COMPARATIVE ANALYSIS OF EARTHWORM POPULATIONS AND SOIL CHARACTERISTICS IN DIFFERENT HABITATS

DISSERTATION
Submitted to the University of Kerala
in the partial fulfilment of the requirement for the
BACHELOR OF SCIENCE IN
ZOOLOGY

Department of Zoology
TKM COLLEGE OF ARTS AND SCIENCE, KOLLAM-5

APRIL 2025

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CERTIFICATE

This is to certify that the dissertation entitled ***"Comparative Analysis of Earthworm Populations and Soil Characteristics in Different Habitats''*** is a bonafide work done by ……………………………………………………....................under my supervision as partial fulfillment of the requirements for the ***Degree of Bachelor of Science in Zoology*** and this report has not been submitted earlier for the award of any degree or diploma or any other similar titles anywhere.

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Examiners: 1.

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DECLARATION

I do hereby declare that this dissertation entitled ***“Comparative Analysis of Earthworm Populations and Soil Characteristics in Different Habitats’’*** is a bonafide work done by me under the supervision of Dr. Mumthas Y., Assistant Professor, Department of Zoology, TKM College of Arts and Science, Kollam as partial fulfilment of the requirements for the award of ***Degree of Bachelor of Science in Zoology***. No part of this has been presented earlier for any degrees or diploma of any university.

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Karicode
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CONTENTS

I. INTRODUCTION

Soil is a vital component of our ecosystem, and its importance cannot be overstated. It provides essential ecosystem services that support life on Earth. One of its most fundamental roles is supporting plant growth by supplying nutrients, water, and oxygen. Soil also acts as a natural filter, helping to purify water by trapping sediments and pollutants before they reach waterways. Additionally, it plays a critical part in regulating the Earth's climate by storing and releasing carbon dioxide. Soil is incredibly biodiverse, serving as a habitat for approximately a quarter of all living organisms, including microorganisms, insects, and plant roots.

In terms of food security, soil is the foundation of our agricultural systems. It provides the necessary elements for crop production and supports a wide variety of plant species, ensuring food diversity and nutrition. Moreover, healthy soil is essential for livestock farming as it supplies grazing areas and the nutrients needed for growing animal feed. Without fertile soil, sustaining food production and feeding the global population would be impossible. Environmentally, soil offers numerous benefits. It plays a significant role in carbon sequestration, helping to mitigate climate change by storing carbon. Soil also regulates the water cycle by absorbing rainfall and preventing both floods and droughts. It stabilizes landscapes by preventing erosion, landslides, and sedimentation. Furthermore, soil contributes to waste management by filtering and breaking down pollutants and organic matter.

Soil also impacts human health in several ways. It contributes to nutrient cycling, providing essential vitamins and minerals that are transferred to plants and eventually consumed by humans. Soil is the source of many life-saving medicines, including antibiotics and vaccines, thanks to the diverse microbes it harbours. Additionally, it supports recreational activities and tourism, providing natural spaces for hiking, camping, and other outdoor pursuits. Economically, soil underpins agricultural productivity, which is vital for local and global economies. It plays a key role in urban development, serving as the foundation for buildings and infrastructure. Effective natural resource management depends on the conservation and sustainable use of soil to ensure long-term productivity and environmental health.

Soil pollution can have devastating effects on earthworm populations, which are vital for soil formation and maintaining ecosystem balance. As highly sensitive organisms, earthworms serve as excellent bio-indicators of soil health their presence or absence often reflects the degree of contamination in the environment. One of the major impacts of soil pollution on earthworms is metal toxicity. Heavy metals such as cadmium, lead, and mercury can lead to oxidative DNA damage, bioaccumulation in tissues, and, in severe cases, death. In addition to toxicity, pollutants can interfere with earthworm reproduction, causing reduced cocoon production and lower hatching rates. Behavioral changes are also commonly observed in polluted environments, with earthworms displaying altered burrowing patterns or avoidance behavior in contaminated soils. On a physiological level, exposure to pollutants may lead to changes in body weight, deformities, and disruptions in internal organ function.

Earthworms play an essential role in sustaining healthy soil ecosystems. Through their burrowing activity, they facilitate soil formation and improve aeration and structure. They are key agents of nutrient cycling, breaking down organic matter and making nutrients more accessible to plants. Furthermore, earthworms contribute to ecosystem stability by serving as a food source for other organisms and helping regulate soil microbial populations.

Earthworms have long been recognized as ecosystem engineers, significantly influencing soil structure, nutrient cycling, and overall soil fertility (Edwards and Bohlen, 1996). Their activities such as burrowing and organic matter breakdown not only enhance soil aeration and water retention but also promote the bioavailability of nutrients essential for plant growth. Because of their intimate contact with the soil environment and their ability to accumulate pollutants, earthworms have been widely regarded as suitable bio-monitoring organisms for assessing soil health and pollution (Spurgeon et al., 2003; Nahmani et al., 2007).

Given their ecological significance, the decline of earthworm populations due to soil pollution can trigger a cascade of negative effects across entire ecosystems. It is crucial to monitor soil quality and implement pollution mitigation strategies to protect these indispensable soil engineers. Earthworms play an important role in the soil macrofauna biomass (Steenbergen etal., 2005). They are extremely important in soil formation, principally by consuming organic matter, fragmenting it, and mixing it intimately with soil mineral particles to form water-stable aggregates. In particular, the bioaccumulation ability of earthworms is essential for a bio-monitoring organism. Therefore, the earthworm is likely to be an excellent organism for this purpose (Edwards and Bohlen, 1996).

A bio-monitoring method would be appropriate to evaluate metal toxicity, because of its sensitivity and availability for unknown metabolites. Organisms such as fish, snails, and plants have been employed as bio-monitors. Although this approach is useful and promising, it is also somewhat limited, because it could be available only for a specific combination of a living organism with certain substances. Hence, it is important to find appropriate living organisms as bio-monitors for each type of assessment (Lavelle and Spain, 2001; Fent, 2013).

The primary aim of this study is to gather detailed information on the distribution of different earthworm species across Kollam and Alappuzha districts and to analyze how geographic and edaphic factors influence their diversity and abundance. Understanding these relationships is crucial not only for ecological monitoring and conservation efforts but also for enhancing soil management practices that can improve agricultural productivity and sustainability in the region.

II. OBJECTIVES OF THE STUDY

1. **To survey and document** the occurrence, distribution, and diversity of earthworm species across different habitats in Kollam and Alappuzha districts.
2. **To assess the influence of edaphic factors** (such as soil pH, moisture content, organic carbon and texture) on earthworm abundance and species composition.
3. **To identify potential bio-indicator species** that reflect soil health and environmental conditions in the study regions.

III. REVIEW OF LITERATURE

Among earthworm species, *Eisenia fetida* (Savigny, 1826) is particularly notable and has been extensively used in ecotoxicological research due to its resilience, ease of breeding under laboratory conditions, and sensitivity to various chemical exposures (Brulle et al., 2006). Its continuous exposure to soil contaminants and its ecological relevance make it an excellent candidate for evaluating soil chemical toxicity (Reinecke and Reinecke, 2004; Steenbergen, 2005).

