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THE STATUS OF FURBISH'S LOUSEWORT, PEDICULARIS FURBISHIAE

S. WATS. IN CANADA AND THE UNITED STATES

by

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PREFACE

Because Pedicularis furbishiae occurs in New Brunswick, Maine, and in Maine on the international section of the St. John River, its status and the problems in dealing with it have an international aspect. These have been taken into account in the many statistics and discussions on the populations of the plant living in Maine.

Much of the recent knowledge of the plant has been derived from the work of the scientists employed by the U.S. Corps of Engineers, Waltham, Mass., in Maine and New Brunswick during the years 1976-1979. The greater part of this work was, of course, located in Maine and other areas of the United States.

The scientists employed were Dr. Charles D. Richards, botanist, University of Maine, Orono; Dr. L.W. Macior and his co-workers at the University of Akron, Akron, Ohio; Mr. Harold L. Hinds, botanist, University of New Brunswick, Fredericton, N.B. and Dr. Geo. M. Stirrett, retired, formerly Chief Naturalist of the National Parks of Canada, Ottawa, now living in Grand Falls, N.B.

The Reference List is more than just that - it is a bibliography of the world literature on the plant, except that it does not include references to standard botanical texts or regional floras.

The appendix, filed separately, contains copies or in some cases, the original publication, of all pertinent literature including newspaper articles. Both the citation of a paper in the Reference List and in the appendix are given when referring in the body of the report to specific papers. An example is Stirrett (1977D, App. 1) which means the paper is listed in References under his name in the year 1977 and that a copy of the paper is in the appendix and is labelled paper number 1.

A. ABSTRACT

The Furbish's Lousewort, Pedicularis furbishiae S. Wats. is a rare, local endemic plant growing in an apparently specialized habitat in certain sections of the upper St. John River in New Brunswick and Maine. It grows nowhere else in the world. Its present population is approximately 1115 plants of which 402 are in New Brunswick and the remaining 713 plants are in Maine.

The plant was described in 1882 by Sereno Watson and named after the collector, Miss Kate Furbish.

There was little interest in the species after its description except by a few botanists who collected it from time to time. Most of the collections were made in the early 1900's and the last in this period of its history was made in New Brunswick in 1943 and in Maine in 1946. By the year 1975, since no one had seen or collected the plant since these dates, it was thought to be extinct or so rare that it should be declared endangered. The Smithsonian Institution in Washington, D.C., listed it as very rare and probably extinct in 1975. With this announcement the U.S. Fish and Wildlife Service started procedures to have it listed as endangered under the U.S. Endangered Species Act 1973. It was not pronounced legally endangered, however, until April 26, 1978. In the meantime it had been found growing on the site of the proposed Dickey-Lincoln School project in northern Maine in 1976, and further surveys in 1977 revealed more plants in both Maine and New Brunswick.

The U.S. Corps of Engineers in charge of planning and building the dams were faced with a serious problem - the dam could not be built if it would endanger the plant or its habitat. This state of affairs produced world-wide publicity for the plant and the dam and the controversy still continues.

The U.S. Corps of Engineers, with the help of the U.S. Fish and Wildlife Service and a group of scientists, are studying the plant with the hope of finding a way to transplant it successfully from the dam site to sections of the river that will not be affected by the construction and operation of the dams.

In Canada and New Brunswick no recognition of the presence of the plant has been given by any official agency and no attempts have been made by them to afford the plant and its habitat protection under existing legislation designed for such purpose.

The greatest menace to the plant in New Brunswick is the proposed plan of the New Brunswick Electric Power Commission, a Crown Agency, to build a new dam at Morrell Siding on the St. John River and to redevelop the dam and power facilities at Grand Falls. Both schemes, if carried out, would raise the water in the headponds and flood two of the three populations of the plant in New Brunswick.



## B. DISTRIBUTION

### (1) GEOGRAPHICAL RANGE

Pedicularis furbishiae is a local endemic plant confined to a narrow strip of land close to the water's edge along the banks of the upper St. John River in northern New Brunswick in Canada and northern Maine in the United States.

#### (a) Distribution According to Surveys 1976-1979

The plant is found in scattered stations or population areas along both banks of the upper St. John River from Township 14 R 13 in Aroostook County, Maine, eastward and southward to the mouth of the Aroostook River in Grand Falls Parish, Victoria County, New Brunswick, a distance of about 130 miles. Along the 260 miles of river bank there are 44 stations<sup>1</sup> in Maine and New Brunswick but only three of them are located on the right bank (northward and eastward side). Of these stations 18 are in Maine and 26 (confined to three population areas) in New Brunswick (figures 1 and 2).

Surveys of this area included the St. John River from Baker Lake, Maine, to Woodstock, N.B., and many of its tributaries in both Maine and New Brunswick. In many stretches of these rivers the lousewort was not found.

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<sup>1</sup> A station is the location of one or more plants separated by a short distance without plants, far enough that plants would not be seen from a point in the counting procedure.

(b) Distribution According to Historical Field Botany 1861-1972

A study of the historical field botany of the area revealed that, according to the reports of 51 expeditions and field trips taken during the period 1981 to 1972, not one record was made of the lousewort being found away from the upper St. John River (Stirrett 1977D, App.1).

(c) Herbarium Specimens of the World 1878 - 1977

Stirrett (1977D App. 1) has been gathering records of the museum specimens extant in the herbaria of the world since 1971. He now has detailed records of 72 specimens collected between 1878 and 1977. All are from the banks of the Upper St. John River.

(2) ALTITUDINAL RANGE

The plant grows at the river's edge from an elevation of 400 feet above mean sea level to a little over 600 feet above mean sea level.

C. PROTECTION(1) IN CANADA AND NEW BRUNSWICK

There is not protection of any kind given the plant by any federal government department, Act or other agency. So far as known there is, at present, no federal legislation under which the plant and its habitat could be protected.

There are at present legislative Acts in force in New Brunswick under which the species could receive some protection but no action has been taken to place the species within the Acts.

The legislation available is as follows:-

- (a) Endangered Species Act N.B. - (Anon. 1974 App. 34).
- (b) Ecological Reserves Act. - (Anon. 1975A App. 34A).

Efforts by the author to interest New Brunswick agencies that have jurisdiction in this matter have had little effect (Stirrett 1971, App. 19, 1976, App. 20, 21 and 22).

The plant has been listed as rare in New Brunswick by Fernald 1940, Choate 1973, Maher 1977 and Argus 1979. Fernald (1940) was the first to point out that the plant needed protection if it is to survive.

International recognition has been given to the need for conducting an environmental assessment of the St. John River basin by the International Joint Commission (Anon. 1977B) and the risk to some Canadian populations by the construction of the Dickey-Lincoln dam was pointed out by Greenwalt, Chief of the U.S. Fish and Wildlife Service (1978, App. 44).

The plants in Population Area III N.B., which are away from the river, are now protected by the Canadian Pacific Railway by agreement with the author and John Dee, local agent of the railway. The area is staked and otherwise marked and will be preserved. The plants are safe from all railroad activities that would harm them, such as weed control.

Under the United States Endangered Species Act (Anon. 1978A, App. 41) Pedicularis furbishiae was declared an endangered species in Maine and New Brunswick, Canada, on April 26, 1978. This declaration has no effect in Canada except that it recognizes the plant to be endangered in its entire range and habitat.

There is very little public interest in New Brunswick about the plant and its preservation. What little knowledge the people have is gleaned from newspaper articles and reports emanating from save-the-lousewort proponents "battle" with the U.S. Corps of Engineers and their Dickey dam project.

There are two organizations and their affiliates in New Brunswick that might be interested in a campaign for public enlightenment on the lousewort and its preservation. These are the Conservation Council of New Brunswick, Box 541, Fredericton, N.B., and the New Brunswick Federation of Naturalists, 277 Douglas Ave., St. John, N.B.

Proposed plans to build a new dam, and rebuild another will raise the water level in the St. John River and flood the plant's present habitats along the river in New Brunswick.

All official departments and agencies that have jurisdiction in Canada and in New Brunswick are aware of the presence of the lousewort in New Brunswick and its need for protection but none so far have done their duty and acted to protect it.

(2) Protection in the United States - Maine

The efforts to protect the lousewort in Maine and the United States have been vigorous. Here strong environmental and

other organized groups have been against building the Dickey-Lincoln dams even when the project was first proposed in 1965. The magnitude of the dam project is enormous and it will result in great changes over thousands of acres of forests and countryside (Swanson 1977A, App. 31). The finding of the rare and endangered lousewort plant on the dam site in 1976 renewed their protests by giving them some concrete evidence. It was not only a fight to prohibit biological and environmental damage in general but to save the lousewort.

In 1975 (Anon. 1975) the Smithsonian Institution listed the lousewort as rare and probably extinct and the U.S. Fish and Wildlife Service began preparations to have it officially declared as endangered. This meant that under law the U.S. Corps of Engineers were forced to consult the Fish and Wildlife Service and also to prepare an environmental impact study relative to their proposed construction of the Dickey dam.

This study had already started before the lousewort was found at the dam site in 1976 but it was not until April 26, 1978 (Anon. 1978A, App. 41), that the lousewort was officially declared as endangered. This caused additional anxiety as to whether the dam could be built or not. It also caused increased research and survey work by the Corps of Engineers to study the plant to find a way around the dilemma - perhaps the lousewort could be transplanted from the dam site?

The Critical Areas program carried out by the State of Maine, recognizes the unique plant flora of the upper St. John River in Aroostook County, Maine, including the lousewort (Tyler and Gawler 1980). The state, however, has done very little to protect the lousewort or the region. The reasons given for the inaction are the unsettled controversy over the dam and political involvement.

It is understood the Nature Conservancy in the United States is interested in securing land supporting lousewort populations in order to protect the plant.

The U.S. Fish and Wildlife Service and presumably the U.S. Corps of Engineers intend to continue their study of the lousewort in 1980 and Dr. Charles Richards of the University of Maine has been employed to work in both Maine and New Brunswick (U.S. Fish and Wildlife Service 1980, App. 9). Among his projects will be one to set out permanent plots to trace the population behavior through the years.

