Na_3AlF_6	+3000	"	"
	Cuprichloride	$CuCl_2 . 2H_2O$	0 (—)	Calcite (+)	Quartz (—)
4	Fluorite	CaF_2	+10,000	Quartz (—)	Calcite (+)
2.5	Halite	NaCl	+2000	"	"
2	Sylvite	KCl	+10,000	"	"
	Oxides of Silicon				
7	Quartzite (Rib Mountain)	SiO_2	—9000	Calcite (+)	Quartz (—)
	Quartzite (Baraboo Bluffs)	SiO_2	—4200	"	"
	Quartz crystals	SiO_2	—10,000	"	"
	Quartz crystals	SiO_2	—4000	"	"

TABLE 1—*(Continued)*

ELECTROSTATIC PROPERTIES OF VARIOUS FINELY POWDERED MATERIALS WHICH HAVE BEEN INCLUDED IN INSECTICIDAL DUST MIXTURES

HARDNESS	MATERIAL		CHARGE ON TUBE AND SIGN OF MINERAL (Volts)	ELECTROSTATIC EFFECT OF MINERAL TESTED WITH RESPECT TO STANDARD MINERALS OF KNOWN CHARGE	
				Depresses Charge	Accelerates Charge
5.5–6.5	Milk opal	$SiO_2 \cdot nH_2O$	—5400	Calcite (+)	Quartz (—)
	Celite	SiO_2	—250	..	..
	Diatomite	SiO_2	—4000	..	..
	Diatomite	SiO_2	—2000	..	..
7	White sand (Portage)	SiO_2	—8000	..	..
	Oxides and Hydroxides of Metals				
	Aluminum oxide U.S.P.	Al_2O_3	0 (+)	Quartz (—)	Calcite (+)
	Arsenic trioxide U.S.P.	As_2O_3	0 (+)	..	..
	Bauxite	$Al_2O_3(H_2O, 3H_2O)$	0 (+)	..	..
2.5	Brucite	$Mg(OH)_2$	+2700	..	..
5–5.5	Calcium oxide U.S.P.	CaO	+6800	..	..
	Cupric oxide U.S.P.	CuO_2	0 (+)	..	..
	Ferric oxide U.S.P.	Fe_2O_3	+8000	..	..
5.5–5.6	Franklinite	(Fe, Zn, Mn)O. (Fe, Mn) $_2O_3$	+5000	..	..
5–5.5	Goethite	FeOOH	+4400	..	..
5.5–6.5	Hematite	Fe_2O_3	+4000	..	..
	Lead oxide (yellow) U.S.P.	PbO	+7000	..	..
5–5.5	Limonite	$2 Fe_2O_3 \cdot 3H_2O$	+5000	..	..
5–5.5	Limonite	$2 Fe_2O_3 \cdot 3H_2O$	+2800	..	..
5.5–5.6	Magnetite	$FeO \cdot Fe_2O_3$	+2200	..	..
4	Manganite	$MnO(OH)Mn_2O_3 H_2O$	+4000	..	..
	Magnesium oxide U.S.P.	MgO	0 (+)	..	..

TABLE 1—*(Continued)*

ELECTROSTATIC PROPERTIES OF VARIOUS FINELY POWDERED MATERIALS WHICH HAVE BEEN INCLUDED IN INSECTICIDAL DUST MIXTURES

HARDNESS	MATERIAL		CHARGE ON TUBE AND SIGN OF MINERAL (Volts)	ELECTROSTATIC EFFECT OF MINERAL TESTED WITH RESPECT TO STANDARD MINERALS OF KNOWN CHARGE	
				Depresses Charge	Accelerates Charge
	Carbonates				
3	Calcite crystals	$CaCO_3$	+8000	Quartz (—)	Calcite (+)
3	Calcite crystals	$CaCO_3$	+6000	..	..
3	Calcium carbonate (limestone)	$CaCO_3$	+10,000	..	..
3.5–4.5	Magnesite	$MgCO_3$	+600	..	..
5.5	Smithsonite	$ZnCO_3$	+4500	..	..
3–3.5	Barium carbonate	$BaCO_3$	0 (+)	..	..
	Copper carbonate	$CuCO_3$	+10,000	..	..
	Silicates				
6–6.5	Albite	$NaAlSi_3O_8$	+4000	Calcite (+)	Quartz (—)
6.5–7.5	Almandite (Garnet)	$Fe_3Al_2(SiO_4)_3$	0 (—)	..	..
5.0–6	Hornblende (Amphibole)	$(CaMgFe)_4SiO_3$. $(NaAlSiO_2(F,OH)$	+2500	..	..
5–6	Tremolite	$CaMg_3(SiO_3)_4$	+4000	..	..
1–2	Bentonite (clay+quartz)	$Na_{0.33}(Al_{1.67}Mg_{0.33})Si_4O_{10}(OH)_2+SiO_2$	+500	Quartz (—)	
2.5–3	Biotite	$K(Mg,Fe)_3(AlSi_3)O_{10}(OH)_2$	0 (+)	..	
4.5–5	Calamine (Hemimorphite)	$(ZnOH)_2SiO_3$	0 (+)	..	
6.5	Chlorite*	$(Fe,Mg)_2Al(OH)_6$ $(Mg,Fe)_3(AlSi_3)O_{10}(OH)_2$	0 (+) or (—)		

*Chlorite samples may produce small (—) or (+) charges depending upon composition, possible impurities, and particle size.

TABLE 1—*(Continued)*

ELECTROSTATIC PROPERTIES OF VARIOUS FINELY POWDERED MATERIALS WHICH HAVE BEEN INCLUDED IN INSECTICIDAL DUST MIXTURES

HARDNESS	MATERIAL		CHARGE ON TUBE AND SIGN OF MINERAL (Volts)	ELECTROSTATIC EFFECT OF MINERAL TESTED WITH RESPECT TO STANDARD MINERALS OF KNOWN CHARGE	
				Depresses Charge	Accelerates Charge
	Silicates (contd.)				
5.5	Enstatite	$MgSiO_3$	+4000	Quartz (—)	
2–2.5	Kaolinite	$Al_2Si_2O_5(OH)_4$	0 (—)	Calcite (+)	
5–6	Labradorite	$(NaAlSi_3O_8)+(CaAl_2Si_2O_8)_3$	+8600	″	Quartz
6–6.5	Microcline	$KAlSi_3O_8$	+4500	″	″
2–2.25	Muscovite	$KAl_2(AlSi_3)O_{10}(OH)_2$	0 (+)	Quartz (—)	
	Mica+Impurities (?)		+1000	″	
5–5.6	Nephelene	$(NaK)AlSiO_4$	+800	″	
1–2	Pyrophyllite	$Al_2Si_4O_{10}(OH)_2$	—5500	Calcite (+)	
5.5–6.5	Rhodonite	$MnSiO_3$	+4500	″	Quartz (—)
2.5–4	Serpentine "talc"	$Mg_3Si_2O_5(OH)_4$	0 (+)	Quartz (—)	″
1–1.5	Talc (Wis.)	$Mg_3Si_4O_{10}(OH)_2$	—8000	Calcite (+)	
	Tremolite "talc" (fibrous)		0	Quartz (—)	
	Steatite talc	$Mg_3Si_4O_{10}(OH)_2$	+4200	″	Calcite (+)
	"AA Mica" (micaceous)	SiO_2—34.87%, MgO—40.11%, Al_2O_3—6.84%, K_2O—11.3%	+7600	″	
	Borate, Molybdate, and Phosphate				
	Borax	$Na_2B_4O_7 \cdot 10H_2O$	0 (+)	Quartz (—)	Calcite (+)
	Ammonium molybdate	$(NH_4)_6Mo_7O_{24} \cdot 4H_2O$	0 (—)	Calcite (+)	Quartz (—)
	Rock phosphate	$(CaF)Ca_4(PO_4)_3$	0 (+)	Quartz (—)	Calcite (+)

TABLE 1—(*Continued*)

ELECTROSTATIC PROPERTIES OF VARIOUS FINELY POWDERED MATERIALS WHICH HAVE BEEN INCLUDED IN INSECTICIDAL DUST MIXTURES

Hardness	Material		Charge on Tube and Sign of Mineral (Volts)	Electrostatic Effect of Mineral Tested with Respect to Standard Minerals of Known Charge	
				Depresses Charge	Accelerates Charge
	Sulphates				
2.5–3.5	Barite	$BaSO_4$	0 (+)	Quartz	
	Calcium sulphate	$CaSO_4 . 2H_2O$	0 (+)	"	
1.5–2	Gypsum	$CaSO_4 . 2H_2O$	+9200	"	Calcite (+)
	Epsom salts	$MgSO_4 . 7H_2O$	+4200	"	
	Glauber's salts	$Na_2SO_4 . 10H_2O$	0 (—)	Calcite (+)	Quartz (—)
2	Potassium alum	$K\,Al(SO_4)_2 . 12H_2O$	0 (—)	"	"
2	Ammonium alum	$(NH)_4\,Al(SO_4)_2 . 12H_2O$	0 (—)	"	"
	Organic Acids				
	Citric	$H_3C_6H_5O_7$	—1000	"	"
	Oxalic	$H_2C_2O_4$	—3400	"	"

TABLE 2

ELECTROSTATIC CHARGE RESULTING FROM MECHANICAL MIXTURES OF FINELY GROUND MINERALS

MATERIAL TESTED AND CHARGE A	REFERENCE MATERIAL AND CHARGE BEFORE MIXING B	WEIGHT RATIO A : B	ELECTROSTATIC CHARGE PRODUCED WHEN COMBINED (Volts)
Albite (+)4000	"Pyrax" (—)7900	1 : 1	(—) 9000
	"AA Mica" (+)7600	1 : 1	(+) 3000
Almandite 0(+)	"Pyrax" (—)7900	1 : 1	(—) 9000
	"AA Mica" (+)7600	1 : 1	(+) 2600
Hornblende (+)2500	"Pyrax" (—)7900	1 : 1	(—) 9600
	"AA Mica" (+)7600	1 : 1	(+) 2200
Rhodenite (+)4550	"Pyrax" (—)7900	1 : 1	(—) 8500
	"AA Mica" (+)7600	1 : 1	(+) 2500
Manganite (+)2000	"Pyrax" (—)7900	1 : 10	0
	"AA Mica" (+)7600	1 : 1	0
	" "	1 : 3	(+) 300
	" "	1 : 6	(+) 4000
Smithsonite (+)5900	"Pyrax" (—)7900	1 : 50	(—) 4850
	"AA Mica" (+)7600	1 : 1	(+) 7800
Sulphur 0(+)	$CaCO_3$ (+)14000	1 : 1	(+)14000
	"AA Mica" (+)7600	1 : 1	(+) 9000
	"Pyrax" (—)7900	1 : 1	0
	" (—)7900	1 : 2	(—) 200
	" (—)7900	1 : 3	(—) 1000
	" (—)7900	1 : 10	(—) 3100
Tremolite "talc" 0	"Pyrax" (—)7900	1 : 1	0
	"AA Mica" (+)7600	1 : 1	0
Steatite talc 0(+)	A pure talc (—)7800	1 : 2	(—) 5000
	" " " (—)7800	3 : 1	0
	" " " (—)7800	4 : 1	(—) 100
	" " " (—)7800	5 : 1	(+) 1500
	" " " (—)7800	7 : 1	(+) 3000
Barium carbonate U.S.P. 0(+)	A pure talc (—)7800	1 : 1	0
	" " " (—)7800	1 : 25	(—) 400
	" " " (—)7800	1 : 50	(—) 2200

TABLE 3

THE EFFECT OF SCREEN SIZE ON THE DEVELOPMENT OF ELECTROSTATIC CHARGES IN DUST CLOUDS

	SCREEN SIZE	CHARGE
Limonite Ala.	100	0
"	200	+ 3500
"	325	+ 3800?
Limonite N.C.	100	+ 2000
"	200	+ 4850
"	325	+ 5000
Goethite	100	+ 500
"	200	+ 1500
"	325	+ 2200
Steatite Talc	100	+ 4500
" "	200	+ 4200
" "	325	± 0
Brucite	60	+ 2700
"	100	+ 2200
"	200	0
"	325	0
Wisconsin Talc	60	—14,000
" "	100	— 9100
" "	200	— 7560
" "	325	— 5800
Pyrophyllite	100	—14,000
"	200	—10,000
"	325	— 5500
Silica Crystals	Over 60	0
" "	60	— 200
" "	100	— 2500
" "	140	— 4000
" "	200	— 4000
" "	300	— 9600
" "	325	—14,000

FACTORS CONTROLLING THE DEVELOPMENT OF ELECTROSTATIC CHARGE

The generation of the electrostatic charge of the dusts probably lies in the friction and impact between dust particles, as shown by the development of electrical charges in dust storms. However, it may arise in part also by striking of the dust particles against the walls of a dust blower, because the dust blower always has a charge opposite to that produced in the dust cloud, as illustrated in Figure 2.

