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Number 1

WETLANDS AND AQUATIC STUDIES:
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PLANT COMMUNITY TYPES:
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PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE, INC.

VOLUME CONTENTS

Vol. 17 NOVEMBER 1991 Number 1

PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE

WETLANDS AND AQUATIC STUDIES

PLANT COMMUNITY SUCCESSION IN A RICH FEN IN THE BYRON-BERGEN SWAMP

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ABSTRACT

Multivariate analyses were used to determine vegetation pattern in a rich fen in western New York. Two-way indicator species analysis (TWINSPAN) divided the samples into a fen group and a hummock and encroaching forest group. Further subdivisions of samples resulted in groups with similar hummock dimensions, and species composition.

The first DCA axis of the detrended correspondence analysis was significantly correlated with increasing promontory height and soil cation-exchange capacity. The second axis was correlated with decreasing microelevation and soil pH.

Tree age data, peat stratigraphies, DCA and TWINSPAN results were used in the generation of a successional model for this system reflecting a physiognomic progression from sedge fen to shrubs and then to trees. This progression corresponds to an autogenic increase in promontory dimensions.

INTRODUCTION

Peatland development has been associated with changes in hydrology and water chemistry partially or wholly created by peat forming vegetation (Kulczynski 1949). Moore and Bellamy (1974) described the geomorphology, hydrology and microclimate determining the gross morphology of the peatland and "hydroedaphic conditions affecting the biotic expression of the component peat forming ecosystems". They decribed biotic modifications of the abiotic template through the alteration of hydroedaphic conditions resulting in succession from pioneer aquatic to more mesic ecosystems.

The objectives of this study were to: (1) elucidate successional tendencies of the wetland communities under the influence of calcareous surface drainage and corresponding changes in peat stratigraphy; (2) attempt to clarify the causes of such changes; and (3) examine the interaction of vegetation and environment in areas where rich fen is changing to poor fen occupied by shrubs and stunted trees.

STUDY AREA

The Byron-Bergen Swamp is a 530 ha wetland in northeastern Genesee County, New York (43° 06' N, 78° 01' W). This wetland complex is composed of sedge dominated fens on both marl and peat substrates surrounded by *Thuja occidentalis*, *Pinus strobus* and *Acer rubrum* wetland forest.

The swamp lies in the Salina Depression and is underlain by Camillus shale carrying an overburden of calcareous glacial till (Fairchild 1928). Waters drain into the depression from the Niagara Escarpment of Lockport dolomite to the north and from the Onondaga Escarpment of Onondaga limestone to the south. These waters flow through the ecosystem, at or near the surface, in a northeasterly direction draining into Black Creek at the northern edge of the wetland.

The waters flowing through these fens are minerotrophic; they are saturated with calcium and magnesium carbonates resulting in rich fens as described by Wheeler (1980), Slack et al. (1980) and Karlin and Bliss (1984). They are not necessarily nutrient rich because phosphorus and iron precipitate as marl forms (Wetzel 1972, 1975).

Successional trends for the Byron-Bergen Swamp have been suggested by Stewart and Merrell (1937), Muenscher (1946) and Walker (1967, 1974). These studies addressed successional tendencies in a general way but not succession specific to the fens, nor did they use soils, peat stratigraphic or hydrologic evidence. Ordination of the vegetation of marl beds have been reported by Bernard et al. (1983) and Seischab (1984).

METHODS

Vegetation

Two transects, 150 m and 75 m in length, were established to intersect vegetation of two fens and an adjacent forest. Contiguous square meter plots were established along both transects. Cover values were estimated for all trees, shrubs, herbs and bryophytes rooted in and overhanging each of the 225 plots. Relativized cover values were subjected to (i) Detrended Correspondence Analysis (Hill 1979a) to assist in the determination of correlations between vegetation and environment and (ii) Two-way Indicator Species

Analysis (TWINSPAN) (Hill 1979b) to identify vegetation groupings.

In order to gain information on possible tree encroachment onto the fen, 37 of the largest trees within two meters of the transect and evenly distributed along the first 35 m of the transect were cored at ground level and aged. Nomenclature for vascular plants follows Fernald (1950), for bryophytes Crum and Anderson (1981).

Substrate

Single 2.5 cm^2 perforated galvanized pipes were driven through the peat to the underlying clay substrate at 30 m intervals along the longest transect. We monitored water table depth weekly for one year.

Every 7.5 m along the same transect we removed a substrate core of the entire depth of the peat (about 2.5 m). Each core was subdivided into 15 cm segments and each segment was analysed for pH and specific conductance. Mixtures of 1:1 peat to distilled water were prepared for each segment. Specific conductance and pH were determined on each prepared sample using an Orion 801A pH meter and a YSI Conductivity meter.

Six stratigraphic cores, 7.5 cm in diameter and approximately 60 cm in depth, were removed from sites representative of the fen vegetation along the transects. These cores were used for macrofossil and stratigraphic examination of the upper peat layers. The 60 cm approximates the maximum rooting depth of trees found along the transects (Seischab 1977). The cores were weighed before and after drying to a constant weight at 105°C. They were divided horizontally according to morphological differences in the strata. Each stratum was analysed for organic matter content, percent carbonate-carbon, cation-exchange capacity and bulk density.

Percent carbonate-carbon and percent organic matter were determined by wet oxidation according to Allison(1965) and Broadbent (1965). Cation-exchange capacity (CEC) was determined by sodium saturation (at pH 7.0) according to Chapman(1965). Bulk density was based on volume before drying.

Simple linear correlations (Sokal and Rohlf 1973) were calculated between environmental measures and DCA axis scores of the sample plots. Weighted averages of soils parameters were determined by multiplying the depth of each stratum by its corresponding measured value, summing these intermediate products and dividing the sum by the depth of the core.

Water Analysis

Water samples were removed biweekly from four shallow (60 cm) wells, two in fen communities and two in adjacent forest communities. These samples were filtered to remove debris and were examined for pH, conductance, and phosphate and nitrate content within one hour of sampling. Other filtered samples were refrigerated at 35°C in polyethylene bottles for up to a month before being examined for calcium, magnesium and iron content.

Specific conductance was measured with a YSI conductivity meter. No corrections for hydrogen ion concentration were needed in these highly alkaline waters. An Orion 801A specific ion meter was used for determining pH and nitrate content (Orion 1976). A colorimetric molybdate procedure (Wetzel and Likens 1979) was used in phosphate determinations. Calcium, magnesium and iron were determined on a Perkin-Elmer 303 atomic absorption spectrophotometer.

are usually saturated in water.

The mosses also tend to form small promontories, sometimes growing up the Eleocharis rostellata shoots, this being the start of hummock and tussock formation. The first low promontories allow low shrubs such as *Potentilla fruticosa* and *Juniperus horizontalis* to begin growth. This is the third stage in succession (Fig. 6C).

Glime et al. (1982) described a Michigan fen where the dominant mosses (*Drepanocladus revolvens, Campylium stellatum, Sphagnum fuscum, S. girgensohnii,* and *S. warnstorfii*) were similar to the present study site. They showed that these mosses reduced the pH of the water. The reduced pH by non-*Sphagnum* mosses facilitates succession from rich fen to *Sphagnum* bog. This process was associated with a vertical zonation of the mosses on hummocks. In our study *Campylium stellatum* and *Drepanocladus revolvens* are found in the sedge fens. *Drepanocladus* is seen on many of the hummocks. *Sphagnum* species are only on hummocks. This arrangement is similar to the vertical zonation reported by Glime et al. (1982). In Byron-Bergen this progression from fen to hummock corresponds to an increase in soil cation-exchange capacity probably due to an increase in galacturonic acid as described by Spearing (1972) who indicated an increase in cation-exchange with distance above the surrounding water level.

Tussocks of *Scirpus cespitosus* var. *delicatulus* (10-25 cm in ht.), the dominant in Fen-b, tend to be taller than those of *Eleocharis*. *Scirpus cespitosus* was observed in the Hohe Venn in Germany (Schwickerath 1944), where the *Scirpetum caespitosi* (*germanici*) association was reported as developing into a shrub-scrub community dominated by the *Betulum pubescentis* association. This association contained a variety of shrubs and the mosses *Sphagnum recurvum* and *Polytrichum commune*. The *S. cespitosus* in Byron-Bergen occurs with shrubs, shrubby trees, and *Sphagnum* species in large hummocks (Fig. 6E) and at the leading edge of the encroaching forest in groupings similar to those in Fig. 6D.

The tops of the *Scirpus* tussocks are considerably drier than the surrounding small promontories and moss mat. It is common to see a variety of shrubs established in these tussocks. Moore and Bellamy (1974) suggested that drying of the surface favors hummock formers to the detriment of hygrophilous species. Such seems to be the case in the *Scirpus* tussocks which are invaded by *Potentilla fruticosa, Myrica pennsylvanica, Gaylussacia baccata* and *Ledum groenlandicum* in the Byron-Bergen fens (Fig. 6E).

The multispecies large hummocks (Fig. 6E) have a similar orientation as the forested "islands" of patterned fens reported from Minnesota peatlands (Griffin 1977, Heinselman 1963, 1970). The large hummocks are not teardrop shaped as are the forested "islands" or the hammocks of the Everglades (Egler 1952). However, their long axes do extend downslope. Like the forested "islands", their upstream ends contain clusters of trees surrounded by *Sphagnum*. Shrubs found at the upstream ends are larger in stature than those at the downstream ends, implying hummock expansion at the downstream ends. *Scirpus cespitosus* is found at the downstream ends and the sides of the hummocks, which also suggests hummock expansion at these locations.

Sphagnum fuscum, a dominant moss in these hummocks, has been described as an agressive hummock former in other peatlands (Kulczynski 1949, Heinselman 1970, Moore and Bellamy 1974). As such, it may account, in part, for hummock expansion into the surrounding *Eleocharis rostellata* dominated fens.

Tussock formation by *Scirpus cespitosus*, and hummock formation by *Sphagnum* and their associated shrubs is suggestive of two mechanisms for areal reduction of the fens. Forest encroachment is indicated by the tree and stratigraphic cores. Expansion and coalescence of hummocks is the second. Such a coalescence has been suggested by Watt (1947) in grasslands and if a similar process is occurring in these fens then they will become dominated by shrubs with a resulting reduction of fen.

CONCLUSIONS

Succession in these rich fens proceeds from short sedges such as *Eleocharis rostellata* to mound forming sedges like *Scirpus cespitosus* and then to larger multispecies hummocks. The sedge dominated fens are also being succeeded by encroaching *Thuja occidentalis, Larix laricina, Pinus strobus* forest. Hummock formation and forest encroachment both progress by shrub and tree invasion of *Scirpus* tussocks. Encroachment of forest on fen is supported by the stratigraphic record and by tree core data.

The successional process from fen to hummock and developing forest corresponds to an increase in soil cation-exchange capacity and a decrease in soil carbonate-carbon and both soil and water conductance. This suggests that the spatial pattern is reflective of the successional pattern.

The conversion of sedge dominated rich fen to shrub and stunted tree dominated poor fen appears to be primarily an autogenic process whereby the sedges, shrubs and *Sphagnum* species accumulate organic debris, forming mounds. This process results in the shrubs and trees being rooted further above the highly calcareous water table.

Acknowledgements

We appreciate the continued support of our efforts by the principal land owners of the study site, the Bergen Swamp Preservation Society. We also recognize the field assistance of our numerous students. The senior author was granted a Dean's Summer Fellowship from the Rochester Institute of Technology for a portion of this research.

BIBLIOGRAPHY

Allison, L. E. 1965. Organic carbon. In Black *et al.* 1965 Methods in soil analysis. Amer. Soc. of Agron., Inc. Madison, WI.

Bernard, J. M., F. K. Seischab and H. G. Gauch, Jr. 1983. Gradient analysis of the vegetation of the Byron-Bergen Swamp, a rich fen in western New York. Vegetatio 53:85-91.

Black, C. A., D. D. Evans, J. L. White, L. E. Ensminger, F. E. Clark. 1965. Methods in soil analysis. Amer. Soc. of Agron., Inc. Madison, WI.

Broadbent, F. E. 1965. Organic Matter. In Black et al. 1965. Methods in soil analysis. Amer. Soc. of Agron., Inc. Madison, WI.

Chapman, H. D. 1965. Cation-exchange capacity. In Black et al. 1965. Methods in soil analysis. Amer. Soc. of Agron., Inc. Madison, WI.

Crum, H. and L. E. Anderson. 1981. Mosses of eastern North America. Columbia Univ. Press, NY.

Egler, F. E. 1952. Southeastern saline Everglades vegetation, Florida, and its management. Vegetatio 3:225-263.

Fairchild, H. L. 1928. Geologic story of the Genesee Valley and western New York. Rochester, NY. pp. 125.

Fernald, M. L. 1950. Gray's manual of botany. 8th ed. VanNostrand Reinhold Co., NY.

Glime, J. M., R. G. Wetzel and B. J. Kennedy. 1982. The effects of bryophytes on succession from alkaline marsh to *Sphagnum* bog. Amer. Midl. Nat. 108:209-223.

Griffin, K. O. 1977. Paleoecological aspects of the Red Lake Peatland, northern Minnesota. Can. J. Bot. 55:172-192.

Heinselman, M. L. 1963. Forest sites, bog processes and peatland types in the glacial Lake Agassiz region, Minnesota. Ecol. Mono. 33:327-374.

Heinselman, M. L. 1965 String bogs and other organic terrain near Seney, Upper Michigan. Ecol. 46:185-188.

Heinselman, M. L. 1970. Landscape evolution, peatland types and environment in the Lake Agassiz Peatlands Natural Area, Minnesota. Ecol. Mono. 40:235-261.

Hill, M. O. 1979a. DECORANA - A FORTRAN program for detrended correspondence analysis and reciprocal averaging. Ecology and Systematics, Cornell Univ., Ithaca, NY.

Hill, M. O. 1979b. TWINSPAN - A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Ecology and Systematics, Cornell Univ., Ithaca, NY.

Karlin, E. F. and L. C. Bliss. 1984. Variation in substrate chemistry along microtopographic and water chemistry gradients in peatlands. Can. J. Bot. 62:142-153.

Kulczynski, S. 1949. Peat bogs of Polesie. Mem. Acad. Sci. Cracovie, B 15:1-356.

Moore, P. D. and D. J. Bellamy. 1974. Peatlands. Springer-Verlag, NY, Inc. 221 p.

Muenscher, W. C. 1946. The vegetation of Bergen Swamp. I. The vascular plants. Proc. Roch. Acad. Sci. 9:64-117.

Orion Research Inc. 1976. Nitrate determination. 24 p.

Schwickerath, M. 1944. Das Hohe Venn und seine Rundgebiete: Vegetation, Boden und Landschaft. Jena. Verlag von Gustav Fischer. 278 p.

Seischab, F. K. 1977. Plant community development in the Byron-Bergen Swamp: A rheotrophic mire in Genesee County, New York. Ph.D. thesis, SUNY College of Env. Sci. and Forestry, Syracuse, NY. 201 p.

Seischab, F. K. 1984. Plant community development in the Byron-Bergen Swamp: Marl bed vegetation. Can. J. Bot. 62:1006-1017.

Seischab, F. K., J. M. Bernard and K. Fiala. 1985. Above- and belowground biomass and production of biomass by *Eleocharis rostellata* Torr. on three sites in the Byron-Bergen Swamp. Amer. Midl. Nat. 114:70-76.

Sjors, H. 1948. Myrvegetation i Bergslagen. Almquist and Wilsells, Upsala. 299 p.

Sjors, H. 1959. Bogs and fens in the Hudson Bay lowlands. Arctic 12:2-19.

Slack, N. G., D. H. Vitt and D. G. Norton. 1980. Vegetation gradients of minerotrophic rich fens in western Alberta. Can. J. Bot. 58:330-350.

Sokal, R. R. and F. J. Rohlf. 1973. Introduction to biostatistics. W. H. Freeman & Co., SanFrancisco, CA. 368 p.

Spearing, A. M. 1972. Cation-exchange capacity and galacturonic acid content of several species of *Sphagnum* in Sandy Ridge Bog, Central New York State. Bryologist 75:154-158.

Stewart, P. A. and W. D. Merrell. 1937. The Bergen Swamp: An ecological study. Proc. Roch. Acad. Sci. 7:209-262.

Walker, R. S. 1967. A taxonomical and ecological study of the vascular plants along a transect in the Byron-Bergen Swamp. M.S. Thesis, Cornell Univ., Ithaca, NY.

Walker, R. S. 1974. The vascular plants and ecological factors along a transect in the Bergen-Byron Swamp. Proc. Roch. Acad. Sci. 12:241-270.

Watt, A. S. 1947. Pattern and process in the plant community. J. Ecol. 35:1-22.

Wetzel, R. G. 1972. The role of carbon in hardwater marl lakes. In G. E. Likens, ed. Nutrients and eutrophication: The limiting nutrient controversy - Special symposium, Amer. Soc. Limnol. Oceanog., 1:84-91.

Wetzel, R. G. 1975. Limnology. W. B. Saunders Co. 743 p.

Wetzel, R. G. and G. E. Likens. 1979. Limnological analysis. W. B. Saunders Co.

Wheeler, B. D. 1980. Plant communities of rich-fen systems in England and Wales: I. Introduction. Tall sedge and reed communities. J. Ecol. 68:365-395.

Table 1. Mean environmental values for fens and hummock and developing forest. Means are based on soil data gathered to a depth of 60 cm. One standard deviation is indicated.

Soils	**Fens**	**Hummock and Forest**
Promontory Height (cm)	8.1 +/- 2.6	26.7 +/- 1.27
Percent CO_3-C	6.1 +/- 1.3	4.7 +/- 1.5
Cation-exchange Capacity (me/100g)	77.2 +/- 13.0	113.8 +/- 21.7
Water TableFlux (cm)	18.8 +/- 10.8	34.3 +/- 0.6
Bulk Density (g/cc)	0.22 +/- 0.05	0.22 +/- 0.03
Specific Conductance (S)	216 +/- 28	202 +/- 31
pH	7.3 +/- 0.1	7.4 +/- 0.0
Percent Organic Matter	21.4 +/- 3.1	21.2 +/- 1.2
Water		
pH	7.48 +/- 0.23	7.53 +/- 0.30
Specific Conductance (S)	1415 +/- 193	1357 +/- 181
Calcium (ppm)	297 +/- 31.6	291 +/- 30.4
Magnesium (ppm)	55.1 +/- 6.0	54.4 +/- 5.4
Nitrate (ppm)	0.24 +/- 0.20	0.29 +/- 0.28

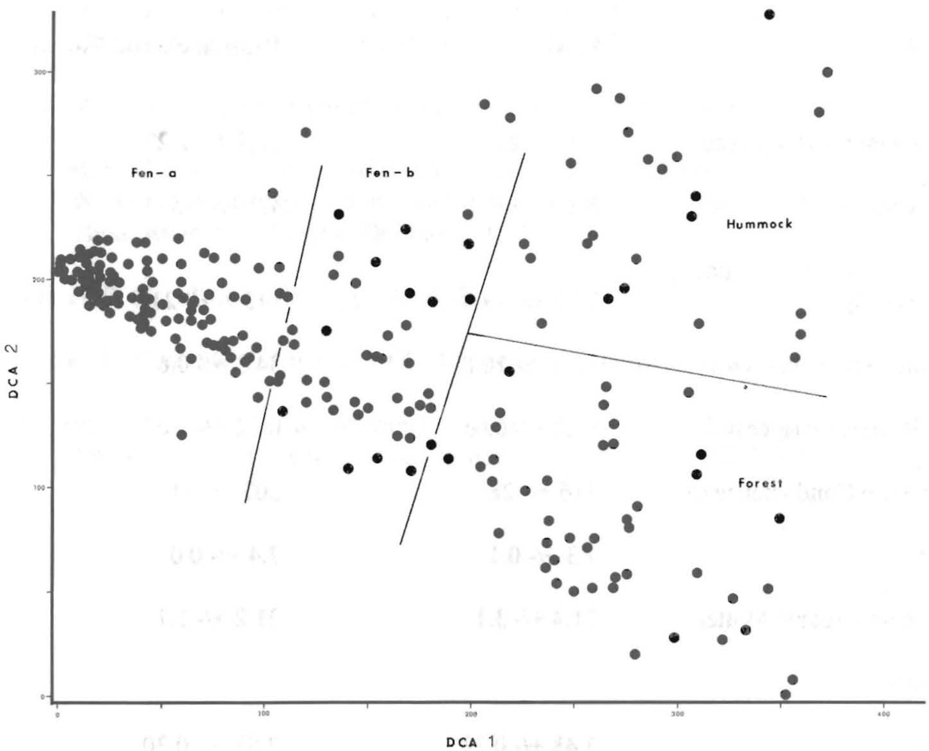

Figure 1. Detrended correspondence analysis of 225 square meter saples. Fen-a was dominated by *Eleocharis rostellata* and Fen-b by *Scirpus cespitosus* var. *delicatulus*. The hummocks were dominated by shrubs, the forest by shrubs and shrubby conifers.

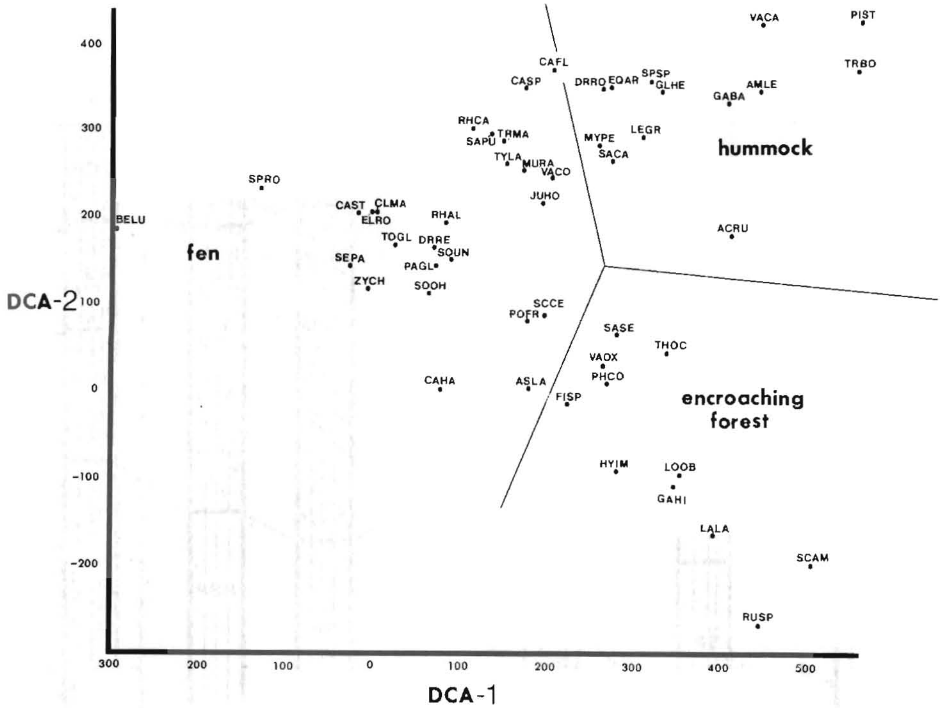

Figure 2. Detrended correspondence analysis of species. Fen species are *Aster lateriflorus* (ASLA), *Betula lutea* (BELU), *Callicladium haldaneanum* (CAHA), *Campylium stellatum* (CAST), *Carex flava* (CAFL), *C. spicata* (CASP), *Cladium mariscoides* (CLMA), *Drepanocladus revolvens* (DRRE), *Eleocharis rostellata* (ELRO), *Juniperus horizontalis* (JUHO), *Muhlenbergia racemosa* (MURA), *Parnassia glauca* (PAGL), *Potentilla fruticosa* (POFR), *Rhyncospora alba* (RHAL), *R. capillacea* (RHCA), *Sarracenia purpurea* (SAPU), *Scirpus cespitosus* var. *delicatulus* (SCCE), *Senecio paupercaulis* (SEPA), *Solidago ohioensis* (SOOH), *S. uliginosa* var. *linoides* (SOUN), *Spiranthes Romanzoffiana* SPRO), *Tofieldia glutinosa* (TOGL), *Triglochin maritima* (TRMA), *Typha latifolia* (TYLA), and *Zigadenus glaucus* (ZYCH). Hummock species are *Acer rubrum* (ACRU), *Amelanchier laevis* (AMLE), *Drosera rotundifolia* (DRRO), *Equisetum arvense* (EQAR), *Gaylussacia baccata* (GABA), *Glechome hederacea* (GLHE), *Ledum groenlandicum* (LEGR), *Myrica pensylvanica* (MYPE), *Pinus strobus* (PIST), *Salix candida* (SACA), *Sphagnum* sp. (SPSP), *Trientalis borealis* (TRBO), and *Vaccinium myrtilloides* (VACA). Forest species are *Fissidens* sp. (FISP), *Gaultheria hispidula* (GAHI), *Hypnum imponens* (HYIM), *Larix laricina* (LALA), *Lonicera oblongifolia* (LOOB), *Phragmites communis* (PHCO), *Rubus* sp. (RUSP), *Salix serissima* (SASE), *Scirpus americanus* (SCAM), *Thuja occidentalis* (THOC), and *Vaccinium oxycoccus* (VAOX).

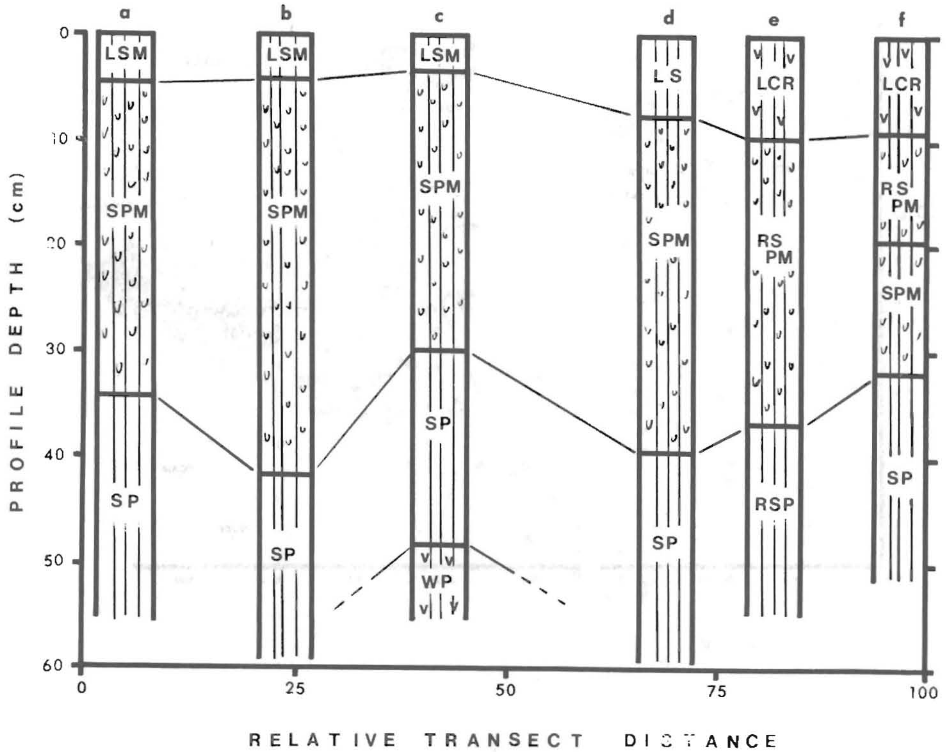

Figure 3. Peat core stratigraphies. The cores are arranged according to their sequence along the first axis of the sample DCA ordination. Cores a, b and c were from an *Eleocharis rostellata* dominated fen. Core d was from an area with *Scirpus cespitosus* and cores e and f were from the forest. The symbol designations are as follows: LS, litter, sedge; LSM, litter, sedge and marl; LCR, litter, coniferous and reed; SP, sedge peat; SPM, sedge peat and marl; RSP, reed and sedge peat; RSPM, reed and sedge peat plus marl; WP, woody peat.

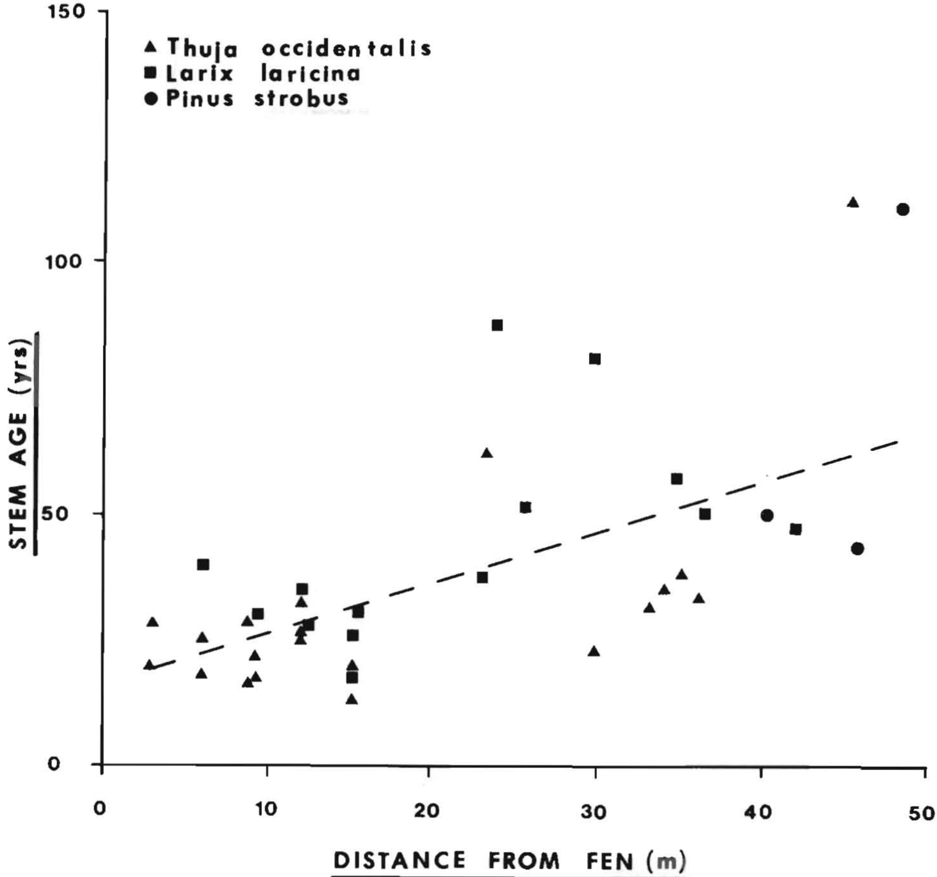

Figure 4. Tree ages along one transect. The slope of the least squares line is shown (b = 0.247).

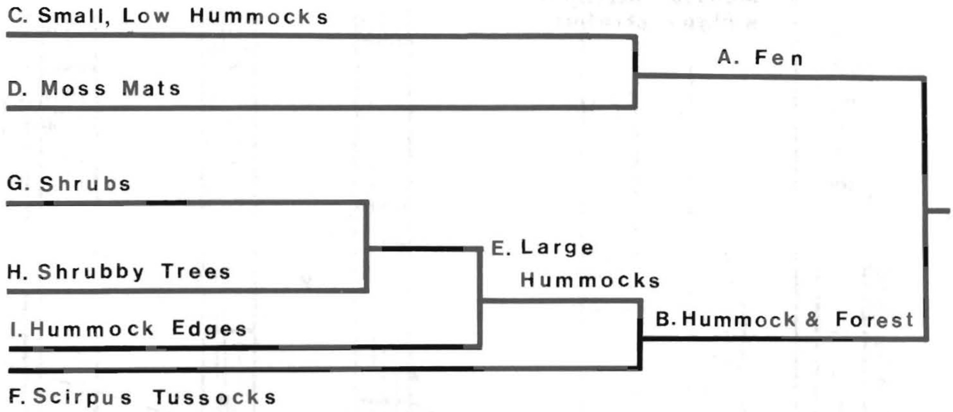

Figure 5. TWINSPAN species dendrogram. Vegetation groups include: A. Fen; B. Large hummock and forest; C. Small, low hummocks containing *Saracenia purpurea, Potentilla fruticosa, Muhlenbergia racemosa* and *Triglochin maritima*; D. Moss mats containing *Eleocharis rostellata, Solidago uliginosa, Rhynchospora capillacea, R. alba, Drepanocladus revolvens, Campylium stellatum, Tofieldia glutinosa, Parnassia glauca, Betula lutea, Solidago ohioensis, Carex flava, Callicladium haldaneanum* and *Fissidens* sp.; E. Large hummocks; F. *Scirpus* tussocks containing *Scirpus cespitosus, Juniperus horizontalis,* and *Vaccinium corymbosum*; G. Shrubs including *Glechoma hederacea, Salix candida, Drosera rotundifolia, Vaccinium myrtylloides, Sphagnum* sp., *Pinus strobus, Amelanchier laevis* and *Trientalis borealis*; H. Shrubby trees with *Thuja occidentalis, Myrica pennsylvanica, Phragmites communis, Hypnum imponens, Ledum groenlandicum, Larix laricina, Salix serissima, Lonicera oblongifolia, Scirpus americanus, Rubus* sp., *Gaultheria hispidula* and *Acer rubrum*; I. Edges of hummocks with *Aster lateriflorus* and *Carex spicata.*

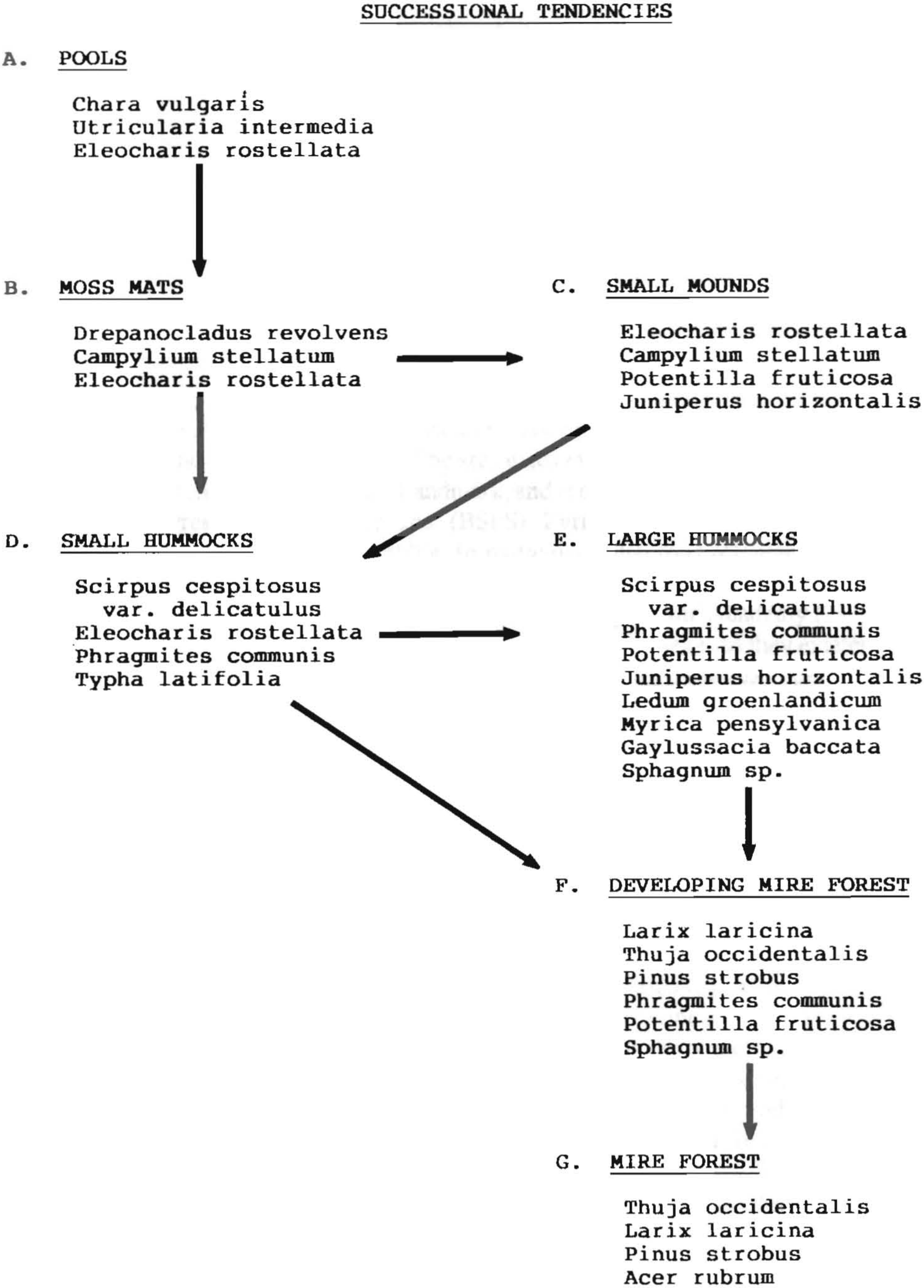

Figure 6. Successional model for the rich fens. Arrows indicate the direction of succession. Species commonly found in each community are shown.

