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An Ecological Study on Earthworm (*Pheretema* sp.) in Different Environments of Nam Pong Soil Series (Ustoxic Quartzipsamment), Northeast Thailand

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Abstract: A field survey was carried out on farmer land areas in Northeast Thailand where earthworms have been inhabited. Methodology being used was a grid method of 10 × 10 m plots in four different inhabitancies, i.e. native dipterocarp forest, tamarind orchard, natural grazing areas and sugarcane plantation. The results showed that earthworm inhabitants were largely found in soils with organic matter contents (OM%) ranging from 0.40-0.89% and soil pH values of the studied sites ranging from 4.68-6.29 whilst electrical conductivity (EC) values of soil locations were ranging from 52.9-94.0 μMho/cm. There were no clear trends on earthworm (*Pheretema* sp.) distribution have been recorded yet it seems more likely that organic matter, soil moisture contents, soil disturbances and seasonal changes had its effects on earthworm distribution. Variation in soil characteristics had no effect on earthworm distribution in Northeast Thailand and it was not considered as a limiting factor to proliferation of the earthworms.

Keywords: Earthworm, *Pheretema*, soil ecology

Introduction

Northeast Thailand, a region of diversity in agricultural activities has its main income from agricultural productivity, and it consisted of about one-third of the country both population and land areas (KKU and FORD, 1982). Nevertheless, income of farmer families has been relatively low due to poor crop yields as a result of erratic rainfalls and poor sandy soils. In addition, agricultural production in the region seems to decline with time due to agricultural resource degradation (Polthanee, 1986; Craig and Pisone, 1988). Therefore, in order to achieve better crop production, some soil fertility improvement programmes must be applied, e.g. the application of soil organic materials, chemical fertilisers and land conservation must be practiced. One of the many alternative improvements to be carried out on soil fertility could possibly be the use of soil biological living creatures such as earthworms and others. The introduction of living creatures to soils may have some significant values in improving soil conditions, for instance it may be assisting in improving or reconstructing both physical and chemical fertility of the poor sandy soils. The use of soil macro-animals, such as earthworm (*Pheretema*) species could possibly create both macro-pore spaces, and mediate massive displacement of surface soil where plant roots thrive on. The circumstances as such could presumably improve water drainage, aeration, and soil fertility along soil pore spaces (Marinisen and Miedema, 1994). Feeding and grazing activities could possibly accelerate organic matter decomposition and soil aggregate bindings. An estimation of soil casts created by *Pheretema* species in northeastern soils was reported to reach the values ranging from 132.6-224.9 ton ha^{-1} (Watanabe and Ruaysoongnern, 1984). The massive amount of cast production could presumably be beneficial to agricultural production in poor soils in the region due to their advantages in facilitating fertility and aeration over normal soils (Werner and Cuevas, 1996). It may be observable that land areas with high frequency in growing some agronomic crops such as maize, soybeans, groundnuts and etc. the productivity could be gradually declined with time probably due to the depletion of soil nutrients and poor soil management. For example, high frequency in ploughing by deep tillage causes high soil erosion rate, high rates of pesticides and herbicides applications resulted in high amount of soil pollutants, and other soil disturbances may have caused soil deterioration. The management and practices as such could presumably have caused a severely effect on species and number of earthworms available in soils (Zhang *et al*., 1996). Therefore, in order to gain more benefits from earthworms with respect to agricultural productivity, factors affecting earthworm distribution may be of tangible value and they must be sought out and elucidated. The data attained could possibly be useful in maintaining earthworm natural population for further beneficial purposes in all productive land areas in Northeast Thailand. The objectives of this work were to identify soil properties suitable for earthworm inhabitancy particularly soil pH, electrical conductivity (EC) and organic matter percentage (% OM) under Nampong soil series (subgroup: Ustoxic Quartzipsamment) in the ecosystems of natural dipterocarpous forest, tamarind orchard farm, grazing pasture land area, and sugarcane plantation.

Materials and Methods

A preliminary survey was carried out to identify earthworm (*Pheretema*) density with respect to their general ecological inhabitancy and patterns of distribution. Some common distributions of the earthworms of 4 ecological sites of Nampong soil series (subgroup: Ustoxic Quartzipsamment) were identified and used as principal guidelines for sampling of data collection and analysis. The four ecological sites were native dipterocarp forest, tamarind orchard, grazing land area, and sugarcane plantation. The chosen sites were located in an area adjoining Khon Kaen and Udonthani Provinces along the main road number 2. Sampling plot areas for detail sampling sites were 10 × 10 m, using grid layout of 100 samples per site. Data collection for each sampling plot includes number of monthly newly built casts, each newly built cast was used as indicator for number of individual worms per m^2, collected soil and cast samples were used for soil chemical analysis. Soil analysis includes pH, electrical conductivity (EC) and organic matter percentage (%OM). Collected soil samples were analysed for soil pH (1:2.5 soil:water), EC (1:5, soil:water) and % OM by the method of Westerman (1990). The collected data were used to compare with the standard soil analysis data of the Department of Land Development (1976), Ministry of Agriculture and Cooperatives, Thailand.