#### D. POPULATION, LOCATION, SIZE AND TRENDS

##### (1) POPULATION, LOCATION AND SIZE

###### A- New Brunswick

The following descriptions of populations in New Brunswick are based on the work of Stirrett in 1977D

(App. 1) and his unpublished observations in 1978 and 1979 on the work of Hinds 1977 (App. 5).

There are three population areas in New Brunswick containing a total plant population of about 402 plants. Each population area will be discussed separately.

### 1. Population Area I N.B.

a) Geographic Location: Situated on the south bank of main stem of St. John River, Grand Falls Parish, Victoria County, N.B. Nearest village, Hamlin, Me. Location is shown on Canada Topographic Map, 1:50,000, sheet 21<sup>0</sup>/4 and 21<sup>N</sup>/1 Saint Andre, N.B. - Maine, Edition 2, 1974.

b) Universal Mercator: Universal Transverse, Mercator Grid. Reference Zone 19T, 920127.

c) Plant Populations: There are about 154 mature flowering plants and 100 young non-flowering plants. The population is scattered in 15 stations along 2 miles of river bank. The largest station held about 59 plants.

### 2. Population Area II N.B.

a) Geographic Location: East (or north) bank of St. John River near mouth of Little River, New Denmark Parish, Victoria County, N.B. Nearest village, North Tilley. Location is shown on Canada Topographic Map 1:50,000, sheet 21<sup>J</sup>/13 Aroostook, Edition 2, 1974.

b) Universal Mercator: Universal Transverse Mercator Grid. Reference Zone 19T, 999889.

c) Plant Populations: There are about 69 mature flowering plants and about 46 young plants scattered in 10 stations along 0.8 miles of river bank (Stirrett 1979 count).

### 3. Population area III N.B.

a) Geographic Location: on east bank of Canadian Pacific Railway cut. One-quarter mile inland from both the St. John and Aroostook Rivers. Grand Falls Parish, Victoria County, N.B. Nearest village, Aroostook, N.B. Location shown on Canada Topographic Map 1:50,000, sheet 21<sup>J</sup>/13 Aroostook, Edition 2, 1974.

b) Universal Mercator: Universal Transverse Mercator Grid. Reference Zone 19T, 972848.

c) Plant Populations: There are about 33 plants (Stirrett 1978 count) consisting of one station.

### B- Population in Maine, U.S.A.

The following figures are derived from the following reports: Richards 1976, App. 2 and 1977A, App. 4; Macior 1977, App. 3; and Richard Dyer, U.S. Fish and Wildlife Service, on February 4, 1980 (personal communication).

There are 18 stations of plants from T15 R13 eastward and southward to just below Van Buren, Maine. The total plant population is about 713.

A 1979 report of several hundred plants at Cross Rocks has been given to the author and for the purposes of this report is



recorded as 200 plants. The find and the actual number of plants will be checked in the summer of 1980.

C- Total Population

The present known population of Pedicularis furbishiae is about 1115 plants. The New Brunswick population is about 402 plants and that of Maine is about 713.

(2) POPULATION TREND

There are little data on which to base trends in population. Macior (1980, App. 8) thought the reproductive rates in Maine approximated replacement levels with some potential for population increase. The author's field impression is that the population is increasing slightly over the whole range in New Brunswick. There are some data (Stirrett 1977) to show an increased population in Population Area II N.B. between 1977 and 1979.

August 20, 1977 44 flowering, ca. 26 young = ca. 70 plants

June 26, 1979 69 flowering, ca. 46 young = ca. 115 plants

E. HABITAT

(1) DESCRIPTION

The three population areas in New Brunswick are each growing in a different type of habitat and the Maine habitats are also different.

In spite of a difference in aspect all the various habitats are confined to the bank of the St. John River, except Population Area III N.B., and all must be supplying the essential needs of the plant.

A- Habitat Population Area I N.B.

Here the plants grow on a narrow bank of moist, well drained, sandy or gravelly calcareous soil. The plants grow within a distance of twenty-five feet of the water and from inches to three feet in a vertical distance above it, depending on the controlled water level at any given time.

The plants are on a sloping terrace at the bottom of a forested bank about 100 feet high. The plants are shaded most of the day but do receive a short period of sunshine. This is the most shaded habitat of the three in New Brunswick.

The forest here is typical of the Sugar Maple-Hemlock-Pine Zone (Loucks 1962) which is characterized by the presence of Balsam Fir, White Spruce and with Black Spruce and White Pine in certain areas. Yellow Birch, Sugar Maple and Beech are prominent. Red Spruce and Hemlock occur only locally and Wire Birch is practically absent. Stations 17 and 18 near Van Buren, Maine, are in the same type of forest zone.

The associated small plants growing within 10 feet of the lousewort are varied and numerous. Among the more common encountered were Mosses, Equisetum sp., Luzula sp., Pyrola sp.,

Galium sp., Vicia craca, Amphicarpa bracteata, Aralia nudicaulis, Diervilla lonicera, Thalictrum sp., Acer spicatum, Corylus cornuta, Anemone canadensis. Epilobium sp., Aster sp., Solidago sp., Actaea rubra, Hieracium canadensis, Grasses. Linnaea borealis, Cornus canadensis, Alnus crispa, Alnus rugosa, Eupatorium maculatum, Athyrium thelypteroides, Impatiens capensis, Helenia deflexa, Lysimachia ciliata. Athyrium filix-femina, Carex sp., Ranunculus sp., Fragaria sp. and Dryopteris phegopteris. The most striking feature of the area is the clean-cut line where forest and river meet and where the lousewort grows. The usual shrubs of alder, willow, dogwood and Mountain Maple are present in small numbers and do not clutter the shore. A general view of the habitat is shown in figure 7 and figures 10, 12, 14, also show the lousewort plants in this habitat. Figure 8 shows the type of habitat and a general view of the right river bank directly across the river from Population Area I N.B. (fig. 7). This is search site 6 and here the bank was searched for one mile and no louseworts were found. The habitat was judged unsuitable for the plant.

B- Habitat, Population Area II N.B.

The general habitat and situation of the plants here is quite different from those in Population Area I or Population Area III. It is a much more open area and most of the lousewort plants are growing on pieces, lumps or blocks

of earth slumped or eroded from the edge of the forested bank by the water and carried out some distance toward the bed of the river. Such eroding action usually takes place during spring floods but here it could take place at anytime during the year when the dam gates at Grand Falls are fully opened. As the blocks were once situated at the edge of the forested hillside where the plants would receive shade for a good part of the day they now are exposed to a much more open situation with more sunlight per day. The plants tolerate this change in their situation and in fact are increasing in numbers. Some of the blocks are well eroded while others appear to be freshly separated from the river bank.

The soil here is much more gravelly and there are numerous small boulders strewn about.

The hillside forest here belongs to the Sugar Maple-Ash Zone of the St. John Ecoregion of Loucks (1962) and is generally called The St. John River Forest (Stirrett 1978A, App. 8). It is characterized by the presence of Butternut, White Ash, Ironwood and Basswood in association with Sugar Maple and Beech. Red Spruce and Eastern Hemlock are found sparingly. Elm, White Spruce and Balsam Fir are common.

The Butternut, which is conspicuous in this forest, does not grow in northern Maine and in New Brunswick; it is found only in the St. John River Valley south of Grand Falls.

The nature of the habitat is shown in figure 9 and figures 13, 15, 16 show lousewort plants in situ in the area.

The same plants as listed under Population Area I are here also found growing within 10 feet diameter of lousewort plants. Equisetum and mosses are very prevalent here - as are liverworts. Other plants not found in Population Area I but noticed here are:- Parnassia sp., Lobelia kalmii, Melilotus alba, Chelona glabra and Allium schoenoprasum.

C- Habitat, Population Area III N.B.

Here the habitat is strikingly different from that found in Area I and II. The plants are growing on the east bank of a railway cut through a hill and are situated at least one-quarter of a mile from either the St. John or the Aroostook Rivers. The soil is a sandy-gravel, well drained but moist and probably drier than in the other two areas. The plants are shaded most of the day and probably receive only about two hours of sunshine each day.

The forest on top of a forty foot hill, and in the area, is the St. John River forest similar to that in which Population Area II is situated.

The small plants growing with the lousewort are similar to those growing at the other two population areas. Although here they are subject to cutting and spraying by the railroad crews in an effort to keep the hillside clear. Equisetum and mosses are common.

The railroad was built in 1876-77 and taken over by the Canadian Pacific railroad in 1882. Figure 6 is a photograph of the habitat. The plants are growing half-way up the bank immediately under the large pine tree on top of the bank.

(2) DISTRIBUTION OF HABITAT

Suitable habitat is found over long stretches of the St. John River in New Brunswick. It is localized and interrupted by farm lands, forest clearing to the water's edge, gravel pits, road building and other types of construction.

The Aroostook River and the Little River in New Denmark Parish also have suitable habitat along many parts of their banks. A survey of suitable habitat was restricted to the range of the plant as shown in figures 2 and 3, but it is likely that the lousewort could grow successfully outside this area if it were introduced.

(3) TREND IN QUALITY AND RATE OF CHANGE OF HABITAT

A slow but persistent change in the quality of habitat because of reasons listed above. All man-made factors.

(4) PROTECTION OF HABITAT

There is no protection of any kind to the habitat of the lousewort at the present time.

The greatest threat to the habitat of two of the three population areas in the province is the intention of

the New Brunswick Electric Power Commission to build a new dam and power facilities at Grand Falls. Both developments would raise the water level and flood existing habitat and plants, except at Population Area III on the railroad cut.

The proposed future developments are described by Henderson et al. (1975, App. 26), Sigvaldason (1975) and in two newspaper releases Anon. (1977C, App. 27) and Anon. (1978, App. 28).

The redevelopment at Grand Falls would raise the water at Grand Falls and Van Buren, Me., about 20 feet.

The Morrell dam is proposed for a site 1.5 miles upstream from the mouth of Aroostook River and would raise water between it and Grand Falls.

The proposed Dickey-Lincoln dam in Maine would give more and therefore higher regulated water levels downstream to at least Grand Falls.

These projects are perhaps five years in the future but planning has already begun.

