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SPREAD OF THE HUNGARIAN PARTRIDGE IN WISCONSIN

ALDO LEOPOLD

The process of pioneering contains orderly developmental sequences and recurrent patterns of movement and behavior. This pioneering pattern, once discovered, makes possible the interpretation of chains of facts each hitherto standing in isolation, known but not understood.

In human history the great exponent of this concept was Frederick Turner.[1]

In natural history, a worldwide transplantation of animals into new environments is now taking place. Whether deliberate or accidental, success or failure, wise or unwise, each such transplantation offers a chance to observe the pioneering process in daily detail.

A successful transplantation spreads like ripples from a cast stone. The rate of spread reflects the resistance of the environment. Good records of the rate and manner of spread are, however, uncommon.

The spread of the pheasant, for example, was confused by the great number of almost simultaneous plantings.[2] That of the starling, on the other hand, took place unobscured and has been recorded.[3]

The spread of the honey bee, like that of the starling, took place unobscured by plantings, but it was not recorded because it took place in the wilderness. European black honey bees, transplanted into New England in 1638,[4] spread westward more rapidly than European settlers. By 1797 they had passed the Mississippi. In 1812 we find the hero of Cooper's novel "Oak Openings"[5] gathering wild honey on a commercial scale in southern Michigan, a region as yet devoid of settlements, and like the rest of the continent, devoid of native honey bees. The European bees had arrived long enough in advance of 1812 to enable the bears to develop a honey-hunting technique.

No one mapped the spread of the bee, and probably no one but the bears possessed the necessary data.

The spread of the European gray (Hungarian) partridge (*Perdix perdix*) was, in most states, masked by widespread plantings.[2,6] In a few states, however, these birds were allowed to spread, without interruption, from single focal points, notably in the Canadian wheat belt,[7] in northern Iowa,[8] in southern Michigan,[6] and in southeastern Wisconsin.

This paper attempts to amplify and bring up to date my preliminary accounts [9,10] of the introduction and spread of the partridge as a member of the Wisconsin animal community.

PABST PLANTINGS

The established partridge populations of Wisconsin originate (with minor exceptions) from a series of plantings made by Colonel Gustave Pabst of Milwaukee on his farms in Ottawa Township, Waukesha County, from 1908 to 1929. From this focal center the partridges spread, without interruption, for two decades, and with only minor interruptions for a third. Other plantings were made, but for at least 20 years none was successful.

Here then we should be able to reconstruct the pattern by which this pioneering species invaded a new but heretofore inaccessible environment. Fig 1 shows the spread contours for 1920, 1930, and 1937, as reconstructed during this study. These are the "ripples" of the stone cast by Colonel Pabst in 1908.

Walter E. Scott[11] has published a history of the Pabst plantings, but his dates are incomplete. My own previous accounts lack detail as to numbers planted, and contain errors in dates. To settle these discrepancies Scott has placed at my disposal all records available in the Conservation Department, while Colonel Pabst has loaned me what remains of his correspondence. The following account combines this authoritative information with data collected in the field since 1928.

Colonel Pabst's gamekeeper, Jack Porter, remembers that the first importation of partridges was made in 1908, two years before his employment in 1910. There is no record of the number. The birds were pinioned and placed inside a 40-acre enclosure which also contained deer, turkey, guinea hens, and ducks. The young were not pinioned, and were supposed to fly out. "The

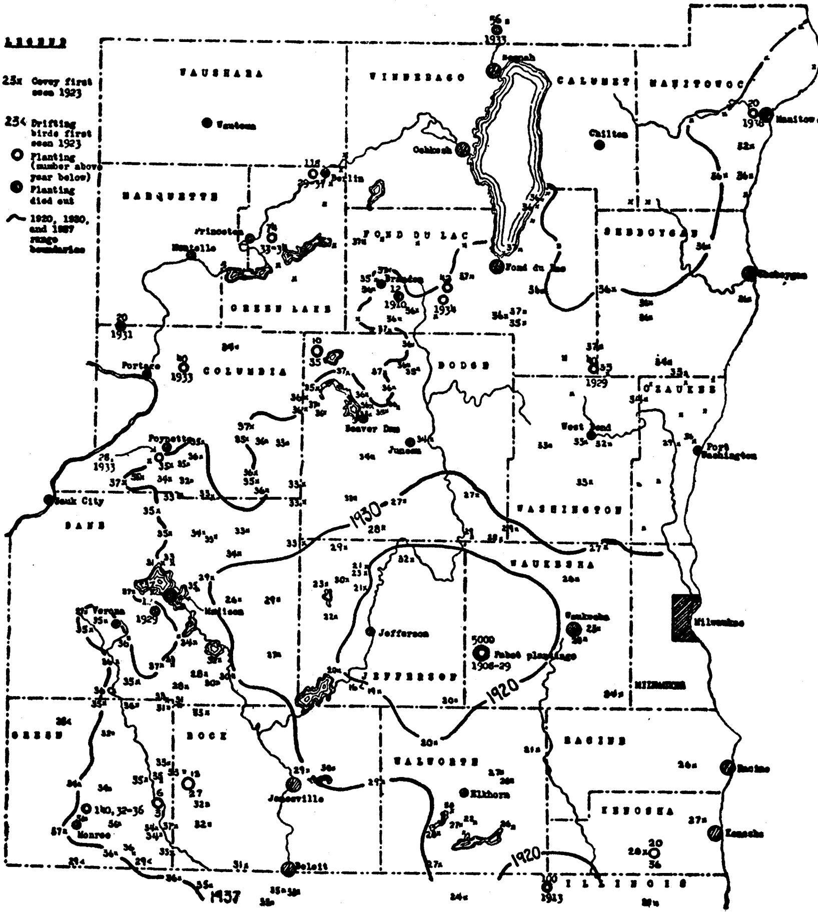

FIG. 1. Spread contours and arrival dates of Hungarian partridge in southeast Wisconsin.

experiment was not a howling success, but . . . a few birds were reared . . . and there were still a few pairs in the enclosure when Porter came to me in 1910" (Pabst letter of October 11, 1937).

It is doubtful whether this initial importation resulted in any wild coveys. It was followed, however, by a series of four shipments released directly into the field. Letters from Colonel Pabst written in 1924, 1925, and 1929 ascribe his first establishment of partridges in the wild to these four plantings. The dates are not given, but each letter mentions four successive plantings, made in identical locations, during alternate years, over a period variously estimated as six to eight years.

There is an anonymous official report,[12] published in 1919, of 1,000 partridges planted by Colonel Pabst in 1913, and 1,000 in 1915. Scott's "Conservation History"[11] draws its data from this source. The Pabst correspondence contains the statement that the first of the series came "about 1910," and the strong inference that the last came about 1918. I conclude, therefore, that 1910, 1913, 1915, and 1918 are the probable dates, the first three being accurate and the last conjectural.

The anonymous report gives some interesting detail: the 500 pairs imported in 1913 were kept confined until March, 1913, when 100 pairs died of roup. The remainder were then released. It also records a large shipment in 1914, all of which died en route. It estimates that a total of 25,000 "Huns" had been turned out on the Pabst farms. This incredible figure undoubtedly refers to the wild population which *resulted from* the Pabst plantings up to 1919. Palmer[13] records only 98,000 imported into the United States from 1906 to 1911, Yeatter[6] records 268,401 imported from 1900 to 1932. The Biennial Report for 1921-22[15 p. 6] states: "About six years ago . . . Gustave Pabst . . . liberated about 1,200 pairs." This checks roughly with the summary of Pabst plantings recorded in Table 3.

The geographic origin of the five Pabst importations between 1908 and 1918 is indicated by the following quotations: "The majority of the birds I received were direct shipments from what was formerly Bohemia. A Mr. Sonnenschein, a large landowner there, living in the city of Prague, was one of the large growers and exporters of Bohemian hops, and from him the Pabst Brewing Company bought a very large part of their (hops) requirements. On one of his visits he learned of my importation of the Hungarian partridge, and from him I bought probably the largest number of birds" (Pabst letter of November 11, 1937). "The Hungarians I partly bought from dealers in this country, largely from the old firm of Wentz and Mackensen, but the majority of the birds I purchased direct from Bohemia" (letter of July 30, 1925).

The sixth Pabst planting came in 1927, and was made "to bring in a new infusion of blood." It consisted of 27 pairs purchased through Julius Loewith, Inc., of New York (letter of

September 5, 1929). Mr. Loewith writes me (September 21, 1937) that all his partridges came from Bohemian estates. His records are destroyed, but he remembers selling Colonel Pabst "several lots . . . a small lot right after the war." The "small lot" may be the 1918 shipment.

The seventh and last Pabst planting was in 1929, and again consisted of 27 pairs, purchased through Loewith. The purpose was to bolster a shortage, which, however, "it did not help at all" (letter of January 14, 1930).

The total number of partridges planted is estimated by Colonel Pabst in his letters as "five to six thousand" (1925, 1929) and "six to eight thousand" (1925). The assumed total of his plantings here used (Tables 1 and 3) is 5,000.

Colonel Pabst was so beset by inquiries about his partridge enterprise that he devised a "form letter." Identical verbiage recurs in many replies to correspondents.

Other Private Plantings

J. W. Foster of Brandon, Fond du Lac County, tells me that Colonel Pabst presented him with 12 partridges from his "first importation," and that he planted these birds near Brandon. He does not remember the date, but I here assume the Foster birds were part of the 1910 Pabst shipment. The site is now occupied by birds which have spread from the south. Mr. Foster thinks this present population results from his planting, but my evidence, gathered from other sources, indicates that the original planting died out about 1912. This is the first of many instances in which natural spread proved more potent than desultory plantings.

About 1914 the Sportsman's Club of Independence, Trempealeau County, bought three pairs from the Mackensen Game Farm and released them just north of Independence. The birds drifted west and raised at least one covey two years later. They then disappeared.

In 1922 F. R. Mueller of Waukegan, Illinois, is said to have released about a dozen "Hungarian pheasants" near Moose Lake, Sawyer County. It has been impossible to untangle the question of whether they were partridges or pheasants. This terrain is entirely unsuitable for either, and the release illustrates the slight knowledge of partridges and pheasants then prevalent. The birds of course disappeared.

In 1923, 20 partridges were planted near Hudson, St. Croix County. The origin is unknown, but some persisted until later state plantings in 1930. None now survive.

During the period 1925-1931, the Rock Creek Trout Club in Polk County, after corresponding with Colonel Pabst, propagated and released a total of about 300 partridges. The birds were reared by Joseph Burkhart from eggs bought in Alberta. These plantings did not become established, so the club is now trying chukars.

The Berlin Izaak Walton League (Green Lake County) imported 20 partridges in 1929, the shipment being a part of the state's importation for that year. Later the state supplied additional birds, a total of 118 being planted. Four coveys persist, but there is no indication of active spread.

In 1929 the Milwaukee Izaak Walton League imported 20 pairs for propagation on the Moon Lake Game Farm in Fond du Lac County, but failing to get any eggs, the birds were turned loose in 1930. In 1933 the locality was invaded by birds spreading from the south. There is no intermediate information, so the question of whether this planting survived must remain unanswered.

In 1931 Otto Beyer bought 20 birds and released them on his shooting preserve near Briggsville, on the border of Columbia County. They disappeared.

In 1933 the New Lisbon Conservation Club (Juneau County) bought six birds, which were augmented by 20 state birds and planted. A covey was seen in 1934 but none persist now. A previous plant of six birds in 1929 disappeared in 1931.

In general, then, no private plantings except those of Colonel Pabst show unmistakable evidence of success.

The data on private plantings are segregated in Table 1. They also are included in a summary by counties (Table 3). Locations of all plants, both private and state, appear in Fig. 2.

SPREAD FROM ILLINOIS AND MINNESOTA

The Pabst plantings coincided with a wave of sportsman-enthusiasm over partridges which began as early as 1900 on the Atlantic seaboard, and reached Illinois by 1913. Imported birds,

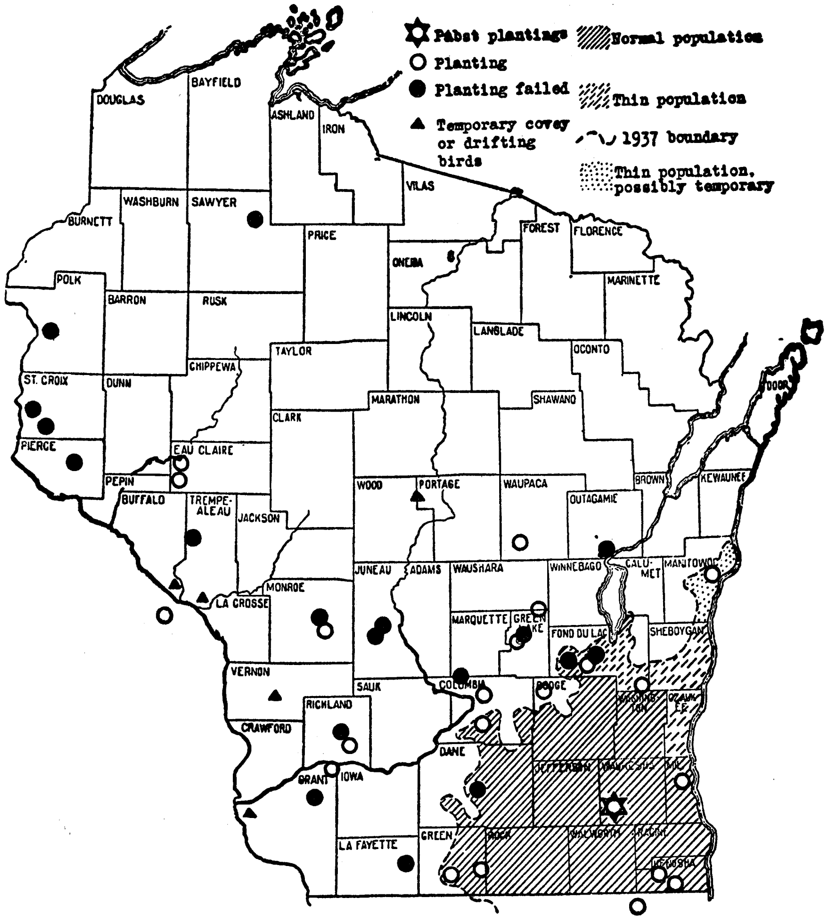

FIG. 2. Plantings of Hungarian partridge in Wisconsin, also density of population within the 1937 boundary.

purchased both by private individuals and by the state, were planted in Illinois[10] near the Wisconsin boundary as follows: 100 at Richmond, 1913; 100 at Fox Lake, 1918; 100 at Waukegan, 1918. These Illinois plantings were successful and may have spread into southern Walworth and Kenosha counties before the arrival of the Pabst birds, but the fact that the spread in Illinois has always lagged behind the spread in Wisconsin (see receding boundary, Fig. 1) makes it unlikely that they account for any great part of the Wisconsin stock. In the aggregate, Wisconsin probably contributed more birds to Illinois than vice versa.

A wave of Hungarian planting passed over Iowa[8] during the period 1909-1913, but none became established near the Wisconsin boundary.

A persistent effort to establish partridges began in Minnesota in 1926. Some of the heaviest plantings were made near Winona, opposite Trempealeau County. Partridges drifting or spreading into Wisconsin from Minnesota are of record in my notes as follows:

	Appeared	*Disappeared*
Near village of Trempealeau	1928	1930
East of Fountain City, Buffalo Co.	20 in 1928	?
West of Viroqua, Vernon Co.	40 in 1928	?
South of Prairie du Chien, in Grant Co.	?	?

Locations of these drift colonies appear as triangles in Fig. 2.

Two coveys of unknown origin appeared in St. Croix and Pierce counties in 1932 and 1934. These may have arisen from the Hudson plantings shown in Fig. 2, or they may have drifted in from Minnesota. They have now disappeared.

Drift colonies from the Minnesota planting also appeared in the northeastern corner of Iowa.[8]

All the Wisconsin colonies of Minnesota birds have, in so far as known, proved ephemeral.

State Game Farm Production and State Plantings

Previous to 1928 the partridge was considered by most state game farms as impracticable to propagate. In that year Michigan produced several hundred birds from wild-trapped stock which had spread into the state from Indiana. Encouraged by this success, Wallace Grange, Wisconsin's Superintendent of Game, in the winter of 1928-29 trapped about 100 partridges near Oconomowoc. The trapping was done by K. J. MacFarlane. A dozen of these birds were planted on the site of the present University Arboretum near Lake Wingra (but never seen since). The remainder were sent to the Fish Creek Game Farm, Door County, for propagation.

Fish Creek was the center of partridge propagation until 1931, when the breeding stock was moved to Moon Lake, Fond du Lac County, and placed in charge of Frank Hopkins, who had learned game keeping in England and had operated the Moon Lake Refuge for the Milwaukee chapter of the Izaak Walton

League since 1926. In 1936 operations were transferred to Poynette, Columbia County, where a new propagating plant had been built in 1934.

In addition to the initial stock wild-trapped in 1928, an importation of breeding stock was made in 1929.[14] Hand-reared stock was borrowed from Michigan in 1931 and Oregon in 1932. Some was purchased in Manitoba in 1934 and in Wisconsin in 1937.

To reconstruct an accurate record of the state's output of planting stock is difficult. Records go back only to 1933, recollections of previous output do not agree, and the Biennial Reports[15] do not always give usable figures. There is also confusion between the number reared and the number planted. Table 2 attempts to select what seem to be the most dependable figures on the state's operations.

In Table 3 all known plantings, both state and private, are arranged by counties. This table is offered with more confidence, for it consists in large part of data gathered at first hand in the field from the sportsmen and wardens who made the plantings.

Combining all available records, there appear to have been planted in Wisconsin to date:

669	partridges propagated by the state at the State Game Farm
224	imported or trapped by the state
5,460	imported or propagated by private persons
6,353	

There survive at this writing, in addition to the established populations within the 1937 spread contour, about 25 scattered coveys, most of which appear in Fig. 1.

Types of Spread

The years of first arrival recorded in Fig. 1 were accumulated piecemeal during the past decade. Each figure represents the year of arrival at the spot marked "X", and is the outcome of personal inquiry among local farmers, sportsmen, or wardens.

Such a process of interrogation disclosed a vast disparity in competence as between observers. Prominent sportsmen sometimes revealed their inability to distinguish a partridge from a pheasant. Others had at their fingertips the complete chronology, size, location, mortality and movement of every covey. The best information came from those who had conducted winter feeding operations. Some farmers had partridges in their fields without knowing it; others knew of the first outposts miles away. Many a day's questioning yielded only discarded data; again an hour's discussion yielded a clear picture of half a county. All data were accumulated on county maps.

During the summer of 1937 John Beule, one of my students, mapped the spread in Dodge County and adjoining parts of Fond du Lac and Sheboygan. His data are incorporated in Fig. 1.

Both my own work and Beule's support the hypothesis that the Wisconsin partridge "front" advances by three mechanisms:

(1) By slow yearly overflow into adjacent unoccupied territory. This is the "ripple" type of spread.

(2) By salients suddenly thrust out into unoccupied territory and then slowly amalgamated with the main front.

(3) By isolated outposts of population thrown far ahead of the main front. These may enlarge and eventually coalesce with the main front.

While the long-time trend is one of aggression into new territory, this trend is the net resultant of many local retreats and halts as well as advances. Salients or outposts are thrust out only to encounter bad seasons or adverse range and die. "Bubbles" or vacant spots are left behind the main advance, and may not become populated for a decade (for example, most of Ozaukee County). Some are submarginal range and persist indefinitely (for example, Horicon Marsh and parts of the kettle moraine). Others of marginal quality doubtless disappear and reform with varying population pressure. But despite these local defeats, the partridge front has, during the 30 years since their introduction, advanced steadily across the fertile farmlands eastward to the barrier of Lake Michigan, southward to a juncture with the Illinois populations, westward into the prairies of the driftless area, northwestward to the border of the sands. and northward into the rich clays of the Green Bay region. What will ultimately halt their advance no man can yet say.

The finer details of spread pattern during the early years are lost. The outward movement can be depicted only in terms of crude 10-year contours, such as those for 1920 and 1930 (Fig. 1).

Some of the more recent spread-phenomena have, however, been reconstructed in more detail, and are now discussed.

Spread by Salient

Exodus of 1935-36. About Christmas time during the winter of 1935-36, Sheboygan and Manitowoc counties, up to that time unoccupied by partridges, simultaneously received an influx of "thousands" of these birds. There must have been a wholesale exodus from the established range to the southward. This sudden invasion represents a northward thrust of 50 miles, a greater distance than had been covered by the usual mode of spread during the preceding 25 years.

It is hard to gather an intelligible account of this extraordinary movement. No one saw the birds move. No one knows anything except a few wardens, sportsmen, and farmers, who, in braving the historic blizzards of that winter to carry grain to their feeding stations, noticed the presence of the new arrivals. Their advent was regarded as lucky, but hardly as phenomenal. In biology, as in history, the greatness of an event is seldom appreciated by its eye-witnesses.

The 1932 exodus of sharptail grouse into southern Canada was observed by at least one scientist,[16] but no scientific institution even knew of this partridge exodus until nearly two years after the event.

Warden James Edick of Sheboygan says "there were six to eight coveys of 30 to 75 birds each in the 10-mile stretch of lakeshore south of town. We put out feed, but they would not enter our shelters, so we fed them on wind-swept knolls." Warden John Egan of Manitowoc gives a similar account. He tells of one covey which appeared in a lakeshore willow thicket on the outskirts of the city, and being fed, spent the winter.

Most of the new arrivals appeared on the belt of rich red soil, about 10 miles wide, which parallels the lake shore. At least a dozen known coveys survived until 1937. Two coveys even invaded the sterile gravel hills of the "kettle moraine" which comprise the western edge of these counties, and some birds persisted there, for a nesting hen was seen in 1937. By the fall of 1937, however, the upper half of Manitowoc County appears to have died out. During the present winter (1937-38) four coveys persist in the southeast corner of Manitowoc County.

Sheboygan County is at least sparsely populated over most of its area, for 135 partridges were reported killed during the 1937 season (Table 5).

During the same winter a similar but smaller salient was thrust northward up the center of Fond du Lac County, and encountering the south end of Lake Winnebago, moved up its east shore to the border of Calumet County, a total distance of 20 miles. This salient encountered rich farming soils similar to the Sheboygan-Manitowoc lake shore belt, and most of the coveys were represented by nesting birds and broods in 1937.

A third salient was thrust up the Sugar River in Dane County from Belleville to Verona, a distance of 12 miles. It is not certain, however, that this occurred at exactly the same time. It is known that most of the coveys in this salient first appeared in 1936, that they nested in 1937, and that at least one made a further advance to the Riley Game Area in September, 1937, where it persists at this writing (January, 1938).

All three salients have four features in common:

(1) All were thrust northward.
(2) All have, to this date, an extremely thin population.
(3) The first two certainly (and the third probably) took place during the first onset of killing weather about Christmas of 1935.
(4) All three were fed after arrival, and thus had a good chance to survive.

The three salients are unlike in two respects: The Sheboygan-Manitowoc movement was partly into rich agricultural soil and partly into poor hill-land, whereas the other two were entirely into good soil. Those on good soil persist and have even spread; that partly on poor soil has lost half its original gains.

It is doubtful whether these sudden winter movements are selective as to route or destination. They seem to be blind movements; those stumbling upon poor environment die off and are forgotten, or perhaps wander until good environment is encountered.

Previous Movements. There is fragmentary evidence that similar movements have occurred before, some of them into the identical regions invaded in 1936. Thus a covey appeared south of Manitowoc about 1932, and may have persisted until overridden by the 1936 exodus. The south half of Washington County was colonized in 1933, and the adjacent corner of Sheboygan received two coveys the same year, all persisting. The orientation of this thrust was northward. Its date was probably late fall or winter, for local sportsmen attributed it to the scattering of partridges within the established range by pheasant hunters.

The impression of blind movement is supported by sporadic appearances of single birds in localities far removed from inhabited range. Thus a single bird was killed by a snowplow in January, 1937, near Wisconsin Rapids, between Portage and Wood counties. Another was found dead during the same month near Reedsburg, in Sauk County.

Depopulation. The invasion of whole counties by "thousands" of partridges implies depopulation of the region from which the birds moved. In the case of the 1935-36 exodus, there is historical evidence of such depopulation. On the Faville Grove Game Area in Jefferson County, Hawkins[17] recorded a winter decrease of 50 per cent, despite continuous feeding.

The state kill for 1936, the year following the exodus, shows a 35 per cent decrease over 1935 (Table 4).

The exact region depopulated is unknown, nor is it possible to disentangle ordinary starvation loss *in situ* from loss by exodus. The only certain thing is that a widespread decrease within the established range coincided in time with the hard winter and the exodus to new range.

Spread by Outposts

In 1927 the main western front had just entered Rock County at Lima Centre near Whitewater. Further south it had advanced to Delavan in Walworth County. In January 1928 (another hard winter), a covey of 10 partridges was seen near New Glarus, in Green County, 40 miles west of what was then the main front. In July, 1929, a single bird was seen near Clarno, 40 miles west of the main front, and in July, 1929, a covey was seen at Oakley, 30 miles west of the main front. These outposts must have died, for during the ensuing decade no birds were seen, and the main front has just reached the sites where outposts appeared in 1928.

These outpost-colonies differ from the salients previously described in that the movement was westward, not northward.

There is probably no real distinction between outposts and salients; a salient is a continuous string of outposts.

Open Seasons and Kill; Fluctuations

All spread phenomena should be interpreted in the light of population density. There are available in Wisconsin three indices to partridge population status:

Open seasons since 1921. (See Table 4).
Kill records since 1932. (See Table 5).
Census of the Faville Grove Game Area, Jefferson County, since 1935.

Open Seasons and Kill. In 1919, 11 years after the first Pabst planting, the legislature opened Waukesha and Jefferson counties for a five-day partridge season with a limit of two birds per day. This season continued through 1920, but in 1921 the limit was increased to five. In 1922, 1923, and 1924 the season was shortened to two days and the bag limit was reduced to four birds. In 1925 and 1926 the season was closed; this possibly reflects the "die-off" of the 10-year cycle, which peaked in 1924.

1927 and 1928 were again open, but only in a few townships. The open area was so small as to induce a severe concentration of hunters and much annoyance to farmers. Severely localized open seasons have ever since been abandoned as bad policy.

1929-1930-1931 were again closed. Colonel Pabst definitely records a scarcity during the winter of 1929-30, and mentions two wet, cold breeding seasons as the cause.

Since 1932 a season of 4 to 14 days has been allowed yearly in a slowly enlarging area, which in 1937 included 9 counties. At least two of these, however, have only a sprinkling of coveys: Ozaukee and Sheboygan.

Table 4 shows the kill, as reported by licensees and corrected by the Conservation Department for those not reporting.

Table 5 shows the uncorrected kill by counties, and the percentage of licensees reporting each year. Both tables go back to 1932, the first open partridge year in which reports were required.

The formula for correcting the reports seems to have varied from year to year, hence Table 5 is more reliable than Table 4. Both tables indicate that 1935 was a year of great abundance, and that a decrease followed in 1936. This decrease may be ascribed to the killing winter of 1935-36, and to the exodus of birds during that winter into closed territory to the northward.

The highest "corrected" kill, 23,252 birds in 1935, represents the productivity of six populated counties, with an aggregate area of 3,300 square miles. This is a kill of seven birds per square mile. If we assume a fifth of the population to have been killed, the average density is 35 partridges per square mile, or one per 18 acres.

If we take the highest uncorrected report for the best county (Racine, 3,739 in 1933), we get, by the same indirect computation, a hypothetical stand of one partridge per 12 acres. The poorest county in 1936 (Ozaukee, 364) gives one partridge per 85 acres.

In the Canadian wheat belt, in England,[19] and in Bohemia,[20] densities of one partridge per acre are known, and one per two acres not uncommon. Sparse populations are apparently characteristic of all partridge range in the north-central states, and no game manager has yet succeeded in breaking this dead-level of mediocrity in abundance.

Faville Grove Census. Arthur S. Hawkins has censused the partridge population of the Faville Grove Game Area as follows:

1935	1,200 acres	118 in January
1936	2,300 acres	223 in January
		179 in February
		73 in March
1937	2,300 acres	178 in January
		143 in March
1938	2,500 acres	314 in January

The density has fluctuated from 8 to 13 acres per bird. 1936, as already explained, showed a severe decrease during the winter, either by exodus or mortality or both. January 1938 showed an increase over November 1937, evidently by influx.

The combined trend of all Wisconsin evidence (seasons, kill, and census) shows partridge highs about 1924 and about 1934. These are the highs of the continental 11-year cycle.

That the Hungarian partridge does respond to the continental cycle, at least in Canada, has already been suggested by Rowan,[21] who recorded a severe decrease beginning in 1934.

The Wisconsin evidence, however, is too fragmentary to be considered as proof of cyclic behavior.

CONCLUSIONS

One may deduce from the foregoing evidence certain characteristics of the pioneering process in Wisconsin partridge populations; and certain requirements for survival, both in natural spread and in artificial spread by plantings.

Origin. With few and inconclusive exceptions, the 7,000 square miles now constituting the partridge range in Wisconsin was populated by spread from a single point in Waukesha County, at which repeated large plantings were made for a decade. These repeated plantings unwittingly simulated the process of repeated colonization which takes place in nature.

Spread Rate. The longest radius from the point of origin is 102 miles (northeast) in 27 years, or four miles per year on the average. Single thrusts of 50 miles in a year are recorded in two instances.

Mechanism. The usual mode of spread is by slow overflow into vacant territory, but at times advance colonies are thrown out either in strings (salients), or as isolated outposts, for distances up to 50 miles in a year.

Season. The season of slow overflow is unknown, but is believed to be early fall. The sudden thrusts seem to occur in early winter, especially in hard winters. The two hardest winters of the past decade, 1928-29 and 1935-36, were both accompanied by outthrusts.

Orientation. The direction of large outthrusts was northward except in one case, which was westward. This seemingly northward orientation may be accidental, for Lake Michigan blocks eastward spread, while the adjacent portions of Illinois are not vacant, hence southward outthrusts would be obscured.

Selectivity and Soils. The location of outthrusts is not selective, for they blindly invade sterile, wooded, marshy, or sandy terrain. Survival, however, is highly selective, and is confined to the richest agricultural soils. It is notable that there have been no survivals, in the sandy regions to the northwest of the center of spread, although the present boundary abuts on the sand at several points.

The suitability of the unglaciated prairie of southwestern Wisconsin is as yet unsettled. Most plantings and drift colonies in this region have failed, but the steady westward march in Green County indicates the possibile suitability of uplands in the whole driftless area.

Density and Fluctuation. Population pressure is doubtless the propulsive force behind slow spread of the "ripple" type, but not all sudden outthrusts occur during years of high population. The only area continuously censused (Faville Grove) showed a lower partridge population during the year of the exodus (1935-36) than during the previous year (1934-35), and the annual kill for the state supports this conclusion. The year 1933, however, had a high population and also a considerable outthrust.

The density on territory acquired by outthrusts is at first low, and is built up by slow consolidation during the periods when the exterior boundary remains quiescent.

Even the best stands in Wisconsin are sparser than those of Canada, England, and Silesia. Low densities are characteristic of all partridge population in the north-central states.

All partridge populations fluctuate, and in a given locality fluctuations in reproductive success may be further intensified by influx or exodus. Fluctuations show some indication of being cyclic in character.

Spread vs. Plantings. In many instances partridges have spread naturally over localities in which previous artificial plantings had failed, and also localities where previous natural outpost colonies had been extinguished. Pioneering is evidently a process which is indefinitely repeated.

We may glean from the foregoing a generalized picture of the partridge's "march of empire." The impulse to venture forth is born of adversity—either the adversity of too many neighbors, or the adversity of killing weather. Each adventure is a blind groping for pastures new, repeated until a favorable year and a good location happen to coincide and bring success.

TABLE 1. *Private Plantings of Hungarian Partridge*

Year	Name	County	Source of birds	No. planted
1908	Gustave Pabst	Waukesha	Bohemia	5,000 ?
1910	J. W. Foster	Fond du Lac	Gift from Gustave Pabst	12
1922	F. R. Mueller	Sawyer	Purchased outside state	12 ?
1925-31	Rock Creek Trout Club	Polk	Purchased eggs in Alberta	300
1929	Milwaukee I.W.L.A.	Fond du Lac	Imported	40
1929	Berlin I.W.L.A.	Green Lake	Purchased outside state	20
1929, 1932	G. R. Rahr	Manitowoc	Raised from stock imported from Europe and Canada	40
1931	Otto Beyer	Columbia	Purchased in Alberta	20
1932	E. L. Young	Dodge	Raised from hay-field(?) eggs near Ripon	10
1929, 1933	New Lisbon Conservation Club	Juneau	Purchased outside state	12
				5,466

TABLE 2. *Propagation and Plantings of Hungarian Partridge by the State Conservation Department*

Year	Imported or purchased		Trapped		Reared but perhaps not planted	Reared at Game Farm and planted	Total planted
	Planted	Kept	Planted	Kept			
1928			12	88			12
1929	100	38				40	140
1930	124	116?				32	156
1931		24			(40)		
1932		60			(160)	120?	120?
1933					(140)	224	224
1934						96	96
1935					(50)	2	2
1936					(75)	155	155
1937		50		50		0	0
Total	224	288	12	138		669	905

1928: From Biennial Report 1929-30, p.84, also p.92. Also letter from K. J. MacFarlane 9-24-37.

1929: A news release, undated, says 162 birds were imported, 24 belonging to the Berlin I.W.L.A., 138 to the state. Another release dated Jan. 22, 1930, gives the same figures, but adds that 10 or 12 pairs each were sent to River Falls, Richland Center, Tomah, and Argyle for planting. The Argyle plant is known (from field reports) to have been sick. The 1929-30 Biennial Report speaks of 70 pair (140 birds) stocked between May, 1928, and June, 1930.

1930: Progress Report of May, 1931, says 120 pairs were purchased in 1929-30 and from these 32 birds were produced (and planted?), presumably in 1930. Letter from W. F. Grimmer says 124 imported birds were planted Feb., 1930.

1931: 12 pairs borrowed from Michigan as breeders, 40 reared, probably none planted.

1932: Field record shows 140 planted in Green County, 1932-36, but only 20 appear on state record for 1933 or later. Hence it is assumed that the remaining 120 were planted in 1932. This, however, may be in error, since in another letter Hopkins says none were planted in 1932, although 160 were reared.

1933-36: Plants from report by H. B. Kellogg to Walter Scott dated 9-4-37.

1937: No breeding stock was available in spring. Some wild eggs were reared but lost, and no plantings were made. In September 50 hand-reared birds were purchased, which, with 50 wild-trapped birds, constitute the stock for 1938.

TABLE 3. *State and Private Plantings of Hungarian Partridge by Counties*

County	Year	No. birds	Source	Planted by	Remarks
Columbia	1931	20	Imported from Alberta	Otto Beyer	Disappeared
	1933	40	State Game Farm	F. B. Ernsberger	2 coveys persist.
	1933	28	State Game Farm	Art Walters	Merged*
Dane	1929	12	Trapped at Oconomowoc	Wallace Grange	At Lake Wingra. Disappeared at once.
Eau Claire	1934	50	State Game Farm	O. W. Fischer	Near Eau Claire. Some persist.
Fond du Lac	1910	12	Gustave Pabst	J. W. Foster	Near Brandon. Survived 3 years.
	1929	40	Imported	I.W.L.A.	Near Moon Lake. Probably persisted. Now merged.
	1933	44	State Game Farm	L. K. Bryan	In Lamartine and Oakfield. Merged.
Grant	1936	24	State Game Farm	C. E. Gordon	Near Fennimore. Disappeared 1937.
	1936	10	State Game Farm	Russell Young	Near Muscoda. Status unknown.

County	Year	No. birds	Source	Planted by	Remarks
Green	1930 or 1931	6?	?	Dr. Stevenson	Near Brodhead.
	1932-36	140	State Game Farm	Geo. Luchsinger	Near Monroe. 7 coveys by 1937.
Green Lake	1924?	14	?	?	Disappeared.
	1929	40	Imported from Europe	Berlin I.W.L.A.	Near Berlin. 4 coveys persist.
	1929-36	78	Possum Valley Game Farm	W. N. Crawford & Frank Chapman	
	1933-34	74	State Game Farm	Dan Trainor	6 coveys persisted, 1936.
Juneau	1929	6	Purchased outside	J. C. Curtis	Near New Lisbon. Disappeared 1931.
	1933	20	State Game Farm	J. C. Curtis	Near New Lisbon. Covey seen 1934 but disappeared.
	1933	6	Purchased outside	Conservation Club	
Kenosha	1936	20	State Game Farm	J. W. Staplecamp	Near Bristol; near Silver Lake. Merged.
Lafayette	1930 (or 1929?)	20	Imported from Europe	Conservation Department	Arrived sick. Disappeared.
Manitowoc	1936	20	State Game Farm	G. H. Rahr	Near Manitowoc. Merged.
	1929, 1932	40	Raised by planter	G. H. Rahr	
Milwaukee	1934	12	State Game Farm	Haskell Noyes	Merged.
	1936	38	State Game Farm	Haskell Noyes	
Monroe	1930	24	Imported from Europe	Conservation Department	On H. L. Stevens farm. A few said to persist.
	1936	10	State Game Farm	E. Jenke	Status unknown.
Outagamie	1931	49	State Game Farm	R. J. Meyer	Near Appleton.
	1933**	56	State Game Farm	?	1 covey persists.

County	Year	No. birds	Source	Planted by	Remarks
Polk	1925-31	300	Raised by planter	Joseph Burkhart	Near St. Croix Falls. Disappeared.
Richland	1930	20	Imported from Europe	Conservation Department	3 coveys persisted, 1937.
	1936	20	State Game Farm	Percy Button	
Rock	1927	12	?	Henry Knudsen	Merged.
	1936	4	State Game Farm	Geo. Parker	Merged.
St. Croix	1923	20?	Probably imported	Andrew Hope	2 coveys survived until 1934. Now disappeared.
	1930	20	Imported from Europe	Conservation Department	
	1930	30	State Game Farm	?	
Sawyer	1922	12	Purchased outside	Mueller	Near Moose Lake. Disappeared.
Trempealeau	1914	6	Purchased from Wentz and Mackensen	Independence Sportsman's Club	Disappeared 1916.
Waukesha	1908	?	Shipped by Mr. Sonnenschein, Prague, Bohemia; also imported through Wentz and Mackensen, Yardley, Pa.	Gustave Pabst	Pabst Farms, Ottawa Township. Spread over S. E. Wisconsin
	1910	?			
	1913	1,000			
	1915	1,000			
	1918?	?			
	1927	54	Imported from Bohemia through Julius Loewith, Inc., New York		
	1929	54			
		5,000?			
Waupaca	1936	20	State Game Farm	A. R. Hansen and F. D. Rundall	E. of Waupaca

* This term is here used to describe the over-riding of a planting by the advancing front of established population before the outcome of the plant could be finally determined.

** This planting appears on the state's records but cannot be traced on the ground. The record is probably erroneous.

TABLE 4. *Open Seasons, Bag Limits, and Kill of Hungarian Partridge in Wisconsin*

Year	Open season	Open area	Daily bag	Possession limit	Kill reports (corrected)
1919, 1920	5 days (Sept. 7-11)	Jefferson & Waukesha	2		
*1921	5 days (Sept. 7-11)	Jefferson & Waukesha	5		
*1922, 1923, 1924	2 days (Sept. 7 & 11)	Jefferson & Waukesha	4		
1925, 1926	closed				
1927	5 days	7 townships in Waukesha, Jefferson	3?		
1928	5 days (Sept. 4-8)	7 townships in Waukesha, Jefferson	3		
1929-31	closed				
1932	3 days (Oct. 1-3)	Kenosha, Racine, Walworth	4	8	10,926
1933	5 days (Sept. 30-Oct. 4)	Kenosha, Walworth, Racine	4	8	18,310
1934	4 days (Sept. 29-Oct. 2)	Dane, Jefferson, Kenosha, Racine, Walworth, Waukesha	4	8	22,181
1935	6 days (Oct. 19-24)	Dane, Jefferson, Kenosha, Ozaukee, Racine	4	8	23,252
1936	6 days (Oct. 17-22)	Dodge, Jefferson, Kenosha, Ozaukee, Racine, Walworth, Washington, Waukesha	4	8	15,516
1937	14 days (Oct.23-Nov. 5)	Dane, Dodge, Jefferson, Ozaukee, Racine, Sheboygan, Walworth, Washington, Waukesha	4	8	14,669

* The Conservation Commission issued orders restricting the statutory season of 5 days to 2, and the statutory bag limit from 5 to 3, during the years 1922-1924. The federal bulletins[18] erroneously give the bag limit for 1921 as 2 birds instead of 5. The seasons for 1922-1924 are edroneously given as 5 days (Sept. 7 to 11) instead of 2 days (Sept. 7 and 11).

TABLE 5. *Hungarian Partridge Kill Reports by Counties*
(uncorrected figures)

County	1932	1933	1934	1935	1936	1937	Totals
Dane			275	410		586	1,271
Dodge					905	1,861	2,766
Jefferson			1,296	1,812	1,518	1,754	6,380
Kenosha	1,750	1,152	765	916	1,813		6,396
Ozaukee				156	208	404	768
Racine	3,002	3,739	1,817	2,128	3,241	2,261	16,188
Sheboygan						135	135
Walworth	1,596	1,204	765	862	1,334	1,468	7,229
Washington				400	361	612	1,373
Waukesha			1,438	1,643	2,169	1,106	6,356
Totals	6,348	6,095	6,356	8,327	11,549	10,187	48,862
Per cent of hunters reporting	62%	33%	48%	45%	80%	70%	

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A WILDLIFE HISTORY OF FAVILLE GROVE, WISCONSIN

ARTHUR S. HAWKINS*

Explorers, in their journals, have given us the earliest written information about Wisconsin wildlife. Much later came the surveyors, some of whom gave excellent accounts of the vegetation which they found a century ago. During the pioneering period came letters, newspapers, and in a few cases journals, some of which refer to the fauna or flora. Luckily the early pioneers included a few outstanding naturalists. Fortunately, too, some of the early settlers who appreciated nature are still alive and can relate what they saw to those who will listen.

Our earliest records, dating back several centuries, came not from writings, but from animal remains brought to light by archeological excavations. The wildlife history of Faville Grove near Lake Mills, Jefferson County, begins with the animal bones taken from the ruins of ancient Aztalan, oldest known Indian civilization in Wisconsin. These bones, plus original land survey notes and such notable natural history publications as those of Kumlien,[1] Hoy,[2] Cory,[3] and King[4] have greatly enriched the background for this paper.

Since 1933 the University of Wisconsin has conducted studies in wildlife management at Faville Grove. Reports on nesting,[5] feeding[6,7] rodent damage,[8] the trapping of game birds,[9] pheasant movements and survival,[10,11] and winter quail mortality[12] have been published. This paper aims to record a background of ecological history for these reports.

Acknowledgments

Much of the information here set forth is based on the recollections of early settlers in the Lake Mills area. To the members of these pioneer families who endured my many hours of ques-

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Area Studied

This report deals principally with 10 farms (2400 acres) now within the Faville Grove Wildlife Area. The area lies on the west bank of the Crawfish River in the towns of Waterloo, Milford, and Lake Mills. Events of particular importance, however, are traced for a larger area, roughly 10 miles in radius.

CHANGES IN THE LANDSCAPE, 1838-1938

I have attempted to trace the major alterations in the landscape from the days when the first settlers arrived to the present. Most pronounced is the change from no cultivation in 1838 to almost complete cultivation in 1938. Agriculture has modified every feature of the landscape, as is shown in Table 1. Figures 1 and 2 show the parts of the Faville Grove Area in which these revisions took place. The most important of them are discussed in detail under the following captions.

Forests vs. Oak Openings

Reference is made, in the following discussion, to "forests" and to "openings." Both were more or less tree-covered. Forests, as the term is here used, means a rather dense stand made up of numerous tree and shrub species. The closed canopy cast a shade too dense for sod; hence the ground cover was composed of numerous herbaceous species. The trees, being crowded, produced straight and clean boles.

Openings were characterized by scattered trees and little or no underbrush. A heavy grass sod covered the ground. The trees had little competition from their neighbors; hence spread

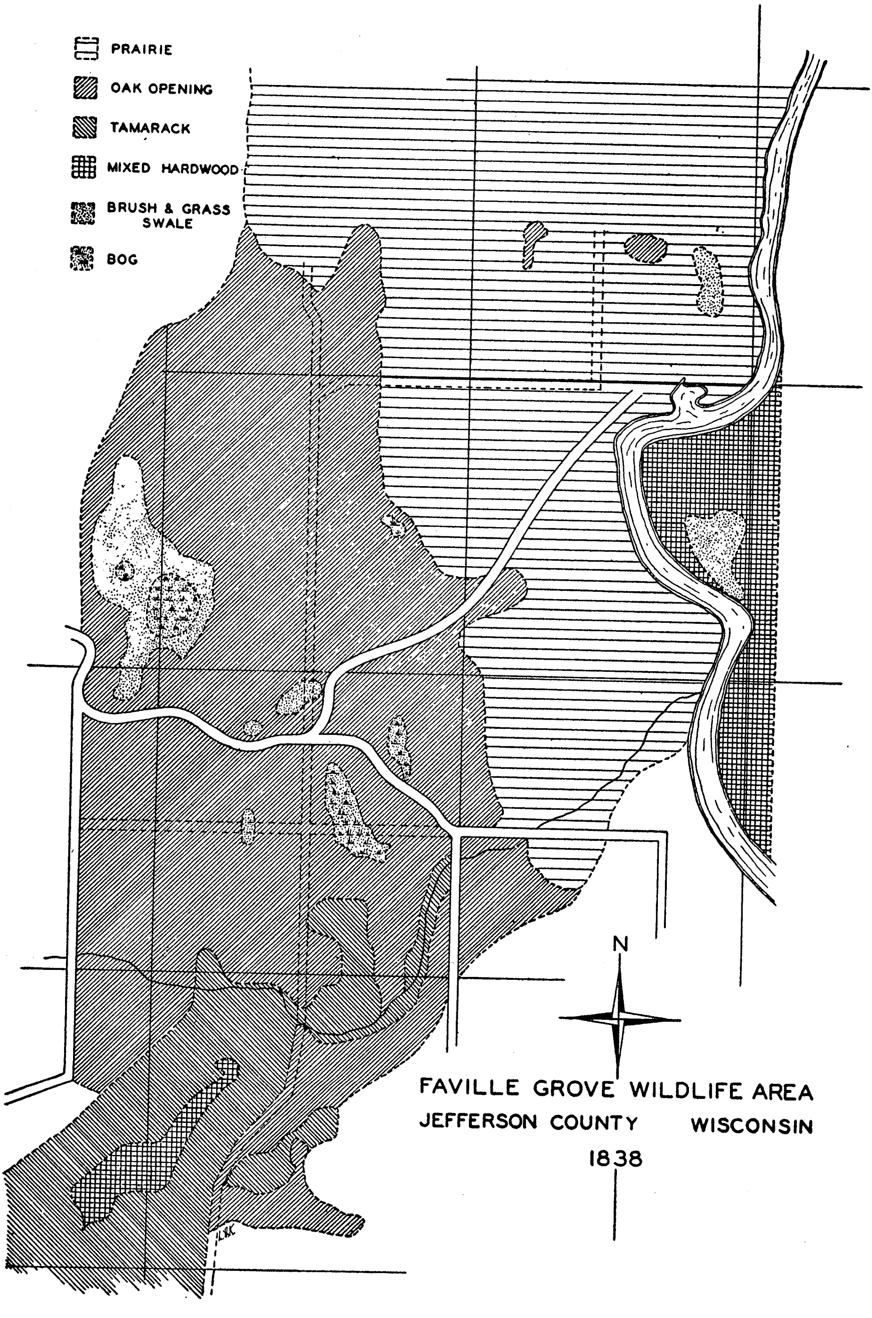

FIG. 1. The Faville Grove landscape as it appeared to the first white settlers when they arrived a century ago.

outward rather than upward. Many gnarled branches covered the massive boles. Old timers say that in the openings deer could be easily chased on horseback, but the forest was too dense to allow hunters to see deer at any distance, much less chase them on horseback.

The forests near Faville Grove contained elm, ash, basswood, hickory, black cherry, oaks, soft and hard maple, ironwood, black walnut and aspen, but the openings had mainly bur, white and black oaks, a few hickories, and clumps of red cedars on the gravelly knolls.

A century ago, east of the Crawfish River was a forest; west of it an opening (see Fig. 1). Since the maximum width of the Crawfish River is less than a hundred yards with similar terrain on both sides, the question arises: Why this difference?

TABLE 1. *Comparison between the 1838 and the 1938 landscape at Faville Grove*

Type	Per cent in 1838	Per cent in 1938
Oak openings	40	2*
Prairies	42	9
Tamarack swamps	11	1
Acid bogs	3	0.5
Sloughs and potholes	2	1.5**
Forests	1	3
Thickets	1	3**
Agricultural land	0	80**
	100	100

* Grazed
** Partially grazed

Fire is at least a partial answer. Large upland prairies lie to the west of Faville Grove. Periodically those prairies burned, the fires swept unchecked until stopped by natural barriers. The Crawfish River flows at right angles to the prevailing westerly winds of the fire season; hence it formed a natural barrier (see Fig. 2).

Of the tree species indigenous to this region, only mature oaks can withstand the heat of a prairie fire. Evidently this characteristic accounted for the original establishment of oak openings. The role of fire can be deduced from numerous oak openings which have been protected against fire. These fire-protected areas occur in three places, (1) east sides of north-

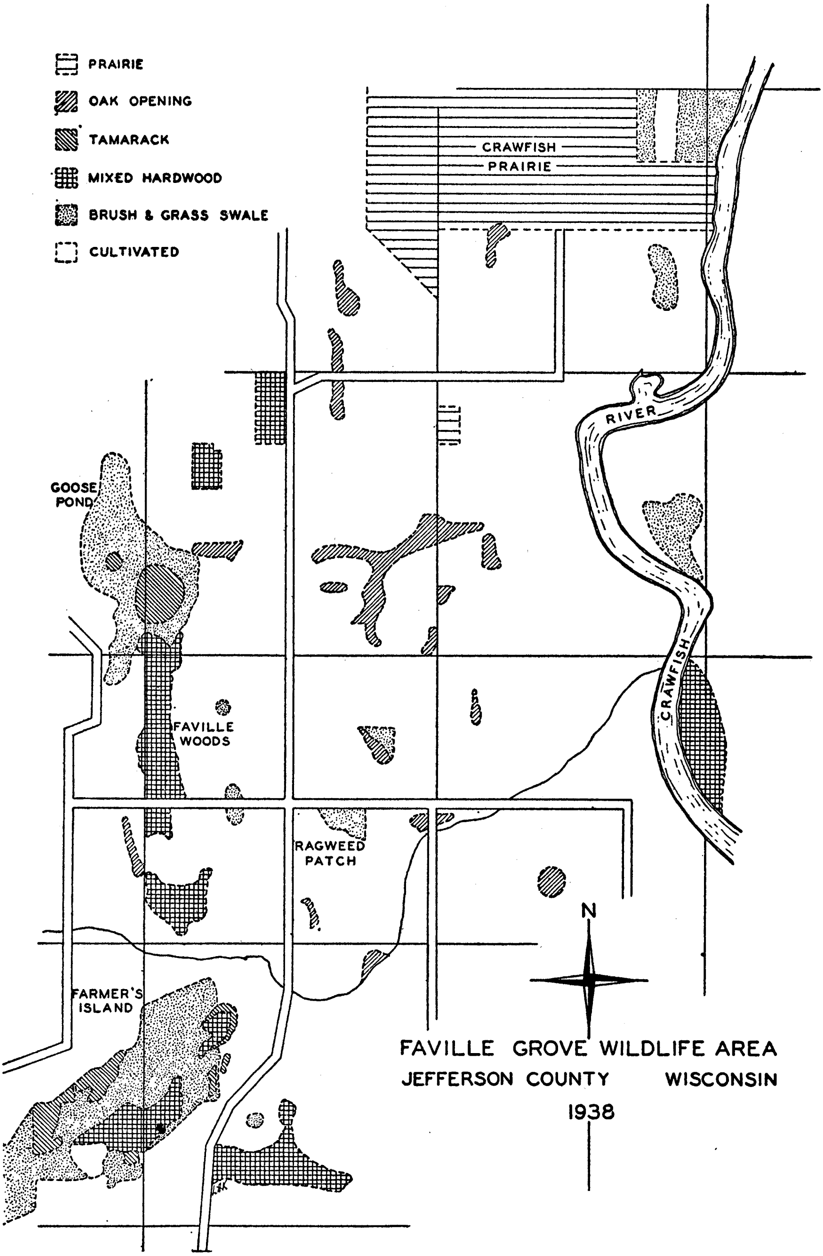

FIG. 2. The Faville Grove landscape as it appears today, the result of a century of agricultural development.

south streams, (2) "islands" which were never burned because of surrounding fire barriers, (3) areas which once burned but have been fire-free for nearly a century.

The forests east of the Crawfish seem to owe their existence to the fire barrier presented by the river. Dr. John T. Curtis has found a similar forest along the east banks of the Rock and Fox rivers. Both have openings on their west banks.

Farmer's Island (see Fig. 2) and Eagle Island (near Rock Lake) were forests which lay west of the river, and hence in the path of prairie fires, but the former was protected by a tamarack swamp, and the latter by a swamp and lake. Both have the rich forest plants characteristic of the east bank of the Crawfish. Certain species found east of the river are lacking, however. One of these, wahoo (*Euonymus*), is extremely palatable to deer and rabbits and may have been eliminated by overbrowsing during heavy concentrations of game after fire had removed food from the surrounding area. The absence of another, prickly ash (*Xanthoxylum*), cannot be explained on grounds of browsing. A list of plants found on Farmer's Island in 1937 is given in Appendix A.

In Faville woods (see Fig. 2) and numerous other woods, open-grown oaks have been swallowed by a thicket of younger trees, all less than a century old. This young stand consists of species once uncommon west of the river: red oaks, basswood, black cherry, elm, and many shrubs.

It may indeed be said that all former oak openings would, since the cessation of fires, have been swallowed up by young thickets, were it not for grazing. Grazing, like fire, eliminates the underbrush, but, unlike fire, also eliminates wild flowers and encourages noxious weeds.

Prairies

Both low (marsh) and high (upland) prairies are found at Faville Grove. The high prairie is at present restricted to two small gravel knolls having a combined area of about an acre. I am unable to reconstruct its status in 1838, but suspect that all of the gravelly knolls and most of the uplands were once high prairie. The low Crawfish prairie (see Fig. 2) is partly wet meadow and partly dry meadow. There are other meadows nearby, but these have fewer prairie plants than the Crawfish prairie.

The low prairie has receded much less, under clean farming, than have the oak openings (see Table 1). In Wisconsin most of the large hay meadows are divided into many small holdings which are usually some distance from the main farms. The farmer, knowing that these meadows are a dependable source of hay during drouths, is reluctant to gamble on higher but more sporadic returns which might accrue from turning his hay land into crop land or pasture. Except during dry years, these meadows are too wet for cropping or pasturing. Result: a sizable remnant of the low prairie still exists.

The Crawfish prairie has escaped plowing but not modification by other forces. About 1845 a dam was built at Milford which flooded about one-tenth of the Crawfish prairie. The other nine-tenths was affected by the higher water table thus established and many prairie plants were drowned.

Later when land prices rose, the farmers decided that too much land was being wasted by flooding, so they had the dam removed. This was about 1883. As the prairie dried out the grasses and sedges, willows and aspens, which had gained a foothold after the prairie plants had drowned, spread rather than retreated. About 1900, according to Mr. Otto Lange, large willow and aspen thickets dotted the prairie. Some of these thickets have since been grubbed out.

The most serious damage to the prairie occurs during dry years when farmers, forgetting that a wet spell will cancel their efforts, break new prairie sod or pasture their cattle in new places. Wet springs discourage these optimistic attempts. Wet summers prevent mowing. Following years when mowing is impossible, the prairie is burned to remove the dead grass.

What effect has continued mowing on prairie plants? Even before the dam was removed, mowing was possible on the higher spots, if the horses were shod with marsh shoes to prevent miring. At present very little of the prairie is left unmowed except during wet years. It is reasonable to suppose that mowing has important effects on plants, but we do not yet know them.

The large permanent pastures which today border the prairie are Canada thistle nurseries which provide a ready supply of seed to inoculate newly broken lands. All the plowed lands are infected, but none of the mowed lands are.

Sometimes the farmer is not satisfied with the native grasses so he plants red top, bluegrass, timothy or canary grass in the hay meadows. All of these compete with and often crowd out the native plants.

What with droughts and wet spells, plowings and mowings, the status of the low prairie flora is as unsettled as a writhing serpent. Constant warfare is being waged between native grasses and rare wildflowers on one side and introduced and native weeds on the other. Weather seems to be the umpire of the battle. The drought years, especially 1936, favored weeds and such high prairie plants as rattlesnakes master (*Eryngium*), but the wet summer of 1938 brought immediate gains to most prairie plants, and losses to *Eryngium* and weeds.

Following is a list of plants, usually considered to be high prairie indicators, which were found at Faville Grove in 1938. A list of plants found on the low Crawfish prairie is given in Appendix B.

Amorpha canescens
Andropogon furcatus
Andropogon scoparius
Asclepias tuberosa
Bouteloua curtipendula
Euphorbia corallata
Liatris scariosa
Petalostemum purpureum
Solidago rigida
Tradiscantia canaliculata

Tamarack Swamps

Axe and dredge account for the shrinkage of many a tamarack swamp in southern Wisconsin. Unlike cutting, however, drainage has occasionally created rather than destroyed tamarack swamps. One excellent example of the creation of a tamarack swamp by drainage is the Goose Pond (see Fig. 2). It is called Goose Pond because it once was a pond and geese once nested there. In 1854 a railroad company contemplated running a line through the Goose Pond, but gave up when they "couldn't hit bottom." Mr. Faville remembers that the Goose Pond in 1870 consisted of a ring of open water surrounding a treeless floating island of sphagnum and heaths.

Tamaracks began to spring up shortly after the pond was drained about 1870. Today, a dense stand of tamaracks covers what was once the floating bog. The stand is less dense than before the drought of 1936, however, for in places maples and other tree and brush species are encroaching on the tamarack.

It will be noted (see Figs. 1 and 2) that the remaining tamarack swamps at Faville Grove suffered heavily through cutting and draining.

Small Water Areas

The general lowering of the water table, already mentioned, combined with a thorough program of tiling, caused the drying out of numerous small upland pot-holes. One of these, now called the Ragweed Patch (see Fig. 2), was wet enough as late as the Sixties so that a boat was needed to retrieve the many ducks shot over it. Mr. Faville remembers that pitcher plants once grew in this area and that ducks nested there. Evidently the ragweed patch was then a typical acid bog.

Drainage, about 1900, brought a heavy stand of ragweeds and nettles. The farmer, in an effort to combat these weeds, burned them. The inevitable result was more and bigger weeds. The weeds grew so rank that even pheasant and quail would not use the cover.

Since 1934 this area has been protected from burning. Result: goldenrods and asters are replacing the ragweeds and nettles, and grass and brush are in turn replacing the goldenrods and asters. Two years ago (1937) 16 pheasants moved in. Last year 32 pheasants and 25 rabbits were counted. Thus can waste areas sometimes be made useful by allowing the plant succession to convert the vegetation from a monotype to a variegated covert.

Miscellaneous Landscape Features

Crawfish River. In 1838 the Crawfish River was narrower, deeper, and clearer than it is today. A wide fringe of wild rice (*Zizania*) bordered the river, which was in places almost choked by aquatic plants. Water-dwelling animals found an abundance of excellent foods, and were themselves plentiful.

Evidently the water table was higher than now. A prairie slough which, during the early years of the present century, held fish throughout the year now dries out every summer. The earlier effect on the river level of the dam at Milford has already been mentioned.

About 1900 the river began to change. The wild rice and other aquatics and semi-aquatics disappeared, leaving a bare, muddy stream. Freshets began to cause severe bank erosion.

One farmer recalls cutting three swaths of hay between a certain willow and the river. This tree now has its exposed roots washed by the stream. Silting has been severe. In 1870 a boat 70 feet long by 15 feet wide, sometimes loaded with 200 barrels of flour, made regular trips up and down the Crawfish. A white pine pole 22 feet long and 3½ inches in diameter furnished the main motive power. There were then places in the river where the poler was compelled to "bend down" to reach bottom. The late Mr. William Scribner, who was cabin boy, described all these details to me. Today the main channel is less than four feet deep during the summer, and holes over six feet deep are rare.

Industrial Developments

Having reviewed the changes which have taken place in the landscape, I shall summarize the economic activities which are directly responsible for these changes.

Milling. The settlers' first needs were food and shelter. Both called for the clearing of land. Sawmills sprang up to satisfy the demand for building materials. Every stream that could be harnessed had its sawmill during this period. Sawmill dams restricted fish movements, and this was one of the first direct effects of settlement on wildlife. Dams also had the indirect effect (by raising the water levels) of markedly altering both plant and animal populations.

Agriculture. The clearing of the land changed the flora in favor of light-demanding plants which provide more food and cover for animals than the plants that tolerate shade. Fences built around cultivated fields offered places for light-demanding plants to grow and provided excellent feeding, resting and nesting places as well as good travel lanes. Entire logs were used for fences at first, but as the trees became less abundant, rails and stumps were used. Mr. Faville's farm, like most farms in this region, still had rail fences in 1880. Mr. Frank Myers told me that his father's farm in Dodge County, where trees were scarce, had wire fences as early as 1870.

With the Civil War came a boom in the wheat market. The incentive of high prices caused farmers to work day and night to clear more land. Trees were girdled by the wholesale. When they died, wheat was planted among the stumps, which presented no serious obstacle to the harvest, for at this time wheat was cut with a cradle. The introduction of the stump-puller in the early seventies permitted complete clearing of the fields.

Dairying, which had been important from the first, soon became the leading industry. The cultivated and pasture area was further increased to meet the demands of more livestock. The advent of the wire fence in the nineties was another step toward modern clean farming. As Mr. Leopold[13] points out, no step in the history of agriculture was more depressing to upland game than this. The effect of the motor era and modern agriculture on plants and animals is too well known to need repeating.

Hunting and Fishing. The family larder was at first heavily dependent on wild plant and animal foods. Probably killing for the family larder had little effect on game, but the later market hunting and commercial fishing had a great effect. Further heavy losses can be charged to overshooting and overfishing for sport.

Changes in Plant Life, 1838-1938

Certain plants which were abundant in 1838 are rare or absent today. Conversely, some of the plants which are common today were rare or did not occur in the local flora of a century ago. A few examples of each case are considered in some detail below.

Evidently the decline in Wisconsin wildflowers started at an early date for in 1876 Thure Kumlien published an article titled "On the rapid disappearance of Wisconsin wildflowers; a contrast of the present time with 30 years ago."[14]

Bluejoint (*Andropogon* and *Calamagrostis*)

These grasses "sold" Faville Grove to the pioneers. Here was an unlimited supply of good livestock feed free for the taking, so those moving westward stopped.

The first settlers reported endless acres of "shoulderhigh bluejoint" (evidently *Andropogon furcatus*) covering the Crawfish prairie. In 1937 only a few patches of bluejoint remained, but in 1938, following a wet summer, a marked increase in bluejoint was noted especially in *Andropogon scoparius*. The ability of the latter to come back is shown by a fine stand of this grass in 1938 on a field which in 1934 produced corn. The *Andropogons* have held up better than *Calamagrostis.*

Wild Rice (Zizania)

The former abundance of this plant, which was once an important food source both to man and wildlife, is attested by a statement of Mr. John McGovern. He says that one winter in the early eighties, after the ice had formed, he harvested 48 loads of rice stems from about 10 acres and sold them for $1.00 per load for livestock bedding. This was in a widespread of the Crawfish called Mud Lake, near Hubbleton. Twenty-five years later the rice was gone. Mr. Otto Lange and Mr. John Radke remember many rice plants which floated down the river and became lodged at a bend, forming a dam. They blame the carp, which were well established by 1906, for the destruction of the rice.

Ginseng and Golden Seal

About 1900, collectors found it profitable to harvest ginseng (*Panax*) and golden seal (*Hydrostis*). Mr. John Hooper kept careful records of his ginseng hunts from 1904 through 1908 and has given me the use of these records (see Appendix C). In 1937, I looked for ginseng plants in several woods which are referred to in the table, but found only a half-dozen plants. This excellent indicator of a rich forest has been largely exterminated in this region.

Orchids

In 1838 the orchid family was well represented in the flora, both in species and number of individuals. It still is, but within the past decade orchids have fared badly and have dwindled in numbers at an alarming rate (Appendix D). How much of this decline is due to picking and how much to drought and habitat changes is a matter for conjecture.

Fringed Gentian (Gentiana crinita).

Dr. John T. Curtis counted about 100 fringed gentians at the artesian well on the Crawfish prairie in 1934. None has been seen since.

Scarlet Painted Cup (*Castilleja coccinea*)

Mr. Faville and several others told me that this showy parasitic plant was formerly common on the uplands at Faville Grove. Ten years ago Mr. Bruce Taylor brought Mr. Faville two plants, collected near the area. None has been seen since, to my knowledge.

Berries

Blueberries and cranberries (*Vaccinium*), huckleberries (*Gaylussacia*), strawberries (*Fragaria*), and various species of *Rubus* were once harvested in quantities by man and beast alike, according to early settlers at Faville Grove. Today cranberries and huckleberries are no longer found; blueberries were almost exterminated by the drought of 1936; strawberries are rare; and only *Rubus* can at present be considered a source of food.

Plants of Gravelly Knolls

Dry gravelly knolls (eskers) are common in this vicinity. Formerly they had a luxuriant mantle of pasque flowers (*Anemone patens*) and bird's-foot violets (*Viola pedata* var. *lineariloba*). Within the past 20 years heavy grazing has removed both from the area. A few bird's-foot violets are still found near Hope Lake, and the pasque flower still exists in small numbers at Springer's Hill, near Faville Grove.

Weeds

Among the native plants which are considered by many to be undesirable or weedy, poison ivy (*Rhus toxicodendron*) heads the list. Once uncommon west of the river, this plant has overrun many of the woods west of the river within the past 20 years. Perhaps this recent thriftiness is merely part of the succession between oak openings and the mixed hardwood forest.

Wood nettles (Laportea) are evidently spreading and crowding out desirable plants of the rich woodlands in some instances, but they were a great pest even 35 years ago. I quote from Mr. Hooper's field notes dated June 12, 1904: "The wood nettles are growing in profusion in the lower damp part of the woods." (When collecting ginseng, Mr. Hooper says that to avoid wood nettles he wore leather leggings which came above his knees, and a canvas coat.)

The first weed to bother his crops, according to Mr. Faville, was the wild morning glory (*Convolvulus sepium*), about 1880. However, he had heard his uncle speak of killing a patch of Canada thistle (*Cirsium arvense*) about 1868. In 1887, Mr. Faville made a special trip to Lake Mills to see for himself what the newly introduced quack grass (*Agropyron repens*) looked like. Fifty years later every farm in this region has a serious quack and thistle problem. Some farmers are beginning to worry about two weeds which have been introduced recently: creeping jenny (*Convolvulus arvensis*) and penny cress (*Thlaspi arvense*). The former has not yet been found at Faville Grove, but several patches thrive less than two miles away. The latter is now well established on several farms in the area.

Changes in Animal Life, 1838-1938

As in plants, the general trend in animals has been toward fewer species and less individuals. Meanwhile a few new species have been added and in some groups an increase in numbers has taken place. As in plants, the greatest gains have been made by "weed" species such as English sparrows, starlings, carp, Norway rats, and house mice.

Somers identified the bones, antlers, shells, and other hard parts of animals which he uncovered at Aztalan. His identifications are given in Barrett's *Ancient Aztalan*.[15] Aztalan was the oldest Indian village known to Wisconsin archeologists. The inhabitants of Aztalan had the unique habit of cracking bones for their marrow. This habit, coupled with their characteristic handiwork, has enabled archeologists to distinguish between more recent Indian cultures and that of the Azatalans. It is presumed that animal parts uncovered with the artifacts of the Aztalans came from animals indigenous to the region at the time of the Aztalan culture, several centuries ago.

Part of Somers' collection is housed in the Wisconsin Historical Library at Madison. It is of great historical value. Unfortunately, Somers' identifications were made at a time when reference material was scarce; hence there is some doubt as to their authenticity. Every effort should be made to have the material which is left re-identified.

Birds

Somers reports that he found the following bird bones at Aztalan: wild pigeon, quail, wood duck, black duck, and reed bird. These species, except pigeon, are all present today, but since the advent of settlement many species have been lost. Kumlien and Hollister's *Birds of Wisconsin*, covering the period 1844-1903, deals largely with observations made in Jefferson County. No comparable list for the county has since appeared. Leading ornithologists agree that a few of the records included in this manuscript are not valid. After discarding these questionable records, I have compared the number of species visiting or breeding in Jefferson County before 1903 with a similar summary for the period 1913-1938. My figures for the latter period come from the work done in neighboring Dane County by Dr. Schorger.[16,17] I have made a few changes in Dr. Schorger's list to make it apply specifically to Jefferson County. While crude, the comparison which follows clearly indicates the downward trend in both migrants and breeders.

	1844-1903	1913-38	Loss
Migrants plus breeders	316	260	56
Breeders only	171	120	51

Of the 13 principal game and shore birds breeding at Faville Grove since 1838, 4 have been lost, 5 have greatly decreased, 2 have held their own, and 2 have been introduced and become established (see Table 2).

A summary of trends in various species and groups is given in the following paragraphs.

Quail. Table 3 summarizes available information on the status of quail in South-eastern Wisconsin during the past century. It presents a picture of alternating abundance and scarcity, many of the scarce periods following hard winters.

Mr. Elisha Keyes, one of the earliest settlers in the Lake Mills region, found no quail when he arrived in 1838. In his memoirs[18] he says, " . . . none at the time, for the reason, as I supposed, that wolves and foxes destroyed them." There were undoubtedly some quail in the region when Mr. Keyes arrived, but evidently they were scarce enough to have escaped his notice.

Dr. Schorger,[24] who has scoured the files of early Wisconsin newspapers and otherwise combed the literature for information on the history of native Wisconsin animals, has brought to light much evidence on fluctuations in quail populations. His findings show that the general trend of the quail population was upward until 1855 and downward since. Evidently cultivation, up to a certain degree, is favorable to quail, but past that point is unfavorable.

TABLE 2. *Status of Breeding Game and Shore Birds at or near Faville Grove, 1838-1938*

Species	Breeding Status 1838	Breeding Status 1938	Remarks
Quail	Uncommon	Uncommon	Occasional periods of abundance in between. 1 bird per 40 acres in 1938.
Pheasant	None	Common	First birds seen locally about 1930. 1 bird per 10 acres in 1937.
Ruffed Grouse	Common	None	A single "wanderer" seen in winter of 1936-37.
Hungarian Partridge	None	Common	First bird seen locally about 1922. 1 bird per 8 acres in 1937.
Prairie Chicken	Abundant	Rare	Steady decline since 1900. 26 birds counted in 1937.
Canada Goose	Irregular Uncommon	None	Last nested here about 1870.
Mallard	Common	Regular Uncommon	1 or 2 pairs have attempted to nest at Faville Grove each of past 3 years.
Blue-winged Teal	Common	Regular Uncommon	3 nests found in 1937. (Prob. about average for recent years.)
Wood Duck	Common	None	Most common breeding duck in 1880.
Wilson's Snipe	Common	Irregular Rare	One nest found in 1936.
Woodcock	Regular Uncommon	Prob. irreg.	Young birds seen on area in July, may have been migrants.
Upland Plover	Common	Common	25 birds per section in 1938; 19 nests found in 1937 at Faville Grove, 25 nests found in 1938.
Passenger Pigeon	Regular Uncommon	None	Last birds seen locally about 1885.

Professor Aldo Leopold[20] presents evidence of quail scarcity in Jefferson County in 1903, 1918 and 1923. Mr. Hooper, in his field notes, dated 1904, says: " . . . quail hit a fence and was stunned. A boy picked it up. I suggested, as quail are so scarce,

TABLE 3. *Quail Populations in Southeastern Wisconsin, 1838-1938*

Years	Census	Remarks
1838-39	Scarce	Keyes (18)
1842-43	Scarce	Schorger (24) Following famous "turkey killing" winter
1846-47	Abundant	Schorger (24) Watertown region
1849-50	Abundant	Cravath (19) Whitewater region
1853-55	Abundant	Schorger (24) "All time peak population"
1856-57	Scarce	Schorger (24) Following two consecutive killing winters
1858	Abundant	Schorger (24) Milwaukee region
1863	Abundant	Schorger (24) Madison region
1866	Scarce	Schorger (24) Janesville region (never recovered from killing winters 1856, 57)
1871	Scarce	Schorger (24) Madison region
1879-81	Scarce	Schorger (24) Madison region
1880	Abundant	According to several residents of the Faville Grove region
1881	Scarce	Following a record killing winter, Faville Grove region
1902-05	Scarce	Leopold (20) and field notes of Hooper, Faville Grove region
1918	Scarce	Leopold (20) Following two consecutive killing winters
1922-23	Scarce	Leopold (20) Jefferson County
1928-29	Scarce	According to Kisow. Following a killing winter
1931-32	Abundant	Kisow fed more quail than in any other year between 1928-39
1933-34	Abundant	According to Kisow and others
1934-35	203	"Abundant" According to present standards[1]
1935-36	211	Many quail winter-killed in 1935, but the population staged a remarkable "rebound."
1936-37	75	"Scarce" following the second consecutive killing winter, one which broke most records for severity
1937-38	78	Winter losses were light but no "rebound" occurred
1938-39	80	Winter losses again light
1939-40	112	No winter losses; some rebound, but heavy losses again in Jan., 1940.

[1] Prior to 1928 "abundant" and "scarce" are terms which indicate a wide discrepancy in quail population, but how wide we do not know. Since 1928 the terms hold a definite numerical meaning. "Abundant" means a population at Faville Grove of 200 or more quail. "Scarce" means 100 or less. Schorger's (24) findings suggest that "abundant" in the sixties meant many more quail than it does today. In other words, the quail range now has a lower carrying capacity.

better let it go." Mr. Sam Kisow, who began winter-feeding game birds at Faville Grove in 1928, furnishes reliable data of relative abundance between 1928 and 1933. Since 1933 careful censuses have been taken annually.

Prairie Chicken. Once the favorite and most abundant game bird in this region, the prairie chicken is now on the verge of extermination (see Table 4). Shortly after 1900 the local farmers noticed that each winter fewer chickens visited their corn fields. The first accurate count of 100 birds made in 1933 by Mr. Kisow represents only a fraction of the numbers of chickens which are reputed to have used the Crawfish prairie in the "old days." Since 1933 the prairie chicken at Faville Grove have had complete protection and winter feeding, but have nevertheless continued to decline. Now that the cycle is on the up-swing, it will be possible, through censuses, to determine if the prairie chicken is passing out or merely in the trough of the cycle.*

In addition to the Crawfish prairie flock, the London and the Waterloo marshes each had a prairie chicken flock in 1937.

TABLE 4. *Prairie Chicken Populations at Faville Grove*

Year	Census	Remarks
Pre-1900	abundant	According to all evidence
1910	common	Noticeable shrinkage in numbers since 1900.
1933	100	Using feeding station operated by Sam Kisow.
1935	43	17 cocks use "booming" ground.
1936	37	12 cocks use "booming" ground.
1937	30	12 cocks use "booming" ground.
1938	26	11 cocks use "booming" ground.
1939	5	6 cocks use "booming" ground.

Ruffled Grouse. The "partridge" once vied with the prairie chicken as a favorite among local hunters. Only within the past 10 years has the courtship drumming of this grand bird been stilled at Faville Grove. The last record for the area was a single "wanderer" seen several times during the late winter of 1937. Perhaps a total of a dozen birds still exist at Eagle Island, south of Rock Lake, and in a tamarack swamp just west of Faville Grove. These are the last remnants in northwestern Jefferson County.

* It is with deep regret that I report the passing of the prairie chicken from the Faville Grove farms. Only two cocks were present on the booming ground during the spring of 1940. Since spring no prairie chickens have been seen on the Crawfish prairie.

As late as 1870 ruffed grouse still nested within the limits of Lake Mills. Mrs. Don Fargo, about that time, found a nest behind what is now Schultz's funeral home. Lake Mills, last grouse record was spectacular. About 1894, according to Mr. Hooper and Mr. Kisow, a ruffed grouse shattered the window of the Conrad-Engsberg drug store, in the center of town. This was during the fall "crazy" flight.

Ruffed grouse were still common in 1903-04. In his field notes, Mr. Hooper writes:

> May 16, 1903—Found partridge nest with 12 eggs.
> July 10, 1903—Saw several broods of partridges.
> March 27, 1904—Partridges are drumming.
> September 12, 1904—Saw a few partridges.
> December 25, 1904—Shot partridges.

By 1920 ruffed grouse were becoming scarce; I estimate that the count at Faville Grove was less than a dozen birds. The last stronghold of the ruffed grouse at Faville Grove was on Farmers' Island, from which they disappeared between 1925 and 1930.

Hungarian Partridge. Col. Gustave Pabst released the first partridges in Wisconsin in 1910, at his farm near Oconomowoc. These birds spread out from this and subsequent releases, and by 1922 had reached Faville Grove, 20 miles away. Once established, the partridges increased until halted by the severe winter of 1928-29, which killed many birds. The population recovered rapidly, however, and reached its highest level in 1933. Fewer partridges were found in 1934, but the real drop came during the winter of 1935-36, when 50 per cent were winter-killed. A poor breeding season followed, but winter losses were nil and the following winter census of 1937-38 showed an excellent stand of partridges. (See Table 5)

Pheasant. The early spread of the pheasant was slower and less general than that of the partridge. Pheasants were first released the same year, and the same place as the partridges (Pabst Farm in 1910) but had not reached Faville Grove when the first local pheasant plantings were made in 1929. It is interesting to note, however, that a few miles south of Faville Grove, the frontier of advance had already reached the Dane County line by 1929, but for some reason had missed the northwest corner of Jefferson County, in which Faville Grove is located.

TABLE 5. *Hungarian Partridge Population at Faville Grove*

Year	Census	Remarks
1922	arrive	Leopold: ". . . partridges reached Lake Mills about 1922."
1928	common	Most local people had seen partridges by this date.
1929	fewer	Many were winter-killed the preceding winter.
1933	peak	Local farmers report more birds this summer than before or since.
1934	fewer	Drought year. Poor nesting season.
1935*	118	1200 acres censused—1 partridge per 10 acres.
1936	223	2200 acres censused—1 partridge per 10 acres.
1937	178	2200 acres censused—1 partridge per 12½ acres.
1938**	314	2400 acres censused—1 partridge per 7½ acres.
1939	168	Same area censused—1 partridge per 14 acres.

* The censuses from 1935-38 were taken in December. Fully 50 per cent of the partridges were winter-killed following the 1935 census.

** This high population apparently came partly from an influx and resulting concentration.

Mr. Kisow had in his files a receipt for 100 pheasant eggs purchased from the Moon Lake Game Farm in 1929. Twenty-one birds were reared, banded with unnumbered spiral chicken bands, and released a mile west of Faville Grove. In 1930, two pheasants, banded in this manner, were killed three miles from the point of release, south of Rock Lake. Two years later the first pheasant was seen at Faville Grove, on Farmers' Island; four years later, the first pheasant appeared at the Goose Pond, one and one-half miles north of Farmers' Island; eight years later, a cock pheasant, evidently banded by Mr. Kisow, was found dead a mile east of the Goose Pond. Pheasants were by this time generally distributed throughout the area.

In 1931 the Conservation Department awarded Mr. Kisow a prize of 25 pheasants for excellence in winter feeding. These were released a mile west of Faville Grove, and undoubtedly contributed to the increase shown in Table 6.

About 1931 Mr. Harvey Zibbell released 16 pheasants four miles east of Faville Grove. These were banded with numbered aluminum bands, but the only return was one found dead during the following spring. A complete summary of pheasant releases made at Faville Grove is given in Table 7.

Between 1935-38 the sportsmen of Lake Mills released over 500 pheasants, and other hunting organizations near Lake Mills have released as many more; hence it is no longer possible to trace the results of original plantings. Most of these pheasants have been banded, but sportsmen have so far failed to cooperate wholeheartedly in returning these bands when recovered.

TABLE 6. *Pheasant Populations at Faville Grove*

Year	Census	Kill	Remarks
1929	0		21 birds liberated by Kisow 1 mile west of area.
1931	1		"First bird ever recorded on area"—Kisow.
1933	1 ?		"First bird recorded on upper end of area" —Kisow.
1934	12		All birds found in 2 places, Farmers' Island and Goose Pond.
1935	56		Birds had spread to new locations.
1936	163		Birds now more or less evenly distributed over entire area. Sex ratio: 40 per cent males.
1937	115	23*	Sex ratio: 37 per cent males.
1938	100	34	Sex ratio: 28 per cent males.
1939	126	46	Sex ratio: 17 per cent males.

* This is the recorded legal kill. No hunting until 1937. Census came after the kill, as total population was 115 plus 23, or 138.

TABLE 7. *Pheasant Releases at Faville Grove**

Species	Date	Number	Age	Source	Banded?	Bands recovered**
Ringnecked	July, 1936	30	7 wks.	Game farm	No	
Reeves***	Aug., 1936	11	9 wks.	Game farm	Yes	
Ringnecked	Jan., 1937	58	mixed	Trapped wild	Yes	3
Ringnecked	Dec., 1937	38	25 wks.	Game farm	Yes	3
Ringnecked	Dec., 1937	47	mixed	Trapped wild	Yes	2
Ringnecked	Sept., 1938	30	9 wks.	Game farm	Yes	5
Ringnecked	Aug., 1939	50	9 wks.	Game farm	Yes	6
Totals		264			234	19

* In addition, 39 wild pheasants were trapped and banded "in place" in 1936-37, of which 4 bands were recovered from dead birds the following fall. In 1937-38, 29 were banded and 1 recovered.

** Bands recovered from dead birds the following fall.

*** Three Reeves pheasants were seen during hunting season, 1936, but none since.

Waterfowl. While never so productive as the nearby Horicon Marsh, the Crawfish marshes once produced many ducks. One of these, Mud Lake near Hubbleton, was especially important as a breeding ground. Before 1870, Canada geese nested in some of the Crawfish marshes along with at least 8 species of duck. A few blue-winged teal, mallards and shovellers still breed here.

The Madison *State Journal* of November 23, 1870, quotes the Watertown *Republican* as stating that, "A German hunter residing on the Crawfish River has taken 2,000 ducks this season," according to Dr. Schorger. As late as the nineties, a few men still engaged in market hunting. One market hunter, Mr. John McGovern, who spent most of his 84 years on the shores of Mud Lake, has recounted some of his experiences. He recalls a fall about 1883 when he killed over a thousand ducks, and up to 77 in one day. Wood ducks were then the most abundant duck, he says, with mallards a close second. Other species followed in this order: widgeon and pintail, blue-winged and green-winged teal, redheads, "blue bills," buffleheads, a few canvasbacks, and two or three Canadian geese each year. Canvasbacks brought as high as 25 cent each on the market at Watertown, 15 cents more than mallards.

Mr. McGovern has this to report about nesting: "Redheads and blue-bills nested at Mud Lake occasionally, but they may have been cripples, unable to continue north with the flight." He found many wood duck nests, some in dead aspen, in holes made by "large woodpeckers" (probably the pileated woodpecker). The dam at Milford previously mentioned, flooded a wooded area called Prickly Ash Swamp, thus killing the timber and creating a very productive nesting area for wood ducks. When a boy, Mr. McGovern shot a drake wood duck from its perch beside a nesting cavity in which the hen was incubating. The next day the hen returned with a new mate, which he also shot. This continued until "about 12" drakes had been killed at this one nest. Did this indicate a surplus of non-breeding males ready to mate as soon as the opportunity was given them?

Certain lakes and ponds in this region are said to have consistently attracted certain species of ducks. In the springs of 1936, 1937 and 1938 I made periodic counts of ducks on a dozen lakes, ponds and marshes near Lake Mills, and along the Crawfish River. I found that in some cases ducks have been forced to give up their former haunts because of drainage or changes in food; in others because the species had become rare throughout this area. In all cases a noticeable shrinkage in numbers has taken place.

Krog's Pond, near Krogville, is reputed to have been a favorite stopping-place for redheads. Mr. Julius Cooper tells of shooting dozens of redheads from his barn door which overlooked the pond. Today Krog's Pond is farm land. Redheads also showed preference for a small, unnamed pond on the Alexander Farm, near Lake Mills, according to old hunters. During the past three years, I have never seen a redhead on this pond and in the entire area censused saw less than fifty.

Rock Lake was formerly a favorite stopping-place for lesser scaups and still attracts fair numbers. On April 18, 1938, I counted 1,400 scaups in the Lake Mills region, the highest count in a single day for the census period.

Canvasbacks, en route to Lake Koshkonong, once stopped regularly at Lake Ripley near Cambridge. Wild celery, their favorite food, was then plentiful in this lake but has since become scarce. In recent years a raft of canvasbacks on Ripley is a rare sight. During the past three years my census figures total less than forty canvasbacks for all the lakes which I censused.

If the accounts which I heard are correct, it can be said that at Hooper's mill pond fifty years ago, nearly as many ducks were bagged by hunters in a single day as now stop in an entire year.

Even during the height of the spring migration my total duck count for the day never exceeded 2,000 individuals. Were it not for lesser scaups my total count would not have reached a thousand for "peak" days except for a single occasion—the opening of the duck season October 1, 1938. On this day, according to local hunters, more ducks were seen than had greeted the opening-day shooter for a decade. I estimated that I saw at least 1000 ducks pass over the Crawfish prairie between 7 and 10 a.m. Most of these were pintails, mallards, blue-winged teal, shovellers and baldpates. At Faville Grove 30 man hours of hunting yielded 25 ducks killed over 50 acres of water, an extremely high kill average for an area which during most of the last 10 years has been without water in the fall. Record September rains in 1938 filled the marshes and this probably accounts for the heavy duck flight.

Hope Lake, near Cambridge, produced the greatest variety of species, including a European widgeon seen on April 21, 1937. Several hundred Canada geese and a few flocks of snow geese were seen during the census. My only record of a whistling swan was one which spent several days on Schmidt's Pond, across the river from Faville Grove. It was first seen April 9, 1938. Swans formerly were shot in small numbers on Rock Lake.

Miscellaneous Water Birds. White pelicans were once common on Rock Lake, but since 1913, when Mr. Kisow saw "about a dozen," none has been seen, to my knowledge. Lesser loons are now common in spring, but no longer remain to nest. The general opinion of the local naturalists is that the loons left when cottages became too plentiful around the lake. One of the rarest birds seen locally in many years is the Holboell's grebe. Dr. Arthur A. Allen recorded the calls of this bird at Hope Lake on May 18, 1937.

A colony of blue herons have nested for many years in a tamarack swamp bordering London Marsh. Over 100 nests were counted in 1936, but how many were in actual use could not be determined.

American egrets since 1930 have been regular visitors to the Lake Mills region and due to their striking appearance have been more widely noticed by the public than almost any other species of bird. It is a matter of record that this species was, at an early date, fairly common this far north but was nearly exterminated by plume hunters. Locally there is no evidence that the egret was ever common in the seventy years prior to 1934. If the egret had been present it would have been noticed but Mr. Ben Crump was the only early settler who reported seeing this bird (about 1875).

In a letter Dr. Schorger writes, "The following note evidently refers to the American egret. It was published in the *Milwaukee Sentinel* August 8, 1878, and sent in by its Watertown correspondent. 'A flock of white cranes have been rendezvousing in the river [Rock River] between Sprague's brickyard and Boomer's Dam for the past few days. One of these rare and beautiful birds fell a victim to the unerring aim of Henry Miller, and is now in the hands of the taxidermist, Mr. Sherer, for preservation.' "

Mr. Warner Taylor saw an egret at Mud Lake near Hubbleton on May 30, 1925. I saw one on April 29, 1935, and two others during the same week. These are the only spring records coming to my attention. Twenty-two egrets were counted on the Crawfish prairie on September 8, 1938. One was still present October 1, 1938.

Two immature little blue herons were seen with a group of American egrets at the south end of Rock Lake marsh on August 3, 1938.

Sandhill cranes once passed over this region regularly during migration and occasionally stopped to feed, but Mr. Hooper, who has kept bird records, has seen none since 1924. Mr. Fred Seaver says that cranes once nested in the marsh south of the Lake Mills depot. The late Mr. M. Neupert told me that cranes once nested in the large marsh near Deerfield.

A black-backed gull was seen March 1, 1939, on the area by Mr. Harry Anderson.

Passenger Pigeon. The last great pigeon flight through this region occurred in 1871, the year of the huge nesting near Wisconsin Dells. Dr. Schorger[21] in his masterful account of this nesting has thoroughly covered most of the details that the old timers related to me about pigeons and states that from the huge nesting ground near this roost the pigeons travelled great distances to obtain food. The late Mr. Neupert told me that in 1871 thousands of pigeons descended on a recently-planted corn field and pulled two or three bushels of seed. Corn is not planted until after the pigeons are nesting. Did these pigeons come from the Wisconsin Dells "roost?" If so, it implies a daily feeding range of at least 50 miles.

I found no evidence that pigeons ever nested in numbers near Faville Grove, the nearest nesting being at Deerfield, 15 miles away. A small nesting, at the edge of the Waterloo Marsh, was recalled by Mr. Neupert, who remembered seeing the eggs.

Mr. Hooper's father believed that the ground vegetation under pigeon nesting colonies was altered by the enriching effect of the guano, dead squabs, and broken branches. He based his theory on a woods near Deerfield where pigeons nested, and where ginseng occurred in abundance. Ginseng was not found in the oak openings west of the Crawfish River, presumably because a forest soil is needed. The woods at Deerfield was one of the few places west of the Crawfish River when ginseng was found. The conclusion was that the pigeons had enriched the soil enough for ginseng.

Dr. Schorger told me that according to the Watertown *Republican* of February 22, 1882, several flocks of pigeons had at that time reached Waterloo, 10 miles north of Faville Grove. This was an extremely early arrival date, and followed a record mild winter. Within a decade the flights of pigeons through this region were no more.

Raptors and Vultures. In the past, Mr. Hooper has mounted the following hawks and owls, taken locally: 3 goshawks, 4 barn owls, 5 snowy owls, 2 saw-whet owls, and 7 immature bald eagles. The remainder of this discussion is largely confined to the present status of this group because it has been difficult to obtain concrete evidence of its former status.

Red-shouldered hawks are rare in this vicinity. One pair, however, has nested for at least five years in Wollin's woods just east of Faville Grove. One or two pairs of red-tailed hawks nest regularly on or near Faville Grove. Marsh hawks are the most abundant raptor. Five nests of this species were found in 1936, 2 in 1937, and 4 in 1938. Their greatest abundance, in 1936, corresponded with a heavy mouse population.

I have also recorded the following hawks seen during migration, between 1935 and 1938: 4 duck hawks, 1 osprey, 1 sharp-shinned hawk, 6 sparrow hawks, 12 rough-legged hawks (although only 2 were seen during the winter of 1937-38), 1 bald eagle adult. Two or three Cooper's hawks have wintered at Faville Grove each year.

The only owls which regularly breed at Faville Grove are the screech and the great horned, the former being the more common. At least one great horned owl nest has been found on the area each of the past three years. Two pairs were believed to be nesting nearby. Two nests of the short-eared owl were found on the Crawfish prairie in 1936, and in the same year a nest of the long-eared owl was found in a tamarack swamp less than a mile west of the area. My only definite record of a barred owl concerns one I heard a mile northwest of Faville Grove in 1937. Also in 1937, I obtained a picture of a saw-whet owl on the area. Snowy owls have been reported from Faville Grove in 1904 and 1931. On January 10, 1938, Mr. Irven O. Buss and I saw a snowy owl in a tree overlooking the ragweed patch.

Short-eared owls were first noticed by Mr. Hooper in 1904 when several appeared in the fall. He reports that they were again common in 1908. I found several pairs throughout the year in 1935 and 1936, but saw only two short-ears, both migrants, in 1937. Short-eared owls feed chiefly on meadow mice, which are abundant about every four years. Peaks of mouse abundance fell in 1904, 1908, and 1936, years in which short-eared owls were common. Both mice and owls were scarce in 1937, but in 1938 the mouse population again started upward. Three owls were seen on September 24, 1938, the most in two years. Six owls were seen at one time on April 13, 1939 and at least two pairs remained to nest. Mice were becoming plentiful again.

Turkey vultures have seldom been seen in Jefferson County. Mr. Hooper mounted a "buzzard" which was killed at Milford on April 24, 1903. Dr. John T. Emlen and I saw one at Faville Grove on April 26, 1935.

In 1939 the following were recorded: a burrowing owl (male) taken by William Elder April 9 on the Crawfish prairie; a gray gyrfalcon shot by a hunter near London December 10. The owl is in the University collection. The gyrfalcon was mounted by Mr. Hooper and is at the State Game Farm at Poynette.

Invaders. Usually crossbills, grosbeaks, siskins, northern shrikes, Bohemian waxings, and snowy owls do not winter as far south as Faville Grove. When they do, I consider them invaders from the North. Likewise, visits by red-bellied woodpeckers, and dickcissels, tufted titmice and, until recently cardinals might be termed invasions from the South or West. There is a third type of invasion; the permanent occupation of an area by the exotic English sparrow and the starling.

The field notes and recollections of Mr. Hooper have proved invaluable in dating these invasions. Thus, he recalls an abundance of crossbills in 1887. About 1890 evening grosbeaks were common until apple blossom time. In late March, 1894, Mr. Hooper watched a red crossbill build a nest on Farmers' Island, but no eggs were laid. Both white and red crossbills and snowy owls had been seen the preceding winter. Pine and evening grosbeaks and snowy owls were recorded in 1903, and during the following spring, a sapsucker was found nesting near Milford, which is south of its normal breeding grounds. Bohemian waxings appeared in abundance during the winter of 1908, and a goshawk was killed near Lake Mills. During the 20-year period (1888-1908) northern shrikes were rather common, according to Mr. Hooper. Not until 1931 did northern visitors again become noticeable. That year evening grosbeaks, Bohemian waxings and snowy owls were seen. Between 1936 and 1938 I saw 1 northern shrike, 1 snowy owl, 4 siskins, 6 evening grosbeaks, about 70 common red polls, and 3 flocks of snow buntings. Lapland longspurs were seen throughout each winter in flocks of several hundred.

Of the southern and western invaders the dickcissel appeared first. Mr. Hooper collected the first dickcissel he ever saw in 1900. In 1911 he wrote: "Saw first red-bellied woodpecker in 20 years." The cardinal appeared at Lake Mills in 1918, and was followed by the tufted titmouse in 1924.

Dickcissels are at present very erratic in their visits. Although not seen in 1935 they were common in 1936, very scarce in 1937 and 1938 and fairly common again in 1939. During this same period I saw neither red-bellied woodpeckers nor titmice in this region. Cardinals are now present throughout the year. The present count on the area is about four pairs.

The most pronounced invasion is that of the two exotics, the English sparrow and the European starling. The sparrow arrived in 1873, the starling in 1938. In the Watertown Democrat of May 1, 1873, Dr. Schorger found this note: "Mr. Charles H. Phillips of Lake Mills has obtained eighteen English Sparrows from the city of New York, and turned the little strangers loose on his premises. It is said these birds are famous for their consumption of worms and noxious insects." During the severe winter of 1928-29, Mr. William Coupleman found a dead starling on his barn floor. He had it mounted. Both sparrows and starlings have become too numerous and are now pests.

Mammals

Somers found the following mammal bones in the refuse heaps of ancient Aztalan: bear, raccoon, buffalo, moose, deer, fox squirrel, wood duck, rabbit (several varieties), and wolf.

Of these, the most questionable is moose. Somers did not list elk, but Barrett, also working at Aztalan, found tools and trinkets made from elk bones and antlers. Kumlien found buffalo remains at Lake Koshkonong, 12 miles away, according to Schorger,[22] so it is probable that buffalo also occurred at Faville Grove. Hoy[25] interpreted Father Hennepin's "wild goats" to be antelopes. These were mentioned in Hennepin's logue under the date October 16, 1679, when the explorers were near Milwaukee. Dr. Schorger's more thorough studies, however, seem to invalidate Hoy's interpretation.

Elk. Frequently the extermination of plants or animals can be traced directly to the destruction of the habitat by settlement. Not so the elk, for its demise pre-dated the arrival of the first settlers. I have seen two elk antlers which were plowed up at Faville Grove and have heard about others which were uncovered in the surrounding country. Dr. Schorger says that the Watertown *Democrat* of October 7, 1875, states that a pair of "gigantic elk horns attached together by a portion of the skull" were drawn by fishermen from the bottom of Rock Lake, Lake Mills.

Deer. I could find no records of deer for the 70-year period between 1867 and 1937, but in 1938 the following item appeared in the Lake Mills *Leader* of September 29:

> While working with a team of horses in the cornfield last Wednesday morning, Edwin Wollin, of Wollin Brothers farm at Milford, saw a 10 point deer and doe mingle with the cattle and run off into the woods. His attention had been attracted to their presence when the horses reared and snorted.
>
> Although neither the buck deer or doe have been seen since on the Wollin farm, tracks have been found in the cornfield to indicate the animals are feeding there during the night. It is believed the pair were driven down from Portage due to the extremely high waters there.

To my knowledge they are the first deer seen in this region since the spring of 1867 when Mr. Fred Seaver saw two deer on the west shore of Rock Lake.

Deer became scarce in the openings while they were still common in the forests. West of the Crawfish River deer were scarce by 1855, but two newspaper items found by Dr. Schorger show that east of the Crawfish deer were still plentiful at that time. The January 21, 1854, issue of the Watertown *Weekly Register* states, "The Rock River woods are full of deer, and the hunters are bringing them in by sleigh loads." The Watertown *Democrat* of February 5, 1857, states, "Thirty deer have been shot, during the past winter, by Mr. E. H. Pease in the forest between this city and the village of Jefferson."

Bears. One of Mr. McGovern's earliest recollections is that of a bear which he saw killed about 1865 by George Bleeker on the Haseli farm near Waterloo. This is my most recent record. Mr. Cornelius Cooper told of a bear that was killed on the Madison road, four miles west of Lake Mills about 1847. Mr. Albert Aldrich heard his father, who was one of the earliest settlers at Faville Grove, tell about seeing several bears near his home. Mr. Neupert recalled that a neighbor had a live bear in a cage, which he thought was picked up as a cub near Waterloo. Dr. Schorger found this item in the Watertown *Democrat* of September 25, 1856. "Mr. Lewis Krutt killed a black bear in the town of Lebanon, in this county, last Monday (Sept. 22)." It weighed 120 pounds. The *Democrat* of October 6, 1856, states that a black bear was killed September 26, in a marsh at the edge of Watertown.

Cougars. From the Watertown *Chronicle* of February 5, 1851, Dr. Schorger learned that, "Within a week or two past, a panther has been seen by a number of persons in the woods south of the village." The same paper published the information on December 3, 1851, that a large animal supposed to be a cougar had been attacking cattle and sheep." Mr. Hilliard obtained a glimpse of the animal, and describes it as being "about the height of a large dog but considerably larger."

Mr. Neuport gave me a vivid account of a "panther scare" near Waterloo, about 1860. If panthers were not still present at this time, they evidently had been recently enough so that people still feared them.

Lynxes. According to the Watertown *Democrat* of January 30, 1868, "Mr. Robert Entwisle, of Lake Mills, shot a very large lynx on his farm. It measured four feet long and two feet high." Dr. Schorger, who found this record, says that it is usually impossible to separate lynx from bobcat records, from newspaper accounts.

Bobcats. Most early settlers in this region told of one or more experiences with bobcats. Farmers' Island was once a favorite place for bobcats. My last record is one shot by Mr. Henry Wollin one mile east of Faville Grove about 1892.

Otters. In the Waterloo *Journal* of March 1, 1888, Dr. Schorger found this reference, "The otter is not entirely extinct in this part of Wisconsin yet, a very large one having been caught on the Portland Marsh by trappers, during the past winter; the pelt was purchased by F. J. Vick and may be seen at his store."

The last otters evidently disappeared from the Crawfish about 1883 at the time the dam at Milford was removed. They were never common. In many years of trapping Mr. McGovern caught only three. About 1882 an otter was trapped at Mud Lake and another at Faville Grove.

Beavers. Beavers are not mentioned by the earliest settlers. Evidently the French and Indian trappers had been too thorough. Well-preserved remnants of several beaver dams can still be seen near Milford. Astride one of these dams is an elm tree estimated to be 100 years old. Hence these beaver dams date back at least to the early years of the 19th century.

Wolves. Early records seldom differentiate between timber wolves and coyotes, but some of the early reports, if accurate, certainly refer to timber wolves.

Wolves were abundant during early settlement days and made life miserable for farmers who raised sheep. War was declared on the wolves, and during the period 1860-1900 they became scarce. Then the wolves came back, but to a lesser extent. Organized wolf hunting again became a leading sport for several years. A coyote was killed at Faville Grove about 1926. I have no records since.

Bounty was paid for a "timber wolf" killed a few miles east of Faville Grove in the spring of 1938. However, it was the opinion of two of America's outstanding authorities on wolves that the skull was that of a dog.

Foxes. For many years the hunting of red foxes was a popular and profitable sport. Gray foxes were rare until about 1920 when they began to out-number red foxes. At present, gray foxes are common, but red foxes are extremely rare.

About 1900 a favorite winter sport at Lake Mills was a "handicap" fox chase. When the ice became solid, a gray fox was taken out onto the center of Rock Lake and released. Dogs which had been arranged in handicap style, depending on their speed, were released after the fox had a good start. The fox usually reached the land ahead of the dogs, and then climbed the nearest tree. The sponsor of the chases made good money on entry fees and still had his fox when the chase ended.

Possums. I have only one early possum record—one taken by Mr. Eph Wilson about 1880. My next record is 1928, when Mr. Harry Mason caught a possum near Cambridge. Possums suddenly became common between 1930 and 1936. Mr. Mason killed over a hundred. More than two dozen possums have been seen or killed at Faville Grove since 1932. Following the killing winter of 1936, the possum population slumped, but seems to be recovering again.

Other Mammals. Skunks have had five years of complete protection and are now abundant on the Faville Grove area. *Muskrats* and *mink* have increased but slightly, and *weasels, raccoons,* and *badgers* not at all. The failure of raccoons and mink to increase is probably in part due to poaching.

Squirrels and *rabbits* have clearly responded to protection. The recent cycle which noticeably lowered the populations of these species in the surrounding country did not seem to affect the rabbits and squirrels at Faville Grove.

About 1932 Mr. Peter Dietrich released two pairs of snowshoe rabbits in a tamarack swamp on his farm just west of Faville Grove. Shortly thereafter "giant" rabbits were seen (and several were killed) on the open Crawfish prairie. It is not clear whether these were snowshoes which came from Mr. Dietrich's original release, or jack rabbits which unaccountably appeared at this time. Mr. Sam Kisow saw one of these rabbits several times in 1934 on the Crawfish prairie. On December 29, 1939 Edward Kortendick of Lake Mills killed a jack rabbit on the west shore of Rock Lake.

Mice and *shrews* were at the peak of their cycle in 1935 and early 1936, but lost heavily in late 1936 and were still scarce at the beginning of 1938. By fall 1938, meadow mice, at least, were again abundant. By 1939 they were again decreasing.

Fish

According to Somers, the refuse heaps at Aztalan contained bones of the following fish: pickerel, yellow perch, red horse, pike, sunfish (several varieties), bullhead, mudsucker.

Also at Aztalan Barrett found an awl made from the spine of a sheepshead (*Aplodinatus*). Green[23] found all of these fish except the sheepshead in a recent survey of the Rock River drainage.

Further evidence that the Indians did considerable fishing is a dam which they built near Milford. This was a V-shaped pile of stones placed in mid-stream which forced the fish to pass next to the bank, thereby making them easier to catch. Considerable labor was involved in building this dam, so it is safe to conclude that the fishing was good enough to warrant the trouble taken.

The first settlers counted heavily on fish for food. The red horse (Moxostoma) was the most important food fish. Keyes, in his history of Lake Mills, describes a fish rack which caught the red horse and "pickerel" which were carried over the dam and left them stranded, high and dry. Mr. Scribner has told me of the fever-pitch excitement that accompanied the red horse "run." The run coincided with corn planting time, and the flowering of the wild plum. Farmers from miles around gathered at the dam in the Crawfish at Hubbleton with wagons and dip nets. Some used "drive" nets (seines). Most of the fish were caught at night and many were the drunken brawls which accompanied the fishing. Wagons were backed into the stream, the more easily to fill them. Any kind of fish was taken. The fishermen camped at the old sawmill during the run. Each year they came with barrels and salt. The fish were slit down the back, cleaned, and packed in the brine.

Mr. Albert Aldrich remembers the farmers driving by with their wagon boxes filled with fish taken during the spring run.

Game fish as well as food fish were abundant. Mr. McGovern, about 1875, claims to have caught in one winter 525 pounds of northern pike through the ice at Mud Lake.

The Crawfish River at that time contained northern pike, perch, a few wall-eyed pike (absent or rare at Mud Lake), large-mouth black bass, sunfish, rock bass, a few eels, bullheads, buffalo, and several kinds of suckers. Catfish are reported as absent. Carp had not been introduced yet.

Table 8 shows the kinds and numbers of fish found in the river at present. Carp, catfish and wall-eyed pike, all scarce or absent in 1875, are now three of the most important fish.

Large catches of fish were also taken from Rock Lake in former years. On Labor Day 1937, a creel census supervised by Mr. Buss showed that at Rock Lake 204 fishermen spent 933 hours fishing but caught only 3 wall-eyed pike, 8 northern pike, 15 black bass, 295 bluegills, 2 crappies, 9 perch, and 62 fish of other kinds, an average of 1 fish per 2¼ man-hours of fishing.

Carp. In 1887 Mr. Scribner caught a carp in the Crawfish River; this is my earliest record. Mr. Hooper recalls that in 1888 his father bought several cans of carp in Madison and released them in Hooper's pond (between Rock Lake and the Crawfish River). By 1904 carp were abundant, as shown by Mr. Hooper's field notes:

April 25—Big run of carp. Speared 25. Boys caught and sold three milk wagons full.

May 13—Caught 55 carp.

November 8—Men seining in Crawfish River caught about a ton of carp in two hauls.

Between 1896 and 1906 carp are reputed to have changed the entire appearance of the river by eliminating the wild rice and making the stream muddy. I quote Mr. John Radke: "The carp used to feed at the big bend (in the Crawfish). The rice which the carp had cleaned out floated down to the big bend and formed a dam. Above the dam the water was several feet deep but one could wade below it with boots. The water used to be crystal clear."

Some conception of the present status of the carp can be gathered from Table 8.

TABLE 8. *Contract Fishing Operations, Crawfish River, 1936-37*

Species	No. caught	Species*	No. caught	Weight
Black bass	0	Catfish	1255	
White bass	360	Dogfish	13	
Wall-eyed pike	518	Garfish	14	
Northern pike	129	Other rough fish**		23,529#
		Carp		261,960#
		Total		285,489

* More bullheads (which are not tabulated) than any other fish are taken by line fishermen.

** "Other rough fish" include buffalo and suckers.

Reptiles

Marsh rattlesnakes (*Sistrurus catenatus*) were once fairly common in the London and Waterloo marshes. About 1850, according to Mr. Faville, 70 or more rattlers were destroyed as they were coming out of hibernation from a rocky den. The den was located a mile or two northwest of Faville Grove. Mr. Faville recalls that his father spoke of rattlers on the homestead farm, one of which bit a horse. The first settlers were hesitant about lifting grain bundles because of rattlesnakes. Evidently these snakes became rare at a very early date, for the only one Mr. Faville ever saw was pointed by his bird dog while hunting prairie chickens in the Waterloo marsh. This happened about 65 years ago.

Mr. Schorger found the following news story in the Madison *State Journal*: "The Lake Mills *Union* says Mr. H. Brown, while at work on the farm of his son near that village, found and killed seven large rattlesnakes. They were lying under the haycocks in the meadow."

