The Oriskany Sandstone Outcrop and Associated Natural Features, a Unique Occurrence in Canada

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An unusual type of oak-hickory forest not reported previously in Ontario has been found growing on sandstone in the southern part of the province. The sandstone is the middle Lower Devonian Oriskany Formation (approximately 380 million years old), a unit which crops out to no significant extent anywhere else in Canada and is found only to a very limited degree in the subsurface. This highly fossiliferous outcrop has a total areal extent of less than 250 ha (1 mi^2), most of it either under a thin cover of sandy soil or exposed as actual outcrop. Although the site is very dry it is unusually rich in plant species composition; at least 40 tree species grow in the area including an unusually large representation of oaks. There is an unexpectedly large number of understorey species for a dry forest. Some species in the understorey are more northerly elements that are quite uncommon in southern Ontario; others are southern species which are rare throughout their range in Ontario. A number of prairie associates are present as well. Twenty-two of the plants are rare in Ontario. The site serves as habitat for *Elaphe obsoleta obsoleta* (Black Rat Snake), one of the largest species of snake in Canada, whose southern Ontario populations are declining.

Key Words: Oriskany, sandstone, oak-hickory forest, big-shell community, brachiopods, Black Rat Snake.

The objective of this paper is to outline some of the outstanding natural features of the Oriskany outcrop in southern Ontario. The biologically important aspects of the site, which have been identified only recently, are in imminent danger of being lost owing to quarrying by the Flintkote Company of Canada. An "environmental protection area" has been selected by the company and will remain under company ownership, but it contains little of biological significance. Quarrying of the area is recommended by the Ontario Municipal Board and approved by the Ontario Ministry of Natural Resources. Zoning by-laws were modified in June 1978 to permit aggregate extraction at the Oriskany site, although the Regional Municipality of Haldimand-Norfolk now designates it as an environmentally unique ecological area.

Geology

The Oriskany Formation occurs to a very limited extent in southern Ontario but in no other part of Canada. A number of small outcrops of Oriskany sandstone are indicated on older geological maps (Stauffer 1915; Caley 1940) but just one, the largest of these, has been verified as Oriskany using modern petrographic criteria (J. F. Cowan, 1977, unpublished data, University of Western Ontario). Only the one authenticated exposure is shown on recent maps (Sanford 1969; Hewitt and Liberty 1972; Telford 1975). This outcrop of flat-lying sediments, located about 3.0 km NE of the village of Nelles Corners, Regional Municipality of Haldimand-Norfolk, Ontario (42°56′N, 79°57′W) is shown as an irregularly shaped area with an average diameter of approximately 1.5 km. Air photos and field observations, however, reveal that the outcrop is actually even more limited than the recent maps suggest. The greater part of the formation does not occur as an actual outcrop, but is covered either by the younger Bois Blanc Formation or glacial till. Figure 1 shows an estimate of the areal extent of the outcrop at the surface and in the subsurface. This sketch was drawn on an air photo base using observations made by ground reconnaissance.

There is one unmapped occurrence of authentic Oriskany at "Shoap's Farm" about 2.4 km SE of Springvale, Ontario (42°57'N, 80°97'W) (Parks 1913), which consists of a vertical face only a few metres in length. As it has no horizontal exposure, it reveals only limited geological information and has little influence on native plants growing on the surface. Thus, the small Springvale outlier is of relatively little significance.

The Oriskany sandstone outcrop near Nelles Corners is a flat-lying erosional remnant which is now separated by a distance of 100 km from the edge of the continuous Oriskany in the subsurface south of Lake Erie (Figure 2). The type locality is at Oriskany Falls, southwest of Utica, New York. The New York correlation chart (Rickard 1975) shows the formation as part of the Deerparkian Stage (or the Siegenian, in European terminology) which is middle Lower Devonian or in absolute terms, about 380 million years old. This is an exceptionally coarse-grained sandstone consisting mostly of quartz with some feldspar. The quartz grains are well rounded and closely packed with a minimum of cement, which near the top of the formation may be calcite. The degree of cementation is variable and the rock tends to be friable at the surface where the rock is subject to frost action. The unit is very massive occurring in beds