(5) DEGREE OF SPECIALIZATION

Except in Population Area III N.B., the other habitats consist of a narrow terrace below a wooded hill and near the water edge. Here their similarity ends and one might conclude there is no typical or critical habitat required by the plant. The fact that it can thrive on large pieces of

earth broken away from their typical situation (Population Area II) below the hillside forest, and the fact that another population is living on the bank of a railroad cut away from the river (Population Area III) shows that the plant must be adapted to a wide variety of situations.

Macior (pers. comm., App. 8B) thinks that the lousewort could live in "whatever habitats the boreal forest provides. These would be open areas with enough sunlight and moisture."

#### F. GENERAL BIOLOGY

##### (1) DESCRIPTION OF SPECIES, CLASSIFICATION, HISTORY

A- Family - Scrophulariaceae, Figwort family

B- Species - Pedicularis furbishiae S. Wats.

The species was named by Sereno Watson of Harvard University, on the basis of a specimen from Van Buren, Maine (1882, App. 11). The species was named after the collector, Miss Kate Furbish, an amateur botanist and plant painter who made an extensive collecting trip in the area in 1880 (Furbish 1881, App. 10).

Asa Gray (1888, App. 12) gave a fuller description in 1888. He placed the species next to P. lanceolata but indicated it was closer allied to the Siberian species, P. striata.



It is interesting to note that two specimens had been collected at Grand Falls, N.B., in 1878 and 1879 before Miss Furbish had visited Van Buren and made her discovery. The Canadian specimens had been named P. canadensis and their true identity was not realized until years later.

C- Morphology

The plant is a terrestrial perennial herb averaging about 2.5 feet tall. The stem is simple or with a few branches on upper portion of some stems. One of its main distinguishing characters is the deeply incised pinnae especially on the lower leaves. The plant form is illustrated in figures 13, 14, 15 and the inflorescence in figure 4.

D- Validity of Species

Since Macior's recent work (1977, App. 3, 1978, App. 6 and 1980) the plant, if there were any doubt before, is considered a distinct and valid species. Macior (pers. comm., App. 8 to 8C) has proved beyond doubt that the species is different from "any other on the basis of its floral structure and mode of pollination. I don't know of any other species in eastern North America to which it might be related. Its habitat preference, blooming phenology and pollination syndrome are sufficiently distinct from other Pedicularis species". Macior also adds that "Vegetatively P. furbishiae resembles P. lanceolata which blooms in August-October in the east, but the floral

mechanism is entirely different except for color. The possibility that P. furbishiae is a neararctic isolate of P. scryptum - carolinianum described by Li should be investigated. The floral morphology fits perfectly."

It is interesting to know that there are no other species of Pedicularis growing within about 250 miles of the range of P. furbishiae on the upper St. John River. P. canadensis occurs sparingly in southern New Brunswick and more frequently in the southern half of Maine. P. lanceolata does not occur in either Maine or New Brunswick.

#### E- Origin - Relict of Glaciation or Recent?

There are still arguments as to whether the lousewort survived the glacial period and just how it arrived in its present location and habitat. How it evolved and from what ancestors, is a related question still unsolved. Fernald (1940) thought the presence of the plant indicated "that life on the upper St. John River was not wholly destroyed by Pleistocene ice." As will be shown below, the area was certainly glaciated (Prest 1969, pers. comm., App. 24; Lee, pers. comm., App. 23) but there were nunataks in the glaciers in some areas in the Gaspé Peninsula to the north and not very far from the present population of the lousewort. The species, however, has never been found in Quebec, including the Gaspé.

Boivin (pers. comm., App. 25) believes the lousewort "must have survived the glaciation somewhere since it is absent from south of the terminal moraine. It must have originally occurred only north of it." He adds - "Furthermore, the sea level was lower by some 300 feet and the coastal plain north of Cape Cod must have been largely above sea level providing habitats for the lousewort and other interesting plants."

Stebbins (1980) included P. furbishiae as among those rare species - "that on the basis of distributional evidence must be regarded as neither ancient nor very recent." He went on to point out that "There is little correlation between rarity or localized distributional patterns and chronological age!" Polunin (1960) also noted that local endemics may be confined to very limited areas because they are of recent origin or because of their antiquity and in this case are a last remnant probably because they require specialized habitat conditions.

(2) REPRODUCTION

A- Sexuality

The research of Macior (1980, App. 8) and the author's observations indicate that the species reproduces exclusively by seeds.

#### B- Flowering Period

In New Brunswick the flowering period begins about July 10 and extends to about August 30. Ripe seeds may be obtained as early as September 1. The season in Maine follows closely the above dates. An enlarged flowering raceme was photographed on August 20 (figure 4).

#### C- Pollination and Pollinators

Macior (1978, App. 6) states that the lousewort is pollinated by workers of the bumblebee species, Bombus vagans, and that the bees are coadapted to the pollen mechanism of the plant both morphologically and by behavior.

#### D- Viability of Seeds and Plants, Growth Potential

Viable seed is produced naturally in sufficient quantity to maintain and possibly increase the size of the present wild population (Macior 1978, App. 6).

In the laboratory Macior found that only about 12 percent of the seeds produced seedlings when grown without a host. When planted with crimson clover (Trifolium incarnatum) the survival rate was 47 percent.

#### E- Parasitism

Nothing was known of the parasitic requirements of Pedicularis furbishiae until Macior started his work on the species in 1977. His reports on the subject are contained in the following publications and papers (1978, App. 3; 1979, App. 7; and 1980, App. 8). He has shown that the species

is an obligate root parasite in the seedling stage but that it is not parasitic as an adult. His original field observations did not show haustorial attachments on adult plants and he was surprised that he could not raise seedlings in the laboratory until he offered a host. He planted lousewort seeds and those of crimson clover together and raised healthy plants until the annual clover died and the lousewort plants followed suit in a short while. He is now searching for a perennial host and for a way to transplant lousewort plants directly from the Dickey dam site. This would overcome the necessity of raising plants in the greenhouse and then transferring them to suitable habitats away from the dam site.

Because the lousewort in Maine is usually associated with the shrub Downy Alder, Alnus crispa var. mollis Fern., Macior is trying to produce seedlings of this plant to determine if it is a host. In New Brunswick the lousewort and the Alder are not always associated with each other and in Population Area III N.B. there is no Alder anywhere near the lousewort plants on the railway bank.

The most consistent associates of the lousewort, growing within a circle 10 feet in diameter surrounding the lousewort plants, are mosses and Equisetum sp. Equisetum should be tried as a host plant because it is perennial and no doubt would be easy to grow in the laboratory.

F- Insect and other Animal Associates

Macior (1979, App. 7) reported that in 1977 spittle bugs infested about 90 percent of the immature inflorescences and these did not produce a full complement of seed. The same situation occurred in New Brunswick during 1977 but the infestations were not as severe during 1978 and 1979. Figure 12 shows a spittle bug infested plant.

Other predators noticed feeding on lousewort plants were several types of lepidopterous larvae and field slugs.

G- Distribution of Seeds

The ripe seeds drop to earth beneath the parent plant or close to it. Here they are trapped in the conspicuous covering of mosses, Equisetum and other small plants among which they have fallen. This cover also helps to keep the seeds from being washed away by the water of spring freshets or by that of floods caused by opening the gates at the hydro-electric dams. Each mature plant therefore tends to form a colony around itself (figures 15 and 16).

If seeds are dislodged by water currents and carried away they would be carried down river with the current. Plants also, if dislodged, would take the same route. The flow of the river toward the sea carrying seeds and plants with it might explain why no lousewort plants have been found on any of the many tributaries of the St. John River, except

the Aroostook. This speculation does not explain why the lousewort has not been able to colonize the river bank below Andover, N.B.

#### H- Recolonization of Destroyed Habitat

It is not known how the lousewort repopulated the river bank between Grand Falls, N.B., and St. Basile, N.B., after the original river bank was destroyed at the time the dam at Grand Falls was put in operation in 1928. This headpond flooded the area of Population Area I N.B., Miss Furbish's patch at Van Buren in which she collected in 1880 and the area of the two present populations near Van Buren. The water at Grand Falls and Van Buren was raised at least 5 feet and almost certainly killed plants growing on the bank at the water's edge at that time.

### (3) HABITAT REQUIREMENTS

#### A- Soil - Physical and Chemical Characteristics

No analysis of soil samples has been done in New Brunswick. We know from the character of the bedrock the soils are calcareous in nature and we know also from the kinds of plants growing with the lousewort that the soil has an acid reaction. The type of soil varies widely from sand to gravel and other mixtures. The soils studied by Macior in Maine (1977, App. 3) have a pH of 5.2 to 7.0; they are poor in nitrogen and very high in calcium.

B- Excretion of Minerals by Pedicularis furbishiae

Stirrett (1977) noticed that many of the lousewort's leaves carried a white deposit along the edges of the pinnae. Figure 11 is an enlarged photograph of a leaf showing the dots.

The nature of the deposit has not been as yet determined. It is thought the plant may be getting rid of an excess of calcium which is very high in the soils in which it grows. Specimens collected by Stirrett at Grand Falls, N.B., in 1943 showed abundant secretions. Secretions were not as numerous on leaves during the seasons of 1978 and 1979.

C- Climate

Differences in the effect of climate within the range of the lousewort are probably not great. North of Grand Falls the climate is very similar to that of most of the upper river. Below Grand Falls, however, there are very marked mean annual temperature differences over short distances.

The increased temperature south of Grand Falls may explain the absence of lousewort on the river bank below Andover.

D- Elevation

The total fall in elevation between Little St. John Lake, Maine, and tidewater at St. John is about 1,580 feet. The river slopes gradually about 8 feet per mile near headwaters to 3 feet per mile in vicinity of Grand Falls, N.B. The elevation at Dickey, Maine, is about 600 feet above mean sea level and at Grand Falls, N.B. it is just above 400 feet.



These elevation differences probably have no influence on the lousewort.

E- Nutrient Level

Nothing known.

F- Moisture

Soil samples taken near plants in Allagash Township, Maine, had a soil moisture that varied from 5.0 to 38.4 percent (Macior 1977, App. 3).

Moisture is probably a critical factor but there are no quantitative data on this point. The species grows in well-drained, moist places.

G- Solar Radiation, Sunlight and Shade

All populations face north or northwest and are shielded by hills. Most of them therefore receive only a short period of sunlight per day in this latitude. Population Area II N.B. is in the most open situation but it, too, is in shade some part of the day.