While it is difficult to pin down species, the general statement may be made that both in numbers and species there has been a great reduction of snakes in this region. During the past four years at Faville Grove I have seen only two species: the garter snake (*Thamnophis*), which is common, and five individuals of the milk snake (*Lampropeltis*).

The marketing of snapping turtles has been a thriving part-time business for a few individuals in the past. Competition, however, has caused over-exploitation of this resource. Considerable evidence is available that snapping turtles have decreased markedly during the past decade.

Amphibians

Bullfrogs and green frogs were hunted for the market until recent years and their populations declined accordingly. Bullfrogs, which a decade ago were still common, are now rare.

There is a paucity of both species and individuals in salamanders. In four years less than a dozen individuals have been found despite repeated attempts to collect them. The two species represented in the collection were both *Ambystomas*: *A tigrinum and A. maculatum. Necturus maculosus,* the mud puppy, is commonly found in Rock Lake.

Invertebrates

Clams. Claming once rivaled fishing as an important occupation on the Crawfish River. Clams, locally called "elephant's ears," were harvested by the boat load and wash-tub full as late as 1920. Clam hooks, dredges, and rakes were the tools used in the harvest. Locally the objective of the harvest was pearls. The clam shells which in many other places were sold for buttons were here usually thrown away. What shells were sold brought from $20 to $75 a ton. After a good haul, the clams were usually boiled alive so that they could be more easily opened. Occasionally a bushel of clams produced a pearl or two, but often a boat load yielded nothing. So-called "slugs" were more commonly found than pearls and these brought about $5 per ounce, according to Mr. Joe Davis, local jeweler. Mr. Davis says that he handled almost $800 worth of pearls in August, 1918. Some of the best pearls brought as high as $35, but one lot of 200 pearls brought only $200. With a few exceptions people in this vicinity hunted pearls for fun, not profit.

Between silting and over-exploitation by clam fisherman, clams have been all but exterminated from the Crawfish River.

Bees. Honey bees, which were introduced from Europe, were here when the first white settlers arrived. Cravath and others speak of harvesting honey at an early date.

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APPENDIX A

SPRING FLORA ON FARMER'S ISLAND LAKE MILLS, WISCONSIN

E. B. MOORE AND RUSSELL SANFORD

"Farmer's Island" is located approximately one mile north of Lake Mills, Wisconsin, on the Faville Grove Wildlife Area. It consists of a low wooded knoll rising a few feet above the surrounding bog. The portion included in this survey embraced about twenty-five acres of unpastured upland woods and a small part of the adjoining marsh, some of which is grazed.

The flora of the "Island" is principally mesophytic; that of the surrounding lowlands includes some characteristic bog species.

Ulmus americana, Prunus serotina, Fraxinus americana, Acer rubra and *Tilia glabra* are the most common trees in the overstory. The forest as a whole consists of a group-wise distribution of age classes, with the 21-40 year class predominating. Cordwood has been taken out here and there, recently in the southwestern part of the area, and the resulting openings are at present in the herbaceous-shrub stage of succession. The soil is of the mull type, shows rapid decomposition of litter and a well-developed humic horizon. Maidenhair fern—a common indicator of this type—occurs frequently.

The soil of the bog is made up of sedge-peat and supports various stages of the bog succession. *Larix larcina* and *Rhus Vernix*, a subclimax association, occurs here, as well as thickets of *Cornus stolonifera, Populus tremuloides* and *Salix* spp. Dense stands of *Urtica procera* in places, indicate the misuse of fire in the past. On parts of the lowlands, *Maianthemum canadense* appears as ground cover, usually under stands of *Populus*.

The following species were collected and identified:

Pinaceae
- Larix laricina
- Juniperus virginiana

Cyperaceae
- Carex sp.
- Carex pennsylvanicum

Araceae
Arisaema triphyllum

Liliaceae
Smilax herbacea, var. pulverulenta
Polygonatum pubescens
Polygonatum biflorum
Maianthemum canadense, var. interius
Smilacina stellata
Smilacina racemosa
Uvularia grandiflora

Dioscoreaceae
Dioscorea villosa

Salicaceae
Salix sp.
Populus grandidentata
Populus tremuloides

Juglandaceae
Carya ovata

Betulaceae
Betula pumila, var. glandulifera
Corylus americana
Ostrya virginiana

Fagaceae
Quercus alba
Quercus rubra
Quercus ellipsoidalis

Urticaceae
Ulmus americana
Urtica procera

Caryophyllaceae
Stellaria longifolia
Arenaria lateriflora

Ranunculaceae
Ranunculus abortivus
Ranunculus septentrionalis
Ranunculus recurvatus
Thalictrium dioicum
Anemonella thalictroides
Hepatica americana
Caltha palustris
Actaea rubra
Aquilegia canadensis
Anemone quinquefolia

Berberidaceae
Podophyllum peltatum
Caulophyllum thalictroides

Papaveraceae
Sanguinaria canadensis

Cruciferae
Lepidium campestre
Capsella Bursa-pastoris
Erysimum cheiranthoides
Barbarea vulgaris
Cardamine Douglassii
Roripa Armoracia

Saxifragaceae
Saxifraga pennsylvanica
Ribes Cynosbati
Ribes gracile
Ribes americanum

Rosaceae
Pyrus arbutifolia, var. atropurpurea
Pyrus ioensis
Amelanchier canadensis
Amelanchier humilis
Crataegus sp.
Fragaria virginiana
Fragaria vesca
Potentilla canadensis
Potentilla norvegica, var. hirsuta
Rubus pubescens
Rubus occidentalis
Prunus serotina
Prunus virginiana
Prunus americanum

Leguminosae
Lathyrus ochroleucus
Vicea americana

Oxalidaceae
Oxalis stricta

Geraniaceae
Geranium maculatum

Anacardiaceae
Rhus Vernix
Rhus toxicodendron
Rhus glabra

Aceraceae
Acer rubra

Vitaceae
Parthenocissus vitacea

Tiliaceae
Tilia glabra

Violaceae
Viola cucullata
Viola eriocarpa

Araliaceae
Aralia nudicaulis

Umbelliferae
Osmorhiza Claytoni
Zizea aurea
Sanicula marilandica

Cornaceae
Cornus stolonifera
Cornus Baileyi
Cornus alternifolia
Cornus femina

Oleaceae
Fraxinus americana

Polemoniaceae
Polemonium reptans

Scrophulariaceae
Veronica peregrina

Rubiaceae
Galium Apparine

Caprifoliaceae
Lonicera tatarica
Lonicera dioica
Lonicera prolifera
Viburnum opulus, var. americanum
Viburnum lentago
Viburnum affine, var. hypomalacum
Viburnum affine, var. affine
Sambucus canadensis

Compositae
Taraxicum Officinale
Achillea Millefolium

In addition to the above list, I have collected the following plants on Farmer's Island. These were identified by Dr. N. C. Fassett.

Aster puniceus
Barbarea vulgaris
Cerastium vulgatum
Cirsium altissimum
Epilobium coloratum
Erigeron canadensis
Eupatorium maculatum
Eupatorium urticaefolium
Gentiana Andrewsii
Geum canadense
Hypoxis hirsuta
Impatiens biflora
Latuca scariola
Lemna minor
Lobelia siphilitica
Lonicera hirsuta
Lycopus uniflorus
Oenothera sp.
Phlox pilosa var. fulgida
Polygonum lapathifolium
Polygonum pennsylvanicum
Polygonum sagittatum
Rhamnus alnifolia
Sarracenia purpurea
Spartina pectinata
Spiranthes cernua (1938 only)
Solidago canadensis
Suum suave

APPENDIX B

Plants found during 1936 in Section 19 of the Crawfish Prairie; collected by A. S. Hawkins and identified by Dr. N. C. Fassett.

Agropyron repens
Agrostis alba
Alisma Plantago-aquatica
Amorpha canescens
Andropogon furcatus
Andropogon scoparius
Anemone canadensis
Apocynum cannabinum var. glaberrimum
Asclepias incarnata
Aster novae-angliae
Aster pilosus

Betula pumila var. glandulifera
Betula Sandbergi
Brassica juncea
Cacalia tuberosa
Calamagrostis canadensis
Cardamine bulbosa
Cardamine parviflora var. arenicola
Cicuta maculata
Cirsuim arvense
Cirsium lanceolatum
Comandra umbellata
Convolvulvus sepium
Cypripedium candidum
Dodecatheon Meadia
Dulichium arundinaceum
Echinochloa crusgalli
Echinochloa Walteri
Eleocharis sp.
Elymus sp.
Epilobium glandulosum var. adenocolon
Equisetum arvense
Eragrostis sp.
Erigeron philadelphicus
Eriophorum angustifolium
Eryngium aquaticum
Eupatorium perfoliatum
Euphorbia corollata
Galium boreale
Gentiana Andrewsii
Gentiana crinita
Habenaria leucophaea
Helenium autumnale
Helianthus sp.
Heliopsis helianthoides
Heuchera Richardsonii
Hierochloe odorata
Hypoxis hirsuta
Iris virginica Shrevei
Leersia oryzoides
Lepachys pinnata
Lettuca canadensis
Liatris pyconstachya
Lithospermum canescens
Lilium philidelphicum var. andinum
Lilium michiganense
Lobelia spicata
Lycopus americanus
Lythrum alatum
Matricularia inodora
Mentha arvensis var. canadensis
Mimulus ringens
Nepeta Cataria
Oxalis stricta
Oxypolis rigidior
Panicum capillare
Panicum Scribnerianum
Parietaria pennsylvanica
Parnassia caroliniana
Petalostemum purpureum
Phalaris arundinacea
Phleum pratense
Phlox pilosa
Physostegia virginiana
Poa pratensis
Polygonum pennsylvanicum var. laevigatum
Polygonum Persicaria
Potentilla norvigica var. hirsuta
Pycnanthemum virginianum
Radicula Nasturtium-aquaticum
Roripa palustris
Rudbeckia hirta
Salix longifolia
Saphonaria officinalis
Scirpus atrovirens
Scirpus validus
Scrophularia marilandica
Senecio aureus
Silphium laciniatum
Silphium terebinthinaceum
Sisyrinchium campestre
Solidago rigida
Sonchus oleraceus
Sorghastrum nutans
Sparganium Eurycarpum
Spartina pectinata
Spiraea alba
Spiranthes cernua
Stachys tenuifolia
Steironema quadriflorum
Tradescantia canaliculata
Valariana edulis
Verbascum Thapsus
Verbascum Blattarii
Verbena hastata
Vernonia fasciculata
Veronica virginica
Viola cucullata
Zizia aurea

APPENDIX C

Extracts from the Ginseng Field Notes of Mr. John Hooper, 1904-08:

Ginseng—1904			Name of Woods	No. of Plants	Seeds
July	28	First plants of season	River	30	
Aug.	7		?	few	
	14	Built ginseng garden	?	67	
	18	A few ripe seeds	River	55	few
	21	Seeds ripe on ½ plants	River	80	?
	23	Seeds ripe	Millers'	107	?
	26		Spitzers'	40-50	few
	26	land too low—600 acres	Fred Albrect's	none	
	26		Wollitz'	2	
	26		Smiths'	85	
	27	Worked by someone else	Dams'	100 (small)	
	27		Bohnsacks'	267	
	28		Vandres'	none	
	28		Zimmermans'	3	
	28		Starks'	112	125
	31		Smith', Manskes', Sillimans'	297	1 pt.+
Sept.	4	171 old; rest yearling plants	Sillimans'	316	can full
	6	found biggest roots I have seen	River (Gene got	160 50*)	some
	8		Dams'	100	
	8	mostly small (97 large)	near Steulkes'	323	
	8		River	15	
	9	Goose Lake (Dane Co.)	Big	none	
	9	W. & S. of London	Thompsons'	20	
	11	River Wds, F. Millers', Favilles',** Smiths', Sillimans'		373	some
Sept.	12	Chas. Willin hillside 20 acres			
	12	Plants few & far between, all green as yet, as in summer		90	
	15		Starks'	few small	
	15	Near Grelton	S. of road	305	few
	16	mostly east of ridge	Barichters'	280	quite a little
	16		Barichters' (Gene got)	150	
	17	Cows had run over wds: had been well hunted	Farmers' Island	large 20	

Date 1904			Name of Woods	No. of Plants	Seeds
	25		River	140	
	27	One rotten root	River, Smiths'	330	some
	30	En route to Camp Mc-Kinley Plants yellow & down	3 woods visited	85	
Oct.	1	1 very large head (Yandres') River, Smiths', Favilles', Manskes', Schafers'		235	some
	2	Lowell via Richwood, S. to Reeseville Bridge	Andrews'	467	
	16	All plants yellow & down	River	65	
			Total	5100+	for year
	1905				
May	5	Put up shades; about 15 plants up	Mr. Hooper refers to his ginseng garden plot.)		
	11	Paid $15 for 5000 seeds; plants coming up fast, a few unrolled.			
	15	About all up			
	21	Found no ginseng	River		
June	11	Circuit Millers', Favilles', Smiths', Manskes'; Saw very few plants		48	
June	18		River	89	
July	2		River	80	
	9		River	123	
	16		Dams'	100	
	22	Wds. E. of Milford	Bendels, Ziebell, Starks'	126	
	27		River	110	
	29		River	170	
	31		River	110	
	31	About ½ dozen ripe seeds in garden; no seeds ripe in woods.			
Aug.	5	Picked 400 in beds.			
	6		River	180	
	13	Few seeds ripe	Starks'	132	
	20	Seeds ripe	River	140	
	23	Bought from Roy Newcomb probably from River		24	
Sept.	1	All day	Brendels' & Starks'	192	
	2	Half day	River	121	
	3		River, Smiths'	112	quite a little
	3	Gene (Mr. Hooper's brother)	Farmers' Island	45	
	4	Gene had fine digging, too?	Froelichs'	345	considerable
	6	Near Deerfield noon—3:30 P.M.	Deerfield	300	lots

Date 1905			Name of Woods	No. of Plants	Seeds
	7	10:00 A.M.-4:30 P.M.	Deerfield	480	
	9	10:30 A.M.-4:30 P.M.	Deerfield	468	considerable
	11		Froelichs'	155	
..	11	Bought 85 for 1.75 from Roy Newcomb	Barichters'	85 205	quite a little
	11	1 head had 64 seeds			
	14		River	190	
	17	Bought 100 roots from Fuller for 2.00; 79 from Newcomb—prob. River		179	bought some
	24	Made circuit; plants mostly yellow; some seeds still on	River	240	
	25	Bought from Fuller	River (prob.)	70	
	28	Made circuit; Plants mostly yellow; Some seeds still on		340	
	29	23 lacking of 10,000 for two years	River, Smiths' opposite Creek	245	
Oct.	1		River, Wollin, Schafers'		Some
	1906				
Aug.	12	No seeds ripe	Deerfield	540	
	13		River	100	
	13	Total to this date Bought 150 from Fuller—$2.50		900	
	17		Deerfield	450	
	20		Circuit River	104	
	25		River Wollins'	185	
	28		Near Mud Lake	230	
	29	Seed ripe in woods	Deerfield	450	
	31	To Lowell by bicycle	Rockwood	330	
Sept.	1		S. of Mittons in big woods	137 293	N. of home
	2		Kuhlmans'	470	
	3		Richwood	270	
	16		Richwood	125	
	23	Some plants yellow	Riv. Circ.; except Yandres'	285	
	30	Most of plants yellow	Circuit	200	
	1907				
Oct.	7	Ginseng turning yellow			
	1908				
May	10	Coming fast			

		Name of Woods	No. of Plants	Seeds
July 11	Seed well set			
Sept. 4	Got about 600 plants, mostly 2-3 yrs. old—Deerfield Seeds ripe.			
	Planted seeds again; found some places where I had sewed seed two years ago.—(30-40 seedlings in bunch)			

* Gene is Mr. Hooper's brother

** This Favilles' woods is not the one shown in Fig. 2. It is east of the river. Mr. Hooper refers to this group of woods as the "circuit"

APPENDIX D*

Orchidaceae: past and present status at Faville Grove and Wollin's woods

Species[1]	Former status	1928	1934	1935	1936	1937	1938	Locality
1. Small yellow lady's slipper (Cypripedium parviflorum)	Only 1 plant ever recorded at F. G.	5 plants transplanted to Goose Pond, 1936						Still locally common in nearby tamaracks
2. Large yellow lady's slipper (C. parviflorum pubescens)	Common in all upland woods	100+	3	0	0	0	1	Faville woods
3. White lady's slipper (C. Candidum)	Abundant on low prairie	1000+	1000	0	55	80	0	Crawfish prairie
4. Showy lady's slipper (C. reginae)	Never recorded	4 plants transplanted to Goose Pond, 1936						Still locally common in nearby tamaracks
5. Moccasin flower (C. acaule)	Locally common				40	12	?	Goose Pond
6. Showy orchis (Orchis spectabilis)	Common	a few		0	0	3	0	Wollin's woods
7. Green orchis (Habenaria broacteata)	Prob. common							Faville woods
8. H. hyperborea	Common	Probably still fairly common						Goose Pond
9. Ragged orchis (H. lacera)	Hypothetical							Prairie
10. White fringed orchis (H. leucophaea)	Locally common on prairie		17	30	100	15	150	Prairie
11. Purple fringed orchis (H. psycodes)	Common	a few	25	0	0	0	?	Wollin's woods
12. Calopogon pulchellus	Never recorded							Hope Lake rare

14. Rattlesnake plantain (Goodyera pubescens)	Common	a few	0	0	Faville woods
15. Large coralroot (Corallorrhiza maculata)	Abundant	Still locally common			Upland woods
16. Putty root (Aplectrum hyemale)	Prob. locally common	75	75	75	Wollin's woods
17. Habenaria dilatata	Hypothetical				Goose Pond
18. Liparis Loeselii	Hypothetical				Goose Pond

* Table compiled by Mr. Stoughton W. Faville, Dr. John T. Curtis and the author.

[1] Most of these species have been recorded and probably still can be found within 6 miles of Faville Grove. Those listed as hypothetical have not been found here but have been recorded from the county. More careful search may add them to the orchid list for Faville Grove and vicinity.

NOTES ON WISCONSIN PARASITIC FUNGI. I.

H. C. GREENE

These notes are a continuation of the series of "Notes on Parasitic Fungi in Wisconsin" issued periodically by the late Dr. J. J. Davis, formerly Curator of the Herbarium at the University of Wisconsin. Unless otherwise noted, all collections cited were made during the 1938 season.

PLASMOPARA PYGMAEA (Ung.) Schroet. var FUSCA (Pk.) Davis on *Hepatica americana* (*triloba*). Dane Co., near Mazomanie, July 10. Apparently not uncommon on *H. acutlioba,* but seemingly rarely found on *H. americana,* the only previous collection being one by Davis from Laona, Forest Co.

PHYLLOSTICTA APOCYNI Trel. on *Apocynum cannabinum.* Dane Co., near Madison, July 3. Reported from LaCrosse Co. in 1882 by Trelease, but not collected since in Wisconsin on *A. cannabinum.* Trelease's specimen is not in the Herbarium. The conidia are slightly larger than the 3-4 x 5-7μ specified by Trelease.

PHYLLOSTICA PODOPHYLLI (Curt.) Wint. on *Podophyllum peltatum.* Dane Co., near Pine Bluff, June 3; Mt. Vernon, June 13. The only earlier Wisconsin collection was made by Davis in 1930 at Big Bend, Waukesha Co.

SEPTORIA SILENICOLA Ell. & Mart. on *Silene stellata.* Columbia Co., Gibraltar Rock, June 28. Collected once by Davis at Racine, Racine Co. in 1889.

SEPTORIA sp. on *Linaria canadensis.* Iowa Co., near Arena, June 17. Davis, Notes XVIII, p. 260 (1931) states, "On July 10, 1929 a collection of PERONOSPORA LINARIAE Fckl. on *Linaria canadensis* was made at Arena. On the dead stems are pale spots in which are pycnidia with black, rather firm thick walls and broadly conical ostioles. These pycnidia contain hyaline, lax, filiform scolecospores 30-50 x ½-1μ. The appearance suggests that the death of the host interfered with the normal development of the sporules. Perhaps this bears relation to *Septoria cymbalariae* Sacc. & Speg." In 1938 similar material was collected in great abundance. The pycnidia appear well developed and there is nothing about the spores that suggests abnormality. If such were the case it would hardly be expected that identical correspondence with those originally found would occur. Furthermore, there is a high percentage of germination of the scolecospores in tap water, likewise an indication of normality. The Saccardian description of S. CYMBALARIAE: 'Spots subcircular, dark brown; pycnidia gregarious, punctiform, lenticular, broadly ostiolate, sooty, texture rather firm, parenchymatous; sporules filfiorm, subflexuose, 20-35 x 2.5-3μ rather obtuse at the ends, pluriguttulate, septations obscure, hyaline. . . . In the French form pycnidia 50-60μ diam.; sporules 15-20 x 1-2μ". Plainly the spores of the form in question are not those of S. CYMBALARIAE.

DILOPHOSPORA GERANII Schroet. on *Geranium maculatum*. Dane Co., Madison, June 9. Collected at Madison in June 1883 by Trelease and at Viroqua, Vernon Co. in May 1930 by Davis. The spores are borne in definite pycnidia and are very distinctive. The fungus was formerly wrongly referred to PESTALOZ ZIELLA SUBSESSILIS Sacc. & Ell. (Davis' Notes XX, p. 5, 1937).

PIGGOTIA FRAXINI B.&C. on *Fraxinus americana*. Dane Co., near Blue Mounds, August 11. (A. E. Jenkins & Greene). The fungus is here amphigenous and localized on large, isolated circular, dull purplish-green spots which are up to 1 cm. diam.

COLLETOTRICHUM sp. on *Sanguinaria canadensis*. Dane Co., near Blue Mounds, August 11. Doubtfully parasitic. No. report in Seymour's Host Index of COLLETOTRICHUM on *S. canadensis*.

BOTRYTIS sp. on *Ranunculus abortivus*. Sauk Co., Peewit's Nest, May 21. Seemingly parasitic on young leaves, producing immarginate spots with a water-soaked appearance. The spots tend to be wedge-shaped, tapering inward from the leaf margin. Conidiophores hypophyllous, arising from the leaf parenchyma, sordid yellowish, 2-3 septate, granular, up to 550 x 15μ, several times branched near the summit; branches up to 30 x 8μ; at the end of each principal branch several wrinkled knob-like inflations, each with numerous minute sterigmata; conidia broadly ellipsoidal, smooth, yellowish, 14-21 x 10-14μ, wall about 1μ thick, densely clustered, capitate on each fertile knob. This should perhaps be referred to BOTRYTIS CINEREA Pers.

CERCOSPORA DULCAMARAE (Pk.) Ell. & Ev. on *Solanum dulcamara.* Dane Co., near Mazomanie, July 10. Ellis and Everhart state: The hyphae form indefinite, subolivaceous, or greenish-lead-colored patches on the lower surface of the leaf, and also more sparingly so above but without any distinct spots'. In reference to a collection made by Davis at Ellison Bay, Door Co., August 1929, he states 'the spots are dark blue on both surfaces reminding one of a wood stain'. In the Mazomanie collection the conidiophores are borne on definitely delimited, arid white spots with a wide blackish-brown border. On the basis of microscopic characters the specimen is referred to C. DULCAMARAE.

CERCOSPORA LEPTANDRAE J. J. Davis on *Veronica virginica.* Dane Co., Madison, July 23. This distinctive species is based on a single collection made at Blue River, Grant Co. in 1923. The occurrence of the identical form in some abundance at Madison confirms the validity of the species.

CERCOSPORA ZIZIAE Ell. & Ev. on *Zizia aurea.* Dane Co., Madison, July 3. The only earlier collections made by Davis at Racine, Racine Co. some forty years ago.

ADDITIONAL HOSTS

SYNCHYTRIUM CELLULARE Davis on *Pycnanthemum virginianum.* Dane Co., near Mazomanie, July 10. Summer sporangia scarce in this material; resting spores abundant. Galls of considerable size are produced, a fact perhaps correlated with the moderately thick leaves of *P. virginianum.* With heavy infestation there is much distortion of the host. Seymour does not list SYNCHYTRIUM as occurring on *Pycnanthemum.*

ERYSIPHE POLYGONI DC. on *Thalictrum revolutum.* Collected at Racine, Racine Co., September 1, 1886 by J. J. Davis. This record is based on a specimen in Davis' personal herbarium labelled 'ERYSIPHE COMMUNIS (Wall.) on *Thalictrum cornuti,* Racine, Wis. 9/1/86.' *T. cornuti* is a synonym for *T. polygamum* which does not occur in Wisconsin. The leaves comprising the specimen definitely show the glandular-puberulent character of

T. revolutum. In Davis' Provisional List *Thalictrum dasycarpum* is cited as a host for E. POLYGONI. No specimen of E. POLYGONI on *T. dasycarpum* was to be found in either the Davis or the University Herbarium and it seems probable that the record is based on the above-mentioned specimen on *T. revolutum.* However, *T. dasycarpum* abundantly infested with E. POLYGONI was collected by R. I. Evans at Pine Hollow, Sauk Co., June 26, 1938.

ELSINOE VENETA (Speg.) Jenkins on *Rubus occidentalis.* Dane Co., near Blue Mounds, August 11. (A.E. Jenkins & Greene. Det. by Jenkins). GLOEOSPORIUM VENETUM Speg. is reported by Davis on *Rubus* spp. but there seem to be no specimens on *R. occidentalis* in the Herbarium.

EOCRONARTIUM MUSCICOLA (P. ex Fr) Fitzp. on *Climacium americanum.* Iowa Co., near Ridgeway, R. I. Evans, July 3. Nothing is reported on this host in Seymour's Host Index, and there is apparently no published record of EOCRONARTIUM in Wisconsin.

PHYLLOSTICTA TRILLII Ell. & Ev. on *Trillium grandiflorum.* Dane Co., near Blue Mounds, June 3.

SEPTORIA CONVOLVULI Desm. on *Convolvulus arvensis.* Dane Co., Madison, June 30.

SEPTORIA VERBENAE Rob. on *Verbena stricta.* Dane Co., two miles east of Blue Mounds, July 5.

SEPTORIA VIOLAE Westd. on *Viola eriocarpa.* Dane Co., near Mt. Vernon, June 13.

COLLETOTRICHUM TRILLII Tehon on *Trillium declinatum.* Dane Co., near Mt. Vernon, July 5. Somewhat dubiously referred to Tehon's form. Davis in Notes XX, p.2 (1937), cites a possible collection of this species on *T. recurvatum.* The fungus on *T. declinatum* seems to be truly parasitic.

RAMULARIA SUBRUFA Ell. & Holw. on *Smilax herbacea* var. *pulverulenta.* Columbia Co., Gibraltar Rock, June 28. Davis made collections of R. SUBRUFA on this host, but failed to report them.

CERCOSPORELLA FILIFORMIS J. J. Davis on *Thalictrum dasycarpum.* Dane Co., near Mazomanie, August 14. Davis described

C. FILIFORMIS from a collection on leaves of *Anemone patens* var. *Wolfgangiana* made at Millston, Jackson Co., in June 1914. Several subsequent collections were made on the same host. On *Anemone* the spots are linear, brown, immarginate, ½-4 cm. x 1-2 mm., with conidiophores amphigenous. On *Thalictrum* the conidiophores are, largely at least, hypophyllous on small (1-3 mm. diam.) circular to ovoid spots which are pale brown with a dark brown border and plainly visible on both leaf surfaces. The fungus is referred to C. FILIFORMIS on the basis of the distinctive conidia, the general microscopic habit and the admittedly none too close host relationship.

CLADOSPORIUM NERVALE Ell. & Dearn. on *Euphorbia corollata*. Columbia Co., Highway J, five miles north of Lodi, July 8. This checks well with C. NERVALE on *Rhus typhina*. The parasite is largely confined to the midrib region.

CERCOSPORA BETICOLA (Ces.) Sacc. on *Cycloloma atriplicifolium*. Sauk Co., near Spring Green, July 29, 1935. (J. J. Davis & Greene). Material was sent to Professor Chupp who made the determination. Davis' unpublished notes as follows: 'Spots definite, circular, pale brown with a narrow purplish border and often with a white center, 2-3 mm. in diameter; conidiophores tufted, fuscous, straight or geniculate, sometimes curved, 30-80 x 4μ; conidia hyaline, straight or somewhat curved, upwardly attenuate, septate, 65-120 x 3μ.'

CERCOSPORA SMILACIS Thüm. on *Smilax herbacea* var. *pulverulenta*. Dane Co., near Mt. Vernon, August 17. Determined by Professor Chupp.

PHLEOSPORA MORI (Lev.) Sacc. on *Morus rubra*. Dane Co., Madison, October 28.

ADDITIONAL SPECIES

TAPHRINA SACCHARI Jenkins on *Acer saccharinum*. Dane Co., Madison, June 1904 (collector?). This TAPHRINA (Jenkins, A. E., J. Wash. Acad. Sci. *28*: 353-8 (1938)) was found by Jenkins on a specimen in the University of Wisconsin Herbarium labelled GLOEOSPORIUM SACCHARINUM E. & E.

MYCOSPHAERELLA THALICTRI (Ell. & Ev.) Lindau on *Thalictrum dasycarpum*. Dane Co., near Mazomanie, July 10. Seymour does not list *T. dasycarpum* as a host.

VERMICULARIA COPTINA Pk. on *Coptis trifolia*. Juneau Co., Rocky Arbor State Park, May 21. Doubtfully parasitic.

VERMICULARIA HYSTERIIFORMIS Pk. on *Caulophyllum thalictroides*. Dane Co., near Blue Mounds, August 11. Peck, describing *V. hysteriiformis*, states in part "A species very distinct from all others by the shape of the perithecia which appear longer than broad through the epidermis, resembling in this respect some species of HYSTERIUM". A fungus which is apparently Peck's species was found sparingly on stems and abundantly on leaves of living blue cohosh. On leaves the acervuli are small and do not show the hysteriform character, but in type of setae and conidia are identical with those on the stems. On leaves the acervuli are amphigenous, scattered, superficial, 40-120μ diam. on more or less wedge-shaped, dead, brown areas, the dead areas frequently with a yellowish margin next to the still living portions of the leaflet; setae numerous, blackish-brown, septate, tapering, acute, extremely variable in length, up to 260μ long by 7μ wide at the base; conidia 17-24 x 3-4.5μ, boat-shaped to falcate, guttulate; conidiophores very short, up to 10 x 3μ, inconspicuous among the numerous setae. The fungus seems to be definitely parasitic on stems and leaves. On leaflets the dead areas apparently originate at the margins, progressively involving larger areas until the entire leaflet is killed. Comparison of a specimen of VERMICULARIA PODOPHYLLI Ell. & Dearn. on dead fruit of *Podophyllum* peltatum with V. HYSTERIIFORMIS shows acervuli 100-200μ diam., with setae shorter, less acute and more uniform in length, 100-125μ. The conidia, however, are very similar and it seems probable that V. HYSTERIIFORMIS and V. PODOPHYLLI are closely allied if not identical.

SPHAEROPSIS ELLISII Sacc. on *Pinus laricio* var. *austriaca*. Dane Co., Madison, A. J. Riker, September 27. On needle bases.

MELANCONIUM SPHAEROIDEUM Lk. on *Alnus* sp. Sawyer Co., near Hayward, E. M. Gilbert, April 20. On twigs; seemingly parasitic.

SEPTORIA PLANTAGINEA Pass. var. PLANTAGINIS-MAJORS Sacc. on *Plantago purshii.* Dane Co., near Mazomanie, July 10. Seymour does not report SEPTORIA on *Plantago purshii.* Comparison with a specimen on *Plantago major,* collected at Winnipeg, Manitoba shows similar spores (about 30-35 x 1) and pycnidia but slightly smaller. The pycnidia on *P. purshii* show a more pronouncedly rostrate character than do those on *P. major.*

SPHACELOMA SYMPHORICARPI Barrus & Horsfell on *Symphoricarpos albus* var. *laevigatus.* Dane Co., Madison, August 12 (A. E. Jenkins & Greene. Det. by Jenkins).

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. XXVII. LENTIBULARIACEAE

JOHN W. THOMSON JR.

The aquatic species of *Utricularia*, the only representative of this family in Wisconsin, are characterized by bladders which function as traps to catch small animal life. In the terrestrial species these bladders are usually rudimentary or lacking. The Wisconsin species of the Bladderworts may be identified by the arrangement of the bladders and the leaves as well as by the floral characters. The scales on the flowering scapes and the bracts which subtend the flowers also show characters which assist in identification.

The maps of distribution included in this report are compiled from collections in the herbaria of the University of Wisconsin, the University of Minnesota, the Milwaukee Public Museum, the Gray Herbarium, The Field Museum of Natural History, Mr. S. C. Wadmond of Delavan, Wisconsin, and Mr. Newton T. Bobb of Northland College, Ashland, Wisconsin.

Grateful acknowledgement is made to Dr. N. C. Fassett for his guidance during the work, to Mr. A. M. Fuller, Dr. F. K. Butters, Mr. S. C. Wadmond, and Mr. N. T. Bobb for the loan of the specimens from the various herbaria; and to Mr. C. A. Weatherby and Dr. J. H. Barnhart for information related to the distribution of some of the species.

A. Plants without bladders or very rarely with rudimentary, beaked, bladders; terrestrial on sand, mud or sphagnum bogs; a single stalk bearing a few flowers at the top; the bract subtending the flowers connate (Fig. 2), or with an inner pair of lateral bracts (Fig. 6).

B. Bract subtending the flower connate; pedicels long, extending beyond the bract; a number of vertical stems along a creeping stem; leaves with a few small spineless lobes; flower purple, single and resupinate. . . . . *U. resupinata.*

BB. Bract subtending the flowers tapering to a sessile base and with an inner pair of lateral bracts; pedicels very short, not extending beyond the bracts; leaves entire, rarely seen; flowers yellow, one to five, not resupinate, spur of the corolla pendant and shorter than the lower lip. . . . . *U. cornuta*

AA. Plants bladder-bearing, but the bladder-bearing portion sometimes lost in collecting; aquatic; the bract subtending the flowers peltate (Fig. 5), cordate-sessile (Fig. 3), or tapering to a sessile base (Fig. 4).

C. Leaves absent, the bladders borne directly on the tips of the lesser stems which are whorled; scape scales absent; bracts peltate; corolla purple; pedicels erect in fruit. . . . *U. purpurea.*

CC. Leaves present, the bladders borne on the same or separate stems from the leaves; stems not whorled; scape scales lacking or cordate-sessile, bracts cordate-sessile or tapering to a sessile base; corolla yellow; pedicels erect or recurved in fruit.

D. Ultimate segments of the leaves linear with the tip long-tapering from a definite point on the segment, flattened, midrib present in the ultimate segments; leaf segments dichotomously to trichotomously divided; scape scales and bracts cordate-sessile.

E. Bladders on separate stems from the flattened leaves (Fig. 1); leaves profusely denticulate-spinose (under a lens); spur of corolla appressed to and almost as long as the lower lip; pedicels ascending in fruit. . *U. intermedia.*

EE. Bladders on flattened leaves; segments denticulate only at the tip or occasionally at the sides; spur of corolla short, almost lacking; pedicels recurving in fruit. . *U. minor.*

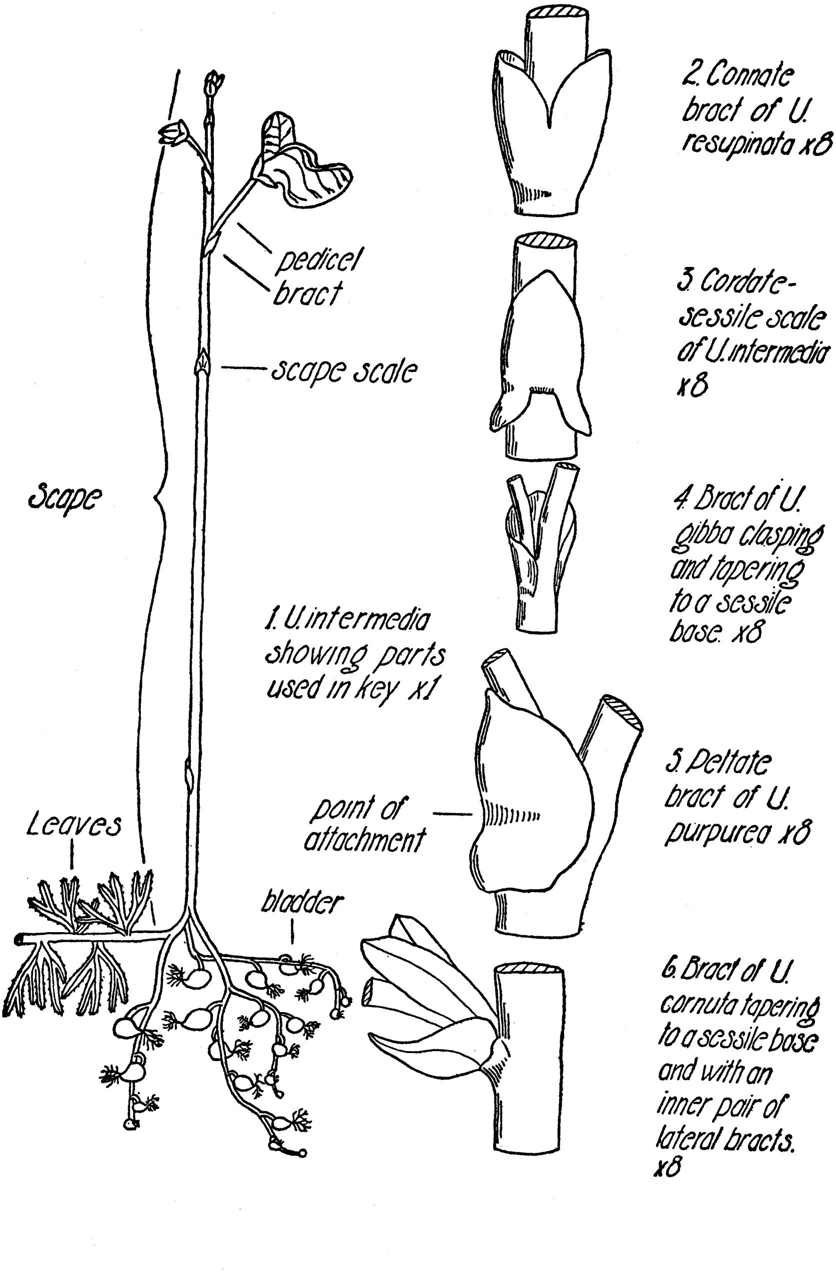
DD. Ultimate segments of the leaves tapering the entire length of the segment, capillary although sometimes appearing flattened when pressed, midrib absent; leaflets pinnately or irregularly divided, dichotomous or single at the base; scape scales lacking or cordate-sessile; bracts cordate-sessile or tapering to a sessile base.

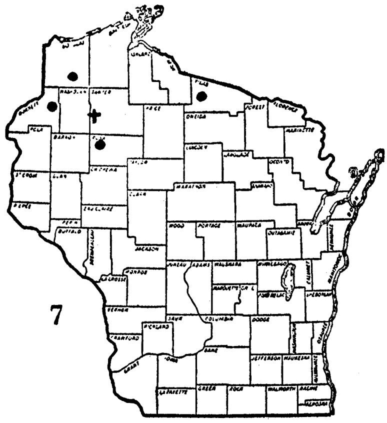
F. Plant stout; flowering scape more than 10 cm. high; the branches long, 3 dm. to over a meter in length, free floating except sometimes attached at one end; leaves dichotomous at the base, pinnately divided; bladders abundant; scapes stout, scaleless or with cordate-sessile scales, bearing 2-20 flowers; pedicels recurved in the fruit.

G. Leaf segments bristly serrulate with elongate spines (under higher magnifications); no cleistogamous flowers present; scapes 6-20 flowered with 1-5 cordate-sessile scales; bracts cordate-sessile. . . . . *U. vulgaris var. americana*

GG. Leaves spineless except for the tips of the segments; cleistogamous flowers present at the base of the scape and scattered along the stems; scapes 2-5 flowered, lacking scales; bracts tapering to a sessile base. . . . . *U. geminiscapa*

FF. Plant slender; flowering scape less than 10 cm. high; the bladder-bearing branches very short, a few cm. long; creeping over mud in shallow water; bladders sparse; leaves single at the base, sparingly and irregularly divided; scapes very slender, bearing one or two flowers; bracts clasping and tapering to a sessile base (Fig. 4); pedicels ascending in fruit. . . . . *U. gibba*


2. Connate bract of U. resupinata x8
pedicel
bract
3. Cordate-sessile scale of U. intermedia x8
scape scale
Scape
4. Bract of U. gibba clasping and tapering to a sessile base. x8
1. U. intermedia showing parts used in key x1
5. Peltate bract of U. purpurea x8
point of attachment
Leaves
bladder
6. Bract of U. cornuta tapering to a sessile base and with an inner pair of lateral bracts. x8



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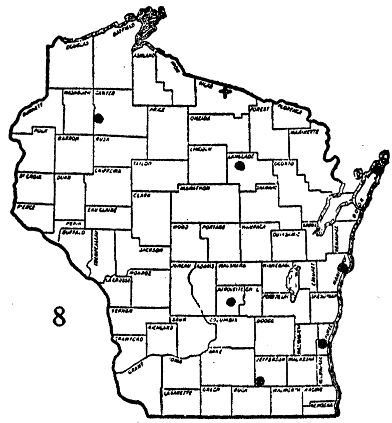
✚ Utricularia purpurea
● Utricularia resupinata



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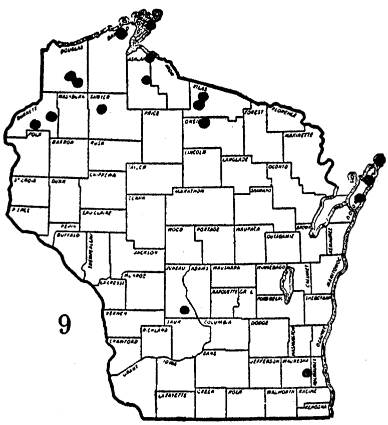
✚ Utricularia geminiscapa
● Utricularia minor



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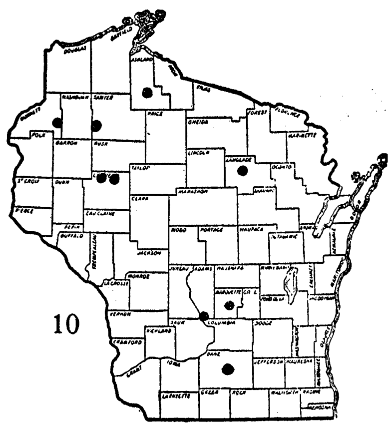
Utricularia cornuta



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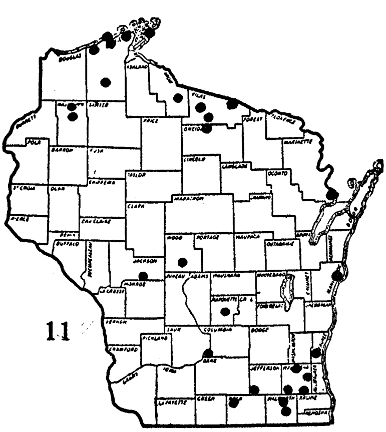
Utricularia gibba



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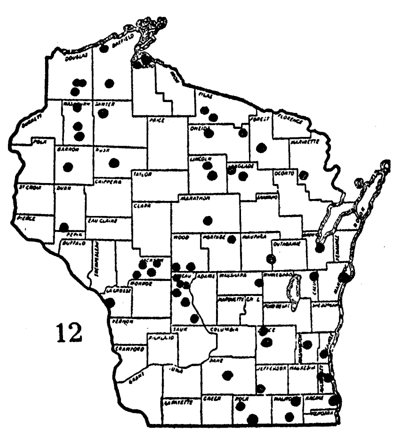
Utricularia intermedia



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Utricularia vulgaris
var. americana

UTRICULARIA RESUPINATA B. D. Greene (Fig. 7, dots) Collected mainly in the northwestern part of the state.

UTRICULARIA CORNUTA Michx. (Fig. 9) Common across the northern part of the state and ranging down along Lake Michigan. One collection in Juneau County near Lyndon Station by J. J. Davis, June 27, 1936.

UTRICULARIA PURPUREA Walt. (Fig. 7, cross) Collected but once in the state in Upper Holly Lake[1] near Stone Lake, Sawyer County, September 4, 1931 by J. H. Steenis (No. 1044, No. 744).

UTRICULARIA INTERMEDIA Hayne. (Fig. 11) Common throughout the state except in the Driftless Area where the drainage is too complete for Utricularia except along the river bottoms which have not been much collected.

UTRICULARIA MINOR L. (Fig. 8, dots) Rare, in the northern part of the state and southward near Lake Michigan.

UTRICULARIA VULGARIS L. var. AMERICANA Gray. (Fig. 12) The commonest species throughout the state.

UTRICULARIA GEMINISCAPA Benj. *U. clandestina* of Gray's Manual. (Fig. 8, cross) Collected but once in the state in pools in marshes near Sayner, Vilas County, by R. Hoffman, August 25, 1916. The specimen on which this report is based is in the Gray Herbarium.

UTRICULARIA GIBBA L. (Fig. 10) Collected in the northwestern sand barren lakes, at the Dells of the Wisconsin River, in the Fox River valley, and in Langlade County. One collection was made in 1894 in Lake Wingra, Dane County, by L. S. Cheney but this station is doubtless now extinct.

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[1] For a discussion of Upper Holly Lake see Fassett, Rhodora xxxvi. 350-351 (1934).

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. XXVIII. CAPRIFOLIACEAE

DOROTHY R. WADE AND DOUGLAS E. WADE

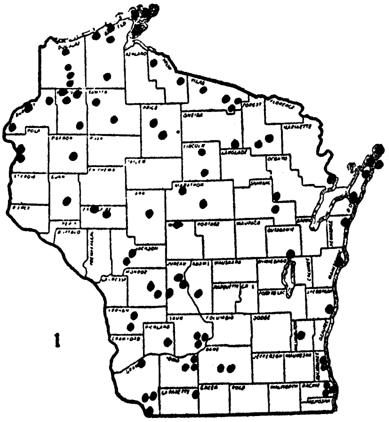
The maps in this report are based on specimens that we have seen in the following herbaria: University of Wisconsin, Milwaukee Public Museum, Mr. S. C. Wadmond, of Delavan, Wisconsin, Mr. and Mrs. F. N. Hamerstrom, Jr., of Madison, Wisconsin, and our own. A list of Wisconsin specimens of the *Caprifoliaceae* in the University of Minnesota herbarium was kindly sent to us by Professor Fred K. Butters. We are indebted to the respective curators for their many courtesies; and we are most appreciative of the assistance and advice of Dr. Norman C. Fassett, University of Wisconsin, in preparing this report.

As the taxonomy of this family is treated adequately in Dr. Fassett's "Spring Flora of Wisconsin", (revised ed. 1938); and in Rosendahl's and Butters' "Trees and Shrubs of Minnesota" (1928) we have made no attempt to supply or repeat keys. Species not included in either of these books are treated in Gray's "New Manual of Botany" (7th ed.).

In this report we have given special attention to the food and cover values of each plant to wildlife in Wisconsin. Outside of our own observations on food habits of various animals, we have drawn freely from other workers and sources in compiling these data and have tried to indicate where known, the authority. A list of references on wildlife food habits is appended. It is hoped that these deviations from the usual type of Preliminary Reports will prove of some aid to present and future workers in the wildlife field.

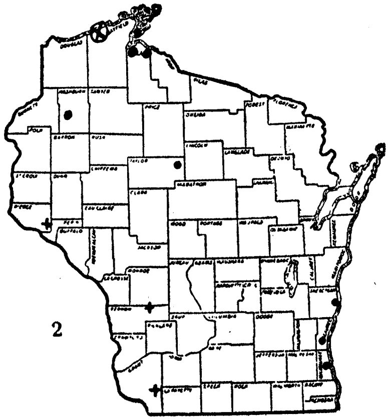
1. DIERVILLA—Bush Honeysuckle

D. LONICERA Mill. (Map. 1). Generally distributed throughout the state, abundant northward and rare southward. Found at base of or on rocky bluffs, on wooded sandstone bluffs, dry quartzite ledges, basalt outcrops, gravelly river banks, wooded, sandy lakeshores, and dry to fresh, rocky woods. Escoll, col-



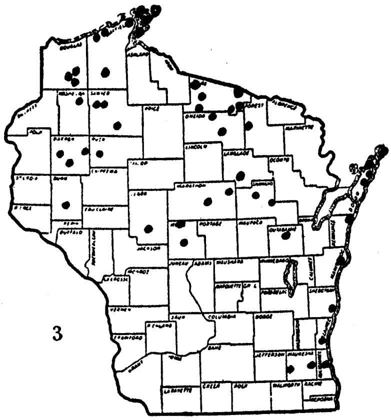
1

Dierville Lonicera



2

● Lonicera caerulea var. villosa
⊗ Lonicera involucrata
✝ Adoxa moschatellina



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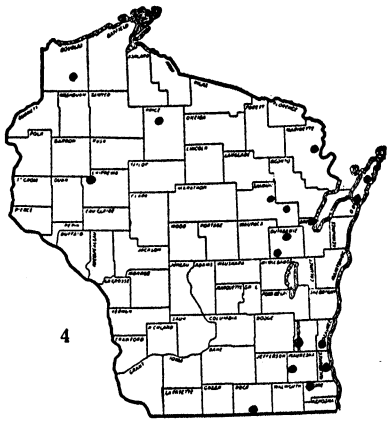
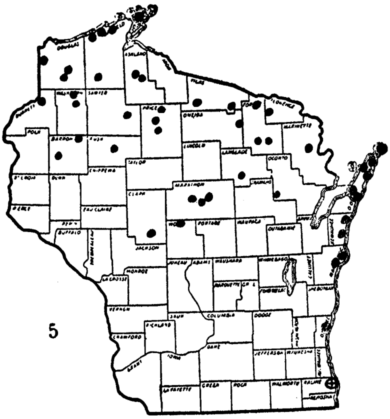
Lonicera canadensis



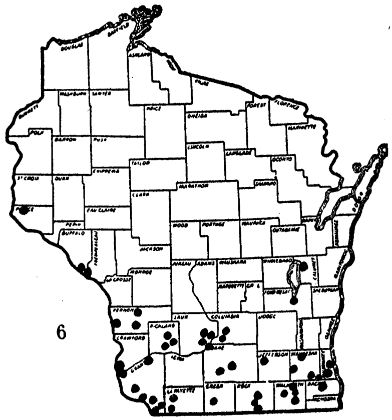
4

Lonicera oblongifolia



5

● Lonicera hirsuta
⊕ Viburnum prunifolium



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Lonicera prolifera

lecting in 1917, reported it to be common on burnt over areas in Price county. Suckers freely and sometimes forms thick clumps. We do not know its wildlife food values, but suspect that it may be browsed by deer. However, due to its low habit, it may be unavailable during winters of heavy snowfall.

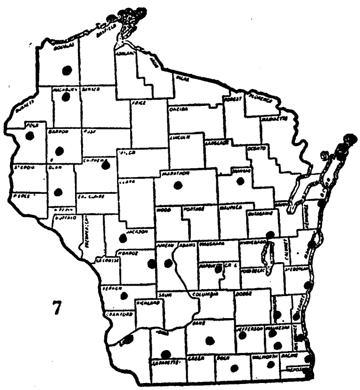
2. LONICERA—Honeysuckles

L. CAERULEA var. VILLOSA (Michx.) T. & G. Mountain Fly Honeysuckle. (Map 2). Rare in deep swamps; confined largely to the northern counties and in bogs bordering Lake Michigan southward to Milwaukee county. A small shrub, with blue-colored berries available June to May. "Generally free from insects and diseases," (Van Dersal). We believe that it is too rare to be of much value to wildlife except locally where abundant.

L. CANADENSIS Marsh. American Fly Honeysuckle. (Map 3). Found throughout the northern part of the state and rarely in bogs south-eastward. Prefers moist, shaded sites. Has been collected in rocky, shaded sites, rich woods, and along shaded banks of streams and lakes. Berry available July to September. We were unable to find any record of its being utilized by birds or mammals in Wisconsin.

L. OBLONGIFOLIA (Goldie) Hook. Swamp Fly Honeysuckle. (Map 4). Rare in swamps northward and eastward. Prefers moist and fairly open sites. Collected in "wet marshes" near Sturgeon Bay, Door county. We have no definite records, but suspect that it may be browsed by deer in Wisconsin. Two writers (Maynard et al. and Howard) state that it is browsed by deer in New York and Michigan. Pearce found this species highly relished by deer in New York State and that it withstood the browsing well.

L. INVOLUCRATA (Richards) Banks. Bearberry Honeysuckle. (Map 2, circled X). Only station in the state is at Port Wing, Bayfield county. Involucre purple, flowers yellow, and fruit a blue-black color. This large shrub prefers moist, shaded sites; suckers freely and may form large patches. "Fruit known to have been eaten by four small birds" (Van Dersal). Same writer says: "Claimed to be poisonous [to stock], but proof is still lacking."



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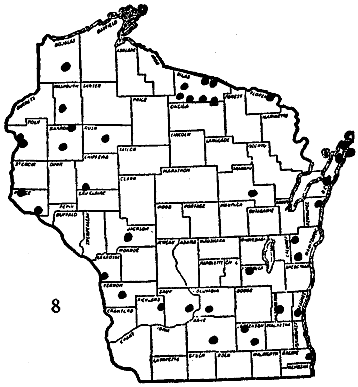
Lonicera dioica



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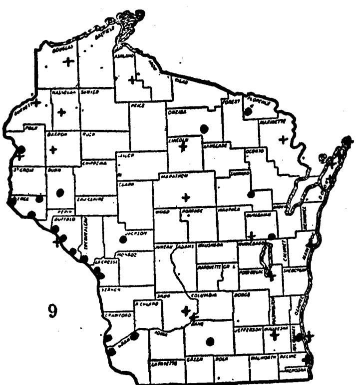
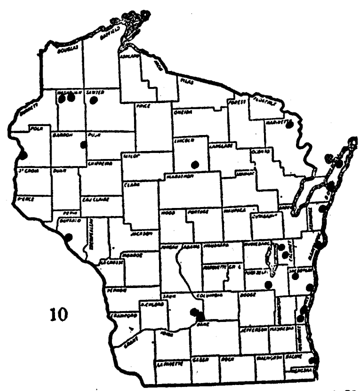
Lonicera dioica var. glaucescens



9

● Symphoricarpus occidentalis
✚ Symphoricarpus albus



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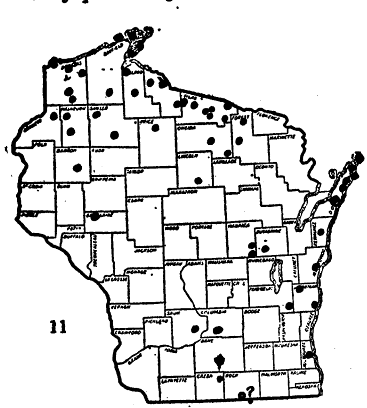
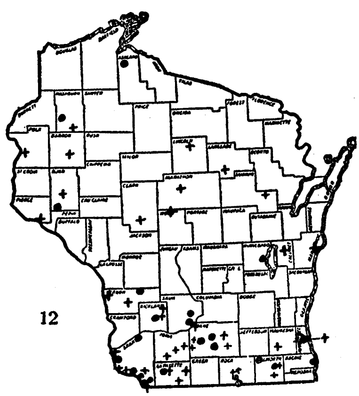
Symphoricarpus albus var. pauciflorus



11

Linnaea borealis var. americana



12

● Triosteum perfoliatum
✚ Triosteum perfoliatum var. aurantiacum

L. HIRSUTA Eaton. Hairy Honeysuckle. (Map 5). Northward coming south to Barron, Wood, and Ozaukee counties. Found in dry thickets, open and rocky woods, occasionally in open swamps and fresh woods. Fruit known to have been eaten by two species of birds (Van Dersal).

L. PROLIFERA (Kirchner) Rehder. *L. Sullivantii.* Sullivant Honeysuckle (Map 6). Southern in range, seemingly avoiding the central sand area, and found northward to Pierce, Columbia, and Calumet counties. This viney-shrub forms tangles that we know have been utilized as cover by pheasants, woodcock, and bobwhite quail in Walworth county. Forbush says that the berries are eaten by bobwhite quail in the New England States. Although locally abundant in parts of southern Wisconsin, we have no records of its being used as food by any wildlife species. In certain pastures in Walworth county, where it was very abundant, we noticed that it was rarely browsed by livestock or damaged by mice and rabbits. This corroborates observations made by Siegler at Lake Mills, Jefferson county.

L. DIOICA L. Mountain or Limber Honeysuckle. (Map 7). Throughout the state except northeastward, and rare in the central sand area where it is found only on the richer sites. Var. GLAUCESCENS (Rydb.) Butters, (Map 8), has the leaves and corolla with spreading hairs, and occupies the same range as the type but is found more abundantly in the northeast counties. Both type and variety prefer some shade, but are found in moist and dry sites. We have no records of either plant serving as wildlife food, with the exception that all the honeysuckles are greatly favored by hummingbirds during the flowering season.

3. SYMPHORICARPUS

S. OCCIDENTALIS Hook. Wolfberry. (Map 9). This shrub is abundant in the prairie regions of Minnesota and northwestern Iowa. Confines itself to the Mississippi and scattered stations northeastward, eastward and southward. One station, although in Illinois just west of Rockton along the C. M. and St. Paul R. R. right of way, collected by S. C. Wadmond, is spotted on the map for the additional evidence that it may offer to those seeking prairie relicts. This region near Rockton is of the oak-opening, prairie type. Has been collected along the river bluffs of the

Mississippi, in limey open pasture near Prescott, Pierce county, on alluvial soil, and in rocky, open sites. Fruit has been known to be taken by pheasants in Nebraska (Swenk) and Iowa (Errington). The latter writer stated that during the dry summer of 1934, wolfberry appeared to be very drought resistant. Fruit is available October to March. Van Dersal, "considers it to be very palatable to stock and an important browse plant. [Also] a good honey-producing plant." We are unaware of any Wisconsin wildlife-use records.

S. ALBUS (L.) Blake. *S. racemosus.* Snowberry. (Map 9, cross). Rocky banks and bluffs, south to Columbia and Racine counties. This small stoloniferous shrub has berries available from August to June. Known to have been eaten by 14 species of birds, including the ring-necked pheasant, ruffed grouse, prairie chicken, and sharp-tailed grouse (Van Dersal et al.). Although this is an imposing list, it is well to keep in mind a statement made by Errington: "Fruits of fleshy consistency or those made up largely of digestion-resistant seeds are quite inadequate as winter-emergency foods for pheasants." It seems justifiable to extend this statement to the species mentioned above, so that the wildlife food importance of snowberry and related plants during the winter will not be over-estimated by both the wildlife worker and the layman.

S. ALBUS var. PAUCIFLORUS (Robbins) Blake. (Map 10). Like the type, but leaves whitened beneath. Intermediate forms exist. Found south to Polk, Columbia, and Racine Counties in rocky woods, and openings. Prefers dry soils. Wildlife value probably same as type.

4. LINNAEA

L. BOREALIS var. AMERICANA L. Twinflower. (Map 11). This creeping, somewhat woody, evergreen is largely restricted to the northern counties; rarely southward as far as Dane, Rock (?), and Milwaukee counties. Found in moist, shady woods, and occasionally in Sphagnum bogs. Has been collected several times northward in association with virgin stands of white pine. The Rock county specimen is labelled "Beloit, June 17, 1884, dry woods. From Herbarium of F. A. Scheuber". The fruit (capsule) has been eaten by ruffed grouse in eastern United States, but we do not know of any Wisconsin records.

5. TRIOSTEUM—Horse Gentian

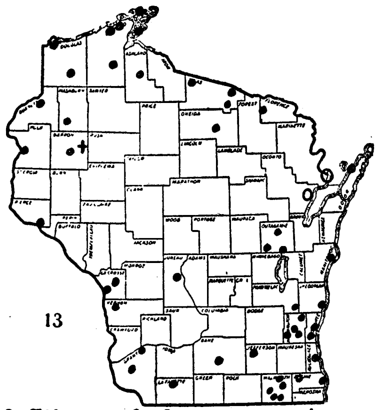
T. PERFOLIATUM L. (Map 12). Largely confined to the southern half of the State, rarely northward. Prefers the heavy soils and apparently avoids the central sand plains. Found in rich woods, open thin woods, rocky ridges, and grassy, wooded pastures. This species has the middle leaves, at least, with their bases united around the stem. Often found with the variety.

T. PERFOLIATUM var. AURANTIACUM (Bicknell) Wiegand. (Map 12, crosses). Leaves narrowed at base, not united. Apparently more northern in range than the type, occupying the same range in the south. Has been collected in rich sites in Clark and Wood counties. The variety flowers earlier than the type. A speciman with three leaves in a whorl was collected by a student at the University of Wisconsin. Unfortunately we did not see and were unable to locate the speciman. Professor Fred K. Butters wrote us concerning this whorled-leaved form as follows: "None of our Minnesota specimens of *Triosteum* has whorled leaves, though I have an impression that at some time I have seen such plants." There are no references, to our knowledge, in the literature to the whorled-leaved *Triosteum,* neither are there references to any of the species being utilized as food by vertebrates.

6. VIBURNUM

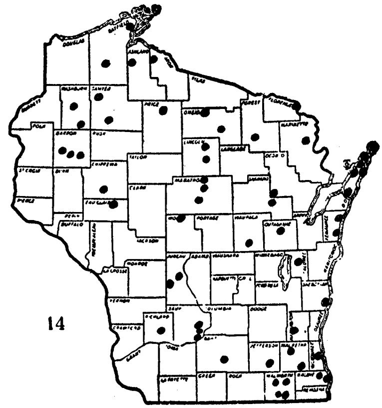
V. OPULUS var. AMERICANUM Ait. American High-bush Cranberry; Pembina. (Map 13). Common throughout the State except in the central sand area. Prefers moist thickets and swamps, although it has been collected in dry, oak woods. Fruit has been taken by sharp-tailed grouse, ruffed grouse, pheasants, and cardinals (Van Dersal *et al*). In Walworth county, we observed pheasants and cardinals taking the fruit as late as December. In some cases fruit was available until late spring. Edible, and makes a very delicious jelly.

V. PAUCIFLORUM Raf. Squashberry. (Map 13, cross). Is more northern in range; found in cold woods north of Lake Superior. One station found in 1933 at Lehigh, Barron county, by N. C. Fassett, at the base of a quartzite talus slope in the Bar-



13

● Viburnum Opulus var. americanum
✚ Viburnum pauciflorum
○ Viburnum cassinoides



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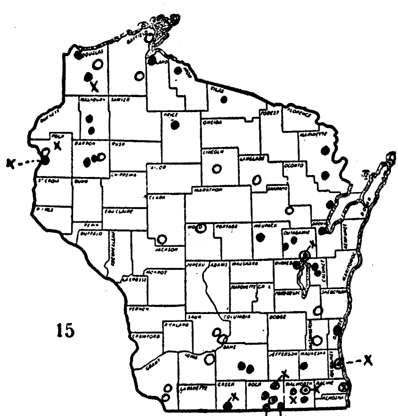
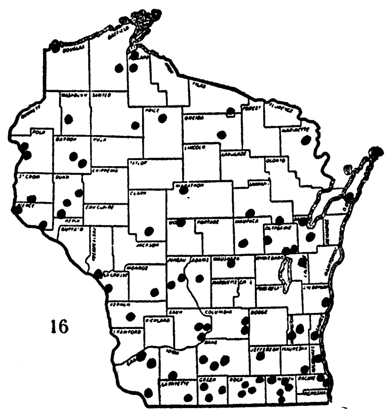
Viburnum acerifolium



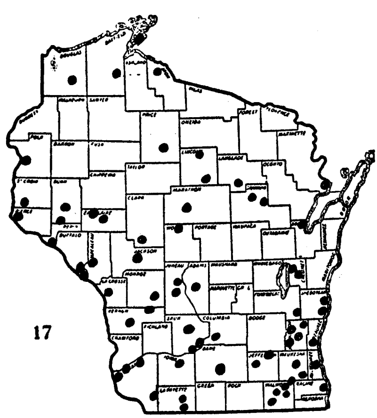
15

○ Viburnum affine var. affine
● Viburnum affine var. hypomalacum
✕ Intermediate forms of two varieties



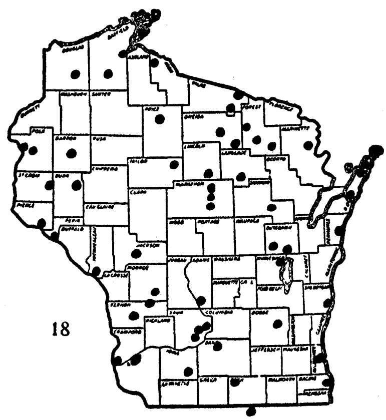
16

Viburnum Lentago



17

Sambucus canadensis



18

Sambucus pubens

ron Hills. Blossoms in June, fruit ripe in late August and early September. Although Wisconsin is not included in the records, Van Dersal writes that the fruit has been eaten by three species of birds, including the ruffed grouse.

V. ACERIFOLIUM L. Maple-leaved Viburnum. (Map 14). Common northward and occasional southward to Richland, Dane and Walworth counties; seemingly rare in the central sand area, although it has been collected twice and reported as seen there in rich woods. In Walworth county we have found it in a basswood-sugar maple associes at four stations. We do not have any Wisconsin records for Wildlife use. Hicks of Ohio, reports that the fruit is eaten by ruffed grouse and that it is available from August to January.

V. AFFINE Bush var. AFFINE Bush, ex Blake. *V. pubescenes* of Gray's Manual. Arrow-wood (Map 15, circles). Leaves not downy beneath, with petioles 5-12 mm. long; much less common than the following variety. Throughout the state except rare in central sand area, where it is has been collected but twice.

V. AFFINE var. HYPOMALACUM Blake. Downy Arrow-wood. (Map 15). Northwestward, eastward, and southeastward. Leaves velvety beneath, with petioles 3-7 mm. long. Between the two above varieties, occur occasional intermediates, with short petioles and smooth leaves, or with long petioles and leaves downy beneath. These are indicated by x's on Map 15. We have observed cardinals eating the fruits of these intermediate forms in October and November. Other wildlife uses in Wisconsin have not been recorded to our knowledge.

V. CASSINOIDES L. Wild Raisin. Map 13, circles). Collected at two stations in Wisconsin, Marinette and Oconto counties. Drupe does not persist very long. Has been taken by ruffed grouse, pheasants, and sharp-tailed grouse in other states. Howard states that *V. cassinoides* is common at Hartwick Pines State Park, Grayling, Michigan, and is heavily browsed by deer. Is considered an important deer food in Massachusetts (Van Dersal). In spite of heavy annual browsing by deer in the swamp regions of New York, Pearce found that it persisted.

V. LENTAGO L. Nannyberry. (Map 16). Throughout the state. Found in dry and moist woods, open, moist pastures and bogs. Prefers heavier soils, but found occasionally on gravelly knolls and in the richer soils of the central sand area. Suckers freely under the crown. Drupe sometimes persists through the winter. We have observed that in spite of moderate browsing by live-stock it does well and fruits heavily. We believe that it would be a satisfactory "living snow-fence" plant in pasture situations in southeastern Wisconsin. We have observed pheasants and Hungarian partridges picking up fallen fruit along open fence-rows in November. On the E. H. Fabrice Farm, Walworth county, it was favored by cardinals and exhausted by early December. Fruit has been known to be taken by ruffed grouse.

V. PRUNIFOLIUM L. Blackhaw. (Map 5, circled plus sign). Only one station in Wisconsin, collected by S. C. Wadmond at Root River, Racine county.

7. SAMBUCUS

S. CANADENSIS L. Common or American Elder. (Map 17). Common southward, occasional northward. Found in pastures, clearings, roadsides, open bogs and swamps, along streams and lakes. During extremely dry summer of 1936, we noticed that it was heavily browsed by cattle wherever accessible. Van Dersal states that the fresh leaves, berries, flowers and roots yield cyanogenetic glucosides, but these break up to form harmless compounds upon cooking. Browsed by whitetailed deer, and fruit known to have been taken by 43 species of birds, including ruffed grouse, pheasants, and bobwhite quail (Van Dersal).

S. PUBENS Michx. *S. racemosa* of Gray's Manual. Red-berried elder (Map 18). Distinctly common northward where it is generally ignored by collectors. Rare southward and consequently taken whenever seen. This will account for the numerous stations in the south as contrasted to those northward. Less common in the central sand plains than *S. canadensis*. Favors drier sites than the preceding species. Found in dry oak woods, at the base of rocky bluffs, on quartzite cliffs, and occasionally along sandy river bottoms. Flowers and matures fruit earlier than *S. canadensis*. Wildlife value not known. Both elderberry species are drought resistant and will sprout from roots when tops are killed back by unfavorable conditions or browsing.

8. Adoxa

A. Moschatellina L. Moschatel. (Map 2, crosses). Has been collected at three stations in southwestern Wisconsin. In a letter, Professor Fred K. Butters wrote: "It is fairly common in the deep valleys on the Minnesota side of the Mississippi from Cannon Valley (West of Red Wing) southward to Decorah, Iowa. It also occurs in the vicinity of Duluth and Thompson, Carlton county."

We lack information on wildlife uses.

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PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. XXIX. ANACARDIACEAE

NORMAN C. FASSETT

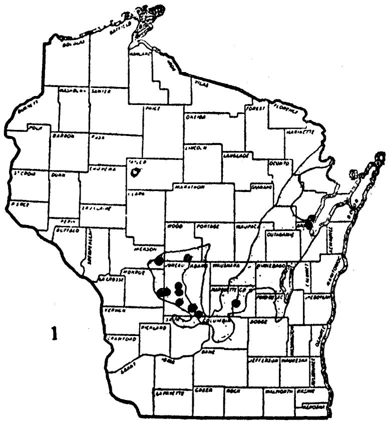
RHUS, our only genus of Anacardiaceae, has recently been monographed by Dr. F. A. Barkley.[1] This monograph has here been followed in its main features, except for the recognition of the Poison Ivy and Poison Sumach as constituting a separate genus in Dr. Barkley's paper. The species of *Rhus* occurring in Wisconsin may be recognized as follows:

a. Panicles erect, dense; fruit red, densely pubescent; plants non-poisonous ..*b*
- *b.* Leaves pinnate, with 5-many leaflets ..*c*
  - *c.* Rachis of leaves winged .... 1. *R. copallina.*
  - *c.* Rachis of leaves not winged ..*d*
    - *d.* Twigs and petioles densely velvety ..*e*
      - *e.* Leaflets toothed ....2. *R. typhina.*
      - *e.* Leaflets deeply cut ....2a. *R. typhina* f. *dissecta.*
    - *d.* Twigs and petioles not velvety ..*f*
      - *f.* Twigs with close hairs; fruits with hairs 1 mm. long ....3. *R. pulvinata.*
      - *f.* Twigs glabrous or with scattered hairs; fruits with hairs 0.5 mm. or less long ..*g*
        - *g.* Twigs glabrous; fruits with hairs about 0.2 mm. long ....4. *R. glabra.*
        - *g.* Twigs sparsely hairy; fruits with hairs about 0.5 mm. long ....4a. *R. glabra* var. *borealis.*
- *b.* Leaves 3-foliolate ..*h*
  - *h.* Terminal leaflet broadest at or below the middle ....5. *R. aromatica.*
  - *h.* Terminal leaflet broadest above the middle ....6. *R. trilobata.*

a. Panicles drooping, loose and open; fruit white, glabrous or nearly so; plants poisonous to the touch ..*i*
- *i.* Leaflets 3 ....7. *R. Toxicodendron.*
- *i.* Leaflets many ....8. *R. Vernix.*

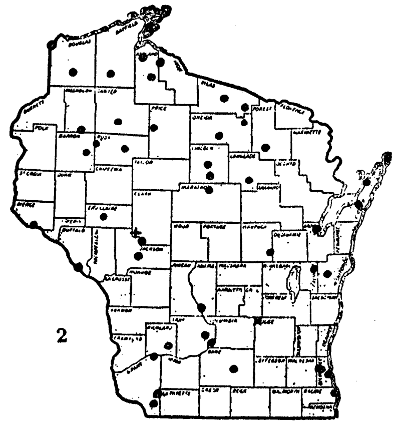
1. R. COPALLINA L. Dwarf Sumach. (Map 1). In sandy soil in a limited area in central Wisconsin, and near Green Bay on both sides of the Oconto-Brown County line. This range recalls that of *Hypericum Kalmianum*[2] in being limited by the beds of

[1] Ann. Mo. Bot. Gard. xxiv. no. 3: 265-498 (1937).
[2] See McLaughlin, Trans. Wis. Acad. xxvi. 282-285 (1931).



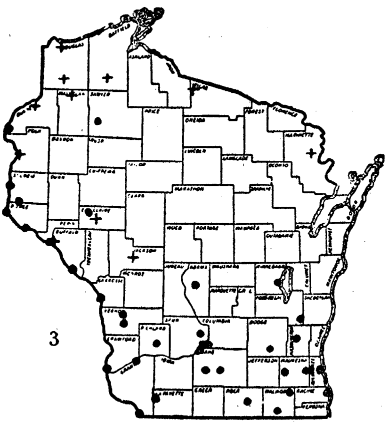
1

• R. copallina



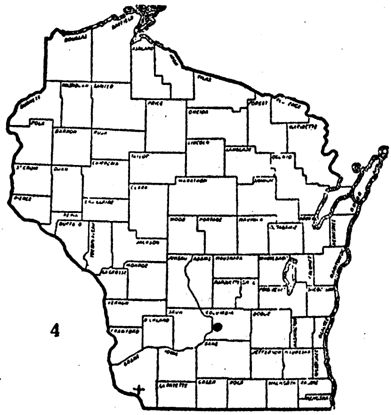
2

• R. typhina
\+ f. dissecta
× R. pulvinata



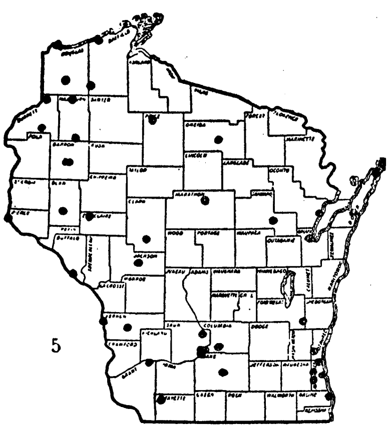
3

• R. glabra
\+ var. borealis



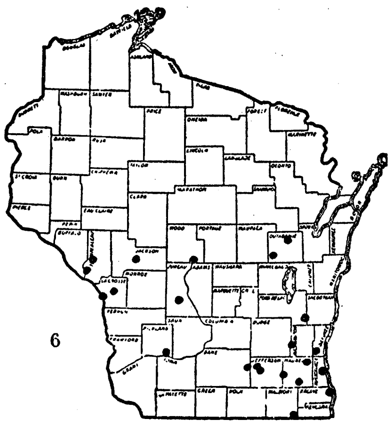
4

\+ R. aromatica
• R. trilobata



5

• R. Toxicodendron



6

• R. Vernix

glacial lakes; the stippeled area on the map indicates Lake Wisconsin, to the west, and Lake Oshkosh, to the east. Reference to a map of the whole range of the species[3] shows the stations in this state (not indicated on Barkley's map) to be some 200 miles to the northwest of any other localities. This isolation is probably to be explained as isolation and survival during the later stages of the Pleistocene in the Driftless Area, and subsequent migration on the shores of early post-glacial lakes Wisconsin and Oshkosh.

2. R. TYPHINA Torner. Staghorn Sumach. (Map 2), large and small dots. The large dots represent herbarium specimens, and the small ones show the range as recorded by L. S. Cheney in 1897 and 1898.[4] In habit this varies from a shrub to a small tree, and the inflorescence is very variable in size, compactness, and color of fruits, the latter ranging from bright red almost to black.

2a. R. TYPHINA f. DISSECTA Rehder. *R. typhina* var. *laciniata* Wood. (Map 2, cross). Barkley treats this as a variety, but it is of sporadic occurrence and so appears better classified as a form.

3. R. PULVINATA Greene. (Map 2, x). Intermediate between *R. typhina* and *R. glabra,* and probably a hybrid between them. Since Map 2 was engraved, it has been observed at Roxbury and at Coon Valley, and is probably not infrequent throughout much of the state.

4. R. GLABRA L. Smooth Sumach. (Map 3, dots). Abundant in the southwestern third of the state, and largely replaced northward by the next.

4a. R. GLABRA var. BOREALIS Britton. (Map 3, crosses). A northern variety reported by Barkley from Ontario, northern Michigan and northern Minnesota. This replaces the smooth phase of the species in northern Wisconsin, and has also been collected (since Map 3 was engraved) in Milwaukee County.

5. R. AROMATICA Ait. (Map 4, cross). This is included in the *R. canadensis* of Gray's Manual, ed. 7. The only collection in Wisconsin is one by T. J. Hale, labelled "Platte River, 1861".

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[3] Barkley, lc., p. 318. The apparent isolation about the head of Lake Michigan becomes less marked when the map in Deam's Shrubs of Indiana is consulted.

[4] See Trans. Wis. Acad. xxv. 177 (1930).

This is about 150 miles north of the nearest known locality in Iowa.

6. R. TRILOBATA Nutt. (Map 4, dot). This also is included in the *R. canadensis* of Gray's Manual. It was collected in 1936 on a sandstone hillside near Durward's Glen, Sauk County, by G. F. Sieker. Its occurrence here represents a considerable extension of range eastward from its nearest known stations in east-central Iowa. It is probable that the isolation of this species and of the last in south central and southwestern Wisconsin is connected in some way with lack of glaciation in this region.

7. R. TOXICODENDRON L. Poison Ivy. (Map 5). Throughout the state, and of course more abundant than is indicated by the number of collections in herbaria. Variable in habit, although the individuals in any region tend to be nearly uniform.

8. R. VERNIX L. Poison Sumach. (Map 6). In Sphagnum bogs and at their margins in the southern half of the state.

The ranges here presented are based on material in the Herbaria of the Milwaukee Public Museum, of Mr. S. C. Wadmond, and of the University of Wisconsin.

PRELIMINARY REPORTS OF THE FLORA OF WISCONSIN. XXX. RHAMNALES

RICHARD W. POHL

The specimens upon which this report is based are deposited in the herbaria of the University of Wisconsin, the Milwaukee Public Museum, Ripon College, and of Mr. Samuel C. Wadmond, of Delavan, Wisconsin. The work was done in cooperation with the Department of Botany of the Milwaukee Public Museum. The author wishes to acknowledge the loan of specimens by Dr. N. C. Fassett and Mr. S. C. Wadmond and to thank Dr. E. S. McDonough for his guidance and encouragement during the course of the work.

RHAMNACEAE—Buckthorn Family

RHAMNUS

R. alnifolia L'Her. Alder Buckthorn. (Fig. 1). Swamps and tamarack bogs, mostly in the glaciated area. The two stations in Richland County in the Driftless Area are in the Hub City and Sextonville bogs.[1]

R. cathartica L. Common Buckthorn. (Fig. 2). Cultivated and occasionally escaping into thin woods in the southeastern part of the state. While this species ordinarily forms an erect shrub, it occasionally becomes a small tree. One specimen in the Menomonee River Valley at Wauwatosa resembles a mature apple tree in form, having several trunks which range from four to six inches in diameter. Increment borings taken in February, 1939, at the three foot level, showed that the trunks were twenty-nine years old.

R. lanceolata Pursh. Lance-leaved Buckthorn. (Fig. 3). Hillsides and limestone ledges, southern Grant County.

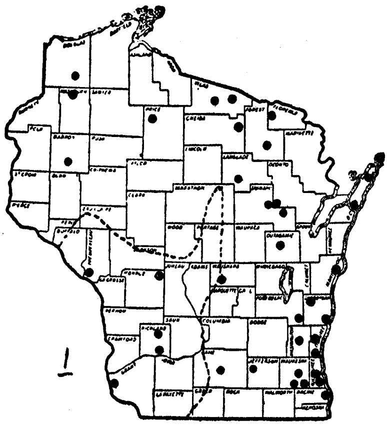
R. Frangula L. (Fig. 2). Escaping from cultivation in the Menomonee River Valley, Wauwatosa, and the Township of Bloomfield, Walworth County.

CEANOTHUS

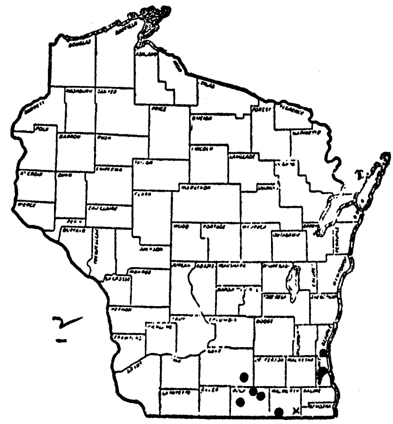
C. americanus L. New Jersey Tea. (Fig. 4). Common and widely distributed in open dry places and thin woods, especially in the southern half of the state. In southeastern Wisconsin, this species is common in the Kettle Moraine Area.

C. ovatus Desf. Inland Jersey Tea. (Fig. 5). Less common than the previous species, and more northern in distribution. On dry soil, in the open or in thin woods, and on the dunes along Lake Michigan.

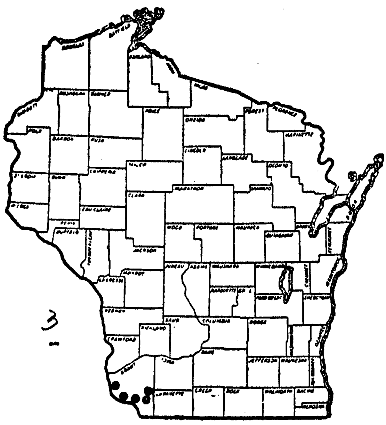
[1] See Hansen: The Tamarack Bogs of the Driftless Area of Wisconsin. Bulletin Public Museum Milwaukee, 7:246. 1933.



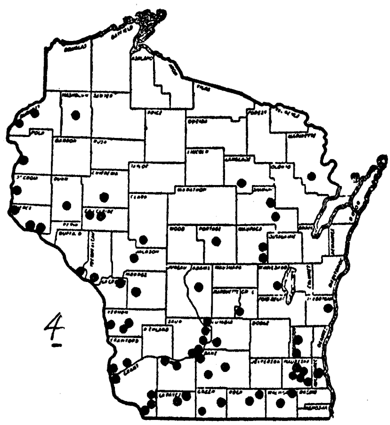
Rhamnus alnifolia



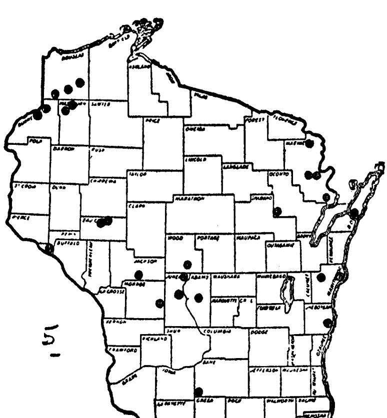
•Rhamnus cathartica
×Rhamnus Frangula



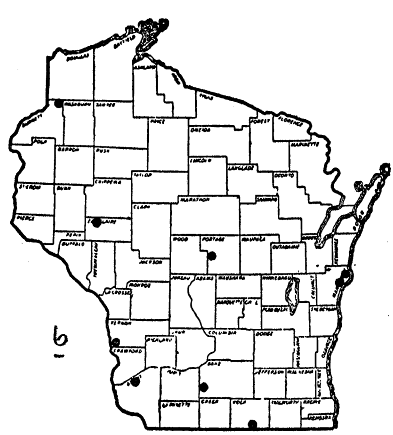
Rhamnus lanceolata



Ceanothus americanus



Ceanothus ovatus



Ceanothus ovatus
var. pubescens

C. ovatus var. *pubescens* T. & G. (Fig. 6). Leaves more or less brownish-pubescent, especially on the undersides. Intergrades with the typical form and found in similar situations.

VITACEAE—Grape Family

VITIS

a. Leaves glaucous or reddish tomentose or webby beneath
  - b. Leaves and new growth strongly reddish—tomentose, at least when young .... *V. aestivalis*
  - b. Leaves and new growth nearly glabrous; leaves whitened or glaucous beneath .... *V. aestivalis,* var. *argentifolia*

a. Leaves green on both sides, not tomentose or webby.
  - b. Leaves, petioles, and young canes glabrous or nearly so at maturity .... *V. riparia*
  - b. Leaves, petioles, and young canes permanently pilose .... *V. riparia,* var. *syrticola*

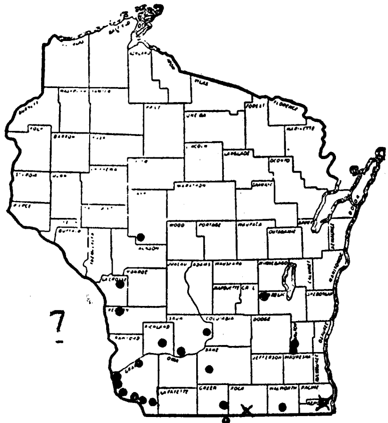
V. aestivalis Michx. Summer Grape. (Fig. 7). Immature leaves and young growth ferruginous-tomentose, the tomentum largely disappearing after maturity. Collected in Wisconsin only at Beloit, Rock County, and Petrifying Springs, Kenosha County. The common form of this species in the State is the variety *argentifolia*:

V. aestivalis, var. *argentifolia* (Munson) Fernald in Rhodora 38:428. (1936). Silverleaf Grape. (Fig. 7). *V. bicolor* Auth., *V. argentifolia* Munson, *V. Lecontiana* House. Young growth nearly glabrous, leaves conspicuously whitened or glaucous beneath. Intermediates between typical *V. aestivalis* and this variety are frequently found in Wisconsin. It occurs in the southern and western counties, north to Trow, Clark County, in the Black River drainage; Devil's Lake, and Ripon. Most of the stations for this variety lie in the drainage basins of rivers tributary to the Mississippi (Black, Wisconsin, Sugar, Rock, and Des Plaines). On hillsides and in sheltered valleys, as at Lake Geneva and Devil's Lake, on a variety of soils ranging in pH from 4 to 7. Rare and of sporadic occurrence except in the extreme southwestern part of the State.

The silverleaf grape has in the past been regarded as a distinct species. Fernald[1] in 1936 reduced it to the status of a variety of *V. aestivalis.* Because of the presence in Wisconsin of numerous intermediates between these two and the occurrence of wide variation among individuals in isolated colonies (such as that located in sec. 25, Township of Erin, Washington County), Fernald's disposition of this plant has seemed more satisfactory and has been accepted in the present paper.

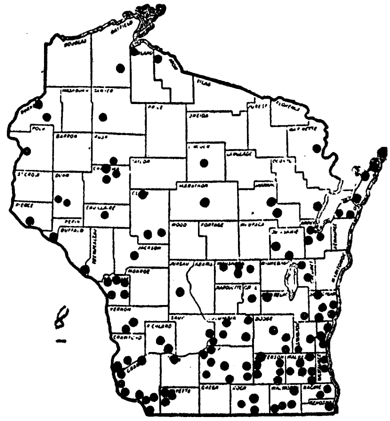
V. cinerea Engelm. This species has been reported once from Wisconsin, the report being based upon a specimen in the Herbarium of the University of Wisconsin, collected by J. J. Davis at Wyalusing, June 12, 1913. The specimen, originally determined as *V. bicolor,* is a vine tip with three leaves and several young inflorescences. The sheet bears the notation by L. H. Bailey, "*V. cinerea* Engelm. L.H.B. 1934". The specimen lacks the marked grayish tomentum which is characteristic of young growths of *V. cinerea.* Such slight tomentum which remains on the unexpended leaves and axis of the inflorescence is pinkish, not gray. In the hope of finding

[1] Fernald, M. L.: Plants from the Outer Coastal Plain of Virginia. Rhodora 38:428 (1936).



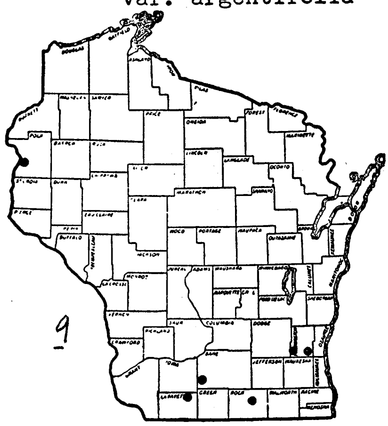
7

× Vitis aestivalis
• Vitis aestivalis var. argentifolia



8

Vitis riparia



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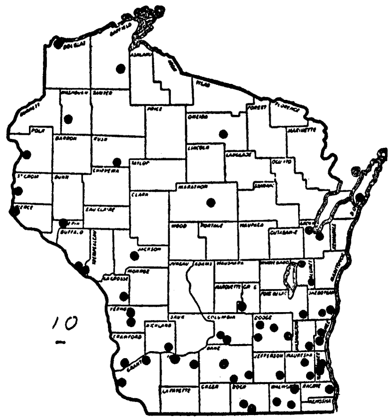
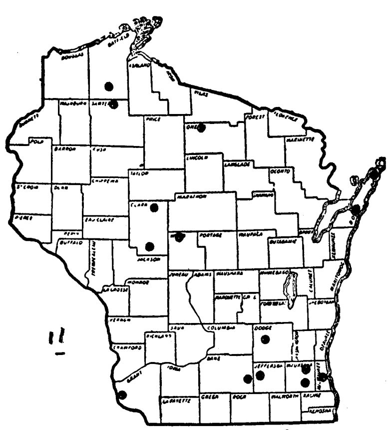
Vitis riparia var. syrticola



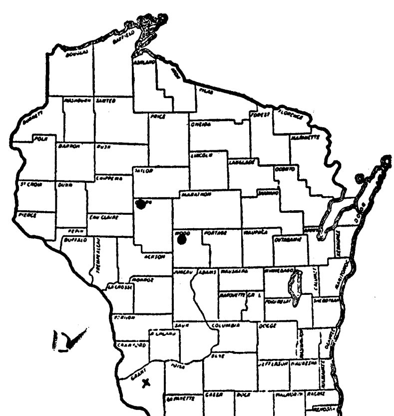
10

Parthenocissus vitacea



11

Parthenocissus vitacea forma dubia



12

• Parthenocissus quinquefolia
× Parthenocissus quinquefolia forma hirsuta

this species in the State, the author surveyed the Wyalusing area in 1935. *V. aestivalis* var. *argentifolia* was found growing abundantly and to great size on wooded hills near Wyalusing, but *V. cinerea* could not be found. In view of the prevalence of *V. aestivalis* var. *argentifolia* in this area, it seems probable that the Davis specimen represents an atypical form of that variety.

V. riparia Michx. Frost Grape. (Fig. 8). *V. vulpina* L. Man. Ed. 7. Vigorous vine, common in thickets, along fence rows, and in woods, especially in the southern half of the State.

V. riparia Michx., var. *syrticola* (Fernald and Wiegand) Fernald in Rhodora 41:431 (1939). Dune Grape. (Fig. 9). Petioles, undersides of leaves, and young canes pilose. Brushland and dry, open situations. Occasional, with type.

Parthenocissus

a. Inflorescence regularly forking, its main branches equal or nearly so; tendrils without well developed adhesive disks.

- b. Plant nearly glabrous .... *P. vitacea*
- b. At least the young parts somewhat pubescent .... *P. vitacea*, forma *dubia*

a. Inflorescence paniculate, not regularly forking; tendrils often with well developed adhesive disks.

- b. Plant nearly glabrous .... *P. quinquefolia*
- b. At least the young parts pubescent; roots often developed at the nodes .... *P. quinquefolia*, forma *hirsuta*

P. vitacea (Knerr) Hitch. Virginia Creeper. (Fig. 10). *Psedera vitacea* (Knerr) Greene, *Parthenocissus quinquefolia* var. *vitacea* (Knerr) Bailey. Throughout the state, common southward.

P. vitacea, forma *dubia* (Rehder) Fernald in Rhodora 41:430. (1939). (Fig. 11). Occasional, often scarcely distinguishable from the type.

P. quinquefolia (L.) Planch. (Fig. 12). *Psedera quinquefolia* (L.) Greene. Collected twice, along roadsides in Wood and Clark Counties, where it probably was an escape. Common in cultivation.

P. quinquefolia, forma *hirsuta* (Donn) Fernald, in Rhodora 41:429. (1939). (Fig. 12). Collected once in Wisconsin, at Werley, Grant County.

A BUTTERFLY MIGRATION IN MEXICO

ARTHUR H. MOECK

On our return trip from Mexico City, in the summer of 1937, our party passed through a migration of butterflies,—or to be exact,—through two migrations, one of *Libythea bachmani* Kirtl., and the other of *Catopsilia argante* F. I have been an amateur collector for perhaps ten years, and therefore our summer vacation trips have been largely in the nature of collecting escapades as well as sight-seeing tours. The immense migration was, of course, a new experience for us, but being from way up in Wisconsin, such a migration in the semi-desert regions of Mexico left us with the feeling that we were seeing something new to us, but something undoubtedly common and well understood in the region,—much as a distant tourist might watch with curiosity the unloading of tropical bananas on the wharves of say New Orleans.

Great was my surprise upon my return home to find that literature on the subject of butterfly migrations is rather scarce, that such information as exists is quite often pieced together from mere fragments of observation, and that the naturalists and authors involved seem to accept this general field of information as still largely uncharted from a scientist's point of view. Furthermore, the field often appears to be filled with numerous conflicting, or at least overlapping, explanations, opinions and hypotheses as to why, from whence, and whither these gay little creatures fly. Often such an article ends with an appeal to record or report such observations as have been made, in order that such record may, in turn become one source of information out of many from which a fuller, more complete picture may eventually be built. It is not with the feeling that I am an authority on the subject that I offer my notations, for that I by no means am. It is rather with the hope that our modest observations, carefully reported, may prove of value as a link in a picture already partially observed and studied elsewhere, that I herewith present our experiences, especially as they appear in the light of the multitude of explanations and suggestions offered by the various observers and students of the phenomenon of butterfly migrations.

We were traveling leisurely to the northward along the Pan-American Highway, with our car and house-trailer, stopping occasionally to do a bit of roadside collecting. About noon, on August 1, perhaps 75 miles south of Victoria, Tamaulipas, we first noticed a heavy flight of the Snout Butterfly, *Libythea bachmani* Kirtl., headed towards the southeast. This flow lasted quite heavily till early evening, when we reached Victoria. Having settled ourselves for the night, we decided to spend several minutes, just about sundown, to collect a few more of the little migrants. It was then that we first noticed the Large Orange Sulphurs, *Catopsilia argante* F., flitting in the same direction in larger and larger numbers.

When morning came we found that the *bachmani* migrations had largely been pushed out of the picture by the immense swarms of *argante*. Several hours during the day of August 2 were spent collecting specimens in nearby fields, in and about Victoria. Early on August 3 we left northward towards Monterrey. We encountered the *argante* in huge numbers until about Linares, Nuevo Leon, a distance of nearly one hundred miles north of Victoria. From there on a few stragglers were still to be seen, but soon all evidence of a migration began to disappear.

Throughout, the migrations were in a southeasterly direction, apparently toward the Gulf of Mexico. Dr. Comstock, in his "Butterflies of California," tends to imply that in such migrations butterflies seem to prefer to fly against the wind rather than with it, as this appears easier for the insect. He says that only in storms or severe winds do they tend to go with the current.[3] It is of interest here that over our entire migration route, a distance of 150 to 175 miles, both species were soaring with the wind, a breeze at times hardly noticeable and at other times quite evident. In this respect we find reference to a L. *bachmani* Kirtl. migration in Texas, in 1894, apparently the first *bachmani* migration recorded, as going eastward with the wind,[8] and another in the same state in 1916, moving northward, borne by a mild south breeze.[4] Austin H. Clark, United States National Museum, refers to different migrations, one *Danaus plexippus* and the other *Catopsilia eubule,* going in opposite directions across the same field simultaneously.[1] C. B. Williams, Chief Entomologist of Rothamsted Experimental Station, Harpenden, England, points out that an analysis of several hundred records leaves the "with and against the wind" score about 50-50,[9] making one wonder whether the wind is a vital factor at all.

That the C. *argante* especially were soaring with the breeze rather than flying entirely on their own strength, proved particularly exasperating at first. Swinging at them head on with the net, had about the same degree of success as trying to grab a floating dandelion down with the hand. Invariably the current created by the net would cause the orange beauty to float sidewise, over, or under. Finally we discovered that bringing the net up behind the insect proved more practical.

Some observers have ventured the suggestion that the butterfly migrant tends primarily to fly towards the sun. That a southerly direction seems common in our hemisphere, may appear true. In the morning the southeasterly route we observed would coincide with this theory, but no shift of direction was observed as the sun worked its way from southeast to southwest. Also, our first migrating C. *argante* F. were met at about sundown, moving southeastward, with the sun directly on the western horizon,—large, clear, bright, and certainly attractive.

The primary cause of such migrations as have been discussed, has created quite a bit of observation and speculation. Food shortage is often mentioned as a basic reason. Dr. Comstock points out that the Painted Lady, *Vanessa cardui* L., and the California Tortoise-shell, *Vanessa californica* Boisd., find migration a necessity when the food source becomes largely used up.[3] On the other hand, George W. Knight of San Marcos, Texas, reported the Snout Butterfly in that state moving over and away from a region where the Hackberry (*Celtis occidentalis*), the main food plant known to the species, was plentiful in the areas involved.[1] Clark suggests that among the *Pierids* migration appears often as the result of an overcrowding condition, involving in the main, only males. It is the surplus of young males, he indicates, escaping the persecution of the older males, which creates the migration picture, in some instances a few of the males later returning, but perhaps more often causing them to just wander on and on, never to return. He refers to migration as merely the "end product of the natural process of the elimination of surplus males".[1] That such an explanation would be a phase of the general "population pressure theory" often advanced,[5] would appear quite evident.

Such a development as Clark suggests would be most natural when food or breeding conditions have been rather favorable for several seasons, it might seem. Another combination here presents itself. Knight relates that in the Texas Snout migration of 1894,[8] there had been a severe drought throughout June and July, followed by several weeks of heavy, warm rains in August, resulting in a more or less simultaneous issuing of a large number of chrysalids,—which would perhaps normally have appeared over a period of say two or three months. The weather conditions, therefore, in this instance, appeared to have been the primary migration causing factor. A similar reference to climatic conditions has been mentioned in the case of a Monarch migration in our eastern states.[1] It might here be noted again that a series of favorable seasons, a general food shortage, or a large, simultaneous emergence due to climatic changes, are in reality only relative angles of the whole "population pressure" approach.

What then, in the view of the above mentioned explanations, were the facts in our observations? Two facts were worthy of attention in this respect. First,—of perhaps 1000 *Catopsilia argante* F. captured, all but perhaps 50 at the most were males. Second,—while in the average day's collecting elsewhere in Mexico perhaps 50 per cent of the specimens caught were in good or excellent condition, nearly all of the argante in this migratory flight appeared perfect. The ratio of good specimens among this same species caught previous to the migration, as well as several days later, was decidedly poorer. The theory of young, healthy males "leaving home" would thus appear plausible. On the other hand, I agree with Mr. Williams,[9] that there was little evidence of "starvation" present in these unmarred, apparently robust chaps.

As regards the weather conditions involved, I report the following facts: Texas, to the northward, had been experiencing somewhat of a dry spell in places as we passed through to the south during the first week in July. The last nine days of the same month we spent at Tamazunchale, San Luis Potosi, about 200 miles south of Victoria. This spot is down in a rich river valley of about 500 feet elevation, just at the foot of the 7000 foot climb towards Mexico City. Here, during the so-called tropical rainy season, we had not been interrupted once in nine days of collecting, by a shower worthy of the name. So severe and unexpected was the drought that the Mexican farmers seriously feared for their crops on the hillsides. I know not what were the weather conditions in the region from whence these Large Orange Sulphurs came, nor even where the region was, except that it was probably to the northwest of Victoria. The preceding drought conditions in the general area, however, seem significant.

There were many variations among the C. *argante* F. taken. Most of them were of the variety Seitz calles *Catopsilia argante agarithe* Boisd.,[7] usually having heavier markings underneath than does the typical C. *argante* F. Perhaps 25 of the total I believed to be *Catopsilia argante miniscula* Btlr., a dwarfed form, which Seitz gives as being found near Havana, Cuba. The female, as is common among *Pierids,* is dimorphic, with the yellow and the albino variety. All of these, both as to sex and variations, were on the trail together. One fact, however, remains to me as very significant. The big, healthy, slender males led all the others. Practically all the females with their relatively heavier bodies, and all the dwarfed varieties of either sex, we found scurrying on behind, during the latter part of the second day.

The ratio of 50 females out of perhaps 1000 caught also brings up another point of interest. That this ratio, even, may be abnormally large is further shown plausible by the fact that of the 50 females, not over 8 or 10 at the most were of the yellow variety, the rest being albinos. When the migration turned out to be a male affair in the main, we naturally tended to spot females for our catch. The yellow females were difficult to recognize ahead of time, hence their ratio to the males may prove more true to facts. The albinos, of course, could be recognized, and it is natural that after picking off males for nearly two days, the net might more readily slip in the direction of the white oncomer.

Another interesting angle may here be raised. This preponderance of males, and especially the fact that they led the procession, would not coincide, in this instance at least, with the suggestion offered by a few authors that some "nuptial flight" factor might be involved in those periodic migrations among lepidoptera.

As we moved northward among the floating C. *argantes*, groups and clusters could be seen about roadside damp spots or moist stones. This phenomenon increased as we progressed, being especially prevalent along the streams we crossed. It seemed to reach its climax along the Rio Pilon, between Hidalgo, Tamaulipas, and Linares, Nuevo Leon. We stopped for an hour or so to look on. Next to the water's edge were huge clusters, areas as large as a table top, with just one compact mass of orange butterflies side by side, usually with wings folded. Such a group could easily have contained several thousand. To get a hundred specimens with a single swing of the net was simple, but to get five out unbroken was another matter. We tried to make estimates of how many we were seeing. To guess at the number of clusters was almost futile, for they seemed to merge one into another as far as the eye could see up or down stream. Disturbing a cluster created a huge, golden cloud. It seems quite possible that the area within view may have contained a million specimens.

I refer to this river incident since Williams,[9] Clark,[1] Seitz,[7] Holland[6] and others occasionally make reference to the gathering of *Pierids* about damp spots, and especially as a possible evidence of an excess number of individuals in the area involved. It may be noted also that the vast majority about the puddle spots were male *C. argante* F. and varieties thereof. There were a few females, some *Terias lisa* Bdv. & Lec., *Catopsilia eubule* L., *Terias mexicana* Bdv., and one or two stray, broken swallowtails.

As regards the *Libythea bachmani* Kirtl., which preceded the flood of C. *argante* F., they were not in as excellent condition as were the latter, fully one half to two-thirds being battered or partially faded. It is interesting that one observer refers to a similar migration of Snout Butterflies in Texas, where the insects soared up as high as the eye could see, literally by the millions, many having evidently completed their alloted span of life and dropping from the air in large numbers.[1] Our impression however was that while the Large Orange Sulphur was soaring high, the Snout seemed to be flying low and with apparent force. The Sulphur seldom struck an object, as the car, the trailer or a building,—rather gracefully floating around it. The Snout, however, seemed to hit the car and the windshield head on, much as a swarm of locusts or beetles might. Their apparent swifter and lower flight than that of C. *argante* may, however, be partly an optical illusion, for while the latter with its large, bright yellow, slowly moving wings was obvious to the eye a block or more distant and perhaps several hundred feet up, the smaller Snout with its somber, grey-tan color and rapidly moving wings was often unnoticed until it dashed by within the range of perhaps 20 to 30 feet. Is it possible that the Snout migration preceding that of the larger number of Large Orange Sulphurs may be comparable to the movements of grasshoppers before a mower? It was noticeable that the tail end of the one migration merged into the beginning of the other.

Another interesting fact is that apparently no migration took place at night. After sundown the procession seemed to halt for the day. We left Victoria early on August 3, in order to get in a full day of observation. We had been on the road perhaps an hour or two, with little evidence of a migration, and we began to think it was over so far as we were concerned. About eight o'clock in the morning, however, the air began to fill up again, and soon the movement was in as full swing as during the previous two days. Where they had settled we do not know, for thinking the migration over, we had failed to look about. They were not, as we remember, very evident on the sagebrush-like desert growths about us before they again took to the air. It was perhaps noon or shortly after, of this third day when we ran into the masses along the Rio Pilon.

I have been asked how rapidly the C. *argante* were flying. My estimate would be perhaps 10 to 15 miles per hour. Their speed was such, and their direction so consistent, that once one had missed a swing of the net, it was useless to pursue that particular insect any further.

And now finally a few remarks as to the number of butterflies and the area involved. I shall limit myself to *C. argante* F. in this case. They were flying in a fairly continuous stream for two days of about ten hours each. At any given time there were perhaps four or five specimens within the range of the swing of one's net. We estimated that an area as large as a good sized room, 25′ x 25′ x 10′, would contain at least 25 specimens, often many more. As to height, they seemed to soar as high as the eye could see the little yellow specks, perhaps a distance of several hundred feet, certainly up to one hundred feet in height, and just as thickly at times as near the ground.

We drove diagonally through the migration, in the main to the northward, the northwest-southeast stream crossing our path at an angle of about 45 degrees. Our course, from the point where we entered the stream to the point where we left it, was about 100 miles. Sketching these facts on a map before me, I would deduct that the area wherein we found ourselves within the migration stream was about 65 miles across, and about 65 miles long. Since 48 hours had elapsed from our time of entry to our time of exit, involving about twenty hours of flying time for the insects, we must assume some 20 x 10 (miles per hour), or 200 flying miles of progress in the meantime. Even assuming that we had entered the beginning of the migration in the evening of August 1, rather than merely cutting into it, and that we had witnessed the end on August 3, instead of merely having gone through it (both assumptions), the migration area would still involve a territory 65 miles wide by perhaps 250 miles long.

That these figures are within the realm of other recorded migrations is shown by Clark's comment that Ellzey in 1888, in observing a Monarch migration says, "There were an innumerable multitude of them at all heights from say 100 feet to a height beyond the range of vision except by the aid of a glass." Again he quotes Hamilton of New Jersey in 1885, as describing an assemblage for migration with, " 'Millions' is but feebly expressive, 'Miles of them' is no exaggeration." In another instance he tells us that McGregor in 1924, refers to a migration as, "at least 40 miles wide and . . . passing for three days at a speed of about six miles an hour."[9] Knight, in Texas, refers to a migration as "about 100 miles square."[8] Perhaps the most breath taking description of a migration of butterflies is that of Cureau, in his "Savage Man in Central Africa", where he tells us, "I have seen clouds of butterflies, all of the same species, passing over a district (in the Congo) for three months at a time, like flakes of red snow, and in such close array that one could destroy dozens of them by throwing one's hat on the ground."[4]

I come now to figures my knowledge of mathematics and my pencil have produced, but which I hesitate to place on paper. If we take our estimate that the space of air equal to a good sized room (25'x25'x10') contained at least 25 specimens, and if we assume that the flight took place mainly within 25 feet of the ground (which I feel is too conservative), how many specimens would an area 65 miles by 250 miles contain? I can hardly accept the results myself, but we get the astounding figure of over 45 billion specimens.

The immensity of the mass of insects is further indicated by the numerous complaints which tourists who had come from the northward made at Tamazunchale the night before our departure (July 31), telling of motor troubles due to clogged radiators, a serious problem, with the temperature hanging around 100 degrees Fahrenheit mark. Upon our arrival at Monterrey on August 3, we heard north bound tourists of a few days previous tell of similar radiator difficulties due to "millions of pests". A number of filling station attendants enroute, we were told, had devised an apparatus whereby with a sort of hose and bellows they could "blow out" the radiators from within, for their customers. And yet, each of these complaints of fellow tourists, both of the southbound and of the northbound, referred to the difficulty as having occurred previous to our arrival in the area, indicating that possibly the *Libythea bachmani* Kirtl. flood may have been more extensive than we thought it to have been. Dead, but apparently good specimens on and along the concrete highway, were very numerous. As one picked them up, they proved to be almost baked specimens dropped from some car radiator, far too brittle for use.

