24 The Flora and Ecology of Southern Ontario Granite Barrens

PAUL M. CATLING AND VIVIAN R. BROWNELL

Naturally open habitats consisting of exposed granite rock with grassy areas, shrubs, and scattered trees often are referred to as granite barrens. These areas are never entirely barren, but nevertheless, openness and bare rock or rock with only lichen and moss cover is a characteristic feature (Figure 24.1). In Ontario, granite barrens are a restricted and special habitat with unique environmental factors and specialized plants and animals.

The terrain is composed of a ridge and trench system of extensively folded granite rockland. A faulting network (differential displacement of bedrock blocks resulting in long, steep-sided depressions) often exists perpendicular to the folds. The trenches often contain oligotrophic ponds created by beaver, or they may contain bog mats. One of the most striking features is the contrast between adjacent wet and dry land, a consequence of the fact that the granite rock is impervious and holds water in depressions. Lakes, ponds, and other wetlands are often as characteristic of granite rock barren landscapes as are the dry rock exposures. Due to the retention of water in small or shallow depressions, extreme wetness may be followed by extreme drought. In fact, granite rock barrens are characterized by a wide variation in soil depth and in water-holding capacity over a short distance. These variations are responsible for the mosaic patterns of vegetation. The rock is acidic and generally contributes to the formation of acidic soils. The wetlands are generally bogs or acidic lakes. However, within the region, barrens also develop on basic metasediments (e.g., marble, amphibolite), but the barrens developed on such substrates differ, often substantially, in their floristic composition from those on granite.

When discussing "barrens" it is often unclear whether the reference is to the patches of bare rock or to the entire landscape. The term most often is used in a landscape sense and indeed it is often difficult to draw a line separating components. Is a vernal pool surrounded by bare rock a feature of the barrens, or is it a wetland that should be considered in a separate context? All assemblages are closely related and determined by scale. Naturally fluctuating water levels and beavers substantially contribute to the maintenance of open areas by reducing tree cover and creating continuous disturbances necessary for the maintenance of open-habitat species. If parts of the assemblage are to be discussed, it seems most appropriate to discuss aquatic, wet, mesic, or dry portions. Here the concern is primarily with the dry zone, but recognizing interdependence, there will be an occasional reference to the entire landscape.

Distribution

Rock barrens exist to a greater or lesser extent throughout the Canadian Shield region, a horseshoe-shaped area that extends around Hudson Bay and includes much of eastern and central Canada. The southern portion of this area is within the Great

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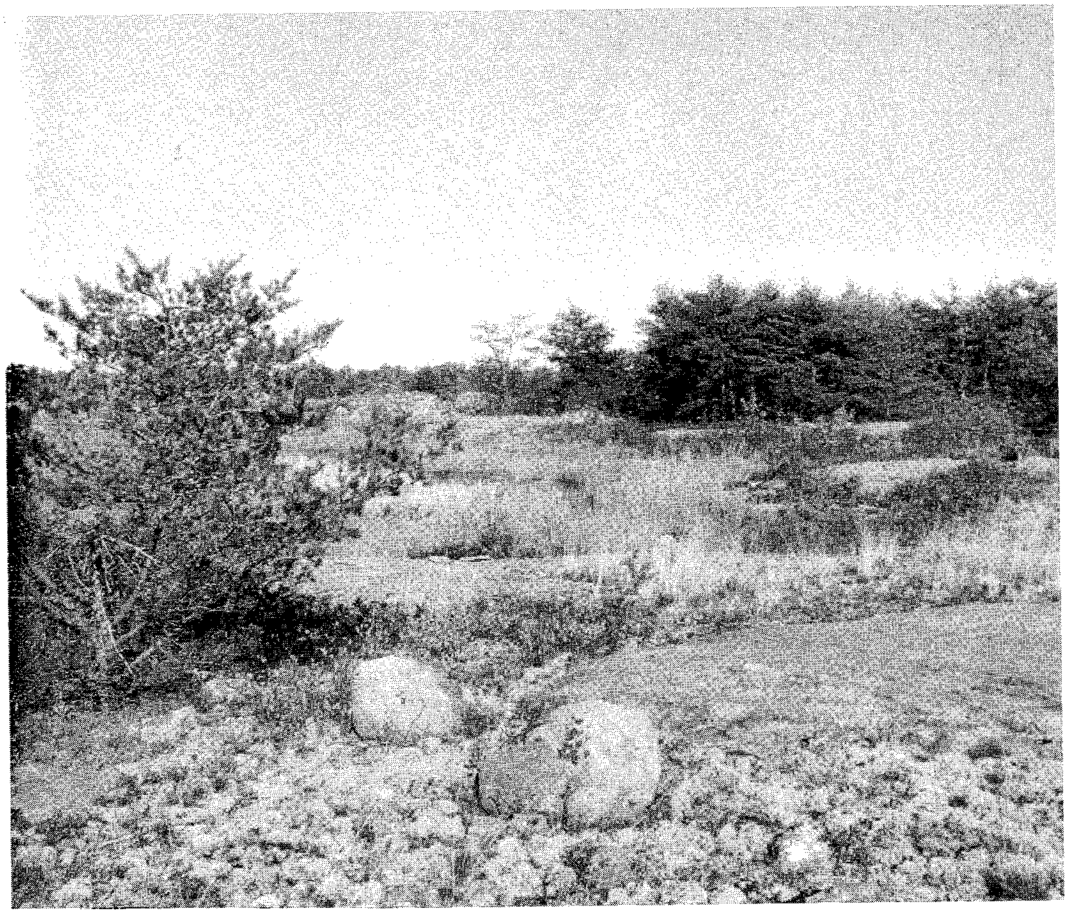

Figure 24.1. Granite rock barren near Kaladar, Ontario, with lichen mat in the foreground, open rock, grassland dominated by *Deschampsia flexuosa*, and scattered trees and groves of *Pinus banksiana*.