Solar radiation in the partial shade in which the plants grow varies from a maximum of  $1.04 \text{ cal./Cm}^2/\text{Min.}$  on July 18, to a minimum on July 30 of  $0.15 \text{ cal./Cm}^2/\text{Min.}$  (Macior 1977, App. 3).

H- Successional Stage

In New Brunswick, all populations are growing below a hill bearing either of the two climax forests already described under D. Population. In Maine the forests are different and are described as Spruce-Fir Type.

(4) SENSITIVITY

A- Fire

Unknown. Population Area III N.B. has experienced fire on the hillside along the railway in recent years and the lousewort is still there; or could it have become established since the fires?

B- Fluctuating Water Levels

The plants in Population Areas I and II N.B. are under water each year during the spring flood season. The plants in Population Area II N.B. are also flooded perhaps several times during the year when it is necessary to lower the level of the headpond at Grand Falls.

Such flooding does not seem to affect the plants unless the bank is eroded and large blocks of their habitat are carried away by the water. If the blocks get stranded nearby the plants continue to grow on them. No one has studied the number of plants lost each year by flooding.

C- Severe Winter

The effect of a severe winter is unknown. It is thought likely to have very little, if any, effect. The plants produce winter terminal buds on the crown. There is in most cases an ample covering of mosses, lichens, Equisetum and other small plants to hold the early snow and the winter snow fall is fairly heavy so that the plants are well insulated. They are also, of course, protected from wind by the hills at the foot of which they grow.

D- Weed Control Sprays

The plants in Population Area III N.B. have been sprayed with a weed killer by the railroad personnel. The date of the last spraying is believed to be in 1976. The chemical used is unknown. The effect on the lousewort is unknown except that they apparently survived as they are still living on the site.

E- Other Human Disturbance

The water between Grand Falls and Van Buren has been heavily polluted since 1917 when the Fraser pulp mill at Edmundston, N.B., followed by their paper mill at Madawaska, Maine, began pouring all waste materials from their mills into the St. John River.

Although pollution control measures are now being adopted, as late as 1974 the water was still heavily polluted with visible wood pulp and other wastes (W.W. Watt, Dept. Environment, Canada, St. John River Basin Board Report 15B 1972).

The effect that this has had on lousewort populations is unknown.

F- Response to Change

Unknown. See under Recolonization above.

## G. LIMITING FACTORS TO POPULATION GROWTH

### (1) IN CURRENT POPULATION

The species is not presently declining in number and is experiencing at least a slight increase in population. See under Population Trend above.

### (2) HABITAT LOSS

Undoubtedly, a large amount of habitat has been lost during the last 50 years and, given present trends, it will continue to be lost. There is still, however, ample habitat for the plant but it is doubtful if it can or will be colonized naturally by the plant. There are suitable areas that could be utilized for artificially transplanting the plant.

### (3) ENVIRONMENTAL CONTAMINATION

Garbage dumps, litter, gravel pit operations, forestry practices, all have some effect along the river banks. What their effect on the plant is, no one knows. Where the contamination destroys habitats it is injurious. See above under H- Recolonization.

### (4) SPECIES COMPETITION

Nothing known. Mostly, the plants grow in a crowded situation where many other species of plants are found. Sometimes it is difficult to see the lousewort plants beneath the foliage of other higher growing plants but they are there and seemingly thriving.

(5) NATURAL PREDATION

Nothing known. See spittle bugs above. The lousewort itself is a parasite on other plants in the seedling stage.

H. SPECIAL SIGNIFICANCE OF SPECIES

(1) STATUS IN WORLD - NORTH AMERICA

The plants growing in New Brunswick and Maine represent the world population of the species. If the species is allowed to become extinct all we will have of this interesting and scientifically useful species is 72 dried museum specimens in the various herbariums of the world.

(2) PUBLIC INTEREST

There is no public or official interest in the plant in New Brunswick except that of a few botanists and field naturalists. In Maine and throughout the United States there is a very great interest in the plant and its preservation. Many conservation groups are opposing the building of the Dickey-Lincoln project by the Corps of Engineers - and are demanding that the lousewort be saved. The fact that the plant could be declared an endangered species in spite of powerful opposition shows some measure of interest in the plant. The controversy over saving an endangered species or building a power dam has caused world-wide publicity.

(3) SECURITY OF TAXONOMIC UNIT AND COMMUNITY

The upper St. John River in northern N.B. and northern Maine has always been recognized as a region famous for its unique assemblage of rare plants. The plants of the area have been discussed by Fernald (1940), Hay (1902), Richards (1976, App. 2) and Stirrett (1978, App. 17). These plants include Pedicularis furbishiae, Carex josselynii, Castilleja septentrionalis, Anemone multifida, Oxytropis johannensis, Primula mistassinica, Astragalus blakei, Astragalus alpinus var. brunetianus, Hedysarum alpinum, Tanacetum huronense var. johannense. All are found as far south as Grand Falls except Castilleja and Carex josselynii.

All of these plants would be threatened if the river water was raised or construction took place in the area.

(4) COMMERCIAL EXPLOITATION

No commercial exploitation.

(5) GENE POOL

It is important to preserve the gene pools of all living organisms. We cannot tell how important the plant may be to mankind in the future.

One cannot envision any commercial utilization of the plant but here again the opinion is one of guesswork.

Scientifically, the plant would appear to be very important. Macior (1978) has discovered many important and formerly unknown facts regarding its parasitic nature, and

its symbiotic relationship with its insect pollinator. Its origin and evolution are still puzzles and it would appear a study of the plant would contribute to an understanding of such fields as plant migration, plant geography in general, species relationships and evolution, to mention only a few.

I. RECOMMENDATIONS, PROPOSALS AND MANAGEMENT OPTIONS

(1) OFFICIAL RECOGNITION AND PROTECTION

A- Canada

There should be federal legislation under which the species could be protected. An Endangered Species Act or similar legislation is needed. The protection of the plant is an international problem as well as a local one because it is found on the international section of the upper St. John River. In addition, it is also found within the Province of New Brunswick and the State of Maine.

B- New Brunswick

The species should be brought immediately under the provisions of the Endangered Species Act which is already in force.

The habitat of the lousewort and the other unique plants making up the interesting plant communities of the upper St. John River should also be a candidate for inclusion under the N.B. Ecological Reserves Act or some other legislation devised to provide protection and preservation.

(2) CREATION OF AN INTERNATIONAL WILDFLOWER PARK

The protection and the preservation of the unique assemblage of plants found on the upper St. John River, including the lousewort, could be accomplished by the creation of an international park or nature preserve by the United States and Canada jointly, with the State of Maine and the Province of New Brunswick cooperating.

The actual park area would have to be determined after adequate consideration and field surveys. It could be located on the international section of the river above Grand Falls, N.B., and embracing the areas on both sides of the river at Van Buren, Maine, and St. Leonard, N.B. Here, bridges across the river are available both at Grand Falls and Van Buren.

Another suitable section of river still in the international section could be the area embracing St. Hilaire in New Brunswick and Fort Kent in Maine. This area might be preferred as the plant communities here include Josselyn's Sedge and the Northern Paintbrush (Castilleja).

(3) PURCHASE OF LAND

It might be feasible for the governments or private agencies to purchase land on which lousewort is at present growing and thus protect the plants.

In the United States the Nature Conservancy has indicated their interest in such a plan.



(4) TRANSPLANT PROGRAM

If Macior and his co-workers are successful in rearing lousewort stock that can be transplanted into wild habitat, it would be possible to create a similar program for New Brunswick, either as a cooperative venture with the Americans or on our own initiative. Plants could be introduced into the present population areas of the plant or new suitable habitat could be planted.

(5) PUBLIC INFORMATION CAMPAIGN

The public must be informed of the presence of the lousewort and the need to save it from extinction. An organized campaign is the only way to accomplish such a task.

(6) RESEARCH AND SURVEYS

It is thought that the importance of the lousewort and its preservation are problems that should receive official recognition by the government departments that are responsible for such matters. Some research and field surveys are necessary to monitor the present lousewort populations. A transplant program should be instituted and this will require technical as well as field skills.

Either the N.B. Department of Natural Resources or the Canadian Wildlife Service should be involved in the study of the lousewort and its preservation.

#### J. EVALUATION

There is no population decline taking place at the present time and in fact, here in New Brunswick it appears to be increasing.

The total population of about 1,100 plants is a small number to represent, as it does, the world population of a species. Management programs might include declaration of endangered status, purchase of habitats and transplanting artificially raised plants to be established in new habitats.

#### K. PROPOSED STATUS

Pedicularis furbishiae S. Wats. should be declared an endangered species in Canada.

It should be placed immediately under the protection of the New Brunswick Endangered Species Act. There should be a national conference convened to plan what actions are necessary, and by whom, to deal with the preservation of the plant and its habitat.

Other recommendations are included under (I) Recommendations and Management Options above.

#### L. ILLUSTRATIONS

Figures 1 to 16 inclusive.