Particle-size factor. From the foregoing data there appears to be a particle-size factor which requires for generation of a charge, whether (—) or (+), that the particle size (extent of frictional sweep across any one crystal) be commensurate with the physical conditions of the apparatus (size, air velocity, etc.). Little if any charge was registered when the particle size became relatively small[6] (under 2 microns). Using some iron ores or pure silica crystals and starting with a sample of coarse powder (60 mesh), the charge usually increases with further grinding (limonite, goethite, and quartz, Table 3). However, after a maximum charge is reached with these materials, the charge declines with further grinding (illustrated with quartz, Table 3). Other minerals, brucite and steatite, showed high charges with coarse powder and declined immediately on grinding to smaller particle size, probably owing to the presence of an excessive number of particles which were much smaller than the screen-mesh sizes indicated. These smaller particles may become distributed over the surfaces of the larger particles and thus interfere with the normal frictional sweep and charge development by the larger particles (mechanical buffer effect). This mechanical buffer effect was produced even when the excessively fine particles are composed of materials which in themselves seemed to be electrostatically rather inactive, as noted with manganite, sulphur, and barium carbonate (Table 2).

Origin of negative charge. The materials found to give rise to negative electrostatic charges were predominantly acid in character. It was noted that the silicate minerals which gave marked negative charges (quartz, talc, and pyrophyllite) shared

[6] With larger apparatus, greater velocities, etc., a different size range of particles might be found to be electrostatically active and a different order of magnitude of voltages be found (active volcanic cone as an extreme example).

the common crystal lattice property of exposing silica tetrahedra at surfaces as a result of cleavage (in the latter two minerals by fracture along the basal 001 planes of perfect cleavage). This gives rise to exposure of oxygen ions (negative) at the surfaces of these materials, while the silicon ions (positive) are enclosed within the tetrahedral units. The presence of negative ions at surfaces (negative dipolar effect) does not, however, explain the observed negative electrostatic charge observed with these minerals; an actual accumulation of excess negative charge is necessary to produce the negative electrostatic charge measured.

The most tenable postulate as to the factor which gives rise to the (—) charge is in the presence of H^+ ions at surfaces of these acidic materials. A few scattered protons (H^+) are swept off the acid surfaces during charge development by frictional contact, thus giving rise to a negative residual charge on these materials. This explanation extends to the various types of negative materials including the alums and organic acids, Table 1.[7]

Origin of positive charge. Materials found to give rise to positive electrostatic charge are predominantly alkaline materials or materials which expose lattice OH^- groups on fracture. The most plausible explanation of the origin of the positive charge is frictional loss of OH^- groups and thus an accumulation of a residual (+) charge. An alternative postulate that a few scattered electrons are lost by frictional contact which would give rise to a positive charge is not considered tenable.

The positive charge is associated with such materials as hematite, goethite, gypsum, and epsom salt which are not particularly alkaline, but which may carry alkaline impurities or expose OH^- or $O^=$ ions in their lattices which are capable of being swept off. A positive charge is also associated with various ground and dried vegetable tissues. Several of the positively charged materials tested are known to yield alkali cations at surfaces on fracture, for example, Na^+ exposed in ground albite, and K^+ in ground mica (AA talc). These cations may act as alkalies by being supplied with OH^- ions through a hydrolysis reaction with moisture from the atmosphere.

These postulates agree with the findings of Davy (3) that acid powders produce a (+) charge on a metal plate, if the metal plate (+) is considered to act as a condenser plate and

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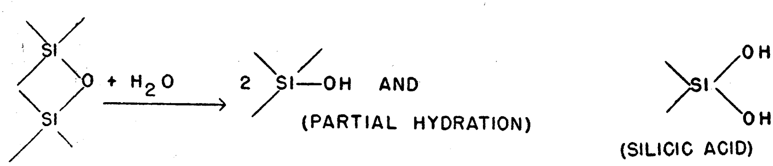
[7] In accord with modern theory of the solid state. See L. B. Loeb, "The basic mechanisms of static electrification," *Science* 102 : 573–576. 1945.

bear a charge opposite to that of the acid powder (—); and conversely for the (—) plate charge found with alkaline powders (+). It also agrees with Rudge (10) who found $CaCO_3$ (alkaline) to be (+) and silica (acid) to be (—).

Discussion

The electrostatic charge of quartz crystals and its effectiveness in insecticidal dust mixtures were usually greater when the material was freshly ground than after aging for a period of a few months. For example, one quartz dust with a charge, when fresh, of 14,000 volts showed a charge, after aging, of only 5,000 volts. The surfaces freshly formed by fracture bear active silicon-oxygen bonds which probably undergo hydrolysis in contact with air with its usual moisture content, according to the following reactions, wherein the $O^{=}$ and OH^{-} ions are freshly exposed by crystal fracture:



Freshly ground quartz is distinctly acidic in reaction, thus indicating some dissociation of H^{+} ions from these surfaces. At this early stage the quartz normally is electrostatically very active, and is an efficient dispersant. Gradual further hydration of the quartz surface, to form a gelatinous film of colloidal silicic acid is considered the probable cause of decreased electrostatic activity of the aged material. This silicic acid film, probably extending to a depth of a few atomic layers, would be expected to have a mechanical masking effect comparable to that of coatings by fine particles already mentioned. In addition, this colloidal silicic acid may cause some deactivation of the toxic constituents of the dusts by chemical action or physical adsorption. Such action is well illustrated with bentonite dusts which, though somewhat active electrostatically, bring about almost total deactivation of rotenone and certain other toxic agents. The presence of certain kinds of impurities may lead to variable results with powdered quartz; one sample did not produce measurable charges with any particle size.

With talc and pyrophyllite (and Pyrax) powders, basal cleavage and exposure of siliceous surfaces predominate with 100-mesh particles and high negative charges are found (Table 3). The pyrophyllite (—) charge passes through a maximum at 200-mesh size. Further grinding of these minerals may involve breakage through the crystal plates and exposure of the central brucite-like layer containing basic cations and OH^- groups. These materials then show a marked decline in charge such as would be expected with a physical admixture of brucite (4). These minerals thus are "silica-like" at first but show a breakdown of charge much more quickly than quartz with a given mesh size.

Chlorites and micas have structures fundamentally analogous to pyrophyllite and talc except for the presence of the basic constituents $[Mg_2Al(OH)_6]^+$ and K^+, respectively between the crystal plates. On grinding they give rise to alkaline reactions immediately and do not go through the initial stage of (—) charge. Considerable variability occurs in the degree of (+) charge obtained from different mica samples, but a charge up to (+) 7600 volts was found with one mica. Chlorites are so easily fractured that an excess of fine particles prevents the development of an appreciable charge at any stage of preparation. However, talcs even though containing appreciable chlorite impurity often give a (—) charge with an optimum amount of grinding (and primary cleavage along 001 planes of talc).

The reversal of the silicates albite, almandite, hornblende, and rhodenite from slight (+) charge when used alone to a (—) charge when mixed with Pyrax (—) seems to indicate neutralization of their alkalinity and an uptake of the basic surface cations by the silicic acid surfaces of the quartz particles contained in the Pyrax powder.

Summary

A mechanism involving electrostatic induction of a charge on the plant is postulated to explain the way in which the electrostatic charge on the dust particles of insecticidal dusts influences the distribution and adherence of the dusts to plants and insects. To obtain further information on the charge of insecticidal dusts, a study was made of a wide variety of materials which have been included in these dusts.

It appears that electrostatic properties are controlled by two general sets of factors: first, are the mineralogical characteristics such as hardness, type of cleavage, ease of fracture, and type of crystal habit (whether fibrous, prismatic, etc.) which affect the particle-size distribution; and second, the chemical constitution and lattice structural arrangements which determine the acid or alkaline reaction. Excessive coarseness ($>$ 60 mesh) or fineness ($< 2\mu$) was found to reduce or prevent charge development. Within the favorable size range, negative electrostatic charges were found with acidic materials, especially the silicates (quartz, talc, and pyrophyllite) which on cleavage or fracture expose SiO_2 tetrahedral structures. Positive electrostatic charges were found with alkaline materials or those silicates which on cleavage or fracture yield alkaline cations or hydroxyl lattice structural groups at surfaces. This relationship may be viewed as a loss of protons from acidic, and loss of hydroxyl ions from alkaline surfaces. The electrostatic charge found with the various minerals agrees well with that expected from the above generalizations coupled with a knowledge of their crystal lattice constituents, arrangements, and cleavage characteristics. It is believed that information on the electrostatic behavior of minerals will aid in proper selection of effective materials for use in insecticidal dusts, and place the selection on a less empirical basis.

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EVOLUTION OF PRAIRIE-FOREST SOILS UNDER COVER OF INVADING NORTHERN HARDWOODS IN THE DRIFTLESS AREA OF SOUTHWESTERN WISCONSIN[1]

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The occurrence of the northern hardwood type in Richland and Vernon Counties, i.e., in the heart of the Wisconsin prairie-forest region, is a somewhat puzzling phenomenon. Some ecologists consider stands of hard maple, basswood, and yellow birch as relicts which survived fires due to the protective effect of rivers. Others attribute the presence of northern hardwoods to climatic factors; the area in question has a somewhat lower mean annual temperature and higher annual precipitation than the surrounding territory (3). Still others are inclined to regard the phenomenon as a part of the general succession in which northern hardwoods are encroaching upon the entire prairie-forest region of Wisconsin (1, 2).

It was felt that the study of soils under the two basic types of the region, i.e., mixed oak and maple-basswood, might give some clues to the solution of this problem. Moreover, a knowledge of the changes which soils undergo under the influence of either type is of importance for practical silviculture (4).

The areas chosen for investigation were selected in the Champion Valley Timber Harvest Forest, in eastern Vernon County. The total of twelve sample plots in both forest types were located within the study area of the Lake States Experiment Station. A complete tally of tree species for these plots was prepared by station personnel. The ground cover vegetation was determined by quadrat analysis. On each plot the soil was excavated to an approximate depth of three feet, or to the depth of the limestone substratum. Samples of soils were collected from the surface horizons (A_0, A_1, and A_2). Sampling was confined to areas of

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nearly level topography. Analyses of soils were made using standard procedures of the Wisconsin State Soils Laboratory. The results of the study of the forest cover and soil follow.

The typical composition of mixed oak and northern hardwood stands is presented in Table 1. The tally indicates that the participation of oak species in the northern hardwood type is reduced to 15 per cent as compared to 85 per cent in the mixed oak type.

TABLE 1

COMPOSITION OF MIXED OAK AND NORTHERN HARDWOOD TYPES

Mixed Oak		Northern Hardwood	
Species	Per cent of Total Stand	Species	Per cent of Total Stand
Quercus borealis	72	*Acer saccharum*	69
Quercus alba	13	*Tilia glabra*	11
Carya spp.	6	*Quercus borealis*	10
Acer saccharum, Fraxinus americana, Populus grandidentata, Ulmus spp.	9	*Quercus alba*	4
		Ulmus, spp., *Fraxinus americana, Ostrya virginiana*	6

TABLE 2

GROUND COVER SPECIES OCCURRING IN CHAMPION VALLEY FOREST

(Numbers represent the relative estimated density of species in four classes as follows: 1—rare; 2—occasional; 3—common; 4—abundant.)