Numerous studies have explored the impacts of different pollutants on earthworms. Spurgeon and Hopkin (1999) evaluated the accumulation of natural and depleted uranium in earthworms, discovering cytotoxic and genotoxic effects at relatively low concentrations despite the absence of mortality or weight loss. Methyl mercury has been identified as a particularly potent pollutant, being readily absorbed and accumulated by earthworms (Nahmani et al., 2007). Lee et al. (2011) noted that earthworm bioaccumulation of metals could serve as a reliable ecological indicator of metal availability, although not all studies agree, with some reporting negligible effects of metal pollution on earthworm community structures.

Pollutants in natural environments often exist as complex mixtures rather than isolated compounds. As a result, ecological risk assessments must focus on mixture effects. Natal-da-Luz et al. (Van Gestel, 2012) examined the impact of sludge contaminated with a mix of chromium, copper, nickel, and zinc on *Eisenia andrei*, finding that high organic matter content in the sludge decreased metal bioavailability. Similarly, Qiu et al. (2023) studied the binary effects of cadmium and zinc on *Aporrectodea caliginosa*, revealing antagonistic interactions that depended on the metals' relative concentrations and absolute magnitudes.

Moreover, studies have indicated the potential influence of environmental factors such as soil pH, organic matter content, texture, and moisture on the distribution, diversity, and abundance of earthworm communities (Lavelle and Spain, 2001; Curry and Schmidt, 2007). Earthworm species distribution patterns are often closely tied to edaphic factors and can thus provide insights into soil conditions across different landscapes.

Despite the growing body of knowledge, there remains a significant gap in data regarding the occurrence, diversity, and distribution of earthworms in relation to geographic and edaphic factors, particularly in certain regions of India. In this context, very little information is available for the districts of Kollam and Alappuzha in Kerala. Both districts are characterized by diverse land-use patterns, soil types, and climatic conditions, making them ideal candidates for studying earthworm biodiversity and distribution dynamics.

Recent research has indicated that the earthworm is a candidate bio-monitor organism for soil pollutants, because it plays an important role in the soil macrofauna biomass. The species Eisenia fetida (Savigny, 1826, E. fetida) is most commonly used in ecotoxicology, and is recognized as a useful bio-monitor for testing the chemical toxicity of soil (Brulle *etal.*, 2006). In particular, this species' proximity to the soil contaminants is a merit for the analysis (Reinecke and Reinecke, 2004; Steenbergen, 2005).

Earthworms have been indicated as a candidate bio-monitoring organism for soil pollutants. To establish a bio-monitoring system using earthworms, the effects of various chemical pollutants on earthworms have been studied. The accumulation of both natural and depleted uranium in earthworms was analyzed to evaluate the corresponding biological effects (Spurgeon and Hopkin, 1999). The study showed that no effects were observed in terms of mortality or weight reduction, but cytotoxic and genetic effects were identified at quite low natural uranium concentrations. Among metals, methyl mercury might be more easily absorbed by and accumulated in earthworms (Nahmani *etal*., 2007) suggesting that the earthworm is an ideal candidate for monitoring methyl mercury. Lee et al. also mentioned that metal bioaccumulation by earthworms could be used as an ecological indicator of metal availability On the other hand, metal pollution reportedly had no effect on earthworm communities.

Chemicals and ecological risk assessments should be based on the effects of the mixture, rather than those of a single compound. In this context, Natal-de-Luz et al. investigated the effects of sludge contaminated with chromium, copper, nickel, and zinc, and soils freshly spiked with the same mixture of metals, on Eisenia andrei (Van Gestel, 2012). They detected a decrease in the metal bioavailability for earthworms, promoted by the high organic matter content of the sludge. The binary mixture effects of cadmium and zinc on the mortality of Aporrectodea caliginosa were also investigated by Qiu *et al*, (2023) They reported that the effects of the cadmium and zinc mixtures on the mortality of Aporrectodea caliginosa were mainly antagonistic, and the magnitude of the antagonism was dependent upon both the relative concentrations of cadmium and zinc and their concentration magnitudes.

Not much information is available on the occurrence, distribution and diversity of earthworms in relation to geographic and edaphic factors of selected regions of Kollam and Alappuzha District. The aim of the study was to gather information on the distribution of different species of earthworms in relation to geographic and edaphic factors of the districts. Such a study is important to know the roles played by these worms on the structure and fertility of soils of Kollam and Alappuzha district.

IV. SIGNIFICANCE OF THE STUDY

Earthworms play a pivotal role in maintaining soil health by improving soil structure, enhancing nutrient cycling, and promoting plant growth. Understanding their diversity and distribution offers critical insights into the ecological status of different soils. Despite their importance, limited information is available regarding the earthworm fauna of Kollam and Alappuzha districts, regions characterized by distinct agro-climatic conditions, varying soil types, and land-use practices.

This study is significant because it will:

- Provide baseline data on earthworm species distribution in two ecologically important districts of Kerala.
- Help identify species sensitive to environmental changes, making them potential bio-indicators for soil health assessment.
- Support conservation efforts by highlighting the relationship between soil conditions and earthworm diversity.
- Offer valuable information for improving sustainable agricultural practices through soil management based on natural soil fauna indicators.
- Contribute to broader ecological knowledge on how geographic and edaphic factors influence soil biota in tropical regions.

V. MATERIALS AND METHODS

Study sites

Site 1 – Karicode

- Area type - Urban-fringe area
- Pollution- moderate pollution levels.
- Soil and terrain: Terrain is mostly flat with occasional slightly raised areas, allowing for average water retention.
- Vegetation: Presence of coconut trees, banana plants, and occasional fruit trees in residential plots. Home gardens with vegetables like spinach, yam, and chili are common.
- Flora: Scattered presence of herbs, flowering shrubs, and shade trees along roadsides and in house compounds.
- : Educational institutions and small commercial areas integrated within residential spaces, with greenery maintained in many plots.

Site 2-Mangadu

- Semi-urban area with low pollution levels
- Moderate water retention due to slightly sloped terrain
- Fruit trees and home-grown vegetables found in residential plots
- Presence of herbs, shrubs, and scattered trees throughout the area

Site 3 kulappadam

- Area type:Marshy place
- Soil Features : ground is consistently or periodically saturated with water
- Soft spongy terrain:soil can be soggy, muddy or squishy underfoot
- Water loving vegetatiin :plants adapted to wet conditions such as cattailes, reedesor sedges, thrive in marshy areas
- Shallow water: marshy area usully have shallow water, which can be permanent or temporary

- Economic importants
- Habitat for wildlife: marshes provide home for various plants,animals,including birds, fishes and amphibians
- Water filtration:Marshes can help filter out impurities and sediment from water
- Flood control:marshes can act as a natural buffers,absorb excess water and reduce flood risk
- Marshes place can be found in various place including coastal areas, river bank and fresh water wetland

Site 4 - Elampalloor

- Pollution free
- Water locking capacity is high
- Crops like tapioca and other fruit plants were being cultivated
- Herbs ,shrubs, and some trees were present

Site 5- kundara

- Area Type: semi - rural ,less agricultural zone
- Pollution Levels: moderate level of pollution, garbage disposal high at side ways of railway station
- Soil and Terrain: Flat terrain with average water retention, ideal for agriculture
- Vegetation: banana plants and tapioca
- Flora: herbs , shrubs and large trees like banyan and she - oke tree
- Water Sources: no water bodies nearby

Site 6 –Mannancherry

- Area Type: Semi-urban with a mix of residential and agricultural zones
- Pollution Levels: Low pollution; clean air and surroundings due to limited industrial activity

