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# Earthworm Population in Relation to Different Agro Climatic Regions of Wayanad District of Kerala

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## Abstract

Among the numerous microorganisms in the soil, earthworms play an important role in the formation and maintenance of soil structure and fertility by altering the physical, chemical and biological properties. A study was conducted in Wayanad district during 2017 to 2018 to collect and identify the earthworm species present in three agro climatic regions of Wayanad. A total of 30 samples were collected from Wetland, upland and an evergreen forest. A total of 15 earth worm species were identified and among this two species were new to Wayanad, the *Dravida thomasi* and *Amynthas corticis*.

**Keywords:** Agroclimatic Regions, Earthworm Population Density, *Dravida thomasi, Amynthas corticis*

## 1. Introduction

Among numerous organisms found in the soil, earthworms are the most important components of soil biota in terms of soil formation

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and maintenance of soil structure and fertility [1]. Earthworms play a major role in soil nutrient dynamics by altering the soil's physical, chemical and biological properties which are generally in synchrony with the plant demands [2]. Therefore, focus has been given to integrate the earthworms into agriculture management in order to increase the crop yield [3]. The crop production was usually higher in the soil with high number of earthworms than no or less earthworms [4,5].

The effects of earthworms on soil biological processes and fertility level differ in ecological categories [6]. Anecic species build permanent burrows into the deep mineral layers of the soil; they drag organic matter from the soil surface into their burrows for food. Endogeic species live exclusively and build extensive non-permanent burrows in the upper mineral layer of the soil, mainly ingest mineral soil matter, and are known as "ecological engineers," or "ecosystem engineers." They produce physical structures through which they can modify the availability or accessibility of a resource for other organisms [7]. Epigeic species live on the soil surface, form no permanent burrows, and mainly ingest litter and humus, as well as decaying organic matter, and do not mix organic and inorganic matter. Earthworms influence the supply of nutrients through their tissues but largely through their burrowing activities; they produce aggregates and pores (i.e., biostructures) in the soil and/or on the soil surface, thus affecting its physical properties, nutrient cycling, and plant growth [8, 9]. The biogenic structures constitute assemblages of organo-mineral aggregates. Their stability and the concentration of organic matter impact some important soil ecological processes within their "functional domain" [10, 11] where they concentrate on nutrients and resources that are further exploited by soil microorganism communities [12, 13]. The effect of EWs on the dynamics of organic matter varies depending on the time and space scales considered [14]. The activity of endogeic earthworms in the humid tropical environment accelerates initial soil organic matter turnover through indirect effects on soil C as determinants of microbial activity. Due to selective foraging of organic particles, gut contents are often enriched in organic matter, nutrients, and water compared with bulk soil and can foster high levels of microbial activity [15, 16]. They have been reported to enhance mineralisation by first fragmenting soil organic matter and then mixing it together with mineral particles and microorganisms, and thereby creating new surfaces of contact between SOM and microorganisms [17]. In the short term, a more significant effect is the concentration of large quantities of nutrients (N, P, K, and Ca) that are easily assimilable by plants in fresh cast depositions [18]. Most of these nutrients are derived from earthworm urine and mucus [19].Therefore, to investigate the potential of the earthworms to integrate into agriculture management, knowledge on different physical, chemical and management factors that affect the distribution and abundance of earthworm population was important. This will help to identify the ecological appropriateness of the earthworms in order to supplement their existing population and quantify the impact of earthworms on agricultural land [20]. Not only from agricultural perspective, earthworms are equally important from ecological point of view because they contain highest soil macro-faunal biomass and are also increasingly regarded as bio-indicators of soil quality [21].

The people in Wayanad district mainly rely on farming for their livelihood. The major agricultural crops in the upland are coffee, pepper, tea and cardamom, andpaddy in the wetlands. In Wayanad, mainly three types of forests are seen which are evergreen forest, moist deciduous forest and dry deciduous forest.

