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# An Assessment of Earthworm Population Density of different Habitat Types in a Mango Cultivation Region of Palakkad District, Western Ghats

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***Abstract:*** ***Earthworms are most important macrofauna in the soil, which plays a major role in soil fertility and nutrient cycling. The present study analysed population density of earthworms in four different habitats namely wooded grass land, irrigation canal, mango plantation with organic cultivation and mango plantation applying synthetic pesticides, in Muthalamada Panchayath, Palakkad District during June 2019 and June 2020. The study recorded five species of earthworms belonging to two families. Population density was varying in different habitats. From the study, it is observed that the intensive use agrochemicals have affected the earthworm diversity and population in the region.***
***Keywords: Earthworm, Population, Muthalamada, Mango Plantation, Pesticide***

## I. INTRODUCTION

Earthworms are considered as an important soil macro fauna, having intense effect on ecosystem. Merely half a dozen species of earthworms in India are regularly used for vermiculture and composting (Julka and Paliwal, 2005). The Indian subcontinent has massive fauna of oligochaetes, which are represented by 509 species and 67 genera (Julka, 1993). Reproductive strategies of earthworms population helps to determine the genetic diversity of these creatures. The different spatial occurrence of earthworms roughly determine three ecological categories in the soil layer. Epigeic species also known as leaf litter dwellers, 2-6cm long, they decompose fresh organic matter near to the soil surface.

They are small and mostly dark red, mainly inhabits grassland, forest and compost, rarely found in cropland due to lack of permanent litter layers. They have a vigorous reproduction rate but a short lifespan. Endogeic species are shallow burrowers, small up to 18cm long, decompose organic substances in the soil and live in horizontal unstable galleries in the root area of the upper soil layer. Their reproduction rate is limited (8-12 cocoons/year) and lifespan is medium (3-5 years). Anecic species (deep burrowers, 15-45cm long) pull plant parts from the soil surface into their vertical stable burrows (diameter of 8-11mm), where they decompose partly and get ready for feeding. Because of their behavior, they are particularly sensitive to soil tillage at times, when they are active. Reproduction rate is limited and lifespan long. Adult animals deposit their faeces into the soil or above ground. Earthworms influence the supply of nutrients through their tissues but largely through their burrowing activities; produce aggregates and pores (i.e., bio structures) in the soil and/or on the soil surface, thus affecting its physical properties, nutrient cycling, and plant growth (Animesh *et al*., 2014, Subin *et al*., 2015, Bhaduarria *et al*., 2000). Earthworms can indicate soil quality by (1) the abundance and species composition at a particular site, (2) the behavior of individuals in contact with a soil substrate (preference/avoidance/activity), (3) the accumulation of chemicals from the soil into the body, and (4) the biochemical/cytological stress-biomarkers in the earthworm(Ayten Karaca, 2011).

In an agricultural ecosystem, earthworms plays several beneficial roles for improving fertility of the soil and are called as cultivators of land. Their habit of burrowing and swallowing helps to increase the mobility and availability of nutrients in soil. Their burrow permits the penetration of air and moisture in the porous soil and improves the drainage; make the downward growth of the roots easier. The earthworms are continuously dragging dead leaves in to their burrows to eat them. They are only partially digested and their remains are thoroughly mixed with the castings. The earthworms consume the soil and organic matter and convert it into humus within short period of time and thereby increasing soil fertility. Reproduction and cocoon production is possible throughout the year.