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WETLANDS AND AQUATIC STUDIES

CHANGES IN THE VEGETATION OF THE ZURICH MUD POND PRESERVE BETWEEN 1850 AND 1985.

by
R. Elliot Stauffer and Dean Moosavi

Zurich Mud Pond is a complex of mires and associated uplands located in Arcadia Township in Wayne County, New York. The area enjoys the status of a U.S. Department of the Interior National Natural History Landmark, and is owned and administered by the Bergen Swamp Preservation Society, Inc. (BSPS). Zurich has been a focus of local naturalists' attention since the mid-1800's. In particular, numerous references appear from 1881 to 1920 in the reports and correspondence of the Botany Section of the Rochester Academy of Science (RAS) and in the Proceedings of the Academy (2).

This author (1959) described the preserve's vegetational complexes as they existed in 1939. These were grouped under five headings: I. the floating moor and open water association of the pond; II. the Sphagnum bog or muskeg south of the pond and east of the island drumlins; III. an Arbovitae bog forest underlain by marl west of the island drumlins; IV. the upland mixed hardwoods with Hemlock on the drier glacial soils of the drumlins with interspersed bog and swamp forest in the low areas between the drumlins; V. a Tamarack-Black spruce-Arborvitae shrub-bog and bog-forest occupying the southern third of the preserve (See map, Figure 1). This same type of bog-forest encircled much of the Sphagnum bog (II) with tongues of bog-forest extending in places into the bog from the east and west. To the northeast of the pond beyond the fringe of floating moor encircling the pond was a swamp forest of Red maple, Ash and Elm. This had been more extensive, but had been cleared and ditched to the north for agricultural muck land.

Proga (1982) reported on a series of linear transects taken across the sphagnum bog (II). Proga concluded that the composition of the vegetation across the bog crudely demonstrated the classical series of concentric succession rings of plant communities as described by Dachnowski (1912). Proga's conclusions seem in need of modification in view of the impact of human activities on the bog succession in Area II from 1876 to the present as outlined later in this paper.

Information about the changes which have occurred in the vegetation of the preserve prior to 1939 were obtained from local historical accounts and from the floristic reports of the Botany Section of the RAS. These cover the period from 1881 to 1920 (2). For the 45 years between 1939 and 1982, regular periodic personal observations by the author supplemented by photographic documentation provide information about the evolution of the vegetation of the pond and Sphagnum bog. This development of the preserve is described for each of Areas I and II in the following paragraphs.

I. The Pond

As late as 1939, Mud Pond consisted of about 5 acres of open water of irregular outline. The open water approached the north end of the island drumlin complex located along the pond's south margin. The zone between the drumlins and the open pond consisted of a narrow band of floating Tamarack-Red maple bog-forest with a fringe of floating moor dominated by Water-willow, *Decodon verticillatus* (3), between the bog-forest and the open water. After 1939, the *Decodon* rapidly colonized much of the open pond, but this Decodon moor has now been succeeded by a floating fen dominated by a tight mat of the sedges Twig-rush, *Cladium mariscoides* and *Eleocharis* spp. There exist lesser areas of Narrow-leaf cat-tail, *Typha angustifolia*. During the summer season, only small patches of open water remain along with surface channels and small shallow surface pools on the fen. The peripheral moat or lagg has persisted between the fen and the adjacent bog-shrub and bog-forest associations along the south edge of the pond.

The *Cladium* moor is rapidly being colonized by the edaphic form of the Northern pitcherplant, *Sarracenia purpurea* ssp. *gibbosa*, characteristic of marl fens of the upper Great Lakes. Scattered plants of the circumboreal Bog twayblade, *Liparis loeselii*, have appeared on the moor. Several species of bladderwort and a clubmoss are found in the surface runnels and pools on the moor. These are Horned bladderwort, *Utricularia cornuta*, Milfoil bladderwort, *U. intermedia*, and Bog club-moss, *Lycopodium inundatum*. To date, a species expected in laggs, runnels and surface pools of marl moors, Bogbean, *Menyanthes trifoliata*, has not appeared, although remnant colonies occur southward in channels on the bog area (II). In a number of places along the lagg the *Cladium* fen is being replaced by patches of hummocky bog in which the Cottongrasses, *Eriophorum opacum, E. virginicum* and *E. alpinum*, are prominent (4). Sphagnum is present in the hollows between patches of hummocky bog. Royal fern, Osmunda regalis, Marsh fern, Thelypteris palustris, and Sweet-gale, Myrica gale, are also found in these areas.

II. The Sphagnum Bog (Stuart or East Bog)

The Sphagnum shrub-bog association south of the pond was dominated in 1939 by a dense growth of Leatherleaf, *Chamaedaphne calyculata*. The historical records show that over the period of 25 years from 1876 to 1900 much of the bog was cut manually for florist's moss resulting in stripping the area of live Sphagnum and shrubs to a depth of about one meter. During the 40 years from 1900 to 1940 the bog had reached an advanced shrub-bog stage (5).

From 1940 to 1943, the bog was cut again for moss to the depth of one meter. Shallowly rooted plants were removed entirely along with the moss, but roots remained of deeply rooted large shrubs of Highbush blueberry, *Vaccinium corymbosum*, Black huckleberry, *Gaylussacia baccata,* and Black chokeberry, *Aronia melanocarpa*. When moss-removal operations were terminated, the bog was left with a surface of bare, brown peat which was flooded with standing rain and snow-melt water during winter. The area has since been observed to develop through the following stages. For the first 10 to 15 years the bog assumed the character of a poor fen dominated by sedges such as White beakrush, *Rhynchospora alba,* along with prominent hummocks of Cottongrasses, *Eriophorum opacum* and *E. virginicum*. Following the poor fen stage, live Sphagnum mosses reestablished themselves over the bog. A feature of the fen and early Sphagnum stages was the rapid spread of a number of species with spectacular floral displays. These included

Rose pogonia, *Pogonia ophioglossoides*, Grass pink, *Calopogon tuberosus*, Bogbean, *Menyanthes trifoliata*, Horned bladderwort, *Utricularia cornuta*, and for a short time, the bladderwort *U. geminiscapa.*

After 46 years (in 1982) the bog again reached an advanced shrub-bog stage. However, there is a noticeable difference between the Chamaedaphne shrub-bog of 1939 and the shrub-bog of 1982. The Chamaedaphne heath of 1939 has not recovered dominance in the bog association. Instead the regrowth of the shrubs of *Vaccinium, Gaylussacia*, and *Aronia* left by the 1940 to 1943 moss removal has resulted in a hummocky bog surface offering a footing for seedlings of Tamarack and Red maple. The rapid growth in stature of these bog-forest trees on the large shrub hummocks is tending both to dry the elevated bog surface and to shade out important rare species for which the preserve was established. Black spruce, *Picea mariana*, on the other hand, has not recolonized the bog significantly. An interesting question is raised by the regeneration process after 1943. Why has the bog-shrub and bog-forest mixed association spread over the area so rapidly, and why was there no such aggressive invasion of the *Vaccinium, Gaylussacia, Aronia, Larix* and *Acer* into the cut areas of the bog after the moss removal by the turfing method employed by the Stuart brothers from 1876 to 1900? Perhaps a clue to the reason for the differences in vegetational complexes of Area II lies in the possibility that from 1876 to 1939, Area II was a poor fen much like that existing today over the pond. Such a poor fen, highly paludified, offered little opportunity for survival of the invading bog-shrub/bog-forest species. In fact we do not know the original extent of the pond. It probably extended further to the southeast based on the significant areas of "quaking bog" at the northern end of Area II today. This suggestion is supported by observations of Morris and Eames (1929).

As described earlier, information about the vegetational changes which took place during the earlier period between 1881 and 1920 can be found in the floristic records of the Botany Section of the RAS and its correspondents, eg., H. L. Hankenson of Newark, New York (2). Other information about plant species in the preserve can be found in the observations of Morris and Eames (1929). These records and the author's observations show that a number of rare plant species disappeared from Zurich Bog between the early 1900's and 1939. These include Prairie fringed orchid, *Platanthera leucophaea*, Ram's head lady's slipper, *Cypripedium arietinum,* Small white lady's slipper, *C. candidum,* and Linear-leaved sundew, *Drosera linearis* (3). Some of these might be questioned as misidentifications, except for the fact that they were repeatedly reported, or that voucher specimens were deposited in the herbaria of the Rochester Academy of Science and the New York State Museum at Albany. Several of these plants have in common a preference for marly fen habitats. Their disappearance seems to point to a more fen-like condition for some of the bog areas at Zurich prior to 1939. This is also confirmed by comments by Morris and Eames (1929) regarding the Ragged fringed orchid, *Platanthera lacera*. They found this orchid growing in tall robust colonies among tall sedgey habitat south of the pond at Zurich. Currently Ragged fringed orchid occurs infrequently in the bog as small slender isolated specimens in deep Sphagnum in the same area south of the pond. Finally, a plant listed as infrequent by the Academy botanists in the late 1800's, Pod-grass, *Scheuchzeria palustris,* was still infrequent in 1939 according to the author's observations, but has since become frequent to common. Pod-grass is associated particularly with deep Sphagnum, highly palludified carpets with strongly acidic pH's. The current Pod-grass association at Zurich is an ombrotrophic mire. The acidic condition of the live

Sphagnum layer is brought about because the water supplied to this layer is entirely rain water. It is the growth of Sphagnum on ombrotrophic mires which creates the acidic upper horizon of moss in which many of the rare plant species grow (6).

In 1985 a stewardship management plan was completed for the Zurich Mud Pond Preserve of BSPS by an ad hoc committee chaired by Mona Rynearson (Rynearson et al, 1985). The committee's report to the Board of Trustees included a history of the evolution of the preserve's plant associations and the changes which have occurred in the 140 years since 1850 as a result of human activities on the bog and its surrounding areas. Clearing of the peripheral areas of woods, as well as the development of farms and orchards, began about 1850. During two periods, from 1876 to 1900, and 1940 to 1943, live sphagnum moss was removed to a depth of one meter. Agricultural activities have continued to the present (Burdick, 1982). The report recommended that several experimental plots in the form of 100 square meter quadrats be established and studied to provide information for establishing procedures for restoring the Stuart bog parcel to the fen and bog conditions of the late nineteenth century. By implementing the procedures resulting from these studies, it was expected that the probability of preserving the following species would increase: Muhlenburg Turtle, *Clemmys muhlenbergi*; Southern Bog Lemming, *Synaptomys cooperi*; Whorled pogonia, *Isotria verticillata*; Southern twayblade, *Listera australis*; Rose pogonia, *Pogonia ophioglossoides*; Grass pink, *Calopogon tuberosus*; White-fringed Orchid, *Platanthera blephariglottis*; Bogbean, *Menyanthes trifoliata*; Pod-grass, *Scheuchzeria palustris*; and Bartonia, *Bartonia virginica*.

In May 1982 a group of students from the Community College of the Finger Lakes, Canandaigua, New York, under the supervision of Lee Drake began testing a method of preserve management. They cleared a quadrat of the large shrubs and young trees of *Vaccinium, Gaylussacia, Aronia,* and *Acer*. They used a come-along to drag these clumps out of the bog and on to the nearby island drumlin to decay. By this means about 10 percent of the area in the northwest corner of the quadrat was cleared. It became clear that without more effective machinery to remove the clumps progress would be very slow. Further clearing has not been resumed to date. However, observations of the cleared section, which contains a number of small pools and areas of raw peat, have shown that clearing is an effective way to set bog vegetation back to the successional stage existing between 1876 and 1939. This successional stage would be expected to last from 50 to 100 years, thus offering new habitat for some of the rare species of the preserve to colonize. In addition, the life span of the pond and fen could be increased by constructing a simple water control dam to block loss of water from the pond into a nearby ditch to the north which is used to drain muck farm fields north of the pond. This was recommended to the Trustees of BSPS (Burdick, 1982).

Conclusion: The historical records of changes which have taken place in the past 140 years have shown that the plant and animal communities have changed at a very rapid rate. The rare species of animals and plants for which the preserve was established are rapidly being crowded out by more aggressive species. Similar anthropogenic forces have been described by Warner et al (1989). In order to arrest the rapid loss of rare species from the preserve's biota the management plan recommended to the Trustees of BSPS needs to be implemented promptly.

NOTES:

1 This report is based on two papers presented at the 12th Annual Papers Session of the Rochester Academy of Science, November 2, 1985.

2 A complete collection of the Proceedings of RAS is kept in the Rush Rhees Library of the University of Rochester; correspondence and reports of the RAS are stored in the Archives of the Library at the University of Rochester. Issues of the Proceedings of special interest are:
Vol. 3 (1), Plants of Monroe County, NY and Adjacent Territory, 1896; Vol. 5 (1), Supplementary List, 1910; and Vol. 5 (3), Second Supplementary List, 1917.

3 Nomenclature follows Richard S. Mitchell, A Checklist of New York State Plants, The State Education Department, 1986, with the following exceptions.

The author recognizes a Northern Pitcherplant sub-species *Sarracenia purpurea* ssp. *gibbosa* (L.) (Raf.) Wherry

Eriophorum opacum is not listed as occurring in NYS.
Drosera linearis is not listed as occurring in NYS.

4 The *Eriophorum* species collected in Zurich Bog which are present in the Rochester Academy of Science herbarium are *E. gracile* and *E. vaginatum* (=*callitrix*=*spissum*). *E. virginicum* has been collected in Newark, NY. E. opacum, which is very similar to *E. vaginatum* is a northern species not known to occur in New York State.

5 While moss cutting was in progress from 1940 to 1943, conversations with the German foreman in charge of Jackson Perkins operations elicited the information that the redevelopment of the cut areas of the bog to the shrub-bog stage would require 25 to 50 years, based on his experience with bogs in Europe. This has been confirmed by the author's observations from 1943 to the present.

6 From May to June of 1982 the author, assisted by Barbara Drake, sampled the water in the upper Sphagnum horizon along a west to east transect running along the north boundary of an experimental quadrat established on the Stuart (East) bog. Water samples, taken every 300 meters, were placed in polyethylene bottles, tightly capped, and placed in an insulated chest containing crushed ice. These samples were measured as soon as possible the same day using a glass electrode/silver-silver chloride electrode in 4 M. potassium chloride. At the west edge of the bog in Tamarack-Hemlock-Black spruce bog-forest, the pH of the sample was 4.00. Within a few meters to the east the pH's dropped to 3.60 to 3.80 .03. At the edge of bog-forest at the east side of the bog, the pH of samples rose rapidly to 4.85. A similar set of samples was obtained along a south to north transect run over the fen pond area. This transect ran from the north end of the island drumlin complex to the Red maple-Ash swamp-forest encircling the pond. The pH values along this transect began with a pH of 3.45 for a surface rivulet near the edge of the Tamarack bog-forest bordering the fen moor on its south side. The pH of the water of the lagg bordering the moor rose to 6.20. The alkalinity of the samples

obtained across the Cladium sedge fen transect ranged from pH's of 7.65 to 8.20. The dominance of the sedge Cladium in the composition of the fen mat is consistent with the hydrological and chemical nature of calcareous moors.

ACKNOWLEDGEMENT:

The author gratefully acknowledges the assistance of Mildred Stauffer.

REFERENCES CITED:

BURDICK, K. (1982). Private communication, unpublished data.

DACHNOWSKI, A. (1912). Peat deposits of Ohio. Geological Survey of Ohio Bull. 16, Series 3: 220-262.

MORRIS, F. AND E.A. EAMES. (1929). Our wild orchids; their trails and portraits. Scribner's, New York.

PROGA, C. (1982). Zurich Bog; a question of succession. Proc. Roch. Acad. Sci. 15 (1):42.

RYNEARSON, M. ET AL. (1985). The Zurich Bog Nature Preserve stewardship plan. Bergen Swamp Preservation Society. 63 p.

STAUFFER, R.E. (1959). Zurich Mud Pond Nature Preserve. Wildflower Vol. 35, Oct.: 44-54.

WARNER, B.G., H.J. KUBLAW AND K.I. HAUF. (1989). An anthropogenic cause for quaking mire formation in southwestern Ontario. Nature 340: 380-384.

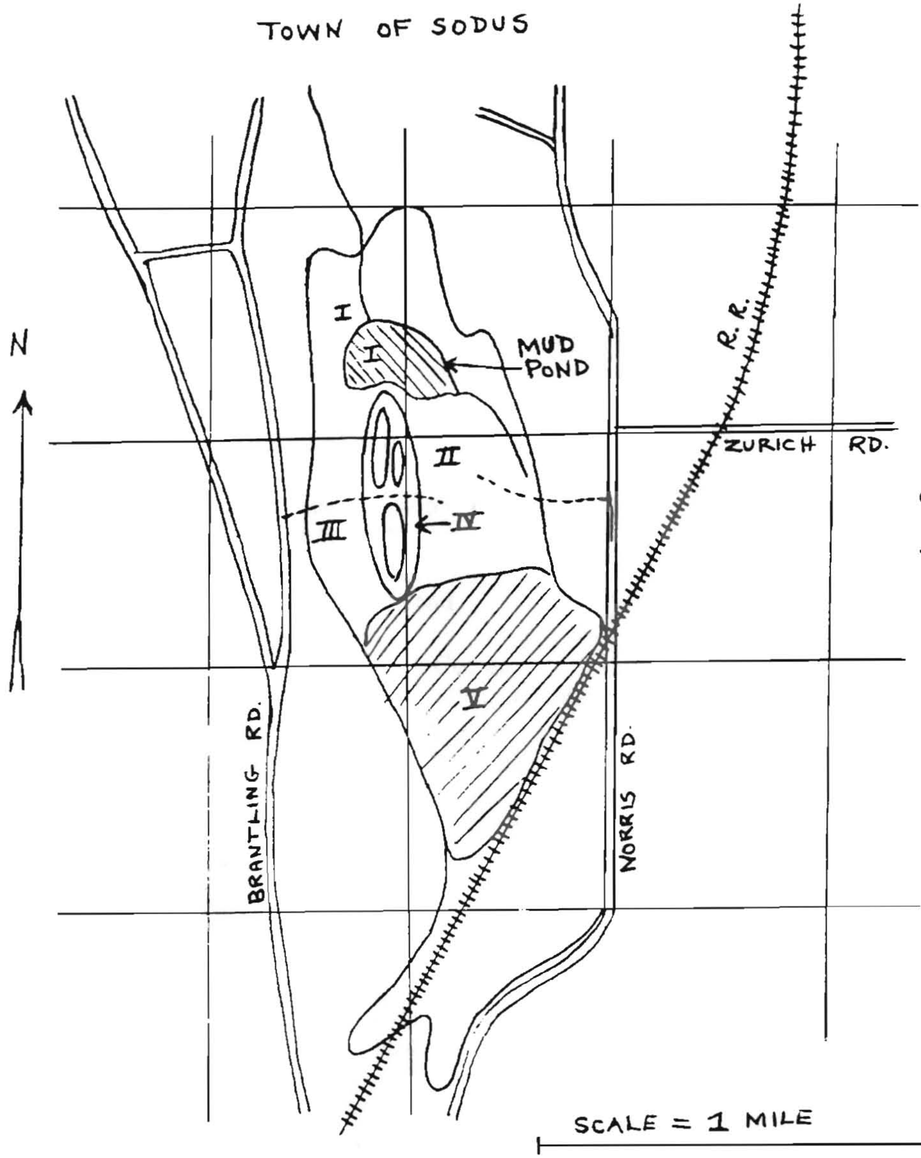

Figure 1. Zurich Mud Pond Preserve

Map redrawn from "Zurich Mud Pond Nature Preserve", Wildflower Vol. 35, October 1959 system at the site. This paper presents and discusses the data collected during that survey of the fish community.

Only two species of fishes were found during this survey: creek chubs, *Semotilus atromaculatus* (Mitchill), and blacknose dace, *Rhinichthys atratulus* (Hermann). Considerable life history information is available on these two species (Carlander, 1969; Dinsmore, 1962; Gunning and Lewis, 1956; Moore, 1968; Reed and Moulton, 1973; Scott and Crossman, 1973; Schemske, 1974). Both species inhabit rivers and streams throughout North America and they are among the species that one would expect to find during this survey. However, an interesting and important aspect of this paper is that it is the only report about a natural system in which the creek chub and the blacknose dace are the only species of fishes present.

STUDY AREA

The subject stream system is located in West Valley, New York, approximately 35 miles SSE of Buffalo (42°26'55"N; 78°39'03W). Most of the stream, known as either Erdman Brook or Frank's Creek, originates from underground seepage and/or surface flow on the property of the Western New York Nuclear Service Center. The section of stream that was studied is inside a 10 ft high chain-link security fence that surrounds the property. At the time of the study, the immediate watershed around the stream was relatively undisturbed by human activities; there has since been some earth moved in the "swale area". Two branches of Erdman Brook join approximately 60 m prior to flowing out of the security area and eventually into Buttermilk Creek about 2.3 km downstream. This study examined 240 m of the west branch and 520 m of the east branch above the confluence as well as the entire 60 m confluent portion of the stream inside the security fence.

Erdman Brook is relatively shallow (5-8 cm deep), although it contains some pools up to 1.5 m deep. Stream width varies from 0.3 to 2.0 m at "normal" flow. The average flow of water under the security fence is approximately 0.75 m^3/sec. Erdman Brook is subject to flash flooding during periods of high rainfall while during extended dry periods (30 days or more) water flow slows to a trickle. The pH of the water is about 8.2. While roughly 70% of the stream has gravel on its bottom, it cuts through a silty clay till and erosion and slumping of the stream banks cause the water to usually be quite turbid. For more hydrologic and geologic information, see Albanese et all (1984).

The habitat surrounding Erdman Brook is predominantly a wooded stream valley composed mainly of maple (*Acer* spp.), ironwood (*Carpinus caroliniana*), ash (*Fraxinus* spp.) and aspen (*Populus* spp.). The uppermost 100 m of the east branch of the stream flows through incised, well-established channels in a swale in which the dominant vegetation consists of grasses, sedges and rushes. Pools up to 2 m deep also occur in the swale.

MATERIALS AND METHODS

Fish were collected from Erdman Brook on May 22, 1976 using a 230 volt, 3.5 amphere DC electroshocker and dipnets. Shocking was conducted along 635 m (77.5% +/- 2.5%) of the total 820 m length of stream studied. Upon collection the fish were immediately placed into sodium borate buffered 10% formaldehyde solution. The bellies of the larger fish were slit to allow for complete penetration of the preservative. These specimens were subsequently taken to the laboratory for examination.

After identifying each specimen to species, determination was made of the total length (L), wet (preserved) weight (W), sex and stage of maturity. Each specimen was examined for external and/or internal parasites and the stomach contents were removed, preserved in 70% ethanol and identified. The age of each specimen was determined by using the Dahl-Lea method of counting scale annuli (Lagler, 1956): samples of scales from each specimen were removed, soaked in a mild soap solution, mounted in glycerin between two glass slides, and the annuli counted using a microfiche reader. The weight-length function and the condition index (Lagler, 1956) for each fish population were determined by using the equations $L = aW^n$ (a and n are empirically determined) and $K = (W/L^3) \times 10^5$, respectively.

RESULTS

A total of 423 fish were collected from Erdman Brook (Table 1) of which 323 (76%) were creek chubs and 100 (24%) were blacknose dace. The creek chubs were generally larger than the blacknose dace by a factor of more than three when considering weight and 1.3 when considering their length, but the creek chub population also had both the largest and smallest individuals. Only 71% of the creek chubs and 47% of the blacknose dace had reached the level of maturity to which their sex could be determined. Of the 122 male creek chubs, only 14 (11.5%) were mature while 71 (93.4%) of the 76 females were clearly mature for a ratio of mature males to mature females of 1:5.1. Of the 23 male blacknose dace, 19 (82.6%) were mature while 22 (91.7%) of the 24 females were mature for a ratio of mature males to females of 1:1.2. One blacknose dace of the I+ year class was found to be an hermaphrodite; it had the coloration of a mature male but lacked nuptial tubercles and had one small testis and one small ovary bearing eggs similar in size to those present in the ovaries of typical females.

Four year classes of creek chub were found in Erdman Brook, but only one male was of the III+ year class (Fig. 1). Three year classes of blacknose dace were found (Fig. 2).

Approximately 35% of the creek chub stomachs were empty while 60% of the blacknose dace stomachs were empty. Stomach contents were primarily allochthonous materials (Table 2). Annelids, mostly earthworms, and insect remains were the predominant food in the creek chub while in the blacknose dace insects prevailed, occurring in 73% of all non-empty stomachs.

DISCUSSION

The condition index for the Erdman Brook creek chub population (Table 1) is similar to values in the literature (Carlander, 1969; Dinsmore, 1962; Greeley, 1930; Swingle, 1965) and it is within the range that indicates general good health (Lagler, 1956). Although virtually all of the creek chubs in this study had internal parasites (generally tapeworms), the weight-length function (Table 1) is very similar to those equations found by Dinsmore (1962) and Schemske (1974). Most of the Erdman Brook blacknose dace were also parasitized, but both the condition index and weight-length function (Table 1) for this species compares favorably with the results reported by Reed and Moulton (1973). These data and the fact that each species had several age classes and sexually mature individuals suggest that this fish community is quite healthy. However, it must be recognized that this community may be influenced by immigration and emmigration by both species.

The available literature indicates that the food of creek chub is primarily insects and plant material (Barber and Minckley, 1971; Dinsmore, 1962). Data from Erdman Brook show that insects are indeed a large part of the creek chub diet, but earthworms are also a major food component. This may be due to the high rate of erosion and landsliding that puts large quantities of annelids into the water. The primary spring foods of Erdman Brook blacknose dace agree with the data reported in the literature (Carlander, 1969; Minckley, 1963; Sibley and Rimsky-Korsakoff, 1931; Traver, 1929). All of the data suggest that both species are quite omnivorous and opportunistic feeders.

A consideration of the weight/age/sex relationships seen in Figures 1 and 2, the weight/length relationships seen in Figures 3 and 4, and the ratios of mature males to mature females suggest that the social system and breeding behavior of the two species of fishes are quite different. The data for the blacknose dace (i.e. males and females maturing at roughly the same age and size) indicate that they have either a paired or promiscuous relationship. However, the creek chub data indicate a system of one dominant mature male mating with a number of females. Creek chub males matured at II+ at about 125 mm (L) and about 30 g (W) while females matured at I+ at a much smaller size, about 75 mm and 6 g (Figs. 1, 3). Much of the difference in size results from a dramatic increase in the growth rate of maturing males attaining the II+ age class. The presence of both mature and immature males in the II+ age class is notable and there are two possible explanations for this. The first is that the male fish simply grow to reach a size at which they mature. The second explanation compatible with the data is that the presence of large and mature males somehow supresses growth and maturation in the other males. In the event that dominant males are lost, the repressed ones may mature and, possibly, grow to a larger size. This second explanation has been reviewed for several taxa (Wynne-Edwards, 1972; Christian, 1975) but has received little attention for the Cyprinidae.

Starrett (1950) and Minckley (1963) reported that blacknose dace have a tendency to select streams with relatively steep gradients and many riffles. During electroshocking of Erdman Brook, only blacknose dace were recovered from the riffle areas. Both species were found in the pools, but here the creek chubs predominated. The fact that both the largest and smallest fish collected in Erdman Brook were creek chubs is probably the result of the time of spawning; the presence of blacknose dace of the 0+ year class indicates that they had spawned much earlier and the creek chubs had spawned later.

An ecological interpretation of the data from Erdman Brook suggests that blacknose dace are not an important food source for the larger creek chub. Based upon our estimate that we collected at least 90% of the fish present in the stream segments that were shocked, and knowing the length of stream shocked (77.5%), the total biomass of the fish present in the 820 m length of stream on the Nuclear Service Center property was calculated (Table 1). Since creek chub were present in numbers and biomass more than three times and ten times, respectively, than blacknose, the energy balance is not appropriate for a significant predator-prey relationship. Rather, the data suggest that the ecological relationship between these two species in Erdman Brook is primarily one of niche specialization and competition in a system that is quite resource limited.

ACKNOWLEDGEMENTS

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Table 1. Natuiral history data of the creek chub and blacknose dace in Erdman Brook, May 1976

	Creek Chub	Blacknose Dace
Total Number Captured	323	100
Weight (g)		
maximum	92.5	6.7
minimum	0.05	1.3
mean	8.0	2.4
biomass (approx.)		
total stream	3,334.2	309.7
g/m of stream	4.07	0.38
Total Length (mm)		
maximum	185	79
minimum	18	28
mean	70.1	53.7
Weight-Length Function	log W = 3.15logL - 5.14	log W = 3.05 logL - 4.97
Condition Index	1.39	1.30
Sexuality		
males	122	23
mature	14	19
immature	108	4
females	76	24
mature	71	22
indeterminate	125	53*

* one hermaphrodite present

Table 2. Frequency of occurrence (in percent of non-empty stomachs) of food items found in Erdman Brook creek chub and blacknose dace in May, 1976.

Percentage Occurence in Feeding Fish

Food Item	Creek Chub	Blacknose Dace
Annelids	38	10
Plant Material	12	26
Snails and Slugs	10	0
Crayfish	2	0
Insect Remains	30	73
Miscellaneous (milipedes, caterpillars, etc.)	8	10

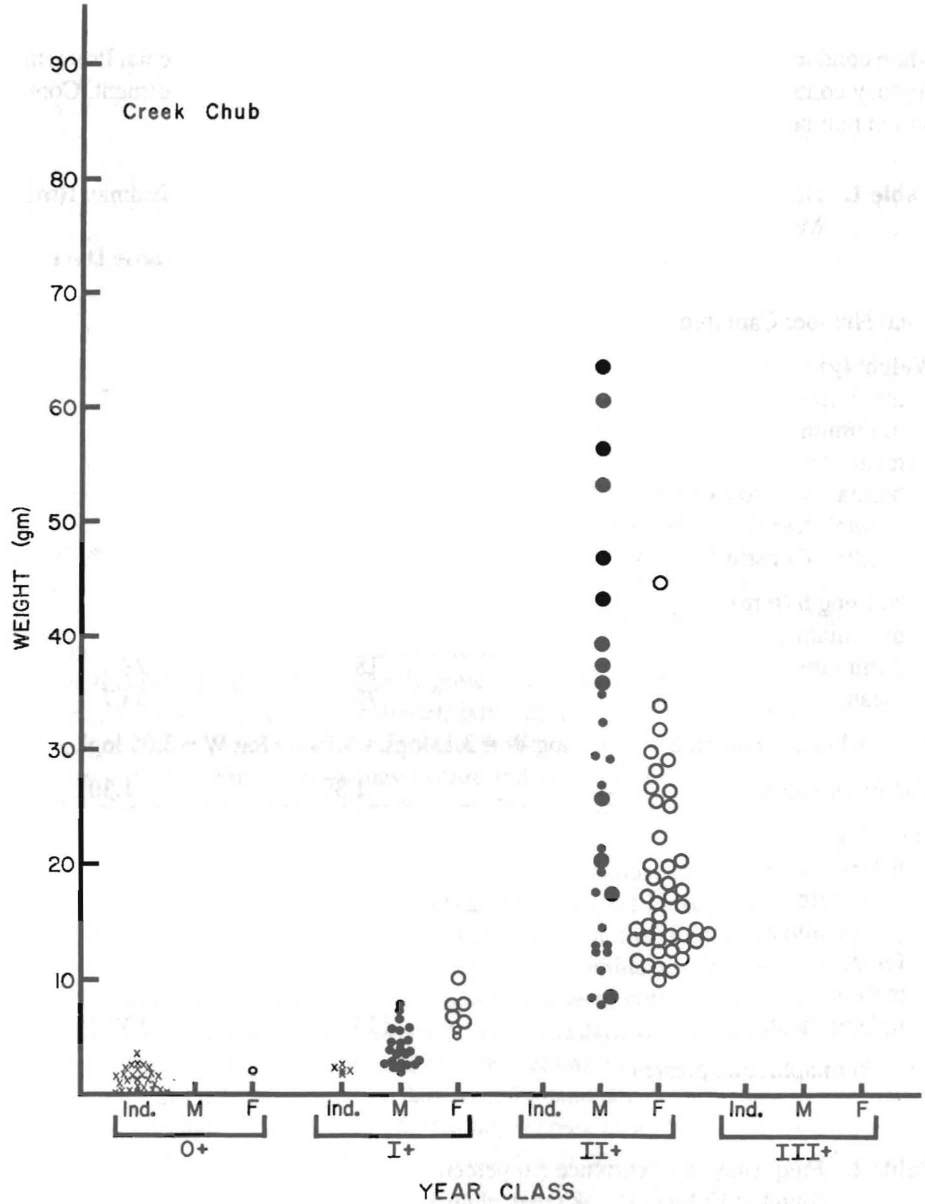

Figure 1. Age-Structure of the Erdman Brook creek chub population as a function of sex and weight. To increase visual clarity, this graph contains only 25% of the data points (randomly selected) from the 0+ and I+ year classes and 100% of the data from the II+ and III+ classes.