Results

Number of newly established castsNumber of newly established casts With number of newly established casts within the experimental plot areas, the results showed that, in general, the average number of newly established casts was highest with natural grazing areas with the value of 11 ± 4.5 casts/m^2. Whilst dipterocarp forest had 7 ± 3.6 casts/m.^{2} followed by sugarcane plantation and tamarind orchard of 5 ± 4.9 and 4 ± 3.0 casts, respectively (Table 1). The distribution of worm casts was evenly distributed in dipterocarp forest and grazing land areas than that of sugarcane plantation and tamarind orchard farm.

Soil Organic Matter: With soil organic matter percentages, the results showed that average organic matter levels and standard deviation of the topsoil in the study areas were 0.89 ± 0.56, 0.64 ± 0.25, 0.59 ± 0.16 and 0.40 ± 0.08% for dipterocarp

Table 1: Study sites and area (m^2) and density of worm casts (No. Of worm casts/m^2)

Study sties	Area sizes (m^2) and density of earthworm cats (No. Of worm casts/m^2)																								Total area (m^2)	Total worm -casts
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		
Dipt. Forest	1	2	6	3	14	11	17	8	6	5	11	7	1	4	1	1	0	1	1	0	0	0	0	0	100	701
Tam. Orchard	14	6	8	16	16	11	6	7	7	6	1	0	1	0	0	1	0	0	0	0	0	0	0	0	100	421
Gra. Pasture	0	0	1	3	2	3	8	6	12	7	16	6	6	5	6	4	2	2	3	2	0	2	3	1	100	1.099
Sugarcane P.	1	13	10	10	15	11	11	6	4	6	5	1	2	1	3	1	0	0	0	0	0	0	0	0	100	534

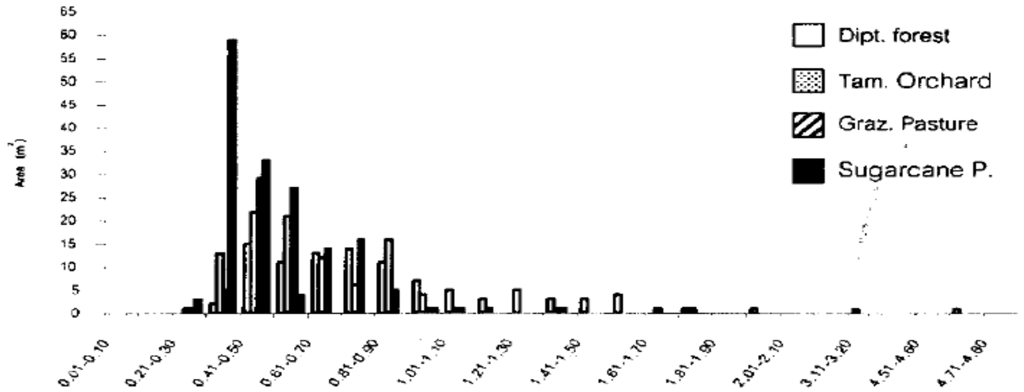

Fig. 1: Sizes of the studied land areas (m^2) and percentages of organic matter contents of the fourlocations, dipterocarp forest, tamarind orchard farm, grazind pasture and sugarcan plantation

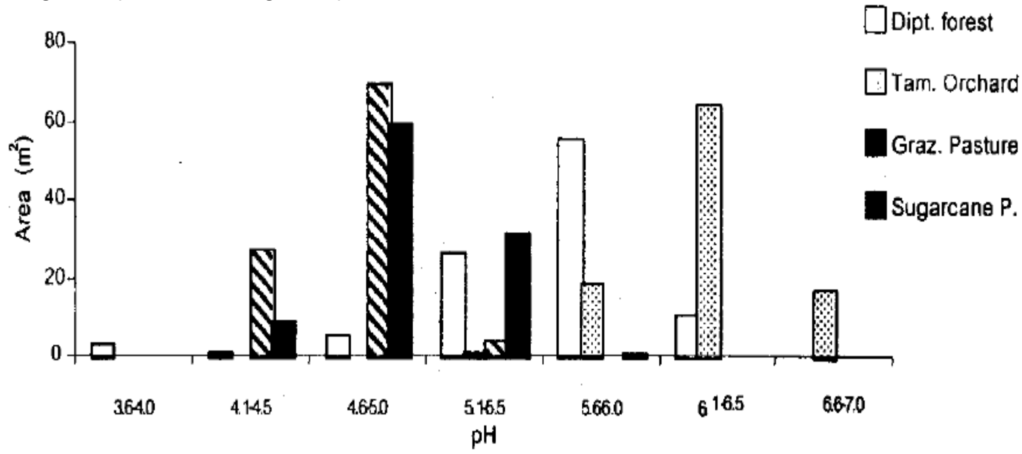

Fig. 2: Mean pH values and studied sizes (m^2) of dipterocarp forest, tamarind orchardfarm, grazing pasture alnd area and sugarcane plantation

