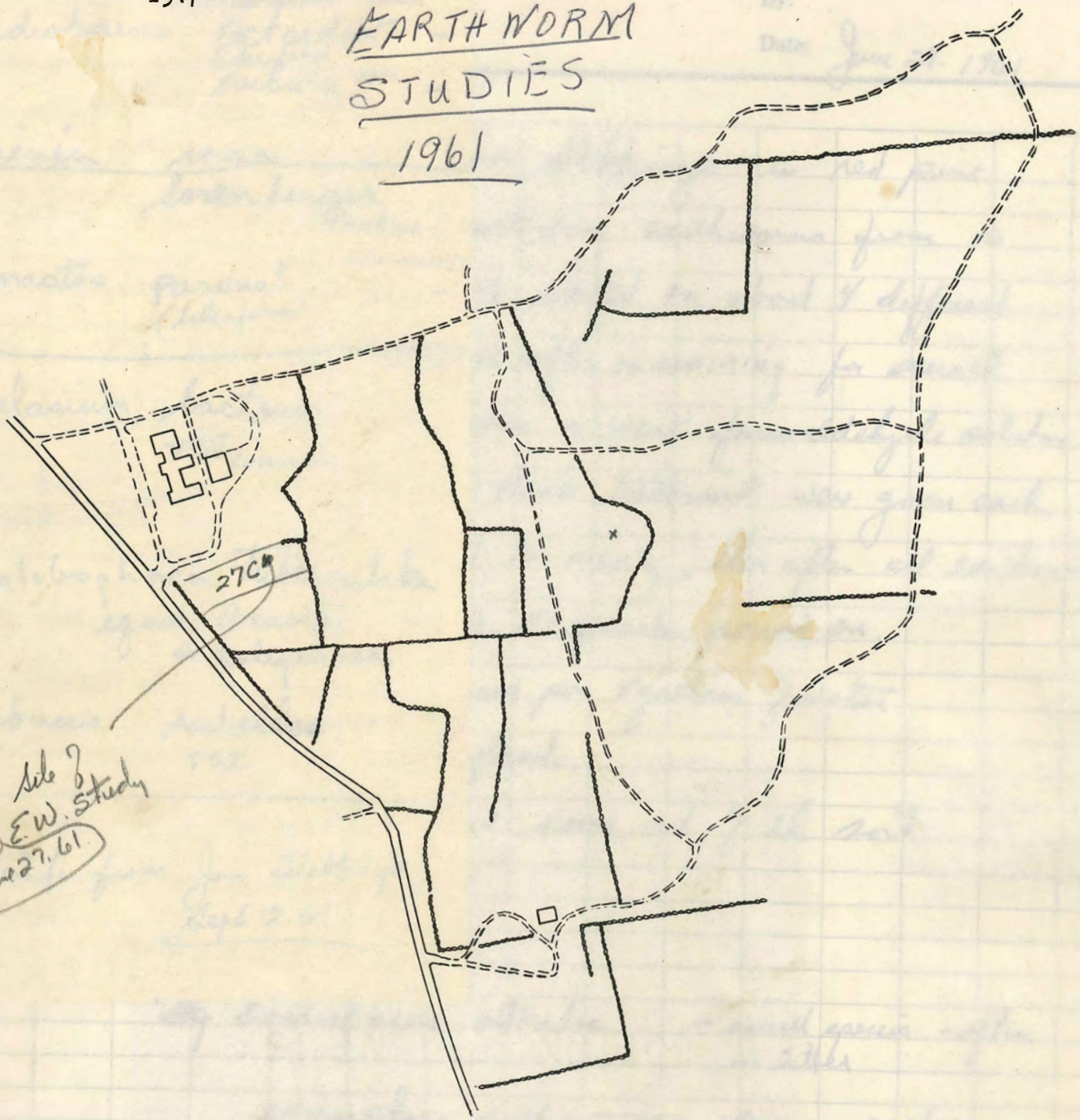
PROSPECT HILL I.
1947

EARTH WORM
STUDIES
1961



Site 3
E.W. Study
Steffgen
June 27, 61

E.W's of Harvard Forest.

