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COMPUTER PLOTTING AND ANALYSIS OF EARTHWORM POPULATION DISTRIBUTION IN PRINCE EDWARD ISLAND

Glenwood A. Jordan¹, John W. Reynolds² and Andrew J. Burnett³

The University of New Brunswick, Fredericton, New Brunswick, Canada E3B 5A3.

Abstract

Computer produced three-dimensional displays of earthworm population distributions for 11 species in Prince Edward Island were presented and interpreted by the authors. The relationship between earthworm distribution and soil series was statistically tested. The usefulness of three-dimensional displays was discussed as a mapping technique for earthworm distribution.

Topométrie et analyse par ordinateur de la répartition de la population des lombrics sur l'Île-du-Prince-Édouard.

Résumé

Les représentations tridimensionnelles, produits par l'ordinateur, des répartitions des populations des lombrics de 11 espèces à l'Île-du-Prince-Édouard furent présentées et interprétées par les auteurs. Le rapport entre la répartition des lombrics et les séries de sol furent examinés du point de vue de la statistique. On a discuté de l'utilité des représentations tridimensionnelles comme une technique de cartographie pour la répartition des lombrics.

Komputerkartierung und Auswertung der Regenwurmverbreitung auf Prince Edward Island

Abstrakt

Der Bericht enthält dreidimensionale Komputerdarstellungen für die Verbreitung von Regenwurmpopulationen auf Prince Edward Island. Die Regenwürmer gehörten 11 Arten an. Der Zusammenhang zwischen Regenwurmverteilung und Bodenart (Soil Series) wurde statistisch geprüft und die Brauchbarkeit der dreidimensionalen Darstellungen als Kartierungsmethode für die Erdwurmverbreitung wird diskutiert.

Rekenaar uittekening en ontleding van die erdwurm bevolking verspreidene in Prince Edward Eiland

Skets

Drievlakkige studies van erdwurm bevolking verspreidings vir elf spesies, wat op'n rekenaar uitgewerk is, is deur die skrywers voorgelê en vertolk. Die verhouding tussen erdwurm bevolking en grond tipe was statistieklik beproef. Die waarde van die drievlakkige studies was ondersoek met die doel om erdwurm bespreiding in kaart te bring.

INTRODUCTION

This study was undertaken to examine the distribution of earthworms (Annelida, Clitellata, Oligochaeta, Lumbricidae) in the province of Prince Edward Island (June, 1974). Computer programs SYMAP (Daugenik and Sheehan, 1975) and SYMVU (Anon., 1971) were used to produce three-dimensional displays of collected field data. Reynolds (1975a) presented all of the detailed data utilized in this study. The data for the province of Prince Edward Island were selected because it is an island and SYMAP and SYMVU were selected for their flexibility.

Recently Thomson and Davies (1974) discussed three methods of interval-selection as mapping methods for studying soil factors and earthworm distribution. The authors are unaware of any previous attempts to utilize three-dimensional computer displays for examining earthworm populations.

METHODS

SYMAP is a FORTRAN program developed at Harvard University (Daugenik and Sheehan, 1975) for the production of maps, on a conventional line printer, representing a continuous surface calculated (interpreted) from observations made at discrete locations, i.e. contour maps. Interpolated points on the surface are assigned to one of several intervals into which the range of the data is divided. A unique symbolism is employed to represent each interval (ranging from grey to black shades by means of overprinting) for display on a line printer.

Input to SYMAP consists of a number of "packages", each of which supplies a particular type of information about the area, e.g. outline of the area, data point locations, observed data and desired output map features (e.g. size, scale, data intervals, etc.).

¹Department of Forest Resources, University of New Brunswick, Fredericton.

²Research Associate, Faculty of Forestry, University of New Brunswick, Fredericton, and Tall Timbers Research Station, Tallahassee, Florida 32303, USA.

³Department of Biology, University of New Brunswick, Fredericton. Present address: Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, B3H 4H7.

SYMAP can also store (magnetic tape or disc) the interpreted surface, in the form of a grid, for input to SYMVU, a FORTRAN program developed at Harvard University (Anon., 1971) for the production of three-dimensional perspective views of a surface employing a plotter. Once a surface is defined, i.e. by SYMAP, one can produce three-dimensional plots of varying size, orientation, tilt and vertical scale.

The hardware employed for the production of the figures illustrated in this study included an IBM System/370 and a GOULD 5100 Electrostatic plotter.

Figure 1 illustrates, in general, the steps involved in the production of the three-dimensional displays given in this study.

RESULTS AND DISCUSSION

The results of the analyses are seen in Figures 2-12. Figure 4 is scaled independently of the other figures. There are two columns on the scale of each Figure (2-12). The left column represents the height on the z-axis (originally in centimetres) and the right column is the corresponding number of earthworms.

The distribution of *Aporrectodea longa* (Ude, 1885) was limited to four collection sites in Queens County (Fig. 2). All four collections were in Orthic Podzol soils (= Typic Cryorthods). *Ap. longa* is an obligatorily amphimictic earthworm species (Reynolds, 1974) usually found in agricultural or human influenced soils (Reynolds *et al.*, 1974). The North American centre of dispersal appears to be in mainland Nova Scotia and southern New Brunswick (Reynolds, 1976a and 1976b).

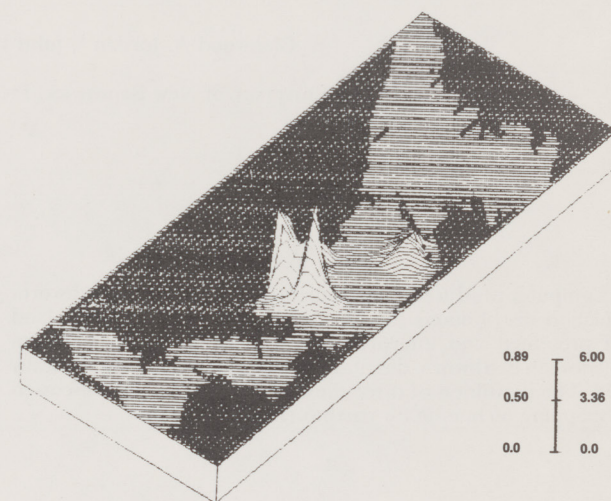


Figure 2. Three-dimensional computer plot of *Aporrectodea longa* distribution in Prince Edward Island during June 1974.