Species	Maple–Basswood	Mixed Oak	Oak Openings	Prairie
Mitchella repens	3	....	....	....
Maianthemum candense	3	....	....	....
Polygonatum pubescens	3	....	....	....
Mitella diphylla	4	....	....	....
Hepatica spp.	3	2	....	....
Uvularia grandiflora	3	2	....	....
Circaea latifolia	1	4	....	....
Desmodium acuminatum	1	4	....	....
Phryma leptostachya	1	3	....	....
Geranium maculatum	2	4	2	1
Lactuca spicata	....	1	3	....
Lathyrus ochroleucus	1	1	3	....
Panicum spp.	....	1	4	4
Campanula americana	....	2	3	4
Dodecatheon media	....	1	2	4
Oxybaphus nyctagineus	....	1	2	4

The outstanding features of ground cover are summarized in Table 2. The nature of lesser vegetation in mixed oak stands and northern hardwood stands reveals a well-arranged spectre of species connecting two floristic extremes, i.e., tall grass prairie and boreal forest. The representatives of the former are by far more common in the mixed oak type than in the northern hardwood type. The conspicuous members of the northern flora particularly deserving mention are *Mitchella repens, Polygonatum pubescens,* and *Maianthemum canadense.*

TABLE 3

ANALYSES OF THE SURFACE HORIZONS OF DUBUQUE SILT LOAM SOILS SUPPORTING STANDS OF MIXED OAK TYPE AND MAPLE-BASSWOOD TYPE

Forest Type Horizon and Depth	Reaction pH	Total N p.ct.	Cation-Exchange Capacity ME/100 g.	Exch. Ca ME/100 g.	Exch. Mg	Avail. P ppm	Avail. K
Mixed Oak							
A_0, 0–1″	6.27	0.960	48.42	38.62	8.41	160	720
A_1, 1–4″	5.54	0.296	15.78	8.98	2.75	19	165
A_2, 4–9″	4.71	0.081	7.21	1.76	1.57	6	42
Maple–Basswood							
A_0, 0–3″	6.85	1.685	70.90	56.85	11.55	340	850
A_1, 3–6″	6.61	0.551	25.76	21.30	3.68	53	300
A_2, 6–10″	5.28	0.137	8.32	3.80	1.17	21	50

The soil supporting the investigated stands (Dubuque silt loam) consists of a two- to three-foot layer of loess over residual limestone. To the casual observer the soil profiles developed under the mixed oak and maple-basswood types may appear to be essentially the same. However, more careful observation reveals pronounced differences, particularly in the surface horizons. The most obvious profile peculiarity under the northern hardwood type is the accumulation of raw organic matter or mor-like humus. Also, the A_1 horizon in this type shows a better development of granular structure than the A_1 horizon in the mixed oak stand. This is the normal result of a higher content of organic matter and bases. No conspicuous difference in the degree of leaching or morphological features of the A_2 horizons were revealed by ocular observations.

The results of soil analyses (Table 3) indicated that the base-enriched litter of maple and basswood moderates acidity and raises the fertility level of the soil. The most significant improvement brought about by the presence of the maple-basswood type is the increase in cation-exchange capacity of soil. The rise in exchange capacity is accompanied by a higher content of replaceable bases. Great increases were also revealed in the contents of total nitrogen, available phosphorus, and available potassium. Thus, the analytical data strikingly illustrate the "nutrient-pumping" ability of sugar maple and basswood.

In order to appraise the biological activities of investigated soils, samples of humus were subjected to nitrification tests at optimum moisture content and temperature at 28° C. The results are given in Figure 1. The near neutral reaction and high level of fertility of the maple-basswood type proved to be more favorable for the activity of nitrifying organisms.

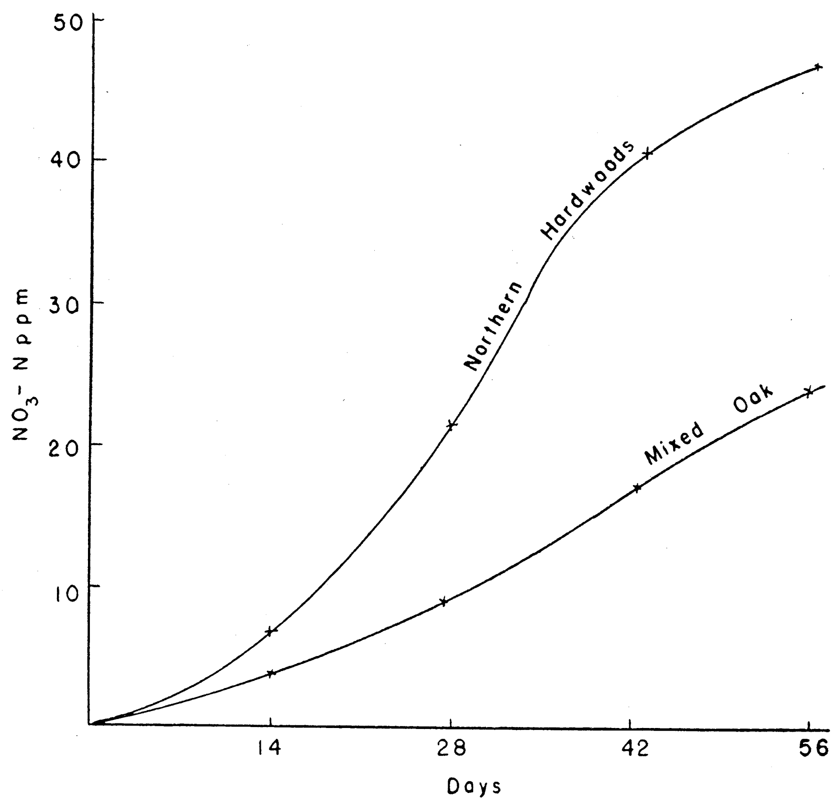

FIGURE 1. Nitrification capacity of humus layers from northern hardwood and mixed oak forest types.

The study in its entirety indicates that the occurrence of the northern hardwood type is associated with a more advanced stage in soil development. Hence, it should be regarded as the initial stage of either soil or vegetational climax. The soil under the northern hardwood type undergoes a process of pronounced podzolization. The latter, however, is partly suppressed by simultaneous enrichment of the soil in bases and moderation of acidity. On the basis of observation of northern stands, it could be predicted that in time the soil profile under the northern hardwood type will obtain the morphology of a mildly podzolized "mull" soil. It was noted that the ground cover plants of the northern hardwood type, especially rhizome geophytes, contribute considerably to the changes in soil composition.

The enrichment of the soil under maple and basswood signifies appreciable improvement of site conditions for silvicultural use. This makes the soils suitable not only to northern hardwoods, but also to the most exacting native species of the region, including black walnut and white ash. Moreover, indications were obtained that the rise in soil fertility, particularly the increase of exchangeable bases, is correlated with a higher site index of stands. Therefore, from the viewpoint of either soil conservationists or silviculturists, the occurrence of northern hardwood types is a highly desirable phenomenon. Aside from direct beneficial effects on soils, hard maple and basswood appear to be highly desirable buffering species which may serve to retard the continuous deterioration of pure oak stands.

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REPORT OF THE JUNIOR ACADEMY COMMITTEE, 1946

Last year the Senior Academy of Science met "on paper" and the papers and committee reports which ordinarily would have been given at the meetings were submitted for publication in the transactions. Among these reports is a description of the founding and the first year's activities of the Wisconsin Junior Academy of Science. Several of the hopes of last year have been realized, others remain to come to fruition, and still others spring anew from the activities and ideas of the second year of growth of the "teen-aged" affiliate of the Senior Academy.

With the addition of new science clubs as charter members of the Junior Academy, it became apparent that an additional district meeting would be necessary, so that two district meetings were held as preliminaries to the statewide meeting. On March 23, a district meeting was sponsored by the Sigma Zeta chapter of Central State Teachers College, Stevens Point. Clubs in the central part of the state were invited to participate in the meeting which was attended by 55 persons. Following the official program, our hosts of Sigma Zeta served some much appreciated refreshments. On the following programs, the papers starred were chosen by the club sponsors to be invited to be presented to the Junior Academy Section at the Academy meeting on April 13.

PROGRAM OF THE STEVENS POINT DISTRICT MEETING

Central State Teachers College, Stevens Point, Saturday,
March 23, 1:30 P. M.

Welcome, Ed Nigbor, President, and Betty Habercorn, Historian, Sigma Zeta, Central State Teachers College.

Address of Welcome—Professor H. A. Schuette, President, Wisconsin Academy of Sciences, Arts and Letters, 5 minutes.

"The Analysis of Water for Soluble Oxygen and CO_2, pH, and Biochemical Demand and Alkalinity"—Donald Kaubisiak, James Kruger and Jack Molsberry, Chemistry Club, Lincoln High School, Wisconsin Rapids, 20 minutes.

*"Soil Analysis"—Anita Kaufman, Chemistry Club, Lincoln High School, Wisconsin Rapids, 15 minutes.

*"Lift and Drag Coefficients of Airfoil Sections"—James Check, Science Club, P. J. Jacobs High School, Stevens Point, 10 minutes.

*"Applications of Atomic Energy"—Kathryn Masterson, Science Club, P. J. Jacobs High School, 10 minutes.

*"Astronomy Hobby"—Robert Bard, Nature Club, Appleton High School, 10 minutes.

"Museum Project"—Dudley Pierce, Nature Club, Appleton High School, 8 minutes.

"Plants as Chemical Indicators"—Molly Hack and Kenneth Beilke, Bios Explorers, Marathon High School, 10 minutes.

"Electrolysis—The Lead Tree"—John Bartlet and LaVerne Seubert, Superchargers, Marathon High School, 10 minutes.

The second district meeting held for the clubs of the Milwaukee area produced the following program:

PROGRAM OF THE MILWAUKEE DISTRICT MEETING

100 Science Hall, Marquette University, Sunday, March 31, 2 P. M.

Address of Welcome—Professor H. A. Schuette, President, Wisconsin Academy of Sciences, Arts and Letters, 5 minutes.

"Soil Analysis"—Sylvia Griffin, Bunsen Burners, Holy Angels Academy, 20 minutes.

*"Blood Will Tell"—Patricia Kasper, Dolores Demski, Mercedes Ironside, Mercy Science Club, Mercy High School, 15 minutes.

*"Backyard Insect Collecting"—Robert Zusy, St. John Cathedral High School, 10 minutes.

"Science Articles in the Milwaukee Journal for the Month of February"—Rose Mary Taylor, The Searchers, Girls' Tech High School, 5 minutes.

"Test of Soaps"—Mary Klein and other club members, Albertus-Magnus Math Science Club, St. Mary's Academy, 15 minutes.

"Organic Chemistry Demonstration"—Bob Mathes, Atom-Smashers, Boys' Tech High School, 15 minutes.

"Qualitative Analysis"—William Ewert, Lyle Fenski, and James Mintner, Atom-Smashers, Boys' Tech High School, 15 minutes.

*"Cold Light"—Melbourne Rabideau, Seminar Club, Mary D. Bradford High School, 15 minutes.

"Assembling a Model Airplane"—Theresa Lukomski, Albertus-Magnus Math Science Club, St. Mary's Academy, 15 minutes.

"Rockets"—Alfred Neumann, Nature Study Club, Washington High School, 15 minutes.

*"Hydroponics"—Lawrence Maurer, Seminar Club, Mary D. Bradford High School, 15 minutes.

"Giant Oudin Coil"—Jerome Pietrowski and Gerald Baykowski, Stan-Sci Club, St. Stanislaus High School, 10 minutes.

"Shortwave Walkie-Talkie"—Bernard Wright and Norman Krohn, Tesla Marconi, Central High School, West Allis, 15 minutes.

"Experiments with Polarized Light"—Clayton Miller and Roland Meyer, West High Science Club, West High School, Madison, 15 minutes.

"Rocks I Have Found in Wisconsin"—Stanley Kulakow, Phi-Bi-Chem Club, Steuben Junior High School, 15 minutes.