Lumbricus terrestris —

castaneus rarer —

Dendrobaena octaedra —

litter form

rubida rare —

Eisenia rosea

native species

loenbergi native

Bimastos parvus? —
(litterforms)

Octolasium lacteum.
TSF common.

Allolobophora tuberculata
equiv. arnoldi.
& caliginosa

Lumbricus rubellus.
TSI

Info from Jim Stebbings
Sept 12. 61

HARVARD FOREST RECORDS

Stand: PHI -27 C. By:

Date: June 27. 1961

Earthworm studies.

In PM worked with Jim Stebbings in red pine plantation where he was collecting earthworms from 10 one meter square quadrats. We worked on about 4 different areas. The litter was removed after examining for small litter-inhabiting forms and then a weak formaldehyde solution was poured over the surface. Two treatments were given each plot. 10 quarts first poured on evenly, then after all earthworms had been collected the second 10 quarts poured on.

Approx. 125 cc formalin used per 5 gallons of water
- this a formula used in England.

The E.Ws are irritated and come out of the soil and crawl along the surface.

Kinds collected

Dendrobaena octaedra - small species - often in litter

Allobarphora calliginosa - Common earthworm

Lumbricus terrestris - Night Crawler.

" castaneus - smaller species

Eisenia rosea.

First two are most common. 2-4 Lumbricus terrestris per plot.

Earthworms were collected in bottles containing solution of 8 gms of NaCl per liter of water

HARVARD FOREST RECORDS

Stand:

By:

Date: June 27. 1961

27C
Plantation

Rather extensive
blown down in
an ice storm
Spring of 1977

Salvaged in Winter
1977-78

The meter-square
area. Forest
floor raked
away from edges
to outline it

HARVARD FOREST RECORDS

Stand:

By:

Date:

Stebbins + S Lyford adding formaldehyd solution to drive out E. W.

Dendrobaena octadra

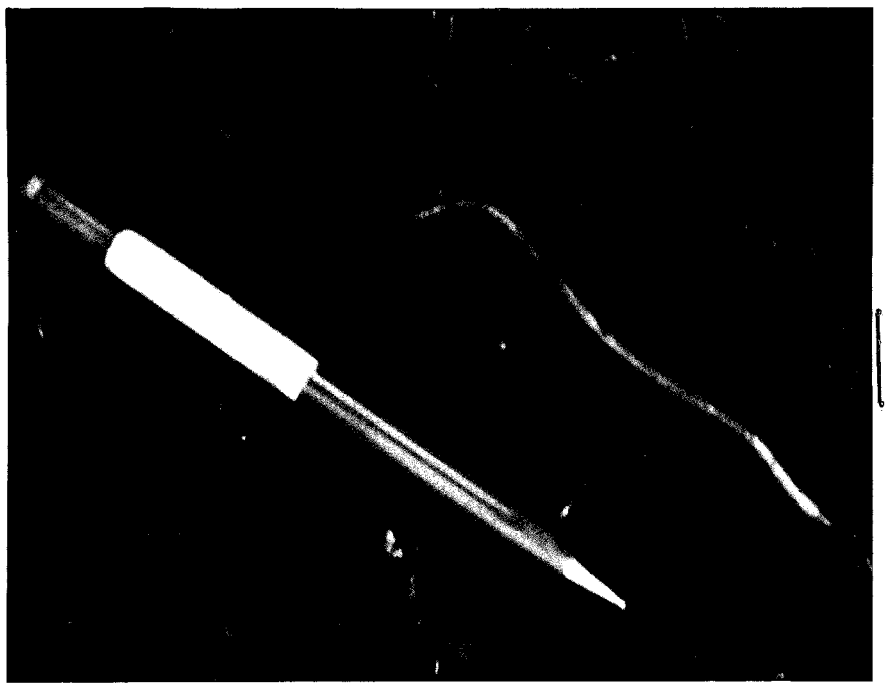
HARVARD FOREST RECORDS

Stand:

By: 27C

Date: June 2761

Earthworm driven out by formaldehyde treatment



10 April 1978
HNL.

Dug a pit in 27C Plantation on June 28, 1961 and made a few observations on character of Earthworm Casts & of soil

This pit, dug only to 20-24", was about 2 x 6' in size & about opposite where road turns sharply toward the back of the HF headquarters building & perhaps 50 feet into the plantation

%

PHI - 27 C

Earthworm Site. - 28 June 1961 p.t

	% whole soil basis	% < 2mm basis								
		Sand					Silt	Clay < .002	Silt + clay
	≥ 2mm	2-1 V.CS	1-0.5 CS	0.5-0.25 MS	.25-.10 FS	.10-.05 V.FS	.05-.002		
A, 0-½	0	.5	3.7	13.6	19.4	13.1	36.0	13.7	49.7 / 52.1
A, at 1½	0	1.0	5.2	12.4	19.1	10.8	37.6	14.5	43.9
Ap 1½-7	~~15.8~~	1.6	7.9	14.7	20.2	11.7	32.4	11.5	42.9
B_{21} 7-16	10.6	2.6	9.3	14.4	18.6	10.3	~~43.9~~ 33.2	~~16.0~~ 9.7	34.0
B_{22} at 20"	32.0	4.0	11.0	17.5	21.5	12.0	26.4	7.6	

↑ Bouyoucos Method

mostly EW casts

The values given for the A, 0-½" and A, at 1½" are essentially particle size distribution in earthworm casts.

July 18. 1961

Prospect Hill III

Walked over area with Jim Stebbings to see if earth worms existed in red pine stands

We found the litter worm Dendrobaena Octaedra almost universal. In many places the ~~to~~ casts of the worm were mixed intimately into the lower ½ inch of litter. In a few places we found Allobophora Caliginosus. - this is the common earthworm. When it is present the cast in the upper ~~portion of~~ 2 or 3 inches of the mineral soil are usually obvious.

We did not see Lumbricus Terrestris

We also visited the large red pine plantation in PH IV with the same results.

Vim Stebbings —

The Implications of Earthworm Distribution in Conifer Plantations

There exists only one published paper dealing primarily with earthworm populations under conifers in this country. This paper (Stegeman 1960) gives the species composition and population data (based on digging and sieving the top 6" of soil) for the following habitats: old field, northern hardwood, Red Pine, Scotch Pine (less than 3' in height), White Pine and Norway Spruce. Ages and previous uses of these stands were not given. Populations, and, in general, number of species, fall in that order, with no worms found under spruce, about 80,000/A under white pine, and twice that under the old field. No map showing the relative position of these locations was presented.

The implication of the methods used and the data reported is that the current vegetation is the factor governing kind and numbers of the population. Ph, organic matter, and soil particle size were reported, but it was not suggested that they accounted for the observed population difference. It was suggested that the amount, and especially the diversity, of humus materials, and the soil moisture, were of greatest importance. Stegeman states "The distribution of earthworms in such a stand (pure conifer) roughly correlates with the amount and diversity of herbaceous ground cover."

Another relevant paper (Read and Walker 1950) deals with soil properties beneath eastern redcedar and red pine in two pine plantations. Differance in physical and chemical properties appeared correlated with differances in earthworm activity in the two plantations. In one, age 35 years, earthworms were found only under the sparsely scattered redcedar. In the plantation of 25 years age, with more abundant redcedar, they were found throughout the area. (The earthworms were not identified.) It was suggested that over a period of years soil conditions became unfavorable for earthworms and lead to their elimination.

March 13, 1978. This report is in the James Stebbins personal file and I can say it accidentally showing never seen it before. D.W. Lofty.

The only previous mention of earthworms of the Harvard Forest was in a paper by Griffith, Hartwell, and Shaw (1936). In this study 62 pine plots and an equal number of hardwood plots were studied. Earthworms were found in only one white pine stand, of twenty years age and previously well cultivated. Earthworms were noted in digging many (not all) of the hardwood profiles and "were always associated with soils having good tilth." Noted Ph values ran from 3.8 - 5.4.