- Soil and Terrain: Flat terrain with good water retention capacity, ideal for farming and gardening
- Vegetation: Abundant presence of coconut trees, banana plants, and home gardens with vegetables
- Flora: Includes medicinal herbs, flowering plants, shrubs, and scattered native trees
- Water Sources: Presence of canals and ponds nearby, contributing to soil moisture

Site 7 – Ponnad

- Area Type: Rural area with agriculture-based lifestyle and low population density
- Pollution Levels: Very low pollution; clean environment with minimal vehicular and industrial activity
- Soil and Terrain: Fertile alluvial soil, mostly flat with excellent water retention—ideal for paddy fields and other crops
- Vegetation: Rich in paddy, coconut palms, banana plants, and seasonal crops
- Flora: Includes medicinal plants, dense shrubs, climbers, and native tree species
- Water Sources: Surrounded by backwaters, ponds, and traditional wells—maintains high soil moisture and supports biodiversity

Site 8 – Kuttikad

- Area Type: Rural village in the Kuttanad region with traditional homes and agriculture-focused lifestyle
- Pollution Levels: Very low; clean environment with limited industrial or vehicular activity
- Soil and Terrain: Alluvial, clayey soil rich in organic matter; flat terrain, with some areas below sea level
- Vegetation: Paddy fields, coconut palms, banana plants, and aquatic vegetation
- Flora: Medicinal herbs, climbers, shade trees like jackfruit, mango, and tamarind
- Water Sources: Close to canals, kayals (backwaters), and wells; consistently high soil moisture due to wetland ecosystem
- Special Features: Traditional rice-farming area with high biodiversity; suitable for vermiculture due to moist soil and abundant plant waste

Site 9 – Ambalakkadav

- Area Type: Rural riverside area with traditional settlements and agricultural surroundings
- Pollution Levels: Very low pollution; clean and calm environment with minimal industrial or vehicular disturbances
- Soil and Terrain: Moist loamy soil with good drainage; flat terrain near water bodies, ideal for plant growth and earthworm activity
- Vegetation: Rich in coconut palms, banana plants, jackfruit, mango trees, and homestead gardens
- Flora: Includes a variety of herbs, shrubs, aquatic plants, and shade-giving trees
- Water Sources: Located close to canals and small rivers, providing consistent moisture and supporting biodiversity

Site 10 – Puthen Kayal Road

- Area Type: Rural backwater region with traditional homes and farming activities
- Pollution Levels: Very low; clean environment with minimal industrial activity
- Soil and Terrain: Alluvial, clayey soil with high water retention; terrain is flat and close to backwaters
- Vegetation: Abundant coconut palms, plantains, vegetable gardens, and aquatic plants
- Flora: Includes climbers, medicinal herbs, and shade-providing trees like jackfruit and mango
- Water Sources: Close proximity to kayal (backwater), canals, and wells maintains high soil moisture
- Special Features: Ideal location for vermiculture due to shaded areas, moisture-rich soil, and abundant organic matter from household and plant waste

Sampling Design

The geographical details such as latitude and longitude and elevation of each sampling station were, Kollam and Alapuzha. The soil factors such as pH, Nitrogen, Phosphorus, Potassium, Calcium and Magnesium and the Textural analyses such as % of sand, % of silt and % of clay of each station were analyzed in the District Soil Testing Lab Kollam. The temperature (^{o}C) of the soil (5 cm deep) was measured with the soil thermometer at each station at the time of earthworm sampling, and the water content of the soil was calculated as the difference between the weights of the initial (measured in the field itself) and oven dried (55 ^{o}C) soil and expressed as a percentage.

- pH: Measure soil pH using a pH indicator.
- Nitrogen (N): Determine available N using spectrophotometry (ASA, 1982).
- Phosphorus (P): Measure available P using spectrophotometry (ASA, 1982).
- Potassium (K): Determine exchangeable K using atomic absorption spectroscopy.
- Calcium (Ca) and Magnesium (Mg): Measure exchangeable Ca and Mg using atomic absorption spectroscopy (ISRIC, 2018).

- **Sediment Texture**

The percentage of sand, silt, and clay portions were determined by Pipette analysis (Krumbein and Petti John, 1938). The percentage composition of sand, silt and clay were calculated and plotted on triangular graphs based on the Nomenclature (Shepard, 1954).

- **Sediment Organic Carbon (%)**

The sediment samples were dried in a hot air oven at 60°C.This was used for estimating organic carbon, using the method of El Wakeel and Riley (1957).

- **Sediment Organic Matter (%)**

This was calculated by multiplying organic carbon values by a factor of 1.724 (Trask, 1953).

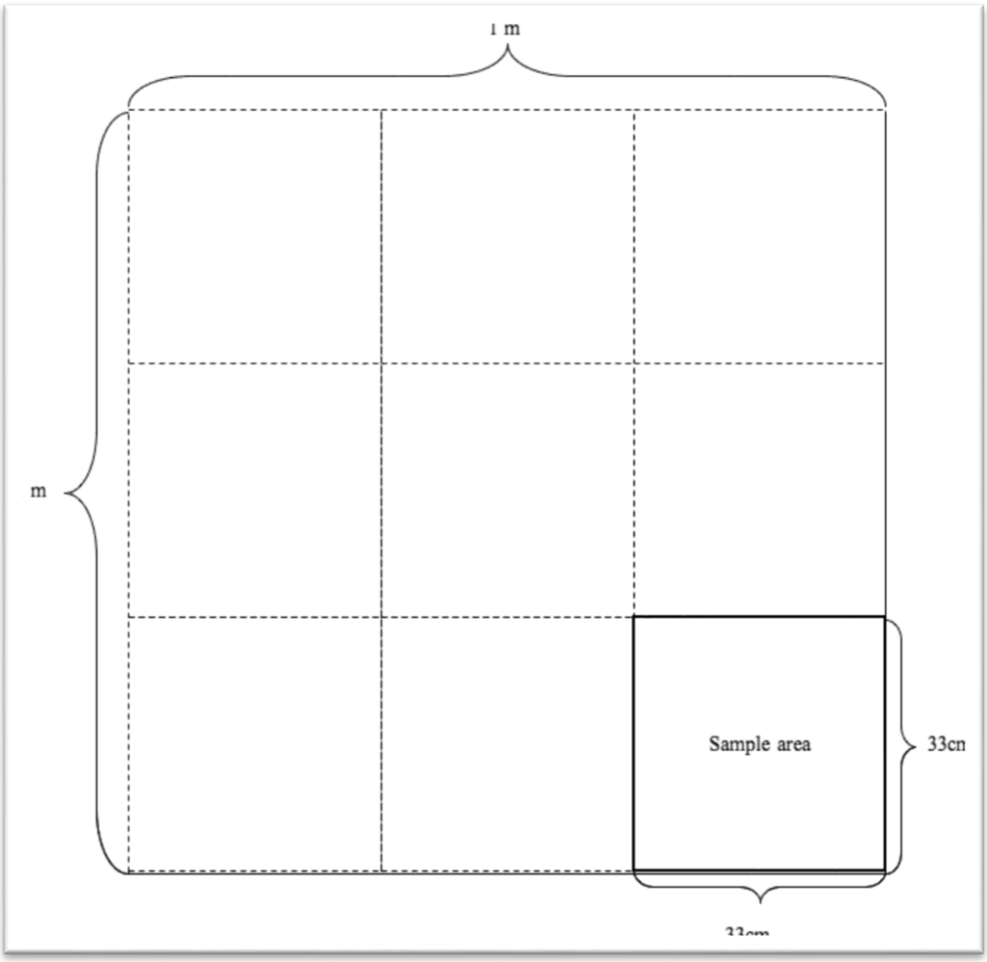
- **Earthworm Identification**

Adult earthworms (having clitellum) were collected from different land use areas in the Kollam and Alappuzha district (Table 1 & 2) using the conventional digging and hand sorting method (Andersen and Ingram 1993) with the help of a spade or shovel. The anterior part of each earthworm and the triplicates of the same species were fixed in 5 % formalin for taxonomical identification or further reference. The earthworms were identified up to the species level with reference to the descriptions and identification keys provided by Stephenson (1915, 1923), Michaelsen (1910), and Julka (1988). The identified specimens were subsequently deposited in the Museum of the Zoology Department, TKM College of Arts and Science, Kollam, Kerala.