The presence of earthworms modifies the environment (soil quality) with their various activities like burrowing and casting which affect the activities of other organisms. So, they are also termed as "ecosystem engineers". Earthworms fall into three distinct ecological groups based on feeding and burrowing habits. Epigeic (litter dwelling) earthworms live and feed on surface litter. They move horizontally through leaf litter or compost with little ingestion or burrowing into the soil. These worms are characteristically small and are not found in low organic matter soils. Lumbricus rubellus is an example of epigeic species. Endogeic (shallow dwelling) earthworms are active in mineral topsoil layers and associated organic matter. They create a three-dimensional maze of burrows while consuming large quantities of soil. The genuses Diplocardia and Aporrectodea have endogeic life habits. Anecic (deep burrowing) earthworms live in permanent and nearly vertical burrows that may extend several feet into the soil. They feed on surface residues and pull them into their burrows. Lumbricus terrestris is an example of anecic species [21]. The population of earthworms is influenced by the availability and quality of food sources, soil organic matter, soil type, depth to a restrictive layer, soil pH, soil moisture and internal drainage, rainfall and temperature, predation, parasitism and earthworm introduction. Many management practices such as tillage, crop rotations and cover crops, fertilizers, pesticides, irrigation and drainage, and worm seeding (inoculation) affect earthworm populations because they change one or more of the environmental factors listed above [22]. The objective of the study was to conduct scientific study on earthworms up to species level and earthworm population density in Wayanad district in three agro climatic regions of Wayanad and on three type of land namely wetland, upland and evergreen forest.

## 2. Methodology

### 2.1 Study location

The study was carried out in Wayanad district of Kerala. The study locations are three panchayats which lie in three different agro-climatic regions of Wayanad namely Pulppally, Kaniyambatta and Pozhuthana gram panchayats. It lies between the latitudes of N-11$^0$33'28.4 and N-11$^0$48'33.2 and longitudes of E-075$^0$59'19.1"and E-076$^0$12'31. Samples were collected on the onset of monsoon during the year 2017 -2018. Samples were collected from three type of areas i.e., from wetland, upland and from forest soil. A total of 30 samples were collected.

### 2.1 Earthworm sampling

Earthworms were sampled by digging a pit of 25 X 25 cm$^2$ to the depth of 30 cm[23]. To observe the depth-wise variation in earthworm distribution and abundance, sampling was done from top layer (0-15 cm).The earthworms were hand-sorted, washed with water and then preserved in 4% formalin [24]. Earthworm Population Density (EPD) was determined by the formula:

$$EPD = \frac{\text{Total number of earthworms in sampling area}}{\text{Sampling area (0.0625)}}$$

The collected and formalin preserved earthworms were identified by observing their external and internal morphological body characteristics with the help of experts [25,26,27,28,29]

## 3. Results and Discussions

During the study period (2017-2018), a total of 30 samples and 678 specimens were collected. Among these specimens, 218 were identified with developed clitellum. The study shows the presence of four earthworm families namely, Megascolecidae, Moneligastrida, Eudrilidae, Glossoscolexidae and Olegochaetae, and seven genera namely, Megascolex,Metaphire, Perionyx, Amynthas, Eudrillus,Pontonex and Drawida which represents fourteen species. The family Megascolex represents the highest species diversity with three Megascolex species followed by two Metaphire Perionix and Amynthas species respectively. These results are closely related with the finding of Prasanth Narayanan, Julka [29] in their publication Checklist of the earthworms (Oligochaeta) of Kerala, a constituent of Western Ghats biodiversity hotspot, India. The results are shown in Table 1.

**Table 1**: Results of taxonomic identification of earthworms

| Order | Family | Genera | Species |
|---|---|---|---|
| Haplotaxida | Megascolecidae | Megascolex | *Megascolex konkanesis* (Fedarb, 1898) |
| | | | *Megascolex lawsoni* (Bourne, 1886) |
| | | | *Megascolex sp.* |
| | | Metaphire | *Metaphire houlleti* (Perrier, 1872) |
| | | | *Metaphire sp* |
| | | Perionyx | *Perionyx ceylanensis* (Mich) |
| | | | *Perionyx sp.* |
| | | Amynthas | *Amynthas alexandri*(Beddard, 1900) |
| | | | *Amynthas corticis* (Kinberg, 1867) |
| | Eudrilidae | Eudrillus | *Eudrilus eugeniae* (Kinberg, 1867) |
| | Glossoscolexidae | Pontonex | *Pontoscolex corethrurus* (Muller,1857) |
| Moniligastrida | Moniligastridae | Drawida | *Drawida thomasi* (Narayanan & Julka, 2017) |
| | | | *Drawida ghatensis* (Michaelsen, 1910) |
| | | | *Drawida modesta* (Rao, 1921) |