The experience was certainly a novel one for us. At the height of our collecting we had worked out quite a technique of having Mrs. Moeck just keep the cyanide jar "ready for action", while Miss Alice Hasak (a teacher at Merrill, Wisconsin) and I pulled them out of the air. Often we took time out, especially when the two one-quart and the one gallon cyanide jars were filled. We had to be sure the insects were dead, and they had to be put into envelopes. In the midst of the migration our 4000 supply of envelopes gave out, but as luck would have it, a Victoria druggist had an extra 2000 of some Mexican make on hand. We traveled to Mexico, hoping to collect a few butterflies on the way, and "we saw a migration."

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WHAT IS THE RED SQUIRREL?

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In the course of some studies on the male and female reproductive tracts of our native squirrels (Mossman, Lawlah and Bradley, 1932) it became apparent that the red squirrel, *Sciurus hudsonicus* Erxleben, is not properly a member of the genus Sciurus, perhaps not even of the family Sciuridae. Its reproductive tract, either male or female, is much less like that of a typical member of the genus such as the gray squirrel, *Sciurus carolinensis* Gmelin, than are the tracts of such genera as *Glaucomys* (flying squirrel), *Tamias* (chipmunk), *Eutamias* (western chipmunk), *Callospermophilus* (rock squirrel), *Ammospermophilus* (antelope chipmunk), *Marmota* (wood-chuck), *Citellus* (spermophile), *Sciurus vulgaris* L. (common European squirrel), *Petaurista petaurista* (the giant Malasian flying squirrel), and the African genus, *Heliosciurus*. I have examined very carefully all the native genera mentioned and also a specimen of *Heliosciurus* kindly given to me by Professor E. T. Engle. *Sciurus vulgaris* has been very carefully described by Tullberg (1899) and especially well by Krölling (1921). The male tract of *Petaurista petaurista* (Pallas) (*Pteromys nitidus*, Desm.) was described rather superficially by Oudemans (1892). All of these are fundamentally similar to our gray squirrel and exhibit the characteristics listed below.

The reproductive tracts of the male Sciuridae mentioned above are typified by the following features: (1) Seminal vesicles are slightly branched tubular glands varying in size from very small ones in the gray squirrel to very large ones in the spermophile. (2) Prostates are compact tubular glands moderately large in all species and opening by a single pair of ducts. either in common with the vasa deferentia and seminal vesicles as in the gray squirrel and chipmunk, with the vasa deferentia alone as in the flying squirrel, or independently as in the spermophile. (Ducts of *Marmota, Callospermophilus, Ammospermophilus, Eutamias, Petaurista,* and *Heliosciurus* have not been studied.) (3) Muscular urethra long, and in some characterized by regularly arranged value-like folds of its epithelium. (4) Penile urethra with usually no para-urethral glands and no large diverticula or true urethral sinuses. (No information on *Petaurista.*) (5) Cowper's glands are large and conspicuous compound tubular organs each opening by a very broad duct which makes an almost or altogether complete spiral turn before entering the bulb of the penis. (6) A marked glandular enlargement of Cowper's ducts in the bulb results in the formation of a bulbar gland distinct in the nature of its epithelium from the Cowper's glands themselves. This is least developed in *Tamias* and best developed in *Citellus* where it is a cylindrical body with rounded ends, placed transversely in the bulb and measuring as much as 20 x 10 mm. in the rutting season. (7) The two enlarged and modified Cowper's ducts join with one another in the body of the bulbar gland. From this common chamber of the gland a long glandular common duct, the penile duct, drains into the ventral side of the urethra near the distal end of the penis, either distal or proximal to its ventral flexure, depending upon the species. (8) The penis is large, ends in an asymmetrical glans, and always possesses an os penis which is often of very elaborate form.

The fundamental divergences from this in the male red squirrel are: (1) Cowper's glands are minute and entirely enclosed within the sheath of the corpus spongiosum of the bulb, thus being practically impossible to demonstrate by gross dissection. (2) There is no bulbar gland. (3) Cowper's ducts join and drain into the ventral side of the urethra in the bulb by a non-glandular common duct not more than 1 or 2 mm. in length. (4) The bulb is occupied by a large true urethral sinus or diverticulum lined by stratified epithelium. Alongside of it lie the minute Cowper's glands. (5) The penis is very long and ends in a symmetrical filiform tip containing no os penis or suggestion of one. The fact of the complete absence of the os has been determined by serial sections.

The Sciurid female genital tract is much like that of rodents in general, the uterus being either duplex or bipartite (long horned bicornate), depending on the species. The uterus is of the duplex type, that is each horn has its own cervix in the spermophile, woodchuck, and chipmunk. In the chipmunk the two cervical canals run to near the tip of a slender pointed cervix, but open separately. In the spermophile and woodchuck the vaginal openings of the cervical canals are directed somewhat laterally by a rather heavy and protruding intermediate partition which supports the medial tips of the openings. In the flying squirrel the cervical canals seem to be separate practically to the tip of the rather broad folded cervix, but, so far as can be determined by dissection under a binocular, they open together, making the uterus a bipartite instead of a duplex type. In the fox and gray squirrels the uterine canals (probably actually the cervical portions) unite some distance from the external os making their uteri distinctly bipartite. The uteri are of moderate length, being longer in the spermophile than in the gray squirrel, as would be expected from the fact that the spermophile averages about eight young to a litter whereas the squirrel probably averages not more than three or four. The vagina is straight and also of moderate length. It increases in size, particularly in breadth and especially at the cephalic end, at the estrus period.

The red squirrel uterus is distinctly of the duplex type, instead of bipartite like that of the gray and fox squirrel. Yet the most remarkable difference between this species and the gray and fox squirrel is that its vagina is coiled. In an immature female, or one which is sexually inactive, it takes close examination to notice anything unusual; but in a pregnant animal, and especially in a female that is in heat, the vagina presents a striking picture. There is relatively moderate swelling of the vulva during estrus, a phenomenon which is marked in the female gray and fox squirrel. When one opens the abdomen, however, he is astounded to find the uterine end of the vagina projecting out of the pelvis and extending cephalically often to the level of the kidneys. This is well cephalic to the ovaries, so that the uteri extend from the vagina laterally and caudally to the oviducts. Upon closer examination the vagina is seen to consist of a coiled and zig-zag tube bound and ensheathed in a thin transparent coat of smooth muscle and peritoneum. The coiling is mostly confined to the true vaginal portion, that is the part internal to the opening of the urethra. The outer portion or urogenital sinus is only slightly enlarged during heat. In a pregnant animal the vagina is still much enlarged, but is more flaccid. Apparently the hypertrophied fibro-muscular wall is undergoing involution at this time in a manner resulting in enlargement of the vaginal canal. In sexually inactive or young females the vagina appears superficially like that of any other rodent of equal size might, measuring about 30 mm. in length by 2 mm. in width in contrast to 55 x 12 mm. in an animal in heat. However, close examination of the inactive vagina reveals its coiled nature. Apparently the main change at estrus is the hypertrophy of an already coiled structure.

The adaptation of the two sexes to one another is obvious in the long thread-like penis of the male which in the non-erected state in a dead animal measures about 55 mm. in length, whereas the vaginal tube when uncoiled by cutting the ensheathing layer of muscle measures at least 100 mm. from vulva to cervices. The penis of the largest gray squirrel is only about 70 mm. in length and the vagina of the female in heat about 30 mm. in length by 10 mm. in width. It must be kept in mind that all these measurements have been made after fixation of the organ, and so, because of shrinkage, are less than the fresh specimen would have shown. The vagina of the female gray seems relatively short, some of this is due to its heavy muscular wall which undoubtedly undergoes a great amount of fixation shrinkage.

Some of these peculiarities of the red squirrel have been known for a long time. Tullberg (1899) and Pocock (1923) noticed that the glans penis of the red squirrel was symmetrical and contained no os penis. Pocock on this basis placed the red squirrel provisionally in a separate sub-family, Tamiasciurinae, and raised the subgenus *Tamiasciurus* Trouessart to generic rank. He did not know of the absence of the typical Cowper's glands, bulbar gland and penile duct; nor of the presence of the sinus urethrae bulbi. Neither did he observe that the red squirrel's uterus is duplex while that of *Sciurus* is bipartite, or that the former's vagina is coiled while that of *Sciurus* is straight. Howell (1938) recognizes the genus *Tamiasciurus*.

In spite of these marked divergences in anatomy, the relationship of the red squirrel to the Sciuridae as a whole is indicated by the development of its fetal membranes (Mossman 1937). In fact, so far as its membranes are known, they are nearer to those of *Sciurus* than to any other genus. This fact illustrates the conservative nature of the fetal membranes in general. Apparently the male and female genital tracts are more subject to modification in the course of evolution than are the accessory fetal structures.

On the basis of both the male and the female reproductive tracts of the red squirrel it seems that its removal from the genus *Sciurus* is justified and also that it should be placed at least in a separate sub-family, both of which Pocock has done on the basis of the glans and os penis alone. He has used the generic name *Tamiasciurus* and has placed it in a separate subfamily, *Tamiasciurinae*. The details of the reclassification of this animal will have to be worked out by taxonomists who are familiar with the other criteria and with the rules of taxonomy. For a discussion of osteology, dentition, and so forth see Allen (1898) and Howell (1938). For a detailed description of the male genital tracts see Mossman, Lawlah and Bradley (1932).

It would be interesting to know how the interrelations of the whole sciurid group would line up on the basis of anatomy of the reproductive tracts. I have recently examined males and females of *Sciurus fremonti* and find them exactly like the red squirrel. *S. douglasi* undoubtedly would fall into the red squirrel group. In the light of the facts presented here it seems that a survey of the reproductive tracts of the Sciuridae is necessary for their proper classification. Whether intergrading forms are existent, and where, will also be of great interest from the evolutionary stand-point and also from the point of view of animal distribution. Perhaps in the Tamiasciurinae we have a group which has at some period been isolated from other members of the family and, after diverging from the type, may have again been freed to extend its range into territories occupied by the others.

KEY TO PLATES (Figures 2 to 10)

(So far as possible to BNA has been used and the abbreviations correlated with it.)

c., cervices
g.a., glandulae anales
g.p., glandula prostatica
g.s., gestation sac
m.b-c., musculus bulbo-cavernosus
m.i-c., musculus ischio-cavernosus
o., oviduct
p., penis
r., ren
s.u., sinus urogenitalis or urinary portion of the vagina
t., testis
u.c., uterine cornu
u.m., urethra muliebris or female urethra
u.,p.m., urethra, pars muscularis
ut., uterus
v.,ce., vagina, cephalic end
v.s., vesicula seminalis
v.u., vesica urinaria

PLATE I

FIGURE 2. Ventral view of the male reproductive apparatus of the red squirrel in situ. Full functional activity. (Slightly retouched). X 1

FIGURE 3. Ventral view of the female genital tract of the red squirrel in situ showing the position of the cervical end of the vagina when enlarged during the estrus period. This specimen was photographed before fixation about eight hours after death. O., indicates the region of the ovary and oviduct which is well caudal to the cephalic end of the vagina. The right ovary and oviduct with most of the right uterine horn were removed for fixation at the time the animal was shot. (Slightly retouched). X 1

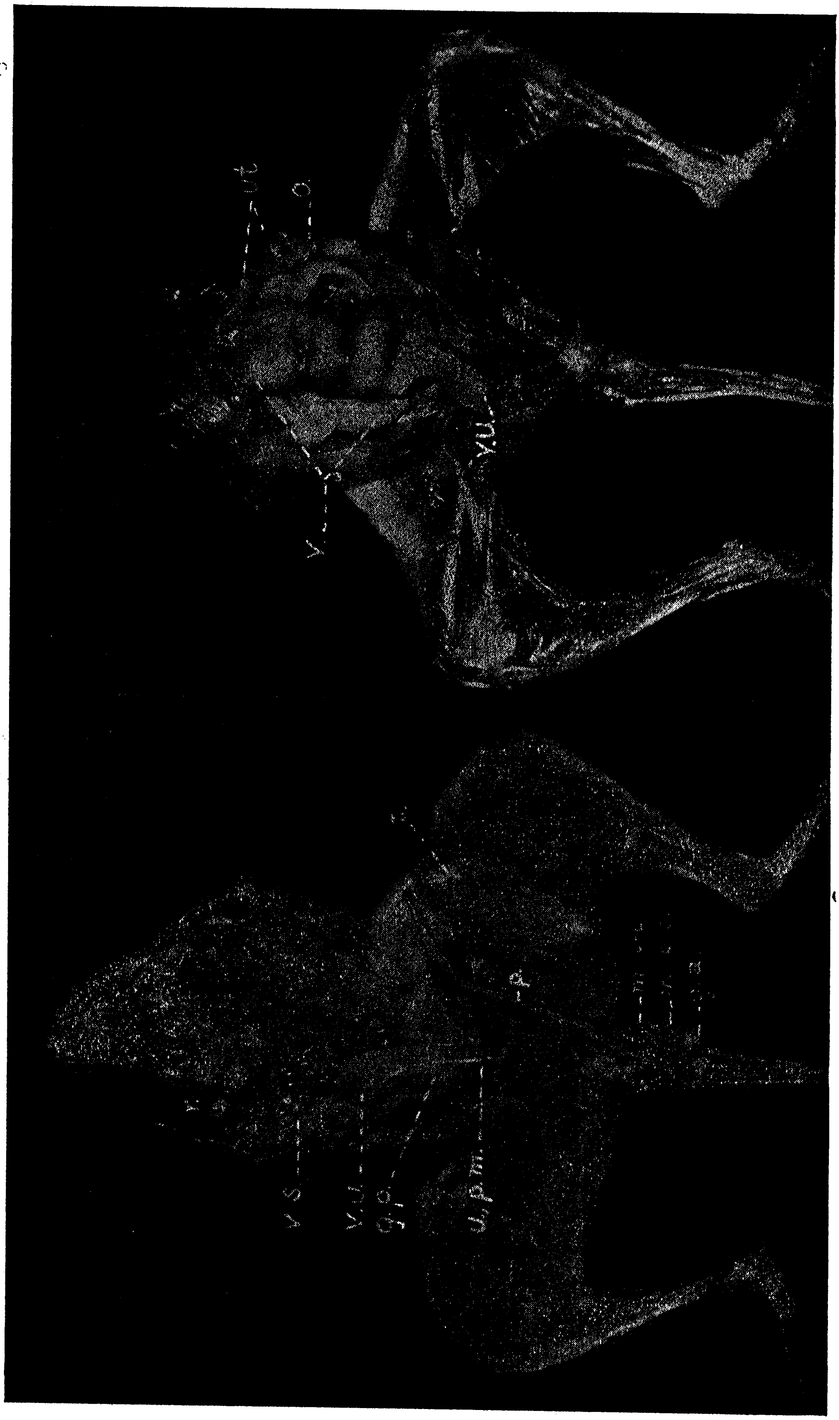


PLATE II

FIGURES 4, 5 AND 6. A series of typical sciurid female genital tracts, in this case the spermophile (*Citellus 13-lineatus*), showing in figure 4 the tract of a sexually inactive adult female, in 5 that of an animal in estrus with the vagina distended by the vaginal plug, and in 6 a pregnant uterus. Ventral views. X 0.7.

FIGURES 7, 8 AND 9. A parallel series of female genital tracts of the red squirrel, showing the enormous enlargement of the coiled vagina during estrus and pregnancy. Figure 7 inactive adult, 8 estrus, and 9 pregnant. Dorsal views. X 1.

FIGURE, 10. The vagina of a red squirrel with the uterine horns cut off and the upper vagina opened to show the two cervices. This specimen was partly uncoiled to show more distinctly the great length of the vagina in this species. Dorsal view. X 1.

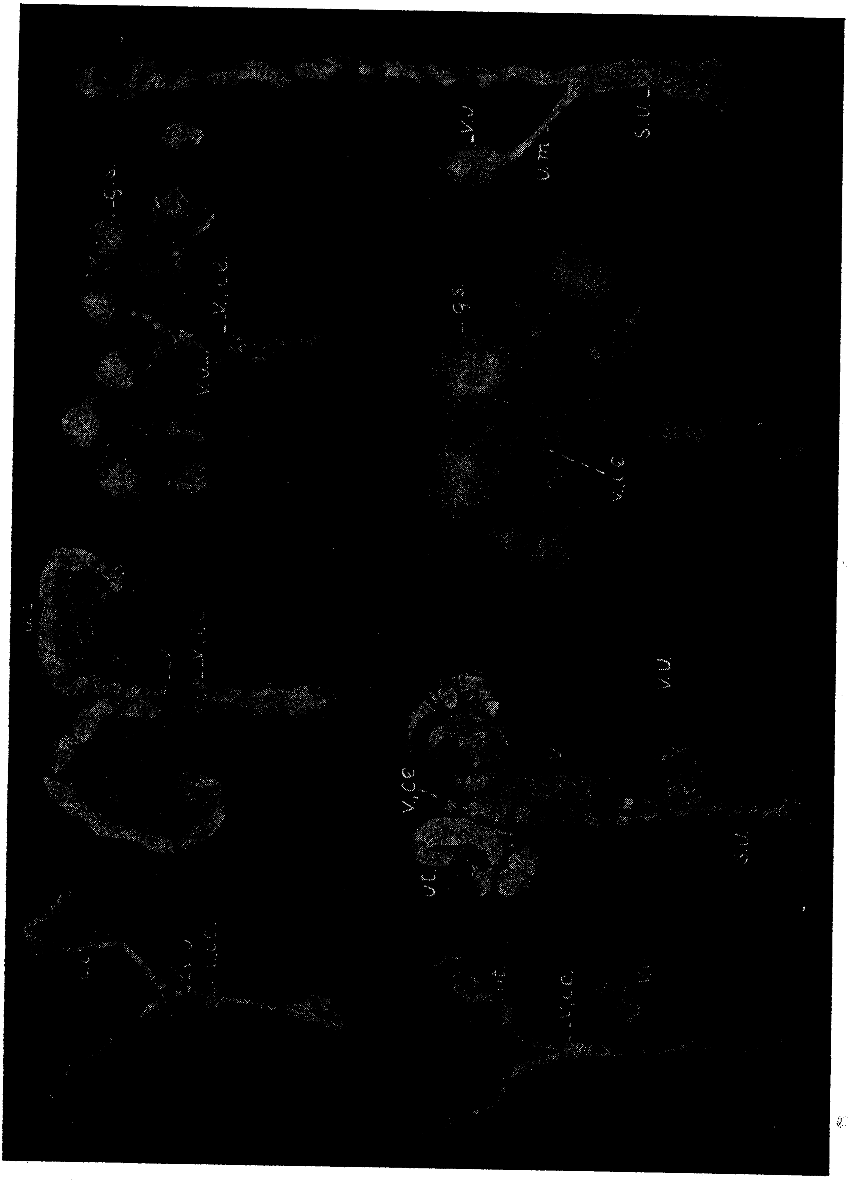
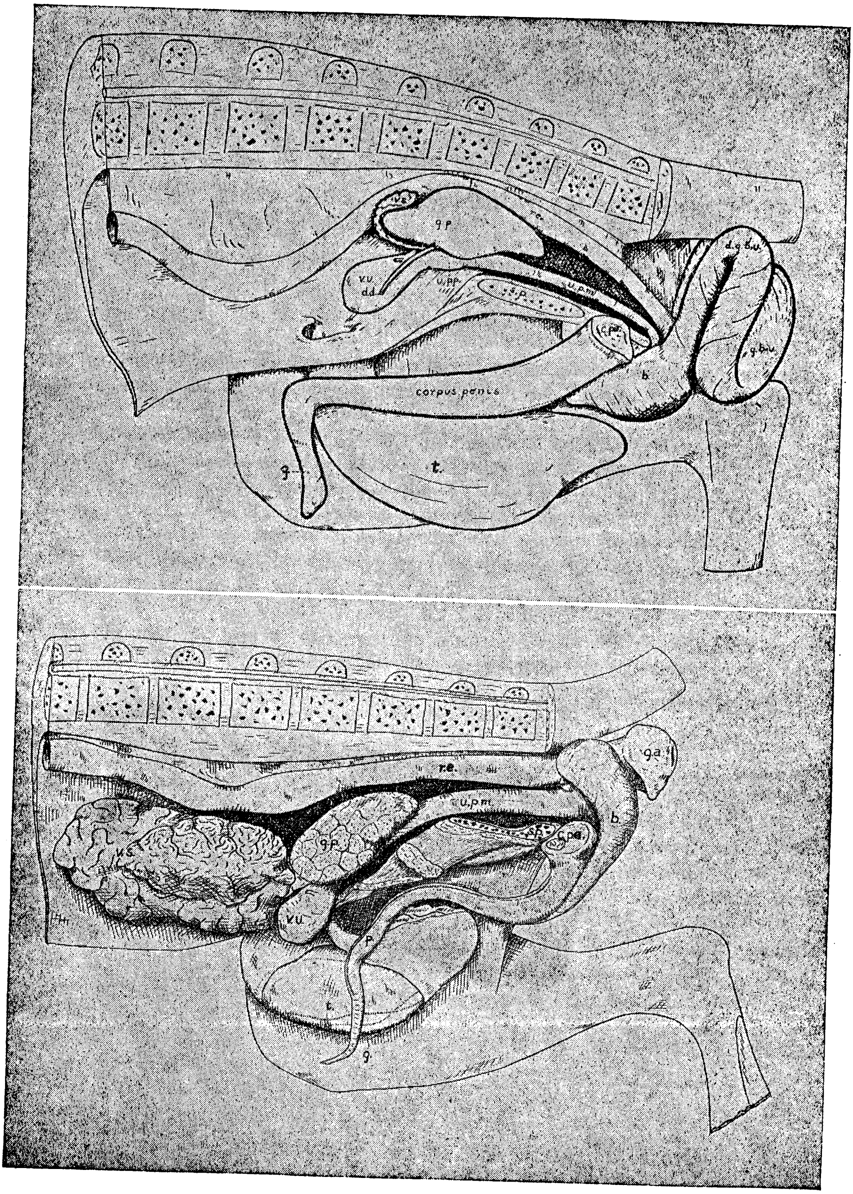


FIGURE 1. Semidiagrammatic sketch of the genital tracts of (a) the male gray squirrel, *Sciurus caroliniensis*, and (b) the male red squirrel, *Tamiasciurus hudsonicus*, as seen from the left after cutting away the left leg, left pelvic and abdominal wall, left half of the vertebral column and back muscles, and all the anterior part of the body with all the alimentary tract except the rectum. Notice the absence of macroscopically visible Cowper's glands and the presence of large anal glands in the red squirrel.

b. bulb, c.pe. crus penis, d.d. ductus deferens, d.g.b-u. ductus glandulae bulbo-urethralis, g. glans penis, g.a. glandulae anales, g.b-u. glandula bulbo-urethralis, g.p. glandula prostatica, p. penis, re. rectum, s.p. symphysis pubis, t. testis, u., p.m. urethra, pars muscularis, u., p.p. urethra pars prostatica, v.s. vesicula seminalis, v.u. vesica urinaria.


g.p.
v.u.
d.d.
d.g.b.u.
g.b.u.
b
corpus penis
t.
g
r.e.
g.a.
u.p.m.
g.p.
v.s.
v.u.
p
t.
g

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PRELIMINARY LIST OF THE HYDRACARINA OF WISCONSIN

PART VI

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Parts I-V of the *Preliminary List of the Hydracarina of Wisconsin* (Marshall, 1931, 1932, 1933, 1934, 1937) recorded eighty species and varieties representing twenty-four genera. Part VI adds forty-six species and varieties, of which five are new, in six genera. This brings the total for the state to 126 species and varieties and thirty genera. The list is known to be incomplete; more intensive collecting, especially at greater depths, and further study of material on hand, will reveal the presence of several other genera and more species in the known genera, as for example in *Eylais*.

It is interesting to compare the results so far obtained with lists for areas which have been studied more intensively and for longer periods. Soar & Williamson (1929) list 247 species and varieties for the British Isles; Dr. K. Viets (1936) gives 441 for Germany. Wisconsin has an area of 56,066 sq. mi., about one-half that of the British Isles and about one third that of Germany, with a surface much less diversified than that of the two countries compared.

The water mites considered in this paper are morphologically the most complex. They are "hard shelled", that is, the body wall is more or less heavily chitinized and porous, and there is a dorsal furrow. The legs bear swimming hairs. The arrangement of the genera here follows in general the revised classification of Viets (1936).

The genus *Albia*, Family *Axonopsidae*, is a small group, with one species in Wisconsin. The body is flattened, with dorsal and ventral surface plates. The epimera are approximated, somewhat removed from the anterior end of the body and partly joined with the underlying plate; the first pair are fused medially but a suture separates them from the second pair. The genital plates are distinct from the epimera and carry many acetabula; they are somewhat angular at the outer margins in the female, rounded in the male and joined at the genital slit.

The genus *Midea,* Family *Mideidae,* is a small and rare group with one species here. The body is oval, arched. The epimera are united into one group but the sutures are evident except that the first pair are fused medially; the fourth are somewhat triangular. The large genital organ lies in a bay bounded by all of the epimera; in the female there are two lunate plates bearing small acetabula on either side of a long slit. In the male there is a basal plate with a complex pattern of fine hairs and processes (typically); the slit is guarded by two delicate valves bearing acetabula. In the palpi the fourth segment is narrow and curved. The third leg in the male is modified for a copulatory organ, the last segment bearing a large claw.

The genus *Mideopsis,* Family *Mideopsidae,* is represented here by two species. The body is circular, dorso-ventrally compressed. The first pair of epimera are fused medially; the second are wedge-shaped, distinct; the third and first are partly fused medially to the basal plate, as is the large fourth pair on most of its borders. The genital organ, its anterior end within the bay formed by the fourth epimera, is bordered by hair-bearing chitin plates, partly fused, which enclose three (rarely four) large acetabula in a row on each side of the slit. The palpus has a large papilla bearing two hairs on the concave side of the elongated fourth segment. The legs are weak.

The genus *Krendowskia,* Family *thienemanniidae,* is a very small group, with one species here. The body is oval, arched, heavily chitinized. The epimera are in three groups, partly united with each other and the ventral plate: the first pair are nearly fused medially; each fourth epimeron is excavated near the anterior medial border to lodge a large gland pore. The genital organ lies partly within the bay formed by the fourth epimera; it has heavy lateral lunar plates with hairs, united at their tips in the male, and there are six (sometimes eight) acetabula. The maxillary organ has a short rostrum. The palpi are stout; the second segment has two long hairs on the medial proximal side; the fourth is curved and drawn out distally into a broad piece against which lies the claw-like fourth.

The genus *Geayia* is closely related to *Krendowskia,* from which it differs chiefly in having eight (rarely six) genital acetabula; a protrusible maxillary organ in two parts; and smaller palpi, the first segment of which is very short. It is a small, rare New World group, with one species here.

The genus *Arrenurus,* Family *Arrenuridae,* is the largest genus of the water mites. The body is elevated, the wall heavy, with large and regular pores. The dorsal furrow (with few exceptions) is closed in the female, open posteriorly in the male. The body in the female is oval and shows great uniformity; in the male there is a more or less well developed appendix (cauda), near the end of which there may be developed an accessory sex organ, the petiole, often with complex hyaline structures. Epimera are in three groups, distinct except for the medial fusion of the first pair, very uniform. The genital cleft in the female is flanked by semicircular valves from which extends on either side a wing-shaped area having many small acetabula. In the male the genital area is similar but smaller, and lies between the body and the appendix. The maxillary organ is shield-shaped. The palpi are stout; the second segment bears on the inner side characteristic groups of bristles or hairs, the fourth has a distal prolongation against which lies the claw-like fifth. The legs show great uniformity; swimming hairs are abundant on the last three, while the fourth segment of the last pair in the male usually bears a spur with a tuft of hairs.

Four sub-genera of Arrenurus, not sharply differentiated, are recognized: *Truncaturus,* type *A. knauthei,* Europe (not represented here, Marshall, 1908, in error), appendix a simple extension of the body without posterior cleft, no petiole; *Micruracarus* (example, *A. muttkowskii*), appendix short, usually narrow, and sheltering a small petiole which may have hyaline structures; *Megaluracarus* (example, *A. marshallae*), appendix long, narrow, petiole absent or reduced; *Arrenurus* (example, *A. americanus*), appendix three-divided, complex, petiole well developed, usually with complex hayaline structures.

The Arrenuri are very common in Wisconsin, with forty known species and varieties. Space does not allow for descriptions of all; reference must be made to the author's earlier papers, especially to *The Arrhenuri of the United States* (1908). The following account is limited to descriptions of new species, additional notes and drawings of previously described species, especially those in earlier papers, and to data on distribution.

Albia caerulea Mar.
Pl. II, fig. 10; Pl. III, fig. 18-21

The original description of this species (Marshall, 1927:277) was based upon the study of two individuals thought to be females, now recognized as nymphs. The male was later described (Marshall 1929:319). The true female is now known and here described. The body is elliptical, 0.725 to 0.80 mm. long in the male, 0.825 to 1.00 mm. in the female. The color is light blue with indistinct brown blotches and a pale dorsal Y-shaped mark; the eyes are deep red. The dorsal plate is somewhat narrower and more elongated than the ventral so that it protrudes slightly at the posterior end, especially in the male. All surfaces are conspiculously papillose; there is a delicate cuticula, finely lined. In the epimera the sutures between the plates are unusually distinct; the anterior ends of the first three pairs are rounded. The genital plates lie close in upon the underlying plate, well back from the end of the body; they are distinct, moderately wide and bear many small indistinct acetabula. Close behind them lies the excretion organ plate, with the usual flanking papillae and hairs. The maxillary organ is broad in the center and lies in a broad bay. The palpi are slender; the long fourth segment bears several fine hairs distally. The legs are much shorter than the body; heavy bristles are found on the last three pairs as well as a few swimming hairs. The nymph closely resembles the adult except for smaller size and the undeveloped character of the genital plates.

Collections have been made in Mirror, Green, Benoit, Como and Jordan lakes, the Madison lakes and three lakes of Vilas County and in small lakes near Montello, Waupaca, Oxford, Briggsville and Eagle River; also in Ontario, Indiana, Illinois, Michigan and Louisiana.

Midea expansa nov. spec.
Pl. IV, fig. 26-30

The body is elongated, 0.70 mm. long in the male. The female is unknown. The body wall is heavily chitinized, finely porous;

the cuticula has conspicuous lines. The color is dull yellow with green blotches. The first three epimera are narrower, the fourth broader than in the related species. The male genital area lies entirely within the broad deep bay formed chiefly by the last epimera pair. The broad basal plate is covered evenly with fine papillae and hairs. The genital opening is guarded by large oblong irregularly scalloped valves, each bearing about fifteen indistinct acetabula; long fine hairs from the basal plate here extend over the valves. In these details of the male genital area the new species differs conspicuously from the type species, *M. orbiculata* (Müll.), widely distributed over Europe, and *M. determina* Mar., known only for British Columbia, chiefly in form and in the lack of appendages on either side of the genital opening. In the palpi the second and third segments are broader than the legs; the fourth is long and slim, bent distally, and bears one long and one short hair on the concave side. The legs are shorter than the body, stout, increasing in length from first to fourth, and well provided with bristles. In the first two pairs the distal segments are expanded, the claws are large, two pointed, with expanded bases. In the third leg of the male the last segment is flattened, more elongated than in the related species and little excavated on the concave side; on the distal end is a groove to lodge the large claw; the accessory claw is very small.

One specimen only is known; it was found in a small lake in Vilas County.

Mideopsis orbicularis (Müll.)

Pl. II, fig. 15-17

The surface is heavily chitinized, with many fine hairs. Females may reach a length of 1.00 mm; males are a little smaller. The color is dull yellow with brown blotches and a central T-shaped light area, often with flecks of color in young adults. The first epimera are elongate, the anterior end of each drawn out, with a medial process. The genital organ is broad; it is somewhat narrowed in the male, with a broader chitin border. Anterior to the genital organ, close in upon the last epimera, are two large pores, each with a fine hair. The palpi are about as wide as the short legs and bear several bristles; the second and fourth segments are long, the papilla on the latter large and two-pointed.

This cosmopolitan species is found all over Europe and has been reported from Mongolia and Siberia. In North America it was first reported by Koenike from Ontario. Later Wolcott identified it in a collection from Oregon. Specimens from Yucatan reported by the author are found on re-examination to belong to another species, probably new. Samples from the present collections were sent to two European hydracarinologists with requests for an opinion as to the validity of the identification. In private correspondance one replied that it "seems not to be identical with our European species"; the other, "that it seems to be *M. orbicularis*". From a third came this reply: "There is no doubt in my mind that there will be variations between material from America and Europe and also the East, . . . and that these are not of sufficient value to cause specific differences". In the latter opinion the author is inclined to concur. Specimens as determined have been found in the Madison and Vilas County lakes and in Green Lake (to a depth of 10 M.); also in Michigan and California.

Mideopsis americanus nov. spec.
Pl. I, fig. 1-4

This mite is smaller and more delicate than *M. orbicularis*. The body is slightly elongated, the male 0.60 to 0.65 mm. long, the female, 0.80 to 0.875 mm. or more. The color in young adults is yellowish with darker blotches and a light dorsal center which may be reddish or violet, with the ends of the first epimera red, as are also the outlines of the two following pairs; older individuals are duller. The dorsal furrow is somewhat angular in outline. Body pores are large and irregular or branched near the body edge, finer on other surfaces. Epimera are like those in the related species with more hairs; but the first pair are broader, with a similar anterior medial process. The male genital organ is elliptical; the encircling wall of chitin, wide at the anterior end, is made up of two lateral curved plates, fused where their tips meet. In the female the organ is broad, closely resembling that of the related species, but with wider lateral plates, likewise fused at their tips. The six acetabula are oblong. The characteristic pair of large pores anterior to the genital organ are accompanied by long fine hairs. The palpi are narrower than the legs; the fourth segment has a heavy convex border and its papilla is truncated and bears two coarse hairs. The legs are reddish, shorter than the body, their segments broadened distally, with abundant bristles; there are a few swimming hairs on the first two pairs, several on the third and many on the fourth.

Collections have been made in Twin, Powers, Fox, Neshota, Mason, Drake, Benoit, Spooner and Green lakes (in the latter to a depth of 29 M.), and in several waters in Adams and Vilas counties; also in Illinois, Iowa, Michigan, Indiana, Montana and British Columbia (in one case from the stomach of a sucker).

Krendowskia similis Viets
Pl. I, fig. 5-9

The species was first described by Viets (1931) from a single male and designated a subspecies of *K. convexa* (Ribago); the latter was described from a single specimen found in Chili. The female of *K. similis* is now known.

The body is nearly circular, with the anterior end narrowed; it measures in the male 0.80 to 0.90 mm., in the female, 1.10 to 1.20 mm. The general color is blue green with brown blotches; inside of the conspicuous dorsal furrow is a pale yellow area with a reddish streak. Long fine hairs are abundant on the general surfaces and on the plates. The surface pores are large and regular; the cuticula is thick, with irregular wavy lines. The epimera show a fine reticulation; the first pair are elongated, their medial and posterior borders faintly outlined, and they form a deep bay for the maxillary organ. The second pair are wedge-shaped; the third, slightly separated from them, are clearly outlined. The fourth epimera are rounded posteriorly, somewhat narrowed in the female; the anterior medial strip over the gland pore is faintly outlined. The genital organ is broad in both sexes; in the male it is enclosed for less than half its length in the epimeral bay, while the larger female organ is closer in. The acetabula on the genital valves are elongated; there are six in both sexes (rarely one is small or wanting.) The palpi are about as wide as the legs; the second segment has a bulging outer border and its two long proximal bristles may be pectinate; the distal prolongation of the fourth is broadly rounded where it meets the slender curved fifth. The legs are blue-green, slender, shorter than the body; all but the first have long hairs, and bristles on all are moderate in size and number.

Collections have been made in Wingra, Mason, Twin and Green lakes (in the latter to a depth of 15 M.), in the Trout Lake region, and in ponds near Montello and Wisconsin Dells; also in Michigan, Indiana and Illinois.

Geayia ovata (Wol.)
Pl. III, fig. 22-25

The species was erected by Wolcott (1900, 1901) as *Krendowskia ovata*; but the males and nymphs described belong to the commoner species, *K. similis*. The true male is here described. The species is closely related to *G. venezuelae* Thor.

The body is broad oval, the anterior end slightly elongated; the length in the two males found is 0.80 mm., in two females, 1.00 mm. The color is greenish brown with dark markings. The dorsal shield is relatively small. Body pores are conspicuous; the thick cuticula has coarse wavy lines; the epimera show a delicate reticulation. Hairs on the body and plates are numerous and long. The three groups of epimera are separated by irregular rows of pores; the sutures are fairly clear except for the long median fusion of the first pair which leaves a shallow bay for the maxillary organ. The free ends of the epimera are well rounded out; the inner medial angle of the fourth is almost obliterated where it makes place for the large pore. The large genital organ is enclosed for about half of its length by the fourth epimera, broader and closer to the latter in the female; the chitin wall is heavy, laterally broad, the outer part with fine hairs. The genital valves bear each four acetabula in both sexes (Wolcott was in error in giving three for the male), a little irregularity in size being noted. The maxillary organ forms a proboscis which can be protruded for over half the body length: there is a soft proximal part (fig. 23,A) and the elongated hard maxillary organ proper (fig. 22) which has a rostrum and carries the small palpi. The legs are short and slender, only the fourth in the male slightly longer than the body; all bear numerous long and short spines, with slight serration, and abundant swimming hairs on the middle segments of the last three. The claws are small and weak.

This species has been found in a small pond near Montello; also in Michigan.

Arrenurus rotundus Mar.

Found in Lake Mason and Goose Pond and in pools near Appleton, Madison, Big Spring and Wisconsin Dells.

Arrenurus ovalis Mar.

Found in a pool near Appleton and in Goose Pond; also in Michigan.

Arrenurus crenellatus Mar.

Found in Mason, Buffalo, Pewaukee, Mirror, Wingra and four lakes of Vilas County, in ponds near Oxford and Jordan Lake; also in Michigan, Maine and New Hampshire.

Arrenurus pseudosetiger Mar.
Pl. IV, fig. 31

Found in a pool near Madison and in Silver Lake.

Arrenurus bicaudatus Mar.
Pl. VI, fig. 51

Found in Neshota, Otter and South Turtle lakes and in a pool near Wisconsin Dells; also in Indiana, Michigan and Louisiana.

Arrenurus acutus Mar.

Found in Mirror Lake; also in Michigan.

Arrenurus scutulatus Mar.

Found in Buffalo and Green lakes (to a depth of 15 M.); also in Michigan and Indiana.

Arrenurus infundibularis Mar.

Found in Wingra, Green and two lakes of Vilas County, in ponds near Jordan Lake and Wisconsin Dells, in Wisconsin River and the Canal at Portage; also in Michigan, Illinois, Indiana, Missouri and Oregon.

Arrenurus lyriger Mar.
Pl. IV, fig. 32

Found in Green and Mirror lakes; also in Michigan, Missouri and New Hampshire.

Arrenurus muttkowskii nov. spec.
Pl. IV, fig. 33-35

The new species belongs to a group of Micruracarus in which the male dorsal shield is very small, its furrow either closed or ending in a medial depression of the appendix, the latter sometimes broader than the body, with a more or less circular posterior identation over which lies a petiole with a complex hyaline structure.

A. muttkowskii closely resembles *A. lyriger* Mar. but the body is more elongated and the two species differ in the structure of the hyaline appendage and in other details of the appendix. The female is unknown. The length in the male is 1.40 mm; the color is brick red with greenish blotches. The body is greatly elevated in the mid-region where there is a low hump on either side of the dorsal shield; there are two conspicuous anterior median protuberances and a bulging over each eye. The dorsal shield is broader than long, with four anterior rounded corners; its furrow is broad posteriorly and opens on the appendix. The epimera resemble those of the related species; the genital wing-shaped plates are narrow and extend over the sides of the body as small welts. The appendix is sharply marked off from the body; its lateral margins are rounded and its deep medial incision expands to form a large perforation. The depressed center of the appendix bears two pairs of small humps as well as hairs; these as well as other details are best understood by reference to fig. 35. The hyaline structure is shorter and less conspicuous than in *A lyriger*; it is bulb-shaped, open dorsally to disclose a small petiole. (This structure does not preserve well and examination of living material may reveal details not shown here.) In the palpi, the second segment bears a thick patch of fine hairs. The fourth leg lacks the spur on the fourth segment.

Three males were found in Lake Mendota by Dr. R. A. Muttkowski, for whom the new species is named. Specimens have also been found in Iowa.

Arrenurus laticaudatus Mar.

Found in Green and Mirror lakes; also in Michigan, Illinois, Iowa and Missouri.

Arrenurus birgei Mar.
Pl. VI, fig. 50

Found in over twenty bodies of water in the state; also in eleven other states east of the Plains, in Ontario and in Haiti.

Arrenurus solifer Mar.

Found in Little John Lake (Vilas County); also in New Hampshire and New York.

Arrenurus morrisoni Mar.

Found in Morrison's Pond, Washburn County.

Arrenurus scutuliformis Mar.
Pl. V, fig. 37

Found in Green, Twin, Big Carr, Little John and Plum lakes; also in Michigan and Maine.

Arrenurus pseudoconicus Piers.

Found in Lake Wingra and in two lakes of Vilas County.

Arrenurus pseudocylindratus Piers.

Found in Mirror, Mason, Powers and four lakes of Vilas County and in ponds near Jordan Lake, Portage and Spooner; also in Michigan, Indiana, New Hampshire, Louisiana and Wyoming.

Arrenurus manubriator Mar.
Pl. V, fig. 47; Pl. VI, fig. 55

Found in Winnebago, Green, Mason, Buffalo, Pewaukee, Lauderdale, Spooner, and the Madison lakes, three lakes of Vilas County and a pond near Portage; also in Illinois, Michigan, Indiana, Iowa, Ohio, Massachusetts, Ontario and Mexico.

Arrenurus marshallae Piers.
Pl. V, fig. 36

One of the commonest species of water mites in shallow waters, a few hundred specimens of this Arrenurus have been secured in some fifty bodies of water in Wisconsin. It has also been found in nineteen other states east of the Plains and also in Ontario. The form of the body is very constant; only a slight amount of variation in the elevation of the anterior part of the appendix has been noted. Copulation was observed several times; in this state it occurred in August (except in one case), while other records, chiefly from Illinois, give July.

Arrenurus megalurus Mar.
Pl. V, fig. 38-40

A re-examination of all collections of this species has been made in order to clear up certain points relative to its variability, already noted (Marshall, '03, '08, '10). Most of the "intermediate forms" are now referred to a new variety, *A. intermedius*, to be described next, while *A. megalurus* remains as a distinct, though variable species. From its nearest relative, *A. marshallae*, it is distinguished in both sexes by a greater development of the dorsal humps, by an unusual posterior prolongation in the female, and by the greater development of the appendix. In the latter the end is drawn out to form not only larger lateral processes but also large medial projections which leave a central indentation (rather than a slight notch as in *A. marshallae*), while the central region is greatly elevated dorsally. The palpi, not adequately shown in former papers ('03, fig. 2c; '08, fig. 52), are shown again in fig. 38; on the large elevation of the second segment, the distal hairs are slightly enlarged and flattened.

Specimens are usually found with the related species but in smaller numbers, and the range appears to be more restricted. A few females of both species, together with unidentified Arrenurus females and specimens of two species of other genera have been found in the digestive tract of snapping turtles (collections of K. F. Lagler).

In a collection from New Hampshire, twelve males, the anterior projections resemble small horns, directed outward. In a collection of eleven males and nine females from Louisiana already reported (1910) all individuals except one showed this same character; also, the females had an extreme development of body humps, while the appendix was only moderately developed. It is possible that these specimens should be set apart as distinct forms.

Dr. O. Lundblad* reports the species from Haiti. The single individual, a male (violet!) is not typical: the anterior end is convex rather than concave, the dorsal shield is too elongated; the appendix is too narrow at the base and flaring at the end, while the central part is too low. It may represent still another form; but in the case of a species as variable as *A. megalurus* a decision should await the study of more material.

Arrenurus megalurus intermedius nov. var.

Pl. V, fig. 41-44

The name of the new variety indicates its position relative to *A. marshallae* and *A. megalurus* but more closely related to the latter; it is erected to include the "intermediate forms" already referred to. (Outlines of the body of the male are shown in fig. 2, e and f, Marshall, '03.) The entire length is 1.05 to 1.08 mm; the color, blue green or sometimes brick red. The dorsal humps on the body are moderate; the dorsal furrow runs over on the appendix. In epimera and genital areas both sexes agree closely with the two related species. The central dorsal region of the appendix is more moderately elevated, the end less developed medially, the lateral processes smaller than in *A. megalurus*, while there is the same conspicuous indentation. In all of these characters considerable variation in degree has been found, aside from differences due to age; even some differences in the two sides of the same male has been noted. In a few individuals some variation was seen in the size of the anterior horns, while the characters of the appendix remained typical.

The female closely resembles the females of the two related species. The following description is based upon the study of one individual found in copula (Twin Lakes, July). The body length is 0.95 mm. The same dorsal humps are present as in *A. megalurus* but they are smaller and more rounded. The palpi in both sexes of the two forms are much alike, the second segment, inner side, having a cushion with fine hairs, the more distal of which are flattened. The female with undeveloped body humps found in copula reported by the author (1910:103, fig. 16) is

* Arkiv för Zoologi, No. 13:21-25, 1935.

probably a newly emerged *A. intermedius*. As mating in May is apparently unusual, the case is not clear.

The new variety is commonly found in collections with the *A. megalurus* but in larger numbers.

Arrenurus pseudocaudatus Piers.

Found in Lake Spooner and in one collection from Michigan.

Arrenurus wardi nov. spec.
Pl. VI, fig. 52-54

The new species closely resembles *A. parallelatus* Mar. from which it differs chiefly in details of the appendix; when preservation is not good the two species may be confused. The length in the male is 1.10 to 1.18 mm. The female is unknown. The body, as in the related species, is concave between the eyes, is both broad and high in the anterior half and bulges again in the genital region. The dorsal furrow encloses a large obovate area and runs over on the side of the appendix. The first two pairs of epimera have acute projecting anterior ends; the other two pairs are of the usual form, as is also the genital area. The appendix is nearly as long as the body; it has a pronounced dorsal hump just anterior to the center and here it is widest. The end broadens slightly and shows on each side slight scallops, the central pair being the longest; here is a small dorsal depression in which lies a delicate petiole (fig. 52, p), anterior to which is a lower pair of humps bearing each on the inner side a hair and a gland opening. Four pairs of long hairs project from the end of the appendix. The palpi have three short bristles and one long one on the inner face of the second segment, with two more long ones on the convex margin. Legs are typical with abundant swimming hairs and a conspicuous spur on the fourth segment of the last pair. The new species is dedicated to Dr. H. B. Ward, in recognition of his interest in the study of the hydracarina.

Collections have been made in Wisconsin in Spooner and Allequash lakes and in ponds near Montello and Jordan Lake; also in Illinois and Indiana. *A. parallelatus* appears to be an eastern form; specimens previously reported by the author for the three states named are now referred to the new species.

Arrenurus rectangularis Mar.

Pl. II, fig. 14

The palpus is characterized by the possession of four short stout hairs on the inner surface of the second segment, distally (fig. 14, from an unpublished drawing of R. H. Wolcott, slightly altered).

Specimens have been found in Green Lake (from 7-12 M.); also in Michigan.

Arrenurus semicircularis Piers.

Pl. V, fig. 46

Found in Wingra, Lauderdale, Mason, Coma and Little John lakes and in a pond near Montello; also in Massachusetts, New Hampshire and Michigan.

Arrenurus cardiacus Mar.

Pl. II, fig. 13

Found in Goose Pond and in one collection from Michigan.

Arrenurus longicaudatus Mar.

Pl. II, fig. 11, 12

A species found first in New Hampshire, it has since been secured in some numbers from three lakes of Vilas County. (One male showed a malformation of the appendix, which was also slightly asymmetrical: the end, instead of flaring out normally, narrowed to half its width and rounded off, while dorsally there was developed a conspicuous truncated hump.) The palpus is now shown (fig. 12); the chief bristles are unusually long and the second segment bears also a group of four small bristles on the inner side distally.

Both sexes were found, some in copula, so that the female can now be described. The color is dull orange red; the length is 1.02 mm. The body is oval, slightly depressed between the eyes, and the posterior end is somewhat drawn out ventrally. The dorsal shield is nearly elliptical. The genital wings are large and broaden out laterally.

Arrenurus apetiolatus Piers.
Pl. V, fig. 45

In the hundreds of specimens of this species examined great uniformity in body form has been found; however, in specimens from three localities from southern Louisiana the appendix in some males lacks the posterior indentation and is slimmer than is typical. These individuals may represent another form or variety. Copulation has been observed (July). The author has already reported (1910:104) that this may occur between males and females of different species of Arrenuri, a fact also known to Dr. R. H. Wolcott (unpublished notes). Two cases have recently been re-examined involving males of *A. apetiolatus*: in one case normal pairing was followed by pairing with *A. marshallae female;* in the second case pairing was with a larger unidentified female (palpi examined for verification).

Collections have been made in Wingra, Mason, Green, Buffalo, Spooner, Benoit, Coma, Jordan, Parker, Goose and Crooked lakes and in ponds near Montello and Wisconsin Dells; also in several waters in Ontario and in thirteen other states east of the Plains.

Arrenurus magnicaudatus Mar.

Found in Mason, Spooner, Mirror and Green lakes and Goose Pond; also in Michigan, Illinois and New Hampshire.

Arrenurus superior Mar.

Found in Mason and Green lakes and ponds in Adams and Vilas counties; also in Michigan, New York and New Hampshire.

Arrenurus trifoliatus Mar.

Found in sloughs near Burlington and in ponds in Illinois, Ohio, Nebraska, Missouri and Louisiana.

Arrenurus reflexus Mar.

Found in Mirror and Beulah lakes and in ponds near Green and Jordan lakes; also in New Hampshire, Vermont and Ohio.

Arrenurus americanus Mar.
Pl. VI, fig. 56.

Collections have been made, usually near the surface, in over thirty bodies of water in Wisconsin; also in eleven other north central and eastern states and in Ontario (in one case from the bladders of Utricularia).

Arrenurus americanus major Mar.

The range for this variety seems to be the same as for *A. americanus.*

Arrenurus compactilis Mar.

Found in small ponds near Oshkosh, Fond du Lac and Green Lake and in Lake Spooner; also in New Hampshire, Michigan and Iowa.

Arrenurus flabellifer Mar.

Found in Buffalo and Green lakes; also in Illinois and Missouri.

Arrenurus pollictus Mar.

Found in three ponds near Wisconsin Dells.

Arrenurus falcicornis Mar.
Pl. VI, fig. 48, 49

A description of the female is now possible; it is based upon the study of one individual found in copula. The body is 1.50 mm. long and dull green; is broad oval, the posterior end slightly bulging. The fourth epimera are broad, with deeply concave posterior borders. The wing-shaped genital areas are of about the same width throughout and the genital valves are broad. Collections have been made in Mirror, Green, Mukwonago, Buffalo and Lauderdale lakes, in Goose Pond and the Lemonweir River; also in Indiana and New York.

Arrenurus laticornis Mar.

Found in Mirror, Buffalo and Jordan lakes and in the rivers and ponds near Wisconsin Dells; also in Illinois, Missouri and Iowa.

Arrenurus serratus Mar.

Found in Mendota and in three lakes of Vilas County; also in Ontario and Saskatchewan (in two cases in fish stomachs), in depths from 3-10 M.

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Plate I

1. Mideopsis americanus, dorsal view, young male
2. " " right palpus, outer side, male
3. " " ventral view, female
4. " " genital area, young male
5. Krendowskia similis, dorsal view, female
6. " " ventral view, male
7. " " genital area, female
8. " " left palpus, inner side, male
9. " " right palpus and maxillary organ

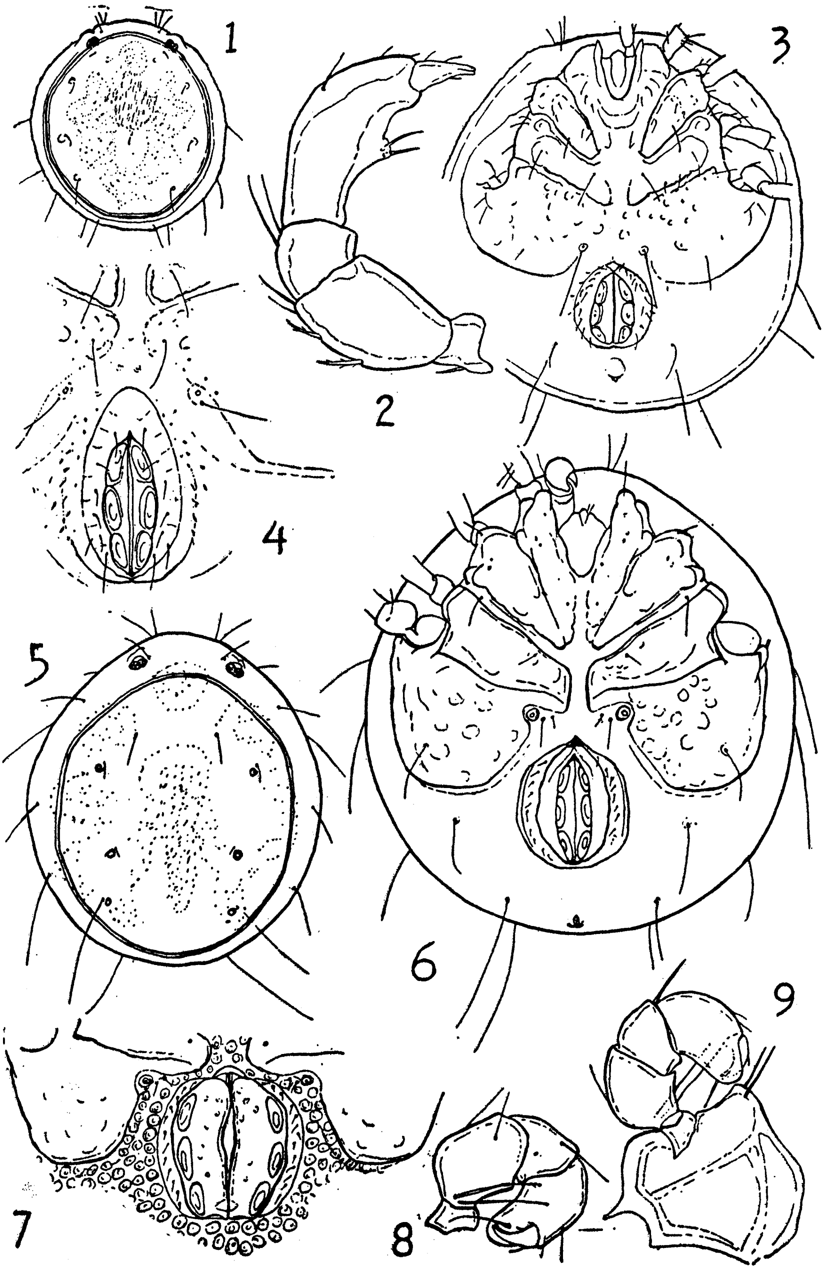
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Plate II

10. Albia caerulea, ventral view, posterior end, nymph
11. Arrenurus longicaudatus, genital area, female
12. " " left palpus
13. " cardiacus, dorsal view of appendix
14. " rectangularis, palpus (by Wolcott)
15. Mideopsis orbicularis, dorsal view
16. " " right palpus, inner side
17. " " ventral view, female

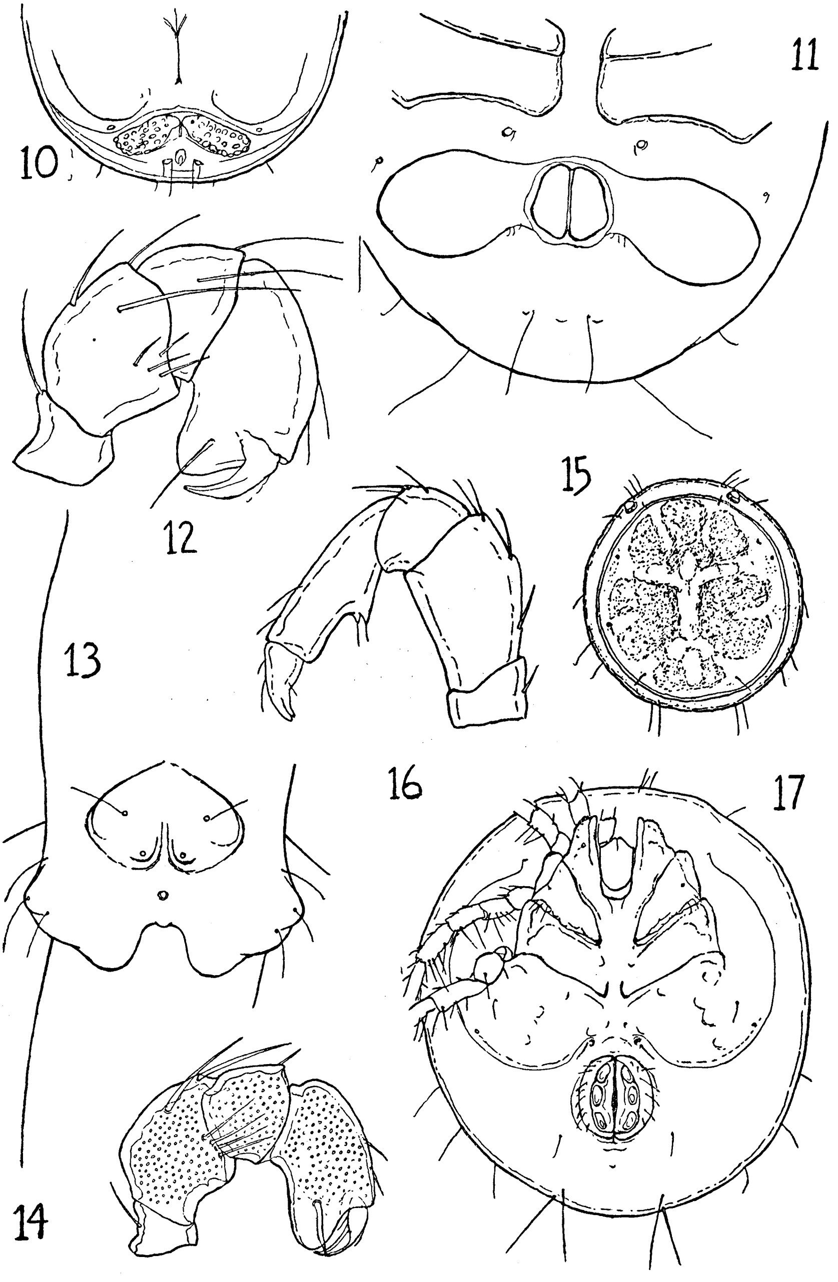
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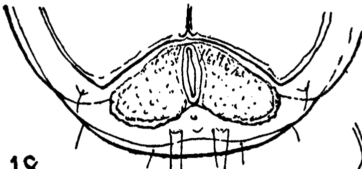
Plate III

18. Albia caerulea, genital area, male
19. " " right palpus, inner side, female
20. " " dorsal view, male
21. " " ventral view, female
22. Geayia ovata, maxillary organ and palpus, male
23. " " ventral plates, male; A, part of proboscis
24. " " dorsal view
25. " " genital field, female



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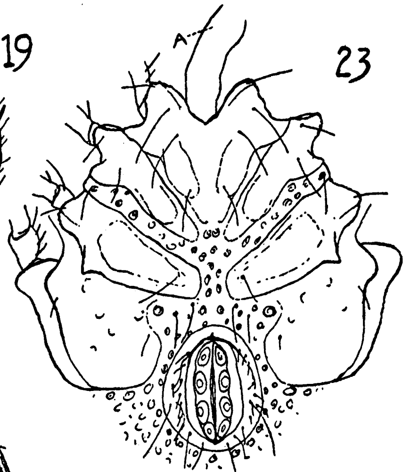

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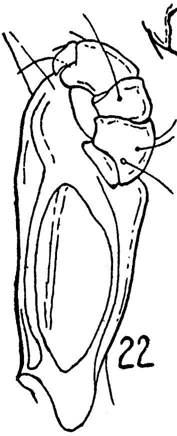

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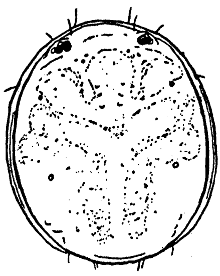

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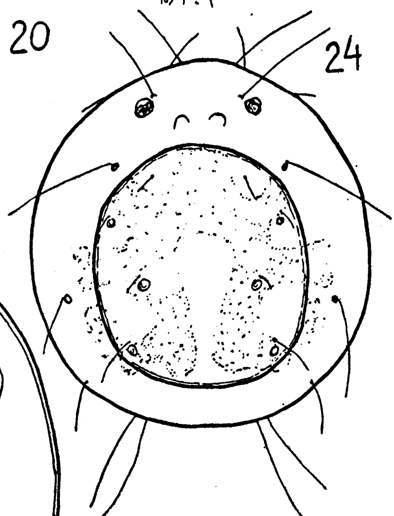

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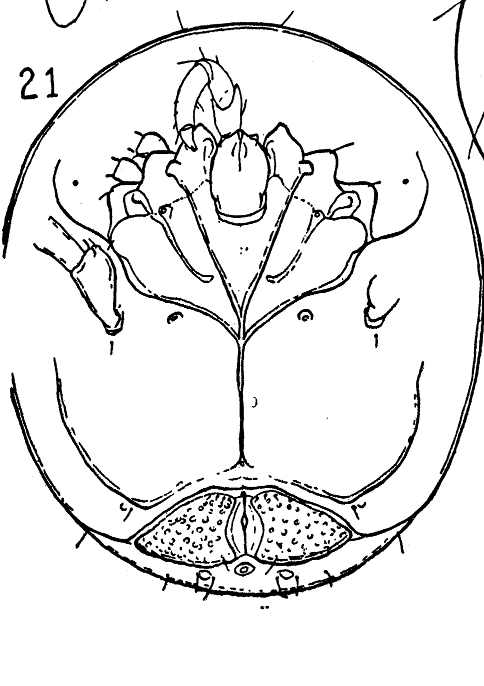

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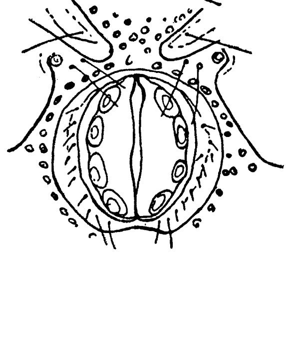

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Plate IV

26.	Midea expansa, left palpus		
27.	"	"	dorsal view, male
28.	"	"	left leg III, 5, 6, male
29.	"	"	genital area, male
30.	"	"	ventral plates, male
31.	Arrenurus pseudosetiger, posterior ventral view, male		
32.	"	lyriger, left palpus, male	
33.	"	muttkowskii, posterior ventral view, male	
34.	"	"	left palpus, male
35.	"	"	dorsal view, male

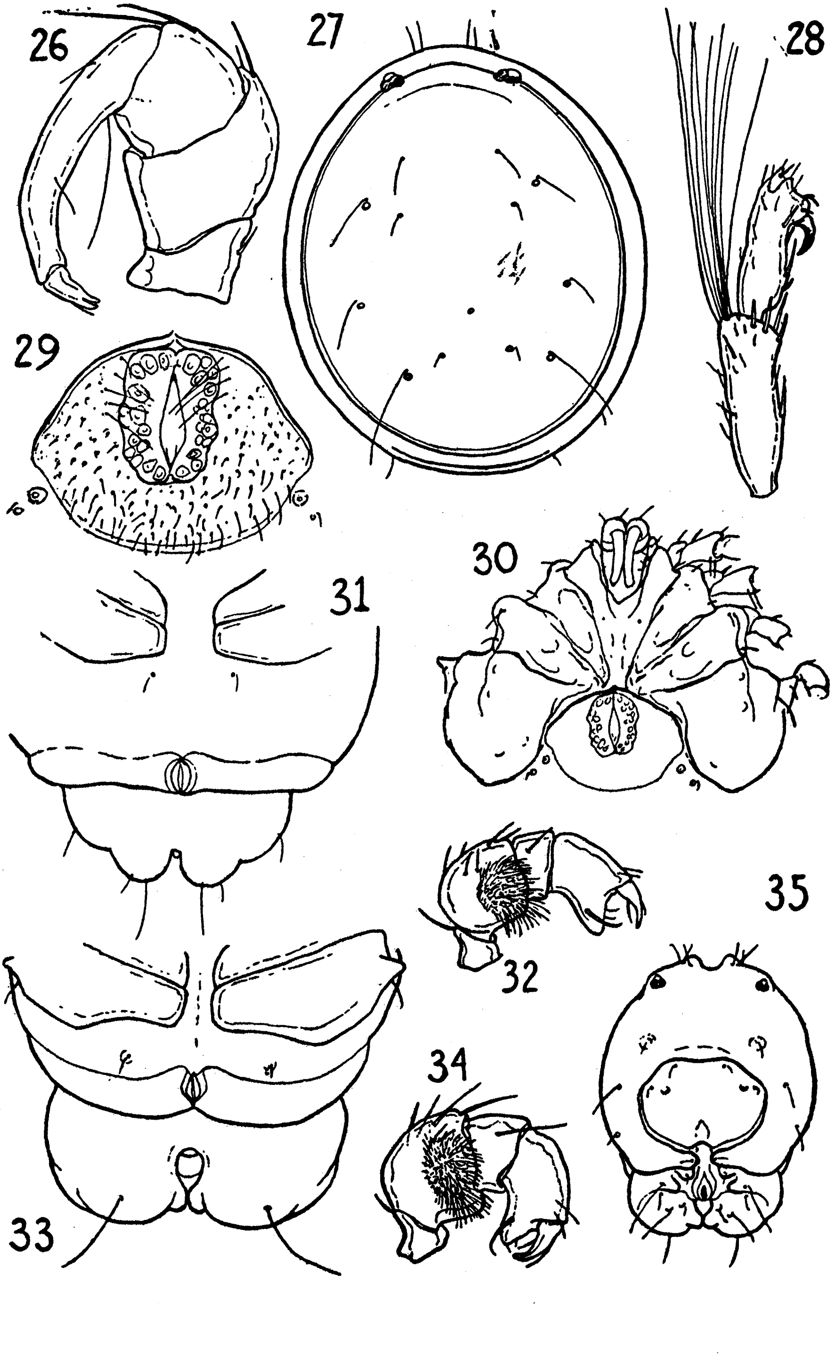
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Plate V

36. Arrenurus marshallae, dorsal view, male
37. " scutuliformis, left palpus, male
38. " megalurus, left palpus, male
39. " " dorsal view of appendix
40. " " lateral view of appendix
41. " intermedius, dorsal view of appendix
42. " " lateral view of appendix
43. " " left palpus, male
44. " " dorsal view, female
45. " apetiolatus, lateral view, appendix
46. " semicircularis, dorsal view of appendix
47. " manubriator, mandible (by Wolcott)

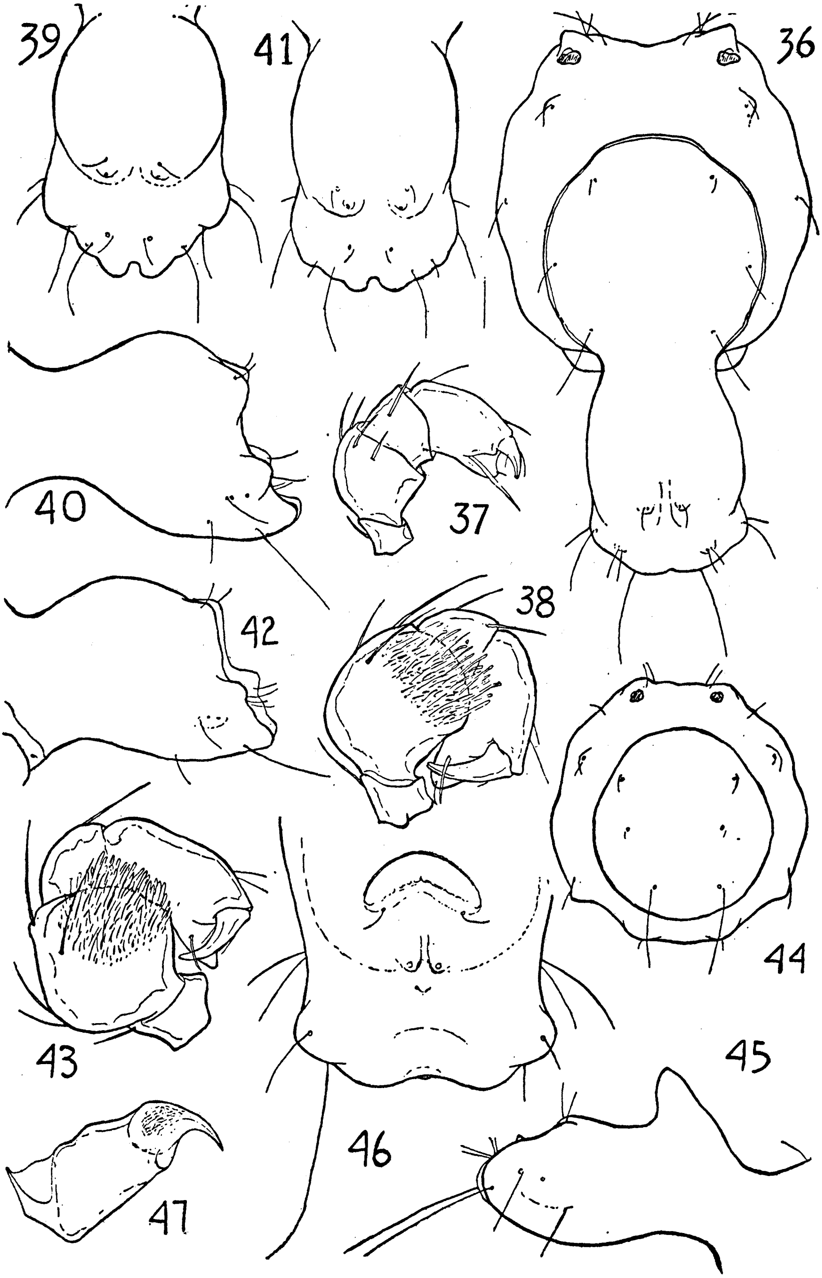
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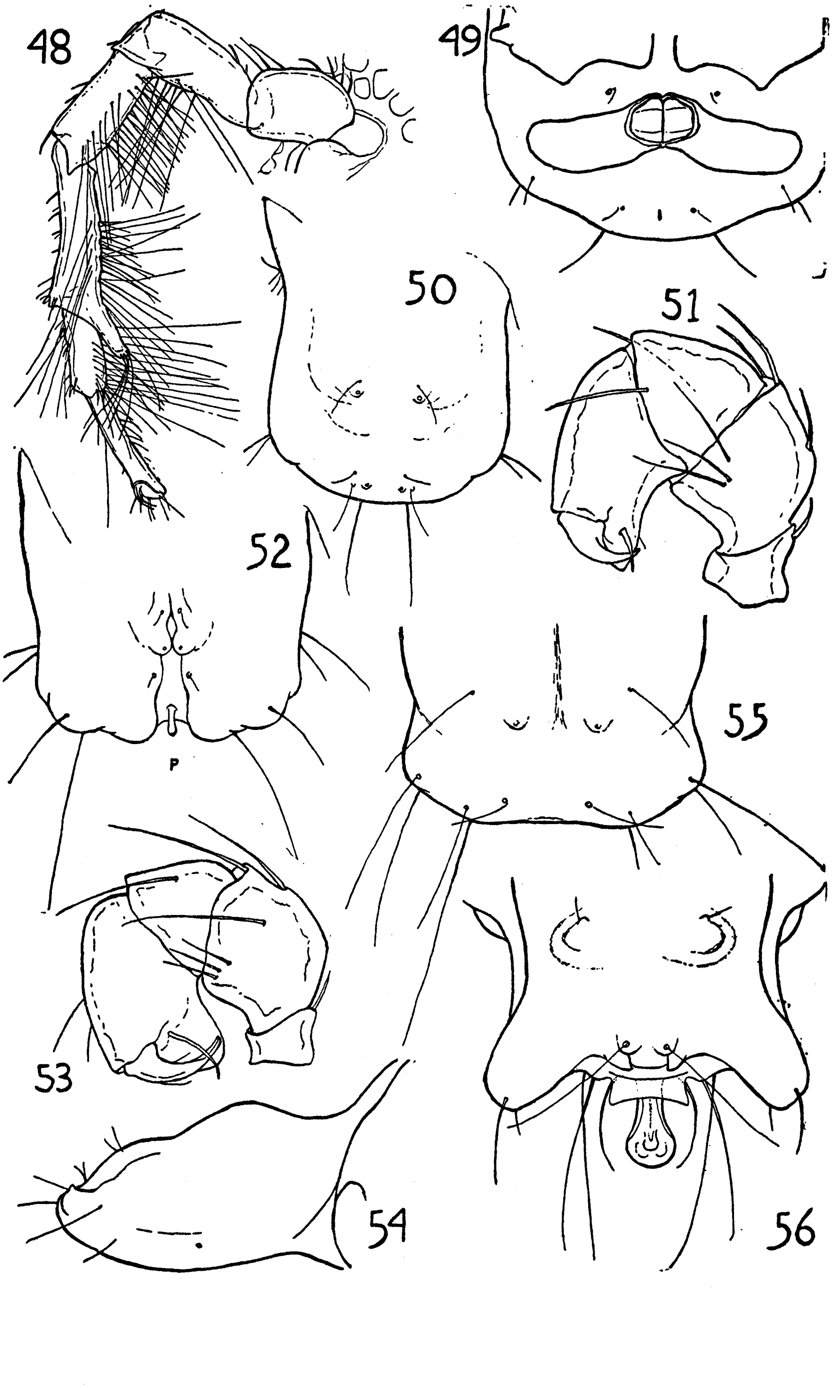
Plate VI

48. Arrenurus falcicornis, leg IV, male
49. " " posterior ventral area, female
50. " birgei, dorsal view of appendix
51. " bicaudatus, right palpus
52. " wardi, posterior dorsal view of appendix; P, petiole
53. " " right palpus
54. " " lateral view of appendix
55. " manubriator, dorsal view of posterior appendix
56. " americanus, dorsal view of appendix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OXYGEN CONSUMPTION OF THYONE BRIAREUS (HOLOTHURIOIDEA) AS A FUNCTION OF OXYGEN TENSION AND HYDROGEN-ION CONCENTRATION OF THE SURROUNDING MEDIUM

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Investigations of the oxygen consumption of various marine invertebrates as well as those of unicellular organisms have resulted for the most part in two types of behavior. Either oxygen consumption (of whole animals, parts of animals, or single cells) behaves as a linear or as a hyperbolic function of oxygen tension. Tang, (1933) using data collected from many sources, has shown that if the oxygen consumption is continued to low enough levels a "critical pressure" will eventually be reached below which the oxygen consumption is more or less dependent upon the oxygen tension (oxygen pressure) of the environment. In some forms, the critical pressure is nearer normal air-water equilibrium than in others. In *Thyone*, as will be shown later, the critical pressure is quite low, being in the neighborhood of a tension of 0.7 cc. of oxygen per liter. Above this pressure oxygen consumption is quite uniform, but below, it drops off very rapidly and practically ceases.

Nomura (1927) reported a hyperbolic relationship between oxygen consumption and oxygen tension for *Caudina*, a holothurioidean. He showed that this relationship is one of dependence of oxygen consumption on oxygen tension since the logarithms of the values when plotted fall on a straight line, or nearly so. Nomura allowed a time of 28 hours for the oxygen tension to be reduced by the respiration of the animal itself which should be ample time for adaptation, and thus prevent a lag in the oxygen consumption behind the reduction of oxygen tension. The writer, in previous experiments with the respiration of the crayfish (1931) found that the amount of available oxygen (i.e. the volume of the respiratory medium in relation to the size of the animal, or the length of time allowed for lowering the oxygen tension) affected the shape of the curve of oxygen consumption obtained. Thus, if the time be too short, or in other words, the volume of the environmental medium too small, a dependence of oxygen consumption upon the oxygen tension of the medium would appear, which would not be a true picture of the respiration of the animal. If Nomura's interpretation of his results is correct, the respiration of *Caudina* is at all oxygen tensions dependent upon the oxygen percentage of its environment. This seems the more remarkable since the respiration of *Thyone*, another holothurioidean, is not dependent upon the oxygen pressure until a low tension is reached at which respiration practically ceases. Evidently *Thyone* possesses a more efficient respiratory mechanism than does *Caudina* since it is better able to continue its normal oxygen consumption rate at lower oxygen tensions. Hyman ('29) studied the respiration of two other echinoderms, the starfish, *Patiria*, and a sea urchin. She reported the respiration of both of these forms dependent upon the oxygen tension of sea water.

The respiration of other forms of invertebrates, e. g. *Eriocheir* (Chen, '32), *Homarus, Nereis, Limulus*, and *Callinectes* (Amberson, Mayerson, & Scott, '24) has been reported to be directly dependent upon the oxygen tension of the surrounding water. In a recent paper, Bosworth, O'Brien, and Amberson ('36) criticize the earlier results of Amberson, Mayerson, and Scott. The former state that a rapid reduction in oxygen tension causes compensatory movements of the gills of the lobster comparable to the hyperpnea of land animals. Too rapid reduction in oxygen tension of the water therefore causes unreliable results in determination of oxygen consumption. Kempner ('37) has shown the respiration of isolated undamaged cells in their physiological medium to decrease with lowered oxygen tension. He has likewise demonstrated that respiration of non-nucleated blood cells and old bacterial cultures does not vary with oxygen tension. He states that the effect of oxygen tension on respiration is influenced by changes in pH, carbon dioxide concentration, salt content, and temperature.

Thyone possesses a "respiratory tree" which in all probability is a very efficient respiratory aid and possibly accounts to a great extent for the high degree of independence that this echinoderm exhibits toward oxygen tension. In this connection the work of Winterstein (1909) should be mentioned. He showed that the "lungs" of holothurians are respiratory organs which under normal conditions account for about 50 to 60 percent of the total oxygen intake. By rendering the respiratory tree useless (ausschaltung) he was able to determine the reduction of oxygen intake and noted an increase after 22 hours. He also demonstrated the part played by anal respiration and that of the head end. Thus it is apparent that the respiratory system of the Holothurioidea is well developed as far as respiratory surface is concerned.

The respiration of invertebrates in general is reduced by lowering the pH of the surrounding medium. This is also true for single cells and unicellular organisms. Root (1930) has shown that increasing the carbon dioxide diminshes the oxygen consumption of *Paramecium* and *Arbacia* eggs. More recently Tang (1936) has shown that oxygen consumption of *Saccharomyces Wanching* is a function of pH. The effect of pH on the rate of oxygen consumption is different in different buffer solutions. In general, it may be stated that oxygen consumption of most invertebrates and unicellular organisms is inversely proportional to the hydrogen ion concentration of the surrounding medium. However, Hiestand and Hale (1938) as a result of investigations with fresh-water molluscs have found an increase in oxygen consumption with lowered pH in unbuffered water. Possibly the explanation lies in the fact that unbuffered water constitutes an unnatural environment. Hyman (1924) has shown that the respiration of *Planaria* is decreased by acidifying the water. She also found that acidification of carbonate-free water had little or no effect upon oxygen consumption, except when the acidity was produced by carbon dioxide.

Material and Methods

For these experiments *Thyone briareus* was chosen as a quiet animal and one that should exhibit a fairly constant respiration rate. This supposition proved to be a fact. The animals proved to be excellent experimental forms as their rate of oxygen consumption under identical conditions was nearly always the same, even though they had been subjected to environmental conditions of different pH values in the meantime. In fact, no other invertebrate form used in previous research by the writer has maintained its integrity to the same degree as *Thyone*. This is no doubt due to its inactive nature and its ability to withstand long periods of inanition without apparent harm.

The results herewith recorded are those of two groups of three animals each selected for uniform size. The weights represent live weights which necessarily include a large amount of sea water. Since a considerable amount of water can be expressed from *Thyone* by pressure, the weights given do not have the same significance as dry weights but nevertheless were used as approaching the live weights more closely. Since the animal does contain a large percentage of water, no attempt was made to compute oxygen consumption in terms of body weight. The weights for each group of 3 animals were as follows:

Group A—total weight: 32.8 gm.
Group B—total weight: 28.2 gm.

The respiratory chamber consisted of a 1000 ml. Erlenmeyer flask in which the animals were placed. A liter of sea water of the desired pH value was added and a thick layer of heavy mineral oil added to the surface to exclude the possibility of gaseous interchange at the surface. The permeability of this layer of oil was tested for a period of 24 hours and found to be negligible. The animal jar was kept in a water bath at a temperature of 22° C. In order to prevent any layering or stratification of the water a stirring device was added consisting of a motor-driven, friction-cone controlled stirrer with a small glass paddle which rotated at approximately 66 times per minute. The amount of agitation was very slight but sufficient to keep the water in movement slightly throughout the experiments.

Oxygen determinations were made at intervals by the micro-Winkler method as described previously (Hiestand, 1931). A slight modification was used, however, in that the samples were withdrawn by a sampling pipette of 11 ml. capacity under oil. Of this sample 10 ml. were used for the determination of dissolved oxygen.

The hydrogen ion concentration of the sea water was changed by the addition of NaOH or HCl to cover a range from pH 5.4 to 8.8. Since a precipitation of the salts of sea water occurred above pH 8.8. no attempt was made to raise the pH above this level. All pH determinations were carried out with color standards prepared by the Marine Biological Laboratory.

Results

The accompanying tables and graphs show the effects both of diminishing oxygen tension and of pH on the rate of oxygen

Table 1.

A-Series:
3 individuals of uniform size.
Total wt: 32.8 gm.

Time hrs.	N/400 thio. ml.	0_2/liter cc.
A-1	pH 8.2	
0	3.70	5.18
2	3.07	4.29
4	2.40	3.36
6	1.83	2.56
8½	1.10	1.54
11	0.54	0.75
A-2	pH 7.0	
0	3.80	5.32
2	3.52	4.93
4	2.98	4.17
6	2.58	3.61
9	1.96	2.74
11	1.54	2.15
13	1.27	1.78
A-3	pH 6.4	
0	3.90	5.46
2	3.63	5.08
4	3.32	4.65
6	3.02	4.23
8	2.81	3.93
11	2.58	3.61
13	2.32	3.25
A-4	pH 8.2	
0	3.62	5.07
2	2.93	4.10
4	2.23	3.12
6	1.74	2.44
8	1.12	1.57
10	0.56	0.78

Table 2.

B-Series:
3 individuals of uniform size.
Total wt: 28.2 gm.

Time hrs.	N/400 thio. ml.	0_2/liter cc.
B-1	pH 8.8	
0	3.90	5.46
2	3.27	4.58
4	2.80	3.92
6	2.32	3.25
8	1.66	2.32
11	1.08	1.51
13	0.72	1.01
B-2	pH 7.2	
0	3.46	4.84
2	3.10	4.34
4	2.84	3.98
6	2.44	3.42
8	2.10	2.94
10	1.63	2.28
12	1.33	1.86
B-3	pH 5.4	
0	3.84	5.38
2	3.76	5.26
4	3.72	5.21
6	3.64	5.10
10	3.56	4.98
13	3.52	4.93
B-4	pH 8.0	
0	3.82	5.35
3	3.23	4.52
5	2.75	3.85
8	2.24	3.14
11	1.63	2.28
13	1.20	1.68
B-5	pH 6.6	
0	3.58	5.01
4	3.18	4.45
6	2.89	4.05
8	2.68	3.75
10	2.50	3.50
12	2.32	3.25

consumption. Since the rate of oxygen consumption is uniform for the tensions encountered in the experiments the results show primarily the effect of variations in pH upon the respiratory rate. Separate experiments were conducted to determine the effect of lower tensions than those met with in these experiments. They showed a diminished oxygen consumption at very low tensions.

TABLE 3.

Rate of 0_2 consumption by Thyone at various pH values.

A-Series:		
A-1	pH 8.2	.420 cc. 0_2/hr.
A-2	pH 7.0	.269 cc. 0_2/hr.
A-3	pH 6.4	.181 cc. 0_2/hr.
A-4	pH 8.2	.437 cc. 0_2/hr.
B-Series:		
B-1	pH 8.8	.364 cc. 0_2/hr.
B-2	pH 7.2	.244 cc. 0_2/hr.
B-3	pH 5.4	.039 cc. 0_2/hr.
B-4	pH 8.0	.284 cc. 0_2/hr.
B-5	pH 6.6	.151 cc. 0_2/hr.

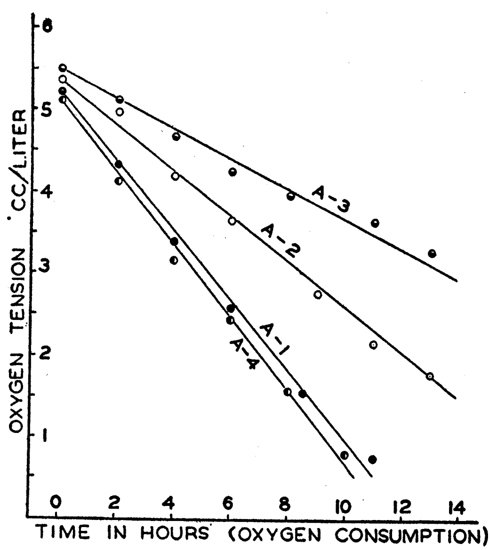

FIG. 1. Graphs showing oxygen consumption of series A individuals at pH ranges from 6.4 to 8.2. (Table 1)

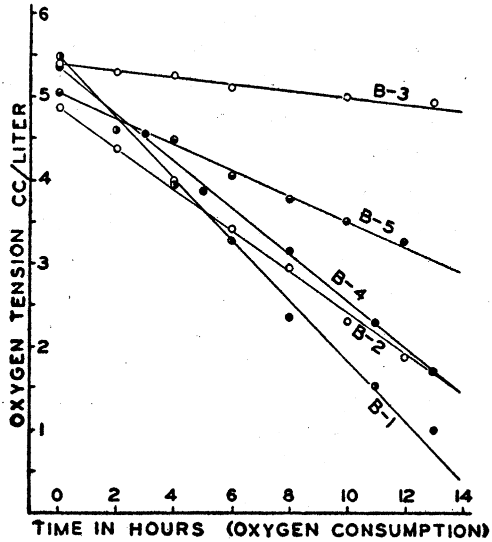

FIG. 2. Graphs showing oxygen consumption of series B individuals at pH ranges from 5.4 to 8.8. (Table 2)

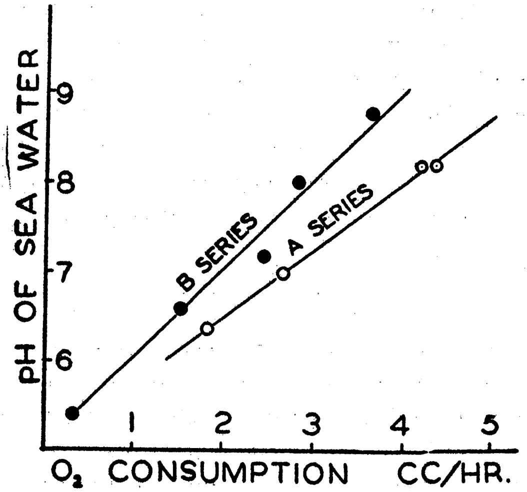

FIG. 3. Graphs showing relationship of oxygen consumption per hour to pH value of sea water. (Table 3.)

Discussion

It is clear from the above results that oxygen consumption in *Thyone* is unaffected by variations in oxygen tension of the water from that of normal air-water equilibrium to approximately one-seventh normal saturation.

Variations of the pH of sea water cause marked variations of the rate of oxygen consumption. This relationship of oxygen consumption and hydrogen ions is an inverse one, i.e. less oxygen is used in sea water of low pH values than at high ones, or it may be stated otherwise that oxygen consumption is proportional to hydroxyl-ion concentration. Figure 3 indicates that the relationship of oxygen consumption to pH is quite exact, since a "straight-line" relationship can be seen to exist over the range of values from pH 5.4 to 8.8.

Because of the ability of *Thyone* to continue its consumption of oxygen at a uniform rate until a low tension of oxygen is reached, one may conclude that it possesses an efficient respiratory system. Morphologically it is well known that the sea cucumbers have a respiratory tree which probably is a successful organ for gaseous exchange. In view of the fact that *Thyone* does respire quite uniformly over such a wide range of tensions, one is at a loss to explain the results reported by Nomura (1927) for *Caudina chilensis*, another holothurioidean, which results tend to show a dependence of oxygen consumption on oxygen tension. As previously mentioned, Nomura plotted the logarithms of the curve he obtained and showed a straight line (or nearly so) indicating an exponential type of curve.

Conclusions

Thyone briareus, a holothurioidean, respires at a uniform rate in sea water of a given hydrogen-ion concentration until the oxygen tension of the water reaches a level approximately one-seventh that of water normally saturated with atmospheric air. Below this critical level oxygen consumption is abruptly lessened.

The respiration of *Thyone* is inversely proportional to the pH value of sea water between pH 5.4 and 8.8.

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Spongilla lacustris (Linnaeus) 1745

Key to Plate I

Colonies large and branching. Fingers 30 centimeters long, 0.3-0.5 centimeters in diameter.
Collected: Island Lake, 7/15/37

PLATE I

Spongilla lacustris (Linnaeus) 1745

Key to Plate II

Gemmule (Photograph)
The gemmule is 519 microns in diameter
Spicules (Camera lucida drawings)

Fig. 1—Megascleres	377.6 microns long	16 microns wide
Fig. 2—Gemmule spicule	249 microns long	19 microns wide
Fig. 3—Megascleres	297.6 microns long	12.8 microns wide
Fig. 4—Microscleres	74.1 microns long	3.1 microns wide
Fig. 5—Microscleres	60 microns long	2.5 microns wide
Fig. 6—Microscleres	82 microns long	8.3 microns wide

Spongilla Fragilis Leidy 1851

Key to Plate IV

Gemmule (photograph)
The gemmule is 456 microns in diameter
Spicules (camera lucida drawings)

1. Megascleres	208 microns long	8 microns wide
2. Gemmule Spicule	76.8 microns long	6.4 microns wide
3. Gemmule Spicule	51.2 microns long	4.8 microns wide
4. Megascleres	214.4 microns long	8.8 microns wide
5. Megascleres (malformed)	75.2 microns long	8.2 microns wide
6. Gemmule Spicule	75.2 microns long	4.9 microns wide

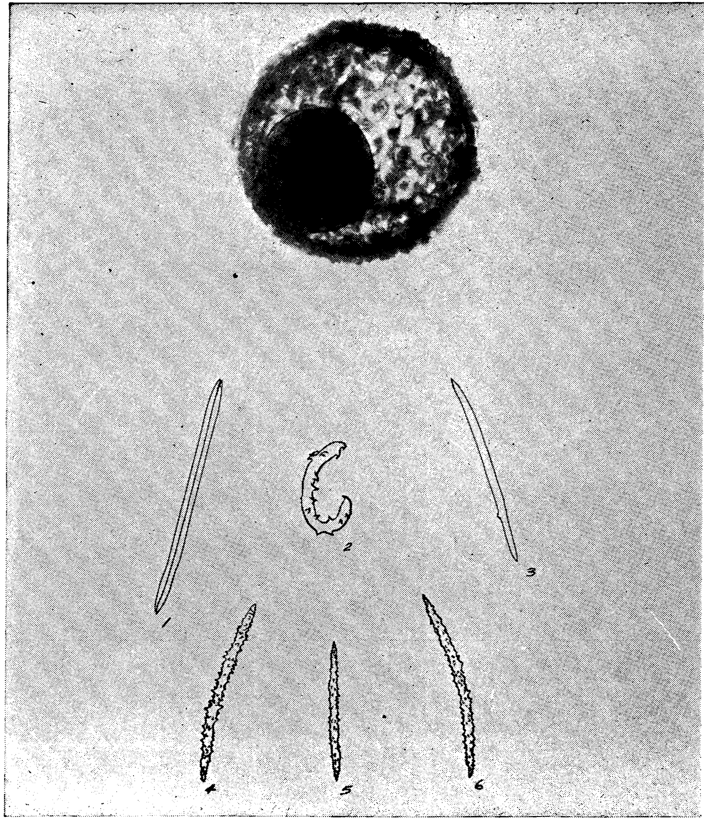

PLATE II

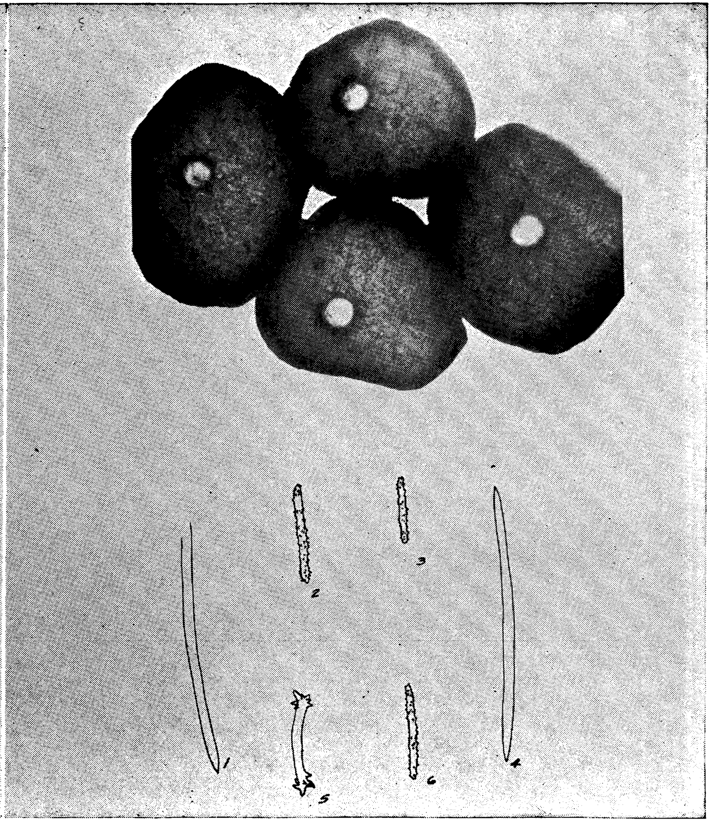

PLATE IV

Spongilla Fragilis Leidy 1851

Key to Plate III

Left—Rugose form showing prominent oscula. Colony 16 centimeters long.
Collected: Rice Creek, 8/6/36

Middle—Smooth form showing the same type of Oscula. 23 centimeters long.
Collected: Clear Lake, 8/11/37

Right—Form between Rugose and smooth forms showing prominent oscula. 17 centimeters long.
Collected: Island Lake, 7/29/37

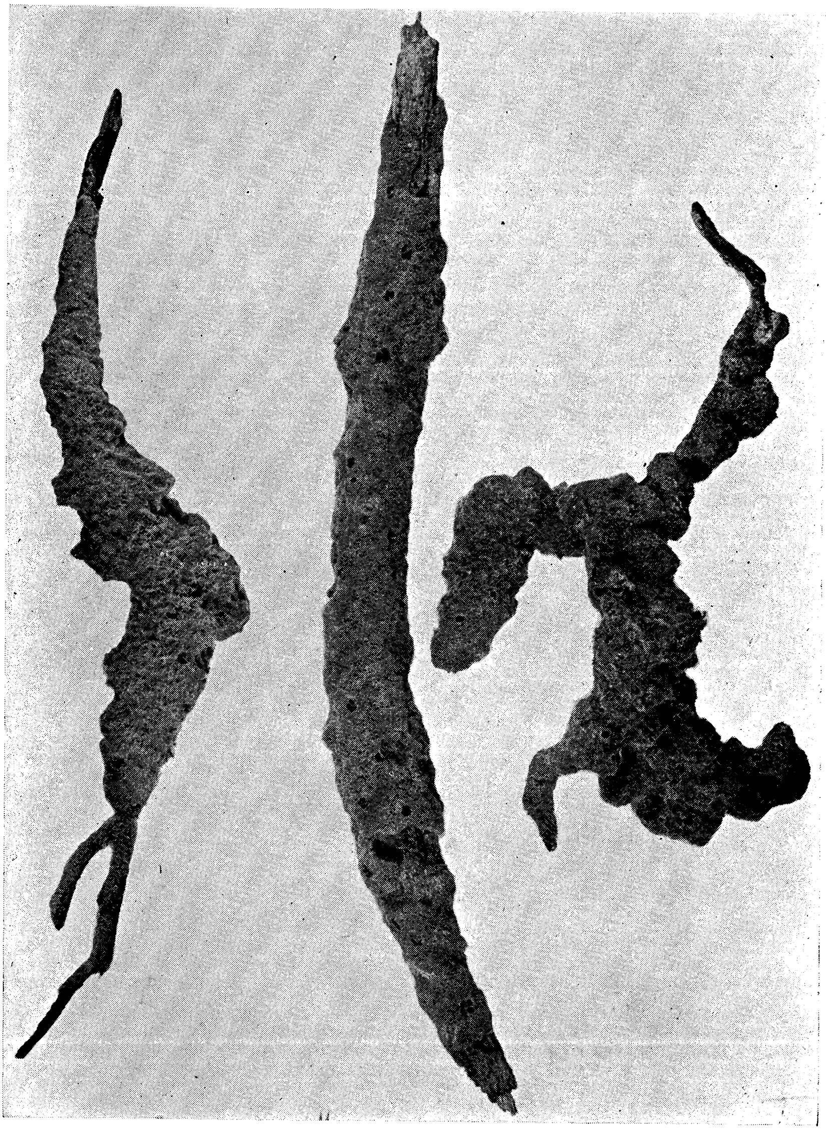

PLATE III

Spongilla igloviformis Potts 1887

Key to Plate V

Left —A colony 16 centimeters long

Middle—A colony 20 centimeters long

Right —A colony 20 centimeters long

Collected: Helmet Lake, 7/30/37

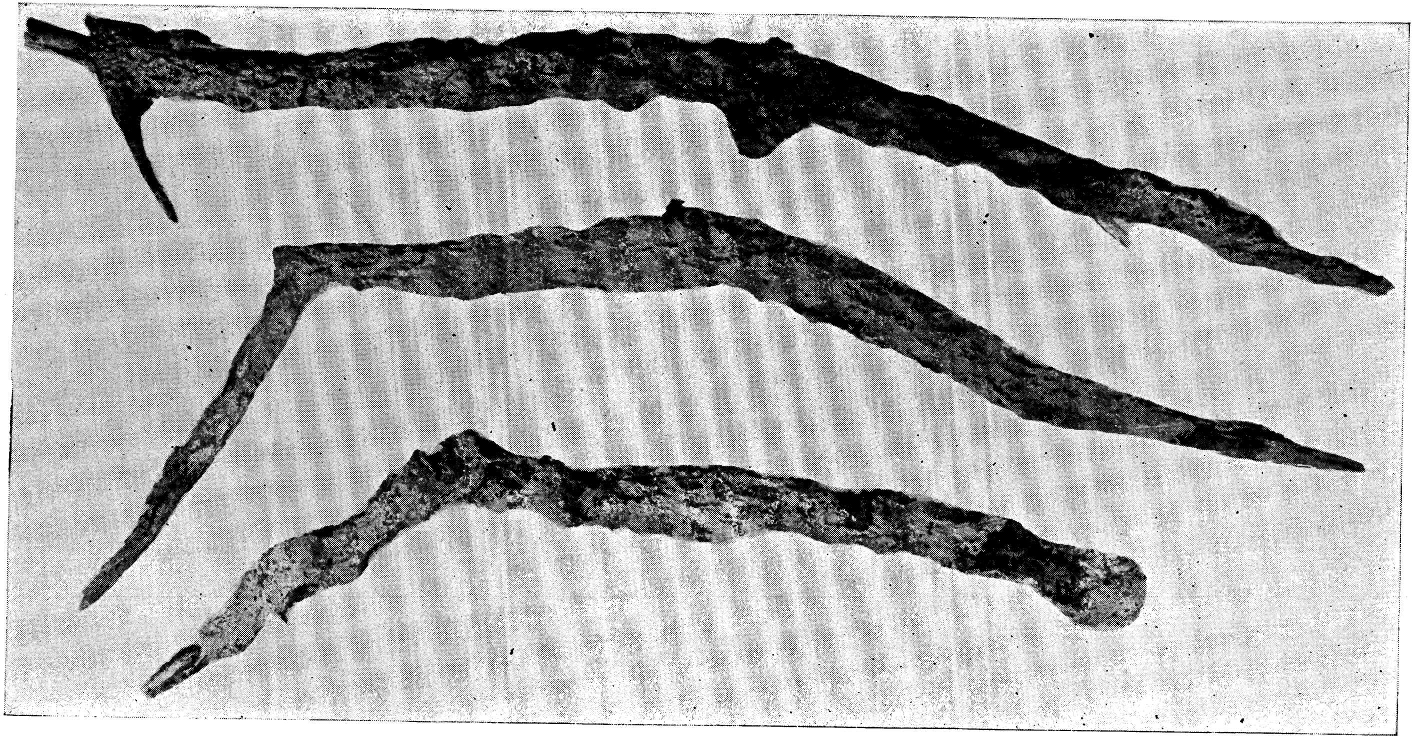

PLATE V

Spongilla igloviformis Potts 1887

Key to Plate VI

Gemmule (photograph)
The gemmule is 275 microns in diameter
Spicules (camera lucida drawings)

1. Megascleres (malformed)	241.6 microns long	14.4 microns wide
2. Gemmule Spicule	129.6 microns long	11.2 microns wide
3. Gemmule Spicule	129.5 microns long	11.0 microns wide
4. Megascleres	225.6 microns long	12.8 microns wide
5. Megascleres	163.2 microns long	9.6 microns wide

Ephydatia fluviatilis (Auctorum)

Key to Plate VIII

Gemmule (Photograph)
The gemmule is 344 microns in diameter
Spicules (camera lucida drawings)

1. Megascleres — 231 microns long; 8.8 microns wide
2. Gemmule birotulate rotules — 12.8 microns in diameter; 9.6 microns in diameter; 14.4 microns in diameter
3. Megascleres — 290.4 microns long; 8.5 microns long
4. Gemmule birotulates (shaft length) — 14.4 microns; 11.2 microns; 17.6 microns

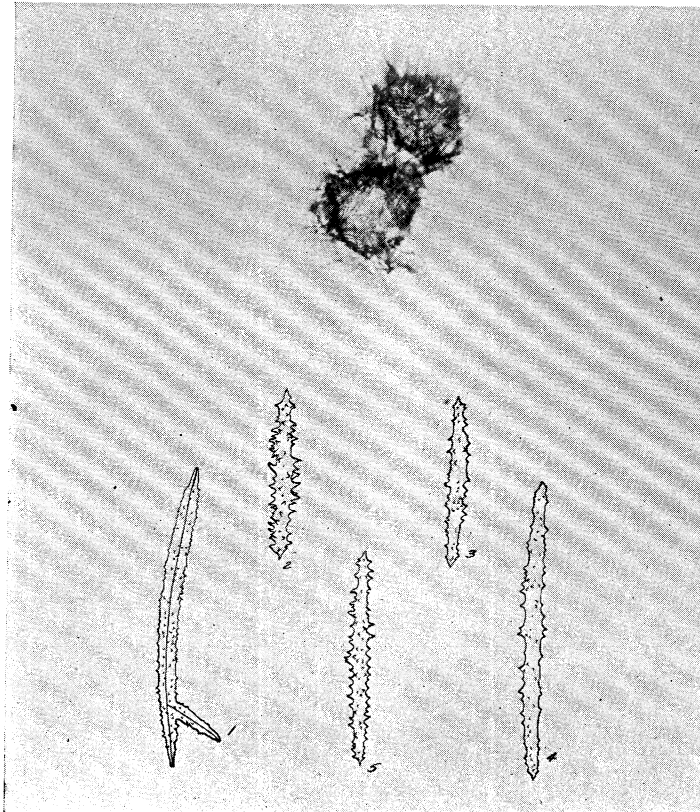

PLATE VI

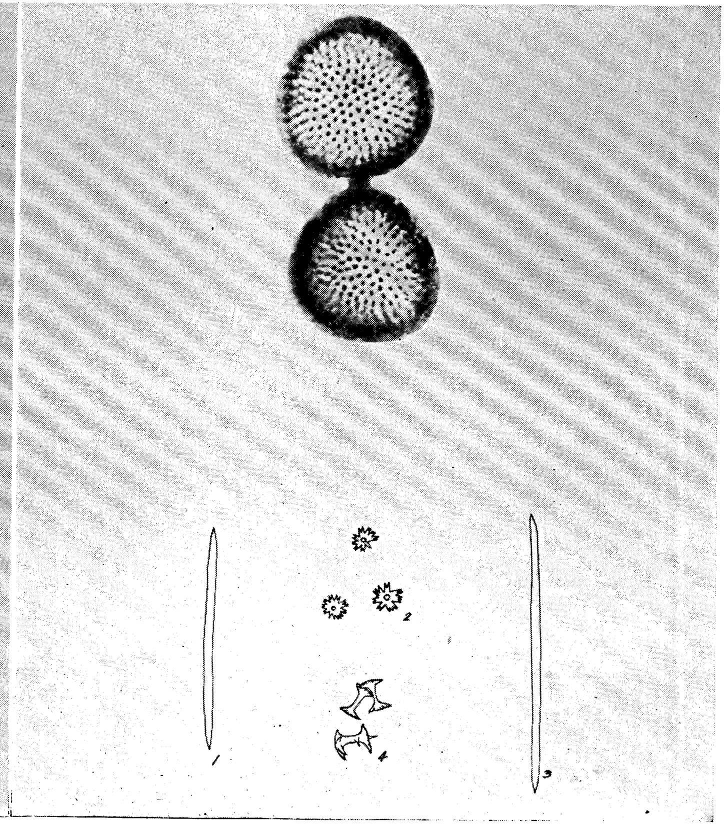

PLATE VIII

Ephydatia fluviatilis (Auctorum)

Key to Plate VII

Obtained through the courtesy of Mr. Blaire Coursen, Chicago, Illinois. Colony 5.2 centimeters long.

