A STUDY ON DENSITY AND BIOMASS OF EARTHWORM IN DIFFERENT ALTITUDES OF SOUTH-EASTERN PART OF SIMILIPAL BIOSPHERE RESERVE, MAYURBHANJ, ODISHA

M.K. Lenka[1*], N. Mohanty[1] and B.C. Guru[2]

[1]P.G. Dept. of Zoology, North Orissa University, Baripada, 757 003, Odisha, INDIA.
[2]P.G. Dept. of Zoology, Utkal University, Bhubaneswar, 751 004, Odisha, INDIA.
E-mail: lenkamahesh@gmail.com

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ABSTRACT: Soil is a natural habitat for microorganisms, plants and animals. Out of which earthworm is the most important soil invertebrate. Since it involved in improving the soil quality, an attempt has been made to study the density and biomass of earthworms in different altitudes of South-eastern part of Similipal Biosphere Reserve (SBR). The above parameters have been investigated in five different altitudes (Balma: 133 mASL, Debkund: 190 mASL, Hadgut: 222 mASL, Katuria: 242 mASL and Nato: 326 mASL) of SBR in different season of a year. It was observed that the number (density) of earthworms is significantly different among different altitudes and different seasons. The biomass of earthworms was significantly different among different seasons but it was not significant among altitudes.

KEYWORDS: Earthworm, Density, Biomass, Altitude, Ecology.

INTRODUCTION

Charles Darwin was the first scientist to bring earthworms to the attention of scientists and the general public more than a century ago. However, it was only in the last 25 years that interest in research into the ecology and biology of earthworms has peaked [10].

Soil is a treasure house of variety of invertebrates and to lesser extent vertebrates. Earthworms are the most important soil invertebrate. Earthworms are involved in improving the soil quality. It helps in conservation of soil profile [3].Traditionally earthworms were used in fishing. But now-a-days earthworm has a wide range of application in agriculture and in many more fields. It plays a vital role in increase of fertility of the soil. Earthworm has a significant role in soil aggregation and soil porosity [26].Therefore, Aristotle rightly called them as "Nature's Plough". So, indirectly it also helps in the increase of soil aeration, water infiltration, water-holding capacity, soil tilt and in soil crusting [11]. The vermicompost or "Black Gold" produced by the earthworm has an endless demand for consumer, since there are no competitors or manmade factories that can ever duplicate the elements of 'Black Gold'. This product can insulate the plant root from extreme temperature, reduce erosion, control weeds and fin3ally increases the fertility of the soil. So, it creates a special place in the field of agriculture as a biofertiliser. Earthworm can accelerate the rate of decomposition from 25% to 40% [4,12,23,24,25]. Earthworm can also influence population of *Rhizobium* bacteria, which fix nitrogen in nodules on the roots of leguminous plants, including some important crop plants. Rouelle [20] reported that *Lumbricus terrestris* increases the spread of root nodules on soyabean (*Medicago sativa*). Double *et al*. [8] demonstrated that several species of earthworm could increase the degree of dispersal of *Rhizobium* bacteria and the amount of root nodulation in alfalfa plants [9]. Although they are not numerically dominant, their large size and habit of burrowing and turning over large quantities of soil make them major contributors to overall soil structure, aeration and drainage [9].

Land invertebrate fauna (surface dwellers) from Similipal Biosphere Reserve (SBR) has been reported earlier [18,19]. But no literature is available on the earthworms of soil of SBR that has different forest types at various altitudes having varied habitats. Therefore, the present study was undertaken to know about the ecology of earthworm in South-eastern part of SBR. The results of the above experiments will reflect which type of ecosystem is more disturbed and which one is less disturbed basing on the density or richness of earthworms in these terrestrial ecosystems.

MATERIALS AND METHODS

The study area covers the transition (peripheral) as well as buffer zones of South-eastern part of Similipal Biosphere Reserve (SBR). Similipal Biosphere Reserve is located (latitude 20^{0} 17'- 22^{0} 34' N and longitude 85^{o} 40'- 87^{o} 10' E) in the central part of Mayurbhanj district of Odisha state in India. The South-East part (latitude 21° 35′ N and longitude 86° 22′ E) of SBR receives more precipitation (about 1,846 mm) during monsoon [7]. Therefore, study sites were chosen from this part of SBR at different altitudes, like at Balma: 133 mASL (Above Sea Level), Debkund: 190 mASL, Hadgut: 222 mASL, Katuria: 242 mASL and Nato: 326 mASL. So, it is more important with respect to other areas of SBR in research point of view, i.e., it has also an altitudinal variation, variation in temperature and variation in richness of forest.

The soil samples were collected from five places of each study sites of different altitudes in different seasons (July-October: Rainy season; November-February: Winter season; and March-June: Summer season) for consecutive 3 years from 2013-2016. For collection of samples, soil block of 25 × 25 × 30 cm were dug up by crowbar and ten replicas (for each season of each year) were made for each site of study area [1]. The soil masses were taken out and from that earthworms observed visually were collected out by handpicked method [6,22]. and were kept in small plastic jars which contain 5% formalin for preservation**.** Then these jars containing samples were taken to laboratory. They were weighed after soaking in a blotting paper for biomass study by monopan balance (Roy Electronics, Varanasi) and counted by hand for density study of each type. To convert the soil block area into one square metre, 16 was multiplied with each data obtained from area of 25 × 25 cm for both the density and biomass studies. Further, as the weight was taken from formalin fixed samples, it is slightly less than the freshly weighed animals. Therefore, a correction factor of 6.39 was multiplied in case of biomass study as per Senapati and Dash [21]. It was then expressed as gram fresh weight (g fresh wt.). As there is no significant difference of data between years, the data of three years were pooled together.