Lakes–St. Lawrence Forest region (Rowe 1977), and the rest, within the boreal forest. The granite barrens are a particularly distinctive habitat type within the southern, temperate, and largely forested portions of the shield. Although small open areas with exposed granite rocks occur throughout the southern Canadian Shield region, extensive areas of barrens are more restricted. Within southern Ontario, extensive areas are present within a discontinuous band extending east of Georgian Bay to the Kaladar area of eastern Ontario. This region of granite barrens was mapped by Chapman and Putnam (1984) as "bare rock ridges and shallow till" (Figure 24.2) and identified by them as the "Georgian Bay fringe" physiographic region. Smaller and more isolated areas exist elsewhere in the Canadian Shield, particularly in the Frontenac Axis region of the upper St. Lawrence River in both New York and Ontario (Kloet 1973; Seischab and Bernard 1991; Bernard and Seischab 1995). In this area, barrens with pitch pine (*Pinus rigida*) have developed on both granite and Potsdam sandstone.

Habitat Ecology

Lack of Tree Cover

Tree cover is limited by lack of soil development, periodic drought, and interaction of these two factors. The barrens areas along the edges of the shield apparently had much of

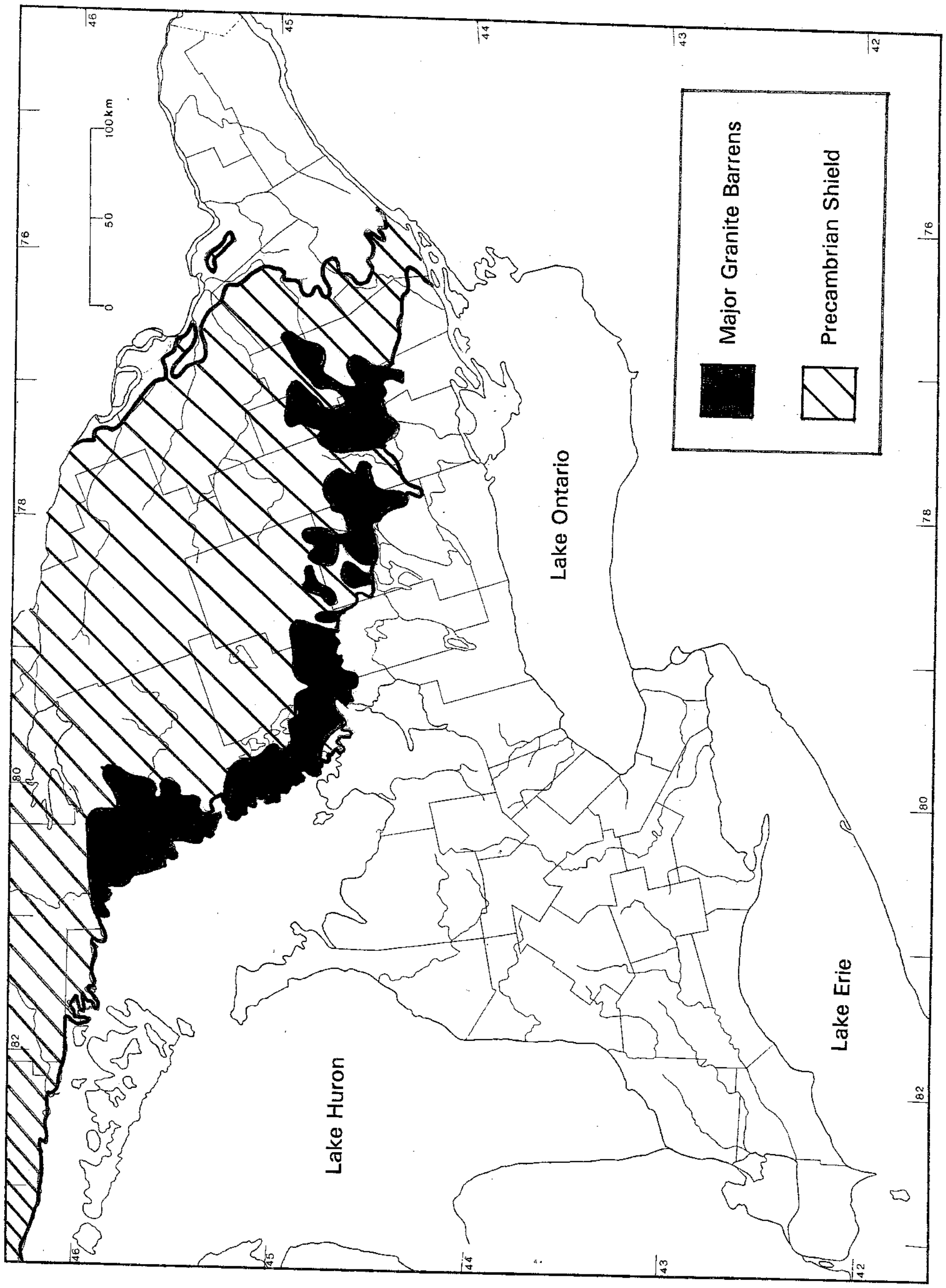

Figure 24.2. Granite barrens region (shaded) of southern Ontario. (After the "bare rock ridges and shallow till" of Chapman and Putnam 1984.)