Ephydatia exeretti (Mills) 1884

Key to Plate IX

Colonies vary in length from 1.5-2.3 centimeters long; 4 millimeters wide. Collected: Malby Lake, 8/15/37

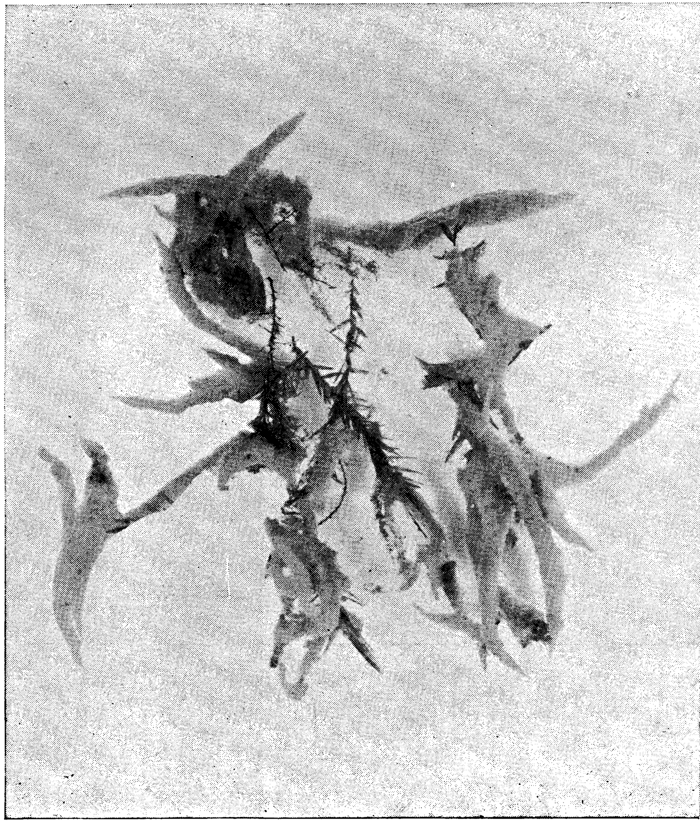

PLATE IX

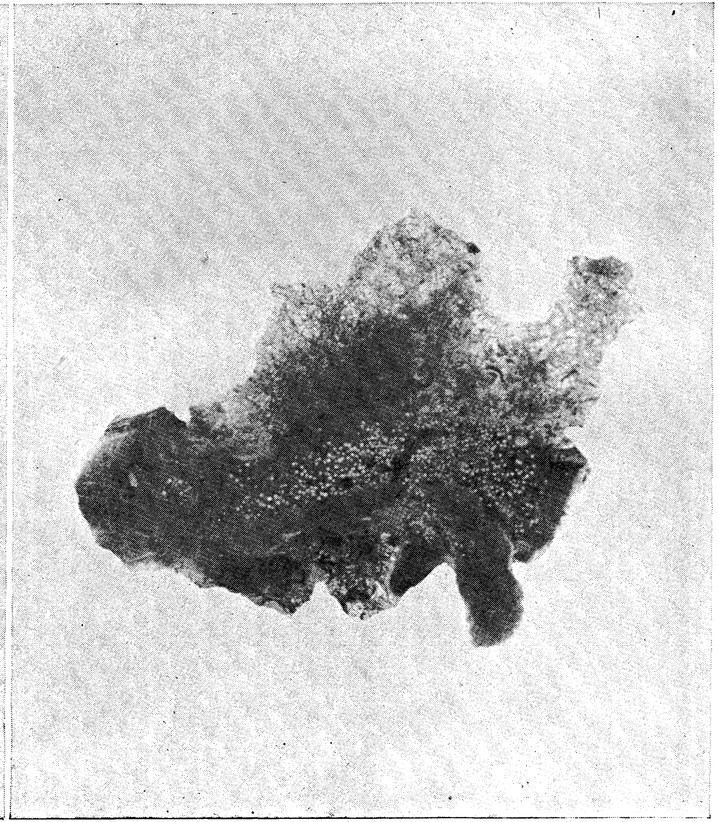

PLATE VII

Ephydatia exeretti (Mills) 1884

Key to Plate X

Gemmule (photograph)
The gemmule is 556 microns in diameter
Spicules (camera lucida drawings)

1. Microscleres	9.0 microns long 0.6 microns wide	
2. Megascleres	196.8 microns long; 2.0 microns wide;	182.4 microns long 1.8 microns wide
3. Microscleres	10.5 microns long 0.7 microns wide	
4. Gemmule birotulate	140.8 microns long 3.0 microns wide	

5. Gemmule birotulates (rotule diameters) 22.4 microns
16.0 microns

6. Gemmule birotulate (shaft length) 128 microns

Ephydatia mulleri (Lieberkuhn) 1856

Key to Plate XIII

Gemmule (Photograph)
The gemmule is 531 microns in diameter
Spicules (camera lucida drawings)

1. Megascleres 172.8 microns long
6.4 microns wide

2. Gemmule birotulate 16 microns long
3.2 microns wide (shaft)

3. Gemmule birotulate (malformed) 14.1 microns long

4. Gemmule birotulate (shaft length) 8.2 microns long

5. Megascleres 192 microns long
10.4 microns wide

6. Gemmule birotulate rotules 17.6 microns in diameter
19.2 microns in diameter
23.9 microns in diameter

7. Gemmule birotulate showing irregular serration and deep dentation

8. Gemmule birotulate rotule 18.8 microns in diameter

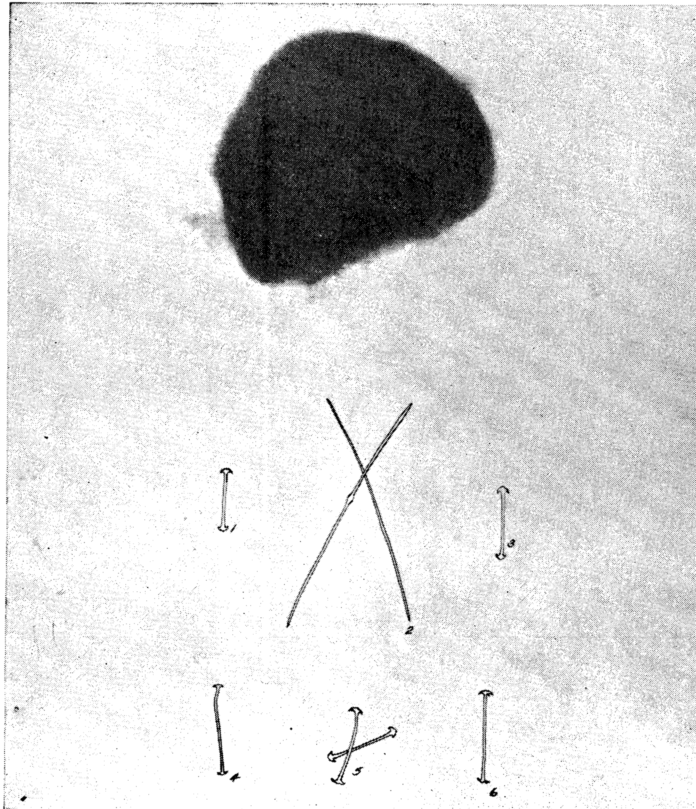

Plate X

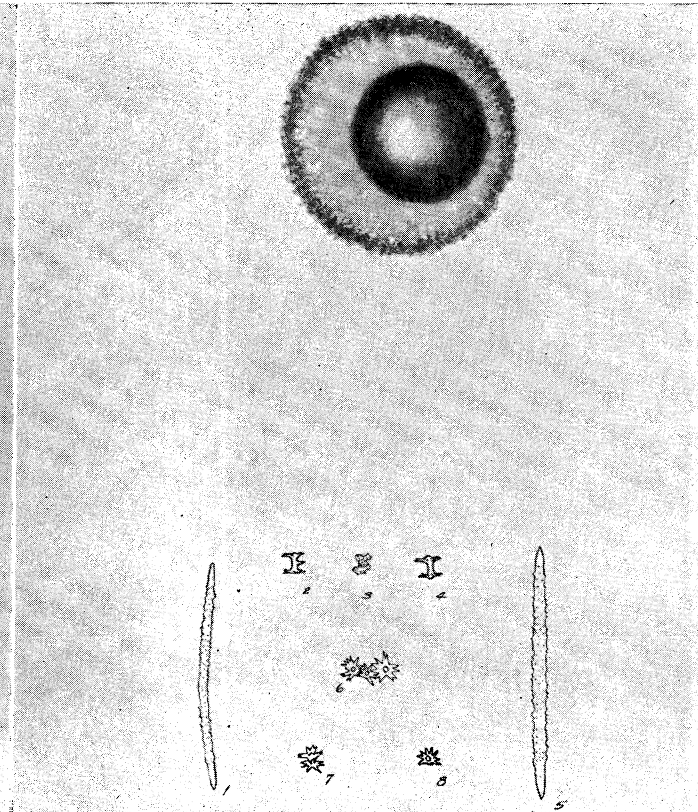

Plate XIII

Ephydatia mulleri (Lieberkuhn) 1856

Key to Plate XI

This is a very large colony. It is 23 centimeters long, 10 centimeters wide, with lobes 4.5 centimeters high. This is the lake form.
Collected: Island Lake, 8/24/37

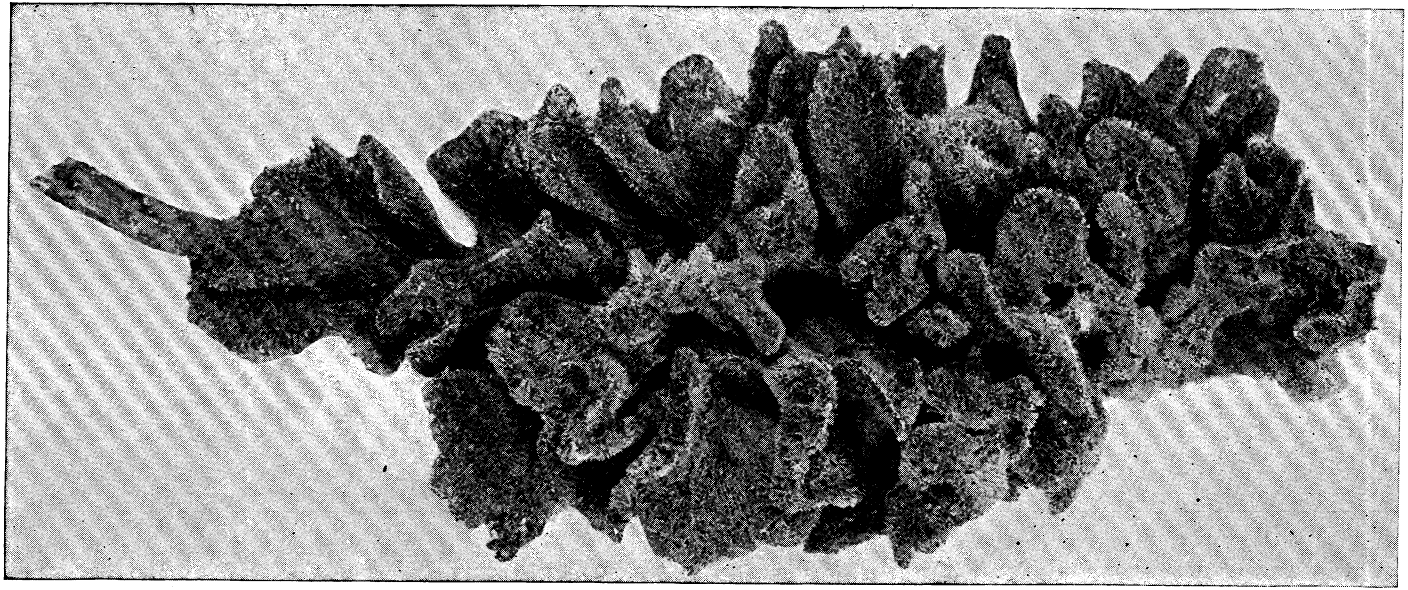

Plate XI

Ephydatia mulleri (Lieberkuhn) 1856

Key to Plate XII

This is the river form of E. mulleri showing the comparatively smooth surface. The colony is 11 centimeters long.
Collected: Circle Lily River, 7/28/36

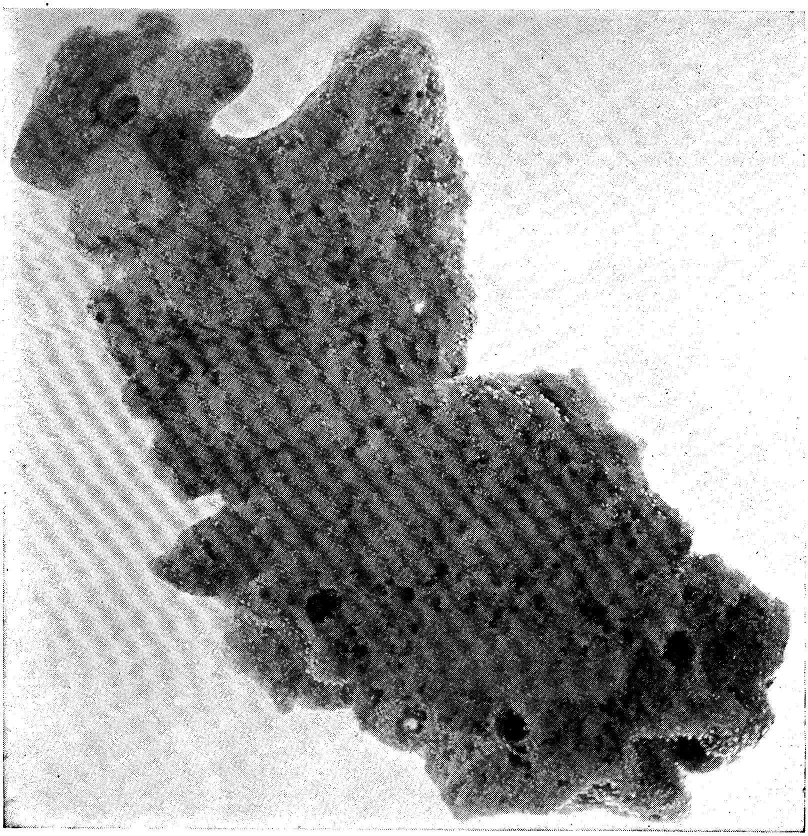

PLATE XII

Ephydatia crateriformis (Potts) 1882

Key to Plate XIV

Gemmule. From Potts (1887)
Section of chitinous coat of gemmule, supporting-b, hooked birotulates with very long shafts: whose positions, normally radial, are, in this species, frequently twisted or confused.
Gemmule diameter 0.013 inches.

Spicules. From Potts (1887)
From Crowe's Mill, Brandywine Creek, Pennsylvania: a,a, slender, microspined skeleton spicules; b,b,b,b, mature gemmule birotulates with short hooked rays; c,d,e,e, supposed immature forms.
Meas. Skeleton spicules 0.01 by 0.0004 inches. Length of birotulate spicules 0.0025 inches. Diameter of rotules 0.0004 inches; of shaft 0.00015 inches.

Tubella pennsylvanica Potts 1882

Key to Plate XXII

Gemmule (photograph)
The gemmule is 387 microns in diameter
Spicules (camera lucida drawings)

1. Megascleres 192 microns long
   12.8 microns wide

2. Gemmule birotulates 16 microns long
   19.2 microns large rotule diameter
   4 microns small rotule diameter
   8 microns shaft length

3. Megascleres 142 microns long
   10 microns wide

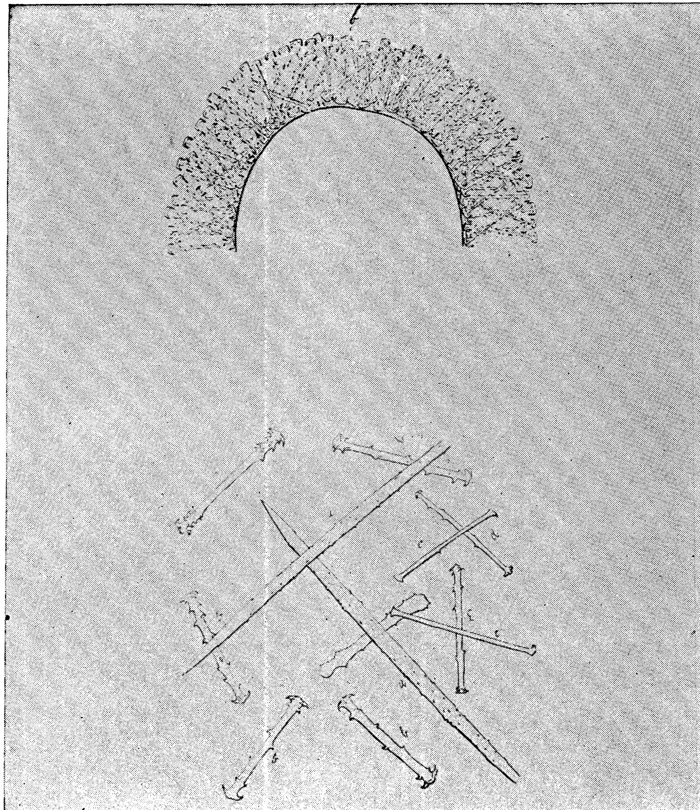

Plate XIV

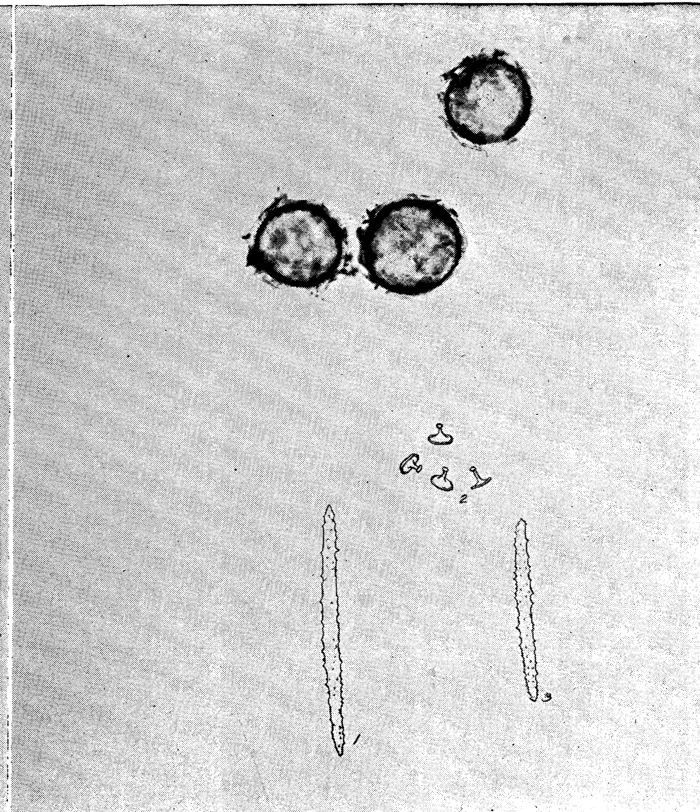

Plate XXII

Heteromeyenia ryderi Potts 1882

Key to Plate XV

This specimen obtained through the courtesy of Dr. M. E. Jewell, Thornton Junior College, Harvey, Illinois. It is 7 centimeters long and 2 centimeters in diameter.

Collected: Outlet of Little Mamie, August, 1936.

Heteromeyenia argyrosperma Potts 1880

Key to Plate XVII

Colony is small and branched. The branches are of varying length and width. The fingers 0.3-0.6 centimeters wide. There is also a thin encrusting form of this same species.
Collected: Island Lake, 8/9/37

Carterius tubisperma Mills 1881

Key to Plate XXIII

Sponge growing in loose patches with numerous small papillae on the surface. 1-1.5 centimeters in thickness. (lateral view)
Collected: Island Lake, 7/22/37

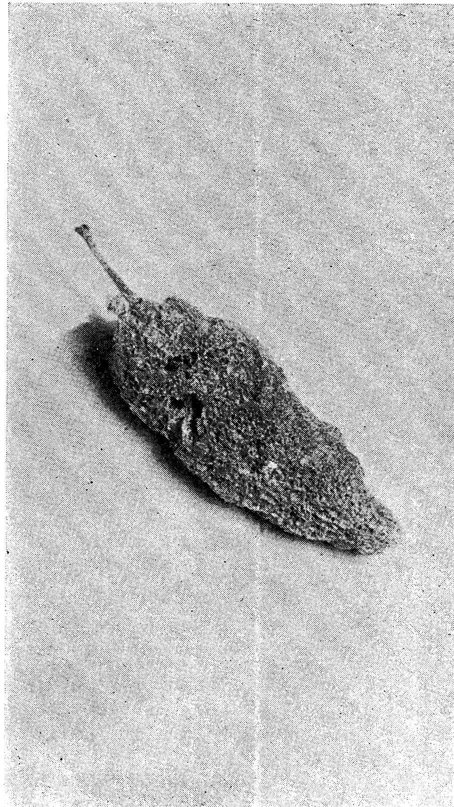

Plate XV

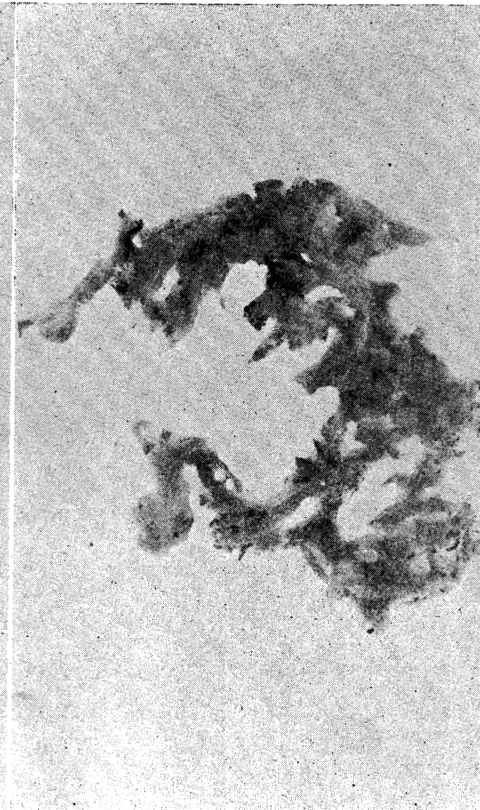

Plate XVII

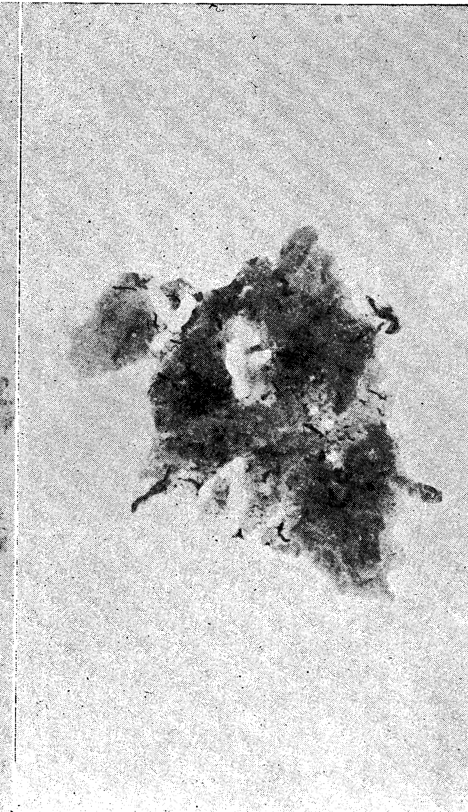

Plate XXIII

Heteromeyenia ryderi Potts 1882

Key to Plate XVI

Gemmule (photograph)
The gemmule is 354 microns in diameter
Sipcules (camera lucida drawings)

1. Megascleres 206.8 microns long
   8.5 microns wide

2. Gemmule birotulate 46 microns long
   4 microns wide

3. Gemmule birotulate (shaft length) 25.6 microns

4. Megascleres 292.4 microns long
   14.3 microns wide

5. Gemmule birotulate (rotule diameter) 19.2 microns

6. Gemmule birotulate rotule 20.8 microns in diameter

7. Gemmule birotulate 57.6 microns long
   8.0 microns wide

8. Gemmule birotulate 52.8 microns long
   8.2 microns (length of rotule ray)

Heteromeyenia argyrosperma Potts 1880

Key to Plate XVIII

Gemmule (photograph)
The gemmule diameter is 954 microns.
Spicules (camera lucida drawings)

1. Megascleres 277.2 microns long
   8.8 microns wide

2. Gemmule birotulate 73.6 microns long
   7.2 microns wide
   8.0 microns spine length

3. Gemmule birotulate 124.8 microns long
   7.2 microns wide
   9.5 microns spine length

4. Gemmule birotulate 137.6 microns long
   16.0 microns ray length

5. Gemmule birotulate 96.0 microns long
   7.4 microns wide

9.0 microns wide
6. Megascleres 257.4 microns long

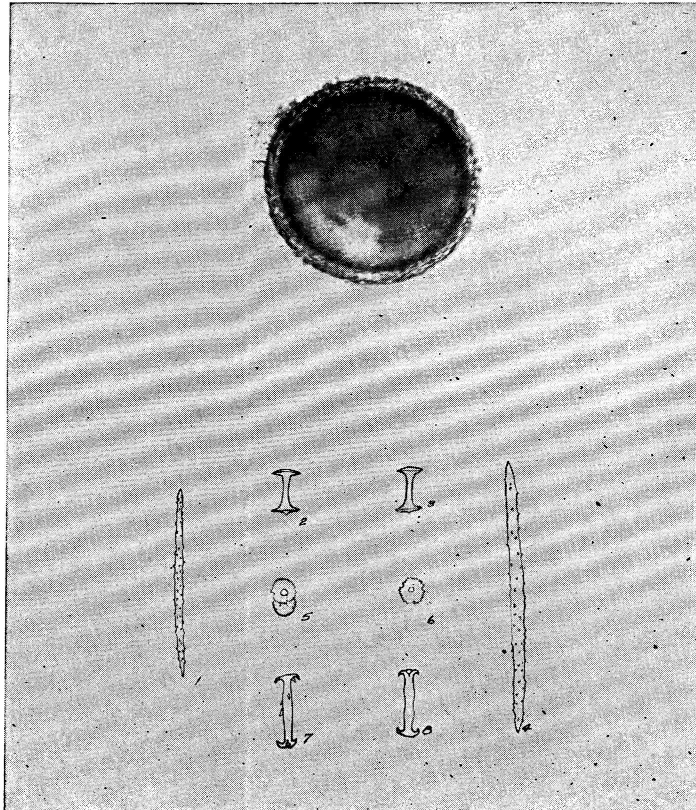

PLATE XVI

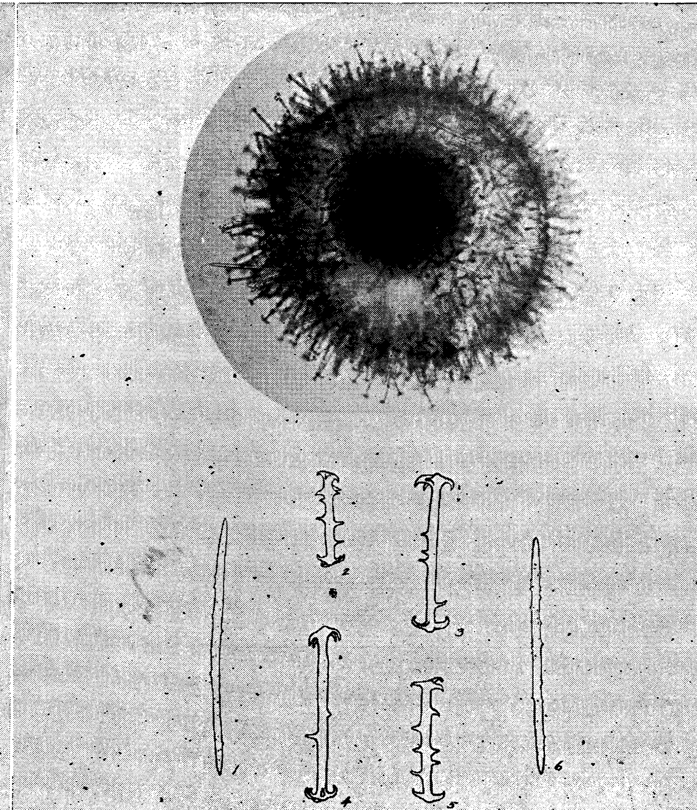

PLATE XVIII

Heteromeyenia repens Potts 1880

Key to Plate XIX

Colony small and much branched. Branches 0.2-0.3 centimeters wide.
Collected: Island Lake, 8/10/37

Carterius tenosperma Potts 1880

Key to Plate XXVI

Colony very small. 15 millimeters long, 5 millimeters wide, and 3 millimeters thick.
Collected: Spider Lake, Spider Lake Township. 7/12/36

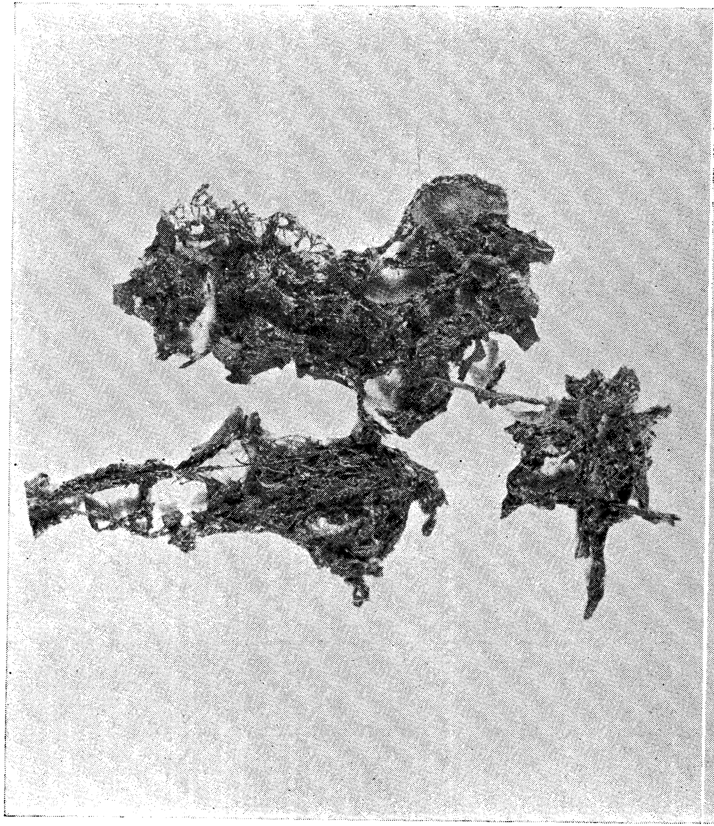

PLATE XIX

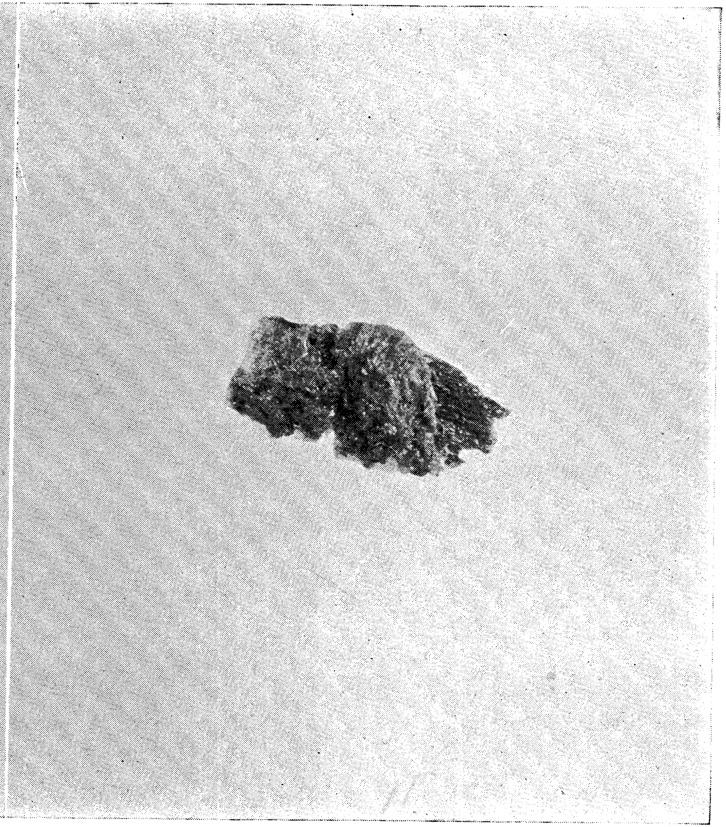

PLATE XXVI

Heteromeyenia repens Potts 1880

Key to Plate XX

Gemmule (photograph)
The gemmule is 493 microns in diameter
Spicules (camera lucida drawings)

1. Megascleres	277.2	microns long
	9.1	microns wide
2. Microscleres	80	microns long
	3.3	microns wide
3. Microscleres	90	microns long
	3.5	microns wide
4. Gemmule birotulate	79	microns long
	6.6	microns wide
	25.6	microns rotule diameter
5. Gemmule birotulate	54	microns long
	5.2	microns wide
	25	microns rotule diameter

Carterius tubisperma Mills 1881

Key to Plate XXIV

Gemmule (photograph)
The gemmule is 424 microns in diameter
Spicules (camera lucida drawings)

1. Megascleres 208 microns long
   8.6 microns wide

2. Foraminal tubule showing the three tendrils. 199 microns long.

3. Megascleres	192	microns long
	6.5	microns wide
4. Microscleres	86.4	microns long
	3.5	microns wide
5. Gemmule birotulate	57.6	microns long
	3.8	microns wide
	19.2	microns rotule diameter
6. Gemmule birotulate	40.0	microns long
	5.1	microns wide
	19.0	microns rotule diameter
7. Microscleres (malformed)	76.8	microns long
	4.4	microns wide

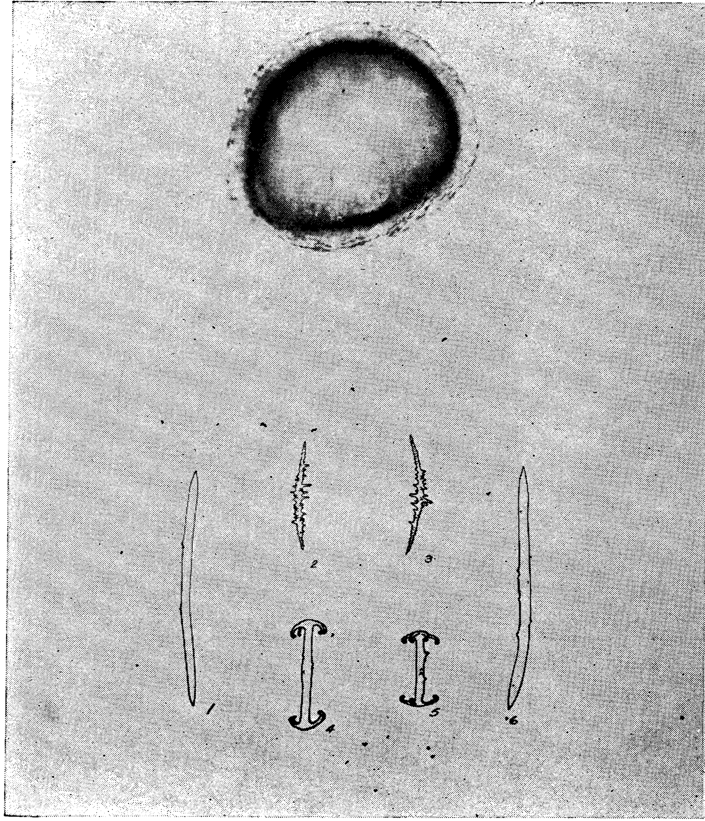

PLATE XX

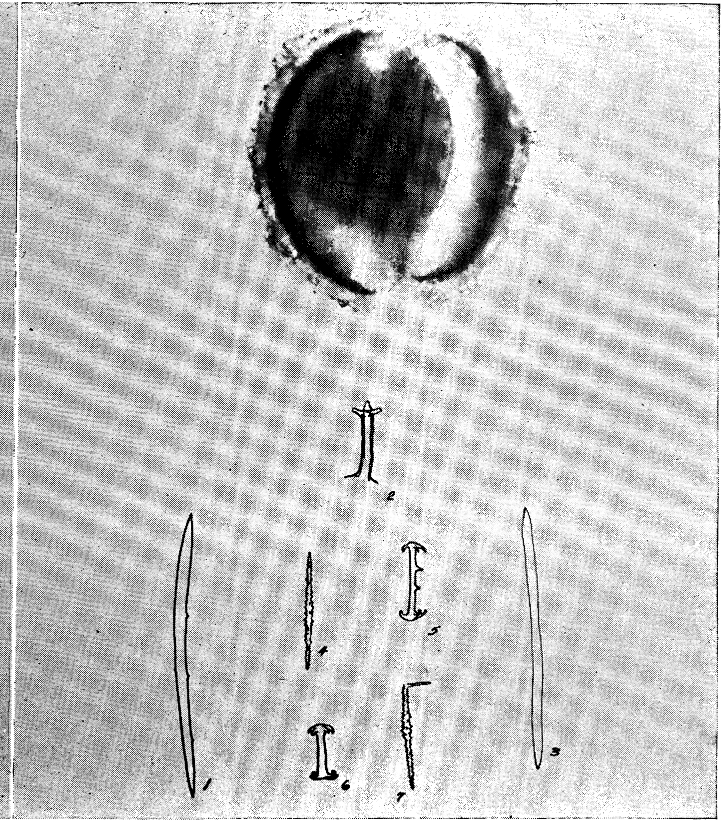

PLATE XXIV

Tubella pennsylvanica Potts 1882

Key to Plate XXI

Large Colony. 41 centimeters long; 2 centimeters wide, 0.2-0.5 centimeters thick.

Collected: Helmet Lake, 7/30/37

Small Colony. This was a thin creeping form covering the whole underside of a log 14 feet long. It varies in thickness from 0.05-0.2 centimeters.

Collected: Mud Lake, Spider Lake Township, 8/3/37

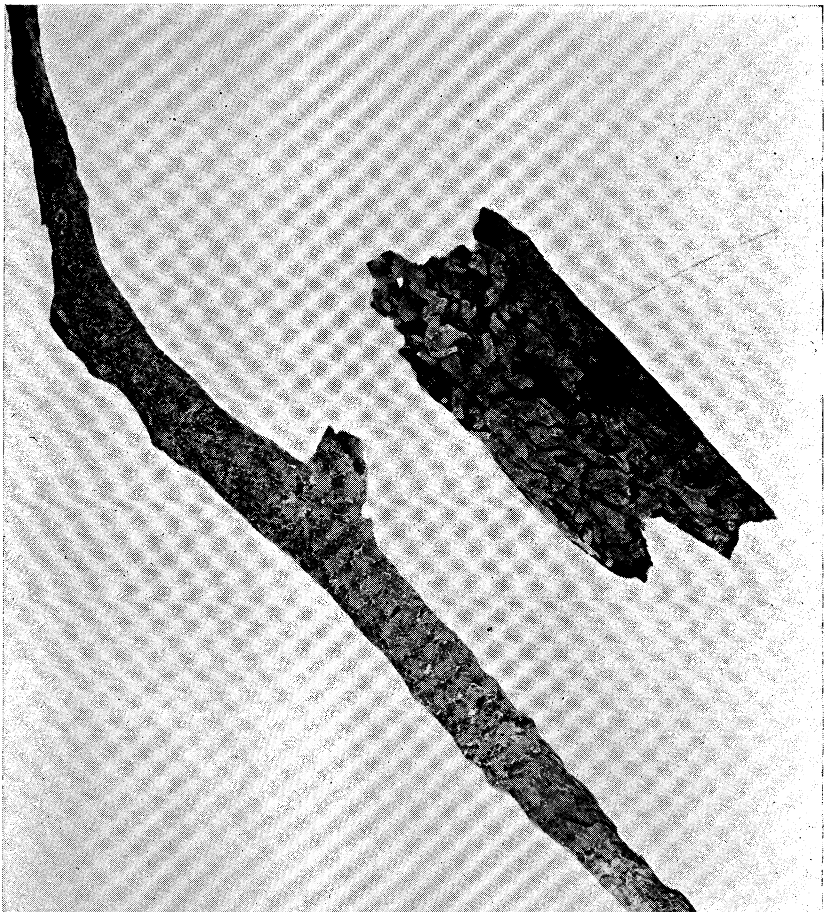

Plate XXI

Carterius latitentia Potts 1881

Key to Plate XXV

Gemmule. From Potts (1887)
Partial section of chitinous coat, bearing crust, and birotulate spicules-b; and extended into a foraminal tubule shorter than that of either of the previous species (C. tubisperma and C. step anowii), surrounded and terminated by one or two long and broad, ribbon-like cirrous appendages-d. No gemmule diameter given.

Spicules. From Potts (1887)
From Chester Creek, Pennsylvania; -a,a, skeleton spicules; b,b,b,b, gemmule birotulates, variable in length; d,d, face of rotules; c, spined dermals. Meas. Skeleton spicules 0.0111 by 0.00045 inches. Length of dermal spicules 0.0038 inches. Birotulates 0.0019 by 0.00015 inches. Diameter of disc 0.001 inches.

Carterius tenosperma Potts 1880

Key to Plate XXVII

Gemmule (photograph)
The gemmule is 424 microns in diameter
Spicules (camera lucida drawings)

1. Foraminal tubule, showing branched twisted tendrils. 63 microns long
2. Megascleres 291 microns long
   11 microns wide
3. Megascleres (malformed) 192 microns long
4. Microscleres 110 microns long
   6.5 microns wide
5. Megascleres (malformed) 179 microns long
6. Megascleres (malformed) 290 microns long
   10.2 microns wide
7. Gemmule birotulate 108 microns long
   7.0 microns wide
8. Gemmule birotulate 86 microns long
   6.8 microns wide

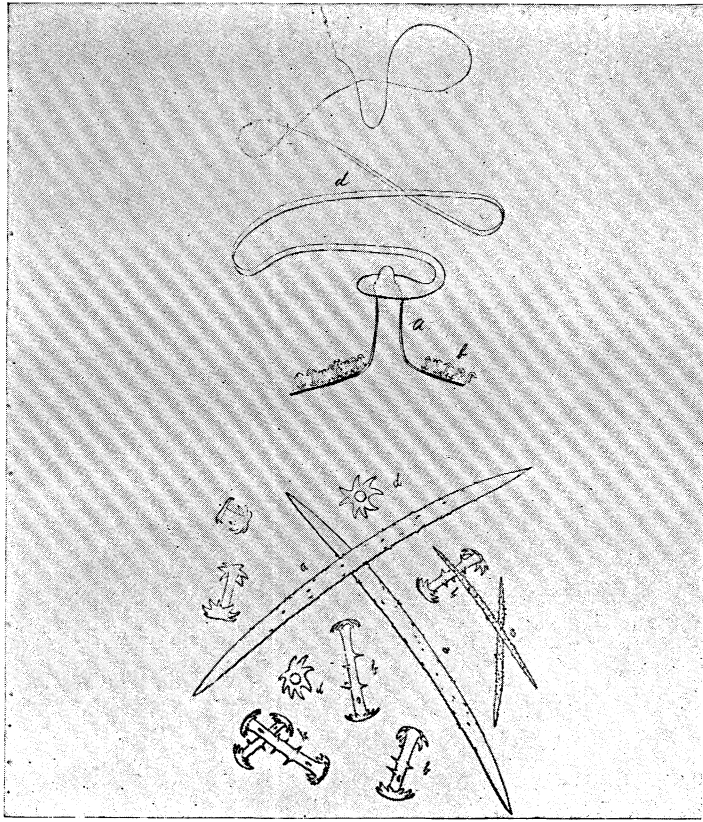

PLATE XXV

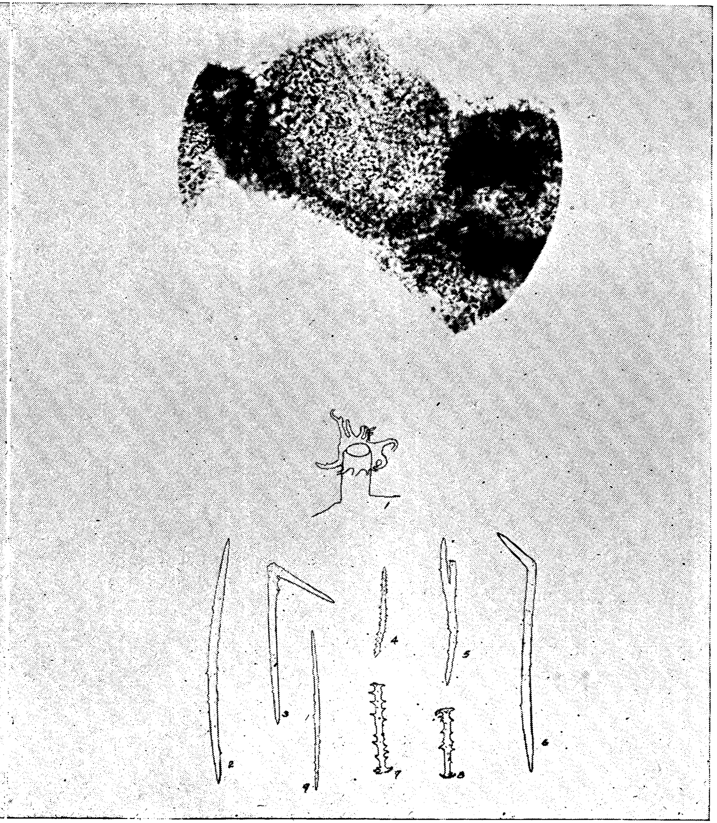

PLATE XXVII

THE FRESH-WATER SPONGES OF WISCONSIN*

By

JAMES RUSSELL NEIDHOEFER

From the Biological Laboratory of Marquette University, under the direction of Rev. Paul L. Carroll, S. J., St. Louis University.

I. INTRODUCTION

The fresh-water sponges were observed but not recognized as animals at a very early period. The early investigators thought they were plants; later workers, colonial protozoa. In 1696, Leonard Plukenet first made public mention of them; and later, in 1745, Linnaeus described them as *Spongia* and made mention of their "globuli". After Linnaeus the term *Spongia* changed many times until, in 1816, Lamarck introduced the generic name Spongilla.

Not until the perfection of the microscope, were the greatest strides toward the systematic classification of these animals made. Grant (1826), and later Meyen (1839), published works on the sponges, the latter describing the "globuli" of Linnaeus as "sphaerulae", stating that they were similar to the winter bodies of the polyps. H. J. Carter of England, in 1859, applied the term "statoblast" to these little bodies, shown to be reproductive bodies in 1842 by John Hogg. Then Johnston (1842) and later Bowerbank (1863) published their work on the sponges. A sexual method of reproduction was sought after and found in 1856 by Lieberkühn who figured both the spermatozoa and the ova of Spongilla.

The greater amount of knowledge of the fresh-water porifera was obtained during the last 60 years. The most important contributor was Dr. Edward Potts who did extensive work from 1880 until his death. Carter, in England, published his well known work on the fresh-water sponges in 1881. In 1887, Potts published his monograph "Contributions towards a Synopsis of Fresh-Water Sponges with Descriptions of Those Named by Other Authors from all Parts of the World". This work is a true classic in the field. In it Potts gave the "statoblast" of Carter its name, Gemmule. Potts and his co-worker, Henry Mills of Buffalo, N. Y., made a careful survey of the Eastern States, Florida, and a few of the states west of the Alleghenies. A. H. McKay of Halifax and B. W. Thomas of Chicago collected in their respective areas. Through all of these workers, together with Carter, most of the fresh-water forms of the United States were described.

One great defect in the work of these men and several subsequent workers, however, was the failure to recognize *Ephydatia fluviatilis* (Auctorum) and *Ephydatia mulleri* (Lieburkühn) as distinct species. Specimens of both species were designated as *Meyenia fluviatilis* (Auctorum) leading many into the error of describing their varieties as distinct species.

After 1910 such workers as Annandale (1911), N. Gist Gee, (1932) of Peking, China, Marcus Old (1932) of Pennsylvania, Frank Smith (1921) of Michigan, and Minna E. Jewell (1935) of Illinois, together with several other workers in their various sections of the country have identified many species of sponges and recorded much valuable data concerning them. The first four worked in the field of Taxonomy, Dr. Jewell in the field of Ecology. Smith (1921) listed twelve species as indigenous to Wisconsin. Jewell, in 1935, listed one new species, *Ephydatia* everetti (Mills), for the state. The collections of the author included twelve species, one of which, *Carterius tenosperma* Potts is a new report for the state, (Neidhoefer 1938). Two species were not found by the author in the region studied, *Ephydatia crateriformis* Potts, and *Carterius latitentia* Potts, Smith being the only one to have ever reported them from the state.

II. MATERIAL AND METHODS

1. Collection Methods

Collection methods for sponges are very simple. A canoe or a rubber inflated boat is used since they can easily be transported and handled. The sponges are gathered in shallow water by merely picking them up, or in deeper water, by diving, or by the use of a long-handled garden rake.

2. Fixation Methods

One of two fixation methods is used depending upon the type of sponge. The large firm specimens, such as *Ephydatia mulleri* (Lieberkühn), are hung in a warm, dry shaded place. They dry very rapidly and are then placed in individual containers. The smaller, more fragile specimens, as *Tubella pennsylvanica* (Potts), are preserved in a 20% formalin solution.

3. Technique Methods

For rapid identification of the sponge, a small portion of the sponge is placed on a slide together with two drops of concentrated nitric acid. The slide is then heated over an alcohol lamp until dry and then a drop of balsam and a cover glass are added.

In making permanent microscopic mounts of spicules, a slightly different procedure is followed. A small portion, four or five cubic centimeters, of the sponge is placed in the bottom of the test tube. About ten cubic centimeters of concentrated nitric acid are then added and the mixture heated to boiling. The test tube is then set aside and allowed to stand for about two days. The nitric acid in the test tube is then diluted by adding enough distilled water to fill the test tube. It is then allowed to stand for another day with frequent agitation. At the end of this time the supernatant liquid is drawn off and the spicules are washed in several changes of distilled water, 95% alcohol is then added and finally absolute alcohol. The absolute alcohol containing the spicules is agitated and then the liquid is drawn into a pipette. Three or four drops of the liquid are placed on a No. 1 cover glass. The absolute alcohol is burned off of the cover glass leaving the silicon spicules adhering to it. A drop of thin balsam is then placed on the middle of the slide and the cover glass is inverted and set on it. In this manner a slide free from debris is obtained.

In preparing permanent mounts of gemmules, a slightly different method is used. The gemmules are taken out of the sponge body either by dissection under a binocular microscope or by allowing the sponge to stand in concentrated nitric acid until the gemmules can be seen in the sponge body or floating in the liquid. The latter method is preferable as there is less chance of damaging the gemmule or its appendages. The gemmules are then put into a test tube containing concentrated nitric acid and allowed to remian in it until they have an orange or yellow, transparent appearance. They are then washed in several changes of distilled water until all of the nitric acid has been removed. Next they are transferred to 95% alcohol and then absolute alcohol, after which they are run into xylol and mounted on depression slides in heavy balsam. It is necessary to have gemmules present in order to definitely classify the sponge.

4. Water Analysis Methods

The hydrogen ion concentration of the water was taken by the LaMotte colorimetric method. The oxygen content of the water was determined by the Winkler method for dissolved oxygen. The bound carbon dioxide content of the water was found by use of the methyl orange titration method.

III. ECOLOGY

1. Physical Factors

In considering the relation of the sponge to its habitat one character to note is the amount of light received by the animal. The limiting factor of the light, most naturally, will be the transparency (table 1) or the color (table 2) of the water, which in turn is limited by the amount of dissolved organic matter in it. It was found by Jewell (1935) and confirmed by the author that all but two of the forms are light positive to a greater or lesser degree; namely, *Tubella pennsylvanica* Potts and *Spongilla igloviformis* Potts. These two prefer light of low intensity and when found in transparent waters were collected from the under side of their support or imbedded in the organic deposits on the bottom. Sponges are commonly found in depths up to seven feet, but a specimen of *Ephydatia mulleri* (Leberkühn) was taken by the author at a depth of twelve feet from Rice Creek, Vilas County, in August 1936.

2. Chemical Factors

The most important factors, chemically speaking, when working with any aquatic forms are the oxygen content, the carbon dioxide content (free or bound) and the hydrogen concentration of the water. In working with the sponges it is found, as shall be pointed out, that the first two of these factors are of little

TABLE 1
Distribution of sponges with reference to the transparency of the water*

Sponge	Transparency as meters visibility of Secchi's disc 0-1	1.1-1.5	1.6-2	2.1-3	3.1-4	4.1-5	5.1-6	Over 6
E. mulleri	1	.	5	4	1	1	.	.
S. fragilis	3	6	8	10	4	1	.	.
S. lacustris	6	6	9	12	4	3	.	1
T. pennsylvanica	6	6	4	7	3	1	3	1
S. igloviformis	4	.	2	2	.	1	1	.
E. everetti	.	.	.	4	1	4	3	4
S. lacustris (atypical)	.	.	.	3	5	2	3	3
Lakes	10	9	14	24	11	13	5	8

TABLE 2
Distribution of sponges with reference to the color of the water*

Sponge	Degree of color of water 0-10	11-20	21-30	31-40	41-50	51-75	76-100	101-150	Over 150
E. mulleri	1	3	3	1	4	3	2	2	.
S. fragilis	3	7	5	6	7	8	3	4	1
S. lacustris	5	6	9	7	5	8	4	9	1
T. pennsylvanica	9	9	1	2	3	6	3	9	2
S. igloviformis	4	4	.	.	.	.	1	4	1
E. everetti	9	1	1	.	.	.	.	.	11
S. lacustris (atypical)	7	1	2	.	.	.	.	.	8
Lakes	23	14	14	6	13	4	11	2	36

* Jewell, M. E., An Ecological Study of the Fresh-water Sponges of Northern Wisconsin. *Ecol. Mono.* 1935, 5:461-504.

importance, while the silicon dioxide content of the water plays an important role in their development. Jewell (1935) did extensive work on all of these factors. She found that neither the oxygen content (table 4) nor the free carbon dioxide content (table 5) could be regarded as influential factors in the distribution of the fresh-water sponges. Birge and Juday (1930), working on the lakes of Northeastern Wisconsin, found that even the "hardest" of the lake waters was in reality "soft." The bound carbon dioxide content (table 6) was found by Jewell (1935) to be a restricting factor for certain forms. She found also that the hydrogen ion concentration (table 7) was a limiting factor for a few species. The writer, in work done in the summers of 1936 and 1937, found similar conditions to hold true in several lakes not studied by Jewell. Welch (1935) and Jewell (1935) state that an adequate supply of silicon is necessary to the fresh-water sponges for the manufacture of their spicules and the development of their silicious skeleton. The silicon dioxide content of the water (table 8), a definite limiting factor, does cause a great variation in the size, shape and number of spicules, and, consequently, in the firmness of the sponge body. *Spongilla lacustris* (Linnaeus) was found in the greatest variety of habitat It may be concluded that the most important limiting factor in fresh-water sponge distribution and growth are bound carbon dioxide, silicon dioxide, and hydrogen ion concentration.

TABLE 3

Distribution of Sponges with reference to Total Organic Content of the water*

Sponge	Total organic content as mgms. per liter						
	3.5-5	5.1-7	7.1-10	10.1-15	15.1-25	25.1-40	Over 50
E. mulleri	.	.	2	6	8	3	.
S. fragilis	.	2	2	14	16	8	1
S. lacustris	.	3	4	15	16	13	1
T. pennsylvanica	3	5	7	6	8	11	2
S. igloviformis	3	1	2	2	.	4	1
E. everetti	6	4	9	3	.	.	.
S. lacustris (Atypical)	2	4	9	3	1	.	.
Lakes	6	6	19	24	25	19	2

TABLE 4

The distribution of Sponges with reference to the dissolved oxygen in the water*

Sponge	Dissolved oxygen as parts per million					
	5-5.9	6-6.9	7-7.9	8-8.9	9-9.9	10-up
E. mulleri	3	3	2	6	.	3
S. fragilis	3	5	7	19	1	5
S. lacustris	3	7	13	21	2	4
T. pennsylvanica	3	9	11	10	3	1
S. igloviformis	.	5	3	2	.	.
E. everetti	1	2	5	7	4	.
S. lacustris (Atypical)	1	2	7	5	3	.
Lakes	8	13	35	44	6	5

* Jewell, M. E., An Ecological Study of the Fresh-water Sponges of Northern Wisconsin. *Ecol. Mono.* 1935, 5:461-504.

TABLE 5

Distribution of Sponges with reference to free carbon dioxide in the water*

Sponge	Free carbon dioxide as parts per million 0-0.9	1.0-1.5	1.6-2.5	2.6-3.5	3.6-4.5	4.6-5.5	5.6-up
E. mulleri	2	7	5	2	.	.	2
S. fragilis	10	11	12	3	2	.	3
S. lacustris	11	12	16	3	5	2	3
T. pennsylvanica	3	12	17	2	3	3	1
S. igloviformis	.	3	4	1	2	2	.
E. everetti	1	11	9	1	.	.	.
S. lacustris (Atypical)	1	12	6	.	.	1	.
Lakes	17	43	36	7	7	3	4

TABLE 6

Distribution of Sponges with reference to bound carbon dioxide in the water*

Sponge	Bound carbon dioxide as mgms. per liter 0.5-1.0	1.1-2.5	2.6-5.0	5.1-10	11-20	21-up
E. mulleri	.	.	.	6	10	3
S. fragilis	.	1	2	9	21	10
S. lacustris	1	6	8	14	17	9
T. pennsylvanica	9	11	10	7	5	.
S. igloviformis	4	6	4	.	.	.
E. everetti	9	8	4	.	.	.
S. lacustris (Atypical)	7	9	2	.	.	.
Lakes	15	29	24	16	29	11

* Jewell, M. E., An Ecological Study of the Fresh-water Sponges of Northern Wisconsin. *Ecol. Mono.* 1925, 5:461-504.

TABLE 7

Distribution of Sponges with reference to the hydrogen ion concentration of the water*

Sponge	pH 5.0 5.1	5.2 5.3	5.4 5.5	5.6 5.7	5.8 5.9	6.0 6.1	6.2 6.3	6.4 6.5	6.6 6.7	6.8 6.9	7.0 7.1	7.2 7.3	7.4 7.5	7.6 7.7	7.8 8.1
E. mulleri	.	.	.	.	.	.	.	.	3	1	3	5	3	2	1
S. fragilis	.	.	.	.	.	1	.	2	3	3	4	9	6	5	3
S. lacustris	.	1	1	1	2	4	1	3	6	3	5	9	6	5	1
T. pennsylvanica	3	1	4	3	5	4	2	6	3	3	5	3	1	.	.
S. igloviformis	2	2	3	2	2	2	1	.	.	.	.	.	.	.	.
E. everetti	4	1	2	2	6	4	2	.	1	.	.	.	.	.	.
S. lacustris (Atypical)	2	.	3	3	4	4	1	1	1	.	1	.	.	.	.
Lakes	6	3	6	6	8	10	9	11	9	9	8	12	7	8	6

TABLE 8

Distribution of Sponges with reference to the silicon dioxide of the water*

Sponge	Silicon dioxide as mgms. per liter 0-trace	0.25-0.4	0.45-0.8	0.9-1.5	1.6-5.5	4.6-8	over 8
E. mulleri	.	.	1	.	10	7	1
S. fragilis	.	1	3	3	18	13	4
S. lacustris	1	7	6	6	17	12	5
T. pennsylvanica	9	10	7	3	9	3	2
S. igloviformis	4	5	2	2	1	.	.
E. everetti	13	7	2	.	.	.	.
S. lacustris (Atypical)	13	6	.	.	.	.	.
Lakes	23	29	13	11	25	17	6

* Jewell, M. E., An Ecological Study of the Fresh-water Sponges of Northern Wisconsin. *Ecol. Mono.* 1925, 5:461-504.

IV. TAXONOMY

1. Distribution of the species in the various states.

Table number 9 shows the distribution of the known species of fresh-water sponges throughout the various states in which they have been located. The data for this chart was gathered from Carter (1881), Potts (1887), Annandale (1909), Smith (1921), and Jewell (1935), and arranged in its present form by the author. It will be noted that *Carterius tenosperma* Potts, recently described by Neidhoefer (1938), is given its place with the other Wisconsin species.

2. Distribution of the Wisconsin species.

Table number 10 shows the distribution of the known species of fresh-water sponges that have been found in Wisconsin. The shaded counties indicate the locality in which Smith (1921), Jewell (1935) and the author have found the various species.

3. Classification of the Wisconsin species.

The following key to the classification of the fresh-water sponges was developed by the author hoping to somewhat clarify and simplify their taxonomy. It was prepared after a careful study of the keyes on sponges found in Pratt (1935), Ward and Whipple (1918), and Potts (1887), and is based solely on the spicule and gemmule characteristics.

TABLE 9

Spongilla fragilis—Me., N.Y., N.J., Pa., Fla., Mich., O., Ind., Ky., Wis., Minn., Ill., Ia., Kan., Tex., Mont., Wy., Colo.
Spongilla lacustris—Mass., N.Y., N.J., Pa., Md., Fla., Mich., O., Wis., Minn., Ill., Ia., Kan., Mont., Wy., Colo., Wash., Mo.
Spongilla igloviformis—Mass., N.J., Mich., Wis.
Spongilla aspinosa—N.J., Va., Mich.
Spongilla heterosclerifera—N.Y.
Spongilla wagneri—
Ephydatia mulleri—Mass., N.Y., N.J., Pa., Md., Va., Mich., O., Ind., Wis., Ill., Ia., Colo.
Ephydatia fluviatilis—Pa., Fla., Mich., O., Ind., Wis., Ill., Colo.
Ephydatia crateriformis—N.Y., Pa., Md., Mich., O., Ind., Wis., Ill., Tex.
Ephydatia everetti—Mass., Wis.
Ephydatia baileyi—N.Y.
Ephydatia millsii—Fla.
Ephydatia subtilis—Fla.
Ephydatia subdivisa—Fla.
Ephydatia robusta—Calif.
Heteromeyenia argyrosperma—Me., N.J., Pa., Va., Mich., Ind., Wis., Ill., Calif.
Heteromeyenia repens—N.Y., N.J., Pa., Mich., Ind., Wis., Ill.
Heteromeyenia ryderi—N.H., Mass., N.Y., N.J., Pa., Va., Fla., Mich., Ind., Wis., Ia., Ga.
Carterius latitentia—N.Y., Pa., O., Ind., Wis., Ill.
Carterius tenosperma—N.Y., N.J., Pa., O., Wis.
Carterius tubisperma—Mass., N.Y., N.J., Mich., O., Ind., Wis., Ill., Ia., Kan., Calif.
Asteromeyenia radiospiculata—O., Ill.
Asteromeyenia plumosa—La., Tex.
Trochospongilla leidyi—N.J., Pa., O., Ky., Ill., La.
Trochospongilla horrida—Ill., Tex.
Tubella pennsylvanica—Me., Mass., N.J., Pa., Fla., Mich., O., Wis., Conn.

KEY TO THE KNOWN WISCONSIN SPONGILLINAE

A_1 (A_2) Gemmule without tendrils on the foraminal tubule or foraminal opening ---------------------------------- B_1

B_1 (B_2) No birotulates present -------*Spongilla Lamarck* C_1

C_1 (C_2) Skeletal spicules smooth -------------------- D_1

D_1 (D_2) Dermal spicules pointed and spined *Spongilla lacustris* (Linnaeus) 1745.

D_2 No true dermals present; spined, subcylindrical acerates present.

Spongilla fragilis Leidy 1851.

C_2 Skeletal spicules spined

Spongilla igloviformis Potts 1887.

B_2 Birotulates present --------------------------------- C_1

C_1 (C_2) Rotules serrate or dentate ------------------ D_1

D_1 (D_2) Gemmule producing one type of birotulate.
Ephydatia Lamouroux ---------------------- E_1
E_1 (E_2) Skeleton spicules smooth -------------- F_1
F_1 (F_2) No dermal spicules present
Ephydatia fluviatilis (auctorum)
F_2 Dermal spicules minute birotulates
Ephydatia everetti (Mills) 1884.
E_2 Skeleton spicules spined ------------------ F_1
F_1 (F_2) Rotules well developed, having a well defined shaft not, or slightly, longer than the rotule diameter.
Ephydatia mulleri (Lieberkuhn)
F_2 Birotulates imperfectly formed, having long, spined shafts, the spines being longer and more abundant towards the ends. The rotules are formed by three to six incurved hooks.
Ephydatia crateriformis. (Potts) 1882.
D_2 Gemmules producing two types of Birotulates
Heteromeyenia Potts ---------------------- E_1
E_1 (E_2) Dermal spicules wanting --------------- F_1
F_1 (F_2) Small birotulates having large flat serrated rotules nearly as great in diameter as the length of the shaft; large birotulates having 3 to 6 incurved hooks for the rotules.
Heteromeyenia ryderi Potts 1882.
F_2 Small birotulates similar in appearance to large birotulates but more abundantly spined.
Heteromeyenia argyrosperma Potts 1880.
E_2 Dermal spicules present, spined; Rotules with incurved rays.
Heteromeyenia repens. Potts 1880.
C_2 Rotules entire, proximal rotule being much larger than distal. (collar-button shaped)
Tubella pennsylvanica Potts 1882.
A_2 Gemmules with tendrils on the foraminal tubule. Carterius Potts ------------------------------------ B_1
B_1 (B_2) Foraminal tubule ¼-1 the diameter of the gemmule body; 4-6 short tendrils present; birotulates with a smooth shaft, or very sparsely spined.
Carterius tubisperma Mills 1881.

$B_2(B_3)$ Foraminal tubule ¼-½ the diameter of the gemmule body; 1-2 long tendrils present; Birotulates with a stout shaft bearing numerous long spines; Rotules deeply cut. (Suggests genus Ephydatia)
Carterius latitenta Potts 1881.

B_3 Foraminal tubule less than ¼ the diameter of the gemmule body, 3-5 very long, twisted, branched tendrils present. Birotulates similar to the first species but more irregular and abundantly spined.
Carterius tenosperma Potts 1880.

Spongilla lacustris (Linnaeus) 1745

The sponge (Plate I) is found in a widely varying habitat. In hard, clear running water the specimens found were large, of firm body, and of a bright green color. Those found in conditions varying from hard, running water to soft bog lakes decreased in size and virility. Some specimens in standing water of a low carbonate and silicate content were almost as soft as an algal mass and of a muddy brown color. It was found attached to twigs, stones or to the bottom itself.

It is a branched form with long green fingers sometimes reaching eighteen inches in length and three quarters of an inch in diameter. It was found in most cases where there was an abundant supply of sunlight. The gemmules (Plate II) are abundant throughout the body of the sponge and are dark yellow or brown in color. The foraminal aperature is hypostomal.

The megascleres (figs. 1, 3) are long, smooth shafted spicules of variable length and thickness, being either straight or slightly curved. The microscleres (figs. 4, 5, 6) are small, slender, slightly curved, abundantly microspined amphioxi. The latter are very numerous in the sponge body. The gemmule spicules (fig. 2) are rather short, nearly straight or curved rods with pointed or rounded ends and varying degrees of spination. The commonest type is curved and abundantly macrospined.

Spongilla fragilis Leidy 1851

The sponge (plate III) is found in a widely varying habitat, but prefers waters of a moderately high carbon content. It is a light positive form of a rather firm body. It is an encrusting form found growing on twigs, roots, rocks, or any other suitable place for it to hold on.

It is an unbranched form varying in color from a bright green in direct sunlight to a very pale yellow in partially shaded areas. The body varies from a relatively smooth surface to a rough one, containing many very prominent oscula. Specimens vary in size from small patches the size of a dollar to colonies as long as eighteen inches and one and one-half inches in thickness. The gemmules (plate IV), varying in color from yellow to orange to brown, are found in groups in one or more pavement layers at the base of the sponge. The foraminal tubule is short and slightly curved.

The megascleres (figs. 1, 4) are long smooth amphioxi. They vary greatly in shape and size in a single specimen. Globular swellings along the axis are frequent, and occasionally axial canals can be observed. Malformations are frequent (fig. 5). Microscleres are wanting. The gemmule spicules (figs. 2, 3, 6) are short, spined acerates.

Spongilla igloviformis Potts 1887

The sponge (plate V) is found in a rather limited habitat. It prefers water of dark color and high organic content, of low pH, low silicate, and low carbonate content. It has a rather soft body and could easily be mistaken for an alga by an inexperienced observer.

It is a thin encrusting form found growing on the roots of bog bushes or old sumberged logs. The largest specimen collected was seventeen inches long but scarcely more than one-quarter of an inch in thickness. The gemmules (plate VI) are small and abundant, being located basally. The foraminal aperature can not be seen since the gemmule is surrounded by a thick crust of spicules.

The megascleres (figs. 1, 4, 5) are abundantly macrospined, straight or slightly curved amphioxi with occasional canals. Malformations are occasionally observed (fig. 1). Dermal spicules are wanting. The gemmule spicules are large and similar in appearance to the megascleres. They are straight or slightly curved abundantly macrospined amphioxi.

Ephydatia fluviatilis (Auctorum)

The sponge (plate VII) is found in running or fresh standing water. It has a firm body. Specimens were kept in a healthy condition for six months in a well balanced aquarium in the laboratory.

It is a flat, thin, encrusting form growing in large patches on logs, rocks, piles, or on the bottom. Old (1931) states that he observed a patch of this animal encrusting on the gravel covering an area of 400 square feet. It is smooth or slightly rugose with very prominent oscula. The color varies from a yellow to a green depending upon the amount of sunlight. The gemmules (plate VIII) are numerous and are located either basally or throughout the sponge body. Foramenal aperature hypostomal, and partially concealed.

The megascleres (figs. 1, 3) are smooth long shafted amphioxi of variable length. The Microscleres are wanting. The gemmule spicules (figs. 2, 4) are typical birotulates. Their shafts are longer than the diameter of the rotules, bearing, frequently, a few macrospines. Margins of the rotules serrate to dentate.

Ephydatia everetti (Mills) 1884

The sponge (plate IX) is found in dark bog water, preferring acid waters of a low silicate and carbonate content. The sponge body is small, delicate, rather soft and is found attached to *Fontinalis* in from six inches to three feet of water.

It is a finely branched, almost filamentous form of a brilliant green color. A filament may be as large as an eighth of an inch in diameter and three inches long. The gemmules (plate X) are very large, brown in color, and found in the fingers. They are very scarce, several colonies being examined, many times, before one gemmule is found.

The megascleres (fig. 2) are long smooth very thin shafted amphioxi. The microscleres (figs. 1, 3) are minute birotulates with smooth shafts. Their rotules are minute consisting of several incurved rays. The gemmules birotulates (figs. 4, 5, 6) have very much the same shape as the dermal spicules (microscleres) with the exception that they are larger and have a longer, heavier shaft.

Ephydatia mulleri (Lieberkuhn) 1856

The sponge (plates XI-XII) is found in a somewhat limited habitat. It is a light positive form preferring alkaline waters of a high carbonate and silicate content. It has a firm body found attached to twigs, rocks, or piles or to the bottom itself if the bed is not too sandy.

It is an encrusting form of variable shape and color depending upon the current and the amount of light received by the animal. Forms found in swift running water vary from smooth to rough, with heavy thumb-like projections on the surface. Patches may cover several square feet. Those found in slow running water or in standing water form very beautiful colonies with large rugose or lobate processes. The gemmules (plate XIII) are very numerous, comparatively small, yellow to brown in color, and located basally in the sponge. The foraminal opening is inconspicuous.

The megascleres (figs. 1, 3) are large, robust amphioxi, microspined except at the tips. The microscleres are wanting. The gemmule birotulates (figs. 2, 4, 6, 7, 8) have a shaft equal to or less than the diameter of the rotules. It is either smooth, or rarely possessing a few macrospines. The rotules are irregularly deeply serate or dentate.

Ephydatia crateriformis (Potts) 1882

The sponge is described by Potts (1887) and later by Old (1932) as a small fragile form. It is found encrusting on rocks, or submerged timber. It has the appearance of a thin grey film, occasionally branched, with numerous gemmules (plate XIV) white to yellow in color, showing easily through the thin dermis of the animal.

The megascleres (figs. a, a) are long amphioxi microspined except at the tips. The microscleres or dermal spicules are said by Old (1932) to be wanting. Potts (1887) says that there may be dermal spicules present. The gemmule birotulates (figs. b, c, d, e) are long and cylindrical. They are macrospined toward the tips, and bear from three to six incurved rays.

Heteromeyenia ryderi Potts 1882

The sponge (plate XV) is rather rare. It was collected by Jewell (1935) from a seepage lake and from running water.

In the former case the specimen was poorly developed. In either case, the water was of low pH concentration, as well as low silicate and carbonate content.

The body of the sponge is rather firm, and has much the appearance of *S. fragilis*. The color varies from a yellow-brown to a green. The gemmules are numerous (plate XVI), very small, white or slightly yellow and are found free in the sponge body or basally. The foramina is very short and inconspicuous.

The megascleres (figs. 1, 4) are long microspined amphioxi of variable length. The microscleres are wanting. The gemmule birotulates are of two types. The small ones (figs. 2, 3, 5, 6) have a shaft longer than the diameter of their discoidal rotule. The edges of the rotule are finely serrated. Those of the second class (figs. 7, 8) have longer shafts, smooth or occasionally sparsely macrospined, with the rotules in the form of three to six incurved hooks.

Heteromeyenia argyrosperma Potts 1880

The sponge (plate XVII) has a rather limited habitat, preferring the running water of streams to any other. It has a moderately firm to loose body varying from yellowbrown to pale green in color. It is an encrusting form found growing on rocks, twigs, piles, or in the debris at the bottom. It is either relatively smooth or has very short projections or filaments horizontal or parallel to the substratum. The gemmules (plate XVIII) are large, yellow white in color, and distributed throughout the body of the sponge.

The megascleres (figs. 1, 6) are long sparsely microspined amphioxi of variable length. The dermal spicules or microscleres are wanting. The gemmule birotulates are of two classes depending upon the length of their shaft and the degree of spination. The smaller birotulates (figs. 2, 5) have a short, frequently macrospined, shaft and from two to five short, irregular incurved rays. The larger class (figs. 3, 4) have a long, sparsely macrospined shaft and from three to six long, claw-like, incurved rays.

Heteromeyenia repens Potts 1880

The sponge (plate XIX) seems to be able to tolerate a variety of habitat. It was collected from lakes and streams varying from seepage lakes, to streams, to moderately hard lakes. It tolerates a wide carbonate, silicate, and pH variation.

The sponge body is rather soft and small. It is smooth, rugose, or branched and is found encrusting on twigs, leaves or other organic detritus of the bottom. It was pale brown to green in color and was collected from somewhat shaded areas. The rather numerous gemmules (plate XX) are large and of a yellow or white color. They are located throughout the sponge body. The foraminal aperature is inconspicuous.

The megascleres (figs. 1, 6) are long, smooth or very sparsely microspined straight or slightly curved amphioxi. The microscleres are smaller, abundantly macrospined, and slightly curved. The spines are the longest toward the center of the shaft. The gemmule birotulates are of two types, the types differing only in length of the shafts and the angle with which the rays of the rotule meet the shaft. The smaller of the two types (fig. 5) has a short shaft, smooth, or sparsely macospined, and has the slender, recurved rays entering the shafts at a greater angle than the larger spicules. The larger of the two has a long shaft, smooth or sparsely macrospined with the slender, recurved rays entering at a smaller angle than the previously mentioned type. The smaller spicules are about two-thirds to three-fourths the length of the larger.

Tubella pennsylvanica Potts 1882

The sponge (plate XXI) prefers a habitat acidic in reaction, of low silicate and low carbonate content. It is a light negative form prefering dark waters of high organic content. When found in other than seepage lakes, it is always found in some bay of flowage region where the chemical conditions will vary from the natural condition of the main body of water due to the large amount of organic material present.

The sponge body is very thin and slimy, having much the appearance of a plasmodium. It is grey or flesh colored, with gemmules (plate XXII) distributed in groups along the substratum. They are very small, orange to yellow in color, and quite numerous.

The megascleres (figs. 1, 3) are large, robust, abundantly microspined amphioxi of variable length. Microscleres are wanting. The gemmule birotulates (fig. 2) are small and have a characteristic collar button shape. The large rotule is proximal to the gemmule body while the small rotule is distal.

Carterius tubisperma Mills 1881

The sponge (plate XXIII) prefers running water. It favors alkaline waters of high silicate and carbonate content, transparent, with low organic content. It is found encrusting on rocks, piles, twigs, or to the bottom itself.

The sponge body is rather soft and seldom if ever smooth. It is covered with small papilla like projections. The color varies from a brown to a pale green. The gemmules (plate XXIV) are numerous, located in the basal portion of the sponge. They are yellow or yellow brown and are characterized by having a very prominent foraminal tubule (fig. 2) varying in length from one-half to once the diameter of the gemmule body. It is terminated by a foraminal disc surrounded by four to six long tendrils.

The megascleres (figs. 1, 3) are long smooth or slightly microspined, straight or slightly curved amphioxi. The microsclers (figs. 4, 7) are smaller, abundantly macrospined amphioxi, the spines being the longest in the middle. The gemmule birotulates are of two classes, resembling very much those of *H. repens.* The smaller type (fig. 6) have a smooth shaft terminated by rotules composed of three to five recurved rays. The larger type (fig. 5) has a longer, thinner shaft, usually smooth, terminated by from three to five incurved rays.

Carterius latitentia Potts 1881

Potts (1887) describes this sponge prefering running water. He found this sponge growing profusely on the rocks a short distance under the surface of the water. It was a rather thin, soft encrusting form, of a green to a brown color. The brown gemmules were laid down in a pavement layer on the substratum on which the sponge was encrusting. Upon the degeneration of the sponge body the filiform appendages of the gemmules could easily be seen.

The gemmules are characterized by a foraminal tubule (plate XXV) one-third to one-half the diameter of the gemmule body bearing one cirrous, long, thread-like appendage coming from the edge of the foraminal disc.

The megascleres (figs. a, a) are long, heavy shafted amphioxi, sparsely microspined except at the tips. The microscleres (figs. c, c) are smaller amphioxi abundantly microspined, being straight or slightly curved. The Gemmule birotulates (figs. b, b, b) are of two principle classes. The smaller class has a short shaft terminated by rotules bearing deeply cut rays, occasionally incurved. The larger type have a long shaft, smooth or sparsely macrospined, bearing rotules similar to those of the above mentioned birotulates.

Carterius tenosperma Potts 1880

In her work on the sponges of Wisconsin, Jewell (1935) does not mention this species as indigenous to the state. The author reported the sponge, Neidhoefer (1938), as new to the state of Wisconsin.

The sponge (plate XXVI) was collected in Spider Lake, Vilas County, in July, 1936. A mass of the sponge, 15 mm. x 3 mm., growing on the underside of a root of a dead tree, was found close to shore in about five inches of water. In this locality the bottom consists of fine gravel; plant life is abundant; and direct sunlight is permanently available. The water is alkaline and rich in silicate and carbonate.

The pale green specimen grew in an encrusting, elongated, irregular mass. The body was soft and was covered by a thin film of slime characteristic of the genus. The gemmules (plate XXVII) are rather numerous and located basally. They are brown in color and characterized by a foraminal tubule (fig. 1) equal in length to one-sixth to one-quarter the length of the diameter of the gemmule body bearing numerous branched, twisted tendrils.

The megascleres are long shafted amphioxi, microspined except at the tips. They vary in length and robustness. The microscleres are smaller, short, thick shafted amphioxi, abundantly macrospined, the spines being the longest in the middle. The gemmule birotulates are of two classes, which differ only in length. The shafts are abundantly macrospined bearing irregular rotules composed of three to five incurved rays.

V. SUMMARY AND CONCLUSION

There are in the United States twenty-six species of Spongillinae widely distributed throughout the various states as indicated by Table 9. Fourteen of these species have been reported by various workers as indigenous to Wisconsin; eleven of these species have been gathered and identified by the author, two species have not as yet been added to the author's collection, one species is being reported by the author for the first time.

The material for this investigation was prepared in several ways. The gross specimens were fixed in a preserving fluid or dried; the microscopic specimens of gemmules and spicules were prepared by a modified nitric acid technique. It can be safely said that 750 spicule slides and 200 gemmule slides were prepared and examined before selecting material for the camera lucida drawings and the microphotographs.

It was observed that the most important physical factors are water transparency and water color, while the most important chemical factors are bound carbon dioxide content, silicon dioxide content, and hydrogen ion concentration.

The body of this work consists of the description and classification of the fourteen reported species. This was facilitated by taking a photograph of the entire sponge, a microphotograph of the gemmule, and camera lucida drawings of the spicules. A taxonomic key, modified by the author after various workers, summarizes the specific characteristics of this group of sponges.

VI. GLOSSARY

1. Acerate (acer, sharp). Spicule with pointed ends.
2. Acuminate (acuo, sharpen). Same as acerate.
3. Amphidisc (amphi, both; discus, round). Same as a birotulate.
4. Amphioxi (amphi, both; oxeos, sharp). Spicules pointed at both ends.
5. Birotulate (bis, twice; rotula, wheel). Spicules secreted by the gemmules of certain genera.
6. Dentate (dentatus, tooth-like). Tooth-like margins of rotules of certain genera.
7. Dermal Spicules (derma, skin). Spicules secreted by the dermal cells.
8. Foraminal aperature (foramina, orifice or short passage). Opening in gemmule through which young sponge escapes.
9. Foraminal tubule (tubus, tube). Projection of the gemmule wall bearing the foraminal aperature.
10. Gemmule (gemmula, a little bud). The asexual reproductive element formed in the sponge body. Comparable to the statoblast of the Bryozoa.
11. Macroscleres (mackros, large; skleros, hard). Skeleton spicules of the sponge. Largest of the sponge spicules.

12. Macrospined (mackros, large; spina, spine). The large spines found on the spicules.
13. Megascleres (megalos, large; skleros, hard). Same as the macroscleres.
14. Microscleres (Mickros, small; skleros, hard). Same as the dermal spicules.
15. Microspined (mickros, small; spina, spine). Small or minute spines found on the spicules.
16. Porifera (porus, a pore; ferre, to bear). Sessile, aquatic, diploblastic, pore-bearing animals called sponges.
17. Osculum (osculum, mouth or opening). Prominent pores found in the sponge body.
18. Plasmodium (plasma, form; oida, like to) multinculeate, amoeboid body of mycetozoa.
19. Rotule (rotula, wheel). One of the wheel-like ends of a birotulate spicule.
20. Serrate (serratus, saw). The saw-like margin of the rotules of some genera.
21. Skeletal spicule (skleros, hard). The same as the macroscleres.
22. Spicule (spiculum, a needle). A small needle-shaped, silicious body secreted by the sponge.
23. Stellate (stella, star). The shape of the rotules of certain genera.
24. Zoochlorella (zoon, animal; chloro, green). Chlorosymbionts living in the sponge body.
25. Zoophyte (zoon, animal; phyton, plant). A plant-like animal; a colony of animals resembling a plant.

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TABLE X

COUNTIES OF COLLECTION

Barron, Brown, Buffalo, Chippewa, Dodge, Fond du Lac, Green Lake, Iron, Jackson, Jefferson, Kenosha, La Crosse, Manitowoc, Milwaukee, Monroe, Oneida, Outagamie, Ozaukee, Polk, Portage, Racine, Sawyer, Shawano, Sheboygan, Trempealeau, Vilas, Washington, Waukesha, Waupaca, Winnebago.

GEOLOGY OF WASHINGTON ISLAND AND ITS NEIGHBORS, DOOR COUNTY, WISCONSIN

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GEOLOGICAL SETTINGS OF THE ISLANDS

Location.—Door Peninsula, the long finger-like extension of northeastern Wisconsin that separates Green Bay from Lake Michigan, is carried northward across the entrance to the bay by a string of islands that ends at the Michigan mainland. The boundary between Wisconsin and Michigan passes eastward between Rock Island on the south and St. Martin on the north. This report will deal exclusively with the islands lying south of the boundary in Door County, Wisconsin.

Geographic relations.—The islands from north to south are Rock, Washington (with little Hog Island [Fig. 1] about one-half mile off the eastern shore and several small sand bars and islets in Detroit Harbor), Detroit, Plum, and Pilot (Plate 1). In area they rank as follows: Washington, about 23 square miles; Rock, about 1½ square miles; Detroit, about 1¼ square miles; Plum, about ¾ of a square mile; and Pilot, only a few acres.

A "submarine" cable connects Rock to St. Martin on the north and to Washington on the south, Washington and Pilot to Plum, where the Coast Guard Station for the area is situated, and Plum to the mainland of Door Peninsula. Mail comes to Gills Rock at the tip of the peninsula, via Ellison Bay, and is delivered by boat to the several islands.

An automobile and passenger ferry makes several trips daily between Gills Rock and Detroit Harbor on Washington Island, depending on the weather and season of the year. Local motor boats must be hired if one wishes to visit Detroit, Plum, Pilot, or Rock islands. In cold winters, the water about and between the

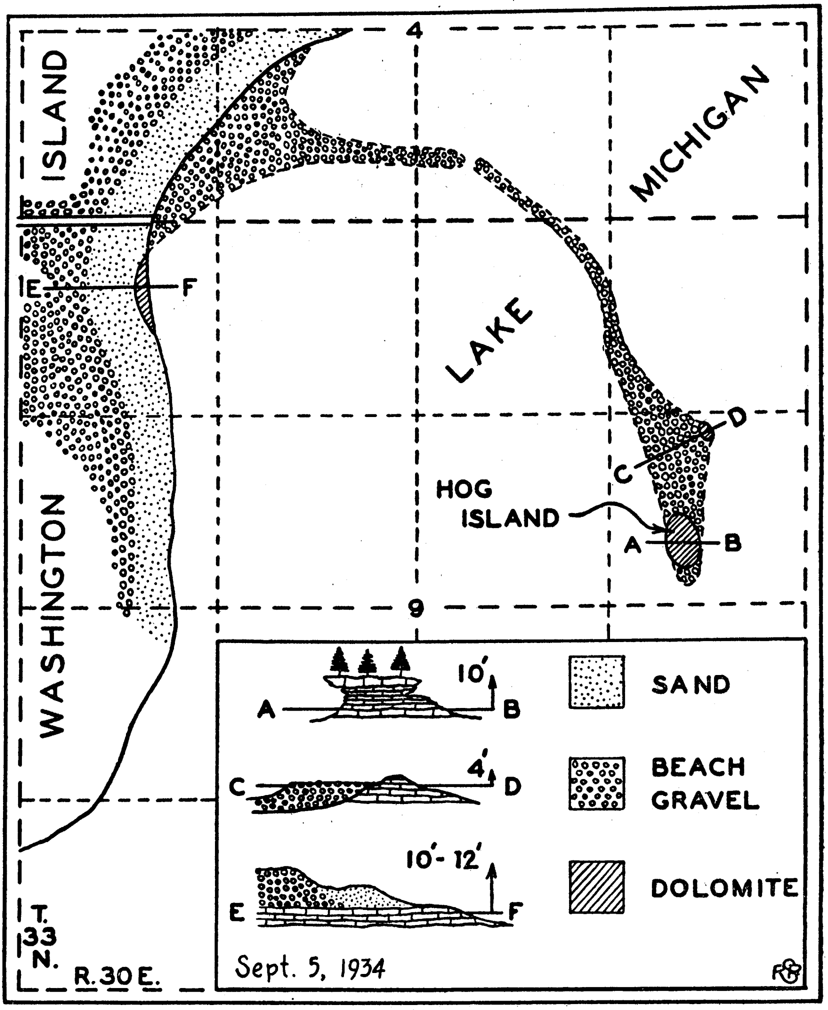

FIG. 1. Sketch map of Hog Island and a portion of Washington Island adjoining.

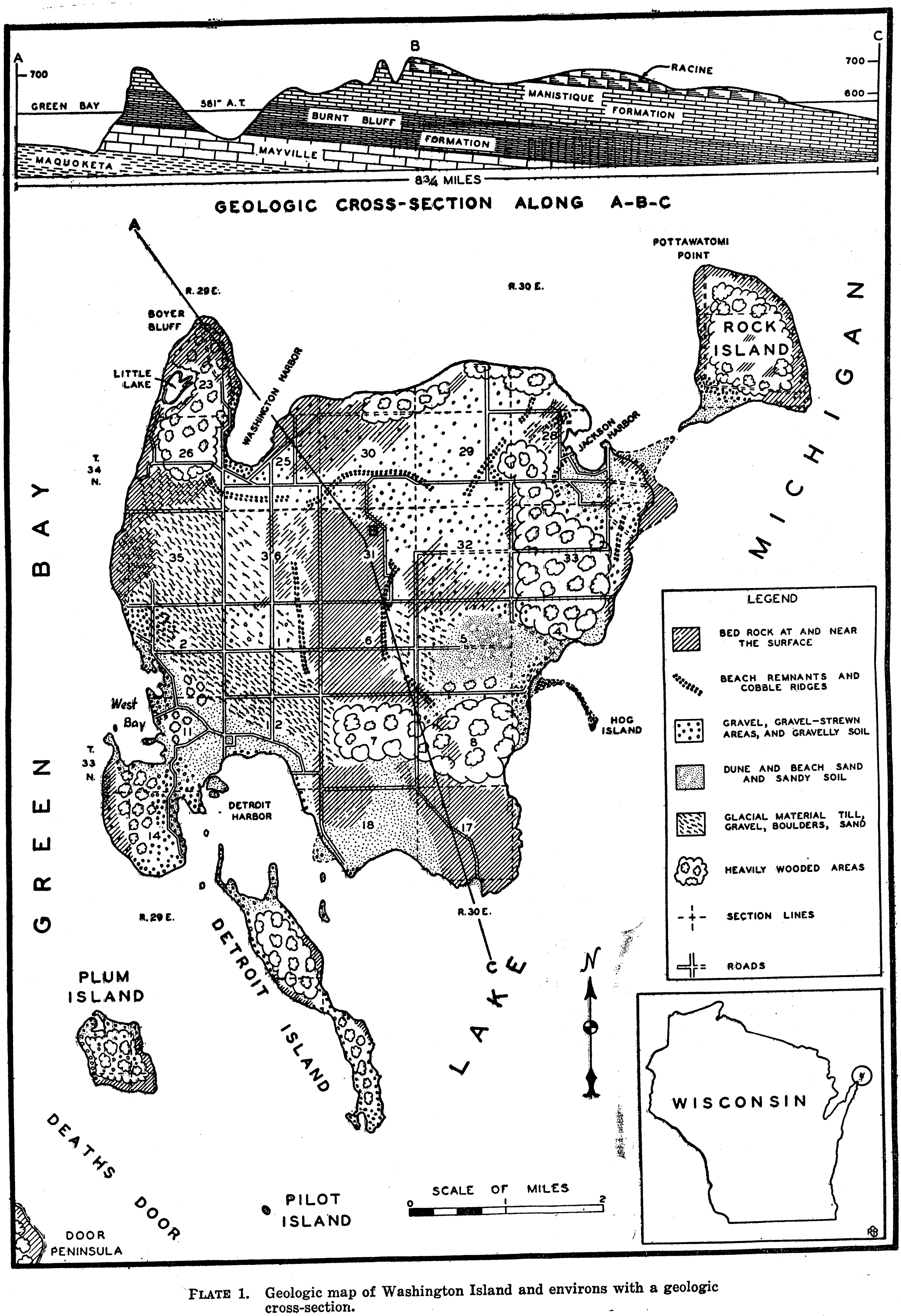

PLATE 1. Geologic map of Washington Island and environs with a geologic cross-section.

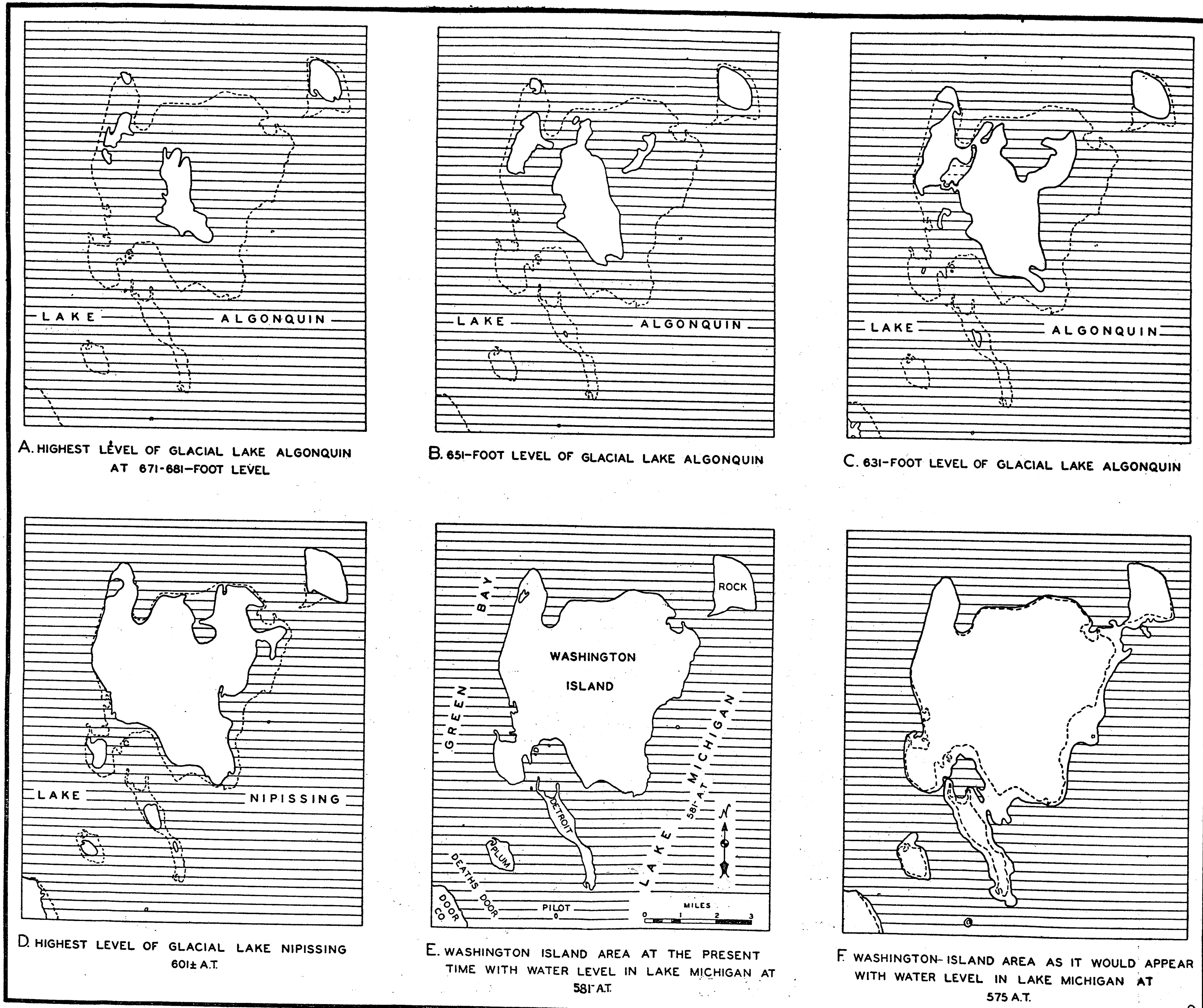

PLATE 2. Chart showing the glacial lake history of the Washington Island region.

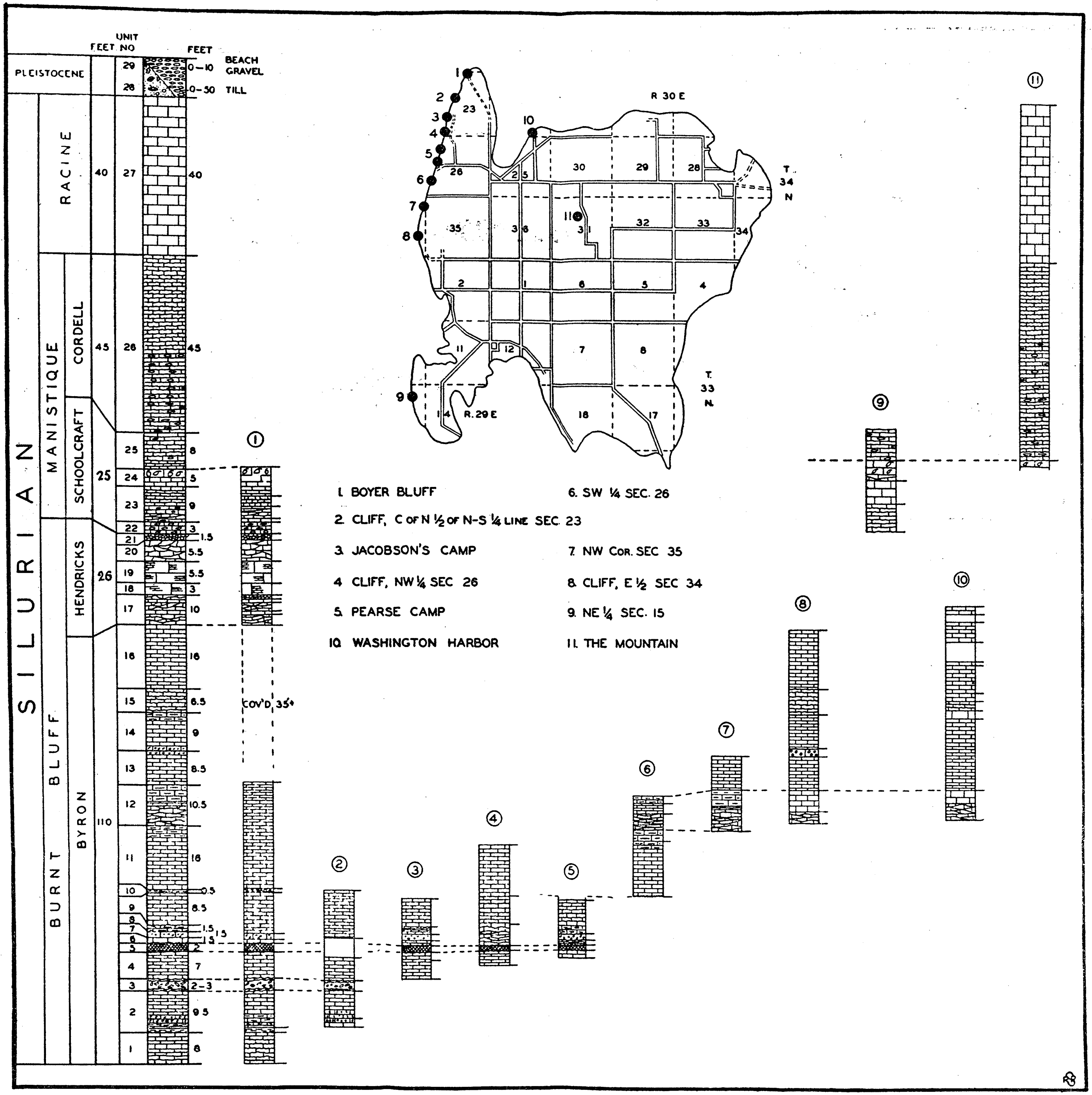

PLATE 3. Generalized geological column, and stratigraphical sections, of Washington Island. Correlations with Michigan formations are shown at the left of the chart.

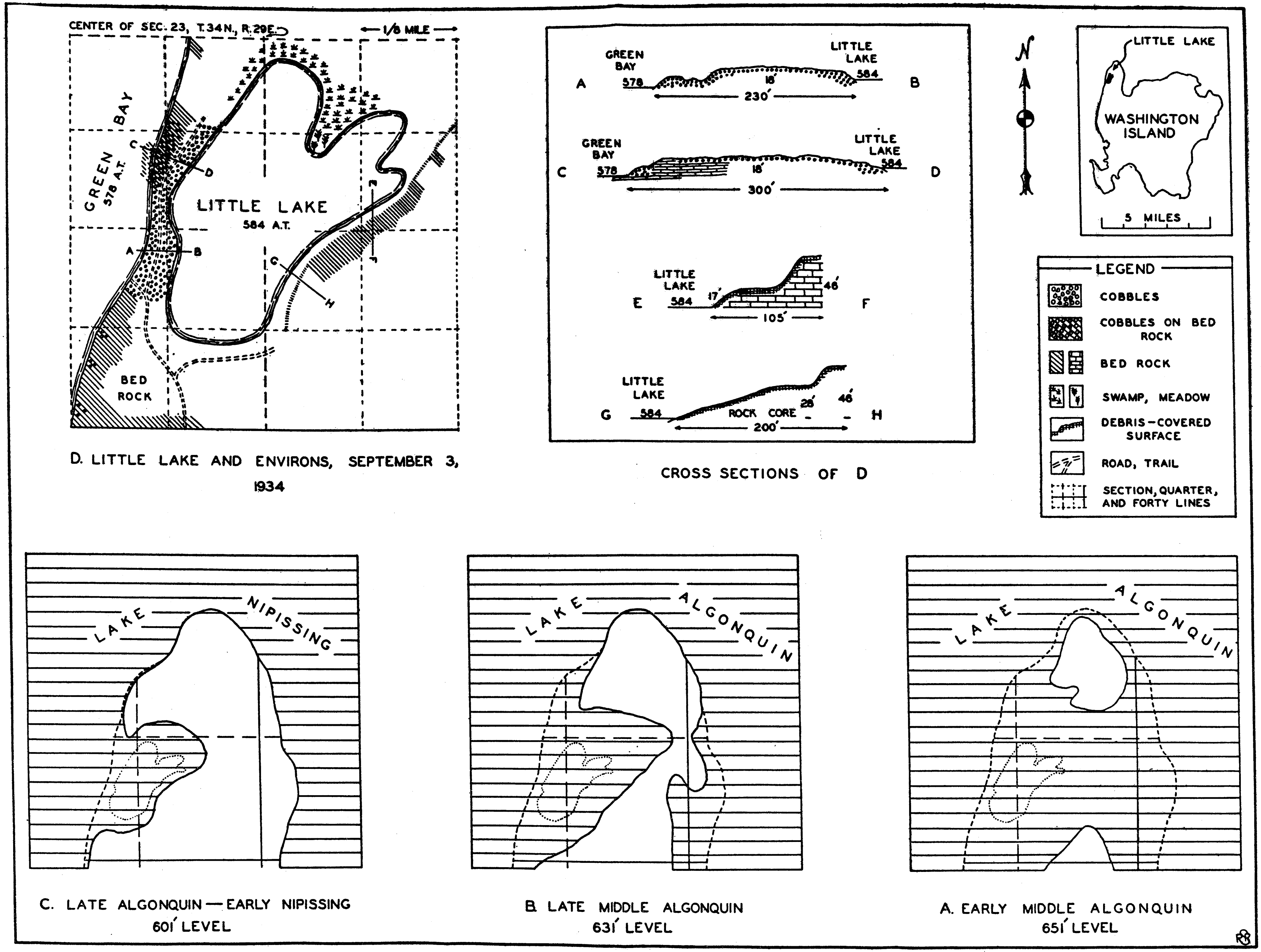

PLATE 4. Diagrammatic sketch maps showing the geological history of Little Lake.

islands freezes to sufficient thickness that automobiles can be driven from the mainland to the islands. This is not always a safe practice, however, for thin ice and open water have taken their toll, along with wind and storm, in Deaths Door.

Niagara Escarpment.—One of the most spectacular surface features in eastern Wisconsin is the Niagara Escarpment or "The Ledge" as it is called locally. It is a steep, westward-facing cliff that rises out of the glacial drift a few miles south of Waukesha and increases in height northward until it stands over 100 feet above the northern end of Lake Winnebago at High Cliff. It then dies out for a short distance, but soon appears as a low bluff east of Green Bay, and clinging to the eastern shore of the bay it increases steadily in height until it culminates in the bold, precipitous cliffs at Eagle Point Park near Ephraim and at Ellison Bay near the northern end of the peninsula. The cliffs at their greatest height rise over 150 feet above the waters of Green Bay.

Northward from the tip of Door Peninsula, the escarpment base becomes submerged beneath at least 140 feet of water; yet because of increased height it still rises well over 140 feet above water in Boyer Bluff, at the northwestern tip of Washington Island, and in the precipitous, triple-notched cliff at Pottawatomi Point, Rock Island (Plates 1 and 6).

The Niagara escarpment may be traced quite easily on the U. S. War Dept. Chart No. 715 (*Entrance to Green Bay, Lake Michigan*) by following the soundings. It is interrupted at Deaths Door Passage (Porte des Morts Passage) by the deep water in a transverse subaqueous valley, but it continues along the western side of Plum Island, thence due north along the western shore of Washington Island to Boyer Bluff, where it turns abruptly eastward to follow the northern shore almost to Rock Island. Then it makes a second right angle turn, this time to the northward, and maintains that direction along the western shore of Rock Island to Pottawatomi Point. Here it is again interrupted by a deep, transverse valley, which is now occupied by the Rock Island Passage, and it does not appear again until St. Martin Island in Michigan is reached.

If the waters of Green Bay and Lake Michigan were lowered 200 feet, the archipelago across the entrance to the bay would then appear as a rather narrow, serrated ridge with a precipitous cliff—the Niagara Escarpment—along the west side, and a rather steep, eastward slope along the opposite side. Before the glaciers overrode this part of Wisconsin and Michigan, therefore, there seem to have been two major valleys with numerous tributaries bounding the ridge just mentioned. The deep channels now occupied by Deaths Door and Rock Island passages were apparently sites where the tributaries of the two major valleys had been approaching each other by headward erosion and had already lowered the ridge considerably below its summit.

Glacial history—The glaciers, coming from the north and northeast and feeling their way southward, first sent great lobes along the two valleys and then finally rode bodily over the intervening ridge, grinding down, smoothing off, and grooving large areas of solid rock and leaving large boulders of igneous rocks not native to this part of Wisconsin on the highest parts of Washington and Rock islands. The lobes must have deepened the valleys many tens of feet, perhaps in the case of the Lake Michigan valley hundreds of feet, and the last to advance along them left a series of crescentic ridges of morainal material at the south ends of the depressions now occupied by the bay and the lake. The main lobe, which followed the eastern valley, deepened it far below what the pre-glacial stream could have done, and as a result the present bottom of Lake Michigan is in some places as deep as 289 feet below sea level. In contrast, the deepest point in Green Bay is 437 feet *above* sea level.*

The last sheet of ice to advance upon Washington Island left a thick morainic blanket of bouldery till over the northwestern quarter of the island. As it melted back, the escaping waters collected in the deepened basins occupying the former river valleys and the Great Lakes came into existence. At an early stage the ancestor of present Green Bay and Lake Michigan, called glacial Lake Algonquin, was considerably larger than those two bodies of water are today and also 90-100 feet deeper. At this time the island group under discussion was reduced to a few small islets (Plate 2). This old level is indicated at several places on Washington and Rock islands by caves and benches cut by the waves, and possibly by some of the higher beach remnants (Compare Plates 1 and 5).

* "College Physiography", R. S. Tarr and L. Martin, The Macmillan Co., 1921, p. 326.

After a period of unknown length, the water level fell some 30 feet to approximately 650′ A. T., and remained at that general elevation long enough for benches and caves to be cut and for cobble ridges to be formed. Again the water level fell, this time about 20 feet to approximately 630′ A. T., and the same features came into existence as before, except at a lower elevation and around the increasingly larger island. Finally, water level dropped about 30 feet, to an approximate elevation of 600′ A. T., and glacial Lake Algonquin came to an end.

The 600-foot stage appears to have persisted for a considerable length of time, judging from the extensive rock benches and caves that were eroded into the resistant dolomites, and the widespread, dolomite cobble deposits that were made and deposited on the benches and in the caves. These shore features are well developed at many points on Washington Island, as well as on Rock Island, and some of them are indicated on Plates 1 and 5. This old level, which marks the closing stage of Lake Algonquin, also marks the highest level of the next lake, which has been named glacial Lake Nipissing. Hereafter, therefore, the 600-foot stages will be referred to as the Nipissing stage; the others at higher elevations as Algonquin stages. (Plate II).

From the 600-foot stage the water apparently fell about to its present level of 580′ ± A. T., or approximately 100 feet lower than at the beginning of Lake Algonquin.

Plate 2 has been constructed to show the shore lines at the various stages of lakes Algonquin and Nipissing, the present approximate shore line (at elevation 578.50′ A. T.), and the shore line as it would appear if water level were to fall another 3½ feet to elevation 575′ A. T. It is interesting to note that in the last condition Rock and Detroit islands would be joined to Washington, but deep water would still separate this superisland from Plum and Pilot islands, and the latter would also remain separated from Door Peninsula.

During the long period of time that has elapsed since the glacial ice melted off the continent and the enlarged Great Lakes gradually shrank to their present outlines, the earth's crust has been slowly readjusting itself to the unloading that took place with the removal of the ice. One way in which this readjustment has become obvious is in the gentle tilting of the beaches of the older stages; hence, the present elevations of the Algonquin stages as marked on Rock Island are somewhat higher than the same appear on Washington Island and farther south along the Green Bay and Lake Michigan shores. The Nipissing level, on the other hand, appears essentially horizontal. For a full discussion of this very interesting aspect of the early history of Green Bay and Lake Michigan, the reader is referred to the Wisconsin Geological Survey reports by Goldthwait and Martin.

General geological sequence.—All of the stratified rocks exposed in the Washington Island region are dolomites belonging to the Niagaran division of the Silurian period. They make a great tablet which is inclined to the eastward with an average slope of about 30-40 feet to the mile, hence the eroded western edge of the tablet is very steep (Niagara Escarpment), whereas the eastern backslope is rather gentle. The strata are subdivided into a number of formations and these in turn, into members.

Fossils are not common in most of the rocks, and the uninitiated would soon conclude that they were absent, but many beds do contain a few and certain layers are quite full of them. In fact, some of the beds are so fossiliferous that they have been designated the "coral beds". A few of the common fossils are illustrated in Fig. 12.

The youngest geological deposits belong to the Pleistocene glacial period and consist of glacial drift and boulders, beach gravels, and beach and dune sand. They are scattered irregularly over the islands and vary considerably in thickness (Plate 1).

WASHINGTON ISLAND

General surface features.—Washington Island is roughly rectangular in shape, with a maximum length of 6¼ miles, and average width of about 5 miles, and an area of approximately 23 square miles. Except for the cliffed western edge and the high backbone of the island, the general surface is gently rolling. There are few streams and these are short, because the natural lakeward slope of most of the island allows easy drainage without much concentration along stream channels.

