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# Biodiversity and vermicomposting potential of indigenous earthworm resources of Sivagangai District

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## Abstract

The population biology provides the first basic information about any species. Biodiversity of earthworm showed wide fluctuation between species, between the months of collection and between the collection sites. The survey showed the presence of eight different species of earthworms belonging to three families and six genera have been identified out of which six species are endogeic, one species each of an anecic and epigeic species, but all are belonging to endemic earthworm species. Vermicomposting potential of locally abundant earthworm species showed that *Perionyx excavatus* was able to produce vermicompost efficiently followed by *Lampito mauritii* and *Drawida pellucida pallida*. This is a first detailed study of diversity of earthworms in all the revenue blocks of Sivagangai District.

**Keywords:** Earthworm survey, *Perionyx excavatus,* Sivagangai District, vermicomposting.

## Introduction

In India, with its great variability in habitat conditions, occurrence of large number of earthworm species with a variety of biological traits but there is a need for an in-depth study of different earthworm populations and communities. Earthworms are sensitive to different agrotechnical and forestry activities, as well as to the anthropogenic pollution. They are an appropriate soil quality change bioindicator, as they are relatively less sensitive to the influence of different natural external factors (Paoletti, 1999).

Earthworms as major soil macro fauna, have gained importance as the modulators of the physicochemical properties of the soil. The country with its diversified geographical regions, edaphic and climatic factors is characterized by species diversity and richness. Out of the different families of earthworms distributed in the world, the sub-continent has representative genera and species from nine families. Preliminary survey and documentation of earthworm diversity in each district is essential to conserve our indigenous species. Due to depletion of our native species through chemical toxicity, such species has to be domesticated, mass multiplied and supplied to the farmers. Earthworm survey will be helpful to identify native earthworm species and also for their conservation. This study is aimed to survey the availability of different species of earthworms in various localities of Sivagangai District for vermiculture and vermicomposting.

## Materials and Methods

### Collection of earthworm species

Frequent survey was conducted in all the eleven revenue blocks of Sivagangai district and the available earthworm species were collected by hand sorting method. The local earthworm was simply obtained by digging up the soil. Samples were obtained from sites that showed earthworm activity, such as their worm castings. They were also taken from moist soils near ponds and trenches and from garden and farm areas that had manure which are all excellent environments for earthworms, as they are high in nutrients and moisture.

The earthworm survey was carried out in all the eleven collection sites at regular monthly intervals from a total of eight quadrants of 0.50m x 0.50m x 0.30m size at each sampling site during each sampling occasion. The soil core was dug out and the worms were hand sorted according to the method described by Lewis and Taylor (1968). The soil lumps were broken and the soil was passed through fingers to sort out the worms. The worms thus picked up were sorted out species-wise and kept separately for each quadrant in polythene bags containing the mother soil taken from the collection site. Care was taken when digging for the earthworms so as to avoid damaging or killing them.

Earthworms were transported to the laboratory and the worms were preserved in 5 - 10% formalin solution following the method suggested by Julka (1993). Earthworms were identified preliminary using conventional methods by Dr. N. Karmegam, an Indian earthworm taxonomist, Tamil Nadu, India and further confirmed by COI gene sequencing.

### Collection of Soil sample and analysis

During each sampling occasion, the soil from each quadrant was collected in polythene bags, numbered and taken to the laboratory for analysis. Physico-chemical and climatic characteristics of the soil samples was done using standard methods. Soil pH and electrical conductivity were measured in 1:5 suspension of soil and distilled water using electronic pH meter and conductivity bridge respectively (Jackson, 1973). Organic carbon and organic matter content was estimated by Walkley and Black method (1947) and total nitrogen content was analysed by microkjeldhal method (Jackson, 1973). Phosphorous and potassium was analysed by the method of Tandon (1993).Soil temperature was measured by using digital thermometer and the moisture content was found out by keeping the fresh soil sample in hot air oven at 105°C until getting constant weight.