The use of inorganic agriculture practices kill earthworms besides the target organisms. They are very susceptible to minimal dosages of agrochemicals, thus used as bio indicator of soil contamination providing an early warning of decline in soil quality. They serve as model organisms in toxicity testing. Earthworms are characterized by high ability to accumulate a lot of pollutants from soil in their tissues, thus they are used for studying of bioaccumulation potential of chemicals. A microcosm study conducted in orchards in the South Africa indicated adverse effects of spraying by pesticides (Chlorpyrifos and Azinphos methyl) on earthworm's biomass and cholinesterase activity. Authors concluded that earthworms were detrimentally affected by the pesticides due to chronic and intermittent exposure (Reinecke, 2007). A laboratory experiment that reproduced vineyard conditions in France showed that mixture of insecticides and/or fungicides at different environmental concentrations caused a neurotoxic effect in earthworms. After a long period of exposure or high concentrations, earthworms were physiologically damaged and could not cope with the high toxicity (Schreck *et al*., 2008). The earth worm diversity and population density in Western Ghats was poorly studied especially in the intensive agricultural regions and mono culture plantations. The present study aims to estimate the population density of earthworms in different habitat types in and around the mango cultivating regions of Muthalamada, to understand the impacts of land use and cultivation practices on the diversity of earthworms.

## II. MATERIALS AND METHODS

### A. *Study Area*

Muthalamada is a village in Palakkad District in central Kerala, bordering with Tamil Nadu, is well known for mango plantation. Its geographical coordinates are 10° 38' 0" North, 76° 48' 0" East. The harvest season in Mango plantations in muthalamada begins by February end and goes on till the end of July. Muthalamada mango orchards well-known for the usage of extensive pesticides. The classification of study area were given in the table.1

### B. *Earthworm Sampling and Preservation*

The sampling location was located based on availability of worm caste on soil surface and humidity. Adult worms were collected by digging a pit of 25 X 25 cm to the depth of 30 cm and hand sorting method; the earthworms were sorted, washed with water and then preserved in 4% formalin (Julka, 1993, Julka, 1988). Collection was done during month of July 2019 and July 2020. The collected specimens were identified using systematic taxonomic procedures and keys with the help of experts.

Earthworm population density (EPD) was determined by the formula:

EPD = Total no of earthworms in a sampling area / Sampling area (0.0625 $m^2$)

## III. RESULT

In the present study, five different species of earthworms were identified which belonging to family Benhamiidae and Megascolicidae. During the study period (2019-2020) a total of 697 specimens were collected. The results are shown in Table 2 and 3. Among these specimens, 293 were identified with developed clitellum (mature worms). The study shows the presence five species namely *Dichogaster affinis* (Michaelsen, 1890), *Perionyx excavates* (Perrier, 1872), *Megascolex konkanensis* (Fedarb, 1897)*), Metaphire houlleti* (Perrier, 1872) *and Megascolex sps*. The family Megascolex represents the highest species diversity with three Megascolex species followed. These results are comparable with the finding of Julka (2005). It is observed that earthworm population density is law in inorganic mango plantation, followed by grass covered portion with wooded area(chemmanampathi), water canal and organic mango plantation. Population density of *Perionyx excavates* was high in the study area and it was widely distributed in all the habitats. *Dichogaster affinis* is an exotic species which is widely distributed in the soils of mango plantation. The ecological categories of earthworms were given in the table 4.

## IV. DISCUSSION

Mariappan *et al*., 2014 studied earthworm abundance in Rajapalayam cultivated lands, reported *Lampito mauritii* and P. *excavates* in paddy field, sugarcane farm, banana plantation, coconut grove and mango farm. They also assessed population density of earthworm and observed that lowest density in mango plantation while, coconut farm has highest density. Chaudhuri *et al*., (2008) reported *Dichogaster affinis* in rubber plantations of Tripura. Julka, (1988) also reported *Dichogaster affinis* from Shasthankottah, Trivandrum (Thiruvananthapuram). *Metaphire houletti* also recorded from Coconut plantation, manure heap, cocoa plantation, rubber plantations in Karnataka State (Siddaraju *et al*., 2010). *Megascolex konkanensis, Metaphire houlleti, megascolex sp.* were recorded in the agro climatic regions of Wayanad District(John *et al*., 2019). 10 different species of earthworms were obtained from different land areas like crop lands, agricultural lands, dense forests and river side's ecosystems in Wayanad which includes *Perionyx excavates (*Jijo *et al*., 2019*).*

