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Monthly Variation of Diversity, Density and Biomass of Earthworm in Mid Hills of North Western Himalayas under Three Different Land Use Systems, District Bilaspur, Himachal Pradesh

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Abstract

The current research aims to assess monthly fluctuations in the diversity, population density, and biomass of earthworms within three different land use categories: cultivated land, orchards, and mixed forest land. In total, six earthworm species were identified, categorized across five genera and three families. These species were categorized into two groups: 1) Exotic species including *Metaphirebirmanica* (Rosa), *Amynthasalexandri* (Kinberg),*Eudriluseugeniae* (Kinberg) and *M. houlleti* (Perrier); 2) Native peregrine species comprising *Eutyphoeuswaltoni* (Michaelsen) and *Octochaetonabeatrix* (Beddard). The mango orchard exhibited the highest earthworm density and biomass (49.89 m -2 & 74.98 gm-2), while the cultivated land showed the lowest values (36.87 m -2 & 64.66 gm-2). The presence of exclusively exotic and Indian peregrine earthworm taxa suggested a significant impact of human activities on the landscape. Diverse earthworm densities and biomass levels across different land use types were linked to variations in vegetation, environmental conditions, soil characteristicsand human interventions. Earthworm populations tended to increase during the monsoon season and decrease in winter. Notably, less impacted land use types such as mixed forests exhibited a higher species diversity, with six species observed compared to five in cultivated land and four in orchards, indicating the impact of land utilization on earthworm populations.

Key Words: Diversity, earthworm,mixed forest, native peregrine species, cultivated land, exotic species,orchard.

Introduction

India boasts a rich diversity of earthworm species, renowned for their crucial roles as detritivores, ecosystem architects, and soil contributors.[1-3]This diversity finds support in India's geological history, originating from the ancient supercontinent of Gondwana Land, which split in the late Jurassic and eventually collided with the Asian mainland in the Eocene.[4]Among the noteworthy species is the *Metaphirehoulleti* from the Megascolecidae family, widely distributed across various Indian regions, including the north, northeast, central, and south.[5-7]India is home to a wide variety of earthworm species, encompassing 453 identified subspecies and species across 10 families and 67 genera.[8-10]In India, it was approximated that there were 52 peregrine earthworms, constituting approximately 12.1% of the nation's earthworm diversity.[11] Indian earthworms were divided into three categoriesbased on endemicity and dispersal: endemic or native species, exotic peregrine species, and native peregrine species.[12] Earthworms, for example, are important in the elimination of hydrocarbons from polluted soils.[13] Due to their sensitivity to agricultural methods, earthworms can serve as bioindicators of the health of the soil.[14] Earthworms are often called "ecosystem engineers"because of their incredible capacity to alter soil and plant habitats.[15]In the humid regions of Africa andAsia, thediversity of earthworms and population fluctuate across various land habitats due to differences in soil temperature, moisture,veg+etation, propertiesand land use practices. Different functional categories of earthworms influence the physico-chemical properties of soil in multiple ways and respond differently to land use changes.[16] Agricultural intensification adversely affects the diversity and abundance of anecic earthworms, as tillage destroys their burrows and exposes them to unfavourable environmental conditions and predators.[17] Since earthworms quickly respond to changes in soil chemical and physical properties, they can be used as indicators to assess the effects of land use changes on below-ground biodiversity and soil sustainability.[18] They have been used to evaluate soil quality and contamination, as well as changes in various biochemical, biological, and physical soil properties.[19] Managing earthworm populations is crucial for maintaining soil productivity and fertility.[20] However, the impact of land use practices on earthworm communities in the Himalayan Biodiversity Hotspot remains largely unknown. which is facing ecological degradation and climate change impacts. The current investigations aim to fill gaps in our knowledge about the distribution, diversity, and abundance of earthworms in diverse land use systems at various altitudes, therefore, this study aims to assess the functional diversity and biomass of earthworms, which are significant components of soil macroinvertebrates.The primary objectives include (a) determining the biomass anddiversity of earthworms in three diverse land use types, and (b) investigating the relationships between earthworm diversity and abundance in relation to various soil physicochemical properties in theLesser Himalayan.

Material and Method

The research was carried out in the Bilaspur district of Himachal Pradesh, located between latitudes 31°12'30" N and 31°35'45" N, and longitudes 76°23'45" E and 76°55'40" E, in the outer regions of the Himalayas.Spanning approximately ninety kilometres, the river Satluj courses through Bilaspur. Covering an area of 1167 square kilometres, its elevation varies from 290 meters to 1980 meters. Despite its modest size, the district boasts remarkable biodiversity, hosting a variety of plant and animal species. The riverSatluj flows through

Bilaspur for approximately ninety kilometres. The region spans an area of 1,167 square kilometres, with an altitude ranging from 290 meters to 1,980 meters. Although the district is small one yet great diversity exists in plant and animal species inhabiting it.Sampling of earthworm was carried out in the Jukhala valley, which is about 21 km from Bilaspur District. It covers an area of approximately 1,264 hectares. Three sites, namely (i) Cultivation field (ii) orchard (iii) MixedForest have been selected for the present studies.

(i). **Orchard**- Mango *Mangifera indica* (Linnaeus), located at Makri village (altitude 375 m), on 20 km from district Bilaspur.