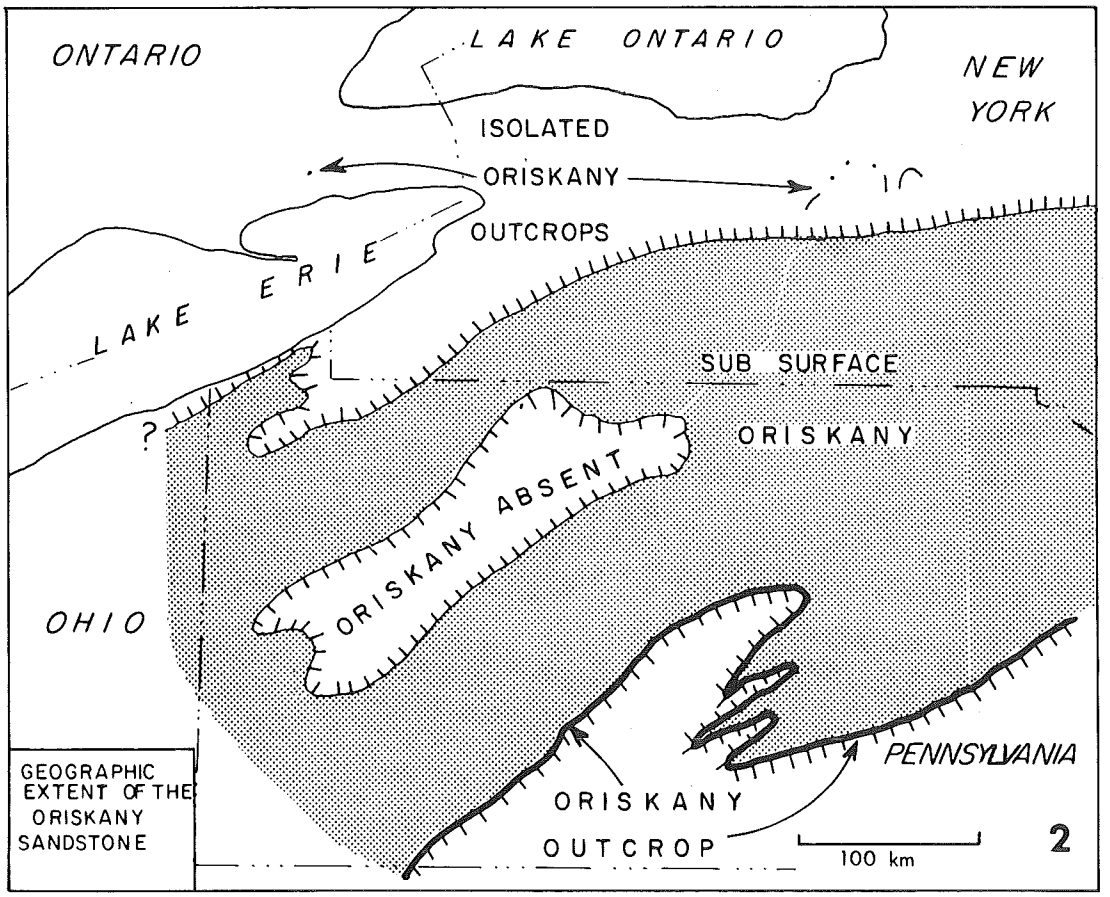

FIGURE 2. Geographic extent of the Oriskany Sandstone Formation. The stippled area represents Oriskany in the subsurface south of the Great Lakes. Isolated erosional remnants are indicated where they crop out in New York State and Ontario. Constructed from Rickard (1975), Kreidler (1964), and Lytle (1964).

Vegetation

The first indications that the vegetation was in any way unusual were the observations of F. S. Cook (University of Western Ontario, personal communication 1976) who noted the presence of saxicolous mosses which are rarely seen in southern Ontario because their required substrate is essentially unavailable. Outcrops most common in southern Ontario are associated with the Niagara Escarpment and they are mainly limestone and dolostone. These rocks differ markedly from sandstone in their calcium content, the pH of materials derived from them by weathering, and their suitability for certain kinds of plant growth.