Legend: ● mature males; O mature females; • immature males; ο immature females; x indeterminate sex.

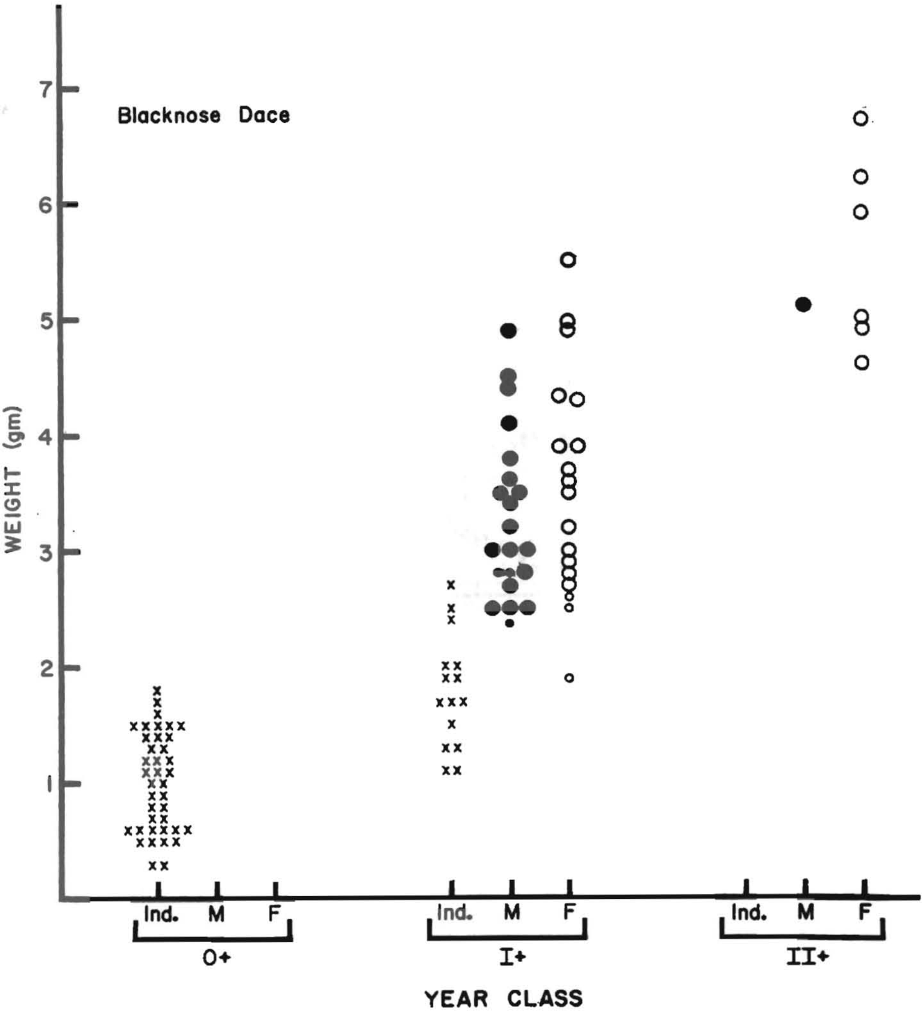

Figure 2. Age-Structure of the Erdman Brook blacknose dace population as a function of sex and weight. Graph shows all data points.
Legend: ● mature males; O mature females; • immature males; o immature females; x indeterminate sex.

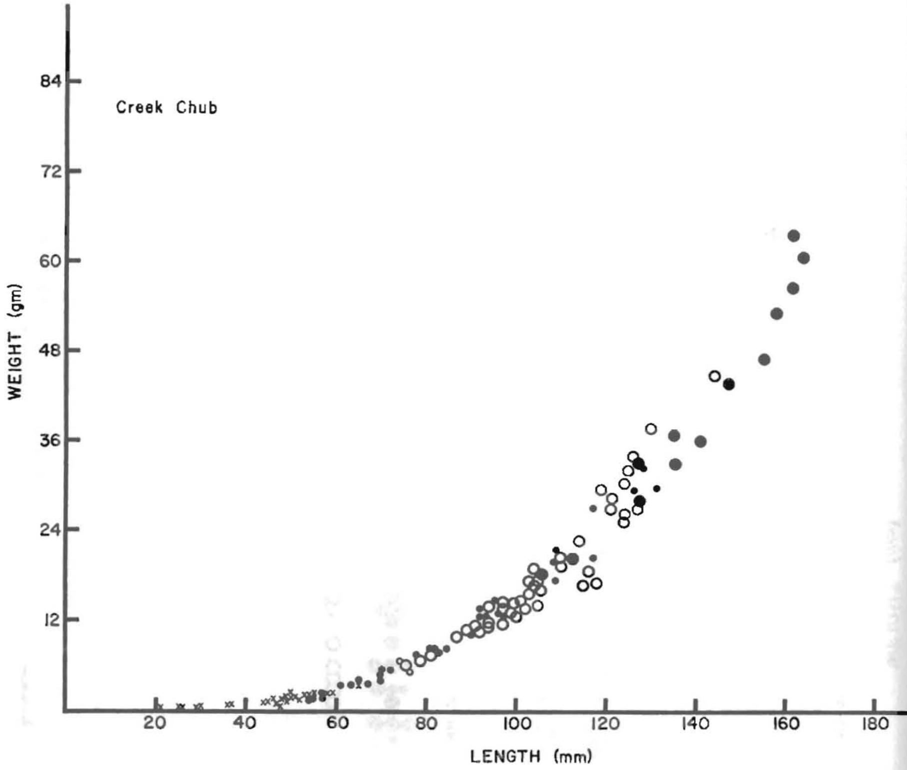

Figure 3. Relationship of length to weight as a function of sexuality and maturity in the Erdman Brook creek chub population. To increase visual clarity, this graph contains only 25% of the data points (randomly selected) from the 0+ and I+ year classes and 100% of the data from the II+ and III+ year classes.
Legend: ● mature males; O mature females; • immature males; o immature females; x indeterminate sex.

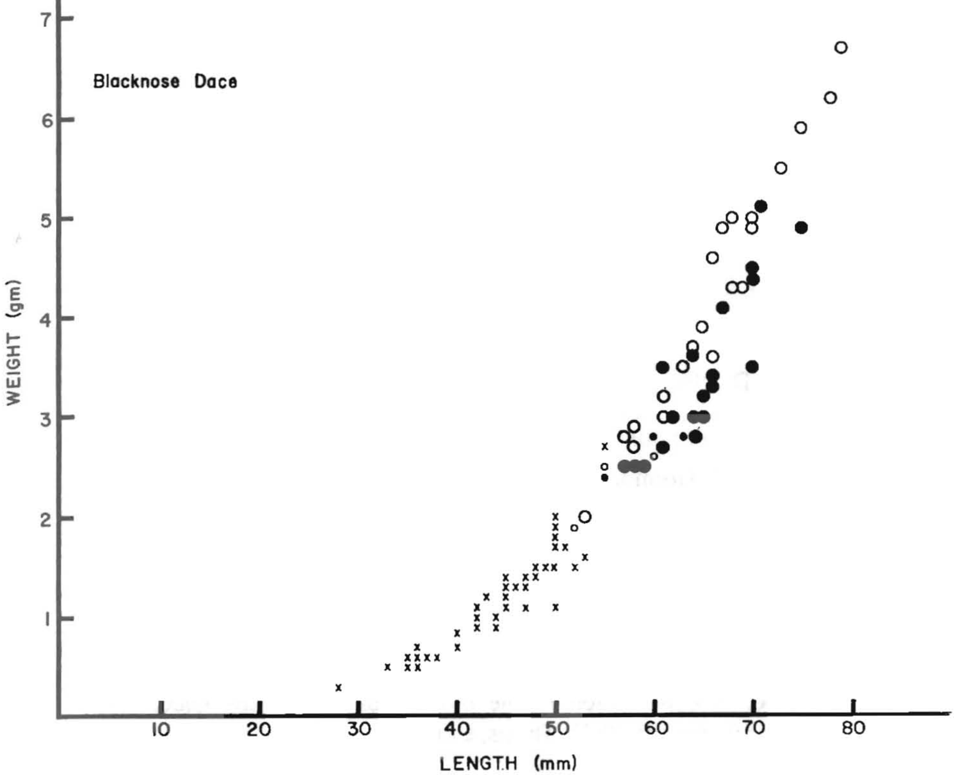

Figure 4. Relationship of length to weight as a function of sexuality and maturity in the Erdman Brook blacknose dace population. Graph show all data points.
Legend: ● mature males; O mature females; • immature males; o immature females; x indeterminate sex.

REFERENCES

Albanese, J.R., S.L. Anderson, R.H. Fakundiny, S.M. Potter, W.B. Rogers and L.F. Whitbeck. 1984. Geologic and hydrologic research at the Western New York Nuclear Service Center, West Valley, New York final report. U.S. Nuclear Regulatory Commission report NUREG/CR- 3782.

Barber, W.E. and W.L. Minckley. 1971. Summer foods of the cyprinid fish *Semotilus atromaculatus*. Trans. Am. Fish. Soc. 1971(2): 283-289.

Carlander, Kenneth D. 1969. Handbook of freshwater fishery biology. Vol. 1. The Iowa State University Press, Ames.

Christian, John J. 1975. Hormonal control of population growth, p. 205-274. *In* B.E. Eleftheriou and R.I. Sprott (eds.). Hormonal correlates of behavior, Vol. 1. Plenum Press, New York.

Dinsmore, James J. 1962. Life history of the creek chub with emphasis on growth. Proc. Iowa Acad. Sci. 69: 296-301.

Greeley, J.R. 1930. A contribution to the biology of the horned dace, *Semotilus atromaculatus* (Mitchill). Ph.D. Thesis, Cornell University.

Gunning, G.E. and W.M. Lewis. 1956. Age and growth of two important bait species in a cold-water stream in southern Illinois. Am. Midl. Nat. 55(1): 118-120.

Lagler, Karl R. 1956. Freshwater fishery biology. 2nd ed. W.C. Brown Co., Dubuque, Iowa.

Minckley, W.L. 1963. The ecology of a spring stream, Doe Run, Meade County, Kentucky. Wildl. Monogr. 11: 1-124.

Moore, G.A. 1968. Fishes. *In* W.F. Blair, A.P. Blair, P. Brodkorb, F.R. Cagle and G.A. Moore (eds.). Vertebrates of the United States. 2nd ed. McGraw-Hill Book Co., New York.

Reed, R.J. and J.C. Moulton. 1973. Age and growth of blacknose dace, *Rhinichthys atratulus*, and longnose dace, *R. cataractae,* in Massachusetts. Am. Midl. Nat. 90(1): 206-210.

Schemske, Douglas W. 1974. Age, length and fecundity of the creek chub, *Semotilus atromaculatus* (Mitchill), in central Illinois. Am. Midl. Nat. 92(2): 505-509.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Bull. Fish. Res. Bd. Can. 184: 966 p.

Sibley, C.K. and V.N. Rimsky-Korsakoff. 1931. Food of certain fishes in the watershed. NYS Conserv. Dept., Ann. Rept. 20 (Supp.): 102-120.

Starrett, W.C. 1950. Distribution of the fishes of Boone County, Iowa, with special reference to the minnows and darters. Am. Midl. Nat. 43(1): 112-127.

Swingle, W.E. 1965. Length-weight relationships of Alabama fishes. Auburn Univ. Agric. Exp. Sta. Zool. - Ent. Ser. Fish. 3: 1-87.

Traver, Jay R. 1929. The habits of the black-nosed dace, *Rhinichthys atronasus* (Mitchill). J. Elisha Mitchell Sci. Soc. 45(1): 101-129.

Wynne-Edwards, V.C. 1972. Animal dispersion in relation to social behavior. Hafner Publ. Co., New York. 653 p.

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PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE

WETLANDS AND AQUATIC STUDIES

A STUDY OF THE NEW YORK STATE POPULATIONS OF THE HELLBENDER, *Cryptobranchus alleganiensis alleganiensis* (Daudin)

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ABSTRACT

The Hellbender population of New York State was studied in both the Susquehanna River and Allegheny River watersheds. The Susquehanna River population shows few adult specimens and no larval or immature ones. Two nests were found. The Allegheny River popluation appears healthier, with greater numbers of specimens and showing all age groups. Twelve incidences of nesting were discovered in four years. Ecological densities for the Hellbender in the Allegheny River watershed were estimated by mark/release experiments. These results will form base line data for comparisons with future studies to determine the actual status of the Hellbender in New York State. Until these are done, we suggest putting the Hellbender in the "Special Concern" category.

In 1981 the senior author received a grant (#S 184357) from the Endangered Species Unit of the N. Y. State Dept. of Environmental Conservation for studying the Hellbender, *Cryptobranchus alleganiensis alleganiensis* in New York State. This study occupied the summer and autumn seasons of 1981 and 1982. Further investigations on population density and nest sites were done by the junior author and formed the subject matter of his graduate research. This paper combines parts of these studies into a single contribution.

The purpose of these studies was to gain knowledge of the present distribution and abundance of the Hellbender in New York State. This area represents the most northern part of the range of this form, which has been recorded in this state from the Allegheny River and its larger tributaries and from the Susquehanna River and one of its larger tributaries, the Unadilla River (Bishop, 1941). Unfortunately, Bishop did not provide any data concerning the relative numbers or density of this form.

Accordingly, the seasons of 1981 and 1982 were spent investigating the Allegheny and Susquehanna River systems in New York State for the purposes of reestablishing old locality records, discovering new ones and gathering some idea of the abundance of this animal. Nests were also sought at the proper time. In addition, the junior author spent the late summer and autumn seasons of 1983-1985 and 1988 acquiring nest site information and performing mark/release density studies in the Allegheny River drainage of New York State. All this information was used to help determine the status of *Cryptobranchus alleganiensis alleganiensis* in this state, thus allowing management recommendations to be decided upon. It must be emphasized that these data can only give an initial impression and are to be used as base line data for using in a comparison against future investigations. The comments of Bishop (1941) are too few and too vague ("...sev. ads....." and "abdt.") to allow for comparisons.

MATERIAL AND METHODS

The two river systems (Fig. 1) were investigated by either floating them in a flat bottomed skiff where practicable or by driving along parallel roads and examining likely habitat. This latter method was the primary method used to study the immense Susquehanna drainage. The Allegheny River, on the other hand, has a much smaller drainage in New York State and was traversed by boat for its entire length from the Pennsylvania line above Portville, N. Y. to the beginning of the Allegheny Reservoir below Salamanca N. Y. The tributaries were primarily investigated by wading.

Initially we attempted to use a Smith - Root Type VII 12 volt D. C. Electrofisher for our survey. This was borrowed from the N. Y. S. D. E. C. Wildlife Resource Center. Williams et al. (1981) reported good success electroshocking Hellbenders in Pennsylvania. Our results, however, were unacceptably poor - most of the salamanders appeared to be only slightly disturbed when actually touched by the electrode and completely unaffected when they were close to, but not in contact with it. We finally concluded that it was better to lift every suitable rock we encountered. These animals are almost always found in flowing water 60 cm or less in depth. The daylight periods are spent beneath large flat rocks averaging above 30 cm in "diameter", although they will also hide beneath other rubble on the bottom. Any animals discovered were scooped up in a "trout net" or grabbed by hand. At each collecting site the following data were recorded: date, time, location, weather, air and water temperatures, current velocity (fast = over 0.4M/sec.; slow = less than 0.2M/sec.), size and depth of rock cover, size of specimen to nearest cm and sex of specimen which can only be determined (short of dissection) on adults in breeding condition, which for this area begins in July and persists into September (Smith, 1907; Bishop, 1941).

The mark/release and nest studies were done on the Allegheny River whose proximity to the St. Bonaventure University campus allowed much time to be spent there. These studies focused on specific areas that the 1981 and 1982 survey found to contain sufficient rock cover to harbor populations of Cryptobranchus. These areas were in Ischua Creek, Oswayo Creek and the Allegheny River proper (Fig. 2). They varied in depth from 10 cm to about 1M. After the first week in September, while oviposition is going on, the downstream edges of likely looking nest rocks were lifted slightly to check for eggs without unduly disturbing the nest or its male guardian. Captured Hellbenders were measured, sexed (when possible) and tagged. Tagging was done using a "Buttoneer" button fastening machine to secure small, colored plastic tags (Pough, 1970) to the proximal dorsal edge of the tail blade of the salamander. The specimen was then released at the site of capture. The time interval between tagging and recapture varied from one to four weeks depending on weather - heavy rains cause prohibitive turbidity. Each riffle site used for mark/release studies was measured with a steel tape and the area expressed as M^2 of habitable space (i. e. containing rocks large enough to afford cover for the Hellbenders).

Mark/release data were used to establish a Lincoln - Peterson Index of Population Density using the adjusted equation N = M(n+1)/R+1 as suggested by Brower and Zar (1984). Ecological density of the Hellbender was then calculated by dividing the estimated number of animals in the sample site by the habitable area sampled. In addition, all instances of nesting were recorded and included the date, location, number of clutches contained in the egg mass and presence or absence of a guardian male.

RESULTS

I. The Susquehanna River Watershed.

Fig. 3 depicts the old locality records as well as those for this study for the Susquehanna and Unadilla Rivers. These are the only parts of the Susquehanna drainage known to harbor Hellbenders.

In 1981 10 specimens of the Hellbender were discovered, one of which escaped and could neither be measured nor sexed. Of the nine captured specimens four were female and five were male. The 1982 collecting trips were more successful, undoubtedly because we were now working familiar territory. Twenty specimens were collected of which 11 were female and 9 were male. A composite of both years reveals 29 examinable specimens (15 female and 14 male) for a virtual 1:1 M:F ratio. All of the specimens, including the one that escaped, were over 40 cm in total length, which, according to Smith (1907), suggests them to be five to sex years or older. No larval or immature Hellbenderrs were seen. In addition, two nest sites were discovered in 1982. The first site was in the Susquehanna River at Ouaquaga in Broome Co. and was discovered on 10 Sept., 1982. Here, about 20 eggs were seen trailing out from very large (unliftable) rocks by the bridge abutment of Doolittle Road. The other site was in the Unadilla River just above the bridge, County Route 1 at Rockdale in Otsego County. The egg mass was disclosed by turning over a rock 100cm by 61 cm and consisted of perhaps 400 to 600 eggs. A more accurate count could not be made for the rock was immediately replaced before the eggs could wash away. According to the data of Smith (1907) this would probably represent the egg mass compliments of 1 or 2 females. This was on 11 Sept., 1982.

II. The Allegheny River Watershed.

Fig. 4 shows the old localities, as well as those for the present study, of the Hellbender in the Allegheny River watershed of New York State. This rather spotty distribution of sites reflects those areas of the river system where there are sufficient numbers of flat rocks large enough to conceal Hellbenders.

During the 1981 season 45 Hellbenders were discovered, 10 of which escaped and thus could not be measured. Also, in late August (26;27) of 1981 three mark/release studies were initiated; two on the Oswayo Creek and one on the Allegheny River. A total of 39 specimens were marked and released. Unfortunately, the weather turned very rainy right after this and the swollen, discolored waters did not recede until well into October by which time the salamanders would have scattered making a recapture attempt meaningless. In any event, the specimens collected for the initial marking and releasing can be used to show size distribution and sex ratios.

Most of the 1982 season was spent on the Susquehanna River; the rest was spent searching Conewango Creek, a western tributary of the Allegheny River in a vain attempt to discover Hellbenders there. Table 1 shows the size distribution of all the Hellbenders collected in the Allegheny River during 1981, including those used in the unsuccessful mark/release experiments. Next to this is placed the age estimates for each size class. These estimates are taken from Smith (1907) who studied the Hellbender in northwestern Pennsylvania. Specimens above 40 cm in total length can only be classified as over 5 to 6 years.

During the years 1983-1985 and 1988 the junior author captured 219 specimens of Hellbenders. Of these, 153 were breeding adults and thus could be sexed. Table 2 presents the size distribution and estimated ages of these 219 specimens. Fig. 5 graphically presents the combined results of Tables 1 and 2. A preponderance of older (sexually mature) individuals is evident. Smith's data (1907) suggest that sexual maturity is attained at a total length of about 34 cm representing an age of 3 - 4 years, although Bishop (1941) considers 5 - 6 years to be the age at which sexual maturity is attained.

A series of mark/release experiments was performed at eight different sites in the Allegheny River system. These sites represent areas of good rock cover and are located in Fig. 2. Furthermore, as a check on the accuracy of the technique, sites 7 and 8 were each worked twice - in 1985 and again in 1988. The density estimates for both years were enough to engender confidence. These results appear in Table 3. The density data are expressed in terms of ecological density; that is, number of individuals per unit area of habitable space. Habitable space in this case means the estimated square meters of cover rock in the test area. This is the method used by Nickerson (pers. comm.) and allows us to compare our figures with his (Nickerson and Mays, 1973).

The junior author, during the course of the mark/release studies, was able to obtain a total of 10 sex ratio estimates on 7 of his 8 sites. Site 5 was worked earlier in the season when the adults could not be sexed. Added to these data are the sex ratios gleaned during the initial mark/release studies of 26 and 27 August, 1981 that were, as stated above, unsuccessful. Table 4 presents these figures.

Incidences of oviposition or nesting were recorded on 12 occasions during the 1983-1988 phase of this study. The discovery of, and analysis of, nests, it must be understood, is rendered difficult for two reasons. First, the nest, which is always located beneath a large rock, can be located beneath a rock much too large to lift an thus can remain undiscovered. The second problem relates to the ease with which the egg mass may be displaced and thus destroyed. The only safe way to uncover a nest is to slowly lift the suspected cover rock by its downstream edge just far enough to see the egg mass and, if possible, to estimate the number of eggs contained in it. Any disturbance beyond this usually results in letting water currents in under the rock. These can wash away the eggs almost instantly and thus destroy the clutch. Smith (1907) observed that female Hellbenders can yield about 450 eggs per clutch. Bishop (1941) records a clutch of 317. Thus, a nest with an estimated number of eggs between 300 and 450 would presumably represent the contribution of 1 or 2 females. Table 5 describes the nesting activities observed during this study.

DISCUSSION

I. The Susquehanna River Watershed.

Although all major tributaries of the Susquehanna River in New York State were searched, specimens of the Hellbender were found only in the Susquehanna River proper and in the Unadilla River, one of its larger tributaries. This conforms with the previous literature (Bishop, 1941). We found Hellbenders at a few new locations as well as at all the older locations except at the New Berlin site. The river here appeared to be good habitat with moderate flow and plenty of large cover rocks. Perhaps further searching will disclose specimens here, too. Overall, the Hellbender population discovered in the Susquehanna watershed was a disappointment for several reasons. First, the number of specimens discovered (29) in two seasons seems very low. Secondly, the specimens were all over 40 cm in total length - in other words mature 5 to 6 years or older individuals (this form may have a longevity well in excess of 30 years). The fact that no larval or immature specimens were found is disturbing. Smith (1907) states that his smallest mature animals were a 33 cm male and a 25 cm female. Thus there is no evidence of a younger age group. Also, only two nests were found, although these appeared to be "healthy".

The quality of the waters in this river system appeared to be reasonably good - some sewage from the streamside hamlets and, of course, agricultural runoff. Nevertheless, the water when not in flood was clear and supported dense populations of fish, especially small largemouth bass. Why then are there no juvenile Hellbenders? We cannot make accurate judgements on the status of Cryptobranchus in the Susquehanna River system until this question can be answered. There is the possibility that more specimens (perhaps even juveniles) might be utilizing cover in the deeper pools. Bait fishermen not infrequently catch Hellbenders while fishing the deeper stretches. Furthermore, on the advice of some local fishermen, we checked the Jennison Power Station below the town of Bainbridge in Chenango Co. They use river water as a coolant and informed us that for "many years" they removed an average of one or two Hellbenders per month from their intake grille. The water adjacent to this plant is too deep to collect.

Since all 29 specimens we discovered were collected between July and September, we were able to sex all of them. The male:female sex ratio we found was virtually 1:1 (14M; 15F). Sex ratios previously reported for the Hellbender vary, according to authorities from 2 or 3 or more males: 1 female (Smith, 1907) to 1:1 (Nickerson and Mays, 1973). Bishop (1941) declares that on the breeding grounds the males are more abundant than the females or much more in evidence. Hillis and Bellis (1971) studied this animal in French Creek in northwestern Pennsylvania and determined a ratio of 1.58M:1F.

II. The Allegheny River Watershed.

We found Hellbenders in the Allegheny River and all of its important tributaries and these conformed to most of the old locality records. The only old locality area where we didn't find specimens was at the mouth of Wolf Run which is now inundated by the Allegheny Reservoir. This is unfortunate for apparently this was once a fine area for the Hellbender. Alexander (1927) on p. 17 mentions discovering "... immense males in numbers, each in his self excavated nest"., where the (Allegheny) river passes the mouth of Wolf Run.

All of the localities in the Allegheny Watershed coincided with the presence of sufficient numbers of large rocks to afford concealment for these salamanders. Indeed, within their range and within their physiological limits of tolerance, cover rocks are the "sine qua non" of Hellbender existence.

The Hellbender is much better represented in the Allegheny River Watershed than in the Susquehanna both as regards numbers of specimens and also as regards size (age) distribution. Its density in prime areas compares favorably with the data from Nickerson and Mays (1973) who suggest densities (at 95% confidence level) of from 1 specimen per 6 - 7 M^2 to 1 specimen per 13 - 16 M^2. This figure is for Missouri populations. Peterson et al. (1983) worked on the Ozark subspecies of the Hellbender and estimated densities of about 1 specimen per 20 M^2. These estimates are reasonably close to our N. Y. State estimates.

The size distribution data suggest a greater representation of sexually mature individuals. This has been noticed by other observers as well; Taber et al (1975) for example.

The sex ratios for the Allegheny River watershed Hellbenders varied considerable, but generally fall close to the ratios determined by other authorities (see above).

Nesting data gleaned over the four seasons of study suggest a rather low reproductive effort. Since there are no quantitative records of nesting for this area, it isn't possible to know if nesting activities are down in New York State.

We record several instances of a male guarding the nest. This has been observed by all other authorities as well. Unfortunately, we failed to record the presence or absence of a guardian male at every nest examined. We believe this habit to be far more common than our data would indicate.

In conclusion, we find the Hellbender to be of apparently very low density in the Susquehanna River watershed of New York State. Furthermore, there is a dearth of larval and immature forms. Nesting also appears to be of low frequency. It is felt that for reasons as yet to be determined the Hellbender is declining in the Susquehanna system although only future studies, when compared with ours, will be able to demonstrate this. In the Allegheny River watershed, on the other hand, the Hellbender appears to be doing better. Most age classes are represented and nesting, although, not all that common, appears to be more frequent than in the Susquehanna. Comparison with future studies will shed more light on this problem.

Because of the lack of past quantitative data and also because of the paucity of adult specimens and lack of juveniles in the Susquehanna River system we suggest that the Hellbender, *Cryptobranchus alleganiensis alleganiensis*, be placed in the "Special Concern" status in New York State.

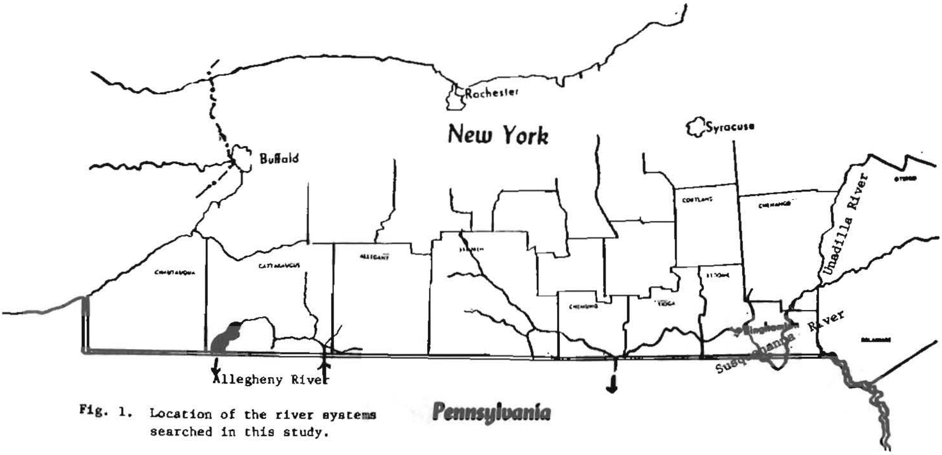

Fig. 1. Location of the river systems searched in this study.

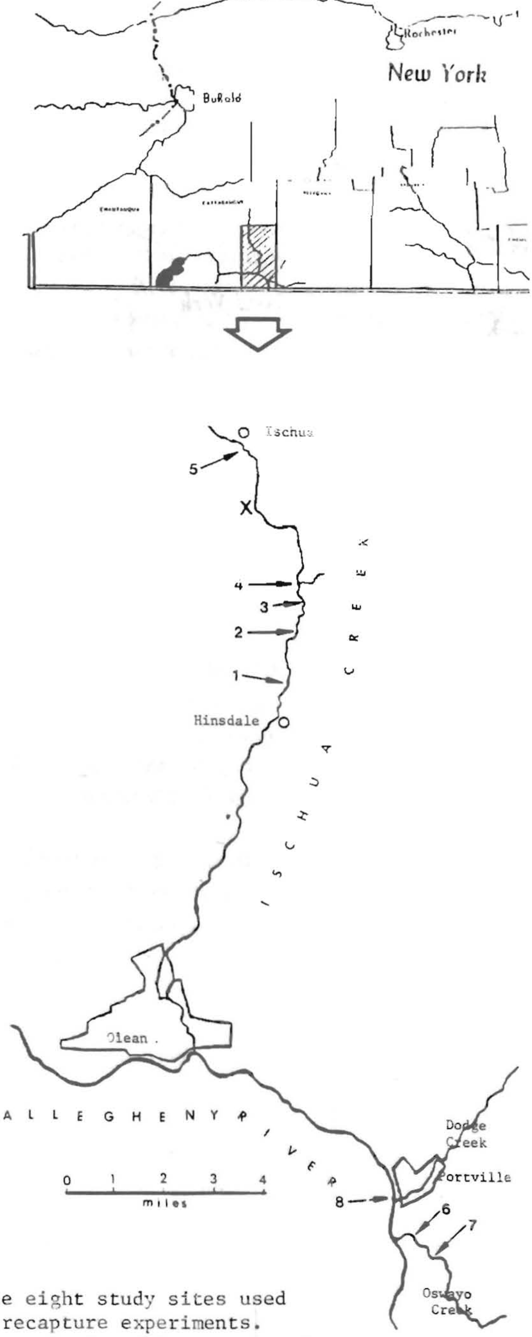

Fig. 2. Location of the eight study sites used in the mark - recapture experiments. "X" refers to a nest found in a non-study area.

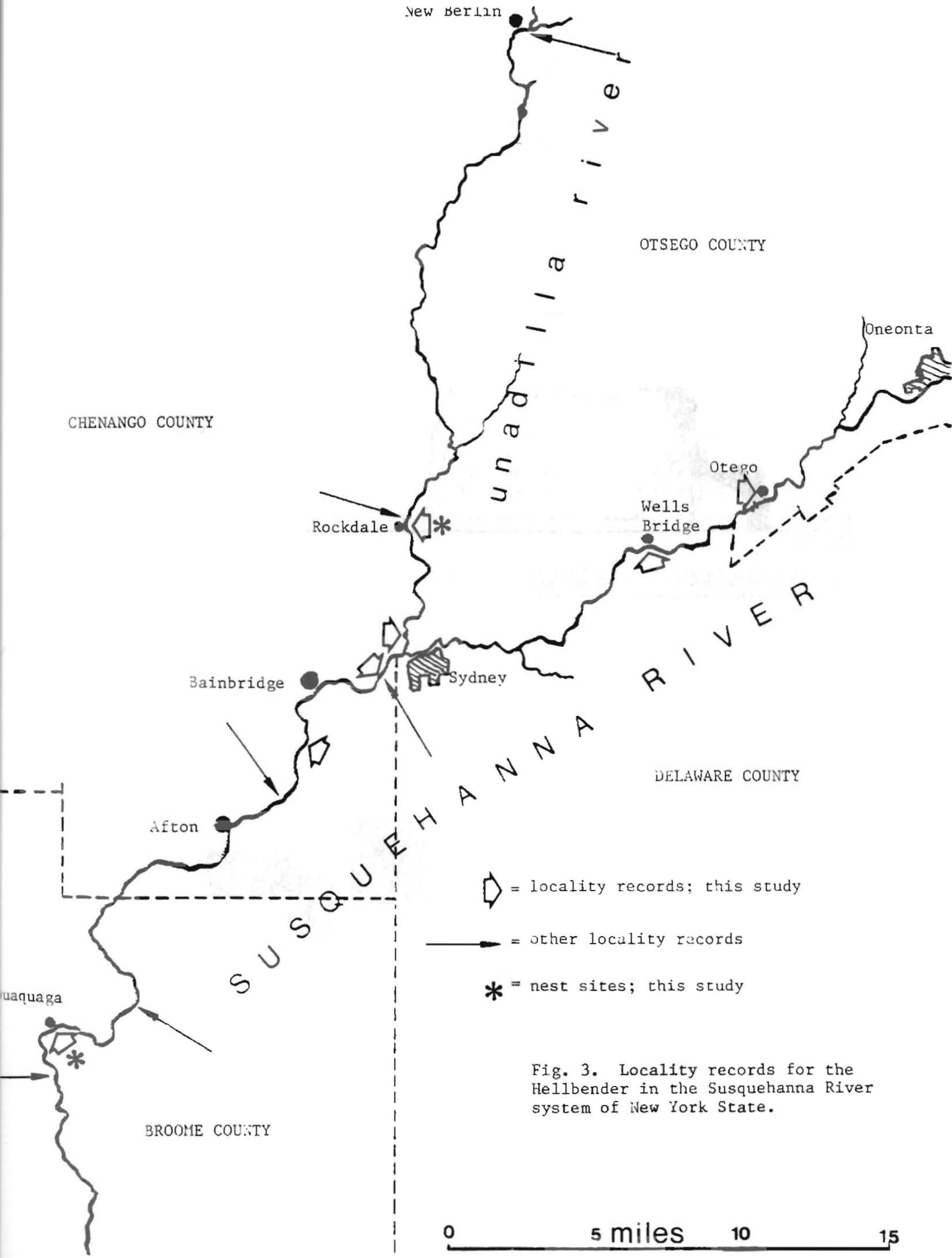

Fig. 3. Locality records for the Hellbender in the Susquehanna River system of New York State.