Species richness of earthworms was high in the forest soil with ten species, followed by upland with nine species and wetland with six species in the study area. Among these 14 species, two are new to Wayanad-*Dravida thomasi* and Amynthas *corticis* which represent the upland. The results are shown in Table 2. The earthworm population was also studied in these three habitats. The earthworm population was high in forest soil with 116 numbers followed by wetland and upland with 71 and 31 numbers respectively, and the results are shown in Table 3 and in Figure 1. The Earthworm

Population Density (EPD) was high in forest soil with 185.6 followed by wetland with 113.6 and upland with 49.6.

**Table 2**: Results of earthworm species richness in the three habitats

| Sl. No | Forest | Upland | Wetland |
|---|---|---|---|
| 1 | *Megaascolex konkanensis* (Fedarb, 1898) | *Megascolex sp* | *Megascolex sp.* |
| 2 | *Drawida ghatensis* (Michaelsen, 1910) | *Megascolex lowsoni*(Bourne,1886) | *Drawida modesta* (Rao, 1921) |
| 3 | *Drawida modesta* (Rao, 1921) | *Megascolex konkanensis*(Fedarb,1898) | *Metaphire sp* |
| 4 | *Metaphire houlleti* (Perrier, 1872) | *Drawida thomasi* (Narayanan &Julka,2017) | *Metaphire houlleti* (Perrier, 1872) |
| 5 | *Metaphire sp* | *Amynthas alexandri* (Beddard,1900) | *Eudrilus eugeniae* (Kinberg, 1867) |
| 6 | *Amynthas corticis* (Kinberg, 1867) | *Amynthas corticis* (Kinberg,1867) | *Perionyx sp* |
| 7 | *Amynthas alexandri* (Beddard, 1900) | *Eudrilus eugeniae* | *Perionyx ceylanensis* (Mich) |
| 8 | *Pontoscolex corethrurus* (Muller, 1857) | *Perionix sp* | - |
| 9 | *Perionyx sp* | *Pontoscolex corethrurus*(Muller,1857) | - |
| 10 | *Perionyx ceylanensis* (Mich) | - | - |

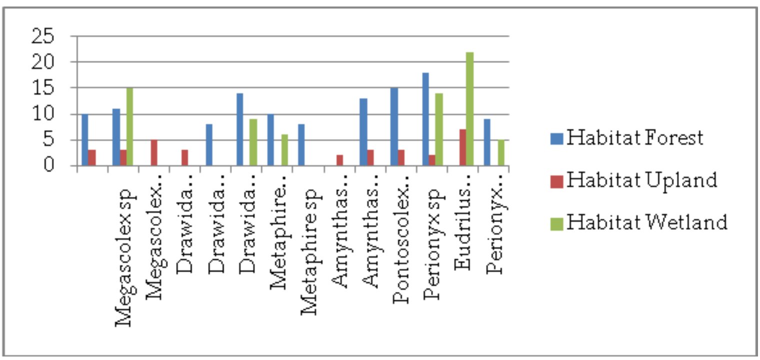


**Figure 1:** Earthworm population in three different habitats

**Table 3:** Earthworm population in three different habitats

| Earthworm species | Habitat | | |
|---|---|---|---|
| | Forest | Upland | Wetland |
| *Megascolex konkanensis* | 10 | 3 | 0 |
| *Megascolex sp* | 11 | 3 | 15 |
| *Megascolex lowsoni* | 0 | 5 | 0 |
| *Drawida thomasi* | 0 | 3 | 0 |
| *Drawida ghatensis* | 8 | 0 | 0 |
| *Drawida modesta* | 14 | 0 | 9 |
| *Metaphire houlleti* | 10 | 0 | 6 |
| *Metaphire sp* | 8 | 0 | 0 |
| *Amynthas corticis* | 0 | 2 | 0 |
| *Amynthas alexandri* | 13 | 3 | 0 |
| *Pontoscolex corethrurus* | 15 | 3 | 0 |
| *Perionyx sp* | 18 | 2 | 14 |
| *Eudrilus eugeniae* | 0 | 7 | 22 |
| *Perionyx ceylanensis* | 9 | 0 | 5 |

To quantify the biodiversity $(D)=\Sigma\ n\ (n-1)\ /N\ (N-1)$,where, n denotes the total number of organisms of a particular species and N denotes the total number of organisms of all species. Simpson Diversity indices of earthworm species in three different habitats is calculated and shown in Table 4.