- **Earthworm Density**

The 33cm x 33cm plot (use by the GLWW) then simply multiply the number of earthworms for that plot by 9 to get the same data "per m^2". Each 33 x 33cm plot is 1/9th of a m^2. Converting plot based data to "per m^2" (https://wormwatch.d.umn.edu/research/research-methods/analyzing-earthworm-data.)

Number of earthworms (per 33 by 33 plot) * 9 = Earthworm Density per m^2



VI. RESULTS

Soil Analyses

The physico-chemical characters of soil such as moisture, pH, Nitrogen, Organic Carbon (OC), Phosphorus, Potassium, Calcium and Magnesium of study sites and earthworm samples are presented in Tables 1, 2 and 3.

Table 1: Earthworms collected from study stations at Kollam district

Sites	Species	No of Individuals
Site 1 -Karicode	*Pontoscolex corethrurus* (Muller, 1856)	10
Site 2 - Mangadu	*Megascolex travancorensis (Michaelsen, 1910)*	13
Site 3- Kulappadam	*Plutellus variabilis* (Aiyer, 1929)	05
Site 4 – Elampalloor	*Megascolex travancorensis* (Michaelsen, 1910)	08
Site 5 – Kundara	*Megascolex travancorensis* (Michaelsen, 1910)	12

Table 2: Earthworms collected from study stations at Alappuzha district

Sites	Species	No of Individuals
Site 6 -Mannancherry	*Megascolex cochinensis* (Stephenson, 1915)	06
Site 7- Ponnad	*Lampito mauritii*	11
Site 8-Kuttikkad	*Megascolex konkanensis* (Fedarb, 1898)	04
Site 9 - Ambalakkadav	*Amynthas alexandri* (Blakemore, 2012)	05
Site 10- Puthen kayal Road	*Megascolex pentagonalis* (Stephenson, 1916)	02

Table 3: Geographical details, habitats and soil physiographic factors along the study sites

Stations	Latitude & Longitude	Habitat Description	No of Individuals	Density of worm per m^2
Site 1 -Karicode	8.9153° N, 76.6326° E	Grass land	10	$90/m^2$
Site 2 - Mangadu	8.9149° N, 76.6211° E	Open fields	13	$117/m^2$
Site 3- Kulappadam	8.9029° N, 76.6976° E	Marshy land	05	$45/m^2$
Site 4 – Elampalloor	8.9565° N, 76.6709° E	Crop lands	08	$72/m^2$
Site 5 – Kundara	8.9602° N, 76.6788° E	Open fields	12	$108/m^2$
Site 6 -Mannancherry	9.5675° N, 76.3464° E	Open fields	06	$54/m^2$
Site 7- Ponnad	9.5858° N, 76.3623° E	Marshy land	11	$99/m^2$
Site 8-Kuttikkad	10.3257° N, 76.4013° E	Marshy land	04	$27/m^2$
Site 9 - Ambalakkadav	9.5768° N, 76.3572° E	Grass land	05	$45/m^2$
Site 10- Puthen kayal Road	9.5918^0N, 76.3609^0 E	Marshy land	02	$18/m^2$

The physico-chemical analysis of soils of all sampling sites is given in figures 1- 10. The texture of soil was found to be loam to sandy loam at maximum sites with sand (%), silt (%) and clay (%) were in the range of 22.00–79.90, 17.10–37.31 and 2–43.7 respectively. The moisture content of the soil at each sampling site was more than 40%. The diversity of earthworm species were maximum at site 2 in the soil moisture is 46%, pH is 6, OC 2%, N 0.15 (%).

