The vascular flora of raised bogs in southeastern Labrador and its phytogeographic significance[1]

PAUL H. GLASER AND DAVID R. FOSTER[2]
Limnological Research Center, University of Minnesota, Minneapolis, MN, U.S.A. 55455

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The vascular flora of raised bogs in southeastern Labrador is composed of only 26 species, which may be grouped into three different elements: wide-ranging arctic–boreal species, boreal species reaching their northeastern range limits in the forest–tundra transition, and boreal species reaching their range limits along the shores of Lake Melville. The striking impoverishment of the Labrador bog flora relative to those in Newfoundland and other parts of the Gulf of St. Lawrence region is apparently the result of the colder more continental climate of Labrador, which excludes from the regional bog flora the less hardy species of southern affinities.

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La flore vasculaire des tourbières bombées du sud-est du Labrador comprend seulement 26 espèces, qui peuvent être groupées en trois éléments: des espèces arctico-boréales de vaste répartition, des espèces boréales atteignant leur limite d'aire dans la zone de transition de la toundra forestière et des espèces boréales atteignant leur limite d'aire le long des rivages du lac Melville. La pauvreté marquée de la flore des tourbières du Labrador, par rapport à celle des tourbières de Terre-Neuve et des autres parties de la région du golfe du Saint-Laurent, semble résulter du climat plus continental et plus froid du Labrador, ce climat excluant de la flore régionale des tourbières les espèces moins rustiques d'affinité méridionale.

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Southeastern Labrador is covered by extensive forests of black spruce and balsam fir, with local areas of lichen woodland, paper birch, and patterned peatlands adding variability to the landscape (Rowe 1972; Foster 1983). The significant extent of peatlands in this remote region has been noted from both field studies (Tanner 1944; Wenner 1947) and aerial surveys (Hare 1959; Hare and Taylor 1956; Lopoukhine *et al.* 1977), which unfortunately were insufficiently detailed to distinguish between ombrotrophic bog and minerotrophic fen. Thus, Damman (1979) most recently noted the conspicuous absence of data on raised bogs in southeastern Labrador at their northeastern continental limits.

In September 1981 an extensive survey was made of raised bogs in southeastern Labrador between the Eagle and Alexis Rivers and along the shores of Lake Melville (Fig. 1). Raised bogs in this region are distinguished by dome- or plateau-shaped accumulations of peat that rise conspicuously above the adjacent areas of mineral soil. The bog surface is differentiated into concentric, excentric, or reticulate arrangements of pools, wet depressions (hollows), and firm peat ridges (hummocks; kermi). The bog waters have a pH below 4.1 and Ca^{2+} concentrations below 1.3 mg/L. A complete list of all vascular plants observed or collected on these bogs is presented in Table 1, with notes on the relative abundance and habitat preference given for each species. Nomenclature follows Fernald (1970).

The 26 species in Table 1 may be divided into three separate elements on the basis of distribution maps found in Hultén (1958, 1964), Rousseau (1974), and Porsild and Cody (1980). (*i*) Wide-ranging arctic–boreal species that extend to treeline or the northern tip of Labrador include the following (Fig. 2): *Larix laricina, Andromeda glaucophylla, Picea mariana, Chamaedaphne calyculata, Carex pauciflora, Kalmia polifolia, Carex paupercula, Vaccinium angustifolium, Eriophorum spissum, Vaccinium uliginosum, Scirpus cespitosus, Vaccinium vitis-idaea, Drosera rotundifolia, Vaccinium oxycoccos, Rubus chamaemorus, Ledum groenlandicum*, and *Empetrum nigrum*. (*ii*) Boreal species that extend north of Lake Melville into the forest–tundra transition include the following (Fig. 3): *Carex limosa, Gaultheria hispidula*, and *Carex oligosperma*. (*iii*) Boreal species that reach their northeastern limits along the shores of Lake Melville include the following (Fig. 4): *Scheuchzeria palustris, Drosera anglica, Nuphar variegatum, Kalmia angustifolia, Sarracenia purpurea*, and *Eriophorum virginicum*.

The raised bog flora of southeastern Labrador is distinguished by its regional uniformity and striking impoverishment relative to the vascular flora of bogs on the island of Newfoundland and adjacent regions along the Gulf of St. Lawrence. The 26 species listed in Table 1, for example, compare with more than 56 species reported for bogs in Gros Morne National Park, western Newfoundland (Bouchard and Hay 1976), 43 species for bogs in eastern Newfoundland (Wells 1981), and 56 species from a single bog in southern Nova Scotia (Damman and Dowhan 1981). The relative impoverishment of the Labrador bog flora is unexpected because the surface features on Labrador bogs are typical of those found throughout the maritime region of eastern Canada and northern Maine.