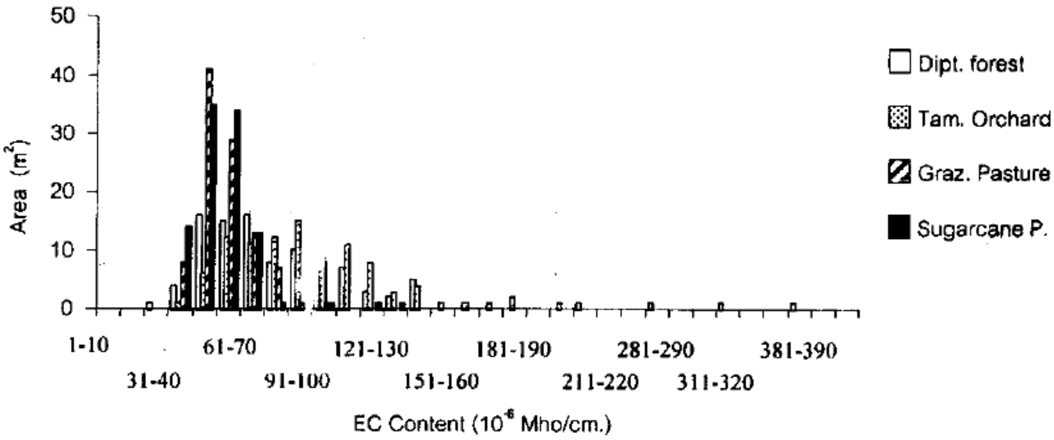

Fig. 3: Sizes of studied areas (m^2) with their respective soil electrical conductivity ranges of the ecological sites

forest, tamarind orchard, natural grazing areas and sugarcane plantation, respectively. By spatial distribution in different quadratic areas, organic matter percentages of dipterocarp forest soil samples, in most cases, were approximately 0.74%, while tamarind orchard and natural grazing areas showed only 0.57 and 0.47%, respectively. The lowest value was found with sugarcane plots with the mean value of 0.39% (Fig. 1). The values of organic matter levels found with this work were lower than that of the standard value of this soil series (cf. Department of Land Development, Ministry of Agriculture and Cooperatives of Thailand) with the value of 1.0%.

Soil pH: For soil pH values within the four ecosystems, the results evidently showed that tamarind orchard had the highest mean value of soil pH with standard deviation value of 6.29 ± 0.25, followed by dipterocarp forest, sugarcane plantation and natural grazing land area with the values of 5.59 ± 0.49, 4.93 ± 0.26, 4.68 ± 0.21, respectively. The majority of quadratic areas of dipterocarp forest and tamarind orchard were 6.0 and 6.4, respectively. Nevertheless, grazing land area and sugarcane plantation, their values were at lower levels with the values of 4.7 and 5.0, respectively (Fig. 2). These values were at the range of standard soil pH of Nampong soil series, i.e. at the range of 4.98-6.56 (1:2.5 soil:water).

Soil Electrical Conductivity (EC): With electrical conductivity mean values of soils within the four ecosystems, the results showed that EC values were relatively low in all cases studied. An average and standard deviations of EC values were 83.5 ± 52.87, 94.0 ± 31.45, 53.3 ± 12.20 and 52.9 ± 13.14 µMho/cm for dipterocarp forest, tamarind orchard, natural grazing land area and sugarcane plantation, respectively whilst the mode values of quadratic measurements of the four locations were 56, 90, 51, and 55 µMho/cm for dipterocarp forest, tamarind orchard, natural grazing land area and sugarcane plantation, respectively. That is tamarind orchard had the highest EC value followed by dipterocarp forest, sugarcane plantation, and grazing land area, respectively (Fig. 3). The EC values found with this work were at the range of standard values of 11.8-380.7 µMho/cm.

