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Assessment of Earthworm Distribution in Different Seasons in and around Pondicherry, India

R. Alexandar

Department of Ecology and Environmental Sciences, Pondicherry University, Pondicherry 605 014
✉ feralalex@gmail.com

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Abstract: The properties of soil determine the nature of the vegetation present and, indirectly, the number and types of animals. Eleven sites were sampled to study the distribution of earthworms in Pondicherry. Earthworms are probably the most important macro animals in soils (Brady and Weil, 1999). Hence the soil surveyed were analysed for various physical and chemical parameters to correlate their influence on earthworms and vice versa. The surveys were scheduled for four seasons—rainy season (Oct '02), winter (Jan '03), early summer (April '03), and late summer (July '03).

Key words: Earthworms, soil texture, classification, bulk density, organic carbon.

Earthworms

Charles Darwin, and numerous scientists before and after him, have described earthworm as great benefactors of soil and agriculture (Satchell, 1983). Earthworm continuously till and aerate the soil, supply it with organic matter, and help moisture reaching it via the burrows they make (Bhawalkar, 1996). Barring a few exceptions, most species of earthworms reduce plant pathogens, and are believed to release enzymes and hormones in their excreta beneficial to plant growth. In recent years earthworms have been increasingly employed in vermicomposting biodegradable solid wastes (Bhawalkar, 1993; Ismail, 1997; Kale and Madan, 1999; Abbasi and Ramasamy, 2001; Gajalakshmi and Abbasi, 2003b).

In the present study, an attempt is made to assess the earthworm distribution in different seasons in the Pondicherry town and surrounding areas, with the characteristic feature of the sampling sites.

Methods

Earthworm Population Estimation

Hand sorting method: To estimate earthworm populations, some method of determining the number of worms in a small sample area is necessary. Most of the early studies involved digging up soil samples and sorting these by hand (Stockli, 1928). Indeed many workers still use this method, except that they take cores or quadrates of soil of exact dimensions to enable accurate population estimates to be made. In this present study, earthworm resources were estimated in various locations, which includes soils of various textures. Samples were collected from two units in each location in the months of October '02, January '03, April '03, and July '03. These months indicate rainy season, winter, early summer and late summer respectively. The sampling size was 60 cm × 60 cm × 30 cm according to Lee (1985). From the soil sample, the earthworms were hand sorted, identified and counted.

While sampling, temperature of the soil in sampling site was recorded. The soil was taken to laboratory for analyzing other physical and chemical parameters.

Analysis of soil type

Analysis of particle size estimates the percentage of sand, silt and clay contents of the soil and is often reported as percentage by weight of oven dry and organic matter-free soil. The analyses were performed on air-dry soil.

Based on the proportions of different particle sizes, a soil textural category was assigned to the sample.

The eleven sample sites are:

Site A Pillaichvadi, 9 kms north from the town of Pondicherry
Site B Pommaiyarpalayam, 4 kms north from the town of Pondicherry
Site C Kanagachettikulam, 11 kms north from the town of Pondicherry
Site D Abishegapakkam, 10 kms west from the town of Pondicherry
Site E Ariyankuppam, 6 kms west from the town of Pondicherry
Site F Ellaipillaichavadi, Pondicherry town
Site G Villianur, 12 kms north west from the town of Pondicherry
Site H Kazhuperumpakkam, 20 kms north from the town of Pondicherry
Site I Kadaperikuppam, 22 kms north west from the town of Pondicherry
Site J Kalapet, 10 kms north from the town of Pondicherry
Site K Karasur, 21 kms north west from the town of Pondicherry

Results and Discussion

Soil Type/Texture

The texture of the soil has a profound influence on many soil properties; it affects the suitability of the soil for most uses. Of the eleven sites sampled, three sites had sandy loam type of soil, four had loamy sand, two had clay soil, and another two had loamy kind of soil. Of all the types of soil, the loamy sand harboured large earthworm population (Tables 1 to 4) except site C (Kanagachettikulam). Site C is a banana plantation area, where tillage was frequently done. Due to this disturbance, the worms would not prefer this area and hence migrated. The sandy loam was the next kind of soil where more earthworm population was found. Loam had a fewer number of worms; whereas clay was the soil type with very few earthworm population (Tables 1 to 4). Clay, being a poor drainage soil, becomes anaerobic when soil water content becomes high, thereby leading to mortality of the worms. The species identified in loamy sand include *Lampito mauritii*, *Drawida* sps., and *Megascolex mauritii*. The sandy loam harbours all the above three species and *Perionyx* sps. In loam soil also, *L. mauritii*, *Drawida* sps, and *Perionyx* sp were found. Clay soil also had *L. mauritii*. Hence *L. mauritii* followed by *Drawida* sps and *Perionyx* sps were found to be widely distributed. *L. mauritii* is an anecic, burrowing specie, geophytophagous in habit and a voracious feeder of humus in preference to soil (Ismail, 1997).