Methods

Collecting was carried out on 53 plantations of the Tom Swamp and Prospect Hill tracts of the Harvard Forest. Collecting was done by digging. The large area to be covered, rocky and irregular terrain in places, and the highly aggregated nature of earthworm populations precluded random sampling by quadrats. Therefore no formal pattern of sampling was observed, but an attempt was made to cover the area with reasonable thoroughness. Transects, crossing or parellel were often used. The data is given for the plantation (or the portion sampled) as a unit; in only three cases are intra-plantation differences noted. The data is mapped according to the plantation outlines presented on the base maps, which are not always up to date, as not all portions of a plantation may have been successful. As a result data mapped for less than an entire plantation, especially the larger ones, may not be relevant. This limitation, however, is not sufficient to obscure the interpretation.

The map categories are as follows: neither Lumbricus terrestris nor the true soil forms (Allolobophora tuberculata, Eisenia rosea, Octolasium lacteum) found, and no recognizable earthworm casts to be found in the soil; true soil forms present, but in isolated pockets, or in small numbers, such that the entire upper 15 cm of the soil is not so mixed and aggregated as to be homogenous and morphologically

identifiable in large part as cast material; and areas where true soil forms are sufficiently numerous to create an homogenous A horizon of cast material. Details of the associated humus forms will be found in another portion of this paper. Included in the first group are three areas where partially decomposed earthworm cocoons were found with occasional loose pockets of soil with a structure which might be considered as a decomposed crumb mull.

With the maps of earthworm occurence are presented maps from the Harvard Forest files showing cultivation history, stand composition in 1908 and 1919, cover at time of planting, and ultimate forest type, as indicative of moisture relationship. Soil types were not mapped as the U.S.D.A. Soil Survey types have not been found to correlate with forest communities (Stout 1952).

Results

The results of the survey of the Prospect Hill Tract may be seen on the map. There is no need for a verbal resumé. In Tom Swamp Compartments VIII and IX, no earthworms (soil forms) were to be found in plantations 27-E, G, H, & I, or 28-G. Some were found spottily distributed through 23-B (white pine). In the south portion of the Tom Swamp tract, plantations 19-C, 26-A, B, G, M, ~~xxxxxx~~ 30-A, and the whole of Compartment I were checked. In 30-A (mostly red pine) introduced lumbricids were scattered, and in 22-C and 25-A L. terrestris of the exotics alone was found. The native lumbricid Eisenia lonnbergei was scattered sparsely, ~~xxx~~ ~~xxxxxxx~~, through 19-C, 26-G, 22-C, and 25-A. L. terrestris, O. lacteum, and A. tuberculata were found throughout the hardwood area of Compartment I.

Discussion

There are several implications of the distribution pattern shown, but first the validity of the observations relating to the earthworm distribution must be discussed. It is assumed that in the 200 years since the settlement of the area

that earthworms have had adequate access to the entire area. This is borne out by the constant presence of Dendrobaena octaedra throughout the area. It will not be maintained that absolutely no soil forms exist in any plantation, only their comparative rarity will be maintained. Since populations may maintain themselves in very small areas (Read and Walker 1950), the possibility of an isolated population occuring is real. This is particularly true of L. terrestris, which seems to wander at times, and may live as a litter form without showing a midden. Observations in red pine plantations 22-C and 25-A, near abundant L. terrestris under hardwood, indicate that where hardwood litter is present, from a hardwood understory, or near the edges, middens, though rare, will be observed. In plantations where hardwood litter is essentially absent (27-C, 24-B) middens will not be observed. This implies that, if it were present, it would be noted near the borders of plantations where hardwood litter was present, or throughout if a hardwood understory were present. Under pure conifer litter casting still takes place on the surface, but in rather diffuse piles; thus a very low population could have escaped scrutiny. The best evidence for the accuracy of the survey is the consistent pattern shown by associated plantations.

The implications of this pattern are several, and will be discussed separately.