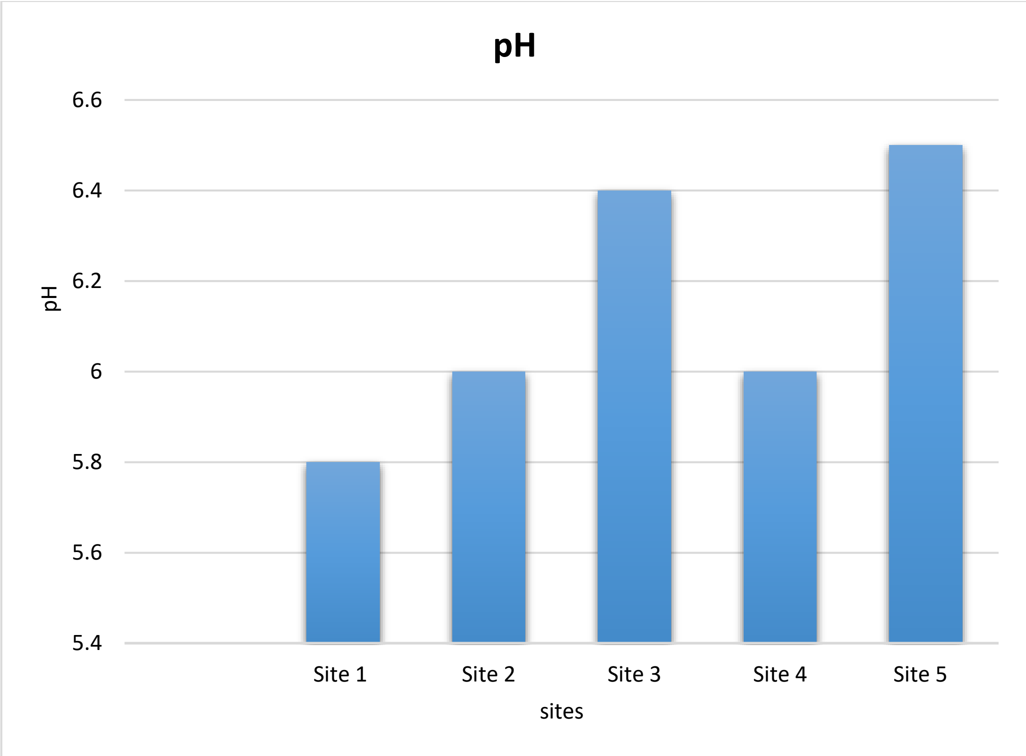


Fig 1- The pH analysis of soils along the sampling sites at Kollam

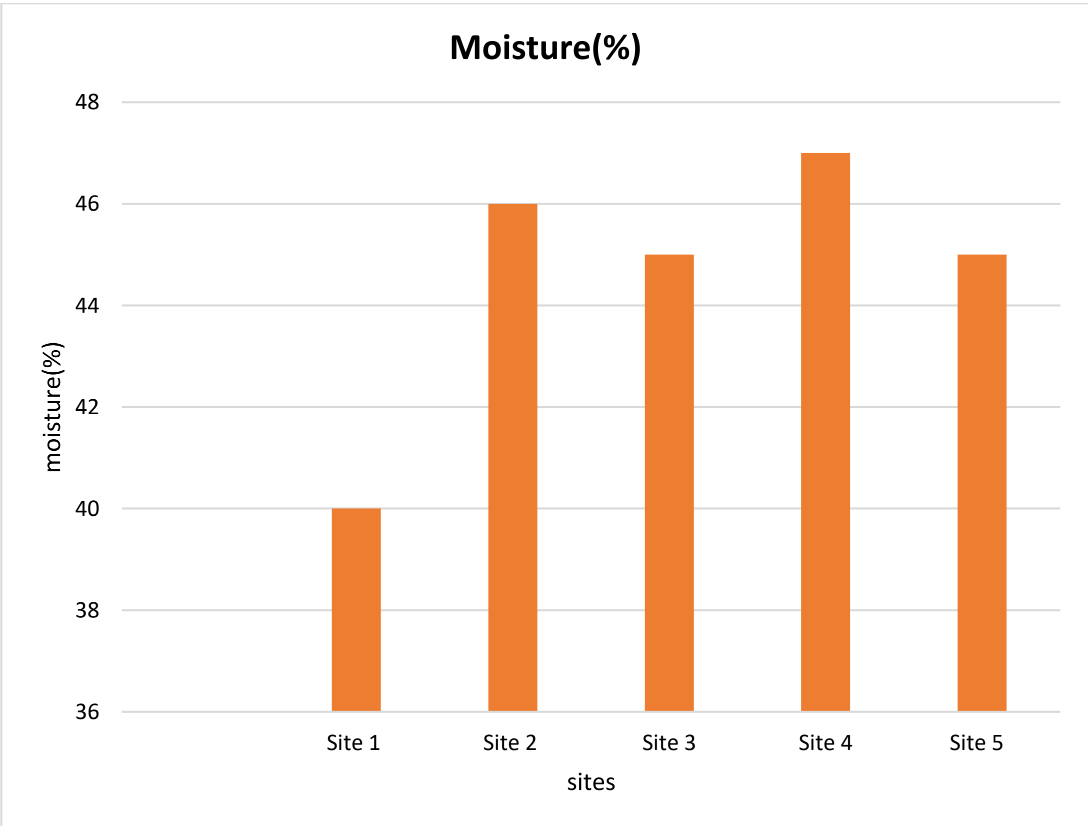


Fig 2- The moisture analysis of soils along the sampling sites at Kollam

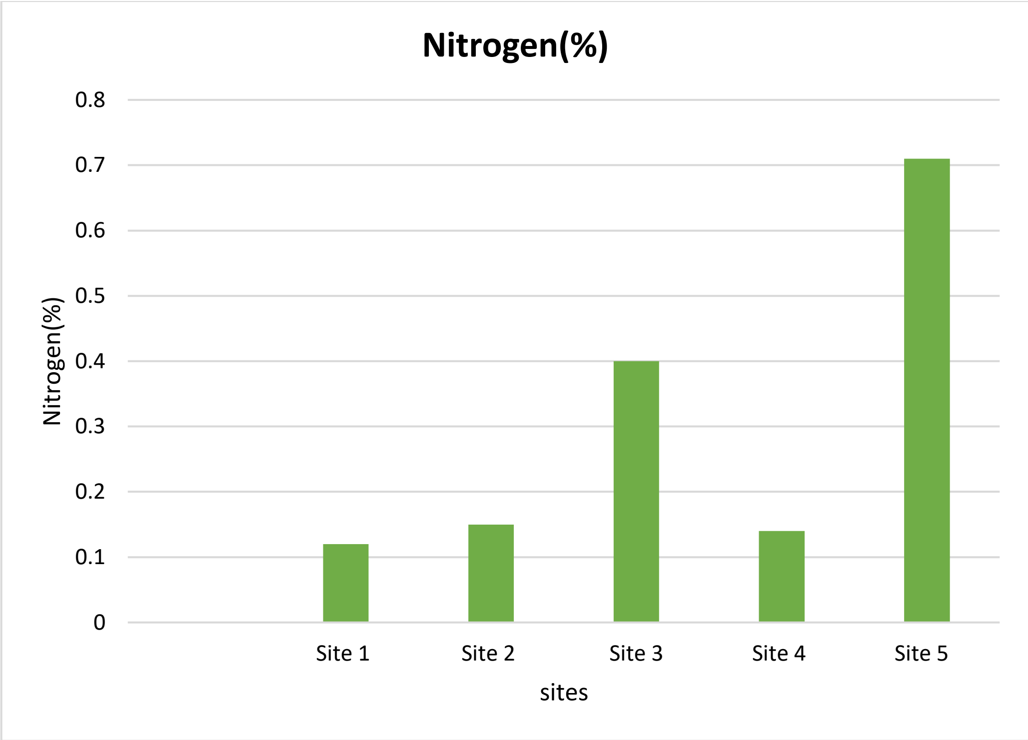