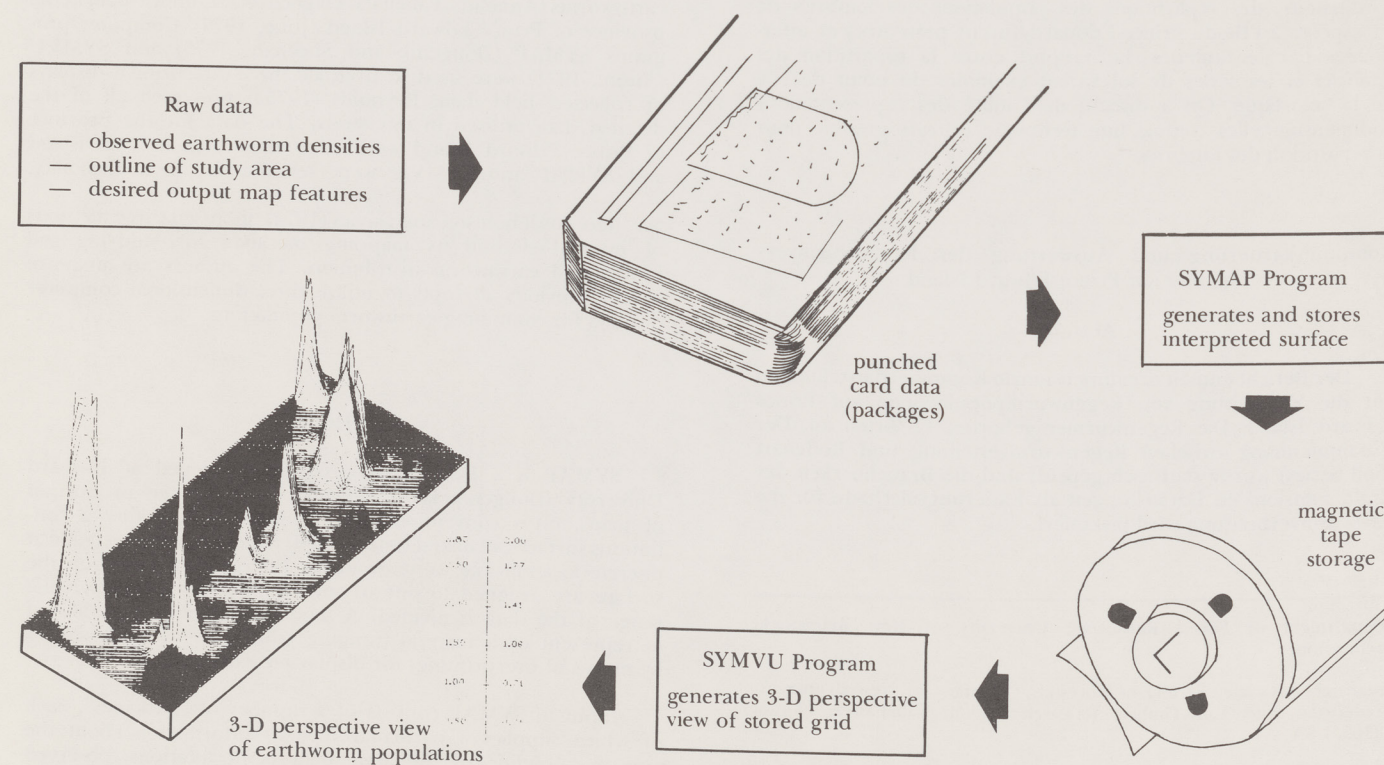


Figure 1. Schematic representation of three-dimensional display production for Prince Edward Island earthworm populations.

The distribution of *Aporrectodea trapezoides* (Dugès, 1828) was spread across the Province but in limited numbers, usually only one or two specimens per site (Fig. 3). All six collections were in Orthic Podzol soils. *Ap. trapezoides* is facultatively parthenogenetic, with male sterile morphs (Gates, 1972), and is found in a wide variety of both agricultural and sylvicultural habitats. The Prince Edward Island distribution is near the northern part of the range of this species in North America (Reynolds 1975d and 1976d).

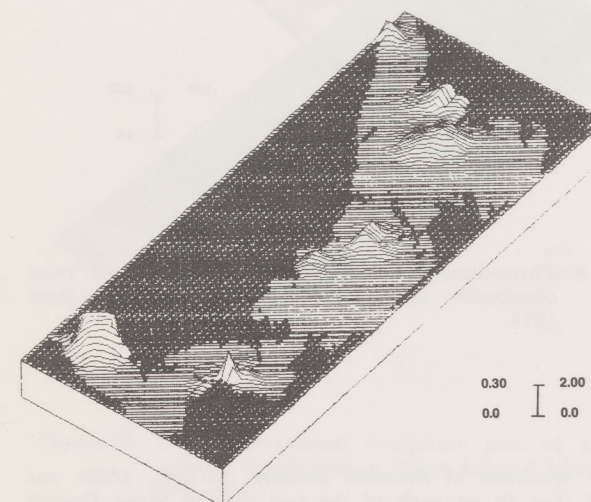


Figure 3. Three-dimensional computer plot of *Aporrectodea trapezoides* distribution in Prince Edward Island during June 1974.