An explanation for this phytogeographic pattern may be based on historical, climatic, or genetic factors. Little is known about the genetic composition of these species so it is presently impossible to assess the relationship of genetic variability to geographic range. Edaphic factors may also be excluded from consideration because raised bogs are isolated from groundwater by dense accumulations of peat and, therefore, rely solely on the atmosphere for water and dissolved salts. The bog substrate in Labrador is also differentiated into the same physiognomic units of pools, hollows (mud bottoms, lawns, solid carpets), and hummocks (dwarf shrub communities) that Damman (1979, 1980) identified as typical of maritime bogs in eastern North America.

[1]Limnological Research Center Contribution No. 285.
[2]Present address: Harvard Forest, Petersham, MA, U.S.A. 01366.

FIG. 1. Map of southeastern Labrador and adjacent regions in the Gulf of St. Lawrence region. Localities mentioned in the text are labelled. The sites studied in Labrador are (1) Lake Melville bog, (2) Eagle River 1 (two sites), (3) Eagle River 2 (two sites), (4) Gilbert Lake bog, (5) Reticulate bogs (four sites), and (6) Alexis River bog.

The rich floras of certain famous localities in the Gulf of St. Lawrence region has sometimes been explained by the persistence of species in ice-free nunataks during the Wisconsin glaciation (Fernald 1925). After many decades of disrepute, the famous nunatak hypothesis has recently been resurrected as a result of geological field work on weathering zones. Late Wisconsinan nunataks have now been identified in areas with rich bog floras in eastern (Grant 1977*a*) and western (Grant 1977*b*; Brooks 1977) Newfoundland and other areas along the shores of the Gulf of St. Lawrence (Rogerson 1981). However, Fulton and Hodgson (1979) suggest that part of southeastern Labrador east of the Paradise Moraine was also free of ice during the last glaciation and, therefore, may also have been a refugium for plants during the Wisconsinan period.

The richer flora of maritime bogs in Europe has been explained by various climatic factors affecting the ionic balance of bog waters or influencing the growth of various mire species. The occurrence of typical fen species such as *Schoenus nigricans* on maritime bogs in Ireland, for example, is explained by (*i*) a higher concentration of dissolved salts derived directly from sea spray or indirectly from precipitation (Tansley 1939; Osvald 1949), (*ii*) a lower acidity of maritime bogs caused by reducing conditions produced by permanent waterlogging (Pearsall 1938; Pearsall and Lind 1941), (*iii*) a greater flushing of H^+ and SO_4^{2-} ions because of higher precipitation (Bellamy and Bellamy 1967), and (*iv*) a lower toxicity of elements such as aluminum because of the higher pH of maritime bogs (Sparling 1967). The transition toward more impoverished bog floras in more continental locations has also been explained by (*i*) a restricted release of nutrients because of lower temperatures (Gore 1963) and (*ii*) a greater climatic stress in continental bogs creating differing sensitivity to low nutrient levels (Gorham 1957; Gore 1963; Goodman and Perkins 1968).

TABLE 1. Vascular flora of ombrotrophic bogs in southeastern Labrador

	Habitat preference[a]	Relative abundance[b]
Pinaceae		
Larix laricina	*hu*	*c*
Piceae mariana	*hu*	*c*
Juncaginaceae		
Scheuchzeria palustris var. *americana*	*ho*	*r*
Cyperaceaea		
Carex limosa	*ho*	*o*
Carex oligosperma	*ho*	*o*
Carex pauciflora	*ho*	*r*
Carex paupercula	*ho*	*r*
Eriophorum spissum	*hu,ho*	*c*
Eriophorum virginicum	*hu*	*o*
Scirpus cespitosus var. *callosus*	*hu,ho*	*c*
Nymphaeaceae		
Nuphar variegatum	*p*	*c*
Sarraceniaceae		
Sarracenia purpurea	*hu,ho*	*c*
Droseraceae		
Drosera anglica	*ho*	*r*
Drosera rotundifolia	*hu*	*c*
Rosaceae		
Rubus chamaemorus	*hu*	*c*
Ericaceae		
Andromeda glaucophylla	*ho,hu*	*c*
Chamaedaphne calyculata	*ho,hu*	*c*
Gaultheria hispidula	*hu*	*c*
Kalmia angustifolia	*hu*	*c*
Kalmia polifolia	*hu,ho*	*c*
Ledum groenlandicum	*hu*	*c*
Vaccinium angustifolium	*hu*	*o*
Vaccinium oxycoccos	*hu,ho*	*c*
Vaccinium uliginosum var. *alpinum*	*hu*	*o*
Vaccinium vitis-idaea	*hu*	*r*
Empetraceae		
Empetrum nigrum	*hu*	*o*

[a] *ho*, hollow; *hu*, hummock; *p*, pool.
[b] *c*, common; *o*, occasional; *r*, rare.