From the eight papers chosen by the club sponsors to represent their areas at the Junior Academy Section meeting were chosen the recipients of the honorary memberships in the American Association for the Advancement of Science and the Wisconsin Academy. An impartial committee representing various fields of science judged the merits of the papers and demonstrations. Dr. A. W. Schorger, Dr. E. F. Bean, Dr. H. A. Schuette, Dr. L. E. Noland and Dr. J. G. Winans served on this committee. The prize of a war bond for the best paper was awarded to James Check for his paper on "Lift and Drag Coefficients of Airfoil Sections"; second prize of $6.25 in war savings stamps was awarded to Lawrence Maurer for his project on "Hydroponics." The generosity of an anonymous member of the Academy made these awards possible. The Gamma Alpha award of $10.00 for the most original work was presented to Robert Bard for his discussion of his "Astronomy Hobby." The A.A.A.S. memberships were awarded to Melbourne Rabideau of Mary D. Bradford High School, Kenosha and jointly to Mercedes Ironside, Dolores Demski, and Patricia Kasper of Mercy High School, Milwaukee.

Academy memberships were awarded to Robert Zusy of St. John Cathedral High School, Milwaukee, Anita Kaufman, Lincoln High School, Wisconsin Rapids, Kathryn Masterson, P. J. Jacobs High School, Stevens Point, Robert Bard, Appleton High School, Lawrence Maurer, Mary D. Bradford High School, Kenosha, and James Check, Jacobs High School, Stevens Point.

Memberships in the A.A.A.S. and in the Academy entitle the recipients to publications and other privileges of these scientific organizations. A.A.A.S. memberships are limited to juniors and the Academy memberships are open to all participants in the state-wide meetings.

There were about 75 persons present at the annual meeting this year. Clubs which sent delegates include: Seminar Club, Kenosha; Chemistry Club, Wisconsin Rapids; Mercy Science Club, St. John Cathedral Science Club, St. Stanislaus Science Club, Milwaukee; Tesla Marconi Club, West Allis; Nature Club, Appleton; Science Club, Jacobs High School, Stevens Point; West High Science Club, Madison; and Bios-explorers, Marathon.

At the meeting the club delegates voted to have co-presidents, Mercedes Ironside of Mercy Science Club, Mercy High School, Milwaukee, and Melbourne Rabideau of the Seminar Club, Mary D. Bradford High School, Kenosha being elected to serve for 1946–1947.

Services to the Clubs

To advise with the club sponsors and the club members, the Chairman of the Junior Academy Committee travels over the state visiting clubs and sponsors for conferences on Junior Academy activities. Thirteen schools in Milwaukee and schools in Wisconsin Rapids, Eau Claire, Wausau and Black River Falls have been visited during the past year for this purpose.

To help provide programs and suggest projects for the club members, lectures by Mr. Thomson on Wildflowers and on Bird Songs, illustrated by kodachrome and phonograph records were made available free of charge to the clubs. Fifteen clubs availed themselves of these services during the spring.

Newsletters are sent out at irregular intervals to keep the clubs informed on events in the Junior Academy. Five have been issued this year. The first, (No. 4) announced the winners of the awards at the Milwaukee District last spring, the acquisition of lantern slides from the collection of the late E. R. Downing for loan collections for the schools, two free lectures for schools, the plans for a news bulletin by the schools and a list of the first 15 charter members. No. 5 announced the spring meeting dates and the start of the club publication. No. 6 gave the programs of the spring meetings, announced a co-operative project with the Soil Conservation Service, the readiness of a set of the Downing slides and the gift of a war bond by a member of the Academy to be presented at the annual meeting. No. 7 announced the state-wide meeting, the publication of the "Test Tube Times," the availability of a list of projects in forestry and offered Dr. Thomson's talks to the clubs. No. 8 described the state-wide meeting, the awards presented, the officers elected and the free materials available from the Junior Academy.

The first issues of the "Test Tube Times" appeared in March and April. Mercy Science Club, Mercy High School, Milwaukee prepared the first issue; Appleton High School Nature Club prepared the second. A third is expected to be prepared by West Allis High School Science Club. It is planned that the editing and production of this publication be rotated among the member clubs.

A further means of keeping the clubs in touch with each other's activities is the issuance of a list of all of the science clubs of the state. This list states the interests of the clubs, the meeting time, the principal activities, the nature of the membership (boys or girls or both) and the sponsor's name. Sixty-nine science clubs are active in Wisconsin.

Co-operative projects are another means of motivation of high-school science work. Two projects are at present offered by the Junior Academy, one on Distribution of Wisconsin Trees, and one on Phenology. Clubs co-operating in this program are located in Milwaukee, Appleton, Neenah, Black River Falls, Marathon and Superior. More are needed to make this project a satisfactory one and every effort is being made to include more individuals and clubs in the project. A co-project with the U. S. Soil Conservation Service in this state also makes it possible for clubs interested in this phase of science to obtain much help. Other co-projects with federal agencies are also available through the efforts of Science Clubs of America.

Other services made available to the clubs included a bibliography of books and pamphlets dealing with science club projects; a bibliography of plays on science and scientists; a descriptive instruction list of projects on forestry for conservation clubs; and lantern slides from the collection of the late E. R. Downing, one set thus far being ready with a prepared talk to accompany a set on "Forestry."

Publicity

An important factor in the development of any young and growing organization is the attempt to acquaint as broad a public as possible with the aims and activities of the organization. At the convention of two of the locals of the W. E. A., the Southern Wisconsin Education Association on February 8, 1946, and the Northwestern Wisconsin Education Association on October 12, 1945, talks were given on the activities of the W. J. A. S. At the meeting of the Milwaukee Archdiocesan Science Teachers' Association, opportunity was given to present the aims and activities of the W. J. A. S. to a large group of Catholic science teachers.

Radio broadcasts have also been used to obtain publicity. On October 8, 1945, Mr. McNeel, "Ranger Mac," very kindly devoted his broadcast to the W. J. A. S. so as to acquaint the young people ready to enter high school with the possibilities of science work in high school. On April 2, 1946, the opportunity was taken on the Homemakers program to acquaint that group with the phenology project of the W. J. A. S.

Much has been written in the newspapers this year about the activities of the Junior Academy and it has not been possible to obtain all of the references about which we have heard. Known articles have appeared in the University *Press Bulletin* for February 20, 1946; The Wisconsin *State Journal* for February 20, 1946; *The Capital Times*, March 17, 1946 and March 23, 1946; The Milwaukee *Journal*, April 1, 1946; The Milwaukee *Sentinel*, April 1, 1946; and The Appleton *Post Crescent*, April 1946. Additional articles which we have not seen but which were reported to us appeared in The Appleton *Post Crescent* and The Minneapolis *Herald Tribune*. The Wisconsin *Journal of Education* carried two notes on the W. J. A. S. activities in the December 1945 and March 1946 issues. A fine series of pictures taken by Phil Harrington at the Annual Meeting appeared in The Milwaukee *Journal* for May 12, 1946.

Membership

Growth of the organization has been very satisfactory. Twenty-nine clubs were enrolled by May 1946 with a total of about 1,100 boys and girls as Junior Academy members. Those clubs which are new charter members this year are:

Nature Club, Appleton High School, Appleton.
Students of Science, Cochrane High School, Cochrane.
Science Club, Eau Claire High School, Eau Claire.
Seminar Club, Mary D. Bradford High School, Kenosha.
Phy-Chem Science Club, Central High School, Madison.
Science Club, West High School, Madison.
Super Chargers Club and Bios-Explorers Club, Marathon High School, Marathon.
Atom Smashers, Boys Trades and Technical High School, Milwaukee.
The Searchers, Girls Trades and Technical High School, Milwaukee.
Albertus–Magnus Club, St. Robert School, Shorewood.
Nature Study Club, Washington High School, Milwaukee.
Conservation Club, Neenah Senior High School, Neenah.
Science Club, Wauwatosa High School, Wauwatosa.
Chi-Rho-Beta Science Club, Cathedral High School, Superior.
Science Club, P. J. Jacobs High School, Stevens Point.
Science Club, North Division High School, Milwaukee.

Our Hopes

What are our aims for the following year? Of course we expect to continue the activities initiated during the past two years, but we hope to expand the services offered to the clubs and to the high-school youth.

(1) Our most important objective is a science talent search for those of scientific ability in Wisconsin. We need to have scholarships offered by the colleges of this state to worthy boys and girls, and we need to organize a search for these students.

(2) We need to enlarge the list of speakers available to the science clubs. Will some of the Academy members offer their services here?

(3) If the organization continues to grow, more district meetings will have to be held and more areas in the state covered.

(4) More co-operative projects with state scientists need to be in operation. The fields of physics and chemistry especially need encouragement. Can the Academy members help with such suggestions?

(5) Circulating loan collections need to be obtained and started.

(6) More sets of slides from the Downing Memorial collection will be made ready with prepared lectures for loan to the clubs.

(7) We still need an advertising folder.

(8) Radio programs.

Signed:
JOHN W. THOMSON, JR.
Chairman, Junior Academy Committee

PROCEEDINGS OF THE ACADEMY

The Wisconsin Academy of Sciences, Arts and Letters held its 77th annual meeting on the 11th and 12th of April, 1947, at the Milwaukee Public Museum. The Academy section met in the Conference Room for the Friday session and in the Lecture Hall for the Saturday morning session. The Junior Academy held its meeting in Room 100, Science Hall, Marquette University, Milwaukee. More than 100 persons attended the various meetings. The annual business meeting and election of officers was held on Friday afternoon. The following program of scientific papers and a symposium was presented.

ACADEMY SECTION

April 11, 1947

E. S. McDonough, Marquette University. A cytological study of development of the oospore of *Sclerospora macrospora;* Herbert W. Levi, University of Wisconsin. The life history of the pseudoscorpion, *Chelifer cancroides* (Linn.); Raymond H. Reis, S. J., Marquette University. Factors affecting change of form in *Pelmatohydra oligactic.* I. Presence of food in the enteron; James C. Perry, Marquette University. Manifestations of the alarm reaction in spermatogenesis; Alvine F. Weber, University of Wisconsin. Metrorrhagia in the virgin bovine; Lester W. J. Seifert, University of Wisconsin. The problem of speech-mixture in the German spoken in northwestern Dane County, Wisconsin; Hisako O. Yokoyama, University of Wisconsin. Hematology of the perch; Mona M. Marquette, Betty M. Noble, Helen T. Parsons, University of Wisconsin. Availability to human subjects of pure riboflavin ingested with live yeast; Joan A. Wright, University of Wisconsin. (Introduced by Norman C. Fassett.) Distribution of species of Liliales in Wisconsin. (By title); Theodore J. Walker, University of Wisconsin. (Introduced by Arthur D. Hasler.) Methods for testing the chemical senses of the bottom-feeding fishes—especially the blunt-nosed minnow, *Hyborhynchus notatus.* (By title); Harold J. Elser, University of Wisconsin. (Introduced by Norman C. Fassett.) Some peripheral phenomena as revealed by tree rings. (By title); William H. Hobbs, University of Michigan. North American glacial deposits interpreted on the basis of studies of existing continental glaciers. (By title); E. David Le Cren, University of Wisconsin. (Introduced by Arthur D. Hasler.) An experiment with fish populations. (By title); John C. Neess, University of Wisconsin. (Introduced by Arthur D. Hasler.) Some basic aspects of fish-pond fertilization. (By title.) H. A. Schuette, University of Wisconsin. Grandfather–Botanist. (By title.)

Academy Section

April 11, 1947

Peter J. Salamun, University of Wisconsin. Botanizing in the Aleutian Islands; Robert S. Ellarson, University of Wisconsin. The vegetation of Dane County, Wisconsin, in 1835; Banner Bill Morgan, University of Wisconsin. Tularemia (Rabbit Fever) in Wisconsin; B. L. von Jarchow, M. D., Racine, Wisconsin. Notes on predation; Robert K. Richardson, Beloit College. Plato's medicinal lie in history; Rev. John P. O'Brien, Marquette University. Irradiation injury and trauma as factors in the regression of irradiated non-regenerating limb stumps of Urodele largae; Aaron J. Ihde and H. A. Schuette, University of Wisconsin. Early days of chemistry at the University of Wisconsin; S. D. Beck and J. H. Lilly, University of Wisconsin. Progress report on European corn-borer resistance investigations.