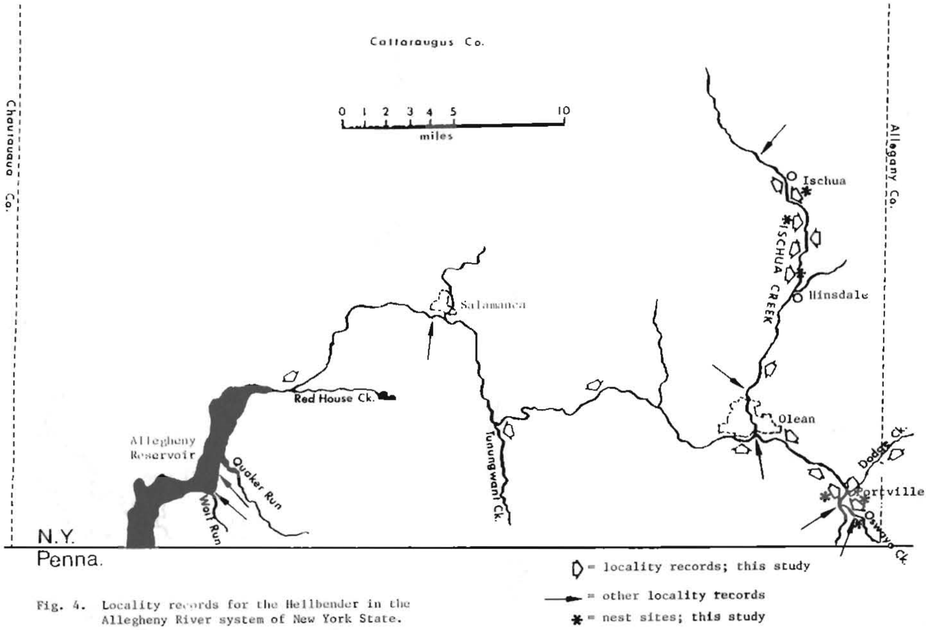

Fig. 4. Locality records for the Hellbender in the Allegheny River system of New York State.

Table 1. Size distribution and estimated ages of Hellbenders collected in the Allegheny River system during the 1981 season. (N= 74)

Total Length (cm)		N	Estimated Age	% of Total
51 - 60	mature	10	over 6 years	13.5
41 - 50		21	5 to 6 years	28.4
31 - 40		12	3 to 4 years	16.2
21 - 30	immature	28	2 to 3 years	37.9
11 - 20		3	1 - 2 years	4.0

Table 2. Size distribution and estimated ages of Hellbenders collected in the Allegheny River system during the 1983,4,5 and 1988 seasons. (N= 219)

Total Length (cm)		N	Estimated Age	% of Total
51 - 60	mature	55	over 6 years	25.1
41 - 50		89	5 to 6 years	40.6
31 - 40		54	3 to 4 years	24.6
21 - 30	immature	20	2 to 3 years	9.1
11 - 20		1	1 to 2 years	0.4

Fig 5. Size distribution (total length in cm) of combined collections of Hellbenders during the entire study. (N= 293)

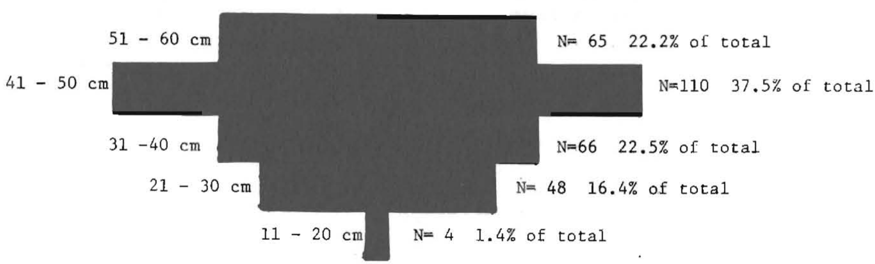

Table 3. Results of mark/recapture experiments on Hellbenders in the Allegheny River drainage of New York State. See Fig. 2 for location of sites.

Site #	Area studied (M^2)	% area covered by habitable rocks	Habitable space (M^2)	Estimated N with 95% confidence limits	Ecological density (individual/M^2 of rock cover)
1	424	2	8.5	3(.06-5.94)	1/2.8
2	1209	2-3	24.2-36.3	6(4.0-7.1)	1/4.0-1/6.0
3	806	2-5	16.1-40.3	5(2.3-7.7)	1/3.2-1/8.1
4	625	10	62.5	23(4.2-42.4)	1/2.7
5	6049	8-10	483.9-6o4.9	40(20.8-60)	1/12.0-1/15.0
6	2082	6-8	124.9-166.6	24(6.8-41.6)	1/5.2-1/6.9
7 (1985)	1593	6-8	95.6-127.4	52(39.4-64.6)	1/1.8-1/2.5
7 (1988)	"	"	"	58(31.2-83.9)	1/1.7-1/2.2
8 (1985)	14003	3-5	420.1-700.2	40(0-692.6)	1/10.4-1/17.4
8 (1988)	"	"	"	45(30.6-59.9)	1/9.3-1/15.5

Table 4. Sex ratios of Hellbenders from the Allegheny River drainage in New York State. See Fig. 2 for locations of sites.

Site #	M	F	Total	M:F Ratio	Remarks
1	2	1	3	2:1	
2	0	5	5	0:5	
3	0	3	3	0:3	
4	8	5	13	1.6:1	
5	-	-	-	--	unsexable due to season
6	5	8	13	1:1.6	1981 study
6	4	9	13	1:2.25	
7	1	2	3	1:2	1981 study
7	12	17	29	1:1.4	1985 study
7	14	17	31	1:1.2	1988 study
8	2	5	7	1:2.5	1981 study
8	12	9	21	1.3:1	1985 study
8	17	18	35	1:1.1	1988 study

Table 5. Incidences of nesting by the Hellbender in the Allegheny River drainage of New York State. See Fig. 2 for location of nest sites.

Site #	Date	Probable number contributing F	Remarks
1	14 Sep '83	1	Brooding male present
4	19 Sep '83	1	
4	8 Sep '84	1	
4	8 Sep '84	1	
X	3 Oct '83	1	Non-study site; see Fig. 2.
6	21 Sep '85	1	Brooding male present
6	21 Sep '85	-	eggs exposed in open
6	Sep '88	1	
7	1 Oct '88	1	Brooding male present
8	17 Sep '85	2	
8	17 Sep '85	-	Large F trailing eggs from cloaca
8	22 Sep '88	1	Brooding male present

LITERATURE CITED

Alexander, W. P. 1927. The Allegheny Hellbender and its habitat. Buffalo Soc. Nat. Sci. (Hobbies) 7(10):13-18.

Bishop, S. C. 1941. The salamanders ofNew York. New YorkState Mus. Bull. No. 324. 365 pp.

Brower, J. E. and J. H. Zar. 1984. Field and laboratorymethods for general ecology. 2nd Edition, pp. iii-113. W. C. Brown, Inc., Dubuque. Iowa.

Hillis, R. E. and E. D. Bellis. 1971. Some aspects of the ecology of the Hellbender, *Cryptobranchus alleganiensis alleganiensis*, in a Pennsylvania stream. J. Herpetology. 5(3-4):121-126.

Nickerson, M. A. and C. E. Mays. 1973. A study of the Ozark Hellbender *Crypto-alleganiensis bishopi*. Ecology. 54(5):1164-1165.

Peterson, C. L., R. F. Wilkinson, Jr., M. S. Topping and D. E. Metter. 1983. Age and growth of the Ozark Hellbender. Copeia 1983(1): 225-231.

Pough, F. H. 1970. A quick method for permanently marking snakes and turtles. Herpetologica 26(4):428-430.

Smith, B. G. 1907. The life history and habits of *Cryptobranchus alleganiensis*. Biol Bulletin 13(1):5 39.

Taber, C. A., R. F. Wilkinson, Jr. and M. S. Topping. 1975. Age and growth of the Hellbender in the Niangua River, Missouri. Copeia 1975(4):633-639.

Williams, R. D. and G. V. Taylor. 1981. The Hellbender: a non-game species in need of management. Wildlife Society Bull. 9(2).

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PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE

PLANT COMMUNITY TYPES OF THE CENTRAL FINGER LAKES REGION OF NEW YORK: A SYNOPSIS AND KEY

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ABSTRACT

A key to community types of the central portion of New York's Finger Lakes Region is presented along with a brief summary of the characteristics of each type. the composition and site conditions of 31 types and subtypes are described. The key uses information on species dominance to identify types, and is intended to be usable in the field. It has been used to map the vegetation on over 600 ha of land in Tompkins County.

INTRODUCTION

Vegetation types of the state of New York have been summarized by Mohler (1986) and Reschke (1990), and Bray (1930) and Braun (1950) provide general descriptions of the vegetation of the state. Although vegetation has been described for several regions within the state (Taylor 1928, Hotchkiss 1932, Raup 1938, Gordon 1940, Heimburger 1934, Shanks 1966, McIntosh 1972, Greller 1977, Nicholson et al. 1979, Leopold, Reschke and Smith 1988), there is no comprehensive description of plant communities in the Finger Lakes region in central New York. Seischab (1985) intensively analyzed a small area on the western edge of the region. The present paper presents a description of vegetation types of the central Finger Lakes region, and a key for determining the type of any particular stand.

The area treated here covers an ellipse of about 2500 square km centered on Cayuga Lake. It includes all of Tompkins and Seneca Counties, all but the northern end of Cayuga County, the eastern half of Schuyler County and the northwestern fringe of Tioga County. The key and community descriptions are probably valid for most of the central portion of the state. All natural and seminatural terrestrial and wetland vegetation found in the region is covered, including successional communities growing on abandoned agricultural land. Submerged aquatic vegetation, urban vegetation, plantations, orchards and cultivated fields are not included.

The present paper is intended primarily as a tool for evaluating and mapping vegetation in land use planning. Although keys to vegetation types have been developed for many regions in the western United States (Hoffman and Alexander 1976; Youngblood and Mauk 1985; Hess and Alexander 1986; Kovalchik 1987), this approach to the description of vegetation has rarely been attempted for the more complex forests in the eastern half of the country. In draft form, the key and type descriptions have been used to map plant communities on more than 600 ha in Tompkins County.

METHODS

The classification and description of the types were based on 180 0.1 ha samples of the sort used by Whittaker (1960) plus 258 relevés. The relevés consisted of estimates of the percent cover of each woody species, with additional notes on herbaceous species. In both 0.1 ha and relevé samples, slope, aspect, position on slope, and elevation were recorded and soil type was determined using published soil surveys (Neeley 1965, Hutton 1971, Hutton 1972, Puglia 1979). Samples were grouped into initial vegetation types using two-way indicator species analysis (TWINSPAN) (Hill, Bunce and Shaw 1975) and by consulting published descriptions of the ravine and swamp forests of the region (Lewin 1974, Huenneke 1982). The initial classification was then refined by hand using an iterative process in which samples were moved between types until the best possible match between categories of environmental conditions and composition of vegetation was approximated. Sampling and classification procedures will be described more thoroughly elsewhere, along with a more detailed discussion of the types (Mohler and Marks, in preparation).

Latin names of plants follow Mitchell (1986). Appendix A contains a comprehensive list of the latin and common names of all species mentioned.

THE UNITS OF THE CLASSIFICATION

Vegetation tends to change continuously along environmental gradients (Gleason 1926, Whittaker 1956), and while division of vegetation into community types is useful for some purposes, it is necessarily somewhat artificial. Unavoidably, some stands are compositionally intermediate between types. As a result, when mapping or otherwise analyzing the vegetation of an area using the key and type descriptions presented here, it will sometimes be necessary to recognize the existence of mosaics or intergrades of closely related types.

The types are based on combinations of dominant species, and type names refer to species which frequently dominate actual stands of the type. Unfortunately, no brief name can adequately describe the range of community composition which is encompassed within most types. Type names indicate a compositional tendency, rather than the actual composition of every stand. Thus, many stands of, say, the Sugar maple-Basswood-White ash type are not composed precisely of those three species, and for example, a stand dominated by bitternut hickory and basswood would be within that type as it is here conceived. Although such assignments may seem unsatisfying, the only alternatives are either the use of long, syntactically complicated names, or recognition of an inordinately large number of types.

The types are approximately equal in terms of compositional distinctiveness. Major exceptions are the Sedge-Grass type and the Bog Complex. Both are highly variable, but poorly represented in the region and hence difficult to study quantitatively. The cutgrass marshes (*Leersia oryzoides*) are distinguished from the rest of the Sedge-Grass type by being designated as a subtype. The author has repeatedly observed *Leersia* dominated communities occurring as the first stage in succession following pond drainage. Although other distinctions could be made within non-cattail marshes, effective classification of these wetlands will require study over a larger geographical area. Communities of acid bogs also form a successional series which is here broken into a sequence of subtypes within the Bog Complex unit. These several bog communities are at least as compositionally distinctive from one another as are, say, the mesophytic forest types. However, they typically intergrade with one another at a scale less than the minimal area for a reasonable vegetation sample, and hence they have not been given type status.

Two subtypes have also been designated within the Maple type. The two kinds of maple swamps are very similar in canopy dominants but differ consistently with regard to the shrub, herb and minor tree species. The key also recognizes a variant of the Sugar maple-Basswood-White ash type which is apparently a successional intermediate between the Sycamore-Cottonwood type and the Sugar maple-Basswood-White ash type proper.

The key is designed to produce a type designation for any conceivable community composition. Consequently, the key forces peculiar combinations of species, some of which may not occur in the field, into one or another of the types. In the key, compositions which depart significantly from the norm for the type are indicated by the word "aberrant" following the type name. This designation indicates that the community is unusual for the region, even though the stand is compositionally related to the indicated type. Stands which key to an aberrant form of a type often have an unusual history of disturbance.

THE STRUCTURE OF THE KEY

Classifications of plant communities are generally based on similarities in the distribution of species in the landscape, and the present classification is no exception. The species lists in Table 1 define groups of species which have similar distributions with respect to environmental gradients within the region. The key frequently refers to the species groups specified in Table 1. Although Table 1 indicates the typical or modal habitat for the species groups, all species in a group may not occur in any particular stand in that kind of habitat, and species usually occur in other habitats as well. The relationships between species and environment expressed in Table 1 are specific to the central Finger Lakes Region and may not apply elsewhere. For example, *Quercus macrocarpa* is chiefly a wetland species in central New York although it occurs on dry sites in the midwestern U.S.

The shrub lists in Table 1 are not exhaustive but rather are intended to include the most common and indicative species. The tree lists include all species which sometimes reach the forest canopy plus all understory tree species which can potentially constitute a major portion of the stand in terms of basal area. Only species groups mentioned in the key are included in Table 1.

The key is based almost entirely on the species of vascular plants which are dominant in the plant community. In a very few places information about the environment is used to simplify otherwise complicated distinctions. The key uses multiple branches. Arranging the key as lists of alternatives rather than strictly as dicotomies makes it shorter and therefore easier to use in the field. To facilitate recognition by the user of multiple branches the following convention is used. When a branch is dichotomous the lettering consists simply of the letter (e.g., B) for one alternative and the letter plus an apostrophe for the other (B'). With multiple branches, each of the alternatives has a number as well as a letter (e.g., B1, B2, B3, etc.).

Occasionally one may encounter a stand which does not key because a dominant species is not indicated in any of the choices. In such cases either (a) the dominant in question is an exotic, and the stand is thus beyond the realm of this study, or (b) it is in one of the lists of "incidental" species in Table 1. Here "incidental" is used to refer to species which are rarely among the most abundant species in a stand. In general, the species listed as "incidental" only dominate stands following anthropogenic disturbances. Presumably, stands dominated by such species will develop some more commonly encountered composition eventually, and in most cases, the other species present roughly indicate the direction in which the composition is changing. Rather than define additional types or greatly elaborate the key to accomodate the rare stand dominated by incidental species, such stands are forced into the existing types. In the key this is accomplished as follows. If a species on one of the lists of incidental species is a dominant, ignore it, and key the stand as if the next most abundant species were the dominant or second dominant or whatever. Incidental species count, however, when the branch asks for a comparison of the overall abundance of two groups of species. For example, if the key asks whether species of the *Quercus* group or the *Tilia* group are more abundant, *Ostrya virginiana* should be counted with the *Quercus* group when making the evaluation.

In most cases the same type may be arrived at by several different paths through the key. This is an unavoidable consequence of the continuum nature of vegetation. Unlike plant and animal species which are naturally discrete entities having only a single closest relative, plant community types usually intergrade by degrees with several other types. In most cases, the distinction between each pair of intergrading types requires at least one final branch in the key.

The following terminology is used in the key. "Abundance" refers to basal area for trees and large shrubs, and refers to projective cover for herbs and low shrubs. The word "dominant" refers to the most abundant species in the tallest closed or nearly closed stratum of the community. Second and third dominants are the second and third most abundant species in that stratum. In this context, canopy and subcanopy trees in a forest are considered to form a single stratum. "Present" means that the species is represented by at least a one or two small saplings per 0.1 ha if it is a tree, or by a mature individual if it is an herb or shrub. Thus, a species is not considered present if it is only represented by seedlings. "Significantly present" means that a tree species is represented by at least one or two individuals in the midstory or subcanopy, or if it is an herb or shrub, by several clumps or mature stems. A species must be at least "significantly present" to be considered a second or third dominant. "Essentially absent" is the converse of "significantly present". "Abundant" means that a tree species is represented by one or more canopy individuals, or by many subcanopy individuals, or, for herbs and shrubs, that it is more than just "significantly present". A group of species is "abundant" if together they satisfy the criterion just stated.

Table 1. Species groups referred to in the key.

SHRUBS AND SMALL TREES OF CALCAREOUS CLIFFS

- *Juniperus virginiana* L.
- *Rhus aromatica* Ait.
- *Viburnum rafinesquianum* Schultes

WETLAND SHRUBS

Shrubs of acid wetlands (bogs and bog forests

- *Andromeda polifolia* L.
- *Chamaedaphne calyculata* (L.) Moench
- *Ledum groenlandicum* Oeder
- *Nemopanthus mucronatus* (L.) Coesener ex Koehne
- *Vaccinium corymbosum* L.
- *Vaccinium macrocarpon* Ait.
- *Vaccinium oxycoccos* L.
- *Viburnum cassinoides* L.

Shrubs of calcareous wetlands

- *Cephalanthus occidentalis* L.
- *Lonicera oblongifolia* (Goldie) Hook
- *Myrica gale* L.
- *Potentilla fruticosa* L.
- *Rhamnus alnifolia* L'Her
- *Salix candida* Flügge ex Willd.

Other wetland shrubs

- *Alnus incana* (L.) Moench
- *Aronia melanocarpa* (Michx.) Ell.
- *Cornus sericea* L.
- *Ilex verticillata* (L.) Gray
- *Lindera benzoin* (L.) Blume
- *Viburnum trilobum* Marsh
- *Rhus vernix* (L.) Kuntze
- *Rosa palustris* Marsh.
- *Spiraea alba* DuRoi
- *Solanum dulcamara* L.
- *Salix* spp.

SHRUBS AND SMALL TREES OF ABANDONED AGRICULTURAL LAND

- *Crataegus* spp.
- *Cornus foemina* Mill.
- *Malus coronaria* (L.) Mill.
- *Malus pumila* Mill.
- *Rhamnus cathartica* L.
- *Rhus typhina* L.
- *Rubus allegheniensis* Porter ex Baile
- *Rubus occidentalis* L.
- *Viburnum recognitum* Fern.
- *Viburnum lentago* L.

TREES OF THE QUERCUS GROUP (DRY SITES)

Principal species of the Quercus group

- *Carya glabra* (Mill.) Sweet
- *Carya ovata* (Mill.) Koch
- *Quercus alba* L.
- *Quercus rubra* L.
- *Quercus montana* Willd.
- *Quercus velutina* Lam.
- *Pinus resinosa* Seland. ex Ait.
- *Pinus rigida* Mill.
- *Pinus strobus* L.

Incidental species of the Quercus group

- *Amelanchier* spp.
- *Castanea dentata* (Marsh.) Borkh.
- *Cornus florida* L.
- *Nyssa sylvatica* Marsh.
- *Ostrya virginiana* (Mill.) Koch
- *Prunus avium* (L.) L.
- *Quercus coccinia* Muenchh.
- *Sassafras albidum* (Nutt.) Nees

MESOPHYTIC TREES

Tilia group (nutrient rich soils)

- *Carya cordiformis* (Wang.) Koch
- *Fraxinus americana* L.
- *Juglans cinerea* L.
- *Juglans nigra* L.
- *Tilia americana* L.
- *Ulmus rubra* Muhl.

Tsuga group (cool microclimates)

- *Acer pensylvanicum* L.
- *Acer spicatum* Lam.
- *Betula lenta* L.
- *Betula alleghanensis* Britt.
- *Tsuga canadensis* (L.) Carr.

Platanus group (creek floodplains)

- *Acer negundo* L.
- *Platanus occidentalis* L.
- *Populus deltoides* Bartr. ex Marsh.

Mesophytic dominants not in a group

- *Acer rubrum* L.
- *Acer saccharum* Marsh.
- *Fagus grandifolia* Ehrh.
- *Liriodendron tulipifera* L.

Incidental mesophytic species

- *Ailanthus altissima* Mill.) Swingle
- *Betula populifolia* Marsh.
- *Carpinus caroliniana* Walt.
- *Magnolia acuminata* (L.) L.
- *Morus rubra* L.
- *Populus grandidentata* Michx.
- *Populus tremuloides* Michx.
- *Prunus serotina* Ehrh.
- *Robinia pseudo-acacia* L.

WETLAND TREES

Wetland dominants not in a group

- *Fraxinus nigra* Marsh.
- *Larix laricina* (DuRoi) Koch
- *Picea mariana* (Mill.) BSP
- *Quercus macrocarpa* Michx.
- *Salix* spp.

Incidental species

- *Ulmus americana* L.

Acer saccharinum group

- *Acer saccharinum* L.
- *Fraxinus pennsylvanica* Marsh.
- *Quercus bicolor* Willd.

SYNOPSIS OF THE VEGETATION TYPES OF THE CENTRAL FINGER LAKES REGI(

I Herbaceous communities.

Ia Herbaceous communities of agriculturally disturbed sites.

1. Pasture-Hay meadow type.

--Site: The type occurs on agricultural land as permanent or semipermanent sod and in rotation with row crops and small grains. It also sometimes appears as an early stage of old field succession when land is abandoned following small grain production.

--Composition: Dominants are forage grasses and legumes, usually some combination of *Phleum pratense* L., *Dactylis glomerata* L., *Bromus inermis* Leyss., *Lotus corniculatus*, *Medicago sativa* L. and *Trifolium* spp. Usually *Agropyron repens* (L.) Beauv., *Poa* spp., *Daucus carota* L., *Plantago* spp. and *Taraxacum officinale* Weber ex Wiggers occur as well. Older stands may be invaded by *Aster* spp., *Solidago* spp. and other species of the Goldenrod-Aster old field type. Sedges and rushes are usually important on wetter sites.

2. Ragweed type.

--Site: The type occurs on abandoned agricultural fields 1 to 3 years after the last cultivation.

--Composition: Dominants vary greatly from field to field but are some mixture of annual and monocarpic perennial herbs, for example, *Ambrosia artemisiifolia*, *Digitaria sanguinalis* (L.) Scop. *Setaria glauca* (L.) Beauv., *Panicum capillare* L., *Stellaria media* (L.) Vill. *Leucanthemum vulgare*, *Daucus carota*, and *Verbascum thapsus* L. Some of the species characteristic of the Pasture-Hay meadow and Goldenrod-Aster types are usually present and may be abundant..

3. Goldenrod-Aster type.

--Site: The type occurs primarily on abandoned agricultural fields 3 to 15 years after the last cultivation.

--Composition: Dominants are chiefly perennial composites, especially *Solidago canadensis* L., *S. rugosa* Mill., *S. juncea* Ait., *Euthamia graminifolia* (L.) Nutt. ex Cass., *Aster novae-angliae* L., and *A. lateriflorus* (L.) Britt.. Other important species include *Fragaria virginiana* Mill., *Potentilla* spp., *Prunella vulgaris* L. and the grasses and forbs typical of the Pasture-Hay meadow type.

Ib Herbaceous wetlands.

4. Cattail type.

--Site: The type occurs primarily on flooded muck soils at margins of the Finger Lakes and less frequently in wetlands near drainage divides.

--Composition: *Typha*, usually the "hybrid" *T.* x *glauca* Goder. forms a nearly pure stand. *Lemna minor* L. is usually abundant on the standing water between *Typha* stalks. *Impatiens capensis* Meerb., *Cicuta bulbifera* L. and a few other species may be present.

5. Sedge-Grass type: Cutgrass subtype.

--Site: The type occurs on poorly drained soils following a several year period of deep flooding. The type frequently occurs in wetlands near drainage divides following the break up of a beaver dam.

--Composition: *Leersia oryzoides* is usually strongly dominant. Some *Carex* spp. and other cyperaceous species may be present as well as a scattering of forbs such as *Epilobium coloratum* Biehl., *Eupatorium perfoliatum* L., *Bidens* spp. and *Polygonum* spp.

--Comments: Appears to be replaced in time by Sedge-Grass subtype.

6. Sedge-Grass type: Sedge-Grass subtype.

--Site: The type occurs on muck soils in various sorts of wetlands which receive mineral nutrients via ground water or streams. Sedge-Grass marshes are often adjacent to open water.

--Composition: Composition is highly variable. Dominants are usually robust species of *Carex* such as *C. lacustris* Willd., *C. stricta* Lam., or *C. rostrata* Stokes ex With. but occasionally *Scirpus tabernaemontanii* Gmel., *S. acutus* Muhl. ex Bigel., *Dulichium arundinaceum*(L.) Britt., *Calamagrostis canadensis, Phalaris arundinacea, Phragmites australis, Pontedaria cordata, Sagittaria latifolia, Alisma plantago-aquatica, Sparganium eurycarpon* or *Thelypteris palustris* are dominant. A great variety of other wetland species occur in the type.

--Comments. The community can be nearly a monoculture or can be moderately diverse, with as many as 30 to 40 species per 0.1 ha.

7. Bog complex: pitcher plant subtype.

--Site: The type occurs on living sphagnum peat in small, rain fed basins. The pH is typically 4.2 or less.

--Composition: Dominant vascular plants are usually some mixture of *Vaccinium macrocarpon, V. oxycoccus, Sarracenia purpurea* L., *Eriophorum virginicum* L., *Carex trisperma* Dewey and *C. limosa*, but vascular plant cover may be rather sparse. *Drosera intermedia* Hayne, *Calopogon tuberosus* (L.) BSP. and *Pogonia ophioglossoides* (L.) Juss. are indicators of the type. Patches of *Chamaedaphne calyculata*, and *Andromeda polifolia* are usually present.

--Comments: The type is rare in the region. It grades into the Bog complex: Leatherleaf subtype.

II Shrub dominated communities.

(See also type no. 18, Oak-Red cedar scrub and forest.)

IIa Shrub dominated communities of abandoned agricultural fields.

8. Viburnum-Grey dogwood type.

--Site: The type occurs on abandoned agricultural fields approximately 10 to 25 years after the last cultivation, especially on sites with restricted soil drainage.

--Composition: Dominant shrubs are typically some mixture of *Viburnum recognitum*, *V. lentago*, *Cornus foemina* and *Rubus* spp. *Rhamnus cathartica* is abundant in the northern part of the region. Herbs are typically those of the Goldenrod-Aster type. Seedlings and saplings of *Pinus strobus*, *Acer rubrum*, *Fraxinus americana* and other invasive tree species are usually present.

IIb Shrub dominated wetlands.

9. Willow type.

--Site: The type occurs on poorly or very poorly drained soils of intermediate pH which are recovering from intense disturbance such as forest clearing followed by grazing. The type also sometimes occurs as a strip along stream courses through wet pastures.

--Composition: Species of *Salix* are dominant. A variety of herbs and shrubs typical of wetland soils with intermediate pH may be present.

--Comments: The canopy may be only a few meters tall if shrubby species like *S. fragilis* L., *S. sericea* Marsh. and *S. discolor* Muhl. are dominant, or it may be 15 meters or more if *S. alba* L. or *S. nigra* Marsh. is dominant.

10. Alder type.

--Site: The type usually occurs on muck soils of intermediate pH, primarily in drainage divide wetlands.

--Composition: Dominant is *Alnus incana*, typically in a nearly pure stand. A few individuals of *Acer rubrum* are often present as well. *Cornus sericea* is often very abundant as an understory beneath the *Alnus*. The herb layer is typically a lush and diverse mixture of species common in Sedge-Grass marsh and the Hemlock-Red maple-Yellow birch forest.

--Comments: The type appears to replace Sedge-Grass marsh. The overall composition of the *Alnus* thickets which occasionally occur on well drained old fields adjacent to wetlands indicates that they are best considered an aberrant form of the Viburnum-gray dogwood type.

11. Red osier-Shrubby cinquefoil type.

--Site: The type occurs on muck soils with marl deposition.

--Composition: Composition is variable. Characteristic dominant shrub species include *Potentilla fruticosa, Cornus sericea, Rhamnus alnifolia* and *Cephalanthus occidentalis*. More widely distributed species like *Spiraea alba* and *Viburnum lentago* may be abundant as well. Open areas are dominated by *Carex hystericina, C. interior, C. flava* L., *Eriophorum viridi-carinatum* and *Muhlenbergia glomerata*. *Solidago uliginosa* Nutt. and *Parnassia glauca* Raf. are restricted to the type. Several rare species are associated with this type.

--Comments: The type is rare in the region. Physiognomy ranges from closed, low thicket to open meadow with scattered shrubs.

12. Bog complex: Leatherleaf subtype.

--Site: The type occurs on living sphagnum peat in small, rain-fed basins. The pH is typically 4.2 or less.

--Composition: *Chamaedaphne calyculata* forms a nearly continuous mat, often with *Andromeda polifolia, Vaccinium macrocarpon, V. oxycoccos, Sarracenia purpurea, Eriophorum virginicum, Carex trisperma* and *C. limosa* interspersed or growing beneath. Margins of the bog typically have taller acidophilic shrubs like *V. corymbosum, Nemopanthus mucronata* and *Viburnum cassinoides* as well as other wetland shrubs. Sometimes these taller forms invade the central portion of the bog also.

--Comments: The type is rare in the region. The community intergrades with the Pitcher plant and Tamarack-White Pine-Black spruce subtypes of the Bog complex.

III Tree dominated communities.

IIIa Tree dominated communities of abandoned agricultural fields.

(See also no. 9, Willow type)

13. <u>White pine-Red maple-White ash-Poplar type.</u>

--Site: The type occurs on abandoned agricultural land about 25 years or more following the last cultivation.

--Composition: Dominants are usually some mixture of *Pinus strobus, Acer rubrum, Fraxinus americana, Populus grandidentata, P. tremuloides* and, less frequently, *Acer saccharum. Crataegus* spp. and *Malus* spp. are sometimes abundant in the understory, particularly in stands developing on abandoned pasture land. Some of the more typical herbs include *Lycopodium digitatum* A. Br., *Veronica officinalis* L. and *Botrychium* spp. In closed stands the herb layer is often sparse.

--Comments: The type intergrades with the Viburnum-gray dogwood type which it replaces. ***Populus*** increases in abundance with elevation.

14. <u>Red cedar-White ash-Black walnut type.</u>

-- Site: The type occurs on abandoned agricultural land in Seneca, Cayuga and northern Tompkins counties, particularly on fertile soils and on slopes along the lakes. It also occurs occasionally on well drained alluvial soils in the major valleys of the southern part of the region.

--Composition: The dominants are typically some mixture of *Juniperus virginiana*, *Fraxinus americana*, *Juglans nigra* and *Carya* spp. *Rhamnus cathartica* is often abundant in open stands of the type.

IIIb Dry upland forests.

15. Chestnut oak type.

--Site: The type mostly occurs on exposed, steep, upper S- and W-facing slopes, mostly south of Ithaca. Soil is usually shallow to bedrock and acid (pH 4.4-5.2).

--Composition: Dominants are *Quercus rubra* and *Q. montana* with some *Q. alba*, *Acer rubrum*, *Pinus strobus* and *Tsuga canadensis*. *P. rigida*, and *P. resinosa* are sometimes present. *Castanea dentata* sprouts are common and *Kalmia latifolia* L. is present in some stands. Herbs are moderately diverse and abundant, but cover of *Viburnum acerifolium* L. and ericaceous shrubs usually exceeds that of herbs.

16. Mixed oak type.

--Site: The type mostly occurs on steep to moderate S- and W-facing slopes along the lakes. The type seems to be associated with soils which have calcareous materials at depth, although the surface soil may be quite acidic.

--Composition: Dominants are *Quercus rubra, Q. velutina, Q. alba* and *Pinus strobus*. A few large *Carya glabra* and *Acer rubrum* are usually present, and *Acer saccharum* may be abundant in the subcanopy. *Cornus florida* and *Prunus virginiana* L. are often abundant in the understory. Herb flora is primarily mesophytic; large patches of *Aralia nudicaulis* L. are common.

17. <u>Oak-Red cedar type.</u>

--Site: The type occurs on steep S- and W-facing cliffs and talus slopes on limestone or calcareous shale, mostly north of Ithaca.