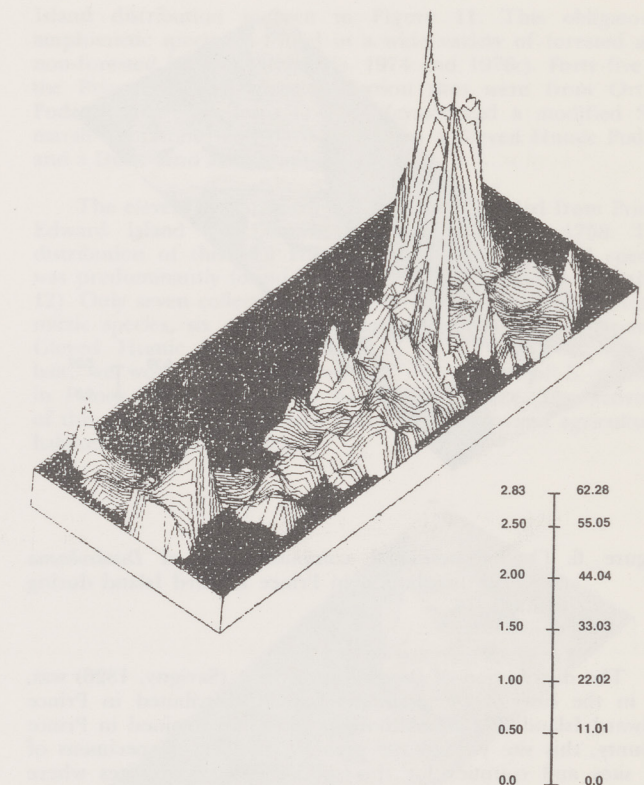


Figure 4. Three-dimensional computer plot of *Aporrectodea tuberculata* distribution in Prince Edward Island during June 1974.

According to Reynolds (1975a), the most abundant and dominant earthworm species in Canada is *Aporrectodea tuberculata* (Eisen, 1874). Its Prince Edward Island distribution is seen in Figure 4. *Ap. tuberculata* was found across the Province in 109 collections, of which 105 sites were on Orthic Podzols (= Typic Cryorthods), and one each on Gleyed Humic Podzols (= Aquic Cryohumods), Orthic Gleysols (= Typic Cryaquepts), Dune sand (Orthic Regosols — Orthic Quartzsammments) and Salt Marsh (Rego Gleysols = Hydraquents) associations. The latter two were in modified microhabitats within the generalized associations. *Ap. tuberculata* is an obligatorily amphimictic species (Gates, 1972), utilizing a wide variety of habitats (Reynolds *et al.*, 1974).

Aporrectodea turgida (Eisen, 1873), the second most abundant species present in this genus in Prince Edward Island (Reynolds, 1975a), is similar in reproduction and habitat requirements to that of *Ap. tuberculata*. The distribution of *Ap. turgida* in Prince Edward Island is illustrated in Figure 5. Twenty-one collections were obtained from Orthic Podzols and the other from an Orthic Gleysol.

Fifty per cent of the collections of *Dendrobaena octaedra* (Savigny, 1826) were obtained in Queens County (Fig. 6). One hundred per cent of the collections were on Orthic Podzols. *Db. octaedra* is a parthenogenetic species involving male sterile morphs (Gates, 1974a). This species utilizes a wide variety of habitats and is often associated with areas of high organic matter (Reynolds, 1975a).

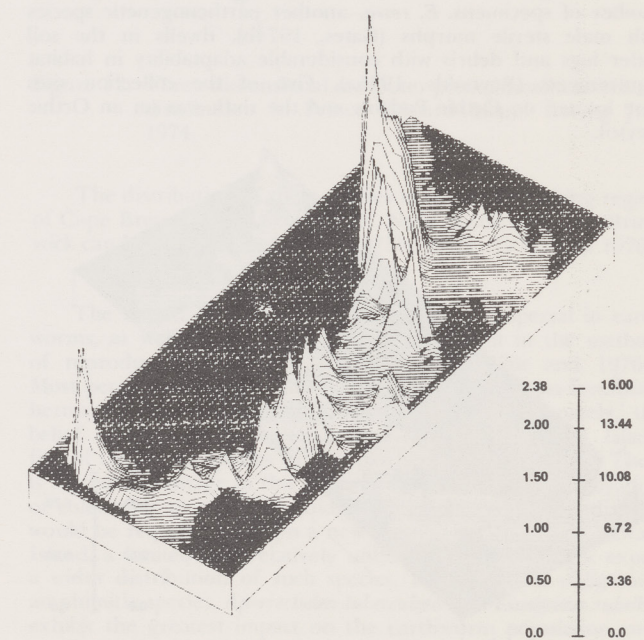


Figure 5. Three-dimensional computer plot of *Aporrectodea turgida* distribution in Prince Edward Island during June 1974.

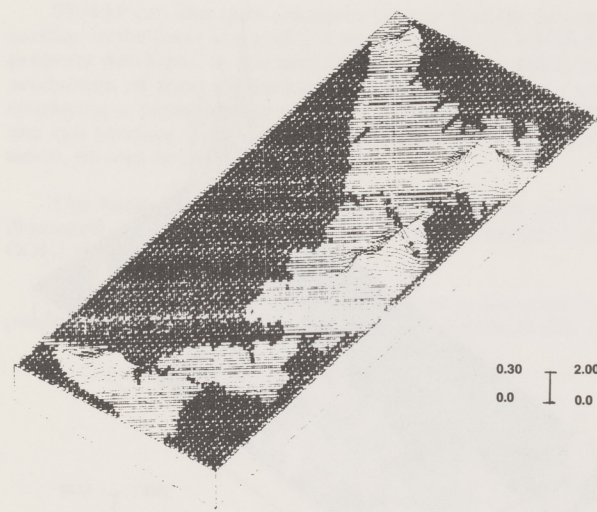


Figure 6. Three-dimensional computer plot of *Dendrobaena octaedra* distribution in Prince Edward Island during June 1974.

The distribution of *Dendrodrius rubidus* (Savigny, 1826) was, as in the case of *Db. octaedra*, sparsely distributed in Prince Edward Island (Fig. 7). Although only once obtained in Prince County, this site yielded the greatest number of specimens of all sites and counties for this species. All eleven sites where *Db. rubidus* was obtained were on Orthic Podzols. This parthenogenetic species (Reynolds, 1974) is generally found in decaying wood or under other organic debris.

From the six collections of *Eisenia rosea* (Savigny, 1826) a similar distributional pattern to *Db. rubidus* is observed (Fig. 8), i.e. the single Prince County collection yielded the greatest number of specimens. *E. rosea*, another parthenogenetic species with male sterile morphs (Gates, 1974b), dwells in the soil under logs and debris with considerable adaptability in habitat requirements (Reynolds, 1975a). Five of the collection sites were located on Orthic Podzols and the sixth was on an Orthic Gleysol.