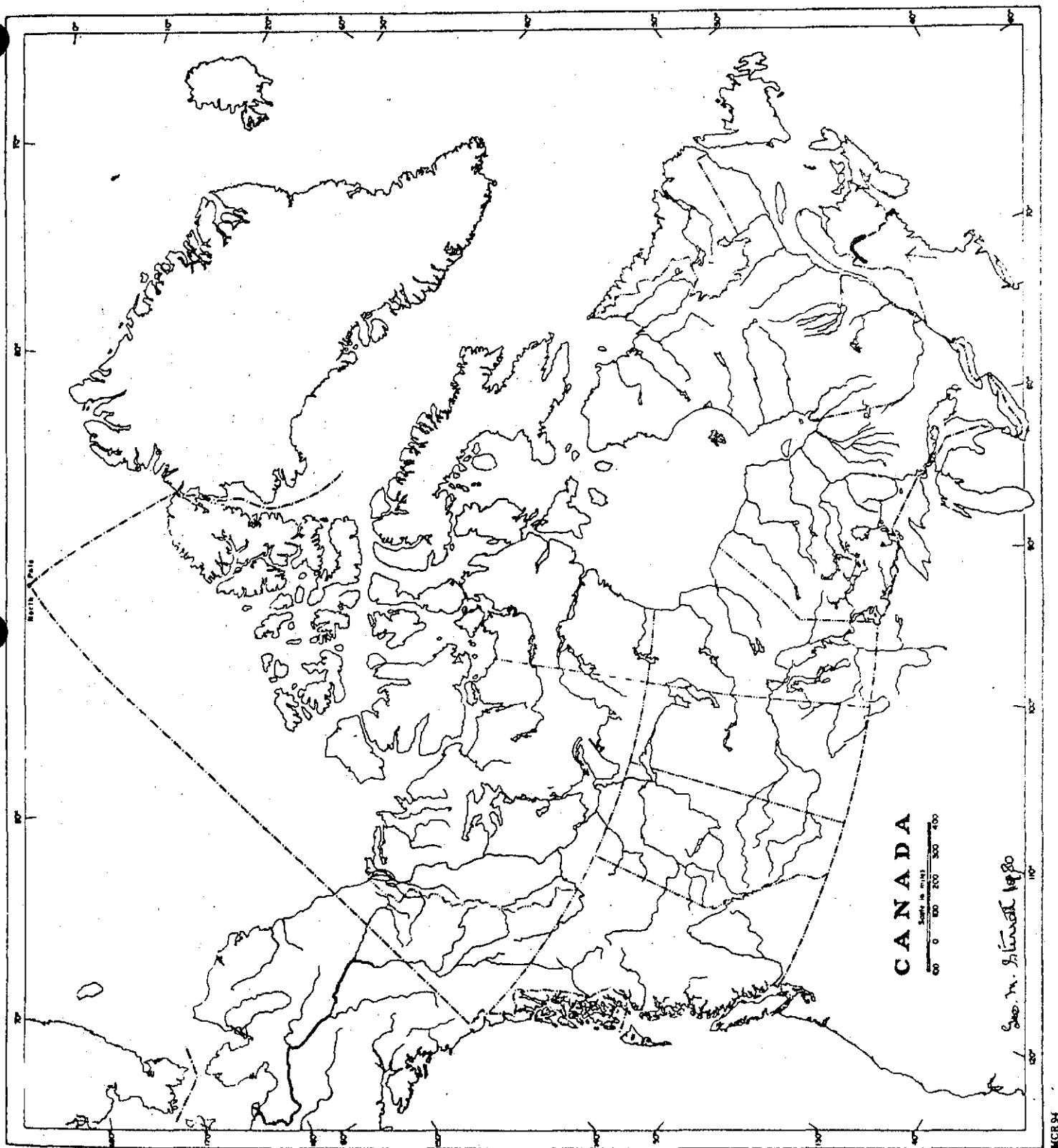


FIG. 1. *PEDICULARIS FURBISHIAE* S. WATS. WORLD AND NORTH AMERICAN DISTRIBUTION. THE RED CURVED LINE (BLACK IN PHOTOCOPIES) SHOWS THE LOCATION OF PLANTS GROWING ALONG THE ST. JOHN RIVER IN NEW BRUNSWICK AND MAINE.



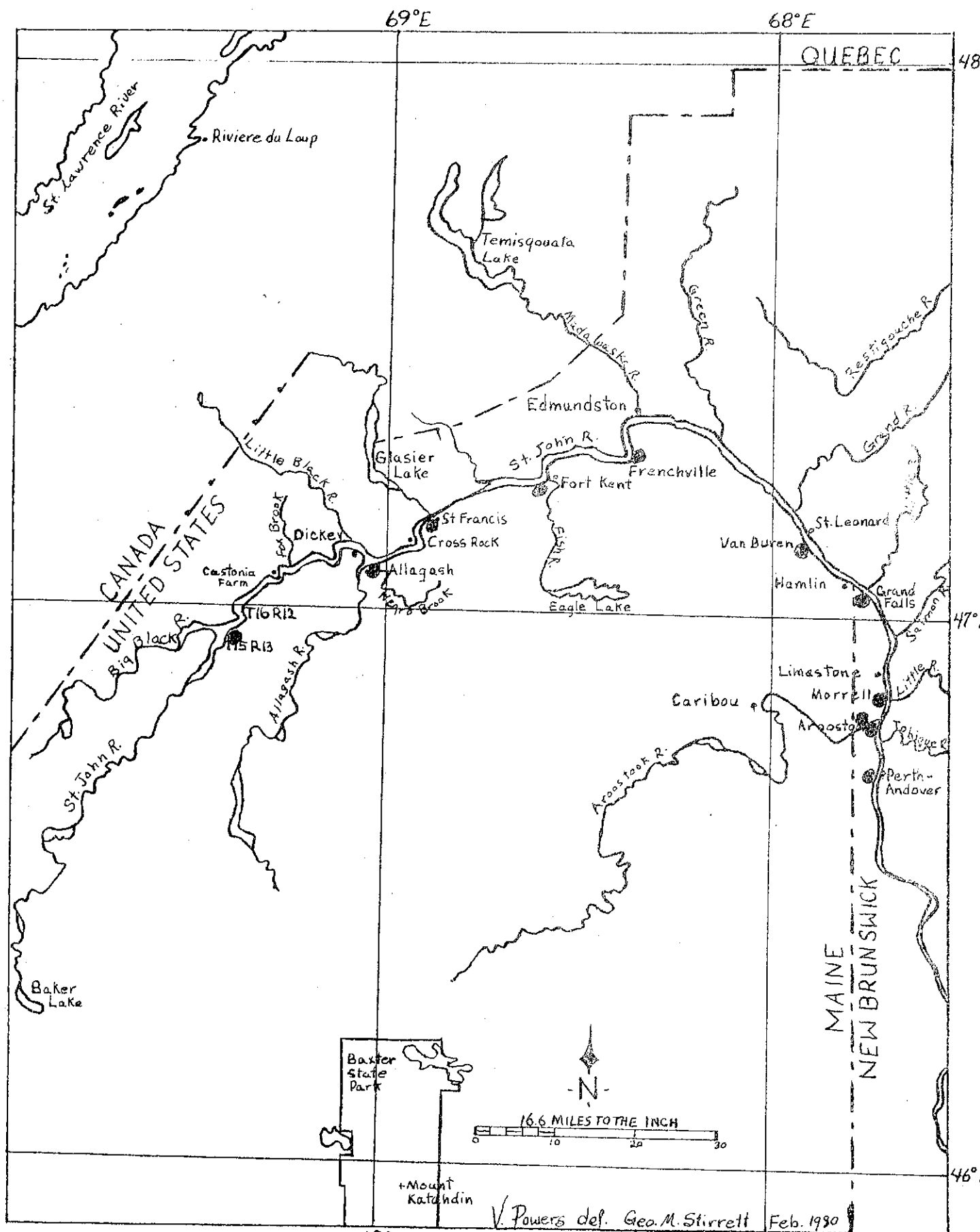


FIG. 3. *PEDICULARIS FURBISHIAE* S. WATS. DISTRIBUTION AND RANGE IN NEW BRUNSWICK AND MAINE ACCORDING TO KNOWN HERBARIUM SPECIMENS COLLECTED BETWEEN 1878-1946. EACH RED DOT (BLACK IN PHOTOCOPIES) REPRESENTS FROM 1 TO 19 PLANTS.

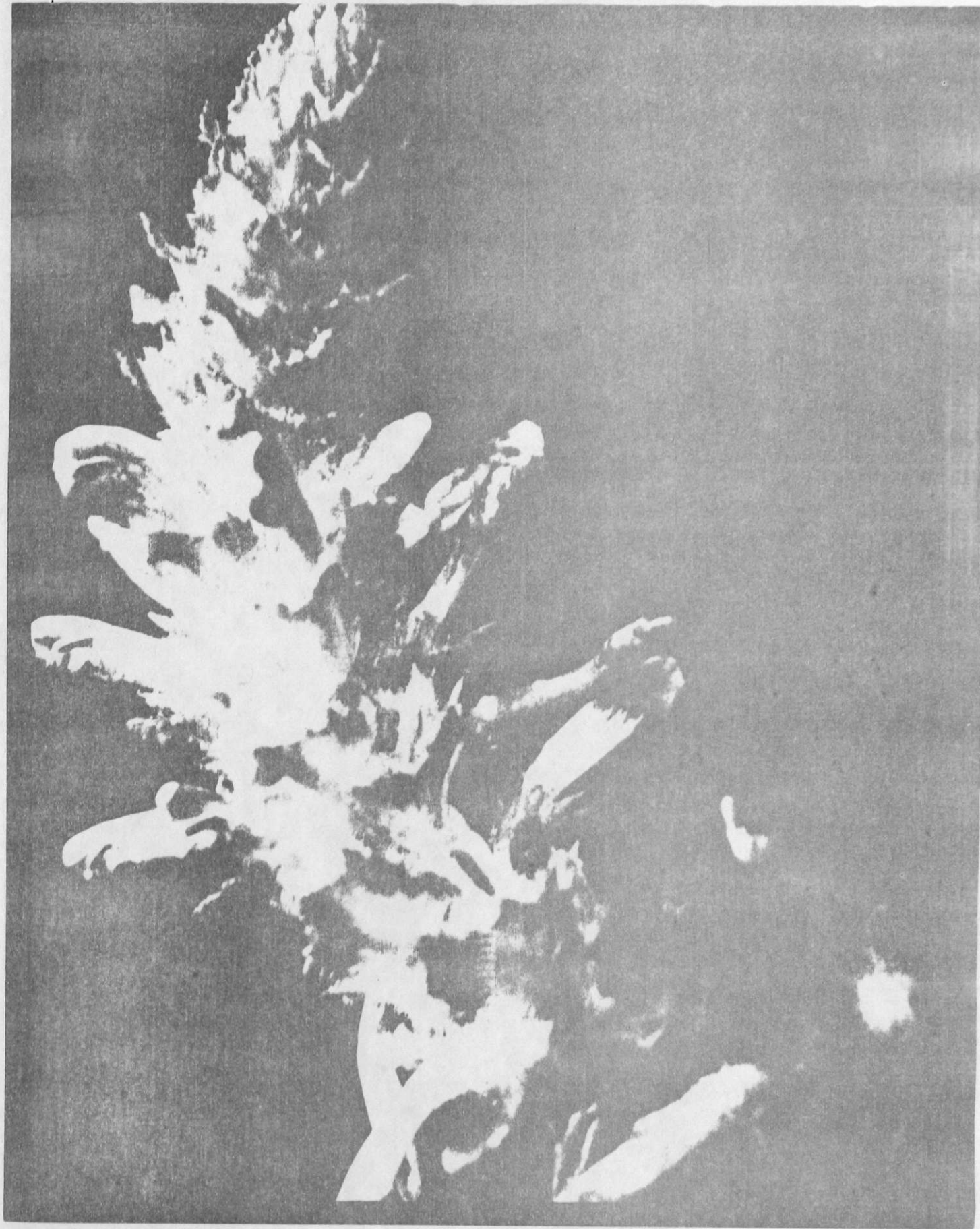


Fig.4. PEDICULARIS FURBISHIAE FLOWERING RACEME. POPULATION AREA II  
N.B. AUGUST 20, 1977. PHOTO, F.W. TRIBE. KODACHROME PRINT.