Discussion

With the four sites studied, the soil type of the four locations was the same but the vegetation was not of the same ecological context. This soil series contented a majority amount of sand particles with some small amount of silt, clay and organic matter. Soil disturbances have been carried out by ploughing at least twice a year for sugarcane land area for the plantation of sugarcane crop while other sites had no soil disturbances except weeding and pruning of orchard branches for better crop production. The disturbances of soil in the sugarcane plantation may have caused some effects on living earthworms as stated by Ramesh and Gunathilagaraj (1996). They have suggested that land area without disturbances and occupied with vegetation normally increases earthworm population density by the increasing amount of available root exudates, dead plant tissues and plant those roots remained in the soil. Whilst, Shakir and Dindal (1997) pointed out that numbers and biomass of earthworms could be varied with plant species and their chemical composition.With the four sites studied, the soil type of the four locations was the same but the vegetation was not of the same ecological context. This soil series contented a majority amount of sand particles with some small amount of silt, clay and organic matter. Soil disturbances have been carried out by ploughing at least twice a year for sugarcane land area for the plantation of sugarcane crop while other sites had no soil disturbances except weeding and pruning of orchard branches for better crop production. The disturbances of soil in the sugarcane plantation may have caused some effects on living earthworms as stated by Ramesh and Gunathilagaraj (1996). They have suggested that land area without disturbances and occupied with vegetation normally increases earthworm population density by the increasing amount of available root exudates, dead plant tissues and plant those roots remained in the soil. Whilst, Shakir and Dindal (1997) pointed out that numbers and biomass of earthworms could be varied with plant species and their chemical composition. The results on the total density of newly established worm casts/m^2 indicated that the highest amount was found with grazing land area followed by dipterocarp forest, sugarcane plantation and tamarind orchard farm with the values of 1,099, 701, 534 and 421, respectively. Whilst the percentages of organic matter were highest with dipterocarp forest followed by tamarind orchard, natural grazing land area and sugarcane plantation, respectively. The results indicated that there was no relationship between total density of newly established casts and organic matter percentages, EC and soil pH. However, the distribution of worm casts was more evenly distributed with dipterocarp forest and grazing land area than that of sugarcane and tamarind orchard. The results suggested that earthworm distribution tends to distribute in the areas with evenly distributed amount of organic matter and perhaps the higher the percentages the better. At the same time tamarind orchard earthworm distribution was concentrated in some spots only. The results suggested that high number of living earth worms could possibly be found in the land areas where no soil disturbances had been occurred particularly ploughing of land area with the use of tractors or deep tillage and also the availability of organic matter. In addition, the high amount of cast spots in tamarind orchard could possibly be attributed to the adequate amount of soil moisture content and perhaps the clay contented greater amount of moisture contents and organic matter. The results from this study may be concluded that general characteristics of Nampong soil series is not limiting to earthworm *Pheretema* sp. distribution. However, other soil physical properties such as soil moisture distribution; decomposing organic matter, soil disturbances and seasonal changes may have some tremendous effect on earthworm distribution for this particular soil series.

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References

Craig, I.A. and U. Pisone, 1988. Overview of rainfed agriculture in Northeast Thailand. Proceedings of the Workshop on Rainfed Agriculture in Northeast Thailand, February 25-March 1, 1985, Khon Kaen University, Thailand, pp: 24-39.

Department of Land Development, 1976. Soil analysis report of Northeast Thailand. Soil Analysis Division. Ministry of Agriculture and Co-Operative, Thailand.

KKU. and FORD., 1982. Cropping systems project, annual report. Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand, pp: 126.

Marinisen, J.C.Y. and R. Miedema, 1994. Theory and practice of methods to study soil structure formation by earthworms. Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut, 89: 101-110.

Polthanee, A., 1986. Rainfed Cropping Systems in Northeast Thailand. In: Traditional Agriculture in Southeast Asia: A Human Ecology Perspective. Martin, G.G. (Ed.). Westview Press, Boulder and London, ISBN: 9780813370262, pp: 103-131.

Ramesh, P.T. and K. Gunathilagaraj, 1996. Population of earthworms under weed cover. Madras Agric. J., 83: 475-476.

Shakir, H.S. and L.D. Dindal, 1997. Density and biomass of earthworms in forest and herbaceous microecosystems in central New York, North America. Soil Biol. Biochem., 29: 275-285.

Watanabe, H. and S. Ruaysoongnern, 1984. Cast production by the rnegascolecid earthworm *Pheretema* sp. in Northeastern Thailand. Pedobiologia, 26: 20-28.

Werner, M. and J.R. Cuevas, 1996. Vermiculture in Cuba. Biocycle, 37: 57-61, 62.

Westerman, R.L., 1990. Soil Testing and Plant Analysis. 3rd Edn., Soil Science Society of America Inc., Madison, Wisconsin, USA.

Zhang, Y., Z. Wang, X. Xing, Y. Guo and J. Deng, 1996. On effects of earthworm by soil pollution. Acta Scientiarum Naturalium Univ. Normalis Hunanensis, 19: 84-90.