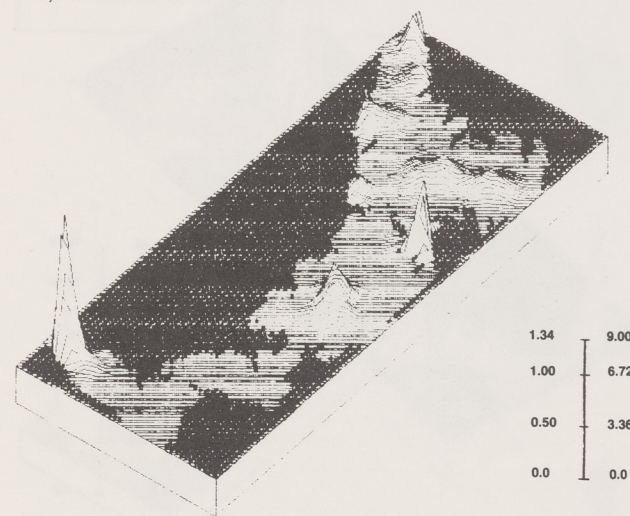


Figure 7. Three-dimensional computer plot of *Dendrodrius rubidus* distribution in Prince Edward Island during June 1974.



Figure 8. Three-dimensional computer plot of *Eisenia rosea* distribution in Prince Edward Island during June 1974.

One specimen of *Eiseniella tetraedra* (Savigny, 1826) was obtained (Fig. 9) on each of the two sites in Kings County and Prince County. Since *El. tetraedra* is a cosmopolitan parthenogenetic species (Reynolds, 1974 and 1975a), transported around the world by man, the less than optimum weather during the collection period was regarded as the probable reason for the limited number of collections and specimens. *El. tetraedra* is usually associated with damp or wet habitats and rarely in the soil except in wet soft muck of ditches or stream banks. One specimen was obtained in an Orthic Podzol and the other in an Orthic Gleysol.

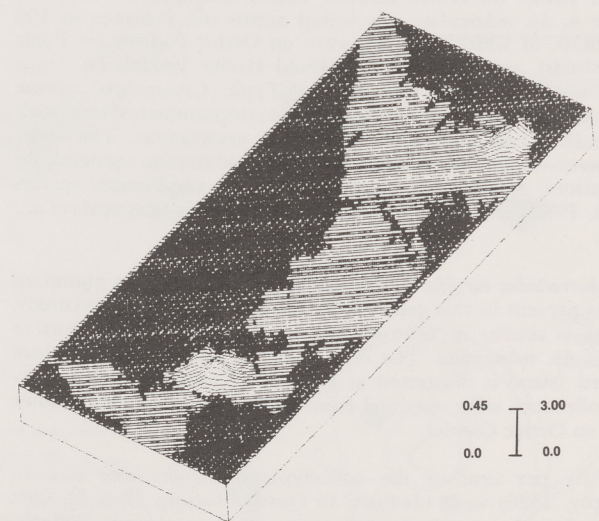


Figure 9. Three-dimensional computer plot of *Eiseniella tetraedra* distribution in Prince Edward Island during June 1974.

The distribution of *Lumbricus castaneus* (Savigny, 1826) was limited to twelve collections on Orthic Podzols (Fig. 10). *L. castaneus* is an obligatorily amphimictic species (Reynolds, 1974) usually found in the upper soil horizons or under debris of non forested soils. The abundance and distribution in North America of *L. castaneus* appears to be centred in the New England states and the Canadian maritime provinces (Reynolds 1975d and 1976d).

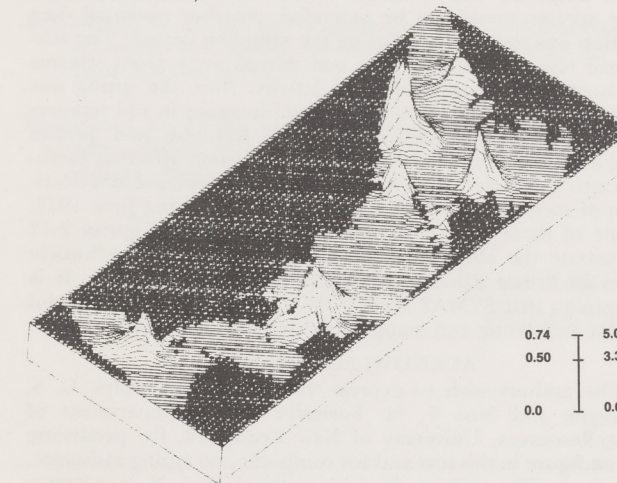


Figure 10. Three-dimensional computer plot of *Lumbricus castaneus* distribution in Prince Edward Island during June 1974.

The second most abundant and widespread earthworm species in northeastern North America, including Prince Edward Island, is *Lumbricus rubellus* Hoffmeister, 1843. Its Prince Edward

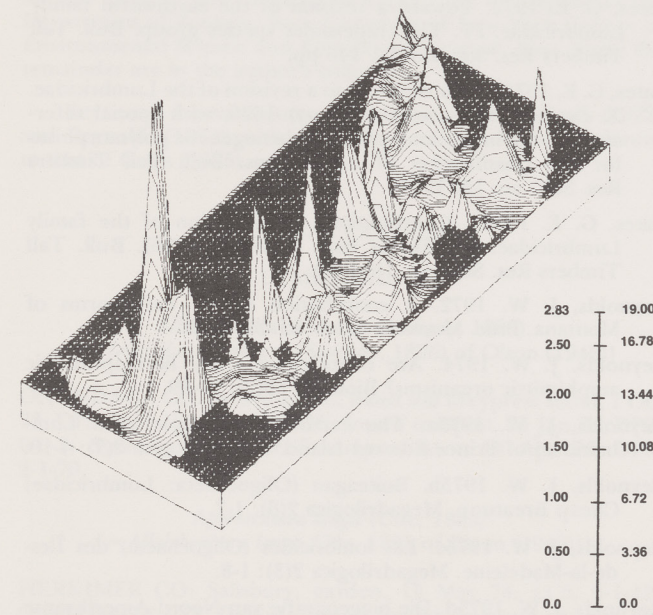


Figure 11. Three-dimensional computer plot of *Lumbricus rubellus* distribution in Prince Edward Island during June 1974.