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the overlying glacial till removed by glacial meltwater and possibly also by wave action. The hard rock itself does not readily form parent material. Where the rocks are rounded rather than cracked there is little opportunity for the establishment of trees, and many of the barrens areas are characterized by a relatively smooth, undulating, rather than blocky, surface. In spring and fall, the granite barrens may be very wet due to water held on the surface by the impervious rock, but as evaporation increases over summer they are sometimes extremely hot and dry for extended periods. Both the extremes and severe heat and dryness limit establishment of tree growth. Burned stumps and fire scars throughout the barrens region suggest that natural and anthropogenic fire also has been a major factor in determining vegetation cover. Several severe fires burned on the eastern Kaladar barrens in the late 1880s, and the most recent severe and extensive fire occurred between 1931 and 1936. In the 1950s, fire was used briefly to enhance blueberry production. No major fires have occurred in the past 40 years.

However, severe heat and drought and fire are not the only factors limiting tree establishment and growth. In 1981, the introduced gypsy moth (*Lymantria dispar*) arrived, and the abundance of red oak in the barrens region provided favorable conditions for population expansion. Defoliation over much of the area was severe for several consecutive years, and by the mid-1980s a large proportion of the trees were dead. The population of gypsy moths crashed in 1986. A spray program was initiated with the bacterium *Bacillus thuringensis* on government-owned lands. This spraying was continued, but the moth population increased again and then crashed in 1992.

During the most recent peak in the gypsy moth population, there also was an outbreak of forest tent caterpillar (*Malacosoma disstria*), which feeds mainly on maple and ash. However, either species may defoliate a variety of trees as the populations expand. Trees may recover from forest tent caterpillar, which often has a single year of major defoliation followed by near absence for a relatively long period of 10–20 years. Gypsy moth is more likely to cause death of trees than are tent caterpillars, because gypsy moth causes heavy defoliation for many consecutive years with less time between population explosions. Trees weakened by defoliation have an increased susceptibility to drought and, undoubtedly, recent drought has played a role in the extensive reduction of tree cover.

The many wetlands characteristic of granite rock barrens provide habitat for beavers, and these animals also contribute to the lack of tree cover in some areas, particularly reducing fast-growing species such as poplars and birches. Beaver activity is largely confined to areas near shorelines. Shorelines of larger lakes and rivers also are important to the barrens ecosystem, because they tend to be more continuously open due to the disturbance of fluctuating water levels and the action of strong desiccating or abrading winds on adjacent barrens. When succession results in closure of sites distant from shore, or a lapse in catastrophic events leads to a loss of certain seral stages, the continuously disturbed shoreline acts as a refuge for rare species. Furthermore, shorelines are very significant portions of the barrens ecosystem. For example, in the Salmon River drainage, most of the occurrences of bear oak (*Quercus ilicifolia*) are along shores. Big bluestem (*Andropogon gerardii*) is often dominant at high water level and up to 20 m upslope; however, it does not occur away from major river and lake shores. Although not community dominants, other species (e.g., *Allium canadense*, *Aristida dichotoma*) have a similar distribution. When water levels are stabilized with dams, there can be major impacts to the barrens ecosystem as well as to the aquatic ecosystem (P. A. Keddy 1985; P. A. Keddy and Wisheu 1989), in addition to pollution effects due to reduced flushing. The effect of fluctuating water levels has been associated with high diversity of shoreline flora, but its significance to the dry barrens vegetation on shores has not been investigated.

Edaphic Characteristics

The soil is frequently extremely shallow and low in nutrients, and it may be organic, sandy, or gravelly. In general, the soils belong to the Brunisol group. Since the massive rock is impervious, the interaction between depth of substrate and slope of underlying and surrounding bedrock is a major factor in the presence or absence of particular species of vascular plants. The extremes of wetness and dryness are greater than those on nearby alvars, where the rock is porous and substrate depth alone is a predominant factor.

Granite rock barrens generally have an acid soil reaction, but the extent of acidity depends upon the nature of the underlying rock and the presence or absence of overlying calcareous till. Many other types of rocks are present in the barrens regions (e.g., Harding 1944; Hewitt 1964; Wolff 1982; Bright 1986), and these weather to varying degrees to parent material for soil. The metasediments have barrens floras different from those of the granite rocks, and distinctive floras exist in some places where marbles and biotite- and hornblende-rich metasediments accompany the granite.