--Composition: Dominants are a mixture of trees and shrubs, most frequently, *Quercus rubra*, *Fraxinus americana*, *Juniperus virginiana*, *Rhus typhina*, *Acer saccharum*, *Ostrya virginiana* and *Q. alba*. *Viburnum rafinesquianum* and *Rhus aromatica* are indicative of the type. Woody vines, notably *Parthenocissus* spp. and *Celastrus scandens* L. are abundant.

--Comments: The trees are often stunted by the xeric conditions, and the canopy may be open. The community is sometimes species poor on actively eroding cliffs, but where the substrate is more stable it may have 50 or more species per 0.1 ha.

18. <u>Oak-Beech-Hickory-Pine type.</u>

--Site: The type occurs primarily on flat hilltops and S- to W-facing slopes, mostly south of Ithaca. Soils are acidic, and well to moderately well drained, but usually have a restricted rooting depth due to bedrock or a fragipan.

--Composition: Dominant trees are *Quercus rubra*, *Q. alba*, *Fagus grandifolia*, *Acer rubrum*, *Pinus strobus*, *Carya glabra* and *Populus grandidentata*, with some *Ostrya virginiana*. Shrubs and herbs are abundant and moderately diverse.

--Comments: Many stands seem to have a history of repeated logging.

19. <u>Hickory-White ash-Oak type.</u>

-- Site: The type occurs mostly on flat uplands and gentle to moderate slopes, mostly north of Ithaca. Soil is usually of intermediate pH and well to moderately poorly drained.

--Composition: Trees are a mixture of oaks, hickories and the mesophytes of fertile soils. Dominants are usually some mixture of *Carya ovata*, *C. glabra*, *C. cordiformis*, *Quercus alba, Q. rubra, Fraxinus americana, Tilia americana, Acer saccharum* and *A. rubrum*. Shrubs and herbs vary in composition and abundance, but often have a weedy component.

--Comments: Most stands have been heavily logged at some time. Some stands dominated by *Carya* spp. seem to have a history of severe cutting followed by grazing and then abandonment.

20. Pine-Hemlock type.

--Site: The type occurs on gravelly glacial outwash of the Howard soil series, adjacent to the larger gorges of the region.

--Composition: Dominants are *Tsuga canadensis, Pinus strobus* and *P. resinosa*, often with some *Quercus rubra, Q. alba, Q. velutina* or *Acer rubrum*. The herb layer is depauperate.

--Comments: Tree reproduction is scant. Some stands show evidence of past fires.

IIIc Forests of mesic slopes and creek floodplains.

21. Sugar maple-Basswood-White ash type.

--Site: The type is best developed on fertile, well-drained soils north of Ithaca. North of Ithaca it occurs on well drained flat lands, in ravines and on hill slopes of any aspect, but less frequently on slopes along the lakes. South of Ithaca the type mostly occurs on gentle S- and W-facing slopes, on mid to lower N- and E-facing slopes, and occasionally in ravines. It is also sometimes found on alluvial terraces.

--Composition: Dominant trees are *Acer saccharum, Tilia americana, Fraxinus americana, Carya cordiformis*, and occasionally *Quercus rubra*. *C. cordiformis* has its peak abundance in this type. Spring wildflowers are usually abundant.

--Comments: This is the most common forest type in the region.

22. Sugar maple-Basswood-White ash type (Sycamore variant).

--Site: The variant occurs as a mid-successional stage on coarse, circumneutral to alkaline soils in active flood plains of the larger creeks.

--Composition: Dominants are as in the type proper except that *Platanus occidentalis* and sometimes *Robinia pseudo-acacia* are important components of the stand. Shrubs and vines are diverse and abundant. Many species of spring and summer wildflowers are usually present in great abundance. Several species which are rare in the region occur in stands of this type.

--Comments: The type seems to occur as an intermediate stage in a succession from Sycamore-Cottonwood to true Sugar maple-Basswood-White ash.

23. Maple-Beech type.

--Site: The type occurs on N- and E-facing slopes and on gently sloping hilltops of any aspect. It rarely occurs in ravines. The soil is usually acid and well-drained.

--Composition: Dominants are *Acer saccharum, Fagus grandifolia* and, less frequently, *A. rubrum, Fraxinus americana* and *Quercus rubra*, with lesser amounts of *Tilia americana*, and *Prunus serotina*. Shrubs have low abundance. Herbs may be moderately abundant, but tree seedlings are often the most noticeable component of the ground layer.

--Comments: The type is quite common.

24. Hemlock-Sugar maple-Tulip tree type.

--Site: The type occurs extensively in ravines, particularly north of Ithaca. It also occurs on N- to E-facing hill slopes, especially steep, lower slopes. It is typical, and reaches its best development, on the moderately acid soils of higher stream terraces which no longer flood.

--Composition: Dominants are *Tsuga canadensis*, *Fagus grandifolia*, *Acer saccharum*, *Tilia americana*, *Liriodendron tulipifera* and sometimes *Quercus rubra*, often with lesser amounts of other mesophytes of fertile soils and occasionally a few *Pinus strobus*. Shrubs have low abundance. Spring wildflowers are often very abundant and diverse.

25. Hemlock-Beech-Birch type.

--Site: The type occurs on sides of ravines and small creek valleys, occasionally on upper N- to E-facing open slopes, and sometimes also on moderately well to well drained soils at the margins of drainage divide swamps. North of Ithaca, the type occurs only rarely.

--Composition: Dominants are *Tsuga canadensis*, *Fagus grandifolia*, *Acer rubrum* and *Betula lenta*, often with a few *B. alleghenensis*, *Prunus serotina* and *A. saccharum*. Shrubs have low abundance. Herbs which are characteristic of northern and montane areas are common (e.g., *Dryopteris carthusiana* (Vill.) Fuchs, *Maianthemum canadense* Desf., *Oxalis acetosella* L.).

26. Sycamore-Cottonwood type.

--Site: The type occurs in active flood plains of the larger creeks.

--Composition: Dominants are *Platanus occidentalis*, *Populus deltoides*, and, formerly, *Ulmus americana*. *Acer negundo* is indicative of the type but rarely attains canopy stature. The forest usually has a dense, tangled understory of vines, *Rubus* spp., and introduced shrubs, especially *Lonicera tatarica* L. *Tilia americana*, *Fraxinus americana*, *Carya cordiformis* and *Acer saccharum* are frequently found in the understory.

IIId Wetland forests.

27. Maple type: Red ash subtype.

--Site: The subtype occurs in major lake basins and along the Seneca River, and in upland depressions north of the Tompkins-Cayuga Co. line. Soil is circumneutral muck over marl or gray clay. Some stands are deeply flooded.

--Composition: Tree layer is almost exclusively *Acer rubrum*, *A. saccharinum* or a mixture or hybrid of the two. Occasionally *Quercus bicolor* occurs as well. *Ulmus americana* was formerly abundant. *Fraxinus pennsylvanica* is indicative of the type but rarely attains canopy stature. *F. americana* is also frequently present in the subcanopy. *Cephalanthus occidentalis* L. is very abundant in some stands. The herb layer often contains a strong component of species like *Leersia oryzoides* and *Bidens* spp. which increase following a rapid drop in water level, or herbs may be sparse.

--Comments: In many stands the dominant maples show extensive crown death. The dominant *Acer* in many swamp forests in the central Finger Lakes region is intermediate in most features between *Acer saccharinum* and the *Acer rubrum* found in the uplands. It may be a hybrid between the two species (Moore 1985).

28. Maple type: Yellow birch subtype.

-- Site: The subtype occurs in upland depressions south of the Ontario lake plain, in small lake basins and, less commonly, in drainage divide wetlands. The soil is slightly acidic muck over gray clay.

-- Composition: Tree layer is heavily dominated by *Acer rubrum*, *A. saccharinum* or a mixture or hybrid of the two. *Betula alleghenensis*, *Fraxinus nigra* and occasionally *Pinus strobus* may be abundant in the understory. Shrubs, including *Alnus incana*, *Vaccinium corymbosum*, and *Ilex verticillata*, are usually abundant. The herb layer is lush and similar to that of the Hemlock-Red maple-Yellow birch type described below.

--Comments: It is possible that in some circumstances the type may replace the Alder type during succession. See comments above on the taxonomy of swamp maples.

29. Hemlock-Red maple-Yellow birch type.

--Site: The type occurs on moderately acid muck over gray clay in drainage divide wetlands, primarily south of the Tompkins-Cayuga county line.

--Composition: Dominants are *Tsuga canadensis*, *Acer rubrum*, *Betula alleghenensis* and formerly *Ulmus americana*. Sometimes a few large *Pinus strobus* occur. *Fraxinus nigra* is usually abundant, but only rarely attains canopy stature. The herb layer is dense and diverse. It occurs in a two-phase mosaic: herbs with northern and montane distribution like *Coptis trifolia* (L.) Salisb. and *Maianthemum canadense* occur on root mounds; *Osmunda cinnamomea* L., *Onoclea sensibilis* L. and other wet site species grow on the muck.

--Comments: The presence of small, mesophytic herbs only centimeters above the water level may indicate that these swamps have relatively small fluctuations in the water table.

30. Bog complex: Hemlock-White pine-Red maple subtype.

--Site: The subtype occurs on very acid (pH ≤ 4.2) woody peat at margins of small, rain-fed basins.

--Composition: Dominants are *Tsuga canadensis*, *Acer rubrum* and *Pinus strobus* with lesser amounts of *Betula alleghenensis*. These form a dark, closed canopy forest. The herb layer is sparse, species poor, and composed chiefly of species which are most common in northern and montane areas. Tall shrubs of acid wetlands such as *Vaccinium corymbosum*, *Nemopanthus mucronatus*, and *Viburnum cassinoides* may be present.

31. Bog complex: Tamarack-White pine-Black spruce subtype.

--Site: The type occurs on very acid (pH $\leq$ 4.2) sphagnum peat in small, rain fed basins.

--Composition: Dominants are *Pinus strobus*, *Larix laricina* and sometimes *Picea mariana* and *Acer rubrum*, usually in an open stand with tall, acidophilic wetland shrubs like *Vaccinium corymbosum*, *Nemopanthus mucronatus*, and *Viburnum cassinoides* forming thickets between and under the groves of trees.

KEY TO THE VEGETATION TYPES OF THE CENTRAL FINGER LAKES REGION

A1 Herbs are dominant; if woody plants are present they have < 50% cover. (A2 on p. 25).

B Graminoids are more abundant than forbs + ferns.

C1 *Typha* sp. is dominant. **4. Cattail type**

C2 *Sparganium eurycarpon* Engelm. ex Gray is dominant.

6. Sedge-Grass type: Sedge-Grass subtype

C3 Sedges (Cyperaceae) are together more abundant than other graminoids.

D Shrubs of acid wetlands are significantly present on a continuous live *Sphagnum* mat. **7. Bog complex: Pitcher plant subtype**

D' Shrubs of acid wetlands are absent, or substrate is not a continuous live *Sphagnum* mat.

G Shrubs of calcareous wetlands are abundant, or *Carex hystericina* Muhl. ex Willd. + *C. interior* Bailey + *C. limosa* L. + *Eriophorum viridi-carinatum* (Engelm.) Fern.together exceed the combined abundance of other sedges.

11. Red osier-Shrubby cinquefoil type

G' Shrubs of calcareous wetlands are scarce or absent and sedge species of calcareous wetlands listed in G are not dominant.

6. Sedge-Grass type: Sedge-Grass subtype

C4 Grasses are together more abundant than other graminoids.

I An annual grass (e.g., *Setaria*, *Digitaria*, etc.) is dominant, or annual grasses are together more abundant than perennial grasses. **2. Ragweed type**

I' Otherwise.

E1 *Calamagrostis canadensis* (Michx.) Beauv., *Phalaris arundinacea* L.or *Phragmites australis* (Cav.) Trin. ex Steud. is dominant.

6. Sedge-Grass type: Sedge-Grass subtype

E2 *Muhlenbergia glomerata* (Willd.) Trin. is dominant.

11. Red Osier-Shrubby Cinquefoil type

E3 *Leersia oryzoides* is dominant.

5. Sedge-Grass marsh: Cutgrass subtype

E4 Mesophytic perennial grasses are dominant.

1. Pasture-Hay meadow type

B' Forbs and ferns are more abundant than graminoids.

H Shrubs of acid wetlands are present on a continuous live *Sphagnum* mat.

12. Bog complex: Pitcher plant subtype

H' Shrubs of acid wetlands are absent, or substrate is not a continuous live *Sphagnum* mat.

F1 *Thelypteris palustris* Schott+ *Pontedaria cordata* L. + *Sagittaria latifolia* Willd.+ *Alisma plantago-aquatica* L. + *Sparganium eurycarpon* are together more abundant than other forbs and ferns.

6. Sedge-Grass marsh: Sedge-Grass subtype

F2 Herbaceous legumes (e.g., *Medicago* spp., *Lotus corniculata* L. + *Trifolium* spp. etc.) are together more abundant than other forbs and ferns.

1. Pasture-Hay meadow type

F3 Annual and monocarpic perennial non-legume forbs (e.g. *Ambrosia artemisiifolia* L., *Leucanthemum vulgare* Lam., etc.) are together more abundant than other forbs and ferns. **2. Ragweed type**

F4 Perennial composites (e.g. *Solidago* spp., *Aster* spp., etc.) are together more abundant than other forbs and ferns. **3. Goldenrod-Aster type**

F5 Other forbs are dominant. **3. Goldenrod-Aster type (aberrant)**

A2 Shrubs are dominant.

J Shrubs of calcareous wetlands are abundant (see Table 1).

11. Red osier-Shrubby cinquefoil type

J' Shrubs of calcareous wetlands are scarce or absent.

B1 *Alnus incana* is dominant. **10. Alder type**

B2 *Cornus sericea* is dominant.

K Community is on formerly plowed land.

8. Viburnum-gray dogwood type

K' Community is not on formerly plowed land.

C *Alnus incana* is second dominant. **10. Alder type**

C' *Alnus incana* is not second dominant.

11. Red osier-shrubby cinquefoil type

B3 *Salix* sp. is dominant. **9. Willow type**

B4 A shrub of acid wetlands is dominant (see Table 1).

H *Pinus strobus, Larix laricina* and *Picea mariana* together exceed 10% cover.

31. Bog complex: Tamarack-White Pine-Black Spruce subtype

H' *Pinus strobus, Larix laricina* and *Picea mariana* together have less than 10% cover. **12. Bog complex: Leatherleaf subtype**

B5 Dominant is an old field shrub (see Table 1), shrub of calcareous cliffs (see Table 1 *Hamamelis virginiana* L., *Rhus typhina* or *R. glabra* L.

D Community is on a cliff. **17. Oak-Red Cedar type**

D' Community is on soil formerly disturbed by human activity (e.g., agriculture, quarrying, construction etc.) **8. Viburnum-gray dogwood type**

A3 Trees are dominant. (no A4).

B Forest is successional on soil formerly disturbed by human activity (e.g., agriculture, quarrying, construction etc.), or *Populus grandidentata* or *P. tremuloides* is dominant.

C *Salix* spp. are dominant, often in a nearly pure stand. **9. Willow type**

C' Salix spp. are not dominant.

I *Juglans spp., Juniperus virginiana,* or *Carya spp.* is among the first two dominants. **14. Red cedar-White ash-Black walnut type**

I' *Juglans spp., Juniperus virginiana,* or *Carya spp.* are not among the first two dominants. (Stand is probably some mixture of *Acer rubrum, Pinus strobus, Fraxinus americana, Populus* spp. or, less frequently, *Acer saccharum*).

13. White pine-Red maple-White ash-Poplar type

B' Forest is not on soil disturbed by human activity. **Go to G1 immediately below**

G1 Dominant is in *Quercus* group (see Table 1) or is *Juniperus virginiana.* (G2 on p. 30).

H1 Dominant is an incidental member of the *Quercus* group.

Ignore dominant and continue with H2-H5 below

(Stand is an aberrant member of the indicated type)

H2 Dominant is *J. virginiana.* **17. Oak-Red cedar type**

H3 Dominant is a *Quercus* sp. (H4 on p. 28).

L Shrubs of calcareous cliffs (see Table 1) + *Rhus typhina* + *R. glabra* are abundant.

17. Oak-Red cedar type

L' Shrubs of calcareous cliffs + *Rhus typhina* + *R. glabra* are not abundant.

I Either (a) dominant is *Q. montana*, or (b) first two dominants are *Q. rubra* and *Q. montana*, and *Q. velutina* is not abundant, or (c) *Q. rubra* is dominant, *Pinus* sp. or *Acer rubrum* is second dominant, *Q. montana* is third dominant, and *Q. velutina* is not abundant. **15. Chestnut oak type**

I' Otherwise.

J First three dominants are in *Quercus* group plus *Acer rubrum.*

K Second dominant is a *Quercus* spp. or *Pinus* spp., and *Q. velutina* is present. **16. Mixed oak type**

K' Second dominant is not a *Quercus* spp. or *Pinus* spp., or *Q. velutina* is not present. **18. Oak-Beech-Hickory-Pine type**

J' First three dominants are not all members of *Quercus* group or *Acer rubrum*.

M (a) *Acer saccharum* is the only non *Quercus* group species among the first three dominants, (b) *C. ovata* is not among first three dominants and (c) *Q. velutina* is significantly present. **16. Mixed oak type**

M' Otherwise.

N Dominant is *Q. rubra*, *Q. rubra* is less than half the stand, other species in *Quercus* group are essentially absent, and wetland trees (see Table 1) are completely absent.

Go to G2 on p. 30 and key as if the abundance ranking of *Q. rubra* and the second dominant were reversed.

N' Otherwise.

P A *Tilia* group species, *Liriodendron tulipifera* or *C. ovata* is second or third dominant.

Z *Fraxinus americana* is third dominant, and other *Tilia* group species, *L. tulipifera* and *C. ovata* are not abundant.

18. Oak-Beech-Hickory-Pine type

Z' *Fraxinus americana* is not third dominant, or other *Tilia* group species, *L. tulipifera* and *C. ovata* are not abundant.

19. Hickory-White ash-Oak type

P' A *Tilia* group species, *L. tulipifera* or *C. ovata* is not second or third dominant.

T *Acer saccharum* is second or third dominant, and *Tilia* group species + *L. tulipifera* + *C. ovata* are more abundant than *Fagus grandifolia* + *Populus* spp. + *Pinus* spp. + *Tsuga* group species + *Q. montana.*

19. Hickory-White ash-Oak type

T' Otherwise. **18. Oak-Beech-Hickory-Pine type**

H4 Dominant is a *Pinus* sp. (check again that stand is not on disturbed ground).

(H5 on p. 29).

Q Dominant is *Pinus strobus*, and wetland shrubs are present (see Table 1).

R Community is on living *Sphagnum*, and either *P. strobus* is the only canopy tree species, or *Larix laricina* or *Picea mariana* is abundant.

31. Bog complex: Tamarack-White pine-Black spruce subtype

R' Community is not on living *Sphagnum*, or canopy trees other than *P. strobus* are present and *Larix laricina* and *Picea mariana* are not abundant.

30. Bog Complex: Hemlock-White pine-Red maple subtype

Q' No wetland shrubs are present, or dominant is not *P. strobus*.

S (a) *P. strobus* or *P. resinosa* is dominant, (b) *T. canadensis* is abundant, and (c) no species other than *Quercus* spp., *Acer rubrum* or *C. glabra* is more abundant than *T. canadensis*. **20. Pine-Hemlock type**

S' Otherwise.

U Shrubs of calcareous cliffs (see Table 1) + *Rhus typhina* + *R. glabra* are abundant. **17. Oak-Red cedar type (aberrant)**

U' Such shrubs are not abundant.

V Other species are together more abundant than species of the *Quercus* group.

W *Tilia* group species + *Acer saccharum* + *L. tulipifera* are at least twice as abundant as other non-*Quercus* group species.

19. Hickory-White ash-Oak type (aberrant)

W' *Tilia* group species + *A. saccharum* + *L. tulipifera* are less than twice as abundant as other non-*Quercus* group species.

18. Oak-Beech-Hickory-Pine type

V' *Quercus* group species are together more abundant than other species.

X The three most dominant canopy tree species are in *Quercus* group plus *A. rubrum*, and either *Q. montana* or *Q. velutina* exceeds *Q. alba* in abundance.

Y *Q. montana* is more abundant than *Q. velutina*.

15. Chestnut oak type

Y' *Q. velutina* is more abundant than *Q. montana*.

16. Mixed oak type

X' Three most dominant canopy tree species are not all in *Quercus* group plus *A. rubrum*, or *Q. alba* is more abundant than *Q. montana* and *Q. velutina*. **18. Oak-Beech-Hickory-Pine type**

H5 Dominant is *Carya glabra* or *C. ovata*. (no H6).

I Dominant is *C. ovata* **19. Hickory-White ash-Oak type**

I' Dominant is *C. glabra*.

K Abundance of *C. ovata* + *L. tulipifera* + *Tilia* group exceeds abundance of *Fagus grandifolia* + *Pinus* spp . + *Q. montana* + *Tsuga* group (see Table 1).

19. Hickory-White ash-Oak type

K' Abundance of *C. ovata* + *L. tulipifera* + *Tilia* group does not exceed abundance of *F. grandifolia* + *Pinus* spp.+ *Q. montana* + *Tsuga* group.

18. Oak-Beech-Hickory-Pine type

G2 Dominant is a mesophytic tree (see Table 1). (G3 on p. 40).

B1 Dominant is an incidental species of the mesophytic tree group (see Table 1). (Be certain that the stand is not on disturbed ground.)

Ignore dominant and continue with B2-B4 below

(Stand is an aberrant member of the indicated type)

B2 *Acer rubrum* is dominant. (Be certain that stand is not on disturbed ground.)

(B3 on p. 33).

L1 Overstory is nearly pure *A. rubrum* with at most a few *Ulmus americana, Betula alleghanensis* or *Fraxinus nigra*, or second dominant is *Quercus macrocarpa* or a member of the *Acer saccharinum* group.

T Cover of *Alnus incana* exceeds cover of *A. rubrum*. **10. Alder type**

T' Cover of *Alnus incana* does not exceed cover of *A. rubrum*.

Maple type (see key to subtypes on p. 41)

L2 Second dominant is *A. saccharum*. **23. Maple-Beech type**

L3 Second dominant is *B. lenta, A. pensylvanicum* or *A. spicatum*.

25. Hemlock-Beech-Birch type

L4 Second dominant is *F. grandifolia*.

P Abundance of *Tsuga* group exceeds abundance of *A. saccharum* + *Tilia* group. **25. Hemlock-Beech-Birch type**

P' Abundance of *Tsuga* group does not exceed abundance of *A. saccharum* + *Tilia* group. **23. Maple-Beech type**

L5 Second dominant is in *Quercus* group.

M1 Second dominant is *Q. montana*, or *Q. montana* is third following *Q. rubra* or *Pinus* sp. **15. Chestnut oak type (aberrant)**

M2 Second dominant is *Q. velutina*, or *Q. velutina* is third dominant following *Q. rubra, Q. alba, P. strobus* or *P. rigida*.

16. Mixed oak type (aberrant)

M3 Second dominant is *Pinus strobus*, other *Quercus* group species are not abundant, and wetland shrubs are significantly present.

C *Tsuga canadensis* is abundant.

29. Hemlock-Red maple-Yellow birch type

C' *T. canadensis* is not abundant.

Maple type (see key to subtypes on p. 41)

M4 Otherwise.

N *Fraxinus americana* is third dominant, or *Tilia americana, Carya cordiformis* or *C. ovata* is abundant.

19. Hickory-White ash-Oak type

N' *Fraxinus americana* is not third dominant, and *Tilia american, Carya cordiformis* and *C. ovata* are not abundant.

18. Oak-Beech-Hickory-Pine type

L6 Second dominant is *Liriodendron tulipifera* or a member of the *Tilia* group.

A *Fraxinus americana* is second dominant, *A. rubrum* is over 50% of the stand, and wetland shrubs are significantly present.

Maple type (see key to subtypes on p. 41)

A' Otherwise.

O A member of the *Quercus* group is the third dominant, or at least two members of the *Quercus* group are abundant.

19. Hickory-White ash-Oak type

O' Otherwise.

Y Third dominant is *Tsuga canadensis*, or *T. canadensis* and *L. tulipifera* are both abundant.

Hemlock-Sugar maple-Tulip tree type (aberrant)

Y' Otherwise.

Z Third dominant is *Acer saccharum, L. tulipifera* or a member of the *Tilia* group. **21. Sugar maple-Basswood-White ash type (aberrant)**

Z' Third dominant is not *Acer saccharum, L. tulipifera* or a member of the*Tilia* group. **23. Maple-Beech type (aberrant)**

L7 Second dominant is *T. canadensis*, *B. alleghanensis* or *Fraxinus nigra*.

C *T. canadensis* is abundant.

Q (a) Second dominant is not *F. nigra*, (b) wetland shrubs are essentially absent, and (c) either *B. lenta* + *F. grandifolia* + *A. pensylvanicum* + *A. spicatum* are more abundant than *B. alleghanensis* + *F. nigra*, or all these species are absent. **25. Hemlock-Beech-Birch type**

Q' Second dominant is *F. nigra*, or wetland shrubs are significantly present, or *B. lenta* + *F. grandifolia* + *A. pensylvanicum* + *A. spicatum* are less abundant than *B. alleghanensis* + *F. nigra*.

R *P. strobus* is third dominant.

30. Bog complex: Hemlock-White pine-Red maple subtype

R' *P. strobus* is not third dominant.

29. Hemlock-Red maple-Yellow birch type

C' *T. canadensis* is not abundant.

D *F. nigra* or wetland shrubs are significantly present.

Maple type (see key to subtypes on p. 41)

D' *F. nigra* and wetland shrubs are essentially absent.

25. Hemlock-Beech-Birch type (aberrant)

L8 Second dominant is *Picea mariana* or *Larix laricina.*

31 Bog complex: Tamarack-White pine-Red maple subtype

L9 Second dominant is member of *Platanus* group. (No L10).

26. Sycamore-Cottonwood type (aberrant)

B3 Dominant is a member of the *Platanus* group.

T1 Second dominant is also in *Platanus* group.

26. Sycamore-Cottonwood type

T2 Second dominant is *A. saccharum* or a member of *Tilia* group.

23. Sugar maple-Basswood-White ash type (Sycamore variant)

T3 Second dominant is not *A. saccharum* or a member of *Tilia* group.

26. Sycamore-Cottonwood type (aberrant)

B4 Dominant is *Acer saccharum, Fagus grandifolia, Liriodendron tulipifera,* a member of the *Tilia* group or a member of the *Tsuga* group. (no B5).

S The first three dominants are mesophytic trees (see Table 1) or *Q. rubra*, and either (a) *Tsuga canadensis* is among first three dominants, and *A. saccharum* or a member of the *Tilia* group is also among the first three dominants, or (b) *Liriodendron tulipifera* or *T. canadensis* is abundant and the other is significantly present.

E (a) The first two dominants are *T. canadensis*, plus either *A. rubrum*, *F. grandifolia*, *B. lenta* or *B. alleghanensis*, and (b) the third dominant is *A. saccharum*, (c) *L. tulipifera* is absent and (d) the combined abundance of *A. rubrum* + *B. lenta* + *B. alleghanensis* + *A. pensylvanicum* + *A. spicatum* exceeds the abundance of the *Tilia* group.

25. Hemlock-Beech-Birch type

E' Otherwise **24. Hemlock-Sugar maple-Tulip tree type**

S' Neither *T canadensis* nor *L. tulipifera* is abundant, or the stand otherwise lacks the characteristics described above. **Go to Q1 immediately below.**

Q1 Dominant is *A. saccharum* , *L. tulipifera* or is in *Tilia* group. (Q2 on p. 36).

K Second or third dominant is in *Quercus* group or is a shrub of calcareous cliffs or *Rhus typhina*, or *R. glabra*.

I Shrubs of calcareous cliffs + *Rhus typhina* + *R. glabra* are abundant.

17. Oak-Red cedar type

I' Shrubs of calcareous cliffs + *Rhus typhina* + *R. glabra* are not abundant.

F *Quercus rubra* is only member of *Quercus* group significantly present.

Go to C1-C4 under K' below and Key with *Q. rubra* ignored.

F' Members of *Quercus* group other than *Q. rubra* are significantly present.

H *Q. velutina* is abundant, and abundance of *Quercus* group species other than *C. ovata* exceeds abundance of *Tilia* group species + *C. ovata*.

16. Mixed oak type (aberrant)

H' *Q. velutina* is not abundant, or abundance of *Quercus* group species other than *C. ovata* does not exceed abundance of *Tilia* group species + *C. ovata*.

19. Hickory-White ash-Oak type

K' A species of the *Quercus* group, or a shrub of calcareous cliffs, or *Rhus typhina* or *R. glabra* is not second or third dominant.

C1 Second dominant is *A. saccharum*, *L. tulipifera* or member of *Tilia* group.

X First two dominants are *A. saccharum* and *Fraxinus americana*.

Y Third dominant is *Fagus grandifolia*, *Acer rubrum* or a member of the *Tsuga* group, or there is no third dominant.

23. Maple-Beech type

Y' Third dominant is not *F. grandifolia, A. rubrum* or member of the *Tsuga* group. **21. Sugar maple-Basswood-White ash type**

X' First two dominants are not *A. saccharum* and *F. americana.*

W Species in *Platanus* group are significantly present.

22. Sugar maple-Basswood-White ash type (Sycamore variant)

W' Species in *Platanus* group are essentially absent.

21. Sugar maple-Basswood-White ash type

C2 Second dominant is member of *Platanus* group.

22. Sugar maple-Basswood-White ash type (Sycamore variant)

C3 Second dominant is not *Acer saccharum, L. tulipifera,* in *Tilia* group or in *Platanus* group, or there is no second dominant. (no C4).

Z Dominant is *Acer saccharum.*

D *A. saccharum* constitutes more than 80% of the stand.

J Most trees other than *A. saccharum* are in *Tilia* group.

21. Sugar maple-Basswood-White ash type

J' Most trees other than *A. saccharum* are not in *Tilia* group, or *A. saccharum* is the only tree species present. **23. Maple-Beech type**

D' *A. saccharum* is less than 80% of the stand.

E Second dominant is *Fagus grandifolia, Acer rubrum, Prunus serotina* or *Betula lenta.* **23. Maple-Beech type**

E' Second dominant is not one of these species.

23. Maple-Beech type (aberrant)

Z' Dominant is *L. tulipifera* or is in *Tilia* group.

H Abundance of *Tilia* group + *A. saccharum* + *L. tulipifera* exceeds abundance of *Tsuga* group + *A. rubrum* + *F. grandifolia.*

21. Sugar maple-Basswood-White ash type (aberrant)

H' Abundance of *Tilia* group + *A. saccharum* + *L. tulipifera* does not exceed abundance of *Tsuga* group + *A. rubrum* + *F. grandifolia.*

25. Maple-Beech type (aberrant)

Q2 *Fagus grandifolia, Betula lenta, Acer pensylvanicum* or *A. spicatum* is dominant.

V Abundance of *Quercus* group exceeds abundance of *Acer saccharum* + *Tilia* group + *Tsuga* group + *Liriodendron tulipifera.*

T *Quercus rubra* is the only *Quercus* group species significantly present.

Go to Y-Y' under V' below and key with *Q. rubra* ignored.

T' *Quercus rubra* is not the only *Quercus* group species significantly present.

U Second or third dominant is a member of the *Tilia* group.

18. Oak-Beech-Hickory-Pine type (aberrant)

U' Neither second nor third dominant is a member of the *Tilia* group.

18. Oak-Beech-Hickory-Pine type

V' Abundance of *Quercus* group does not exceed abundance of *Acer saccharum* + *Tilia* group + *Tsuga* group + *L. tulipifera.*

Y Abundance of *A. saccharum* + *L. tulipifera* + *Tilia* group exceeds abundance of *Tsuga* group.

C *F. grandiflolia* is dominant. **23. Maple-Beech type**

C' *B. lenta, Acer pensylvanicum* or *A. spicatum* is dominant.

23. Maple-Beech type (aberrant)

Y' Abundance of *A. saccharum* + *L. tulipifera* + *Tilia* group is less than abundance of *Tsuga* group.

25. Hemlock-Beech-Birch type

Q3 *Tsuga canadensis* or *Betula alleghanensis* is dominant. (No Q4).

H Second dominant is *F. grandifolia*, *A. rubrum*, a member of the *Tsuga* group, a member of the *Platanus* group, or a wetland tree (see Table 1). (H' on p. 38).

J1 Second dominant is *F. grandifolia*, *B. lenta*, *Acer pensylvanicum* or *A. spicatum*. **25. Hemlock-Beech-Birch type**

J2 Second dominant is *F. nigra*. **29. Hemlock-Red maple-Yellow birch type**

J3 Second dominant is *A. rubrum*, *T. canadensis*, *B. alleghanensis* or *Ulmus americana*.

K (a) dominant is *T. canadensis*, (b) *Pinus strobus* is not exceeded in abundance by species other than *B. alleghanensis* or *A. rubrum*, and (c) *U. americana*, *Carpinus caroliniana*, *Alnus incana*, *Cornus* spp. and *Salix* spp. are essentially absent.

30 Bog complex: Hemlock-White Pine-Red maple subtype

K' Otherwise.

L *Fraxinus nigra* and wetland shrubs (see Table 1) are essentially absent.

I (a) dominant is *T. canadensis*, (b) second dominant is *A. rubrum* and (c) *Pinus strobus* or *P. resinosa* is third dominant or is exceeded only by *Quercus* spp. **20. Pine-Hemlock type**

I' Otherwise. **25. Hemlock-Beech-Birch type**

L' *F. nigra* or wetland shrubs are significantly present.

29. Hemlock-Red maple-Yellow birch type

J4 Second dominant is a member of *A. saccharinum* group.

29. Hemlock-Red maple-Yellow birch type (aberrant)

J5 Second dominant is *Picea mariana* or *Larix laricina*.

31. Bog complex: Tamarack-White pine-Black spruce

subtype (aberrant)

J6 Second dominant is a member of *Platanus* group.

26. Sycamore-Cottonwood type (aberrant)

H' Second dominant is *A. saccharum, L. tulipifera,* a member of the *Tilia* group or a member of the *Quercus* group.

F *T. canadensis* is dominant. (F' on p. 39).

Z *Acer saccharum, L. tulipifera* or a member of the *Tilia* group is second dominant. (You should not have gotten here.)