Open oak-hickory forest growing on sandstone bedrock is very unusual for Ontario. In order to develop a precise idea concerning the structure and composition of the forest, the vegetation was examined in detail and part of the area was sampled quantitatively.

Methods

Five homogenous areas ranging in size between about 2 and 6 ha were selected. Four were forested and one was an opening within the forest. A list was compiled of all trees, shrubs, and herbs in each forested area. Two of the larger areas were sampled quantitatively using the Point Quarter Method (Curtis 1959); 30 sampling points were scattered at random throughout each site. Around each point four trees and four saplings were randomly selected in each of four quadrants, i.e., the nearest specimens to the center point in each quadrat were selected. At every other point a sample of the ground layer was taken by recording presence (frequency) in metre-square quadrats. A number of environmental features as well as additional structural and compositional details of the vegetation were recorded when the sampling procedure was completed.

A frequency value was determined for each tree species on the basis of its percentage occurrence at points. These values were summed for all tree species and the contribution of an individual species to that sum was calculated as a percentage (= relative frequency). Similarly, the number of stems contributed by a species at points of occurrence was calculated as a percentage of the contribution of all species at all points (= relative density). The total basal area for one species was calculated as a percentage of basal area for all species (= relative dominance). The three values for a given species, relative frequency, relative density, and relative dominance, were combined to give its importance value. This is a precise measure of the ecological influence of a tree species in the forest.

In the forest openings lists were taken of all vascular plants present, and general observations on community structure and environmental features were recorded.

Parts of the outcrop along Townline Road (Figure 1) were badly disturbed with old foundations, old buildings, small abandoned quarries, and road systems. Because much of the associated vegetation was weedy, it was not examined in the same way as other sites within the general area.

Results and Discussion

Open oak-hickory communities (Figure 8) of the type located near Nelles Corners on sandstone bedrock had not previously been found during an extensive survey of forest vegetation of southern Ontario (Maycock 1963). At least 28 different tree species are found in the stands sampled on the Oriskany outcrop area (Table 1). This is considerable diversity for such a poor dry site.

At Site I (Figure 1) where the soil is very shallow there are no clear-cut dominants but *Quercus velutina* (Black Oak), *Q. rubra* (Red Oak), *Prunus serotina* (Black Cherry), *Quercus alba* (White Oak), and *Carya ovata* (Shagbark Hickory) are the major tree species. The source of names used in the text and tables is Fernald (1950). All 28 tree species are found in Site I, but more than half of stand importance is accounted for by oaks which together have an importance sum of 163 (Table 1). In the sapling layer *Fraxinus americana* (White Ash), *Prunus serotina, Amelanchier arborea* (Serviceberry), and *Acer saccharum* (Sugar Maple) are well represented. All of the oaks are represented to a limited extent in the sapling layer (approximately 20% of sapling-density) but are less important here than in the tree layer. Hickory reproduction appears to be maintaining the status of this species. A rich assortment of tall shrubs is found including (listed in order of

TABLE 1—Tree species growing in selected stands at the Oriskany outcrop area. Locations of the four sites are shown in Figure 1. Presence is indicated by plus signs and importance values (defined in text) for the two larger sites are given in parentheses