Megascolex mauritii and *Pheretima posthuma* belongs to the *Megascolecid* group of earthworms. Both *Pheretima* and *Megascolex* are burrowing earthworms (endogeics). *Pheretima* species are quite comfortable in soil that has very little organic content. They do not pull their feed into their burrows, but feed on the surface organics and deposit their casts on the surface. Great for land reclamation areas where there is plenty of shade and organic matter to consume. It may be manure, food waste, leaves, etc.

Drawida specie is endemic to southern India, belonging to anecic group. They are also burrowing type and are geophytophagous in habit.

Perionyx is the only epigeic specie identified of the 11 sites. It usually inhabits humus laden upper layers of the garden earth and manure pits. Epigeics generally have a higher frequency of reproduction and a faster rate of growth to adulthood than anecics and endogeics. They are non burrowing species and are phytophagous in habit (Lee, 1985).

Bulk Density and Particle Density

A good soil must ensure proper aeration, high filtration and provide a healthy environment for root growth of plants. The bulk density of the soils from various sites varied between 1.112 g/cm^3 and 2.432 g/cm^3 in winter; and 1.193 g/cm^3 -2.26 g/cm^3 in early summer and 1.112 g/cm^3 and 1.724 g/cm^3 in late summer (Tables 1-4). The particle density varied from 1.32 g/l to 1.899 g/l (Jan '03); 1.21 g/l to 1.86 g/l (Apr '03) and 1.15 g/l to 1.633 g/l (July '03). These values are considered to be ideal (Soil Science Education, 2003).

Water Holding Capacity

Earthworm burrows may gently increase the infiltration of water into the soils thus playing an important role in water conservation and prevention of soil erosion. Soils with a greater available water holding capacity has a greater capability for agricultural use and, particularly in areas of low and erratic rainfall, for maintaining an effective cover of vegetation that ensures protection of the soil.

Soil water content and bulk density both affect soil strength. Soil strength is increased when a soil is compacted to a higher bulk density, and also when a soil dries out and hardens (Brady and Weil, 1999).

Table 1: Earthworm species and the factors influencing their distribution (October 2002)

Sites	*Ambient temperature ^oC*	*Soil temperature ^oC*	*Soil moisture (%)*	*Soil pH*	*Soil organic matter (%)*	*Soil type*	*Flora found*	*No. of worms 0.1 cu.m*	*Worm species*
Site A (Pillaichavady)	33	26	7.62	7.9	4.15	Sandy clay loam	*Moringa, Cocos nucifera, grass*	75	*Lampito mauritii*
Site B (Pommayarpalayam)	28	25	7.69	6.7	2.14	Loamy sand	*Crotons Sparciflorus, grass, Assystasia*	55	*Lampito mauritii* *Drawida* sps. *Megascolex mauritii*
Site C (Kanagachettikulam)	32	28.5	6.31	6.5	3.28	Sandy clay loam	*Musa paradesiaca*	8	*Drawida* sps.
Site D (Abhishegapakkam)	33	27	7.0	7.5	4.75	Loamy sand	*Crossandra, Hibiscus rosasi nensis*	44	*Lampito mauritii* *Megascolex mauritii*
Site E (Ariankuppam)	33	28	7.06	6.9	2.21	Clay	*Coccinea indica, Melothria sps, grass, Cocos nucifera*	13	*Lampito mauritii*
Site F (Ellapillaichavady)	33	28	8.28	7.5	10.10	Loamy sand	*Azadiracta indica, Cleome viscosa*	84	*Lampito mauritii, Drawida* sps, *Perionyx sps, Megascolex mauritii*
Site G (Villianur)	33	27	6.57	7.8	2.27	Sandy clay	*Ipomoea, grass, Cleome viscose*	39	*Lampito mauritii*
Site H (Kazhupunumbakkam)	33	28.5	6.25	7.4	2.14	Sandy loam	*Musa paradesiaca, grass, Casuarina equisetifolia*	52	*Lampito mauritii* *Drawida* sps, *Perionyx* sps, Unidentified aquatic sps
Site I (Kadaperikuppam)	32	28	7.46	7.9	2.21	Clay	*Oryza sativa, Casuarina equisetifolia, grass*	3	*Lampito mauritii*
Site J (Kalapet)	32	27	8.25	7.3	3.35	Sandy loam	*Musa Paradesiaca*	39	*Lampito mauritii* *Lampito* sps.