### Mass culture and vermicomposting

The earthworms were cultured in mass culture tanks containing cowdung medium. From the mass culture tanks, fifty healthy adult worms of uniform size were sorted out and transferred to plastic containers of 45cmx30cmx15cm size filled 2/3 with predecomposed cowdung and leaf litter (1:1) holding 70 to 80 percent moisture content. A total of three replicates were maintained separately for all the species. Substrates without earthworms served as control. The substrate was mixed once in a week and maintained upto 70 days. The physico-chemical composition of the vermibed substrates were analyzed for the selected parameters such as organic carbon (Walkley and Black, 1947) and total nitrogen (Jackson, 1973). The ratio of the percentage of carbon to that of nitrogen (i.e. C/N ratio) was calculated by dividing the percentage of carbon estimated for the sample with the percentage of the nitrogen estimated for the same sample. To find out the percentage decomposition, the vermibed substrates were sieved through 2 mm sieve and the percentage decomposition was calculated as follows (Goswami and Kalita, 2000):

$$\text{Percentage decomposition} = \frac{A - B}{A} \times 100$$

Where,

A = Total weight of organic substrate in the vermibed
B = Weight of decomposed material (sieved through material)

## Results and Discussion

The name of the revenue blocks of Sivagangai District is given in Table 1. Available earthworm species and their families in all the eleven revenue blocks of Sivagangai District are given in Table 2. Images of the identified earthworm species collected in all the eleven revenue blocks of Sivagangai District is given in Plates 1 to 8. In the present study eight species of earthworms belonging to three families and six genera have been identified out of which six species are endogeic, one species each of an anecic and epigeic, but all are belonging to endemic earthworm species.

Table 1. Eleven revenue blocks of Sivagangai District

| Block No | Block name |
|---|---|
| 1 | Devakottai block |
| 2 | Ilaiyankudi block |
| 3 | Kalayarkoil block |
| 4 | Kallal block |
| 5 | Kannankudi block |
| 6 | Manamadurai block |
| 7 | S.Pudur block |
| 8 | Sakkottai block |
| 9 | Sivagangai block |
| 10 | Tiruppattur block |
| 11 | Tiruppuvanam block |

Table 2. Different species of earthworms collected from the eleven revenue blocks of Sivagangai District

| Earthworm species collected | Revenue blocks | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| FAMILY: MEGASCOLECIDAE | | | | | | | | | | | |
| *Lampito mauritii* (Kinb.). | + | + | + | + | + | + | + | + | – | + | + |
| *Megascolex insignis* Mich. | + | – | – | – | – | + | – | – | + | – | – |
| *Perionyx excavatus* | – | – | – | – | – | – | – | – | – | + | + |
| *Metaphire* sp. | – | + | – | + | – | – | + | – | + | – | – |
| FAMILY: OCTOCHAETIDAE | | | | | | | | | | | |
| *Octochaetona sp.* | – | – | + | – | + | – | + | – | + | – | – |
| FAMILY: MONILIGASTRIDAE | | | | | | | | | | | |
| *Drawida chlorina* (Bourne). | – | + | – | – | – | + | – | – | – | + | – |
| *Drawida circumpapillata* | – | – | – | + | – | – | – | + | – | – | + |
| *Drawida pellucida* var. *pallida* Mich. | + | + | + | – | + | + | + | – | + | + | + |

\+ =Present; –= Absent.

The results of the abundance of different species of earthworms showed that *L. mauritii* was the most abundant in all the study sites except site 9 and *D. pellucida pallida* was the most abundant in all the study sites except site 4 and 8. Formation of aggregation of species has been observed in sites 1 to 11; that is, wherever *L. mauritii* was in association with *D. pellucida pallida*. This sort of association of earthworm species sharing the same habitat is not uncommon (Edwards and Bohlen, 1996).In Tamil Nadu, India, very limited information is available on the distribution pattern of earthworms. The data on earthworm distribution is available for the stations like Palni Hills (Jamieson, 1977), Madras (Ismail and Murthy, 1985), and Sirumalai Hills (Karmegam and Daniel, 2007). Studies on different region of the globe and on different ecosystem have revealed that the earthworm diversity is highly variable owing to geographical region, climatic condition and disturbances in habitat concerned. The manipulation of natural habitat by anthropogenic activities has resulted into displacement of earthworm species. A regional survey undertaken by Bano and Kale (1991) in southern Karnataka revealed that native species were well adapted to agroecosystems. From a total number of 44 species (36 natives and eight exotics), 25 native species were found only in managed ecosystems. The reason for this adoption is not clear, but it could be related to the prevalence in the region of low input agricultural practices and to the fact that most of these earthworms are endogeic species more resistant to changes in land use practices.

Plate 1. *Megascolex insignis*

Plate 2. *Octochaetona* sp.

Plate 3. *Lampito mauritii*

Plate 4. *Drawida circumpapillata*

Plate 5. *Metaphire* sp.