In the present study the maximum number of earthworms recorded were *Megascolex konkanensis* and *Perionyx excavates* from a water canal which is 2 km apart from the mango plantation. *Dichogaster affinis* , was evenly distributed all over the study area. Moreover these earthworms were distributed all over Kerala (Achuthan *et al*., 2017, Harish kumar *et al*., 2018, Prasanth narayanan *et al*., 2014). *Eisenia fetida* (Savigny, 1826), *Pontoscolex corethrurus*(Müller, 1857), *Eudrilus eugeniae* (Kinberg,1867), *Nematogenia panamaensis* (Eisen,1900), *Metaphire houletti* (Perrier, 1872), *Polypheretima elongata* (Perrier, 1872), *Polypheretima taprobanae* (Beddard, 1892), *Ocnerodrilus occidentalis* (Eisen, 1878), *Pontodrilus litoralis* (Grube, 1855), *Dichogaster affinis* (Michaelsen, 1890), *Dichogaster annae* (Horst, 1893), *Dichogaster bolaui* (Michaelsen, 1891), *Gordiodrilus elegans* (Beddard, 1892), and *Pithemera bicincta* (Perrier, 1875) are the exotic earthworms so far reported from Kerala state (Stephenson 1923, Aiyer 1929, Julka & Paliwal 1990, Kathireswari *et al*. 2005, Narayanan *et al*. 2012). *Metaphire houletti* (Perrier, 1872), *Dichogaster affinis* (Michaelsen, 1890) were recorded in the Muthalamada mango plantation and it recorded that native species was less compared to other habitats. The population density was high in mango plantation with organic cultivation practices during last samplings especially *Metaphire houlleti* followed by *Dichogaster affinis* and *Megascolex konkanensis*. *Megascolex* sp. was also recorded in all habitats except mango plantation with inorganic cultivation. Sreelakshmi *et al*., (2017), previously reported *megascolex konkensis* were recorded from Palakkad District. According to Julka (1993), family Megascolecidae, the distribution range of this family extends between Asia- and Australia. Megascolex and perionyx are confined to southern portion of Western Ghats. A few peregrine forms also introduced in soil in and around the roots of exotic plants which include Megascolecidae family. Successful colonization of peregrine species is mainly due to their tolerance to a wide range of ecological conditions. The reason for low population density in plantations is soil tillage and pesticide application. In water canals and mango plantation with organic cultivation practices the density was high which indicates better ecosystem services, such as decomposition of organic residues are carried out and the porosity is improved for infiltration. Endogeic species seem to adapt better to disturbances caused by ploughing and may benefit from soil inversion because of the incorporation of organic matter (Pelosi *et al*., 2009). In arable soils, densities of epigeic species are low, depending on the amount of organic residues at the soil surface, since they are living in the mulch layer. They are better indicators of disturbances in soil. But in the present study total number of juvenile was 152, means a high reproduction rate and habitat suitability in canal area. The total earthworm density increases significantly with reduced tillage, due to the increased number of juveniles, while numbers of cocoons were many times higher with reduced tillage (Kuntz *et al*., 2013). But in the present study no cocoons were observed in any of the sampling locations.

## V. CONCLUSION

From the study it was observed that organic cultivation farm followed by natural habitat have high population density and least in plantation with inorganic cultivation practices Earthworms are highly susceptible to insecticides causing immobility, rigidity and also show a significant effect on biomass reduction, growth and reproduction by disrupting various physiological activities leading to loss of earthworm population and soil biodiversity. So the application of chemical pesticides has significantly affected the population density of earth worms in Muthalamada mango planations.