Climatic Aspects

In general, the region where extensive granite barrens occur is one with warm summers and mild to cool winters, a long growing season, and more or less reliable, year-round precipitation. The barrens shown in Figure 24.2 are distributed in three climatic regions: Those barrens near Georgian Bay are in the Muskoka region; those further east, in the Haliburton Slopes region; and those in the easternmost areas, in the Eastern Counties region (Brown, McKay and Chapman 1980). The mean annual growing season ranges from 190 to 200 days in the Muskoka region and the southern portion of the Eastern Counties region, whereas it is 180–190 days in the Haliburton Slopes region and the northern portion of the Eastern Counties (Brown, McKay and Chapman 1980). Some of the major differences in the floras of Ontario granite barrens are associated with these different climatic regions, but regional differences have yet to be fully quantified. The Western Muskoka region is the mildest (mean daily maximum temperature in July is 24.4 °C and in January it is 3.3 °C) and has proportionately more precipitation (96–102 cm of precipitation annually compared to 81–86 cm). The central Haliburton Slopes region is the coolest and has the shortest season. The easternmost barrens are the warmest (mean daily maximum temperature in July is 27 °C and in January it is 3.3 °C) and contain a number of southern species.

Plant Characteristics

A number of the plants present are able to grow rapidly during the spring, when water is held on top of the rock. *Saxifraga virginiensis* sets seed by June, but growth of rosettes begins again during the autumn wet period in September and October. The biennial *Corydalis sempervirens* similarly completes flowering and fruiting early, then plants appear again in the autumn. Many species flower in May, with fruit production dependent upon adequate moisture extending into at least early summer. This is true of the juneberries (*Amelanchier* spp.), cherries (*Prunus* spp.), and blueberries (*Vaccinium* spp.). Other species, such as *Aster ciliolatus* and *Solidago nemoralis*, are characterized by growth of rosettes in spring followed by a slower growth rate that increases as the environment becomes cool and moist in autumn. Flowering extends from September to past the first frosts of October.

Species that flower during the summer, such as *Spiranthes lacera* and *Juncus secundus*, appear irregularly, apparently depending on moisture of current and previous years.

With rather severe summer droughts, many species tend to grow primarily during the spring or fall moist periods. Some annuals, such as *Bulbostylis capillaris,* may initiate growth during summer if moisture is adequate but may not appear at all in some years.

Flora

On granite barrens there are 70 characteristic vascular plant species, of which 36 are considered dominant or codominant (Table 24.1). Apart from scattered trees and groves, the prominent vascular plant species are the grasses *Danthonia spicata* and *Deschampsia flexuosa,* the sedge *Carex pensylvanica,* the shrubs *Comptonia peregrina, Diervilla lonicera, Rhus typhina, Vaccinium angustifolium* and the fern *Pteridium aquilinum.* A few alien species, such as *Hieracium piloselloides* and *Hypericum perforatum,* have spread into natural granite barrens that have not been substantially influenced by human activity. *Trifolium aureum, Melilotus alba,* and *Medicago lupulina* are characteristic of areas previously grazed by cattle. Heavy grazing leads to invasion of mostly introduced grasses, such as *Poa compressa* and *Agropyron repens,* generally not present or dominant in rock barrens, as well as invasion of alien species such as *Bromus inermis, Phleum pratense,* and *Dactylis glomerata.*

Distinctive zones of vegetation exist, but often on a small scale and less well defined than on nearby alvars, because the slopes are both more variable and usually steeper. The granite barrens frequently undulate in all directions. Thin substrates up to 1 cm deep (shallow soil) have a lichen (*Cladina* spp., *Cladonia* spp.) and moss (e.g., *Grimmia* spp., *Polytrichum* spp.) cover that often grades into a combination of bryophytes and herbs (Wong and Brodo 1973; Crowder, Greer and Fongern 1979). The major herbs on moss mats and shallow soil are mostly perennial (*Saxifraga virginiensis, Selaginella rupestris*). *Corydalis sempervirens* is an annual or biennial. *Agrostis scabra* is the only prominent annual on shallow soil (which often accumulates rainwater temporarily); others, such as *Polygonum douglasii* and *Bulbostylis capillaris,* are rarely common or dominant and often are inconspicuous in dry years. The lack of annuals is a distinct contrast to alvars (Catling and Brownell 1995) and, evidently, to the granite barrens in the granite outcrops of the Piedmont Plateau of the southeastern United States, where annuals such as *Diamorpha smallii* and *Arenaria uniflora* are characteristic of open shallow soil (Burbanck and Platt 1964; Shure and Ragsdale 1977). Perennial grasses (*Danthonia spicata* and *Deschampsia flexuosa*) or shrubs (e.g., *Comptonia peregrina, Vaccinium angustifolium,* and *Rhus typhina*) occur as soil depth increases. Different environmental tolerances and competitive abilities probably characterize some of the species along the soil depth gradient, as has been shown for the flat-rock areas of the southeastern United States (see Chapter 6). In general, the heaths and/or *Carex pensylvanica* appear to occupy the mesic sites, whereas the perennial grasses occupy drier sites of equivalent soil depth.

Where substrates are a few decimeters deep or where there are deeper cracks, trees or patches of woodland have established. Oaks (*Quercus rubra, Q. alba*) occur in dry, relatively deep substrates, and red maple (*Acer rubrum*) occurs in more moist sites. Jack pine (*Pinus banksiana*) occupies the driest sites and those prone to the greatest extremes of wetness and drought. *Deschampsia flexuosa, Gaylusaccia baccata,* and *Vaccinium angustifolium* dominate the understory of jack pine groves. In oak groves, *Aralia nudicaulis, Carex pensylvanica, Gaultheria procumbens,* and *Pteridium aquilinum* often dominate the understory. *Helianthus divaricatus* is also a conspicuous species. Shrubs are few except in areas where metasediments and/or marble is present, in which case dense thickets of *Cornus* spp. may develop.