Academy Section

April 12, 1947

Kenneth M. Mackenthun and Elmer F. Herman, Wisconsin Conservation Department. A preliminary creel census of perch fishermen on Lake Mendota, Wisconsin; Deam Ferris, University of Wisconsin. Phase microscopy; Donald R. Thompson, University of Wisconsin. Vitamin A in wild pheasants and quails; Robert A. McCabe, University of Wisconsin. Reestablishing a local breeding stock of wood ducks at the University of Wisconsin Arboretum.

Symposium on Safeguarding the Purity of Wisconsin's Natural Waters

Willis M. Van Horn, Institute of Paper Chemistry, Appleton. Stream pollution abatement studies in the pulp and paper industry; Victor H. Kadish, Sewerage Commission of the City of Milwaukee. Milwaukee's activated-sludge sewage-disposal project; Arthur D. Hasler, University of Wisconsin. Biological implications of the use of copper for the control of algae scums in lakes; Louis F. Warrick, State Sanitary Engineer. The work of the State Board of Health in safeguarding the purity of Wisconsin's natural waters.

Junior Academy Section

April 12, 1947

John Casida, West High Science Club, West High School, Madison. Lady bugs in evolution; George Koehler, West High Science Club, Madison. Bird study in a Madison cemetery; Melbourne Rabedeau, Seminar Club, Mary D. Bradford High School, Kenosha. Chemiluminescense; Fred Lindstrom, Seminar Club, Mary D. Bradford High School, Kenosha. Potentiometric titration; Eugene Haugh, Reedsburg High School. Semi-micro methods for the home chemist; Kenneth McCabe, Science Club, Aquinas High School, La Crosse. Radio and radio tubes; Ted Taylor, West High Science Club, West High School, Madison. Anesthetics; Carl Stapel, Nature Club, Appleton. The Optiphone in action.

JUNIOR HIGH PAPERS

Roy Gromme, Phi-Bi-Chem Club, Steuben Junior High School, Milwaukee. Some birds of prey that I have known; Peter Jansen, Lincoln Junior High School, Kenosha. Fish as a hobby.

ANNUAL ACADEMY LECTURE

The annual Academy dinner was held on Friday evening, April 11, in the East Room, Pfister Hotel. President L. E. Noland of Madison presented his presidential talk, the title of which was "For the Sake of the Record."

ACADEMY BUSINESS MEETING

The annual business meeting was held in the Conference Room of the Milwaukee Public Museum.

The nomination committee with A. W. Schorger as chairman presented the following slate of officers for the next Academy year:

President: L. E. Noland, Department of Zoology, University of Wisconsin.

Vice-President in Science: E. L. Bolender, Superior State Teachers College, Superior, Wisconsin.

Vice-President in Arts: Don Anderson, Madison, Wisconsin.

Vice-President in Letters: Robert K. Richardson, Beloit College, Beloit, Wisconsin.

Secretary-Treasurer: Banner Bill Morgan, Department of Veterinary Science, University of Wisconsin.

Librarian: H. O. Teisberg, Historical Library, Madison, Wisconsin.

PROCEEDINGS OF THE ACADEMY

The Wisconsin Academy of Sciences, Arts and Letters held its 78th annual meeting on the 23rd and 24th of April, 1948, at Central State Teachers College, Stevens Point, Wisconsin. The Academy sections were held in Room 116, Main Building. More than 100 persons attended the various meetings. The annual business meeting and election of officers was held April 24th. The following program of scientific papers was presented.

ACADEMY SECTION

April 23, 1948

Harold R. Wolfe and Eleanor Dilks, University of Wisconsin. The variation in antibody response among birds; Eleanor Springer, Stata Norton, H. R. Wolfe and C. A. Herrick, University of Wisconsin. The route of injection correlated with precipitin production in chickens; Stata Norton, H. R. Wolfe and C. A. Herrick, University of Wisconsin. Effect of injection of a soluble antigen on spleen size in chickens; Lester W. J. Seifert, University of Wisconsin. Methods and aims of a survey of the German spoken in Wisconsin; Kenneth MacArthur, Milwaukee Public Museum. Contributions to the knowledge of the Hippoboscidae (Diptera); John W. Thomson, Jr., University of Wisconsin. Experiments upon the regeneration of certain species of the lichen genus *Peltigera;* D. R. Lincicome, W. H. Thiede and E. Carpenter, University of Wisconsin. Occurrence of *Endamoeba histolytica* and related organisms in Wisconsin. Preliminary report.

ACADEMY SECTION

April 24, 1948

Albert M. Fuller, Milwaukee Public Museum. Nature reserves and the permanent protection of wild flowers in Wisconsin; C. A. Herrick, University of Wisconsin. The value of the ceca of birds as a source of energy; Warren O. Haberman, University of Wisconsin. Bionomics of the warble fly (Hypoderma) under Wisconsin conditions; Lowell E. Noland, University of Wisconsin. Highlights in the history of the Department of Zoology at the University of Wisconsin; Aaron J. Ihde, University of Wisconsin. The inevitability of scientific discovery; Fung-haan Fung, Ruth Aaness and Helen T. Parsons, University of Wisconsin. The availability to the pig of dietary thiamine in the presence of fresh, viable yeast.

READ BY TITLE

Robert Rausch and Everett Schiller, University of Wisconsin. Studies on cestodes of the genus Paranoplocephala Luhe, 1910; Robert Rausch, Everett Schiller and Banner Bill Morgan, University of Wisconsin. The helminth fauna of Wisconsin birds and mammals; A. D. Hasler and W. G. Einsele, University of Wisconsin. Fertilization for increasing the productivity of inland waters; A. D. Hasler and J. E. Bardach, University of Wisconsin. Daily migrations of perch in Lake Mendota, Wisconsin (from direct and indirect observations); T. J. Walker and A. D. Hasler, University of Wisconsin. Olfactory discrimination of aquatic plants by *Hyborhynchus notatus* (Raf.); H. Neuenschwander, University of Wisconsin. (Introduced by A. D. Hasler). The history of the cisco in Lake Mendota, Wisconsin; Rev. Raymond H. Reis, Marquette University. Congenital unilateral urogenital agenesis with unilateral pregnancy and accompanying vascular modifications in a domestic cat; Louis Scherger, University of Wisconsin. Histology of the bovine oviduct.

Junior Academy Section

April 24, 1948

Robert Bertelson, Science Club, Washington High School, Milwaukee. An interesting derivative of phenolphthalein; George Koehler, West High Science Club, Madison. Bird study in a cemetery; Jane Morton, West High Science Club, Madison. The substitution of crude casein for alcohol extracted casein in the semi-synthetic diet for rats; James Chapel, Seminar Club, Mary D. Bradford High School, Kenosha. The oscilloscope; Peter Bunde, Chemistry Club, Lincoln High School, Wisconsin Rapids. Three-stage bleaching of sulfite pulp; Carl Stapel, Nature Club, Appleton Senior High School, Appleton. The seeing ear; James Pearse, Aquinas Science Club, Aquinas High School, La Crosse. Air conditioning; Robert Koehler, Nature Club, Appleton Senior High School, Appleton. Raising orchids as a hobby.

Junior High Papers

Carol Zabel, Mercy Science Club, Mercy High School, Milwaukee. Guinea pigs in shells; Ronald Rabedeau, St. Thomas Junior High School, Kenosha. Telescopes.

Annual Academy Lecture

The annual Academy dinner was held April 23, 1948 in the Club Room, Hotel Whiting, after the afternoon tea which was held in the Home Economics Parlor, Central State Teachers College. President L. E. Noland of Madison, presented his presidential address, the title of which was "The Problems and Opportunities of a State Academy in These Times of Increasing Specialization."

Academy Business Meeting

The annual business meeting was held in Room 116, Main Building, Central State Teachers College.

The nomination committee presented the following slate of officers for the next Academy year:

President: Otto L. Kowalke, University of Wisconsin.

Vice-President in Science: E. L. Bolender, Superior State Teachers College.

Vice-President in Art: Don Anderson, Madison.

Vice-President in Letters: Robert K. Richardson, Beloit College.

Secretary-Treasurer: Banner Bill Morgan, University of Wisconsin.

Librarian: H. O. Teisberg, State Historical Society, University of Wisconsin.

PROCEEDINGS OF THE ACADEMY

The Wisconsin Academy of Sciences, Arts and Letters held its 79th annual meeting April 19 and 20, 1949 at the University of Wisconsin (Memorial Union, Play Circle) as part of the University's centennial program. The Junior Academy held its meeting in the Auditorium, Biology Building, University of Wisconsin, Madison. Approximately 150 persons attended the various sessions. The following program of papers was presented.

ACADEMY SECTION

April 19, 1949

Arlan C. Helgeson, Madison, Wisconsin. Athens, Wisconsin: the early history of a cut-over village; Clarence A. Brown, Marquette University. Emily and God; Einar Haugen, University of Wisconsin. The Bilingual's dilemma: a study of the Norwegian language in Wisconsin; Lester W. J. Seifert, University of Wisconsin. The types of English loans in Wisconsin German; Aaron J. Ihde, University of Wisconsin. A Wisconsin chemical genealogy; Heinrich Henel, University of Wisconsin. Goethe's studies of nature; Victor M. Hamm, Marquette University. Form and the ambivalence of literature; Philip Whitehead, Beloit College. Art, science and poetry; Svend Riemer, University of Wisconsin. Functional housing in the middle ages; Rev. Francis Bloodgood, St. Francis House. Is eastern Orthodoxy to have a passive or active role in our time?

ACADEMY SECTION

April 20, 1949

George H. Conant, Triarch Botanical Products. Some correlations between sporophyte development and gametogenesis in *Lilium michiganense;* Howard K. Suzuki, Marquette University. Some notes on the distribution of the Wisconsin amphibians; Paul A. Knipping, University of Wisconsin. A report on some ticks known to occur in Wisconsin; Clarence A. Schoenfeld, University of Wisconsin. Interpreting the science of wildlife management; Walter R. Sylvester, Central State Teachers College. Improving the public's attitude toward conservation; R. C. Dosen, S. F. Peterson and D. T. Pronin, Nekoosa–Edwards Paper Company, University of Wisconsin. Effect of ground water on the rate of growth of red and white pine in central Wisconsin; Andre Lafond, University of Wisconsin. Relation to morphological and chemical composition of humus to the rate of forest growth in Wisconsin; Benson H. Paul and S. A. Wilde, University of Wisconsin. Rate of growth and composition of wood of aspen in relation to soil fertility; Garth K. Voigt, University of Wisconsin. Causes of winter injury to coniferous plantations during the winter of 1947–1948; S. A. Wilde and G. W. Randall, University of Wisconsin. Chemical characteristics of ground water in forest and marsh soils of Wisconsin; Chester T. Youngberg, University of Wisconsin. Evolution of prairie-forest soils under cover of invading northern hardwoods in the driftless areas of southwestern Wisconsin.

JUNIOR ACADEMY SECTION

April 20, 1949

Ann Furminger, Nature Club, Appleton High School President, Wisconsin Junior Academy of Science, *presiding;* Thomas Krueger, Nature Club, Appleton High School, Appleton. Fundamentals of Television; Peter Bunde, Chemistry Club, Lincoln High School, Wisconsin Rapids. Vitamin C, Assay; Harold Leland, Radio Club, Wausau Senior High School, Wausau. Ultra-High Frequency Oscilator; Jack Ramlo, La Crosse Central Science Club, Central High School, La Crosse. Duplication of the castner process of making sodium; Robert J. Blattner, Shorewood High School, Shorewood. On general invariants; Thomas B. Norton, Science Club, Washington High School, Milwaukee. A new antibiotic substance; Elmer Waldschmidt, Science and Camera Club, Messmer High School, Milwaukee. Antimony electrode pH meter; Ralph Burnett, Seminar Club, Mary D. Bradford High School, Kenosha. Study of protein deficiency in albino rat.

JUNIOR HIGH PAPERS

Wallace Nelson, Lincoln High School, Wisconsin Rapids. Bacteriology; Edward Oakes, Lincoln High School, Wisconsin Rapids. Ultraviolet light and its uses.

ANNUAL ACADEMY LECTURE

The annual Academy dinner was held on April 19, 1949 in the Round Table Room, Memorial Union, University of Wisconsin. President Otto Kowalke of Madison gave the presidential address on "The Problems Facing the Academy Today."

