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Earthworm Diversity and Analysis of Soil Inhabited by Earthworms in the Vatakara area, Kozhikode, Kerala, India

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A B S T R A C T

A comprehensive study was conducted on the distribution of different species of earthworms in relation to geographic regions of the Vatakara taluk located in Kozhikode District, Kerala, India. We selected different ecosystems present in the Vatakara, which includes near costal region, agro ecosystem, forest land and the polluted ecosystem. The role of earthworm in soil biology is well studied. As natural bioreactor they convert organic waste in to organic manure. Along with these functions they play a crucial role in soil porosity, soil fertility, soil health and productivity, balance of green house gases etc. The present study reveals that six different species of earthworms found in four different study sites and influence of the soil parameters like Nitrate, Phosphate, Magnesium and Calcium on earthworm diversity.

Introduction

Earthworms belong to the phylum Annelida, class Oligochaeta, and evolved in last Precambrian period (Darwin 1890). They have the applications in both agro-ecosystem and therapeutic areas and also used for the solid waste management. India is one of the major earthworm diversity countries and has 11.1% available out of total earthworm diversity in the world. Totally 505 species and sub species of earthworm belonging to 67 genera and 10 families have been identified from the India (Kathireswari, 2016). The earthworm diversity of the study region is predominantly represented by native species (357 spp,) which constitute 88.8% of total earthworm diversity. Though the majority of Indain earthworm has specific preference for natural habitats, a few exotic ubiquitous Indian species have successfully colonized in different agro ecosystems. Julka (2001) has divided earthworm diversity zones in India, *viz.,* mega diversity, high diversity, medium diversity, low diversity, and poor diversity zones. Some exotic peregrine species mostly occur in disturbed habitats created by deforestation and intensive cultivation. Success full colonization of almost all agro climatic zones in India by the exotic species is mainly due to their inherent

ability to withstand disturbance and interference (Julka 1988). Some widely distributed native peregrine species are able to tolerate disturbed conditions. There are some ecological types of earthworm have been recognized viz., epigeic, endogeic, anecic.

In agriculture ecosystem earthworms play a beneficial role and are called as cultivators of land. Their habitat of burrowing and swallowing helps to increase the fertility of soil in many ways. 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.

Earthworm provides optimum conditions for plant growth by reducing both acidity and alkalinity of soil. Plant growth stimulants such as auxins are produced in the earthworm castings. These hormones stimulate roots to grow faster and deeper. A more important beneficial effect of soil is the mixing and changing of soil texture caused by burrowing and improves water filtration rates and absorption rates of soil. The tunneling activity improves soil aeration and permeability. It increases water holding capacity of the soil and it carries out high turnover soil.

The present study of earthworm diversity and analysis of soil inhabited by the earthworms are conducted in the four different sites of Vatakara, Kerala that including near coastal region, agro-ecosystem, forest land and polluted ecosystem.

Materials and Methods

Study Site

Vatakara is located at 11.60°N 75.58°E. It has an average elevation of 15 m (49 ft). Geographically, Vatakara is situated about 48 km to the north of Kozhikode City, approximately 44 km to the south of Kannur City and it is proximate to Mahe (Mahe district). This is the third largest town of North Malabar. The town lies by the side of a river known by different names as Moorad river, Kuttiadi river or Kotakkal river. Originally known as *Vadakkekara* (north shore). It has a good beach called Sand Banks that's near Vatakara municipality. Rainfall is significant for most of the months and the rainfall here averages about 3508 mm. The average annual temperature in Vadakara is 27.3 °C.

Soil Analysis

Soil analysis was done by titration method. The methods of soil analysis are given below.

Determination of Nitrate in Soil Sample

10 g of soil sample was mixed with 100ml of distilled water and 10ml of soil solution is filtered in test tube and added 0.2ml of sulphanyilic acid and 0.2ml of 0.5% α-naphthalamine solution. The development of pink colour was observed. The intensity of pink color is measured in colorimeter at 530 nm and 10 ml of distilled water is used as blank.

Determination of Phosphate in Soil Sample

10g of soil sample was dissolved in 100ml of distilled water and filtered using whatman no 1 filter paper. 2.5ml of filtrate was taken in a test tube and add 0.5ml of ammonium molibdate and 0.3ml of elon. Then it is kept for 15 minute for the development of blue color and it was measured at 650nm in calorimeter.