Plate 6. *Drawida chlorina*

Plate 7. *Drawida pellucida pallida*

Plate 8. *Perionyx excavatus*

Chaudhuri and Bhattacharjee (2011) reported reproductive biology of eight tropical earthworm species of rubber plantation in Tripura. Of the 8 species, 3 species was peregrine while the remaining 5species were native. Sathianarayanan and Khan (2006) reported 10 species of earthworms from Pondicherry region belonging to 7 genera and 6 families.

Physico-chemical and climatic characteristics of the soil samples of study sites 1 to 11 is given in Tables 3 and 4. All the parameters showed fluctuations in all the eleven study sites. No single physico-chemical and climatic parameters would sufficiently support the existence of earthworm population in a particular study site. It was found that the contribution of soil moisture and temperature to earthworm population is predominant.

Table 3. Physico-chemical and climatic characteristics of the soil of study sites 1 to 6 (Mean± S.D.).

| S. No. | Parameters Observed | Study sites | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | pH | 7.46±0.21 | 7.17±0.15 | 7.08±0.11 | 7.23±0.19 | 7.35±0.24 | 6.86±0.16 |
| 2. | Electrical conductivity (dS/m) | 0.13±0.02 | 0.29±0.02 | 0.12±0.01 | 0.24±0.02 | 0.19±0.02 | 0.28±0.02 |
| 3. | Organic carbon (%) | 2.91±0.28 | 3.68±0.45 | 4.38±0.27 | 4.06±0.15 | 3.11±0.29 | 3.75±0.21 |
| 4. | Organic matter content (%) | 5.01±0.24 | 6.33±0.35 | 7.53±0.48 | 6.98±0.43 | 5.35±0.31 | 6.45±0.33 |
| 5. | Nitrogen (%) | 0.38±0.01 | 0.32±0.02 | 0.42±0.02 | 0.30±0.02 | 0.34±0.02 | 0.41±0.03 |
| 6. | Phosphorus (%) | 0.29±0.02 | 0.25±0.01 | 0.19±0.01 | 0.27±0.02 | 0.32±0.02 | 0.18±0.01 |
| 7. | Potassium (%) | 0.25±0.01 | 0.20±0.02 | 0.22±0.02 | 0.18±0.01 | 0.20±0.02 | 0.29±0.02 |
| 8. | Soil temperature ($^{o}$C) | 25.35±1.42 | 26.23±1.76 | 28.31±2.05 | 25.94±1.20 | 27.94±2.13 | 23.73±2.08 |
| 9. | Soil moisture (%) | 11.39±4.16 | 9.20±3.57 | 14.25±6.51 | 10.64±6.73 | 16.09±8.43 | 15.08±5.31 |

Table 4. Physico-chemical and climatic characteristics of the soil of study sites 7 to 11 (Mean± S.D.).

| S. No. | Parameters Observed | Study sites | | | | |
|---|---|---|---|---|---|---|
| | | 7 | 8 | 9 | 10 | 11 |
| 1. | pH | 7.57±0.14 | 7.15±0.21 | 7.89±0.23 | 6.73±0.16 | 7.11±0.12 |
| 2. | Electrical conductivity (dS/m) | 0.27±0.02 | 0.36±0.03 | 0.26±0.02 | 0.31±0.02 | 0.17±0.01 |
| 3. | Organic carbon (%) | 5.23±0.21 | 3.37±0.28 | 6.16±0.23 | 2.33±0.13 | 3.86±0.29 |
| 4. | Organic matter content (%) | 9.00±0.65 | 5.80±0.49 | 10.60±0.62 | 4.01±0.25 | 6.64±0.47 |
| 5. | Nitrogen (%) | 0.31±0.03 | 0.34±0.02 | 0.29±0.02 | 0.35±0.02 | 0.42±0.03 |
| 6. | Phosphorus (%) | 0.29±0.02 | 0.25±0.02 | 0.19±0.01 | 0.30±0.02 | 0.31±0.02 |
| 7. | Potassium (%) | 0.15±0.01 | 0.24±0.02 | 0.17±0.01 | 0.22±0.01 | 0.33±0.02 |
| 8. | Soil temperature ($^{o}$C) | 22.92±2.38 | 28.61±2.52 | 29.08±2.49 | 25.76±1.31 | 28.07±2.16 |
| 9. | Soil moisture (%) | 9.76±4.28 | 10.55±4.23 | 14.45±7.64 | 12.04±6.91 | 16.33±5.20 |