(ii) **Cultivation Field**-Situated in Gasaur village at an altitude of 372 meters, maize (Zea mays) is planted from July to October, while wheat (Triticum aestivum) is grown from November to April.Farmers generally spread cow dung and organic manure during the time of field preparation.

(iii) **Mixed Forest**-Located at Markand (altitude 377 m), it is 22 km far from its District Bilaspur, tree composition of *Dalbergia sisso*(shisham),*Toona cilata*(Toon), *Acacia catechu* (Khair), *Acacia Arabica (*willdenow), and under growth story of lantana bushes and grasses.

Methodology

Earthworm sampling and identification

Earthworms were gathered according to the guidelines outlined in the Program for Soil Biology and Fertility in Tropical Regions.[21]Soil monoliths measuring 25×25×30cm were extracted by excavating the soil. Sampling was carried out in three land use systems described above. Each land use type was two distinct plots, each measuring 5×5 meters. From each plot, five soil monoliths were randomly selected, this yields a combined total of 15 samples for each type of land use.Earthworm were hand sorted and preserved in 5% formalin. The samples were collected monthly for five seasons. The earthworm samples were identified using the classification methods.[22,23]

Soil analysis:

A 500 g composite soil sample were gathered from each sampling plot for laboratory analysis of various soil parameters. Samples from different land use types were undergo preparation, aside from eliminating pebbles, it entails sifting through a sieve with a 0.5 mm mesh.Sampling wasoccurred across various seasons over two years (from July 2019 to July 2021), with soil samples stored in well-labelled airtight plastic containers for subsequent analysis.

At each sampling time, soil samples were collected, the soil samples are enclosed within plastic bags and conveyed to the zoology laboratory. Analysis of soil texturewasincluding determining clay (%), sand (%), and silt (%) using the hydrometer method.[24] Soil temperature was measured during sampling using a standard soil thermometerand moisture content was determined gravimetrically. Soil pH was measured with a digital pH meter, organic carbon wasanalysed using the Walkey and Black method, nitrogen was determined through the Kjeldahl method, and available phosphorus was assessed using Oleson's and Bray's method.[25,26]Potassium levels was assessed using a flame photometer.[27]

Statistical Analysis

Various formulas have been used in statistical analysis.

Relative density (%)	$\frac{\text{Number of individuals of species A}}{\text{Total number of individuals of all the species}} \text{ X } 100$
Relative biomass (%)	$\frac{\text{Biomass of species A}}{\text{Total biomass of all the species}} \text{ X } 100$
Species diversity index (H)	Shannon Index (H)= $-\sum_{n=1}^{s}(\frac{ni}{N} ln(\frac{ni}{N}))$
Dominance Index (c)	Simpson dominance index (c) = $\sum_{n=1}^{S}\left(\frac{n_i}{N}\right)^2$
Species richness Index (d)	Margalef species index $(d) = \frac{s-1}{\ln N}$
Evenness Index (e)	Pielou evenness index (e) = $\frac{H'}{\ln s}$
Bray – Curti's similarity Index	Bray – Curti's similarity Index $(bii') = \frac{\sum_{j=1}^{j}\lvert n_{ij} - ni'j\rvert}{n_{i+} + ni'_{+}}$

Taxonomy of Earthworms

Earthworm specimens were examined using a Magnus MSZ-Bi microscope to observe their internal and external taxonomic features. Identification followed the monographs by Julka (1988), Gates (1972), Stephenson (1923), Easton (1983), Sims and Easton (1972), and Blakemore (2012).[22,23,28-31] The identifications were further verified by Dr. J.M. Julka, a distinguished oligochaete taxonomist at Shoolini University, Solan. Statistical analyses will be conducted using the IBM SPSS Statistics 20.

Statistical analyses will be conducted using the IBM SPSS Statistics 20.

Results

Table 1: Soil physico-chemical parameters (Mean ±SE) across various land use categories in Jukhala, Bilaspur District, Himachal Pradesh between 2019 and 2021.

Soil parameters	Cultivated Land	Mixed Forest	Orchard
Temperature	19.9 ± 1.21	18.8 ± 1.29	18.9 ± 1.21
Moisture (%)	21.6 ± .71	20.4 ± .62	20.8 ± .55
pH	6.5 ± .11	6.4 ± .10	6.2 ± .09
Organic carbon (%)	1.4 ± .060	1.5 ± .05	1.5 ± .03
Available nitrogen (kg/ha)	306.9 ± 13.14	301.9 ± 18.05	300.4 ± 14.38
Available phosphorus (kg/ha)	22.1 ± .82	21.5 ± .74	19.7 ± .52
Available potassium (kg/ha)	287.2 ± 21.82	316.0 ±20.01	284.8 ± 18.62

Values with different letters within rows are significantly distinct according to Tukey's test at a significance level of $p<0.05$.

Soil texture

The soil particle size distribution across various land use types in Jukhala, District Bilaspur, is detailed in Table 2.According to the USDA's soil classification system,the soil textural classes were Sandy loam in Cultivated land, Sandy clay loam in Mixed Forest and Silty clay loam in the orchard at Jukhala.

Table 2: The Feel Method Technique was employed to analyse soil texture across various land use types in Jukhala, District Bilaspur, Himachal Pradesh, during the years 2019-21.