Determination of Magnesium in Soil Sample

10g of soil sample was dissolved in 100ml of distilled water and filtered using whatman no.1 filter paper. 20ml of the filtrate was taken in a conical flask and add 1ml of buffer solution and 1ml of erychrome black T indicator and it was titrated against EDTA solution in the burette. The color changes from pink colour to greenish blue was observed as final results and the burette reading was noted and calculated.

Determination of Calcium in Soil Sample

10g of soil was dissolved in 100ml of distilled water and filtered using whatman no.1 filterpaper. 20ml of the filtrate was taken in a conical flask and add 1ml of sodium hydroxide followed by 200mg of indicator mixture. A pink color develops and it was titrated against EDTA from the burette. The pink color changes to purple color and this is an end point.

Earthworm Collection and Preservation

Adult earthworms were collected from the four regions viz., agricultural land, forest region, land near by coastal region and polluted area of Vataka region, Kozhikode, Kerala, India by digging and hand sorting method (Julka 1993). Collection was done during the month of December 2015. The collected specimens were identified up to species level by Dr. (Mrs.) P. Kathireswari. The presence of earthworm was located based on the availability of worm casts on the surface soil and color and humidity of soil. Adult earthworms were sorted and taken in to the college laboratory along with their native soil. Then they are washed with distilled water and preserved in formalin solution for identification.

Results and Discussion

The earthworm survey conducted in 4 different stations of Vatakara taluk revealed that the occurrence of six species of earthworms belonging to five families namely Megascolecidae, Glossoscolecidae, Almidae, Octochaetidae, Lumbricidae collected from different habitat such as forest area, polluted area, land near by sea shore, and agro ecosystem. The different species of earthworms and their stations are given in table 2.

Earthworm Fauna

The list of six earthworm species belonging to five families sampled from four different stations of Vatakara and it was ecologically categorized into three types are given in the table 5.

Details of sampled earthworm from four different stations of Vatakara, Kozhikode, Kerala.

Glyphidrilus annandalei

Taxonomy: It is included in the phylum-Annelida, class-Clitellata, sub class-Haplotaxida, family-Almidae

Distribution: This species was known from India: Malabar Coast, Travancore, Coorg, Mysore, Calicut, Malapuram and Tiruvallur, Gadana River, and tributaries in the buffer zone of Kalakkad-Mundanthurai Tiger Reserve from a sub basin of the river in the southern Western Ghats, Bangalore, and Bhadravatha and along the edge of Bhavani River, northern parts of Tamil Nadu, and southern parts of Karnataka, India. Sandy banks of the Harangi, Madapur (Coorg), and of the Cauvery, Dubari forests, Fraserpett (Coorg).

Argilophilus variabilis (Aiyer, 1929)

Taxonomy: It is included in the phylum-Annelida, Class-Clitellata, Subclass-oligochaeta, Order-Haplotaxida and famil-Megascolecidae.

Distribution: Neartic, oriental

Eisenia fetida

Taxonomy: It is included in the phulum-Annelida, class-Oligochaeta, order-Haplotaxida, family-Lumbricidae

Distribution: They are native to Europe, but have been introduced to every other continent except Antarctica.

Dichogaster bolaui

Taxonomy: It is included in phylum-Annelida, Class-Clitellata,Order-Haplotaxida, Suborder-Lumbricina and family-Octochaetidae

Distribution: *Dichogaster bolaui*, one of the most frequent peregrine species in tropical and subtropical regions . This species has an eastern African origin. In cold temperate countries, it has been reported only in greenhouses. However, Terhivuo and Erse´us et al., have repeatedly found the species within the sewerage systems of buildings.

Lampito mauritii

Taxonomy: It is included in phylum-Annelida, Class-Clitellata, Subclass-Oligochaeta, Order-Haplotaxida, Suborder-Lumbricina, and family-Megascolecidae

Distribution: It is a peregrine species, distributed all over the world. Its habitat include garden, manure heaps, field etc.

Pontoscolex corethrurus

Taxonomy: It is included in the phylum-Annelida, Class-Oligochaeta, Order-Opisthopora and family-Glossoscolecidae.

Distribution: Cosmopolitan. This species is originally endemic to tropic America. At present it has pantropical distribution caused by human activity and is one of the most widely spread earthworms in the world. In India and Taiwan, this species is widely distributed. It is also recorded in the Lanyu, Siaoliouciou, Turtle and Kinmen Islands.