Fig 3- The Nitrogen analysis of soils along the sampling sites at Kollam

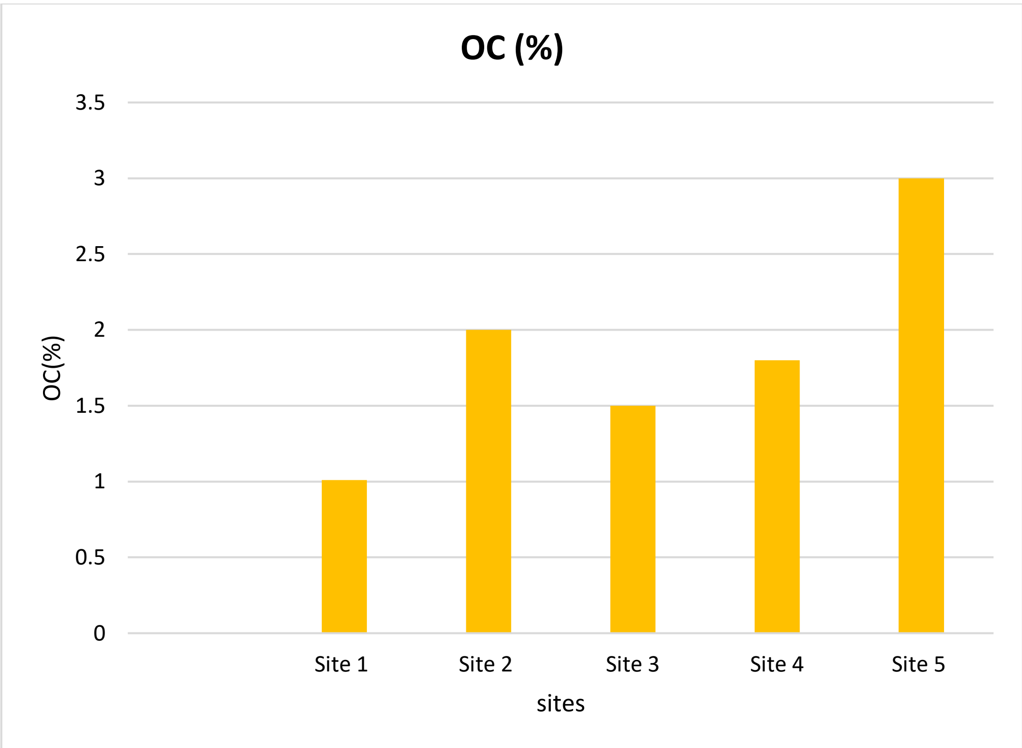


Fig 4 - The OC analysis of soils along the sampling sites at Kollam

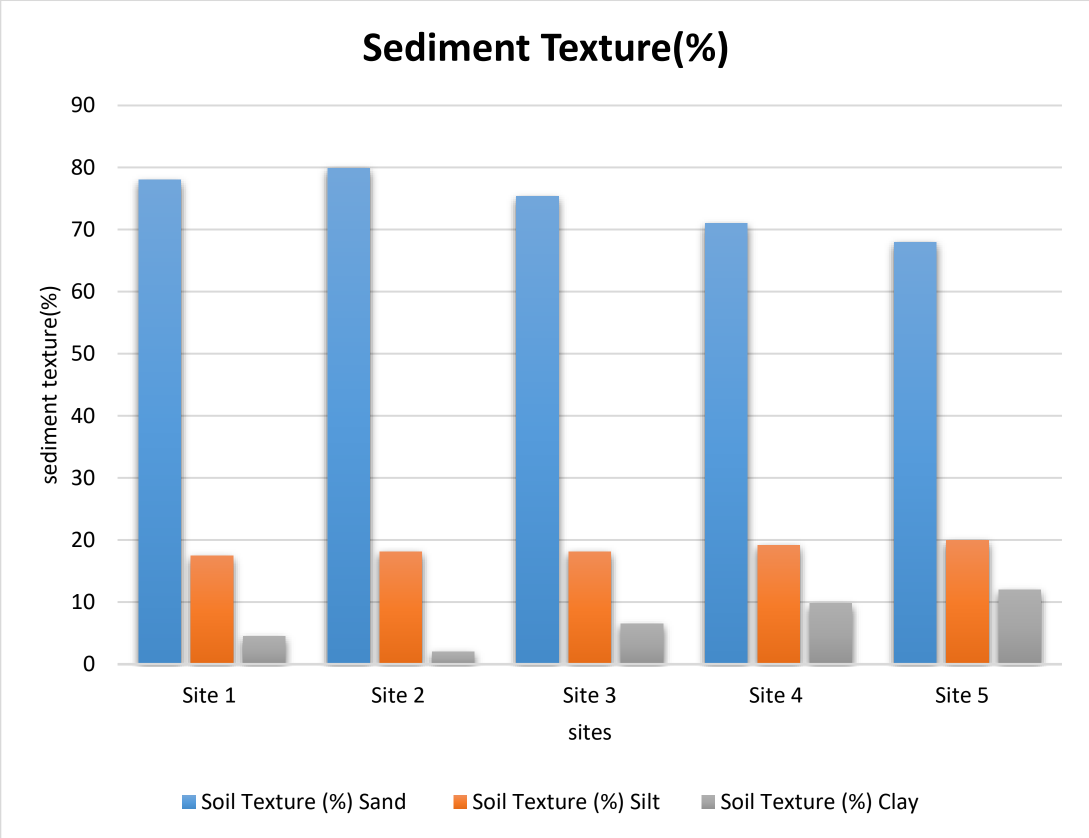


Fig 5 - The sediment texture analysis of soils along the sampling sites at Kollam