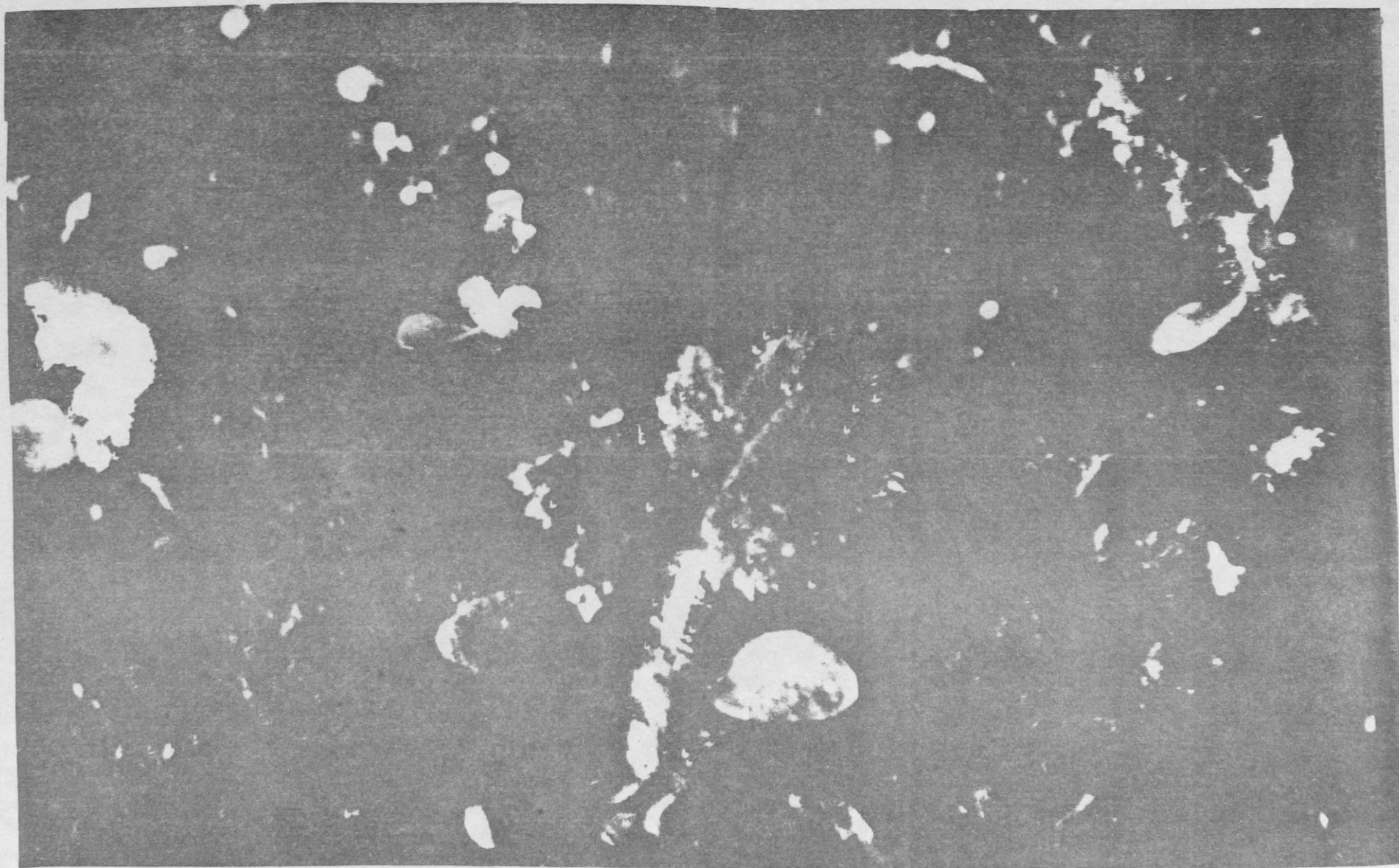


Fig. 5. *PEDICULARIS FURBISHIAE* - YOUNG PLANTS GROWN IN ORDINARY GARDEN SOIL. PLANTED MARCH 1978. PHOTO JULY 1978. THE PLANTS DIED LATER IN SEASON. GROWN BY F. W. TRIBE. PHOTO BY F.W. TRIBE. KODACHROME PRINT.



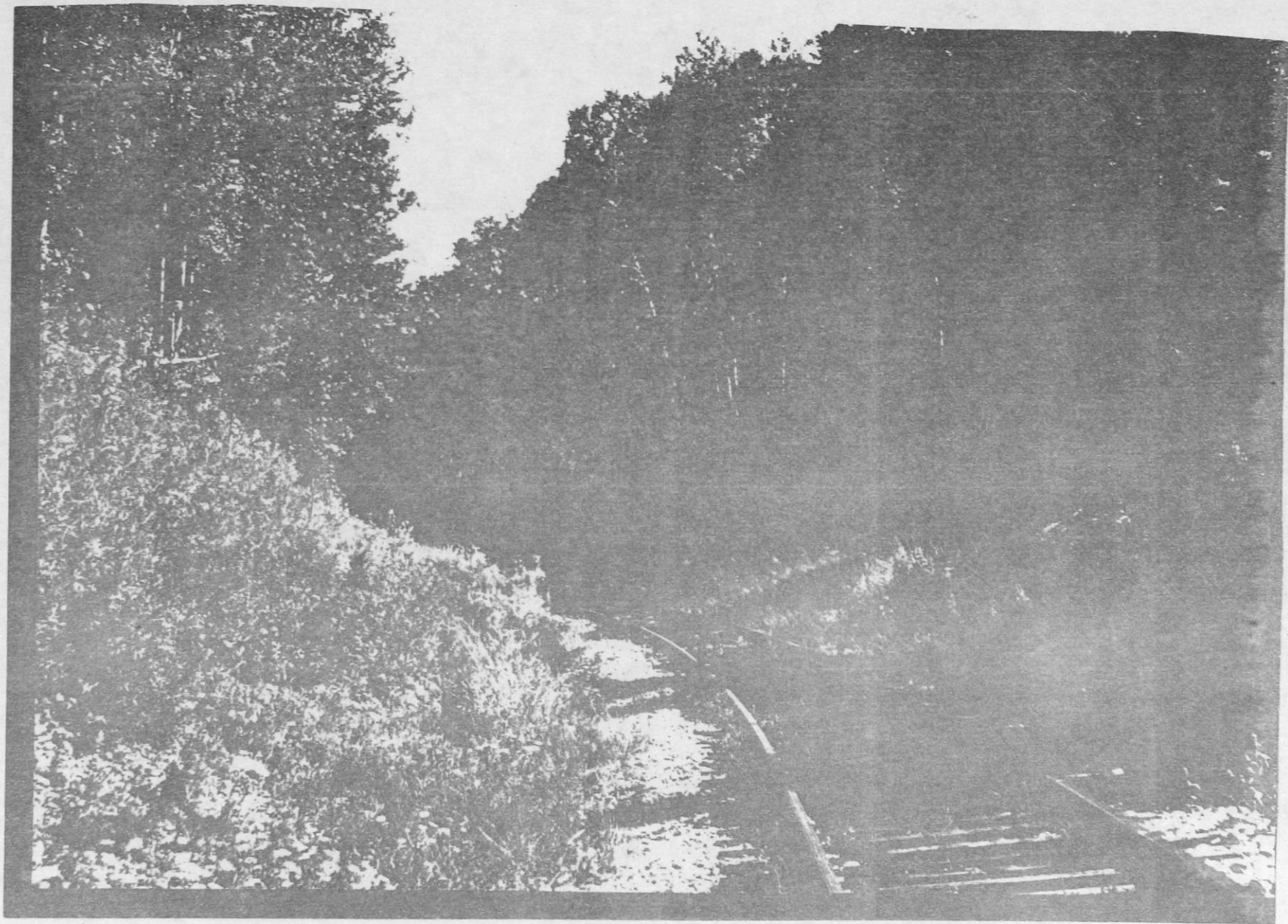


FIG. 6. *PEDICULARIS FURBISHIAE* HABITAT, POPULATION AREA III N.B., AUGUST 7, 1978.  
PHOTO F. W. TRIBE. KODACHROME PRINT



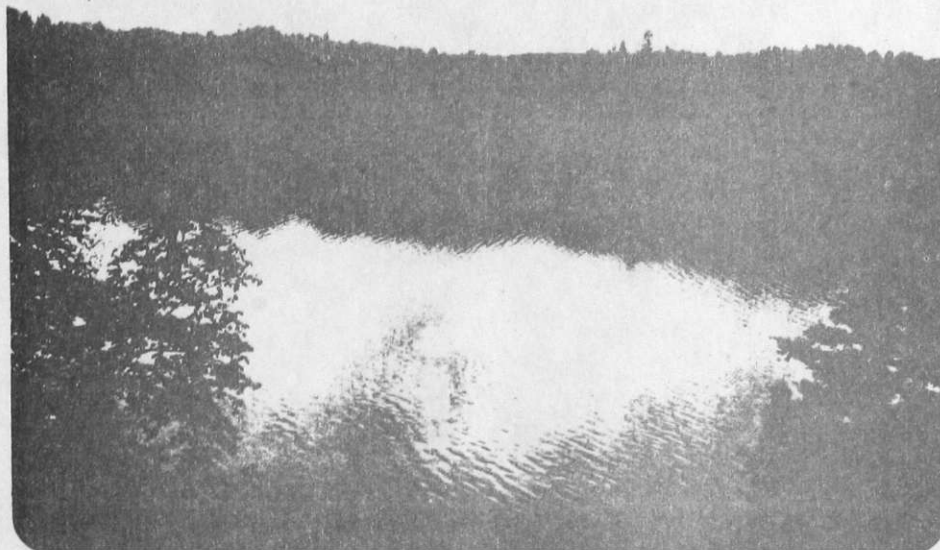


FIG. 7. *PEDICULARIS FURBISHIAE*. HABITAT, LEFT BANK ST. JOHN RIVER. POPULATION AREA I N.B. PLANTS FOUND HERE. PHOTO GEO. M. STIRRETT. JULY 21, 1977. KODACOLOR PRINT.

