THE NATURAL FIRE REGIME OF AN UNPROTECTED SECTION OF THE BOREAL FOREST IN CANADA

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ABSTRACT

Large parts of the Boreal Forest Region of east-central Canada have been under intensive fire management for almost as long as the populated Great Lakes-St. Lawrence Region to the south. Fire history studies in the latter region indicate that the area has been influenced immensely by the presence of people. Prior to the arrival of settlers, the fire periodicity varied between 60 and 100 years. Efforts to suppress forest fires in this century have increased this periodicity to between 500 and 1000 years. Very little fire history research has been carried out in the southern part of the Boreal Region and none has been conducted in the northern part, where fires start only from lightning.

From 1982 to 1984, we investigated the fire periodicity of the boreal forest of northern Ontario on an upland jack pine (*Pinus banksiana* Lamb.) site. Jack pine is an excellent source of fire-scar material because its thick bark is fire resistant. Cross-sectional discs were removed from fire-scarred trees to determine when previous stand-replacing fires had passed through the area. The data suggest that over a 160-year period, the shortest and longest times between major fires were 5 and 30 years, respectively. The average fire periodicity was 20 years.

INTRODUCTION

Forest fire history investigations have been undertaken in various parts of east-central Canada and the United States. Some prominent studies covered the Boundary Waters Canoe Area of northern Minnesota (Heinselman 1973), Quetico Provincial Park in northwestern Ontario (Woods and Day 1977), and Algonquin Park in central Ontario (Cwynar 1977). All these studies were located in the Great Lakes-St. Lawrence Forest Region (Rowe 1972). The structure and composition of the forest stands in this region have been affected immensely by the presence of people, whose most important influence has been their attempt to suppress forest fires over the last 100 years. All of the above studies indicate that the natural fire periodicity of the Great Lakes-St. Lawrence Forest Region, prior to the arrival of people, was between 60 and 100 years. (The fire periodicity in pre-settlement times was based largely on

the analysis of pollen sediments taken from lake bottoms.) Studies of recent fire history (Woods and Day 1977, Harrington and Donnelly 1978) indicate that the fire periodicity has increased to about 500-1000 years during the last 75 years in both the northern Great Lakes-St. Lawrence Forest Region and the southern Boreal Forest Region. (The fire periodicity in recent times was calculated as the reciprocal of the average annual percentage area burned.)

Although this part of the Boreal Forest Region has been under intensive fire management for almost as long as the Great Lakes-St. Lawrence Forest Region to the south, very little fire history research has been carried out in it and none has been conducted in the far north, where natural fires have been left to burn freely.

The purpose of this study was to document the historic fire periodicity of a natural portion of the boreal forest of east-central Canada. Data on understory plant vegetation were also collected to determine whether any range extensions existed for species that are common to jack pine stands of the boreal forest.