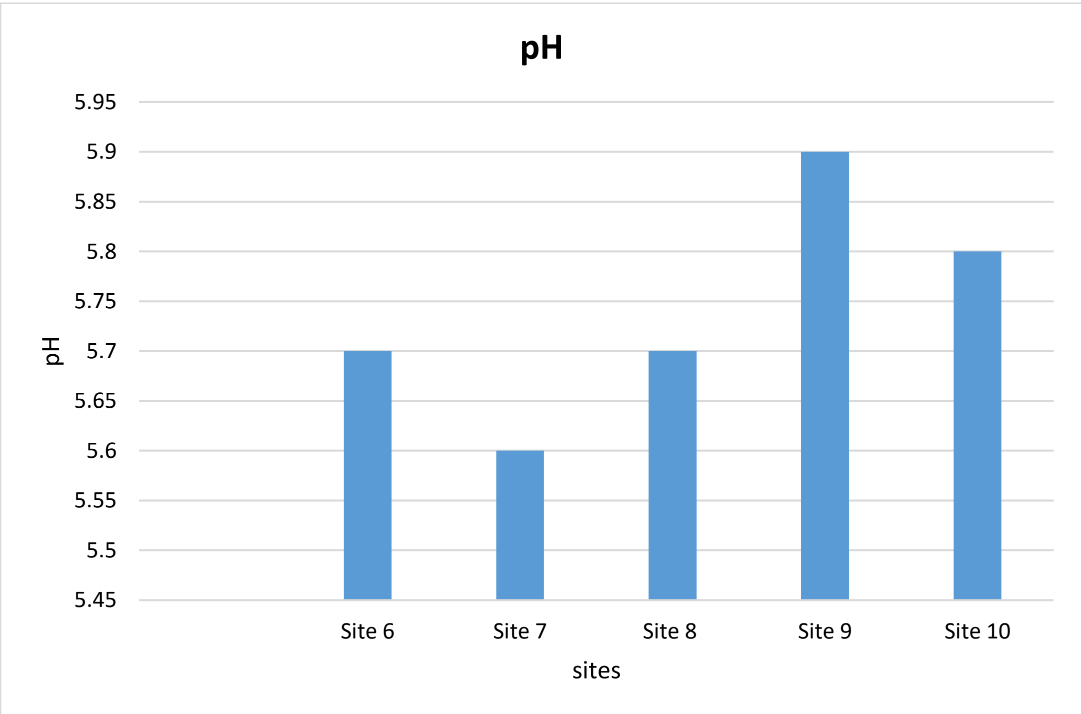


Fig 6 - The pH analysis of soils along the sampling sites at Alappuzha

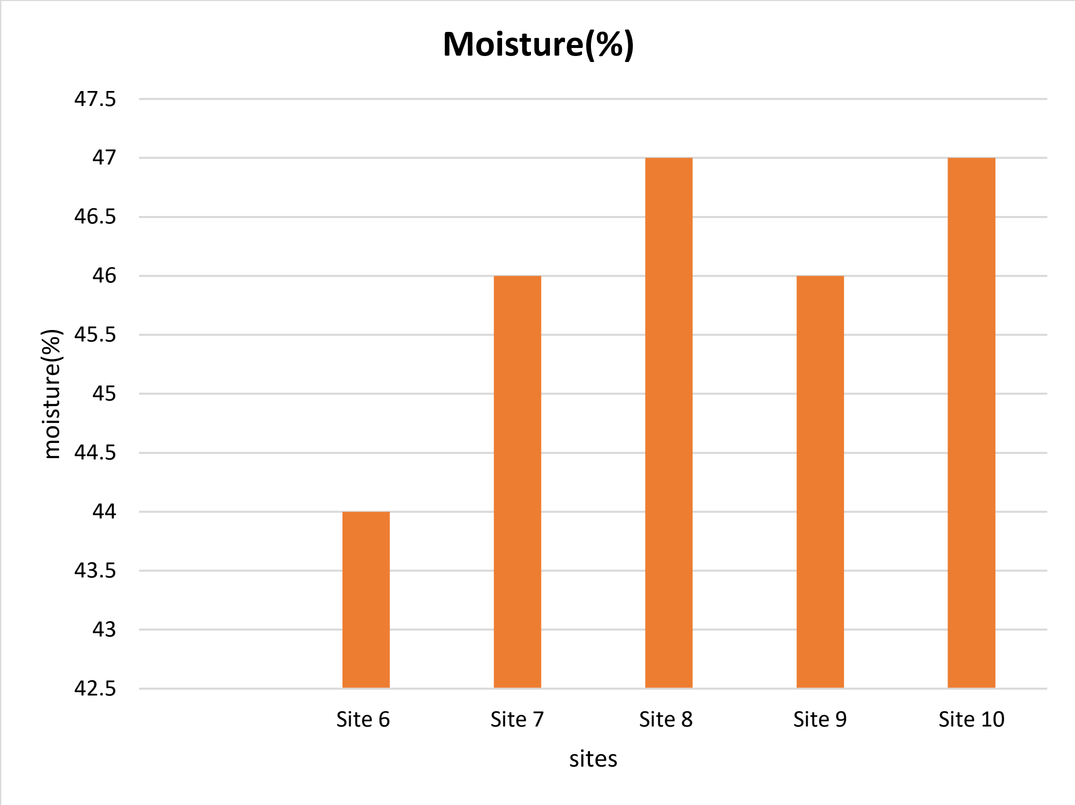


Fig 7 - The moisture analysis of soils along the sampling sites at Alappuzha

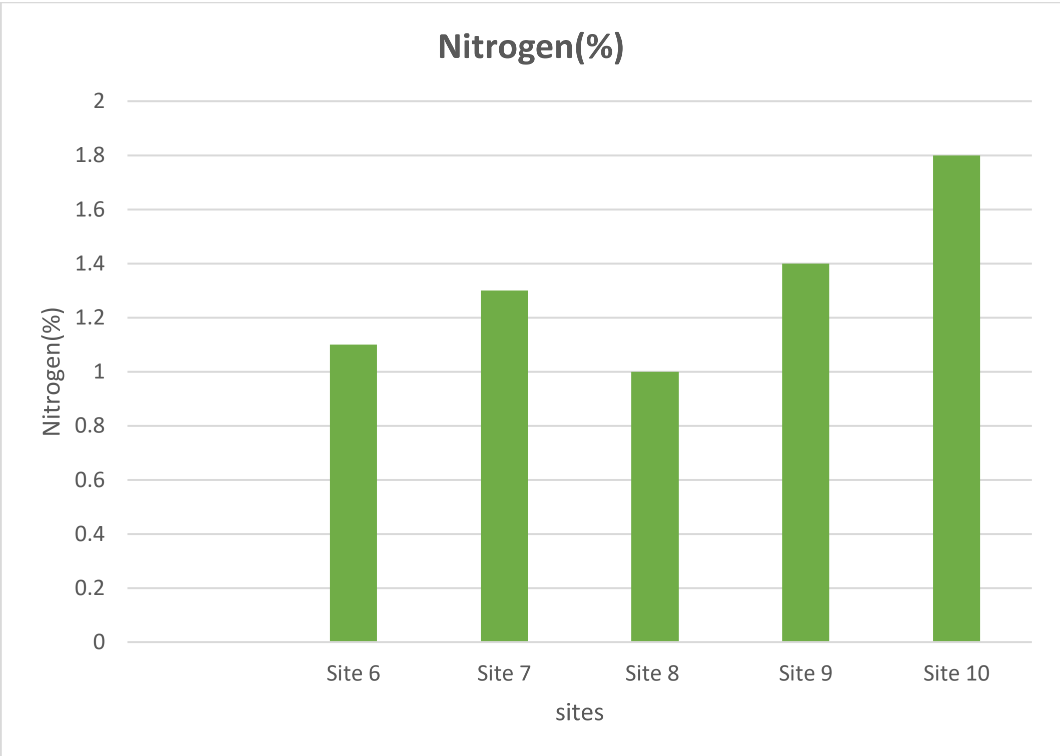


Fig 8 - The Nitrogen analysis of soils along the sampling sites at Alappuzha

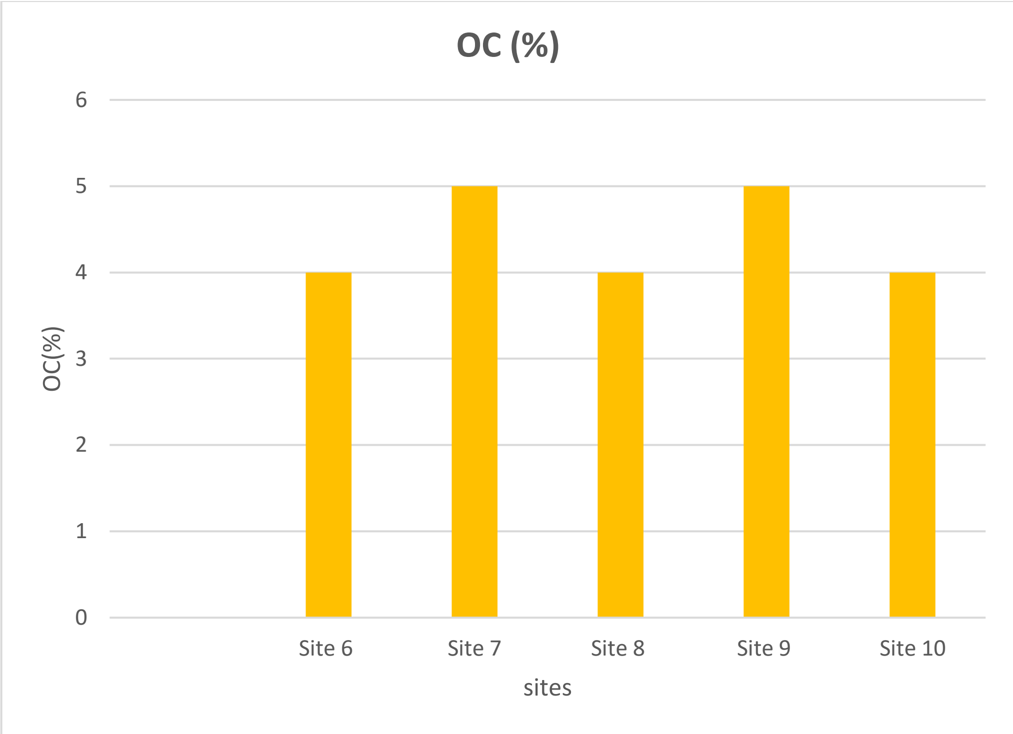


Fig 9 - The OC analysis of soils along the sampling sites at Alappuzha

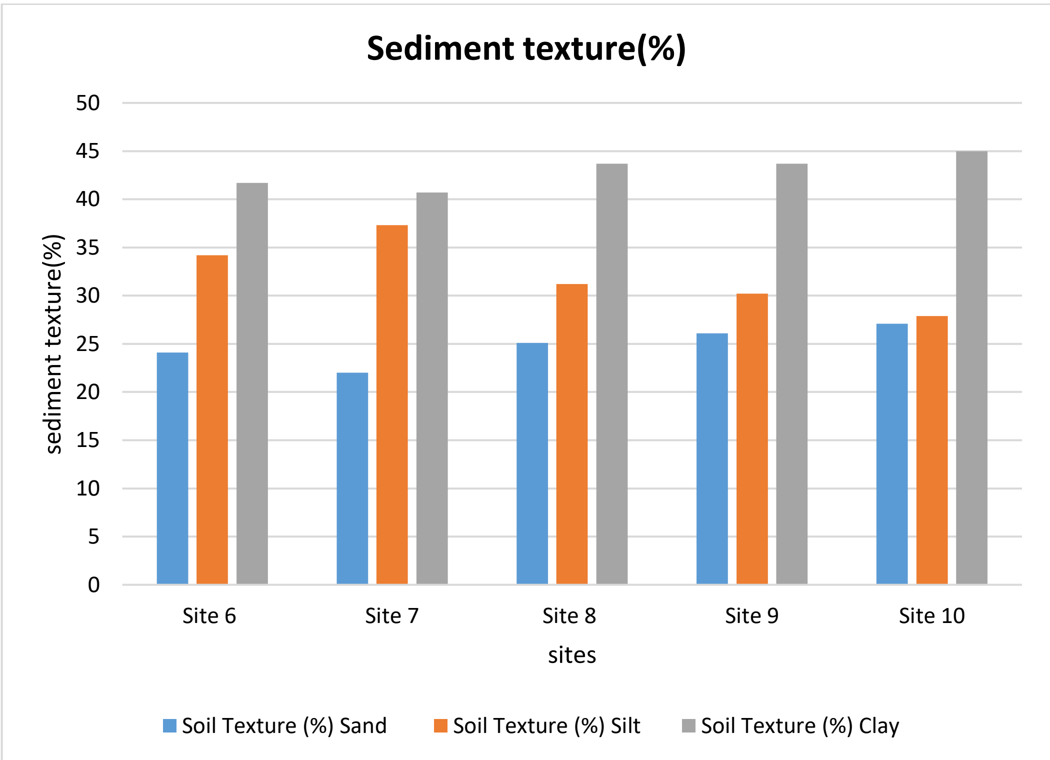


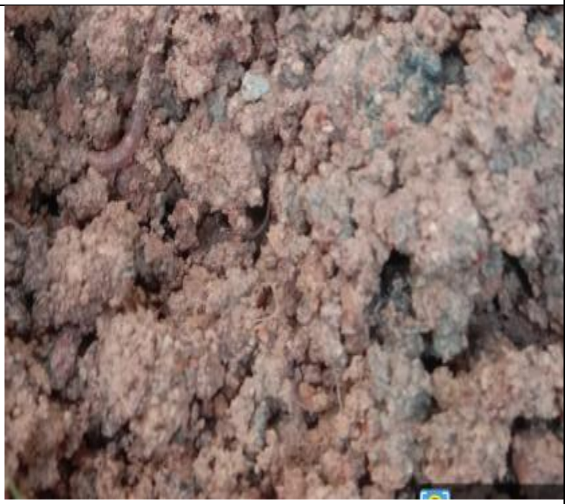
Fig 10 - The Sediment Texture analysis of soils along the sampling sites at Alappuzha

PLATES

Site 1

Site 2

Site 3



Site 4

Site 5

Site 6

Site 7

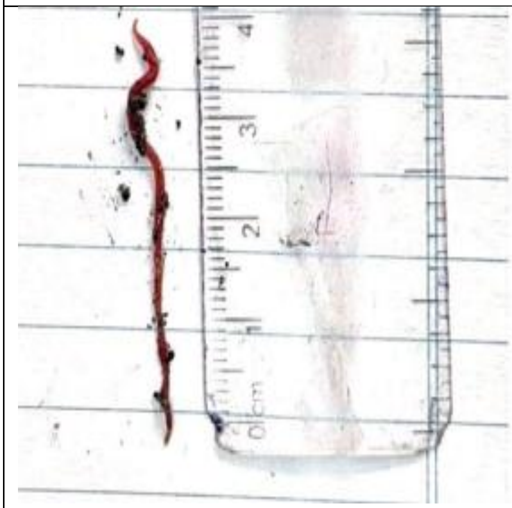
Site 8

Site 9

Site 10

Pontoscolex corethrurus (Muller, 1856)

Megascolex travancorensis (Michaelsen, 1910)



Plutellus variabilis (Aiyer, 1929)

	
	Megascolex cochinensis (Stephenson, 1915)
	
	Lampito mauritii
	
	Megascolex pentagonalis (Stephenson, 1916)

VII. DISCUSSION

The present study assessed the distribution of earthworm populations across different habitats in Kollam and Alappuzha districts and correlated their abundance with soil physico-chemical parameters. The findings highlight the strong influence of soil properties such as moisture content, pH, organic carbon (OC), nitrogen (N), and soil texture on earthworm density and species diversity.

Among the sites studied, Site 2 (Mangadu) exhibited the highest earthworm density (117/m²), followed by Site 5 (Kundara) and Site 7 (Ponnad). These sites shared characteristics favorable to earthworm activity, including moderate to high soil moisture content (>40%), near-neutral soil pH (around 6-7), and elevated levels of organic carbon and nitrogen. It is well documented that moist, organically rich soils support greater earthworm populations due to increased food availability and better conditions for burrowing and reproduction (Edwards and Bohlen, 1996).