ACADEMY BUSINESS MEETING

The annual business meeting was held in the Play Circle of the Memorial Union.

The Academy awarded the 1949 A.A.A.S. grant-in-aid of $86.50 to Mr. Lester W. J. Seifert, Department of German, University of Wisconsin, to help in continuing his work on a "Survey of German Spoken in Wisconsin."

Through the generosity of the Milwaukee Public Museum, $2,000 was made available for publication of our *Transactions.* The specifications were drawn up and let out on bids in the city of Milwaukee. The contract was awarded to the Arrow Press for $2,562.00. All of the costs over $2,000 will be paid by the Academy.

Your Secretary and President Kowalke appeared before the legislature, joint finance committee and education committee to present the Academy's request for financial support to aid in publication of the *Transactions*. Through the continual and thorough efforts of Prof. Kowalke, it appears that the $5,000 request to the Wisconsin Legislature for aid in publishing Volume 40 of the *Transactions* will be a reality.

The following were elected to life membership for long and meritorious service to the Academy: Prof. Otto L. Kowalke, Madison; Dr. Arlow B. Stout, New York Botanical Garden; Prof. Edward M. Gilbert, Madison; Prof. Wayland Chase, Madison and Dr. Harold C. Bradley, Madison.

The following persons were elected to office for the 1949–1950 Academy year:

President: Robert K. Richardson, Professor of History, Emeritus, Beloit College, Beloit.

Vice-President in Science: Allen Abrams, Marathon Paper Company, Rothschild.

Vice-President in Arts: Lucia R. Briggs, Milwaukee–Downer College, Milwaukee.

Vice-President in Letters: R.–M. S. Heffner, Professor of German, University of Wisconsin, Madison.

Librarian: H. O. Teisberg, State Historical Society, Madison.

Secretary-Treasurer: Banner Bill Morgan, Associate Professor of Veterinary Science, University of Wisconsin, Madison.

Committee members elected were as follows:

Library Committee: W. H. Barber, Department of Physics, Ripon College, Ripon, Wisconsin; E. S. McDonough, Department of Biology, Marquette University, Milwaukee, Wisconsin; W. E. Rogers, Department of Botany, Lawrence College, Appleton, Wisconsin; W. B. Sarles, University of Wisconsin, Madison, Wisconsin.

Membership Committee: Arthur D. Hasler, Department of Zoology, University of Wisconsin, Madison, Wisconsin; Katherine Greacen, Department of Geology, Milwaukee–Downer College, Milwaukee, Wisconsin and Robert Esser, Racine Extension Center, Racine, Wisconsin.

Committee on Publications: Merritt Y. Hughes, Department of English, University of Wisconsin, Madison, Wisconsin.

PROCEEDINGS OF THE ACADEMY

The 1950 meeting of the Academy was held at Beloit College, Beloit, Wisconsin, on Friday and Saturday, April 21 and 22, 1950.

ACADEMY SECTION

April 21, 1950

Dr. Carey Croneis, President of Beloit College, gave the Address of Welcome; Sylvester Ludington, Jr., Northwestern University, Sedimentary analysis of the Pleistocene sediments on the bottom of Lake Geneva, Wisconsin; Robert H. Irrmann, Beloit College, Admiral Edward Russel and the Mediterranean Campaign of 1694–1695; Otto L. Kowalke, University of Wisconsin, Location of drumlins in Town of Liberty Grove, Door County, Wisconsin; John W. Saunders, Jr., Marquette University, An experimental analysis of the development of tract-specific characteristics in the humeral feather area of the chick embryo; Robert Siegfried and Aaron J. Ihde, University of Wisconsin, Beginnings of chemical education in Wisconsin Colleges, Beloit, Lawrence, Ripon; Paul W. Boutwell, Beloit College, An early chemical society at Beloit College, 1863–1866.

Friday afternoon

Cyril C. O'Brien, Marquette University, Alcoholism as an industrial problem in Milwaukee County; Donald B. King, Beloit College, The Greek translation of Augustus' *Res Gestae;* James C. Perry, Marquette University, Experimentally induced spermatogenic damage in frogs; David M. Stocking (Introduced by Robert K. Richardson), Beloit College, The eccentric vision of John Jay Chapman; Rev. Raymond H. Reis, Marquette University, Rhythmical change of form in *Pelmatohydra oligactis* (fresh water polyp); Gustav E. Johnson (Introduced by Robert K. Richardson), Beloit College, Some aspects of the United States military and political policy in the China–Burma–India Theater, 1942–1945; John P. O'Brien, Marquette University, Some factors influencing post-irradiation regression (Dissolution) of larval Urodele cartilage.

ACADEMY SECTION

April 22, 1950

Henry A. Schuette, University of Wisconsin, Maple sugar in Wisconsin. I. The fur trade era and thereafter; Lois Bell and E. S. McDonough, Marquette University, A study of wood and bark in relation to the growth of *Schizophyllum commune* Fries; Arthur D. Hasler and Warren J. Wisby, University of Wisconsin, Discrimination of stream odors by fishes and its relation to the parent stream theory; Gerard A. Rohlich and William L. Lea, University of Wisconsin, Origin and quantities of plant nutrients tributary to Lake Mendota; Fulmer Mood, University of Wisconsin, William F. Allen and historical studies at the University of Wisconsin, 1867–1889 (By title).

JUNIOR ACADEMY SECTION

April 22, 1950

Frank Niesen, Science and Camera Club, Messmer High School, Milwaukee, pH measurement of enzyme activity; Thomas Koerber, Science and Camera Club, Messmer High School, Milwaukee, Experiments in entomology and hibernation of small vertebrates; John Bloxdorf, Seminar Club, Mary D. Bradford High School, Kenosha, Photomicrography in black and white; Gordon Greenblatt, Shorewood High School, Shorewood, The phenomena accompanying an electrical discharge through a vacuum.

Saturday afternoon

Nancy Oakes, Chemistry Club, Lincoln High School, Wisconsin Rapids, Chemistry of cosmetics; Edward Oakes, Chemistry Club, Lincoln High School, Wisconsin Rapids, Ultra violet light in analysis; Paul Kroening, Science Club, Wausau Senior High School, Wausau, Ozonator; Thomas Krueger, Nature Club, Appleton High School, Appleton, Radio astronomy; James Rudolph, Science Club, Aquinas High School, La Crosse, Some effects of magnetism; Dick Gullickson, Science Club, Central High School, La Crosse, Photographic observation of the planets; Charles Huber, Science Club, Central High School, La Crosse, Flurochemistry; Herbert Virnig, Science Club, Aquinas High School, La Crosse, The potential reversibility of rheumatoid arthritis and its reaction to Compound E.

ANNUAL ACADEMY LECTURE

The annual Academy dinner was held Friday evening, April 21, 1950 at the First Congregation Church, Beloit, Wisconsin. Prof. R. C. Huffer, Department of Mathematics and Astronomy, Beloit College, announced the winners of the Wisconsin Science Talent Search. Members of the Wisconsin Science Talent Search Committee include the following persons: Aaron J. Ihde, Department of Chemistry, University of Wisconsin; Roy J. Christoph, Department of Biology, Carroll College; Jack B. Greene, Department of Physics, Marquette University; Katherine F. Greacen, Departments of Geography and Geology, Milwaukee Downer College; S. F. Darling, Department of Chemistry, Lawrence College; Henry Meyer, Department of Biology, Ripon College; William Link, Department of Chemistry, Northland College; R. C. Huffer (chairman), Department of Mathematics and Astronomy, Beloit College.

This was followed by a short talk by Prof. Moreau Maxwell, Department of Anthropology, Beloit College. His topic was "The Wisconsin Archeological Survey". Professor Robert K. Richardson, Department of History, Beloit College, presented his presidential speech on "A Beloit Episode in the Life of Carl Schurz".

Annual Academy Business Meeting

The annual business meeting was held in Theodore Lyman Wright Art Hall, Beloit College, Friday, April 21, 1950.

The committee on nominations: H. A. Schuette (chmn), Otto L. Kowalke, L. E. Noland, Luther Zellmer, and C. A. Brown presented the slate of officers for the next Academy year. The following persons were elected:

President: W. C. McKern, Milwaukee Public Museum.
Vice-President in Science: Katherine Greacen, Milwaukee–Downer College.
Vice-President in Arts: Alfred Hornigold, Wisconsin Rapids.
Vice-President in Letters: Carl Welty, Beloit College.
Librarian: H. O. Teisberg, State Historical Society.
Publications Committee: Ira L. Baldwin, University of Wisconsin.
Secretary-Treasurer: Banner Bill Morgan, University of Wisconsin.

The following members were elected to life membership for long and meritorious service in the Academy: William G. Marquette, Pleasantville, New York; Hartley H. T. Jackson, Washington, D. C.; Walter Gloyer, Geneva, New York; W. O. Hotchkiss, Scarsdale, New York.

WISCONSIN ACADEMY TREASURER'S REPORT

April 1, 1947

RECEIPTS

Carried forward in Treasury, April 1, 1946	$1,152.09	
Receipts from Junior Academy	65.00	
Receipts from dues April 1, 1946–April 1, 1947	719.83	
Sale of publications	565.37	
Interest on endowment	86.50	
Grant-in-aid for research from AAAS	86.00	
Total Receipts		$2,674.79

DISBURSEMENTS

Safe deposit box	$ 3.60	
Prizes for Junior Academy winners	35.00	
Printing for Junior Academy	44.00	
Dinners for winners of the Junior Academy	7.20	
Printing programs, stationery, etc.	71.50	
Cuts for the *Transactions*	27.46	
Reprints from the *Transactions*	10.97	
Allowance for Secretary-Treasurer	200.00	
Rubber stamp	1.80	
Grant-in-aid from AAAS to Emil Kruschke	86.00	
Stamps, envelopes, post cards, materials for Newsletter	95.00	
Defraying expenses of the Council	3.90	
Total Disbursements		586.43
Balance, April 1, 1947		$2,088.36

BANNER BILL MORGAN
Secretary-Treasurer

The accounts of the Academy were found to be in order as reported above for the date April 1, 1947.

AUDITING COMMITTEE
HAROLD R. WOLFE
RICHARD I. EVANS

ENDOWMENTS AND ASSETS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

April 1, 1947

1.	U. S. Treasury Coupon Bond 1692B	$1,000.00	
2.	U. S. Treasury Coupon Bond 12894D	500.00	
3.	U. S. Savings Bond Registered Series G–M1696059G	1,000.00	
4.	U. S. Savings Bond Registered Series G–C1563347G	100.00	
5.	U. S. Savings Bond Registered Series G–C1563348G	100.00	
6.	U. S. Savings Bond Series F–D494206F	500.00	
7.	U. S. Savings Bond Series F–M989457F	1,000.00	
8.	U. S. Savings Bond Series G–C3389339G	100.00	
9.	U. S. Savings Bond Series G–C3457898G	100.00	
10.	U. S. Savings Bond Series G–C3512841G	100.00	
11.	U. S. Savings Bond Series G–C3560656G	100.00	
12.	U. S. Savings Bond Series G–C3564110G	100.00	
13.	U. S. Savings Bond Series G–C4154481G	100.00	
	Total Amount of Endowment		$4,800.00
14.	U. S. Savings Bond Series G–C2386504G	100.00	
15.	U. S. Savings Bond Series G–C2386505G	100.00	
16.	U. S. Savings Bond Series G–C2386506G	100.00	
17.	U. S. Savings Bond Series G–C2386507G	100.00	
	Current Assets Invested in U. S. Bonds		400.00
18.	Savings Account No. 3262 (3/14/47)		1,020.10
	Total		$6,220.10

The contents of the safety deposit box and the savings account were found in order as reported above for the date April 1, 1947.