Sr.No.	Sample details	Ball formation	Ribbon formation	Grittiness	Soil Texture
1	Cultivated land	Yes, but with difficulty	Less than 1 inch	comparatively more	Sandy Loam
2	Mixed forest	Yes	1-2 inch	More	Sandy Clay Loam

3	Orchard	Yes	1-2 inch	comparatively lesser & smooth	Silty Clay Loam

Table 3: The dispersion of earthworm species across three distinct land use categories in Jukhala, Himachal Pradesh, between 2019 and 2021. Abbreviations used: MF for Mixed Forest-Cultivated Land, and O for Orchard.

Species/Land	**Cultivated Land**	**Mixed Forest**	**Orchard**
Megascolecidae			
Metaphirehoulleti	+	+	+
Metaphirebirmanica	+	+	_
Amynthasalexandri	+	+	_
Octochaetidae			
Eutyphoeuswaltoni	+	+	+
Octochaetona Beatrix	+	+	+
Eudrilidae			
Eudriluseugeniae	_	+	+
Total number of species	**5**	6	4

Present (+) Absent (-)

Table 4: The density (mean no.m-2) and biomass (mean g.m-2) of earthworms were studied across various land uses in Jukhala, District Bilaspur, Himachal Pradesh from 2019 to 2021.

	Mean Density	**Mean Biomass**
Cultivated land	31.98±7.9	2.19±.51
Mixed Forest	44.4±8.2	3.80±1.1
Orchard	47.05±8.2	5.70±1.7

Figure 1: The relative biomass percentages (RB%) of earthworm species across various land use categories in Jukhala, District Bilaspur, Himachal Pradesh were examined between 2019 and 2021. The abbreviations used are as follows: MH for *M. houlleti*, EW for *E. waltoni*, AA for *A. alexandri*, OB for *O. beatrix*, MB for *M. birmanica*, EE for *E. eugeniae*, CL for Cultivated Land, MF for Mixed Forest, and O for Orchard."

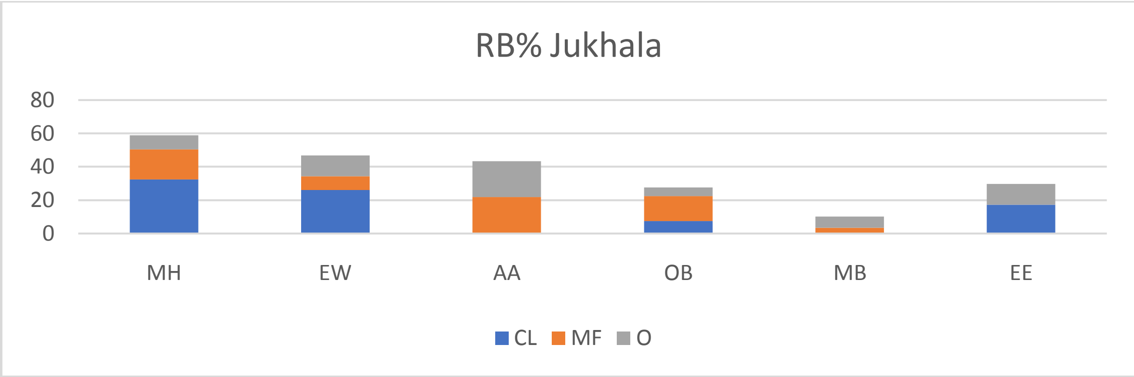

Figure 2: The fluctuations in the biomass of earthworm populations on a monthly basis across various land use categories in the Jukhala region of District Bilaspur, Himachal Pradesh, were observed over the period from 2019 to 2021.

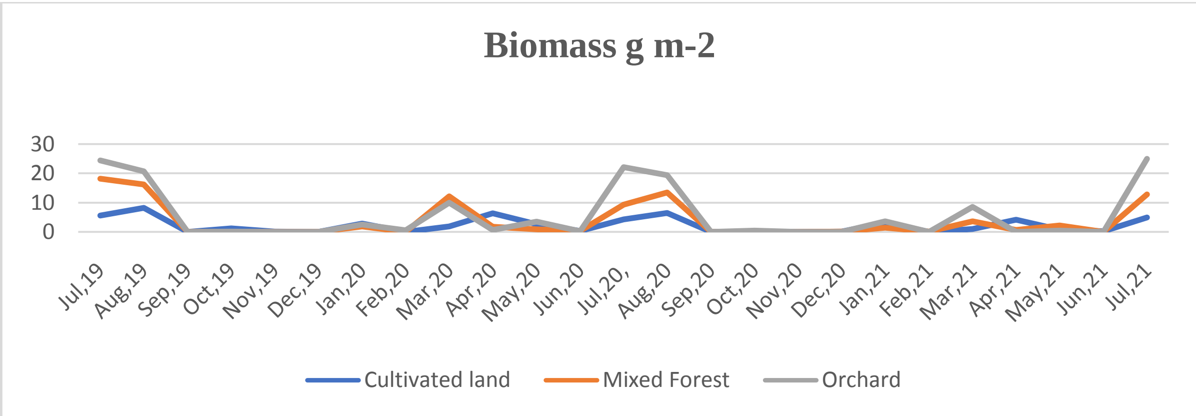

Figure 3: Mean population biomass (g m^{-2}) of earthworm varies across different land use types in the Jukhala area, District Bilaspur Himachal Pradesh during the Period 2019-2021.(Abbreviations: CL- Cultivated land, MF- Mixed Forest, O- Orchard).