## VI. ACKNOWLEDGEMENT

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## VII. CONFLICTS OF INTEREST

Authors declares no conflicts of interest

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## TABLES

Table 1. Sampling sites

| Sampling site | Location | Characteristics |
|---|---|---|
| Grass covered portion with wooded area(S1) | $10^0$ 35’ 41.09’’<br>$76^0$ 47’ 36.20’’ | Standing crop field, zero tillage with grass cover |
| Irrigation canal(S2) | $10^0$ 35’ 29.43’’<br>$76^0$ 45’ 08.08’’ | Sandy soils was moist due to regular water supply for the fields |
| Organic Mango Plantation(S3) | $10^0$ 35’ 35.21’’<br>$76^0$ 47’ 36.20’’ | Mango plantation with weed cover but intensive management |
| Inorganic Mango Plantation(S4) | $10^0$ 34’ 37.77’’<br>$76^0$ 45’ 56.91’’ | Inorganic pesticide application with cultivation and intensive weed management |

Table 2- Earthworm distribution in the soils of Muthalamada (2019)

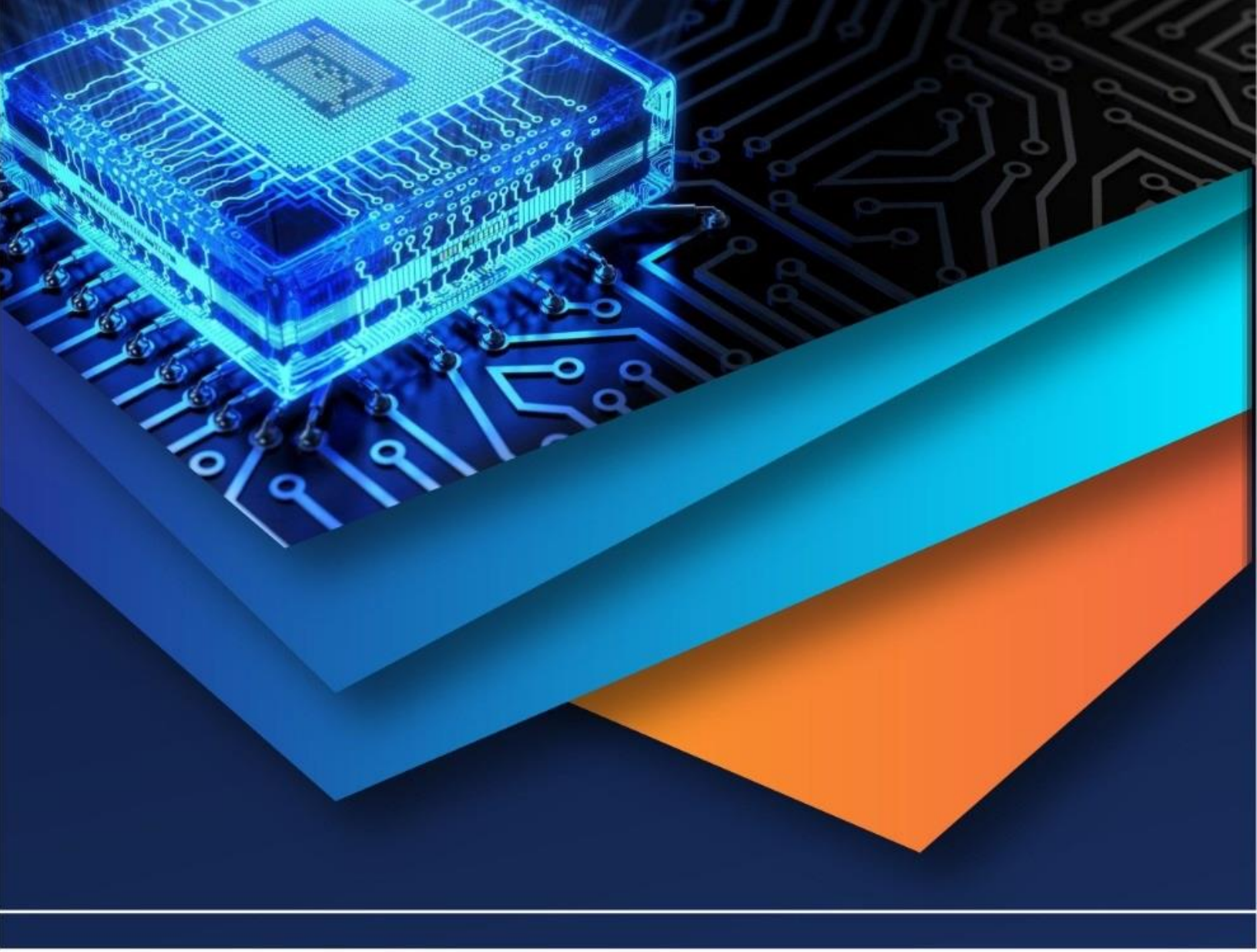
| study area | Species | Total number | EPD |
|---|---|---|---|
| S1 | *Dichogaster affinis* | 8 | 128 |
| | *Perionyx excavatus* | 33 | 528 |
| | *Megascolex konkanensis* | 60 | 960 |
| | *Metaphire houlleti* | 0 | 0 |
| | *Megascolex sps.,* | 0 | 0 |
| S2 | *Dichogaster affinis* | 13 | 208 |
| | *Perionyx excavatus* | 65 | 1040 |
| | *Megascolex konkanensis* | 33 | 528 |
| | *Metaphire houlleti* | 0 | 0 |
| | *Megascolex sps.,* | 0 | 0 |
| S3 | *Dichogaster affinis* | 3 | 48 |
| | *Perionyx excavatus* | 22 | 352 |
| | *Megascolex konkanensis* | 41 | 656 |
| | *Metaphire houlleti* | 0 | 0 |
| | *Megascolex sps.* | 4 | 64 |
| S4 | *Dichogaster affinis* | 8 | 128 |
| | *Perionyx excavatus* | 0 | 0 |
| | *Megascolex konkanensis* | 4 | 64 |
| | *Metaphire houlleti* | 7 | 112 |
| | *Megascolex sps.,* | 0 | 0 |