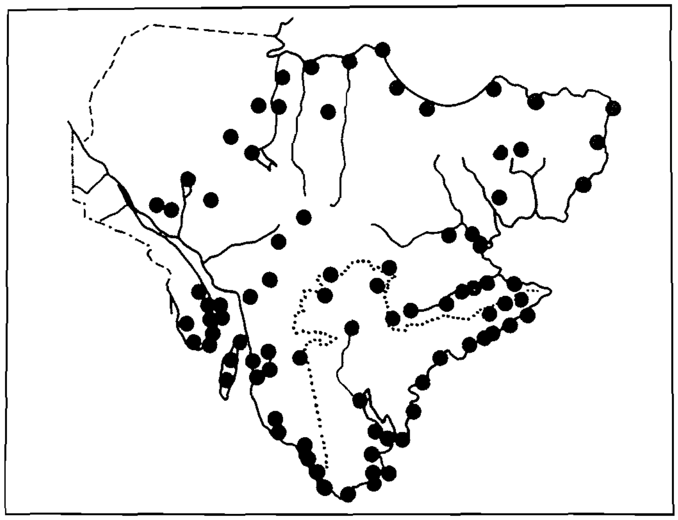

FIG. 2. Distribution of *Scirpus cespitosus* var. *callosus* in Quebec–Labrador illustrating the range of the arctic–boreal element. The map is redrawn after Rousseau (1974).

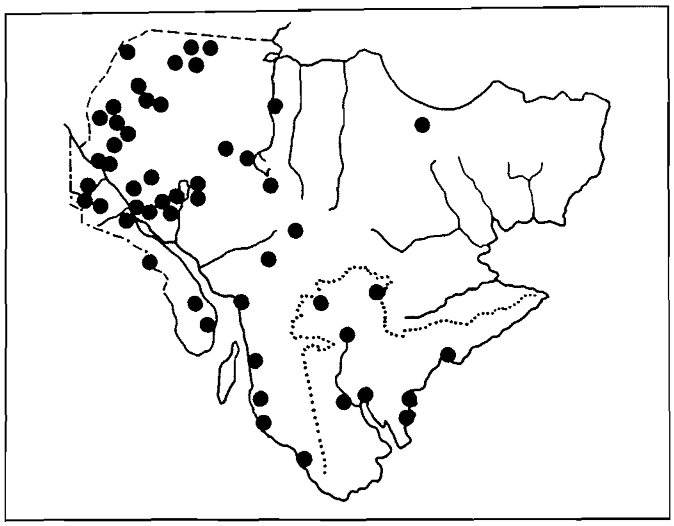

FIG. 3. Distribution of *Carex oligosperma* in Quebec–Labrador illustrating the range of the boreal element extending into the forest–tundra transition. The map is redrawn after Rousseau (1974).

The rich bog floras along the west coast and Avalon Peninsula of Newfoundland are associated with an extreme maritime climate, with precipitation averaging 1300–1400 mm/year at Gros Morne and 1500–2000 mm/year on the Avalon Peninsula (Banfield 1981). In interior Newfoundland, where the climate is more continental and precipitation averages 1100–1500 mm/year, the bogs closely resemble those in Labrador both physiognomically and floristically, although the Newfoundland bogs contain more species particularly in the mud bottoms. Southeastern Labrador has a still more continental climate, although precipitation is relatively high, averaging 1000–1200 mm/year near the coast and 900–1100 mm/year along Lake Melville. The decreasing influence of the ocean on the chemistry of precipitation in Labrador relative to Newfoundland is demonstrated by the lower concentrations of Cl^- in precipitation along a transect from Gander, Newfoundland to Goose Bay, Labrador (Banfield 1981; Anonymous 1979).