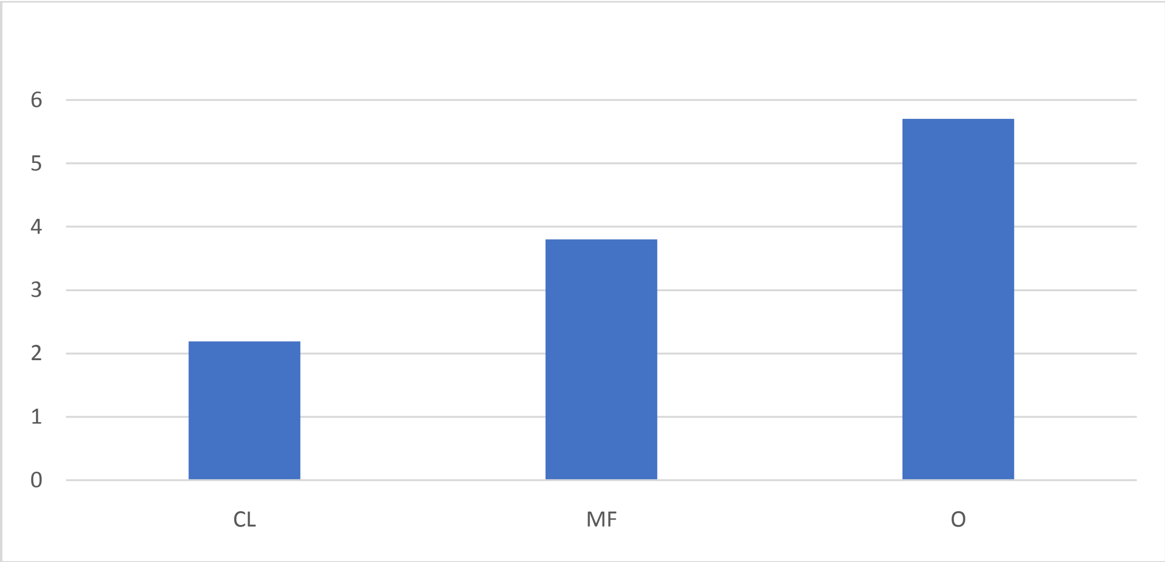

Figure 4: The relative density (RD%) of earthworm species varies across different land use types in Jukhala, District Bilaspur, Himachal Pradesh during the period 2019-21.

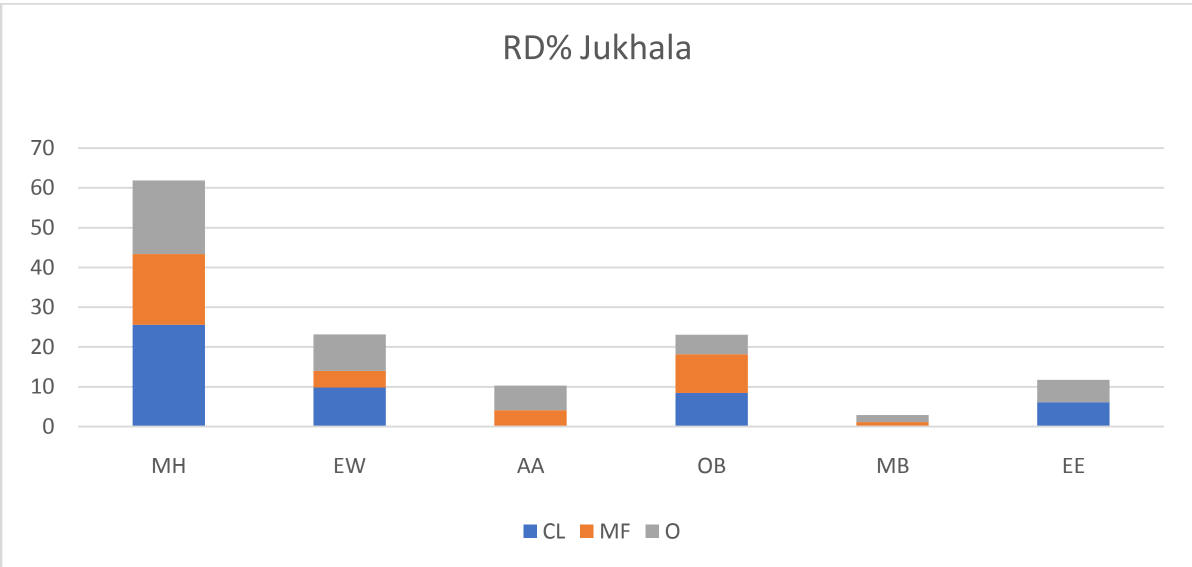

Figure 5: The fluctuation in monthly earthworm population densities across various land use categories in Jukhala, District Bilaspur, Himachal Pradesh, from 2019 to 2021.