STUDY AREA

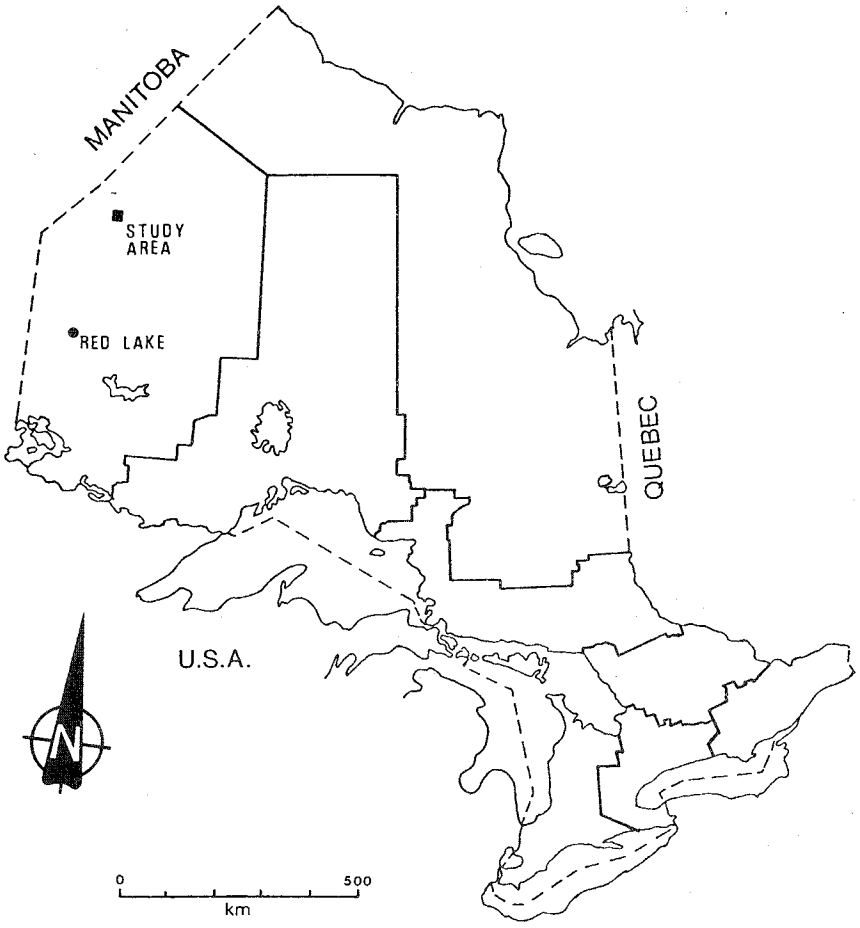
A fire history study of the Sachigo Hills (53°50' N, 92°25' W), north of Red Lake in northwestern Ontario (Fig. 1), was undertaken in 1983 and 1984. The Hills are a unique source of fire history information for several reasons. The elevation of the Hills (275-350 m), the sandy to gravelly nature of the soil, and repeated burning of the Hills have produced continuous jack pine stands that are an excellent source of fire-scar material. In addition, fires in this part of Ontario occur naturally, have not been suppressed, and create an opportunity for fire scars to be produced. These scars can provide information on the natural fire periodicity of the Hills.

The Sachigo Hills are located in the southern half of the Sachigo Interlobate Moraine. This moraine extends in an approximately north to south direction from the Manitoba border to Sandy Lake in Ontario and is identified as "Prominent Ridge" on most topographical maps. The formation of the Sachigo Interlobate Moraine occurred about 14,000 years ago when the Opasquia Lobe of glacial ice, advancing from the northwest, met with the Agutua Lobe of ice, advancing from the northeast (Fig 2). This occurred west of what is known today as Sachigo Lake (Anon. 1972).

The glacial debris pushed ahead of these two lobes was forced up into a ridge along the area of contact between the lobes, approximately 150 km in length. Upon retreat of the glaciers, starting around 13,000 years ago, an interlobate moraine or ridge remained.

It is probable that more ice-molded features were present in the surrounding terrain than can be seen today. These would have been obliterated by the invading waters of ancient Lake Agissi, which left the area that can be seen from the Hills essentially as it is today. The smooth round boulders that can

Figure 1. Location of the Sachigo Hills study area in northwestern Ontario.