Washington Island is essentially a large, differentially sculptured block of dolomite tipped gently to the southeast so that the individual beds or layers in the block, when followed for a few hundred feet, are seen to descend in a general southeasterly direction at the rate of about 30-40 feet per mile. When these beds are examined extensively and in detail, however, they often show local irregularities which sometimes reverse the regional dip for short distances. A few exposures showing the dip of the beds may be cited in support of the general statement just made.

In the low cliff along the western shore northwest of the ferry landing the coralline strata dip gently to the southeast. Beds which outcrop at lake level in the N.E. ¼ of Sec. 34, T. 34 N., R. 29 E., also outcrop at the same level at Washington Harbor settlement, in the S.E. Cor. of Sec. 24, T. 34 N., R. 29 E., and a line drawn through these two points would trend in a northeasterly direction, at right angles to the regional dip, and would indicate the strike of the beds. Essentially the same direction of strike may be obtained by comparing sections 9 and 11 on Plate 3. Because of the southeasterly dip, successively older or lower strata are found at water level as one traverses northward along the western shore of the island, until at the tip of Boyer Bluff, the oldest rocks visible on Washington Island lie at water level.

Along the western shore at Pearse Camp (Plate 3) there is some local irregularity of structure, with dips varying from 18 to 53 feet per mile to the south and southeast within short distances. There is a low dome with maximum relief of perhaps 4 feet just south of the camp.

Local irregularities are again apparent in the vicinity of the rocky platform at the northeastern corner of the island, where for short distances the dip is northeasterly instead of southeasterly, as at Arnold Wickman's cottage in the S.W. Cor. of Sec. 34, T. 34 N., R. 30 E.

The most conspicuous topographic feature of Washington Island is the high cliff along the western shore which rises precipitously out of Green Bay. It begins at the southwestern corner of the island as a low, cobble-covered bluff about 15-20 feet high, and northward becomes increasingly higher until it culminates in the bold face of Boyer Bluff at the northwestern extremity of the island, where the highest point is over 140 feet above the bay (Figs 4, 11). A second prominent topographic feature on Washington Island is a high, rounded, double ridge in the central part, which is locally referred to as "The Mountain".

This twin ridge, which really consists of three ridges if the lower and westernmost one is included, is roughly stream-lined in a general north-south direction, presenting two high, rounded cliffs to the north and a long and broad, gently descending, irregular backslope to the southeast (Plate 5). The cliffs rise about 100 feet above the flat lowland to the north and about 160 feet above the level of Green Bay.

The backslope of the cuesta is fairly broad and slopes gently to the southeastern tip of the island where it continues under the water of Lake Michigan. One could walk on the same kind of dolomite, with occasional interruptions because of soil, gravel or vegetation, from the peak of "The Mountain" to the southeastern tip (See geologic cross-section on Plate 1), and if he could follow the same bedding surface all the way, he would descend about 160 feet in 8 miles, or at the rate of about 20 feet per mile. On the backslope of the eastern ridge are very prominent outcrops of the marble-like Racine dolomite which caps the hill, and the surface is in some places deeply corroded along prominent, enlarged joints, so that it resembles a giant pavement laid with huge rhombic blocks. (Fig. 10).

The glaciers which came from the north must have ripped away many tons of rock from the steep, northern faces of "The Mountain", and a lobe gouged out a typical U-shaped glacial valley between the two ridges. Down the backslope at several places the dolomite is smoothed and striated, and numerous grooves show that the general direction of ice movement was southerly. At the crossroads, where Secs. 5, 6, 7, and 8 corner (Plate 1), well preserved grooves show bearings that vary from N-S to N 15° W., and at the S. W. Cor. Sec. 31, T. 34 N., R. 30 E., similar markings vary from N-S to N 15° E.

STRATIGRAPHICAL SEQUENCE

The strata exposed on Washington Island total about 300 feet in thickness and belong entirely to the Silurian system except for the surficial gravels, sands, and silts that are of glacial or Pleistocene age. A generalized stratigraphical column is shown on Plate 3 and will be described in detail on the following pages. This generalized column is a composite sequence based on a number of scattered exposures as indicated on the index map of Plate 3. It has been subdivided into numbered units so that

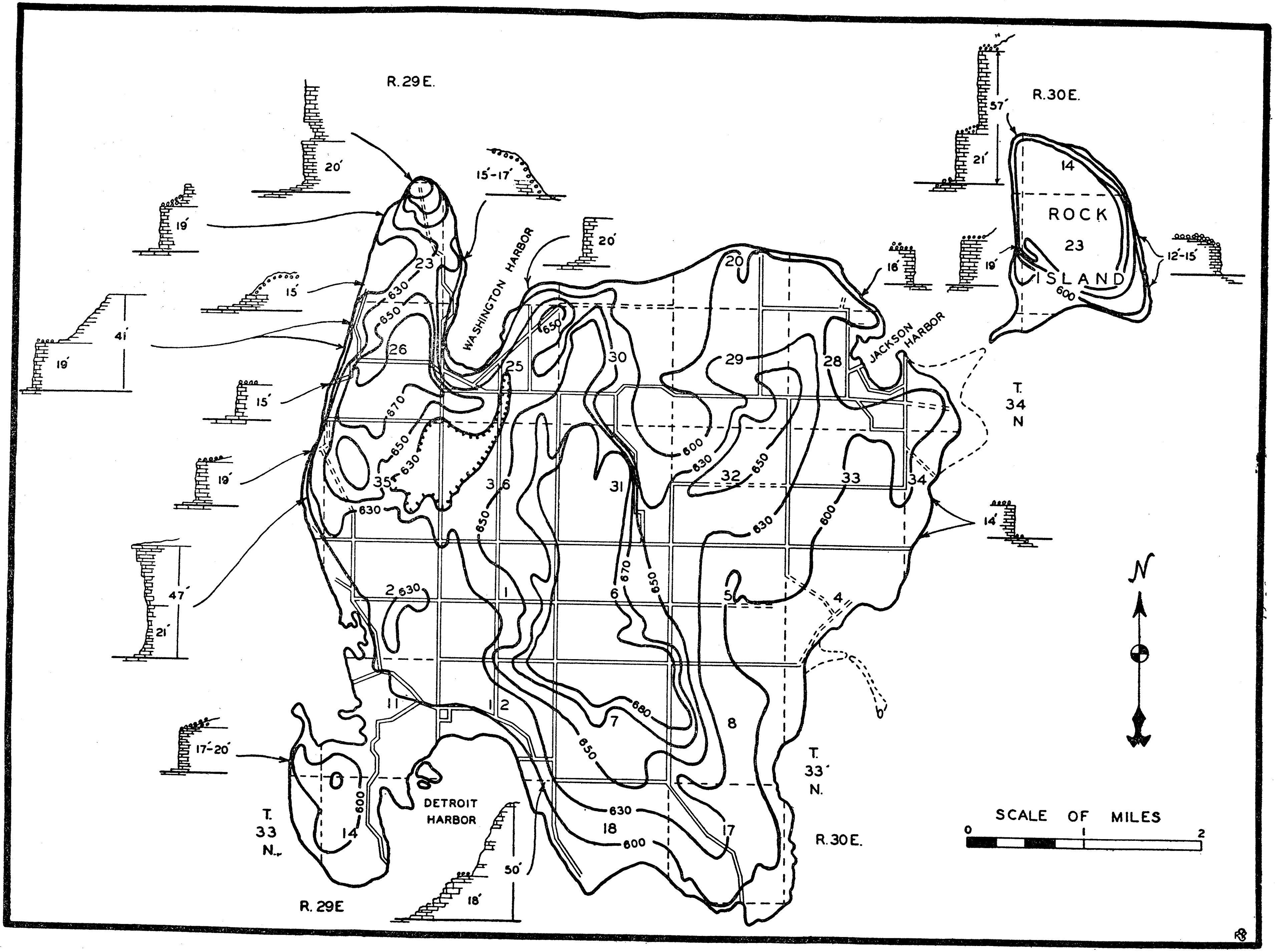

PLATE 5. Rock benches and ancient shore lines on Washington and Rock Islands, showing approximate shore lines of glacial lakes Nipissing (600′ A.T.) and Algonquin (630′‡, 650′‡ and 670-680′‡).

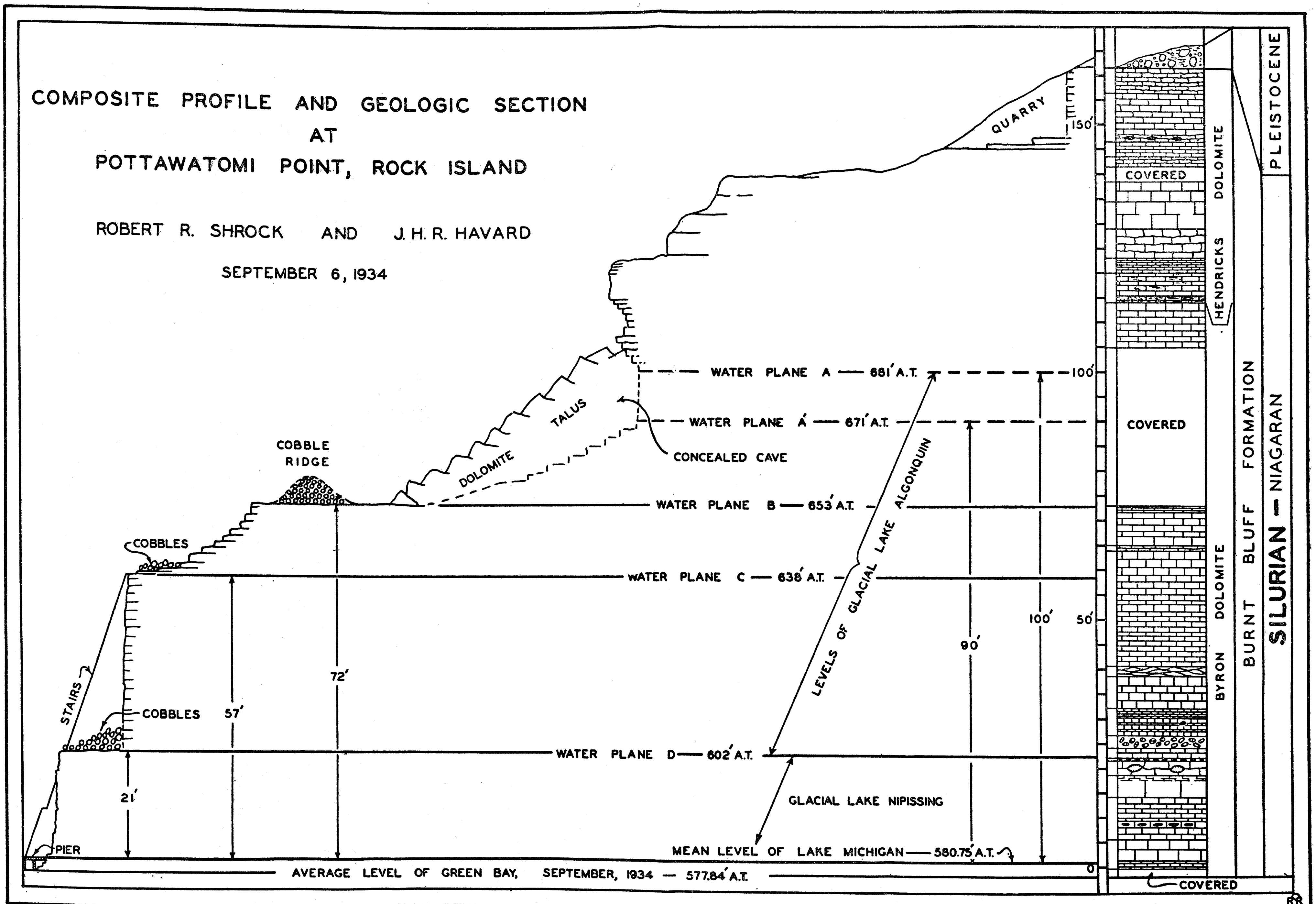

PLATE 6. Geological cross-section of Pottawatomi Point, Rock Island, showing stratigraphical column and evidences of ancient lake levels.

specific beds may be referred to easily. The names of the larger subdivisions (Racine; Manistique, consisting of the Cordell and Schoolcraft dolomites; and Burnt Bluff, consisting of the Hendricks and Byron dolomites) are those now in general use among geologists, but they are not in all instances the designations used by the earlier Wisconsin geologists. For this reason, the newer and older names are correlated in the chart below so that their equivalents may be determined at a glance. Racine and Byron are old Wisconsin names; Burnt Bluff, Manistique, Hendricks, and Schoolcraft are names that have been proposed for Michigan formations, that are well exposed in the Green Bay region.

TABLE 1. *Chart showing new and old names for beds exposed in the Washington Island area*

		New Classification (Shrock, 1934)	Old Classification (Chamberlain, 1873-1879)
SILURIAN-NIAGARAN	Racine Formation	Racine dolomite	Racine dolomite
	Manistique Formation	Cordell dolomite	Upper Coral beds
		Schoolcraft dolomite	Lower Coral beds
	Burnt Bluff Formation	Hendricks dolomite	Transition beds
		Byron dolomite	Byron dolomite

In the following detailed description of the numerous units of the generalized column, the unit will be referred to by the number which appears on Plate 3.

CENOZOIC—Quaternary—Pleistocene

29. Beach ridges and veneer of well rounded igneous, metamorphic, and dolomite cobbles and pebbles, sometimes containing fresh-water clam shells and marking the ancient shore lines of glacial lakes Algonquin and Nipissing. (0′-10′).
28. Glacial drift occurring at various places in hummocky moraines, irregular hillocks, and as a veneer of variable thickness. Numerous large igneous boulders are scattered over the island, even on the highest points. (0′-50′+).

PALEOZOIC—Silurian—Racine Formation

27. Gray, bluish-gray and greenish-gray, tough, dense, marble-like dolomite in thick beds with inclined joints. The rock breaks into large boulder-like masses. There are many peculiar, concentrically ribbed structures which may be cf organic origin, and a few corals and trilobites. Well exposed on "The Mountain", and also on Pilot Island. (40′+).

Manistique Formation—Cordell dolomite

26. Dark gray, thin- and uneven-bedded, somewhat saccharoidal dolomite full of corals and other fossils which are often silicified, and containing numerous chert nodules and lenses in the lower half.

Well exposed at the base of "The Mountain", along the eastern shore at several places, and on Rock and Plum islands. (45′+).

Manistique Formation—Schoolcraft dolomite

25. Buff-gray, uneven-bedded, somewhat saccharoidal dolomite with considerable chert and numerous silicified corals and brachiopods (*Pentamerus*). Exposed just north of "The Mountain", in Washington Harbor, and along the shore northwest of the ferry landing. (8′+).
24. Buff-gray, fairly thick- and uneven-bedded, saccharoidal dolomite full of well preserved specimens of *Pentamerus*, many of which are silicified. In places the rock is a veritable coquina. The lower 1½′ weathers into nodular layers that are less fossiliferous. Exposed on top of Boyer Bluff and on the flat north of "The Mountain". (5′+).
23. Sequence of variable lithology, exposed near the top of Boyer Bluff just below the light tower, in descending order:

1′.	Gray, dense, hard and tough dolomite containing some silicified corals.
1½′.	Gray, dense, crystalline dolomite containing corals and weathering to buff, porous, sugary rock.
2½′.	Massive, buff dolomite full of silicified corals and weathering with a rough and ragged surface.
3′.	Light buff, uneven-bedded, nodular and platy dolomite with a few chert nodules in the upper half.
1′.	Brown, hard and tough, blocky dolomite.
9′..	Total

22. Gray-buff, soft, uneven-textured, saccharoidal dolomite full of white and gray-brown chert nodules and containing some poorly preserved pentameroid brachiopods. The chert is in nodules and discontinuous layers 1″-2″ thick. The rock breaks with shattery fracture into angular fragments. This unit is believed to represent the lowest horizon of *Pentamerus*, except for occasional specimens, and is taken, therefore, as the base of the Schoolcraft dolomite. (3′).

Burnt Bluff Formation—Hendricks dolomite

21. Buff, saccharoidal dolomite with uneven texture, tending to break with shattery fracture into nodular and irregular fragments. (1¼′).
20. Similar to unit 21, but somewhat less shattered and with many minute tubes ramifying the basal layers. The bedding is somewhat lenticular and uneven. (5½′).
19. Buff, massive, finely saccharoidal dolomite in two thick beds which split into thin laminae ¼″-½″ thick on protracted weathering. The upper 3′ bed is dark-brown to gray, dense dolomite which weathers to a sugary condition. (5½′).
18. Buff, massive bed of uneven-textured, granular dolomite which weathers with rounded and smooth surfaces into loose, buff, dolomite sand. (3′).
17. Gray-buff, massive, uneven-bedded dolomite which shatters on weathering into interwedging, lenticular masses, platy chips, and flakes. Beds of this rock alternate with one-foot layers of dense, gray dolomite which does not split on weathering. Partly exposed in Boyer Bluff and at the top of the Washington Harbor section. This unit is believed to mark the base of the Hendricks dolomite because the underlying strata possess the typical, blocky, semi-lithographic, even-bedded character of the Byron dolomite. (10′).

Burnt Bluff Formation—Byron dolomite

16. Gray, fine-grained, even-bedded, blocky fracturing, hard and tough dolomite separating along smooth surfaces into beds from 6″ to 1′ thick. Exposed in the E ½ of Sec. 34, T. 34 N., R. 29 E., in the Washington Harbor section, and elsewhere on the island. (16′).
15. Buff, massive, uneven-bedded, fairly hard and tough dolomite which weathers readily to cream-colored, dolomitic sand. The rock breaks into small chunks of irregular shape because of poor and irregular jointing, and hence contrasts with the blocky beds above and below. It has a buff color which also contrasts with the gray-white of the contiguous strata. There is commonly a slight indentation in cliffs where the unit is exposed because of its ease of weathering. (6½′).
14. Gray, dense, blocky fracturing, uneven-bedded dolomite similar to unit 16. The joints are not at right angles, hence the blocks have wedge shapes. The upper 3′ are somewhat massive and tend to have lighter color. The basal one-foot bed is dark-gray, somewhat saccharoidal rock with many small, flattened cavities disposed horizontally, weathering easily with a horizontally grooved surface. (9′).
13. Light brown (white-weathering), hard, tough, semi-conchoidally fracturing dolomite separating into even beds from 6″ to 1′ thick along smooth bedding surfaces. The smooth joints are at nearly right angles, hence the beds break into cubical or prismatic blocks. (8½′).
12. Buff, fossiliferous dolomite of sugary texture with upper 3′ to 5′ even-bedded and lower part unevenly bedded. The rock weathers to a harsh, dolomite sand resembling ashes. Corals are abundant throughout the unit. The separation planes in much of the unit are very bumpy and the beds of unequal thickness. In some sections, cavities a few inches across are present, apparently the result of solution, and some of the corals are partly silicified. In addition to corals (*Favosites* chiefly), there are stromatoporoids, brachiopods, and gastropods. This important coral horizon is exposed at several places at or just above water level in Green Bay (Fig. 3). (10½′).
11. Gray to light brown (white-weathering), hard and tough, brittle, dense, conchoidally fracturing dolomite in even-bedded layers 3″-8″ thick. The rock first separates into cubical and prismatic blocks and then after considerable weathering these split into thin laminae (¼″-½″ thick). There are a few mud cracks and ripple marks on some of the separation surfaces. The base of this unit is strongly marked by a very bumpy surface along which it separates from the underlying strata, though this relation is sometimes interrupted by a thin unit of laminated, carbonaceous shaly dolomite. (16′).
10. This unit is of interest because it may be marked by a foot or less of dark colored, horizontally streaked, crinkly laminated, argillaceous and somewhat carbonaceous dolomite; or this thin shaly unit may disappear, in which case its place is represented by the very bumpy surface separating units 9 and 11. (0′-1′+).
9. Gray to white-weathering, blocky, semi-lithographic, conchoidally fracturing dolomite in even beds from 6″ to 2′ thick or wavy, uneven beds of variable thickness. The rock weathers with a horizontally grooved surface and often develops scattered holes which owe their origin to solution of crinoid fragments. Mud cracks and ripple marks are common throughout, and small tubes ramify some of the beds. (8½′).

8. Rock is similar to unit 9 except that it is somewhat shaly, banded and laminated, and the bedding is billowy. (1½′).
7. Gray, massive dolomite full of large holes and always conspicuous in a weathered cliff.

   This unit can be traced from Pearse Camp (Plate 3) to and beyond Jacobson's Camp, being from 4 to 6 feet above water level. The rock is brown, has finely crystalline texture and semi-conchoidal fracture. Stratification is lacking, though the bed does tend to become slightly banded at the top on weathering.

   Numerous cavities are present and the bed thickens and thins so that the upper and lower surfaces undulate gently. Overlying and underlying beds thicken and thin in conformity or bend up and down.

   The cavities are generally flattened, average 2″-6″ long and 3″ thick and are often mainly spongy masses of dolomite. Many are partly filled with a reticulose mass of finely crystalline dolomite. In some instances, spongy masses occur in the bulges of the bed, but more often they occur where the bed is somewhat constricted. The origin of the cavities is not apparent. Some may be algal; others seem almost certainly the result of solution. (1½′).
6. A massive layer of dolomite with a rippled upper surface, undulating in conformity with the variations in thickness of unit 7, and a very bumpy lower surface which fits over the uneven surface of unit 5. There are numerous current ripple marks which are about an inch apart and have a general northeasterly trend with the water moving from the southwest. (1½′).
5. White, gray or brown, dense, semi-lithographic dolomite in a single massive bed with a very uneven upper surface. The relief on this surface is as much as a foot locally and there is no definite pattern to the irregularities. The unit is always conspicuous and just south of Pearse Camp it dips southeasterly at about 53 feet per mile. (1′-2′).
4. Gray to light brown, fine-grained, blocky dolomite with same general characters as unit 9. (7′).
3. Conglomeratic dolomite. This unit has a 6″-8″ layer of gray, semi-lithographic dolomite at the top and base, and between is massive, very uneven-textured, cavernous dolomite in which a thin (6″+) conglomeratic layer is commonly present. The lower bounding bed contains a few chert nodules, and undulates considerably in adjusting itself to the very uneven surface of the underlying unit. (2′-3′).
2. Gray to white-weathering, even- and fairly thin-bedded (1′+ thick), blocky, semi-lithographic, conchoidally fracturing dolomite. Some coarsely textured parts weather out causing small holes to develop, and the entire unit weathers with horizontal grooving into iron-stained, dolomite sand. The lower 2′ of rock shows some black, shaly, crinkled laminae alternating with a few thin dolomite layers. (9½′).
1. Gray, dense, blocky dolomite separating, along slightly uneven surfaces, into fairly thin layers (2″-12″ thick). Shale films separate many of the layers. This unit is at least 8′ thick, and probably is somewhat thicker for in September, 1934, it could be seen under water for some distance out from shore. Normally probably not over half of the thickness can be seen above water. (8′+).

It should be noted that the Boyer Bluff section has a total thickness of approximately 150 feet and that the complete column for Washington Island totals slightly over 250 feet.

SHORE LINE

General features.—The rather smooth shore line of Washington Island is broken by four prominent indentations: Detroit Harbor on the south; West Bay on the west; and Washington and Jackson harbors on the north. A small village is present in each of the indentations. Detroit Harbor is the largest of the settlements and has a good-sized hotel, the post office for the island, schools, and numerous other buildings.

Along most of the south shore a narrow zone of beach gravel gives way inland to dune sand and this in turn merges into the wooded hinterland. Along the western shore a cobble beach reaches from the ferry landing to Boyer Bluff with few breaks. The cobbles are predominantly dolomitic and of local origin, though there are some igneous and metamorphic cobbles and boulders of glacial origin. Back from the shore the beach ends in sand, as around West Bay, or against a rocky cliff topped by a veneer of ancient beach cobbles. The lowest of these ancient beaches is at an approximate elevation of 600′ A. T., or about 15 to 20 feet above present water level in Green Bay, and is considered the Nipissing level. It is of interest to reflect that rocky platforms and cobble ridges, in all essential characters exactly like the ancient ones, may be seen in the process of formation at many points along the present western shore of Washington Island (Fig. 11).

The northern shore is margined with a cobble beach and is wooded along much of its extent. There is considerable sand opposite Rock Island and also along the eastern shore south of the cobble-veneered platform at the northeastern corner of the island.

The eastern shore varies from rocky cliffs to low terraces of gravel and sand (Plate 1). At several places the Nipissing level may be identified by rock benches and cobble ridges.

The materials along the present beach consist of the following:

1. Large blocks and slabs of dolomite recently fallen from a cliff or torn from the exposed rock along the shore by waves and winter ice. (Fig. 4).

2. Roundstones of dolomite ranging in size from that of an apple to that of a basketball or large pumpkin. These are the cobbles of future beach ridges.
3. Small rounded cobbles, and a few boulders and pebbles of granite, basalt and metamorphic rock.
4. Gravel consisting of angular and rounded pebbles of dolomite, often piled in windrows a foot or so above water level. Ridges of such material that are now from 5 to 8 feet above the water (elevation 585′+ A. T.) are thought to have been deposited during some past stage of unusually high water as in 1929, when the level reached 582.25′ A. T. during the summer.
5. Beach sand, almost certainly of glacial origin, occurs at a few places and usually forms a strip parallel to the shore, though it may also reach inland for some distance (Plate 1).

Along rocky shores there are overhanging cliffs, stair-stepped rocky platforms a few feet above or below water level, and colonaded cliffs, with square or prismatic columns marked off by prominent, smooth, vertical joints (Fig. 4). Caves have been quarried out of some of the cliffs by waves and winter ice, and these may be seen at several levels. (Fig. 11).

Little Lake.—Little Lake, one of the choicest beauty spots on Washington Island, lies in a shallow bowl of forest and meadowland and is separated from Green Bay by only a narrow strip of bed rock and cobbles (Plate 4). It lies in the extreme northwestern corner of the island on the peninsula which separates Washington Harbor from Green Bay, in Sec. 23, T. 34 N., R. 29 E. It is roughly r-shaped, with an area of about 130 acres, and its longitudinal center line bears generally northeasterly. By hand level the water surface was found to be six feet higher than Green Bay. Since the normal level of Green Bay is about 581 feet above sea level, the level of Little Lake would be about 587 feet. It should be pointed out, however, that the water level of the lake rises and falls in response to that in the bay, for in September, 1934, with the water at 578′ A.T. in the latter, the lake surface stood at 584′ A.T. This low water condition was made obvious by the piers which were much too high for water level and in the rowboat harbors where the former shallow bottoms were high and dry.

According to Mr. Jacobson, who has a camp at the south end of the lake, the maximum depth that has been found in the lake is about 15 feet. He also stated that the bottom is covered to a large extent with mud full of decaying organic matter, and this condition is further suggested by the tangle of weeds and grasses which fringe the shore. There are scattered boulders on the dry bottoms of the small harbors, and along the shore in general, and such are also very likely buried in the bottom muds.

The region around Little Lake is heavily wooded with evergreens and deciduous trees, and there is considerable underbrush. At the north end the lake fades into a marsh, and this in turn gives way to a narrow band of meadowland that extends northward to the heavily wooded slope rising toward the summit of Boyer Bluff (Plate 1).

A low bluff of Byron dolomite extends along the shore of Green Bay north and south of the lake, but disappears where Little Lake most nearly approaches the bay. In this gap an 18-foot, flat-topped ridge of dolomite cobbles holds back the waters of the lake from flowing into the bay. The top of this low bluff averages 15 to 18 feet above the bay (elevation = 595′ ± A. T.) and is nearly always a flat bench veneered with beach cobbles of dolomite, representing the shore deposits of Lake Nipissing.

The east side of the lake basin is bordered by a low, double-stepped escarpment extending in a general northeasterly direction. The lower bench, which has an approximate elevation of 600′ + A.T., represents the Nipissing level and the higher, which varies somewhat in elevation (624′ — 630′ A.T.), is believed to represent the 630-foot Algonquin stage. There are a few small caves in the lower escarpment. (Plate 5).

These two benches are without cobbles, but they are veneered with talus and soil. Apparently disintegration and decomposition have provided enough debris to cover the old beach cobbles, if any ever were present. Several small caves, similar to those that may be seen along the nearby Green Bay shore line, are present in the lower cliff and were probably cut at a time when the storm waves and winter ice of Green Bay could make their effects felt along this old shore.

Present geographical and geological relations indicate that Little Lake is of fairly recent origin, probably dating from sometime during the Lake Nipissing stage. In the early middle Algonquin, when the water level stood at 650′ ± A.T., the Boyer Bluff Peninsula was transected by a wide channel as shown on Plates 2B, 4A, and 5. As the water level fell to a lower stage of 630′ ± A.T. this channel was destroyed by the emergence of the land, but a deep embayment still persisted on the Green Bay side. Finally, when the waters fell still further to 600′ ±, marking the close of the Algonquin and the beginning of the Nipissing stage, this embayment shrank considerably in size but still remained as a prominent indentation, open to the storm waves and probably the winter ice of the bay to the west. It was at this time, apparently, that the caves and rock bench were cut along the eastern side of the lake basin.

Shortly after the beginning of the Nipissing stage, however, it is believed that the storm waves, which must have thundered on the beaches even as they do today, and the powerful winter ice, that shoved with great force against the shore, gradually built a ridge of beach cobbles and talus across the mouth of the small bay and, thus blocked, the bay became the basin of Little Lake. The cobble ridge which acts as a dam averages about 250 feet in width and stands at an average elevation of about 596′ A.T., or about 15 feet above the average level of Green Bay. It would appear, therefore, that the lake came into existence not long after the beginning of Nipissing time.

Once cut off from the bay, the lake basin began to receive clay, silt, and organic materials from the surrounding slopes, and it is believed that these fine deposits gradually filled the voids between the coarser particles of the cobble ridge, ultimately sealing off the waters of the lake and thereby making it possible for the latter to maintain a level 6 feet higher than that of the bay. At the present time Little Lake appears to be fed by springs and the runoff from the surrounding slopes, hence in years of heavy rainfall the level will rise, as will that of Green Bay, whereas in years of drought it will fall.

Little Lake, then, appears to have been formed by the blocking of a preexisting bay of somewhat larger size, and this is further borne out by the presence of the old beach lines and wave-cut caves along the east side of the present lake basin.

Rock Island

GENERAL STATEMENT

Rock Island is the last and northernmost of the Wisconsin islands stringing across the entrance to Green Bay (Plate 1).

It has an area of slightly over 1¼ square miles and is roughly rectangular in outline with a low, narrow southwestern point reaching toward Washington Island. The western side of the island rises precipitously out of Green Bay to a maximum height of over 170 feet, the interior is quite rough with parts standing from 100 to 200 feet above water, and the northern, eastern, and southern shores show only low cliffs of dolomite bordered by cobbles and beach gravel, or by sand. Nearly all of the island is wooded, hence the best exposures are along the shore line where the waves and winter ice are always actively quarrying away the thin-bedded and well jointed rock.

There are said to be many deer on the island but we failed to see any, probably because of the noise we made while traversing the woods. Along the western or Green Bay shore, however, we counted six deer skeletons, apparently representing animals that had plunged over the precipice south of Pottawatomi Point during the previous winter. We were told that many animals meet death every winter in this manner when fleeing from dogs. The deer are known to cross back and forth from Rock to Washington island on the winter ice.

There is a lighthouse at the northwestern corner of the island, on top of Pottawatomi Point, and a family lives here throughout the year. The government owns a small area in the immediate vicinity of the light, but the remainder of the island belongs to C. H. Thordarson, a Chicago manufacturer.

THORDARSON CAMP

Mr. C. H. Thordarson has built a very beautiful group of buildings on the southwestern point of Rock Island, taking advantage of the local materials for building purposes and of the natural configuration of the surface in landscaping his camp. Most of the buildings, which include a large boathouse, a greenhouse, and numerous cottages, are constructed of rounded dolomite pebbles and cobbles laid in successive courses. The masonry is of the highest order and the architecture blends harmoniously with the landscaped surroundings. (Fig. 6).

The ancient beach ridges of dolomite cobbles have been preserved and utilized in the landscaping of the grounds; sand from nearby dunes has been utilized to some extent; cobble stones and glacial boulders have gone into the walls of the buildings and into the fences; and the bedrock of the island has been used for foundations and in other ways. The Thordarson Camp is an excellent example of how effectively local materials and surface features may serve the builder and designer.

TRAVERSE OF THE SHORE LINE

West shore.—A traverse of the west shore shows a low bluff 12 to 15 feet high just north of the Thordarson Camp increasing in height northward to its culmniation in Pottawatomi Point, where there is a sheer precipice over 60 feet high, broken only by a narrow, wave-cut bench at about 24 feet above water level (602′ A. T.). The beds undulate considerably along the shore for some distance north of the camp, but by the time Pottawatomi Point is reached the dip has flattened out and changed to a slight easterly inclination of about 20 feet per mile. This gentle easterly dip may be traced along the northern shore of the island, and distinctive beds which appear 35 to 40 feet above water in the cliff below the lighthouse descend to water level along the eastern shore in a distance of about 1½ miles.

Pottawatomi Point.—Pottawatomi Point is a bold, precipitous cliff at the northwest corner of Rock Island. It is surmounted by a lighthouse which stands on a prominent rock bench about 140 feet above Green Bay. The light is cared for by a family which lives in the lighthouse during the entire year, and is in telephonic connection with the Wisconsin mainland.

The profile of the point is shown on Plate 6 and is very interesting because of the excellent preservation of the rock benches and cobble ridges marking the several levels of Lake Algonquin and the highest stage of Lake Nipissing. Apparently the waves cut a very prominent cave when the water stood at the highest Algonquin level (671′-681′ A.T.), but this feature is now almost completely concealed by talus. It is of further interest to note that the several benches are somewhat higher than contemporaneous ones along the Washington Island shore. This is due to the fact that the land surface was tilted slightly to the southward after the Algonquin benches were cut.

A careful section was measured at Pottawatomi Point and is described in detail below. It starts along the steep shore below the lighthouse and continues upward along the wooden steps leading to the higher benches, thence up another stairway to the flat on which the lighthouse stands, and finally up the slope behind and south of the house, by way of the old quarry, to the highest point along the western shore. (Plate 6).

Geological Section of Pottawatomi Point, Rock Island, September 6, 1934.*

CENOZOIC—Quaternary—Pleistocene

27. Glacial drift containing large boulders of igneous rock and found on the high point a short distance south of the lighthouse. Thickness not over a few feet, though possibly greater in other parts of the island.

PALEOZOIC—Silurian (Niagaran)—Manistique (Schoolcraft) and Burnt Bluff (Hendricks) formations [contact not clear].

26. Buff, uneven-bedded, nodular, sugary dolomite once burned for lime and exposed in the upper part of the old quarry face. (5′).
25. Buff, soft and granular, somewhat laminated dolomite exposed in the quarry, in the cellar of a small building just east of the lighthouse, and in the top of the bluff on which the lighthouse stands (Plate 6). The basal 1½ feet are uneven-bedded and cherty. (10′).
24. Gray, even-bedded, blocky dolomite exposed in the cellar wall. (3¼′).
23. Buff, gray, nodular dolomite. (2′).
22. Covered. (3′).
21. White-weathering, massive, fine-grained dolomite fracturing conchoidally into smooth slabs and exposed in the cliff below the lighthouse. (4′).
20. Buff or gray, massive, granular dolomite in layers 6″-18″ thick and weathering to a dolomite sand. (5½′).
19. Brown, massive, sugary dolomite containing corals and breaking into irregular layers. This unit forms a prominent bulge in the bluff. (6′).
18. Light brown, lithographic dolomite in 3″ layers, fracturing conchoidally and containing many silicified corals (*Favosites*). (3′).
17. Gray to buff, even- and fairly thin-bedded, finely crystalline dolomite fracturing irregularly throughout, and splitting into platy chips in the basal part. (6′).

Burnt Bluff Formation—Byron dolomite

16. Gray, even-bedded, dense, blocky dolomite exposed in prominent caves below the lighthouse, and extending down to the 651-foot bench presumably, though the basal part of this unit and the underlying covered interval are now concealed by talus. (9′).
15. Covered by talus and cobbles of dolomite. Ancient beach gravel. (32′). (See Plate 6).
14. Light gray, lithographic, blocky dolomite that is thin-laminated in the upper few feet at the top of the bench but otherwise in beds averaging 6″-12″ thick. Exposed at top of wooden ladder. (8′).

* The section as shown on Plate 6 has been subdivided into numerous units which are not numbered because of the lack of space. The same units are numbered in this descriptive section.

13. Black, carbonaceous, crinkly laminated dolomite (1′).
12. Gray, even- and fairly thin-bedded (6″-12″), semi-lithographic, blocky dolomite with some lamination and horizontal streaking. The laminae are crinkly and in some layers resemble crude cross-lamination. The beds show mud cracks and ripple marks and the impressions of curved crinoid stems. A few fossils are present (*Conularia*, *Halysites* and *Phragmoceras*). (23′).
11. Gray, semi-lithographic, irregularly fracturing, uneven-bedded dolomite shattering into interfingering wedges on weathering. This unit is always prominent in a weathered cliff because of the irregular bedding. (2′).
10. Light gray, even-bedded, blocky dolomite breaking conchoidally into platy slabs and weathering to a mottled, bluish-yellow pattern. (6½′).
9. Dark gray, thin-laminated dolomite becoming streaked and rotten on weathering (5½′).
8. Gray, massive, dolomite conglomerate which on weathered surfaces shows flat, laminated dolomite pebbles in a gray, crystalline matrix of dolomite. (2′+).
7. Gray, semi-lithographic, even-bedded, blocky dolomite. (2′).
6. Dark gray, laminated, shaly dolomite splitting into paper-thin sheets. (½′).
5. Gray to blue, marble-like, cavernous dolomite full of holes a foot or more across, which are lined with radially directed calcite crystals. The lower 14″ is brown streaked. (3′).
4. One massive bed of gray, semi-lithographic dolomite breaking into conchoidally fractured blocks. The upper foot tends to become laminated on weathering. (4½′).
3. Gray, even-bedded, blocky, semi-lithographic dolomite with a band of brown-gray, chert nodules about a foot thick, 5 feet above the base. The upper foot is massive, angular fracturing dolomite more like the overlying rock. The unit as a whole becomes horizontally grooved on weathered surfaces. (8½′).
2. Gray, thin-bedded (2″-6″), argillaceous, lithographic dolomite which shatters into rounded fragments with marked conchoidal fracture. Extensive weathering reduces the rock to small chips. (6′).
1. Covered by talus from the cliff, but probably same as unit 2. The base of this unit is at water level in Green Bay on September 6, 1934. (1½′).

The contact between the Hendricks member of the Burnt Bluff formation and the Schoolcraft member of the Manistique formation could not be determined because the pentameroid bed marking the base of the latter could not be found. It may be assumed, however, that the Hendricks has about the same thickness here as in Boyer Bluff on Washington Island, hence the base of the Schoolcraft dolomite (as well as the base of the Manistique formation) should be at an approximate elevation of 727′ ± A. T., or somewhere in the wall of the old quarry (Plate 6).

East shore.—There is a low cliff of Byron dolomite along the east shore of Rock Island and at places it is veneered with beach cobbles representing the Nipissing level (Plate 5). This cliff, varying from 12 to 20 feet high, swings westward near the southeastern corner of the island and continues nearly to the Thordarson Camp near which it is lost beneath the well developed cobble terrace.

The following section was measured near the southeastern corner of Rock Island where a low, 18-foot, cobble-strewn, rock bench rises above a narrow rocky platform reaching out to the water line (Fig. 5). The strata dip gently to the northeast.

Section in southeastern corner of Rock Island,
in the S.E. Cor. of Sec. 23

CENOZOIC—Quaternary—Pleistocene

4. At the top of the rock bench there is a veneer of dolomite beach cobbles which are believed to mark the shore line of glacial Lake Nipissing. The lowest of these cobbles are 13′ 9″ above lake level (1934), and the highest slightly over 17½′ above. (4′-5′).

PALEOZOIC—Silurian—Burnt Bluff Formation—Byron dolomite

3. Gray, even-bedded, blocky dolomite = unit 12 of the Pottawatomi Point section. (10′).
2. Gray, uneven-bedded dolomite shattering upon weathering into thin wedges = unit 11 of Pottawatomi section. (2′).
1. Gray, blocky dolomite with billowy bedding surfaces that are mud-cracked, ripple-marked and pitted with many tiny depressions that may be raindrop impressions (Fig. 7). This unit, which is equivalent to unit 10 of the Pottawatomi section, extends to water level in Lake Michigan (September, 1934). (5½′).

South shore.—A traverse from the east shore to the Thordarson Camp crossed the highest point on the island and here silicified corals belonging to the Cordell dolomite were found on several high mounds. While only a few feet of the coralline beds were actually seen, because of the heavy growth of trees and underbrush, there must be approximately 40 feet of them in the higher parts of the island. So far as observed, none of the marble-like Racine seems to be present. It is of interest to note here that glacial boulders were found on top of the highest ridge at an elevation of approximately 790 feet above sea level, showing that the glaciers passed over Rock Island.

In the summer of 1934 a long, narrow sand bar extended southward from the Thordarson Camp toward Washington Island, and was separated from a similar extension from the opposite shore by a narrow ship channel. This sandy point stood only a foot or so above water level and probably becomes partly submerged when the lake level rises to its average elevation of 581′ A.T. There is a rather broad belt of sand along the entire southern shore of Rock Island as shown on Plate 1. Were water level to drop to 575′ A.T. it is probable that Rock and Washington islands would be connected by a broad sand bar unless the narrow ship channel were deepened and kept open. (Plate 2F).

DETROIT ISLAND

Detroit Island lies due south of Washington Island, from which it is separated by shallow Detroit Harbor and to which in times of unusually low water it actually may be attached by sand and gravel bars (Plates 1 and 2F). It is a long, narrow, gravel-bordered, wooded island trending in a northwesterly direction across Secs. 24 and 25, T. 33 N., R. 29 E., and Secs. 30 and 31, T. 33 N., R. 30 E. Its total length is over 3½ miles and its greatest width is about one-half mile. Its total area probably does not exceed 1¼ square miles. The highest point is a rounded knob in the northern half of the island, rising over 70 feet above the water, and there is also a low knob of about 20 feet in height in the southern half (Plate 5). The remainder of the island stands only a few feet above water, is covered by gravel and sand, and passes gently outward under the water to form a shallow platform that extends both eastward and westward for many yards.

Detroit Island is little visited, according to the inhabitants of neighboring Detroit Harbor, because the shallowness of the water around its borders makes landing even a small boat a rather difficult task. If the water level in Lake Michigan were to fall to about 575′ A. T., it is apparent from Plate 2F that Detroit Island would be attached to Washington Island as a long peninsula.

PLUM ISLAND

Plum Island lies about midway between the end of Door Peninsula and Detroit Island, and is a low-lying mass of gravel-covered Cordell dolomite about three-fourths of a square mile in area. The elliptical rock core of the island rises slightly more than 30 feet above water and is mantled with glacial and lacustrine gravel which supports a good stand of trees. Except along the south shore, the island has a narrow gravel beach, largely composed of dolomite pebbles, cobbles, and boulders and rising from 5 to 10 feet above water level. Inland this gravel is piled against low cliffs of cherty, coralline dolomite rising 10 to 15 feet above the lake. This last relation is well exhibited just south of the Coast Guard Station, near the southeast point of the island, and near the range light in the southwestern corner of the island.

The rock of the island belongs to the fossiliferous part of the Cordell dolomite and is best exposed along the eastern and southern shores where low, undercut cliffs, 10 to 15 feet high, form a ragged shore line. It consists of thin (2″-4″), irregular beds of richly coralline dolomite which alternate with thin bands of chert. Many of the former have their surfaces covered with well preserved specimens of *Favosites, Halysites, Arachnophyllum, Thecia,* and *Heliolites; Syringopora* and *Clathrodictyon* from 6″ to over 24″ across; brachiopods of the genera *Pentamerus* and *Atrypa;* gastropods; and numerous straight-shelled cephalopods. There are some excellent exposures of coralline dolomite about 100 yards south of the Coast Guard buildings. A rapid transit of the middle part of the island showed poor exposures of Cordell coralline beds heavily mantled by gravel and glacial boulders.

Judging from the cobbles that mantle the 10-20 foot rock bench, Plum Island was very likely a small, low-lying island or a shoal area during the later part of the Algonquin and the earlier part of the Nipissing stages. It probably appeared as a small island early in the latter stage (Plate 2D).

Pilot Island

Pilot Island is a small, rocky mass of Racine dolomite lying south of Detroit Island, southeast of Plum Island, and about 3 miles east of the tip of Door Peninsula (Plate 1). The island is elliptical in shape and several hundred yards long. There is a prominent rocky point at the southeastern extremity of the island, and in September, 1934, this could be seen extending under water for several hundred yards to the eastward as a shallow shelf. At the time of the writer's visit the inner part of this point was above water (Fig. 8). A few evergreens help to set off the six buildings that are present: a lighthouse and five supplementary buildings (Fig. 9).

Pilot island is composed entirely of rock and except for a few small coves has no cobbles along the shore. In a few places, however, there are occasional large boulders of local dolomite and a few glacial cobbles of granite and basalt. The surface of the island is bare except for a few evergreens, but no glacial grooves could be found. The highest point on the island was found to be 12 feet above the lake, or at an elevation of 590′ + A.T. It would appear, therefore, that the waters of early Nipissing time washed across the island, and that the island did not emerge until water level had fallen to around 590′ A.T.

The rock is gray, fairly even-textured, marble-like dolomite which breaks up into great blocks outlined by prominent inclined joints and irregular separation surfaces. It contains the same concentrically ribbed structures that were seen on the southeastern point of Washington Island and on "The Mountain", and appears to lie at about the same stratigraphic horizon as the rocks at those points do. There is some suggestion of a very gentle southeasterly dip, but the irregularity of the separation surfaces makes this uncertain.

Fish Island and Fisherman Shoal

The recent lake chart of the Washington Island region (U. S. War Dept., Lake Survey, Chart No. 715, *Entrance to Green Bay Lake Michigan,* 1935), with the plane of reference at 578.50 feet above sea level, shows an extensive, northeasterly trending shoal area about three miles off the south-eastern corner of Rock Island. This area, about three miles long and three-fourths of a mile wide, lies less than 30 feet under water and is surrounded on all sides by at least 90 feet of water. It is a submerged, flat-topped pedestal, therefore, and the map shows a tiny island at each extremity.

The northeastern island, named Fish Island on the chart, is surrounded by a flat, submerged platform of about forty acres in area, which is nowhere over 4 feet under water. The southwestern island is unnamed but the submerged platform, similar in size and depth to that at the opposite end of the shoal, above which the tiny island rises, is designated Fisherman Shoal.

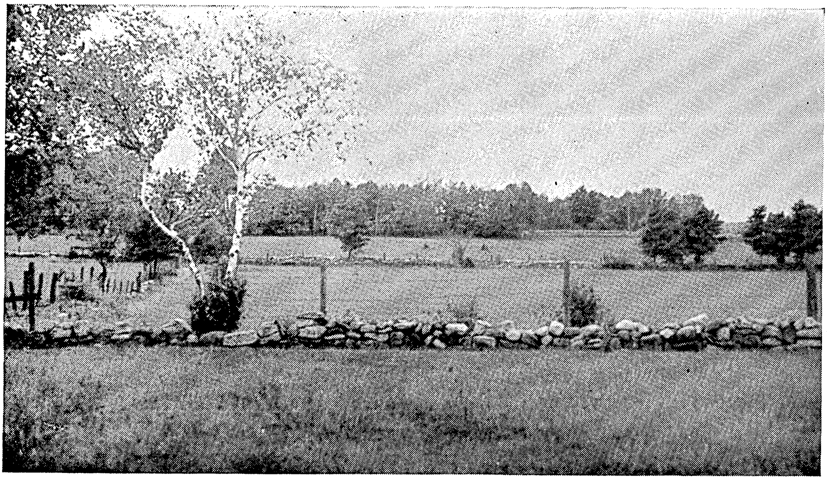

FIG. 2. Rock fences east of "The Mountain" on Washington Island.

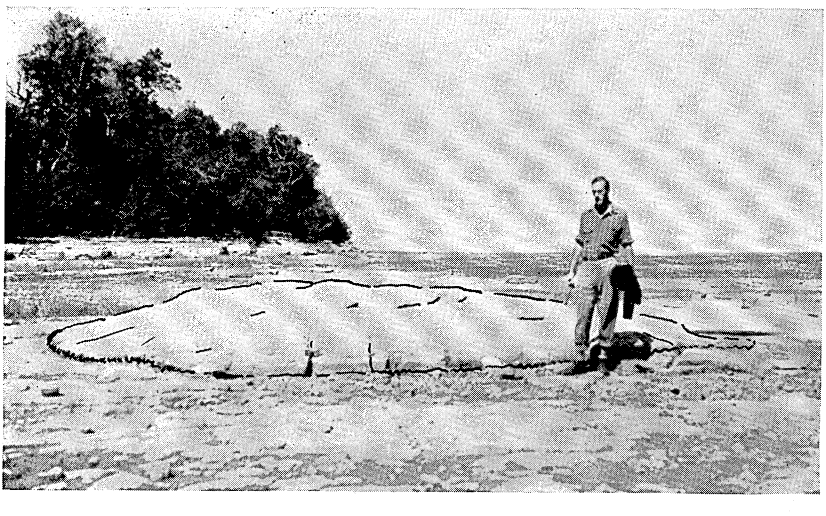

FIG. 3. Reef mound on rocky platform at the northeast corner of Washington Island.

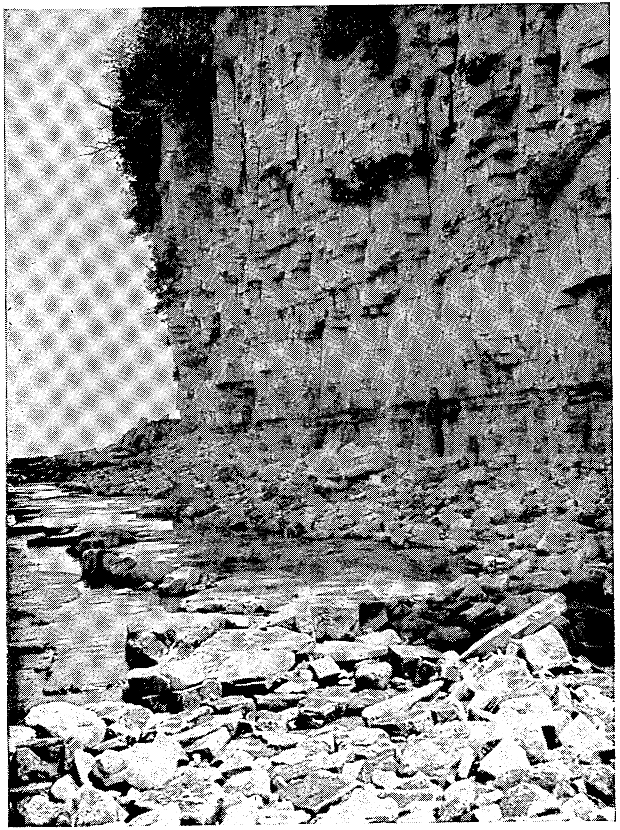

FIG. 4. Profile view of Boyer Bluff.

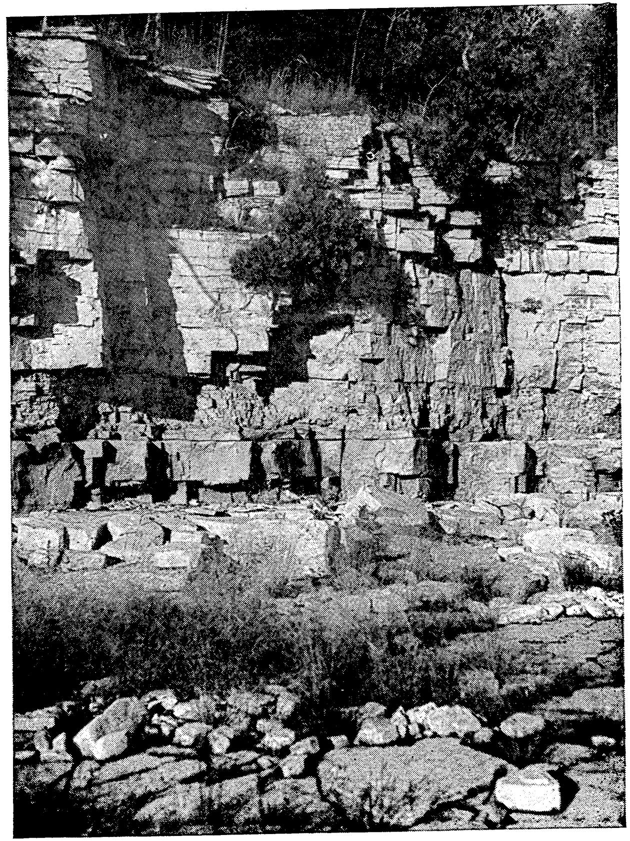

FIG. 5. Low cliff of Byron dolomite near the southeast corner of Rock Island.

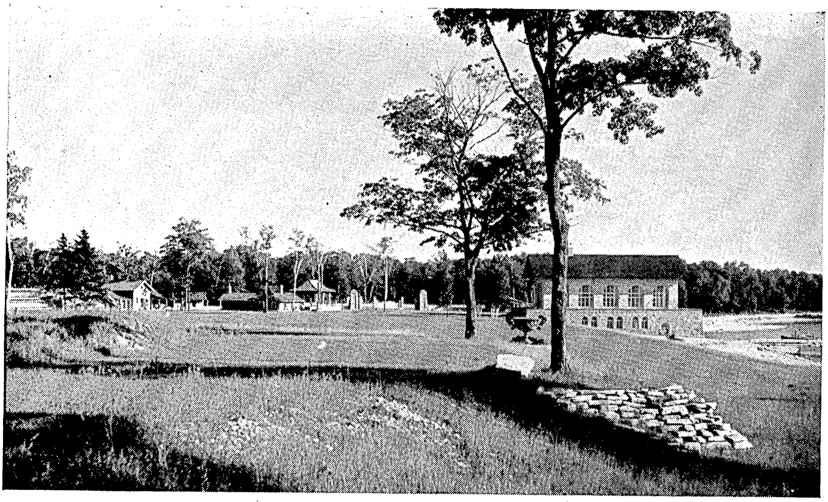

FIG. 6. View of Thordarson Camp, looking south.

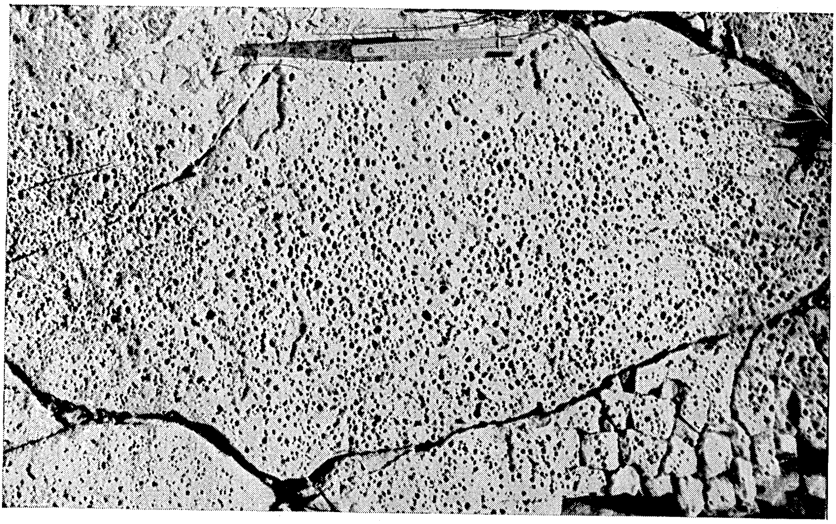

FIG. 7. Pitted bedding surface in the Byron dolomite near the southeast corner of Rock Island.

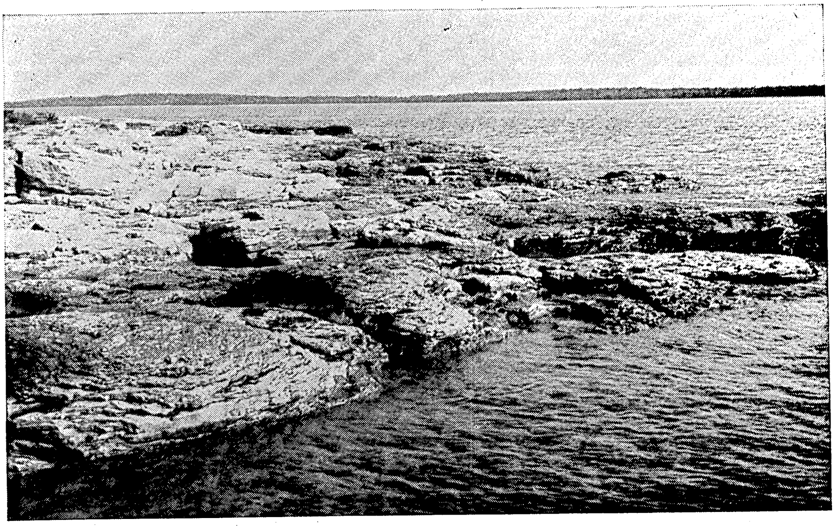

FIG 8. Rocky eastern shore of Pilot Island.

FIG. 9. Lighthouse and adjacent buildings on Pilot Island.

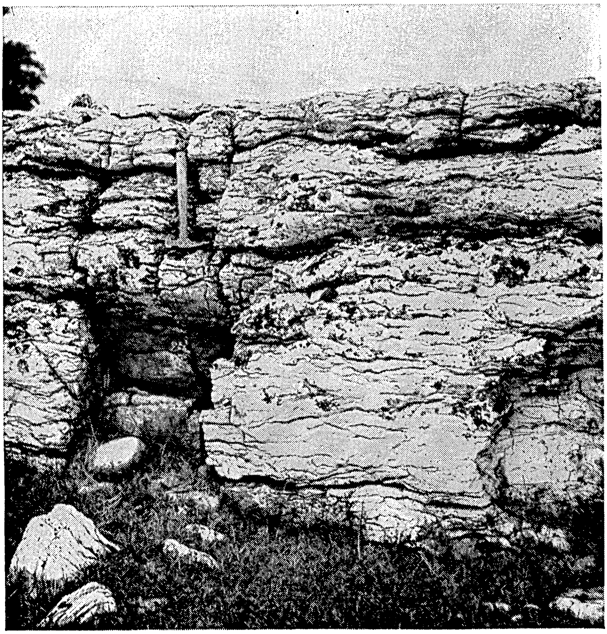

FIG. 10. Weathered Racine dolomite on "The Mountain", Washington Island.

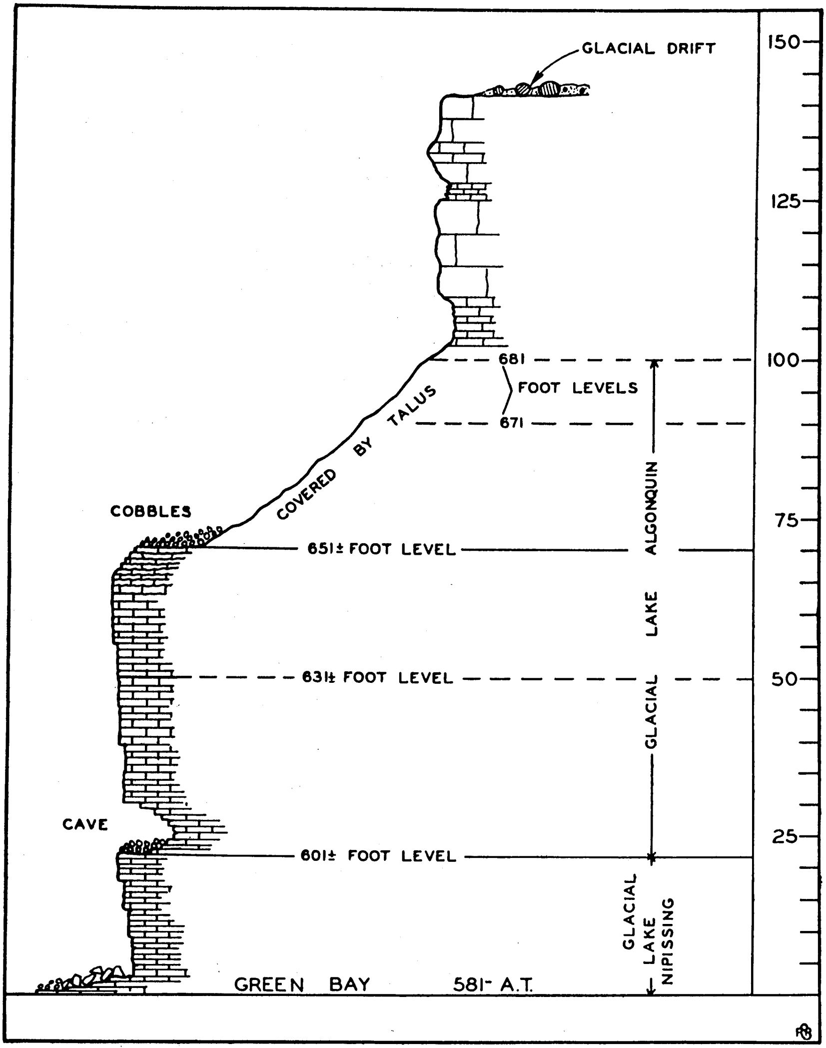

FIG. 11. Diagrammatic geological cross-section of Boyer Bluff.

Fossils Found on the Islands

GENERAL STATEMENT

Well preserved fossils may be obtained at a number of places in the Washington Island region, and since some readers may wish to collect and identify the specimens they collect, a few of the more common genera are illustrated in Fig. 12. In order to determine the different species of a single genus, as for example of *Favosites* which is represented by a number of forms, it will be necessary to consult numerous articles, pamphlets and other sources, but such investigation lies beyond the scope of this brief consideration. Many of the species, however, may be found described and illustrated in Volume 4 of the *Geology of Wisconsin.*

The common genera illustrated in Fig. 12 will be described very briefly so that the amateur collector may have some information about his specimens. Corals are by far the most common of the fossils and will be described first, followed by brachiopods, mollusks, trilobites, and possible plant fossils.

CORALS

1. *Arachnophyllum* (also called *Strombodes*).—This coral consists of large, shallow, five- or six-sided basins, in which the individual organisms sat, bound together into flat, laminar expansions. Some of these colonial masses are a foot or more across.

2. *Cladopora.*—Specimens of this genus look like small twigs or a coarse network of interlacing ribbons with pitted surfaces. An individual organism lived in each of the pits and the entire colony probably looked like a tiny bush on the sea bottom.

3. *Cup corals.*—These small, cornucopia- or horn-shaped corals are common but good specimens are hard to get out of the rock. Most of them are less than 4 inches long. Close examination reveals that the inside of the cone, which usually is filled with hardened mud, is divided into many small compartments by radially directed partitions (these partitions are sometimes called *septa*). The little coral sat on top of the cone and built it and the partitions on the under side of it. Most of the specimens belong to the genus *Zaphrentis.*

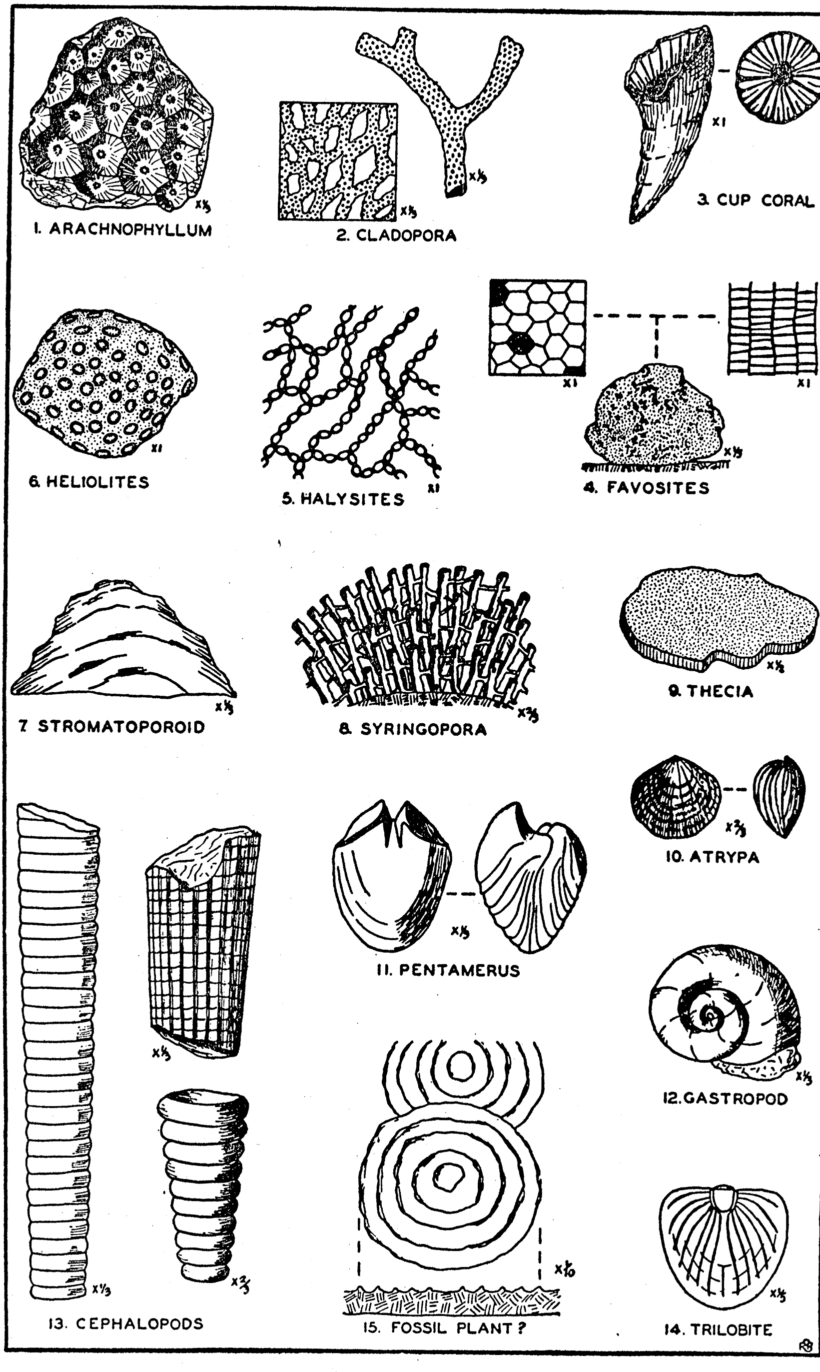

FIG. 12. Fossils found in the Washington Island region.

4. *Favosites.*—This is the well known "honeycomb coral", so named because the colony is made of many five- and six-sided prisms which give it the appearance of a honeycomb. The fossil is often shaped like a cabbage head and is often as much as 6 inches or even a foot across. The individual tubes are divided into many small apartments by transverse floors (sometimes called *tabulae*). In life each tube was occupied by one tiny organism which as it grew upward built one of the little floors under itself.

5. *Halysites.*—This genus has long been called the "chain coral" because, when the colony is seen in cross-section, the small, elliptical tubes in which the organisms lived resemble links in a small chain. The individual tubes are usually from ⅛ to ¼ of an inch across and are arranged much like the posts in a complex stockade or corral. The colonies are usually only a few inches across but in some instances may measure several feet across.

6. *Heliolites.*—This little coral usually occurs as a small nodular head a few inches across, whose surface is pitted with many tiny holes which are really the ends of the tubes in which the organisms lived. In some cases the tubes became filled with material that was more resistant than the coral rock around and so the weathered coral looks as though many tiny pegs had been stuck into it. The pegs will not be connected by cross-bars, however, and this characteristic will help to distinguish it from *Syringopora.*

7. *Stromatoporoids.* These are ancient animals, no longer living, which are believed to have been close relatives of the corals. They built large stony masses shaped like huge cabbage heads, which are composed of many thin laminae arranged in a concentric fashion somewhat like the leaves in a head of cabbage. It is believed that thousands of tiny organisms sat on the surface of a single stony mass and gradually built it upward by precipitating calcium carbonate from the surrounding water. Many of the heads reach a foot or two in greatest dimension, though they more commonly are only inches across.

8. *Syringopora.*—This is the "organ pipe coral", so called because when seen from the side the many little tubes of the

colony have the appearance of pipes in an organ. These tubes may sometimes weather out and then the surface will look like a large pin cushion stuck full of huge needles, except that the tubes will be connected at intervals by tiny cross-bars. Colonies of this genus often attain diameters of several feet.

9. *Thecia.*—Some beds of the Cordell dolomite are covered with small, wafer-like masses which have many pits on their surfaces. These little pits are really the ends of short tubes in which the tiny coral organisms lived. The individuals of this genus built flat colonies, however, instead of the usual domed ones that are so common in most of the other corals that have been described above.

BRACHIOPODS

10. *Atrypa.*—This is a small, double-valued shell an inch or less across, which has an oval shape, with one end somewhat pointed, and a surface covered with numerous, herring-bone ribs or ridges which radiate from the pointed end. The animal that made this shell lived on the inside and attached itself and shell to the sea bottom by the pointed end. These shells are not common and are hard to get out of the rock.

11. *Pentamerus.*—Silicified fillings of this brachiopod shell are quite common in the Schoolcraft dolomite and sparingly in the overlying Cordell beds. These fillings, often composed of white chert, are conspicuous because of their shape and the peculiar structure of the pointed end. In these fossils the original shell has long since disappeared and only the internal filling is left.

MOLLUSKS

12. *Gastropods.*—A few fossil snail shells are scattered through the Schoolcraft and Cordell dolomites, but they are not common and usually can not be removed from the rock with very much success. They are difficult to identify because as a rule they are not well preserved.

13. *Cephalopods.*—Straight-shelled cephalopods are very commonly mistaken for fossilized vertebrae or backbones, or for fossilized snakes, but it should be emphasized that these animals were not yet in existence when the fossil shells were made. The

shell is a long, slowly expanding cone which is divided into a number of compartments by curved, transverse partitions. Usually the shell is seen in longitudinal section, since it will as a rule come to rest in a flat position on the bedding plane, and so the division of the shell into a series of compartments is remindful of vertebrae. In some of the shells there is a complicated structure along the axis and this, in longitudinal section, has the appearance of a string of large beads. As a rule these cephalopod shells can not be specifically or even generically identified with much success except by an expert, hence no generic names will be given here.

TRILOBITES

14. *Goldius.*—Trilobites, which bear some resemblance to crabs and crayfish, have long since died out but they seem to have been present in small numbers during the time that the Racine dolomite was being deposited on the sea bottom, for a few fragments of their shells have been preserved. One of these, *Goldius,* had a large tail piece or "flipper" which is illustrated in Fig. 12. These pieces may be found if diligently sought for in the Racine dolomite at the southeast corner of Washington Island.

Possible Plant Fossils

So far nothing has been said about the peculiar, concentrically ribbed structures that are so common in the Racine dolomite where it outcrops in the Washington Island region. It is believed that these interesting structures may possibly have been formed by lime-secreting, one-celled plants known as algae. These lowly plants are able to precipitate calcium carbonate out of salt waters and build thin layers of the material under themselves, and they may have constructed the fossils that are being discussed, though there is no way of being sure about it.

RECTANGULAR MUDCRACKS

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ABSTRACT

Rectangular mudcracks occur on the same bedding surface with polygonal and irregular types in the thin-bedded, semi-lithographic Byron dolomite of Middle Silurian age in northeastern Wisconsin. The arrangement of these cracks is so regular that the surface resembles a pavement composed of rectangular blocks. Besides mudcracks, the Byron dolomite contains wave and current ripple marks and numerous rill marks which indicate that the original muds were deposited in shallow water, and the fauna of brachiopods, cephalopods, and trilobites shows that the water was marine. The way in which these unusual mudcracks formed is not apparent, but their wide spacing over parts of the surface strongly suggests that they resulted from rather rapid desiccation. They may have been caused by differential desiccation of a layer of mud of fairly uniform thickness, or by the drying out of a mud layer overlying a rippled surface.

INTRODUCTION

Many writers have described mudcracks and discussed the modes of formation,[1] but none seems to have mentioned the rectangular type which is here described. A brief note, therefore, seems warranted.

OCCURRENCE AND NATURE

The Byron dolomite in which the mudcracks occur is a gray, thin- and even-bedded, semi-lithographic dolomite of Middle Silurian age, outcropping along the Niagara Escarpment in northeastern Wisconsin. The rock separates into thin and

[1] Kindle, E. M., *Some factors affecting the development of mud-cracks*, Jour. Geol., vol. 25, 1917, pp. 135-144; Twenhofel, W. H., *et al.*, *Treatise on Sedimentation*, 2nd. ed., Williams and Wilkins, 1932, pp. 685-692.

smooth-surfaced beds which range from a few inches to less than one-fourth of an inch in thickness. The surfaces of the layers frequently show well preserved current and wave ripple marks, rill marks, mudcracks of several kinds, and some other features indicative of shallow water deposition. The fauna, which includes graptolites, brachiopods, cephalopods, and trilobites, shows that the water from which the calcareous muds settled was marine.

The bedding surface which preserves the rectangular mudcracks is exposed in the floor of the Chilton County road materials quarry about 1½ miles south of Chilton, in the N. W. ¼ Sec. 30, T. 18 N., R. 20 E. (Fig. 1E). It is billowy with low, rounded domes 10 to 20 feet in diameter and intervening shallow basins of somewhat smaller size. This condition may be a reflection of mounds of porous, granular dolomite like those in the immediately underlying strata a short distance west and northwest of the quarry. The bedding surface as a whole dips eastward about 3½ feet in 100 feet.

Rectangular mudcracks change laterally into irregular or regularly polygonal types (Figs. 1A, D), and there seems to be no obvious relation between the configuration of the bedding surface and the kind of mudcrack developed.

The cracks are now only partly filled and they appear as narrow, shallow grooves one-half inch to over an inch in width and usually less than one-half inch deep. Originally, however, they were completely filled with calcareous material similar to the bed in which they occur, for the upper parts of these fillings still remain in some places as strap-like ribbons. So far as observed, there does not seem to have been a shale film between the mudcracked layer and the overlying bed.

The cracks themselves are of two kinds: one continuous and presumably older; the other discontinuous. The former extend in a general north-south direction for many feet, tend to be roughly parallel and slightly sinuous, especially on the gentle slopes of the rounded domes, and divide the surface into narrow strips from 3 to 8 inches in width. The latter, disposed approximately at right angles, may be straight or curved, do not commonly transect more than one strip, and divide the strips into segments from 3 to 18 inches in length. Together, these two types of cracks divide the bedding surface into rectangular polygons, which have the appearance of paving blocks laid in parallel rows (Figs. 1A-B, D, F), or elongated, irregular blocks which lack rectangularity but exhibit the same linear arrangement in north-south rows (Figs. 1A, C). In general, the irregular blocks tend to be somewhat larger than the rectangular ones, reaching widths of 16 inches and lengths of over 20 inches.

Some of the floor in the south part of the quarry is divided into regular, five-, six-, and seven-sided polygons a foot or more in diameter, which themselves are further cracked throughout so as to consist of many small polygonal blocks averaging about one-fourth of an inch in diameter. Fairly large polygonal mudcracks are also present in the northern end of the quarry floor.

Conditions of Formation

So far as observed, no type of mudcrack is limited to any definite part of the gently undulating surface, and, even though the areas of rectangular mudcracks are now fairly flat, it does not follow necessarily that they were so at the time of formation. The continuous cracks nearly always trend in a general north-south direction, regardless of the configuration of the bedding surface. Two suggestions may be offered in explanation of how the rectangular mudcracks formed, but neither is very satisfactory.

Kindle[2] found experimentally that muds which dried out differentially or zonally developed ribbon-shaped polygons disposed approximately at right angles to the front of the retreating water. He did not, however, mention any development of transverse cracks and his photograph shows none. Twenhofel[3] repeated the experiment, using a larger vessel, and concluded that the results "only partly supported the generalization" that differential or zonal desiccation produces parallel mudcracks. The Wisconsin mudcracks could have been formed in this way, for the undulating nature of the bedding surface (assuming of course that this condition was original) would have caused differential withdrawal of the water and consequent zonal desiccation of the mud. Whether they were formed in this manner, however, can not be stated with certainty.

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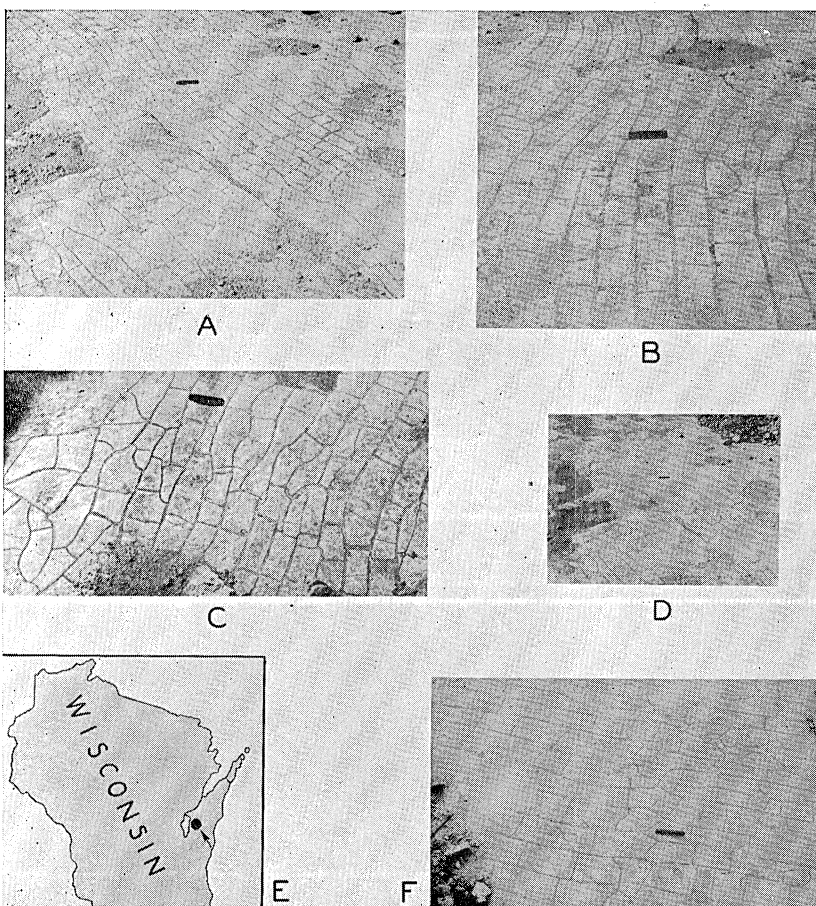
[2] *Op. cit.*, pp. 138-139.
[3] *Op. cit.*, p. 690.

It may be suggested, also, that the rectangular and elongated, irregular mudcracks overlie buried, rippled surfaces, in which case the crests of the ripple marks would influence the position of the continuous cracks. This suggestion, however, has little in its favor other than the fact that the more prominent cracks are aligned in a general north-south direction, presumably the approximate trend of the ancient Silurian seashore on the west.

Whatever the mode of formation, however, it appears likely that the mudcracks resulted from rapid desiccation, as several investigators have found experimentally that rapid drying produces much more widely spaced cracks, hence larger polygons, than slow drying.



FIGS. 1A-D, F. Mudcracks in the Byron dolomite near Chilton, Wisconsin. Photographs by W. L. Wilgus and the author, 1931. (All except 1D are retouched slightly, and in each the rule represents seven inches).

A, D. Photographs of a part of the quarry floor, showing rectangular mudcracks changing laterally into irregular types (Fig. 1D has been left untouched).

B, F. Rectangular mudcracks showing prominently developed, north-south trending cracks.

C. Irregular blocks outlined by prominent continuous cracks and curved transverse cracks.

BURIED PRE-CAMBRIAN OF WISCONSIN

F. T. THWAITES

During the eight years which have elapsed since the publication of the original paper on the "Buried pre-Cambrian of Wisconsin"[1] a considerable amount of new information has been acquired by the Wisconsin Geological Survey. The map here shown shows corrections from data available at the end of October, 1939.

Of special note is the Hustisford well which demonstrated an extension of the Waterloo quartzite range at a remarkably shallow depth of only 268 feet. It is, therefore, possible that in eastern Wisconsin there may be drift-covered areas of pre-Cambrian quartzite which are not yet known. Another important record is that on the Hanson farm near Brothertown, which disclosed a pronounced elevation in the completely concealed Fond du Lac range. As is the case in much of Hartford, quartzite was encountered exactly at the bottom of the Platteville dolomite. Fig. 2 shows subsurface conditions at Hartford. It may be postulated that marine erosion was the cause of these platforms which are similar to the crests of so many of the Baraboo Bluffs.[2] A prolonged stillstand in the relations of sea and land would allow wave planation of islands, leaving a far more perfectly flat surface than is conceivable by weathering and stream erosion on a rock so extremely obdurate both to mechanical and chemical attack.

At Brandon a considerable amount of quartzite bowlder conglomerate made it difficult to determine the exact top of undisturbed quartzite. The Wisconsin Power and Light Company well at Ripon failed to find pre-Cambrian or any sign of its nearby presence, at an elevation only about 300 feet higher than the inferred contact at Brandon. There certainly are a number of buried monadnocks in that vicinity.

[1] Thwaites, F.T., Buried pre-Cambrian of Wisconsin: Geol. Soc. America, Bull., vol. 42, pp. 719-750. 1931.

[2] Thwaites, F.T., Physiography of the Baraboo district, Wisconsin: Kansas Geol. Soc., Ninth Annual Field Conference, Guidebook, pp. 395-404. 1935.

Attention should be directed to the ill-advised "oil tests" at De Forest, Cambria, Black Creek, and Friendship. Such explorations are without any doubt wasted effort, for the large amount of subsurface data already available in Wisconsin gives no encouragement with respect to oil and natural gas, especially in the Cambrian and pre-Cambrian. All these tests were drilled in complete disregard of advice from the Wisconsin Geological Survey.

A large number of deep wells have also been drilled which failed to reach the pre-Cambrian hard rocks. Among these may be mentioned the following which are bottomed below sea level: Monroe at 683 feet, Campbellsport at 272, Waukesha at

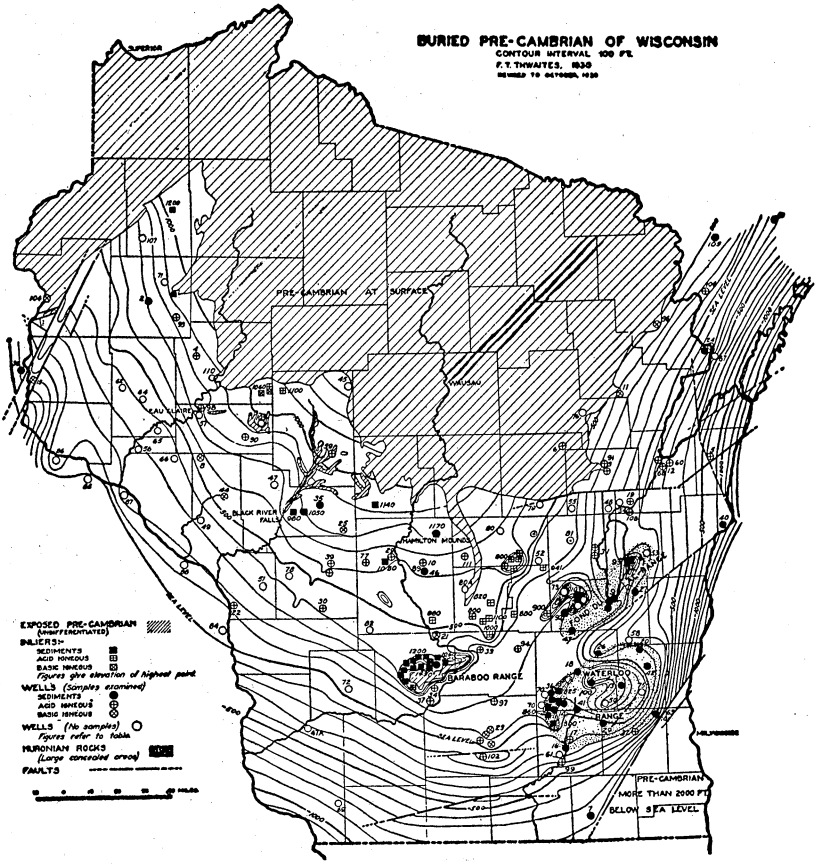


FIG. 1. Contour map of surface of buried pre-Cambrian of Wisconsin. F. T. Thwaites. 1939. Contour interval 100 feet.

1099, Kewaunee at 1110, and Burlington at 1140. Of these, only the first necessitated any change in contouring of the probable surface of the pre-Cambrian.

The deep oil test near Irene, Illinois, (not shown on map) indicates a more rapid southward inclination at the top of the pre-Cambrian than was formerly thought.

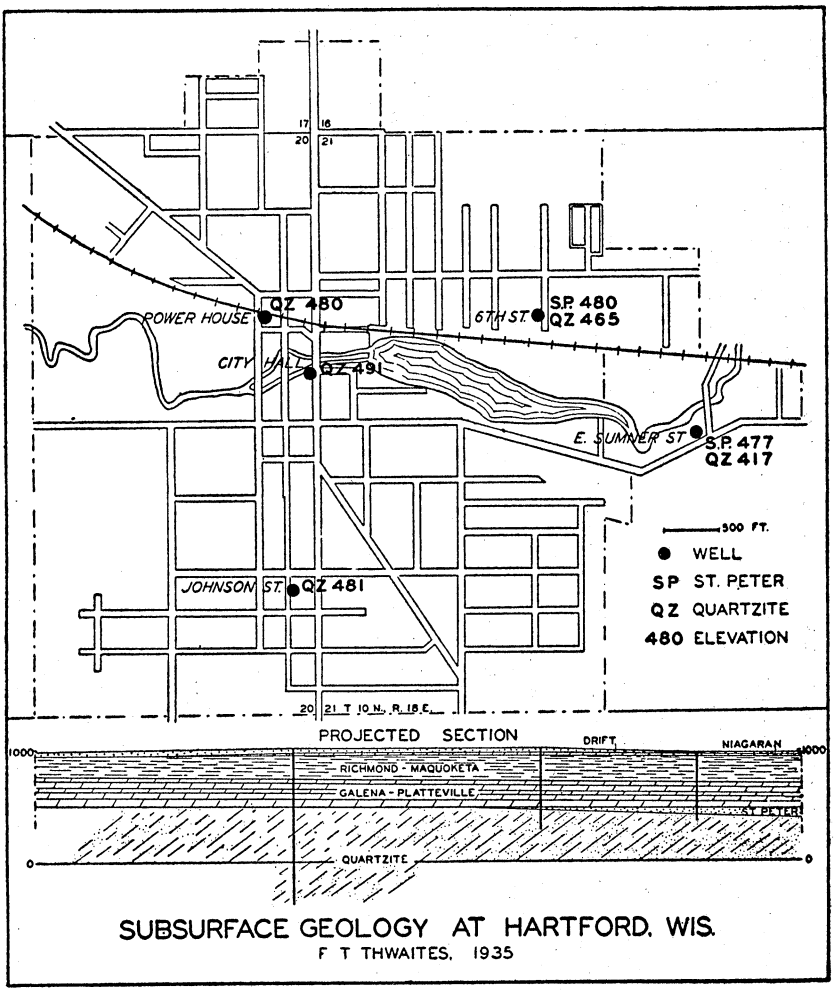


FIG. 2. Buried pre-Cambrian quartzite at Hartford, Wisconsin, showing level top, possibly due to wave planation.

TABLE 1

Well records showing nature of concealed pre-Cambrian rocks in Wisconsin; samples have been examined by geologists.

Map number—city	Owner or location	Surface elevation	Depth to pre-C.	Pre-C elevation	Rock; remarks
1. Baraboo	City test	856	424	432	Quartzite
2. Barron	City	1120	420	700	Quartzite or conglomerate
3. Black Creek	Borden Co.	785	512	273	Granite under drift
4. Bloomer	Armour Co.	1006	170	836	Granite
5. Casco Junction	G.B. and W.R.R.	728	1675	—947	Granite
6. Clintonville	City test	825	140	685	Granite under drift
7. Delavan	Bradley Knitting Co.	938	1660?	—720?	Quartzite? (doubtful)
8. Eleva	Jackson Farm	870	300	570	Basalt
9. Fond du Lac	City test	750	740	10	Quartzite, slate, etc.
	Galloway West Co. No. 1	760	440	320	Quartzite
	No. 9 city	755	835	—80	Slate
10. Friendship	Oil test NE¼ NW¼ Sec. 30, T. 18 N., R. 6 E.	960?	265	655?	Gneiss, granite
11. Gillett	Gillett Canning Co.	801	412	389	Hornblende schist under drift
12. Green Bay	Waterworks	590	855	—265	Granite
	Ninth St.	610	855	—245	Granite
	Cass St.	585	912	—327	Granite
	Gray St.	615	800	—185	Granite
	Preble	601	960	—359	Schist
13. Hartford	Power House	980	500?	480?	Quartzite
	City Hall	981	490	491	Quartzite
	Johnson Street	1013	532	481	Quartzite
	Sixth Street	1015	550	465	Quartzite
	East Sumner Street	982	560	417	Quartzite
14. Hubbleton	Diamond drill holes T. 9 N., R. 14 E.				
	NE¼ SW¼ Sec. 31	790	614	176	Slate, quartzite[a]
	SE¼ SE¼ Sec. 31	785	457	328	Slate, quartzite
	SW¼ NE¼ Sec. 15	800	753	47	Dolomite, slate, schist, quartzite
15. Hudson	City	670	393	277	Basalt

Map number—city	Owner or location	Surface elevation	Depth to pre-C.	Pre-C elevation	Rock; remarks
16. Jefferson	Carnation Milk Co.	790	825	—135	Quartzite
17. Jefferson Jct.	Ladish-Stoppenback Co.				
	No. 1	820	879	—59	Granite
	No. 2	820	880	—60	Granite
18. Juneau	Libby, McNeil & Libby	910	730	180	Quartzite
	Fire station	949±	664	285±	Quartzite
	City waterworks	910			Quartzite
19. Kaukauna	City No. 3	650	778	—128	Granite
20. Kewaskum	Rosenheimer Malt and Grain Co.	950	1045	—95	Quartzite
21. Wisconsin Dells (Kilbourn)	Artesian test	928	450	478	Basalt, etc.
22. La Crosse	City	640	537	103	Granite[b]
23. Madison	Station well	858	733	125	Basalt
	East Station	851	720	131	Basalt[c]
	No. 11	850	733	177	Basalt
	Unit No. 1	856	835	21	Granite
	Unit No. 2	851	730	121	Basalt
	Unit No. 3	850	730	120	Schistose rhyolite
	Unit No. 4	854	715	139	Rhyolite
	Unit No. 5 (9 spring)	892	825	67	Basalt
	Unit No. 6	875	740	135	Rhyolite
	Unit No. 7	890	725	165	Granite
	Capitol	929	800	129	Basalt[d]
	Kennedy Dairy Co.	863	740	123	Basalt
	C. M. St.P. and P.	863	790?	73?	Basalt[e]
24. Marinette	City test	590	712	—122	Quartzite[f]
	Southern Kraft Paper Mill	590	687	97	Granite
	Gas Works, Menominee, Mich.	588	658	—70	Granite
25. Mather	Appleton Cranberry Co. Sec. 21, T. 20 N., R. 1 E.	1000	175	825	Basalt
26. Mayville	Youngstown Sheet and Tube Co.	920	1160	—240	Jasper
	No. 2	1060	1176?	—116?	Quartzite or granite[g]
27. Mount Calvary	College				

Map number—city	Owner or location	Surface elevation	Depth to pre-C.	Pre-C elevation	Rock; remarks
28. Necedah	C. and NW Ry	905	310	595	Granite
	No. 1 test hole	905	229	676	Diorite[h]
	No. 2 " "	905	202	703	Granite, diorite[h]
	No. 3 " "	905	192	713	Diorite[h]
	No. 4 " "	905	203	702	Quartzite, granite[h]
29. Oconomowoc	Montgomery Ward	896	950	—54	Quartzite[i]
30. Oil City	Wildcat test	890	490	400	Granite[j]
31. Oshkosh	Algoma Street	755	680	75	Granite[l]
	Diamond Match Co.	750	675	75	Granite[k]
	State Hospital	765	714	51	Granite[l]
32. Pewaukee	Edgewood Farm	860	1190	—330	Granite
33. Portage	Courthouse	819	530	289	Rhyolite[m]
34. Prairie du Sac	Phillip Farm	859	560	299	Granite
35. Pray	Adbar Exploration, Secs. 1, 2, T. 21 N., R. 2 W.	950	85-98	860	Iron formation and schist
36. Reeseville	Etscheid Farm	850±	93	860±	Quartzite under drift
37. Sauk City	City	757	523	234	Granite
38. Stillwater, Minn.	Gas test	762	706	56	Sandstone[n]
39. Tomah	Park	980	452	528	Gneiss
	City, north well	955	310	645	Granite
40. Two Rivers	Test No. 2	587	1610	—1023	Quartzite
41. Watertown	City No. 1	809	750	59	Slate[o]
	City No. 3	809	715	94	Iron formation
42. West Bend	City	920	930??	—10??	Chert?? (doubtful)
43. Waupun	City	883	750	133	Pegmatite
	Insane Hospital	880	509	371	Quartzite
44. Whitehall	City	815	265	550	Gabbro
89. Adams	City	956	278	678	Quartzite
	New wells since publication in 1931				
90. Augusta	Village	968	88	880	Granite
91. Black Creek	Oil test, Sec. 28, T. 24 N., R. 17 E.	780	500±	280±	Granite

Map number—city	Owner or location	Surface elevation	Depth to pre-C.	Pre-C elevation	Rock; remarks
92. Brandon	Village	997	855	142	Quartzite
93. Brothertown	Hanson Farm	850	350±	500±	Quartzite
94. Cambria	Oil tests:				
	No. 1, Slinger, Sec. 1, T. 12 N., R. 11 E.	870±	650±	220±	Granite
	No. 1, Roberts, Sec. 31, T. 13 N., R. 12 E.	915±	665±	250±	? (no sample)
95. Chetek	No. 2 Village	1084	256	828	Granite
96. Crivitz	C. M. St.P. and P. R.R. Co.	682	196	486	Greenstone under drift
97. DeForest	Oil test, Sec. 8, T. 9 N., R. 10 E.	940	745	195	Granite
98. Eau Claire	Test No. 8, T.27N., R.9W.	820	110	710	Gneiss
	Dells Paper & Pulp Co.	837	100	737	? (no sample)
99. Fort Atkinson	No. 3 city	782	1060	—278	Granite
100. Hustisford	Cannery	860	268	592	Quartzite
101. Menomonee Falls	City	880	1360	—480	Quartzite, granite
102. Oregon	Industrial School	936	850	86	Rhyolite
103. Rosendale	Cannery	905	440	456	Quartzite
104. St. Croix Falls	City	920	249	671	Basalt
105. Powers, Mich.	C. and N.W. Ry.	867	403	464	Marble
106. Stephenson, Mich.	Whitehouse Milk Co.	683	385	298	Granite
107. Shell Lake	City	1225	520	705	? (no sample)
108. Kimberly	City	745	800	—55	Granite
109. Wilson	Fire Tower		124		? (no sample
110. Reaspur	Power Plant	946	65	881	? (no sample
111. Coloma	Village	1040	380	660	Granite
59. Granton	Test	1140	60	1080	Granite
77. Shennington	Cranberry farm	912	250	662	Granite
83. Wells, Mich.	C. & N.W. Ry. Co.	608	760	—152	Schist
Irene, Ill.	Oil Test No. 1, Taylor, Sec. 28, T. 45 N., R. 3 E.	820	2925	—2105	Granite[p] (not on map)

[a] Data from files of C. K. Leith.
[b] Moses Strong: Geology of the Mississippi region. Geology of Wisconsin, vol. 4, 1882, pp. 60-61, 520.
[c] O. U. Stromme: Geology of Madison and parts of adjacent townships. Unpublished thesis, Library of University of Wisconsin. 1907.
[d] I. A. Lapham: Ann. Rep. for 1874. Geology of Wisconsin, vol. 2, 1877, p. 50.

[e] R. D. Irving: Geology of central Wisconsin. Geology of Wisconsin, vol 2, 1877, p. 605.

[f] R. A. Smith: Deep well borings. Michigan Geological Survey, Pub. 24, 1917, pp. 238-239.

[g] Samuel Weidman and A. R. Schultz: The underground and surface water supplies of Wisconsin. Wisconsin Geol. and Nat. Hist. Survey, Bull. 35, 1915, p. 340. Examination of samples by H. R. Aldrich shows that the pre-Cambrian is really granite.

[h] C. R. Van Hise and C. K. Leith: Geology of the Lake Superior region. U. S. Geol. Survey, Mon. 52, 1911, p. 358; Samuel Weidman: Geology of north central Wisconsin. Wisconsin Geol. and Nat. Hist. Survey, Bull. 16, 1907, pp. 518-520.

[i] Notes by Samuel Weidman.

[j] Moses Strong. Op. cit., p. 520.

[k] Record by R. M. Bagg, Geology laboratory, Lawrence College, Appleton, Wis.

[l] T. C. Chamberlin: Geology of eastern Wisconsin, vol. 2, 1877, pp. 156-157.

[m] Samuel Weidman and A. R. Schultz: Op. cit., p. 276.

[n] F. T. Thwaites: Sandstones of the Wisconsin coast of Lake Superior. Wisconsin Geol. and Nat. Hist Survey, Bull. 25, 1912, p. 60. C. R. Stauffer et al: A reinterpretation of the Stillwater deep well records. Journ. of Geol., vol. 43, 1935, pp. 630-638.

[o] Samuel Weidman and A. R. Schultz: Op. cit., p. 385. The record given on authority of Clements describes the rock at 1,000 feet as "hard siliceous shale", but it is more likely pre-Cambrian slate. Granite was encountered below 85 feet of this rock. Another version of this log in the files of the Geological Survey, as copied from notes by W. C. Alden, gives "red and gray shale" from 759 to 975, below which "sandy quartzite shale", probably slate, extended to 1,030. The rock from 1,030 to 1,060 was described in one version of the driller's log as "sand and light calcareous quartzite", possibly a marble, and in another as "quartz". All accounts agree that very hard crystalline rock was encountered at a depth of 1,060.

[p] Record furnished by Illinois Geological Survey.

TABLE 2

ell records showing concealed pre-Cambrian rocks in and near Wisconsin which appear to be authentic reports

Map number—city	Owner or location	Surface elevation	Depth to pre-C	Pre-C elevation
. Abbotsford	Railroad	1422	80	1342
. Adams	Railroad	956	315	641[a]
. Alma Center	City	967	312	655[b]
A. Boscobel	City	690	965	—275
	C.M. St.P. and P.R.R.	675	1000	—325
. Appleton		720	822	—100
. Arcadia	City	723	376	347
. Ashippun	Railroad	854	443?	411?
. Bangor	Railroad	753	400	353
. Berlin		762	431	331[c]
. Chilton	Malting Company	877	885	—8
. Combined Locks	Paper Mill	655	790	—135
. Dale		807	500	307
. Durand	Courthouse	720	460	260
. Eau Claire	Brewery	790	82	708
. Elmore		980	1248	—268[e]
. Granton		1112	40	1072
. Green Bay		590	910	—320
. Jefferson	County Farm	826	988	—162
. Knapp	Oil test	970	630	340
. Menomonee Falls	Sugar factory	835	1175	—340[e]
. Menomonie	City	810	400	410
. Meridean		746	352	394
. Mondovi		788	418	370
. Oakwood Beach		585	917	—322
. Depere	City	595	811	—221
. Platteville		900	1714	—814
. Portland	NW¼ 2, T.9N.,R.13E.	830	695	135[e]
	NE¼ 29, T.9N.,R.13E.	830	695	135[e]
. Rice Lake		1112	220	890
. Richland Center		736	665	71
. Ripon	SE¼ 14, T.16N.,R.14E.	970	101	870[e]
. Rosendale	SE¼ 14, T.15N.,R.15E.	940	140	800[e]
	SW¼ 6, T.15N.,R.16E.	920	102	820
. Rugby Junction		983	840	143
. Shawano		822	142	680
. Shennington		912	250	662[d]
. Sparta		789	365	424
. Weyauwega		779	212	567
. Wild Rose		997	295	702[a]
A. Westfield	SE¼ NE¼ 15, T.16N., R.8E.	860	360	500[e] under drift
. Winneconne		754	426	328
. Wonewoc	City	914	428	486
. Escanaba, Mich.	Brewery	590	732	—142[f]
	C. & N.W. Ry. Co.	590	855	—265[g]
	Escanaba Mfg. Co.	590	931	—341[f]
	Oil test	620	795	—175[h]
	Test hole, SW¼, NW¼ 8, T.39N., R.21W.	600?	780	—180[f]

Map number—city	Owner or location	Surface elevation	Depth to pre-C	Pre-C elevation
84. Brownsville, Minn.		639	570	69[i]
85. Lake City, Minn.		712	820?	—108?[i]
86. Red Wing, Minn.		708	479	229[i]
87. Wabasha, Minn.		708	440	268[i]
88. Winona, Minn.		661	510	151[i]

[a] Record furnished by Chicago & Northwestern Ry. Co.
[b] Record furnished by W. G. Kirchoffer.
[c] Samuel Weidman: Pre-Cambrian igneous rocks of Fox River valley, Wisconsin. Wisconsin Geol. and Nat. Hist. Survey, Bull. 3, 1898, p. 33.
[d] Record obtained by writer; sample of gneiss received January 20, 1931.
[e] W. C. Alden: Quaternary geology of southeastern Wisconsin. U. S. Geol. Survey, Prof. Paper 106, 1918, pp. 71, 110.
[f] R. C. Allen: Relative to an extension of the Menominee iron range. Michigan Geol. and Biol. Survey, Pub. 18, 1914, p. 163.
[g] R. A. Smith: Results of deep borings. Michigan Geol. and Biol. Survey, Pub. 24, 1917, pp. 214-215.
[h] R. B. Newcombe: Oil and gas development in Michigan. Michigan Geol. Survey, Pub. 37, 1928, p. 282.
[i] C. W. Hall et al: Geology and underground waters of southern Minnesota. U. S. Geol. Survey, Water Supply Paper 256, 1911. Other records from Samuel Weidman and A. R. Schultz: Underground and surface water supplies of Wisconsin. Wisconsin Geol. and Nat. Hist. Survey, Bull. 35, 1915.

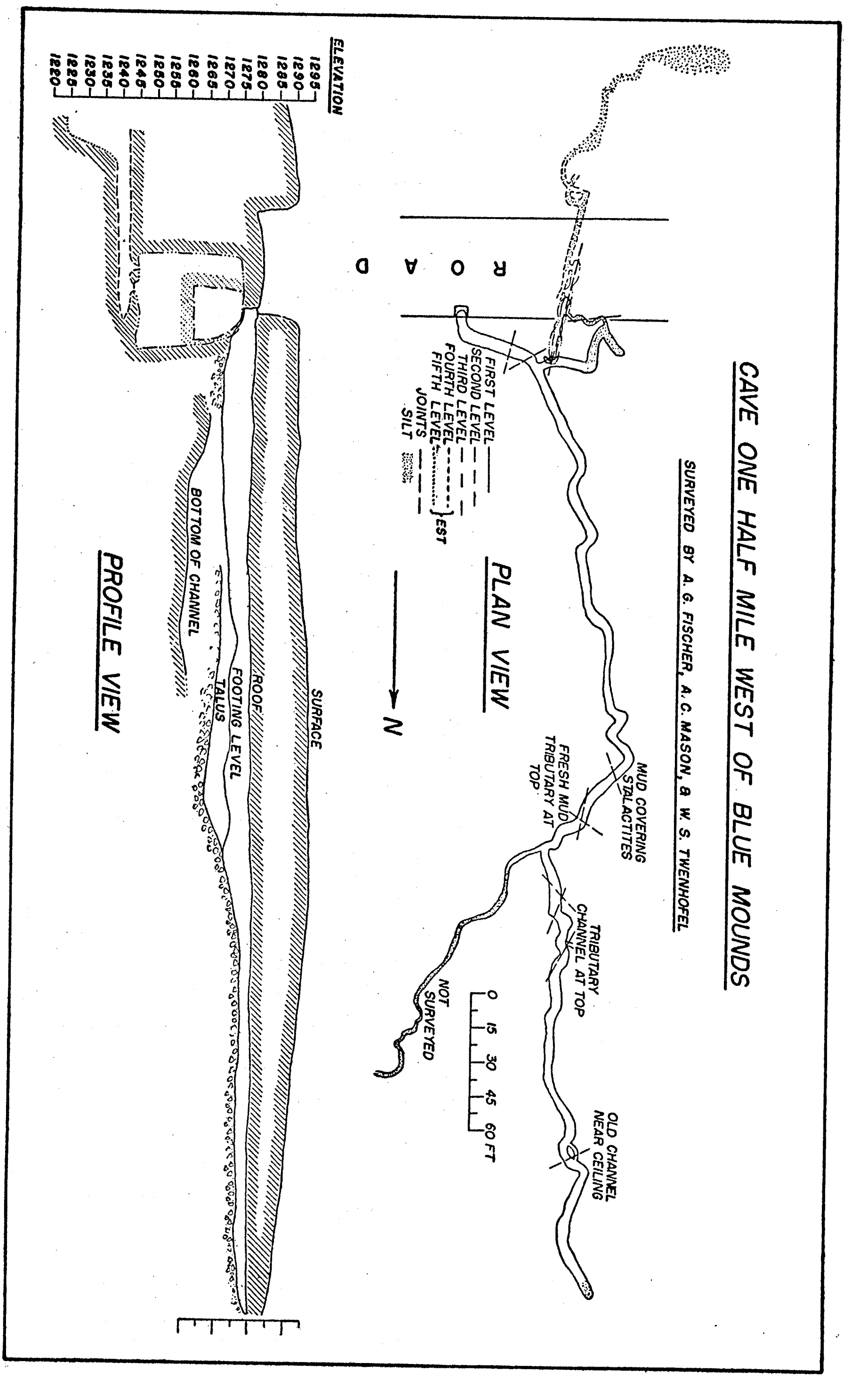
SURVEY OF POKERVILLE CAVE, BLUE MOUNDS, WISCONSIN

ALFRED G. FISCHER, ARNOLD C. MASON, AND W. S. TWENHOFEL

A cut one half mile west of the village of Blue Mounds, Wisconsin, in the SE 1/4 of Sec. 1, T6N, R5E, a few hundred feet west of the Iowa-Dane county line, made during highway grading on U. S. Route 18 in the spring of 1938, exposed a cave of which previous record is unknown. This was termed Pokerville Cave by the inhabitants. The cave has been kept open for use as a drain for the road cut. The entrance is at an elevation of approximately 1280 feet above sea level, and is one mile southeast of Blue Mounds, the highest elevation (1716 feet above sea level) in southern Wisconsin. The surrounding area is located on the gentle southern slopes of Military Ridge, and is moderately dissected by the headwaters of the East Branch of the Pecatonica River, one such valley lying north and east of the hill in which the cave is located, and another west. A local relief of 100 to 200 feet is common, but the vicinity of the cave the valleys that bound the hill in which the cave is situated are less than 100 feet deep.

The cave is entirely formed in the Galena formation of the Ordovician system. Locally this formation is about 190 feet thick. Its base in the Blue Mounds area is about 1210 feet and its top 1400 feet above sea level. The underlying Platteville dolomite is about 60 feet thick; and overlying, but eroded away except on the Mounds, is the Maquoketa shale with a thickness of about 200 feet. The strata have a dip of less than one degree to the south.

The Galena formation is composed of dolomite which acquires a characteristic honeycombed appearance on weathering. The approximate chemical composition according to an analysis by Daniels is as follows:


CAVE ONE HALF MILE WEST OF BLUE MOUNDS
SURVEYED BY A. G. FISCHER, A. C. MASON, & W. S. TWENHOFEL
PLAN VIEW
ROAD
FIRST LEVEL
SECOND LEVEL
THIRD LEVEL
FOURTH LEVEL
FIFTH LEVEL
EST
JOINTS
SILT
N
MUD COVERING STALACTITES
FRESH MUD TRIBUTARY AT TOP
TRIBUTARY CHANNEL AT TOP
NOT SURVEYED
OLD CHANNEL NEAR CEILING
0 15 30 45 60 FT
PROFILE VIEW
ELEVATION
1295
1290
1285
1280
1275
1270
1265
1260
1255
1250
1245
1240
1235
1230
1225
1220
SURFACE
ROOF
FOOTING LEVEL
TALUS
BOTTOM OF CHANNEL

$CaCO_3$	54.33%
$MgCO_3$	41.56
Fe_2O_3	.90
Al_2O_3	.99
SiO_2	2.10
	99.88%

The analysis does not include any flint nodules or shaly portions, which are not uncommon. Excepting these, the rock is almost entirely composed of soluble minerals.