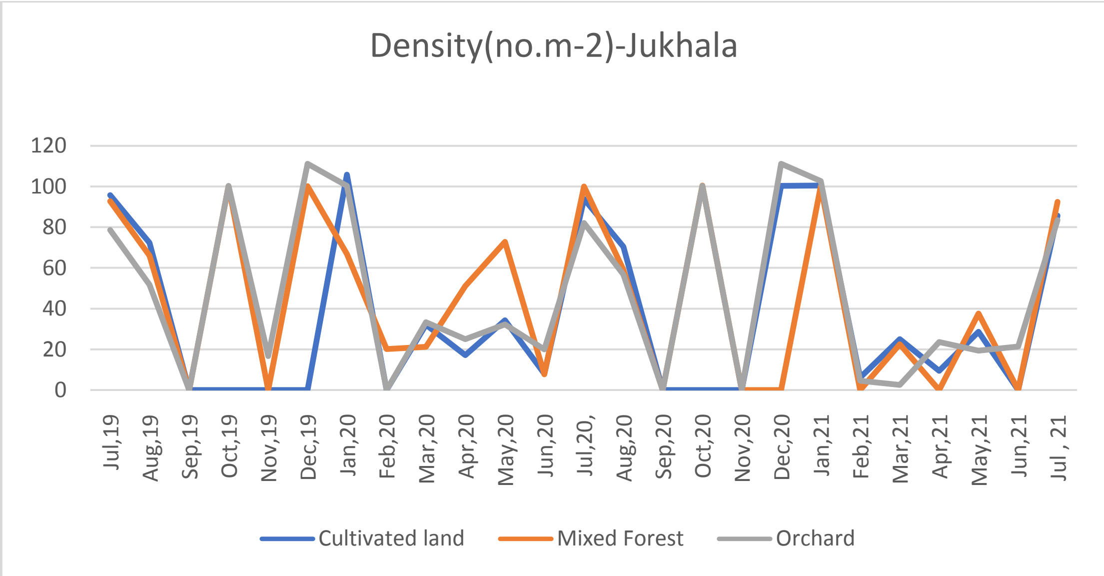

Figure 6: Mean population density (no. m-2) of earthworm at different land use types at Jukhala, District Bilaspur Himachal Pradesh during the Period 2019-2021. (Abbreviations: CL- Cultivated land, MF- Mixed Forest, O- Orchard).

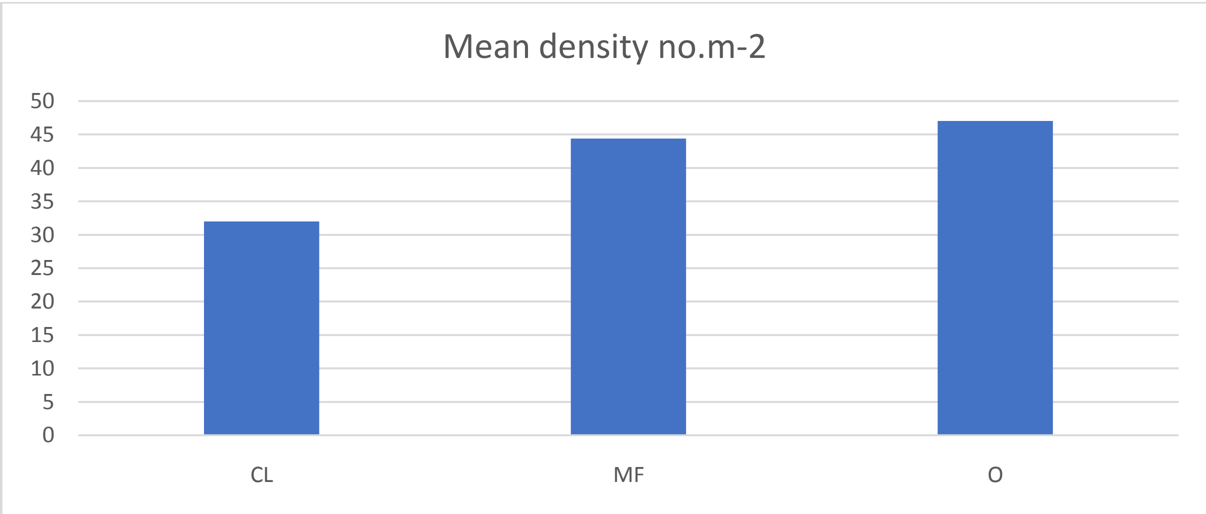

Table 5: The spatial distribution of both exotic and native peregrine earthworm species was examined across three distinct land use types in Jukhala, Himachal Pradesh from 2019 to 2021: Mixed Forest-Cultivated Land (MF) and Orchard (O).

Species/Land	Cultivated Land	Mixed Forest	Orchard
Exotic			
1.*Metaphire houlleti*	+	+	+
2.*Metaphire birmanica*	–	+	+
3. *Amynthasalexandri*	–	+	+

4.*Eudrilus eugeniae*	+	_	+
Native peregrine			
1.*Eutyphoeus waltoni*	+	+	+
2.*Octochaetona beatrix*	+	+	+
Total	**4**	**5**	**6**

Table 6:The distribution of exotic and native peregrine earthworm species (number of species) across three distinct land use types in Jukhala, Himachal Pradesh during the period 2019-21. Abbreviations: MF-Mixed Forest-Cultivated Land, O-Orchard.

	Exotic	Native peregrine	Total
JUKHALA			
1.Cultivated Land	2	2	4
2.Mixed Forest	3	2	5
3.Orchard	4	2	6

Figure 7: Illustrates the mean biomass (g m-2) of both exotic and native peregrine earthworm species across various land use types in Jukhala, District Bilaspur, Himachal Pradesh, over the period from 2019 to 2021. The land use types include Cultivated Land (CL), Mixed Forest (MF) and Orchard (O).

