Long Island Botanical Society

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Why Are Plants on the Stony Brook Campus Thriving Despite Acid Rain and Acid Soil?

by Jeffrey E. Hudson and Gilbert N. Hanson, Stony Brook University

In this report we present data relating to the effects of acid rain on the soil and plants in the wooded areas of the Stony Brook University campus. The data include soil pH with depth, exchangeable[1] calcium (Ca) and aluminum (Al) in soil with depth, the species distribution of plants, pH of soil and the Ca and Al concentrations of leaves and roots on the Stony Brook University campus (Fig. 1). A more complete presentation of these results is on the web at: www.geo.sunysb.edu/reports.

Figure 1. Location of study sites on the Stony Brook University campus. The yellow five-pointed star identifies the Ashley Schiff Park Preserve, location of soil-pH and leaf-collection sampling. The four-pointed star is the location of cation exchange capacity (CEC) analysis of soil.

Acid rain has been falling on Long Island for at least the last 70 years. The pH of rain was 5.6 before industrialization. By 1987 it was 4.3, an increase in acidity by a factor of 30. From that low point in 1987 pH has increased to 5.0 in 2013 (Table 1). So, things are getting better as a result of the Clean Air Act of 1963 and later amendments.

Wherry (1923) studied the plant distributions and the pH of soil in a deciduous forest in Locust Valley some 40 km west of the Stony Brook University campus. This forest is on the Harbor Hill moraine just as the Stony Brook campus is. Greller et al. (1990) restudied the pH of soil and plant distributions in 1985. They found a significant decrease in pH compared to that found by Wherry (1923) (Table 2) and concluded that the decrease in soil pH was a result of acid rain. Greller et al. (1990) also found that there were fewer species of dominant plants within the forest, an increased dominance of acid-tolerant plants, and a loss of acid-sensitive plants.

Hedin and Likens (1996) suggest that acid rain inhibits the growth of plants because acid rain washes plant nutrients (mainly exchangeable Ca) from the soil and makes available toxic aluminum. However, atmospheric dust replenishes some of the lost Ca.

When acid rain infiltrates the soil, it enriches exchangeable hydrogen ions on soil particles. These hydrogen ions promote the production of exchangeable aluminum and

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[1] Exchangeable elements are available to plants in the soil. Exchangeable, positively-charged elements (cations) that are soil nutrients are calcium, magnesium and potassium. Calcium is used as a proxy for all of these nutrients because it is usually the most abundant.

Society News

Lois Lindberg, LIBS Membership Chair, offers the following report:

LIBS Membership by the Numbers

As the long-time membership chair, I recently reviewed some noteworthy facts about our 30-plus year history. The Society currently has a membership of approximately 175, with 18 professional organizations represented. Although most of our members hail from New York, people have joined from 14 states across the country, and Canada. Our first Life Member signed up in 1998, and now 29 people are part of that elite group. Looking back to the Society's beginnings, ten of the original "class of 1986" are still members today. And LIBS certainly builds a loyal following: almost 70 of you folks have been members for at least twenty years – Wow! And such diverse professions and interests – teachers, field researchers, ecologists, gardeners, authors, artists, citizen scientists – all with a common goal to protect our botanical heritage. Thank you to everyone for your support of LIBS.

JOIN LIBS TODAY!

Annual Membership is $20 payable to:
Long Island Botanical Society

Mail your dues to:
Carol Johnston, LIBS Treasurer
347 Duck Pond Road
Locust Valley, NY 11560

Announcements:

April 13-15, 18th Northeast Natural History Conference (NENHC), Burlington, VT

This conference has been the largest regional forum in which researchers, natural resource managers, students, and naturalists can present current information on the varied aspects of applied field biology (freshwater, marine, and terrestrial) and natural history of the Northeastern United States and adjacent Canada. By bringing together people with diverse backgrounds it will serve as a premier venue for identifying research and management needs, fostering friendships and collegial relationships, and encouraging a greater region-wide interest in natural history. https://www.eaglehill.us/NENHC_2018/NENHC2018.shtml

The Town of North Hempstead offers classes in: Composting, Installing and Using a Rain Barrel, Sustainable Yard Care, Creating a Rain Garden, and Native Plant Gardening. http://www.northhempsteadny.gov/Composting-Rain-Barrels-and-Gardens

(Why Are Plants Thriving, continued from cover)

Table 1. pH of rain on Long Island

Date	pH
1955-56[1]	4.8
1987[2]	4.3
2005[2]	4.6
2013[3]	5.0

[1] Mackenzie & Mackenzie, 1995

[2] NYSDEC, 2005

[3] Extrapolation based on pH of rain in Washingon Crossing, NJ which also had a pH of 4.3 in 1987 and a pH of 4.5 in 2005. In 2013 the pH of rain had increased to 5.0 New Jersey DEP, 2016.

replace the exchangeable Ca on the soil particles (Hedin and Likens, 1996). Exchangeable Ca ions are essential for healthy plant growth, whereas exchangeable species of Al impede plant growth (Ericsson 1995). Cronan and Grigal (1996) found that there is a greater than 50% risk of adverse impacts on plant growth if the Ca/Al molar ratio is less than 12.5 in plant leaves, 1.0 in soil solution and 0.2 for fine root tissue.