Table 2: Earthworm species and the factors influencing their distribution (January 2003)

Sites	*pH*	*EC µs/cm*	*BD* g/cm^3*	*PD# g/l*	*MC@ (%)*	*OM** (%)*	*C (%)*	*WHC ## (%)*	*N kg/acre*	*K kg/acre*	*Ca mg/l*	*Mg ml/l*	*Flora found*	*No.of worms 0.1 cu.m.*	*Soil Texture*	*Worm species*
A (Pillaichavadi)	7.4	200	2.07	1.72	11	3.103	1.8	39	182.50	89.60	112.22	32.97	*Moringa, cocos nucifera, grass*	118	Loamy sand	*Lampito mauritii*
B (Pommaiyarpalayam)	6.1	90	2.26	1.86	12	3.21	1.9	37	87.50	80.64	475	52.75	*Crotons sparciflorus grass, Assystasia*	4	Loamy sand	*Lampito mauritii Drawida sps. Megascolex mauritii*
C (Kanagachettikulam)	8.0	440	1.732	1.443	16	0.78	0.45	48.1	70.00	80.64	128.3	19.78	*Musa paradesiaca*	10	Loamy sand	*Drawida* sps.
D (Abishegapakkam)	5.3	970	1.223	1.412	23	4.7	1.95	54.4	140.2	72.32	88.18	6.63	*Crossandra Hibiscusrosacinensis*	33	Sandy loam	*Lampito mauritii Megascolex mauritii*
E (Ariyankuppam)	6.0	660	1.316	1.354	28	2.74	1.59	51	132.1	64.45	149.18	38.24	*Coccinea indica melothria sps grass, cocos nucifera*	59	Loam	*Lampito mauritii*
F (Ellaipillaichavadi)	8.1	520	1.917	1.665	15	0.362	0.21	42.9	170.3	82.31	137.9	142.4	*Azadiracta indica, cleome viscose*	39	Sandy loam	*Lampito mauritii, Drawida sps, Perionyx* sps, *Megascolex mauritii*
G (Villianur)	6.2	500	1.40	1.394	14	3.103	1.8	34	120.2	91.32	64.14	82.25	*Ipomea grass cleome viscose*	26	Sandy loam	*Lampito mauritii*
H (Kazhuperumpakkam)	8.4	360	1.917	1.742	14	0.931	0.54	47.4	140.3	74.35	160.32	39.56	*Musa paradesiaca grass, causur equisetifolia*	12	Loam	*Lampito mauritii Drawida* sps, *Perionyx* sps, Unidentified aquatic sps
I (Kadaperikuppam)	8.1	126	1.542	1.44	18	7.76	4.5	57	169.6	60.32	356.71	199.1	*Oriza sativa casurina equisetifolia grass*	4	Clay	*Lampito mauritii*
J (Kalapet)	6.8	480	1.193	1.21	24	8.10	4.68	51	151.8	74.31	152.3	19.78	*Musa paradisiacal*	28	Loany sand	*Lampito mauritii Lampito* sps.
K (Karasur)	7.7	620	1.698	1.691	17	0.310	0.18	42.4	168.2	62.48	272.54	6.63	*Cocos nucifera casurina equisetifolia*	4	Clay	*Lampita mauritii*

*Bulk density; #Particle density ; @Moisture content ; **Organic matter; ##Water holding capacity

Table 3: Earthworm species and the factors influencing their distribution (April 2003)