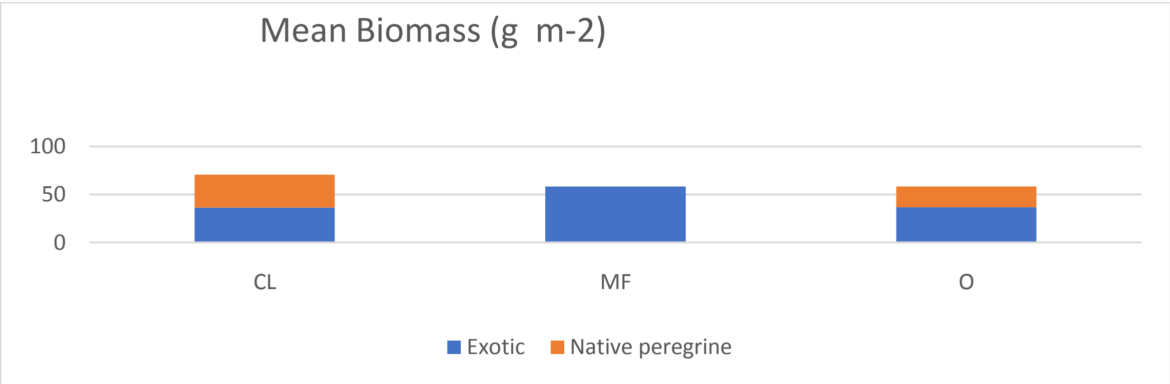

Figure 8: The mean density (g m-2) of both exotic and native peregrine earthworm species was examined across various land use types in Jukhala, District Bilaspur, Himachal Pradesh, from 2019 to 2021. Land use types included Cultivated Land (CL), Mixed Forest (MF), and Orchard (O).

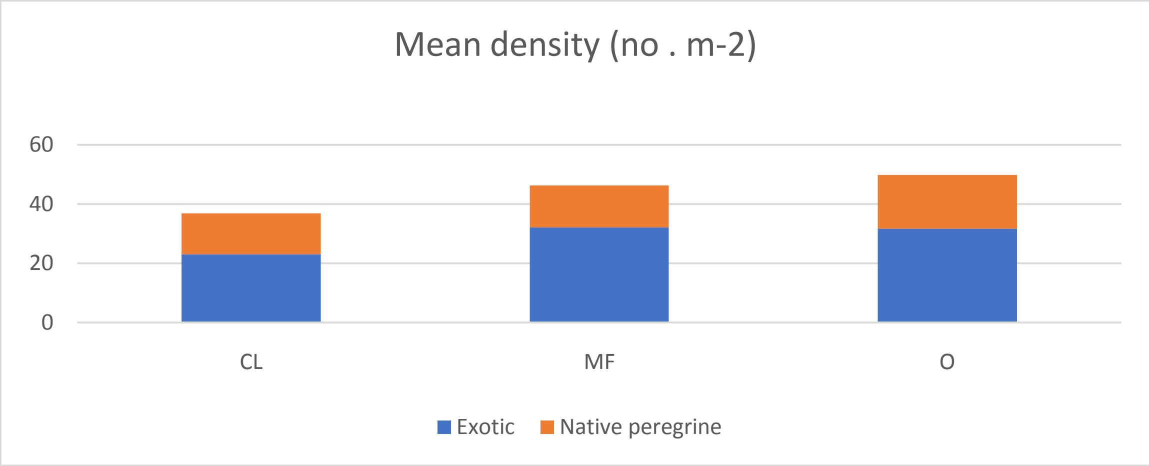

Table 7: Diversity Indices of earthworm in three different land use types in Jukhala, District Bilaspur, Himachal Pradesh during the period 2019-21**.**

Diversity Indices	**Cultivated land**	**Mixed Forest**	**Orchard**
Taxa_S	**5**	**6**	**4**
Individuals	**35**	**43**	**48**
Dominance_D	**0.3283**	**0.2449**	**0.3448**
Simpson_1-D	**0.6717**	**0.7551**	**0.6552**
Shannon_H	**1.298**	**1.578**	**1.219**
Evenness_e^H/S	**0.7327**	**0.8075**	**0.8462**
Brillouin	**0.9522**	**1.128**	**0.9592**
Menhinick	**0.8234**	**0.8816**	**0.5663**
Margalef	**1.125**	**1.329**	**0.775**
Equitability_J	**0.8067**	**0.8806**	**0.8795**

Figure 9: A dendrogram displaying Bray-Curtis linked clustering, illustrating the similarity indices of earthworm communities across various land use types in Jukhala,District Bilaspur.