Species	Sites			
	I	II	III	IV
Acer nigrum (Black Maple)	+	+ (3)		
Acer rubrum (Red Maple)	+ (4)	+ (3)	+	+
Acer saccharum (Sugar Maple)	+ (9)	+ (18)		+
Amelanchier arborea (True Serviceberry)	+ (20)	+ (3)	+	
Carpinus caroliniana (Ironwood)	+ (3)	+	+	
Carya cordiformis (Bitternut Hickory)	+	+ (7)		
Carya ovata (Shagbark Hickory)	+ (21)	+ (21)	+	+
Celtis occidentalis (Hackberry)	+			
Crataegus chrysocarpa (Hawthorn)	+	+		
Crataegus sp. (Hawthorn)	+	+		
Fagus grandifolia (Beech)	+			+
Fraxinus americana (White Ash)	+ (17)	+ (1)	+	+
Juglans nigra (Black Walnut)	+	+		
Juniperus virginiana (Red Cedar)	+	+		
Ostrya virginiana (Hop-hornbeam)	+ (1)	+ (15)	+	+
Pinus strobus (White Pine)	+ (6)	+ (4)	+	+
Populus grandidentata (Large-tooth Poplar)	+ (11)	+ (6)	+	+
Populus tremuloides (Trembling Aspen)	+ (3)	+ (5)		
Prunus cerasus (Cherry)	+			
Prunus serotina (Black Cherry)	+ (43)	+ (19)	+	+
Pyrus coronaria (Wild Apple)	+	+		
Quercus alba (White Oak)	+ (26)	+ (78)	+	+
Quercus macrocarpa (Bur Oak)	+	+ (4)		
Quercus muehlenbergii (Chestnut Oak)	+ (4)	+		
Quercus rubra (Red Oak)	+ (48)	+ (86)	+	+
Quercus velutina (Black Oak)	+ (81)	+ (19)	+	
Tilia americana (Basswood)	+ (4)	+ (8)	+	+
Ulmus americana (White Elm)	+			
Total trees	28	24	13	12
Total herbs and shrubs	108	87	45	27
Soil				
pH	4.6–7.0	8.0	7.5	6.4–7.8
Depth A_1 (cm)	6	8	10	10
Depth B (cm)	13	10	48	18
Moisture	dry	dry–mesic	dry–mesic	mesic

unconsolidated surface soil is deeper (see Table 1) than in either Site I or II. White Oak and Shagbark Hickory are the two dominant trees and scattered Black Cherry is also found. In the sapling layer cherry and White Oak are well represented. Prominent tall shrubs are *Cornus racemosa* and *Viburnum acerifolium*, while herbs include *Aster macrophyllus, Carex pensylvanica, Galium aparine,* and *Potentilla simplex* (Old-field Cinquefoil). In total there are 13 tree species in Site III and 45 species of herbs and shrubs.

Site IV, like Site III, is on deeper soil. The dominants are Sugar Maple and Red Maple with some White Oak, White Ash, and Red Oak. This stand is heavily shaded and the saplings are mostly maple. The low shrub layer is very sparse and includes scattered *Viburnum acerifolium.* The only herbs are low and include *Carex pensylvanica, C. pedunculata,* and *Solidago caesia.* There are 12 tree species represented in Site IV and 27 herbs and shrubs. There are few mosses or lichens.

In the forest openings, common dominants are *Cornus racemosa, Danthonia spicata* (Poverty Grass), *Rhus typhina* (Staghorn Sumac), *Prunus virginiana, Desmodium canadense* (Canadian Tick-trefoil), *Hypericum perforatum*

Clubmoss (*Lycopodium clavatum*) are without doubt present here owing to the sandstone substrate and are otherwise quite rare in southernmost Ontario. Because of its southern location, the site also contains a number of uncommon species that are members of the Carolinian flora of Ontario. This flora occupies the region directly north of Lake Erie to a sinuous line from Toronto through London to Port Franks on Lake Huron. Examples of such species in this area are Wild Crab (*Pyrus coronaria*), Black Walnut (*Juglans nigra*), Hackberry (*Celtis occidentalis*), and Chestnut Oak (*Quercus muhlenbergii*). In summary, the unique vegetational status of the area is complemented by the presence of a number of rare and interesting species. Twenty-two of the species found in the Oriskany outcrop area are among those that have been listed as rare by Argus and White (1977) (Table 2). It is most unusual to find such a large number of rare plants concentrated in so small an area.

Habitat for the Black Rat Snake

The presence of unusual forest associations and unusual understorey plants provides a particular habitat for wildlife. The most notable animal known to inhabit the Oriskany site is the Black Rat Snake (*Elaphe obsoleta obsoleta*), the largest species of snake in Canada. The Black Rat Snake is considered rare, threatened, or endangered in Ontario and Canada by several authors (Campbell 1969; Cook 1970a; Anonymous 1970; Froom 1972; Stewart 1974; Parsons 1976; Cook 1977; Gregory 1977).