**Table 4:** Simpson Diversity indices of earthworm species

| Habitat | No of species | Simpson Diversity index(D) |
|---|---|---|
| Forest | 10 | 0.0996 |
| Upland | 9 | 0.1021 |
| Wetland | 6 | 0.1964 |

The value of D varies between 0 and 1.With this index, 0 represents infinite diversity and 1 represents no diversity. It can be inferred that the bigger the value of D, the lower the diversity. Simpson index of diversity varies between the habitat with 0.0996, 0.1021 and 0.1964 for forest, upland and wetland respectively. This above difference in index is due to habitats containing many different species but with most individuals belonging to few common species. This result shows close similarity with the Simpson diversity index of the study by Rinku Goswami and Mondi Lal. Table 4 shows lower value in forest (0.0996) which means the highest diversity.

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## References

[1] J.P Curry and D.C Cotton. "*Earthworms and land reclamation*", In DL Dindal (Ed). Earthworm Ecology from Darwin to Vermiculture. Chapman and Hall, London. pp. 215-228, 1983.
[2] P. Lavelle. *"Earthworm activities and the soil system"*Biology and Fertility of Soils, vol. 6, no. 3, pp. 237–251, 1988.
[3] B.K Senapati, P.Lavelle, P.K Panigrahi, S. Giri and G. Brown. "*Restoring soil fertility and enhancing productivity in Indian tea plantations with earthworms and organic fertilizers*". In: Program, Abstracts and Related Documents of the International Technical Workshop on Biological Management of Soil Ecosystems for Sustainable Agriculture, Série Documentos. pp. 172-190. 2002.
[4] C. A Edwards and J.E Bater. "*The use of earthworms in environmental management*". Journal of Soil Biol. Biochem,Vol 24, pp1683-1689. 1992.
[5] W.H Elmer. "*Using Earthworms to Increase Soil Health and Supress Diseases*", The Connecticut Agricultural Experiment Station, 2012.
[6] G. G. Brown, I. Barois, and P. Lavelle. *"Regulation of soil organic matter dynamics and microbial activity in the drilosphere and the role of interactions with other edaphic functional domains,"*European Journal of Soil Biology, vol. 36, no. 3-4, pp. 177–198, 2000.
[7] C. G. Jones, J. H. Lawton, and M. Shachak. "*Organisms as engineers,"*Oikos, vol. 69, no. 3, pp. 373–386, 1994.
[8] R. Lal. "*Soil conservation and biodiversity," in The Biodiversity of Microorganisms and Invertebrates: Its Role in Sustainable Agriculture*, D. L. Hawksworth, Ed., pp. 89–103, CAB International,Wallingford, UK, 1999.
[9] S. Scheu. *"Effects of earthworms on plant growth: patterns and perspectives,* "Pedobiologia, vol. 47, no. 5-6, pp. 846–856, 2003.
[10] S. Coq, B. G. Barth`es, R. Oliver, B. Rabary, and E. Blanchart.*"Earthworm activity affects soil aggregation and organicmatter dynamics according to the quality and localization of crop residues—an experimental study (Madagascar),"* SoilBiology & Biochemistry, vol. 39, no. 8, pp. 2119–2128, 2007.

[11] P. Lavelle. *"Faunal activities and soil processes: adaptive strategies that determine ecosystem function,"* Advances inEcological Research, vol. 27, pp. 93–132, 1997.

[12] S. Scheu. *"Microbial activity and nutrient dynamics in earthworm casts (Lumbricidae),"* Biology and Fertility of Soils, vol. 5, no. 3, pp. 230–234, 1987.

[13] J. C. Y. Marinissen and P. C. De Ruiter. *"Contribution of earthworms to carbon and nitrogen cycling in agroecosystems,"* Agriculture, Ecosystems and Environment, vol. 47, no. 1, pp. 59–74, 1993.