Table 24.1. *Characteristic vascular plant species of the dry portions of granite rock barrens in the southern Canadian Shield region (Frontenac Axis) of eastern Ontario. Species found at most eastern Ontario sites and often dominant or codominant in some of the plant associations are preceded by an asterisk (*).*

* *Acer rubrum* L.
Agropyron trachycaulum (Link) Malte ex H.F. Lewis
* *Agrostis scabra* Willd.
Antennaria neglecta Greene (incl. *A. neodioica* & *A. canadensis*)
* *Apocynum androsaemifolium* L.
* *Aralia hispida* Vent.
Arctostaphylos uva-ursi (L.) Spreng.
* *Aronia prunifolia* (Marsh.) Rehd. (incl. *A. melanocarpa*)
* *Aster ciliolatus* Lindl.
* *Aster macrophyllus* L.
Aster umbellatus Mill.
Betula papyrifera Marsh.
Bromus kalmii A. Gray
Campanula rotundifolia L.
* *Carex pensylvanica* Lam.
* *Carex rugosperma* Mack.
Carex tonsa (Fern.) Bickn.
* *Comandra umbellata* (L.) Nutt.
* *Comptonia peregrina* (L.) Coult.
Corydalis sempervirens (L.) Pers.
* *Danthonia spicata* (L.) R.&S.
* *Deschampsia flexuosa* (L.) Beauv.
* *Diervilla lonicera* Mill.
* *Fragaria virginiana* Dcne.
* *Gaultheria procumbens* L.
* *Gaylussacia baccata* (Wang.) K. Koch
Helianthus divaricatus L.
Juniperus communis L. var. *depressa* Pursh
* *Lechea intermedia* Legg.
Lilium philadelphicum L.
* *Maianthemum canadense* Desf.
Malaxis unifolia Michx.
* *Melampyrum lineare* Desr.
* *Oryzopsis asperifolia* Michx.
* *Oryzopsis pungens* (Spreng.) Hitchc.
Panicum depauperatum Muhl. (*Dichanthelium depauperatum* (Muhl.) Gould)
Panicum lanuginosum Ell. var. *implicatum* (Scribn.) Fern.
* *Panicum latifolium* L. (*Dichanthelium latifolium* (L.) Gould & Clark)
* *Panicum linearifolium* Britt. (*Dichanthelium linearifolium* (Scribn.) Gould)
Pinus banksiana Lam.
* *Pinus strobus* L.
Poa compressa L.
Populus tremuloides Michx.
Potentilla simplex Michx. (incl. *P. canadensis*)
* *Prunus pensylvanica* L. f.
Prunus susquehanae Willd.
Prunus virginiana L.
* *Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) Underw.
* *Quercus alba* L.
* *Quercus rubra* L.
* *Rhus typhina* L.
* *Rubus allegheniensis* Porter
Rubus flagellaris L. (incl. *R. arundelanus* Blanch.)
Rubus hispidus L.
Rubus strigosus Michx.
* *Rumex acetosella* L.
Salix humilis Marsh.
Saxifraga virginiensis Michx.
Selaginella rupestris (L.) Spring
Solidago bicolor L.
Solidago graminifolia (L.) Salisb. (*Euthamia graminifolia* (L.) Nutt.)
* *Solidago juncea* Ait.
* *Solidago nemoralis* Ait.
* *Spiraea alba* DuRoi
Spiranthes casei Catling and Cruise
Spiranthes lacera (Raf.) Raf. var. *lacera*
* *Vaccinium angustifolium* Ait.
Vaccinium angustifolium Ait. var. *nigrum* (Wood) Dole
Viburnum rafinesquianum Schultes
Viola fimbriatula Sm.

The extent to which bryophyte mats expand over smooth, bare rock surfaces is unknown, but some expansion of bryophyte mats appears likely on wet and mesic sites (including temporary pools). Soil depth probably increases extremely slowly, especially on drier sites, and a slow successional change related to soil depth is likely, as in granite barrens further south (Burbanck and Platt 1964; Shure and Ragsdale 1977; also see Chapter 6). A sward of *Deschampsia flexuosa*, for example, might be regarded as stable vegetation on very dry, open sites, due to the slowness of change.

A relatively rapid succession is noticeable in groves of trees where there is a strong development of herbs following death of woody cover (due to fire, defoliation by insects, or drought). Within one to three years low shrubs become prevalent, probably due to resprouting. Occasionally, shrubs that were nearly dead appear to have an uncanny ability to persist in large numbers (e.g., *Amelanchier* spp., *Ceanothus ovatus*). Taller shrubs and trees replace these in turn, as light becomes increasingly limited. Catastrophic events, such as cutting by beaver, may interrupt succession at any time and return the system to an earlier stage. As with the composition of vegetation in the pitch pine communities in northeastern New York state (Bernard and Seischab 1995), the composition of vegetation in southern Ontario granite barrens probably depends not only on simple succession, but also on the degree, nature, and timing of past disturbances. Although an extensive literature exists on succession in the granite barrens of the southeastern United States (e.g., Shure and Ragsdale 1977; Quarterman, Burbanck and Shure 1993; also see Chapter 6), similar literature for Ontario sites is not available.