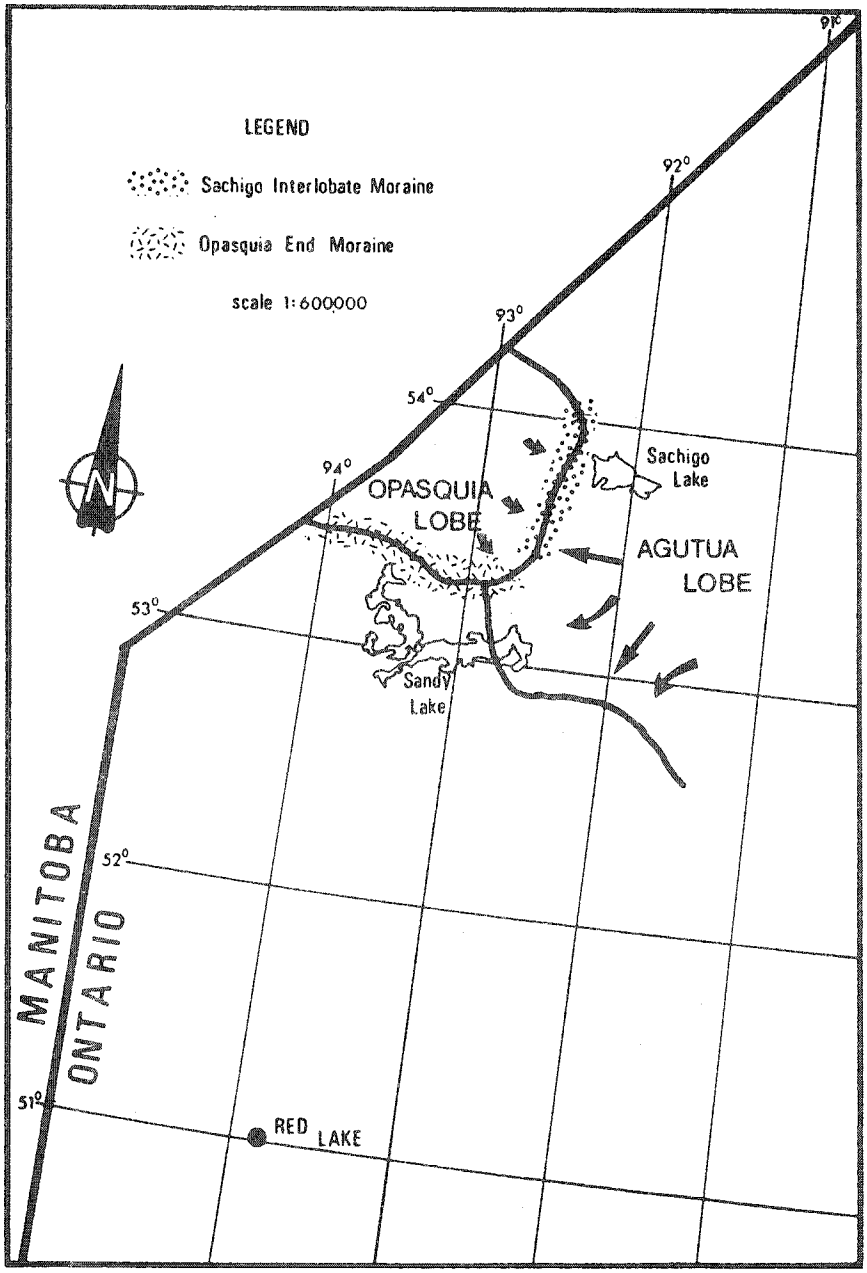


be observed on the western slopes are further evidence of the effect of water and wave action on glacial debris, as is the spiral-shaped curl of the western ridge.

Boulder terraces were formed in response to shifting water levels in Lake Agissi as lake levels were lowered and raised in response to blocking and unblocking of outlets. There is an unresolved question as to whether the Hills represent an island in ancient Lake Agissi or were part of an extensive shoreline. In either case the landscape features would be the same.

Overstory vegetation in the Sachigo Hills consists of jack pine stands of various age classes on ridges and slopes. The visual impression from the air is that the Hills are largely young-age-class jack pine. Low-lying areas are dominated by black spruce (*Picea mariana* [Mill.] B.S.P.) with patchy stands of balsam poplar (*Populus balsamifera* L.), white birch (*Betula papyrifera*

Figure 2. Glacial origin of the Sachigo Hills of northwestern Ontario.



Marsh.) and trembling aspen (*Populus tremuloides* Michx.) scattered throughout. Brown (1973) stated that discontinuous permafrost is present in the region; however, the study area of the Hills does not appear to be underlain by permafrost.

METHODS

A reconnaissance flight was made by float plane over the Sachigo Hills in August 1982 and the lack of roads and bodies of water made it evident that the Hills could only be accessed by helicopter.

The first of two field trips to the Hills took place late in the summer of 1983. On this trip the research group was dropped by helicopter on the western edge of the Hills where they set up a base camp. The area of the Hills sampled during a 10-day period in 1983 was restricted to the vicinity of the base camp because of the difficulty in traversing the rocky, rugged terrain on foot. A chain saw was used to remove fire-scar discs from trees (primarily jack pine) at each sample site. Discs about two inches in thickness were cut at any height on the tree where the fire scar was prominent and were marked with a number for mapping purposes. When different herb and shrub species were encountered they were identified and recorded. In addition, notes were taken about the soil, and unusual herbs and shrubs were collected for identification in the laboratory.

A second visit to the Hills occurred late in the summer of 1984. Dedicated use of a small helicopter permitted sampling of the entire study area in one trip. Data were collected in the same manner as in 1983, but samples were also collected in some lower areas beyond the ridges.

