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Geological substratum, tree vegetation, and floristic diversity of mature upland forest sites in northern New Jersey

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Summary: Data from twenty-nine stands of upland forests in northern New Jersey were used to determine the impact of geological substratum on species diversity of tree plants. Nine different substrata were studied, with more than three stands available on five of the substrata. The nine geological substrata were Kittatinny Limestone (24 species), Martinsburg Shale (22 species), Brunswick Shale (11), Triassic Conglomerate (15), Basalt (24), Longwood Shale (12), High Falls Sandstone (24), Green Pond Conglomerate (11), and Shawangunk Conglomerate (14). Species which are restricted to specific substrata are discussed. These studies encompass 40 tree species. These tree species are in general quite deeply rooted, and thus it would not be likely to have significant tree speciation taking place rapidly on specific substrata / soil types over 10,000 years since the Wisconsin Glaciation.

Keywords: geological substrata, tree vegetation, upland forest, forest flora of New Jersey, species diversity, distribution

Northern New Jersey is a region of considerable topographic diversity (700–800 feet in relief) and of extensive geological diversity, with geological substrata that include ten different types. These are Gneiss (Byrum, Pochuck and Losee), Triassic Shale, Triassic Conglomerate, Kittatinny Limestone, Basalt, Martinsburg Shale, Shawangunk Conglomerate, Green Pond Conglomerate, Longwood Shale and High Falls Sandstone. In these studies the field work was conducted from August 1959 until August 1963 with subsequent lab and herbarium studies continuing up until the present time, including the fall of 2004. Voucher specimens are on file in the John W. Thompson Herbarium, University of Wisconsin-Superior. The Geomorphic Provinces covered in this study are: (1) The Ridge and Valley Province, (2) The Highlands Province, and (3) The Piedmont Province. The valleys in these regions have elevations of 130 to 140 meters with a few ridges rising to higher elevations.

Glaciation has had a pronounced influence on northern New Jersey, and north of the Wisconsin Age Terminal Moraine. The surface is a sandy till, which is commonly thinner on ridge tops than on slopes and valley bottoms. Since the ice moved across New Jersey from northeast to southeast, the deposits are more or less of the same materials as the rocks they overlie. Drift older than the Wisconsin occurs south of the Wisconsin Moraine (LEWIS & KUMMEL 1940).

Twenty-nine stands of vegetation in the upland well-drained sites of northern New Jersey were studied and were connected primarily with floristic composition of trees, shrubs and herbs. The herb and shrub papers have been published (DAVIDSON 2004a,b), and thus were gathered by a combination of the Point Quarters Method (COTTAM & CURTIS 1956) and the floristic survey was also conducted within each of the twenty-nine stands studied. Quantitative importance values were computed, but it has been felt that the best approach was floristic presence study computed on each of the ten substrata, and then to compare the presence of the twenty-nine stands on the total number of sties (stands) for each substratum. This has also been done for the twenty-nine stands of herbs and shrubs (see DAVIDSON 2004a,b). The results are shown in tables 1–5.

Table 1: Total number of forest sites for each substratum type.

Kittatinny Limestone	3
Martinsburg Shale	5
Brunswick Formation	1
Triassic/Border Conglomerate	1
Basalt	5
Longwood Shale	2
Gneiss no tree data in this paper	(11)
High Falls Sandstone	8
Green Pond Conglomerate	3
Shawangunk Conglomerate	1
	29

Table 2: Average number of trees per substratum.

Kittatinny Limestone	24
Martinsburg Shale	22
Brunswick Formation	11
Triassic/Border Conglomerate	15
Basalt	24
Longwood Shale	12
Gneiss no tree data in this paper	
High Falls Sandstone	24
Green Pond Conglomerate	11
Shawangunk Conglomerate	14

Table 3: Species of trees found on only one substratum.

Kittatinny Limestone	*Juglans nigra*
Martinsburg Shale	*Quercus palustris*
Brunswick Formation	no species restricted to this substratum
Triassic/Border Conglomerate	*Prunus avium*
Basalt	*Carpinus caroliniana*
Longwood Shale	no species restricted to this substratum
High Falls Sandstone	*Betula lutea*
Green Pond Conglomerate	no species restricted to this substratum
Shawangunk Conglomerate	*Acer pennsylvanica*
Franklin Marble not part of the original substrate study	*Quercus muhlenbergii*

Table 4: Specifically of species of New Jersey trees from 29 stands, in search of specific tree / substrate relationships (GLEASON & CRONQUIST 1991).

Acer saccharum	Rich to fairly dry woods, especially in calcareous soils
Carya ovata	Rich, moist soil
Fagus grandifolia	Rich, upland soils
Fraxinus americana	Rich, moist soils
Juglans cinerea	Rich, moist soils
Juglans nigra	Rich, moist soils
Liriodendron tulipifera	Rich woods
Quercus muhlenbergii	In good, chiefly calcareous soils (According to PEARSON (1960a,b, 1962), yellow oak is found in New Jersey only on Franklin Marble, but I have it on one site elsewhere)
Tilia americana	Rich woods
Ulmus americana	Usually in moist, fertile soil

Some comments on types of trees found on only one substratum.

Kittatinny Limestone:
Juglans nigra is commonly thought to be found only on limestone in New Jersey (PEARSON 1960a,b, 1962; Davidson, unpubl. observations) so it is expected to be restricted to limestone in New Jersey. *Ulmus* spp. would not be, as it is a combination of the two species *U. rubra* and *U. americana*.