Results

All the plants in the Stony Brook study areas (Table 3) are considered acid tolerant (Gawler and Sneddon 2015). Maple-leaved viburnum (*Viburnum acerifolium*) is the most abundant species by groundcover. These species were also found by Greller (1990) and Wherry (1923).

Soil pH was determined in the Ashley Schiff Park Preserve in October 2017 by Karim Hanna (pers.comm.) (Fig. 2). The pH of the soil on the ridge and along the slope is less than that in valley floor (bottomland) even though the change in elevation is only three meters. For each site the pH value of the organic matter in the O-horizon (0 to +5 cm) is significantly higher than at the boundary with the underlying topsoil. These data suggest that as the rain passes through the O-horizon it releases organic acid.

We collected leaves in the Ashley Schiff Park Preserve for chemical analysis at three different times, newly fallen leaves in November 2015, leaves on the plants in July 2016, new buds In April 2017.

Table 2. Soil pH using distilled water[1] in a forested area in Valley Stream, NY.

	Ridgetop	Slope	Bottomland
Wherry (1923)	4.5	5.5	6.5
Greller et al (1990)	3.8	3.9	4.1

[1] Distilled water gives a pH about 0.6-0.7 pH units greater than that given by using 0.01 m CaCl2 (Bauch, 2007).

Table 3. Estimated plant cover

Fagus grandifolia American Beech	1%
Viburnum acerifolium Maple-leaved Viburnum	44%
Thelypteris noveboracensis New York Fern	3%
Toxicodendron radicans Poison Ivy	6%
Acer rubrum Red Maple	1%
Sassafras albidum Sassafras	5%
Gaultheria procumbens Wintergreen	2%
Total	62%

There are, however, not enough samples to show a seasonal pattern of changes in the Ca/Al ratio for the various species (Table 4). Maple-leaved viburnum, the most abundant groundcover plant, has the lowest Ca/Al ratio. It is not clear if the deviations are related to changes in leaf chemistry associated with the season of collection or to other factors. For both sassafras and black birch, the only two species

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(Why Are Plants Thriving, continued from page 9)

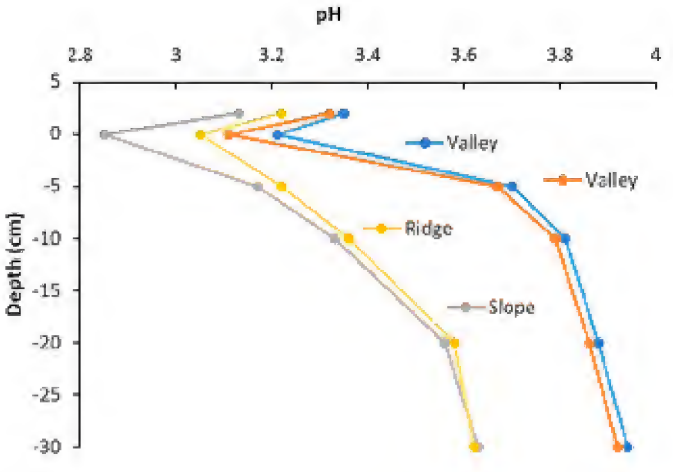

Figure 2. Depth versus soil pH above and below the organic-mineral boundary at the top of the soil horizon

sampled in more than one season, the fallen leaves collected in November have a lower Ca/Al ratio than those collected in the spring or summer.

The lowest value for molar Ca/Al found in foliar tissues is 17.2 for Maple-leaved viburnum (*Viburnum acerifolium*; Table 4). The mixed fine root tissue shows a Ca/Al molar ratio of 0.92. Both values are well above the 50% risk ratio determined by Cronan and Grigal (1990) and show that the plants are in favorable conditions for growth.

The soil pH and exchangeable cation concentrations (CEC) were determined for a small wooded area near the Earth and Space Sciences building (Fig. 1) by Jovet Llanos (pers.comm.) in 2015 (Fig. 3). The paucity of exchangeable soil calcium and low Ca/Al ratios at 15 cm and greater depths suggest that plants are absorbing essentially all their calcium within the upper 15 cm of soil.