Wetlands ranging from small temporary pools to extensive and permanently wet bogs or lakes occupy the characteristic depressions between dry open ridges. Even on the tops of the highest and driest ridges, an isolated depression 1 m deep may contain characteristic bog plants such as *Sphagnum* mosses and Virginia chain fern (*Woodwardia virginica*).

Biogeography and Origin

Species that are dominant and frequent in the granite rock barrens of the southern Canadian Shield region generally have widespread distributions. The western element is not as conspicuous as in the prairies and alvars of southern Ontario, but *Carex siccata* is a notable example. A few of the species, such as *Pinus banksiana* around Kaladar in eastern Ontario and *Potentilla tridentata* in southern Muskoka, are boreal in their affinity and near to the southern limits of their distribution. The second largest group is the southern species that reach their northern limit on the eastern Ontario rock barrens. Included in this group are *Asclepias exaltata, Desmodium paniculatum, Cirsium discolor, Juniperus virginiana, Panicum oligosanthes, Pinus rigida, Quercus ilicifolia, Rhus copallina, Solidago arguta, Solidago puberula, Spiranthes ochroleuca,* and *Woodsia obtusa.*

Unlike the flat-rocks of the southern Appalachians, where more than one-third of the 44 characteristic species are endemic (McVaugh 1943; also see Chapter 6), no endemic vascular plants have been reported from southern Ontario granite barrens. Flat-rock endemism decreases rapidly north of North Carolina (Harvill 1976), and no granite barren endemics in the Appalachians occur north of Virginia (Murdy 1968). The endemism in the south is associated with a long-term habitation by plants as compared to the short-term habitation in the north due to recent Wisconsin glaciation.

Although there are no strict endemics in Ontario, several species have most of their Ontario occurrences on the granite barrens. *Juncus secundus* is a good example, but it also occurs on thin soil over limestone. *Aster ciliolatus, Prunus susquehanae, Quercus ilicifolia, Rhus copallina,* and *Spiranthes casei* var. *casei* are concentrated in granite rock barren ecosystems in Ontario, but also occur on sand barrens. *Bulbostylis capillaris* is mainly a species of the granite barrens, but also occurs on gravelly roadsides and sandy, receding shorelines.

Granite barrens in Ontario are also quite different from the flat-rock areas of the southeastern United States in their general floristic composition. Only a few of the prominent species of the southeastern sites, such as *Polytrichum commune* and *Bulbostylis capillaris*, are also present in the north. Characteristic species of flat-rock, such as

Andropogon virginicus, Agrostis elliotiana, Arenaria brevifolia, Crotonopsis elliptica, Diamorpha smallii, Hypericum gentianoides, Linaria canadensis, and *Virguiera porteri,* are absent from the granite barrens in southern Ontario. However, the southern Ontario granite barrens are similar in many respects to the basalt glades of Wisconsin and Minnesota (Glenn-Lewin and Ver Hoef 1988a), which are approximately the same distance away, but near to the same latitude. In common is the abundance of lichens and bryophytes and dominants such as *Carex pensylvanica, C. siccata, Danthonia spicata, Quercus* spp., *Juniperus communis, Rhus* spp., *Rubus* spp., and *Vaccinium angustifolium.* The Wisconsin and Minnesota sites differ in having characteristic prairie species among the dominants, including *Amorpha canescens, Andropogon gerardii, Lespedeza capitata,* and *Schizachyrium scoparium. Sorgastrum nutans* is the only tall grass generally distributed on the Ontario barrens sites. The fewer midwestern species make the southern Ontario barrens less likely to be regarded as forest–grassland transition as the Wisconsin basalt barrens are (Glenn-Lewin and Ver Hoef 1988a).

Species Richness Trends

The greatest species richness of vascular plants is in areas near to metasediments, where oaks are the dominant trees. Fire, drought, and infestations of gypsy moth and forest tent caterpillar, which killed many of the woody plants, have enlarged the open areas. Areas where pine is dominant have fewer total species, but not necessarily fewer rare species. A 2-ha granite barren (not including the wetlands) may have up to 100 native species whereas sites with lower richness may have 30–40 species (Brownell 1994; Brownell 1997a, b). The richest associations are found in the open or semishaded depressions with 5–10 cm deep soil. Here, up to 15 species may be present in a 1-m^2 quadrat. The moderate to relatively high species richness in the dry granite barrens may be attributed to the patch diversity, which is a consequence of local variations in soil depth over rock and in water-holding capacity, as reported by Glenn-Lewin and Ver Hoef (1988b) for Wisconsin basalt balds.