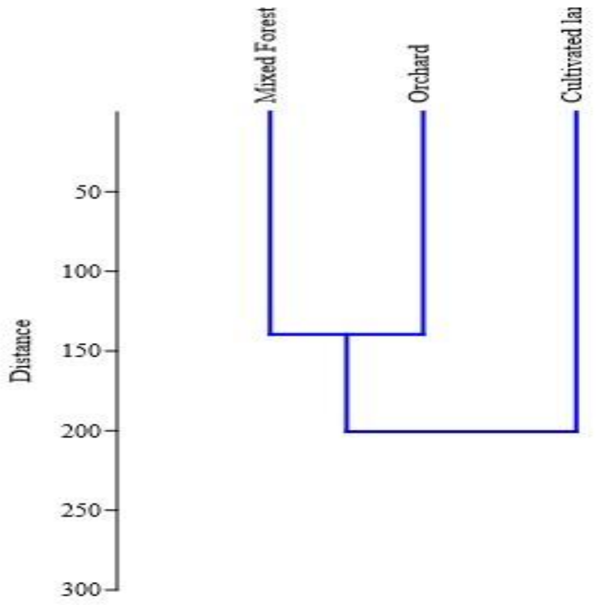

Table 8:The Bray-Curti similarity index (%) was utilized to compare earthworm communities across various land use types in Jukhala, District Bilaspur (H.P) between 2019 and 2021.

	Cultivated land	**Mixed Forest**	**Orchard**
Cultivated land	-		
Mixed Forest	0.69	-	
Orchard	0.75	.81	-

The Bray-Curtis index was employed to assess the similarity of earthworm across different land use types at each site (refer to Table 8). For example, the highest similarity was found between orchard and mixed Forest (.81%), whereas the lowest was between Cultivated land and Mixed Forest (.69%).

Table 9:The earthworm speciesbiomass (measured in gm-2) across different land use types in Jukhala, District Bilaspur (H.P), was documented from 2019 to 2021.

	Cultivated land	**Mixed Forest**	**Orchard**
Metaphirehoulleti	21.93	12.55	32.21
Eutyphoeuswaltoni	2.18	9.73	21.77
Amynthasalexandri	22.09	17.61	0
Octochaetonabeatrix	15.08	3.42	4.48
Metaphirebirmanica	3.38	7.43	0
Eudriluseugeniae	0	14.72	16.52

Total	**64.66**	**65.46**	**74.98**

Table 10: During the years 2019 to 2021, the collective density (no. m^{-2}) of earthworm species in diverse land use types was measured at Jukhala, District Bilaspur (H.P).

	Cultivated land	Mixed Forest	Orchard
Metaphirehoulleti	17.8	18.49	25.58
Eutyphoeuswaltoni	4.2	9.2	9.77
Amynthasalexandri	4.07	6.25	0
Octochaetonabeatrix	9.7	4.95	8.46
Metaphirebirmanica	1.1	1.75	0
Eudriluseugeniae	0	5.65	6.08
Total	**36.87**	**46.29**	**49.89**

Discussion

Among Annelida, six species of earthworms were identified, spanning five different genera and three familiesand categorized into exotic and native peregrine species. Mango orchards (49.89 m^{-2}& 74.98 gm^{-2}) exhibited the maximumbiomass and density of earthworms among the observed environments,while the lowest were recorded in cultivated land (36.87 m^{-2}& 64.66 gm^{-2}). The composition of earthworm communities varied among the three different land use categories, with mixed forests exhibiting the highest morpho species diversity.

In this study, the Mixed Forest showed the greatest species diversity, with 6 species observed, whereas Cultivated Land had 5 species and Orchards had 4 species. The calculated Shannon diversity index (1.57) and Pielou's evenness index (.88) were notably higher in the Mixed Forest, suggesting increased species diversity and suitable habitat for earthworms due to its complexity, consistent with observations by Blanchart and Julka and Whalen. [32,33]Conversely, cultivated land showed a lower value of Pielou's evenness index (.73), suggesting decreased suitability attributed to factors such as the burning of post-harvesting wheat crop residue, regular pesticide sprayingand the application of inorganic fertilizers. Orchards exhibited lower Shannon diversity index values compared to other land use types, with a higher Simpson index (D) value (.34), indicating lower diversity.

Four out of the six species gathered were labeled as exotic, with the remaining two identified as native peregrine. Exotic species were found predominantly in orchards (4), mixed forests (3) and cultivated lands (2), while native peregrine species were less frequently observed across these three land use systems. Among exotic species, Metaphirehoulleti was found in all three land use systems, Metaphirebirmanica and Amynthasalexandri were observed in mixed forests and orchards and Eudriluseugeniae was present in cultivated lands and orchards. In contrast, among native peregrine species, Eutyphoeuswaltoni and Octochaetonabeatrix were discovered in all three land use types.

Soil samples were collected monthly from the three land use types for analysis of various physicochemical parameters.In the cultivation field, temperatures ranged from 9^0 C to 30^0 C, in mixed scrub forest from 10^0 C to 29^0 C and in the orchard from 7^0 C to 30^0 C. Monthly mean temperatures varied, with the highest mean of 19.9^0 C (±1.21) in the cultivation field and the lowest mean of 18℃ (±1.29) in the mixed scrub forest. The peak soil temperature of 30^0 C occurred in July 2021 in both the cultivation field and orchard, while the lowest temperature of 7^0 C was recorded in the orchard in December 2019. The findings indicated that there were no significant temperature variances ($P<0.05$) among the averages within various land use categories. The monthly mean moisture values also exhibited differences, with cultivation fields experiencing a range of 21.6% (± 0.71) to 20.4% (± 0.62) in mixed scrub forests. Notably, the highest soil moisture (32.12%) was observed in July 2020 in cultivation fields, whereas the lowest (15%) was recorded in mixed scrub forests in February 2020. Mean pH values varied between 6.5 ± .11 in cultivation fields and 6.2 ± .09 in mixed scrub forests, respectively. The highest soil pH (7.80) was recorded in May 2021 in cultivation fields, while the lowest (5.10) was observed in mixed scrub forests in August 2020. Significant pH differences ($P<0.05$) were found between cultivation fields and orchards.