The study showed that the family Megascolecidae was dominant in the two habitats of the study area. The earthworm species *Lampito mauritii* was seen in both polluted area as well as land near by sea shore. This may be due to their high innate immunity to withstand disturbed conditions. Among the six species four species are epigeic and one species is anecic and the other one is endogeic. Epigeic species are *Glyphidrilus annandali, Argilophilus variabilis* and *Dichogaster bolaui.* Anecic species is *Lampito mauritii* and endogeic species is *Pontoscolex corethrurus.* The study revealed that the three species are exotic and other three species are native to India. According to Julka (1998) earthworms in India have been introduced in to the new areas by man and other agencies along with the import of soil containing materials (Plants, agricultural and horticultural products) and the species colonize successfully due to their inherent ability to withstand disturbance and interference..

Results of Soil Analysis

The results of soil analysis showed that earthworm containing soil have the high macronutrients as well as micronutrients

content. In the present study the nitrate, and magnesium level are high in forest area and low in land near by sea shore when compared to other region. The high level of nitrate and phosphate in forest area may be due to the presence of more leaf liters and their decomposition by microbes as well as swallowing of leaf liters by earthworms. But in land near by sea shore was found to be less in nitrogen and phosphorus availability. This may be due to the sandy soil type of that area and there is no any leaf liters and organic debris seen when compared to that of forest ecosystem. In agro ecosystem the nitrate level is moderate when compared to others .The phosphorus level is high in the agro ecosystem.. This may be due to the presence of fertilizers. The earthworms also play an important role in maintaining this nutrient in agro ecosystem. The result of soil nutrient levels is given in table 4.

In forest area 37% of Nitrogen is present. It is highest value when compared to other areas.But in land near by sea shore less percentage (14%) of nitrate was found. In agro ecosystem 32% of nitrates were observed, may be due to chemical fertilizers applied in that area and in polluted area it was about 17%. The percentages of nitrates were presented in the graph 1.

Among the nutrients analyses, the phosphates were found to be higher amount in agro ecosystem (35%). The minimum levels of phosphate were found to be in the polluted area and it was about (16%). In forest area the phosphate level was found to be about (31%) and in land near by sea shore is about 16%. The percentage of phosphate in different sampled stations are given in graph 2

The amount of Magnesium in soil was found to be higher in forest area (35%). In the land near by sea shore and in the polluted area the presence of magnesium was found to be 17%. But in agro ecosystem it wasx about 31%. The percentage of magnesium in different sampled stations of Vatakara are given in the graph 3.

The high amount of calcium were analyzed in the agro ecosystem, and it was found to be 32%. Among the four sampled stations 19% of calcium was found to be in the land near by sea shore. In forest area 29% of calcium were analyzed. And in polluted area it was found to be 20%. The percentage of calcium in different sampled stations is given in graph 4

Vatakara taluk contain different geographical regions such as sea shore, agro ecosystem, and forest area. The soil of these regions may vary according to these habitats. The soil analysis of this region revealed that the presence of more amount of nutrients in the forest ecosystems followed by agro ecosystems. In agro ecosystem high phosphate and calcium was high when compared to the other areas. The minimum levels of nutrients were found in land near by sea shore as well as in the polluted area. The high content of nitrate in forest may be due to the presence of leaf liters and also because of the less anthropogenic activities.

The soil nutrient plays an important role in plant growth as well as the earthworm diversity. Nitrogen is an important building block of proteins, nucleic acids, and other cellular constituents which are essential for all forms of life. Plants normally take up majority of nitrogen they require as nitrate, which is a form of nitrogen that is found in the soil and also mineral fertilizer. In the present study the high amount nitrate were found in forest area, so the earthworm diversity of these area have the maximum diversity when compared to other areas.