Island distribution is seen in Figure 11. This obligatorily amphimictic species is found in a wide variety of forested and non-forested habitats (Reynolds, 1974 and 1976c). Forty-five of the Prince Edward Island collection sites were from Orthic Podzols, two each from Orthic Gleysols and a modified Salt marsh association, and once each from a Gleyed Humic Podzol and a Dune sand association.

The eleventh earthworm species to be recorded from Prince Edward Island was *Lumbricus terrestris* Linnaeus, 1758. The distribution of this well known and widely distributed species was predominantly found in eastern Prince Edward Island (Fig. 12). Only seven collection sites included this obligatorily amphimictic species, six were from Orthic Podzols and one from a Gleyed Humic Podzol. Because of its wide use as a fish-bait, we would have expected the distribution of *L. terrestris* in Prince Edward Island to have been greater. The activities of this species are highly tied to human activity and agricultural habitats (Reynolds, 1976c).

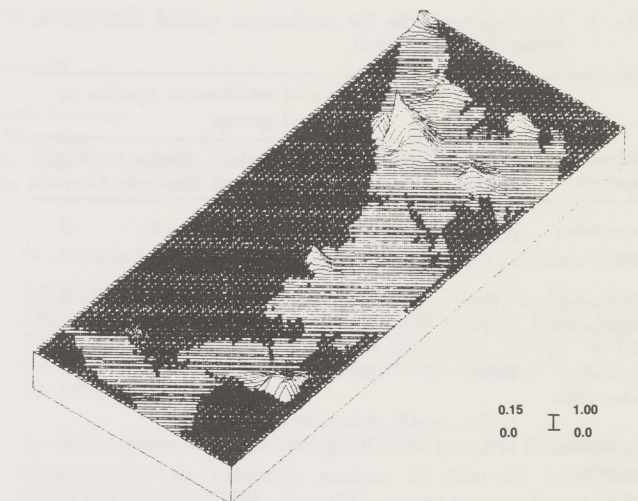


Figure 12. Three-dimensional computer plot of *Lumbricus terrestris* distribution in Prince Edward Island during June 1974.

The distribution of these species in the neighbouring regions of Cape Breton, Magdalen Islands, Nova Scotia and New Brunswick can be found in Reynolds (1975b, 1975c, 1976a and 1976b).

The impact on population structure and dispersal in earthworms, as well as other organisms, is inherent in the methods of reproduction (Reynolds, 1972, 1975d, 1976c and 1976d). Most people consider earthworms as biparental, cross-fertilizing, hermaphroditic organisms (Reynolds, 1974). Fortunately, this belief is receiving some challenge. In Prince Edward Island, five of the eleven species exhibit parthenogenetic morphs. There is a great advantage in this form of reproduction when invading or colonizing an area (Reynolds, 1972) since only one individual would be required to begin a new population. In Prince Edward Island, a limited and relatively uniform area, one might expect a wider distribution of such species. However, two obligatorily amphimictic species, *Aporrectodea tuberculata* and *Lumbricus rubellus*, exhibit the greatest impact on the earthworm population community structure in northeastern North America. It is possible for a single specimen of an obligatorily amphimictic species to begin a new colony if, after copulating, the individual with its spermathecae laden with sperm is transported to a new location. The amictic individuals have the advantage that their cocoons

can be readily transported and this can give rise to a colony, even if (theoretically) only one individual emerges from one cocoon. This would not be the case with the amphimictic species (Reynolds, 1972 and 1976a).

In order to statistically test the relationship between earthworm distribution and soil series we employed the Chi Square (X^2) analysis. Our null hypothesis was: H_0 =independence between earthworms and soils. The calculated X^2 was 42.504 with $df = 40$ (cf. Table 1) which is not significant at the .05 level, i.e. there is no reason to reject the hypothesis. It is our experience that there is a relationship between soils and earthworm distribution (Reynolds, 1976e, Reynolds and Jordan, 1975). This relationship probably does not show up in these data because of the limited diversity (at higher taxonomic levels) of the soils in the Province. According to Whiteside (1965), >83.5% of the soils in Prince Edward Island are classified as Orthic Podzols. This also helps to explain the large percentage of earthworms reported for Orthic Podzols in the Province.

Table. 1. Contingency table for earthworm species and soils in Prince Edward Island.

Earthworm species	Number of collections of earthworm species in each soil group				
	Orthic Podzols	Gleyed Humic Podzols	Orthic Gleysols	Orthic Regosols	Rego Gleysols
<i>Aporrectodea longa</i>	4	0	0	0	0
<i>Aporrectodea trapezoides</i>	6	0	0	0	0
<i>Aporrectodea tuberculata</i>	105	1	1	1	1
<i>Aporrectodea turgida</i>	20	0	1	0	0
<i>Dendrobaena octaedra</i>	8	0	0	0	0
<i>Dendrodrius rubidus</i>	11	0	0	0	0
<i>Eisenia rosea</i>	5	0	1	0	0
<i>Eiseniella tetraedra</i>	1	0	1	0	0
<i>Lumbricus castaneus</i>	12	0	0	0	0
<i>Lumbricus rubellus</i>	45	1	2	1	2
<i>Lumbricus terrestris</i>	6	1	0	0	0

$X^2 = 42.504$; $df = 40$.

The number of earthworms on the z-axis of Figures 2-12 are approximately equal to those obtained on one-to-two square metres. The objective of the initial study was only to determine the presence, abundance and distribution of megadriles in the province of Prince Edward Island (Reynolds, 1975a). Therefore, it would have been better if we had had true quantitative data for the application of the computer plotting technique. Nevertheless,

the plots are extremely useful to visualize and to study organismal population distribution. We have employed 134 collection sites across the Province which we believe is considerable for an area of this size. Although the sites sampled do include most of the Province, there are areas of Prince Edward Island where sites were not selected. In the initial study, additional sites were not selected because it was believed that no additional species would be added to the Provincial list and the ranges of the species would not be extended. Another potential data limitation was the weather during the sampling period. The surface soil was extremely dry as one moved away from streams etc., thereby reducing earthworm activity. Also, the spring was abnormally cold and the usual seasonal increase in soil temperatures was retarded. According to the Reynolds and Jordan (1975) model, these are two of the major factors affecting earthworm activity which may have depressed the abundance and distribution of megadriles in Prince Edward Island during June 1974. In spite of these potential limitations of our data, Figures 2-12 do illustrate the abundance and distribution of the earthworm species in Prince Edward Island during late June 1974. It is our opinion that SYMAP and SYMVU offer exciting and useful tools for examining and mapping earthworm distribution.