RESULTS

Eighty-nine fire-scar discs from 41 sample sites were collected during the two years. The frequency of stands of various age-classes resulting from wildfires is shown in Figure 3. There is a predominance of stands less than 15 years old as well as those between 20 and 40 years old, which emphasizes the short periodicity of wildfire in the Hills in comparison with that of more southern forests (Harrington and Donnelly 1978). Figures 4a to 4f show the locations and pith dates for the fire-scar discs. The high density of sample points in the central Hills area reflects the restricted travel in 1983.

Major fires appear to have invaded the Hills from the west and southwest. As a result, the southern part of the Hills has burned more frequently than the northern. Some fires probably approached from the west but lacked the right fuel or weather conditions to rise up and over the Hills and instead burned around the northern and southern ends of the Hills to consume the timber on the eastern terraces. Triple fire scars, which are very rare in

Figure 3. Frequency of stands, by age (at time of burning), in the Sachigo Hills of northwestern Ontario.

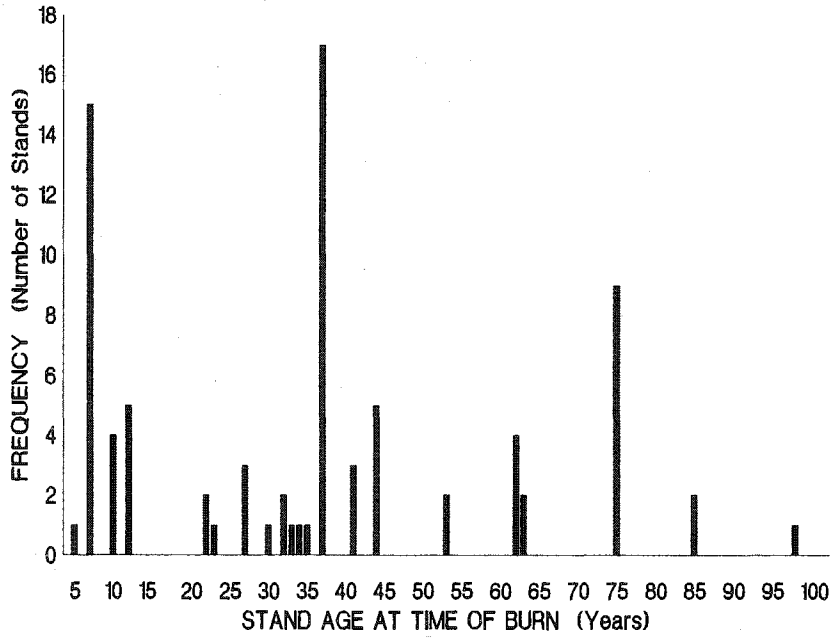
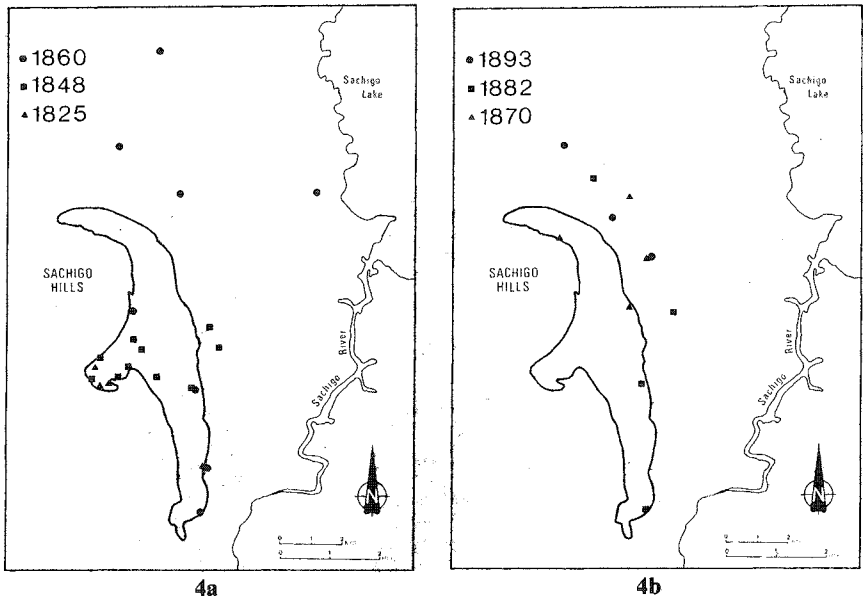
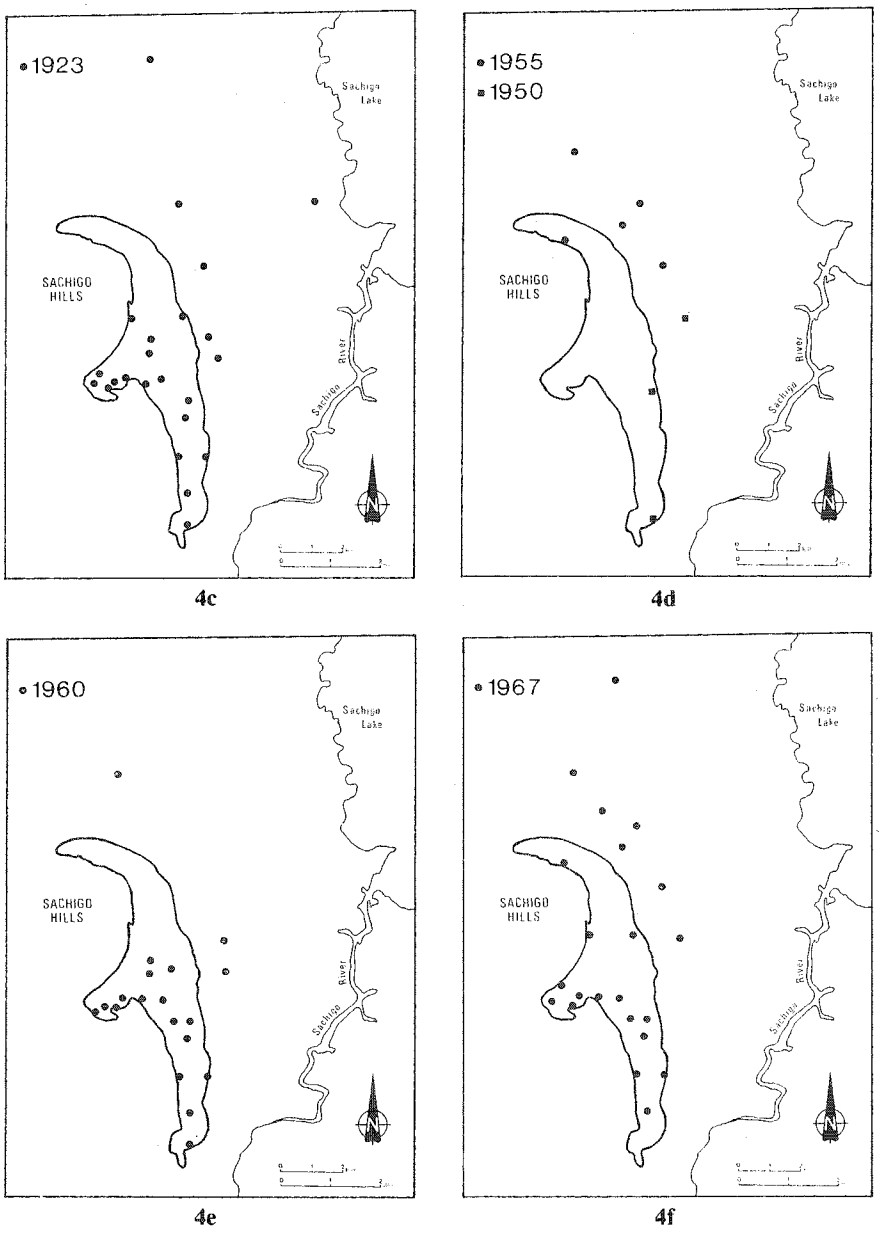


Figure 4. Location of ground sample sites in the Sachigo Hills where analysis of fire scar data showed wildfires originating in (a) 1825, 1848 and 1860, (b) 1870, 1882 and 1893, (c) 1923, (d) 1950 and 1955, (e) 1960, and (f) 1967.



4a 4b



4c 4d

4e 4f

jack pine stands where intensive fire protection has been in effect for the last 75 years, are very common in the Sachigo Hills. One jack pine tree was found with four scars.