Thus the richness of the regional bog flora decreases between Newfoundland and Labrador in accordance to an increase in the continentality of the climate. Within Labrador, however, the bog flora is remarkably uniform across the region indicating little response to gradients in precipitation or increasing continentality. Bogs near the coast along the Alexis River, for example, are floristically indistinguishable from those in more continental settings at Gilbert Lake or along Lake Melville. The major phytogeographic feature of these bogs is the tension zone along Lake Melville where a number of bog species reach their range limits. Typical species of mud bottoms in bogs from Nova Scotia and Newfoundland such as *Rhynchospora alba*, *Utricularia cornuta*, and *Drosera intermedia* also reach their range limits along Lake Melville, but here these species are absent from ombrotrophic sites and occur only in poor fens. This pattern suggests that an important climatic threshold exists near Lake Melville for many species of more southern affinities. Thus, the colder more continental climate in Labrador seems responsible for excluding from the regional bog flora all but the wide-ranging and apparently more genetically variable species.

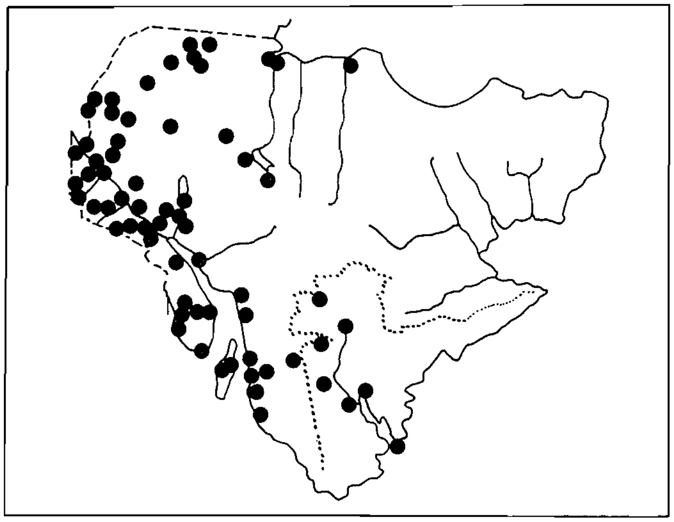

FIG. 4. Distribution of *Sarracenia purpurea* in Quebec–Labrador illustrating the range of boreal species that reach their range limits along the shores of Lake Melville.

The locations of the 12 bogs sampled are as follows: Eagle River 1 (two sites), 53°27′ N, 27°38′ W; Eagle River 2 (two sites), 53°30′ N, 57°31′ W; Gilbert Lake, 52°44′ N, 56°52′ W; Reticulate bogs (four sites), 52°47′ N, 56°45′ W; Alexis River, 52°36′ N, 56°43′ W; Lake Melville, 53°25′ N, 59°35′ W; Ranger bog, 53°55′ N, 59°50′ W.

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ANONYMOUS. 1979. Canadian network for sampling precipitation: data summary, 1977–1979. Fisheries and Environment Canada, Atmospheric Environment UDC 551.578.8

BANFIELD, C. E. 1981. The climatic environment of Newfoundland. *In* The natural environment of Newfoundland, past and present. *Edited by* A. G. Macpherson and J. B. Macpherson. Department of Geography, Memorial University of Newfoundland, St. Johns. pp. 83–153.

BELLAMY, D. J., and S. R. BELLAMY. 1967. An ecological approach to the classification of the lowland mires of Ireland. Proc. R. Irish Acad. Sect. B, **65**: 237–251.

BOUCHARD, A., and S. HAY. 1976. The vascular flora of the Gros Morne National Park coastal plain, in Newfoundland. Rhodora, **78**: 207–260.

BROOKS, I. A. 1977. Geomorphology and Quaternary geology of Codroy Lowland and adjacent plateaus, southwest Newfoundland. Can. J. Earth Sci. **14**: 2101–2120.

DAMMAN, A. W. H. 1979. Geographic patterns in peatland development in eastern North America. *In* Classification of peat and peatlands. Proceedings of the International Peat Symposium, International Peat Society, Helsinki. pp. 42–57.

——— 1980. Ecological and floristic trends in ombrotrophic bogs of eastern North America. *In* La vegetation des sols tourbeux. Colloq. Phytosociol. (Lille), **7**: 61–79.

DAMMAN, A. W. H., and J. J. DOWHAN. 1981. Vegetation and habitat conditions in Western Head Bog, a southern Nova Scotian plateau bog. Can. J. Bot. **59**: 1343–1359.

FERNALD, M. L. 1925. Persistence of plants in unglaciated areas of boreal America. Mem. Am. Acad. Arts Sci. **15**: 241–342.