Table 4. Chemical analysis of leaves

	Date collected	Ca/Al molar
Fagus grandifolia Beech	April 2017	56.2
Betula lenta Black Birch	April 2017	220
Betula lenta	July 2016	121
Betula lenta	Nov. 2015	78.5
Acer sp? Maple	July 2016	195
Viburnum acerifolium Maple-leaved Viburnum	July 2016	17.2
Acer rubrum Red Maple	July 2016	193
Sassafras albidum Sassafras	July 2016	62.6
Sassafras albidum Sassafras	Nov. 2015	22.6
	Average	107

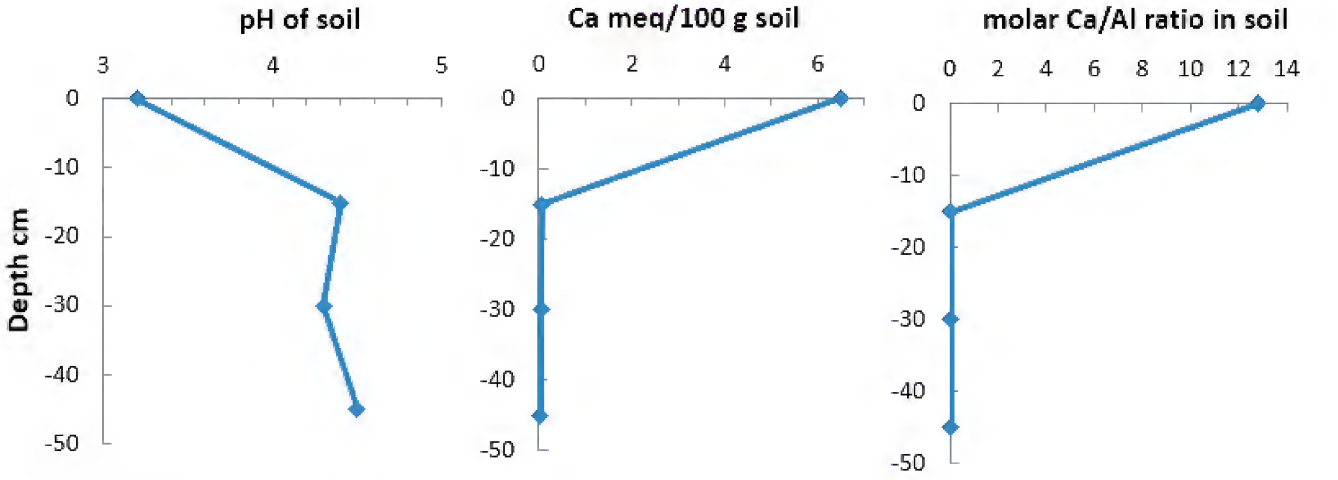

Figure 3. pH of soil, Ca in meq/100 grams of soil, and molar Ca/Al ratio in soil with depth from the organic-mineral horizon near the Earth and Space Sciences building (Fig. 1).

Table 5. Molar Ca/Al ratio of bulk samples with depth in woods in Cathedral Pines County Park (Boguslavsky 2000).

Depth	Molar Ca/Al
0 to 30 cm	0.16
30 to 60 cm	0.05
60 to 90 cm	0.12

While the uppermost soil has a high Ca/Al molar ratio (12.8) the fine roots, which are around this depth, exhibit a much lower Ca/Al ratio of 0.92. Cronan and Grigal (1995) identified a similar trend and attributed the ratio difference to the aging of fine roots, suggesting that the fine-root filters prevent the aluminum from entering the tree sap so that over time aluminum accumulates in the root tissue.

Boguslavsky (2000) analyzed exchangeable Ca and Al in forest soil in Cathedral Pines County Park on Long Island. She found the Ca/Al molar ratios for bulk samples representing intervals of 0 to 30 cm, 30 to 60 cm and 60 to 90 cm depths (Table 5). These data are consistent in suggesting that the molar Ca/Al ratios in soil water at depths greater than 15 cm are much less than 1.

The most likely reason that the Ca is restricted to the uppermost layer of the soil column is that the quartz-rich and calcium-poor soils on Long Island are not an important source of Ca in the soil (Kundic 2005, Xin and Hanson 1994). The source for Ca in the upper layer of the soil is primarily from recycled Ca in decaying plant litter and the continuous supply of Ca in airborne dust (Hedin and Likens 1996).