AUDITING COMMITTEE
HAROLD R. WOLFE
RICHARD I. EVANS

WISCONSIN ACADEMY TREASURER'S REPORT

April 1, 1948

RECEIPTS

Carried forward in Treasury, April 1, 1947	$2,088.36	
Receipts from Junior Academy	44.00	
Receipts for lapel pins from Junior Academy	70.80	
Sale of publications	237.77	
Sale of reprints	621.20	
Receipts from dues April 1, 1947 to April 1, 1948	774.50	
Receipts from Life Membership	400.00	
Interest from Endowment	127.50	
Grant-in-aid for research from A.A.A.S.	86.00	
Gifts for Publication Fund	276.00	
Transferred from Savings Account	830.00	
Total Receipts		$5,556.13

DISBURSEMENTS

Junior Academy Printing Certificates	$ 12.00	
Junior Academy Prizes	35.00	
Junior Academy Dinners	10.50	
Junior Academy Reprints of Articles	20.60	
Junior Academy Printing of Letterheads	17.00	
Junior Academy Loan for purchase of lapel buttons	204.71	
Safe deposit box	3.60	
Printing Programs, Prospectus	87.00	
Student help in wrapping *Transactions*	76.00	
Grant-in-aid from A.A.A.S. to Howard Suzuki	86.00	
Allowance to Secretary-Treasurer	200.00	
Postage and supplies for Newsletter	35.00	
Purchase of 4 Bonds for Endowment Fund	400.00	
Cost of Volume 37 of *Transactions* not covered by appropriation	481.86	
Cost of reprints from Volume 37 of *Transactions*	450.00	
Cost of Volume 38 of *Transactions*	2,613.50	
Cost of reprints from Volume 38 of *Transactions*	283.00	
Cost of mailing Volume 38 of *Transactions*	25.00	
Total Disbursements		5,140.77
Balance, April 1, 1948		$ 415.36

BANNER BILL MORGAN
Secretary-Treasurer

The accounts of the Academy were found to be in order and as above for the date, April 1, 1948.

AUDITING COMMITTEE
PHILIP G. FOX
ERNEST F. BEAN

ENDOWMENTS AND ASSETS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

April 1, 1948

1. U. S. Treasury Coupon Bond 1682B	$1,000.00	
2. U. S. Treasury Coupon Bond 12894D	500.00	
3. U. S. Savings Bond Registered Series G–M1696059G	1,000.00	
4. U. S. Savings Bond Registered Series G–C1563347G	100.00	
5. U. S. Savings Bond Registered Series G–C1563348G	100.00	
6. U. S. Savings Bond Series F–D494206F	500.00	
7. U. S. Savings Bond Series F–M989457F	1,000.00	
8. U. S. Savings Bond Series G–C3389339G	100.00	
9. U. S. Savings Bond Series G–C3457898G	100.00	
10. U. S. Savings Bond Series G–C3512841G	100.00	
11. U. S. Savings Bond Series G–C3560656G	100.00	
12. U. S. Savings Bond Series G–C3564110G	100.00	
13. U. S. Savings Bond Series G–C4154481G	100.00	
14. U. S. Savings Bond Series G–C5044011G	100.00	
15. U. S. Savings Bond Series G–C5044012G	100.00	
16. U. S. Savings Bond Series G–C5074307G	100.00	
17. U. S. Savings Bond Series G–C5074308G	100.00	
Total Amount of Endowment		$5,200.00
18. U. S. Savings Bond Series G–C2386504G	100.00	
19. U. S. Savings Bond Series G–C2386505G	100.00	
20. U. S. Savings Bond Series G–C2386506G	100.00	
21. U. S. Savings Bond Series G–C2386507G	100.00	
Current Assets Invested in U. S. Bonds		400.00
22. Savings Account No. 3262 (2/3/48)		200.30
Total		$5,800.30

BANNER BILL MORGAN
Secretary-Treasurer

The contents of the safety deposit box and the savings account were found in order as reported above for the date April 1, 1948.

AUDITING COMMITTEE
PHILIP G. FOX
ERNEST F. BEAN

WISCONSIN ACADEMY TREASURER'S REPORT

April 1, 1949

RECEIPTS

Carried forward in Treasury, April 1, 1948	$415.36	
Receipts from Junior Academy	57.00	
Receipts for lapel pins from Junior Academy	14.20	
Sale of reprints (at cost)	70.00	
Sale of publications	206.13	
Interest from Endowment	108.50	
Grant-in-aid for research from A.A.A.S.	113.50	
Receipts from dues April 1, 1948 to March 31, 1949	667.25	
Receipts from Life Membership	100.00	
Total Receipts		$1,751.94

DISBURSEMENTS

Safe deposit box	$ 3.60	
Printing of letterheads, envelopes	80.00	
Printing Annual Program	63.00	
Printing Certificates	20.00	
Junior Academy Prizes	35.00	
Junior Academy Dinners	10.50	
Junior Academy Printing	2.00	
Stamps, stamped envelopes	57.60	
Salary allowance to Secretary-Treasurer	200.00	
Office supplies	37.11	
Grant-in-aid from A.A.A.S. to Paul Knipping	113.50	
Miscellaneous supplies	20.29	
Cost of copper half-tones, zinc plates, Vol. 39	100.92	
Cost of color-plate for Volume 39	22.64	
Purchase of one bond for Endowment Fund	100.00	
Total Disbursements		866.16
Balance, April 1, 1949		$ 885.78

BANNER BILL MORGAN
Secretary-Treasurer

The accounts of the Academy were found to be in order and as reported above for the date April 1, 1949.

AUDITING COMMITTEE
ERNEST F. BEAN
NORMAN C. FASSETT

ENDOWMENTS AND ASSETS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

April 1, 1949

1. U. S. Treasury Coupon Bond 1692B	$1,000.00	
2. U. S. Treasury Coupon Bond 12894D	500.00	
3. U. S. Savings Bond Registered Series G–M1696059G	1,000.00	
4. U. S. Savings Bond Registered Series G–C1563347G	100.00	
5. U. S. Savings Bond Registered Series G–C1563348G	100.00	
6. U. S. Savings Bond Series F–D494206F	500.00	
7. U. S. Savings Bond Series F–M989457F	1,000.00	
8. U. S. Savings Bond Series G–C3389339G	100.00	
9. U. S. Savings Bond Series G–C3457898G	100.00	
10. U. S. Savings Bond Series G–C3512841G	100.00	
11. U. S. Savings Bond Series G–C3560656G	100.00	
12. U. S. Savings Bond Series G–C3564110G	100.00	
13. U. S. Savings Bond Series G–C4154481G	100.00	
14. U. S. Savings Bond Series G–C5044011G	100.00	
15. U. S. Savings Bond Series G–C5044012G	100.00	
16. U. S. Savings Bond Series G–C5074307G	100.00	
17. U. S. Savings Bond Series G–C5074308G	100.00	
18. U. S. Savings Bond Series G–C5463975G	100.00	
Total Amount of Endowment		$5,300.00
19. U. S. Savings Bond Series G–C2386504G	100.00	
20. U. S. Savings Bond Series G–C2386505G	100.00	
21. U. S. Savings Bond Series G–C2386506G	100.00	
22. U. S. Savings Bond Series G–C2386507G	100.00	
Current Assets Invested in U. S. Bonds		400.00
23. Savings Account No. 3262 (4/1/49)		202.30
Grand Total		$5,902.30

BANNER BILL MORGAN
Secretary-Treasurer

The contents of the safe deposit box and the savings account were found in order as reported above for the date April 1, 1949.

AUDITING COMMITTEE
ERNEST F. BEAN
NORMAN C. FASSETT

WISCONSIN ACADEMY TREASURER'S REPORT

April 1, 1950

RECEIPTS

Carried forward in Treasury, March 31, 1949	$885.78	
Receipts from dues April 1, 1949 to April 1, 1950	830.00	
Sale of reprints	782.16	
Sale of publications	387.82	
Interest on endowments	110.00	
Grant-in-aids for research from AAAS	189.50	
Receipts from Junior Academy	48.60	
Total Receipts		$3,233.86

DISBURSEMENTS

Safe deposit box rental	$ 4.80	
Cost of mailing Transactions (Volume 39)	50.00	
Office supplies, incidentals	110.00	
Junior Academy Prizes	35.00	
Junior Academy (Cost of Test Tube Times)	13.80	
AAAS grant in aid to L. J. Seifert	86.50	
Expenses of Academy Teas (Annual Meeting)	12.90	
Junior Academy (Cost of dinners for winners)	21.25	
Cost of printing Academy Program	67.50	
Cost of printing membership cards, letter heads	23.00	
Cost of making certificates	34.00	
Allowance for Secretary-Treasurer	200.00	
Cost of cuts for Volume 39 Transactions	129.70	
Cost of printing Volume 39 Transactions not covered by Museum	472.87	
AAAS grant in aid to Deam Ferris	103.00	
Cost of author reprints	724.00	
Total Disbursements		2,089.22
Balance, April 1, 1950		$1,144.64

BANNER BILL MORGAN
Secretary-Treasurer

The auditing committee has examined the accounts of the Treasurer and has found them in order for the date April 1, 1950.

AUDITING COMMITTEE
LOUIS W. BUSSE
NORMAN C. FASSETT

ENDOWMENTS AND ASSETS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

April 1, 1950

1.	U. S. Treasury Coupon Bond 1692B	$1,000.00	
2.	U. S. Treasury Coupon Bond 12894D	500.00	
3.	U. S. Savings Bond Registered Series G–M1696059G	1,000.00	
4.	U. S. Savings Bond Registered Series G–C1563347G	100.00	
5.	U. S. Savings Bond Registered Series G–C1563348G	100.00	
6.	U. S. Savings Bond Series F–D494206F	500.00	
7.	U. S. Savings Bond Series F–M989457F	1,000.00	
8.	U. S. Savings Bond Series G–C3389339G	100.00	
9.	U. S. Savings Bond Series G–C3457898G	100.00	
10.	U. S. Savings Bond Series G–C3512841G	100.00	
11.	U. S. Savings Bond Series G–C3560656G	100.00	
12.	U. S. Savings Bond Series G–C3564110G	100.00	
13.	U. S. Savings Bond Series G–C4154481G	100.00	
14.	U. S. Savings Bond Series G–C5044011G	100.00	
15.	U. S. Savings Bond Series G–C5044012G	100.00	
16.	U. S. Savings Bond Series G–C5074307G	100.00	
17.	U. S. Savings Bond Series G–C5074308G	100.00	
18.	U. S. Savings Bond Series G–C5463975G	100.00	
	Total Amount of Endowment		$5,300.00
19.	U. S. Savings Bond Series G–C2386504G	100.00	
20.	U. S. Savings Bond Series G–C2386505G	100.00	
21.	U. S. Savings Bond Series G–C2386506G	100.00	
22.	U. S. Savings Bond Series G–C2386507G	100.00	
	Current Assets Invested in U. S. Bonds		400.00
23.	Savings Account No. 3262 (4/1/50)		204.32
	Grand Total		$5,904.32

BANNER BILL MORGAN
Secretary-Treasurer

The contents of the safe deposit box and the savings account were found in order as reported above for the date April 1, 1950.

AUDITING COMMITTEE
LOUIS W. BUSSE
NORMAN C. FASSETT

FINANCIAL STATEMENT ON VOLUME 39 TRANSACTIONS

At the Council Meeting held April 23, 1948, the Milwaukee Public Museum through their generosity offered to make available $2,000 for aid in the publication of the *Transactions* since the legislature failed to appropriate funds for this purpose at the last session. This money was formally accepted at the annual business meeting held April 23, 1948 at Central State Teachers College, Stevens Point, Wisconsin.

COST OF VOLUME 39

TRANSACTIONS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS (1200 COPIES)

From the Milwaukee Public Museum	$1,999.43
From Academy Funds (Printing)	472.87
From Academy Funds (Cuts and Plates)	129.70
Total Cost	$2,602.00

It was stipulated that any copies of Volume 39 which were sold, the proceeds were to go to the Milwaukee Public Museum.

The Council on October 29, 1949 passed a motion instructing the Secretary to keep a separate account for the receipts obtained from the sale of Volume 39. Consequently, a separate account was established at the First National Bank on November 4, 1949 (Special Account Number 498).

Deposits have been made as follows:

November 4, 1949	$15.00
November 8, 1949	3.00
November 15, 1949	3.00
November 29, 1949	3.00
December 15, 1949	3.00
February 23, 1950	3.00
March 7, 1950	15.00
	$45.00

BANNER BILL MORGAN
Secretary-Treasurer

THE CONSTITUTION OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

(April 23, 1948)

ARTICLE I—NAME AND LOCATION

This association shall be known as the Wisconsin Academy of Sciences, Arts and Letters, and shall be located at the city of Madison.

