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SECONDARY PRODUCTION OF THE EARTHWORM *Perionyx Sansibaricus* (MICHAELSEN) IN A GARBAGE SITE AT RANCHI, JHARKHAND

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Abstract

Perionyx sansibaricus (Michaelsen) - a dominant earthworm species in garbage sites of different districts of Jharkhand, has not been studied in detail from ecological viewpoint. The present communication records for the first time the secondary production of the species in a garbage site near Ranchi University Hostel, Ranchi. The secondary production of the species was 537.08 g dry weight/m^2/year. The tissue growth was 61.09% and the tissue lost due to mortality was 38.90% of the secondary production. The secondary production of the worm in terms of energy value (K cal/m^2/yr) was 2481.30, while the production turn over value was 4.12 and elimination turnover value was 2.57 times yr^{-1}. The average instantaneous growth rate for the species was 4.64% $month^{-1}$.

Key Words : *Secondary production,* Earthworm, *Biomass, Elimination turnover.*

INTRODUCTION

Earthworms are known as good friends of farmers since the time of White (1789) and Darwin (1881). Earthworms are both soil managers as well as decomposers. In tropical ecosystems although earthworms dominate the soil invertebrate biomass (>80%), they were not studied in detail until Bhal (1925). ICAR published research series no.2 (Bhat and Khambata, 1959) on the role of earthworms in agriculture. Now the real value of earthworms is being recognised by a good number of workers with respect to fertility of soil, vermicompost and vermitechnology, which is the demand of the day as part of biotechnology programme.

Much of our knowledge on ecology, ecophysiology and vermicomposting came from the works of Dash and Patra (1977); Dash (1978); Dash and Senapati (1980); Senapati and Dash (1981); Mishra and Dash (1984); Sahu and Senapati (1986); Sahu *et al.*, (1988); Senapati *et al.*, (1987); Mishra and Sahoo (1997) apart from contribution of Kale and Krishnamoorthy (1978, 1981), Kale and Bano (1986), Krishnamoorthy (1985,1986) and Goswami *et al.*, (2001). The review of literature reveals that *Perionyx sansibaricus* (Michaelsen)- a vermitechnologically suitable (Julka & Mukherjee, 1986; Dash, 1999; Sinha *et al.*, 2001) and endemic earthworm species has not been studied so far. Since no information is available on this species, the present investigation has been designed to know the secondary production of the species in terms of biomass, energy and turnover value.

MATERIAL AND METHODS

Earthworms were sampled from a wet organically rich garbage site near Ranchi University hostel, Morhabadi campus, located between 21°58' N to 25°19'N latitude and 83°20'E to 88°4'E longitude at a height of 629 m above mean sea level (MSL). Sampling was done during morning hours by monolith method following procedure of Dash and Patra (1977) and hand sorted once in a month during the study period from October 99 to September 2000. Sample size was 20 x 20 x 20 cm and five samples were taken during each sampling occasion.

On the basis of length and clitellar development earthworms were divided into three age classes. They are (i) Juvenile (< 2 cm, non clitellate), (ii) Immature (≥ 2 < 4cm, non clitellate) and (iii) Mature (≥ 4cm, clitellate). Preservation and analysis of worms were made according to Dash and Patra (1977) and Senapati and Dash (1980). Five replicates of freshly sampled worms were categorized into different size groups and were weighed separately after being gut evacuated and were kept in oven at 85^{0}C for 24 hrs to obtain dry weight.

Gut evacuation of worms was made by keeping them half immersed in distilled water (changed every 12 hrs) in glass petriplates for 24 hours.

Secondary production is defined as the amount of tissue substance produced due to change in body weight (Δb) and reproduction (Δg) over a period of time (say one year) irrespective of whether it has survived to the end of that period or not (Cragg, 1961, 1969; Macfadyen, 1967). According to Golley (1961), production can be written as P= ΔB + E, where ΔB represents the change in biomass (growth + reproduction) and E stands for elimination (loss) i.e., the biomass of individuals that have died or been killed. Changes in number of worms show loss or gain of weight. Growth and mortality were thus calculated from the gain and loss of number and biomass of earthworms following the method of Dash and Patra (1977). Since cocoon of earthworms could not be detected by hand sorting method, the secondary production has been calculated taking the change in biomass and tissue lost due to mortality into consideration.