The Pokerville Cave is approximately 500 feet long (see Fig. 1). There are five levels, and three passages on the first or main level. Entered from the road cut, the main passage veers slightly toward the west, then trends north. From its mid-point a narrow branch leads northeast. A branch near the entrance trends west and then south. This is termed the west branch. The main passage averages 6 feet wide and its ceiling averages 7 feet high above shelves which serve as footing levels. The main passage has a remarkably level ceiling. Below the footing shelves it narrows downward to a deep constricted channel, irregularly filled with rock debris. This channel averages 1½ feet in width and 10 to 15 feet in depth, and exhibits entrenched undercutting meanders or curves.

The north or far end of the main passage and the entire northeast lateral branch are floored by silt and their terminations are only a few feet beneath the surface. Underground hammer strokes at the end of the main passage are easily heard at the surface. Hand level surveying indicates 4 feet of intervening rock and soil. No sinkholes or other surface indications of the presence of a cave are evident. The main passage terminates suddenly by the silt deposit rising to the ceiling, but the lateral branch, floored with silt, becomes so constricted that it was not surveyed, or followed to its end.

Except where it joins the main passage, the west branch is floored with silt. About 50 feet from this junction, the silt completely fills this branch. On the south side of the west branch near this termination there begins a constricted, twisting tributary which trends eastward for 20 feet and then pierces a chamber whose floor (second level) is 8 feet lower and also lies 8 feet below the footing level of the main passage. This chamber is underlain by another, whose floor (third level) is an additional 12 feet lower. Both chambers extend in part under Highway 18. They are formed along a joint, which directly connects them with the west branch near its junction with the main passage. This joint extends to the depth of the floor of the third level, but large rocks are wedged in it at the elevation of the second level.

Nearly a year after the cave was opened, members of the Hoofers Club of the University of Wisconsin discovered a series of passages at still lower levels. Breaking through dripstone deposits at the bottom of the third level chamber near its south end, they discovered a parallel north-south passage offset about 4 feet to the east and extending south beyond the highway. Its roof is approximately at the elevation of the third level, but its floor, forming a fourth level, averages 9 feet lower. Much of this passage is so narrow that ingress is possible only by turning sideways. At the time visited, in the spring of 1939, the walls were coated with mud, so that surveying by Brunton compass, hand level and tape, was abandoned, and this lower section was merely explored. Fresh mud and straw were plastered on the roof and sides of this lower section. A 10° east dip of the beds between the third and fourth levels indicates localized movement between the joint surfaces which controlled the formation of these passages.

About 30 feet to the south of its entrance the passage becomes dual, but on different levels, and both turn to the east, then unite to form a narrow passage in the form of an arc that swings to the southwest . The floor of the narrow passage drops 15 feet to form a fifth level, on which a small stream was flowing at the time visited. About 30 feet from the east turn, the fifth level widens to form a small chamber. On the south side of this chamber a higher lying, small gallery leads about 50 feet to the southwest, and descends into another chamber which contains a higher chimney. The floor of the latter chamber corresponds to the fifth level, and the chimney's height of approximately 45 feet brings its roof near the surface.

Dripstone is rare or wanting in the cave except in the second, third and fifth levels. The chambers on these levels contain numerous stalagmites and stalactites. The outer portions of these are quite impure.

Relatively few joints are observable in the cave. An insufficient number was observed to establish the existence of a definite joint pattern. The trend of many of the passages suggests, however, development in accordance with sets of joints.

The cave is not very large and its attractive parts are not easily accessible. Like most other Wisconsin caves, it is probably not of commercial value.

Views on Cave Formation

Caves in limestone or dolomite are mainly formed through solution by water containing carbon dioxide or organic acids. The solvent action of carbonic acid has long been recognized, and Murray and Love,[2] and Howard and David,[3] have shown organic acids such as butyric and propionic acid to be one to ten times as effective. These acids are formed by bacterial action on decaying vegetation, and must be important factors in solution in regions of abundant plant growth.

The character of the underground circulation dissolving out and enlarging caves has long been a subject of controversy. Many writers have avoided reference to the water table level, but some[4] consider the solution to have been done by vadose waters. Gardner,[5] believing the majority of caves to have been so formed, stresses the formation of caves on the up-dip side of the entrenched stream receiving the subterranean drainage.

Matson[6] realized there is some sub-water table circulation and Davis[7] explained reticulated cave systems by sub-water table circulation, and he considers the fact that the higher water table level under hills, as compared with the lower level determined by streams in adjacent valleys, forms a hydrostatic head causing, in general, a movement of subsurface water downward beneath hills and upwards in valley areas of less hydrostatic pressure.

Bretz[8] recently reaffirmed Davis' theories, concluding "that the caves or crevices in the Galena formation beneath the Dubuque region were dissolved out along the joints while below the water table, that no direction of concentration of flow of dissolving water is recorded, and that almost no alteration (other than clay and sand filling) has occurred in the caves since air entered them as the water table was lowered."

In a reply to Davis, Swinnerton[9] stressed the lateral movement of water upon reaching the water table, believing reticulated passages could be formed by fluctuations in this level.

It is difficult to see how vadose waters, impelled by gravitation, would move laterally except upon meeting a bed impervious because of lack of jointing, shaly character, or saturation with water. This has been pointed out in identical words by Lobeck[10] and by Weller:[11] "Water which finds its way into the joints of the rock descends until its downward progress is brought to a stop. This may be the result of one or two causes: First, a bed, such as shale or a massive limestone layer which is impervious to water may be encountered; or second, the ground water table, or the depth at which all the openings in the rock are filled with water, may be reached. In either case, when the downward movement of the water is brought to a stop, lateral movement begins and channels are dissolved along the bedding planes or in porous layers in the limestone. At the surface of the ground water table, the greatest tendency for motion of the water is in a lateral direction. Slow circulation, however, also takes place downward and outward below the ground water table."

Field examples indicate that underground streams may produce caves above, at, or below the water table. A vadose stream forms Falling Springs near Stolle, Ill., the discharge occurring 150 feet high on a vertical river bluff of the Mississippi River. At Big Spring, Mo., a series of horizontal cave openings, each at slightly lower elevation, indicates the adaptation of a large water table level stream to the downcutting of the Current River into which the spring discharges. Deep seated circulation is found at Bennett Spring, Mo. The exit of this spring descends 20 feet vertically, then slants at 40 or 50 degrees southwestward, opposite to the dip. The sounded depth is below that of the Niangua River, one and one-half miles away, which drains the area.

Geologic History of Pokerville Cave

Pokerville Cave is thought to have been formed by vadose waters and its geologic history is believed to have been somewhat as follows: The cave had its origin subsequent to the removal of the overlying Maquoketa shale, but before development to their present depths of the tributary valleys that bound the hill in which the cave is situated. As there are no associated massive or shaly beds, except in the lowest levels, study of the cave suggests the horizontal main passage to have been made by a laterally moving water table stream whose early exit was by way of the channel intersected by the road cut. The northeast lateral was a minor tributary, and the west branch formed another tributary.

Subsequent to a lowering of the water table of the area, seepage along the joint defining the immediately lower chamber caused its enlargement. This diverted the cave's stream near the junction of the west branch and the main passage, and as a vadose stream it then eroded the deep constricted channel in the main passage. The undercutting of the entrenched meanders was caused by the greater erosion on the outside of curves where the water has its greatest movement. The horizontal roof of the main passage was formed by falling of portions of unsupported weak strata which left an overlying stronger bed spanning the passage width. Accumulation of talus partially filled the constricted channel. The second level chamber was enlarged sufficiently to intersect the minor tributary on the south side of the west branch.

The constricted channels of the lower levels were probably similarly formed by vadose streams, causing entrenchment without lateral widening. The fifth level is near the elevation of the base of the Galena formation, locally about 1210 feet above sea level.

Dripstone deposition took place mainly in the second, third, and fifth level chambers, and in a few isolated places in the main passage. Vertical channels have brought increasing quantities of silt and even plant matter as the outside surface has been worn nearer to the cave level. The outer portions of dripstone deposits generally have more impurities than the center. As the valley to the northeast became eroded to its present depth it may have intersected the main passage and the northeast branch (both first level) in the two previously mentioned places where silt has filled the passages. It is possible however that neither passage extended as far as the present valley, but terminated beneath surface sinkholes now disappeared.

BEARING OF THE CAVE ON THE PHYSIOGRAPHIC HISTORY OF THE REGION

Attempts have been made to correlate the physiographic history of a region to that expressed by cave levels. The elevation of the entrance of Pokerville Cave, 1280 feet, is approximately at the level of the Dodgeville peneplain postulated by Trowbridge,[12] which in later cycles became dissected by stream rejuvenation. The lowering of the water table in the cave may possibly be associated therewith. However, lowering may occur long after conditions make such possible, so that correlation is not certain. The nearby presence of Blue Mounds cave, approximately 100 feet higher, suggests that the lower cave was not excavated during a period of extensive baseleveling in which the water table was relatively fixed at a particular elevation.

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THE PLEISTOCENE OF PART OF NORTHWESTERN WISCONSIN

JOHN T. MATHIESEN

INTRODUCTION

The area embraced in this report involves slightly less than a thousand square miles, including all but the northwestern corner of Barron County, three Federal townships each in Rusk and Chippewa Counties, slightly more than one township in Dunn County, and approximately ten sections in Washburn County. The general location of the area and its relation to the rest of the state may be seen in Fig. 1. Included are parts of three of the commonly accepted physiographic regions of Wisconsin (Martin, p. 34), and practically the entire area lies within the geographic subdivision known as the Northwest Dairy Region (Durand, Strain).

GENERAL GEOLOGY

Except in the northeastern part of the area, where the pre-Cambrian basement reaches the surface as the Keweenawan quartzite of the Barron Hills, and in the extreme southwestern corner near Reeve, where a small amount of Lower Magnesian dolomite is still preserved, the entire region is floored by Cambrian sediments, including, in descending order, the Trempealeau, Franconia, Dresbach, Eau Claire, and Mt. Simon formations. The beds dip gently toward the west, very much as does the ancient peneplain surface below (Thwaites, 1930, p. 32), and although varying considerably in detailed composition and character, they may all be thought of as relatively soft sandstones and shales which range from a few feet to several hundred feet in thickness. The quartzite is in general much more resistant than the standstones, but it, too, varies quite markedly both in hardness and appearance.

Glacial drift of several ages is universally present over the area in greater or less amount and in numerous forms.

Disregarding the effects of glaciation, the landforms of Barron County and adjacent regions reflect the results of differential erosion upon more or less flat-lying sedimentary strata of slightly diverse character, and, in part, upon older and harder crystalline formations. Consequently, the most prominent topographic feature are the Barron Hills (locally known as the Blue Hills), Fig. 2. These rise to an elevation of over 1650 feet within the area, and to over 1750 feet not far to the northeast in Sawyer County (Martin, Plate I). Relief in the range locally exceeds four hundred feet. The hills present a rugged appearance, with bold talus slopes, and their rough upland character is continued northward and southeastward in belts of moraine and sandstone outliers.

Surrounding this section on the west and southwest are stretches of nearly level outwash plain, interspersed here and there by sandstone or drift hills. This roughly crescentic lowland is replaced on the northwest by heavily drift-covered uplands broken by smaller patches of outwash, and on the southwest by dissected sandstone hills. The hill land is most thoroughly eroded along the major stream valleys, which are filled to considerable depths by outwash and alluvium. The local relief here may attain values of 250 feet or more, and the landscape reminds one strongly of the Driftless Area of southwestern Wisconsin. Elevations above sea level drop to less than a thousand feet in the Red Cedar valley south of Sand Creek.

Lakes are abundant in the eastern, northern, and western portions where the drift is deepest and youngest, but are by no means absent in the central part and may even be found in the south. A more thorough discussion of their origins will be made in later connections.

Sources of Data and Field Procedure

Previous to the summer of 1937, when the field observations upon which this paper is based were made, base maps on a scale of one inch to two miles were secured from the State Highway Commission, and from these and certain other maps, such as those of the Mineral Land Survey and the Land Economic Inventory of Wisconsin, township base maps on a scale of one inch to one mile were constructed. Railroads and railroad elevations

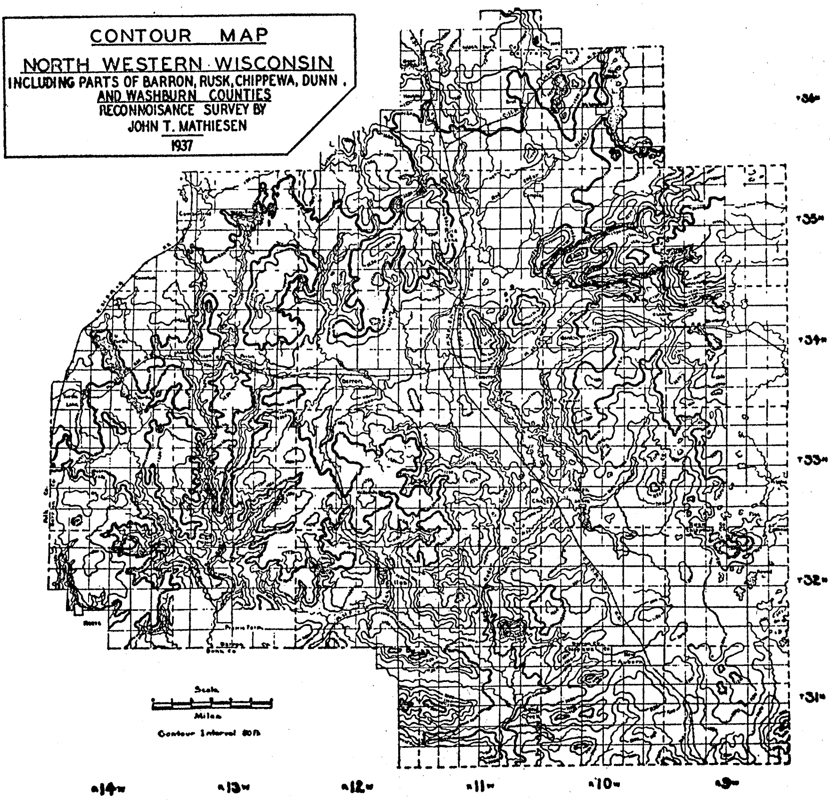

FIG. 2. Contour map of the field area.

were then plotted from profiles furnished by the previously mentioned lines, the datum planes being subsequently checked against bench marks established by the United States Geological Survey in the near-by Chippewa Falls quadrangle and modified accordingly. Locations of numerous gravel pits and quarries were secured from the road materials maps of the Wisconsin Geological and Natural History Survey. Several hundred farm well records were obtained from the field notes of Weidman and his associates, and a number of deeper well logs from Mr. F. T. Thwaites. Maps for sixty townships were originally prepared, but time permitted the use of only thirty-two of these in the field.

The elevations of most road crossings and of many other critical points were determined barometrically by Lahee's method, using a Paulin instrument and working from known railway elevations. The writer feels that the results thus achieved are in general correct within ten feet, although greater errors must inevitably occur occasionally when any barometric system is used. The hand level was also employed in certain instances, and a Brunton compass was used to plot the more irregular roads determine the direction of striae, etc.

THE PRE-WISCONSIN DRIFT

General Character and Distribution

That portion of the area south of the limit of First Wisconsin Drift (Fig. 3) shows at first sight so little evidence of glaciation

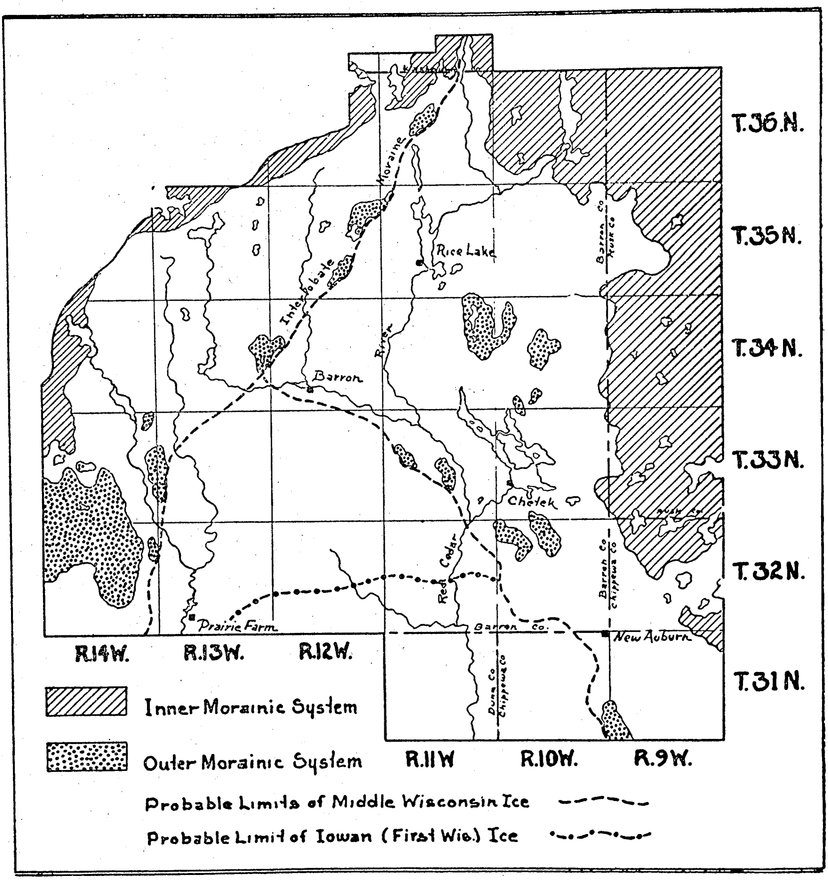

FIG. 3. Morainic systems and drift borders of the field area.

that it might well be thought of as part of the Driftless Area. Closer inspection, however, reveals the facts that erratic boulders are common and that considerable deposits of weathered till and old eroded outwash at high levels are not lacking. The drift corresponds to that called the "First Drift" by Weidman in his report on the geology of north central Wisconsin (1916, p. 434), and has variously been stated by him and other writers to be of Illinoian, Kansan, or even Nebraskan age (Antevs, p. 644; Thwaites, 1937, pp. 95-97). Certain it is that the ice which laid down these deposits far antedated that which left such abundant traces to the northeast, north, and northwest; but much detailed investigation remains to be done in this and near-by regions before any conclusive statements in regard to age can be made. The advanced erosion and mature topography would perhaps indicate Kansan or even earlier; yet these features might well be the result of sharp pre-glacial relief, an originally sparse drift cover, and subsequent rapid erosion upon the weak sandstone. Because of the thinness of the drift, observed cuts show few features which might not well be Illinoian. In this report it shall be considered only as pre-Wisconsin, the Iowan being considered the earliest Wisconsin.

Although there is a general accordance of the Knox (Hartland) and Auburn soils as mapped by Weidman (1914, Plate I) and the distribution of pre-Iowan drift as shown in this report, the latter extends somewhat further north and not as far east as the former. The differences are not great, however, and further discussion of the will be defered until the limits Wisconsin drift are described.

Topography and Drainage

The physical landscape of the old drift region is essentially a sandstone upland intricately carved into a region of steep-sided valleys separated by more level or rolling interfluves, grading toward the northeast and east into a multitude of detached hills or outliers, many conical in shape. The several Cambrian escarpments determined elsewhere in the state are not here well-defined, and before any such determinations can be made, if ever, the stratigraphy must be worked out in detail. At present the number of deep well records and field observations are too few to make cross-sectional reconstructions of any value.

The valleys of the Hay and Red Cedar rivers and of many of the lesser streams are filled to considerable depths with glacial outwash and valley alluvium, most of which is rather fresh and young. The deposition of alluvium has gone on up to the present. Scattered remnants of older, higher, eroded terraces may be found, but are not as prominent as those in the regions of younger drift further north. Sand dunes are locally conspicuous; these, together with abandoned meanders and blocked minor tributaries, have in places formed small ponds and marshy tracts.

Character of Drift and Soils

The glacial materials of this section (excepting fluvial deposits) are so thin that no soil profile developed in drift alone was observed to extend much below the A horizon, and any indication of age determined by profile change is most difficult to obtain. Well records and exposures seem to show an average thickness of drift, exclusive of valley deposits, of no more than three feet, dwindling to little or nothing on steeper slopes. Forty-six farm well records collected within the section give an average depth, of drift of fifteen feet; it must be added, however, that most of these were from valley farms, so that the figure arrived at is not a fair indication of conditions on the uplands, where drills more often than not strike bedrock practically at the surface. A thin covering of loess is general over large areas. Thus it is evident that the soils, though notably modified by glacial influences, derive their character in large part from the underlying sandstones, shales, and greensands, or from aqueous and aeolian materials.

In his report on the soils of this part of the state, Weidman, as has previously been indicated, mentions two types of upland soils within the area here termed old drift, the Auburn Loam and the Knox (Hartland) Silt loam. Of the first he says: "Sandy and silty loams; hilly and sloping uplands; forest trees mainly light growth of hardwood trees with some pine", and of the second: "Silt loam (loess soil); undulating slopes and uplands; forest trees, mainly dense hardwoods mixed with some white pine." The two actually merge gradationally one into the other, the Auburn locally containing a goodly amount of the loess characteristic of the Knox, but the prevailing steeper slopes of the former have led to greater erosion and the inclusion of more sandy material in the upper soil.

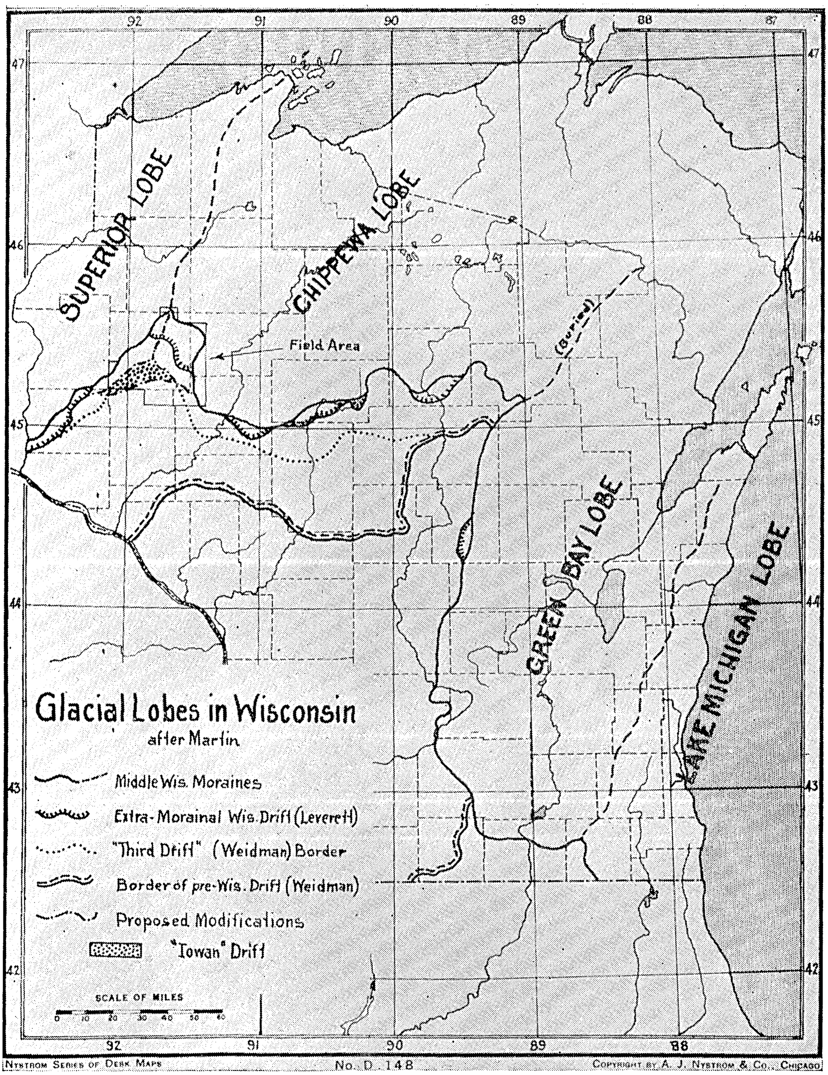

FIG. 1. The glacial lobes and major drift borders of Wisconsin, showing also the location of the field area to the rest of the state.

The level, sandy valley soils were classed by Weidman as Plainfield (Sterling) Sand and Plainfield (Chetek) Sandy Loam. The former is described as: "Light sandy soil; level valley bottom land; forest trees mainly jack pine", the latter: "Sandy loam, with gravel or sand subsoil; level valley bottom land; forest trees, dense jack pine with some scrub oak." This sandy loam phase is more extensive in regions further north. All of the abovementioned soils are lumped together as Boone Fine Sandy Loam in A.R. Whitson's more recent *Soils of Wisconsin* (p. 108).

The drift contains large amounts of sandstone, greenstone, gabbro, quartzite, granite, and trap, and lesser amounts of other materials. The quartzite, according to Weidman, is of the Barron Hills variety, at least to a large extent; it and gabbro make up a majority of the larger boulders.

That the older drift or drifts of this section must also underlie the adjacent younger formations is certain, and although no clear evidence of this was observed in field exposures, a number of well sections indicate such a condition. As an example may be cited a log noted by F. T. Thwaites in SE-SW Sec. 30, T. 34N., R. 14W., well within the Cary drift:

Red, sandy "hard pan"	36′	Wisconsin
Clay, reddish-brown	26′	
Gravel	16′	
Clay	14′	
Quicksand, yellow	20′	
Quicksand, dark	4′	
Clay, sand, sticky	26′	Old drift
Hard quicksand and gravel	5′	
Sandstone at	134′	

Signs of two older formations appear in several wells in T.32N., R.15 W., in near-by Polk County, a representative one from NE-NE Sec. 20 reading as follows:

Red boulder till to	44′	Wisconsin
Sand	12′	
Hard red clay	5′	Old drift
Hard, coal-black clay	2′	Older drift
Gravel and sand to	67′	

The writer feels that at present, at least, no justification exists for using more specific terms than the "old drift" and "older drift" employed above.

THE FIRST WISCONSIN OR IOWAN DRIFT

General Character and Distribution

The zone of First Wisconsin or Iowan drift (Fig. 3) corresponds quite closely to the southern part of the Colby soil area of Barron County south of Barron and east of Range 15 West. The "Third Drift" of Weidman included this section and a considerable area surrounding it in all directions except south. In his *Geology of North Central Wisconsin,* Weidman states this formations to be somewhat older than the "Wisconsin", but definitely younger than the deposits further south; in his field notes concerning the area he writes time and again of its probable Iowan age. Yet, upon evidence not clear to this writer, he later came to consider it Illinoian and certainly pre-Wisconsin in age, and this belief became the basis for subsequent soils classifications and glacial boundaries. The matter is further complicated by confusion of the terms "older drift", "pre-Wisconsin", "pre-Iowan" and the like in the literature, for the general acceptance of the Iowan as earliest Wisconsin is a relatively recent event.

In the opinion of the writer, the freshness of the materials, the relative abundance of youthful glacial landforms, and the weight of contributory evidence in adjacent sections date the drift in question beyond serious doubt as Iowan.

Topography and Drainage

Topographically, this section is essentially a northward extention of that to the south, but one more profoundly affected by glacial influences. The similarity decreases with the increase of drift from south to north, but almost everywhere the marked influence of bedrock control upon landforms is apparent. That such a condition persists despite the comparative youth of the drift is due (a) to the fact that the original amount of glacial debris was not great, being laid down near the thin outer margin of a waning sheet of ice, (b) to the fact that this drift mantled an already rough and dissected terrain, and (c) to the fact that erosion has been operative somewhat longer than in the regions of more recent Wisconsin drift.

The uplands are broadly rolling or undulating and generally well-drained. The local relief, which normally ranges from 50 to 100 feet, in places exceeds 150 feet along the major streams where dissection is furthest advanced, especially in the vicinity of the Hay River and its tributaries. Bedrock outcrops at many points in the steeper valleys and less commonly on the uplands. The young glacial forms scattered throughout the zone, while not as abundant or widespread as in the region of younger Wisconsin drift, are most striking in their occurrance within an area so seemingly mature at first glance, and in their appearance of excellent preservation. Obviously pitted outwash and morainic features exist primarily in two types of locations: on upland divides, where erosion has been ineffective, and in protected valleys, where the original concentrations were greatest. Yet they are by no means confined to such places; indeed, the most striking of all are to be found in Township 33 North, Range 13 West, a short distance southeast of Arland. Here morainic knobs and sags rest precariously upon the steep slopes of a valley, strongly pitted outwash still remains in the valley of the Hay River, and a small lake perches upon a narrow divide between a steep-gradient tributary of the Hay and a north-flowing branch of the Yellow River.

The two major streams draining this section are again the Hay and the Red Cedar, each supplied with many tributaries. Although both valleys contain large amounts of outwash, that of the Red Cedar is wider than that of the Hay, for in much of its course it flows east of the upland proper in broad outwash plains and lowlands. A rather well-developed system of terrace levels may be discerned in the young sediments of the Red Cedar and are also present, though less marked, along the Hay. The lowest of these parallels the rather narrow present flood-plain in strips varying from a few feet to several hundred yards in width. The feature is locally broken and discontinuous, and rises to an average height of eight to ten feet above the normal valley bottom. Rising in turn from five to ten feet above this level is the outwash plain proper, which varies greatly in width. It contains pitted tracts, and is furrowed here and there by old drainage lines. This plain is but a continuation of the great outwash sheets within the region of later Wisconsin drift.

Still another level might be included with these; it consists of isolated patches of older, eroded outwash, rising twenty feet or more above the major plain, and more often than not preserved within tributary valleys or in narrow bands roughly parallel to the younger outwash. Portions are till-covered.

Character of Drift and Soils

In spite of the fact that the drift of this section is much younger and uniformly thicker than that further south, deep glacial soil profiles are rarely observed, for road cuts are few except in the more rugged, bedrock-controlled portions; the soils developed under such conditions resemble the old drift types in many respects, being greatly influenced by the underlying sandstone. But boulders are definitely more numerous, and whereever considerable sections in drift occur the materials appear nearly as fresh, unaltered, and undecomposed as those well within the post-Iowan drift. This fact is especially evident in the morainic patches and the drift-covered uplands, which assume progressively stronger characteristics of youth north of Hillsdale.

No distinct, sharp differences exist between B and C horizons. Except where sands and gravels predominate, the soil is rather dense and compact, containing large amounts of clay and silt at all depths, but especially near the surface, where a thin loessial accumulation may generally be found. Below a shallow gray-brown A horizon the drift is almost invariably reddish in color; it is probable that this coloration is at least in part primary, and thus not necessarily an indication of great age and extensive oxidization (similar factors relating to the younger drifts will be discussed in later connections).

Instances of an older drift below the Iowan were rarely observed in the field, but indications of such a situation gleaned from well records are many although inconclusive (see page 257). Such must often be the case, and the surface till no doubt consists to a marked degree of re-worked older material. That certain high, partially eroded, and deeply weathered gravel terrace remnants antedate Iowan time is certain. Many of these terraces display contorted bedding and are capped by fresh till; yet their originally level surface has not been completely obliverated.

The upland soils of this section were grouped with the so-called Colby by Weidman, who defined the type as: "Silt loams, with some stone; gently sloping well-drained land; forest trees, dense hardwoods, hemlock and pine." The description is an apt one, by and large, although detailed mapping would rule out morainic spots, old outwash, and similar local variants. This classification has been retained by the later soils survey (Whitson, 1927, Plate I), which, however, considers the outwash soils mapped by Weidman as Plainfield (Chetek) and Rice Lake Sands a part of the Boone Series (see page 257). These valley soils are not markedly different from those discussed in connection with the old drift, except that coarser gravels are somewhat more abundant and fine sandy stretches with dune somewhat less so.

The average depth of drift in 169 farm wells is about 31 feet, those of the northern half averaging nearly twice as much as those in the southern.

The distribution of moraines and associated features deemed Iowan in this report would suggest that the ice of the period advanced from a direction slightly west of north. Striae trending $S_{20}E$ are well developed in parts of the Barron Hills and probably correspond to this movement. It is also notable that the quartzite erratics so common in both the older drift and the later Wisconsin are rare in the Iowan section, as might be expected if the ice moved in the direction stated, for the Barron Hills unquestionably contributed much of the material of this type.

Borders of the Iowan Drift

No well-defined, continuous morainic system separates the Iowan from the older drift; indeed, a definite demarkation is frequently impossible. The occurance of low morainic ridges in place and rather clear-cut changes in topography, however, make possible the location of a generalized border as shown in (Fig. 3). In many ways the change of soils types between the two sections is more striking than landform differences; hence the southern border of Colby soil is nearly coincident with the limits of Iowan drift.

The borders between Iowan and later Wisconsin or Cary drifts are on the whole, though not everywhere, much more obvious.

Resemblance to Iowan Drift Outside the Area

Although there is no areal connection between the First Wisconsin of northwestern Wisconsin and the type locality of this formation in northeastern Iowa, the topographic expressions of both are very similar. In each case the landforms strike a sort of mean between constructional and erosional forms, with the latter generally predominating. Distinct terminal moraines are mutually lacking, so that clear-cut separations of Iowan from adjacent older drifts cannot readily be made on topographic bases (Alden, 1915). A further bond may be found in the direction of ice advance, which appears to have been somewhat east of south in Iowa as in northwestern Wisconsin, as shown by the trend of the drift border and the direction of striae in the Barron Hills, which, as mentioned on page 261, are probably to be correlated with this movement.

THE THIRD WISCONSIN OR CARY DRIFT

General Character and Distribution

The previously accepted limits of Wisconsin drift are indicated on Fig. 1. It will be seen that a reentrant angle in the endmoraines has its apex in the northeastern corner of the field area near Brill. The area of this reentrant as mapped by Weidman was considerably reduced by Leverett (1929, Plate I), who proposed a southwestward extention of the Chippewa lobe (Fig. 1), and suggested that the drift immediately to the south was probably Illinoian rather than Iowan as stated in this report. The writer proposes to further reduce the area of pre-Cary drift by extentions of both the Chippewa and Superior lobes, thus to include practically all of the supposedly old-drift Colby soils not previously discussed as Iowan. It is felt that the sediments and topography of the portions involved prove their youth and general relationships as here set forth, although further refinements and more detailed correlations remain to be made locally.

Topography and Drainage

The area of younger drift includes a great variety of landforms, ranging from the talus slopes of the Barron Hills to table-flat, sandy outwash; local relief varies from a foot or two to several hundred; drainage is practically non-existant in some parts, exceedingly well-developed in others. The parts will therefore be considered more or less individually as: (a) the moraines, (b) the ground moraine, (c) the rock-controlled ground moraine, a special type of which is the Barron Hills, and (d) the several kinds of outwash.

The Moraines

The most prominent moraines are: that of the Superior lobe on the west, which trends northeast from the vicinity of Turtle Lake, and that of the Chippewa lobe on the east which runs slightly west of north from the southeastern corner of the area. The two meet but a short distance north of Brill. Chamberlin early considered these part of his "Kettle Range" of the "Second Glacial Epoch" (vol. 1, pp. 382-385; vol. 2, pp. 205-215). They were thought of by Weidman, and are shown on most maps, as the endmoraines of Wisconsin ice in northwestern Wisconsin. Both have been correlated as Third (Cary) Wisconsin, and are nearly contemporaneous in age. They are characteristically young, rugged moraines, a veritable maze of kames, crevasse fillings, kettles, till ridges, and like forms. Lakes and marshes of all sizes abound, and drainage is most irregular. Local relief may exceed two hundred feet, and elevations rise from eleven hundred feet to over sixteen hundred feet where the main Chippewa moraine climbs the Barron Hills. The borders of the moraines are irregular; the Barron Hills, for instance, cause an indentation to the east very similar to that at Baraboo (Martin, p. 121); and the gradations of terminal moraine into outwash or ground moraine are limitless.

A second set of moraines, in general paralleling those mentioned above, are also shown in Fig. 3. Although not as continuous and somewhat less conspicuous, they are equally youthful and complex in form, albeit on a smaller scale. Weidman repeatedly recognized them in his field notes, but any mention of them in the literature is lacking, except indirectly in connection with the extra-morainal Wisconsin drift delimited by Leverett (1929, Plate I). The distribution of these moraines is indicated in Fig. 3.

The abovementioned double morainic system bears a strong resemblance to the situation in southeastern Wisconsin near Darien, at the reentrant between the Michigan and Green Bay lobes which forms the base of the famed Kettle Interlobate Moraine (Alden, 1904, 1918; Martin, pp. 253-264). It is indeed probable that the age relationships between the terminal and recessional moraines of the two areas may be somewhat comparable, the indistinct and broken morainic patches stretching northwest from Barron toward Rice Lake representing interlobat accumulations. A distinct interlobate moraine extends from the morainic junction near Brill northward to the Bayfield Peninsula (Fig. 1).

Separating the smaller terminal or "Outer" moraines from the larger recessional "Inner" moraines (Fig. 3) are large areas of outwash, some of which is highly pitted, ground moraine and patches of thinly-covered bedrock hills. The relief of the Inner moraines is normally less than that of the Outer, but the topography is essentially similar. Needless to say, the Inner moraines vary considerably in ruggedness from place to place, being in places merely gentle swells, hardly distinguishable from the adjacent ground moraine, in others broken and relatively rough belts, as, for instance, just east and southeast of Clayton. Being surrounded by areas of excellent agricultural possibilities, they were cleared and in part put under cultivation long ago, and therefore do not resemble the large moraines as much today as they must certainly have done in years gone by.

Materials and Soils of the Moraines

Weidman (1914) designated the soils of the Inner or supposedly terminal, Wisconsin moraines as Chelsea Loams: "Sandy and silt loams with some stone; hilly uneven land containing some swamps and ponds; forest of dense hardwoods and pine." This classification included the Barron Hills, certain rugged phases of the ground moraine, and areas of highly pitted outwash as well as the moraines proper. The later soils survey groups these into the Kennan Series, and locally, as in the Barron Hills, the "Rough Land Series". In any event, the description given by Weidman fits in general; the soils are young, quite unaltered, and normally bouldery, though by and large somewhat less so than many of the Cary moraines of eastern Wisconsin; they are subject to the wide variety of drainage conditions characteristic of the land forms involved.

The drift of both the western and eastern moraines, Inner and Outer, is dominantly red or reddish in color, that of the former tending to be slightly more so than that of the latter. Since both lobes advanced from regions of iron-bearing rocks in the Lake Superior district and the bedrock of the area itself contains much iron, this is but to be expected. Furthermore, there is unquestionably an admixture of older, reworked drift (see page 257). The eastern moraines contain a higher content of quartzitic material, derived in large part from the Barron Hills. The less prominent Outer moraines present drift characteristics very similar to those of the Inner moraines; yet they are shown to be part of the Colby area on all published soils maps.

Comparative Age of the Moraines

In summary it may be said that the youth of the Outer moraines is amply attested by their topographic forms, by the freshness of the materials, and by the widespread presence of pitted outwash behind them. (Thwaites, 1926, pp. 308-319) Proof that they date from Cary time rather than Second Wisconsin or Tazewell time lies in the facts that their lobation corresponds directly to that the great Inner moraines, and that the reentrant junctions near Barron and Brill are essentially component parts of a continuous interlobate system.

The Ground Moraine

Separating the Outer moraines from the Inner are, as has previously been indicated, extensive areas of outwash and till plain. The latter varies from one or two to more than two hundred feet in thickness; a well in NE-SE Section 3, Township 34 North, Range 12 West, for example, showed 230 feet or drift, and records of over one hundred feet are common.[1] The surface is generally rolling and well-drained (especially since the introduction of agriculture); a region by the large excellently

[1] 367 wells in post-Iowan areas indicate an average depth of drift of 64 feet, all landform types included.

suited for agriculture. Smaller areas are nearly as level as outwash, which indeed occurs in close association with them. This section, with minor exceptions, was mapped as Colby by Weidman (see page 261), the classification being retained by the later soil survey (Weidman, 1914, pp. 43-45; Whitson, pp. 144-154). The description fits the true ground moraine well, but is obviously inappropriate for the morainic features previously discussed as well as for a number of included areas of outwash, nearly drift-free hills, and the like. Undrained depressions, marshes, and even small lakes occur, but are by no means as common as in the moraines and pitted outwash.

Materials and Soils of the Ground Moraine

Although the drift of the Cary ground moraine is on the average thicker than that of the Iowan, the topographies of the two types are similar in certain respects. It may be noted that, although Colby soils are thought characteristically to be developed upon old drift, a large area behind the Wisconsin endmoraine in the central part of the state has long been considered Colby; however, the latter area is principally underlain by granites and other crystaline rocks, whereas the Barron County Colby rests largely upon sandstones and older drift (Whitson, p. 144). Indeed the variety of parent materials and landforms upon which Colby soils are said to have developed is so great that a revised classification, and of course more detailed differentiation by mapping, seems necessary.

The Cary ground moraine locally contains considerable amounts of stone and boulders, but the handicap which this may present to farming is offset by its other, good qualities. The drift, like that of the moraines, is predominantly red, with a rather compact, clayey matrix containing variable amounts of sand. It locally displays rather poor sub-soil drainage. There is no well-marked difference between B and C horizons, and the lighter, gray-brown. A horizon is everywhere shallow.

The writer is convinced that the red coloration of the soil is not a secondary phenomenon indicative of advanced weathering, but a primary feature, for the following reasons: (a) the color is characteristic of all horizons except in part the uppermost, (b) the same color is found in the obviously young moraines, (c) the sources of drift, reddish, ferrugenous rocks and old drift, would tend to impart such color. Striking evidence of primary coloration was observed at Reeve, where a cellar being dug exposed a fresh section about eight feet deep in red, clayey, and apparently oxidized till. Near the bottom a layer of fresh sand containing bits of kaolin was encountered. About midway between the top and the bottom was found a large ball of fresh, unaltered sand, probably a mass ploughed up into by the ice while frozen. Several smaller bodies of similar nature were observed scattered elsewhere throughout the cut. It seems unlikely that these masses could escape alteration entirely if the surrounding materials had been subjected to prolonged weathering since deposition.

Rock-Controlled Ground Moraine

Locally, as along the main streams, the pre-Wisconsin relief was so great subsequent erosion has been so much accelerated that the bedrock is but thinly mantled with drift or actually exposed. Rock-controlled landforms also prevail in certain peripheral zones and isolated hills where only slight amounts of drift were deposited. The soils in such places as well as the topography are influenced to such an extent by the inclusion of nonglacial material as to resemble in many ways the Iowan drift to the south Weidman (1914, Plate I) mapped these in part as Colby, in part as Auburn soils.

The Barron Hills

The character of this section has previously been mentioned in brief. Where heavily burdened by drift, the old, underlying topography is not particularly evident, but west of the eastern Inner moraine the drift is thinner and the marginal valleys cut in quartzite form conspicuous, gorge-like features, bringing to mind the Devils Lake region. Certain of them appear to wind in deeply-entrenched meanders; this is especially true of the valley of Rock Creek, on the south side of the range. The uplands, on the other hand, are gently rolling, with broad, old-looking valleys.

Soils in the Barron Hills are extremely rocky, attaining even passable utility only locally on the uplands. Agricultural occupance has, because of this fact and because of the sharp landforms, been limited, and much of the area remains in dense second-growth forest and brush, some of which is exploited for cord and pulp wood.

The Problem of the Talus Slopes

The fact that talus slopes exist in the western parts of the Barron Hills has long and reasonably been held as evidence that this section was not covered by Wisconsin ice. Paradoxically, the moraines and outwash immediately to the west appear beyond question to be of Cary age, according to both Leverett (1929, Plate I) and this writer. Since the Barron Hills, and especially the valleys within them in which the debris is found, are hardly prominent enough to have formed a nunatak, the ice must indeed have covered them, though possibly in a much-thinned condition. It would therefore seem that either the ice was too thin or burdened to remove all the talus, or talus from this formation forms more rapidly than has been supposed; perhaps a combination of both factors is responsible. It is interesting to note that talus is at present confined almost exclusively to southerly slopes, where freezing, thawing, and hence mechanical disintegration is most intense. The eastern part of the range is so heavily covered with drift that the amount of talus still in situ beneath it cannot be determined.

The Outwash

About half of the area separating the Cary terminal and recessional moraines is occupied by extensive outwash plains of varying aspect. The glacio-fluvial material was contributed by both lobes, but the largest portion is concentrated on the east-central side of the field area in the lowland between the main sandstone uplands and the crystaline and morainic sections. The bulk of the outwash is moderately pitted or very gently undulating, while some practically flat, unpitted plain may be found scattered here and there. Bordering upon or contiguous with the moraines are more local areas of intensely pitted outwash; the largest and best developed of these is that in Township 36 North, Range 10 West, about Red Cedar Lake. Where strongly pitted outwash and moraine occur in close proximity, separation of the two in mapping may be difficult, especially if the terrain is densely wooded; the areas shown as moraine on Plate III therefore include numerous smaller patches of assorted material which, although outwash per se, constitute integral parts of the morainic system as a whole. Sharp and topographically distinct divisions, such as that in the northeastern part of Township 31 North, Range 9 West, are relatively rare. Further complications are introduced when a plain, especially if pitted, has been dissected into a maze of interstream remnants by glacial and postglacial waters; such is the case in the west-central portions of Township 35 North, Range 12 West, the plain in this instance being part of the interlobate morainic and outwash system.

Although altitudinal variations within the plains are mainly the result of a delta or fan-like structure, such as that evident between Rice Lake and Red Cedar Lake, a series of riverine terraces essentially like that of the Iowan Area (see page 259) is also present in the youngest area, for, as might be expected, the latest outwash deposition in each took place concurrently. The series includes the old high-level, partially till-covered outwash remnants, which are perhaps best developed in the southern parts of Townships 34 North, Ranges 12 and 13 West, from whence they extend southward some distance into the Iowan section. Being weathered, eroded, and overridden, the remnants would appear to be pre-Iowan. It seems that Iowan outwash is either scarce or largely obscured by Cary detritus. According to Leverett (1930, p. 21), Iowan ice developed little outwash in southeastern Minnesota and northeastern Iowa.

The highly pitted outwash in the northwest corner of Township 32 North, Range 10 West displays two distinct levels, the one from fifty to seventy feet higher than the other. In sections 10, 11, 14 and 15 of Township 31 North, Range 9 West is a singular patch of level outwash, bounded by steep slopes, surrounded by rolling round moraine, and more than 100 feet above the nearest main outwash level.

Perhaps the most remarkable "two story" plain is that near Brill, just south of the juncture between the two Inner moraines. The western moraines rests upon a terrace some thirty feet higher than that on the east, which is split in twain by the south-flowing Brill River (also refered to as Long Lake Stream). Both levels are moderately pitted, the separation between the two is abrupt and escarpment-like, and the lower level rises gradually east of the river to a highly pitted zone, which in turn merges with the moraine. Downstream the terraces become less and less distinct, finally ceasing to be distinguishable.

An explanation of the situation might be that the break between the two levels is a constructional or ice-margin feature; i.e., the eastern lobe once stood further west than the present moraine would suggest, and outwash from both this and the western lobe built up before it. The shape and face of the low escarpment would not rule out this explanation, and by it the pitting of both levels and their confluence to the south are made possible. The depression formed upon recession of the ice served to localize drainage, a factor which would in a measure tend to preserve the differentiation. Lastly, this hypothesis is in accord with the concept of a progressively retreating interlobate reentrant.

Drainage Channels and Lakes

The great glacial drainage channels traversing the plains, some now occupied by underfit streams, others by ill-drained swamp land, are conspicuous elements of the landscape, and may in most cases be traced to breaks in the moraines or to glacial valleys extending far back into them. Many are today the sites of chains of minor lakes and swamps, while the intramorainal valleys with which they connect may be occupied by large bodies of water, formed in part by drift dams, in part by the melting of residual ice blocks preserved in the valleys. Red Cedar, Vermillion, and Turtle Lakes appear to be features of this type. It should be mentioned that the distribution of certain recessional moraines, lakes, and drainage courses indicate that they outline pre-glacial, or at least pre-Wisconsin, valleys in many instances. The eastern Inner moraine dips almost to obscurity in an east-west depression just south of the Barron Hills, a basin which serves as a locus of present drainage, carried large quantities of glacial melt waters, and appears to have been of prime importance in the old drainage system of the crystaline area.

The countless kettle-holes of the plains proper also form lake and marsh basins. Sharply-defined, undrained, and unfilled features of this type are well-nigh conclusive evidence of recency. Resulting from the melting of isolated, stagnant ice-blocks, numerous and large kettle-holes probably cannot be formed in areas not just previously occupied by the parent glacier. The abundance of these forms twenty miles and more beyond the major moraines establishes the latter as recessional.

Rice and Chetek Lakes, originally agglomerations of small lakes and marshes within ancient channels, owe their present form and size to artificial damming during logging days, with the resultant merging of the small lakes. An interesting outcome of this in the case of Lake Chetek (especially the northwest arm, known as Prairie Lake) has been the formation of floating islands as the marsh bottom tore loose with the rise of water level. These "bogs" drift aimlessly with the wind, attain the size of a city block, and support a low growth of brush and tamarack. Slowly breaking up, many have taken root anew along shore, or have been artificially anchored to prevent damage to boat houses and bridges.

A small lake in Section 2, Township 32 North, Range 11 West displays a mode of origin different from the others. At one time the Red Cedar apparently joined the Chetek River near the present location of this small lake; it then shifted to a more direct southerly course, part of the abandoned meander subsequently becoming an integral part of the Chetek River, the natural levee of which thereafter blocked off the remaining, or northern, part to form the present lake and marsh basin.

Outwash Materials and soils

The composition of the outwash varies from fine sand to coarse gravel, depending upon the distances from points of origin in the moraines, or upon a multitude of local conditions. The extent to which profile development has progressed appears to depend to a considerable extent upon the porosity of the drift. As a rule no marked differences between B and C horizons are to be seen, although instances of good development of the former are not uncommon. The A horizon tends to be shallow, podsolic where originally covered by coniferous forest, dark and well-supplied with organic material where evolved beneath grasses.

Weidman (1914, Plate I, pp. 58-65) divided the outwash soils into the Plainfield (Chetek) type (see page 257) and the Rice Lake Loams. The latter contains somewhat more silt and less coarse material than the former, and was originally forested by dense white pine and hardwood or, locally, covered by grasses, rather than by the oak and jack pine vegetation so characteristic of the former. The Rice Lake soil has proven itself to be of very good agricultural use, and supports a large number of normally productive farms. The later Soils Survey (1927) makes the Rice Lake variety a part of the all-inclusive Boone Series. Relatively small areas of peaty or marsh-border soils are abundant.

Eskers

Although no attempt has been made to describe in detail the numerous eskers and crevasse fillings of the moraines and deeply pitted outwash, mention might be made of a prominent esker which runs in a generally northeasterly direction through sections 16, 20, 21 and 29 of Township 35 North, Range 12 West. Portions of this feature are buried by outwash, but its true ridge-like character may be discerned in places.

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DEGREE OF PIGMENTATION AND THE POTENTIAL ACID-BASE BALANCE OF HONEY

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Some 26 years ago Sherman and Gettler ('12) in reporting on the inorganic constituents of foods offered a simple method for computing the balance of the acid-forming and base-forming elements from the data obtained in a mineral analysis of the substance in question. Since honey was not among the large list examined by them it remained unclassified in this respect until Lothrop ('36), taking advantage of a simple titrimetric method which had been suggested previously by Davidson and Le Clerc ('35), assigned it to the so-called alkaline ash group of foods.

The mineral analysis of honey having become an object in itself in this Laboratory, there have been obtained data whose interpretation along the above lines leads to confirmation of the former's findings not only with respect to this fact but also to the suggestion that there apparently exists a relationship between degree of pigmentation of this food and its acid-base balance. The approach to these conclusions, simplified by the development of more rapid techniques than were available in their time, is the same as was used by Sherman and Gettler ('12).

EXPERIMENTAL

The group of 20 honeys which had been brought together for this study represented almost as many of the popular floral sources which are associated with this food. For this reason the lot is deemed to represent an average cross section of consumer preference with respect to honey. It included various species of clover honeys from the north central and the eastern States, sage and orange blossom honeys from California, alfalfa honeys from Colorado and neighboring States, buckwheat honey mixtures from Wisconsin and New York, and some which are typical of southern bee pastures, particularly Georgia.

As a necessary prelude to analysis, dry incineration was used in all instances except in the case of samples intended for sulfur determinations; those were oxidized with nitric and perchloric acids. Retention of the phosphorus was insured by the addition of magnesium nitrate to the sample before ignition. Chlorine losses were prevented by the use of the sodium carbonate.

The optimum conditions for the determination of each element were first established by preliminary experiment and recovery trials. No procedure was used unless it proved to be simple, rapid, accurate, and adaptable to the problem in hand.

Gravimetric procedures were used for the determination of the base-forming elements. Calcium was precipitated with oxalic acid, after which magnesium was removed with 8-hydroxyquinoline. Potassium was combined with hexanitrodiphenylamine ("dipicrylamine") to form an insoluble complex and, similarly, from a separate solution, sodium was removed by means of uranyl zinc acetate.

Sulfur and chlorine were determined volumetrically; the former by direct titration with barium chloride solution in the presence of tetrahydroxyquinone as internal indicator, the latter with silver nitrate solution. Phosphorus was determined colorimetrically through the medium of the blue color produced by the action of stannous chloride upon a sulphuric acid solution of its ammonium molybdate complex.

Data (Table 1) on each of the honeys analyzed have not been made part of this summary because degree of pigmentation[1] was primarily the point of departure involved in this study. Therefore, only averages for the honeys in each color classification have been recorded. Parenthetically, it might be remarked that this course is consistent with the present merchandizing practice for a statement of floral source is not a condition involved in the lawful, interstate sale of honey. Next, all data were more or less arbitrarily grouped again into two large divisions, light and dark, as typifying, in a qualitative sense the most obvious color differences. By this scheme of division, then, the

[1] This expression is used here in the sense conveyed by the terminology of the United States grading rules (Sechrist, E. L., 1925. The color grading of honey. U. S. Dept. Agric. *Circ.* 364, p. 5) according to which intensity of color increases with numerical values on the Pfund scale.

light-honey group includes those whose predominating floral sources are orange blossoms, alfalfa, cotton bloom and several species of clover, respectively. Similarly, the members of the dark-honey group had their origins in white sage, gallberry, tupelo, Mexican clover, thistle, buckwheat and late-blooming flowers.

CONCLUSIONS

That one may expect to find distinct differences in the acid-base balance of honeys which on the one hand are deeply pigmented and on the other less so, is evident from the data obtained in this study of a group which, because of different geographical origins and the variety of floral sources involved, may very well be deemed to represent consumer preference as to this natural, unrefined food. Although qualitatively in agreement with those of Lothrop ('36), yet quantitatively the base values which were found represent a lower order of magnitude than those which were reported by him. If these data are plotted, a smooth curve will be obtained which in spite of its regularity, however, is not deemed to have any mathematical significance.

It is evident, also, that those factors which are contributive to the flavor of honey bear little, if any, direct relationship to those which make for its acid-base balance. In the latter respect, the delicately flavored types of honey fall below those whose principal non-saccharine characteristic is a deep color and a not-so-delicate taste. It is, indeed, an interesting observation that the buckwheat honeys of the northern States and most of those typical of the South possess a greater potential acid-base balance than do those honeys whose predominating floral sources are the various species of clover, alfalfa, orange blossoms, etc.

Summary

Distinct differences in the acid-base balance of honeys which, on the one hand, are deeply pigmented and, on the other, less so, may be expected in any group of them in which a variety of floral nectar sources is involved. The change is progressive, proceeding, for example, from the delicately flavored water-white and white clover, alfalfa and orange blossom honeys

TABLE 1.

SUMMARY OF THE CONTENT OF INORGANIC CONSTITUENTS OF HONEY AND THEIR POTENTIAL ACID-BASE BALANCE

Classification	Samples	Basic Elements					Acid Elements				Base Values
		Ca	Mg	Na	K	Equiv.	S	Cl	P*	Equiv.	balance
		mgs. per kg.				*ml. N sol.*	*mgs. per kg.*			*ml. N sol.*	*ml. N sol.*
Light Honeys											
Water White	3	47	19	17	117	7.7	54	50	32	6.8	0.9
White	8	47	18	13	203	9.7	72	52	40	8.6	1.1
Average		47	19	15	160	8.7	63	51	36	7.7	1.0
Dark Honeys											
Light Amber	6	57	37	27	467	19.0	68	216	42	13.1	5.9
Amber	3	63	38	31	769	27.2	101	160	54	14.2	13.0
Average		60	38	29	618	23.1	84	188	48	13.6	9.4

* PO_4 anion considered as bivalent

through the deeper pigmented light amber and amber wild aster, gallberry, tupelo gum products to the dark, or buckwheat honeys.

Honey belongs to the alkaline-ash group of foods. This fact was deduced from a computation of the balance of acid-forming and base-forming elements from data obtained in making mineral analyses of a wide variety of honeys. Average minima and maxima in mgs. per kg. found for the elements in question are: calcium 47 to 63; magnesium 18 to 38; sodium 13 to 31; potassium 117 to 769; sulfur 54 to 101; chlorine 50 to 216 phosphorus (phosphate anion considered dibalent) 32 to 54. The average base balance of the light honeys (water white and white) was found to be 1 ml. *N* solution per kg.; for the dark (light amber and amber) 9.4 ml.

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The Relation of *Le Philosophe anglais* by the Abbé Prévost to the Religious Controversies in France and England during the Early Eighteenth Century[1]

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The novel *Le Philosophe anglais* by the Abbé Prévost merits consideration as a part of the history of thought in France and in England from 1730 to 1740 both because of its theme and because of its bibliographical history. It is the purpose of this paper to discuss the relation of the theme of the novel to the philosophical and religious controversies of the early eighteenth century.

Le Philosophe anglais, which Prévost represented to be the memoirs of Mr. Cleveland,[1] natural son of Oliver Cromwell, relates the search of the hero for a philosophy of life which will enable him to bear sorrow with equanimity and which can reconcile the apparent conflicts and oppositions of existence. The story begins with the presentation of views resembling neo-Stoicism and Deism; then Cleveland, disillusioned with philosophy and natural religion because they fail him completely in time of sorrow, examines critically both Catholic and Protestant

[1] The writer wishes to make grateful acknowledgement to the American Association for the Advancement of Science and the Wisconsin Academy of Sciences, Arts, and Letters for the assistance of the Grant-in-Aid for Research for 1937-38.

[2] The book was apparently accepted at first as the genuine memoirs of Cleveland, for it was so reviewed in a magazine devoted exclusively to nonfiction, *Historia Litteraria,* II, No. IX (March, 1731), 285-92. Professor George Sherburn, in reviewing Mysie Robertson's edition of Prevost's *Memoires et avantures d'un homme de qualité,* gives evidence for Prévost's publishing an English translation before the French edition in order to substantiate his claims, made in the preface to the book, that he was translating a manuscript received in London from Cleveland's son. See *Modern Philology,* XXV (1927), 246-8, for discussion of this evidence.

dogma. After failing to find peace of mind in either faith and experiencing no satisfaction through a period of association with a group of French *philosophes,* he is finally converted to a religion which the author does not identify with any church.

A brief summary of the philosophy in which Cleveland was educated by his mother and which he accepted as a guide in his early life will show some of its resemblances to the neo-Stoicism of the seventeenth and eighteenth centuries.

This philosophy is described as moral philosophy which has as its aims truth and happiness attained through the subjugation of the passions by the reason. The story of the genesis of this philosophy through the experiences of Elizabeth Cleveland is told in terms of the conflict between reason and the passions which destroy peace of mind. Ambition, Elizabeth's dominant passion, leads her to become the mistress of Charles I. Her wounded pride, when her royal lover discards her, makes her the victim of Cromwell, who recognizes the political usefulness to him of Charles' former mistress. When Cromwell's selfish interests are served, he, too, discards Elizabeth, who renounces slavery to love and ambition for a life of solitude and the study of ancient and modern philosophers.[3] From her reading, she formulates a set of maxims which become the foundation of her peace of mind and a textbook for her son. As he studies science and history, he evalutes what he reads in the light of these maxims compiled by his mother.[4]

News of Cromwell's rise to power upsets the composure of Elizabeth by reawakening some of her former worldly ambition. She tells her son about his father and urges the boy to seek the recognition and preferment which is his right as Cromwell's son. Young Cleveland, judging his father by the principles of honor and virtue, detests Cromwell; yet the lad recognizes in himself a natural feeling of filial affection and a desire to see his father which oppose the dictates of reason.[5] After several years, the mother's worldly wisdom prevails,[6] but the result of the interview is that the two must flee from Cromwell's vengeance to hide for years in Romney Caverns. They agree in preferring this solitude to the hatred and malice of mankind.[7]

[3] *Le Philosophe anglais* (Rouen: Racine, 1785), I, i, 6.
[4] *Ibid.*, pp. 8-9.
[5] *Ibid.*, pp. 9-11.
[6] *Ibid.*, p. 12.
[7] *Ibid.*, pp. 42-3.

Cleveland concludes that men voluntarily bring misery upon themselves, for nature intended them to be happy, but their passions destroy their peace of mind. Elizabeth tells her son that she can never attain the philosophic calm which is possible for him, because the passions of which she was a victim in early life have introduced desires which are in opposition to those natural and right inclinations that in his case are unspoiled by violent passions and have been fortified by education in the right principles.[8]

This resumé of the philosophy of Cleveland's early life will serve to indicate that it is based upon the conflict in man's nature between reason and good inclinations on the one side and weak and selfish passions on the other. In Cleveland's case there has been introduced a conflict between the maxims dictated by reason and filial affection springing from the good inclinations. But at the revelation of the full extent of Cromwell's villany, reason approves hatred[9] and the conflict is temporarily resolved.

After his mother's death, Cleveland's many adventures take him to America where he becomes absolute ruler of a tribe of Indians to whom he teaches a religion which inspires the savages with respect for his authority.[10] This religion strongly resembles Deism in its principles: (1) belief in a Supreme Being, (2) submission to his will, (3) punishment for sin, (4) no religious ceremonies except a brief prayer repeated in general assembly twice a week and in the homes daily.[11] Cleveland states later in the narrative that such beliefs with emphasis upon just and virtuous conduct formed the essence of his religion at this period of his life.[12] Although he seldom uses the word religion when speaking of his earlier views, but refers to them as his former principles or as his philosophy,[13] his conversations with Minister C. and with Lord Clarendon make clear that he has always accepted the principles of natural religion.[14]

This combination of moral philosophy and natural religion has met Cleveland's need until he becomes convinced that his wife, Fanny, has eloped with his good friend, Gelin. Up to this time he has prided himself on his ability to control his passions

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[8] *Ibid.*, pp. 43-4.
[9] *Ibid.*, p. 15.
[10] *Ibid.*, III, iv, 158.
[11] *Ibid.*, pp. 159-65.
[12] *Ibid.*, V, vii, 4-7.
[13] *Ibid.*, IV, vii, 145-6, 162.
[14] *Ibid.*, V, vii, 4; VIII, xv, 201.

by his reason,[15] but this tragedy makes him a helpless victim of his wounded affections.[16]

It is out of his despair following this sorrow that Cleveland denounces philosophy as a weak and impotent phantom and finds that his reason approves suicide, but natural affection for his little sons frustrates the intent he had thought reasonable, to kill them as well as himself.[17] To please his anxious friends, he consents to listen to the arguments for revealed religion as presented first by the Protestant, Minister C.; then by the Jansenist, Father le Bane; and finally by the Jesuit, Father Ruel.[18]

The views of the first two he characterizes as sad and repulsive.[19] The casuistry of the Jesuit, although it diverts him, brings neither intellectual nor spiritual satisfaction.[20] The narrow dogmatism of each group, their attempts at coercion, their persecution of those of dissenting faith offend his standards of justice and tolerance. Their arguments are unconvincing.[21] In fact a very weak case for revealed religion is presented in the narrative of Cleveland's conversations with Minister C., Father le Bane, and Father Ruel.[22] The greatest defects in all three religions are emphasized in the characterization of these representatives: dogmatism, intolerance, narrow sectarianism, overzeal for making converts, interference with personal liberty, and lack of logical support for arguments. The Jesuits are presented as they are characterized by their enemies: sly; crafty, ambitious, and even unscrupulous casuists; but neither Protestants nor Jansenists are placed in a more favorable light.

The fourth volume leaves Cleveland disillusioned both with his former principles and with orthodox religion, Protestant and Catholic.

In the continuation volumes, which were not published until 1738-39,[23] the chief interest lies in the steps leading to the con-

[15] *Ibid.*, II, iii, 12-25; IV, viii, 3, 20, 47.
[16] *Ibid.*, IV, vii, 2, 8-9, 44.
[17] *Ibid.*, 167-79.
[18] *Ibid.*, V, vii, 2, 3-9, 44.
[19] *Ibid.*, VIII, xv, 205.
[20] *Ibid.*, V, vii, 16, 19, 22, 58.
[21] *Ibid.*, vii, 119, 187.
[22] *Ibid.*, vii, 8, 12, 57.
[23] Prévost's life up to the year 1734 is a record of conflict between the call of the world and that of holy orders. In 1713 he became a novitiate in the Society of Jesus at Paris, from which he twice ran away, returning each time to receive the forgiveness of the order. In 1720 he was a novice in the Benedictine Order at St. Maur; in 1721 he took the vows of the order at the Abbey of Jumieges with a mental reservation which, he says, could authorize him to break those vows. Sainte-Beauve says (*Portraits of the eighteenth century*, New York: Putnam, 1905, p. 11) that

version of Cleveland and in the principles of the religion which he finally accepts.

His happiness is almost completely restored by the discovery of Fanny's innocence and by a perfect reconciliation with her, but even yet something is lacking for intellectual and spiritual satisfaction. Companionship with a group of French *philosophes* fails to advance him further in his quest for peace of mind.[24] He realizes that another disaster to his loved ones would destroy a happiness attained by reunion with his wife.[25] He has observed upon the death of his daughter that his wife finds in the Roman Catholic faith a strength to meet sorrow.[26] He notes Lord Clarendon's remarkable self-control when grief comes to him,[27] and so it is to this friend he turns for help. According to his appeal to Lord Clarendon, Cleveland makes two principal demands from a system of thought which can bring him peace of mind: that it enable him to conquer grief, or at least bring consolation for it, and that it provide a philosophy which reconciles the inconsistencies and cruelties of life.[28]

How, then, do Cleveland's new views meet these two demands? The desire for a consolation which balances, if it does not remedy, the effects of sorrow is satisfied by making celestial things the objects of one's desires, by viewing the objects of one's affections in this world as temporal goods relating to and leading to the celestial and the eternal, and by a faith in a happy future state which compensates for the losses and sorrows of this world.[29] Reconciliation of the inconsistencies and cruelties of life is effected by their relation to ultimate perfection.[30]

Cleveland now ranks spiritual and worldly desires and his duties in an order resembling that of the neo-Platonic scale of

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Prévost's letters during the period 1721-27 show a conflict between a desire for the world and a desire for the cloister. In 1728 he left the Benedictine Order before receiving Papal permission and as a result became Prévost d'Exile, living in England and Holland from 1728-34, until a pardon from the Pope allowed him to re-enter the Benedictine Order. The year 1734 divides a period of turmoil and spiritual conflict from one of apparent peace of mind. It is significant that the first volumes of *Le Philosophe anglais* were published at the climax of the conflict and that the concluding volumes were published after the adjustment to ecclesiastical life had been made. The evidence presented up to this time by biographers of Prévost (See Henry Harrisse, *L'Abbé Prévost,* Paris: Levy, 1896, and V. Schroeder, *L'Abbé Prévost,* Paris: Hachette, 1898) shows that the years 1734-63 were spent in performing the duties of ecclesiastical life, principally as *aumônier* to Prince Conti, and in the scholarly pursuits of study, translating, and creative writing. There is one slight exception to this statement: in 1741 there was some difficulty about an article in a *Gazette a la main* which resulted in Prévost's being an exile in Brussels for about a year.

[24] *Le Philosophe anglais,* VII, xiv, 53-70.

[25] *Ibid.,* VII, xiii, 136-7.

[26] *Ibid.,* VIII, xv, 187.

[27] *Ibid.,* pp. 192-9.

[28] *Ibid.,* p. 203.

[29] *Ibid.,* p. 215.

[30] *Ibid.,* p. 214.

Being: (1) love of God and desire for celestial things, (2) the duties of religion, (3) love for his wife, (4) the duties of society, (5) the study of the Bible and of nature, (6) the moderate use of pleasure.[31]

As a result he is able to bring order out of the confusion which has tortured him. Philosophy is no longer opposed to religion for it merely anticipates the ideal of the tranquil mind which it could not attain without the inner grace which only religion gives.[32] Natural religion is no longer opposed to revealed, for to the enlightened mind the order of nature is related to God as is the order of grace,[33] and the study of nature is ranked with the study of the Bible as a means of growth. There is no opposition between the life of the senses and the life of the spirit: natural desires for the temporal goods of this world, for harmless amusements, for the society of fellow-creatures, and for the pleasures of love are not in conflict with the love of God and of spiritual goods. The relation is of a lower order to a higher in the same system.[34]

Such a system of thought opposes asceticism as well as excessive indulgence. Cleveland condemns withdrawal from society as a cowardly running away from combat.[35] The view found in many of the books of piety that love of creatures draws man away from God he censures as a fanaticism that wounds religion as well as nature.[36] Those who ignore the manner in which the laws of nature and of religion are related will not approve, he says, but his view is that all lawful desires are ennobled by their contribution to a higher objective. Christianity sanctifies innocent passion and by teaching the temporal character of the life of the senses intensifies the desire for eternal happiness.[37]

In spite of the evidences of Jansenistic influences in Prévost's novels which have been presented in studies by Harrisse, Hazard, Pauli and others,[38] it is obvious that these views in *Le Philosophe anglais* are diametrically opposed to those of Port Royal. They have much more in common with the point of view of the seventeenth century Cambridge Platonists and the lati-

[31] *Ibid.*, pp. 213-4.
[32] *Ibid.*, p. 215.
[33] *Ibid.*, pp. 213-4.
[34] *Ibid.*, p. 212-15.
[35] *Ibid.*, p. 212.
[36] *Ibid.*, p. 213.
[37] *Ibid.*, pp. 214-5.

tudinarianism of the Anglican divines in the seventeenth and eighteenth centuries. Perhaps Prévost's exile in England may have been responsible for some influence of the theology of the Anglican church upon the religious views expressed in *Le Philosophe anglais.*

Although there is an unauthenicated story that Chancellor d'Aguesseau refused to allow the printing of *Le Philosophe anglais* in France unless Cleveland were made a Catholic in the concluding volume,[39] there is no mention of the Catholic doctrine or of the Catholic church in connection with his conversion. Furthermore, he is converted by Lord Clarendon, whose name could not be very pleasant to Catholic ears and whose Protestantism is emphasized in the narrative. Prévost is definite enough about the religion of other characters: Cécile is converted to Catholicism on her deathbed;[40] Fanny adopts the Catholic faith;[41] the repentant Gelin becomes a Jesuit.[42] But in the summary of Cleveland's religious ideas there is no mention of entering into communion with any church.

Throughout the story Prévost has satirized narrow sectarianism in both Protestants and Catholics. One of the stumbling blocks in the way of Cleveland's conversion was the hatred and the intolerance among the religious sects with whom he came in contact. In a passage omitted in a number of editions after 1750 he laments that religion should be confined within the narrow limits of creeds. Wherever matters of religious controversy enter the narrative, they are presented with an objective appraisal of the weaknesses of each group. Dogmatism, narrow sectarianism, and persecution are satirized without favor to Protestants, Jansenists, or Jesuits. No sect is presented as showing the moderation, justice, tolerance, and respect for reason which are Cleveland's standards for true religion. The conver-

[38] Henri Harrisse, *La Vie Monastique de l'abbé Prévost* (Paris: Le Clerc, 1903), pp. 25-9, 49-50; Paul Hazard, "Jansénisme," *Etudes critiques sur Manon Lescaut* (Chicago: University of Chicago Press, 1924), pp. 47-69; Eugene Lasserre, *Manon Lescaut de l'abbé Prévost* (Paris: Société Française d'Éditions Littéraires et Techniques, 1930) pp. 90-118; André de Maricourt, *Ce bon abbé Prévost* (Paris: Hachette, 1932), pp. 101-09. Franz Pauli, *Die Philosophischen Grundanschauungen in den Romanen des Abbé Prévost, im besonderen Manon Lescaut* (Marburg: Ebel, 1912), pp. 13-92. It must be noted that *Le Philosophe anglais* presents later evidence of Prévost's own attitude than does *Manon,* and, as both Hazard and Lassere have pointed out, Prévost revised a passage on grace in the later edition of *Manon.* In another paper I have tried to show that the conclusions in these studies rest upon a somewhat superficial and incomplete idea of Jansenism.

[39] Harrisse, *L'abbé Prévost,* pp. 269-70.

[40] *Le Philosophe anglais,* VIII, xv, 174.

[41] *Ibid.,* VII, xii, 165.

[42] *Ibid.,* VIII, xv, 226-7.

sion of Cleveland to a religion unidentified with any church or sect is consistent, therefore, with the point of view throughout the narrative.

Religion of any particular sect or dogma, as it has been presented to Cleveland, satisfies neither his need for a philosophy that explains the frightful contradictions of existence nor for a faith that brings comfort, if not a remedy, for grief.

True religion, Cleveland seems to conclude, must recognize man both as a creature of reason and as a creature of strong affections, or desires toward God and toward fellow-creatures. Philosophy failed because it tried to subordinate all desires to reason. Grief caused by loss of loved ones can not be cured through reason but through meeting the need for love. Dogmatic and sectarian religion failed to satisfy both reason and love, but true religion recognizes both love and reason. Love is of many degrees from the highest, that of love of God and of celestial things, to the lowest order, that of love of sensual pleasures; between these two extremes fall love of wife and love of friends. Reason is satisfied because the system corresponds with the facts learned through experience, that true peace of mind comes only through meeting both needs of human nature.

Thus, the religion which Cleveland finally accepts resolves for him the conflicts arising from a philosophy which failed to take into account love as well as reason.

Variations in the Texts of Eighteenth Century Editions of *Le Philosophe anglais*[1]

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Le Philosophe anglais by the Abbé Prévost concerns matters of religious controversy in the early eighteenth century in England and in France. The first four volumes, published in 1731, tell the story of the disillusionment of the hero with neo-Stoic philosophy and sectarian religion. The last four volumes, published in 1738-39, give the story of the hero's conversion to a Christian faith which reconciles the conflicts within his own nature and the opposition between philosophy and religion.[2]

The publication of the first four volumes in 1731 and of a spurious fifth volume in 1734 provoked attacks from the Jesuits because of the satire of their order in these volumes. The ensuing controversies between the author and the Jesuits are related to two interesting bibliographical problems: the authorship of the spurious fifth volume and the textual variations in later eighteenth century editions. It is to the second of these two problems that the present paper is devoted.

A comparison of those editions of *Le Philosophe anglais* which are available in the United States reveals textual differences which appear to be related closely to the religious controversies of the eighteenth century. Of the fourteen editions of the French text which the writer of this paper has examined, there are six which do not follow the prevailing text, the one finally adopted in the 1783 and in the 1810 Paris editions of

[1] The writer wishes to express her appreciation to the American Association for the Advancement of Science and the Wisconsin Academy of Sciences, Arts, and Letters for the grant-in-aid for Research for the year of 1938-39.

[2] The point of view of the novel on matters of religious controversy has been discussed in an earlier paper, "The Relation of *Le Philosophe Anglais* to Religious Controversies of the Early Eighteenth Century," which was read before the Wisconsin Academy of Sciences, Arts, and Letters in April, 1938. A paper on the problem of the spurious fifth volume is being prepared.

Prévost's complete works. Four of these six agree in omitting certain passages concerned with the Roman Catholic church and particularly with the Jesuits.[3] Two editions, that of London 1788 and that of Paris 1788, are special condensed versions found in a sort of "Reader's Digest" series of popular romances: the London edition is condensed by omissions; the Paris, by retelling the narrative in the third person.

When compared with the predominating text the editions of 1757, 1778, 1781, and 1785 reveal three types of textual differences: omissions, revisions, and substitutions. In order to present graphically the omissions, the predominating text is quoted with the passages omitted from the 1757, 1778, 1781, and 1785 editions in italics.

> Je ne connoissois cet Ordre que de nom, *ou s'il m'étoit arrivé quelquefois d'en entendre parler plus particulièrement, ce n'avoit point été d'une manière qui m'en eût fait prendre une idée avantageuse.*[4]
>
> Je lui racontai, dans toutes ses circonstances, l'entretien que j'avois eu avec le J. . . . *Elle en fit le jugement que j'ai déja rapporté;* et malgré le peu de disposition que je me sentois à faire l'essai de sa méthode, elle m'y engagea par ses instances. Que risques-vous? me dit-elle. Quand vous ne prendriez la chose que sur le pied d'un amusement, c'est toujours une diversion considérable que vous ferez à vos chagrins. *Vous ne sauriez croire combien ces gens-là sont comiques.* J'y consentis.[5]
>
> Si le J . . . avoit déja formé quelque projet digne de son zèle, sur les prémières lumières qu'il avoit pû tirer de ma froideur et de mon embarras, lorsque je m'étois rencontré avec lui chez M. de R . . . l'éclaircissement qu'il reçut de Madame Lallin le fit agir par un noveau motif. Peut-être avoit-il eu quelque affection pour moi jusqu'alors; mais il crut trouver quelque chose de si offensant pour lui dans ma conduite, qu'il n'écouta plus que le ressentiment *de la haine et le desir de se venger. Je ne puis attribuer à une autre cause les excès auxquels il se porta aussi-tôt . . . .* Trois conquêtes de cette importance eussent flatté extrêmement *sa vanité; car rien n'étoit alors plus à la mode parmi les gens d'Eglise, que la charité, et le zèle pour la conversion de leurs Frères errans; c'est le nom qu'ils donnoient aux Protestants.*[6]

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[3] Comparison of fourteen editions of *Le Philosophe anglais*

Original text		*Censored*		*Condensed*	
Utrecht: E. Neaulme,	1732				
	1736-39				
	1741 2v				
	1741 6v				
Amsterdam et Leipzig: Arkstee et Merkus,	1744 4v	Amsterdam: Ryckhoff,	1757		
	1744 8v		1778		
London: Valliant,	1777	Rouen: Dumesnil,	1781	Londres,	1788
Paris: Serpente,	1783	Rouen: Racine,	1785	Paris,	1788

[4] *Le Philosophe anglais,* (Utrecht: Neaulme, 1736) V. vi, 139-40.

[5] *Ibid.,* 150.

[6] *Ibid.,* vii, 266.

In addition to deleting the phrases and sentences just indicated, these four Amsterdam-Rouen editions also omit from the account of Cleveland's conversion the following paragraph:

> Je tremble néanmoins que ce ne soit faire tort à la Religion que d'en resserrer les élemens dans des bornes si étroites. Mon respect qui croît tous les jours pour elle, avec ma reconnoissance, m'oblige de prévenir par cette refléxion le reproche auquel je pourrois m'attendre, d'avoir donné moins d'énténduë à mes éclaircissemens qu' à mes doutes. Mais au fond n'est-ce pas rendre un témoignage glorieux à la vérité, que de reconnoître avec quel empire elle nous a soûmis? Et lorsque par d'autres raisons l' on est forcé de supprimer une partie de ses progrès, peut-on mieux dissiper les nuages dont on a eu le malheur de l'obscurcir, qu'en se faisant honneur de avoir embrassée sans intérêt et sans contraite? D'ailleurs, la principale objection qui m'avoit refroidi si long-tems, et que j'avois même renouvellée au Comte, se trouvoit fort heureusement détruite par quelques-uns de ses principes. Si la diversité des Religions est un obstacle qui arrête la Raison dans le choix, c'est à la Raison fiere et orgueilleuse à le craindre. Celle qui cherche à s'éclaircir, avec cette humble défiance que sa foiblesse naturelle est capable de lui inspirer, n'a point à redouter d' obstacles, puisque dans les principes de la doctrine que j'adoptois, elle est dirigée par un secours intérieur, que supplée à ses lumieres. Mon expérience même suffisoit donc pour ruiner un malheureux sophisme. J'ajoute, que, n'étant encore qu'à l'entrée de la Foi, je ne pouvois être arrêté par la concurrence de quelques Religions monstrueuses qui sont l'opprobre de la Raison; et quand mon objection auroit eu quelque force, ce ne pouvroit être qu'à l'égard des différentes sectes qui partagent le Christianisme.[7]

It will be observed that the content of the passages struck out has to do with the disparagement of the character of the Jesuits, with the intolerance of the Roman Catholic church toward Protestants and their over zeal to convert them, and with criticism of narrow sectarianism.

The content of the text revised is similar in nature to that of the deleted passages. A comparison of the passages revised can be presented most easily by placing the passages from the predominating texts and that of the 1778, 1781, and 1785 editions in parallel columns.

Text of Eight Agreeing Editions	Revisions of 1757, 1778, 1781, 1785
. . . . en lui faisant entendre qu'il avoit à l'entretenir d'une affaire où le salut éternel de son ame étoit intéresse.[8]	. . . . et avoir employé les discours les plus insinuans.[9]

[7] *Le Philosophe anglais* (Amsterdam et Paris: Serpente, 1783), IV, xv, 430. Reference cannot be made to the Utrecht, 1739 edition because volume VIII is missing in the only 1739 edition available for this study.

[8] *Le Phil Ang.*, (Utrecht, 1736) v, vii, 263.

[9] *Ibid*, (Rouen, 1785) V, vii, 118.

Madame Lallin, qui ne croyoit pouvoir déguiser la vérité sans crime à son Pere Confesseur, demeura fort embarassée. J'ai su depuis d'elle-même, que la voyant dans le doute de ce qu'elle avoit à répondre, il leva tous ses scrupules par ce dilemme. Ce que vous craignez de me dire blesse la Religion, ou ne la blesse point. S'il la blesse, vous ne pouvez me le cacher, sans vous rendre digne de l'enfer. S'il ne la blesse pas, vous assurez la paix de votre conscience, en vous ouvrant à votre Confesseur; et vous savez que vous ne courez aucun risque, puisque cela demeure caché sous le secret de la Confession. Elle répondit aprés cela sans balancer à toutes les questions qu'il lui fit.[10]

Madame Lallin, qui ne s'attendoit pas à une pareille question, demeura fort interdite; mais le P. profitant de son embarras, et la voyant dans le doute de ce qu'elle avoit à repondre, la détermina si bien par tous les motif de Religion qu'il crut propres à l'alarmer, qu'elle lui découvrit enfin tout ce qu'il voulut sçavoir.[11]

. . . . éviter la persécution qui les menaçoit.[12]

prevenir l'orage dont elles étoient menacées.[13]

Le service qu'il m'avoit rendu lui faisoit compter aussi que j'en serois plus disposé à l'écouter et qu'il pourroit m'amener tôt ou tard à la Religion Romaine.[14]

Il comptoit aussi qu'il pourroit m'amener tôt ou tard à la Religion Romaine.[15]

The content of these revised passages concerns three topics: the casuistry practiced by the Jesuit in getting Mrs. Lallin to betray to him a secret, the persecution of the Protestants in France, and the zeal of the Jesuit to convert Cleveland to the Roman Catholic faith. The Jesuit's intent is to use the secret learned through the confessional to keep Cleveland in France, for he believes that he can convert him. He has tried to persuade the archbishop to put Cécile in a convent and Cleveland in the Bastile so that Cleveland will become a Catholic in order to get his freedom and to marry Cécile. The archbiship, however, fears to act until the king and the Duchess return, for Cleveland had appealed to them when forcible methods were used by Father le Bane and his bishop.

The treatment of these passages, as well as the content of the omissions, suggest a desire on an editor's part to tone down

[10] *Ibid,* (Utrecht, 1736) V, vii, 264.
[11] *Ibid,* (Rouen, 1785) Vi, vii, 118.
[12] *Ibid,* (Utrecht, 1736) V, vii, 266.
[13] *Ibid,* (Rouen, 1785) V, vii, 119.
[14] *Ibid,* (Utrecht, 1736) V, vii, 266-267.
[15] *Ibid,* (Rouen, 1785) V, vii, 119.

Prévost's satire and irony in respect to the character of the Jesuits and the intolerance of the Catholic church.

Both deletions and revisions are arguments for ecclesiastical censorship. A detailed comparison of texts reveals also substitutions of one word for another, or insertions of words within a phrase which are in some respects of little significance; in others these changes serve to corroborate the conclusion suggested by the omission and substitutions, that changes in text have been made for the purpose of avoiding offense to ecclesiastical authority.

Words Used in Eight Agreeing[16] Editions	Substitutions in 1757, 1778, 1781, 1785
le Jesuit, or le J.	le P.
La Dévotion aisée	la Pratique aisée de la Dévotion
confesseur	Directeur
à confesseur	à avouer
sa vengeance	son projet
de procurer	d'avancer
embrasser la Religion Romaine	cela
ce projet	ce dernier projet
son confesseur	son perfide confesseur

The substitution of "le P." for "le Jesuit" in every instance where it is used in these passages is probably designed to take attention from the charges of having satirized the Jesuit order.[17] Whether the change in title of the book *La Devotion aisée* makes it less satirical may be a matter for difference of opinion. The changes of "sa vengeance" to "son project" and perhaps one or two of the other word changes are consistent with an intent to avoid charges of malicious satire of the Jesuits or implied criticism of Catholic zeal.

Harrisse lists no edition of *Le Philosophe anglais* between 1744 and 1757, and this study has resulted so far in discovering no edition between these two dates. As far as present evidence indicates, the 1757 Amsterdam edition of Ryckhoff was the first to delete and to revise passages and to substitute other words and phrases for those in the original text. This censored text, which was followed until the original text was restored in the 1783 Paris edition of Serpente, suggests a number of problems related to the religious controversies of the period and to the censorship exerted by ecclesiastical authorities.

[16] The passages in which these word changes occur are found in Utrecht, 1736, V, vii, 150-271.

[17] Prévost asks in his preface to the continuation of 1738-39 that any one into whose hand an earlier text may fall, erase all the letters except the initial one from the word Jesuit.

In the first place, we may note that all the censored texts examined in this study were published either in Amsterdam or in Rouen; the one, a city in a Protestant country in which were published many books, periodicals, and newspapers suppressed in France; the other, a city which, according to Bachman,[18] headed the list of those provincial cities which carried on a flourishing business in the printing of forbidden works.

It seems a pecular fact that an edition apparently censored so as to be less offensive to the Roman Catholic church and to the Jesuits should appear in cities which were often the printing centers of forbidden books.

A second fact of interest is that the Rouen texts were based upon the Amsterdam text. This relation may indicate a business connection between the two publishing houses.

The 1785 Rouen edition of Racine contains, in the official permission for publication, the stipulation that the Amsterdam text of 1778 is to be followed, and the comparison made in this study shows that they do agree page for page, line for line. Furthermore, the Rouen 1781 edition of Dumesnil contains in its official permission a similar stipulation that the text is to be that of the Amsterdam 1766. It has not been possible up to this time to examine the 1766 edition, but since the 1781, based upon it, agrees with the 1757, the 1778 and the 1785 editions, it seems justifiable to conclude that there are at least five of these editions of Amsterdam and Rouen agreeing in text.

In seeking to discover the reason for these censored texts we may consider several hypotheses. Since so many of the passages concern the Jesuits, one may well look first for evidence of their reactions to *Le Philosophe anglais,* and then consider whether they could have exerted the necessary pressure to produce the censored edition.

As evidence of the resentment of the Jesuits to certain passages in *Le Philosophe anglais,* we have Prévost's letter addressed to the order and existing only in manuscript until Harrisse published it in 1896.[19] It is apparent from this document that the order had resented not only Prévost's attacks in the first four volumes of *Le Philosophe anglais* but also his comments on Père Daniel and Loyola contained in the notes to his transla-

[18] Albert Bachman, *Censorship in France from 1715 to 1750,* (New York: Columbia University, 1934) p. 44.

[19] *L'Abbé Prévost,* pp. 239-244.

tion of de Thou's *l'Histoire universelle.* Furthermore the Jesuits refused to accept his repudiation of the fifth volume of 1734 and found in its style and its calumnious portraits of the Jesuits evidence that it was by the author of the first four volumes.[20]

Without entering into a detailed discussion here regarding these controversies[21] with the Jesuits, one should note that the point pertinent to the problem of the censorship of the 1757 edition is that Prévost had provoked the wrath of the Jesuits and that, through articles in the July and November issues of the *Journal de Trevoux,* they made charges which he answered in the unpublished letter.

In spite of Prévost's protests that he respected the Jesuits and that he was not the author of the fifth volume of 1734, the matter of the treatment of the order was still a live enough issue in 1738 for him to make further defenses of his attitude in the preface to the continuation volumes. The plot, he said, had demanded the introduction of a wicked ecclesiastic and nothing would add interest to the book so much as the contrast of one bad member in an order so celebrated for its merit and reputation. True to a good eighteenth century precedent, he requested that those into whose hands the manuscript might fall would erase from the word Jesuit all letters except the initial "J". In conclusion he mentioned the complimentary description of the Jesuit college of Louis-le-grand in the last volumes.[22]

This evidence of bitter controversies with the Jesuits makes it seem entirely plausible that they would attempt to use their influence to have the offensive passages removed. It was during the middle of the century that they were growing in power and influence, but the difficulty of attributing the censorship of the 1757 edition to the Jesuits' influence is that they would have little influence and no power over the Amsterdam press.

A study of the nature of the changes made in the text suggests, however, that they are the work of an editor eager to avoid giving offense to authorities rather than the work of a member of the Jesuit order, for there seems to be a care exerted not to mutliate the story and to keep the essential character of the Jesuit unchanged, but to modify the keenness of the satire.

[20] Harrisse cites as evidence *Memoires de Trevoux,* juillet 1735, p. 2386.

[21] A good summary of these controversies is given by Harrisse in his *L'Abbé Prévost,* pp. 238-244, and by Hazard in his "Jansénisme" in *Etudes Critique sur Manon Lescaut,* pp. 59-65.

[22] *Le Philosophe anglais* (Utrecht: Neaulme, 1738, 91) VI, "Preface", i-iv.

In view of the friendlier relations between Holland and France after the beginning of the Seven Years War and the drawing away from England at the same time, it is possible that Ryckhoff found it a good business policy to produce an edition acceptable to French authorities.

A third place to seek for a solution for a Dutch publisher's printing this censored edition is in the religion of Ryckhoff. If one could discover him to be a Catholic, that fact would explain his own interest in toning down these passages.

Until more evidence is found, however, the reason for the censorship of the Amsterdam-Rouen texts is merely a subject for interesting speculations.

In addition to these censored editions, we have two other types of editions, the condensed versions of London and Paris.

The London edition of 1788, for which no publisher is given, is a condensed version shortened by omissions. In some places the text is abbreviated to the extent of omitting passages of thirty pages or more in length. Frequently five or six pages are cut out. The cutting is done with some care, too, for short phrases which would be inconsistent on account of previously deleted passages have been struck out and proper transitions are inserted wherever the omissions make such additions necessary for coherence. When the extensive deletion of all religious discussions was first noted, a connection with the history of religious controversy seemed plausible.

A laborious examination of the content of the passages omitted shows, however, that they are of several definite kinds. Nearly all of them can be classified under one of these heads: philosophical or religious discussions, narrative or exposition regarding the conflict between reason and feeling, distinctly sentimental comments or reflections by Cleveland, anticipations of later events in the story often in a fatalistic tone, and omissions of matter not germane to the main narrative. There are some omissions for which it is difficult to find any principle of classification, but the majority suggests a definite editorial purpose: either to remove from the story matter of which the editor did not approve or which he felt would not interest the reader, or to condense. Evidently the work was done upon the basis of definite principles, but not merely to avoid offending the church.

Since the title page of volume I of this edition bears the words "Collection de Roman", the editorial principle may have been merely to condense a long novel by omitting that material which would not appeal to readers looking for an entertainment. Certainly, as a story to divert the mind, *Le Philosophe anglais* has enough of melodramatic adventure to satisfy those in quest of vicarious thrills. If the omissions are on the basis of making the book a more entertaining novel, it is easy to explain the omission of long philosophical and religious discussions; but this theory does not account for the omissions of such passages as Cleveland's tirade over Fanny's unfaithfulness, or the whole incest story, which appear to be the stuff to catch the interest of a sensation-loving reader.

The following list of omitted passages,[23] classified as to the general nature of content, will serve to demonstrate that the cutting has been done upon the basis of a definite editorial policy toward certain types of passages. Although there are a few omissions which seem merely to shorten the narrative, the general policy has been to delete philosophical and religious discussions, analyses of the conflict between reason and passion, and introspective discussions of the power of the sentiments.

[23] The references in the list of passages are to the 1785 edition.

Omitted Passages of Philosophical and Religious Discussions

Neo-Stoicism of Cleveland's mother	I, i,	6-7; 8-9; 43-47; 48-49
Religion taught to Abaquis	III, v,	150-56
Reference of Neo-Stoicism	IV, vii,	52
Re-examination of philosophy	IV, vii,	141-42; 143-67
Condensation of conversation with Minister C.	V, vii,	5-8
Condensation of conversation with Père Bane		10-15
Condensation of conversation with Jesuit		52-58; 66-67
Discussion of philosophy with Count Clarendon	VII, xii,	134-42
Clarendon's discussion with Père Recteur		163-67; 180-89
Description of the religion of the Nopandes	VIII, xiv,	19-24
Cleveland's comment on strength Fanny receives from religion	xv,	187-88
Conversion of Cécile		173-77
Conversion of Cleveland		193-215

Omitted Passages Treating Conflict between Reason and Natural Feeling

Cleveland also has a heart	II, iii,	1, 2
Cleveland a man of sensibility	III, iv,	62-63; 69
Struggle to concentrate on studies when Fanny in same room	IV, vii,	86-92

Wild ravings after Fanny's elopement		128; 130; 133
Philosophy powerless to comfort him when love is denied	V, vii,	33; 34; 35
Love, a disorder of the reason		109-10; 110-11
Struggle against power of love		115-16; 149

Omitted Passages Distinctly Sentimental in Content

Pleasure in writing of sorrows	I, i,	2-3
Gratitude to Mrs. Riding		41
Reflections upon mother's death		49-52
Reflections upon Axminster's fate		67
Analysis of love for Fanny		104-10
Musing on leaving England and on influence of his mother	ii,	116-17
Great love for Fanny		140-41
Extravagant statements about his happiness		171
Lament over misfortunes	iii,	31-2; 113; 151
	IV, vii,	121-23
Misunderstanding of Fanny's tears		110
Beautiful friendship with half-brother		116-17
Tirade against Fanny's unfaithfulness	V, vii,	29
Beginning of love for Cèçile		65
More of love for Cècile		85; 88-89; 115-16
Death of Duchess Henrietta; sadness	vii,	159-60; 161
Ravings against Fanny		172-73
Illness from wounds		180-84
Introspection on reactions to sorrows		191; 200
Love of Duke of Monmouth	VII, xii,	191-92; xiv, 121-23
Sentiment in Mrs. Riding's story of adventurers		211-12
Mrs. Riding nourishes Cécile with her blood.	xii,	219; 220-22
Don Thadeo's mad love	VIII, xiv,	39
Incest story		44-52; 154-62
Happiness not in worldly pleasures		76-77
Fanny discusses Cécile's mood		78-79
More sentimentality: vanity of pleasure; great sorrows paralyze sensibilities	xv,	169

Omitted Passages Anticipating Later Events, Often in Fatalistic Vein

Obliged to punish Mou severely	III, v,	141
Fanny really faithful and Cleveland innocent of crime	v,	146-147
Trip to get Mrs. Lallin unfortunate decision by Providence	IV, viii,	94
New evils to come—great happiness snatched away	V, viii,	159-60
Not destined for happiness	VIII, xv,	184

Omitted Passages Which Merely Shorten Narrative

Story of gullibility of Cleveland upon first experience with life in French city	I, ii,	126-31
Incidents from story of colony on St. Helena	III, v,	142-43; 170-71; 182-83; 190; iv, 12-13
Story of General Lambert	IV, vii,	55-78

Comment on affairs at French court	V, vii,	75-76
Visit to Mme. Lallin and Mrs. Bridge to Chaillot to see Fanny	viii,	135
Comment when Gelin reveals himself in attempting to kill Cleveland		150-51
Complimentary reports about Fanny by one of the nuns.		206-11

The simplest conclusion to draw regarding the reason for omitting so many long passages in the 1788 edition of *Le Philosophe anglais* is that the editor wished to condense an overly long novel and did so by striking out passages which, in his judgment, were of least interest to the novel-reader and of no value in advancing the plot. If this be the case, the editor was a person with a very superficial view of the plot of *Le Philosophe anglais,* for shorn of such passages as those stressing the neo-Stoic philosophy in which Cleveland was educated, those relating his despair when this philosophy fails him, and those giving the story of his conversion, the novel becomes merely a series of melodramatic adventures strung on the biographical thread. With these passages retained, the story is one of inner conflict resolved by the conversion of the hero to religion. Prévost's own statement in his defense of the book in *Pour et Contre*[24] and in the preface to the continuation volumes of 1738-39 makes clear that such was the theme he had chosen.

Since the bibliographical history of *Le Philosophe anglais* is closely involved with religious controversies of the earlier eighteenth century, one might consider, as another reason for these omissions, that the bitter religious controversies of later date, such as the violent anti-catholic riots in London in 1780, might cause a prudent editor to delete from a novel by a Catholic abbé passages which might in any way touch upon matters of religious differences. Such a theory would account for the omission of passages from the arguments with the three ecclesiastics and from the story of Cleveland's conversion. Again, as in the case of the Amsterdam-Rouen editions, there is the possibility of a connection between a good business policy and the history of religious conflicts.

The Paris edition of 1788 has no bearing upon our present discussion, for it is merely a version condensed by being retold in the third person and published as one in a series of popular

[24] IV, 36.

romances retold in the *Bibliothèque universelle des Romans,* issued monthly.

From the preceding comparison of the texts of eighteenth century editions of *Le Philosophe anglais,* these tentative conclusions may be drawn.

1. Passages concerning the Catholic church and especially the Jesuits were deleted from at least five eighteenth century texts.
2. These censored editions, agreeing in deletions and revisions, were published in Amsterdam and in Rouen.
3. There are three theories, each fairly plausible, but without satisfactory proof, for the censorship of these editions: the influence of the Jesuits, the religion of the publisher, and the business interests of the publisher.
4. Of the three theories that of the business interests of the publisher seems to be the most plausible explanation.
5. The content of passages omitted from the condensed London edition of 1788 suggests two editorial policies: to cater to the taste of the average reader and to avoid offending readers through the treatment of controversial subjects. Either or both reasons are consistent with business interests.

Whatever explanation may be established by further evidence one fact remains unaffected: *Le Philosophe anglais* was a work of sufficient importance to merit the minute attention of those who were engaged in the religious controversies of the eighteenth century.

LITERARY CRITICISM IN THE *NORTH AMERICAN REVIEW*, 1815-1835

HARRY HAYDEN CLARK

Before a satisfactory history of American literary criticism can be written, an immense amount of spade-work and inventorying will have to be done, especially in the magazines. As a beginning in this direction, the present paper seeks to provide an chronological bibliography of critical essays which appeared in the *North American Review* (the major critical journal of the period) from its founding in 1815 to 1836, the eve of Transcendentalism which was then ushered in by Emerson's *Nature*. Fairly full summaries have been provided, the key phrases being quoted with page-references, and the essays have been numbered for convenient reference below.

On the whole, it is hoped that a study of the material presented will justify a revision of the generally accepted opinion of the *North American Review*, which may be illustrated in the words of George E. DeMille: "In spite, however, of their admiration for Byron, Scott, and Wordsworth, the fathers of the review were by no means Romantic in their literary doctrines. They are indeed a clear illustration of the late survival of the Eighteenth Century in America."[1] A careful study of *all* the evidence shows, however, that, granting a reactionary element, the *Review* embodied a rather surprising number of articles setting forth romantic ideas. The *personality* of Emerson and the beauty with which he *expressed* his ideas, together with the absence of any one comparable personality in New England during the 1815-36 period seems to have led most readers to look upon his *ideas* as sharply original and very different from those to be found in the *North American Review* of the decade preceeding. It may seem startling, but the evidence now presented warrants the view that, although Emerson surely had many other sources, he *could* have found practically all his early

[1] *Literary Criticism in America*, New York, 1931, P. 23.

Transcendental and romantic ideas in the very pages of the *Review* he is supposed to have so sharply departed from. Indeed, it may well be that the reception accorded Emerson is partly accounted for by the fact that many New Englanders had been gradually but steadily moving in his direction, and that the *Review* had done much to acquaint its readers with the ideas to which he was to give the prestige of his impressive personality. In 1819 he liked the *Review* so much that he urged his brother to subscribe for it; in 1822 he said it "grows better and travels further"; in 1823 he wrote, "The last N. A. Review . . . is full of wit and literature of which the Idol (Edward Everett) wrote six articles."[2] Indeed, it is not strange that he should have admired it, for two of the leading editors were his old Harvard teachers for whom he had profound respect—Edward T. Channing (who taught Emerson rhetoric and to whom many of his ideas about style and literature [see No. 14 following] may be traced) and Edward Everett, his "Idol" who taught him Greek and inspired him with his eloquence. Transcendental ideas appear in the discussion of Gerando's work on Plato (No. 106 following), in essays on Madame de Staël and her introduction of German thinkers (Nos. 66, 84, 43, 200), in a panegyric on Cousin (No. 193; see also 55), in numerous essays on German thinkers (especially Nos. 114, 19, 117), in essays on Coleridge (Nos. 218, 224; see also 36, 229 and 47), on Wordsworth (No. 109; see also No. 47), and on Carlyle (No. 231; see also No. 229).

Another issue which was vigorously debated in the *Review* was the question whether American literature ought to be distinctively "national" or "universal" in appeal and without conscious departure from European standards. For nationalism see Nos. 1, 3, 4, 7, 8, 14, 29, 39, 42, 45, 46, 53, 64, 74, 75, 76, 91, 92, 108, 114, 119, 120, 121, 127, 146, 159, 166, 175, 183, 186, 189, 192, 194, 223, 226. For aspects of the counter-argument for universalism and respect for European traditionalism, see Nos. 17, 33, 34, 41, 48, 51, 57, 61, 67, 70, 80, 107, 112, 128, 134, 140, 144, 150, 151, 155, 165, 166, 171, 174, 205. Faith in progress is expressed in Nos. 141, 160, 168, 184, 222; it is questioned in Nos. 140, 158, 188, 221.

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[2] Emerson followed the *North American Review* closely, even to ascertaining the authorship of many of the anonymous articles. See his *Letters*, edited by Rusk, I, 27, 41, 81, 110, 113, 123, 131, 142, 149, 168, 219, 287, 291, 292, 345, 419, 433.

For aspects of the romantic point of view, consult Nos. 10, 12, 14, 23, 27, 29, 36, 38, 43, 45, 47, 50, 52, 56, 57, 66, 69, 75, 97, 102, 109, 118, 122, 152, 160, 184, 194, 198, 207, 213, 219, 224, 225. It is possible that the general notion that the *Review* was primarily hostile to romanticism and transcendentalism, primarily the advocate of a reactionary neo-classicism, has been suggested (among the moderns who have read it at all) by the extreme truculency of the Peabody brothers/W.B.O., and O.W.B., —see Nos. 174, 158, 190, etc.

The editors of the *Review* were as follows: William Tudor, 1815-17; Jared Sparks, 1817-18; E. T. Channing, 1818-19; Edward Everett, 1820-23; Jared Sparks, 1824-30; A. H. Everett, 1830-35. Contemporary judgment of the quality of the *Review* may be found in the rival *Knickerbocker Magazine,* (V, 465, May, 1835):

"In every respect the *North American Review* is an honor to the country. In politics it is liberal and impartial. We hail it as the sole exponent, in its peculiar sphere, of our national mind, character, and progress; and are proud to see it sent abroad . . . as an evidence of indigenous talent, high moral worth, and republican feeling."

SUMMARIES

1815

1. William Tudor, "The United States and England," I, 61-91. (May, 1815).

A review of a pamphlet entitled, "The United States and England, being a reply to the criticism on Inchiquin's Letters, contained in the Quarterly Review for January, 1814." Maintains that English reviews and writers have a "disposition to think themselves infallible" and give a "vehement misrepresentation" of our character (62-3). Denies the reliability of such writers on America as Weld, Parkinson, Moore, and Cobbet. Quotes at length from the pamphlet reviewed to show the deficiency of American literature is mainly due to the constant demand here for an active life in fighting Indians, the struggle for existence, the Revolution, and the turmoil of the French Revolution (83-7). Ends with a plea for better relations between the two countries; "there is nothing essentially conflicting in the permanent interests of the two nations" (88). Suggests we "exchange a few individuals annually" as a means of disseminating knowledge of "the true state of things in the countries of each other" (89). (For orientation see Jane L. Mesick, *The English Traveller in America, 1785-1835.* New York, 1922.)

2. William Tudor, "Miss Huntley's *Poems,*" I, 111-121 (May, 1815).

A favorable review of *Moral Pieces in Prose and Verse* by Miss Huntley (Mrs. Sigourney), in which Tudor reveals himself as a transitional figure, veering from a liking for neo-classical "freedom and facility" of style, "correctness and harmony" of matter, and freedom from "false taste" (119-120), to a liking for the "exquisitely beautiful and pathetick" and "sublime" of early romantic sentiment and melancholy. Tudor is also a nationalist; the American scene is an unopened "rich and various" (120) source for literature, consisting of the frontier and the French and Indian Wars, the Indians themselves, a great variety of people, and finally a great "magnificence of the scenery" (121).

3. William Tudor, "The Lord of the Isles," (Scott), I, 275-284 (July, 1815).

A review favorable to Scott in which Tudor expresses his "reverence for the old school of poetry" and the "versification of Dryden and Pope," but believes Scott will live by "the freshness, energy, relief and transparency of his description" and "the vigour and enthusiasm of some of his sentiments" (275).

4. Walter Channing, "American Language and Literature," I, 307-314 (Sept., 1815).

Channing is an extreme nationalist. He gives two reasons for America's backwardness in literature: (a) the possession of the same "language with a nation, totally unlike it in almost every relation"; and (b) America's reliance on English literature rather than on "a laborious independent exertion of its own intellectual powers" (307-8). He discusses the first statement at length here and the second in a later article (see no. 8 below). The English language is fitted to the climatic, social, political, literary, and religious conditions of England. These conditions are utterly different in America, and the English language therefore is not a fit vehicle for an American literature based on these conditions. Ends with an expression of the noble savage ideal: the only original literature in America is the "oral literature of the aborigines"; it uses languages fitted to American conditions (313).

5. William Tudor, ". . . a memoir on the present state of the English language in the United States of America . . . by John Pickering," I, 386-9 (Sept., 1815).

Tudor is a purist, attacking the idea of an American language. He advocates instead "sound respect for the great standard authors of the language" and for English critics who point out American peculiarities. He is a nationalist nevertheless; our language is to be an improved "second edition" (387) of the language which has begun to decay in England.

6. William Tudor, "Guy Mannering," I, 403-436 (Sept., 1815).

Takes the position of Scott for granted, and merely summarizes the plot for his readers. Dislikes the use of dialect and Scott's invention of new words.

7. William Tudor, "An Address delivered to the Phi Beta Kappa Society, &c.," II, 13-32 (Nov., 1815).

Summarizes the materials from which a national literature can be created. These are: the Revolution, the events prior to 1750 (which constitute our antiquity), the French and Indian Wars, the natural scenery including native animals, and, above all, the Indians. In this respect the Five Nations are comparable to the Greeks "in the heroick ages" and the epic materials of Homer (19).

8. Walter Channing, "Reflections on the literary delinquency of America," II, 33-43 (Nov., 1815).

Our literary delinquency is due to the habit of depending on English literature in the period of our political infancy (see the companion article No. 4 above). The remedy is "a vigorous assertion of our own minds" to discover our character, by a national history stressing American peculiarities and perhaps a history of our poetry.