Summary of Importance

Berry Production, Germplasm

Blueberries have been harvested in the Kaladar region for many decades, and blueberries once were a significant source of income to the local inhabitants. Presently, the local harvest (*Vaccinium angustifolium* var. *angustifolium* and *V. angustifolium* var. *nigrum*) is sold at roadside stands along with the larger, imported blueberries (*Vaccinium corymbosum*) from the Maritime Provinces, New England, Pennsylvania, or New Jersey. The generally preferred local crop sometimes sells for twice the price of the imported blueberry. Local blueberries are in peak production in mid to late July. Prior to the 1950s, blueberry harvesters in the area burned the barrens to improve production of blueberries. When the Kaladar area came under the Fire Control Act in 1952, residents were no longer allowed to burn the blueberry areas, so residents of Kaladar, Sheffield, and Kennebec townships requested a prescribed burning program from the Department of Lands and Forests. The request was granted, and in 1957 a prescribed burning management program for blueberry production was initiated, mostly on 200-acre tracts of government-owned land. Interest in local blueberries declined after 1957 and the management program was discontinued.

In addition to blueberries, germplasm of other native berry crops is potentially valuable, including three species of cherries (*Prunus*), of which *Prunus susquehannae* is restricted in Ontario. Seven native species of raspberries and blackberries (*Rubus*) are present, as well as five species of saskatoons (*Amelanchier*) and two species of strawberries (*Fragaria*). Some of these species probably are represented by ecotypes adapted to extreme periodic drought.

Significant Plant Species

Although no plants in the dry granite barrens of Ontario are considered endemic, 16 provincially rare species are present along with 29 regionally rare plants (Table 24.2). Most of these are southern species at their northern range limit. This number of rare species is less than in other ecosystems, such as prairie or deciduous forest. Some of the provincially rare species are confined within Ontario largely or entirely to the dry granite barrens of the Frontenac Axis (e.g., *Opuntia fragilis, Pinus rigida, Quercus ilicifolia, Rhus copallina, Solidago puberula,* and *Woodsia obtusa*) (Kloet 1968, 1973; Brownell, Blaney and Catling 1996). Some of the regionally rare species have a Canadian Shield distribution to a greater or lesser extent, but they are more geographically widespread and occur on sandplains as well as on granite rock (e.g., *Aster ciliolatus, Comptonia peregrina, Prunus susquehannae,* and *Selaginella rupestris*). In addition to the rare species of dry sites, the barrens landscapes contain rare coastal plain elements (P. A. Keddy and Reznicek 1982; C. J. Keddy and Sharp 1994; Reznicek 1994), most of which are wetland plants, including *Isoëtes engelmannii, Panicum spretum, Polygonum careyi, Potamogeton bicupulatus, Rhexia virginica, Xyris difformis,* and *Bartonia paniculata*. These are prominent in the Georgian Bay region. Outside of this region, there are few detailed reports on the rare species of barrens landscapes, the one exception being for the St. Lawrence Islands (Brownell 1984).

Significant Animals

The granite barrens support a diverse fauna with at least 30 mammal, 136 breeding bird, 10 reptile, 9 amphibian, and 46 butterfly species (e.g., Brownell 1997; White 1994). Probably more than 80% of the occurrences of a rather restricted lizard, five-lined skink (*Eumeces fasciatus*), are on granite barrens, and the distribution of this rare (in Ontario) lizard is closely correlated with the major areas of barrens along the southern Canadian Shield between Georgian Bay and Kingston (Seburn 1990). Black rat snake (*Elaphe obsoleta obsoleta*), rare in Ontario, also has most of its Ontario localities within the granite rock barrens region of the Frontenac Axis, although it is not necessarily confined to the open areas.

The olympia marblewing butterfly (*Euchloe olympia*) occurs on granite and limestone rock barrens, and the only Ontario locations outside of rock barrens are the dunes at Grand Bend, where a different morphotype is present (Wagner 1977). It appears that the olympia was either scarce or absent from the Ontario rock barrens prior to the 1970s (D. Lafontaine, personal communication). Another butterfly, chryxus arctic (*Oeneis chryxus*), is also largely confined in Ontario to rock barrens, although it also occurs on a few limestone and sand barren areas. Gray hairstreak (*Strymon melinus*) is the only butterfly regarded as rare in Ontario that has a rock barrens habitat, but it is less confined to the barrens than are the preceding two species. Although not rare in Ontario, dark crescent, *Phyciodes batesii* ssp. *batesii*, occurs in some rock barrens sites and is extirpated over much of its range in the United States. There are almost certainly many other insects that are more or less restricted in Ontario to dry granite rock barrens, but distributions of many are poorly documented.

More than 80% of Ontario populations of prairie warblers (*Dendroica discolor*) are in granite rock barrens areas (Lambert and Smith 1984a, b). These birds do not occur on the limestone rock barrens to the same extent, and are scarce in southern Ontario outside of the prairie scrub areas of Norfolk County and the sand dunes at Grand Bend. Although not as strictly confined to granite rock barrens as prairie warbler, yellow-billed cuckoo (*Coccyzus americanus*) is prominent in the eastern Ontario barrens, but scarce over much of the remainder of Ontario. Its recent abundance in

Table 24.2. *Regionally and provincially (P) rare species found on dry granite rock barrens of the Frontenac Axis region. Provincial rarity is based on Argus et al. (1982–1987).*

