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Recommended Citation

Potzger, J. E. (1954) "Post-Algonquin and Post-Nipissing Forest History of Isle Royale, Michigan," *Butler University Botanical Studies*: Vol. 11, Article 22.

Available at: <http://digitalcommons.butler.edu/botanical/vol11/iss1/22>

Butler University
Botanical Studies
(1929-1964)

Edited by

J. E. Potzger

The *Butler University Botanical Studies* journal was published by the Botany Department of Butler University, Indianapolis, Indiana, from 1929 to 1964. The scientific journal featured original papers primarily on plant ecology, taxonomy, and microbiology. The papers contain valuable historical studies, especially floristic surveys that document Indiana's vegetation in past decades. Authors were Butler faculty, current and former master's degree students and undergraduates, and other Indiana botanists. The journal was started by Stanley Cain, noted conservation biologist, and edited through most of its years of production by Ray C. Friesner, Butler's first botanist and founder of the department in 1919. The journal was distributed to learned societies and libraries through exchange.

During the years of the journal's publication, the Butler University Botany Department had an active program of research and student training. 201 bachelor's degrees and 75 master's degrees in Botany were conferred during this period. Thirty-five of these graduates went on to earn doctorates at other institutions.

The Botany Department attracted many notable faculty members and students. Distinguished faculty, in addition to Cain and Friesner, included John E. Potzger, a forest ecologist and palynologist, Willard Nelson Clute, co-founder of the American Fern Society, Marion T. Hall, former director of the Morton Arboretum, C. Mervin Palmer, Rex Webster, and John Pelton. Some of the former undergraduate and master's students who made active contributions to the fields of botany and ecology include Dwight W. Billings, Fay Kenoyer Daily, William A. Daily, Rexford Daudenmire, Francis Hueber, Frank McCormick, Scott McCoy, Robert Petty, Potzger, Helene Starcs, and Theodore Sperry. Cain, Daubenmire, Potzger, and Billings served as Presidents of the Ecological Society of America.

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POST-ALGONQUIN AND POST-NIPISSING FOREST HISTORY OF ISLE ROYALE, MICHIGAN*

By J. E. POTZGER

Isle Royale, the largest island in our Great Lakes, is located in the northwestern part of Lake Superior, 50 miles nw. of the Keweenaw Peninsula, 20 miles se. of the Canadian mainland, and 19 miles east of Grand Portage, Minnesota. Maximum elevation is 1300 feet, but most of the higher central ridge does not exceed 1,000 feet. Present altitude of Lake Superior is 602 feet.

The island is a national park, to be kept as a wilderness area without roads. But here as well as in the vast untouched forest regions of Quebec, lightning-ignited fires have destroyed much virgin timber and have reduced succession to initial primary status on bare rock surfaces. The writer could not escape the impression that most of the island has been burned over in the not too distant past. Deep fjord-like harbors and coves as well as numerous barrier chains of islands constitute striking peripheral features.

Isle Royale presents a rugged, much deformed and uptilted rock formation with the scars of glaciation still plainly visible. Soil constitutes an extremely thin veneer on pre-Cambrian rocks. Nowhere has the writer seen more windfall damage to forests. For the palynologist Isle Royale is of interest because during Mankato time Algonquin and Nipissing high water stages of Lake Superior submerged much of the Keweenaw Peninsula and most or all of Isle Royale. Thus the forest history recorded in peat of bogs on the island could not record all of post-Mankato time, but surely all of post-Algonquin and post-Nipissing times. It was therefore assumed that the earliest forest history recorded in the bogs on the mainland, which was above the altitude of submergence should be wanting on Isle Royale. Also, if process of emergence was slow, one might find variation in forest succession in bogs of higher and lower elevations.

* This is publication 278 from the Botanical Laboratory of Butler University.

During the summer of 1948 nine bogs were bored, two of these were at or below the present lake level (Raspberry Island bog and Senter Point bog). The others ranged from 625 to 900 feet in elevation. All bogs except the Raspberry Island kettle had very shallow peat deposits.

DESCRIPTION OF BOGS

SISKIWIT MINE BOG: located at T 64 N., R 37 W., Sec. 20 (se. corner), borders on the Siskiwit Copper Mine. *Picea mariana* and Thuja were on the bog mat. *Acer saccharum*, *Betula lenta*, *A. rubrum* and *A. spicatum* were present on surrounding uplands.

ANGLEWORM LAKE BOG: T 66 N., R 34 W., Sec. 22, represented the valley-type bog. It was near Anglemorm Lake along the Ojibway trail. The mat has a dense cover of *Picea mariana* (Black spruce).