1. The effect of the current forest type is exerted over a period of years or decades, rather than immediately. Whether this corresponds to the rate of changeover of the litter type is not known with certainty: this may lag, but the litter over the highest populations is purely coniferous. A slow changeover of the very slowly decomposable decomposition products is indicated.

Allolobophora tuberculata has maintained itself in large numbers under Red Pine for 35 years, and, in much smaller numbers, for 45 years under spruce. Spruce and larch (whose litter has a very high C:N ratio) have no obvious effects on populations when mixed with red pine.

2. Earthworm populations, where they exist, do not show sharp boundaries coexistent with vegetation type or past land use. Thus they are yet to be found under the highly unfavorable spruce (even L. terrestris is present under spruce as far as hardwood litter blows in), and on lands only grazed in a dominantly cultivated area (part of 37-A, and a white pine - hardwood tract between 14-F and 27-C).

This same phenomenon is shown in TS I where L. terrestris and the soil forms are present over the entire area, which includes old plowed fields, pasture land, pastured woodland, and a bouldery woodlot. L. terrestris is also found, though sparsely, on the nearby plantations 22-C and 25-A where soil forms are quite rare or non-existent.

3. Present significant earthworm populations correlate rather well with past intensity of land use in general, but not in particular. The maps of the Prospect Hill tract show no historical factors unique for the tracts with an earthworm population currently present, but the number of stone walls remaining is an indication of the relative intensity of past use. It may also be significant that most of these plantations were mown yearly (all those with crumb-mull formations) until planting. First successional vegetation which is noted to have been established to some, if not to a great, extent in certain plantations of V and VIII may conceivably be quite unfavorable to earthworms through formation of a dense rhizogenous endo-humus and by their acidifying and mor-forming tendencies. Potential mor-forming litter appears to be generally less acceptable to earthworms (Handley 1954). Mor-forming tendencies, in the form of notable gelatin-precipitating ability, have been noted for Vaccinium and Viburnum spp. (Handley 1954).

It should also be noted here that the Tom Swamp I Compartment is also the most heavily and the earliest utilized area in the Tom Swamp tract (Raup and Carlson 1941).

4. It seems probable then that earthworms are being gradually eliminated from these plantations. Evidence of this is a small relict earthworm population on a grassy knoll by an old road in 31-A, and by the finding of decomposed cocoons in 31-A, ~~&~~ 26-G (2), and 26-P. Age is impossible to estimate. They are not of L. terrestris and almost certainly not Eisenia lonnbergei. O. lacteum and E. rosea cocoons were not available for comparison, but the size, shape, and openings (on 2) almost certainly identified them as A. tuberculata.

No extensive surveys have been made in other than the TS I Compartment for earthworms under hardwoods, but some observations relevant to the problem of the maintenance of exotic forms may be related.

It has already been noted that if L. terrestris was present in the vicinity of a plantation, middens would be noticeable whereever hardwood litter of the ~~proper~~ proper type was present. That is, around the edges, and throughout if a hardwood understory is present. On this basis L. terrestris seems generally to be absent. High populations of the soil forms would be expected to spread in detectable numbers. It is doubtful that any areas with a high population of L. terrestris would lack a considerable population of true soil forms (if for no other reason than that the middens seem to be an excellant environment for these forms), and the converse also seems unlikely, although no definite evidence can be adduced for this opinion.

The impression gotten by this writer, from scattered observations of hardwood and natural white pine - hardwood stands near plantations is that conditions correspond to those under the plantations, if the drainage class is the same. If this is not so, they may even be absent from hardwood while present under an adjoining plantation, as under 30-A and the west shore of the Harvard Pond. The hardwood observations, it must be noted, depend to an even greater extent on the nature of the soil humus forms than does the plantation survey.

Observation of the hemlock-whte pine uplands in Tom Swamp IX have established with some certainty that earthworms are absent. Likewise an old growth area of hemlock-northern hardwood forest in Slab City X appeared to lack earthworms and the soil was of a type associated with their absence. Under swale or swamp hardwoods, earthworms are unlikely to be present in number for reasons discussed ~~under~~ in the section on environmental factors.