Observations of *Elaphe obsoleta* at the outcrop were made by W. W. Judd (University of Western Ontario) in 1976 and J. Webber (Erindale College, University of Toronto) in 1977, and by at least four local residents during the past two years. Judd observed a snake at close range for about 1 min; Webber was able to sketch anatomical details from a distance of 2 ft. One local person observed many snakes (of varying sizes) simultaneously in the spring of 1977.

It should be noted that the combination of rocky terrain and extensive relatively undisturbed forested area such as that found at the Oriskany site constitutes ideal habitat for the Black Rat Snake. Knudsen (1955) stated that the Black Rat Snake inhabits areas that have an abundance of rocky areas and crevices, and from these sites they venture out into nearby agricultural lands. The snake is sometimes considered a forest species (Hay 1892; Morse 1904;

TABLE 2—Rare plants (Argus and White 1977) found at the Oriskany outcrop. Areas are those shown on Figure 1

Species	Common name	Area found
Asplenium platyneuron	Ebony Spleenwort	I
Panicum lanuginosum var. *praecocius*	Woolly Panic Grass	P
Carex laxiflora var. *gracillima*		V
Disporum lanuginosum	Fairy Bells	II
Polygonatum biflorum	Solomon's Seal	I,II
Juglans nigra	Black Walnut	I
Quercus bicolor	Swamp White Oak	V
Quercus muehlenbergii	Chinquapin Oak	I,II
Ranunculus hispidus	Stiffly-hairy Buttercup	I
Arabis canadensis	Sickle-pod	I
Prunus americana	Wild Plum	I,II
Desmodium rotundifolium	Round-leafed Tick-trefoil	I
Lespedeza intermedia	Intermediate Bush-clover	P
Linum virginianum	Virginia Flax	P
Viola pedata var. *linearíloba*	Bird-foot Violet	P
Thaspium barbinode	Meadow Parsnip	V
Vaccinium pallidum (V. vacillans)	Hillside Blueberry	I
Asclepias exaltata		I,II
Conopholis americana	Squawroot	I
Galium pilosum		I
Swertia caroliniensis	American Columbo	V
Aster pilosus		P

quite different. Also there would be cold air drainage into the quarry bottom. If commercial removal of dolostone does take place an excavation with sheer vertical faces would result and this would have adverse effects on any peripheral remnants of forest. The edge effect associated with a disturbance as drastic as quarrying would likely be much more pronounced in a dry area such as this than it would in a mesic site. The establishment of a preserve for the fossiliferous portion of the Oriskany outcrop would not have a sufficiently large geographic area to support the unique plant communities such as those in Sites I and II, nor would it be suitably placed to include them.

Another problem associated with a possible quarry operation would be the effects of wind-blown particulates. Dust reduces available light and in some cases reacts with water to form toxic solutions. Trees growing near a source of carbonate dust were reported to have reduced terminal growth (Manning 1971) or to be in a generally poor condition (Brandt and Rhoades 1972). Particulate interference with stomatal behavior seriously affects the diffusion resistance of leaves and changes the rates of gaseous exchange (Ricks and Williams 1974). This could aggravate moisture stress on sites that are exposed or dry (Smith 1974). The rates of degradation of photosynthetic pigments in the leaves of *Quercus petraea* were significantly changed owing to particulate pollutants (Ricks and Williams 1975) and senescence occurred earlier at the polluted sites. Leaves with moderate limestone dust deposits had a greater incidence of fungal leaf spots (Manning 1971), and plants dusted with cement-kiln dust were more susceptible to fungus leaf spot disease (Schonbeck 1960).

A numerical model which predicts the rate of dispersion of atmospheric particulates and the amounts of deposition in wooded areas was described by Belot et al. (1976). A forest canopy significantly increases the concentration of particulates deposited near the source. It is predicted that maximal deposition would occur within 1 km of dust-producing activities.