[14] P. Mora, E. Miambi, J. J. Jim´enez, T. Deca¨ens, and C. Rouland. *"Functional complement of biogenic structures produced byearthworms, termites and ants in the neotropical savannas,"* Soil Biology & Biochemistry, vol. 37, no. 6, pp. 1043–1048, 2005.

[15] R. J. Haynes and P. M. Fraser. *"A comparison of aggregate stability and biological activity in earthworm casts anduningested soil as affected by amendment with wheat or Lucerne straw,"* European Journal of Soil Science, vol. 49, no. 4, pp. 629–636, 1998.

[16] R. D. Kale. *"Significant contribution with Vermiculture,"* in Proceedings of the DST and DBT Sponsored NationalSeminar Cum Workshop on Conservation and Inventerization of Soil Biota, Kathireswari and R. D. Kale, Eds., pp. 1–2,Tiruchengode, Tamil Nadu, India, 2008.

[17] R.W. Parmelee, P. J. Bohlen, and J. M. Blair. *"Earthworms and nutrient cycling processes: integrating across the ecologicalhierarchy,"* in Earthworm Ecology, C. Edwards, Ed., pp. 179– 211, St. Lucie Press, Boca Raton, Fla, USA, 1998.

[18] T. Bhadauria and P. S. Ramakrishnan. *"Earthworm population dynamics and contribution to nutrient cycling during croppingand fallow phases of shifting agriculture (jhum) in northeast India,"* Journal of Applied Ecology, vol. 26, no. 2, pp. 505–520, 1989.

[19] Barois and P. Lavelle. *"Changes in respiration rate and some physicochemical properties of a tropical soil during transit through Pontoscolex corethrurus (glossoscolecidae, oligochaeta),"Soil Biology & Biochemistry*, vol. 18, no. 5, pp.539–541, 1986.

[20] P.M Mele and M.R Carter. "*Species abundance of earthworms in arable and pasture soils in south-eastern Australia*", Appl. Soil Ecol. Vol.12,pp 129-137, 1999.

[21] C.A. Edwards and P. J Bohlen. "*The Biology and Ecology of Earthworms*", Chapman and Hall, 4th edition London. 1996.

[22] D.C Coleman and D.A Crossley. *"Fundamentals of soil ecology"*, Academic Press, San Diego, United States. Elsewire Science publishing co inc, 2nd (edi)ISBN10:0121797260. 2004.

[23] USDA. "*Agricultural management effects on earthworms population*". Technical note, No. 11: soil quality institute (www.soilusda.gov/squi). 2001.

[24] J.M, Anderson and J.S.I Ingram. "*Tropical Soil Biology and Fertility: a Handbook of Methods*", Second Edition. Edited by J M Anderson and JSI ingram with 13 appendices by various authors Wallingford. Oxforshire: CAB International, pp221. ISBN 0-85198-821-0. 1993.

[25] J. M. Julka. "*The fauna of India and adjacent countries: Megadrile Oligochaeta (Earthworms). Haplotaxida: Lumbricina: Megascolecoidea: Octochaetidae*, Editted by the director zoological survey of India – Printed at DOON phototype printers, 14, old Connaught place Dehradun Calcutta. 1988.

[26] J. Stephenson. "*The Fauna of British India including Ceylon and Burma. Oligochaeta*",– London. 1923.

[27] J. M. Julka. "*Distribution of earthworms in different agro-climatic regions of India. Workshop on Tropical Soil Biology and fertility programme*", pp. 1-12. – New Dehli: School of Environmental Science.2001.

[28] J. M. Julka and B. K. SenapathiI. "*Records of Zoological Survey of India: Earthworms*" (Oligochaeta: Annelida) of Orissa, India.- Miscellaneous Publication (Occasional Paper No. 92),Edited and published by the director Zoological Survey of India, Printed in India at graphic print all 31 B, Potteri road, Culcutta .1987.

[29] J. M Julka and R. Paliwal. "*On a new species of Plutellus Perrier (Acanthodrilidae: Oligochaeta) from northwest Himalayas, India*",– Research Bulletin of the Punjab University 44: 217-220. 1994.