Differences among mean density and biomass in relation to different altitudes of SBR in different seasons of a year were determined by two-way analysis of variance (ANOVA) [4]. A difference was considered to be statistically significant if $p < 0.05$.

RESULT AND DISCUSSION

The biological characteristics (density and biomass) of earthworms were studied in three different seasons (summer, rainy and winter) for 3 years (2013-2014, 2014-2015 and 2015-2016) at different altitudes of SBR.

It was found that mean number (density) of earthworm was decreased from lower altitude to higher altitude (Table 1). And the mean number of earthworm was more in rainy season whereas comparatively less in winter season and again it was less in summer season (Table 1).

Table 1: Average density (in no.) and biomass (in g) (of three years) of earthworms at different altitudes of SBR in different season (Summer, Rainy and Winter)

Study area of different altitudes	Parameter	Summer	Rainy	Winter
Balma (133 Masl)	Density	102.39	133.86	115.73
	Biomass	16.30	49.93	22.45
Debkund (190 Masl)	Density	92.26	125.80	107.19
	Biomass	15.11	41.02	20.99
Hadgut (222 Masl)	Density	83.73	120.53	105.59
	Biomass	13.85	39.44	19.55
Katuria (242 Masl)	Density	81.59	111.99	97.06
	Biomass	13.40	34.86	20.12
Nato (326 Masl)	Density	71.46	109.86	93.33
	Biomass	12.23	32.38	17.98

Table 2: Summary of computations for two-way analysis of variance (F- test) of data of density of earthworms at different altitudes of SBR in different seasons (Summer, Rainy and Winter)

Source of Variation	Degree of Freedom	Sum of squares	Mean square	Variance ratio (F)
Between Seasons	r-1=5-1= 4	RSS = 1206.66	RMS = 301.66	F_{CR} = 57.94 F ∝ = 3.84, at 0.05 level
Between Altitudes	c-1=3-1= 2	CSS = 2913.43	CMS = 1456.71	F_{CC} = 279.83 F∝ = 4.46, at 0.05 level
Error	(r-1)(c-1)= 8	ESS = 41.64	EMS = 5.20	
Total	(r c)-1= 14	TSS = 4161.74		

Source of Variation	Degree of Freedom	Computed F	Critical F	Probability P	Significance Type
Between Altitudes	d_1 = 2 d_2 = 8	57.94 >	3.84	∝=0.05	Significant
		(Null Hypothesis is rejected)			
Between Seasons	d_1 =4 d_2 =8	279.83 >	4.46	∝=0.05	Significant
		(Null Hypothesis is rejected)			

Table 3: Summary of computations for two-way analysis of variance (F- test) of data of biomass of earthworms at different altitudes of SBR in different seasons (Summer, Rainy and Winter)

Source of Variation	Degree of Freedom	Sum of squares	Mean square	Variance ratio (F)
Between Seasons	r-1=5-1= 4	RSS = 129.44	RMS = 32.36	F_{CR} = 3.46 F ∝ = 3.84, at 0.05 level
Between Altitudes	c-1=3-1= 2	CSS = 1753.00	CMS = 876.50	F_{CC} = 93.74 F∝ = 4.46, at 0.05 level
Error	(r-1)(c-1)= 8	ESS = 74.80	EMS = 9.35	
Total	(r c)-1= 14	TSS = 1957.24		

Source of Variation	Degree of freedom	Computed F	Critical F	Probability P	Significance Type
Between Altitudes	d_1 = 2 d_2 = 8	3.46 <	3.84	∝ = 0.05	Not Significant
		(Null Hypothesis is rejected)			
Between Seasons	d_1 =4 d_2 =8	93.74 >	4.46	∝ = 0.05	Significant
		(Null Hypothesis is rejected)			

It was found that mean weight (biomass) of earthworms was also decreased from lower to higher altitude. Mean weight of earthworm was also decreased from rainy to winter and from winter to summer season. An exceptional case was observed at study site Katuria in winter season i.e., mean biomass of earthworm at Katuria (20.12 g) was more than that of mean biomass of earthworm at Hadguth (19.55 g) though Katuria is present at higher altitude than the Hadguth study site (Tables 1). According to Spurgeon and Hopkin [27] more numbers of earthworms are found in winter than in summer season at Avonmouth in South-West England. Density and biomass of earthworm are more in summer than winter at Narayankoti in Garhwal region of western central Himalaya [13]. The highest rainfall was recorded during October-November and the earthworm population with emphasis on Indian ecosystems was also the highest at this period, i.e., rainy season [14].

From two-way analysis of variance (ANOVA) study, it was observed that density of earthworm among different seasons and different altitudes of SBR were significantly different ($p< 0.05$) from each other (Table 2). There was a significant difference ($p< 0.05$) in biomass of earthworm among different seasons of SBR. But among altitudes it was not significantly different (Table 3). In agro-ecosystem tillage, cropping sequence, geographic location as well as climate both singly as well as in combination can all influence density and biomass of earthworm [17]. Higher earthworm population during June (beginning of monsoon) than that during October (post monsoon) supports the fact that earthworms are usually recorded higher during rainy season. Among different soil parameters, moisture content and organic matter content affected the distribution of earthworms in Panchase area, mid-hill of western Nepal [15]. In Mizoram, earthworm biomass of two agro-forestry based plots was significantly affected by rainfall and moisture content of the soil [16]. The density of earthworm increased along with parameters, such as rainfall and soil moisture content. In the present study there was also a seasonal variation in earthworm population in study sites and peak density was observed during the monsoon season.

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