24. Hemlock-Sugar maple-Tulip tree type

Z' A member of the *Quercus* group is the second dominant.

N1 *Pinus strobus* is second dominant, and wetland shrubs are significantly present.

30. Bog complex: Hemlock-White pine-Red maple subtype

N2 *P. strobus* or *P. resinosa* is second dominant, and *F. nigra* and wetland shrubs are essentially absent.

A No deciduous trees other than *Quercus* group species or *A. rubrum* are abundant. **20. Pine-Hemlock type**

A' Deciduous trees other than *Quercus* group species and *A. rubrum* are abundant. **20. Pine-Hemlock type (aberrant)**

N3 Otherwise.

S Second dominant is *Q. rubra* and other *Quercus* group species are essentially absent. **25. Hemlock-Beech-Birch type**

S' Second dominant is not *Q. rubra*, or several *Quercus* group species are significantly present.

T Abundance of *Quercus* group species exceeds abundance of *Tsuga* group species.

U Abundance of *F. grandifolia* + *C. glabra* + *C. ovata* exceeds abundance of *Pinus* spp., or all these species are absent.

18. Oak-Beech-Hickory-Pine type (aberrant)

U' Abundance of *F. grandifolia* + *C. glabra* + *C. ovata* is less than abundance of *Pinus* spp. **20. Pine-Hemlock type**

T' Abundance of *Quercus* group species does not exceed abundance of *Tsuga* group species.

X *Pinus* spp. are abundant, and abundance of *Quercus* group species exceeds abundance of *Betula* spp. + *F. grandifolia.*

20. Pine-Hemlock type

X' *Pinus* spp. are not abundant, or abundance of *Betula* spp. + *F. grandifolia* exceeds abundance of *Quercus* group species.

25. Hemlock-Beech-Birch type (aberrant)

F' *Betula alleghanensis* is dominant. (To get here you said that the second dominant is *A. saccharum, L. tulipifera,* a member of the *Tilia* group or a member of the *Quercus* group.)

P *T. canadensis* is not abundant, and either (a) a *Quercus* group species is third dominant or (b) a *Quercus* group species is abundant and another *Quercus* group species is significantly present.

19. Hickory-White ash-Oak type (aberrant)

P' *T. canadensis* is abundant or *Quercus* group species are not so important.

Q In addition to *B. alleghanensis*, another member of the *Tsuga* group is significantly present. **25. Hemlock-Beech-Birch type**

Q' Members of *Tsuga* group other than *B. alleghanensis* are essentially absent.

R Abundance of *F. grandifolia* + *A. rubrum* exceeds abundance of *L. tulipifera* + *Tilia* group species.

23. Maple-Beech type (aberrant)

R' Abundance of *F. grandifolia* + *A. rubrum* is less than abundance of *L. tulipifera* + *Tilia* group species.

21. Sugar maple-Basswood-White ash type (aberrant)

G3 Dominant is a wetland tree species (see Table 1).

U1 Dominant is *Ulmus americana*. **Key with *U. americana* ignored, beginning with U2 immediately below.**

U2 Dominant is *Fraxinus nigra*.

V *Pinus strobus* is second or third dominant.

30. Bog complex: Hemlock-White pine-Red maple subtype (aberrant)

V' *P. strobus* is not second or third dominant.

29. Hemlock-Red maple-Yellow birch type

U3 Dominant is *Salix* spp. **9. Willow type**

U4 Dominant is a member of *Acer saccharinum* group or is *Quercus macrocarpa*.

W Dominant is *A. saccharinum*.

Maple type (see key to subtypes on p. 41)

W' Dominant is not *A. saccharinum*. **27/28. Maple type (aberrant)**

U5 Dominant is *Larix laricina* or *Picea mariana*.

31. Bog complex: Tamarack-White pine-Black spruce subtype

Key to the subtypes of the Maple type.

A *Betula alleghanensis* is present, and either *Vaccinium corymbosum* or *Ilex verticillata* is present. (*Fraxinus americana* is probably absent.)

28. Maple type: Yellow birch subtype

A' Either *B. alleghanensis* is absent, or *V. corymbosum* and *I. verticillata* are both absent. (*Fraxinus americana* or *F. pennsylvanica* is probably present.)

27. Maple type: Red ash subtype

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REFERENCES CITED

BRAUN, E. L. (1950). Deciduous forests of eastern North America. Hafner, New York. 596 pp.

BRAY, W. L. (1930). The development of the vegetation of New York state. N. Y. State College of Forestry Tech. Pub. No. 29. 189 pp.

GLEASON, H. A. (1926). The individualistic concept of the plant association. Bull. Torrey bot. Club 53:7-26.

GORDON, R. B. (1940). The primeval forest types of southwestern New York. N. Y. State Mus. Bull. No. 321. 102 pp.

GRELLER, A. M. (1977). A classification of mature forests on Long Island, New York. Bull. Torrey bot. Club 104:376-382.

HEIMBURGER, C. C. (1934). Forest type studies in the Adirondack region. Cornell Univ. Agr. Expt. Sta. Mem. 165. 122 pp.

HESS, K. AND R. R. ALEXANDER. (1986). Forest vegetation of the Arapaho and Roosevelt National Forests in central Colorado: a habitat type classification. U.S.D.A. Forest Service Research Paper RM-266, 48 pp.

HILL, M. O., R. G. H. BUNCE, AND M. W. SHAW. (1975). Indicator species analysis, a divisive polythetic method of classification, and its application to a survey of native pinewoods in Scotland. J. Ecol. 63:597-613.

HOFFMAN, G. R., AND R. R. ALEXANDER. (1976). Forest vegetation of the Bighorn Mountains, Wyoming: a habitat type classification. U.S.D.A. Forest Service Research Paper RM-170, 38 pp.

HOTCHKISS, N. (1932). A botanical survey of the Tug Hill Plateau. N. Y. State Mus. Bull. No. 287. 123 pp.

HUENNEKE, L. F. (1982). Wetland forests of Tompkins County, New York. Bull. Torrey bot. Club 109:51-63.

HUTTON, F. Z., Jr. (1971). Soil survey of Cayuga County, New York. U.S.D.A. Soil Conservation Service. 205 pp.

HUTTON, F. Z., Jr. (1972). Soil survey of Seneca County, New York. U.S.D.A. Soil Conservation Service. 143 pp.

KOVALCHIK, B. L. (1987). Riparian zone associations. Deschutes, Ochoco, Fremont, and Winema National Forests. U.S.D.A. Forest Service Ecology Technical Paper PNW-279-87, 171 pp.

LEOPOLD, D. J., C. RESCHKE AND D. S. SMITH. (1988). Old-growth forest of Adirondack Park, New York. Nat. Areas J. 8:166-189.

LEWIN, D. C. (1974). The vegetation of the ravines of the southern Finger Lakes, New York, region. Am. Midl. Nat. 91:315-342.

MCINTOSH, R. P. (1972). Forests of the Catskill Mountains, New York. Ecol. Monogr. 42:144-161.

MITCHELL, R. S. (1986). A checklist of New York State Plants. N. Y. State Mus. Bull. 458. Albany, NY. 272 pp.

MOHLER, C. L. (1986). A classification of forest types for New York state based on

U.S. Forest Service forest inventory data. Ecosystems Research Center Report No. 069. Cornell University, Ithaca, New York. 65 pp.

MOHLER, C. L., AND P. L. MARKS. In preparation. Vegetation-environment relations in the central Finger Lakes Region of New York.

MOORE, M. I. (1985). A preliminary study on hybridization of red and silver maple. The Plant Press 3:24-26.

NEELEY, J. A. (1965). Soil survey of Tompkins County, New York. 241 pp.

NICHOLSON, S. A., J. T. SCOTT AND A. R. BREISCH. (1979). Structure and succession in the tree stratum at Lake George, New York. Ecology 60:1240-1254.

PUGLIA, P. S. (1979). Soil survey of Schuyler County, New York. U.S.D.A. Soil Conservation Service. 192 pp.

RAUP, H. M. (1938). Botanical studies in the Black Rock Forest. The Black Rock Forest Bull. No. 7. 161 pp.

RESCHKE, C. (1988). Ecological communities of New York state. New York State Department of Environmental Conservation, New York Natural Heritage Program. Latham, NY. 95 pp.

SEISCHAB, F. K. (1985). An analysis of the forests of the Bristol Hills of New York. Amer. Midl. Nat. 114:77-83.

SHANKS, R. E. (1966). An ecological survey of the vegetation of Monroe County, New York. Proc. Rochester Acad. Sci. 11:108-252.

TAYLOR, N. (1928). The vegetation of the Allegany State Park. N. Y. State Mus. Handb. 5. 126 pp.

WHITTAKER, R. H. (1956). Vegetation of the Great Smoky Mountains. Ecol. Monogr. 26:1-80.

WHITTAKER, R. H. (1960). Vegetation of the Siskiyou Mountains, Oregon and California. Ecol. Monogr. 30:279-238.

YOUNGBLOOD, A. P. AND R. L. MAUK. (1985). Coniferous forest types of central and southern Utah. U.S.D.A. Forest Service General Technical Report INT-187, 89 pp.

APPENDIX A. ALPHABETIC LISTING OF LATIN AND COMMON NAMES

Acer negundo L.	Box-elder
Acer pensylvanicum L.	Striped maple
Acer rubrum L.	Red maple
Acer saccharinum L.	Silver maple
Acer saccharum Marsh.	Sugar maple
Acer spicatum Lam.	Mountain maple
Agropyron repens (L.) Beauv.	Quackgrass
Ailanthus altissima Mill.) Swingle	Tree-of-heaven
Alisma plantago-aquatica L.	Water plantain
Alnus incana (L.) Moench	Speckled alder
Ambrosia artemisiifolia L.	Ragweed
Amelanchier spp.	Shadbush
Andromeda polifolia L.	Bog rosemary
Aralia nudicaulis L.	Wild sasparilla
Aronia melanocarpa (Michx.) Ell.	Black chokeberry
Aster lateriflorus (L.) Britt.	Calico aster
Aster novae-angliae L.	New England aster
Betula alleghanensis Britt.	Yellow birch
Betula lenta L.	Black birch
Betula populifolia Marsh.	Gray birch
Bidens spp.	Beggars-ticks
Botrichium spp.	Grape fern
Bromus inermis Leyss.	Smooth brome
Calamagrostis canadensis (Michx.) Beauv.	Bluejoint grass

Calopogon tuberosus (L.) BSP	Grass pink
Carex hystericina Muhl. ex Willd.	Sedge
Carex interior Bailey	Sedge
Carex lacustris Willd.	Sedge
Carex limnosa L.	Sedge
Carex rostrata Stokes ex. With	Sedge
Carex stricta Lam.	Tussock sedge
Carex trisperna Dewey	Sedge
Carpinus caroliniana Walt.	Hornbeam
Carya cordiformis (Wang.) Koch	Bitternut
Carya glabra (Mill.) Sweet	Pignut hickory
Carya ovata (Mill.) Koch	Shagbark hickory
Castanea dentata (Marsh.) Borkh.	American chestnut
Celastrus scandens L.	American bittersweet
Cephalanthus occidentalis L.	Buttonbush
Chamaedaphne calyculata (L.) Moench	Leatherleaf
Cicuta bulbifera L.	Water hemlock
Coptis trifolia (L.) Salisb.	Goldthread
Cornus florida L.	Flowering dogwood
Cornus foemina Mill.	Gray dogwood
Cornus sericea L.	Red osier
Crataegus spp.	Hawthorn
Dactylis glomerata L.	Orchard grass
Daucus carota L.	Queen Anne's lace
Digitaria sanguinalis (L.) Scop	Large crabgrass
Drosera intermedia Hayne.	Narrowleaf sundew

Dryopteris carthusiana (Vill.) Fuchs	Spinulose wood fern
Dulichium arundinaceum (L.) Britt.	Three-way sedge
Epilobium coloratum Biehl.	Purple-leaf willow-herb
Eriophorum virginicum L.	Tawny cotton grass
Eriophorum viridi-carinatum (Englem) Fern.	Cottongrass
Eupatorium perfoliatum L.	Boneset
Euthamia graminifolia (L.) Nutt ex. Cass	Flat-top goldenrod
Fagus grandifolia Ehrh.	Beech
Fragaria virginiana Mill.	Wild strawberry
Fraxinus americana L.	White ash
Fraxinus nigra Marsh.	Black ash
Fraxinus pennsylvanica Marsh.	Red ash
Hamamelis virginiana L.	Witch-hazel
Ilex verticillata (L.) Gray	Winterberry
Impatiens capensis Meerb.	Spotted jewelweed
Juglans cinerea L.	Butternut
Juglans nigra L.	Black walnut
Juniperus virginiana L.	Eastern red cedar
Kalmia latifolia L.	Mountain laurel
Larix laricina (DuRoi) Koch	Tamarack
Ledum groenlandicum Oeder	Labrador tea
Leersia oryzoides (L.)Sw.	Rice cutgrass
Lemna minor L.	Duckweed
Leucanthemum vulgare Lam.	Ox-eye daisy
Lindera benzoin (L.) Blume	Spicebush
Liriodendron tulipifera L.	Tulip tree

Lonicera oblongifolia (Goldie) Hook	Swamp fly honeysuckle
Lonicera tatarica L.	Tartarian honeysuckle
Lotus corniculata L.	Bird's-foot trefoil
Lycopodium digitatum A. Br.	Running pine
Magnolia acuminata (L.) L.	Cucumber tree
Maianthemum canadensis Desf.	False lily-of-the-valley
Malus coronaria (L.) Mill.	Crabapple
Malus pumila Mill.	Apple
Medicago sativa L.	Alfalfa
Morus rubra L.	Red mulberrry
Muhlenbergia glomerata (Willd.) Trin.	Spike muhly
Myrica gale L.	Sweet-gale
Nemopanthus mucronatus (L.) Coesener ex Koe	Mountain holly
Nyssa sylvatica Marsh.	Black gum
Onoclea sensibilis L.	Sensitive fern
Osmunda cinnanomea L.	Cinnamon fern
Ostrya virginiana (Mill.) Koch	Hop hornbeam
Oxalis acetosella L.	Common woodsorrel
Panicum capillare L.	Witchgrass
Parnassia glauca LRaf.	Grass-of-Parnassus
Parthenocissus spp.	Virginia creeper
Phalaris arundinacea L.	Reed canary-grass
Phleum pratense L.	Timothy
Phragmites australis (Cav.) Trin. ex. Steud	Common reed
Picea mariana (Mill.) BSP	Black spruce
Pinus resinosa Seland. ex Ait.	Red pine
Pinus rigida Mill.	Pitch pine

Pinus strobus L.	White pine
Plantago spp.	Plantain
Platanus occidentalis L.	Sycamore
Poa spp.	Bluegrass
Pogonia ophioglossia (L.) Juss	Rose pogonia
Polygonum spp.	Smartweed
Pontedaria cordata L.	Pickerel-weed
Populus deltoides Bartr. ex Marsh.	Cottonwood
Populus grandidentata Michx.	Big-tooth aspen
Populus tremuloides Michx.	Quaking aspen
Potentilla fruticosa L.	Shrubby cinquefoil
Prunella vulgaris L.	Heal-all
Prunus avium (L.) L.	Bird cherry
Prunus serotina Ehrh.	Black cherry
Quercus alba L.	White oak
Quercus bicolor Willd.	Swamp white oak
Quercus borealis L.	Red oak
Quercus coccinia Muenchh.	Scarlet oak
Quercus macrocarpa Michx.	Bur oak
Quercus montana Willd.	Chestnut oak
Quercus velutina Lam.	Black oak
Rhamnus alnifolia L'Her	Alder-leaf buckthorn
Rhamnus cathartica L.	Common buckthorn
Rhus aromatica Ait.	Fragrant sumac
Rhus glabra L.	Smooth sumac
Rhus typhina L.	Staghorn sumac

Robinia pseudo-acacia L.	Black locust
Rosa palustris Marsh.	Swamp rose
Rubus allegheniensis Porter ex Bailey	Northern blackberry
Rubus occidentalis L.	Black raspberry
Sagittaria latifolia Willd.	Wapato
Salix alba L.	White willow
Salix candida Flügge ex Willd.	Hoary willow
Salix discolor Muhl.	Pussywillow
Salix fragilis L.	Crack-willow
Salix nigra Marsh.	Black willow
Salix sericea Marsh.	Silky willow
Sarracenia purpurea L.	Pitcher-plant
Sassafras albidum (Nutt.) Nees	Sassafras
Scirpus actus Mohl ex Bigel	Hardstem bulrush
Scirpus tabernaemontanii Gmel.	Softstem bulrush
Setaria glauca (L.) Beauv.	Yellow foxtail
Solanum dulcamara L.	Climbing nightshade
Solidago canadensis L.	Canada goldenrod
Solidago juncea Ait.	Early goldenrod
Solidago rugosa Mill.	Tall hairy goldenrod
Solidago uliginosa	Swamp goldenrod
Sparganium eurycarpon Englem	Bur reed
Spiraea alba DuRoi	Meadow-sweet
Stellaria media (L.) Vill.	Common chickweed
Taraxacum offinale Weber ex Wiggers	Common dandelion
Thelypteris palustris Schott	Marsh fern

Tilia americana L.	Basswood
Toxicodendrom vernix (L.) Kuntze	Poison sumac
Trifolium spp	Clover
Tsuga canadensis (L.) Carr.	Hemlock
Typha spp.	Cattail
Ulmus americana L.	American elm
Ulmus rubra Muhl.	Slippery elm
Vaccinium corymbosum L.	Highbush blueberry
Vaccinium macrocarpon Ait.	Large cranberry
Vaccinium oxycoccos L.	Small cranberry
Verbascum thapsus L.	Mullein
Veronica officinalis L.	Common speedwell
Viburnum acerifolium L.	Maple-leaf viburnum
Viburnum cassinoides L.	Withe-rod
Viburnum lentago L.	Nanny-berry
Viburnum rafinesquianum Schultes	Downy arrowwood
Viburnum recognitum Fern.	Arrowwood
Viburnum trilobum Marsh	Highbush cranberry

PROCEEDINGS OF THE ROCHESTER ACADEMY OF SCIENCE

In Volume 16 of THE PROCEEDINGS it was noted that abstracts of the fall paper sessions would no longer be published as a regular procedure. As a result of requests from members and presenters, all those persons who presented a paper at the 1986 through 1990 paper sessions were sent a letter asking if they wished to have their abstracts published or if they would submit short esssays based on their presentations. What follows are the titles and authors and their addresses from all five paper sessions. At the end are abstracts and essays by those presenters who replied with written requests or manuscripts.

THIRTEENTH ANNUAL FALL SCIENTIFIC PAPER SESSION
and
ANNUAL FALL PUBLIC LECTURE

"Anthropological Perspective on Lands at Risk in the Third World."
by
Dr. Michael Horowitz

COMMUNITY COLLEGE OF THE FINGER LAKES
CANANDAIGUA, NEW YORK

Chair: Bruce Gilman

NOVEMBER 1, 1986

Arranged alphabetically by first author.

LIFE HISTORY AND GROWTH RATES OF *CAREX COMOSA* BOOT., A CLUMP-FORMING WETLAND SEDGE. John M. Bernard, Department of Biology, Ithaca college, Ithaca, New York 14850.

EFFECT OF HUMAN BLOOD FLUKE INFECTION ON TESTOSTERONE AND ESTROGEN LEVELS IN LABORATORY MICE. H. Isseroff, C. L. Bessette, P.L. Jones, P.W. Sylvester, and T. A. Rynkowski. SUNY College at Buffalo, 1300 Elmwood Avenue, Buffalo, New York 14222.

RE-ESTABLISHMENT OF THE EASTERN BLUEBIRD (*Sialia Sialis*) NEST BOX TRAIL AT SOUTH HILL, ONTARIO COUNTY, NEW YORK. P.E. Brasington, N. Hauf, F. Smith, Community College of the Finger Lakes, Canandaigua, New York 14424 and M. Allen, New York State Department of Environmental Conservation, Avon, New York 14414.

AN EURYPTERID FROM THE SILURIAN LOCKPORT GROUP IN WESTERN NEW YORK STATE. Samuel J. Ciurca, Jr., 48 Saranac Street, Rochester, New York, 14621.

A NEW EURYPTERID HORIZON (HARRIS HILL BED) IN THE VERNON FORMATION, SALINA GROUP, SILURIAN OF WESTERN NEW YORK STATE. Samuel J. Ciurca, Jr., 48 Saranac St., Rochester, New York, 14621.

USE OF MICROCOMPUTERS IN AN ARCHAEOLOGICAL FIELD SCHOOL. David Day, Department of Sociology and Anthropology, Monroe Community College, Rochester, New York 14623.

CONSTRUCTION OF AN EXPRESSION VECTOR CONTAINING THE PROTECTIVE ANTIGEN GENE FROM *BACILLUS ANTRACIS*. Diane M. Forster and Robert S. Greene, Niagara University, Lewiston Road, Niagara University, New York 14109.

ISOLATION AND PRELIMINARY CHARACTERIZATION OF DNA REPAIR DEFICIENT MUTANTS FROM CORYNEBACTERIUM FLAVUM. Karen Frediani, Jean Douthwright and Thomas Wengenack, Department of Biology, Rochester Institute of Technology, Rochester, New York 14623.

A CYTOSTRUCTURAL STUDY TO AID THE DETECTION OF OSTEOGENETIC INDUCTION. A.A. Haymes, J.P. Rausch*, C.R. Lange and V.L. Bolton**; *Division of Biology, Alfred University, Alfred, NY 14802. **SUNY Ag and Tech, Medical Services Dept., Alfred, NY 14802.

GLYCOSAMINOGLYCANS REVERSE DRUG-INHIBITED GROWTH OF MOUSE MAMMARY EPITHELIAL CELLS. J. Hitzeman and H.L. Hosick, Department of Biological Sciences, SUNY College at Brockport, Brockport, NY 14420.

USING THIRD WORLD RESOURCES FOR ARMS RACE PROFITS. D.Q. Innis, Geography Department, Geneseo, N.Y., 14454.

CULTURAL EVOLUTION: A COMPUTER SIMULATION. Presented by: Carl Lewis, Genesee Community College, Batavia, NY. Program Authors: Michael Davis, Dee Medley, Gene Muehlbauer, Lake Forest College, Lake Forest, IL.

"GANNAGARO" - An Ethnographic Documentary. Alexandra J. Lewis-Lorentz. 499 Pinegrove Avenue, Rochester, New York 14617.

FALL STANDING CROP BIOMASS OF AQUATIC MACROPHYTE COMMUNITIES IN HONEOYE LAKE, NEW YORK. A. Liguori and B. Gilman, Department of Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

VIDEO DIGITIZATION OF MULTITEMPORAL IMAGERY TO MONITOR ARID LANDS BIOMASS. Ray Lougeay, Department of Geography, State University College, Geneseo, New York 14454.

THE EXIT NOT TAKEN: EVOLVING EXIT COMMERCIAL CLUSTERS ON AN INTERSTATE HIGHWAY. Darrell A. Norris, Department of Geography, S.U.N.Y. Geneseo, Geneseo, N.Y. 14454.

GROWTH OF CARP (*CYPRINUS CARPIO*) IN TWO MADISON COUNTY ALABAMA STREAMS. Kevin C. Owen, Department of Biological Sciences, Cooke Hall, SUNY at Buffalo, New York 14260.

SUSCEPTIBILITY OF CATTARAUGUS COUNTY, NEW YORK, STREAMS TO ACID DEPOSITION. Robert A. Phillips. Department of Biological Sciences, State University of New York, Buffalo, New York, 14260.

COMPUTER SEARCH PROGRAM FOR A CROSS-CULTURAL DATA BANK. John Rhoades Department of Anthropology, St. John Fisher College, Rochester, NY 14618.

ICHTHYOPLANKTON ENTRAINMENT INVESTIGATIONS AT ROCHESTER GAS AND ELECTRIC'S GINNA STATION. Paul M. Sawyko, Rochester Gas and Electric Corporation, 89 East Avenue, Rochester, NY 14649.

PRESETTLEMENT FOREST COMPOSITION OF THE HOLLAND COMPANY LANDS. Franz K. Seischab. Department of Biology, Rochester Institute of Technology, Rochester, NY 14623.

DISCUSSION AND DEMONSTRATION OF COMPUTER APPLICATION SENECA ARCHAEOLOGY RESEARCH PROJECT. Martha Sempowski, Lorraine Saunders, Gian Carlo Cervone, Rochester Museum and Science Center, Rochester, New York 14603.

ANGLER CHARACTERISTICS AND ECONOMIC IMPACT OF THE 1985 NATIONAL LAKE TROUT DERBY. F.W. Smith, Community College of the Finger Lakes, Canandaigua, New York 14424.

INEQUALITY IN EGALITARIAN SOCIETIES. Marjorie H. Stewart, Department of Anthropology, State University of New York College at Brockport, Brockport, N.Y. 14420.

INVESTIGATIONS INTO THE REPRODUCTIVE BIOLOGY OF *EPIFAGUS VIRGINIANA* (L.) BART. Cynthia L. Williams. Biology Department, Hobart and William Smith Colleges, Geneva, NY 14456.

FOURTEENTH ANNUAL FALL SCIENTIFIC PAPER SESSION

STATE UNIVERSITY COLLEGE OF NEW YORK, GENESEO, NEW YORK

Chair: Herman S. Forest

NOVEMBER 7, 1987

Arranged by session topic.

BOTANY AND ENTOMOLOGY

EFFECTS OF AMINO ACIDS ON THE NECTAR FEEDING BEHAVIOR OF THE CABBAGE WHITE BUTTERFLY (*ARTOGEIA RAPAE*). Janis Alm, Thomas Ohnmeiss and Janet Lanza. Biology Department, State University College at Fredonia, Fredonia, NY 14063.

THE STABILITY OF GROWTH INHIBITORS FOUND IN *SOLIDAGO CANADENSIS*. M. Williams and A. Reid. State University of New York College at Geneseo, Geneseo, NY 14454.

HONEY BEE BEHAVIOR AND POLLINATION ECOLOGY. E.E. Southwick, Dept. of Biology, SUNY, Brockport, NY 14420.

THE FENS OF THE BERGEN SWAMP: DISTURBANCE MAINTAINED ECOSYSTEMS. Franz K. Seischab, Department of Biology, Rochester Institute of Technology, Rochester, NY 14623.

PRESETTLEMENT FOREST TREE DISTRIBUTION ON THE HOLLAND COMPANY LANDS AND IN THE PHELPS AND GORHAM PURCHASE. Franz K. Seischab. Department of Biology, Rochester Institute of Technology, 1 Lomb Memorial Drive, Rochester, NY 14623.

THE STRUCTURE AND FUNCTION OF BRISTLES ON *PEDIASTRUM BORYANUM*. S.R. Gawlik, C. Pontbriant, and J. Kane. Biology Department, St. John Fisher College, Rochester, NY 14618.

LIFE HISTORY OF *WOLFFIA AUSTRALIANA*. John M. Bernard. Department of Biology, Ithaca College, Ithaca, NY 14850.

ANATOMY OF VEGETATIVE AND FLOWERING TISSUES OF *WOLFFIA AUSTRALIANA*. Florence A. Bernard. Department of Biology, Ithaca College, Ithaca, NY 14850.

SEICHES IN LAKE ONTARIO DURING THE SUMMER OF 1987. Paul M. Sawyko. Rochester Gas and Electric Corporation, 89 East Avenue, Rochester, NY 14649.

LAKE RESTORATION TECHNIQUES: A PROGRESS REPORT FOR HONEOYE LAKE. Robert Pierce Jr., Douglas Stone, and Stanley Sutton. Community College of the Finger Lakes, Canandaigua, New York 14424.

GEOGRAPHY DEMONSTRATION

DEMONSTRATION OF MICROCOMPUTER-BASED DIGITAL IMAGE PROCESSING SYSTEMS FOR ENVIRONMENTAL ANALYSIS. Alex Judkins, Rachelle Grein, Matthew Stoll, and Ray Lougeay. Department of Geography, State University of New York at Geneseo, NY 14454.

GEOLOGY

PROGRESS IN UNDERSTANDING THE ORIGIN AND EVOLUTION OF THE GRAND CANYON, ARIZONA. R.A. Young. Department of Geological Sciences, State University of New York College at Geneseo, Geneseo, NY 14454.

EFFECTS OF CHEMICAL WEATHERING ON THE RB-SR DATE OF FELDSPAR IN TILLS FROM ANTARCTICA. P.D. Boger and J.L. Boger, Department of Geological Sciences, State University of New York at Geneseo, Geneseo, NY 14454.

A FANTASTIC NEW SILURIAN EURYPTERID OCCURRENCE IN EASTERN NEW YORK STATE: FARMERS MILLS BED, ILLION-VERNON TRANSITION. Samuel J. Ciurca, Jr. 48 Saranac St., Rochester, NY 14621.

"I WAS THERE AT THE BEGINNING,"? by H. L. Fairchild: COMMEMORATING THE CENTENARY OF THE GEOLOGICAL SOCIETY OF AMERICA. Lawrence W. Lundgren. Dept. of Geological Sciences, University of Rochester, Rochester, NY.

SECULAR VARIATION OF GEOMAGNETIC DECLINATION DURING DEGLACIATION OF NEW YORK STATE. William J. Brennan. State University College at Geneseo, Geneseo, NY 14454.

DYNAMIC STRATIGRAPHY OF THE SILURIAN APPALACHIAN BASIN. C.E. Brett and W.N. Goodman, University of Rochester.

PRELIMINARY STUDIES OF CARBONATITE VOLCANISM IN THE AFRICAN RIFT SYSTEM: A PROGRESS REPORT. Brian Henderberg and W.D. Rhodes. Department of Anthropology, State University of New York, College at Geneseo, Geneseo, NY 14454.

CNY AMERICAN SOCIETY FOR MICROBIOLOGY

ANALYSIS OF DNA SEQUENCES CONTROLLING Messenger RNA PRODUCTION OF A MITOCHONDRIALLY ENCODED PROTEIN IN YEAST. M. West, G. Culver and V. Cameron. Biology Department, Ithaca College, Ithaca NY 14850.

HEAT RESISTANCE OF SPORES OF A *BACILLUS SUBTILIS* MUTANT DEVOID OF A MAJOR HEAT-SHOCK PROTEIN. P. Khoury*, R. Slepecky*, M. Walid Qoronfleh** and U. Streips**. *Syracuse University, Syracuse, NY and **University of Louisville, Louisville, KY.

AMINO ACID INHIBITION OF THE ANTIBIOTICS PRODUCED BY *ERWINIA HERBICOLA*, A POTENTIAL BIOLOGICAL CONTROL AGENT FOR FIRE BLIGHT. M.B. Mudgett and R. Wodzinski. Biology Dept, Ithaca College, Ithaca, NY 14850.

IRON TRANSPORT IN *PSEUDOMONAS PUTIDA*. J. Lodge. Biology Department, Rochester Institute of Technology, Rochester, NY.

THE FURTHER MICROBIOLOGY OF THE KOALA. R.G. Simon and H. Huddle. Department of Biology, SUNY College at Geneseo, Geneseo, NY 14454.

SCIENCE HISTORY, PHILOSOPHY AND PEDAGOGY

FROM EUROPE TO AMERICA: THE DISPLACED FOREIGN PSYCHOLOGISTS, 1938 TO 1943. Melvyn D. Yessenow. Department of Psychology, State University College, Geneseo, NY 14454.

LEE A. DUBRIDGE AND THE ROCHESTER CYCLOTRON IN THE 1930'S. Thomas D. Cornell. College of Liberal Arts, Rochester Institute of Technology, Rochester, NY 14623.

UNDERGRADUATE RESEARCH: WHYS AND HOWS. Janet Lanza. Biology Department, State University of New York College at Fredonia, Fredonia, NY 14063.

A REVIVAL OF THE HUMANITIES AT ERIE COMMUNITY COLLEGE. D.J. Jezewski, Physics, and J. Zeis, Philosophy, Erie Community College, Williamsville, NY 14221.

POSTERS

NON-INVASIVE ESTIMATION OF DAMAGE/RECOVERY IN BIOLOGICAL TISSUE SYSTEMS FOLLOWING CHILLING/FREEZING EXPOSURE. Raymond L. Szymanski, Allen R. Tice*, and John G. Baust, Center for Cryobiological Research, State University of New York, Binghamton, NY 13901 and *Cold Regions Research and Engineering Laboratory, Corps of Engineers, United States Army, Hanover, NH 03755.

PNMR AND DSC ANALYSES OF CRYOPROTECTANT MIXTURES. John M. Wasylyk, Raymond L. Szymanski, Jan Wolanczyk, John G. Baust. State University of New York at Binghamton, Binghamton, NY 13903.

DIFFERENTIAL SCANNING CALORIMETRIC AND MASS SPECTROMETRIC ANALYSIS OF MAMMALIAN TISSUE SAMPLES. J.G. Baust, S.R. May*, J.P. Wolanczyk, S.A. Livesey*, and J.G. Linner*, Center for Cryobiological Research, University Center at Binghamton, State University of New York, Binghamton, New York, 13901 and * LifeCell Corporation, The Woodlands, Texas, and Cryobiological Research Center, The University of Texas Health Science Center at Houston, The Woodlands, Texas, 77380.

TRIGGER SENSITIVITY OF CRYOPROTECTANT SYNTHESIS IN *EUROSTA SOLIDAGINIS* (Fitch). Christopher J. Pio and John G. Baust, Center for Cryobiological Research, State University of New York at Binghamton, Binghamton, NY 13901.

METABOLIC RESPONSE TO TEMPERATURE PULSING IN THE GOLDENROD GALL FLY, *EUROSTA SOLIDAGINIS*: CRYOPROTECTANT SYNTHESIS AND CATABOLISM. Christopher J. Pio and John G. Baust, Center for Cryobiological Research, State University of New York, University Center at Binghamton, Binghamton, NY 13901.

DIFFERENTIAL SCANNING CALORIMETRIC ANALYSIS OF ANTIFREEZE PROTEIN ACTIVITY IN THE COMMON MEALWORM, *TENEBRIO MOLITOR*. Thomas N. Hansen, Christopher J. Pio, and John G. Baust. Center for Cryobiological Research, State University of New York, Binghamton, NY 13901.

ISOLATION AND STRUCTURE ELUCIDATION OF TERPENES FROM *SOLIDAGO CANADENSIS*. John M. Wasylyk, John G. Baust, Center for Cryobiological Research, State University of New York at Binghamton, Binghamton, NY 13901.