In contrast, sites with extreme soil textures (high clay or sand content) or lower organic matter, such as Site 10 (Puthen Kayal Road), recorded minimal earthworm densities (18/m²). This aligns with previous research indicating that compacted, poorly aerated clay soils or excessively sandy soils with low nutrient content can inhibit earthworm activity and survival (Lavelle and Spain, 2001). The species diversity recorded varied between sites. *Megascolex travancorensis* and *Lampito mauritii* were among the most frequently encountered species, reflecting their adaptability to a wide range of soil conditions. The presence of species like *Pontoscolex corethrurus* at Site 1 (Karicode), often regarded as a pioneer species in disturbed or poor-quality soils, suggests that certain areas may have experienced more anthropogenic stress.

Moreover, marshy lands, though rich in moisture, had moderate to low worm densities, potentially due to reduced aeration and waterlogging, factors known to negatively impact earthworm populations (Spurgeon and Hopkin, 1999). This indicates that while soil moisture is important, excessively saturated soils can also act as limiting factors for earthworm habitation.

The study also confirms that earthworms are excellent bioindicators of soil health. Sites with richer earthworm populations coincided with better overall soil health indicators, including balanced nutrient profiles and good soil structure.

VIII. CONCLUSION

The study clearly demonstrates that soil properties significantly influence earthworm populations and species distribution across different habitats in Kollam and Alappuzha districts. Soils with moderate to high moisture, near-neutral pH, higher organic carbon, and nitrogen levels support more abundant and diverse earthworm communities. Conversely, extremes in soil texture and poorly aerated conditions correspond to lower densities.

Earthworms prove to be valuable indicators of soil health and quality, reflecting subtle changes in the soil environment. Protecting earthworm diversity and abundance through sustainable soil management practices is essential for maintaining soil fertility, structure, and ecosystem functions. Future studies could further explore seasonal variations and the impact of anthropogenic activities to develop more comprehensive soil health assessment protocols based on earthworm populations.

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