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REFERENCES

- Anon. 1971. SYMVU Manual. Laboratory for Computer Graphics and Spatial Analysis, Harvard University, Cambridge, 53 pp.
- Dougenik, J. A. and D. E. Sheehan. 1975. SYMAP User's Reference Manual. Laboratory for Computer Graphics and Spatial Analysis, Harvard University, Cambridge, 151 pp.
- Gates, G. E. 1972. Toward a revision of the earthworm family Lumbricidae. IV. The trapezoides species group. Bull. Tall Timbers Res. Stn., no. 12, 146 pp.
- Gates, G. E. 1974a. Contributions to a revision of the Lumbricidae. X. *Dendrobaena octaedra* (Savigny) 1826, with special references to the importance of its parthenogenetic polymorphism for the classification of earthworms. Bull. Tall Timbers Res. Stn., no. 15: 15-57.
- Gates, G. E. 1974b. Contributions to a revision of the family Lumbricidae. XI. *Eisenia rosea* (Savigny, 1826). Bull. Tall Timbers Res. Stn., no. 16: 9-30.
- Reynolds, J. W. 1972. A contribution to the earthworms of Montana. Proc. Montana Acad. Sci. 32: 6-13.
- Reynolds, J. W. 1974. Are oligochaetes really hermaphroditic amphimictic organisms? Biologist 56(2): 90-99.
- Reynolds, J. W. 1975a. The earthworms (Oligochaeta: Lumbricidae) of Prince Edward Island. Megadrilogica 2(7): 4-10.
- Reynolds, J. W. 1975b. Boiteagan (Oligochaeta: Lumbricidae) Cheap Breatunn. Megadrilogica 2(6): 1-7.
- Reynolds, J. W. 1975c. Les lombricidés (Oligochaeta) des Îles-de-la-Madeleine. Megadrilogica 2(3): 1-8.
- Reynolds, J. W. 1975d. Die biogeografie van Noord-Amerikaanse erdwurms ten noorde van Meksiko (Oligochaeta). I. Indikator 7(4): 11-20.
- Reynolds, J. W. 1976a. The distribution and ecology of the earthworms of Nova Scotia. Megadrilogica 2(8): 1-7.

Reynolds, J. W. 1976b. A preliminary checklist and distribution of the earthworms of New Brunswick. N. B. Nat. 7(2): (in press).

Reynolds, J. W. 1976c. Un aperçu des vers de terre dans les forêts nord-américaines, leurs activités et leurs répartition. Megadrilogica 2(9): 1-11.

Reynolds, J. W. 1976d. Die biogeografie van Noord-Amerikaanse erdwurms ten noorde van Meksiko (Oligochaeta). II. Indikator 8(1): (in press).

Reynolds, J. W. 1976e. The earthworms (Lumbricidae and Sparganophilidae) of Ontario. Life Sci. Misc. Publ., Roy. Ont. Mus. (in press).

Reynolds, J. W. and G. A. Jordan. 1975. A preliminary conceptual model of megadrile activity and abundance in the Haliburton Highlands. Megadrilogica 2(2): 1-9.

Reynolds, J. W., E. E. C. Clebsch and W. M. Reynolds. 1974. The earthworms of Tennessee (Oligochaeta). I. Lumbricidae. Bull. Tall Timbers Res. Stn., no. 17, viii + 133 pp.

Thomson, A. J. and D. M. Davies. 1974. Mapping methods for studying soil factors and earthworm distribution. Oikos 25(2): 199-203.

Whiteside, G. B. 1965. Soil survey of Prince Edward Island, 2nd edition. Can. Dept. Agric. and P.E.I. Dept. Agric. Queens Printer, Ottawa, Canada 70 pp. + 1 pl.

RECENT RECORDS OF EARTHWORMS (OLIGOCHAETA: LUMBRICIDAE) FROM CENTRAL NEW YORK STATE

Donald P. Schwert

Department of Earth Sciences
University of Waterloo
Waterloo, Ontario N2L 3G1
Canada

INTRODUCTION

Reports on the earthworm fauna of central New York State have been included in major surveys by Olson (1940), Eaton (1942), Stegeman (1960), and within various incidental records. Most of these studies, including Stegeman's (1960) survey, were based on material collected before World War II.

This note summarizes records obtained by the author and others in central New York State between 1972 and 1975. All collections were made by hand sorting. Those records listed below as "HV SGMA" and "HERKIMER CO." are on deposit in the Department of Zoology, State University of New York College of Environmental Science and Forestry in Syracuse, New York; the remainder are in the author's collection.

Keys used for earthworm identification include Gates (1972) and Reynolds (1974), with adjustments of generic nomenclature to that of Gates (1975).

MATERIAL EXAMINED

LUMBRICIDAE

Allolobophora chlorotica (Savigny, 1826)

[= *Helodrilus chloroticus* (Savigny, 1826) of Olson (1940)]

ONONDAGA CO. Syracuse, OC, moist soil in cypress stand, 1 Oct 73, DPS, 5-11-15; Syracuse, OC, frozen compost, 24 Jan 74, DPS, 0-0-3; Syracuse, SUNYCESF campus, lawn, 14 Apr 74, DPS, 2-1-70.

Aporrectodea longa (Ude, 1885)

[= *Allolobophora longa* Ude, 1885 of Eaton (1942)]

HERKIMER CO. Salisbury, garden, 15 May 74, LCS, 6-1-12. ONONDAGA CO. DeWitt, Jamesville Rd, compost, 8 Apr 74, DLD, 0-0-1; Syracuse, Columbus Ave. lawn, 14 Apr 74 DPS, 1-1-3. OSWEGO CO. HV SGMA, mature aspen stand, 6 Jan 74, DPS, 1-0-0. TOMPKINS CO. Etna, Lower Creek Rd, lawn, 18 Oct 75, RAW, 0-0-1.