A growth curve results when simply the weight is plotted at each interval of time but a common and useful alternative is to calculate the instantaneous growth rate. This expresses the time interval (daily or weekly or monthly or yearly) increment per unit of existing biomass and is expressed as percentage using the following equation (Brafield and Llewellyn, 1982).

$$IG(\%) = \frac{\log_{10} YT - \log_{10} Yt}{T - t} \times 2.3026 \times 100$$

Where t = time at the beginning of the observation, T = time at the end of the observation, YT = weight at time T and Yt =weight at time t and 2.3026 is conversion factor.

RESULTS

The total biomass of the worms in the site during the study period ranged between 11.63 and 328.38 g dry wt/m^2. The peak of biomass (328.38 g dry wt/m^2) was recorded in the month of August 2000. The higher peak was associated with rainy season. The worm biomass was observed minimum as 11.63 g dry wt/m^2 in June 2000 (Table-1).

Variation in Biomass

The biomass of the worms at a depth of 0 – 10 cm varied between 8.99 and 80.32 g dry wt/m^2 in the months of May 2000 and July 2000 respectively. Biomass was nil in June 2000 (Fig.1). The average monthly worm biomass at this depth was 30.67 g dry wt/m^2. Juvenile, immature and mature worms had a share of 0.82 g dry wt/m^2, 13.20 g dry wt/m^2 and 16.65 g dry wt/m^2 towards biomass respectively.

The variation in worm biomass at a depth of 10 – 20 cm, as shown in Fig. 1 was minimum and maximum in the months of June 2000 and August 2000 and it was in the tune of 11.63 g dry wt/m^2 and

267.16 g dry wt/m^2 respectively. The average monthly worm biomass at 10 – 20 cm depth was 99.54 g dry wt/m^2. The different age classes i.e. juvenile, immature and mature worms contributed 2.73 g dry wt/m^2, 40.36 g dry wt/m^2 and 56.45 g dry wt/m^2 towards biomass respectively.

The two-way analysis of variance showed significant difference between different months ($F = 2.848$; $df = 11,11$; $p < 0.05$) as well as different depths ($F = 12.109$; $df = 1,11$; $p < 0.01$).

Instantaneous growth rate

The average instantaneous growth rate was calculated to be 4.64% month^{-1} The instantaneous growth rate ranged between –113.8 to 332.4% in the months of June and July 2000 respectively (Fig. – 2).

Secondary Production

The loss in biomass due to mortality of worms mostly occurred during late autumn, winter and summer as shown in Table – 1. The average monthly loss of earthworms was 17.41 g dry wt/m^2. The secondary production of *Perionyx sansibaricus* was 537.08 g dry wt/m^2 (Table –1).

The change in biomass (growth & reproduction) was maximum and minimum in the months of July 2000 and August 2000 with a value of 311.38 g dry wt/m^2 and 5.37 g dry wt/m^2 respectively. The elimination was maximum in the month of December 99 (66.32 g dry wt/m^2) and minimum in the month of May 2000 (0.99 g dry wt/m^2). Population biomass turnover ratio of secondary production to average monthly biomass was calculated to be 4.12. The elimination turn over value was 2.57 times yr^{-1}.

The secondary production in terms of energy was found to be 2481.30 Kcal/m^2/year. The contribution of tissue growth increment was 61.09% and the tissue lost due to mortality was recorded as 38.90% of the secondary production.

Table 1: Secondary production of *Perionyx sansibaricus*.