THE INFLUENCE OF HOLDING TEMPERATURE ON THE PHENOMENON OF "TIME DEPENDENCY" IN HYDRATED LYSOZYME GLASSES AS MEASURED BY DIFFERENTIAL SCANNING CALORIMETRY. Jan P. Wolanczyk and John G. Baust, Center for Cryobiological Research, University Center at Binghamton, State University of New York, Binghamton, New York 13901.

PHOTOLYSIS OF A PAH AND ITS AZA-DERIVATIVE IN AQUEOUS SOLUTION. Maria Pacheco and Julie Wang. Dept. of Chem., Buffalo State College, 1300 Elmwood Ave., Buffalo, NY 14222.

CULTURE OF FATHEAD MINNOWS IN THE LABORATORY. J.K. Buttner, S.W. Duda and W.S. Ewell*. SUNY College at Brockport, NY and *Eastman Kodak Company, Rochester, NY.

4-H AQUACULTURE CLUB GROWS FISH IN BRADDOCK BAY. Joseph K. Buttner, Department of Biological Sciences, SUNY Brockport, Brockport, NY 14420.

HOMING, MOVEMENTS, ACTIVITY AND TEMPERATURES OF POTADROMOUS CENTRARCHIDS IN SOUTHCENTRAL LAKE ONTARIO AND TWO TRIBUTARIES. G.P. Gerber and J.M. Haynes. Aquatic Ecology Section, Department of Biological Sciences, SUNY College at Brockport, NY 14420.

THERMAL ECOLOGY OF SALMONIDS NEAR SOMERSET STATION, NIAGARA COUNTY. J.M. Haynes, G.P. Gerber and J.K. Buttner. Aquatic Ecology Section, Department of Biological Sciences, SUNY College at Brockport, NY 14420.

SPECTATOR ION INDIRECT PHOTMETRIC DETECTION IN REVERSED PHASE HPLC. James A. Boiani. Chemistry Dept., SUNY College, Geneseo, NY 14454.

A NEW MODEL FOR PROTEINS CONTAINING ASSOCIATED TETRAPYRROLE MACROCYCLES. David K. Geiger. Chemistry Dept., SUNY College, Geneseo, NY 14454.

PURIFICATION AND COLORIMETRIC ASSAY OF PLASMA AMINE OXIDASE. Richard A. Smith. Chemistry Dept., SUNY College, Geneseo, NY 14454.

STEVENS REARRANGEMENT OF 1-BENZYL AND 1-ALLYL-SUBSTITUTED-3-AMINO-4,5-DIHYDRO-1-PHENYL-1-H-PYRAZOLIUM BROMIDES. Richard F. Smith. Chemistry Dept., SUNY College, Geneseo, NY 14454.

THE AMERICAN ROADSIDE LANDSCAPE: A COMPUTER CARTOGRAPHIC AND PHOTOGRAPHIC SYNTHESIS. Brian Coffey and Darryl Norris. Geography Dept., SUNY College, Geneseo, NY 14454.

LAND USE TRENDS IN AN ELITE RESIDENTIAL DISTRICT: EAST AVENUE, ROCHESTER 1900-1986. Elaine Damari and Brian Coffey. Geography Dept., SUNY College, Geneseo, NY 14454.

INTOXICATION AND IMPAIRMENT CONVICTIONS IN NEW YORK STATE COUNTIES, 1982: A SPATIAL ANALYSIS. Lisa Roberts. Geography Dept., SUNY college, Geneseo, NY 14454.

GENESEO AND LIVINGSTON COUNTY: AN OBLIQUE ZENITHAL LOGARITHMIC TRANSFORMATION. Cartography Students, GEO 391. Geography Dept., SUNY College, Geneseo, NY 14454.

CONESUS LAKE SURVEY RESEARCH PROJECT, 1986: DEVELOPMENTAL IMPACT STUDIES CENTER AND CONESUS LAKE ASSOCIATION. Sharon Paulman and Lisa Nagle. Geography Dept., SUNY College, Geneseo, NY 14454.

RED CROSS DISASTER RESEARCH: DEVELOPMENTAL IMPACT STUDIES CENTER AND AMERICAN RED CROSS. Barbara Hasselmann and Steve McGrattan. Geography Dept., SUNY College, Geneseo, NY 14454.

NEW YORKERS' AWARENESS OF CENTRAL AND SOUTH AMERICA: A MULTIPLE REGRESSION ANALYSIS. Christine Nientimp and Darryl Norris. Geography Dept., SUNY College, Geneseo, NY 14454.

FIFTEENTH ANNUAL FALL SCIENTIFIC PAPER SESSION
and
LARRY J. KING MEMORIAL LECTURE

"Biology of Rare Plant Species and Management of Significant Habitats."
by
Dr. Donald Leopold, SUNY ESF, Syracuse, N.Y.

NAZARETH COLLEGE OF ROCHESTER
ROCHESTER, NEW YORK

Chair: William Hallahan

NOVEMBER 5, 1988

Arranged alphabetically by first author.

OBSERVATIONS ON LIFE HISTORY AND VEGETATIVE REPRODUCTION IN THE GENUS *CAREX*. John M. Bernard, Department of Biology, Ithaca College, Ithaca, New York 14850.

ISOLATION OF A NUCLEAR SUPRESSOR OF A YEAST MITOCHODRIAL MUTANT DEFECTIVE IN TRANSCRIPTION OF A SPECIFIC MITOCHONDRIAL GENE. Joseph Bliss and Vicki Cameron, Biology Department, Ithaca College, Ithaca, NY 14850.

FREQUENCY AND DISTRIBUTION OF CERTAIN NUISANCE WILDLIFE PROBLEMS WITHIN MONROE COUNTY. Lynn Braband. The Critter Control Co., P.O. Box 19389, Rochester, NY 14619.

CAN OF WORMS BIOSTROME, SILURIAN LOCKPORT GROUP AT ROCHESTER, NEW YORK. Samuel J. Ciurca, Jr., 48 Saranac Street, Rochester, New York, 14621.

SILURIAN ALGAL MOUND/EURYPTERID ASSOCIATION, NEW YORK STATE AND PENNSYLVANIA. Samuel J. Ciurca, Jr., 48 Saranac Street, Rochester, New York, 14621 and Mark Domagala, 239 West Avenue, East Rochester, New York.

ELECTRON MICROSCOPY OF ASCOSPOROGENESIS IN THE SEXUAL YEAST, *SCHIZOSACCHAROMYCES OCTOSPORUS*. K. J. Czymmek, and T. M. Hammill, Department of Biology, SUNY College, Oswego, New York 13126.

DNA REPAIR AND MUTAGENESIS IN *CORYNEBACTERIUM GLUTAMICUM* RADIATION-SENSITIVE MUTANTS. Jean A. Douthwright[1], David Crawford[2], and John Wong[2]. [1]Department of Biology, Rochester Institute of Technology, One Lomb Memorial Drive, Rochester, NY 14623. [2]Division of Natural Sciences, New College, 5700 North Tamiami Trail, Sarasota, Florida 34234.

IN VITRO STUDIES OF CULTURED RAT TROPHOBLAST CELLS. H. Elam and S. Chan. Department of Biological Sciences, State University of New York College at Brockport, Brockport, NY 14420.

THE ROLE OF BRISTLES AND OF A SPOROPOLLENIN CELL WALL IN THE SURVIVAL OF THE GREEN ALGA *PEDIASTRUM BORYANUM*. Stanley R. Gawlik. Biology Department, St. John Fisher College, Rochester, N.Y. 14618.

VEGETATIVE REPRODUCTION IN *CAREX PROJECTA MACKZ.* Kathleen M. Kayes, Department of Biology, Ithaca College, Ithaca, New York 14850.

FREEZING-INDUCED CHANGES IN THE HEART RATES OF WOOD FROGS (*RANA SYLVATICA*). J. R. Layne, Jr., R. E. Lee, Jr., T. L. Heil: Dept. of Biology, Nazareth College, Rochester, NY 14610, Dept. of Zoology, Miami University, Hamilton, OH 45011, and Dept. of Biology, Wheeling College, Wheeling, WV 26003.

INTEGRATING INFORMATION SYSTEMS INTO THE GEOGRAPHY CURRICULUM. Cheryl Walley Lougeay, Department of Geography, State University of New York College at Geneseo, Geneseo, New York 14454.

ELECTRON MICROSCOPY OF CONIDIOGENESIS IN THE IMPERFECT FUNGUS, *DORATOMYCES MICROSPORUS*. Marissa Maningas, and T. M. Hammill, Department of Biology, SUNY College, Oswego, New York 13126.

HISTORICAL ARCHAEOLOGY AT FLOWERDEW HUNDRED. Henry Maus, Department of Social Science, Community College of the Finger Lakes, Canandaigua, New York, 14424.

NEW BRYOPHYTE RECORDS FOR MONROE COUNTY. P. Martin. 27 Bonnie Brae Ave., Rochester, NY 14618.

LOWERING OF ATMOSPHERIC PRESSURE BY WINDS - ABSTRACT. Frank Mooney, 6135 Dugway Rd., Canandaigua, NY 14424.

CLASSIFICATION OF MACROPHYTE COMMUNITIES IN PORT BAY, NEW YORK BY TWINSPAN ANALYSIS. Sadredin Moosavi and Bruce Gilman, Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

THE MECHANISM BY WHICH *ERWINA HERBICOLA* 318 ANTIBIOTIC INHIBITS *ERWINA AMYLOVORA*. Mary Beth Mudgett, Richard Wodzinski, Ithaca College, Ithaca, New York 14850.

ACUTE TOXICITY OF DIQUAT TO EARLY LIFE STAGES OF MUSKELLUNGE, SMALLMOUTH AND LARGEMOUTH BASS, AND CARP. G.N. Neuderfer, R.W. Bauer, J. Skea, J. Symula and J. Miccoli, New York State Department of Environmental Conservation, 6274 E. Avon - Lima Road, Avon, N.Y. 14414.

ASSESSMENT OF FISH MORTALITY DURING MACROPHYTE HARVESTING: A COMPARISON OF SODUS BAY AND HONEOYE LAKE, NEW YORK. Kurt Palmateer, Frank Smith and Bruce Gilman, Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

SYNTHESIS AND CHARACTERIZATION OF N-(2-MERCAPTOETHYL) SALICYLALDIMINE AND ITS COMPLEXES. Katherine L. Pollock and Thomas A. Donovan, Dept. of Chemistry, Buffalo State College, 1300 Elmwood Ave., Buffalo, NY 14222.

MARGARET MEAD'S SAMOAN DATA: A CASE STUDY OF THE SOCIOLINGUISTIC APPRAISAL OF ETHNOGRAPHY. John Rhoades, St. John Fisher College, Rochester, New York 14609.

THE USE OF INJECTION WELLS FOR DRAINAGE. M. L. Rhoades. 30 Presque Street, Rochester, New York 14609.

EFFECTIVE TREATMENT FOR EXPOSURE TO HOT PEPPERS (CAPSICUM ANNUUM VARIETIES). M.F. Schneider, R.A. Lawrence, M.D., Finger Lakes Regional Poison Center, University of Rochester Medical Center, 601 Elmwood Ave., Rochester, N.Y. 14642.

ANOMALIES IN THE PRESETTLEMENT FORESTS OF WESTERN NEW YORK. F. K. Seischab and D. Orwig. Department of Biology, Rochester Institute of Technology, Rochester, NY 14623-0887.

THE IMPLICATIONS OF BIOLOGICAL HUMAN REPRODUCTION FOR GENDER INEQUALITY. Marjorie H. Stewart. Department of Anthropology, State University of New York College at Brockport, Brockport, N.Y. 14420.

FIREWATER AND BIG MEDICINE: NATIVE AMERICAN PEOPLE AND ALCOHOLISM. Mary Sullivan. 95 Hilltop Road, Rochester, New York 14616.

A COMPARISON OF PROTEIN PATTERNS IN NORMAL AND IN ACTIONOMYCIN D-TREATED MEDAKA FISH EMBRYOS. Adelaide J. Svoboda and Joanne Guiseppetti. Dept. of Biology, Nazareth College, 4245 East Ave., Rochester, N.Y. 14618.

RESTORATION OF LAKE ONTARIO BAYS, WAYNE COUNTY, NEW YORK: PHASE ONE - INVENTORY OF MACROPHYTE COMMMUNITIES. Sylvia Thomson, Bruce Gilman and Frank Smith, Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

EFFECTS OF DEAFENING ON THE MAINTENANCE OF SCOTOREFRATORINESS IN ADULT MALE JAPANESE QUAIL. E. Trabuco, J. Kerlan, J. Greenspon. Department of Biology and Psychology, Hobart and William Smith Colleges, Geneva, N.Y. 14456.

THE EFFECTS OF PHENOLICS ON THE GROWTH AND SEXUAL REPRODUCTION OF *CHAMPIA PARVULA*. James Wolfe, Biology Department, Houghton College, Houghton, N.Y. 14744.

SIXTEENTH ANNUAL FALL SCIENTIFIC PAPER SESSION
and
LARRY J. KING MEMORIAL LECTURE

"Social Behavior and Acoustic Communication of the Humpback Whale."
by
Adam Frankel
University of Hawaii, Humpback Whale Research Project

THE STATE UNIVERSITY COLLEGE
BROCKPORT, NEW YORK

Chairs: Charles Edwards
Marjorie Stewart

NOVEMBER 4, 1989

Arranged alphabetically by first author.

MAINTAINED MESOTROPHY IN A HARDWATER MICHIGAN LAKE. R. Almquist, Jr., C. Bergstrom, T. Borrowman, R. Erickson, O. Foster, C. Seese, J. Skubinna, M. Wright, and J. Wolfe. AuSable Institute, 7526 Sunset Trail N.E., Mancelona, MI 49659 and Houghton College, Houghton, NY 14711.

USE OF CONSTRUCTED WETLANDS FOR TREATMENT OF LANDFILL LEACHATE — A REPORT ON THE TOWN OF FENTON PROJECT. John M. Bernard, Dept. of Biology, Ithaca College, Ithaca, N.Y. 14850.

THE INDIVIDUAL AND BEYOND: REFLECTIONS ON THE LIFE HISTORY PROCESS. Margaret B. Blackman (SUNY Brockport).

DISCOVERY OF AN EURYPTERID AT NIAGARA FALLS: SILURIAN LOCKPORT GROUP, NIAGARA RIVER, NEW YORK. Samuel J. Ciurca, Jr., 48 Saranac Street, Rochester, New York 14621.

A SILURIAN FAUNA FROM THE MAPLEWOOD SHALE, CLINTON GROUP, GENESEE RIVER GORGE, ROCHESTER, NEW YORK. Samuel J. Ciurca, Jr., 48 Saranac Street, Rochester, New York 14621.

LIGHT AND ELECTRON MICROSCOPY OF THE WORLD'S SMALLEST FLOWERING PLANTS: *WOLFFIA COLUMBIANA, W. PAPULIFERA*, AND *W. PUNCTATA* (LEMNACEAE). Jennifer M. Collart and T. M. Hammill, Department of Biology, SUNY College at Oswego, Oswego, New York 13126.

ELECTRON MICROSCOPY OF MITOSIS DURING SPORANGIAL DEVELOPMENT IN THE ZYGOMYCETE, *MUCOR MUCEDO* (MUCORALES). Monica L. Converse and T. M. Hammill, Department of Biology, SUNY College at Oswego, Oswego, New York 13126.

BRADDOCK BAY RAPTOR RESEARCH - OWL MIGRATION ECOLOGY. Jeffery Dodge.

ULTRASOUND AS A VISUAL FEEDBACK AID FOR THE HEARING IMPAIRED. M. C. Foss[+], B. Whitehead*, M. Paterson*, R. Whitehead* [+]Department of Clinical Sciences, College of Science, Rochester Institute of Technology, Rochester, NY 14623-0087. *National Technical Institute for the Deaf, Rochester Institute of Technology, Rochester, NY 14623-0887.

PATTERN FORMATION IN THE SPOROPOLLENIN CELL WALL OF *PEDIASTRUM BORYANUM*; PLASMA MEMBRANE POLYMERIZATION PROMOTING SURFACES. Stanley Gawlik, Biology Department, St. John Fisher College, Rochester, NY 14618.

RE-DISCOVERING AN EDUCATIONAL TREASURE: THE NEW YORK STATE LANTERN SLIDE COLLECTION. Benarta Glickman, Biology Department, Monroe Community College, 1000 East Henrietta Road, Rochester, NY 14623.

CULTURAL MATERIALISM: A TOOL FOR HISTORICAL ANALYSIS? Paul Grebinger. Behavioral Science Division, College of Liberal Arts, Rochester Institute of Technology, One Lomb Memorial Drive, Rochester, New York 14623.

PREPARATIONS OF INDOLIZINOLS BY REACTIONS OF CYCLOPROPENONES WITH SUBSTITUTED PYRIDINES. Barry L. Hafer, Brockport, N.Y. 14420.

THE DETECTION AND DIFFERENTIATION OF SELENIUM COMPOUNDS BY CATHODIC STRIPPING VOLTAMMENTRY. Michele E. Hrehocik, Walter J. Bowyer. Hobart and William Smith Colleges, Department of Chemistry, Geneva, New York 14456.

NATURAL HISTORY IN IROQUOIS FOLKLORE. Russell A. Judkins, Department of Anthropology, SUNY Geneseo, Geneseo, New York 14454.

CATACLASTIC PLAGIOCLASE: EVIDENCE FOR TURBULENCE IN A NEWRY, MAINE PEGMATITE. Vandall T. King, P.O. Box 90888, Rochester, New York 14609.

LIGHT AND ELECTRON MICROSCOPY OF THE WORLD'S SECOND SMALLEST FLOWERING PLANTS: *LEMNA MINOR* AND *L. VALDIVIANA* (LEMNACEAE). Kristen J. Mosher and T. M. Hammill, Department of Biolgy, SUNY College at Oswego, Oswego, New York 13126.

CHARACTERIZATION OF BAND MICROELECTRODE ARRAYS PREPARED FROM METAL FOIL AND HEAT SEALING TEFZEL FILM. David Odell, Walter J. Bowyer. Hobart and William Smith Colleges, Department of Chemistry, Geneva, New York 14456.

USE OF RADIOGRAPHS TO DETERMINE TURTLE CLUTCH AND EGG SIZES. Peter J. Petokas, Department of Biology, Pennsylvania State University, 120 Ridge View Drive, Dunmore, Pennsylvania 18512.

EFFECT OF IRON ON MACROPHAGE PHAGOCYTIC ACTIVITY. R. Rebres, D. Merrill, D. Doolittle. Dept. of Biology, Rochester Institute of Technology, Rochester, NY 14623.

KINDS OF SPEECH AND KINDS OF SOCIAL EVALUATION. John Rhoades, Department of Anthropology, St. John Fisher College, Rochester, New York 14618.

IS THE FITZHUGH-NAGUMO OSCILLATOR CHAOTIC? Andrew Sarat, Stephen Luzader, Department of Physics, SUNY Brockport, Brockport, New York 14420.

MUTAGENESIS AND ISOLATION OF MNNG-INDUCED UV-RADIATION SENSITIVE OR AUXOTROPHIC MUTANTS OF *CORYNEBACTERIUM GLUTAMICUM*. Brian M. Shewchuk, Scott C. Johnson, Kelly Radzik-Marsh, and Jean A. Douthwright, Department of Biology, Rochester Institute of Technology, One Lomb Memorial Drive, Rochester, NY 14623.

PITCH PINE (*PINUS RIGIDA* MILL.) IN CENTRAL AND WESTERN NEW YORK. F. K. Seischab, Dept. of Biology, Rochester Institute of Technology and J. M. Bernard, Dept. of Biology, Ithaca College.

MULTIPLE IMAGES TYPES FOR COMPUTER VISION. Dawn A. Smith.

THE DENERVATED CANINE HEART AS A MODEL OF THE TRANSPLANTED HEART. D.C. Smith. Department of Biological Sciences. SUNY College at Brockport, Brockport, NY 14420.

THE IMPACT OF BEES ON AGRICULTURE. E.E. Southwick, Biology Dept., State Univ. New York, College at Brockport 14420.

OBSERVATIONS ON THE LIFE HISTORY OF REED CANARY GRASS (*PHALARIS ARUNDINACEA*). Richard A. Solby, Dept. of Biology, Ithaca College, Ithaca, N.Y. 14850.

BEAT OF A DISTANT DRUMMER: COMMUNITY AND THE CLASSIFIEDS. Rob Wells and Darrell Norris, Department of Geography, S.U.N.Y. Geneseo, Geneseo, NY 14454.

SEVENTEENTH ANNUAL FALL SCIENTIFIC PAPER SESSION
and
LARRY J. KING MEMORIAL LECTURE

"The State Acid Rain Program: A Blueprint for a Clean Air Act Amendment."
by
David Bassett
Pollution Prevention Office,
U.S. Environmental Protection Agency

ST. JOHN FISHER COLLEGE
ROCHESTER, NEW YORK

Planning committee:
Melvin J. Wentland, Stanley R. Gawlik, John D. Rhoades

NOVEMBER 3, 1990

THE LIMNOLOGY OF HARDWATER LAKES IN KALKASKA COUNTY, MICHIGAN. P. Adams, R. Bevis, D. Burden, C. Diefenbaugh, M. Magnusson, D. Mitchell, K. Stuart, and J. Wolfe. AuSable Institute 7526 Sunset Trail N.E., Mancelona, MI 49659.

THE CONSTRUCTION AND USE OF A LOW-TEMPERATURE INFRARED CELL. Jordan Adelson, Romana Lashewycz-Rubycz and John Hill. Hobart and William Smith Colleges, Geneva, New York 14456.

CAN WE DETERMINE THE AGE AT DEATH OF PLIO-PLEISTOCENE FOSSIL HOMINIDS? Robert L. Anemone. Department of Anthropology, State University of New York, Geneseo, NY 14454.

NEW ARTHROPODS: THE ONTARIO EURYPTERIDS FROM THE SILURIAN ROCKS OF NEW YORK STATE AND ONTARIO, CANADA. Samuel J. Ciurca, Jr., 48 Saranac Street, Rochester, New York 14621.

STANDING CROP BIOMASS OF MACROPHYTE BEDS IN CANANDAIGUA LAKE. Chris Cranmer and Bruce Gilman. Dapartment of Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

ERROR-FREE AND ERROR-PRONE DNA REPAIR IN WILD-TYPE AND MUTANT *CORYNEBACTERIUM GLUTAMICUM*. Jean A. Douthwright. Department of Biology, Rochester Institute of Technology, One Lomb Memorial Drive, Rochester, NY 14623.

A 1990 UPDATE ON THE FISHES OF CANANDAIGUA LAKE. Dan French and Frank Smith. Department of Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

MANAGEMENT OF THE EXOTIC PERIWINKLE (*VINCA MINOR*) AT THE GREAT GULLY PRESERVE, CAYUGA COUNTY, NEW YORK. Mary Gleason. Central New York Chapter, The Nature Conservancy, 315 Alexander Street, Rochester, New York 14604.

LIGHT AND ELECTRON MICROSCOPY OF *UMBELLOPSIS VINACEA* AND *U. NANA* (ZYGOMYCETES; MUCORALES). Terrence M. Hammill and Eric K. Cottrell, Department of Biolgy, SUNY College at Oswego, Oswego, New York 13226.

IDENTIFICATION OF POSSIBLE LUNGFISH BURROWS IN THE UPPER TRIASSIC CHINLE FORMATION OF SOUTHEASTERN UTAH: PERIODIC ACID SCHIFF (PAS) REACTION AND MUCUS BURROW LININGS. Stephen Hasiotis and Robyn Hannigan, Department of Geology, State University of New York at Buffalo, 4240 Ridge Lea Road, Buffalo, NY 14260.

TUMOR PROGRESSION IN COLLAGEN GELS: ROLE OF HYALURONIC ACID. J. Hitzeman, P. G. Woost, and H. L. Hosick, SUNY College at Brockport, Brockport, NY 14420.

PETROGENETIC CONSTRAINTS ON THE PEGMATITES OF MAINE: NEWRY - A CASE STUDY. Vandall T. King. P.O. Box 90888, Rochester, New York.

THE INDIVIDUALISTIC RESPONSE OF FINGER LAKE STREAMS TO STORM EVENTS. Mark Mason and Bruce Gilman. Department of Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

WATER QUALITY TRENDS SINCE PERIMETER SEWERING OF HONEOYE LAKE. Lynn McGrath. Department of Science and Technology, Community College of the Finger Lakes, Canandaigua, New York 14424.

TIDE-INDUCED ICE-AGE THEORY. Frank Mooney. 6135 Dugway Road, Canandaigua, NY 14424.

BEYOND *DO'S AND TABOOS*: APPLYING ANTHROPOLOGY TO INTERNATIONAL BUSINESS. Walter E. Pond, Monroe Community College, 1000 E. Henrietta Rd., Rochester, NY 14623.

THE DIVERSITY OF THE ANTIBIOTICS OF *ERWINIA HERBICOLA* THAT INHIBIT *ERWINIA AMYLOVORA*. Tim Quinn and Richard Wodzinski, Department of Biolgy, Ithaca College, Ithaca, NY 14850.

PHOTOCHEMICAL CYCLOADDITIONS TO HETEROCYCLES. Robert Reuter and John Hill. Department of Chemistry, Hobart and William Smith Colleges, Geneva, New York 14456.

THE MYCORRHIZAL HABIT OF *PISONIA ALBIDA*. Ross A. Rupert and Terrence M. Hammill, Department of Biology, SUNY College at Oswego, Oswego, New York 13126.

EVIDENCE OF MIXED-MESOPHYTIC FOREST IN PRESETTLEMENT WESTERN NEW YORK. F. K. Seischab, Department of Biology, Rochester Institute of Technology, Rochester, NY 14623.

THE IMPACT OF AFRICANIZED HONEY BEES. Edward E. Southwick. Department of Biological Sciences, S.U.N.Y. College, Brockport, New York 14420.

THE GEOLOGICAL AND HUMAN HISTORY OF THE GENUS SARRACENIA. Robert E. Stauffer. 3553 Oakridge Drive, Rochester, New York 14617.

THE COURSE OF EVOLUTION OF THE VEGETATIONAL COMPLEXES OF ZURICH PEATLAND FROM 1949 TO 1987. Robert Eliot Stauffer, F.R.A.S. 353 Oakridge Drive, Rochester, New York 14617.

THE EVOLUTIONARY HISTORY OF THE GENUS SARRACENIA, PART I. Robert Eliot Stauffer, F.R.A.S.

THE EVOLUTIONARY HISTORY OF THE GENUS SARRACENIA, PART II. Robert Eliot Stauffer, F.R.A.S.

PRELIMINARY QUANTITATIVE SURVEY OF HONEOYE LAKE FISH. Carl Terwilliger, Jr., and Frank Smith. Department of Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

AN IN VIVO EXPERIMENTAL APPROACH TO MOUSE LIMB BUD DEVELOPMENT. Nancy Wanek. Biology Department, Rochester Institute of Technology, One Lomb Memorial Dr., Rochester, NY 14623.

ABSTRACTS

The abstracts below are printed at the request of the authors following letters of appeal sent to all first authors who presented papers at the 1986-1990 Fall Scientific Paper Sessions.

Author(s):	Year Presented:
Anemone	1990
Cranmer & Gilman	1990
Douthwright	1988
Hintzman, Woost, Hosic	1990
Hrehocik, Bowyer	1989
Ligouri & Gilman	1986
Mason & Gilman	1990
Mooney	1990
Moosavi & Gilman	1988
Odell & Bowyer	1989
Palmeteer & Gilman	1988
Pollack & Donovan	1988
Southwick	
Svoboda & Guisepetti	1988
Thompson & Gilman	1988
Wolfe	1988, 1990

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CAN WE DETERMINE THE AGE AT DEATH OF PLIO-PLEISTOCENE FOSSIL HOMINIDS?

Estimation of the age at death of immature fossil hominids (human ancestors) has traditionally been attempted on the basis of patterns of dental development in the fossils and analogies with the known rates of tooth eruption into the oral cavity among modern humans (Mann, 1975; Mann, 1988; Mann, Lampl, & Monge, 1987). Thus the "Taung child", the type specimen of *Australopithecus africanus*, named by Raymond Dart in 1925 on the basis of a skull and mandible with the permanent first molar (the human "6 year molar") recently erupted, has long been thought to have died at 5-6 years of age (Dart, 1925). Recent work, however, has questioned the assumption that fossil hominids shared similar patterns and rates of dental development with modern humans: it is equally likely that the teeth of our fossil ancestors developed at the more rapid rates characteristic of modern apes, in whom the first permanent molar erupts at 3.5 years of age (Beynon, & Dean, 1987; Beynon, & Dean, 1988; Bromage, 1987; Bromage, & Dean, 1985; Dean, & Wood, 1981; Smith, 1986; Smith, 1987). How can we determine if dental development among the fossils occurred at rates characteristic of modern humans or apes? One approach is through comparative analysis of the timing of calcification of the adult dentition through the study of radiographs of modern humans and apes.

While the sequence and timing of dental development among humans has been well studied, there are almost no published data on calcification of the dentition among extant apes. Recently, two colleagues (Elizabeth S. Watts, Tulane University and Daris R. Swindler, University of Washington) and I examined a series of 99 lateral head radiographs of 16 chimpanzees of known chronological age, taken at irregular intervals throughout the entire postnatal period of dental development from birth to 13 years of age (Anemone, Watts, & Swindler, 1991). We rated permanent mandibular molars on an 8 point maturation scale from initial radiographic appearance through crown and root calcification and apical closure of the root canals. In addition, we were able to document initial crown calcification and completion, as well as root completion and apical closure in incisors, canines and premolars.

Our results suggest major differences between the pattern and timing of dental development in chimps and humans. Perhaps the most significant difference is in the great degree of temporal overlap in calcification of the crowns of adjacent molars, a pattern very unlike that seen in human molars, which are characterized by long delays between the onset of crown calcification in adjacent molars.

These differences suggest another approach to determining ape or human affinities in dental development among fossil hominids, and thus a more secure idea of their age at death. If we compare the relative state of development of the anterior teeth at the time of M1 eruption in apes (3.5 years) and humans (6 years), major differences are apparent. When M1 erupts in a human child, all of the other permanent teeth (except M3, the "wisdom tooth") have complete crowns and most have significant amounts of root development. Conversely, when M1 erupts in a chimpanzee, only the incisors have complete crowns and a small amount of root development. The second molar, both premolars, and especially the canine have little crown development, and no root development. Recently, Glenn Conroy and Michael Vannier of Washington University have used computerized tomography to investigate the stage of development of the unerupted adult dentition of the Taung specimen (Conroy, & Vannier, 1987; Conroy, & Vannier, 1988). Their results indicate that the anterior teeth resemble modern chimps in having little or no root development and mostly incomplete crowns. These results provide support for the retention of a primitive, "apelike" pattern of dental development in *Australopithecus africanus*, and suggest that the Taung "child" met his/her unfortunate end at around 3-4 years of age, rather than 5-6.

LITERATURE CITED

Anemone R, Watts E, and Swindler D (1991) Dental development of known-age chimpanzees, *Pan troglodytes* (Primates, Pongidae). Amer. J. Phys. Anthropol., In Press:

Beynon A, and Dean M (1987) Crown-formation time of a fossil hominid premolar tooth. Archs. Oral Biol., 32:773-780.

Beynon A, and Dean M (1988) Distinct dental development patterns in early fossil hominids. Nature, 335:509-514.

Bromage T (1987) The biological and chronological maturation of early hominids. J. Hum. Evol., 16:257-272.

Bromage T, and Dean M (1985) Re-evaluation of the age at death of immature fossil hominids. Nature, 317:525-527.

Conroy G, and Vannier M (1987) Dental development of the Taung skull from computerized tomography. Nature, 329:625-627.

Conroy G, and Vannier M (1988) The nature of Taung dental maturation continued. Nature, 333:808.

Dart R (1925) *Australopithecus africanus*: the ape-man of South Africa. Nature, 115:195-197.

Dean M, and Wood B (1981) Developing pongid dentition and its use for ageing individual crania in comparative cross-sectional growth studies. Folia Primatol., 36:111-127.

Mann A. (1975). Some Paleodemographic Aspects of the South African Australopithecines.(No. 1). University of Pennsylvania, Philadelphia.

Mann A (1988) The nature of Taung dental maturation. Nature, 333:123.

Mann A, Lampl M, and Monge M (1987) Maturational patterns in early hominids. Nature, 328:673-674.

Smith B (1986) Dental development in *Australopithecus* and early *Homo*. Nature, 323:327-330.

Smith B (1987) Maturational patterns in early hominids. Nature, 328:674-675.

STANDING CROP BIOMASS OF MACROPHYTE BEDS IN CANANDAIGUA LAKE. Chris Cranmer and Bruce Gilman. Department of Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

Five locations along the shoreline of Canandaigua Lake were inventoried for aquatic vegetation during the summer, and again during the fall 1990 season. At each location, a 410 foot transect line containing five samples was arranged from the shoreline to deeper water. Utilization of SCUBA facilitated the collection of deep water samples. In total, eighteen species of aquatic vegetation were detected. Waterweed (Elodea canadensis) and Eurasian milfoil (Myriophyllum spicatum) were most frequent, while stonewort (Chara vulgaris) had the greatest biomass. Spatial patterns were present along water depth gradients.

ERROR-FREE AND ERROR-PRONE DNA REPAIR IN WILD-TYPE AND MUTANT CORYNEBACTERIUM GLUTAMICUM.

Jean A. Douthwright. Department of Biology, Rochester Institute of Technology, One Lomb Memorial Drive, Rochester, NY 14623.

Corynebacterium glutamicum (Cg)13287, a gram positive glutamic acid producer and a homoserine auxotroph, has been studied for the ability to repair and mutate DNA after exposure to UV-radiation. These procaryotic cells exhibit both error-free (nonmutagenic) and error-prone (mutagenic) repair pathways. Cg13287 is able to repair DNA using one of the error-free repair pathways, photoreactivation (PR). An enzyme, photolyase, complexes with the UV-damaged DNA lesion, a pyrimidine dimer. In the presence of visible light the dimer is cleaved. In this study Cg13287 was exposed to 0-80 J/m^2 of UV-radiation, followed by visible light. Repair of 100-1000 fold was measured at the various doses. Cg13287 is also able to use the error-prone DNA repair pathway as measured by the increase in mutation-frequency to homoserine auxotrophy after UV-radiation. Mutants of Cg13287 have been isolated (PJ1 and PJ2), which are unable to carry out this type of repair. PJ1 and PJ2 show a decrease or lack of mutation as compared to the wild-type parent. Presently our laboratory is studying the ability of Cg13287 to carry out error-free excision repair by doing liquid-holding experiments.