Tree species respond differentially to dust accumulation. Brandt and Rhoades (1973) have shown that while lateral growth of *Liriodendron tulipifera* (Tulip Tree) was increased as a result of deposition of dust from nearby limestone quarries and processing plants, *Quercus prinus, Q. rubra,* and *Acer rubrum* underwent a reduction in lateral growth. Therefore, in a mixed stand involving these species, importance values would be altered with time. In fact Brandt and Rhoades (1972) documented significant differences in the seedling-shrub and sapling strata between two comparable sites, one with a heavy accumulation of limestone from quarries and processing plants and the other a control area with no dust accumulation. The dominant species at the dusty site would therefore change with continued dust accumulation. The papers by Brandt and Rhoades indicate that it would be difficult to maintain a natural balance among tree species in a forest adjacent to a sustained source of heavy limestone dust.

It cannot be imagined that quarrying would have anything but a detrimental effect on *Elaphe obsoleta*. First, the snake is susceptible to road-kill (Fitch 1963). Second, it retreats with the advent of disturbance to wooded areas (Morse 1904; Minton 1968). Quarrying would lead to an obvious loss of suitable habitat.

Synopsis

We have emphasized the geological importance of the Oriskany Formation in Canada and provided some indication of the unusual nature of this forest tract and its richness in tree and other plant species as well as its unusual structural and compositional features. We have also attempted to show its value as a habitat for the Black Rat Snake. The Oriskany site represents the *only* example of oak-hickory forest on sandstone in Ontario. It is decidedly unique in representing a dry upland type of oak-hickory forest not recognized in Ontario. The oak-hickory type in Ontario is usually associated with heavy clay soils which have peculiar drainage and moisture features and never seems to approach a classical dry oak-hickory type as does the existing example at Nelles Corners. This feature coupled with the large number of unique and interesting plant occurrences, especially the unusually large number of oak species, combines to produce a natural area of great value and interest, and one which should

Congress Field Guide Book Number 4.

Parsons, H. 1976. Foul and loathsome creatures. Parks Canada, Ottawa.

Rickard, L. V. 1975. Correlation of the Silurian and Devonian rocks in New York State. New York Science Service Geological Survey, Chart Series 24.

Ricks, G. R. and **R. J. H. Williams.** 1974. Effects of atmospheric pollution on deciduous woodland. Part 2. Effects of particulate matter upon stomatal diffusion resistance in the leaves of *Quercus petraea* (Mattuschka) Leibl. Environmental Pollution 6: 87–109.

Ricks, G. R. and **R. J. H. Williams.** 1975. Effects of atmospheric pollution on deciduous woodland. Part 3. Effects on photosynthetic pigments of leaves of *Quercus petraea* (Mattuschka) Leibl. Environmental Pollution 8: 97–106.

Sanford, B. V. 1969. Geology: Toronto–Windsor area. Geological Survey of Canada, Map 1263A.

Schonbeck, H. 1960. Beobachtungen zur Frage des Einflusses von industriellen Immissionen auf die Krankbereitschaft der Pflanze. Berichte der Landesanstalt Bodennutzungsschutz (Bochum) 1: 89–98.

Smith, W. H. 1974. Air pollution — effects on the structure and function of the temperate forest ecosystem. Environmental Pollution 6: 111–129.

Stauffer, C. R. 1915. The Devonian of southwestern Ontario. Geological Survey of Canada, Memoir 34.

Stewart, Darryl. 1974. Canadian endangered species. Gage Publishing, Toronto.

Stickel, W. H. and **J. B. Cope.** 1947. The home ranges and wanderings of snakes. Copeia 1947(2): 127–136.

Telford, P. G. 1974. Dunnville area. Ontario Department of Mines, Map P988.

Weetman, G. F. 1972. Canadian Institute of Forestry policy for selection, protection and management of natural areas. Forestry Chronicle 48: 1–3.

Wright, A. H. and **A. A. Wright.** 1957. Handbook of snakes of the United States and Canada. Volume I. Comstock Publishing Associates, Ithaca, New York.

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