Months	Total worm Biomass (g dry wt/m^2)	ΔB	E
Oct. 99	158.18	-	-
Nov. 99	129.01	-	29.17
Dec. 99	62.69	-	66.32
Jan. 2000	68.67	5.98	-
Feb. 2000	62.33	-	6.34
Mar. 2000	67.74	5.41	-
Apr. 2000	37.27	-	30.47
May 2000	36.28	-	0.99
Jun. 2000	11.63	-	24.65
Jul. 2000	323.01	311.38	-
Aug. 2000	328.38	5.37	-
Sep. 2000	276.38	-	51.00

Where,

ΔB= Change in Biomass; E= Elimination

1. Average biomass=130.21 g dry wt/m^2
2. Secondary production
   - Change in Biomass (ΔB) = 328.14 g dry wt/m^2
   - Elimination (E) = 208.94 g dry wt/m^2
   - Total = 537.08 g dry wt/m^2
3. Biomass turnover = 4.12 times yr^{-1}
4. Elimination turnover = 2.57 times yr^{-1}

DISCUSSION

The biomass (dry wt.) of *Perionyx sansibaricus* was observed to be 11.63 – 328.38 g dry wt/m^2 (Table 1) in the present study. The recorded biomass was considerably higher than the reports of Dash & Patra (1977), Lavelle (1978) and

Fig. 1 : Variation in total biomass of *Perionyx sansibaricus* at different depths in a garbage site near Ranchi University Hostel, Jharkhand

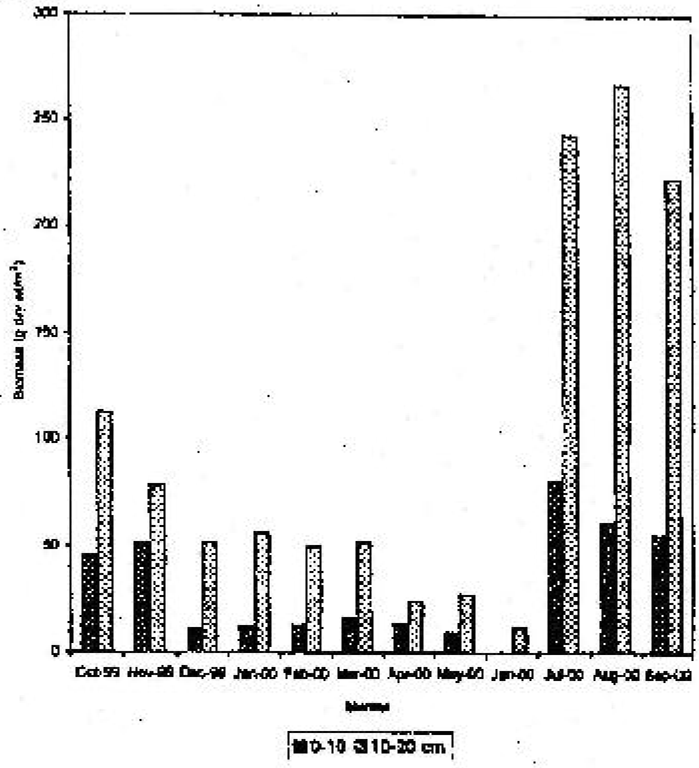
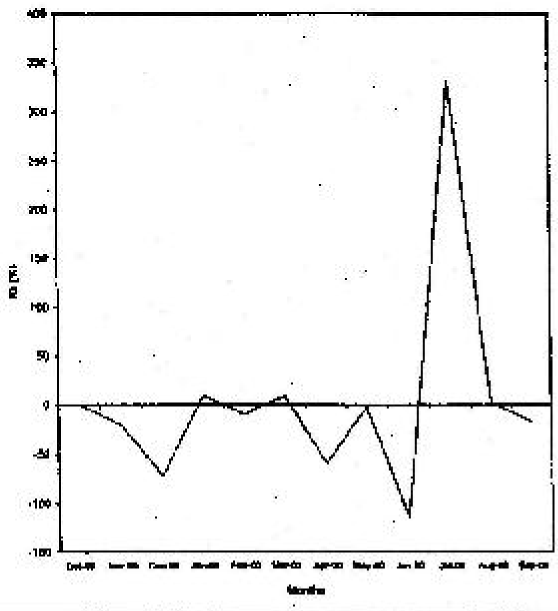


Fig. 2 : Instantaneous growth rate (IG) of *Perionyx sansibaricus* during the period of investigation.