DNA REPAIR AND MUTAGENESIS IN CORYNEBACTERIUM GLUTAMICUM RADIATION-SENSITIVE MUTANTS.

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[2]Division of Natural Sciences, New College, 5700 North Tamiami Trail, Sarasota, Florida 34234.

Radiation-sensitive mutants of Corynebacterium glutamicum (Cg)13287 (American Type Tissue Collection) were isolated by screening 10,000 ultraviolet-mutagenized colonies. These mutants have been shown to be defective in DNA repair. Corynebacterium glutamicum13287 is a gram-positive glutamic acid producer, and a homoserine auxotroph.

Two of these mutants, PJ1 and PJ2, have been characterized for the ability to repair DNA damage and mutate to homoserine prototrophy after exposure to the chemical mutagens ethyl methanesulfonate (EMS) (5% v/v), methyl methanesulfonate (MMS) (1% v/v), and nitrosoguanidine (NTG) (200 ug/ml). Overnight cultures were grown in tryptic soy broth at 30°C., washed two times in phosphate buffer, exposed to the mutagen, and assayed for survival and mutation frequency.

It has been shown in E. coli that an inducible error-prone repair pathway is responsible for mutations when the organism is exposed to mutagens (1). PJ2 exhibits a higher inducible mutation frequency than Cg13287 and PJ1 when exposed to EMS and NQO. This suggests that PJ2 has a functional error-prone repair pathway for EMS and NQO damage. Both mutants exhibit a lower inducible mutation frequency than Cg13287 when exposed to MMS suggesting a defect in an error-prone repair pathway for damage caused by MMS. Therefore it appears that two different cellular responses are responsible for mutagenesis with EMS or NQO, and that for MMS.

(1) B. Singer and J.T. Kusmiered, Ann. Rev. Biochem., 52, 655 (1982).

TUMOR PROGRESSION IN COLLAGEN GELS: ROLE OF HYALURONIC ACID.

J. Hitzeman, P. G. Woost, and H. L. Hosick, SUNY College at Brockport, Brockport, NY 14420.

The glycosaminoglycan, hyaluronic acid (HA) has been implicated as a modulator of cell division in actively growing normal and cancerous mouse mammary epithelial cells. We used a collagen gel assay to select from the preneoplastic CL-S1 cell line, which is immortal but nontumorigenic, those variants that grow without attachment to a substratum. We hypothesized that collagen favors the retention of HA, and that it stimulates growth as it accumulates in the extracellular matrix, so that mitosis and HA synthesis are mutually reinforcing processes that model tumor growth.

Contrary to earlier reports, exogenous HA neither enhanced nor inhibited the growth of CL-S1 cells in collagen. Moreover, the initial densities at which cells were suspended in collagen had no significant effect on the growth rate after the cells began cycling. Synthesis of HA peaks on day 6 while cells are still dividing logarithmically. When cells reach saturation density (ca. 4.5 x 10^6 cells) 2 days later, HA production is declining. As the cultures age, the HA associated with the cell fraction shifts to the extracellular matrix.

While earlier passaged cells (36^o-64^o) showed prolonged cycling rates (from 28 to 34 h), cells from passages in the late 70's cycled in 24 h, and those in the 80's cycled at 18 h, at rates similar to those of the fully tumorigenic +SA cells. The CL-S1 cell line is aneuploid, with chromosome numbers in the sixties (the normal diploid number for Mus is 40). Cells in passage 27^o had chromosome numbers in the low fifties, while 26% of cells in passage 97^o had cells with 96-104 chromosomes.

These changes may be markers for cells that are becoming more tumorigenic. Confirmation of this requires the culture of the faster-dividing CL-S1 cells in the cleared fat pads of young mice.

THE USE OF MICROELECTRODES FOR THE ELECTROCHEMICAL DETECTION OF SELENIUM COMPOUNDS.

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The trace element selenium has become a concern in recent years because humans as well as many species of wildlife have a relatively narrow range of tolerance for it. We show that anodic stripping voltammetry (ASV) analysis employing gold disc microelectrodes (d = 10 microns) offers several advantages over ASV using conventional sized (d = 2 mm) electrodes. With a 60 second preconcentration step, the limit of detection with the microelectrode is better than 1 ppb. Detection of lower concentrations is limited by the small currents. In contrast, with a macroelectrode under identical conditions, detection is limited by relatively large background currents.

At moderate concentrations (10 - 100 ppb) analysis can be performed more rapidly with microelectrodes than macroelectrodes because of the high flux inherent to spherical diffusion. With both electrodes, the linear dynamic range is about two orders of magnitude. At high concentrations, the selenium apparently plates onto the electrode in two forms yielding two peaks. We are currently optimizing electrode geometry to maximize the linear dynamic range.

FALL STANDING CROP BIOMASS OF AQUATIC MACROPHYTE COMMUNITIES IN HONEOYE LAKE, NEW YORK. A. Liguori and B. Gilman, Department of Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

Twenty transects, each containing five inventory stations, were systematically located in a nearby equal spacing along the lake shore during the fall of 1984. At each station, all vegetation occurring within a submerged weighted quadrat frame was removed. Water depth and transparency were recorded while a substrate sample was collected for subsequent laboratory analysis. Eelgrass, Vallisneria americana, was found to be the most widely distributed vascular plant often forming dense beds in shallow water. Curly Pondweed, Potamogeton crispus, extended to the deep water edge of some weedbeds. In total, twenty species were collected, seventeen vascular plants, two macroscopic algae and one aquatic moss.

Fall standing crop biomass ranged from 1 to 1373 gm/m^2 dry weight. Macrophyte communities in Honeoye Lake were categorized into three groups: areas of probable high, medium and low productivity. Biomass peaked nearshore (75 cm) in the low productivity communities due to poor substrate conditions. In the medium productivity communities, biomass increased steadily with depth to the secchi disk level (275 cm). Biomass in the high productivity areas was greatest at 125 cm. This last group had the highest species richness and overall diversity.

Regression analysis revealed positive correlations between fall standing crop and richness, textural class, percent organic matter and percent silt. Significant negative correlations occurred with percent sand, substrate, p^H and substrate phosphorous concentration. Multiple regression analysis of all measured factors accounts for 30.9% of the pattern in macrophyte biomass.

THE INDIVIDUALISTIC RESPONSE OF FINGER LAKE STREAMS TO STORM EVENTS. Mark Mason and Bruce Gilman. Department of Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

As part of a comprehensive watershed project, tributary streams to Canandaigua Lake were monitored weekly during the spring runoff period for the years 1989 and 1990. Parameters included stream temperature, turbidity, nutrient levels and flow. A strong correlation exists between flow and the timing of storm events. Each stream, however, responded differently to the storm when considering the other parameters. Causes of unique stream response appear to be related to watershed landuse, hydrologic slope and stream basin catchment area.

Tide-Induced Ice-Ages, An Hypothesis

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(Summary of Paper delivered in Fall 1990)

Eight ice-ages match the 100 ky cycle[1] of Earth's orbital eccentricity. Broecker and Denton[2] identified reduction of a wind-driven oceanic waterwheel in the North Atlantic with these ice-ages. Handler[3] has correlated stratospheric aerosols with shifts of anticyclones that control monsoons and El Niños. Correlations of major calderas with global cooling have been suggested by Wexler[4] and others[5]. This paper explains how largest orbital eccentricities exaggerate lithospheric tides that can quake Earth deeply and subduct muddy seafloor under volcanic hot-spots with subsequent volcanic winters and uninterrupted thickening ice-cover.

Resulting darkened skies would decrease Earth's equator-to pole thermal gradient that motivates the storms that drive the waterwheel that restrains icing. This scenario dismisses the dilemma that orbital eccentricity barely changes annual insolation but triggers ice-ages. Weakened thermal gradient by calderas induce ice-ages; lesser volcanos induce swings of pressure systems in the Pacific; and excess warming of high latitudes by greenhouse-gases (as predicted in models of global warming) may be partly or intermittently offset by consequent weakened storms and less oceanic warming. This warming-begets-cooling sequence may relate to Earth's spasmodic climate of recent decades.

The table below lists changes of relative tidal stresses ΔF by Moon m and Sun s for low present orbital eccentricities ε and for larger values. Mass relative to Earth is μ, and distances D at perigee (perihelion) and apogee (aphelion) are reported in gigameters or millions of km. These distances are added linearly for close approaches and quadratically for remote positions in order to get the range and ratio of relative stresses.

x	ε_x	μ_x	D_{per} in Gm	(ΔF_{per})	D_{aph} in Gm	(ΔF_{aph})	Ratio
m	0.044	0.012	0.3702	0.2365	0.4043	0.1816	
s	0.01	333,000	148.005	0.1027	150.995	0.0967	
			$\Sigma(\Delta F_{per})_{lin}$ =	0.3392	$\Sigma(\Delta F_{aph})_{quad}$ =	0.2057	1.65
m	0.066	0.012	0.3564	0.2651	0.4067	0.1784	
s	0.05	333,000	142.025	0.1162	156.975	0.0861	
			$\Sigma(\Delta F_{per})_{lin}$ =	0.3813	$\Sigma(\Delta F_{aph})_{quad}$ =	0.1981	1.92
m	0.2046(?)	0.012	0.3058	0.4196	0.4833	0.1063	
s	0.05	333,000	142.025	0.1162	156.975	0.0861	
			$\Sigma(\Delta F_{per})_{lin}$ =	0.5358	$\Sigma(\Delta F_{aph})_{quad}$ =	0.1368	3.91

This table uses the inverse-cube derivative of Newton's gravitational Law for tidal stress, and it assumes constant lengths of semi-major axes.

Increased eccentricity (decreased angular momentum) implies a less circular orbit, but it does not imply a lengthened semi-major axis[6], which depends on Earth's gravitational energy relative to the Sun and which sets the length of a year (Kepler's Third Law). Earth's and Moon's orbital eccentricities increase when larger planets at their perihelions are closest to Earth-Moon because Earth [or Moon] then has an increased component of angular momentum around these planets and an equal decreased component around Sun [or of Moon around Earth].

These circumstances are mechanically analogous to a proton with an orbiting electron, for which the principle quantum number (energy) is unaffected by the size of its orbital quantum number (angular momentum). Orbiting of additional electrons in larger atoms does affect their energies but only slightly despite their strong interaction. Even less should weak gravitational interaction of planets change their energies, their periods of revolution around the Sun, or the long-axis of their orbits.

Sensitivity of tidal stress and strain to proximity of Moon and Sun are given by expanding the inverse cube formula in terms of the change ΔD. A 4% decrease of separation magnifies the increment of tidal stress by almost 3-fold to 12%. Triggering of earthquakes by tidal maxima is statistically unclear, but lunar seismometers regularly telemetered deep quakes fortnightly[7] during each New-Earth and Full-Earth. Earth's floating tectonics seem to produce earthquakes, regardless of tides; but extremely large tides would encourage rifting and subduction.

Largest orbital eccentricities recur with a period near 413 ky, and slightly smaller ones have periods near 100 ky. Phases of these were such that the last 100 ky maximum was canceled (according to graphics by Berger[1]) by the 413 ky minimum. Otherwise Earth was scheduled for another ice-age as of 10 ky ago; testing of this is about 90 ky ahead.

The list of known climate-changing volcanic events is short. Tambora's collapse (1815 A.D.) gave the famous Year with no Summer; Rabaul's collapse (536 A.D.) fatally famished about 90% of China's people; Thera became Santorini (1650 B.C.) and possibly (?) helped Moses; and Toba about 75 ky ago seems to have reenvigorated the Wisconsin Ice Age that began some 50 ky earlier. Chichon's aerosols (1982) preceded an El Niño.

1 A. Berger : ***Vistas in Astronomy, Vol 24,*** 103-122, (1980, Pergamon Press).
2 W. Broecker & G. Denton: *What Drives Glacial Cycles?,* **Sci.Am. 262,** 48-56, Jan 1990.
3 P. Handler : ***Volcanic Aerosols,...,*** **Int.J.Climatology, 9,** 001-012, 1989.
4 H. Wexler : *Volcanoes and World Climate,* **Sci.Am. 186,** 74-80, Apr 1952.
5 J. Bray, **Science**, 15 Jul 1977; R. Bryson & B. Goodman, **Science**, 7 Mar 1980; S. Porter, **Nature,** 14 May 1981; M. Rampino, S. Self, R. Stothers, **Ann.Rev.Earth,Planet.Sci.,** 1988.
6 F. Moulton : ***An Intro. to Celestial Mechanics,*** (1914, 1923, MacMillan).
7 G. Latham and 8 co-authors: *Moonquakes,* **Science, 174,** 687-692, 23 Nov 1971.

CLASSIFICATION OF MACROPHYTE COMMUNITIES IN PORT BAY, NEW YORK BY TWINSPAN ANALYSIS. **Sadredin Moosavi and Bruce Gilman, Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.**

Standing crop biomass data provided by the Wayne County Aquatic Plant Management Program was classified through use of the microcomputer software package TWINSPAN (Two-way Indicator Species Analysis). A total of 85 samples, containing 23 different species, was analysed and a dendrogram illustrating similarity among species and samples was produced. The relationship of this classification to the actual underwater plant habitat will be discussed.

CHARACTERIZATION OF BAND MICROELECTRODE ARRAYS PREPARED FROM METAL FOIL AND HEAT-SEALING TEFZEL FILM. David Odell and Walter Bowyer, Department of Chemistry, Geneva, NY 14456

A new procedure for preparing microelectrode arrays is described. This procedure is based on making a multidecker sandwich of metal foil and heat-sealing teflon, sawing the sandwich to expose a cross section, affixing the wafer to a length of glass tubing, and polishing the end to prepare an array of band electrodes. This method of fabrication has proven to be useful in constructing various sizes of active (Pt, Au, Ag, and Ni foil) and inactive (Tefzel heat-sealing teflon) sites. The electrodes produced were characterized electrochemically by cyclic voltammetry of anthraquinone and ferrocene. Results show an encouraging consistency with theoretical predictions.

ASSESSMENT OF FISH MORTALITY DURING MACROPHYTE HARVESTING: A COMPARISON OF SODUS BAY AND HONEOYE LAKE, NEW YORK. Kurt Palmateer, Frank Smith and Bruce Gilman, Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

The impact of accidental fish capture while harvesting aquatic vegetation is a topic of concern to both scientists and sportsmen. During the late summer of 1988, research conducted by the students and staff of CCFL provided data on the number, size and species of fish taken during harvesting on Sodus Bay and Honeoye Lake. Samples were collected from the harvestor conveyor as vegetation was being cut.

Ten samples from each location were analysed. In total, thirteen species of fish were collected, twelve in Sodus Bay and ten in Honeoye Lake. Sodus Bay samples yielded 1806 fish while Honeoye Lake samples contained 4136 fish. Statistical analysis of species composition, richness and diversity revealed some similarities between sites. Size class analysis of all fish species indicates a tendency towards juvenile cohort capture.

SYNTHESIS AND CHARACTERIZATION OF N-(2-MERCAPTOETHYL) SALICYLALDIMINE AND ITS COMPLEXES.

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Linear terdentate ligands containing more than one type of donor atom are uncommon and terdentate ligands containing more than two types of donor atom are very rare. The title compound was prepared via a Schiff's base condensation reaction between salicylaldehyde and 2-mercaptoethylamine. Characterizations of the ligand and its complexes with copper (II), nickel (II), and zinc (II) were based on elemental analyses, infrared spectra, and nuclear magnetic resonance spectra.

Social Physiology in Colonial Honey Bees

Edward E. Southwick, Biology Dept, SUNY-Brockport 14420

The 30 to 70 thousand honey bees (*Apis mellifera* L.) living together in a typical colony function as a social entity which shows coordinated social responses to a variety of environmental stimuli. There is actually a "social physiology" which is very different from that shown by individuals isolated from the group. The organized colonial responses rarely resemble the summation of responses seen in individuals outside the social framework. Because of their eusocial behavior with overlapping generations living together and offspring assisting parent through division of labor in caring and provision of the family (Michener 1974, Wilson 1975), there are many functions that need to be examined in the context of the colony. Colony-level homeostasis and adaptations have clearly aided in the successful exploitation of a large variety of habitats in many regions of the world (Ruttner 1988). Physiological functions of the social unit are adaptations toward solving common problems of homeostasis (such as water balance, or temperature regulation) that involve fundamentally different mechanisms, resulting from selective pressures operating on the colony, than those utilized to solve the same problems in normal intact metazoans. The social processes used by the colony can be measured, analyzed and compared quantitatively to processes employed by mammals, birds, and other animals. In this paper I will describe one of these processes in the control of colony respiration.

The high metabolic rates of the bees require adequate exchange of respiratory gases (oxygen and carbon dioxide) between the colony and the environment. Circulation of the atmosphere within the nest cavity is maintained by fanning behavior of the bees. The ventilation activities of fanning bees may be observed at the entrances to natural nests or manmade hives on hot summer days. When their nest cavities have only one entrance, the fanning activity must function in a way that assures the outflow of stale air and the inflow of fresh air in a way similar to eupnea in vertebrates.

Methods

Ventilation activities of honey bees (*Apis mellifera* L.) were observed under long wavelength red light (to which the bees are blind) in nest chambers made of acrylic, each with only a single small (2 cm diameter) bottom entrance (Southwick and Moritz 1987). It was necessary to provide a landing platform under the opening to allow bees room to fan outside the entrance. The small queenright colonies of 2500 bees were moved into the acrylic chamber from their nucleus hives one comb at a time and the combs were left *in situ*. No brood was present. Using a low velocity anemometer, copper-constantan thermocouples, and oxygen and carbon dioxide gas analyzers, in-out ventilatory air movement was documented under the conditions of the experiment.

Results

The bees form legions of fanners in fixed positions about the bottom and sides of the nest cavity, and even outside the entrance on the landing platform. One to three fanners orient themselves in the entrance hole. The side fanners circulate the inside air, but the behavior of the entrance fanners is the crucial factor in determining the direction of air flow into and out of the nest cavity. When these few bees fan with their abdomens pointed outward at the entrance, stale warm air flows outward. This is indicated by an increase in thermocouple temperatures resulting from the warm air which is drawn across the thermocouples from the nest, and a simultaneous decrease in oxygen content and increase in carbon dioxide content in the sampled air stream (Figure 1). Normal ventilation during the day showed an average respiratory frequency (RF) of 3 "breaths"/min (Southwick and Moritz 1987). Normal tidal volumes (TV) averaged 147 ml, with a maximum TV of 462 ml. This results in an average minute volume (MV) of 0.42 1/min. Whether air moves into or out of the cavity is determined solely by the few bees located directly in the entrance hole.

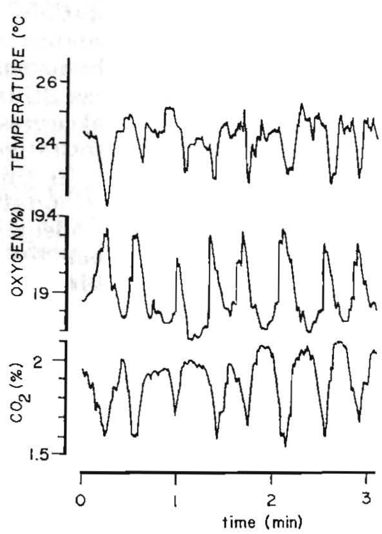

Figure 1 - Ventilation patterns in a honey bee colony of 2000 bees confined in a cavity with a single entrance (from Fig 2 in Southwick and Moritz 1987).

Discussion

The respiratory data reported here are well within the range reported for vertebrates such as cats (RF=15 breaths/min, TV=25 ml and MV=0.38 1/min) and marmots (RF=8 breaths/min, TV=22 ml, MV=0.17 1/min). In the honey bee colony, respiration activity was depressed at night (RF of 0.4 breaths/min, TV remained the same, periods of apnea occurred). Normal eupnea in vertebrates is a negative pressure type in which inspiration is active and expiration passive. Instead of a muscular thoracic pump such as utilized by intact mammals, the honeybee colony actively changes direction of air flow by the behavior of entrance fanners. Natural nest cavities could have several entrances allowing for one way ventilation. In mammalian organisms, regulation of respiration is determined by centrally coordinated effects of carbon dioxide receptors and the need to cool. Similar regulation is effected in ventilation of bee nest cavities through social group coordination.

The same type of ventilatory behavior has been found in other cave dwelling social bees under natural field conditions. Ground nesting *Trigona denoiti* and tree nesting *T. gribodoi* are native stingless bees of South Africa that colonize cavities with only small entrances. These small colonies, too, ventilate by active respiratory breathing (Moritz and Crewe 1988).

Literature Cited

Michener CD (1974) The Social Behavior of the Bees. Harvard Univ Press, Cambridge, MA

Moritz RFA, Crewe RM (1988) Air ventilation in two African stingless bees *Trigona denoiti* and *Trigona gribidoi*. Experientia 44:1024-1027

Ruttner F (1988) Biogeography and Taxonomy of Honeybees. Springer, Heidelberg

Southwick EE, Moritz RFA (1987) Social control of air ventilation in colonies of honey bees, *Apis mellifera*. J Insect Physiol 33:623-626.

Wilson EO (1975) Sociobiology: The New Synthesis. Harvard Univ Press, Cambridge

A COMPARISON OF PROTEIN PATTERNS IN NORMAL AND IN ACTIONOMYCIN D-TREATED MEDAKA FISH EMBRYOS.

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The fresh water teleost Oryzias latipes, the Japanese medaka fish, can be induced to ovulate daily by establishing a photoperiod of 16 hours of light and 8 hours of darkness in the laboratory. We have used SDS acrylamide gel electrophoresis to study the protein banding patterns of fertilized medaka eggs in progressive stages of normal development. Using the additio of the transcriptional inhibitor Actinomycin D to fert ilized medaka eggs at various times after fertilizati the effects of such inhibition on embryonic developme as well as the protein banding pattern have been studied. The disappearance of a major protein band i embryos treated with Actinomycin D very soon after fe ilization coincides with the failure of these embryos to gastrulate. Actinomycin D added at later times in development has only minor effects on the protein pattern and little observable effect on embryonic dev opment. These data suggest a very early and importan period of embryonic transcription essential to normal embryonic development in the medaka fish.

RESTORATION OF LAKE ONTARIO BAYS, WAYNE COUNTY, NEW YORK: PHASE ONE - INVENTORY OF MACROPHYTE COMMUNITIES. Sylvia Thomson, Bruce Gilman and Frank Smith, Natural Resources Conservation, Community College of the Finger Lakes, Canandaigua, New York 14424.

Eutrophication of inland waters results from a complex interaction of human activities. Common lake symptoms of eutrophication include reduced water clarity, algal blooms and excessive macrophyte growth. Within New York, state sponsored restoration programs take an holistic approach towards recovery that begins with a thorough inventory and assessment of in-lake problems. During the summer of 1988, a program of this design took place on Port Bay, East Bay and Sodus Bay. Shoreline macrophyte communities were sampled with a transect method of regularly spaced quadrats. A total of 253 standing crop biomass samples was collected. Each sample was sorted by species, air dried and weighed. Concurrent environmental measurements of water depth and substrate type were recorded. Data from this summer study have provided valuable information on species distribution and potential productivity of shoreline communities, and provided some insight on the applicability of certain management techniques.

THE EFFECTS OF PHENOLICS ON THE GROWTH AND SEXUAL REPRODUCTION OF CHAMPIA PARVULA.

James Wolfe, Biology Department, Houghton College, Houghton N.Y. 14744.

The effects of phenolics on the growth and sexual reproduction of the red alga *Champia parvula* (C.Ag.) Harvey were studied in culture. The sexual reproduction of *Champia* was significantly ($p < 0.05$) inhibited by the addition of phloroglucinol to culture media. The number of cystocarps produced after a 2-day exposure to phloroglucinol at 5000 ug/L during fertilization was about 10 % that of the control. In one trial the number of cystocarps produced at 2000 ug/L was less than 30 % that of the control. Growth (as dry weight) of *Champia* tetrasporophytes was also significantly ($p < 0.05$) inhibited by added phloroglucinol, with only 50 % growth at the 2000 ug/L concentration.

Both macroalgal exudates and water collected from southern Rhode Island tidepools caused a decrease in the number of *Champia* cystocarps produced after a 2-day exposure during fertilization. Exposure to a *Petalonia fascia* (Mull.) Lamour. exudate with a measured concentration of 520 ug/L phloroglucinol units caused a 50 % decrease in the number of cystocarps produced. Exposure to tidepool water with a concentration of 600 ug/L also produced a 50 % decrease. A slight decrease in cystocarp production was seen after exposure to water from another tidepool with a concentration of 950ug/L.

Measured levels of phenolics in some Rhode Island tidepools can be as high as 1500 ug/L phloroglucinol units. These results suggest that phenolics exuded by macroalgae may act as allelopathic agents towards *Champia parvula* in tidepools

THE LIMNOLOGY OF HARDWATER LAKES IN KALKASKA COUNTY, MICHIGAN.

P. Adams, R. Bevis, D. Burden, C. Diefenbaugh, M. Magnusson, D. Mitchell, K. Stuart, and J. Wolfe. AuSable Institute 7526 Sunset Trail N.E., Mancelona, MI 49659

Three kettlehole hardwater lakes in the central Michigan watershed of the Manistee River were studied from 1984 to 1990 with regard to their biology and chemistry. Big Twin, Pickerel and Starvation Lakes showed high water clarity, with Secchi readings ranging from 4.7m for Starvation Lake to 6.7m for Big Twin Lake. All three lakes were stratified during the summer with the thermocline at 9m. These hardwater lakes had high alkalinity values (70-103ppm), high conductivity (65-180 μ mhos), and slightly alkaline pH readings (7.7-8.5), all reflecting the contribution of groundwater through calcareous sands. Metalimnetic oxygen maxima were evident during the summer in the three lakes while chlorophyll a values were highest below the oxygen maxima. The hypolimnion in each lake during summer was essentially devoid of oxygen, and contributed to release of phosphorus from the benthic sediments. While rooted macrophytes were not in abundance, phytoplankton (mainly the dinoflagellate Ceratium) were in high numbers. Trophic status as indicated by secchi readings, phosphorus concentrations, and chlorophyll a levels showed the three lakes to be oligotrophic to mesotrophic. The trophic status of the lakes, all of which have extensive shoreline development, is maintained by the biochemical processes unique to hardwater lakes.

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THOMAS W. DEY
FELLOW
1988

Scientific attainment or distinguished service to the Academy are the requisites for Fellowship in the Rochester Academy of Science. Tom Dey fulfills both of these requirements admirably.

His scientific attainment is attested to by his excellence in astrophotography. Astrophotography is an important means of gathering astronomical information. The extremely low light levels and the significant rotation of the earth during exposures, makes this a challenging field of photography. He has developed special techniques for treating film and has designed ingenious equipment which result in pictures of superb quality. Many selections from his large collection of photos have received top honors at the Syracuse Summer Seminar photo contests, which include contestants from all of Western New York and nearby Canada. Some have been published in National magazines. Tom is currently working on a project to build a 22 foot octagonal observatory which will eventually house a 29 inch telescope, by far the largest amateur installation in the area.

Tom is also an active participant in the Astronomy Section. He has served two terms as Section Chairman, and gives frequent technical talks. He has a scientific curiosity which he follows up with good methodical analysis often resulting in simplified views of complex ideas which are easy to understand, and scientifically accurate. He frequently gives talks to schools, scouts, and other astronomy groups. He has taught several courses in astronomy and photography at the Gannett School of Science and Man.

It is with pride that the Rochester Academy of Science bestows the honor of Fellow on Thomas W. Dey.

FRANK DOBSON JR.
FELLOW
1989

As a young man Frank Dobson lived and worked on the Dobson Brothers Fruit Farm in the Town of Greece. He grew to know the many birds, animals and plants in the surrounding countryside. He would often explore the farm woodlot with his friend Dr. Leo Tanghe, whose expertise helped him find and identify mushrooms and discover other secrets of the wild.

Frank's art talent exhibited itself early when as a fifth grader, he won a prize in a state-wide poster contest. His first literary effort was a story he wrote about life on the farm while attending Aquinas Institute.

Photography, bird-watching and writing were interests which grew with him. At age 12 he obtained his first camera, and learned to process his own color slides. He became his High School's newspaper photographer and, acquiring better equipment, took many more pictures of wildlife, their habitat and the environment. In his travels along the East Coast he has identified over 300 species of birds, most of them captured on slides or movie film. He has also recorded the songs and calls of over 200 species of birds.

Since 1980 he has been writing a weekly column on birds for the Democrat and Chronicle. His excellent line drawings of birds featured in the articles, and his pleasant non-technical style have enticed many non-birders into a fascinating hobby.

Frank has been an instructor in the highly successful GOS Birding School for its four years of operation, and is conducting a course on waterfowl identification for the Gannett School. He regularly leads bird walks for the GOS and other groups, and is an active member of the GOS statistics committee. Several years ago he was instrumental in improving the bird-attracting environment at the Borroughs Audubon Nature Sanctuary with extensive plantings of suitable vegetation.

For his ability to teach and interest the public in Ornithology, The Rochester Academy of Science welcomes Frank Dobson as a Fellow.

KEVIN C. GRIFFITH
FELLOW
1989

One of the purposes of the Rochester Academy of Science as stated in our constitution is to disseminate scientific knowledge. Kevin Griffith has been doing just this since graduating from SUNY Brockport with a Bachelor of Science Degree in 1972.

He has been a science teacher in the Greece Elementary School system for 17 years, the Greece Continuing Education Program for 7 years, and an instructor in the GOS Birding School for the past 3 years. He is a Boy Scout Merit Badge counsellor, and a former Eagle Scout.

For the past 10 years he has been an active member of The Ornithology Section. He has also been active in other birding groups including Genesee West Audubon Society as President, Education Chairman and Newsletter Editor, and the Rochester Birding Association where he chaired the Education Committee, and was a member of the Board of Directors.

He is an avid photographer and has taken over 7000 wildlife photographs which he uses in lectures on birds and their habitats to bird clubs, garden clubs, scout groups and others throughout Western New York.

A five year holder of a Federal-State Bird-Banding license, Kevin has been actively engaged for the past four years in the Migratory Bird Project of the Western Lake Ontario Shore. In this project he has been netting birds in the Manitou Beach area, weighing, determining age and sex, and then releasing them, hoping they will be caught again, and thus traced. He is a member of the Braddock Bay Raptor Research Organization, which has funded his Population Ecology Studies of the American Kestrel and Eastern Screech Owl. Here he has erected 43 nesting boxes suitable for kestrels and screech owls and is studying their population dispersal, wintering population, longevity, and predators (which have turned out to be squirrels, raccoons, and starlings).

It is because of his scientific investigations, and his enthusiasm and ability in teaching that the Rochester Academy of Science welcomes Kevin Griffith into Fellowship.

JEFFERY ROBERT DODGE
FELLOW
1990

Jeffery R. Dodge was born in Petaluma, California. He studied at the University of California at Santa Barbara and graduated in 1978 with a M. S. degree in philosophy. He and his wife, Joan, came to Rochester the year, and he began studies on a Ph. D. in philosophy at the University of Rochester. He presently is employed at Theatre Confections, Incorporated, where he is vice president, in charge of operations.

Jeff was interested in birds before he came to Rochester; and when he visited Braddock Bay and saw the ongoing counting of hawks at the Hawk Lookout, he immediately became an enthusiastic hawk watcher. He joined the Genesee Ornithological Society and the Rochester Academy of Science; and because his studies in graduate school permitted it, he and his wife spent many long days helping at the Hawk Lookout. They became so interested in hawk watching that they bought a house near Braddock Bay over which thousands of migrating raptors pass each spring on their eastward flight along the south shore of Lake Ontario. Jeff and Joan have two sons, Jeffery and John, who are now in grade school.

In 1986 Jeff took over the management of the Braddock Bay Hawk Watch which he renamed Braddock Bay Raptor Research. he has a hawk counter at the Braddock Bay Hawk Lookout where the daily count of hawks is continued for four months in spring and part-time in fall. Through Jeff's efforts, banding of hawks was incorporated in the total operation; and an owl banding project was undertaken in an effort to learn more about the migration of these birds along the lakeshore. In 1989 he established a hawk counting site at Sodus Bay in a specific attempt to determine where the thousands of migrating Turkey Vultures go after they pass through the Rochester area.

Jeff lectures frequently on diurnal and nocturnal raptor migration and banding to many diverse groups, including the Rochester Academy of Science's Fall Paper Session, the Genesee Ornithological Society's Birding School, public schools, and the Boy Scouts.

He is editor of the newsletter of the Hawk Migration Association of North America and has expanded it into a 108-page publication with a much-improved format, called "Hawk Migration Studies". It is distributed nation-wide.

For his contributions in the field of ornithology and in particular in the studies of diurnal and nocturnal raptors in western New York, we are pleased to make Jeffery R. Dodge a Fellow of the Rochester Academy of Science.

MARION E. SMITH
FELLOW
1991

One of the purposes of the Rochester Academy of Science as stated in our constitution is to disseminate scientific knowledge. Marion Smith has been doing just this from an early age. She was born in the village of Garland, Monroe County and moved to Lyndonville when she was seven years old. Here her family accumulated land and built the estate now called Robin Hill. She was active in helping the family plan the landscaping, plant their trees, flower gardens, and vegetables, and in physically gathering the stones to build the house. The family interests included keeping a list of the first day of each year that each species of bird was seen on or over their land. The lists sometimes totaled as many as 116 species in an year. She started the unusual hobby of raising, banding, and releasing monarch butterflies in 1973, and has released as many as 1,000 in one year. One was recovered in Florida. She is also an avid mycologist studying with Dr. Leo Tanghe.

She has accumulated an extensive, and frequently used reference library covering a large variety of nature subjects. Friends and neighbors soon discovered that she had the facilities, expertise and interest to answer their nature-related questions. Her reputation spread rapidly, and many members of the Academy have taken advantage of her hospitality, and gained from her knowledge. She greatly enjoys guiding groups through her arboretum, and around the pond and gardens of Robin Hill.

Marion Smith earned a bachelors and masters degree at Syracuse University, and has taught both high school and college English. She is a life member of both the Academy and the Ornithology Section, and a member of the Botany Section.

For her years of enthusiastic sharing of her home, grounds, and knowledge of the natural sciences we are honored to extend our Fellowship to Marion Smith.

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