——— 1970. Gray's manual of botany. 8th ed. Van Nostrand-Reinhold, New York.

FOSTER, D. R. 1983. Phytosociology, fire history, and vegetation dynamics of the boreal forest of southeastern Labrador, Canada. Ph.D. thesis, University of Minnesota, Minneapolis, MN.

FULTON, R. J. and D. A. HODGSON. 1979. Wisconsin glacial retreat, southern Labrador. Geol. Surv. Can. Pap. No. 79-1C. pp. 17–21.

GOODMAN, G. T., and D. F. PERKINS. 1968. The role of mineral nutrients in *Eriophorum* communities. III. Growth response to added inorganic elements in two *Eriophorum vaginatum* communities. J. Ecol. **56**: 667–683.

GORE, A. J. P. 1963. Factors limiting plant growth on high-level blanket peat. III. An analysis of growth of *Molinia caerulea* (L.) Moench. in the second year. J. Ecol. **51**: 481–491.

GORHAM, E. 1956. On the chemical composition of some water from the Moor House Nature Reserve. J. Ecol. **44**: 377–384.

GRANT, D. R. 1977*a*. Glacial style and ice limits, the Quaternary stratigraphic record, and changes of land and ocean level in the Atlantic Provinces, Canada. Geogr. Phys. Quat. **31**: 247–260.

——— 1977*b*. Altitudinal weathering zones and glacial limits in Western Newfoundland, with particular reference to Gros Morne National Park. Geol. Surv. Can. Pap. No. 77-1A. pp. 455–463.

HARE, F. K. 1959. A photo-reconnaissance survey of Labrador–Ungava. Geogr. Branch, Mines and Tech. Surv. Mem. No. 6.

HARE, F. K., and R. G. TAYLOR. 1956. The position of certain forest boundaries in southern Labrador–Ungava. Geogr. Bull. **8**: 51–73.

HULTÉN, E. 1958. The amphi-atlantic plants and their phytogeographical connections. Almquist & Wiksell Periodical Co., Stockholm.

——— 1964. The circumpolar plants. 1. Vascular cryptogams, conifers, monocotyledons. Almquist & Wiksell Periodical Co., Stockholm.

LOPOUKHINE, N., N. A. PROUT, and H. E. HIRVONEN. 1977. Ecological land classification of Labrador. Lands Directorate (Atlantic Division), Environment Management Service, Fisheries and Environment Canada, Ecological Land Classification Series, No. 4. pp. 1–85.

OSVALD, H. 1949. Notes on the vegetation of British and Irish mosses. Acta Phytogeogr. Suec. **26**: 1–62.

PEARSALL, W. H. 1938. The soil complex in relation to plant communities. III. Moorlands and bogs. J. Ecol. **26**: 298–315.

PEARSALL, W. H., and E. M. LIND. 1941. A note on a Connemara bog type. J. Ecol. **29**: 62–68.

PORSILD, A. E., and W. J. CODY. 1980. Vascular plants of continental Northwest Territories, Canada. National Museum of Natural Sciences, National Museum of Canada, Ottawa.

ROGERSON, R. J. 1981. The tectonic evolution and surface morphology of Newfoundland. *In* The natural environment of Newfoundland, past and present. *Edited by* A. G. Macpherson and J. B. Macpherson. Department of Geography, Memorial University of Newfoundland, St. Johns. pp. 24–55.

ROUSSEAU, C. 1974. Geographie floristique du Quebec/Labrador. Les Presses de l'Universite Laval. Québec.

ROWE, J. S. 1972. Forest regions of Canada. Can. For. Serv. Publ. No. 1300. pp. 1–172.

SPARLING, J. H. 1967. The occurrence of *Schoenus nigricans* L. in blanket bogs. II. Experiments on the growth of *S. nigricans* under controlled conditions. J. Ecol. **55**: 15–31.

TANNER, V. 1944. Outlines of the geography, life and customs of Newfoundland–Labrador. Acta Geogr. (Helsinki), **8**: 1–909.

TANSLEY, A. G. 1939. The British Islands and their vegetation. Cambridge University Press, Cambridge, England.

WELLS, E. D. 1981. Peatlands of eastern Newfoundland, distribution, morphology, vegetation, and nutrient status. Can. J. Bot. **59**: 1978–1997.

WENNER, C.-G. 1947. Pollen diagrams from Labrador. A contribution to the Quaternary geology of Newfoundland–Labrador, with comparisons between North America and Europe. Geogr. Ann. **29**: 137–374.