Earthworm distributions also expand and contract over time, primarily following changes in soil moisture that are usually driven by weather conditions. However, majority of earthworms prefer less acid, neutral soils, reaching their maximum density at pH 6- 8. Distribution of the species is largely determined by the mechanical composition of the soil, content of the organic matter and different agrotechnical activities. In general, earthworm densities begin to drop off once soil pH falls below 5 (Tiunov et al., 2006). The temperature and moisture are usually inversely related and higher surface temperature and dry soils are limiting factors to earthworms than low and water logged soils (Nordstrom and Rundgren, 1974). The soil temperature plays an important role in the maintenance of earthworm population in an ecosystem and available information also indicates the negative correlation of soil temperature to earthworm population (Karmegam and Daniel, 2007). The physicochemical properties like pH, EC, organic C, total N, available P, K,Na, Ca, and Mg of casts did not differ in zero tillage land treated with mulch of residues of annuals or perennials (Reddy et al., 1997).

Soil tests measure the portion of nutrients that are likely to become plant available; they do not report total quantities present in the soil (Hornbeck et al. 2011). Studies have also shown that earthworms may increase soil pH through casting activities (Sackett et al., 2013). Previous studies have demonstrated relationships between litter depletion for epigeic and anecic earthworms such as *Amynthas* and *L. terrestris* (Holdsworth et al., 2012), yet *Drawida* sp. was a bit of a puzzle, since it primarily consumed soil organic matter and not litter.

Preliminary vermicomposting trial was carried out using eight different species of earthworms in order to find out the species suitable for vermicomposting operation. Vermicomposting parameters such as C/N ratio and percentage decomposition of vermibed material were more in *Perionyx excavatus* and *Lampito mauritii* than that in the substrates worked by other species, i.e., *Drawida pellucida pallida*, *Octochaetona* sp, *D.circumpapillata*, *D. chlorine*, *M. insignis* and *Metaphire* sp. (Table 5). Percentage decomposition was maximum in the substrates worked with *Perionyx excavatus i.e.*, 87.43 and worm un worked substrates showed only 10.95. The C/N ratio also showed a greater decrease from the initial values in the *Perionyx excavatus* and *Lampito mauritii* worked substrates than in the substrates worked by the other species.

Table 5. Vermicomposting potential of earthworm species of Sivagangai District

| Earthworm species | Organic carbon (%) | | Nitrogen (%) | | C/N ratio | | Percentage decomposition |
|---|---|---|---|---|---|---|---|
| | Initial | Final | Initial | Final | Initial | Final | |
| Control (WUW) | 53.35 | 49.04 | 0.82 | 0.85 | 65.06 | 57.69 | 10.95 |
| *L. mauritii* | 53.35 | 35.41 | 0.82 | 1.19 | 65.06 | 29.76 | 81.75 |
| *M. insignis* | 53.35 | 47.28 | 0.82 | 0.87 | 65.06 | 54.34 | 14.58 |
| *P. excavatus* | 53.35 | 32.05 | 0.82 | 1.38 | 65.06 | 23.22 | 87.43 |
| *Metaphire* sp. | 53.35 | 47.01 | 0.82 | 0.86 | 65.06 | 54.66 | 13.22 |
| *Octochaetona sp.* | 53.35 | 42.35 | 0.82 | 0.91 | 65.06 | 46.54 | 21.09 |
| *D. chlorina* | 53.35 | 45.06 | 0.82 | 0.88 | 65.06 | 51.20 | 15.62 |
| *D. circumpapillata* | 53.35 | 44.09 | 0.82 | 0.89 | 65.06 | 49.53 | 18.81 |
| *D. pellucida pallida* | 53.35 | 40.15 | 0.82 | 0.95 | 65.06 | 42.26 | 28.10 |

WUW- Worm unworked

There are more than a dozen of earthworm species that have been reported to be efficient in vermicomposting. Most of the species that are included under genus *Perionyx* show great potential to work on organic matter. Apart from the well-known *P. excavatus*, other *Perionyx* species such as *P. ceylanensis, P. bainii, P.nainianus*, and *P. sansibaricus* are recently considered to be the potential vermicomposting earthworms (John Paul et al., 2011; Suthar, 2009). From this study it is concluded that *Perionyx excavates* can able to produce vermicompost efficiently followed by *L. mauritii* and *D. pellucida pallida*. Future investigations provide scope for identifying more species with vermicomposting potential.

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