Sites	*pH*	*EC µs/cm*	*BD* g/cm³*	*PD# g/l*	*MC@ (%)*	*OM** (%)*	*C (%)*	*WHC ## (%)*	*N kg/acre*	*K kg/acre*	*Ca mg/l*	*Mg ml/l*	*Flora found*	*No.of worms 0.1 cu.m.*	*Soil Texture*	*Worm species*
A (Pillaichavadi)	6.4	410	2.432	1.68	20	1.293	0.75	30	126.25	60.92	73.75	23.74	*Moringa, cocos nucifera, grass*	195	Loamy sand	*Lampito mauritii*
B (Pommaiyarpalayam)	7.2	130	2.326	1.831	13	2.07	1.2	13.8	155.0	206.8	96.19	26.4	*Crotons sparciflorus grass, Assystasia*	164	Loamy sand	*Lampito mauritii Drawida* sps. *Megascolex mauritii*
C (Kanagachettikulam)	7.8	120	2.391	1.72	9	1.63	0.95	38.5	165.0	123	128.3	46.15	*Musa paradesiaca*	19	Loamy sand	*Drawida* sps.
D (Abishegapakkam)	7.1	640	1.555	1.295	20	1.965	1.14	64.21	140.00	188.16	148.30	19.78	*Crossandra Hibiscusrosacinensis*	92	Sandy loam	*Lampito mauritii Megascolex mauritii*
E (Ariyankuppam)	6.1	420	1.42	1.32	22	2.89	1.682	52	103.75	265.21	142.3	30.1	*Coccinea indica melothria sps grass, cocos nucifera*	72	Loam	*Lampito mauritii*
F (Ellaipillaichavadi)	6.9	340	1.62	1.6	17	1.345	0.78	41.5	162.23	189.15	120.4	82.7	*Azadiracta indica, cleome viscose*	25	Sandy loam	*Lampito mauritii, Drawida* sps, *Perionyx* sps, *Megascolex mauritii*
G (Villianur)	7.2	340	1.75	1.751	25	1.034	0.6	50.2	76.25	98.56	69.74	22.42	*Ipomea grass cleome viscose*	4	Sandy loam	*Lampito mauritii*
H (Kazhuperumpakkam)	7.5	200	2.212	1.899	15	1.034	0.6	51.90	140.62	93.74	152.30	73.84	*Musa paradesiaca grass, causur equisetifolia*	18	Loam	*Lampito mauritii Drawida* sps, *Perionyx* sps, Unidentified aquatic sps
I (Kadaperikuppam)	7.8	42.0	1.83	1.83	19	1.138	0.7	52.3	130.41	140.60	351.10	23.74	*Oriza sativa casurina equisetifolia grass*	6	Clay	*Lampito mauritii*
J (Kalapet)	6.8	120	2.424	1.48	18	2.69	1.56	41.8	141.56	130.21	120.24	52.75	*Musa paradisiacal*	76	Loany sand	*Lampito mauritii Lampito* sps.
K (Karasur)	7.9	200	2.17	1.58	17	1.293	0.75	68.50	132.72	140.52	296.62	13.19	*Cocos nucifera casurina equisetifolia*	11	Clay	*Lampita mauritii*

*Bulk density; #Particle density ; @Moisture content ; **Organic matter; ##Water holding capacity.

Table 4: Earthworm species and the factors influencing their distribution (July 2003)