Senapati & Dash (1981) for tropical pasture. Sahu *et al.*, (1988) reported a biomass of 0-66.2 g live wt/m^2 and 0-51.4 g live wt/m^2 from a pasture receiving kitchen waste and in a dung deposit site respectively which was the highest biomass reported so far for *Dichogaster bolaui*. *Dichogaster bolaui* is a small epigeic species with high population density, high reproductive rate and with sudden emergence pattern, whereas *Perionyx sansibaricus* is a large species, which occurred throughout the year without showing any stress. Further a rebuilding of population biomass was not observed which could probably resulted into very high biomass for the species during the present work. A population biomass of 0.86 - 67 g live wt/m^2 and 0 - 183.33 g live wt/m^2 was reported by Mishra and Sahoo (1997) in control and 50% waste water irrigated plots respectively.

While many authors recognise that growth may encompass repair and maintenance (Needham, 1964), production (P) includes only increase in biomass or a change in body constituents. As growth is essentially quantitative its most important property is its rate, which varies considerably. The growth rate with respect to unit time interval i.e. the instantaneous or specific growth rate calculated for *Perionyx sansibaricus* ranged from –113.8% to332.4% (Fig.-2).

Many environmental factors affect the growth and reproduction and hence the growth rate declines or increases at different time interval. The variation in the instantaneous growth rate of *Perionyx sansibaricus* in the present study was mostly due to changes in temperature and soil moisture. The summer season decreased the growth upto –113.8% while rainy season favoured the growth rate upto 332.4%.

The secondary production data are not available from many world sites. Secondary production in many species varies significantly seasonally and with climatic extremes. Lakhani and Satchell (1970) and Satchell (1971) reported secondary production as 56.02 Kcal/m^2/year for *Lumbricus terrestris* population in Europe. Lavelle (1977, 1983) reported production of 16.80 Kcal/m^2/year for *Millsonia anomala* earthworm in Lamto Savanna, Ivory coast. Nowak (1975) reported oligochaeta production of 58.02 Kcal/m^2/year and 12.03 Kcal/m^2/year from a partly protected and grazed pasture respectively. Senapati and Dash (1981) reported 122.05 Kcal/m^2/year and 144.06 Kcal/m^2/year of secondary production by earthworms in tropical protected pasture and grazed pasture respectively from India. Sahu and Senapati (1996) reported a secondary production of 277 KJ/m^2/year and 151 KJ/m^2/year from a pasture and dung deposit sites respectively. Mishra and Sahoo (1997) reported the secondary production values for *Lampito mauritii* to be 140.37 Kcal/m^2/year and 207.01 Kcal/m^2/year in control and 50% wastewater irrigated plot respectively. However, the secondary production value obtained in the present investigation (2481.30 Kcal/m^2/year) was much higher than the any previous reports, which may be due to the presence of worm population throughout the study period.

Data on biomass turnover value of earthworms are also not available from many world sites (Petersen, 1982). Average production biomass ratio (P/B) for earthworms was 2.4 and 3.9 - 4.5 for ungrazed and grazed pastures respectively (Dash *et al.*, 1974, Senapati and Dash, 1981). Lavelle (1977) reported that P/B ratio in oligochaeta population in Lamto Savanna varied from 1.2 to 2.6. Nowak (1975) reported P/B ratio of 0.9 and 1.3 in temperate regions in a partly protected and grazed pastures respectively. Sahu and Senapati (1996) reported a high P/B ratio of 5 and 4.8 times/year in the pasture and dung deposit site respectively for

Dichogaster bolaui. However, the P/B ratio in the present study was 4.12, which lies in the range of 3.9 – 4.5 as reported, by Senapati and Dash (1981) for grazed pasture. The higher turnover values obtained in the present study indicate rapid replacement in tropical habitats in comparison to temperate habitats.

The high biomass, high production coupled with high instantaneous growth rate and higher turnover values are some of the positive attributes of the species for Vermicomposting.

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