ARTICLE II—OBJECT

The object of the Academy shall be the promotion of sciences, arts and letters in the state of Wisconsin. Among the special objects shall be the publication of the results of investigation and the formation of a library.

ARTICLE III—MEMBERSHIP

The Academy shall include six classes of members, viz.: life members, honorary members, sustaining members, patrons, corresponding members and active members, to be elected by ballot.

1. Life members shall be elected on account of special services rendered the Academy. Life membership may also be obtained by the payment of one hundred dollars and election by the Academy. Life members shall be allowed to vote and to hold office.

2. Honorary members shall be elected by the Academy and shall be men who have rendered conspicuous services to science, arts or letters.

3. Sustaining members shall be elected by the Academy or the Council and shall pay annual dues of $10. They shall have the same rights and privileges as active members, and shall be specially listed in the membership roll in recognition of their support of the Academy's work.

4. Patrons shall be elected by the Academy in recognition of special services or contributions. An account of such contributions shall be published to the membership in the minutes of the meeting at which the patron is elected. Patrons shall have the rights and privileges of active members during the year following their election.

5. Corresponding members shall be elected from those who have been active members of the Academy, but who have removed from the state. By special vote of the Academy men of attainments in science or letters may be elected corresponding members. They shall have no vote in the meetings of the Academy.

6. Active members shall be elected by the Academy or by the council, and shall enter upon membership on payment of the first annual dues.

Article IV—Officers

The officers of the Academy shall be a president, a vice-president for each of the three departments, sciences, arts and letters, a secretary, a librarian and a treasurer. These officers shall be chosen by ballot, on recommendation of the committee on nomination of officers, by the Academy at an annual meeting and shall hold office for one year. Their duties shall be those usually performed by officers thus named in scientific societies. It shall be one of the duties of the president to prepare an address which shall be delivered before the Academy at the annual meeting at which his term of office expires.

Article V—Council

The council of the Academy shall be entrusted with the management of its affairs during the intervals between regular meetings, and shall consist of the president, the three vice-presidents, the secretary, the treasurer, the librarian, and the past presidents who retain their residence in Wisconsin. Three members of the council shall constitute a quorum for the transaction of business, provided the secretary and one of the presiding officers be included in the number.

Article VI—Committees

The standing committees of the Academy shall be a committee on publication, a library committee, and a membership committee. These committees shall be elected at the annual meeting of the Academy in the same manner as the other officers of the Academy, and shall hold office for the same term.

1. The committee on publication shall consist of the president and secretary and a third member elected by the Academy. They shall determine the matter which shall be printed in the publications of the Academy. They may at their discretion refer papers of a doubtful character to specialists for their opinion as to scientific value and relevancy.
2. The library committee shall consist of five members, of which the librarian shall be *ex-officio* chairman, and of which a majority shall not be from the same city.
3. The membership committee shall consist of five members, one of whom shall be the secretary of the Academy.

Article VII—Meetings

The annual meeting of the Academy shall be held at such time and place as the council may designate. Summer field meetings shall be held at such times and places as the Academy or the council may decide. Special meetings may be called by the council.

Article VIII—Publications

The regular publication of the Academy shall be known as its Transactions, and shall include suitable papers, a record of its proceedings, and any other matter pertaining to the Academy. This shall be printed by the state as provided in the statutes of Wisconsin.

ARTICLE IX—AMENDMENTS

Amendments to this constitution may be made at any annual meeting by a vote of three-fourths of all members present; *provided,* that the amendment has been proposed by five members, and that notice has been sent to all the members at least one month before the meeting.

BY-LAWS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

1. The annual dues shall be three dollars for each active member, to be charged to his account on the first day of January of each year.

2. The annual dues shall be remitted for the secretary-treasurer and librarian during their term of office.

3. As soon as possible after January first of each year the secretary-treasurer shall send to members statements of dues payable, and in case of non-payment shall, within the succeeding four months, send a second and, if necessary, a third notice.

4. The secretary-treasurer shall strike from the list of members the names of those who are one year or more in arrears in the payment of their dues, and shall notify such members of this action offering at the same time to reinstate them upon receipt of the dues in arrears plus the dues for the current year.

5. Each member of the Academy shall receive the current issue of the Transactions provided that his dues are paid. Any member in arrears at the time the Transactions are published shall receive his copy as soon as his dues are paid.

6. The fee received from life members shall be set apart as a permanent endowment fund to be invested exclusively in securities which are legal as investments for Wisconsin trust companies or savings banks. The income alone from such fund may be used for the general purposes of the Academy.

7. The secretary-treasurer shall receive annually an allowance of three hundred dollars for services. (1950)

8. The secretary-treasurer shall be charged with the special duty of editing and overseeing the publication of the Transactions. In the performance of this duty he shall be advised by the committee on publication.

9. The Transactions shall contain in each volume: (a) a list of the officers of the Academy, (b) the minutes of the annual meeting and (c) such papers as are accepted under the provisions of Section 10 of these By-Laws and no others.

10. Papers to be published in the Transactions must be approved as to content and form by the committee on publication. They must represent

genuine original contributions to the knowledge of the subject discussed. Preference shall be given to papers of special interest to the state of Wisconsin and to papers presented at a regular meeting of the Academy. The privilege of publishing in the Transactions shall be reserved for the members of the Academy.

11. The Constitution and By-Laws and the names and addresses of the members of the Academy shall be published every third year in the Transactions. The Constitution and By-Laws shall also be available in reprint form from the secretary-treasurer at any time.

12. Amendments to these By-Laws may be made at any annual meeting by vote of three-fourths of all the members present.

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

List of Active Members

Corrected to Nov. 1, 1950

1. Aberg, Wm. J. P.____________3401 Lake Mendota Dr., Madison, Wis.
2. Abrams, Allen __________________________________Rothschild, Wis.
3. Alcorn, Paul__________________________Univ. of Conn., Storrs, Conn.
4. Allen, T. C.______________________King Hall, Univ. of Wis., Madison
5. Allison, Leonard N.____________State Fish Hatchery, Grayling, Mich.
6. Andrews, Jay D._____________Virginia Fisheries Lab., Yorktown, Va.
7. Baier, Joseph, Jr.__________________623 W. State St., Milwaukee, Wis.
8. Baldwin, Ira L._________________________Bascom Hall, Madison, Wis.
9. Barber, W. H.______________Dept. Physics, Ripon Coll., Ripon, Wis.
10. Barta, E. F., Dr._________________425 E. Wis. Ave., Milwaukee, Wis.
11. Bartsch, A. P.__U.S.P.H.S., Swan Island Bldg. 24, Portland 18, Oregon
12. Bassett, N. D.______________________714 Farwell Dr., Madison, Wis.
13. Baumann, Carl A.___________________Biochem. Bldg., Madison, Wis.
14. Bean, E. F.____________________________Science Hall, Madison, Wis.
15. Becker, George C.__________________________________86C, Badger Wis.
16. Bender, Paul________________________58 Chem. Bldg., Madison, Wis.
17. Bennett, Edward_______________208 Elec. Engr. Bldg., Madison, Wis.
18. Berger, K. C._____________________________Soils Bldg., Madison, Wis.
19. Bernauer, George___________________713 Chapman St., Madison, Wis.
20. Bertrand, Kenneth C._____________Catholic Univ., Washington, D. C.
21. Black, J. D.____________Northeast Mo. State Teach. Coll., Kirksville
22. Boutwell, Paul W.___________Dept. Chem., Beloit Coll., Beloit, Wis.
23. Bolender, E. L.________________________92 Maple Ave., Superior, Wis.
24. Brauns, Fritz E.____________________306 S. River St., Appleton, Wis.
25. Briggs, Lucia R.__________Holton Hall, Milw.–Downer Coll., Milwaukee
26. Brink, R. A.________________________Genetics Bldg., Madison, Wis.
27. Brown, Bruce K.______________1608 Mirabeau Ave., New Orleans, La.
28. Brown, Robert M.______________________624 Central Ave., Beloit, Wis.
29. Brown, C. A., Dr.________Marquette Univ., Dept. English, Milwaukee
30. Browne, Frederick L._______________Forest Prod. Lab., Madison, Wis.
31. Browning, Harold W.________________R. I. State Coll., Kingston, R. I.
32. Bryan, George S.___________________________Birge Hall, Madison, Wis.
33. Bubbert, Walter___________________1516 N. 37th St., Milwaukee, Wis.
34. Buck, Philo M., Jr.________________________Bascom Hall, Madison, Wis.
35. Buckstaff, Ralph N._______________256½ Algoma Blvd., Oshkosh, Wis.
36. Buss, Irven O.
____Dept. Wildlife Management, Wash. State Coll., Pullman, Wash.
37. Busse, L. W.______________________________Chem. Bldg., Madison, Wis.
38. Cameron, Donald H.____% B. D. Eisendrath Tanning Co., Racine, Wis.
39. Carbine, W. F.__________Fish and Wildlife Serv., Washington 25, D. C.
40. Carriker, M. R.__Zoology Dept., Rutgers Univ., New Brunswick, N. J.
41. Carroll College______________________________________Waukesha, Wis.
42. Carroll, Rev. Paul________________Creighton Univ., Omaha, Nebraska
43. Catenhusen, John_______Rt. 2, Mendota Beach Heights, Madison, Wis.
44. Churchill, W. S._______________________________Box 168, Minocqua, Wis.
45. Clark, Harry H.______________________356 Bascom Hall, Madison, Wis.
46. Clark, O. H._______________Univ. Museums Bldg., Ann Arbor, Mich.
47. Clark, Paul F._________________421 Serv. Mem. Inst., Madison, Wis.
48. Clarke, Herbert M.__________________________Birge Hall, Madison, Wis.
49. Coleman, Thomas E._______________735 Farwell Drive, Madison, Wis.

50. Colmer, Arthur R.______Dept. Bact., La. State Univ., Baton Rouge, La.
51. Conant, Geo. H.________________________719 Watson St., Ripon, Wis.
52. Cooper, Berenice____________________1123 N. 17th St., Superior, Wis.
53. Cooper, Delmar C.________________103 Genetics Bldg., Madison, Wis.
54. Cox, Eleanor H.________________________Stout Inst., Menomonie, Wis.
55. Cull, Irene M.________________________3005 Western Ave., Peoria, Ill.
56. Curtis, John T.____________________________Birge Hall, Madison, Wis.
57. Daniels, Eugene________________________521 N. Henry, Madison, Wis.
58. Daniels, Farrington______________________Chem. Bldg., Madison, Wis.
59. Davies, Ithel B.______________________325 Racine St., Delavan, Wis.
60. Deason, Hilary J.______Fish and Wildlife Serv., U.S.D.I., Wash, D. C.
61. De Cleene, Rev. L.A.V.__________1015 S. Monroe Ave., Green Bay, Wis.
62. Derleth, August W.__________________________________Sauk City, Wis.
63. Deutch, Harold F.______________202 Serv. Mem. Inst., Madison, Wis.
64. Devitt, Andrew B.________________2318-A N. 5th St., Milwaukee, Wis.
65. de Weerdt, Ole N.___________Beloit Coll., 808 Park Ave., Beloit, Wis.
66. Dicke, B. C.___________________5112 W. Starke St, Milwaukee 9, Wis.
67. Dicke, Robert_______________________________King Hall, Madison, Wis.
68. Dickinson, W. E.__________Milwaukee Pub. Museum, Milwaukee, Wis.
69. Doane, Gilbert H.__________________220 Univ. Library, Madison, Wis.
70. Dodge, B. O.______________________N. Y. Bot. Garden, New York, N. Y.
71. Dogger, James R.__________Dept. Entom. Oklahoma A. M., Stillwater
72. Doherty, Mary A._______________________5922 10th Ave., Kenosha, Wis.
73. Domagalla, Bernhard P.________________723 W. Johnson, Madison, Wis.
74. Doolittle, Sears P.________________1519 44th St., N.W., Wash. 7, D. C.
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