FORBES LAKE BOG: T 66 N., R 34 W., Sec. 27 (nw. corner). It is a small circular bog with open Sphagnum mat. Black spruce is invading and Chamaedaphne forms a dense shrub cover.

MOOSE LAKE BOG: T 66 N., R 34 W., Sec. 6 (sw. corner), is one depression in a series of boggy places between rocky uplands. It has a sparse tree cover (black spruce, arbor vitae) with intermittent open areas covered with Sphagnum. It is located nw. of Rock Harbor lodge, in the first valley beyond Tobin's Bay.

TOBIN'S HARBOR BOG: T 67 N., R 33 W., Sec. 34. It is a valley-type bog one mile north-east of Rock Harbor lodge. A rocky ridge separates it from Tobin's Bay. *Picea mariana* has a dense stand on the mat while the upland forest consists chiefly of *Betula papyrifera* and *Picea glauca*.

HOUGHTON POINT BOG: T 63 N., R 37 W., Sec. 3, is a small oblong bowl covered with dense stand of black spruce and paper birch.

ROCK HARBOR BOG: This is an oblong depression separated from the lake by a 50-foot wide rock wall. Black spruce and arbor vitae control the forest cover.

SENER POINT BOG: T 64 N., R 37 W., Sec. 33 (ne. corner), apparently originated as a beach pool. At present it is separated from the lake by 100 feet or more of a sandy gravel bar. The center is a sedge meadow and Sphagnum. The surrounding forest is primarily *Picea mariana*.

RASPBERRY ISLAND BOG: The island is about one mile south east of Rock Harbor lodge. The bog has a fine Sphagnum mat with scattered Chamaedaphne and Ledum shrub layer. The bordering forest consists chiefly of spruce, fir and paper birch.

METHODS

The Hiller-type borer was used in the field sampling. Boring was continued in every bog until compacted sand or rock stopped the operation. Peat samples were placed into carefully marked vials and stoppered securely. In the laboratory the Geisler (6) alcohol method was used to separate the peat. Counts of 200 tree pollens were made at most foot-levels. Pollens of herbaceous plants and spores of Pteridophytes were counted but have not been included in the graphs.

RESULTS

Figures 1 and 2 present the forest history in a summary manner. According to Leverett and Taylor (8) and Flint (4) Isle Royale was submerged entirely by Algonquin high water stage, and in part during Nipissing times. This made the conclusion obvious that early forest history of the region as a whole could not be represented in its entirety in the profiles of bogs from the island. This is clearly shown by the lowest levels of the bogs (Figs. 1, 2) when comparison is made with bogs from nearby Minnesota (10) and Michigan (11). Either the transition pine-spruce or the pine periods were in control at the time sedimentation began in the Isle Royale bogs. All profiles ended in a spruce-pine-birch forest association. Raspberry Island and Senter Point (Fig. 2, bogs 8, 9) bogs originated at a time when lake level was not higher than at present and so should show only the most recent history. In a general way the profiles present three types of forest history (Figs. 1, 2) all culminating in similar forest association. Bogs at 700 to 900 foot elevation (Fig. 1, bogs 1, 2, 3) record the close of the initial spruce-fir period (this association is characteristic for the region), they also indicate the bimodal pattern of spruce-fir which characterizes the profiles from the mainland. Bogs at 625-650 foot elevation (Fig. 2, bogs 3-7) indicate spruce-fir rising from a decided low to a prominent peak at the close, a pattern appearing in bogs at 700 to 900 foot elevation in the upper half of their profiles. The bogs at 600 foot elevation (Fig. 2, bogs 8, 9) show a rather uniform abundance of spruce in the

whole profile, thus recording only the more recent history of spruce and fir.

In bogs at highest elevation *Tsuga* is present chiefly in the upper third of the profiles; it spreads its representation to 3/4 of the profiles of bogs at 625-650 foot elevation, and is present in the whole profile in bogs at present lake level. *Abies* (fir), in greater abundance, shows the same distributional pattern. Fir indicates greater importance in the forest history of the island than on the mainland of Minnesota (9). The best expressed xerothermic period is no doubt represented by the pine climax and the low oak peak near the close of the pine period. While low percentages of hemlock may indicate long distance transfer from the mainland, the higher percentages no doubt indicate former presence of *Tsuga* on the island. Both hemlock and birch have their highest representation at the close of the pine period.