This data set suggests that, for this wooded area, acid-loving plants are tolerating the effects of acid rain on the soil because their roots are getting Ca from the uppermost layer of soil where there is a relatively high Ca concentration and a high Ca/Al ratio.

If the pH of rain continues to increase, this should reduce the amount of exchangeable, toxic Al in the soil. And, if enough Ca is continuously added to the soil from airborne dust, perhaps the plants less tolerant to acid rain will return.

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Field Trips

April 7, 2018 (Saturday) 10 AM
Sagamore Hill National Historic Site, Oyster Bay, NY
Hunting for Marine Algae at Sagamore Hill National Historic Site
Trip Leader: Andrew Greller
E-mail: agreller2@optonline.net

We will hike down to the shore to identify the marine algae that wash up at high tide. Pick up a guide to *Marine Algae of the Northeastern Coast of North America*, and bring it along to help with identification. There may be spring wildflowers out and we will look for them, as well as for the remnants of plants of the coastal sands. Dress for the weather; rubber boots will be useful. Bring a liquid and snacks. A hand lens may be useful. Meet at the parking lot.

Extra 9 AM attraction: Sagamore Hill is offering LIBS members an early-bird first-floor walk-through of Theodore Roosevelt's home prior to the algae field trip. Entrance to the home is limited to 15 people, so if you are interested, please RSVP to Lois Lindberg, email lalindberg3@optonline.net

Directions: Take either the Northern State Parkway to Exit 35N or the Long Island Expressway (I-495) to Exit 41N. At those exits, take Route 106 North for approximately 6 miles to downtown Oyster Bay. Turn right onto East Main Street (at Nobman's Hardware Store) and travel 2 miles on East Main Street/Cove Road. Turn left onto Cove Neck Road and drive 1.5 miles to Sagamore Hill National Historic Site.

May 5, 2018 (Saturday) 10 AM
Welwyn Preserve, 100 Crescent Beach Rd, Glen Cove, NY
A Spring Walk Through Welwyn
Trip Leaders: Al Lindberg, Lois Lindberg, and Lisa Synoradzki
E-mail: ajlindberg@optonline.net

We will explore Welwyn's diverse habitats, from its tuliptree swamp forest, freshwater streams through the saltmarsh, and down to its sandy beach on Long Island Sound, while searching for an assortment of spring ephemerals and Long Island rarities. Rarities will include striped maple (*Acer pensylvanicum*), Ohio buckeye (*Aesculus glabra*), yellow birch (*Betula alleghaniensis*) and American bladdernut (*Staphylea trifolia*). Dress for the weather and please bring a beverage, snacks or lunch, and sunscreen. Welwyn has been noted for its ticks so please also bring insect repellent.

Directions: From the East: Long Island Expressway to Exit 41 North – NY-106/107 N. Bear left where the two roads split to stay on Route 107N, continue for approx. 7 ½ miles into Glen Cove. Where Rte. 107 ends at the Glen Cove Fire Dept, turn right onto Brewster St. Continue for ½ mile, turn left onto Dosoris Lane. Go ¾ mile, turn left on New Woods Rd. and take it to the end. Turn right onto Crescent Beach Rd, Welwyn Preserve is the first driveway on the right. Continue along the driveway to the main parking lot.
From the West: Long Island Expressway to Exit 39 North – Glen Cove Road. After 4 miles, Glen Cove Rd. merges with Route 107N. Continue north on Rte. 107 into Glen Cove and follow the above directions.

June 16, 2018 (Saturday) 9 AM
Brookhaven National Laboratory, Upton, NY
Forest and Fuels Management Area/Wildfire Area
Trip Leader: Kathy Schwager
Trip is limited to 18 people.
Registration is REQUIRED by June 14

Brookhaven Lab is located in the Central Pine Barrens region of Long Island, which has evolved over thousands of years in the presence of frequent fires. As a result, plant and animal species of the pine barrens have adapted to such conditions. A wildfire burned through a portion of the lab site in 2012. Prescribed fire has been implemented to not only reduce fuels, but to promote forest regeneration by helping remove vegetation and leaf litter that prevent seeds of pines, oaks, and other native species from germinating.

We will meet first in Building 860 for a brief introductory presentation. We will then proceed to the prescribed-burn units and Crescent Bow wildfire area to look at post-fire regeneration and the differences between burned and unburned areas as well as the effects of different kinds of fire on the ecosystem (See Fig. 1). Please bring sufficient food and water, and wear long pants and appropriate footwear. Tick repellent is advised.