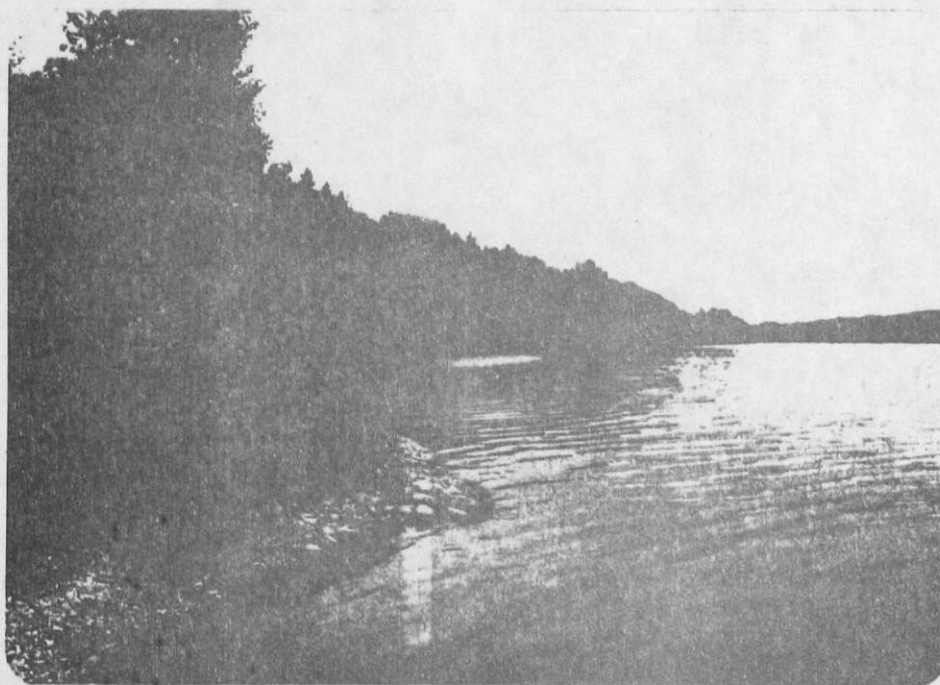


FIG. 8. *PEDICULARIS FURBISHIAE*. HABITAT, RIGHT BANK ST. JOHN RIVER N.B. SEARCH SITE 6. NO PLANTS FOUND. JUDGED UNSUITABLE HABITAT. PHOTO GEO. M. STIRRETT. JULY 21, 1977. KODACOLOR PRINT.



FIG. 9. *PEDICULARIS FURBISHIAE*. HABITAT, RIGHT BANK ST. JOHN RIVER. PLANTS FOUND HERE. STATION 8 SEARCH SITE 38. POPULATION AREA II N.B. PHOTO GEO. M. STIRRETT AUGUST 20, 1977. KODACHROME PRINT.



FIG. 10. *PEDICULARIS FURBISHIAE*. PLANTS ON EDGE ST. JOHN RIVER N.B. POPULATION AREA I SEARCH SITE 1. STATION 4. JULY 20, 1977. PHOTO GEO. M. STIRRETT. KODACHROME PRINT.

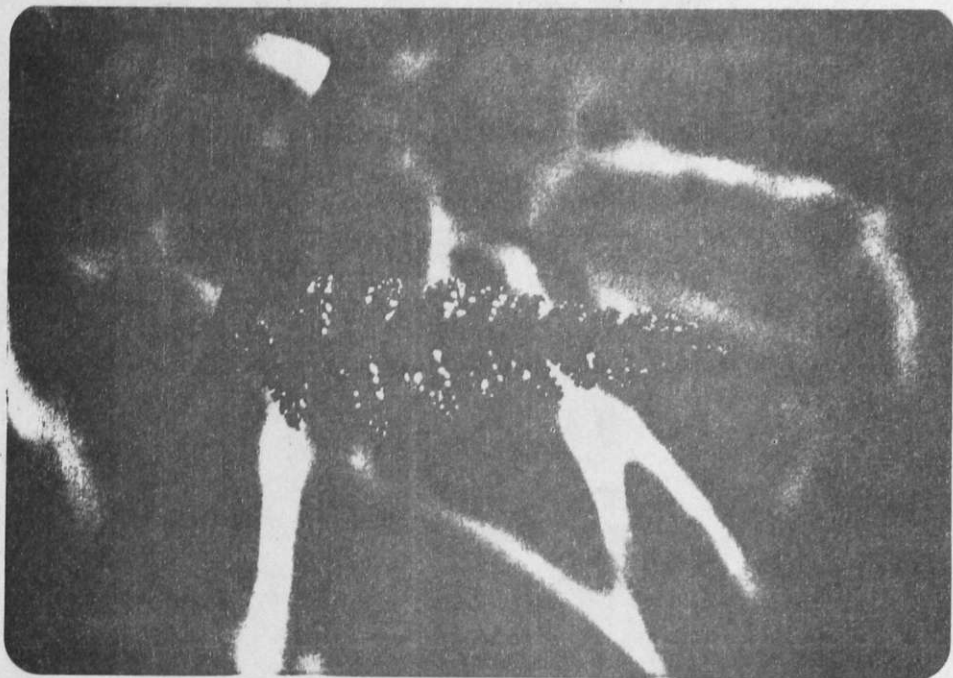


FIG. 11. *PEDICULARIS FURBISHIAE*. UPPER LEAF SHOWING WHITE EXCRETION DEPOSIT ON EDGES OF PINNAE. POPULATION AREA II N.B. STATION 4. SEARCH SITE 38. AUGUST 20, 1977. PHOTO F.W. TRIBE. KODACHROME PRINT.



FIG. 12. *PEDICULARIS FURBISHIAE*. PLANTS INFESTED WITH SPITTLE BUGS (CERCOPID) POPULATION AREA I N.B. STATION 14, SEARCH SITE 1. JULY 11, 1977. PHOTO GEO. M. STIRRETT. KODACOLOR PRINT.



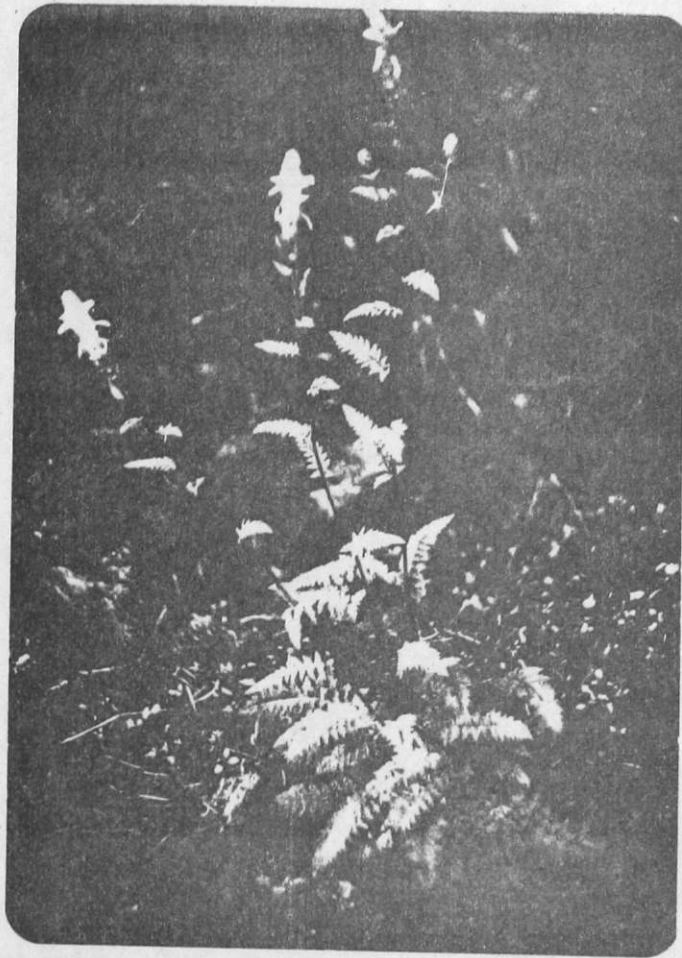


FIG. 13. *PEDICULARIS FURBISHIAE*. MATURE  
FLOWERING PLANT. POPULATION AREA  
II N.B. JULY 30, 1979. PHOTO  
GEO. M. STIRRETT. KODACHROME  
PRINT.



FIG. 14. *PEDICULARIS FURBISHIAE*. FLOWERING  
PLANT WITH PREVIOUS YEARS SEED PODS.  
POPULATION AREA I N.B. STATION 7.  
SEARCH SITE 1. AUGUST 4, 1977.  
PHOTO GEO. M. STIRRETT. KODACHROME  
PRINT.



FIG. 15. *PEDICULARIS FURBISHIAE*. A COLONY OF VARIOUS AGED PLANTS, POPULATION AREA II N.B. STATION 6. SEARCH SITE 38. JULY 30, 1979. PHOTO GEO. M. STIRRETT. KODACHROME PRINT.