Table.1 Earthworm Species from Different Study Stations of Vatakara, Kozhikode, Kerala

Sl No	STATION	Species of Earthworm
1	Agricultural land	*Pontoscolex corethrurus*
2	Land near by sea shore	*Lampito mauritii,* *Eisenia fetida* *Pontoscolex corethrurus*
3	Forest area	*Glyphidrilus annandalei* *Argilophilus variabilis* *Dichogaster bolaui*
4	Polluted area	*Lampito mauritii*

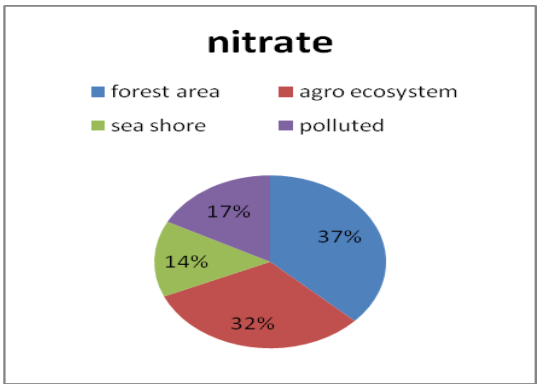
Table.2 List of Earthworm Species, Families and Ecological Categories

Sl No.	Family	Species	Ecological Category	Native/ Exotic
1	Megascolecidae	1.*Argilophilus variabilis* 2.*Lampito mauritii*	Epigeic Anecic	Native Native
2	Glossoscolecidae	3.*Pontoscolex corethrurus*	Endogeic	Exotic
3	Almidae	4.*Glyphidrilus annandalei*	Epigeic	Native
4	Octochaetidae	5.*Dichogaster bolaui*	Epigeic	Exotic
5	Lumbricidae	6.*Eisenia fetida*	Epigeic	Exotic

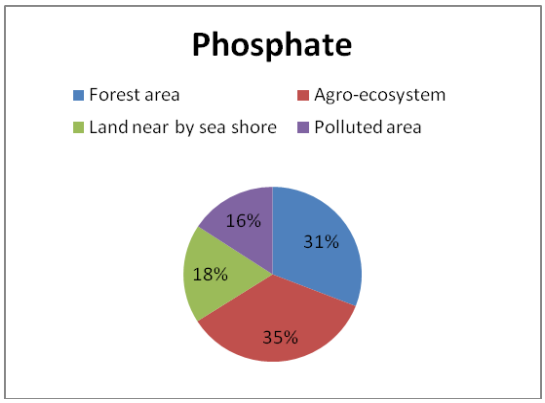
Table.3 Soil Nutrients of Different Earthworm Sampled Stations of Vatakara, Kozhikode, Kerala

Soil nutrients	Nitrate	Phosphate	Magnesium	Calcium
Forest area	30 ppm	49 ppm	140 ppm	1006 ppm
Agro-ecosystem	25.4 ppm	55.6 ppm	122 ppm	1124 ppm
Land near by sea shore	11.6 ppm	28.9 ppm	67.4 ppm	668 ppm
Polluted area	14 ppm	25 ppm	86.6 ppm	702 ppm

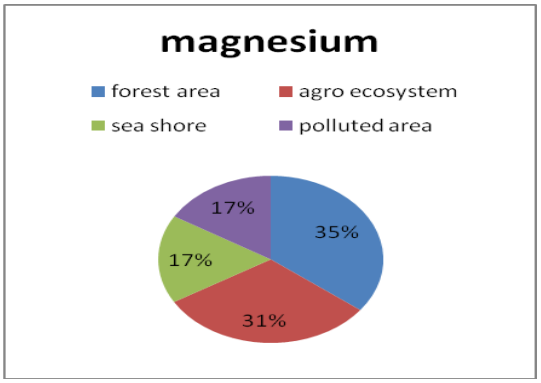
Graph.1 Showing Percentage of Nitrates in Different Earthworm Sampled Stations in Vatkara



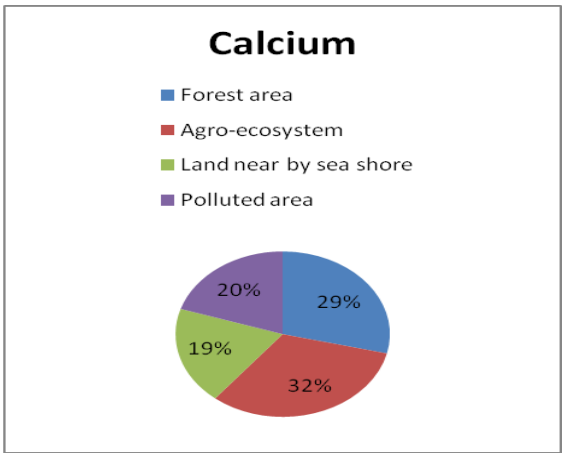
Graph.2 Showing the Percentage of Phosphate in Different Earthworm Sampled Stations in the Vatakara, Kozhikode, Kerala