	Allium canadense L.
	Andropogon gerardii Vitman
	Asclepias exaltata L. (semi-shaded)
	Asclepias tuberosa L.
	Asplenium platyneuron (L.) Oakes ex D.C. Eat.
P	*Aristida dichotoma* Michx.
P	*Bartonia virginica* (L.) B.S.P.
P	*Bulbostylis capillaris* (L.) C.B. Clarke
P	*Carex artitecta* MacKenzie
	Carex backii Boott
	Carex cumulata (Bailey) Fern.
	Carex siccata Dewey
	Carex lucorum Willd. ex Link
	Carex tonsa (Fern.) Bickn.
	Cirsium discolor (Muhl.) Spreng.
	Desmodium paniculatum (L.) DC. (semi-shaded)
	Hedeoma hispida Pursh
	Hieracium canadense Michx.
	Hieracium scabrum Michx.
P	*Hieracium venosum* L. var. *nudicaule* (Michx.) Farw. (semi-shaded)
P	*Juncus greenei* Oakes & Tuckerman
P	*Juncus secundus* Beauv. ex Poir.
	Lonicera hirsuta Eat.
	Lysimachia quadrifolia L.
	Minuartia michauxii (Fenzl) Farw.
P	*Opuntia fragilis* (Nutt.) Haw.
	Panicum oligosanthes Schultes (*Dichanthelium oligosanthes* (Schultes) Gould)
	Polygala polygama Walter
	Polygonum douglassii Greene
	Potentilla arguta Pursh
	Pinus banksiana Lambert
P	*Pinus rigida* Miller
	Prunus susquehanae Willd.
P	*Quercus ilicifolia* Wang.
P	*Rhus copallina* L.
P	*Solidago arguta* Ait. (semi-shaded)
	Solidago ptarmicoides (Nees) B. Boivin
P	*Solidago puberula* Nutt.
	Solidago squarrosa Muhl.
	Sorghastrum nutans (L.) Nash
	Spiranthes casei Catling & Cruise
P	*Spiranthes ochroleuca* (Rydb. ex Britt.) Rydb.
P	*Vaccinium stamineum* L. (semi-shaded)
	Viola fimbriatula Smith
P	*Woodsia obtusa* (Spreng.) Torr.

the area may be related to the outbreaks of gypsy moth and forest tent caterpillar.

A High-Priority Community

Granite rock barrens have a limited occurrence in southern Ontario and deserve a relatively high priority for protection. Although the dry barrens themselves may not have an unusual level of biodiversity within southern Ontario, they are part of a landscape that does have a high level of biodiversity. As many as 500–600 species of vascular plants may be present within an area of several square miles.

Recreation

Although they have a limited occurrence in southern Ontario, the barrens areas are extensive where they occur and have a great potential for development of excellent hiking trails. The terrain is open and interesting but, except for blueberry picking and limited hunting, they are little used. Summer cottages, however, surround many of the larger lakes and rivers. As discussed by Chapman and Putnam (1984), the westernmost barrens region of Georgian Bay and Muskoka include the major recreational area of Ontario with summer cottages, which number over 20,000. It includes the rugged landscape of bare rocks with pines reflected in clear water for which Ontario is so well known.

Protection and Protection Needs

The flora and fauna of barrens developed on acid rocks has been far less affected than those developed on acid sand, in both Ontario (Carbyn and Catling 1995) and New York (Bernard and Seischab 1995). Among the important biological influences on southern Ontario granite barrens are flooding through dams (which destroyed some of the outstanding Precambrian marble barrens in southern Ontario), mineral extraction, cessation of fire due to fire control and stand isolation, and recreational development. Increasing recreational development in the form of cottages on shorelines is probably the principal current influence. As noted previously, shorelines and their associated naturally fluctuating water levels are a very significant portion of barrens ecosystems and require special consideration for protection.

Researchers have largely neglected the flora and fauna of dry granite rock barrens in Ontario, but the protection of representative examples has been considered in various reports (e.g., White 1993). A few sites are protected, and one of these, the Kaladar Jack Pine Barrens, was selected for protection based on representative features (Brownell 1994).

Research and Research Needs

Unlike the flat-rock areas in the southern Appalachians, where the foundation for research on rock barrens was established many decades ago (e.g., Harper 1939; Oosting and Anderson 1939; McVaugh 1943) and has been followed by more recent comprehensive ecological studies, the foundation for research on rock barrens in Ontario is still incomplete. Until recently, no attempt has been made to classify dry granite rock barrens in Ontario or to characterize their major associations in a comprehensive manner. Characterization of the barrens flora and fauna currently is limited to several consultant reports designed to assist in establishing a network of protected sites (e.g., Brownell 1984, 1994, 1997a, b; Macdonald 1986; Varga 1988; Bergsma 1994; White 1994, 1995a, b). Ecological studies are essentially lacking, with the exception of those concerning the barrens near Sudbury that resulted from smelter emissions (Freedman 1989, pp. 30–39). An understanding of the significance of granite rock barrens was so incomplete that there was no research aimed at determining the effect of spraying *Bacillus thuringensis* on the community as a whole, either prior to or during the spray program to control gypsy moth. This is a lamentable situation considering current world commitments to the protection of biodiversity. Research is essential with regard to potential influences such as the construction of dams and the limitations on natural water level fluctuations, as well as spraying to control insects. Apart from the research essential to effectively manage barrens landscapes, there are some very promising opportunities involving evolution of specialized ecotypes, drought tolerance, environmental monitoring, and comparison with better-studied nonglaciated sites further south.

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