Still, no statement that exotic earthworms are incapable of colonizing or are being eliminated from hardwood stands is possible. It has been noted previously that earthworms are present throughout the transition hardwood forest of Tom Swamp I, and they are also abundant in the transition hardwood forest of the Schwarz Tract.

This is partial explanation for the data of Griffith, Hartwell and Shaw (1930), since they state that most ~~of~~ of the hardwood stands were found under moist conditions on southeast, south, and western exposures (which would trend to transition or central hardwood type). Also, maps from which they worked indicate that a large portion of the hardwood plots were located in Prospect Hill I and IX, in Tom Swamp I, and in the Schwarz Tract, which are t e areas in which earthworms would be expected.

Earth Worms

July 19. 1962

Kingston. Sch. pm.

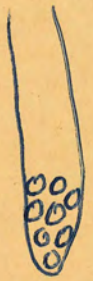
Gravel pit N Side of Rock Runner road.

Under an 18-20" dia Hickory tree.

Much residence of E.W. Tunnels filled with silt loam or loam material.

Pebbles in bottom some E.W tunnels. These are the ones too large for E.W to ingest and have been seen in many soils.

Photos taken of several of these.



One rolled up ~~E.W.~~ punk E.W found in place and photographed.

Earthworms

Arthur Young

Travels during the years 1787, 88 & 90
in the Kingdom of France. (1792)

P352.

"Considering how well adapted the soil and climate are to sheep much the greater part of all the three provinces (Bretagne, Anjou, Maine), ought to be in some such course as this; 1. turnips; 2, barley; 3, clover; 4 wheat. Also, 1. turnips. 2. Barley, or oats; 3, artificial grasses, for three years; 4 wheat; 5. Winter tares, peas, beans or buckwheat; 6. Wheat; with no other variation than taking the Winter tares, peas ~~&c~~ and beans immediately on the lay, if the ground abounded in with the red worm and wheat following."

Earthworms

Occurrence

(1) Particularly prevalent in Brown Forest Soils on Kewannee Penns. Northern Michigan, according to Latimer who made a trip there.

(2) de Sigmond states they gradually die out in degraded chernozems, being prevalent in Chernozems

(3) Weaver. Root Development of Field Crops (+ Vegetable Crops) notes their importance in soils at Lincoln. Nebraska.

(4) Nygard states they are particularly numerous in some soils near Bozeman. Montana being present in injurious quantities.

(5) Coster, Forest Service Kokragluz field supervisor, that they could be too numerous in some instances

(6) Earthworms noted in many places on Kok sagluz study

Mineral soil Klamath Falls, Oregon, Oreg Exp Sta plots.
Umoir. Oregon.
Missoula. Mont.
Only one E. W seen in Bearden soils edge of Bill Kerns feet. some seen in gardens at Fargo on Fargo clay

(over)

(7) Kirkpatrick - Forest Service Supervisor of Pleasant Minnesota says E.W were numerous on Webster Clarion when it was first plowed.

(8) On Stapp Field near Aitkin, Minn. small earthworms with pink at both extremities were noted in acid peat $4.0-4.5$ in all horizons, tho they worked best in slightly less acid burned horizons. Feces noted of no E.W. seen on Gleason field at Aitkin.

(9) St Paul. Univ. Farm. E.W fairly numerous in Kolk plots & also on lawns.

(10) Numerous on Miami soil at U. of Wis Exp Sta Farm. Kolk. plot

(11) Prairie Farm Clyde clay loam Saginaw mucky phase numerous.

(12) Eisenhower Farm, In (x) Wauseon & Brookston areas at time of observation compressing the damp - nearly wet soil with the foot caused many E.W to come to surface.

(13) Muck plots. U of Mich. Kolk plots 1 mile N of town, large E.W. numerous

(14) Hillsdale C.F.S. " " " " 1 " 5 " " E.W. "

(15) Pease field W. Geneva N.Y. E.W. not numerous

(16) Ontario F.S.I. BPI plots quite numerous.

(17) Unadilla F.S.I. E.W. channels seen.