A summary of cardinal points of the various bogs is here given for ready reference:

| Bogs | Elevation Ft. | Depth of Peat | Initial Forest |
|-------------------|---------------|-----------------|-----------------------|
| Siskiwit Mine bog | 900 | 4 feet, 11 in. | pine-spruce |
| Angleworm Lake | 800-850 | 7 feet, 2 in. | pine (spruce) |
| Forbes Lake | 700-750 | 5 feet | pine |
| Moose Lake | 650 | 4 feet, 6 in. | pine |
| Tobin's Harbor | 650 | 6 feet | pine |
| Houghton Point | 625 | 5 feet, 6 in. | pine-spruce-birch |
| Rock Harbor | 625 | 7 feet, 3 in. | pine |
| Senter Point | 600 | 4 feet, 6 in. | pine-spruce-fir-birch |
| Raspberry Island | 600 | 13 feet, 11 in. | pine-spruce-birch |

Note: Elevations according to U. S. Lake Survey Chart 981 (14).

DISCUSSION

Isle Royale has a fascination for geologists as well as for biologists. Copper mining was in operation as early as 1844, and the University of Michigan sent an expedition to the island in 1908 (Adams (1) pp. 1-53) to study the biota found on the island. Isle Royale is separated from the mainland at least 20 miles at the nearest point, and this must no doubt present migration problems for both plants and animals. The classical survey of the forests by Cooper (3) in 1913 brought the forest ecology of Isle Royale to the attention of the world. One is somewhat surprised that migration diffi-

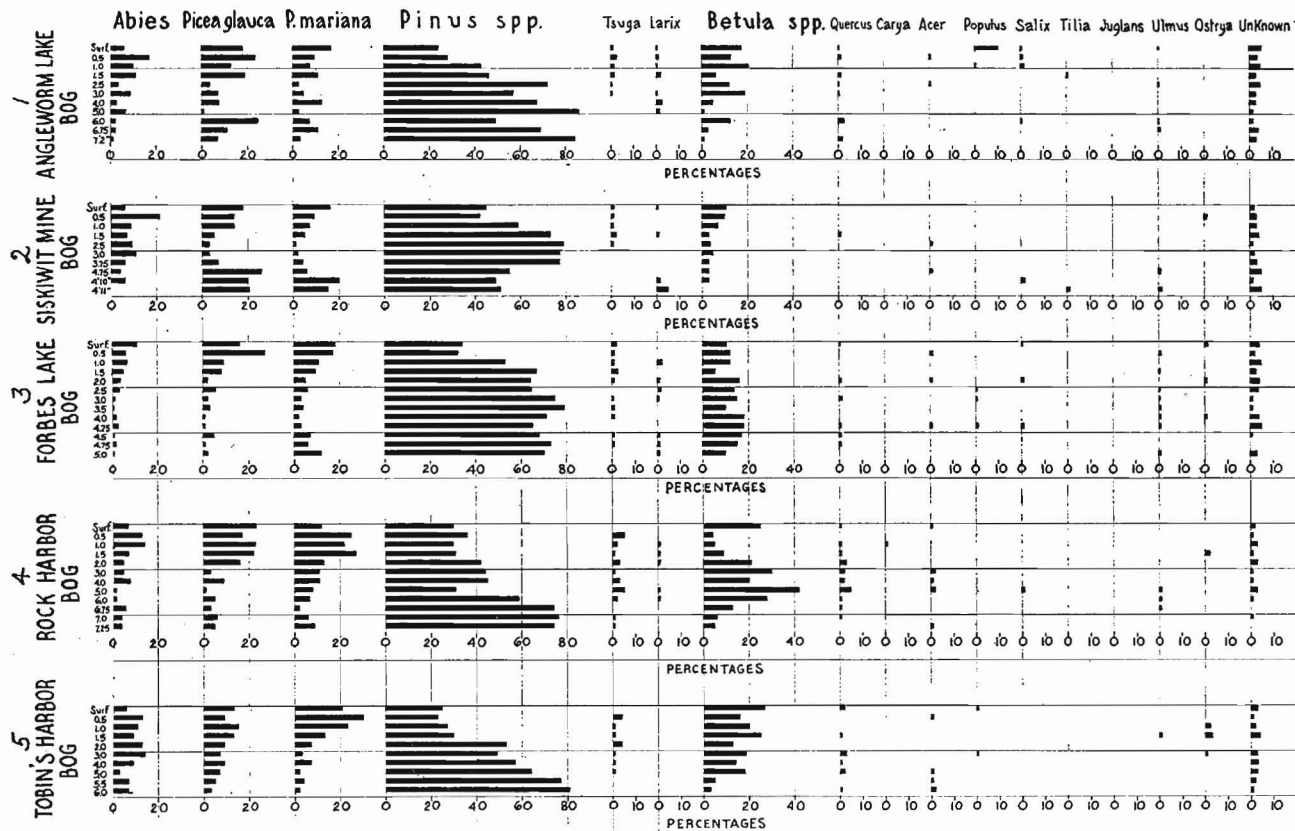


Fig. 1. Profiles from bogs 1, 2, 3, 4, 5.