9. Horace Holley, "On the pleasure derived from witnessing scenes of distress," II, 59-67 (Nov., 1815).

Approaches a psychological study of the phenomenon, but seems to be within the sentimental traditional of the later 18th century, rather than the great tradition of Aristotle. The "cultivated and benevolent take delight in the emotions excited by the well wrought scenes of distress" invented by the "muse of Tragedy, or the genius of Romance" (60). Particularly affecting are "the disinterested sentiments of afflicted virtue" (67).

10. William Tudor, "The Queen's Wake: a legendary poem, by James Hogg," II, 103-109 (Nov., 1815).

Hogg has "the delicacy, purity, and feeling" attributed to shepherds by the ancient poets (104). Dislikes the resurrection of "obsolete, unintelligible, and barbarous terms" by Hogg and other Scotch writers. Ends praising "romantick tales and ballads founded on local superstitions" which lend themselves to "fancy and originality" (109).

11. William Tudor, "Latin Classicks," II, 129-130.

Cicero can be "safely entrusted to youth and innocence" because he contains "no wild metaphysicks" to pervert the mind nor "licentious sentiments" to corrupt the morals. Moreover he is an advocate of "freedom and republican government" (130).

1816

12. Willard Phillips, "Cowper's Poems," II, 233-241 (Jan., 1816).

Defines the nature of criticism. Exalts historical criticism in the place of criticism based on rules and standards. "In matters of taste, every man's opinion must be right in respect to himself;" it is folly to try "to reason men into pleasure or disgust. To judge rightly of others," therefore, we must "transfuse ourselves into, and become identified with them" (235). Doesn't agree with Cowper's ideas, but he is "animated by the glow of benevolence" and is a poet of second rank.

13. Walter Channing, "On the Fine Arts," III, 194-201 (July, 1816).

The fine arts are highly developed in America, but due to the youthfulness of our country and the lack of public taste many artists go to Europe. The only solution is to establish an academy of fine arts for the double purpose of instructing our artists and improving public taste (197).

14. Edward T. Channing, "On Models in Literature," III, 202-209 (July, 1816).

In many ways Channing foreshadows Emerson, who was actually his pupil at Harvard. He quotes Wordsworth and upholds the romantic doctrine of genius and originality. To set up rules and models "comes in the way of nature, and reduces all her irregularities, . . . her endless change, into straightness, smoothness, and harmony" (203). Learning and especially the study of the "classicks" (206) result in an "acquiescing and unproductive" mind (205). Makes a strong plea for a native literature. "Its charm is its nativeness" in spite of its rudeness (207). When a nation through luxury comes into its Augustan age, its only hope is to turn back to its Elizabethan age. (See Channing's *Lectures (On Rhetoric) Read Before the Seniors of Harvard College.* Boston, 1856.)

15. Willard Phillips, "Rhoda," III, 216-218 (July, 1816).

States his preference for the realistic novel of manners, based on daily "occurrences and observations", to the Gothic novel based on "superhuman characters and preternatural incidents" (217). The former shows more maturity, "requires greater progress in the arts," demands "greater skill" from the artist, and shows "improved susceptibility and taste" in the public (217).

16. William Tudor, "The Story of Rimini, a poem, by Leigh Hunt," III, 272-283 (July, 1816).

Tudor is here strongly neo-classical; taste and judgment are based on certain fixed standards (273). There are three schools of poetry in our language: Chaucer to Milton, Dryden to Johnson, and the contemporary age. The latter is a chaos of undisciplined and unchastened inspiration.

17. F. C. Gray, "An Address pronounced before the Society of B. K. . . . ," III, 289-305 (Sept., 1816).

The American man of letters is too ignorant of the world. He must study all history, including philosophy, oratory and poetry, as well as the history of New England (293). Gives three reasons for the deficiency of America: freedom of opportunity draws talent into other fields; the Indians, the Revolution, and the Constitution exacted all our best efforts; and our language brings in English competition. Concludes that America cannot equal Europe without first undergoing a long strenuous period of study.

18. Sidney Willard, "A Vocabulary, or collection of words and phrases which have been supposed to be peculiar to the United States of America . . . By John Pickering," III, 355-362 (Sept., 1816).

A purist view of language. American writers must make a diligent study of the English language to "avoid improprieties and barbarisms" (358). Mentions Dryden as a pure writer. Native American words should be admitted only "with caution" (357).

1817

19. Edward Everett, "Goethe's Life—by himself," IV, 217-262 (Jan., 1817).

A summary with translated excerpts of Goethe's autobiography; its purpose is to increase American interest in the great German (261). Everett attacks Goldsmith's *Vicar of Wakefield* as a too realistic picture of life (249) and says Goldsmith himself proves "the original inspiration of Genius" (260). Yet Everett says that "the elements of poetry" are drawn from the conflict of the spirit of man with the "inexorable conditions of destiny" (261). A notable review, introducing Goethe to America. (See No. 109 following.)

20. Jared Sparks, "Augustan Age of Italian Literature," IV, 309-327 (March, 1817).

Main object is to acquaint Americans with Italian literature which has not "attracted the attention it deserves" (315). Takes the position that the "progress of literature" was the cause of the Reformation, and shows some intimacy with and adherence to neo-classical literary principles.

21. William Tudor, "A new volume of poems, by Lord Byron, . . ." IV, 369 (March, 1817).

Byron is one of the "most signal instances of the perversity of genius, that the world has ever known." Accuses Byron and Sterne of exploiting sentiment for the vulgar.

22. Franklin Dexter, "Airs of Palestine; a Poem; by John Pierpont, Esq.," IV, 408-420 (March, 1817).

Justifies our lack of a literature; our "increasing population, peculiar form of government, and the republican doctrine of rotation in office" demand all our talent (408). Dexter is a neo-classicist; he regrets that the heroic couplet, used in this poem, has gone out of fashion in the present age of "ballad-mongers and song-wrights" (411).

23. Edward T. Channing, "Memoir of the early life of William Cowper, Esq. written by himself . . . ," V, 48-55 (May, 1817).

Romantic in temper, Channing has only praise for Cowper. He brings the "humblest reader to visit nature with his heart" (53), and has become a popular poet "without sparing a single fault" or departing "from a pure native taste" (54).

24. Willard Phillips, "Poems by Lord Byron," V, 98-110 (May, 1817).

Phillips is a romanticist and a thoughtful critic. Refuses to judge Byron by the rules (by which "little minds fancy they can comprehend great things"). Poetry is most "easily and accurately estimated by its effects" and, of all the arts, it "can least endure the fetters of a system, as its vital principles are novelty and invention" (107). He attacks the "monotonous cadences of Pope" but thinks Byron's verse could be improved (108).

25. Willard Phillips, "The Village; a Poem," V, 224-226 (July, 1817).

The poem's chief merit is that it keeps up the practice of the art in America. It indicates no "bold strokes of genius" (226) but some "talents", and might better, since it is mostly descriptive, have been done "in plain prose" (225).

26. Franklin Dexter, "Sancho, or the Proverbialist," V, 239-244 (July, 1817).

A conservative and neo-classicist, Dexter deplores the extensive diffusion of literature and learning; books must now be gauged "to the taste of the lowest capacity" which is that of "sentimental chambermaids or romantick cooks" (240). A few "gentlemen authors" remain, but the demands of philanthropy are greater than those of literature.

27. J. G. Palfrey, "Tales of My Landlord," V, 257-286 (July, 1817).

Defends the novel on the grounds that it: (1) is a good vehicle of morality; (2) gives a "more vivid impression of reality" (259) than history; (3) suits the general level of capacities and should be used by "men of abilities" instead of by sentimentalists and libertines; and (4) is an instrument of culture destined to do much to determine the "character of the age" (260). One of the glories of our age is the transfer of romance of a high order from the castle to "the cottage and workshop", (261) and the leading light of this movement is Scott.

28. Samuel Gilman, "The Faery Queen of Spencer," V, 301-309 (Sept., 1817).

Gilman, who made the translation of the satires of Boileau which appeared in the various numbers of the *Review* at this time, leans toward neo-classic literary principles. The Elizabethan age is the result of three streams, the classics of antiquity, the romances of the Middle Ages, and the translation of the Scriptures, which contributed respectively, reason, fancy, and elevated morality. "Taste" was embarrassed by the union, but "genius", "loftier passions", and the "expression of god-like sentiments" were richer fruits. Lauds Spenser and laments the decline of allegory.

29. R. H. Dana, Sr., "The Sylphs of the Seasons, with other poems. By W. Allston," V, 365-389 (Sept., 1817).

Gives three reasons for our slowness in literature: dependence on England makes us forget "what is well done here" and leads us to distrust "our own judgment and taste"; and finally our materialism is creating a contempt for intellectual endeavor (366). A disciple of Coleridge, Dana hails the romantic movement as the return to "true taste." Poetry is now freed from "its narrow views of material nature" (368) and, on a much larger scale, from narrow views "on the human level." This "enlarged philosophy" brings the common within the domain of poetical. Praises Allston as a romantic.

30. Edward T. Channing, "Lalla Rookh, an oriental Romance. By Thomas Moore," VI, 1-25 (Nov., 1817).

Unsympathetic to Moore but not to romanticism (an "age of firm and healthy poetry"). There is a "natural alliance between genius and purity" which makes Moore's transgressions inconsistent. His ingenious fancy is artificial and ornamental; it is not a "poetical embodying of thought" (5).

1818

31. Willard Phillips, "Harrington, a Tale, and Ormond, a Tale, by Maria Edgeworth," VI, 153-178 (Jan., 1818).

A favorable review praising the author's realism (she "discriminates between the real and the seeming") (154) and her "moral wholesomeness". Attacks the novel of the past; on the one hand, the "sentimental deliriums of romance" and, on the other, "false views of life" in Fielding, Smollett, and Madame de Staël. Especially vicious are those which represent "chance as the arbitress of the world" at the expense of virtue and prudence (155). Miss Edgeworth has reformed "the novel-sick mind" of all this (156).

32. "Magnalia Christi Americana. . . . By the reverend and learned Cotton Mather . . . 1702," VI, 255-272.

In this "efeminate period" with its "restless . . . novelty-seeking" "a fair perusal of Mather's *Magnalia* is an achievement not to be slighted" (255-6). In general defends Mather; his "faults were those of his age" (257); and though it is inaccurate his history is the best on the "state of society and manners" of the time (272).

33. Levi Frisbie, "Well's Edition of Tacitus," VI, 324-331 (March, 1818).

Frisbie believes there are great advantages to be derived from the "study of the classicks", especially for "our rising literature" (324). They help "discipline" the mind, enable us to acquire "copiousness of expression," and give a knowledge of life in ancient times which is at least as valuable as that of geography and natural science.

34. Willard Phillips, "Letters from the South" (Paulding), VI, 368-382 (March, 1818).

A very sane review, unfavorable to Paulding, who thought that we could develop a superior literature by relying on a race of original geniuses and by substituting the study of belle-lettres for mathematics in our colleges. Phillip's reply is that of the universalist; we must read and study "night and day the most distinguished authors in literature and science, both in the ancient and modern languages" (373). Says the insistence on complete independence from Europe by men like him has led America into useless "novelties"; we should learn to imitate "judiciously" as all great nations have done.

35. F. W. Winthrop, "Beauty," VII, 1-25 (May, 1818).

An attack on the theories of beauty which Jeffrey expressed in the *Encyclopedia Britanica.* Denies Jeffrey's contention that there are general laws of beauty based on the "theory of associations" (22); or upon the rules of the critics. The standard of beauty of a work of art is "its effect on us, as individuals" (23). To avoid eccentric decisions, however, we should conform ourselves to the universal which is "the material and intelligent universe" ("the beauties and moral influences of nature" and the "pleasing or grand or impressive in her scenery") (24).

36. R. H. Dana, Sr., "Edgeworth's Readings on Poetry," VII, 69-86 (May, 1818).

A sane critical attack on a book of poetry for children based on neo-classical literary principles. The Edgeworths want to make of children "little matter-of-fact men and unbreeched philosophers", and by their passion for clarifying, the strong passions are cut off and the children "are scarcely allowed to feel" (72). It would be better for children to be left "to the workings of nature"; they must "first have imagination, a poetical sense, and the unnumbered and defineless connexions and feelings, which make up that wonder of creation, . . . a poet, before they can understand his character and works" (76). Poetry is as necessary to society as "well ordered industry"; Coleridge is "the most tasteful and acute of criticks".

37. Willard Phillips, "Godwin's Mandeville," VII, 92-105 (May, 1818).

An impartial, clear-minded review. Godwin abounds in "absurdities, and distortions and misconceptions" but he probably has not "done much absolute mischief to mankind" (95). These "agitations" are "greatly salutary" in themselves unless they cause a fundamental subversion. Admits Godwin's capacity for knowledge and reflection, but notes that this is nullified by a tendency to pursue an "eccentick course with more energy, the further it carries him from nature" (97). His novels are philosophical "dissertations" the actors of which are "certain principles and opinions and passions" (104).

38. Edward T. Channing, "Rob Roy," VII, 149-184 (July, 1818).

Great admiration for Scott by a romantic critic. Stresses the naturalness and reality of the novels on Scotch life and the "singular intimacy with men in the practical, common pursuits" (155). Scott conveys truth "without the formality and limitations of history" (150). He teaches by a "large philosophy" based on "the union between life and poetry" "established by nature" herself (155).

39. W. C. Bryant, "Essay on American Poetry," VII, 198-211 (July, 1818).

A just and rational estimate of Solyman Brown's extreme literary nationalism. Our literature has suffered equally from "unmerited contumely" abroad and "pompous pretensions" at home. We must teach the prospective poet that "only the productions of genius, taste, and diligence" are acceptable at the "bar of criticism" (199). Condemns our early poets for imitating 18th century diction, versification, and lack of imagination (206).

40. S. Gilman, "Eustaphieve's Demetrius," VII, 258-268 (July, 1818).

A dull review of a dull subject. Gilman is a neo-classicist and uses the review to admire this foreigner's grasp of the English language and to notice instances of "violated syntax" and "un-English phrases" (259).

41. J. T. Kirkland, "Literary Institutions—University," VII, 270-278 (July, 1818).

Supports the thesis that universalism is the only way to a true nationalism. Wants to set up one or more large universities like those of Europe devoted to the study of all that "is worth knowing." This will create "a literary profession" which in turn will formulate the diverse elements of our life into a true "national spirit" (276).

42. Andrews Norton, "Dr. Franklin," VII, 289-323 (Sept., 1818).

A review of Franklin's memoirs and letters, somewhat deprecatory. Norton thinks "very differently" from those who hold up Franklin's character as a model for imitation (302). He was a man of this world distinguished by "his zeal and talents for being useful" (318), but his "mind was defective in the higher class of conceptions and feelings" (320). Acknowledges his fame in literature and science. Norton is a nationalist. "We are in advance of the rest of the civilized world" (312). Our greatest need is for a literature growing out of and perpetuating American life and ideals. "There is but one thing wanting—ENCOURAGEMENT" (322).

43. Andrew Ritchie, "Madame de Staël's French Revolution," VIII, 26-63 (Dec., 1818).

Ritchie opposes the ideals of the Revolution, but attributes its cause to the corruptions of the Old Regime. He leans toward romanticism; Madame de Staël is "the finest genius in France" (43). Her style is one of "very rare energy and beauty" (57); her chief fault is an "aspiring desire to be always original, brilliant, discriminating" (59). Notes her distinction between genius and talent, but disagrees with her denial of genius to Mirabeau (60).

44. Willard Phillips, "Women; or, Pour et Contre" (By Maturin), VIII, 118-134 (Dec., 1818).

A very favorable review by a romantic critic. Maturin's chief merit is the "fertility, splendour, and terrible grandeur of his imaginations" (133). He should not rely on the "common and obvious" for his material, as in this novel, but should rely on his own "imagination" (134).

45. Edward T. Channing, "Battle of Niagara" (John Neal), VIII, 142-156 (Dec., 1818).

Channing is a romantic critic, but is fully aware of the falsity of Neal's romanticism. His defects are fancifulness, unreality, indefinite topics, unwillingness to call things by their right names, poverty of expression, and uniformity of tone. Attacks Neal's elevated diction in describing American scenery; our poets will never do it justice till they "paint it as it is" and not in "general terms" and "grand and swelling phrases" (144). The chief business of the critic is to save our poetry from being "a bad imitation of popular authors abroad", and the way is to insist on "originality" (156).

46. John Knapp, "National Poetry," VIII, 169-176 (Dec., 1818).

A mine of material for a national poetry lies unopened in our early history. Such a literature based on traditions and fables, fabulous as well as authentic, is more permanent than one based on imagination alone. Stresses the Revolution, the frontier, and especially the Indians and external nature, as sources of literature (175). Americans are "inspired with some peculiar moral graces, by their grand and lovely landscapes" (174).

1819

47. R. H. Dana, Sr., "Hazlitt's English Poets," VIII, 276-322 (March, 1819).

A review by a romantic critic, attacking Hazlitt as desultory and biased. Agrees with Hazlitt's admiration for the early English poets; next to "studying nature itself" the poetic ideal can best be found by studying their works (256). Disagrees with Hazlitt's praise of Pope and the neo-classic poets; they wrote rather for well-dressed "ladies and gentlemen, than for the man of sentiment and genius alone in his study" (297). Defends the romantic poets against Hazlitt, and gives high praise to Wordsworth. "He brings right thoughts and pure wishes into our minds and hearts, clears our dim imaginations, and the poetry of our being becomes its truth" (319). Dana underrates Hazlitt as a critic, but correctly diagnoses his weakness as being too "full of himself to have a sincere love and interest for what is abstractly good and great" (321). "Mr. Coleridge's critique upon Mr. Wordsworth contains more of philosophy, subtile analysis, and good taste, than does any other criticism upon him, or, indeed, upon any other man whom we can call to mind. In fact, our better criticism owes its birth to that."

48. J. C. Gray, "Dante," VIII, 322-347 (March, 1819).

Gray is a classicist and a universalist who believes that Dante is too little known outside Italy. Thinks the "union of sententiousness, majesty and liveliness" of Dante can be be represented by English "heroic rhyme" (325). Dante has the "first and highest merit of a poet, originality" (334). Says that Dante's "extraordinary share of classical learning" is a great aid to the man of genius (340). Dante most resembles Shakespeare as "the poet of nature"; Milton is the poet "of the invisible world", and Cowper "that of Christian morality" (342).

49. Levi Frisbie, "Smith's Theory of Moral Sentiments," VIII, 371-396 (March, 1819).

Disagrees with Smith's theory. His theory for the solution of the moral problem, like those who "resolve all virtue into self-love, or benevolence, or regard to utility, or the sense of justice," seems to be right only because it sometimes coincides with the internal laws of rectitude implanted in the heart of man by "the great Author of all." Rectitude, therefore, is "not founded exclusively in sympathy, or self-love, or benevolence; but is that principle which controls and directs them all. It is in the moral, what attraction is in the natural world; it regulates and guides the whole system of our affections and powers, preserves each in its proper sphere and due subordination to the rest, and conducts man to the proper end of his being" (396).

50. Franklin Dexter, "Hogg's Works," IX, 1-23 (June, 1819).

A favorable, sympathetic review. Discusses at length the relative importance of genius and education in literary creation and decides that poetry "is eminently the work of genius" (4). Yet training is almost equally necessary; for that reason we cannot expect the "highest efforts" from men like Hogg (5). Considers also the problem of the personality as a poetic factor: "No matter what be the subject, poetry is an appeal from heart to heart, and we cannot but answer it with our sympathy" (6).

51. W. Loring, "Milman's Samor," IX, 26-35 (June, 1819).

Unfavorable. Considers the problem of genius versus learning and decides that there may be either "work of genius, self-dependent," with other factors as auxiliaries, or of "taste and learning, using them as principals" (26-7). Milman must not intrude in "the province of genius." Loring is a universalist and attacks nationalism (34).

52. Edward T. Channing, "The Life of Charles Brockden Brown . . . By William Dunlap," IX, 58-77 (June, 1819).

Favorable to Brown. Analyzes the difference between realistic and romantic fiction. The former makes "the fable subservient to the developing of national character, or of the manners, usages, prejudices and condition of particular classes" (65). But America is not ready for realistic fiction because the social classes are not yet well defined and established (66). Brown was wise to write romantic fiction; he uses American settings but our chief interest is not "dependent upon the conviction that we ever saw the place or the man" (69).

53. G. C. Verplanck, "Lambrechtsen's New Netherlands," IX, 77-91 (June, 1819).

Favors the development of a distinct national literature. The "great interests both of philosophy and of taste are much promoted by the distinct cultivation of each nation's peculiar literature" (78).

54. John Pickering, "Wyttenbach on Classical Education," 192-206, 413- 426 (June, Sept., 1819).

Strongly advocates the study of both classical poetry and prose.

55. A. H. Everett, "History of Intellectual Philosophy," XXIX, 67-123 (July, 1829).

The first few pages, a review of Cousin's works, attack Cousin's New Platonism as a "repulsive system" attempting to identify the Supreme Mind with the material universe "and thus deny its personal and separate existence" (71). The bulk of the article completes Everett's survey of the History of Philosophy begun in an earlier article (see XVIII, 234-66). Everett is a thorough Lockeian: he pays tribute to Newton and Locke for stating clearly for the first time all the knowledge that had been discovered since Bacon and Descartes rediscovered the inductive method of Aristotle (78-9). The "Essay on the Human Understanding" is "the textbook of the noblest branch of human learning" (79). He attacks Berkeley, the Scotch school, and German transcendentalism as modern departures from the true way of Locke (91). He denies any notion of innate ideas (92). Says the material world is susceptible of "perfectly rigorous demonstration" (93). With the exception of Kant, all idealists have been "persons in whose minds imagination seemed to predominate over the other faculties" (108). Concludes that "idealism, historically viewed, presents itself as an unsubstantial dream, which charms the infantile period of intellectual philosophy" (109): gives a point by point analysis of the weaknesses of idealism. (For orientation of Everett's position, see Merle Curti, "The great Mr. Locke: America's Philosopher, 1783-1861," *The Huntington Library* Bulletin, No. 11, April, 1937, pp. 107-152; and for further analysis and praise of Cousin's as "the only possible philosophy" see Mrs. Minot's article, "Cousin's Philosophy," NAR, XXXV, 19-36, July, 1832.)

56. Edward T. Channing, "Greenland and Other Poems, By James Montgomery," IX, 276-288 (Sept., 1819).

Montgomery has little talent. Speaking of criticism, Channing says it is not possible to kill a writer or make him live; all that criticism can do about poor writers and bad taste in the reader is to "put them both to school" (279). Believes in romantic principles; a poet has something more to do "than secure an approving public;" (281) his first object is "to awaken the imagination, to make men feel, to breathe the spirit of poetry into them" (281).

57. R. H. Dana, Sr., "The Sketch Book," IX, 322-356 (Sept., 1819).

Very good critical article, favorable to Irving. Begins with a general criticism of nationalism in American literature. His own policy is to notice any American book of merit, but he examines it "without any home feelings" (323). America is too young to equal Europe; our universal talent for action is inconsistent with an "abstract, ideal, reflective cast of mind" (324). Denies the decay of learning in Europe; all society has gone forward, but "great minds have always reasoned and felt very much as they do now" (325). Outlines a two-fold plan for America: development of American schools and scholarship and the formation of a professional class of men of genius. Labels as faults Irving's neo-classical characteristics, but predicts that "he will always be a standard author amongst us" (356).

58. W. C. Bryant, "On the Use of Trisyllabic Feet in Iambic Verse," IX, 426-31 (Sept., 1819).

The refusal of the neo-classical writers to allow such substitutions causes a "frequent sacrifice of beauty of expression, and variety and vivacity of numbers." The principle is "not incompatible with the principles of English versification, nor displeasing to an unperverted taste"; it is not entirely an innovation but our "ancient birthright" found in Shakespeare and Milton. It ought to be reclaimed. (A brief but important essay paving the way for the more liberal and flexible prosodic practise of Romanticism.)

1820

59. Edward Everett, "Memoirs of Professor de Rossi," X, 1-14 (Jan., 1820).

First pages devoted to pointing out the necessity of scholarship in America. Our civil and political freedom gives us no immunities from "intellectual laws." We must labor and study and not hope to take "a single step by force of genius, which has been taken in the old world by the dint of labor" (2).

60. Edward Everett, "Mississippian Scenery: a poem descriptive of the interior of North America. By Charles Mead," X, 14-19 (Jan., 1820).

Says he ridicules this attempt to make poetry out of a prose subject because of the number of like performances "of late gaining upon us". Poetry has a "beautiful secret of *unity*" and every word sets an "image before you"; prose cannot do this.

61. T. Parsons, "Comparative merits of the earlier and later English Writers," X, 19-33 (Jan., 1820).

An excellent essay by a romantic critic who believes in universal literary values. Prefers the "vigor and originality" of 17th century prose to the "excessive refinement" of 18th century prose (21). The two essentials of good writing are "strength and refinement" (25). Says the *Edinburgh Review* is shaking the hold which the prose of Addison and Steele had on England and is awakening "the slumbering intellect of Great Britain" (27). Looks for the development of a national literature in America. The most effectual means of attaining this object is "study of the classics, in the first place, and next, of the English writers of the middle of the 17th century" (30).

62. Edward Everett, "University of Virginia and University Education," X, 115-137 (Jan., 1820).

Thinks more room should be given to the study of the classics (120) and less to science (126). We need professional schools for advanced study on the model of the continental European schools (125). Laments that the "government of America is the only government in the civilized world, that has never founded a literary institution" (137).

63. Alexander H. Everett, "Geoffroy on Dramatic Literature," X, 291-316 (April, 1820).

A review of Geoffroy's collection of articles on French drama. Defends the thesis that the theater is not harmful to public morals. Discusses at length French drama in order to increase American interest and gives high praise to Voltaire.

64. Edward Everett, "An appeal from the judgments of Great Britain respecting the United States . . . By Robert Walsh," X, 334-371 (April, 1820).

Contains a section in defense of the English language in America against "the hostilities of the British reviews" (362).

65. Edward Everett, "Canova and his Works," X, 372-386 (April, 1820).

Everett is a true classicist. Art was at a low ebb in the middle of the 18th century, but Winckelmann's interest in antiquity purified "public taste of the absurd notions that had corrupted it" (372). The new English school of sculpture enjoins the closest possible imitation of nature and adherence to historical truth, but these are not just principles of art. "Nature is to be imitated, only in her noble, select, and pleasing parts, and historical truth adhered to no farther than it adds to the beauty, grandeur, and charm of the work; provided that the deviation be not such as to shock our judgments" (385-6).

66. T. Parsons, "Life and Writings of Madame de Staël," XI, 124-140 (July, 1820).

Madame de Stael is "the greatest female that has ever written" (139). Yet *Corinne* is a bad novel and the best of her books is that on the French Revolution. Advocates the cultural freedom of women (125). The doctrine of perfectibility put forth in her work is "directly opposed to all right reason and tolerably fair argument" (130).

67. A. M. Fisher, "On the Priority of Greek Studies," XI, 209-218 (July, 1820).

Regrets that in the midst of our success in science, "comparatively few among us have pursued the track which leads to distinction in classical learning" (209). Greek should be studied before Latin. The road to eminence in literature "lies through Greek alone" (214).

68. Edward Everett, "Anastasius; or Memoirs of a Greek. . ." By Thomas Hope, XI, 271-306 (Oct., 1820).

A great progress of taste has been made in the novel, which has now "grown into a vehicle of history, poetry, ethics, and eloquence" (272). This novel is not of the "highest order". Defines the position of the critic: he is absolutely free and executes his charge "as seemeth him good". His function is to spread the reputation of good books and check the circulation of bad ones (277).

69. W. C. Bryant, "Percy's Masque, a Drama, in five acts" (James A. Hillhouse), XI, 384-393 (Oct., 1820).

Tragedy is the most difficult of all "poetical composition" (385), yet he expresses the romantic notion that "tragedy is a noble province of poetry" and "proud would be the triumph of him who, at this day, should overcome its difficulties" (386). Attacks the diction of tragedies for the last hundred years as "too florid and stately, and too far removed from the common idiom of our tongue." Such a language is "not the dialect of feeling" (392).

70. John C. Gray, "Study of the Classics," XI, 413-423 (Oct., 1820).

An article of first importance by a classicist. Recommends the study of the classics in conjunction with "the finest English writers." The chief reason for the study of the classics is "to correct the bad taste, which, more than any thing else, has checked the growth of American literature" (414). Shakespeare and Franklin are brought forward as proofs that the classics are not necessary. A "thorough knowledge of the classics could never have encumbered" the genius of Shakespeare and might have prevented his faults (418). Franklin accepted as a pattern "the classic Addison." Thinks society has gained little "from studious astronomers" (419). Cites the devotion of the New England forefathers to the classics; they "saw the connexion between one kind of useful knowledge and another" (423).

1821

71. Alexander H. Everett, "Private Life of Voltaire," XII, 38-60 (Jan., 1821).

No voluminous writer has ever written in proportion "to the extent of his works less that will finally be overlooked and forgotten than Voltaire" (51). His tragedies are his best work because he had been "tempered in the fiery furnace of adversity" (52). *Candide* is the "sharpest satire that ever was composed" (59).

72. Sidney Willard, "Swedenborgianism," XII, 89-111 (Jan., 1821).

Distrusts the supernaturalism of Swedenborg; he gave "too ready admission to impressions" (90). His doctrines do not "develop a single point of morals before unknown, or make any disputable questions in morality more clear" (93).

73. Edward Everett, "The History of Grecian Art," XII, 178-198 (Jan., 1821).

Dislikes the architecture of St. Peter's as the source of the "superficial theatrical character" of modern taste (184). Next to the Grecian", the old Gothic is "the most pure and noble" architecture (185). Our great insensibility to the beauty of Greek architecture, along with the want of insight into the whole ancient character, constitute the great defect "in our education in this country" (187).

74. Alexander H. Everett, "Literary History of the Eighteenth Century," XII, 246-268 (April, 1821).

Attacks the noble savage ideal of Rousseau (250). Montesquieu's *Spirit of Laws* is "deficient in perspicuity" (252). Attacks the religious theories of Helvetius, Diderot, and Holbach (256). American booksellers and printers are to blame for the backwardness of our literature because they republish foreign books.

75. J. G. Palfrey, "Yamoyden, a tale of the wars of King Philip, in six cantos. By the late Rev. James W., Eastburn, A. M. and his friend" XII, 466-488 (April, 1821).

Praises this Gothic romance for "the very happy use which the writers have made of their reading in the antiquities of the Indians" (477). Glad to see that somebody has found out "the unequalled fitness of our early history for the purposes" of fiction; no country or age has "such capacities in this view as New England in its early day"; there is no "element of the sublime, the wonderful, the picturesque and the pathetic, which is not to be found here" (480). Stresses especially the "powerful action" developed by the stern puritans "coming into conflict with the relentless wilderness". Defends puritan character against the charge of being a "lifeless, unpoetical monotony" (481). Practically predicts Hawthorne when he concludes that the first first-rate writer of fiction in this country "will lay his scene here" (484).

76. Edward Everett, "England and America," XIII, 20-47 July, 1821).

Answer to an essay in the *New London Monthly Magazine* sneering at American complaints against the English press. The English public is "a too willing patron of abuse of America" (22). Americans are not super-patriots in literature; Barlow's *Columbiad* has always been regarded "as a total failure" (29). Defends the English language in America; it is better "spoken here than in England" (30). We are firmly anchored "to the rock of English literature" (32) and are not starting a new language.

77. Edward Everett, "Marino Faliero . . . by Lord Byron," XIII, 227-246 (July, 1821).

Objects to certain romantic excesses. Byron's hero is too old for such violent passions; the style is too harsh; the romantic poets have gone too far in reacting from Pope's regularity (240). The historical drama of Shakespeare is superior to the French in method; Byron is wrong in following the latter (230). Strongly objects to basing a play wholly on love; the best acting cannot keep a love scene from degenerating into disgust (243). The drama should have a wider range of themes; America happily has no fixed associations in this regard.

78. Willard Phillips, "Bryant's Poems," XIII, 380-384 (Oct., 1821).

Recognizes Bryant as a true poet. Praises the "strain of pure and high sentiment", the "subtle and ever varying beauties of nature", and the natural diction.

79. Edward Everett, "Valerius, a Roman Story," XIII, 393-417 (Oct., 1821).

Hopes that the best genius of the age will not go into novel-writing, but fears that it will. Following *Kenilworth*, imitators are springing up everywhere (393).

80. W. H. Prescott, "Byron's Letter on Pope," XIII, 450-473 (Oct., 1821).

A discussion by a semi-romantic critic of neo-classicism and romanticism by means of an analysis of Pope and Byron. Decides that images drawn frcm nature are more poetical than those drawn from art (451). Dislikes "the puling affectations" of the Cockney School (which may have a bad effect on America) and the "mysticism" and "unmeaning strain of sentiment" in the Lake poets; regrets that these have discredited "the perspicuous, direct, and manly flow of thought and expression" of Pope (467-8). Disagrees with Byron's high opinion of Pope; he lacks the "power of awakening the most sublime and tender emotions so requisite to the perfection of poetry" (469); his versification has the "great and obvious defect" of faultlessness (471).

81. John C. Gray, "An Oration . . . before the Society of Phi Beta Kappa, at Cambridge, Aug. 30, 1821," XIII, 478-490 (Oct., 1821).

Refutes the idea that writing in the English language is a great disadvantage to the development of American literature. (a) In the English classics we possess "numerous striking and chaste models of style" (481). (b) We have the benefit of English criticism (482). Yet we should not be too deferent towards English critics; the greatest progress will be made when we ourselves develop "a spirit of enlightened and liberal yet exact and fearless criticism" (483). (c) Our writers have an "unequalled sphere of celebrity and usefulness" opened to them (484).

1822

82. Edward Everett, "Percival's Poems," XIV, 1-15 (Jan., 1822).

Insists on high standards; "Pretty good poetry is no poetry at all" (3). A critic must have a sixth sense to distinguish the premature good poet from the mediocre. Denies that adverse criticism harms a poet of merit; it matures him. Sees no cause why the American critic should encourage the "multitude of indifferent poetical essays which are made among us" (6). Percival has some "genuine poetical talent" (7).

83. John C. Gray, "Fairfax's Tasso," XIV, 87-101 (Jan., 1822).

Fairfax, an Elizabethan translator, is at last being given his merited place. Strictly literal translations are usually not "faithful". Tasso excels by the "majestic brevity" (89) of his style and the sustained interest of his story.

84. Alexander H. Everett, "Posthumous works of Madame de Staël," XIV, 101-128 (Jan., 1822).

Her great merit is "poetical coloring of the language" (104). She lacked the power of invention and was not a poet. "Philosophy, and not poetry, was her proper department . . ." (108).

85. Edward Everett, "Aristophanes and Socrates," XIV, 273-296 (April, 1822).

Defends Socrates against the calumnies of Aristophanes in *The Clouds*. Condemns the latter's vulgarity. Praises German scholarship but says it is too prone to develop wild theories.

86. W. H. Prescott, "Essay Writing," XIV, 319-350 (April, 1822).

Attempts an impartial analysis of all English prose styles. 17th century prose had "unprecedented *vigor* of original genius", but lacked good taste which only comes with "long cultivation" (323-4). With the Restoration a simple, conversational, and idiomatic style developed and is due to the influence of France, the rise of the study of criticism, and chiefly the peculiar character of the Queen Anne intellect, especially Addison (326). By Johnson's *Rambler* in 1750 English prose had been carried "to a point which it cannot hope to surpass in the gracefulness of Melmoth, and the Attic simplicity of Hume" (327). The imposing style of Johnson and the simple style of Addison represent the two extremes of English prose beyond which it cannot go without bombast on one side and feebleness on the other (328). Thinks the last half of the century is "the Augustan age of English fine writing." Present-day English prose is in some danger of degeneracy from the ornamented and highly artificial style of Stewart, the mystical, indefinite phraseology of Coleridge, and the corrupt taste for notoriety in the Cockney School (331). The two styles today are those of the Edinburgh and Quarterly Reviews, with the purpose of instructing, and *The Sketch Book* with the purpose of pleasing (333). American prose will be highly developed by liberal institutions, but we must set the example of a "pure, perspicuous, classical composition" without "extravagance or affectation" (350).

87. Edward Everett, "Academy of Language and Belles Lettres," XIV, 350-359 (April, 1822).

Favors a more active and more closely organized literary society than the one he writes about.

88. Alexander H. Everett, "Life of Jean Jacques Rousseau," XV, 1-21 (July, 1822).

Refutes the claim that all literary men are morbid (9). Rousseau's philosophical opinions are gaining ground with the raise of the liberal spirit of the world, but his politics will not bear examination (21).

89. James Marsh, "Present Literature of Italy"; "Ancient and Modern Poetry," XV, 94-131 (July, 1822).

A very important critical essay by a disciple of Coleridge, devoted to a defense of the Middle Ages and the subjective spirit of modern poetry. Condemns adherence to rules and slavish imitation of the ancients. Thinks that the principles for each specific art form was developed by the Greeks from the "unchangeable laws of the human mind", and are thus permanent (103-4). But the spirit, which constitutes the elements of literature, has changed. It is seen in the principle of unity. The unsophisticated Greek derived the principle from the form and character of the external world. The modern mind, turned from the living world inward upon the soul, sees unity as a "predominating spirit or sentiment" (105-7). This great change from ancient to modern times is the result of one main and two minor factors; the main cause is the introspection and spirituality of the "christian religion" (109); the minor causes are the "profoundly supernatural" religious and introspective character of the inhabitants of northern Europe (116-7) and the Middle Ages which were a union of the other two factors in specific cultural and religious forms (118). Thinks the Middle Ages are undervalued today (124-5).

90. Edward Everett, "Sismondi's Julia Severa," XV, 163-177 (July, 1822).

This is another attempt to "make grave truths attractive, by the form in which they are delivered"; such a form is very ancient and hence acceptable. The merit of this novel is its antiquarianism. But the author should study Scott to discover the "wonderful chemistry" by which "a strong human interest of character and incident" is breathed into "the manners of ages past" (166).

91. Edward Everett, "Bracebridge Hall, or the Humorists," XV, 204-224 (July, 1822).

Americans are much better informed of the state of literature in England than the English are about American literature. This "inexcusable ignorance is no ground for the diligent abuse, which has been heaped on our press" (208). Condemns Irving for not revealing his work "as an American production" rather than trying to engraft himself on "the English stock" (214). Irving's book is equal to anything "the present age of English literature has produced in this department" (209).

92. W. H. Gardiner, "The Spy," XV, 250-282 (July, 1822).

Attacks the position of E. T. Channing (see no. 52 above) that the novel is unsuited to the classless society of America. We have the same classes as England with a "greater variety of character". Disapproves of the Gothic romance as a genre foreign to our soil, but asserts that no nation has "more abundant matter of romantic interest than ours" (254). Cites as fruitful the times just succeeding the first settlement, the era of Indian wars, and the Revolution (255). Cooper has inventiveness, the chief characterstic of genius, and is the first "distinguished American novel writer" (281).

93. Alexander H. Everett, "Anecdotes of Morellet and his Contemporaries," XV, 319-340 (Oct., 1822).

Tells anecdotes from the lives of various French writers with the purpose of exciting American interest.

94. J. C. Gray, "Arden's Translation of the Tristia," XV, 348-351 (Oct., 1822).

Confirms Dryden's theory of translation and says that Pope's *Homer* is superior to Cowper's. Glad to see the classics made available to the American public, but thinks Ovid's *Tristia* not worth translation.

1823

95. Edward Everett, "Essays by a Virginian," XVI, 45-58 (Jan., 1823).

American literature is held back by the number of bad English and American books produced. Thinks true scholarship should appear before the public more often. Classical education is best fitted to the "essential condition of our natures" and at the same time deals directly "with the finest intellectual processes" (52-3).

96. S. Gilman, "Clio . . . by James G. Percival," XVI, 102-123 (Jan., 1823).

Judges Percival and the romantic poets by strict neo-classical principles. Their unpopularity is due to their "abstracted and unsocial" poetry. Writers like Southey are failures because of their "inability" to write according to "the natural inclinations and principles of taste implanted in the general mind" (106).

97. W. H. Prescott, "The French and English Tragedy," XVI, 124-156 (Jan., 1823).

As a romanticist Prescott favors English drama. The great defect of the French is a great passion for rules and hence a "want of deep and genuine sensibility" (125). It is due, not to Greek models, but to two elements of their national character, a desire for outward perfection of art and a keen perception of the ridiculous. English drama, under happier influences, developed directly from popular character, and its underlying principle was veracity (130). French drama leaves the heart unsatisfied; it shows that "faultlessness is one thing and perfection another"; it is "the triumph of art and not of nature" (141). In the present century English poetry is "breaking through the chilling atmosphere of French criticism" back to the "old English feeling and freedom" of the national ballad. The "animating principle" of "egotism" in the poets and the high spirit of speculation in the age prevent the development of the drama today; if it should have any, it will be from "Scott, exhibiting the drama of real life" (147).

98. N. L. Frothingham, "Grillparzer's Golden Fleece," XVI, 283-299 (April, 1823).

Laments the meagerness of contemporary English drama, but says that the Germans "are destined to produce most finished specimens of dramatic poetry" (285). They have studied both Shakespeare and the Greeks, and their "rich, powerful language has a flexibility" fitted to the most "delicate" and "difficult achievements" (285).

99. Edward Everett, "The Life of Francis Bacon . . . By Mr. Mallet," XVI, 300-337 (April, 1823).

"*Baconian* philosophy has becomeo synonymous with *true* philosophy." Defends the character of Bacon; he was "a mild, moderate, conscientious man, estimated by all parties, but unwilling to sell himself to either," and therefore hated by both (310).

100. T. Parsons, "Moore's Loves of the Angels," XVI, 353-365 (April, 1823).

Parsons is here mildly romantic and praises the intuitional element in literature, but thinks that Moore's genius is "cramped and polluted" by his "depraved, licentious tastes" (354).

101. Alexander H. Everett, "Life and Writings of Schiller . . . By Henry Doering," XVI, 397-425 (April, 1823).

Genius and taste are only different operations of the same agents and demand the "union of experience and sensibility" (400). Schiller relied on "the abundance of his own wealth," which is the "true sign of real genius" (401). Attacks the attempt to represent the "most contradictory moral qualities as existing together" in the same individual (402). Inadequately understands "romantic" as meaning "fictitious" in contrast to "historical and natural" (421). Hence claims that Schiller's work is more like English tragedy of the 18th century than Shakespeare (408).

102. George Bancroft, "Schiller's Minor Poems," XVII, 268-287 (Oct., 1823).

As a romanticist Bancroft praises Schiller highly. He is "distinguished for his genius," "the purity of his taste," "the perfection of his style" (268), his constant "fever of imagination," his optimistic view of human nature, his reverence for religion and the domestic relations (269), his veneration for the classics, his personification of nature, and love for the antique.

103. Edward Everett, "The Works of Maria Edgeworth," XVII, 383-389 (Oct., 1823).

In reaction against the licentiousness of Fielding and Smollett, Fanny Burney invented the "safe reading" type of novel which Miss Edgeworth writes. Thinks the public is tiring of Scott. Miss Edgeworth is inferior to Scott but "inferior to him alone" (385).

1824

104. Willard Phillips, "Confessions of an English Opium-Eater," by De Quincey XVIII, 90-98 (Jan., 1824).

Possesses a "strain of original and philosophical thinking" but often sinks into an "obscure sort of metaphysical and mystical prosing, and becomes very formally dull and dry" (92).

105. George Bancroft, "Buttman's Greek Grammar," XVIII, 99-106 (Jan., 1824).

Strongly recommends the study of the Greek classics, especially Homer, Herodotus, and Plutarch. Homer's works present a mirror of "the purest qualities of our nature" (105).

106. Alexander H. Everett, "The History of Philosophy," XVIII, 234-66 (April, 1824).

A review of that part of Gerando's work on classical philosophy up to Cicero. Discusses particularly the theory of knowledge. "Plato and Aristotle are "the two first names in the intellectual science of all time" (246). Asserts that Locks sprang from Aristotle, and Kant from Plato (252),—the "distinction taken by Kant between *purely rational* and *empirical* (experimental) notions" resembles that of Plato (253). Gerando exalts Plato, but Everett says that it would not be difficult to prove "the author's preference is unjust" (247). The chief error of Plato was the notion that "ideas are *innate* and have an existence *in our minds*, independently of perception, a proposition, which, in its obvious and literal sense, is quite absurd" (252). Gives an accurate exposition of the various types of philosophy. Praises Cicero's concreteness and, like a neo-classicist, sees the Middle Ages as a "gulf of ignorance and barbarism" (265). (Although Everett takes an unfavorable view, this exposition of Gerando's Platonism, with its Kantian analogies, may have led Emerson [*Journals, II*, 283, *Letters, I*, 291] to Gerando, to whom he was considerably indebted.)

107. George Bancroft, "Jacob's Greek Reader," XVIII, 280-284 (April, 1824).

A strong plea for universality in American literature. We should search through "the literary stores of all nations," and select whatever will impart the most knowledge or best fit our need (283). There is but "one republic of letters, and that republic should pursue but one policy, the advancement of truth and science, of free and familiar intellectual intercourse of all parts of the world with each other, a commerce of minds, limited by no resticting prejudices, and checked by no unworthy jealousies or partialities" (284).

108. Willard Phillips, "The Pilot, a Tale of the Sea," XVIII, 314-329 (April, 1824).

Our literature like our territory is still mostly "uncultivated and wild", and Cooper has done a yeoman's task in trying to subdue it (314). In choosing American actors, incidents, and frequent historical allusions, Cooper has "made the story strike deep into the feelings of American readers" (328).

109. F. W. P. Greenwood, "The Miscellanious Poems of William Wordsworth," XVIII, 356-371 (April, 1824).

An appreciative but judicious critical essay of very high excellence. Gives three reasons for Wordsworth's unpopularity in America: (a) incapacity of the mass to appreciate his most refined beauties; (b) defects of his own such as, pushing his theory of humble life "too far" and following the train of his thought to the point of vagueness; and (c) the unfair notices in the *Edinburgh Review* on which "nineteen out of twenty" formed their opinion. Wordsworth's beauties are: (a) the great principles that "nothing is beneath a poet's regard, which has to do with the mind and heart of man"; (b) a diction taken from "nature and life" as the vehicle for real passion; and (c) the glory of his "intimate converse . . . with Nature," resulting in a closer union between the "universe and the heart of man" (366).

110. W. C. Bryant, "The Ruins of Paestum, and other Poems," XIX, 42-49 (July, 1824).

Praises Pickering's poems as an indication of the rise of a truly American literature. Thinks his inverted and diffuse style, imitated from Thomson's *Seasons*, is a defect, as is the "elaborate magnificence" of the diction. Advocates careful revision before coming before the public. Disapproves of the use of weak syllables or unaccented words and the addition of extra syllables in blank verse.

111. C. Cushing, "Boccaccio's Decameron," XIX, 68-86 (July, 1824).

Commends Boccaccio's prose style, his classicism, his elevation of the street tale into a new literary type, and panorama of life displayed. Excuses his licentiousness on the basis of contemporary taste.

112. George Bancroft, "Value of Classical Learning," XIX, 125-137 (July, 1824).

Lists the reasons why classical literature should be studied in America: (a) Classical remains cover the continent of Europe but we can know Greek and Roman genius only through their literature. (b) They favor free institutions. (c) It is the "common property of mankind". (d) They exert a strong influence for a high national character. (e) Because in a free country there should be no limits on free inquiry. (f) Classical is "the best." The Greeks remain in the gloom of the ages "stars of changeless and unequalled brilliancy" (132).

113. W. H. Gardiner, "The Wilderness," [James McHenry] XIX, 209-223 (July, 1824).

Most people have the mistaken idea that the "*Americanism* of an American novel" is a facsimile of American peculiarities. Actually the typical American novel, like the present one, is an imaginary tale parading under American names with an Indian or two, and passes for American "simply because it is not English" (210).

114. George Bancroft, "Life and Genius of Goethe," XIX, 303-325 (Oct., 1824).

Says we should approach the literature of a great nation "with respect." "The literature of each nation is national," and the true critic must see it from that point of view. Goethe's genius can no longer be disputed. Holds the romantic doctrine that where the critic and the multitude are at variance in judgments, the multitude is right and the critic wrong (306). Stresses the importance of explaining Goethe's works by the conditioning factors in his life. Americans dislike his morbid imagination and his disregard for social conventions. Asserts the superiority of Greek sanity to the morbidity of the romantics. (On Goethe see also no. 19)

115. W. H. Prescott, "Italian Narrative Poetry," XIX, 337-389 (Oct., 1824).

Discusses the influence of the Italians on the Elizabethan and Romantic periods in contrast to the distrust of the Neo-classicists.

Stresses the broadening of intellectual activity in the present age (340). Says that the transplanting of romantic fiction from Normandy and England to Italy at the end of the 15th century caused the rise of Italian narrative poetry (342). Attributes the differences between Italian and English literature to differences of climate (345). Italian literature is devoted too "*exclusively* to purposes of mere amusement" (385), due to the Italian peculiarity of being "sensible to *beauty*, independent of every other quality" (387). English literature is far superior by its moral and philosophical gravity. Writes special critiques on Politan, Pulci, Boiardo, Berni, Ariosto, Tasso, Tassoni, and Fortiguerra.

1825

116. Alexander H. Everett, "Lord Byron," XX, 1-47 (Jan., 1825).

Byron has genius of the highest order; he "rose far above any English poet who has lived since the time of Pope." He has two great defects: "an occasional extravagance of thought and language as respects substance, and a want of care and finish in versification." Everett looks at Byron from the eyes of a confirmed neo-classicist. He looks on the age of "Pope as the point of perfection" in poetry and on the present as the "declining age" (14). Condemns the immorality of Byron; in the manner of Plato, he says his works should be given the merit of art, then removed "forever from the public view" (43).

117. George Bancroft, "Writings of Herder," XX, 138-149 (Jan., 1825).

Herder seems to be Bancroft's ideal of the man of taste. Praises his detachment; he could well "estimate the excellence of others" and could enter upon "the study of a foreign work, as if he had been of the country" (138-9). He possessed a "delicate perception of the beautiful" and a true "love of learning." His knowledge was wide, and in matters of taste he never reasoned coldly, but "communicated his ideas and sentiments with all that warmth, in which they existed in his mind" (141). Eleven years before Emerson's first book, Bancroft says Kant "as a metaphysician, has had perhaps no rival among his countrymen but Fichte" (141). "The influence of Herder on his age was wide, and entirely beneficial to the best interests of our race; he has been extensively read and admired, and always with results beneficial to morals and sentiments of philanthrophy . . . (He) was a blessing and an honor to his age" (144). (For orientation see O. W. Long, *Literary Pioneers*, Cambridge, 1933).

118. Jared Sparks, "Escalala, an American Tale. By Samuel B. Beach," XX, 210-214 (Jan., 1825).

Denies that the Indian theme is a good one for literature. Sparks, as a historian, saw that the Indian had been grossly misrepresented (210). Actually there is "little of the romantic and of the truly poetical in the native Indian character" (211). There are no shades of character beyond "generosity, contempt of danger, patience under suffering, revenge, and cruelty." Predicts however that the exploits of the Iroquois and the Mohawk will be soon "committed to the numbers of ever enduring song" (212).

119. W. C. Bryant, "Redwood, a Tale" (Mrs. Sedgwick), XX, 245-272 (April, 1825).

Maintains that there "is a strong love of romance inherent in the human mind" which the writer can rely on to fill "up the outline he gives with bright colors and deep shades of its own." Stresses the "fertility of our country, and its history, in the materials of romance." Great variety of character (which is the basis of fiction) has developed from our equalitarian institutions, from the variety of our religious denominations, from our geographical situation, and from the immigration of foreign peoples who bring their old world culture and combine it in various ways with the new.

120. Jared Sparks, "Professor Everett's Orations," XX, 417-440 (April, 1825).

The thesis involved is the relation of free government to the development of the arts and sciences; the two men differ on several points. Sparks says that freedom is requisite to development and laughs at the dire predictions about America's future in the *Edinburgh Review* (422). Everett held that our new form of civil society would be a strong motive to political action only. Sparks thinks it will cause a healthy intellectual rivalry like that of the "ancient Grecian states" (425). Everett argued that free institutions did not withdraw talented men from the field of literature; Sparks, that there is "great consumption, and even waste of talents" (427). Everett held our novel political organization affects our literature, Sparks, that literature flourishes as well under one form of government as another (432). Everett thought our common language aided our rising literature, but Sparks again disagrees: literature grows out of a nation's "peculiarities" and must have "modes of expression and forms of language equally varied and peculiar" (437).

121. Jared Sparks, "Recent American Novels," XXI, 78-104 (July, 1825).

Says a new school of American fiction, imitating Scott, has arisen and is gaining "favor with the graver part of the community" to such an extent that the old restrictions are being taken off (79). The critic must exercise "strict *surveillance*" over the new novels in order to counteract their "pernicious influences" and give direction to their force (83). The Waverley type of novel being written has three characteristics: the use of historical material, real scenery, and dialogue to carry the incident (81). Praises Scott but fears that his imitators will copy such weaknesses as careless composition and the use of obsolete or foreign words and idioms.

122. W. H. Prescott, "Da Ponte's Observations," XXI, 189-217 (July, 1825).

Da Ponte, an Italian, objected to Prescott's criticisms of Italian literature (see no. 115 above). This is Prescott's reply. Denies that Marini influenced Donne (194). Says French *style précieux* came from Italy and the English metaphysical school of Cowley came from the French. But the metaphysical conceits can be traced back to early English literature (306). Denies that the Waverley novels were vulgar and deficient in thought; the novel may convey "solid instruction, in its details of life, of human character, and of passion" (208). Condemns neo-classical literary criticism and says the new "science of general literary criticism and history" recognizes the "wants of different nations and ages"; a few general principles of beauty are deduced from "local beauties peculiar to each", but a difference of taste "is now admired as a beautiful variety in the order of nature" (215).

123. Jared Sparks, "Brainard's Poems," XXI, 217-224 (July, 1825).

Sparks attacks the extremes of romantic poetry. Its besetting sins are "eccentricity and haste, a vehement desire to think and talk as nobody ever though or talked before, and to make the largest drafts on the bounty of the Muse in the shortest space of time." Poets are not satisfied to write as Virgil, Milton, and Pope have written.

124. Andrews Norton, "Lord Byron's Character and Writings," XXI, 300-359 (Oct., 1825).

A strong attack on Byron. As a satirist Byron was inferior to Pope; he lacked truth and "just principles of taste and moral judgment" (314). His poetry has not "much tendency to raise and improve mankind, much moral beauty, or much that could be agreeable to our higher and purer feelings" (327). The most striking aspects of his poetry belongs to the age. Admits the "false taste" of 18th century poetry, but thinks the romantic reaction has gone too far—"the unalterable principles of taste, founded in the nature of man, and the eternal truths of morality and religion, have, likewise, been neglected or outraged, as antiquated prejudices" (349). Even Wordsworth, in his dislike for artificial poetry, has "caricatured the simplicity of nature" (350).

125. F. W. P. Greenwood, "Pinckney's Poems," XXI, 369-376 (Oct., 1825).

Commends successful imitation. "Genius catches the thought and spirit of kindred genius, and gives them a fair and well proportioned body of its own." Pinckney successfully imitated a poem of Goethe. Dislikes his obscurity and his imitation of Byron—"we have already had too much of Byron" (376).

126. Edward Everett, "Orphic Poetry," XXI, 388-397 (Oct., 1825).

Shows a keen interest in and a wide knowledge of classical antiquity. His purpose is to awaken American interest.

1826

127. F. W. P. Greenwood, "Hillhouse's Hadad, a Dramatic Poem," XXII, 13-27 (Jan., 1826).

Though a romanticist (see no. 109 above), Greenwood here shows his neo-classical roots, by praising Hillhouse for observing "all the proprieties of place, time, and character" (25) and his "habit of correctness" (26). Defends his own literary nationalism. Says that he is not "blind to the miserable stuff" constantly "thrown off by the presses of our country," that he hails "with infinitely more delight, a good work which is produced by native genius, than one of equal quality" from abroad, and that when he thinks a work is good he will "be sure to say so" (27).

128. J. C. Gray, "Demosthenes," XXII, 34-52 (Jan. 1826).

Thinks that no works could be read "to more advantage by the rising orators of our country, than those of Demosthenes." They would do "much to correct the two most prominent faults of American oratory," "excessive prolixity" and "fondness for unnatural and meretricious ornament" which lead to offenses against classical simplicity (48). This fault "infects in some degree every branch of our literature" and is due to our lack of "assiduous culture" (49). Nothing will correct our false impressions like "the frequent contemplation of the severe beauty of Attic eloquence" (49).

130. John Everett, "Mellen's Ode," XXII, 209-212 (Jan., 1826).

Our writers make two errors. They attempt "to render each passage equally brilliant in execution, whatever is the character of the sentiment expressed". They suppose that originality is to be acquired by study and "make the absurd attempt to say in a manner no one else would have said, what no one else whold have thought" (211).

131. A. Lamson, " Poem delivered before the Conn. Alpha of the Phi Beta Kappa Society, Sept. 13, 1825 by James G. Percival," XXII, 317-333 (April, 1826).

Attacks Percival's romantic idea that since "certain Forms" (Platonic ideas) are diffused through nature the mind knows spontaneously, without search for truth. There is no "instantaneous consent to the true principles of taste" and it "might easily be shown, that the sublime and the beautiful, both in nature and art, require time and cultivation" (319). Denies also the true poet does not receive due recognition (325). Attacks Percival's "excessive diffuseness" and "superabundance of images" (327). Ends with an attack on the disregard for the laws of metrical composition in Percival and other American poets. Ridicule of "sing song" verse has led many to "think that prosaic lines are beautiful, and that a breach of established rules is better than the observance" (332).

132. Sidney Willard, "Milton on Christian Doctrine," XXII, 364-373 (April, 1826).

Recognizes that the discovery of this document will lead to a more complete understanding of Milton.

133. J. C. Gray, "The Rebels," (Lydia M. Child), XXII, 400-408 (April, 1826).

Praises this sentimental novel highly but objects to its profusion of incidents, its want of method, and faulty characterization.

134. A. Lamson, "Miscellaneous Poems selected from the U. S. Literary Gazette," XXII, 432-443 (April, 1826).

Lamson is a universalist; unmerited praise of American works will "be injurious to the cause of letters among us"; our writers should "aspire to rival the richest strains" of England (432). Lamson is also a romanticist and praises spirit of the age as one of "deep, earnest thought" but attacks current style as rapid, hasty, abrupt, and unfinished (433). Praises Bryant highly as a poet of "rare gifts" and recognizes Longfellow (now nineteen) as having the "poetic feeling and imagery" of a true poet (438-9).

135. W. H. Prescott, "The Songs of Scotland, Ancient and Modern," XXIII, 124-142 (July, 1826).

The editor of the poems laments that the modernization of Scottish society and the untimely decay of superstition will ruin Scottish poetry. Prescott denies this antiquarian theory. The principal difference between a rude and a civilized age, as regards "poetical fiction, is, that the latter requires more skill and plausibility in working up the *matériel* than the former". Thinks also that there are very few today "who have not enough of superstitious feeling lurking in their bosoms for all the purposes of poetical interest" (137).

136. George Bancroft, "Classical Learning and (Prof.) Wolf," XXIII, 142-150 (July, 1826).

Defends the thesis that the classics will give an opportunity for the mental and contemplative life of America to unfold, since the active life is already highly developed.

137. W. H. Gardiner, "Cooper's Novels," XXIII, 150-197 (July, 1826).

A review of *The Last of the Mohicans* and *The Pioneers*, chiefly the former; see also his review of *The Spy*, no. 92 above. Very high praise for Cooper; he has "great powers of invention" (151) and has the "same sort of magical authority over the spirit of romance, which belongs in common to Scott, Radcliffe, Walpole, and . . . Brown". His great excellence is the vividness of his action, the rapidity of his incidents, and the invention of machinery to take the place of mythological divinities of the ancient epic. His great weakness is the delineation of female character (163). Glad to see that Cooper has discovered the possibility of the Indian in romance; the visionary character of his Indians is due to his following Heckewelder, "whose work is a mere eulogium" of virtues (166). Thinks Natty Bumppo "deserves to be ranked in the first class of the creations of genius" (172), but Cooper overdoes the supernatural and surprise-escape element (191).

138. Sidney Willard, "Gould's Edition of Vergil," XXIII, 220-224 (July, 1826).

Welcomes this new American edition of Vergil and praises its accuracy—the first American book to be free of errors. The time has "come when we must rely on our own presses to supply the demand for such books" and we have "many scholars among us qualified" for editing such works (223).

139. A. Lamson, "Works of Mrs. Barbauld," XXIII, 368-385 (Oct., 1826).

Thinks the rise of women writers has aided in "rescuing fiction from the service of corruption and profligacy, and converting it into a powerful agent in correcting the moral judgments" (369). Rejects extreme romanticism with its "wild fervor and extravagance." We are in no danger of "famishing over a scanty, cold, and superficial literature, but of being disgusted or surfeited with mawkishness of feeling, wordy insipidity, and the rant of 'maudlin eloquence'" (373). Says Mrs. Barbauld has taken one of the best of models—Addison.

1827

140. W. P. Mason, "The Merry Tales of the Wise Men of Gotham," (by J. K. Paulding) XXIV, 37-55 (Jan., 1827).

Mason is a universalist and comes out for dependence on tradition when discussing the ancient-modern controversy. he "froward spirit" which led Americans to the Revolution "carried them on to still greater extravagancies, and they began to pretend that they were as wise as their ancestors" (38). They at last openly "assert, that there was no science, art, invention, or discovery of any consequence which had not originated, within the last fifty years" (39). Praises Paulding for satirizing three fields of modern achievement, the woman machine, common law, and phrenology. Mason adds a fourth, "the novel science of inversion or transposition"; in education this has taken the place of the classics and what was previously applied to the head is now applied to the heels (55). Shows his indebtedness to the satire of Swift. The discovery of Milton's essay and other ancient works makes us doubt "whether the great march of mind in our day, may not, after all, have been in a circle" (55).

141. Edward Everett, "Phi Beta Kappa Orations," XXIV, 129-141 (Jan., 1827).

A review of orations by Justice Joseph Story and James A. Hillhouse; discusses several controversial critical doctrines from the viewpoint of tradition and universality. (a) Ancients vs. moderns: It is well to "consider the evils, which are incident to the growth and diffusion of great improvements" (129); in spite of brilliant improvements, inventions, and discoveries, there is no "vast difference" between the moral and social character of modern and ancient men (130). Thinks that "the superior activity of the social principle" (the oral expression of literature to large audiences) in ancient life was destroyed by the invention of printing and that this was a great loss (130). (b) Advocates forming a literary society to remedy the division between spoken and written literature in modern life (132). (c) Study of the classics: no other study or system of studies has been suggested which serves a better purpose than the study of languages (137). (d) Classicism and romanticism: says the clear distinction made between the two by continental critics has never been wholly accepted in England and America and is still open to question (137). (e) Problem of imitation: it is well for the epic writer to cast about to choose the best school and then all its laws, but "the poet of epic genius is a school to himself" (140). There is but one school which genius must adhere to; it is "the school of Nature" and in this "Shakespeare is most uniformly the master."

142. George Bancroft, "Greek Lexicography," XXIV, 142-156 (Jan., 1827).

A review of Pickering's *Greek Lexicon.* Praises highly the editions of the classics being put out by the University Press at Cambridge (146). If a man has but time to learn one language, thinks he should learn Greek. Attacks those "who are governed by an undiscriminating and impotent hatred of classical learning" (155).

143. Edward Everett, "Russian Tales; from the French of Count Xavier de Maistre," XXIV, 188-193 (Jan., 1827).

Discusses the supremacy of genius in literature. A tale such as these admits of but two possible treatments: it must be told in its pure Doric simplicity or it must "be transfigured, by some Shakespearian power, beyond the reach of any common genius" (191). In this case, "nature herself is outdone by the genius of her great lord, selecting, combining, and ennobling her most lovely features" (192).

144. George Bancroft, "Mrs. Hemans Poems," XXIV, 443-463 (April, 1827).

Deals at length with the problem of morality in literature. The country has made great moral progress in late years; it is seen in the more general diffusion of intelligence and the higher standard of learning, the spirit of healthy action in all classes, diminished crime, the general security of property, the increase of Sabbath schools, the philanthrophy, and the "active and compassionate benevolence, which does not allow itself to consider any class so vicious . . . as to have forfeited its claim to humane attention" (443). America has no advocates for the theory which regards beauty as "something independent of moral effect" (444); cites Shakespeare as proof. An immoral literature is "the greatest evil, with which a nation can be cursed"; it is worse than "national poverty" (446). Says it is ultimately a question of the universal vs. the transitory. Says his morality is based on intercourse "with the great minds that light up the gloom of the ages, and share in the best impulses of human nature." Rejects "a too delicate sensibility" to nature and "sullen misanthropy" of solitude; the external world provides not the "sublimest themes", it is "mind, and mind only, which can exhibit the highest beauty" (447-8). Ends with the contention the loss of religion would put "an end to the magic of poetry" (460).

145. F. W. P. Greenwood, "Milton's English Prose Works," XXV, 73-89 (July, 1827).

Praises Milton as a social reformer of great value to Americans. His prose works are "fit manuals for a free people" (73). They bring us into intimate contact with the man and his life; in this he is superior to Shakespeare about whom we know nothing (74). Until we know Milton's prose, we cannot know "the whole power of our mother tongue" (75).

146. W. H. Prescott, "Novel Writing," XXV, 183-203 (July, 1827).

The novel is peculiarly suited to English genius for two reasons: the most ample materials are found in a country whose political institutions "allow an entire freedom of social intercourse, and consequently a perfect display of character"; and in expressing his own sentiments the author is restricted by no "other power than public opinion" (187). Spain is unsuited for the novel because it has but two great classes, and Italy because foreign despotism and love of pleasure has kept them from the scientific analysis "of the moral phenomena of our nature" which is the basis of English fiction (188). The French are deficient in the novel because of conventional forms of good breeding, narrow principles of criticism, deficiency of humor, and unfavorable regulation of intercourse between the sexes (190).

Characterization is the great talent of English writers from the time of Chaucer. The novel is the successor to the drama of Shakespeare; and Scott, who worked a revolution in American as in English fiction, is the logical successor of Shakespeare (193).

147. Alexander H. Everett, "Who Wrote Gil Blas?" XXV, 278-307 (Oct., 1827).

A review of two works on the subject by two Spanish priests, having mostly a technical interest. Their excessive patriotism seems ridiculous until we recall "the somewhat excessive movements of indignation into which we have been occasionally betrayed" by the remarks of "meddling foreigners" on the weaknesses of our character (279).

148. Jared Sparks, "Bowrings Servian Popular Poetry," XXV, 352-367 (Oct., 1827).

Shows the broadening range of American literary interests. Bowring had published anthologies of Russian, Polish, Batavian, Ancient Spanish, and Finnish literature.

1828

149. Edward Everett, "Select Specimens of the Theatre of the Hindus," XXVI, 111-126 (Jan., 1828).

The purpose of the review is to create American interest in Hindu literature.

150. W. B. O. Peabody, "Specimens of Polish Poets . . . By John Bowring," XXVI, 146-157 (Jan., 1828).

Looks to literature to create a spirit of internationalism in the world. Both commerce and science have failed to create this spirit as had been expected. But when a land is "lighted up by the universal fire of poetic imagination in all its valleys and hills, it is no longer foreign, nor its people strangers to any other. We know and share their sentiments and feelings, and cannot feel at enmity with them" (147). That is the purpose of Bowring's translations.

151. Franklin Dexter, "Academies of Arts; a Discourse delivered on Thursday, May 3, 1827, . . . before the National Academy of Design on its First Anniversary. By Samuel F. B. Morse," XXVI, 207-224 (Jan., 1828).

Morse defended three theses: the practice of buying old masters neglects living American artists; only professional artists and not critics should belong to American academies; and the American artist after studying abroad finds his own country so far behind him in taste that he starves from neglected merit. Dexter denies all three. Our taste in art is not "of national origin. We have hitherto learned, and must long be content to learn, from older countries" (209). Restricting the academies to professed artists only will lead to a school formed on principles other than those of nature, and "there is but one nature, and there can be but one true way of painting" (211). Artists cannot live independent of the critics and should seek to use the academies to diffuse good taste in America (212). Neither are the old masters a hindrance to American art; to patronize second rate American art because it is art "would improve neither the taste of the public, nor the skill of the artists" (214). Does not want "to see the American system . . . extended to literature or the arts"; a taste for art cannot "grow without care and cultivation" (216). Not hopeful of the future of American literature and art; ours is an age of utility and reason; and in "this cultivation of the reason, the imagination loses its power" (218). Modern artists are most deficient in substance; what they need most is "cultivation of the mind"; there is a difference "between poetry, and mere musical verse" (221).

152. W. C. Bryant, "Dana's Poems," XXVI, 239-247 (Jan., 1828).

Dana is "a man of genius, who possesses the essential qualities of a poet." Bryant praises the romantic qualities of literature; men of genius are free to "exert their powers in their own way"; sadness "is oftentimes as wholesome as mirth" (241); Dana's poetry is "simple and severe in its style, and free from that perpetual desire to be glittering and imaginative" (242).

153. E. Wigglesworth, "Cadalso's Moorish Letters," XXVI, 248-258 (Jan., 1828).

Praises the genre as being that of Goldsmith's *Citizen of the World.* Maintains that the language and literature of Spain is peculiarly interesting to America because of "our connexion with Spanish America" (257).

154. F. W. P. Greenwood, "Hope Leslie" (Catherine M. Sedgwick), XXVI, 403-420 (April, 1828).

Hails the influence of women in literature as "almost sure to be powerful and good." The most deadly poison is the "poison of passion" communicated through books of amusement, and in this woman is "largely administering the healing potion" (410). Many have asserted the richness of the American scene, but only a "few attempts were made, and one or two of them were not entire failures" (412). Mrs. Sedgwick's novels are among the successes.

155. G. Mellen, "The Red Rover," XXVII, 139-154 (July, 1828).

Attacks the idea that the American scene provides a rich field for American writers; our novelists "have made their works too purely of the soil" (140). (a) There is not enough in the "character and life" of the Indians "to furnish the staple of a novel" (141). (b) The taste of the age has changed; romanticism has been replaced by realism, the demand for "real life" and "allegiance to common sense"; and thus the Indian theme no longer suits. (c) Early American society has no sects, classes, and no lore to satisfy popular taste (143). Americans, however, do not have to rely on the American scene; we belong to the "English school of civilization" and what belongs to England "belongs as well to us" (143).

156. G. H. Bode, "German Universities," XXVII, 317-337 (Oct., 1828).

The German universities rightly regard their critical and historical knowledge of the classics as the "basis of all solid improvement" and its absence would be severely felt and would "produce a violent change in the literary world" (333).

157. W. H. Prescott, "Histoire de la Vie et des Ouvrages de Molière, par J. Taschereau," XXVII, 372-402 (Oct., 1828).

Notes the excellence of the French in "narrative, ever since the times of the *fabliaux* and the old Norman romances." It is due partly to the fitness of the language for prose and partly to the intellectual character of the writers (373). Defends Molière from the attacks of Schlegel (whose theory however reasonable in its first principles led him into an exaggerated "admiration of the Romantic models"), and compares him to Shakespeare. Each man attained complete success in his own way. Prescott shows real critical breadth and knowledge.

1829

158. W. B. O. Peabody, "The Decline of Poetry," XXVIII, 1-18 Jan., 1829).

A review of L. Hunt's *Lord Byron and his Contemporaries*. Thinks the whole intellectual life of the Western world including poetry is declining. Lists the causes: (a) modern practicality; (b) rise of humanitarianism; (c) poets have looked backward to old glories instead of forward to new improvements; (d) the false esthetic principles of modern poets who have departed from the good old way of Milton, Dryden, and Pope into general chaos; (e) the want of high and pure morality in modern poets; (f) romantic love for rough versification and "affected vagueness and obscurity"; (g) modern poetry is adapted to youthful taste and is "founded on the excessive passions of youth, or romantic sentiments." Peabody is a complete neo-classicist. Thinks little of Byron "is likely to endure" (13). Entirely disagrees with Wordsworth's theory of poetry being found in the heart of the common man and with his theory of diction (15). In general the age "has afforded all sorts of extravagance" (14); its great fault is "affected originality" and in the end Pope will be "found nearer to truth and nature than his opposers" (18).

159. Henry Wheaton, "Scandinavian Mythology, Poetry, and History," XXVIII, 18-37 (Jan., 1829).

Notes the movement in European countries toward "cultivation of their own native literature, language, and history." Exclusive devotion to classical models, especially those of French literature, "have ceased to be the order of the day" (18).

160. Alexander H. Everett, "Irving's Life of Columbus," XXVIII, 103-134 (Jan., 1829).

Our progress in "polite literature and poetry" has not until recently kept pace with our progress in science, metaphysics, and government; the cause was the urgent demand "for talent in the various walks of active life" (105). Finally after rapid material progress, the preparation of the public for literature, and the galling sneers of foreign critics, Irving appeared and established American literature (109-110). Testifies to the great importance of literature in life; "the literature of one age determines in a great degree the history of the next" (112). Makes the romantic distinction that rhyme and rhythm are not the peculiar features of verse and that Irving's prose is sometimes poetical (114). Makes also the transcendental distinction between reason and Imagination: Irving "confines himself to plain matter of fact." But "the universe is not less worthy of being studied as an expression of the pure and glorious *ideas* or images that dwell eternally in the Supreme mind, than when viewed merely as a pleasing and varied panorama; . . . it even acquires, in the former case, a sublimity and beauty, of which it is not susceptible in the latter" (115).

161. A. S. Packard, "College Education," XXVIII, 294-311 (April, 1829).

A review of Two Reports by the Faculty of Amherst proposing to change the curriculum to fit popular demands. Notes the great controversy over the practical vs. the cultural; the "zeal for reform is not tempered with sufficient caution and discrimination" (299). The reforms made in Europe cannot be made here because we have nothing to correspond with the European university (299). The great complaint is the classics. Says he has "no overweening veneration for ancient usage" but that a classical education "is in the highest degree important" to high success in literature or the professions (304).

162. C. Cushing, "Ancient and Modern History," XXVIII, 312-340 (April, 1829).

A review of Gibbon's *History*. Dislikes Gibbon's hostility to Christianity, but his work is "among the great classics of our language" (313). Discusses the nature of taste: "we judge of beauty by a certain sympathetic intelligence, whether implanted in our bosoms by nature or introduced there by Education," and "when refined by cultivation, it constitutes correct and exquisite taste" (314). Lists the causes of beauty in the classics: (a) the mechanism of the classic languages; (b) the limited means of publication strangled mediocrity; (c) the subserviency of our taste to the ancients—it was theirs "to invent, to conceive, to utter the first coinage of the fancy, undimmed, bright, fresh from the mint of inspiration; ours to imitate, embellish, arrange, and reproduce the images and ideas"; and (d) the taste, fashions, and feelings of the people, and the nature of their public institutions comes nearest "to accounting for the superiority of the Greeks and Romans" (317-8). Thinks science may repress the "spirit and exuberance of fancy" but will compensate "by the bestowment of still greater benefits, having peculiar influence upon the certainty of history" (332).

163. T. Walker, "Pollock's Course of Time," XXVIII, 340-354 (April, 1829).

Praises Milton but attacks Byron, particularly the Byronic hero. Thinks "these heroes are fast ceasing to be favorites in the fashionable world; and Byron himself begins to be judged by the qualities of his heart, as they are displayed in his works" (349).

164. John Pickering, "Elementary Instruction," XXVIII, 489-503 (April, 1829).

Reaffirms the need for the study of the classics. The "very treasures of knowledge" transmitted by Greeks and Romans "constitute a considerable portion of our education; and these we must study, if for no other reason than because those nations produced men of genius, and happened to live before us on this globe" (491).

165. T. Sedgwick, "De Béranger's Life and Writings," XXIX, 123-138 (July, 1829).

Asserts the need of a knowledge of foreign literature, which has "but of late years . . . been diffused among us." Though the "rapid increase of wealth" and the "general advance of cultivation" has made knowledge of foreign languages no longer a rarity, we are still conversant with but a small "part of them" (123). But it is an evil "that time will correct, and which it is even now rapidly correcting" (124).

166. E. Peabody, "American Poems," XXIX, 220-241 (July, 1829).

Review of two obscure women poets. The review is a re-assertion of the old Puritan poetic ideal—very largely the ideal which underlies the poetry of the New England renaissance. Poetry is made up of two main elements: it must have the power of "enchanting us away from the present and the real, into an ideal world" and it must deal "with man's higher and better nature" (221). The poet cannot paint perfection nor set forth everything as abstract truth, but he must "advance men towards perfection" (222) and loosen the mind "from its vassalage to sense" (223). Poetry springs from the "inmost and holiest sanctuary of truth," from the soul of the poet; therefore the poet must have genius; "It is no common man, but one more loftily endowed and dwelling apart,—a prophet of the living God alone" (225). Defines the qualifications of the poet after the manner of Milton: "he must strive earnestly to purify his imagination; to fill his mind with noble desires and motives; to shut out every debasing influence; to divest himself of every selfish, local, or party prejudice; to become, in truth and in deed a citizen of the world" (226). Comes out for the kind of nationalism which depends on self-reliance. Poetry must spring "from the writer's own heart" (227-8); therefore, the great imitation and "too great admiration of the English writers of the present day" is the great "deadening influence upon our poetry" (230-1). Thinks also that the "concentrating power of the imagination" cannot exist in connection with imitation. But imitation of the Bacons, Miltons, Taylors, and Shakespeares is helpful.

167. T. Walker, "Popular Education," XXIX, 241-258 (July, 1829).

Outlines a system of education for the lower classes of the type being established in England by the utilitarian reformers like Brougham (who was attacked by Newman).

168. W. H. Prescott, "Irving's Conquest of Granada," XXIX, 293-314 (Oct., 1829).

Discusses at length the history of historical writings. The classical histories sought "less to instruct than to amuse"; they were written in the comparative infancy of the world and possessed a "finer sense of beauty than the moderns." We live in the prime of civilization; the imagination has been blunted, but the reason has matured; the modern mind has been schooled successively by the classics and Christian doctrine and "a new standard of moral excellence was formed." Thus practicality and the intellectual and physical sciences were given new values; poetry lost much but philosophy gained more (296-7). Analyzes the contributions of Voltaire, Montesquieu, and Gibbon to the writing of history. Irving was wise not to write philosophical history (306).

169. G. B. Cheever, "Authorship of Junius' Letters," XXIX, 315-340 (Oct., 1829).

Presents the evidence. Notes how keen and effective his satire was in the political field; also the advantage of his anonymity.

170. A. Negris, "Modern Greek Literature," XXIX, 340-361 (Oct., 1829).

The article has no critical value except to show a wide range of interest.

171. S. A. Eliot, "Specimens of American Poetry, with Critical and Biographical Notices. . . . By Samuel Kettell," XXIX, 487-496 (Oct., 1829).

Condemns the extreme nationalism of Kettel's anthology which was founded on the principle that everything published among us has value. But would like to see an anthology containing only those writers who "give an idea of the dignity, grace, purity, and sublimity, which may be found among our authors, . . . a collection uncontaminated by the bad taste, the dullness, or the bombast, displayed by too many who are called writers of poetry" (492).

1830

172. F. W. P. Greenwood, "Dana's Thoughts on the Soul," XXX, 274-279 (Jan., 1830).

Praises Dana's "excellence of truth, of purity, of moral elevation and moral purpose" (277). Laments that America has no long poems of worth; we want some of our poets to show us that their genius is "vigorous and broad enough for a sustained flight" (279).

173. O. Dewey, "Diffusion of Knowledge," XXX, 293-313 (April, 1830).

Advocates practical and scienctific education as the best type of knowledge for America.

174. W. B. O. Peabody, "Sprague's Poems," XXX, 313-323 (April, 1830).

Ridicules literary nationalism; we have established the principle that "praise was due to well-meant exertion". Our denial of genius is reaching absurd lengths. The result of denying the need for training in creative writers is that our writers "fall into direct and servile imitation, and that not of the best models" (315). A great proportion of our poetry is of an imitative kind; due to the fact that no one adopts poetry as a serious pursuit. He is confident, however, "that the way of Milton and Pope, by which we mean the way of thoughtfulness, care, and labor, will triumph at last." Genius "is as much a matter of cultivation as of nature"; a "taste for the beauty and grandeur of the visible world is formed by meditation", and "acquaintance with the heart is not intuitive" and is "not to be acquired in an hour" (316).

175. Alexander H. Everett, "Tone of British Criticism," XXXI, 16-66 (July, 1830).

A point by point refutation of an article entitled "American Literature" (in *Edinburgh Review*, no. 99), attacking American writers and literature. The "influence of national pride and jealousy" is the cause of the attack of the English periodicals on America. The English writer said that Irving, Brown, Cooper, and Channing were the only ones ever heard of in England; Everett adds several others. The English writer charged that even these four lacked originality and got their material from England. Everett denies this; Irving's best works are those in which he drew "his inspiration wholly from American sources." Thinks this maliciousness is bad criticism.

176. W. B. O. Peabody, "Villemain's Miscellanies," XXXI, 94-110 (July, 1830).

Defends the position of the critic against the author. Says that Villemain held the qualifications of a critic to be "perfect impartiality", "earnest wishes to promote the success of others", "a union of correct principles with exalted sentiments", and "delicate and unperverted taste" (96). Defends Pope against Villemain; it is "his unquestioned praise, that he carried the sustained harmony and sweetness of English versification to a degree of excellence unknown before." Neither Chaucer, Sidney, Dr. Donne, nor "even the good genius of Shakespeare" can equal him in this (109).

177. W. B. O. Peabody, "Moore's Life of Byron," XXXI, 167-199 (July, 1830).

Thinks it was needless to bring Byron again before the public; his position had already been decided; he was given "a place among the great" but no one "claimed for him a place among the good" (167-8). Refutes Moore's charge that Byron was killed by public opinion (172). Also denies Moore's claim that misery is the parent of poetry. "Poetry is the work, not of circumstances, but of mind; of disciplined and powerful mind; which so far from being the sport of circumstances, makes them bend to its power" (181).

178. G. B. Cheever, "Lowth's Hebrew Poetry," XXXI, 337-379 (Oct., 1830).

Seems to prophesy Whitman when he says that the "English language seems to be the best adapted of all modern tongues" for translating the parallelistic structure of the sacred poets (362).

179. W. B. O. Peabody, "Studies in Poetry by G. B. Cheever," XXXI, 442-460 (Oct., 1830).

Notes again the decline of poetry in his own day. Maintains that the "spirit of poetry is still present with him who meditates at eventide; with the worshipper of nature in her solitary places; with the contemplative" (443). The great cause of the decline is "the influence of perverted taste" which hourly welcomes "inferior classes of romances, tales, and novels" (444). Gives a review of English literature: Dismisses Chaucer; praises Spenser; Shakespeare "looked upon man and nature without looking beyond them to the God of all"; Donne and his group are the Malvolios of English literature"; dislikes the Restoration but likes Milton very much; gives special praise to the age of Pope.

1831

180. G. S. Hillard, "Clarence," (by Mrs. Sedgwick), XXXII, 73-95 (Jan., 1831).

Mrs. Sedgwick's chief merit is a "high and pure tone of moral and religious feeling, without which genius is a fatal curse" (77). Objects to the novel as "unnatural and improbable"; it is too much like some of "Mrs. Radcliffe's wild creations" (85). Thinks the "web of life in our Western world is too coarse to bear the embroidery of romance" (94).

181. H. W. Longfellow, "Origin and Progress of the French Language," XXXII, 277-317 (April, 1831).

Chiefly a discussion of philological matters, but has some critical dicta. Notes the "great influence that poetry exerts over a language, and the great tendency it has to soften and enrich it" (301). Progress in a language does not mean changes in orthography but "its approximation to a perfect medium of thought" (307). The merits of French are "ease, vivacity, perspicuity and directness." It is particularly suited to colloquial elegance, genteel comedy, conversational ease, the antithesis of epigram, the spirited ease in songs, and the simple pathos of the ballad. But in the "higher walks of tragic and epic poetry it but feebly seconds the high-aspiring mind" (316).

182. W. B. O. Peabody, "Waverley Novels," XXXII, 386-421 (April, 1831).

Says some regret that Scott gained so great a reputation merely by amusing the world; replies that, like the parables of Scripture, the novel is "only an extended figure, which illustrates the truth and deepens its impression" (388). Examines the various criticisms of Scott: (a) Some object to the connection "between fact and fable" in the historical form, but history gives an air of truth which pure fiction can never have. (b) Many object to his lack of plot, but history cannot be subjected to the critical demand for unity. (c) His heroes are called inefficient and uninteresting, but when we appeal "from criticisms to nature" Scott is nearer to common men, though far from the traditional hero. (d) Many object to the sameness of his characters, but he drew from nature and there is "sameness in nature". (e) Others say that historical romances decrease the interest in history, but the opposite is true. Lists Scott's qualifications: good sense, his education, the circumstances of the time augmented his particular tastes, and the habits of his early life. Predicts that Scott's type of novel will decline, but that the novel as a literary form will "embrace all that man ever did" (403). Scott, Maria Edgeworth, and Richardson surpass Fielding.

183. O. W. B. Peabody, "The Water-Witch," XXXII, 508-523 (April, 1831).

Defends Cooper from the charge of being an imitator of Scott. The qualifications of a novelist are power of description and the ability to portray character. Cooper has the first in a high degree but lacks "knowledge of human nature"; his characters do not have a proper degree of distinctness, individuality, and variety. Gives high praise to Cooper's "description of American scenery, and of a variety of incidents and circumstances, which could be found in no other country" (521).

184. W. H. Prescott, "Poetry and Romance of the Italians," XXXIII, 29-81 (July, 1831).

Compares Dante and Milton; both are sublime to the highest degree, but "Milton is an ideal poet and delights in generalization, while Dante is the most literal of artists" (33). It was fortunate that the *Divine Comedy* was a subject which enabled Dante "to exhibit the peculiar genius of Christianity, and of modern institutions, and to demonstrate their immense superiority for poetical purposes over those of antiquity." It showed that at last barbarism had receded from the earth(34). Contends that the difference in society from age to age requires new and peculiar forms of expression; hence moderns cannot write by ancient rules. Notes the change of meaning in religion, love, honor; love of country was once the pervading feeling, but now the individual comes first (46). Maintains that the freedom of the political and social institutions of England and America have encouraged expansion of intellect and peculiarities of temper and have made them the best theatre of all time for the study of character (59). The drama and the novel are the staples for this "scientific dissection of character" (75). Prescott had a very wide knowledge of Italian literature itself.

185. George Bancroft, "Harvard University," XXXIII, 216-266 (July, 1831).

The Harvard library should be enlarged so it will attract men of ability and fondness for intellectual research. This is one of the "chief hindrances at present to the rapid progress of American literature, the want of a point of union, a common arena, where accomplished minds are jostled in close proximity" (223).

186. Alexander H. Everett, "American Poets," XXXIII, 297-324 (Oct., 1831).

A review of G. B. Cheever's *American Common-Place Book of Poetry*. Praises the anthology because it was made "with great taste" and "a strict regard to the higher moral considerations" (397). Thinks the present generation of English poets are no greater than the present generation of American poets. Denies that the spirit of poetry is disappearing from the earth; it is one of the essentials of our nature and will live as "long as man preserves his present constitution" (298). Poetry arises whenever the other aspects of life are reinvigorated: poetry is the "instinctive spontaneous expression of feelings awakened by the real action and passion of life" and great periods of poetical activity coincide with great activity in other fields (299). Cheever ranked Dana as the foremost American poet; Everett disagrees and gives the place to Bryant.

Dana imitated "the worst efforts of the worst of all models, Wordsworth" (302).

187. H. Wheaton, "Anglo-Saxon Language and Literature," XXXIII, 325-350 (Oct., 1831).

The English was greatly enriched by Norman, French, and Latin, but "its sturdiest roots are to be looked for and found in the Anglo-Saxon" (325). Hence Anglo-Saxon is "essential to a complete knowledge of modern English" (326).

188. Alexander H. Everett, "American Library of Useful Knowledge," XXXIII, 515-530 (Oct., 1831).

Laments the encroachments of physical science on moral science. The glory of the modern world "lies in the cultivation of physical science, and its application to the useful arts." Moral science has not kept pace and to this might be traced some of "the practical defects in the social and political condition of the nations of Christendom" (530).

1832

189. H. W. Longfellow, "Sidney's Defence of Poetry," XXXIV, 56-78 (Jan., 1832).

This is Longfellow's defence of poetry. The "spirit of the age is clamorous for utility"; we glory in the extent of our territory and the magnificence of our nature but "the true glory of a nation is moral and intellectual preeminence" (59). Then asserts (five years before Emerson's *American Scholar*) the intellectual independence of America. In forming our new literature "we should make it as original, characteristic, and national as possible" (69).

190. W. B. O. Peabody, "Croker's Boswell," XXXIV, 91-119 (Jan., 1832).

Peabody greatly admires the neo-classical writers. Johnson had a mind "of the very first order" (100). Praises Johnson's ideal of style—"to think clearly and then to express the thought in the most direct and natural manner" (102). Condemns the "obscure and shadowy style" of such works as Bulwer's *Pelham* (102).

191. D. L. Child, "Authorship of Junius," XXXIV, 316-363 (April, 1832).

A survey of the evidence and a review of five American books on the subject.

192. W. J. Snelling, "Bryant's Poems," XXXIV, 502-514 (April, 1832).

Hails Bryant's first volume as the "best volume of American poetry that has yet appeared" (512). "Bryant is not a first-rate poet; but he has great power, and is original in his way". Likes his powers of observation and vividness; his simplicity and naturalness; and the fact that he is "never carried out of sight of common sense by his imagination" (505). The publication of this volume is an important event for American literature. There has been "too much looking abroad for examples and models"; we have had "no standard of excellence of our own"; we hardly dare "judge favorably of an American work"; but Bryant has taken the only proper "way to answer the sneers of foreigners" (512). Stresses the need for careful preparation and learning before America can have a literature. This has been the "pernicious error" of American literature and sets at naught our "boundless profusion" of material (513). Ends urging treatment of American materials.

193. Mrs. W. Minot, "Cousin's Philosophy," XXXV, 19-36 (July, 1832).

A review favorable to Cousin, voicing many of the main transcendental ideas which Emerson was to begin to express six years *later*. Makes the distinction between two kinds of reason: (transcendental) "Reason is absolute, universal, devine; human reason is imperfect, because it is enveloped in a finite nature" (25). Defines the "finite" as the "something not ourselves" (25). The foundation of all things lies in three ideas—"unity, multiplicity, and cause" (26). "The world of ideas is hid in the world of facts"; it is the mission of the philosopher to distinguish these ideas and to connect each particular fact "with some general law" (30). History, the compendium not only of human nature but of the universe, is "the result of the necessary operation of wise and beneficent laws, ordained by an infinitely perfect Being" and is not only beautiful "but highly moral" (29-30). Asserts also the doctrine that "great men bear the stamp, and afford the truest specimen of their age" (32). Praises Cousin's eclecticism highly: it "is not only the best, the true, but the only possible philosophy" (33). Ends with a plea which predicts Emerson. The "evils of a speculative and visionary mind" are not those which the present day needs to guard against. The calculation of interest and the division of labor are every where chaining down men's minds to a point" and speculative philosophy should be welcomed as the call which "may rouse us to a sense of the grand features and broad principles of humanity" (36). (For orientation consult William Girard, "Du Transcendantalisme considéré essentiellement dans sa définition et ses origines françaises," *University of California Publications in Modern Philosophy*, IV, Oct. 18, 1916; W. L. Leighton, *French Philosophers and N.E. Transcendentalism*, Charlottesville, Va., 1908; H. M. Jones, *America and French Culture*, Chapel Hill, N. C., 1927, pp. 464-67 and passim.)

194. W. H. Prescott, "English Literature of the Nineteenth Century," XXXV, 165-195 (July, 1832).

Prescott's most important essay. Refuses to discuss whether Pope was a poet or not; his poetry was that "of philosophy, criticism, and satire" (167). Dislikes Dr. Johnson as "equally destitute of imagination and taste" (170). The 18th century was a time of "sluggish calm in which the minds of men seemed to repose"; the American and French Revolutions were tempests "which are occasionally sent to clear the moral atmosphere, and renovate the face of society" (170-1). Cowper is "the morning star of our modern poetry" but the three great modern poets are Scott, Wordsworth, and Byron; Scott is the poet of the long-neglected English minstrelsy; Wordsworth, the poet who attempts to "reconcile man with himself and his destiny" (thinks Wordsworth's muse was shipwrecked by his theory of low and rustic life); and Byron, the poet of the passions (178). Modern criticism: criticism can almost be "reckoned an invention" like creative literature; critical journals have replaced the old periodical essays, but the two great English journals follow rather than guide "public opinion" (183). Thinks criticism has had a salutary effect in America (184). Notes that the novel has replaced the drama: the "novel of character is only a development of the drama in a more expanded form," and is better suited to the "practical, business-like spirit of the times," the need for "accurate and philosophic analysis of character," and the " habits of reading" acquired by the public (186). Prefers Scott to Fielding and Smollett, but the "utility" of Miss Edgeworth's novels is most "characteristic . . . of the present age" (187-8). Literary prospects of America: competition with England has stimulated us and foreign importations have raised our capacity for literature. But ends with an assertion of our literary independence: American literature must "spring from native seed" and the poet "must study the volume which nature herself has unrolled before him" (194-5).

195. Alexander H. Everett, "Irving's Alhambra," XXXV, 265-282 (Oct., 1832).

Praises Irving's style but thinks that "high and deep things, whether of philosophy or feeling, are in a great measure foreign to him" (276). Welcomes the fact that Irving expects in the future to live in America; "the time is not very distant" when the value of domestic will greatly exceed that of foreign readers.

196. H. W. Longfellow, "History of the Italian Language and Dialects," XXXV, 283-342 (Oct., 1832).

Discusses at great length the rise of Italian literature and the leading characteristics of contemporary Italian dialects. Thinks "the study of languages, philosophically pursued, to be one of the most important which can occupy the human mind." The elements of language lie deep among the elements of thought and each follows the changes in the other closely; therefore, "the language of a nation is the external symbol of its character and its mind" (283). Dante, Petrarch, and Boccaccio were giants who fixed "the uncertain foundations of their national language and literature." It is always the "high prerogative of genius to give transcendent value to whatever it touches" (295).

1833

197. W. B. O. Peabody, "Lord Byron's Conversations on Religion," XXXVI, 152-188 (Jan., 1833).

Byron "was entirely destitute of what is called character,—that is, of all fixed principles of thought and action." One of the wonders of his poetical power is that it "could sustain itself in its flights upon its light and inconstant wing" (153).

198. O. W. B. Peabody, "Sir Walter Scott," XXXVI, 289-315 (April, 1833).

Scott is free of the "moral disease, which very frequently besets superior genius"; "excessive sensibility" was never designed for the soul. Scott is the great reformer in poetry and romance. The clarity of his mind set forth everything in the broad light of truth. "Men saw, that he had led them back to Nature" (292-3), from the paralysis of the 18th century (302). Scott's novels supplied what those of Richardson, Fielding, and Smollett lacked (307). Scott is far above all contemporary writers; in the "whole literature of England" Shakespeare is the only one to whom he can be compared (312).

199. H. W. Longfellow, "Spanish Language and Literature," XXXVI, 316-344 (April, 1833).

A companion essay to his studies on the Italian and French languages (see nos. 196 and 181 above). Mainly philology.

200. Mme. C. de la Barca, "Madame de Staël," XXXVII, 1-20 (July, 1833).

"Time is the touchstone of genius"; the "public voice never fails to become correct in its judgments" when freed from prejudice and adulation (2). Compares the Germans to the French of Madame de Staël's time; "while the French materialized mind, they spiritualized matter." Thus, while "one of these schools of philosophy renders us unworthy of heaven, the other unfits us for earth. But the German philosophy at least is the faithful ally of religion" (14). Likes Madame de Staël's distinction between religion and enthusiam, but there is no longer any need to fear enthusiasm. "The day of romance has long since gone by. That of machinery has succeeded" (17).

201. G. Mellen, "Works of Mrs. Child," XXXVII, 138-164 (July, 1833).

She has written the best and most useful books (138). Says he is a stern unbeliever "in Indian tales. We are tired of them" (139). Favors the education of women as giving the life of "man its moral tone" (144). Favors literature with a moral purpose from which morals can be as easily "*deduced*, as *laid down*" (163). High hope for the future of American literature; "Genius is not slumbering in our land" (163).

202. A. S. Packard, "Homer," XXXVII, 340-374 (Oct., 1833).

We see in Homer the "true test of transcendent genius." Hails the classical editions of the American press "as indicating the commencement of a new era in the classical literature of our country" (374).

203. H. W. Longfellow, "Old English Romances," XXXVII, 374-419 (Oct., 1833).

Says the 17th century prose writers are "rare models of that direct and forcible style which has its origin in direct and forcible thinking" (375). Praises the "land of old romance" (378). Fiction vs. truth: "Men do not love truth less, in seeming to love fiction more"; they love fiction because it "resembles truth" (380). It satisfies the desire for "intellectual excitement" (381).

204. Alexander H. Everett, "Fidler's Observations on the U. S.," XXXVII, 273-314 (Oct., 1833).

A defense of American character against an unjust attack. Says that the Americans are more English than the English themselves.

Americans display the same qualities of the common stock "in a fuller state of development"; and the main one is "a bold and lofty spirit of independence" (308).

205. W. B. O. Peabody, "Miss Leslie's Pencil Sketches," XXXVII, 466-494 (Oct., 1833).

Attacks romantic melancholy, primitivism, and misanthropy. Only he who gives kind representations and inspires kind feelings can be called a "philosophical historian of the universal human heart" (470).

206. Mme. C. de la Barca, "Dante," XXXVII, 506-536 (Oct., 1833).

Looks unfavorably on the Middle Ages; it was an age of "barbarism, wilder and more ferocious than that of the earliest ages of Greece." No period "could be less favorable to genius" (507). Dante arose in spite of the time. His example shows that misfortune "is the best school for genius" (511). Science is injurious to art: "In proportion as knowledge is more generally diffused, the imagination becomes less susceptible, and it would seem that as science advances art recedes" (536). (Compare Macaulay's development of the same thesis in his essay on Milton, 1825).

1834

207. A. P. Peabody, "Life of Cowper," XXXVIII, 1-32 (Jan., 1834).

Favorable to Cowper; points to "the healthy action of his powerful intellect and the daily beauty of his unclouded life" (19). His change "in the style of English versification, though it seemed wild and lawless at the time, was a great improvement . . . on the artificial elegance in the measure of Pope" (27). Praises the humanitarianism of *The Task*; it opened the eyes of thousands to "traditional abuses" (29). There is no danger, as many claim, that poetry is in danger of disappearing; we merely live in an age following "a period of great intellectual excitement." We want someone with "the spirit and power of Cowper" to speak in a voice which "shall compel the world to listen" and in a voice, too, that "religion and virtue, as well as literary taste, can hear with applause". We are "confident that such an one will appear" (32).

208. A. H. Everett, "Early Literature of Modern Europe," XXXVIII, 158-177 (Jan., 1834).

Literature is the expression of the social and political condition of a nation itself, but it is still an open matter whether learning and the arts flourish better under liberal or despotic governments (159). Thinks Italian literature is first in value and that England, France, and Germany rival her only in history and moral philosophy (165). Dislikes the allegory of Spencer; "in the *Faerie Queene* . . . the observations of the author upon actual life (for to this, after all, the substance of poetry reduces itself) became unintelligible, and lose their effect in consequence of the precise circumstance by which he probably intended to heighten it, of their being wrapped up in a cloud of allegory" (171). This accounts for the superiority of Shakespeare and Scott (171-2). Everett is a romanticist; the influence of French poetry on English poetry "gave it, for at least a century, a new and false direction" (176). With the romantic movement "the slumbering genius of the country" awoke and "having taken in the main a right direction, promises to pursue a long and successful career on both sides of the Atlantic" (176).

209. Alexander H. Everett, "Men and Manners in America by T. Hamilton," XXXVIII, 210-270 (Jan., 1834).

A refutation of an unjust and indiscriminate attack on America. One section is in defense of New England. Everett claims that "intellectual eminence" accompanied by "high moral qualities" operates to the highest good of a community (241).

210. E. Wrigglesworth, "Navarrete's Life of Cervantes," XXXVIII, 277-307 (April, 1834).

A summary with translated excerpts from the untranslated life by Navarrete.

211. Alexander H. Everett, "Early Literature of France," XXXVIII, 358-381 (April, 1834).

A review of M. Villemain's *Cours de Littérature Française* (1828), discussing general characteristics of the period. No "artificial encouragement can ever create genius," but thinks the patronage of Louis XIV "had a considerable effect in producing the French school of literature" (381).

212. Francis Parkman, Sr., "Memoir of John Cotton, by John Norton," XXXVIII, 486-501 (April, 1834).

Expresses the kind of sympathy for the early Puritans that was soon to be expressed by Emerson, Thoreau, Lowell, and others. Cotton was one of "eminent men of his time" (492). Praises his political liberalism; thinks the mingling of the politician with the pastor was entirely in harmony with the spirit of the time and the needs of the people (496-7). High praise for the "sound learning" of the ministry and for "the martyr-like spirit" of the Pilgrim Fathers. "Their history is one of continually fresh, as it is of exhaustless interest" (500).

213. G. H. Calvert, "Life of Schiller," XXXIX, 1-30 (July, 1834).

Though romantic in theory, Calvert refuses to recognize any transcendental element in poetry. Kant is a "metaphysical illusion" (18); it is a mistake "to regard genius and common sense as incompatible." Genius is only the "original intensity of power in a mental faculty" and intuition is only the extra-efficiency of common sense (1-2). Poetical genius is "intense susceptibility to the beautiful"; all men possess it but "the degree in which it is possessed distinguishes the poet" (2). Besides this poetical superiority the poet must "perceive more vividly and feel more acutely than common men. Then will his mind spontaneously pour out its materials" (3). He also must be rich in knowledge and skilled in the uses of it by action; or, in other words, "to give life and substance to his poetry, the poet must be and do as other men: the man is the basis of the poet" (4).

214. A. Urquhart, "Roman Literature," XXXIX, 57-68 (July, 1834).

Hails the "daily extending progress of sound classical information." The study of Roman literature not only leads to good taste (for it has models of "all that is elegant in expression and lofty in sentiment"), but also to the "practical exercise of the moral powers" (58-9). The latter will result from their "sublime and disinterested tone of national character" (60) and their "severe adherence to the strictest rules of discipline and personal restraint" (61). The effects of these will lead to "the ascending progress of masculine literary refinement" (62).

215. O. W. B. Peabody, "Life and Writings of Crabbe by his son," XXXIX, 135-166 (July, 1834).

Takes the middle of the road in regard to Crabbe's realism: "Life is a sphere, of which the pastoral poets saw only the brilliant side, while Crabbe . . . was familiar only with the dark one. . . . We doubt whether either can produce a happy moral influence" (147). However, he praises Crabbe as a moralist and reformer, and especially for accurately "copying from nature" and drawing his themes from common life. There is much that is unpoetical in common life, but the materials of poetry are "more abundant in a lowly, than in an elevated sphere; for feeling is there unfettered by those conventional restraints, which operate like a law on natural freedom" (154).

216. W. B. O. Peabody, "*Helen* by M. Edgeworth," XXXIX, 167-200 (July, 1834).

An excessively favorable review. The high moral character of this writer and Scott "is indeed a blessing to the world" (167). Delivers a violent attack on the immorality of Disraeli's *Vivian Grey* (168).

217. Mme. C. de la Barca, "The Italian Drama," XXXIX, 329-370 (Oct., 1834).

Attacks modern literature for separating "the useful from the beautiful." The art of the Greeks on the other hand was "employed with a moral and political view" (330). Praises Greek drama very highly; quotes the German critic, Schlegel. The point of the essay seems to be that Italian drama has the opportunity to become the logical successor of Greek drama.

218. R. C. Waterston, "Coleridge's Poems," XXXIX, 437-458 (Oct., 1834).

Highly favorable. The characteristics of Coleridge's poetry are versatility, inimitable mastery of language, condensation, originality, picturesqueness, graphic delineation, and distinct and vivid description. His poetry draws not mere pictures, but embodies also the indwelling life; it is filled with universal benevolence and a deep religious spirit (441-2). The first law of the mind is to conceive, to form images, to create. The second great law is association (452). Love is the great principle of the moral universe: God is love; the mind of man is a portion of the universe; and love is the connecting link between (452). Coleridge saved mindkind from materialism.

His works are "universal" and belong "to all men of all ages". [One of the best critical essays on poetry to date in the *Review*.]

1835

219. G. W. Green, "Petrarch," XL, 1-26 (Jan., 1835).

A good essay favorable to Petrarch; analyzes the poems and translates illustrative excerpts. Greene is a romanticist; it is "useless to scan the poetry of passion with the cold eye of unimpassioned reason. Our moments of truest poetic feeling are those of deepest excitement"; an excitement which "speaks in low tones to the softer senses of our nature, and stirs with a gentle touch the deep sources of passion." And the language of this excitement "flows naturally and freely from the depths of the soul" (17).

220. P. Benjamin, "Sheridan Knowles," XL, 141-150 (Jan., 1835).

A favorable review. Laments the blindness and insensibility of men to contemporary genius.

221. W. B. O. Peabody, "Life and Correspondence of Hannah More," XL, 151-170 (Jan., 1835).

A favorable review showing a wide knowledge of 18th century writers. High praise for her religious and reforming zeal. Attacks the 18th century idea that education is "cultivation of the intellect alone"; the same idea exists today in the idea that "knowledge of a few sciences" will raise society (164). Tone is however favorable to the 18th century.

222. Alexander H. Everett, "Character of Jefferson," XL, 170-232 (Jan., 1835).

Everett is defending the character of Jefferson. The writer of the work reviewed claimed that the French Revolution was a retrogression in the general movement of reform in Western Europe and that Jefferson's support of it was likewise an indication of essential evil. Everett disagrees; the genius of Reform "in his progress over Europe and America, took three giant steps before he fixed his foot at the fourth upon the firm foundation whence he was to shake the world. These three steps were the Reformation and the British and American revolutions. The French revolution was the fourth and last" (189).

223. O. W. B. Peabody, "Calavar: or the Knight of the Conquest; a Romance of Mexico," XL, 232-259 (Jan., 1835).

The novel shows that "this hemisphere abounds in materials for romance" (232). Thinks the greatest reward for ambition in America lies in "doing, for our own hemisphere and our own country, what the mighty minstrel and novelist of Scotland has accomplished for his own" (259). Likens artistic creation to a "chemical process" by which the historical novelist gives "fulness of reality and truth" to his work (255).

224. G. B. Cheever, "Coleridge," XL, 299-351 (April, 1835).

A review of *The Friend* and one of the best essays in the *North American Review*. Cheever is a thorough transcendentalist. Defends the nobility of Coleridge's character; it was ever his delight to discover and "acknowledge ability and excellence in others" (301). The *Biographia* "will remain a master-piece of philosophical criticism, coeval with the English language" (307). Says that "ours is an age of sense, in opposition to an age of spirit; an age of *common* sense, in which all things and knowledges are *sensualized* to all. The speculative reason is forgotten in the enthronement of the practical understanding of man" (311). Coleridge rescues us from this by directing all things "towards general principles" (310). Says that "many of the ripest and most practical scholars, that ever lived, have been Platonists" (321). Thus maintains that essentially "Coleridge's principles are clear" (322). True philosophy will simplify all knowledge by submitting all to "one comprehensive idea" (328). Coleridge's philosophy does that; it asserts "the evil of permitting the mere understanding to usurp the dominion of the pure reason" (329). It is "the office of reason to behold absolute principles; and *spiritual* intuitions are its world of action, especially if it be at one with faith. It is the office of the understanding to behold those principles acting in sense, and to follow them thus developed. The face of reason is turned towards God and the spiritual world; the face of the understanding points to the senses, and the world of material existence" (333). And thus the system of Locke and other mechanical systems based only on understanding are erroneous (336). Ends with high praise for Coleridge's poetry "as a luminous commentary on his philosophy" (343). "To Wordsworth and Coleridge, the latter the greatest philosopher and highest poetical genius, the other the most philosophic poet of modern times, the age is indebted in obligations, which it is difficult adequately measure or acknowledge. If to exert an almost magic power over minds of the noblest structure, and brightest promise; if to turn the hearts of the young with keen and animated gaze to the unveiled countenance of truth; if to awaken and call forth their best energies of intellect; if to form thm to habits of thought and meditation if to rescue them from the baneful influence of that materialism, which has lain with a weight like death upon universal science . . . if to direct and reprove the usurpations of the understanding; if to lead them to the contemplation of law in nature, and to the insight of principles in their own being, and to a reverential acknowledgement of the universal presence of the dread ground of all being;—if all this can constitute a claim to admiration and love, surely these venerable men may demand it."