Sites	*Amb Temp °C*	*Soil Temp °C*	*pH*	*EC µs/cm*	*BD* g/cm³*	*PD# g/l*	*MC@ (%)*	*OM** (%)*	*C (%)*	*WHC ## (%)*	*N kg/acre*	*K kg/acre*	*Ca mg/l*	*Mg ml/l*	*Flora found*	*No.of worms 0.1 cu.m.*	*Soil Texture*	*Worm species*
A (Pillaichavadi)	38	32	5.9	190	1.704	1.633	11	0.983	0.57	30.55	107.50	86.01	48.1	6.59	*Moringa, cocos nucifera, grass*	89	Loamy sand	*Lampito mauritii*
B (Pommaiyarpalayam)	36	34	6.4	200	1.724	1.598	10.5	0.621	0.36	35.82	152.50	127.23	62.52	22.45	*Crotons sparciflorus grass, Assystasia*	118	Loamy sand	*Lampito mauritii Drawida* sps. *Megascolex mauritii*
C (Kanagachettikulam)	30	28	6.4	210	1.252	1.32	16	1.707	0.99	37.59	181.25	53.76	81.76	9.23	*Musa paradesiaca*	8	Loamy sand	*Drawida sps.*
D (Abishegapakkam)	34	28	7.2	570	1.112	0.929	24	2.586	1.5	54.81	190.00	80.64	208.42	121.31	*Crossandra Hibiscusrosacinensis*	36	Sandy loam	*Lampito mauritii megascolex mauritii*
E (Ariyankuppam)	36	27	7.8	840	1.132	1.455	17.3	1.552	0.9	42.16	140.0	197.12	152.30	39.56	*Coccinea indica melothria sps grass, cocos nucifera*	28	Loam	*Lampito mauritii*
F (Ellaipillaichavadi)	34	28	7.1	360	1.017	0.99	14.6	2.069	1.2	38.97	197.50	120.0	64.12	29.00	*Azadiracta indica, cleome viscose*	36	Sandy loam	*Lampito mauritii, Drawida* sps, *Perionyx* sps, *Megascolex mauritii*
G (Villianur)	33	29	6.8	170	1.38	1.4	8	0.310	0.18	35.31	143.75	57.34	96.19	26.38	*Ipomea grass cleome viscose*	8	Sandy loam	*Lampito mauritii*
H (Kazhuperumpakkam)	30	29	7.4	370	1.442	1.15	14	0.362	0.21	45.61	152.50	77.05	168.34	39.56	*Musa paradesiaca grass, causur equisetifolia*	8	Loam	*Lampito mauritii Drawida* sps, *Perionyx* sps, Unidentified aquatic sps
I (Kadaperikuppam)	40	32	7.6	570	1.36	0.924	15.2	2.327	1.35	47.08	131.25	206.08	89.78	59.34	*Oriza sativa casurina equisetifolia grass*	4	Clay	*Lampito mauritii*
J (Kalapet)	36	29	6.9	230	1.5	1.47	9.5	1.396	0.81	31.87	97.50	130.82	224.44	3.96	*Musa paradisiacal*	46	Loany sand	*Lampito mauritii Lampito* sps.
K (Karasur)	40	33	8.1	290	1.32	1.39	15	0.2068	0.12	42.42	98.75	114.68	248.49	52.74	*Cocos nucifera casurina equisetifolia*	7	Clay	*Lampita mauritii*

*Bulk density; #Particle density ; @Moisture content ; **Organic matter; ##Water holding capacity.

Organic Matter

Organic matter is the key factor for earthworm distribution. Organic matter increases the amount of water a soil can hold and the proportion of water available for plant growth. Even more important is its effect in promoting soil granulation and maintaining larger pores through which water can enter and percolate downward. In this way, earthworm plays a significant role (Stevenson, 1995). The organic content in the surveyed soil is given in Tables 1 to 4. Organic matter provides the energy substrate that makes possible the various activities of fungi, bacteria and soil animals.

Temperature

Temperature greatly affects the activity of the earthworms and their metabolism and respiration. The temperature of the sampled soils was within the range 25°C to 28.5°C (Table 1) in Oct '02 and 27°C to 34°C (Table 4) in July '03. These temperatures fall under the optimum range for tropical regions (Lee, 1985).

Moisture Content

Moisture is one of the prime factors on which the existence of earthworms depends upon. Less water in the soil leads to migrations or mortality of the earthworms. Excess moisture leads to anaerobic conditions in the soil, causing death of earthworms in addition to putrefaction.

pH

Earthworms generally survive in soil with pH close to neutral. The pH of the soil during rainy season (Oct '02) ranged between 6.5 and 7.9; in winter it was 6.1-7.9; in summer, the pH value varied between 5.3 and 8.4.

Conclusions

In the eleven sites sampled for earthworm survey in Pondicherry, five species were identified. The survey was done once in three months from Oct '02 to July '03. This includes rainy season, winter season, early summer and late summer. The earthworm species identified were *Lampito mauritii*, *Megascolex mauritii*, *Drawida* sps, *Pheretima posthuma* and *Perionyx* sps. Earthworms were found in abundance even in the summer season. The number of worms or the worm population was almost maintained all through the four seasons. The number of worms were not different significantly in any of the seasons. In case of low number such as site (G, I in Table 3) the reason was that there was human interferences.

Of the above five species, *L. mauritii* and *Drawida* sps belong to the anecic group; *Pheretima* and *Megascolex* are endegeics; and *Perionyx* is the only epigeic. *L. mauritii* is the species abundantly found and widely distributed.

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