Aporrectodea trapezoides (Dugès, 1828)

[= *Allolobophora caliginosa* (Savigny, 1826) (part) of Eaton (1942)]

HERKIMER CO. Salisbury, garden, 15 May 74, LCS, 0-0-7. ONONDAGA CO. Syracuse, SUNYCESF campus, lawn, 14 Apr 74, DPS, 0-0-1; Syracuse, Columbus Ave, lawn, 14 Apr 74, DPS, 0-0-1; Tully, Gatehouse Rd, cultivated and manured field, 6 Oct 73, DPS, 0-0-1.

Aporrectodea tuberculata (Eisen, 1874)

[= *Allolobophora caliginosa* (Savigny, 1826) (part) of Eaton (1942)]

HERKIMER CO. Salisbury, garden, 15 May 74, LCS, 2-0-3. JEFFERSON CO. THSF, Hwy 177, grassy area in heavy underbrush, 8 Aug 75, DPS, 1-0-0; LEWIS CO. 7 km se of Osceola, pasture, 7 May 74, CAB, 7-0-7. ONONDAGA CO. Tully, Preble Twp, SHMF, at edge of Pond #3, 4 May 74, DPS, 1-0-2; DeWitt, Jamesville Rd, compost, 8 Apr 74, DLD, 1-0-1; Syracuse, Columbus Ave, lawn, 14 Apr 74, DPS, 14-16-55. OSWEGO CO. Salmon River State Forest, roadside grass, 7 May 74, DPS, 0-0-1; Co Hwy 17, 2 km e of Greenboro, roadside grass, 7 May 74, DPS, 0-0-4; HV SGMA, mature aspen stand; 18-2-6, hickory stand: 7-0-0, 6 Jun 74, DPS; TOMPKINS CO. Etna, Lower Creek Rd, lawn, 18 Oct 75, RAW, 0-0-8; CH SGMA, well-drained upland pine forest: 3-0-1, maple woods: 10-0-8, old field: 1-0-3, 10 May 74, DPS.

Aporrectodea turgida (Eisen, 1873)

[= *Allolobophora caliginosa* (Savigny, 1826) (part) of Eaton (1942)]

HERKIMER CO. Salisbury, garden, 15 May 74, LCS, 3-2-18. ONONDAGA CO. Syracuse, OC, moist soil in cypress stand, various collections, DPS, 9-8-29-2; Syracuse, OC, under log, 15 May 74, DPS, 1-0-0; Syracuse, SUNYCESF campus, lawn, 14 Apr 74, DPS, 4-0-24; Syracuse, Columbus Ave, lawn, 14 Apr 74, DPS, 0-0-13; DeWitt, Jamesville Rd, compost, 8 Apr 74, DLD, 1-0-4. OSWEGO CO. Mad River near Greenboro, roadside grass, 7 May 74, DPS, 0-0-2.

Dendrobaena octaedra (Savigny, 1826)

JEFFERSON CO. THSF, Hwy 177, grassy area in heavy underbrush, 8 Aug 75, DPS, 0-0-1. ONONDAGA CO. Preble Twp, SHMF, litter in '1931 White Cedar Plantation', 4 May 74, DPS, 0-1-1. OSWEGO CO. HV SGMA, mature aspen stand: 8-9-9, hickory stand: 7-0-0, 6 Jun 74, DPS.

Dendrodrius rubidus (Savigny, 1826)

[= *Helodrilus subrubicundus* (Eisen, 1874) of Olson (1940); = *Dendrobaena subrubicunda* (Eisen, 1874) of Eaton (1942); = *Bimastos tenuis* (Eisen, 1874) of Stegeman (1960)]

ONONDAGA CO. Syracuse, OC, under log, 15 May 74, DPS, 0-0-1; Syracuse, Thornden Park, on playing field after rain, 29 Jan 74, DPS, 0-0-1; DeWitt, Jamesville Rd, compost, various collections, DLD, 2-0-3.

Eisenia foetida (Savigny, 1826)

ONONDAGA CO. Syracuse, OC, well-composted leaves, 15 May 74, DPS, 2-0-3.

Eisenia rosea (Savigny, 1826)

[= *Helodrilus roseus* (Savigny, 1826) of Olson (1940)]

HERKIMER CO. Salisbury, garden, 15 May 74, LCS, 0-1-6. LEWIS CO. 7 km se of Osceola, pasture, 7 May 74, CAB, 1-1-4. ONONDAGA CO. Syracuse, OC, moist soil in cypress stand, 1 Oct 73, DPS, 1-2-1; Syracuse, OC, under log, 15 May 74, DPS, 0-0-1; Preble Twp, SHMF, under log, 4 May 74, DPS, 0-0-1. OSWEGO CO. Co Hwy 17, 5 km w of Greenboro, in mixed deciduous woods, 7 May 74, DPS, 4-0-3; Mad River near Greenboro, roadside grass, 7 May 74, DPS, 0-0-1; HV SGMA, mature aspen stand: 2-0-1, hickory stand: 40-3-1, 6 Jun 74, DPS. TOMPKINS CO. Etna, Lower Creek Rd, lawn, 18 Oct 75, RAW, 0-0-2; CH SGMA, maple woods, 10 May 74, DPS, 0-0-5.

Eiseniella tetraedra (Savigny, 1826)

[= *Helodrilus tetraedrus* (Savigny, 1826) of Olson (1940)]

CORTLAND CO. Truxton Twp, Hwy 91, in stream above Tinkers Falls, 21 Apr 74, DPS, 0-1-0. ONONDAGA CO. Syracuse, OC, moist soil in cypress stand, 1 Oct 73, DPS, 5-0-0; DeWitt Twp, Mott Rd, stream sediments, 15 Mar 74, SA, 6-0-1.

Eisenoides lonnbergi (Michaelsen, 1894)

OSWEGO CO. HV SGMA, mature aspen stand, 6 Jun 74, DPS, 2-0-3.