(Note that this keen recognition of the merits of Transcendentalism appeared a year *before* Emerson's *Nature*).

225. G. H. Devereux, "The Last Days of Pompeii," XL, 447-457 (April, 1835).

Favorable to Bulwer. Says there is "something in the idea of antiquity which fastens deeply upon human sympathies" (447). Thinks that authors should be "careful to set the mark upon every exhibition of erroneous and ill regulated feeling of guileful and specious reasoning", for "vice will double its evil effects, by losing all its grossness" (454-5). Says it is the fashion to underrate the moderns writers by comparing them to the Queen Anne writers. Does not believe the moderns are "inferior"; it is merely that a great change has come in the last fifty years. "Thought is now become introspective and inculcates common truths, more through the tastes and passions and sentiments, than in moral points and antithetic dogmas" (457).

226. Edward Everett, "A Tour on the Prairies," XLI, 1-28 (July, 1835).

The review gives Everett the opportunity to assert the intellectual independence of America. Irving is "the best living writer of English" (1); says he desires to "make a national matter of our countryman's merit" (2). Everett maintains the power of literary creation comes entirely "from within" (12); hence all surroundings "*equally* serve the purpose of the man of genius" (13). Thus he comes to the assertion that he hopes "for nothing so ardently, as that the literature of the country should be the indigenous growth of the soil; indigenous in its topics, associations and spirit.—not for patriotic reasons merely, but on principles of art and taste" (14).

227. C. C. Felton, "Dunlap's History of the Arts," XLI, 146-170 (July, 1835).

At one point discusses the present "state of American art" (169) We have many earnest devotees, some artists of exalted genius, several academies and frequent exhibitions, and an admiring public. "But it must be confessed, that a large proportion of the works of our artists, like a majority of our literary productions, are of an ephemeral character." Our artists are not willing enough to make "a laborious study of the principles which lie at the foundation of all art . . . by careful literary culture" (169-70).

228. H. R. Cleveland, "Classic Mythology," XLI, 327-348 (Oct., 1835).

Maintains that the study of mythology is very important. It is "the key to ancient art", particularly to "the spirit of ancient art" (340-1). Of more importance is "the connexion of the mythology with classic literature" (341); it explains much of the difference between ancient and modern tragedy. But chiefly it helps make "known to us our own nature" (346).

229. Edward Everett, "Dr. Channing," XLI, 366-406 (Oct., 1835).

Says that the works of Irving and Channing are the proper answer to Sydney Smith's question, "*who reads an American book?*" (366). They are "not excelled in their respective departments by any living English or American writers" (370). Says Coleridge is hailed, "especially on this side of the Atlantic," as the greatest man of the age; thinks he has very slender claims to such distinction. The corner-stone of his system is a "supposed distinction between Reason and Understanding . . . which we consider as wholly imaginary" (371); he got all his ideas from Germany and Kant and is not original. Carlyle is "the most profound and original of the living English philosophical writers" (372).

230. W. B. O. Peabody, "Mrs. Sigourney and Miss Gould," XLI, 430-454 (Oct., 1835).

A ministerial eulogy of what female writers are doing for the morality and virtue of the human race.

231. Alexander H. Everett, "Thomas Carlyle," XLI, 454-482 (Oct., 1835).

A favorable review summarizing *Sartor Resartus* in its first English periodical form. The book "contains, under a quaint and singular form, a great deal of deep thought, sound principle, and fine writing" (481). It will be recalled that Emerson was to see an edition of *Sartor* (the first edition in book form) through the Boston press in 1836, reading proof sheets while at work on his own *Nature*. For an acute study of Emerson's debt to Carlyle see F. T. Thompson's Emerson and Carlyle," *Studies in Philology*, XXIV, 438-53 (July, 1927.)

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ALKALINE FLOODING WATER IN CRANBERRY GROWING

N. E. STEVENS, L. M. ROGERS, AND H. F. BAIN

INTRODUCTION

For the past fifteen years the Wisconsin Department of Agriculture and Markets has maintained a field investigator[1] who specialized in cranberry problems. Although the work was devoted chiefly to the control of insects and diseases of the cranberry, the nature of the industry and the interests of the growers made it inevitable that some attention should be given to many phases indirectly related to the main problem. The present paper discusses one of these, the apparent relation between the use of alkaline flooding water and certain cultural problems. In view of the importance of the subject and the fact that there is little prospect of the relationship being experimentally studied within a reasonable time, it seems desirable to record our opinions and the evidence on which they are based in order that they may be available to cranberry growers and to later investigators. We fully realize that experimental work may invalidate some or all of our conclusions and regret our inability to carry out such experimental work ourselves.

Until such experiments are made, however, we are strongly of the opinion that anyone considering the development of new cranberry marshes will do well to have the water analyzed and not undertake development if it shows a pH much above 7 or more than 25 parts per million of bound carbon dioxide.

In response to the natural question as to why the relation between cultural problems and the alkalinity of flooding water has not been noted by other investigators if it is as important as the writers believe, it is necessary only to point out that the greater amount of the investigation of cranberry problems has been done in the eastern states, particularly in Massachusetts, and that nowhere in Massachuetts or New Jersey, or on Long

[1] Bain, 1926-28; Rogers, 1929-36; Stevens, 1937-40.

Island, New York, has any cranberry property been found which uses even slightly alkaline water.

It is our conviction that the use of alkaline water in flooding cranberry marshes greatly increases the difficulties of producing profitable crops of berries.

That the difficulties tend to become greater as the alkalinity of the water is higher.

That the effects are, to a certain extent, cumulative, being more evident and more serious in older marshes, after alkaline water as been used for a number of years.

That the effects of alkaline water are evidenced in some or all of the following ways.

Different and sometimes more serious weeds.
Excess vine growth.
Overgrowth and absorption of flower buds.
Excess leaf drop, not fully controllable by known methods.
Abnormally small crops over a period of years.

That when a certain degree of alkalinity is passed, profitable cultivation of cranberries over a long period becomes impossible by any methods now known.

These opinions rest on our study of the history of the cranberry industry in Wisconsin and on the known record and present condition of certain marshes in that state. They can thus be defended only by stating the evidence, as we understand it, in some detail.

The Importance of Water in Cranberry Culture

As is well known to all interested in the industry, flowage water in large amounts is essential to intensive cranberry culture by modern methods. As pointed out by Bain (2 p.12), the severe climate of Wisconsin has resulted in marsh construction being dominated by the water systems. In 1929 he found that in the Cranmoor district there were on the average 7 acres of reservoir to one acre of vines, a ratio considered fairly typical of conditions throughout the state. However, this extensive development of flooding systems is relatively recent.

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[2] Bain, H. F. Cranberry Industry in Wisconsin. Wis. Dept. of Agriculture, Bulletin 96: 1-15. 1929.

SOURCES OF FLOODING WATER

At the time of the survey on which the 1929 publication was based, only 8 Wisconsin marshes obtained water directly from streams or natural lakes. This number has been increased somewhat since that time, but flooding water for cranberry marshes in Wisconsin still comes predominantly from artificial reservoirs, many of which are, of course, fed to some extent from streams.

Comparison of the sketch map[3] of the larger Wisconsin lakes with the map[2] of the locations of cultivated cranberry marshes, shows how small a part of the cultivated cranberry acreage is to be found in the great lake districts of the state.

The foregoing should not be interpreted as meaning that lakes should be considered as a unit as regards their suitability for flooding cranberry marshes. Actually, as the careful work of various Wisconsin agencies has demonstrated, they show a wide variation in many respects. As regards alkalinity, the characteristic discussed in this paper, lakes within the state differ very widely. Each lake should, therefore, be tested and studied separately, but certain general statements may be made which are of interest in connection with the history of the cranberry industry in Wisconsin. Birge and Juday (3 p.76) state that all of the lakes in the southeastern part of the state, except Devil's Lake, have very hard water, ranging from an average of about 60 to nearly 100 parts per million bound carbon dioxide. The lakes in northeastern Wisconsin show a wide variation in hardness, but Juday, Birge, and Meloche[4] point out a distinction which may be of considerable practical usefulness in cranberry culture. They distinguish between seepage lakes and drainage lakes. By seepage lakes they mean those lakes which do not have an inlet or an outlet. They receive water through precipitation on their surface and from the surface drainage of limited basins. Any gain or loss to the ground water takes place through the process of seepage; hence they have been designated as seepage lakes. In general seepage lakes are characterized by very soft water (4 p.5). Those bodies of water which have temporary

[3] Birge, E. A. and Chancey Juday. "The Inland Lakes of Wisconsin" Wisconsin Geological & Natural History Survey. Bul. 22. 1911.

[4] Juday, C., E. A. Birge, and V. W. Melche. "The Carbon Dioxide and hydrogen ion content of the lake waters of Northeastern Wisconsin". Trans. Wis. Acad. Sci. 29: 1-82. 1935

or permanent outlets have been called drainage lakes. Some of them show characteristics much like those of the seepage lakes because they have no inlets and their outlets possess water only for a brief period each year and sometimes only at intervals of several years.

Types of Water and Their Distribution

Wherever possible throughout this paper we have expressed the condition of the water used on the various marshes in two ways—pH (hydrogen-ion concentration) and in parts per million of bound carbon dioxide. It is possible that if we understood conditions better some other measurable character such as mg. of calcium per liter might more accurately express the differences from the point of view of cranberry culture. pH is, however, generally used in describing the acidity of agricultural soils, and the Wisconsin Geological and Natural History Survey, the Wisconsin State Planning Board and at least some units of the Federal Bureau of Agricultural Economics, all express hardness of water in parts per million of bound carbon dioxide. The following table is that used by Professor Juday to indicate the "nature" of the water in relation to its bound carbon dioxide content.

0- 5	parts per million of bound carbon dioxide yields a very soft water (V.S.)
5-10	parts per million of bound carbon dioxide yields a soft water (S.)
10-20	parts per million of bound carbon dioxide yields a medium water (M.)
20-30	parts per million of bound carbon dioxide yields a medium hard water (M.H.)
Over	30 parts per million of bound carbon dioxide yields a hard water (H.)

There is, of course, some relation between the pH (hydrogen-ion concentration) and the bound carbon dioxide content. On the basis of observations made in 499 Wisconsin lakes, the writers already quoted[4] found that in drainage lakes (those which have an outlet) the neutral points in the pH scale, 7.0, often comes at or near the dividing line between soft and medium water, i.e., at about 10 parts per million of bound carbon dioxide. Our own rather limited observations indicate that water in cranberry reservoirs may sometimes have a considerably higher bound carbon dioxide content, with a pH close to 7.0.

The pH of lake water varies from time to time. In a study of the pH of surface samples from 245 Wisconsin lakes in different years, Juday, Birge, and Meloche (4 p.49) found that in 222 of them, or 90 per cent of the total number, the difference did not exceed 1.4 pH units in the various years, but in six lakes the annual difference exceeded 2 pH units. They also report (4 p.50) that in certain lakes the summer pH was lower than that of the spring, in others the pH of samples taken in summer was higher than that of those taken in the spring, while in 9 cases the spring and summer readings were the same. There was even a difference between readings taken in a single lake on the same day. For example, they note that at Trout Lake on August 15, 1933, the readings taken during the daytime fell between 7.5 and 7.7, but were somewhat lower in the evening, or pH 7.2 to 7.3. Likewise the differences between surface and bottom waters varied from zero to 2.6 units.

Annual variations in bound carbon dioxide were small in seepage lakes whereas in the drainage lakes they varied from less than 2 to as much as 8.5 parts per million (4 p.65). The differences between the bound carbon dioxide content of surface and bottom waters varied from zero to 13.3 parts per million. Bound carbon dioxide thus constitutes a somewhat less variable characteristic by which differences may be measured, but from the above information it is evident that a cranberry grower who is interested in obtaining reliable information regarding the nature of his water supply should not be satisfied with a single test if he finds the water near the border line, but should obtain a series of readings at intervals. In general, however, fluctuations are least in early spring and late fall, which are thus the most favorable times for comparing one water source with another.

The water used in flooding Wisconsin cranberry marshes ranges from pH 5.2 to pH 8.6, and from less than 8 to more than 60 parts per million of bound carbon dioxide. The greater number of marshes, more than 50 of them, are found in the group having water with pH 7 or less, that is neutral or somewhat acid water. This includes all those in the Mather and Cranmoor districts, as well as a number of those in the northern part of the state.

There is a small number of marshes in the northern part of the state with flooding water from 7.2 to almost 8.2, and a still smaller group, chiefly in the southeastern quarter of the state, with flooding water which at times may test as high as pH 8.4 or even pH 8.6.

Specific Cultural Problems Possibly Related to the Use of Alkaline Water

The following observations relate specifically to the three or four marshes in the state which are known to have flooding water which sometimes tests as alkaline as pH 8.4 or 8.6. These marshes have been observed closely over a period of ten or twelve years and have never during this time produced a really satisfactory crop of fruit, even though they have had adequate frost protection and no unusual losses from insects and disease. As already stated, we have no proof that this condition is due to the alkalinity of the flooding water, but there are certain pathological conditions which are observed on these marshes, not often found on those with acid water.

In general, the effect one gets from observing such a marsh is that the vines are constantly over-fertilized and over-stimulated. Vegetative growth is much too abundant and many of the berries actually produced are abnormally large. Growth in the spring is unusually vigorous and rapid and is frequently associated with a condition that we have come to call 'flower bud absorption'. This is a condition in which uprights develop from fruit buds on which the blossom buds have aborted and fail to grow away from enclosing bud scales, although growth of the upright proceeds normally in other respects. The general appearance suggests frost injury, but repeated observations have convinced us it is not due to frost in these cases and may be associated with water. At any rate, this condition is much more common on marshes with alkaline water.

On such marshes in the fall fruit buds tend to overgrow, that is, develop beyond the point normal for the resting period, and are thus more subject to injury, frequently to complete killing, during the winter submergence. In addition to this killing of flower buds, other types of winter injury, the wellknown 'leaf drop' and even death of vines is more common and more difficult to control on marshes having extremely alkaline water.

Whether the abnormalities noted are due to alkaline water or soil is, of course, not proved, but they are certainly associated with it. One theory is that they are, at least in part, the result of excess nitrogen due to the action of bacteria which grow best in alkaline soil. Weed problems appear to be somewhat different and indeed to be somewhat aggravated on these marshes with alkaline water as compared to the usual marsh. Some species of weeds not serious on the more acid marshes cause difficulty on them, and in addition they have their share of many troublesome cranberry weed species. The general impression one gets here, as in the case of the cranberry vines themselves, is that the soil is extremely fertile and favorable to plant growth.

While such extreme conditions as those noted above are not to be found on marshes with slightly alkaline water (pH 7.2-7.8), and some of these under good management produce good crops and pay good dividends, the general management problems seem to be aggravated even here.

History of the Industry of Relation to Flooding Water

In spite of some inevitable conflict in statements as to the exact dates, areas and yields, it is possible from the publications of the Wisconsin State Horticultural Society and the Wisconsin Cranberry Growers Association to reconstruct a fairly consistent and adequate history of the cranberry industry in the state. Some knowledge of this history seems necessary to an understanding of the general problem here discussed.

Unquestionaly cranberries were picked and sold in large quantities from wild vines before there was any attempt at cultivation. The earliest record of actual cultivation found thus far is in connection with a paper on cranberry culture presented before the Horticultural Society in 1876 by Mr. H. Floyd of Berlin. In discussing this paper a Mr. Peffer is quoted (5 p.145) as saying that "he had cultivated cranberries since 1853; found that they grew readily from cuttings, even on clay soil; had found difficulty in the frost heaving the ground and covering the vines with muck where he scalped the marshes." How extensive Mr. Peffer's plantings were is not known, but there is little doubt that the earliest general improvement of marshes was in the region of which Berlin was the commercial and shipping center. E. W. Daniels, writing in 1878 (5 p.140) states that in 1860 he purchased land near Auroraville for cranberry growing, but soon abandoned it to the state. A few years later (1865 seems to be the most probable date) H. S. Sackett purchased a tract of land two miles from Berlin and built dams for flooding the marsh. Sackett is reported to have had a very profitable crop in 1868 and the Carey Brothers a large and profitable one in 1872. The earliest report (1878) of the 1872 crop states that it was over 6000 barrels for the Carey marsh itself and 14,400 for the Berlin area, with a maximum price in Berlin of $11.00 a barrel. Later accounts naturally indicate a somewhat larger yield.

Independent accounts by Hitchcock in 1875 (p. 126-128) and Daniels in 1878 (p. 140-143) are in substantial agreement that there were in the Berlin area at this time over 1000 acres of more or less improved marshes under the ownership of the Careys, Sackett, Walters, Rounds, and Company, and Mason (later Spencer) and others. These marshes, while containing only wild vines, were not unimproved. Mr. Sackett had no canals but held the water from rainfall and spring freshets. Rounds and Company had 10 miles of ditches and Spencer 8 miles. The Carey's had "fifteen miles of ditch" and a canal one and one-fourth miles long from their mill-pond[6] at Auroraville built at a cost of $7,800.

The importance of an adequate water supply and of adequate control of the water for winter protection and insect control is emphasized in detail by H. Floyd of Berlin 1876 (p. 64-68), and C. S. Whittier of Camp Douglas in 1877 (p. 53-59).

It was undoubtedly the large profits made during the early 1870's in the Berlin area that led to the expansion of the industry in Wisconsin and particularly to the establishment of marshes in Wood County and the Mather-Warrens district, estimated in 1875 (p. 126) to comprise 2500 acres of newly improved marshes. It is probably unnecessary to add that an acre of cranberries at that time did not mean what it does today, but merely wild vines with more or less improvement in the way of ditches and dikes.

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[5] Throughout this portion of the paper, page references are to the publications of the Wisconsin State Horticultural Society for the years indicated.

The present importance of the Wood County and the Mather-Warrens Districts in Wisconsin is evident from the fact that they still comprise 75 per cent of the total acreage. Here are located most of the oldest marshes in the state, many of them in successful operation under the direct descendants of the men who first improved them.

In the Berlin area, on the other hand, at the present time there is but one commercial marsh. The decline of the Berlin area has, of course, not been continuous. There were some good crops in this area within the last thirty-five years.

While there may be many factors concerned with the decline of cranberry growing in the Berlin area and its persistence on a profitable basis in Wood, Juneau, and Monroe counties, in spite of such hazards as the drought and fires of 1894 and 1895, and the great drought and winter killing of 1932 and 1934, it is certainly true that the water used in constantly increasing amounts to supplement that held from the rain came in Wood County and those west and south from such streams as Hemlock Creek, the Lemonweir River and later from the Wisconsin River, all somewhat acid, whereas the sources of flooding water in Waushara county, such as the Fox River and Willow Creek, are decidedly alkaline.

It seems highly probable that a casual relation exists between the type of flooding water used and the success of the industry in the Wood County area, and its decline in the Berlin area. It is not, however, necessary to assume such a relation in order to recognize the possibility that present methods of cranberry culture may be unsuited to marshes using alkaline water. Present cultural methods have been developed from the experience of growers in the areas longest occupied and it is a fact that during the intensive development of the industry from 1900 until the present time, the successful growers in the central area have had no experience with the use of alkaline water in flooding. Neither have those in Massachusetts or New Jersey since so far as can be learned no alkaline water is used for flooding in either of these states.

Naturally, the more widely scattered marshes in the northern part of Wisconsin have yielded as yet much less information on this problem. For one thing they are all young compared to

[6] The water in this pond tests at various seasons from pH 7.6 to pH 8.6

those further south, few if any are over 30 years old, and if alkaline flooding water has any effect, it is probably cumulative. Moreover, they do not represent a single type of water, but a wide range of types. It is, however, true that those northern Wisconsin marshes, which during the past decade have proved so outstandingly prolific, have used for flooding, water derived from what Birge and Juday designate as "seepage lakes" characterized by very soft water.

SIGNIFICANCE OF THE ABOVE OBSERVATIONS

For the immediate future it seems clear that in planting commercial cranberry marshes, those locations having only alkaline flooding water should be avoided. It is, of course, entirely possible that the correlation above described is not casual. Yet the chances of its being important are so great that it seems unwise for any individual to risk the large investment usually necessary for starting a new marsh in the face of this additional possible handicap.

It is admitted that we have not even observational evidence bearing on the question of the possibility of growing cranberries with alkaline flooding water on the highly acid peat soil associated with native stands of "brown bush" *chamaedaphne calyculata* (L) Moench. The experiment might well succeed, at least for a time, but on the other hand, might be expensive for any individual to attempt. Obviously, when time and facilities can be made available, this whole subject should be studied experimentally, though adequate experiments might take many years.

It is probably unnecessary to add that many factors other than a suitable water supply must be considered in selecting a suitable location for a cranberry marsh. This factor is emphasized here because in the past it has been so largely neglected.

THE VEGETAL COVER OF THE DRIFTLESS CUESTAFORM HILL LAND:*

PRE-SETTLEMENT RECORD AND POSTGLACIAL EVOLUTION

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Pre-settlement Record

As the first white settlers found it, the flora of the Driftless Hill Land, both in types of plants and in the patterns of their distribution, showed predominantly the effects of Pleistocene glaciation. Two of the major plant formations of North America, the broadleaved or Alleghenian forest entering from the southeast, and the prairie entering from the southwest, were well represented, although the former was dominant. A third type, the northern coniferous and mixed forest, occupied a much smaller area and was concentrated along the northern and northeastern margins. These three great plant formations are not to be thought of as fitting together in the form of broad wedges bounded by relatively simple lines. On the contrary their zones of contact exhibit a complicated mosaic pattern with numerous peninsulas and outliers.

The vegetation maps of the Driftless Hill Land (Figs. 2 and 3) have been constructed from data compiled from the notebooks of the original government surveyors. For the region under analysis these surveys varied in time from 1832 for southwestern Wisconsin to 1855 in parts of Minnesota and northwestern Wisconsin. The source materials are available in the land offices of the state capitols of the four states represented in the Driftless Hill Land.

For each government township of 36 square miles the government surveyor first established the four boundaries of the

* The region here designated as the Driftless Cuestaform Hill Land refers to that part of the inner basin of the Upper Mississippi unmantled by *recent* till sheets, where the local relief usually exceeds 250 feet. It is not identical with the well known Driftless Area although that region is largely included within its borders (Fig. 1).

Aid in completing this study has been received from research assistants subsidized by the University of Wisconsin, and from N. Y. A. students.

land unit by a linear traverse of 24 miles around its perimeter. This is known as the outer survey. Subsequently 60 miles of linear traverse inside of the township established the boundaries of the individual sections. For each mile of traverse, or one side of a section, the surveyor entered at the end of his notes comments concerning the lay of the land and the nature of the vegetation cover, even specifying the principal tree types, and often indicating the density of stand. A synthesis of these, as well as other data, was included in a colored sketch map of the township prepared by the surveyor and included in his notebook. When the notebooks were forwarded to the General Land Office in Washington D. C. engineers there prepared from the field notes township maps, scale two inches to a mile, on which certain major vegetation boundaries were indicated. Volumes containing copies of these original General Land Office plats are likewise available at the state land offices.

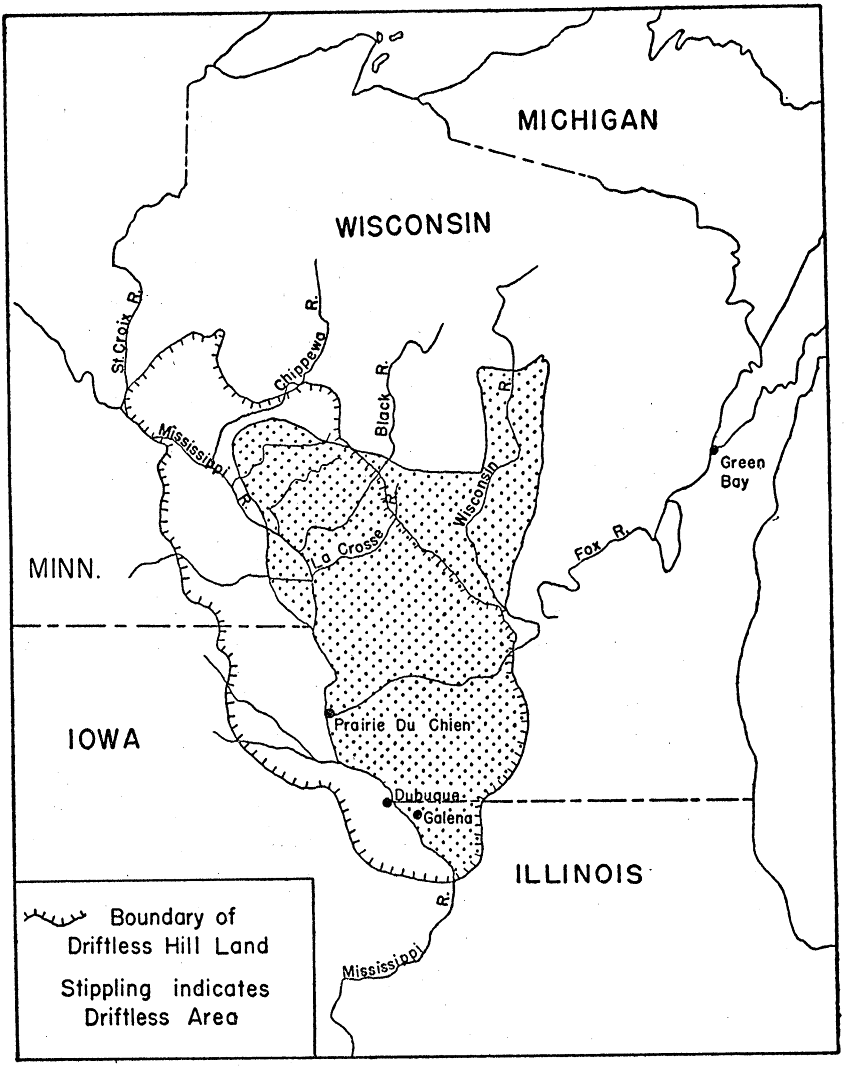
To facilitate copying the information from the surveyors' books, mimeographed work sheets were prepared each having on it the outline and section grid of one civil township, scale one inch to a mile. On the section lines of these sheets, by use of a digit and letter system of recording, were placed the data on native vegetation taken from the surveyors' notebooks and maps. Significant summary remarks by the surveyor concerning vegetation, surface configuration, settlements, etc., were noted on the back of each sheet. In the digit-letter legend placed on a section line, the first digit always indicated the primary form of vegetation, viz., woodland, grassland, brush, and swamp. Succeeding digits or letters represented particular species, usually trees, within the primary formation. These were arranged in order of importance. The completed work sheets were then fitted together into county units and boundary lines drawn around areas having similar vegetation characteristics. These areal subdivisions in simplified form and with slightly smoothed boundaries were later transferred to a map of the Driftless Hill Land, scale about 1/500,000.[1] Due to the fact that the different surveyors were not equally proficient and careful in observing and recording the plant cover, the data for different townships are not of

[1] Credit is due Robert Amaden, a graduate student in geography at the University of Wisconsin, for supervising the clerical work associated with collecting and plotting the data, and for constructing the manuscript map for Fig. 1.

uniform quality and therefore are not strictly comparable. This fact is borne out by the discrepancies to be observed along the margins of adjacent townships surveyed by different men.

An attempt was made to construct a map showing quantitatively by isarithms the dominance of particular tree species in various parts of the Driftless Hill Land. Recordings were made by quarter townships of the number of times particular trees were mentioned by the surveyor, *on the assumption that the number of mentionings was directly proportional to the prevalence of the tree.* The technique was unsuccessful and had to be abandoned, probably because the method required a degree of accuracy not inherent in the data, or because the above assumption concerning relationship between tree numbers and mentionings by the surveyor is incorrect. As finally developed the technique employed was less strictly precise and did not lend itself to drawing of isarithms, since numerical recordings were not made by unit areas. Instead, boundary lines were drawn around areas, irregular in outline and size, within which a certain combination of trees was dominant. Trees not mentioned on at least one fourth of the section-line traverses were usually omitted. The multitude of small areas representing slightly contrasting associations of trees finally required a considerable amount of combining and simplifying in the published map.

Fig. 2 showing distribution of the principal plant formations, together with certain major types of forest, indicates that the Driftless Hill Land is a part of the most northwestern extension of the Alleghenian hardwood forest. The western margin of the Driftless Hill Land's rough terrain fairly well coincides with the transition from hardwood forest on the east to prairie farther west. Within the hardwood area proper the larger prairies coincided with the crests of the broader rolling interfluves and adjacent upper portions of the bordering river bluffs. The latter sites have been facetiously labeled "goat prairies" by a botany graduate student engaged in a field study of them. This coincidence of prairie with the more extensive upland surfaces is sufficient to explain the relatively higher percentage of grassland, (1) south of the Wisconsin River, and (2) north of the Chippewa, in Wisconsin. On its northern and northeastern margins the hardwood forest gradually gives way to a mixed forest in which conifers are prominent. This boundary as well is roughly coincident with that of the Driftless Hill Land. On the north the shift from hardwood to mixed coniferous-hardwood forest would seem normal for the latitude and largely climatically induced. The eastern vegetation boundary appears to be edaphic



in origin, conifers becoming more prominent on the sandy soils of the Cambrian Plain. Extensive areas of brush, and smaller ones of pure conifers, are conspicuous in the transition belt.

Figure 3 presents a more detailed analysis of woodland combinations and their distribution, more especially the deciduous forest. Within the hardwood forest the fact of oak dominance is most striking. On over one half of the total hardwood area oaks were the only trees mentioned by the surveyors. Where other species were present oak usually remained the most prominent tree. Only on some of the more extensive river bottoms, and in the oak-maple-linden-elm forest of Pierce, St. Croix, and Dunn Counties did oak recede from first position and, very occasionally, drop out of the woodland combination completely. From the standpoint of the vegetational history of the region it is very noteworthy that so much of the oak area was described as thin and scattered timber. Such a cover probably represented an intermediate stage in the evolution from prairie to woodland or vice versa. By some it was even spoken of as prairie rather than woodland. Thus certain early settlers in the lead region south of the Wisconsin River in Wisconsin and northwestern Illinois described it more than a century ago as a prairie land of which not more than one tenth was forested. Obviously much of the area designated on Fig. 3 as thin and scattered oak was considered by the settlers more prairie than forest.

Although the hardwood forest of the west central states is often labeled oak-hickory, the latter tree was not conspicuous in the Driftless Hill Land. Along the southern border of the region, in Illinois, there was the most extensive area of oak-hickory forest, and smaller scattered areas were present elsewhere.

Much more extensive were the areas in which maple,[2] linden, elm, aspen, and ash were prominent trees. One such large area centered on Richland County, Wisconsin, just north of the Wisconsin River and extended out to the west, north, and east into Crawford, Vernon, Monroe, Juneau and Sauk counties. In this region, other than oak, sugar maple, linden, and elm were very prominent. Since maple as well as sugar tree was mentioned by the surveyors, one would infer that soft maple was likewise pres-

[2] One cannot be certain at all times from the surveyors' notes what is meant by maple. In a large number of cases hard maple is designated as sugar tree, and where this is the case maple is understood to mean soft maple. But there are good reasons for believing that the term maple as recorded by some surveyors was used to include both the hard and soft varieties.

ent. Somewhat isolated from the larger unit just described, was a neighboring subarea located principally on the Baraboo quartzite monadnock, within the Driftless Area, but extending up to the Wisconsin end moraine.

Other relatively conspicuous centers of the above noted woodland combination were in, (1) Clayton and Fayette counties, Iowa, (2) northwestern Wisconsin in Pierce, eastern St. Croix, and western Dunn and Pepin counties, (3) south central Grant County, Wisconsin, and (4) Stephenson County, Illinois, and adjacent southwestern Green County, Wisconsin. There were other smaller widely scattered areas. In the northernmost of the centers mentioned, maple, especially sugar maple, appears to have been more prominent than oak. There is no striking coincidence between the areas of maple-linden-elm prominence and particular features of physical environment. The reasons for these "islands" in the midst of what is largely an oak woodland is not clear. It has been intimated that they may have been relics of a more extensive forest that found refuge in the Driftless Area during one or more of the periods of glacial advance. It may or may not be significant that in Iowa and in Sauk County (Wis.) the maple-linden-elm forest extended out to the Wisconsin moraine but not much, if any, beyond it.

A much less conspicuous hardwood combination was one in which aspen was associated with oak either as the first or second tree in importance. This type was usually in close juxtaposition to another somewhat different combination in which elm was either first or second in rank, with varying amounts of linden, ash, maple, and aspen. Forests with such tree combinations had principal centers in Wisconsin in (1) western Polk and adjacent parts of St. Croix counties, (2) northwestern Buffalo county, and (3) eastern Richland county.

Since the mixed hardwood-coniferous forest largely lay beyond the borders of the Driftless Hill Land, less attention has been given to its analysis. Assuming the surveyor's observations to be a correct representation of cover, the mixed forest appears to have been composed of numerous contrasting combinations of species, most of the combinations covering no very extensive areas. With even the dominant trees varying within relatively small areas, it is not easy to subdivide the mixed forest into a relatively few groups each covering an area of some magnitude. In part the numerous tree combinations reflect the variety of regolith and drainage characteristics within the mixed-forest area.

Bordering the deciduous forest on the north and northeast in Barron, Polk, Chippewa, Eau Claire and Clark counties was a mixed forest in which white pine, birch, maple and oak appear to have been the dominant trees. Jack (black) pine, yellow pine, tamarack, hemlock, linden and aspen appear however in a variety of combinations. Within this forest it was the white pine and hemlock that were the most desirable timber trees and it was these that were early removed by the lumber companies. Farther south in Jackson, Monroe, Juneau, and Adams counties where the soils are more sandy, and extensive swamps prevalent, the less valuable forest contained more scrub oak, jack pine, and tamarack, although white pine remained one of the most widely dispersed species.

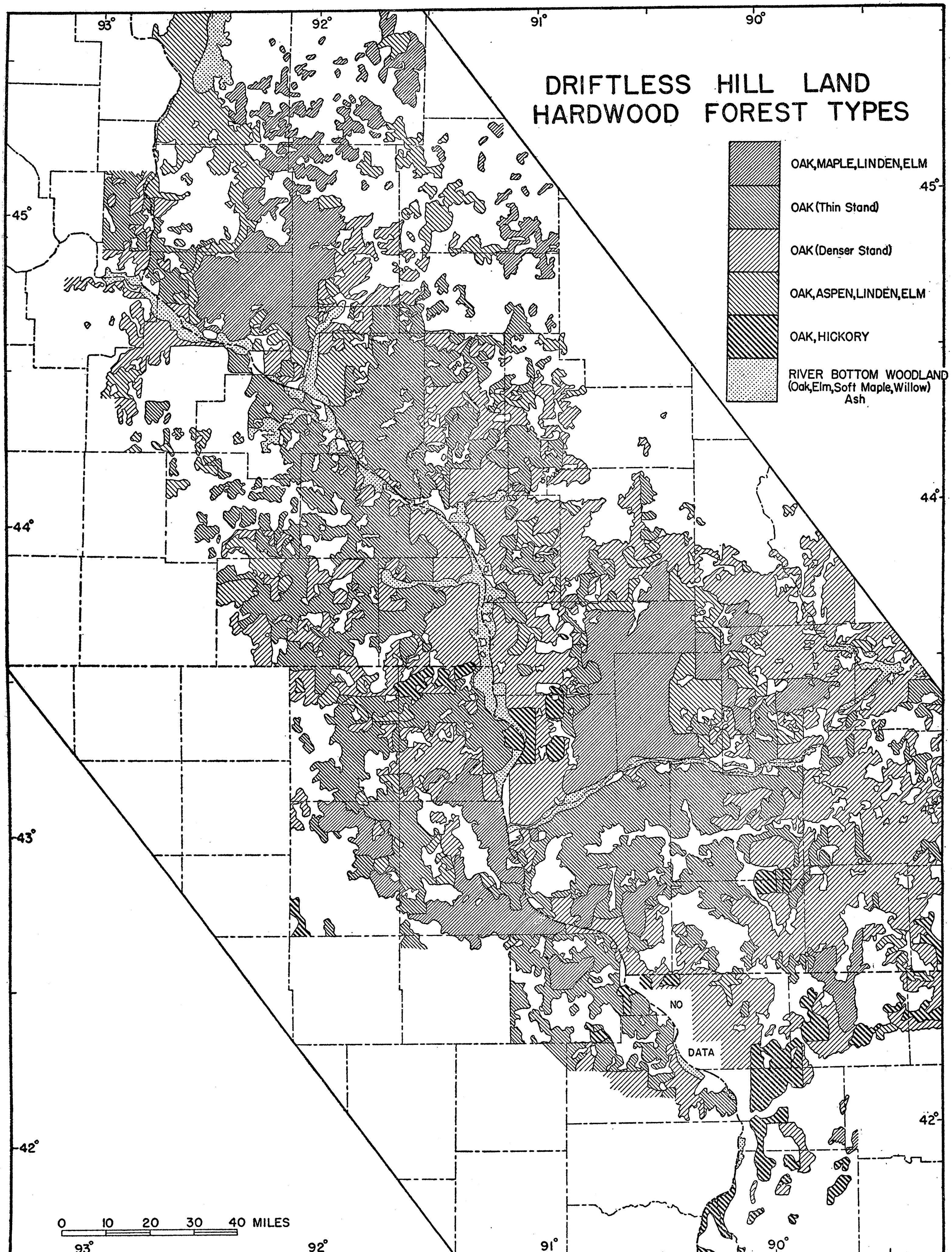
In their broader patterns of distribution the major soil types of the Driftless Hill Land, as recognized and mapped by the United States Department of Agriculture, roughly coincide with the principal vegetation and regolith combinations. Figure 4 was compiled chiefly from data in the state and federal county soil bulletins. Because of the discordance between federal and state soil terminology, harmonizing the published materials of different dates from the two sources required considerable adjustments and interpolations.

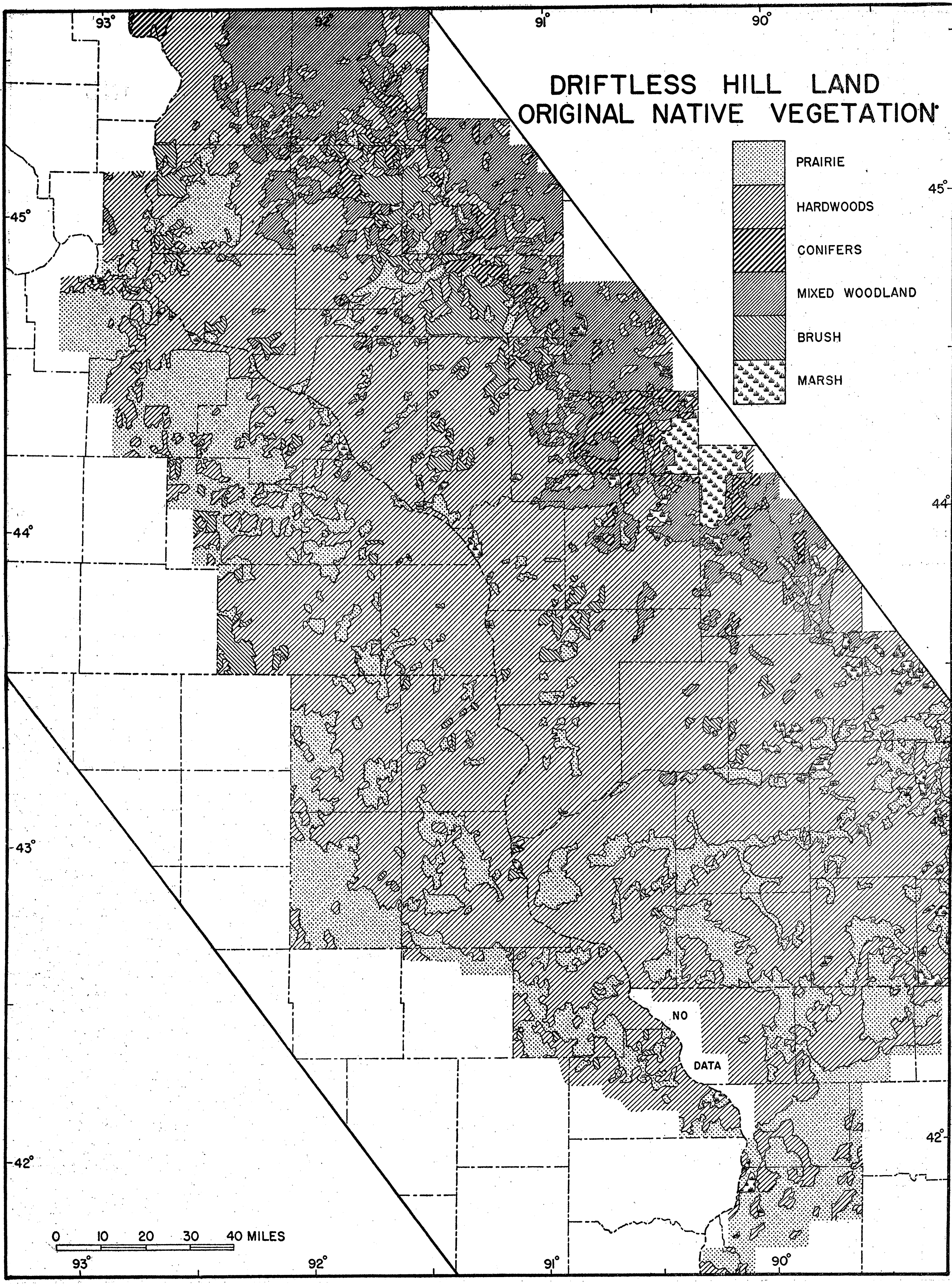
Postglacial Vegetation Changes in the Upper Mississippi Valley—Great Lakes Region

The vegetal cover of a region is dynamic, not static. The present-day distribution of floras depends not only upon the contemporary physical environment, but upon their earlier developmental history as well. Thus the pre-settlement vegetation mantle of the Driftless Hill Land, as of every other region, was the result of repeated advances and retreats of diverse floristic elements induced by environmental change or representing normal plant successions. The vegetation maps (Figs. 2 and 3) therefore represent only one stage in a long developmental history that is still continuing. In most instances, however, current advances and retreats of floras are too slow to permit of observing them first hand, so that conclusions must be drawn from historical and other indirect evidence. Three of the most valuable types of contemporary evidence concerning vegetation migrations are: (1) the successional relations of the species near the margins of their ranges, (2) the presence of relic species, or relic plant colonies, in unique edaphic environments, and (3) the floral stratigraphy and pollen profiles of peat bogs.

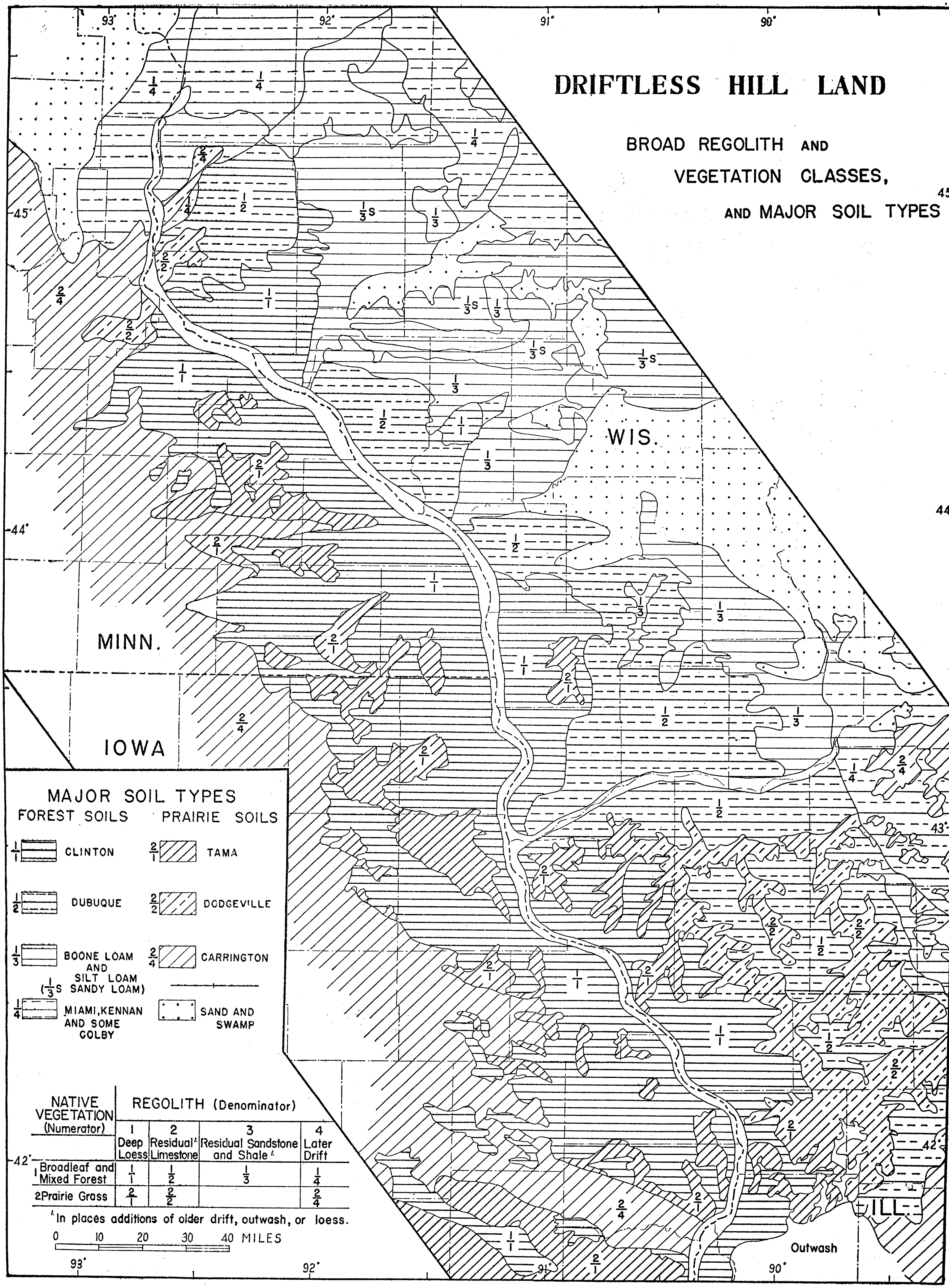
Up to the present time no comprehensive study of the vegetational history of the Driftless Area has been made and only such a study will reveal whether, as some suggest, that region may have been ecologically unique in the northern Middle West. At no period of glacial advance was the Driftless Area an island entirely surrounded by ice, and therefore completely cut off from nonglacial regions farther to the south. Such isolation however was practically complete during the Kansan stage of glaciation, while during the Nebraskan and the first Wisconsin stages the Driftless Area was the northern end of a bulbous peninsula much constricted farther south. At other times of ice advance it was part of a broader peninsula or deep enclave thrust into the ice front. Not once, but several times, therefore, the Driftless Area would appear to have experienced a type of periglacial climate perhaps unique on this earth, and one in which the degree of refrigeration seemingly should have been more intense and long continued than in the broad unglaciated region lying south of the general ice front. At the same time however it at least was not overridden by ice with consequent annihilation of plant life, and so in spite of its refrigeration, may have served as a temporary refuge for certain sorely pressed floral types retreating before the advancing glaciers.

Such a region as the Driftless Hill Land permits of some interesting speculation relative to the effects of its marked periglacial climates upon vegetational forms. Occasional and very incidental observations within the Driftless Area of loess resting upon residual regolith with no intervening humus layer are suggestive. A careful and systematic study of a large numer of loess profiles might yield significant information concerning the character of interglacial, intraglacial, and postglacial climates and floras. Fernald points out that the Driftless Area has a con-


DRIFTLESS HILL LAND
HARDWOOD FOREST TYPES
OAK, MAPLE, LINDEN, ELM
OAK (Thin Stand)
OAK (Denser Stand)
OAK, ASPEN, LINDEN, ELM
OAK, HICKORY
RIVER BOTTOM WOODLAND (Oak, Elm, Soft Maple, Willow) Ash
NO DATA
93°
92°
91°
90°
45°
44°
43°
42°
0 10 20 30 40 MILES



DRIFTLESS HILL LAND
ORIGINAL NATIVE VEGETATION
PRAIRIE
HARDWOODS
CONIFERS
MIXED WOODLAND
BRUSH
MARSH
NO DATA
0 10 20 30 40 MILES
93°
92°
91°
90°
45°
44°
43°
42°


DRIFTLESS HILL LAND
BROAD REGOLITH AND VEGETATION CLASSES, AND MAJOR SOIL TYPES
WIS.
MINN.
IOWA
ILL.
Outwash
93°
92°
91°
90°
45°
44°
43°
42°
MAJOR SOIL TYPES
FOREST SOILS
PRAIRIE SOILS
1/1 CLINTON
1/2 DUBUQUE
1/3 BOONE LOAM AND SILT LOAM (1/3 S SANDY LOAM)
1/4 MIAMI, KENNAN AND SOME COLBY
2/1 TAMA
2/2 DODGEVILLE
2/4 CARRINGTON
SAND AND SWAMP
NATIVE VEGETATION (Numerator)
REGOLITH (Denominator)
1 Deep Loess
2 Residual¹ Limestone
3 Residual Sandstone and Shale¹
4 Later Drift
1 Broadleaf and Mixed Forest: 1/1, 1/2, 1/3, 1/4
2 Prairie Grass: 2/1, 2/2, 2/4
¹In places additions of older drift, outwash, or loess.
0 10 20 30 40 MILES

siderable number of remarkable endemics and is a definite center for plants of a limited range which were able to survive there during Wisconsin glaciation, but after the last retreat of the ice withdrew to more hospitable locations.[3] Fassett has discovered that within the Middle West a number of relics are confined to the Driftless Area, while others less confined, center on it in a significant manner.[4] Thus the Aconite (Monkshood) of the Middle West is isolated within the Driftless Area[5] or close to its margins and appears to have been saved from extermination by the asylum offered during ice advance by this unglaciated spot. Being conservative, the plant has not advanced any distance into glaciated territory since the retreat of the ice. Miner's Lettuce (Montia Chamissoi) grows only in our western mountains and on two hillsides of the Driftless Area. The Jack Oak (Quercus ellipsiodalis) appears to have survived glaciation in the Driftless Area and during post-Pleistocene times has spread out from that center in all directions. This by no means exhausts the list of endemics but it at least suggests a line of evidence that appears somewhat contradictory to that suggested by the loess profiles. Too little data are at hand however upon which to make a judgement. A more thorough analysis of the several kinds of evidence will be necessary in order to establish the nature of the interglacial and post-glacial floras of this unique region.

With the data that are available one can do little better than assume that the Driftless Area experienced, in different degrees perhaps, a great many of the large-scale vegetation changes characteristic of the Upper Mississippi-Great Lakes region during post-Pleistocene times. As a general theory it is assumed that with the advance of the continental ice climatic changes were induced along its front that led tundra, conifers, and broadleaf forests to retreat ahead of it and then follow back in its wake as it melted. What the specific changes of climate were that produced continental glaciation, and in turn were generated by it beyond the ice front, is not clear. There is some evidence to show that the ice advanced over standing and probably living

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[3] Fernald, M. L. Persistence of Plants in Unglaciated Areas of Boreal North America, Mem. Am. Acad. Arts and Sci. 15, 3, pp. 241-342 (317-318).

[4] Fassett, Norman D. Man and the Wisconsin Flora, (unpublished manuscript, Madison, 1939).

[5] See papers by Hansen; numbers 16, 17, 18 in bibliography.

forests in which the annual rings showed a marked decrease in rate of growth only during the last 12 years before death occurred.[6] On the other hand in certain Florida peat bog deposits, buried diatoms have been found that belong to a well known group characteristic of bogs and glacial lakes in Canada, northeastern United States, and northern Europe. Many of these ancient forms at present occur no farther south than New England. By some paleo-ecologists this has been taken as indicating that the diatoms were deposited during the climax of Wisconsin glaciation, when the cooling effects of the ice were extended as far south as Florida. Paleo-ecologists in Europe have evidence that treeless tundra bordered the Riss (third glaciation) and Würm (fourth glaciation) ice in belts 100 to 450 kilometers wide.[7] It is difficult to understand how the northern one-half to two-thirds of the North American continent could have been covered with ice without producing a marked refrigerating effect upon the lands to the south, and more especially upon such an engulfed region as the Driftless Area. Still, the evidence is not entirely corroborative and the whole problem of the climatic effects of continental glaciation beyond the ice front warrants a careful analysis of the numerous peat deposits south of glacial limits.

Sears[8] outlines four important stages through which hypothesis concerning post-glacial climates and vegetation changes have passed:

1. Vegetation retreated southward before the advancing glaciers and later, with the melting of the ice, returned to a relatively stable equilibrium.

2. The Blytt-Sernander hypothesis assumed a series of climatic fluctuations involving both temperature and precipitation. Five periods are recognized: pre-boreal, boreal, Atlantic, subboreal, and sub-Atlantic, of which the first, second, and third are continental or dry in character. The fourth or Atlantic period was thought of as warm and humid and represented a climatic optimum, while the sub-Atlantic period represented a return to

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[6] Wilson, L. R. The Two Creeks Forest Bed, Manitowoc, Wisconsin, Wis. Acad. Sci., Arts, and Letters, 27, 1932, pp. 31-46.

. . . Further Fossil Studies of the Two Creeks Forest Bed, Manitowoc, Wisconsin, Bull. Torrey Botan. Club, 63, June 1936, pp. 317-325.

[7] Sears, Paul B. Glacial and Post-glacial Vegetation, Botan. Rec., I, 1935, pp. 37-51.

[8] Op. cit., pp. 43-44.

more humid conditions. In this country, Sears has been the principal protagonist of the Blytt-Sernander hypothesis as applied to conditions in North America.

3. The Anderson hypothesis denied the reality of the second dry, or sub-boreal, period in the Blytt-Sernander scheme and instead maintained that a gradual climatic deterioration, from the Atlantic period down to the present time, has taken place.

4. According to Von Post three major subdivisions of post-glacial climate are to be recognized: (1) a period of increasing warmth, (2) a period of maximum temperature, and (3) a period of decreasing temperature. Smaller fluctuations in one or more of the climatic elements may have occurred within these principal periods, but they are extremely difficult to recognize. Sears, although not discarding the Blytt-Sernander hypothesis, admits that this simpler one has considerable merit in that it is broad enough to permit of modification and refinement, and yet does no violence to facts as they are at present known.

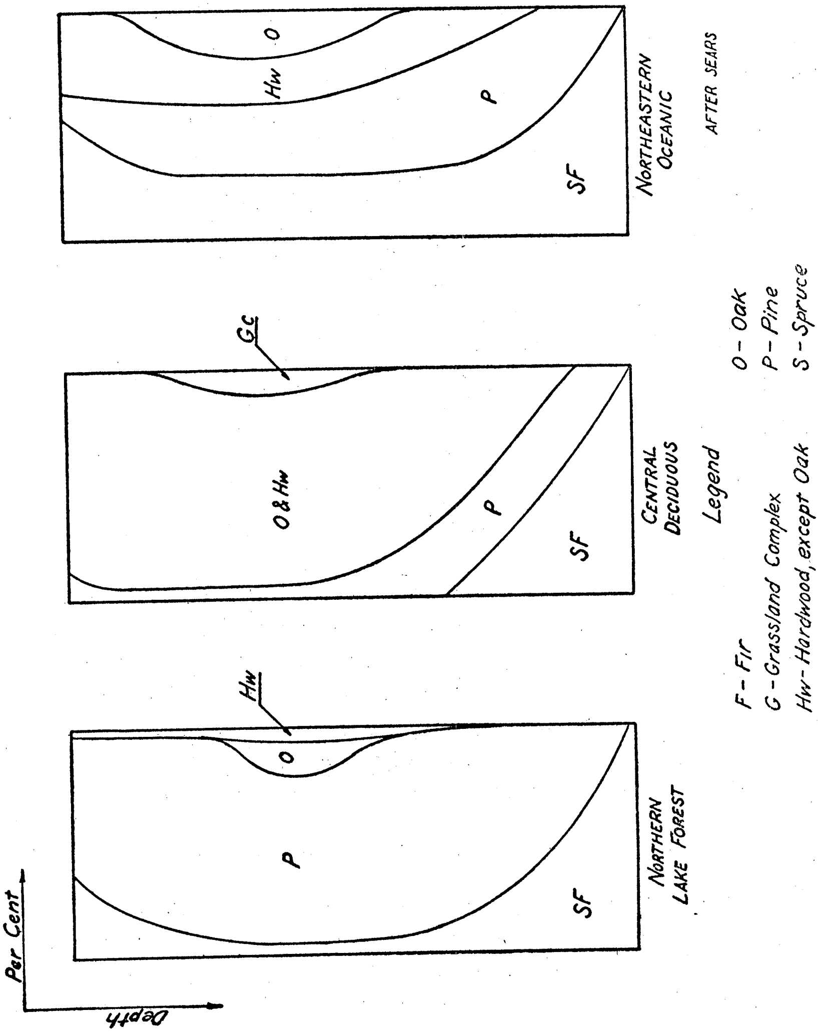
Geothermal measurements in the deep copper mines of Calumet, Michigan, tend to corroborate the Von Post hypothesis of post-glacial climatic changes. These measurements suggest that the last glacial retreat was followed, perhaps after several thousand years, by a period distinctly warmer than the present. This in turn was succeeded by a slightly cooler climate persisting until rather recent times.[9]

Evidence from Analysis of Modern Floras

Based entirely upon a study of present-day floras, Gleason[10] has presented a broad outline of post-glacial vegetation changes in middle western United States. (1) At the time of greatest advance of Wisconsin ice the associated semiarid climate resulted in a narrow and interrupted strip of coniferous forest bordering the front of the ice, and broadening northward in the Driftless Area where some shelter was provided by the deep valleys. Relics of this boreal vegetation are still to be found in the Driftless Area coincident with such edaphically dry sites as rocky hill slopes, sand and gravel terraces, and exposures of

[9] Hotchkiss, W. O. and L. R. Ingersoll. Postglacial Time Calculations from Recent Geothermal Measurements in the Calumet Copper Mines. Jour. Geol. 42, 1934, pp. 113-122.

[10] Gleason, Henry Allen. The Vegetational History of the Middle West, Annals of the Association of American Geographers, XII, 1922, pp. 39-85.



sandstone. The subhumid conditions may have caused vegetational belts to shift as much as 400 miles eastward from what they are at present so that western Illinois was perhaps exclusively prairie. (2) The mild dry xerothermic period of early post-Wisconsin led to a northward expansion of the coniferous forest and a further extension eastward of the prairies in the form of a wedge (Prairie Peninsula) between the northward expanding conifers on the north and the deciduous forests to the south. It was at this time that the prairies moved into southern and western Wisconsin occupying the exposed uplands where the warm dessicating winds in summer, the cold dry winds of winter, and the deficient snow cover were adverse to maintenance of forest. (3) A retardation and eventual stop of the advance of the prairie upon the northward retreating conifers, followed by an advance of the southeastern deciduous forest to the north and west upon the Prairie Peninsula, resulted from a climatic change in the direction of increased rainfall. The deciduous forest advance was participated in by two successional series, a xerarch series chiefly oak and hickory on the uplands, and a hydrarch series (oak, elm, ash, walnut, maple, cottonwood, and others), along the valleys. Gradually the xerarch forests of the bluffs encroached laterally upon the interfluve upland prairies, more and more isolating the prairie colonies. Such was the condition in the Driftless Hill Land when the Indian appeared. Simultaneously with increase in moisture and the advance of the deciduous forest, changes took place in the prairie flora. The xerophytic western species withdrew from the eastern prairie extension, or left relic colonies behind in distinctly xerophytic habitats. Thus developed an eastern peninsula of the prairie distinct from that of the western plains. (4) With the advent of the Indian came the introduction of a new element in the vegetational environment, viz: the prairie fire. Through the destruction of the young seedlings on the margins of the forest, and the more susceptible mature trees as well, the previous advance of the deciduous forest was turned into a retreat. Gradually the forest was pushed back toward the bluffs and the area of prairie expanded. By this means there came into existence the open park-like condition known as the "oak openings", and in places the so-called barrens, characterized by a sparse growth of hazel brush, scrub oak, and wild plum. (5) The arrival of white settlers and the subsequent development of agriculture gradually reduced the effectiveness of forest fires as a factor in vegetation distribution. Once more, therefore, the deciduous forests began their advance, along the stream courses and at right angles to them, and have continued down to the present time except as thwarted by cultivation and pasturage.

The Driftless Area east of the Mississippi gives one the impression of being densely forested at the present time, yet the first settlers of a century and more ago spoke of it as dominantly prairie. Chandler, a resident of Galena, Illinois, during the third decade of the 19th century, estimated that only one tenth of the lead region in the Driftless Area of what is now southwestern Wisconsin and northwestern Illinois was covered with timber[11] Estimates by other eyewitnesses ranged from 10 to 20 percent.[12] This same mining area was described by Keating (1823) as "presenting the waved appearance of a somewhat ruffled ocean; it is covered with a dry short grass", above which rose the higher knobs visible 30 miles away. These same knobs are now concealed by forest.[13] "—the country is still prairie with tufts of inferior timber", according to Col. Charles Whittlesey writing in 1832.[14] Except along the Mississippi most of the timber in the lead area was so small as to make it unfit for construction of large buildings and large importations of lumber are reported at Galena as early as 1842.

Evidence from Peat Bogs

The most recent and perhaps discriminating method for tracing post-glacial changes in vegetation and climate is by statistical analysis of pollen blown from adjacent trees and other plants, that has been preserved in the organic sediments of peat bogs. The idea was originated by G. Lagerheim of Sweden during the first decade of the last century, while credit for development of working methods goes to L. Von Post of the Geological Survey of that country.[15] Much successful work of a paleo-ecological nature has been done in Europe following this method, less in the United States. Indeed in the latter region it is all confined to the period since 1930, and most of it to the last 5 years.

A cylindrical type of borer is used to obtain samples of peat at intervals of six inches to a foot throughout the different levels

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[11] Chandler, R. W. Map of the United States Lead Mines on the Upper Mississippi, Galena, 1829, Copy in Wis. Hist. Lib. See notes on margin of map.

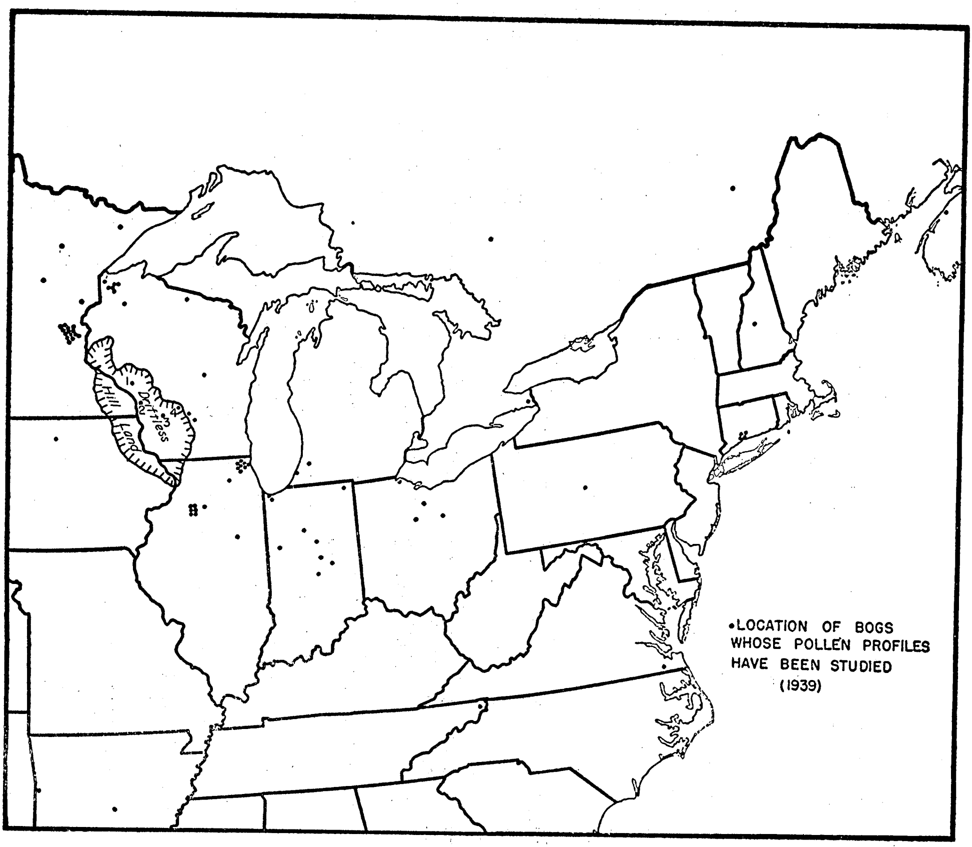
[12] Miners Journal, Sept. 13, 1828; Wis. Hist. Colls., XI, p. 400.

[13] Keating, William H., Narrative in Expedition to the Source of the St. Peter's River—performed in 1823—etc. Philadelphia, 1924.

[14] Wis. Hist. Colls., I, pp. 64-85.

[15] Von Post, L., Problems and Working-lines in the Postarctic Forest History of Europe. Proc. 5th Int. Bot. Congress, Cambridge, 1934, pp. 48-54.

of the bog. Several slightly different methods are employed for treating the samples in preparing them for microscopic examination, the purpose of which is to free the pollen grains from the peat fibers. One hundred fifty to 200 pollen grains are usually



counted and identified for each level sampled. Contrasts in size, shape, markings, etc., are employed in identifying the pollen species.

Analysis of the botanical literature reveals that at least 75 to 80 bogs in northcentral and northeastern United States and adjacent Canada have been studied by the pollen-profile method. For purpose of regional analysis these bogs have been located on a map (Fig. 5). Due to different methods of sampling and microscopic analysis, the profile data for the different bogs are not entirely comparable, so that correlations between bogs is

TABLE I

Percentages of Principle Pollens for Four Driftless Area Bogs
(Data from Hansen)

1. Tamarack Creek Bog (Trempealeau Co.)

Depth in Ft.	12½	12	11	10	9	8	7	6	5	4	3	2	1	½
Fir	58	41	49	28	3	2								
Spruce	25	31	40	42	30	26	13	6	3	2	1	1	2	
Pine	6	13	5	11	27	46	31	32	28	34	44	41	44	45
Oak	3	4	1	6	19	20	29	35	37	36	33	32	36	35
Mixed deciduous	5	7	2	9	12	5	17	18	22	13	12	14	11	12
Birch	2	3	2	4	8	1	8	4	7	9	5	6	4	3
Grasses							1	4	3	6	4	6	3	4

2. Mormon Coulee Bog (La Crosse Co.)

Depth in Ft.	12½	12	11	10	9	8	7	6	5	4	3	2	1	½
Fir				20	17	2	3	1						
Spruce				24	23	12	6	2	2	1				
Pine				39	48	49	43	36	29	32	34	38	16	20
Oak				6	8	24	26	32	41	42	37	34	33	29
Mixed deciduous				3	2	7	17	20	22	21	12	11	21	21
Birch				7	2	6	5	8	3	1	8	5	7	7
Grasses									2	2	9	12	23	22

3. Hub City Bog (Richland Co.)

Depth in Ft.	12½	12	11	10	9	8	7	6	5	4	3	2	1	½
Fir				40	30	16	3	1		1				
Spruce				28	30	30	25	9	6	2				
Pine				20	26	28	43	40	48	42	31	36	38	41
Oak				4	4	11	12	19	18	25	35	32	31	30
Mixed Deciduous				5	2	12	14	20	19	22	23	25	22	21
Birch				2	7	2	3	6	5	3	4	2	3	3
Grasses								5	4	5	7	5	6	4

4. Wisconsin Dells Bog (Juneau Co.)

Depth in Ft.	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Spruce	1.2	2.5	1.2	1.7	1.0	0.5								
Pine	29.0	31.0	28.3	33.5	38.6	33.0	37.1	31.6	30.0	43.0	40.1	33.3	33.5	34.4
Hemlock	0.2	0.2	0.2	0.4		0.4		0.5		1.5	1.6	1.5	0.3	0.9
Larch							0.2	0.2	0.4				0.5	
Oak	21.0	24.0	21.0	22.5	22.0	28.5	26.5	30.5	32.0	14.0	25.0	22.0	15.2	17.5
Beech	20.0	17.0	15.0	10.0	12.0	12.0	10.0	12.0	13.0	12.0	11.0	17.0	26.0	16.0
Maple	2.0	3.5	1.5	6.5	6.0	4.5	7.5	7.0	8.5	11.0	6.5	9.5	8.5	14.0
Linden	0.4	0.5		0.3		0.2	0.8	0.7		0.5				1.3
Hickory	0.2	0.5	1.2		0.2	0.2	0.2	0.2	0.4	0.2	0.9		0.1	0.7
Walnut			0.1	0.3	0.6	0.6	0.4	0.4	0.3		0.4	0.4	0.3	0.4
Elm						0.2						0.4	0.3	0.2
Willow	0.2	1.7	2.6			0.2		0.4	0.6	2.6	2.2	0.4	0.1	0.4
Ericaceae	0.2	0.2	0.5	0.2	0.5	0.2	0.2	0.5	2.2	3.7	2.5	5.5	4.5	3.5
Grasses	3.9	1.0					0.2				0.2		0.1	0.7
Compositae	5.0	5.0	4.4	3.0	3.0	1.1	2.1	2.5	3.9	1.7	3.2	1.9	2.4	1.1

difficult and generalizations are somewhat provisional in character. In spite of this weakness of the data, however, certain general inferences can be made. Without much chance of rebuttal, there appears to be a distinct regional pattern in the pollen profiles.[16] In the following paragraphs are summarized some of the more important generalizations which can be made from a study of eastern North American pollen profiles (Fig. 6), more especially those of four bogs located within the Driftless Area.

There is little or no evidence of tundra in the bottom strata of North American peat profiles. According to Sears this does not necessarily preclude a tundra stage, for the basins in the till plain in which peat eventually accumulated may have been filled with detached ice blocks until the northward advancing coniferous forest had surrounded them. Or the tundra period may have been followed by such dry climate as to prevent peat formation. It seems unlikely however that bog basins within the Driftless Area could have been occupied by ice during, or at least long after, glaciation and yet there is an entire absence of tundra pollen in the lower strata of all four Driftless Area bogs studied.[17] In spite of direct evidence being absent, many paleo-botanists are still of the opinion that the ice front was bordered by a tundra zone, possibly a much narrower one than in Europe.

At the bottoms of practically all of the bog profiles (except those not possessing older strata) in northeastern United States and southeastern Canada, and south as far as north central Illinois, central Indiana, and central Ohio, pollens of subarctic conifers, chiefly fir and spruce, dominate. This is not so clearly the case in the profiles from the four Driftless Area bogs. Only the most northern one shows a strong preponderance of fir and spruce at the lowest level. In Hub City Bog fir and spruce are the most important species but pine is likewise strong (Table I). Mormon Coulee Bog shows pine with the highest percentage at the lowest level although fir and spruce are likewise prominent, while in the fourth bog pine is the only important conifer and deciduous species likewise show high percentages. These data

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[16] Sears, Paul B. Types of North American Pollen Profiles, Ecology 16, 1935, pp. 488-499. . . . Climatic Interpretation of Potglacial Pollen Deposits in North America; Bull. Am. Meteorological Soc., 1938, pp. 177-185.

[17] Hansen, Henry P. Postglacial Vegetation of the Driftless Area of Wisconsin, Am. Midland Nat., 21, 1939, pp. 752-762.

may indicate that an initial forest of fir and spruce was already waning and being replaced by a pine-deciduous forest in the region of the three most southerly bogs when their first strata were laid down. Another suggestion is that these three bogs were relatively late in point of origin and consequently do not so clearly indicate the existence of this earlier forest.

Other types of pollen replace fir and spruce in the upper two-thirds or three-fourths of the characteristic profile for northeastern United States. It is in this part of the generalized profile that evidences of regional differentiation become more marked, profiles of different bogs show greater variability, and interpretations of the data by different workers are less in agreement. In northern Wisconsin and Minnesota the decline of fir and spruce pollen is followed by an increase in pine and later by hardwoods, chiefly oak, although pine remains dominant. The crest of oak coincides with the low point for spruce and fir. Toward the top of the profile as hardwoods wane, spruce and fir show an increase (Fig. 6).

Farther south in the present deciduous area (Northcentral Illinois, southern and western Wisconsin, central Indiana, and Ohio) after the early spruce-fir dominance there is a rapid increase in pine followed shortly by an equally rapid increase in oak and other hardwoods. The upper three-fifths of the profile is dominantly of this latter type with a small percentage of pine persisting. Significantly, perhaps, pine shows a slight increase at the extreme top of the profile. A grassland complex, beginning about half way up the profile, comes to a crest and dies out again some distance below the top (Fig. 6). Profiles from the Driftless Area show a larger proportion of pine than is indicated in the more generalized pattern described above.

Typical of the northeastern states and adjacent parts of Canada is a profile which resembles that of northern Wisconsin and Minnesota in its succession of spruce-fir and pine and in the dominance of conifers, but differs in that spruce-fir remains more important and pine less important throughout. Oak shows a crest as it does in the northern lake states, while hardwoods other than oak are relatively more important, and are more important than pine near the top of the profile (Fig. 6).

It will be useful now to turn to the interpretations of these pollen profiles. In all probability the climatic change associated with glacial retreat was of a greater degree than any that have occurred subsequently. The replacement of fir and spruce by pine is taken by some as evidence that the climate was becoming drier and perhaps warmer, and of pine by oak as indicating a warm maximum. The increase of spruce-fir in the upper parts of the northern profiles contemporaneous with the disappearance of oak, and in the northeastern states with the increase of more northerly hardwoods, suggests a waning of the warm-dry maximum. Other workers, although admitting that the replacement of spruce-fir by pine suggests a waning of the glacial climates, believe that *all changes above the coniferous level are purely the result of local succession and do not require a postulation of climatic change.* The increase in spruce toward the top of the profiles may be the result of increased filling of the basins and their invasion by black spruce.[18]

The profile of the central deciduous area with its shift from an early spruce-fir and pine forest to a later dominance of hardwoods, especially oak, suggests an increase in temperature which reached a xeric climax with the grassland crest. The subsequent decline of grass and slight increase in pine suggests a return to cooler and moister conditions. Some workers, on the other hand, think the evidence for climatic change, after the shift from coniferous to deciduous forest, is dubious.

It becomes fairly obvious that there are two points of view regarding pollen profiles and their interpretation. One group, following the lead of Sears, sees in the record for eastern North America "certain remarkably consistent, fairly synchronous, and long-time trends—which are difficult to explain on the basis of purely local changes." This group strongly favors a climatic interpretation and one that involves a number of significant climatic variations within postglacial times. Within the second group of workers are those who would ascribe all postglacial vegetation changes to purely normal local succession, and others who admit of a postglacial warming resulting in a shift from coniferous to deciduous forest, but see little in the pollen record

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[18] Wilson, L. R. The Postglacial History of Vegetation in Northwestern Wisconsin. Rhodora, 40, 1938, pp. 137-175.

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to require postulation of climatic fluctuations since that major change.

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49—........ The Nipissing flora of the Apostle Islands region. Bull. Torrey Bot. Club 62, 1935, pp. 533-535.

50—........ Further fossil studies of the Two Creeks forest bed, Manitowoc County, Wisconsin. Bull. Torrey Bot. Club, 63, 1936, pp. 317-325.

51—........ The postglacial history of vegetation in northwestern Wisconsin. Rhodora, 40, 1938, pp. 137-175.

52—........ The use of microfossils as a means of studying paleoclimatic conditions in northwestern Wisconsin. Bull. Am. Meteorological Soc., 19, 1938, pp. 168, 186-187.

Madison, Wisconsin,
November, 1939.

THE WATER MITE GENUS TYRRELLIA

Ruth Marshall

Rockford College

The genus *Tyrrellia,* of the hydracarina, was erected by Dr. Koenike (1895), with one species, *T. circularis* Koen., the descriptions being based upon the study of females (two?) found near Ottawa, Ontario. Generic characters given were as follows: general surface covered with fine points as in *Hydryphantes,* plates and appendages porous; a dorsal shield; mouth at the end of the maxillary organ in the center of a small disk; palpi pointed, the second segment with a "chitinstift" on the concave side; epimera in four groups close together, 3rd and 4th placed diagonally, the latter strongly expanded laterally; legs without swimming hairs, claws simple, leg IV attached to the corner of its epimera; genital area lying in a bay formed by the epimera, the two plates carrying large acetabula.

From the study of abundant material now available to the author, it appears that certain characters first given as specific, together with some others, may now be considered as generic. These are the following: a posterior dorsal shield (occasionally two) as well as one or two anterior ones; palpi with distinctive 4th segment (see fig. 4, 15) ; epimeral groups nearly approximate in the male, the anterior group with a thin posterior prolongation (see fig. 9) ; legs shorter than the body, with heavy bristles, I, II very stout, III slender, IV with a curved 5th segment, distal ends of all segments expanded; genital plates as well as 2nd palpal segment as in Limnesia, the former bearing six large acetabula and surmounted by a curved bar. To these characters may be added, as far as the genus is known: short stout antennary bristles; a double eye on each side in a small capsule, appearing single; several gland-hair plates and a single conspicuous plate with a large opening below each eye.

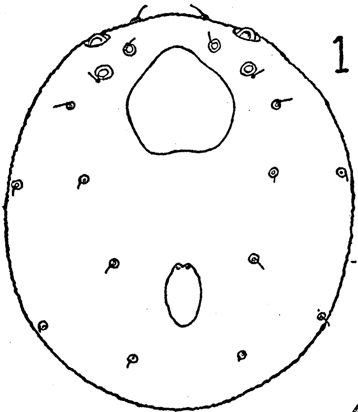
This is the only genus known for the Family *Tyrrelliidae* Viets, and no representatives are known outside of North America.

The late R. H. Wolcott made several collections of *Tyrrellia* (Ward & Whipple, Fresh Water Biology, 1918:869): "a sluggish, dark brown mite of medium size averaging 1.20 mm. in length, known from Canada and found abundantly some years since at Reed's Lake, near Grand Rapids, Michigan, where it was picked up singly with the pipette in the debris at the margin of the water in close proximity; very rare in Birge net hauls at the same place; two species taken, one apparently the same as *T. circularis* Koenike, previously described." The second species proves to be *T. ovalis* Mar. To these collections is now added one specimen from a thermal spring in California. The species will now be discussed with the results of the study of the material now in the author's collection.

Tyrrellia circularis Koen.
Pl. I, fig. 1-4; Pl. II, fig. 14

A total of 36 individuals was found in the Wolcott collections, consisting of old and young adults, found in the vicinity of Grand Rapids, Michigan, in the "summers" of '93, '95, '96, '97. Both sexes were present and so the description of the male can be given, as well as some revision of Koenike's detailed description. Largest females averaged 1.40 mm. in length, 1.20 mm. in width; males are smaller. The anterior end is slightly bulging. The two shields of the dorsal surface are variable in size and shape; the larger anterior one usually broadly pyriform. (The structures shown by Koenike as *k*, fig. 38, were not found.) The smaller ventral shield is very variable in size and form, sometimes slightly asymmetrical, only occasionally with a small posterior cleft; in one case two small plates were present and in another, a young male, the single plate was much enlarged and the end greatly prolonged. The several pairs of hair plates and the opening of a large gland below each eye were found as shown by Koenike. The epimera, shown diagrammatically in the original description (fig. 37), are given in the present paper in more detail (fig. 2, 3) and are more accurately drawn; in the male there is only a slight separation of the three groups. The genital plates in the two sexes are much alike, but broader and smaller in the male; genital acetabula are oblong in mature adults, the two posterior close together. The palpi are stouter in the male (fig. 4); on the very stout second segment the "Chitinstift" of

1



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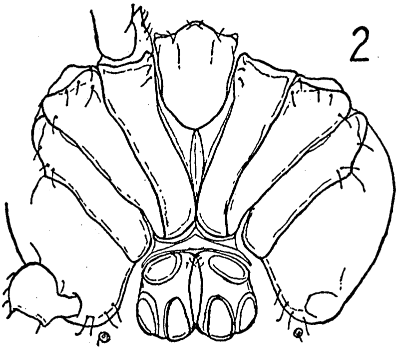

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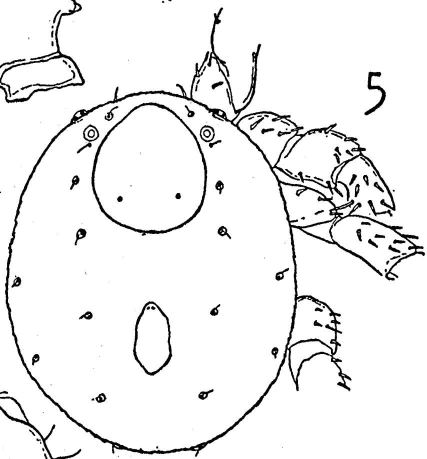

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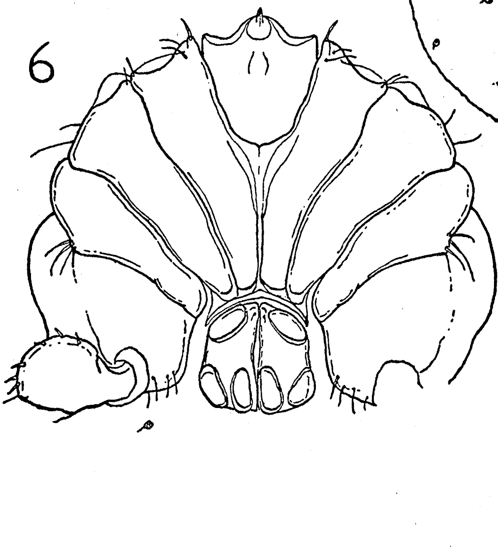

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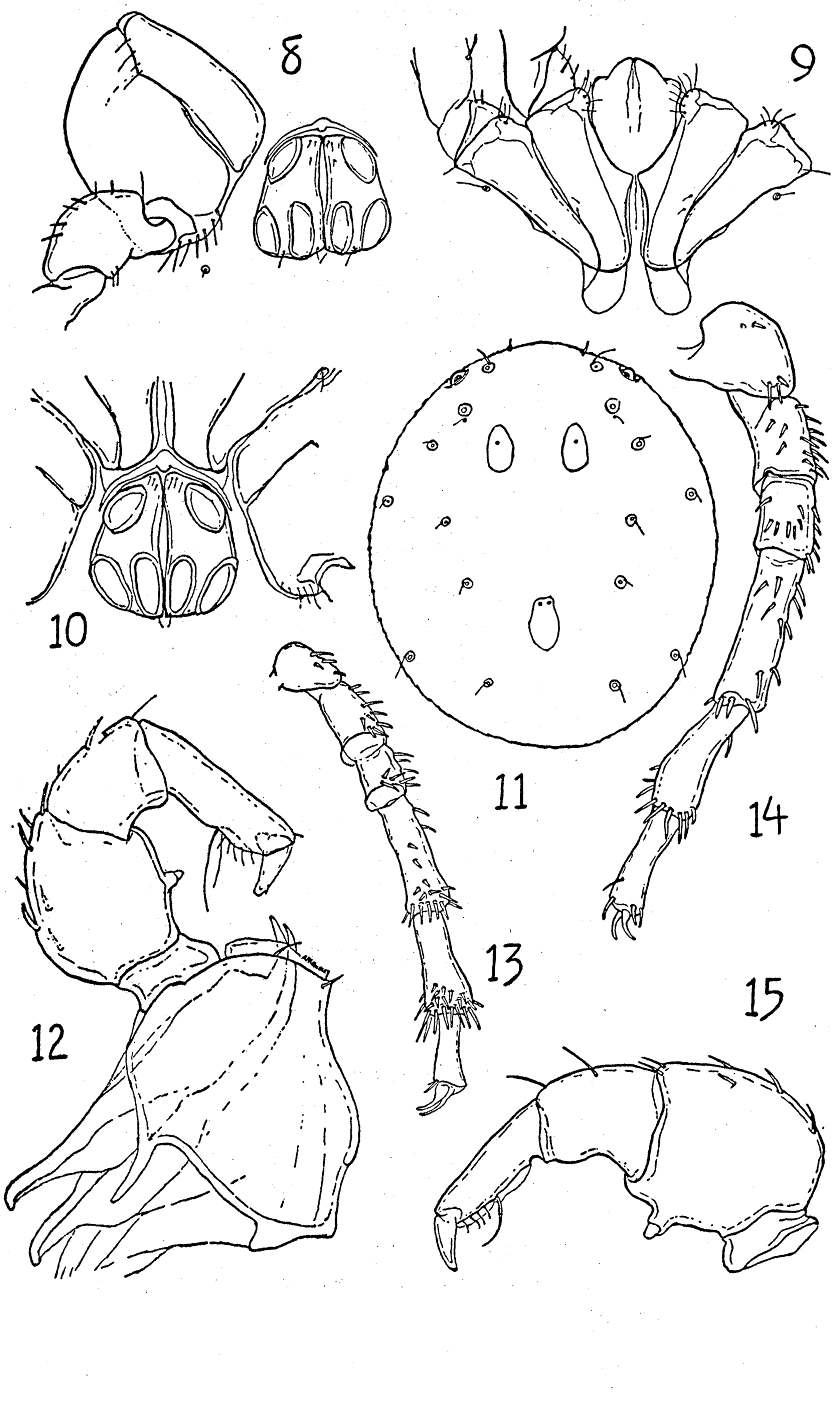
the concave side is set in a larger papilla than is shown in Koenike's fig. 36. The fourth palpal segment, especially characteristic of the genus, has a long curved hair midway on the concave side; distal to this are five or six fine hairs set in a shallow groove. The legs conform closely to the original detailed description.

Tyrrellia circularis monensis nov. var.
Pl. I, fig. 5-7; Pl. II, fig. 15

The single specimen, a male, which represents this form, was found by Dr. C. T. Brues, Aug. 26, 1930, on Paoha Island in Mona Lake, California, in "a large warm spring . . . several hundred feet inland and well above the level of the lake" (#150, sp. grav. 1.0045, pH 8.3, temp. 32.8° C.). This specimen, quite mature, resembles *T. circularis* so closely, although occupying an unusual habitat and far from the known range of the other representatives of the genus, as to be best considered a variety. The body, 1.10 mm. in length, is slightly narrower than in *T. circularis*; the surface shows the same fine points and the same number of gland openings and hair plates, while the two dorsal shields, anterior and posterior, are similar in shape but larger. As these shields have been found to be variable in the two known species of the genus, it may be inferred that they will prove to be so here when more specimens are found. The epimera are relatively larger in the new variety and show some small differences in proportions; the 1st pair are more nearly united medially, with narrower posterior ends, while the 4th are wider. The genital plates are more elongated and consequently the acetabula are more separated than in the parent species. The palpi show the characteristic structures of the 2nd and 4th segments, the latter with a very bulging outer border. The legs show the characters of the genus.

Tyrrellia ovalis Mar.
Pl. II, fig. 8-13

The original description (Marshall, 1932) was based upon the study of three females taken in May (Madison, Wis.); these specimens are now seen to be very young adults. In the Wolcott collection a single individual, also taken in May (near North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Baltimore, Mich.), is likewise a very young adult; but other specimess, over 100, collected in the same localities as *T. circularis* (and the same years), in "July" and "summer", consisted of mature adults of both sexes, although they are of different ages (a few months and one year?). It is apparent that the original description should now be revised and an account of the male added.

The body is a little larger and more elongated than in *T. circularis* (oldest females, 1.63 mm. long), with the same slightly bulging anterior end; the fine points on the surface are slightly more rousded, the hair plates of the dorsal gland openings similarily placed. The epimera are very much alike in the two species but a little heavier, with the 4th pair a little broader in *T. ovalis*. (In one female the right 3rd together with leg III were missing!) Genital plates of mature adults, where the acetabula are fully developed, larger and more elongated than in the young, are also very much alike in the two species: anteriorly they are a little broader in *T. ovalis*, with acetabula slightly smaller, the two posterior a little separated. Palpi and maxillary organ are almost identical in the two species, as are also the legs. Males are difficult to recognize, since the 3rd and 4th epimera are barely approximated; the genital plates are a little broader than in the female and the palpi are stouter.

The two species are chiefly distinguished by the dorsal shields: in *T. ovalis* there is a pair of small oblong anterior plates, well separated, quite uniform in all specimens; posterior to these lies another plate, usually of about the same size and shape as the anterior but very variable, frequently slightly asymmetrical. In the original description it was stated that there were two very small posterior plates; this is now known to be exceptional (but in one specimen four very small plates were present.)

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Explanation of the Plates

Plate I

1. Tyrrellia circularis, dorsal view
2. Tyrrellia circularis, ventral plates, male
3. Tyrrellia circularis, ventral plates, female
4. Tyrrellia circularis, left palpus, male
5. Tyrrellia circularis monensis, dorsal view
6. Tyrrellia circularis monensis, ventral plates, male
7. Tyrrellia circularis monensis, leg I, left

Plate II

8. Tyrrellia ovalis, genital plates and epimera III, IV, right, female
9. Tyrrellia ovalis, epimera I, II, female
10. Tyrrellia ovalis, genital area, male
11. Tyrrellia ovalis, dorsal view
12. Tyrrellia ovalis, maxillary organ and right palpus, female
13. Tyrrellia ovalis, leg III, left
14. Tyrrellia circularis, leg IV, right
15. Tyrrellia circularis monensis, right palpus, male

PROCEEDINGS OF THE ACADEMY

SIXTY-EIGHTH ANNUAL MEETING

The sixty-eighth annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters was held jointly with the meetings of the Wisconsin Archeological Society and the Wisconsin Museums Conference at Ripon College on Friday and Saturday, April 8 and 9, 1938. A total of approximately 200 persons, exclusive of students of Ripon College, attended sessions on Friday afternoon and Saturday morning. A banquet for members and guests was held in the College Dining Room on Friday evening, and was attended by 65 persons. The President and Faculty of Ripon College entertained members and guests of the societies at a tea in the Faculty Club Room of the Lane Library Building on Friday afternoon.

The following program of papers, lectures and special events was presented.

Friday morning. Secretary Loyal Durand Jr. of the Academy spoke before the college assembly of Ripon College, telling of the work and aims of the three organizations, and extending an invitation to the student body to attend the various sessions.

Academy Section

Friday Afternoon

Grace J. Calder. Milwaukee-Downer College. The Composition of Carlyle's *Past and Present*—A Study of Two Manuscripts; Amelia C. Ford. Milwaukee-Downer College. An Eighteenth Century Mark Hanna; Paul W. Boutwell. Beloit College. Conditions Affecting the Bromination of Omega Phenyl Substituted Fatty Acids; John C. Sauer and Paul W. Boutwell. Beloit College. The Composition of Bayberry Wax and the Preparation of Myristic and Palmitic Acids; A. L. Barker. Ripon College. Early Science Teaching in Ripon College; Rufus M. Bagg. Lawrence College. The Study of a Wisconsin Swamp; Louise Wipf and D. C. Cooper. University of Wisconsin. Chromosome Numbers in Nodules and Root Tips of Certain Leguminous Plants; M. A. Brannon and A. F. Bartsch. University of Wisconsin. Algae and Growth Substances; Aldo Leopold. University of Wisconsin. Spread of the Hungarian Partridge in Wisconsin; Eric R. Miller. U. S. Weather Bureau, Madison. Influence of Temperature and Sunshine on Fuel Consumption in the Heating of Buildings; Edward Kremers. University of Wisconsin. Christ as Apothecary; Henry A. Schuette. University of Wisconsin. "Death in the Pot."

The Annual Business meeting of the Academy was held in Ingram Hall immediately following the presentation of papers. After the business meeting the group adjourned to Lane Library for the tea.

ARCHEOLOGICAL-MUSEUM SECTION

Friday Afternoon

W. E. Haseltine. Ripon. Collecting Dreams; George Pasco. Ripon. Indian Mounds of Lake Puckaway; Nile G. Behncke. Oshkosh. Painted Pottery from Winnebago County; John G. Gregory. Milwaukee. Cultural Pioneering in Wisconsin; Alexander G. Guth. Milwaukee. Historic American Building Survey; A. P. Kannenberg. Oshkosh. Prehistoric Pottery Ladles from Winnebago County; Dorothy M. Brown. Madison. Wisconsin Lost Treasure Tales; Robert B. Hartman. Milwaukee. Totem Poles and Totemism; S. M. Pedrick. Ripon. (Introduced by J. F. Groves) Comments on Ripon History; Rev. Elizabeth Wilson. Appleton. The Rediscovery of Smithfield.

Friday Evening

Address by President Silas Evans of Ripon College, "The Spirit and Method of the Scholar."

ACADEMY SECTION

Saturday Morning

A group of nine papers, arranged by Professor Norman C. Fassett of the Department of Botany, University of Wisconsin, was presented under the heading of The Plant Conservation Section. These nine were as follows: R. M. Tryon, Jr. University of Wisconsin. (Introduced by N. C. Fassett). Additions to the Fern Flora of Wisconsin; C. H. Pratt. Ripon. (Introduced by J. F. Groves). Ramblings of an Amateur Botanist; Norman C. Fassett. University of Wisconsin. The Prairie in Wisconsin; Elizabeth Chavannes. University of Wisconsin. (Introduced by N. C. Fassett). Forest Invasion of a "Goat Prairie,"; John W. Thomson. University of Wisconsin. Dynamics of Some Prairie Plants in Central Wisconsin; George H. Conant. Ripon. Prairie Flora of a Gravel Knoll; Arthur S. Hawkins. University of Wisconsin. (Introduced by Aldo Leopold). A Century of Wildlife History at Faville Grove; George F. Sieker. Milwaukee. The Ridges Sanctuary of Bailey's Harbor, A Representative of a New Conservation Movement; Albert M. Fuller. Milwaukee Public Museum. The Ecological Exhibits of the Milwaukee Public Museum in Relationship to the Establishment of Plant Sanctuaries in Wisconsin.

Seven additional papers completed the Saturday morning session of the Academy. These included: Arthur H. Moeck. Milwaukee Entomological Society. A Butterfly Migration in Mexico; T. E. B. Pope. Milwaukee Public Museum. Landlocked Salmon in Wisconsin; Berenice Cooper. Superior State Teachers College. The Relation of the Abbe Prevost's *Le Philosophe anglais* to Eighteenth Century Religious Controversy in England and France; F. T. Thwaites and E. F. Bean. University of Wisconsin. Map of the Surface of the Buried pre-Cambrian of Wisconsin; William H. Twenhofel. University of Wisconsin. Pine Bluff in the Baraboo Basin, A Probable Nunatak During the Ice Age; John T. Mathiesen. University of Wisconsin.

Glacial Drifts in Northwestern Wisconsin; H. A. Schuette and Warren W. Woessner. University of Wisconsin. The Potential Acid-Base Balance of Honey.

Archeological-Museum Section

Saturday Morning

Zida C. Ivey. Fort Atkinson. Etiquette for Gentlemen, 1848; W. E. Dickenson. Kenosha. The First Year (Kenosha Historical and Art Museum); George Overton. Butte des Morts. Early Training Posts in Winnebago County; Albert H. Griffith. Fisk. Abraham Lincoln Memorablia; Albert O. Barton. Madison. Some Ceresco Letters; Gregg Montgomery. Waunakee. Stories of the French Canadian "Pea Soupers" (Lumberjack Lore); H. G. Boeckelman. New Orleans. Archeo-Conchology in the Union of Soviet Socialistic Republics; Charles E. Brown. Madison. A large Notched Copper Point.

TREASURER'S REPORT

April 8, 1938

Balance in Treasury, April 8, 1937	$607.98
Received by R. R. Shrock, and turned over to Loyal Durand Jr., June 2, 1937—total	945.75

RECEIPTS

Cash on hand in bank, June 2, 1937	$945.75
Receipts from dues, interest, sale of publications and sale of reprints to authors	917.03
Grant-in-aid of research from A. A. A. S.	125.00
	$1,987.78

DISBURSEMENTS

Secretary, R. R. Shrock	$100.00
Secretary, Loyal Durand Jr.	100.00
Grant-in-aid of research	125.00
Postage	28.20
Cost of reprints from Volume 30	350.50
Balance for printing of Volume 30	130.77
Reprint deposit for Volume 31	52.00
Cost of plates in Volume 31	4.27
Safety box	3.30
Speaker's expenses, 1937 meeting	21.63
Ledger sheets	2.80
Picture framing of past presidents for Academy Room in State Historical Society Building	20.00
	$938.47

Balance April 8, 1938 ....$1,049.31

PROCEEDINGS OF THE ACADEMY

SIXTY-NINTH ANNUAL MEETING

The sixty-ninth annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters was held at Madison on Friday and Saturday, March 31 and April 1, 1939. Meetings were held in Science Hall on the University of Wisconsin campus, and the annual dinner Friday evening was served at the University Club. Approximately 200 members and guests attended the meetings, and 83 were present at the banquet. The program of papers which was presented was as follows:

Friday afternoon: Ruth Marshall. Rockford College. Preliminary List of the Hydracarina of Wisconsin. Part VI; Chancey Juday. University of Wisconsin. The Annual Energy Budget of an Inland Lake; Willard A. Van Engel. (Introduced by Chancey Juday). University of Wisconsin. Age and Growth of the Northern Pike, *Esox lucius* Linnaeus, in Wisconsin; David G. Frey, Hubert Pedracine, and Lawrence Vike. (Introduced by Chancey Juday). University of Wisconsin. Results of a Summer Creel Census of Lakes Waubesa and Kegonsa; William A. Hiestand. Purdue University. Oxygen Consumption of *Thyone briareus* (Holothurioidea) as a function of Oxygen Tension and Hydrogen-ion Concentration. (By title); B. M. Duggar. University of Wisconsin. Aspects of Inactivation and Aging in the Virus of Tobacco Ring-spot and Common Mosaic; Irven C. Buss. University of Wisconsin. (Introduced by Aldo Leopold). The Upland Plover at Faville Grove, Wiscosin; Berenice Cooper. State Teachers College, Superior, Wisconsin. Eighteenth Century Censorship of *Le Philosophe anglais;* Edward Kremers. University of Wisconsin. The Literary Pharmacopoeia of Scott; Rufus M. Bagg. Lawrence College. Six Miles Under the Sea (A Walk from London to New York on the Bottom of the Sea).

The annual business meeting was held on Friday afternoon, March 31, at 4:30 o'clock. The treasurer reported on the state of the Academy's finances. Grants-in-aid for Research for the year 1939-1940 were made to Berenice Cooper, State Teachers College, Superior, $50 for continuance of her work on *Le Philosophe anglais*, and to John T. Curtis, instructor in Botany, University of Wisconsin, $50 for field expenses in connection with the study of Wisconsin ladyslippers.

The nominating committee, consisting of Charles E. Allen, Leonard R. Ingersoll, and Helen C. White, presented their report for officers for 1939-1942. The slate was elected unanimously, as follows:

President: Paul W. Boutwell, Beloit College
Vice Presidents
- In Science: Ernest F. Bean, Wisconsin Geological and Natural History Survey
- In Arts: J. O. Carbys, Milwaukee
- In Letters: Leila Bascom, University of Wisconsin Extension Division

Secretary-Treasurer: Loyal Durand, Jr., University of Wisconsin

Librarian: Gilbert H. Doane, University of Wisconsin
Curator: Charles E. Brown, State Historical Museum

The annual dinner was held on Friday evening. Following the dinner, members and guests of the Academy were addressed by Mr. A. William Schorger of Madison on the subject The Passenger Pigeon: A Chapter in Extinction.

Saturday Morning

Richard W. Pohl. Milwaukee Public Museum. (Introduced by Kenneth W. MacArthur). Preliminary Reports on the Flora of Wisconsin: Rhamnaceae, Vitaceae; Wilfred F. Horner, Marquette University. (Introduced by Paul F. Carroll, S. J.). Microscopic Anatomy of Lebistes Reticulatus; J. W. Thomson, Jr. University of Wisconsin. Plant Succession on Abandoned Fields in Juneau County, Wisconsin; James R. Neidhoefer. Marquette University. Preliminary Report on the Histology of the Fresh Water Sponges of Wisconsin; Charles G. Wilber. Marquette University. Histology of the Parotoid of Bufo a americanus, the Common Wisconsin Toad; W. H. Twenhofel and V. E. McKelvey. University of Wisconsin. Sediments of Devils Lake; W. H. Twenhofel and W. A. Broughton. University of Wisconsin. Sediments of Crystal Lake; Alfred Fischer, Arnold C. Mason, and W. S. Twenhofel. University of Wisconsin. Survey of Cave West of Blue Mounds; Eric R. Miller. United States Weather Bureau. Snowstorm of October 22, 1938, in Northern Wisconsin; V. C. Finch. University of Wisconsin. The Determination of Average Slopes; J. R. Whitaker. University of Wisconsin. The Distribution of Dairying in Ontario; Glenn T. Trewartha. (Introduced by Loyal Durand, Jr.). University of Wisconsin. A Second Period of Destructive Occupance in the Driftless Hill Land; Loyal Durand, Jr. University of Wisconsin. The Southeastern Cheese Region of Wisconsin.

Saturday Afternoon

A special session of Wisconsin Geography Teachers and those interested in the problems of geography was held in conjunction with the Academy meetings. Short addresses were made by: Leavelva Bradbury, State Teachers College, Oshkosh; Forrest R. Polk, President of State Teachers College, Oshkosh; Glenn T. Trewartha, University of Wisconsin; Loyal Durand, Jr., University of Wisconsin; Luther Zellmer, State Teachers College, Platteville; Charles F. Watson, State Teachers College, Stevens Point; Louise Mears, State Teachers College, Milwaukee; V. C. Finch, University of Wisconsin; and J. Russell Whitaker, University of Wisconsin.

TREASURER'S REPORT

April 1, 1939

RECEIPTS

Carried forward in Treasury, April 9, 1938	$1,049.31
Total receipts, April 11, 1938—March 30, 1939	806.04
	$1,855.35

Less $57.75 for sale of publications to the State of Texas (Texas not honoring vouchers at present)	57.75
Net receipts	$1,797.60

DISBURSEMENTS

Secretary	$ 200.00
E. A. Birge for Volume 31, Transactions	400.00
Grant-in-aid of research	100.00
Deposit with University of Wisconsin for J. J. Davis reprints	48.73
Postage	22.50
Printing	31.25
	$ 802.48
Balance on hand, March 30, 1939	$ 995.12

Loyal Durand Jr.
Secretary-Treasurer.

PROCEEDINGS OF THE ACADEMY

SEVENTIETH ANNUAL MEETING

The seventieth annual meeting of the Wisconsin Academy of Sciences, Arts and Letters was held in conjunction with the annual meetings of the Wisconsin Archeological Society and the Wisconsin Museums Conference at the State Teachers College, Oshkosh, on Friday and Saturday, March 29 and 30, 1940. More than 150 members and guests attended the two-day meeting, and 54 were in attendance at the annual dinner on Friday evening the 29th. In addition, the Academy welcomed several hundred students of the Teachers College at the meetings, and a group of one hundred joined the members following the banquet to hear the annual address given by Dr. Ernest F. Bean.

Hosts to the three societies were jointly the Teachers College and the Oshkosh Public Museum. Mr. Ralph N. Buckstaff of the Museum, a member of each of the societies, extended the invitation to meet at Oshkosh, and President Forrest R. Polk placed the facilities of the Little Theater on the College grounds at the disposal of the organizations.

The Friday morning sessions were given to the Museum group, while members of all groups presented papers at the ensuing sessions. The Oshkosh Public Museum entertained the members of the three organizations at a tea late Friday afternoon in the Museum building. The annual dinner was held in the Athearn Hotel.

The program of papers which was presented follows:

Friday morning: Ralph N. Buckstaff. Oshkosh. A Painted and Incised Winnebago Pottery Vessel; Gerald C. Stowe. Douglas County Historical Museum, Superior. The David F. Barry Sioux Indian Collection; Marvel Ings. University of Wisconsin. The Place of the Museum in the Community; Louise Phelps Kellogg. Wisconsin Historical Society. The Milwaukee Art and Travel Class; Harry Dankoler. Sturgeon Bay. The Door County Historical Museum; C. W. English. Portage. The Indian Agency House Museum; Robert B. Hartman. Milwaukee. Alaska, Another Melting Pot; Albert H. Griffith. Omro. Abraham Lincoln.

Friday afternoon: Zida C. Ivey. Fort Atkinson. The Lee and Lawton Collections of the Fort Atkinson Museum; George H. Overton. Butte des Mortes. Indian Trade Areas; Charles E. Brown. State Historical Museum. The Ringeisen Fluted Stone Axe; George L. Pasco. Ripon. Upper Fox River Valley Native Copper Implements; Otto L. Kowalke. University of Wisconsin. Highest Abandoned Beach Ridges in Northern Door County, Wisconsin; Arthur P. Kannenberg. Oshkosh Public Museum. Pre-Columbian Lead Objects of Winnebago County; Ella S. Colbo. Racine. The Colonel Hans Heg Memorial Museum; Zida C. Ivey. Fort Atkinson. The Octagon House Museum, Watertown; (Presented for the Watertown Historical Museum.); Mary Jane Overton. Buttes des Mortes. Suggestions of a Young Archeologist; Arthur Beatty. University of Wisconsin. Wordsworth and the New Democracy.

Following the afternoon session the members adjourned to the Oshkosh Public Museum Building at Algoma Boulevard and West Algoma Street for the tea, and a tour of the Museum.

Friday evening: Annual dinner at the Athearn Hotel, followed by the annual lecture given by Dr. E. F. Bean, State Geologist of Wisconsin, on the subject "The Geology of the Fox River—Lake Winnebago Region."

Saturday morning: Harold R. Bullock. Oshkosh. The Lasley Point Mounds; Dorothy Moulding Brown. Madison. Wisconsin Indian Corn Origin Myths; Gerald C. Stowe. Superior. Plants Used by the Chippewa Indians; Robert R. Jones. Wild Rose. County Fair Museum Exhibits; Phebe J. Lookaround. Shawano. Streamlining Indian Lore; Edward Kremers. University of Wisconsin. The Significance of the number 4 in Science; Berenice Cooper. State Teachers College, Superior. An Eighteenth Century Dictatorship; Casimir D. Zdanowicz. University of Wisconsin. Samuel Chappuzeau and his "Europe Vivante" 1666-1671; J. F. Groves. Ripon College. Temperature Reactions; H. V. B. Kline, Jr. University of Wisconsin. (Introduced by Loyal Durand, Jr.). The Development of the Urban Settlements on Lake Michigan; Kenneth Bertrand. Oklahoma State College. The Eastern Lake Shore Red Clay Dairy Region of Wisconsin; Loyal Durand, Jr. University of Wisconsin. Rib Lake—one of the Wisconsin Lumber Mill Towns; Arthur D. Hasler. University of Wisconsin. Application of the Dropping Mercury Electrode Apparatus to Respiration Studies in Fish. (By title); Ruth Marshall. Rockford College. The Genus TYRRELLIA of the Water Mites.

The grant-in-aid of research, made possible by the allotment of $100. from the American Association for the Advancement of Science, was awarded to Professor Harry Hayden Clark of the University of Wisconsin.

TREASURER'S REPORT
March 29, 1940

RECEIPTS

Cash on hand, March 30, 1939	$ 995.12
Grant-in-aid of research from A.A.A.S.	100.00

Receipts from dues, interest, sale of publications, sale of reprints to authors	776.13
	$1,871.25

DISBURSEMENTS

Secretary	$ 200.00
Printing	7.00
Postage	23.00
Safety Box	3.30
Lantern operator for 1939 meeting	4.00
Grant-in-aid of research	100.00
	$ 337.30