Directions to the lab can be found at https://www.bnl.gov/maps/index.php at the bottom of the page. Specific directions to Building 860 from the front gate can be found by clicking on the "Building Locations & Custom Map Points" tab. You will be required to go through security at the front gate so please make sure you have valid identification (driver's license or such) to present. Anyone who has not pre-registered **will be turned away at the gate.**

For further information and to register, please contact Kathy Schwager at kschwager@bnl.gov.

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Figure 1. General aerial view of the Brookhaven Lab field trip area

Other field trips to look forward to:

July 14, 2018 (Saturday) 10 AM
Shore Road to Wawapek, Cold Spring Harbor, NY
Trip Leaders: Jane Jackson and Amanda Furcall

September 8, 2018 (Saturday) 10 AM
Hempstead Plains, East Garden City, NY
(Co-Sponsored with NYFA)
Trip Leader: Steve Young

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Upcoming Programs *(continued from back cover)*

(May 8 Program continued from back cover)

and gained an interest in bio-geochemistry during his undergraduate career. Between his undergraduate and graduate studies, Jeff was an educator and Peace Corps volunteer.

Gilbert N. Hanson: "The Natural Surface of Long Island is Covered by Pebbly Loess." The uppermost layer of much of Long Island's natural surface appears to consist of a dun-colored, unlayered, heterogeneous mixture of clay, silt, sand, and pebbles. This deposit is not directly related to glacial activity. The glaciers left Long Island some 20,000 years ago. At two sites, one on Stony Brook campus, dating indicates that the time of deposition was about 13,000 years ago. The hypothesis is that variations in the silt-to-sand ratio in this surficial layer are determining the type of soil and whether deciduous forest, pine barrens, or dwarf pine plains are found. The most important factor may be how small changes in the ratio of silt-plus-clay to sand affect the infiltration rate of precipitation through soil.

Pre-Meeting Field trip to see Pebbly Loess. Meet at 6:30 PM at our regular meeting room. This field trip on the Stony Brook University Campus will be within a quarter of a mile of the Earth and Space Science Building where we will see the pebbly loess in an exposed section in a small stream valley and in forest soil. Walking total of about one-half mile along mostly paved areas.

Location: Earth and Space Science Building
Gil Hanson Room (Room 123)
Stony Brook University, Stony Brook

June 12, 2018 Tuesday, 5:30 PM

(please note early start time for the barbecue)

Annual Barbecue: The annual barbecue, featuring Chef Eric's made-to-order hot dogs and hamburgers. Salads, deviled eggs, desserts, etc. gladly accepted. The traditional location---on the green behind the Muttontown Preserve meeting house.

Location: Bill Paterson Nature Center, Muttontown Preserve, East Norwich

Long Island Botanical Society
PO Box 507
Aquebogue, NY 11931

Upcoming Programs

April 10, 2018* **Tuesday, 7:30 PM**

Lisa Synoradzki: "Welwyn Preserve's Forest: To Restore or Do Nothing." Years ago, "ancient," "magnificent," and "spectacular" were used to describe the 40-acre woodland in Welwyn Preserve, known for its grove of enormous oak and tulip trees. Today, sadly, invasive species, such as creeping euonymus and Japanese knotweed, are spreading unchecked from adjacent yards, threatening to give the forest habitat a new descriptor, "degraded," if nothing is done. Lisa will talk about her study of Welwyn's plants in the context of the ecological restoration debate. Lisa is Senior Development Officer at The New York Botanical Garden (NYBG). She has a Certificate in Botany from NYBG and is a certified NYBG Urban Naturalist.

Location: Bill Paterson Nature Center
Muttontown Preserve, East Norwich

May 8, 2018* **Tuesday, 7:30 PM**

Jeffrey E. Hudson and Gilbert N. Hanson: "Why are Plants Thriving in Spite of Acid Rain and Acid Soil?" Due to acid rain, natural Long Island soils are depleted in the nutrient calcium (Ca) and enriched in toxic aluminum (Al). In a limited study, the speakers found that Ca is restricted to the uppermost layer of the soil where there is less soluble Al. Could it be that plant roots are getting most of their nutrient Ca in that uppermost layer of soil where the Ca is derived from decaying plant litter and atmospheric dust? Gil Hanson is a Professor of Geology at Stony Brook University who spent most of his career in isotope and trace element geochemistry of rocks. In the last 20 years he has become more interested in the geology and ecology of Long Island. Jeff Hudson is a current Stony Brook Masters student in the Geo-science Department. He studied biology and science education

(Programs continued inside on page 13)

* Refreshments and informal talk begin at 7:30 p.m. Formal meeting starts at 8:00 p.m.
Directions to Muttontown or Stony Brook: 516-354-6506