Lumbricus castaneus (Savigny, 1826)

ONONDAGA CO. Syracuse, OC, under log, 15 May 74, DPS, 2-2-5; Syracuse, OC, frozen compost, 24 Jan 74, DPS, 3-0-9; Syracuse, Thornden Park, leaf litter, 3 Mar 74, DPS, 7-0-4; DeWitt, Jamesville Rd, compost, various collections, DLD, 0-1-2.

Lumbricus rubellus Hoffmeister, 1843

LEWIS CO. 1 km se of Osceola, sandy bank, 7 May 74, DPS, 0-0-1. ONONDAGA CO. Syracuse, OC, moist soil in cypress stand, 1 Oct 73, DPS, 2-0-0; Syracuse, OC, under log, 15 May 74, DPS, 1-0-5; Syracuse, OC, frozen compost, 24 Jan 74, DPS, 1-0-4; Tully, Gatehouse Rd, cultivated and manured field, 6 Oct 73, DPS, 0-1-1; DeWitt, Jamesville Rd, compost, various collections, DLD, 1-0-4. OSWEGO CO. Mad River near Greenboro, roadside grass, 7 May 74, DPS, 4-0-0; HV SGMA, mature aspen stand: 3-0-0, hickory stand: 3-0-0, 6 Jun 74, DPS.

Lumbricus terrestris Linnaeus, 1758

HERKIMER CO. Salisbury, garden, 15 May 74, LCS, 6-0-3. LEWIS CO. 7 km se of Osceola, pasture, 7 May 74, CAB, 3-0-2. ONONDAGA CO. Syracuse, OC, moist soil in cypress stand, 1 Oct 73, DPS, 2-0-0; Syracuse, OC, frozen compost, 24 Jan 74, DPS, 6-0-0; Syracuse, OC, lawn, 14 Nov 72, DPS, 4-0-0; Syracuse, SUNYCESF campus, lawn, 6 Oct 73, DPS, 2-0-0; Syracuse, Columbus Ave, lawn, 14 Apr 74, DPS, 12-1-1. OSWEGO CO. HV SGMA, mature aspen stand: 0-0-1, hickory stand: 6-0-0, 6 Jun 74, DPS. TOMPKINS CO. Etna, Lower Creek Rd, lawn, 18 Oct 75, RAW, 7-1-0; CH SGMA, old field, 10 May 74, DPS, 2-0-0.

Octolasion cyaneum (Savigny, 1826)

ONONDAGA CO. Syracuse, OC, lawn, 17 Oct 75, DPS, 10-2-6.

Octolasion tyrtaeum (Savigny, 1826)

[= *Octolasion lacteum* (Oerly, 1881) of Olson (1940), Eaton (1942), and Stegeman (1960)]

HERKIMER CO. Salisbury, garden, 15 May 74, LCS, 0-0-11. LEWIS CO. 7 km se of Osceola, pasture, 7 May 74, CAB, 1-1-4. ONONDAGA CO. Syracuse, SUNYCESF campus, lawn, 14 Apr 74, DPS, 0-0-1; Syracuse, Columbus Ave, lawn, 14 Apr 74, DPS, 0-0-1; Syracuse, SUNYCESF Experimental Station, white pine stand, 26 Jan 74, DPS, 0-1-0. OSWEGO CO. Co Hwy 17, 2 km e of Greenboro, roadside grass, 7 May 74, DPS, 0-0-1; HV SGMA, mature aspen stand, 6 Jun 74, DPS, 0-1-1. TOMPKINS CO. CH SGMA, maple stand, 10 May 74, DPS, 0-0-1.

Abbreviations

Co = county; Hwy = highway; Rd = road; Ave = avenue; Twp = township; km = kilometer(s); n = north; s = south; e = east; w = west; CH = Connecticut Hill; HV = Happy Valley; SGMA = state game management area; THSF = Tug Hill State Forest; OC = Oakwood Cemetery; SUNYCESF = State University of New York College of Environmental Science and Forestry; LCS = LeRoy C. Stegeman; CAB = Carolyn A. Burner; SA = Sandra Allen; RAW = Rhoda A. Walter; DLD = Daniel L. Dindal; DPS = Donald P. Schwert; x-x-x-x at the end of the site locations indicate the number of juveniles — acitellate adults — clitellate adults — postclitellate (if a fourth figure is used).

DISCUSSION

Sixteen species of Lumbricidae, including two new state records (*Octolasion cyaneum* and *Eisenoides lonnbergi*) were collected during this survey. With the exception of *E. lonnbergi*, all have been listed as exotic species by Gates (1970).

The collections of *E. lonnbergi* were made immediately below a state public fishing area. Human transport of this species to this site as a baitworm is probable. However, future records of *E. lonnbergi* in the southern portion of New York State are anticipated as this species is abundant in many areas of north-central Pennsylvania (Schwert, in preparation).

Bimastos gieseleri var. *hempeli* Smith, 1915 [= *Bimastos tumidus* (Eisen, 1874)] reported by Olson (1940) as "abundantly found" near the campus of Syracuse University, was never located by the author, although numerous attempts were made to sample likely habitats near the campus.

Several fruitless attempts were made by the author to collect limicolous earthworm species from ponds in the Sven Heiberg Memorial Forest (Tully Forest). Stegeman's (1960) specimens of *Haplotaxis gordioides* (Hartmann, 1821) (Oligochaeta: Haplotaxidae) from a pond in this forest are missing from his collection, and, therefore, his identifications could not be confirmed.

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REFERENCES

- Eaton, T. H. Jr. 1942. Earthworms of the northeastern United States: a key with distribution records. J. Washington Acad. Sci. 32:242-249.
- Gates, G. E. 1970. Miscellaneous Megadrilologica VII. Megadrilologica 1(2):1-14.
- Gates, G. E. 1972. Burmese earthworms — an introduction to the systematics and biology of megadrile oligochaetes with special references to southeast Asia. Trans. Amer. Philos. Soc., Philadelphia. 62(7):1-326.
- Gates, G. E. 1975. Contributions to a revision of the earthworm family Lumbricidae. XII. *Enterion mammale* Savigny, 1826 and its position in the family. Megadrilologica 2(1):1-5.
- Reynolds, J. W. 1974. Checklist, distribution, and key to the Lumbricidae in Tennessee. J. Tennessee Acad. Sci. 49(1): 16-20.