Fires have burned over the entire Hills on more than one occasion. One such fire burned the Hills in 1860 (Fig. 4a). Fire-scar material taken from the shore of Lake Sachigo suggests that the fire may have burned right to

the lake. Widespread fires in 1923 and 1967 (Fig. 4c and 4f) also burned the entire Hills. Fires in 1950 (Fig. 4d) and 1960 (Fig. 4e) burned the southern half of the area. Fires in 1870 (Fig. 4b) and 1955 (Fig. 4d) burned the northern half of the Hills.

The distribution of fire scars shows that at least 10 major fires (1848, 1860, 1870, 1882, 1893, 1923, 1950, 1955, 1960, and 1967) burned over the Hills in the last 136 years. If all of these fires had burned the entire area of the Hills, then the average fire periodicity would be 14 years, but seven of these fires burned only half the area of the Hills, which suggests that the fire periodicity is closer to 20 years. The shortest period between major fires was 5 years (1950-1955 and 1955-1960) and the longest period was 30 years (1893-1923).

No unusual vegetation types were found in the Hills but three species, bristly aralia (*Aralia hispida* Vent.), mountain-ash (*Sorbus americana* Marsh.) and running serviceberry (*Amelanchier stolonifera* Wieg.) were found outside their known range (Soper and Heimburger 1982). Table 1 lists the most common understory species found in the Sachigo Hills.

DISCUSSION

This study of the Sachigo Hills of northwestern Ontario documents the fire periodicity of an unprotected section of the boreal forest under a natural fire regime. The average fire periodicity of the Hills is approximately 20 years. Burgess and Methven (1977) reported a fire cycle of about 37 years at the Petawawa Forest Experiment Station (Chalk River, Ontario) between 1860 and 1919. Dominy (1981) reported that the fire cycle in Parke Township, west of Sault Ste. Marie, Ontario, was 30 years during the period between 1727 and 1877. Both of these forests lie in the Great Lakes-St. Lawrence Forest Region of Ontario.

The Sachigo Hills study exemplifies a simple field procedure that can be used to provide background information on important areas of northwestern Ontario in which fire is a critical factor in resource management. The Hills offer the unique opportunity to study fires as an ecosystem process. The region is located in an area that was traditionally outside the area of intensive fire protection, thus allowing fire to play the role it has played there since the last glaciation. In this way, past fire activity can serve as a yardstick against which present fire periodicity can be measured. Deviation from historical patterns can then be used as a basis to formulate questions as to the underlying reasons for changed fire frequencies, which may or may not be related to human activities.

Table 1. Species list of understory vegetation for the Sachigo Hills of northwestern Ontario. (Scientific and common names are from Cunningham 1975.)

Botanical Name	Common Name
Alnus cripsa (Ait.) Pursh	green alder
Amelanchier stolonifera Wieg.	running serviceberry
Aralia hispida Vent.	bristly aralia
Aralia nudicaulis L.	sarsaparilla
Arctostaphylos uva-ursi (L.) Spreng.	bearberry
Calamagrostis canadensis (Michx.) Nutt.	blue-joint
Cladonia alpestris (L.) Rabenh.	reindeer moss
Cladonia rangiferina (L.) Web.	reindeer moss
Cornus canadensis L.	bunchberry
Cornus stolonifera Michx.	red-osier dogwood
Dicranum spp.	moss
Epilobium angustifolium (L.)	fireweed
Hylocomium splendens (Hedw.) BSG.	feathermoss
Ledum groenlandicum Oeder	labrador tea
Linnaea borealis L.	twinflower
Lonicera sp.	honeysuckle
Lycopodium complanatum L.	ground cedar
Lycopodium obscurum L.	ground pine
Maiaenthemum canadense Desf.	Canada miainthemum
Melampyrum lineare Desr.	cow-wheat
Monotropa uniflora L.	Judian pine
Peltigera aphthosa (L.) Willd.	spotted peltigera
Pleurozium schreberi (BSG.) Mitt.	Schreber's moss
Polytrichum commune Hedw.	hair-cap moss
Prunus sp.	cherry
Pyrola sp.	pyrola
Ribes glandulosum Grauer	skunk current
Rosa acicularis Lindl.	prickly rose
Salix sp.	willow
Sorbus americana Marsh.	mountain-ash
Stereocolon sp.	lichen
Trientalis borealis Raf.	star-flower
Vaccinium myrtilloides Michx.	sour-top blueberry
Vaccinium vitis-idaea L. var. *minus* Lodd.	cowberry
Viburnum edule (Michx.) Raf.	squashberry
Viola sp.	violet

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