Monthly mean values of soil organic carbon fluctuated between 1.5% (±.05) in mixed scrub forests and 1.4% (± .060) in cultivation fields. The highest soil organic carbon content (2.10%) was recorded in August 2020 in mixed scrub forests, while the lowest (0.90%) was observed in cultivation fields in June 2020.Whereare available nitrogen fluctuated between 306.9 kg/ha (± 13.14) in cultivation fields and 300.4 kg/ha (± 14.38) in orchards. The highest soil available nitrogen (460 kg/ha) was recorded in December 2020 in orchards, while the lowest (144.63 kg/ha) was observed in mixed scrub forests in July 2020.

Monthly mean values of soil available phosphorus fluctuated between 22.1 kg/ha (±.82) in cultivation fields and 19.7 kg/ha (±.52) in orchards. The maximum soil phosphorus (32 kg/ha) was recorded in January 2021 in cultivation fields, while the minimum (14 kg/ha) was observed in both cultivation fields and mixed scrub forests in August 2019. Significantly different ($P<0.05$) soil available phosphorus levels were found between cultivation fields and orchards / orchards and cultivation fields. Whereas soil available potassium varied between 316.0 kg/ha (± 20.01) in mixed scrub forests and 284.8 kg/ha (± 18.62) in orchards. The maximum soil available potassium (591.00 kg/ha) was recorded in mixed scrub forests in January 2020, while the minimum (161.00 kg/ha) was observed in cultivation fields in May 2020.

The data was subjected to one-way analysis of variance (ANOVA), and subsequently, Tukey's multiple comparison test was employedto analyse the variance in moisture among the three different land use types in Jukhala, District Bilaspur.The results indicated that the differences in moisture content, soil available potassium, nitrogen, The significance of organic carbon levels was not observed ($p<0.05$) across the three land use types.

Agricultural intensification negatively affects earthworm populations, resulting in lower species richness.[34]The number of species present within an earthworm community can be considered a simple and direct indicator of species diversity.[35-38] However, significant discrepancies in earthworm species diversity were observed across various land use categories. For example, cultivated lands harbored 1-5 species, while forests in the central Himalaya contained 3-8 species.[39,40]Similarly, the Haryana plains were observed to have 4-7 species,whereas the Doon valley in Uttarakhand's Western Himalaya was inhabited by a total of 12 species.[41,42]Misirlioglu recently published a comprehensive checklist comprising 5,738 species/subspecies, distributed globally across 382 genera and 23 families.[43]Shivalik ecosystem as one of the eight most degraded agroecosystems in the country. [44]

Temperature and soil moisture significantly influence earthworm populations.[45,46] Seasonal variations also impact earthworm abundance, with higher populations observed during wet seasons in the Himalayan region.[47,48]The global impact of rising air temperatures on earthworm communities.[49] High temperatures can directly inhibit earthworm activity and reproduction while indirectly affecting soil moisture levels.Conversely, some other researcher discovered a positive relationship between earthworm population density and soil moisture content.[50] Soil water content has been identified as a mitigating factor against the effects of heat waves.[51] Someresearcher noted positive correlations between earthworm density,biomass and soil temperature.[52,53]

Regarding soil properties, earthworm populations exhibit preferences and tolerances to pH levels.[54,55] Organic carbon content positively influences earthworm diversity.[56,57]Several research findings suggest a direct relationship between the density of earthworms and the presence of soil organic carbon.[58,59] Additionally, soil organic carbon and nitrogen levels positively correlate with earthworm biomass and density.[60,61]There is disagreement about how organic carbon levels relate to the abundance of earthworms.[62,63]Nitrogen availability significantly influences earthworm abundance and distribution.[61,41] Available phosphorus and potassium levels also impact earthworm populations, although findings regarding their correlation vary.[54,64]

Conclusion

This study involved collecting earthworm species from six different species across three families: *Amynthasalexandri*(Kinberg),*Metaphirehoulleti* (Perrier) and *Metaphirebirmanica* (Rosa) from the Family Megascolecidae; *Octochaetonabeatrix* (Beddard) and*Eutyphoeuswaltoni* (Michaelsen) from the Family Octochaetidae; and *Eudriluseugeniae,* originally classified by Kinberg, is a member of the Eudrilidae family.Mixed forests boasted the highest diversity of land use types, accommodating six species, followed by cultivated land with five species, and orchards with four species. Among the collected species, four were identified as exotic, while the remaining two were considered native peregrine. The dominance of exotic and Indian peregrine earthworm species across all land use systems suggests significant anthropogenic impacts on forest ecosystems. These findings offer valuable baseline data for developing management strategies for forests and agroecosystems, aiming to enhance soil ecosystem functioning and resilience, particularly in response to changing environmental conditions. Additionally, the correlation between high earthworm density and soil moisture underscores the ecological significance of earthworm in soil health and ecosystem dynamics.This study examines the abundance and species diversity of earthworms across various land use types with different levels of disturbance. Additional research is required to identify the factors accountable for the decrease in endemic earthworm species and the introduction of exotic species and effects of exotic earthworm species on terrestrial vegetation should be investigated.

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