Martinsburg Shale:
Quercus palustris is found only on Martinsburg Shale, but it is somewhat of a weedy species and thus would not be expected to be restricted to Martinsburg Shale by evolution.

Triassic / Border conglomerate:
Prunus avium is a weedy species and an exotic from Europe, and thus would not be expected to be restricted to this substrate in this study.

Basalt:
Carpinus caroliniana is found only on Basalt, and is found widely in other areas in eastern United States, and thus would not be expected to be found only on Basalt in northern New Jersey.

High Falls Sandstone:
Betula lutea is found only on High Falls Sandstone in the study areas, but is found extensively throughout eastern U.S. on other substrata, and thus would not be expected to be restricted to just High Falls Sandstone in this study. It is more of a northern New Jersey species where it occurs.

Shawangunk Conglomerate:
Acer pennsylvanica is found only on Shawangunk Conglomerate in northern New Jersey, but it is found in just one stand in the study region. It may simply be an outlier from the northern forest of adjacent Northeast Pennsylvania and northern New York to the north.

The three substrata with no trees restricted to them were Brunswick Formation, Longwood Shale, and Green Pond Conglomerate.

Table 5: Trees found on specific substrata.

Kittatinny Limestone	*Acer rubrum* *Acer saccharum* *Betula lenta* *Carya cordiformis* *Carya ovalis-glabra* *Carya* spp.	*Carya tomentosa* *Cornus florida* *Fraxinus americana* *Juglans cinerea* *Juglans nigra* *Liriodendron tulipifera*	*Ostrya virginiana* *Pinus strobus* *Populus grandidentata* *Quercus alba* *Quercus prinus* *Quercus rubra*	*Tsuga canadensis* *Ulmus americana* *Ulmus rubra* *Quercus velutina* *Tilia americana*
Martinsburg Shale	*Acer rubrum* *Acer saccharum* *Betula lenta* *Carya cordiformis* *Carya ovalis-glabra* *Carya ovata*	*Carya* spp. *Carya tomentosa* *Cornus florida* *Fagus grandifolia* *Fraxinus americana* *Liriodendron tulipifera*	*Nyssa sylvatica* *Ostrya virginiana* *Quercus alba* *Quercus coccinea* *Quercus palustris*	*Quercus prinus* *Quercus rubra* *Quercus velutina* *Sassafras albidum* *Tsuga canadensis*
Brunswick Formation	*Acer rubrum* *Betula lenta* *Carya ovalis-glabra*	*Cornus florida* *Fagus grandifolia* *Fraxinus americana*	*Quercus alba* *Quercus coccinea* *Quercus prinus*	*Quercus rubra* *Quercus velutina*
Triassic/Border Conglomerate	*Acer rubrum* *Betula lenta* *Betula populifolia* *Cornus florida*	*Fagus grandifolia* *Liriodendron tulipifera* *Nyssa sylvatica* *Prunas avium*	*Prunus serotina* *Quercus alba* *Quercus coccinea* *Quercus prinus*	*Quercus rubra* *Quercus velutina* *Sassafras albidum*
Basalt	*Acer rubrum* *Acer saccharum* *Betula lenta* *Carpinus caroliniana* *Carya ovalis-glabra* *Carya ovata*	*Carya tomentosa* *Cornus florida* *Fagus grandifolia* *Fraxinus americana* *Juglans cinerea* *Liriodendron tulipifera*	*Nyssa sylvatica* *Ostrya virginiana* *Quercus alba* *Quercus coccinea* *Quercus prinus* *Quercus rubra*	*Quercus velutina* *Sassafras albidum* *Tsuga canadensis* *Tilia americana* *Ulmus americana* *Ulmus rubra*
Longwood Shale	*Acer rubrum* *Acer saccharum* *Betula lenta*	*Cornus florida* *Fagus grandifolia* *Liriodendron tulipifera*	*Nyssa sylvatica* *Quercus coccinea* *Quercus prinus*	*Quercus rubra* *Quercus velutina* *Sassafras albidum*
Gneiss	no data available			
High Falls Sandstone	*Acer rubrum* *Acer saccharum* *Amelanchier* spp. *Betula lenta* *Betula lutea* *Carya ovalis-glabra*	*Carya ovata* *Cornus florida* *Fagus grandifolia* *Fraxinus americana* *Liriodendron tulipifera* *Nyssa sylvatica*	*Ostrya virginiana* *Prunus serotina* *Populus grandidentata* *Pinus rigida* *Pinus strobus* *Quercus coccinea*	*Quercus prinus* *Quercus rubra* *Quercus velutina* *Sassafras albidum* *Tsuga canadensis*
Green Pond Conglomerate	*Acer rubrum* *Betula lenta* *Carya ovalis-glabra*	*Prunus serotina* *Populus grandidentata* *Quercus coccinea*	*Quercus prinus* *Quercus rubra* *Quercus velutina*	*Sassafras albidum* *Tsuga canadensis*
Shawangunk Conglomerate	*Acer pennsylvanica* *Acer rubrum* *Acer saccharum* *Amelanchier arborea* *Amelanchier* spp. *Betula lenta*	*Betula lutea* *Betula populifolia* *Carya ovalis-glabra* *Nyssa sylvatica* *Ostrya virginiana*	*Prunus serotina* *Pinus rigida* *Pinus strobus* *Quercus alba* *Quercus coccinea*	*Quercus prinus* *Quercus rubra* *Quercus velutina* *Sassafras albidum* *Tsuga canadensis*

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