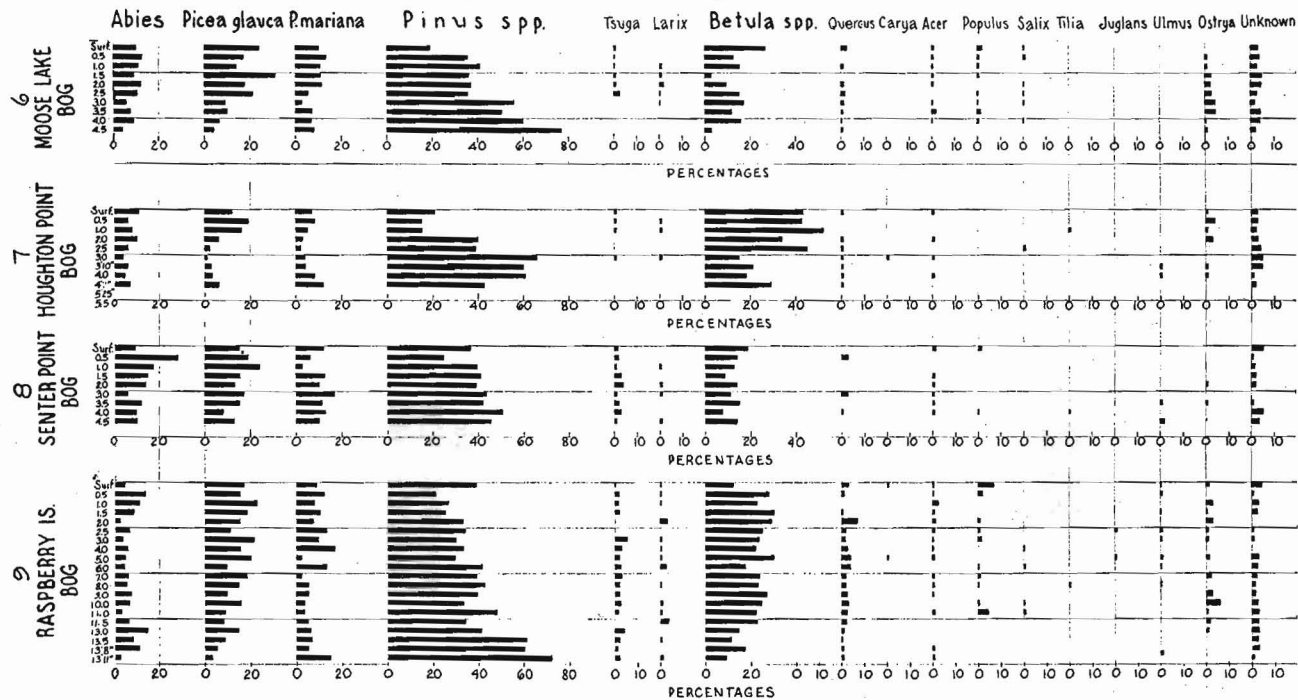


Fig. 2. Profiles from bogs 6, 7, 8, 9.

culties permitted so many plant species to become established on this rocky outpost. Brown (2) lists a total of 671 species of ferns and flowering plants. Of these 26 are trees (8 evergreens) and 87 are shrubs. Cooper (3) lists the island as the northernmost station for sugar maple (*Acer saccharum*) for that part of North America. While sugar maple reaches a higher latitude in the Saguenay valley of Quebec, it still remains a critical location for certain broadleaved genera. The same author considers *Abies*, *Picea glauca* and *Betula papyrifera* as climax forest association. The pollen profiles support such conclusions, for it is very evident that even though pine has still a significant representation its climatic climax has been replaced by spruce-fir climax.