Table -3 Earthworm distribution in different habitats of Muthalamada (2020)

| study area | Species | Total number | EPD |
|---|---|---|---|
| S1 | *Dichogaster affinis* | 10 | 160 |
| | *Perionyx excavatus* | 40 | 640 |
| | *Megascolex konkanensis* | 70 | 1120 |
| | *Metaphire houlleti* | 0 | 0 |
| | *Megascolex sps.,* | 7 | 112 |
| S2 | *Dichogaster affinis* | 15 | 240 |
| | *Perionyx excavatus* | 49 | 784 |
| | *Megascolex konkanensis* | 38 | 608 |
| | *Metaphire houlleti* | 0 | 0 |
| | *Megascolex sps.,* | 0 | 0 |
| S3 | *Dichogaster affinis* | 3 | 48 |
| | *Perionyx excavatus* | 51 | 816 |
| | *Megascolex konkanensis* | 84 | 1344 |
| | *Metaphire houlleti* | 6 | 96 |
| | *Megascolex sps.,* | 0 | 0 |
| S4 | *Dichogaster affinis* | 10 | 160 |
| | *Perionyx excavatus* | 0 | 0 |
| | *Megascolex konkanensis* | 6 | 96 |
| | *Metaphire houlleti* | 12 | 192 |
| | *Megascolex sps.* | 0 | 0 |

Table 4- Ecological categories of sampled earthworm

| Sl No | Family | Species | Ecological Category | Native/Exotic | Habitat |
|---|---|---|---|---|---|
| 1 | Benhamiidae | *Dichogaster affinis* | Epegeic | Exotic | Grass areas |
| 2 | Megascolecidae | *Perionyx excavatus* | Epigeic | Exotic , Endemic peregrine | Water canal |
| 3 | Megascolecidae | *Megascolex konkanensis* | Endogeic | Native | Open ground areas |
| 4 | Megascolecidae | *Metaphire houlleti* | Epianecic | Exotic, Endemic peregrine | well wooded areas |
| 5 | Megascolecidae | *Megascolex sp.* | Epigeic | Native | Water canal |



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