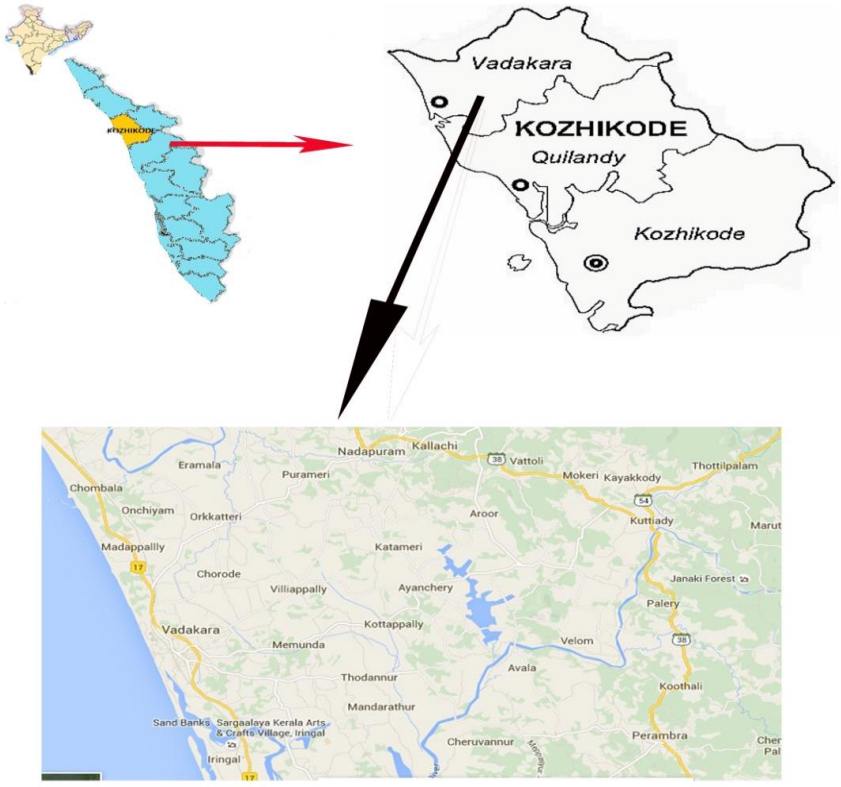
Graph.3 Showing Percentage of Magnesium in Different Earthworm Sampled Stations in Vatakara



Graph.4 Showing Percentage of Calcium in Different Earthworm Sampled Stations in Vatakara



MAP 1 SHOWING STUDY AREA



The phosphate provides plants with a means of using the energy harnessed by photosynthesis to drive its metabolism. A deficiency of this nutrient can lead to impaired vegetative growth, week root systems etc. in plants. In the present study the high level of phosphate contents has found in agro ecosystem and also in the forest area. But in other two areas only minimum level of phosphate was found.

The magnesium were found to be more in the forest ecosystem and low amount in the polluted area. Magnesium acts together with phosphorous to drive plant metabolism and is part of chlorophyll, a vital substance for photosynthesis.

Regarding the analysis of calcium the result showed that maximum amount of calcium was found in the agro ecosystem and low amount of calcium were found in the land near by sea shore. The calcium is essential for the proper functioning of plant cell walls as well as the membranes.

There are six different species belonging to five family have been observed in the four different stations of Vatakara, Kozhikode, Kerala. In which forest area contains 3 different species of earthworms namely *Glyphidrilus annandali, ?Argilophilus variabilis,* and *Dichogaster bolaui.* The soil analysis result of this region showed that presence of high amount of soil nutrients when compared to other regions. This may

be due to less anthropogenic activity and also high leaf litters. The present study revealed that the *Lampito mauritii* was predominantly observed in polluted area, Vatakara and also in land near by sea shore areas. This may be due to dumping of solid wastes, domestic waste from houses which is being polluted by decomposing activities of the microbes which enhances the favorable soil conditions for the growth and reproduction of this species. Earthworm species *Lampito maurtii* can with stand in any conditions because it is a peregrine species. Naturally earthworm's shows high resistance in adapting to various soil conditions which are highly contaminated by various factors. In the case of *Lampito mauritii* it has high adaptability and natural innate immunity resistance power to withstand against various soil climatic conditions which unfavours the growth or presence of other earthworm species in their locality.

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