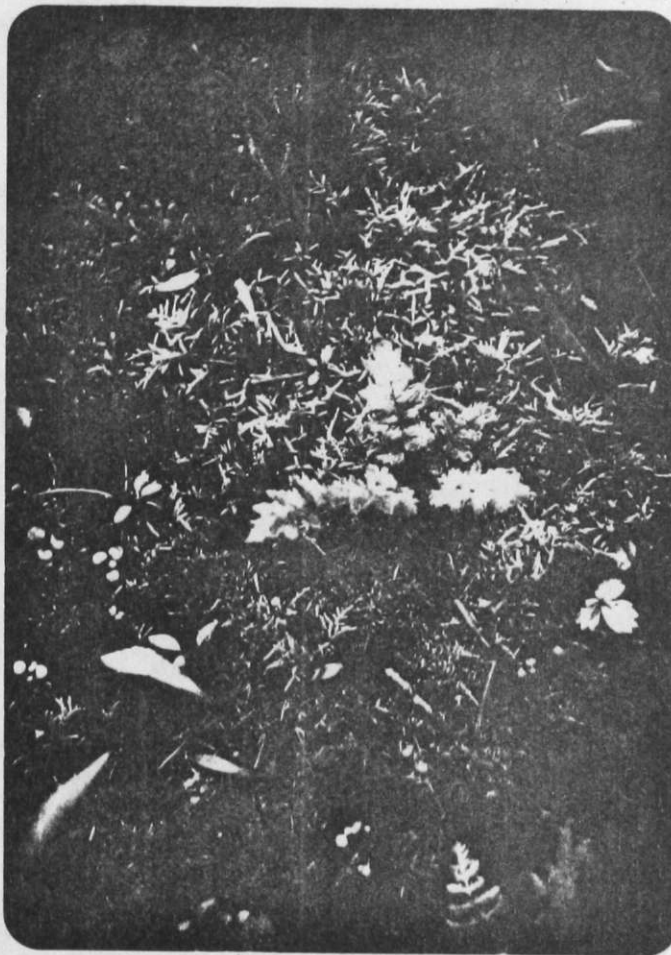


FIG. 16. *PEDICULARIS FURBISHIAE*. YOUNG PLANT GROWING IN A BED OF THE MOSS *PLEUROZIUM SCHREBERI*. POPULATION AREA II N.B. STATION 6. SEARCH SITE 38. JULY 30, 1979. PHOTO GEO. M. STIRRETT. KODACHROME PRINT.

### M. ACKNOWLEDGEMENTS

A large number of persons have given me indirect help in bringing together this status report. Only a few can be recognized here.

Mr. Richard W. Dyer, Endangered Species Botanist, U.S. Fish and Wildlife Service, Newton Corner, Mass., has been of great help by keeping me informed of progress in the problems relating to the lousewort in the United States and in sending copies of the various papers emanating from the scientists employed by the U.S. Corps of Engineers on lousewort investigations.

Dr. L. W. Macior, Professor of Biology, Akron University, Akron, Ohio has corresponded with me on lousewort problems since 1978 and has kept me informed on many of his research activities in connection with the plant.

Dr. B. Boivin, Plant Research Institute, Canada, Department of Agriculture, Ottawa, has through the years, but especially since 1971, been very patient and thorough in answering my questions on plants of one sort or another. Many questions have referred to the lousewort.

Dr. W. J. Cody, Curator, Vascular Plant, Herbarium, Research Branch, Agriculture Canada, Ottawa, has also always been patient with my botanical questions to him.

Mr. Fred W. Tribe of Andover, N.B. helped me make the river bank surveys in 1977 to discover the lousewort and we continue to enjoy field trips together when they can be arranged. Mr.

Tribe has given his permission to use his photographs for figures 4, 5, 6, and 11.

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Note: The app. designation followed by a number indicates that a copy of the reference so marked will be found in the Appendix attached to this report, under the number indicated.

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- 1977D. Report on Investigations of the Flora of Northern Maine and Northern New Brunswick with particular Reference to Pedicularis furbishiae and Other Rare Plants. U.S. Dept. Army Corps of Engineers, Waltham, Mass. Sept. 7. 61 pp. Illustrated App. 1.

In Three Parts:

- Part I a History of Field Botany in the Area - - - 1.  
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Susan C. Gawler.

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Watson, Sereno.

1882. Contributions to American Botany II Description of New Species of Plants. Chiefly from our Western Territories. Proceed. Amer. Academy of Arts and Sciences. Whole Series XVII. Boston, Mass. App. 11. (Original description of Pedicularis furbishiae is on page 375).

## O. SOURCES OF ILLUSTRATIVE MATERIALS

### (1) PHOTOGRAPHS

In addition to myself the following are known to have taken photographs of the lousewort: -

Dr. W. J. Cody, Herbarium, Research Branch,

Agriculture Canada, Ottawa, Ontario.

Mr. R. D. Muir, 44 Queensline Drive,

Ottawa, Ontario. K2H 7J2

Dr. Charles D. Richards, Professor of Botany,

University of Maine, Orono, Maine.

Mr. Fred W. Tribe, Andover, New Brunswick.

In addition there must be a pool of good photographs at:

a) Endangered Species Section, U.S. Fish and Wildlife Service, Newton Corner, Mass.

b) U.S. Corps Engineers, Waltham, Mass.

### (2) PAINTINGS AND DRAWINGS

The only source known is the Library, Bowdoin College, Brunswick, Maine. This library has Miss Furbish's paintings of over a thousand wild flowers of Maine, including that of the lousewort done in 1880. Cole (1977) used colored illustrations of a few of the plants in this collection in his paper including that of the lousewort.



P. APPENDIX

A list of documents and papers copied and supplied in the appendix is given below. This is thought necessary because the appendix is voluminous and the documents in it will not likely be photocopied when copies of the report are made for distribution, and this list will be the only means a reader of the report will have of knowing that the extensive appendix is available if items are needed. The Appendix proper is bound separately.

The appendix items are marked in the Reference - Bibliography of the report by the designation App. followed by a number which corresponds to the number of the item in the appendix and this list. Just enough information is given here to identify the publication. Complete details for each will be found in the list of references under the name of the author.

The number of each item is marked in heavy black pencil within a circle.

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1977D. Report on Investigations of the Flora of Northern Maine and Northern New Brunswick. U.S. Army Corps Engineers, Waltham, Mass.

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3. Macior.  
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4. Richards.  
1977A. Report on Survey of St. John River, Maine and some major tributaries for Furbish's Lousewort and other Rare Plants. U.S. Dept. Army Corps Engineers, Waltham, Mass.
5. Hinds.  
1977. A Report on Field Reconnaissance for Pedicularis furbishiae and Carex josselynii during summer 1977. U.S. Dept. Army, Corps Engineers, Waltham, Mass.
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- 8A - 8C. Stirrett.  
1978A. Correspondence Stirrett with Macior on Furbish's Lousewort.

9. U. S. Fish and Wildlife Service  
1980. Outline of work and surveys, Maine and New Brunswick  
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10. Furbish.  
1881. A Botanist's Trip to the "Aroostook".
11. Watson.  
1882. Description of New Species - Pedicularis furbishiae.
12. Gray.  
1888. Description of Pedicularis furbishiae.
13. Stirrett.  
1973. The St. John River Valley. Its Natural Features  
and Use. Protection and survey for Pedicularis  
furbishiae.
14. DeMerchant.  
1977. Rare N.B. Plant "Found" Again.
15. Banville.  
1977. N.B. discovers Lousewort 80 miles down river.
16. Anon.  
1977G. More Louseworts found in New Brunswick.
17. Stirrett.  
1978. Plants of Falls and Gorge - Grand Falls, N.B.  
including history of Pedicularis furbishiae in  
area.
18. Stirrett.  
1979A. The St. John River Forest and Its Preservation.

19. Stirrett.  
1971. Dickey Dam Impact in N.B. Correspondence Stirrett and St. John River Basin Board Officials.
20. Stirrett.  
1976B. Furbish's Lousewort and Impact of Dickey Dam in N.B. Correspondence Stirrett and Minister of Environment, Canada.
21. Stirrett.  
1979. Dickey Dam impact on Furbish's Lousewort in New Brunswick. Correspondence Stirrett and Choate, Dept. of Environment, New Brunswick.
22. Stirrett.  
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23. Stirrett.  
1977B. Pedicularis furbishiae and Glaciation, Correspondence Stirrett and Lee.
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25. Stirrett.  
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26. Henderson et al.  
1975. A plan for Water Management, St. John River Basin, Fredericton, N.B.

27. Anon.  
1977C. N.B.P.C. Budgets 292 Millions for Dams, etc.
28. Anon.  
1978H. New Brunswick Power not considering new Projects now.
29. Anon.  
1977E. Dickey favored by Corps Engineers.
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31. Swanson.  
1977, 1977A. Dickey-Lincoln Project would change Country, Life, Economy, etc. 2 parts.
32. Anon,  
1977I. Two Views of Dam - A Forester, A Commissioner.
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1974. The Endangered Species Act, N.B. and Regulations  
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- 34A. Anon.  
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1975A. Preservation of Vulnerable Areas in New Brunswick.
35. Anon.  
1976A. Flower Power or Electric Dam. Rare Snapdragon.
36. Anon.  
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37. Anon.  
1977A. Rare Plant may Topple Dickey Dam.
38. Anon.  
1977D. The First Endangered Plants.
39. Anon.  
1977H. In Search of Elusive Lousewort.
40. Anon.  
1978. Stalking the Law - Species Act Endangered.
41. Anon.  
1978A. Determination that Various Plant Taxa are endangered or Threatened. Pedicularis furbishiae declared endangered.
42. Anon.  
1978B. Court Halts Work on Dam. Tellico, Tenn.
43. Anon.  
1978C. Lousewort Defenders see Hope in Court Ruling.
44. Greenwalt.  
1978. Biological Opinion Effect of Dickey Dam on Pedicularis furbishiae.
45. Anon.  
1978E. Endangered Species, Tellico Dam, Tenn.
46. Anon.  
1979. Maine's Dickey-Lincoln Project - Hydro Dam Opponents sense Victory soon.

47. Coburn,  
1924. Kate Furbish, Botanist.
48. Richards.  
1977. Furbish's Lousewort, Endangered Plant of the St.  
John River.
49. Irwin.  
1977. Miss Furbish's Lousewort Must Live.
50. Cole.  
1977. The Woman Behind the Wildflower that Stopped a Dam.

NOTE: There are actually 55 items in Appendix, counting those subnumbered A, B, C. etc.