For the present study the most important item for consideration was that on Isle Royale the palynologist had an opportunity to fit post-Algonquin and post-Nipissing time into the forest history of nearby mainland locations which were above the high water stages of Lake Superior. According to Leverett (7) and Leverett and Taylor (8) Algonquin water covered the island completely and Nipissing submergence reached 656 foot elevations. From the pollen profiles we know that earliest post-Algonquin forest history began at the close of the spruce-fir period and at the beginning of the pine climax, which in this location no doubt also represents the major xerothermic period. One is also justified to correlate the pine climax on the island with that on the mainland as reported by Potzger (10) for the Quetico-Superior forest region. A carbon-dating by Libby (9) for the Johnson Camp bog in Minnesota placed the pine period initiation at 7128 (plus or minus 300 years). Since the Quetico-Superior forest lies in the same latitude as nearby Isle Royale, we should be justified to assume the same age for the pine period on Isle Royale.

In the bogs from the post-Nipissing time (Bogs 4, 5, 6, 7) one should expect decline of spruce and fir because the continued wasting of the ice northward must be an indicator of warming climate (major xerothermic period). It is, of course, interesting that waning climax of pine and gradual increase of spruce and fir also marks the close of Nipissing times (Fig. 2, bogs 8, 9), so that in the Lake Superior region Nipissing time is represented by the maximum pine peak, including at least a portion of its rise and decline. Since the general

pattern of forest history on higher elevations of Isle Royale (Fig. 1, bogs 1, 2) is so similar to that of southern Quebec, as shown by Potzger (12) and Potzger and Courtemanche (13), one is inclined to assume that forests of both regions began during early post-Algonquin time, and both locations experienced the pine maximum up to the period of obvious decline during Nipissing times. Potzger (12) came to this conclusion while analyzing the geological happenings in the St. Lawrence valley. To all appearances, lower Quebec could not have been invaded by forests until close of Algonquin IV, and the beginning of the xerothermic period. While in all profiles from Isle Royale spruce and fir did not decline to such low representation in mid-profile as in Quebec, bogs above 700 foot elevation show the same bi-modal tendencies for spruce as the Quebec bogs, and those of the Quetico-Superior area. Rise of spruce and fir in upper third of profiles indicates a cooling climate during more recent times. The study by Potzger (10) in Minnesota, Ontario, and in Gogebic county, Michigan (11) plainly show the early prominent spruce-fir dominance following Mankato retreat. Preliminary examination of peat from the lowest levels of bogs on the Keweenaw Peninsula, Michigan by the writer indicates more truncation of forest record there than on Isle Royale (700 to 900 foot elevation) because hemlock (*Tsuga*) plays a prominent role already in lowest levels. These bogs began during early post-Nipissing times. According to Leverett and Taylor (8) Nipissing waters covered the Keweenaw peninsula up to 600 foot elevation.

SUMMARY

1. The study presents nine pollen profiles from bogs on Isle Royale, Michigan, ranging in elevation from Lake Superior (602 feet) up to 900 feet.

2. It is assumed that because of complete submergence of Isle Royale during Algonquin times, and up to 656 foot elevation during Nipissing times these bogs record the forest history of post-Algonquin as well as of post-Nipissing times.

3. Three distinct patterns of forest, determined by elevation of bogs, are interpreted as marking post-Algonquin, post-Nipissing and the stability of the present lake level.

4. Algonquin IV apparently closed when pine replaced spruce-fir, as shown by comparison with early forest history of the bogs from the Quetico-Superior forest region and with those from Gogebic County, Michigan.

5. Nipissing time is represented by the rise, dominance and beginning of decline of pine.

6. Climate cooled during the time that the upper fourth of the sediments in the bogs accumulated. This is indicated by marked rise in spruce and fir.

7. While oak never was very abundant on Isle Royale, decline occurred during deposition of the upper levels marked by cooling climate.

8. All bogs record essentially the same forest composition in the upper foot-levels, indicating that differences in altitude on the island are not significant control factors in forest composition during the recent past. Upper levels indicate a forest similar to that found on the island today.

ACKNOWLEDGMENTS

Sincere thanks is expressed to the American Philosophical Society for grant 1062 (1948) to cover expenses for an assistant in the field work. Grateful recognition is also made of the following aid: Information on Isle Royale by Dr. C. C. Adams; arrangements for transportation on the Tonawanda to Siskiwit Bay by Mr. Charles E. Shevlin, superintendent of the park; information and maps provided by Mr. Charles Humberger; efficient help in the field work and use of his outboard motor provided by my assistant, Mr. Walter Lauterbach, Central High School, South Bend, Indiana. Thanks is expressed to Mr. Edward A. Rumely of New York for stimulating interest in the work and for gift of launch service to distant locations on the island, and to my wife for preparation of graphs for figures 1 and 2.

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