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Growth and reproduction of *P. excavatus* and *P. cressiseptatus* in different months of throughout the year during vermicomposting

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ABSTRACT

Due to their importance in processing the organic materials, enhancing the fertility of soil and their supportive role to the agriculture and due to interest of biologists in the study of animals and plants, earthworms had been subject of attention of several workers. Earthworms constitute a large part of biomass in the soil. They have been recognized as soil movers and conditioners. In this study, efforts have been made to compare the growth and reproductive potential of *Perionyx excavatus* and *Perionyx cressiseptatus* by using a common substrate or culture material such as cattle dung waste that had not been explored extensively in previous studies. The effect of different months on growth and reproduction of *Perionyx excavates* and *Perionyx cressiseptatus* was studied at vermicomposting center. For each month, viz., 50 gm adult earthworms per 5 kg of cattle dung were inoculated and monitored for total biomass gain, cocoons production, sexual maturity. Mortality was not observed in any month. The better performance (% change) with reference to biomass and bio number was agreed by *Perionyx excavatus* in the month of July while *Perionyx cressiseptatus* was generated in the month of August.

Keywords: Earthworms, Biomass, Bionumber, *Perionyx excavatus*, *Perionyx cressiseptatus*, Vermicomposting.

1. INTRODUCTION

In an integrated nutrient management approach, the chemical fertilizer is substituted by compost, the well-decomposed organic manure prepared from crop residues, weeds, lawn mowing, tree leaves, kitchen refuges, animal excreta and city garbage's. The earthworms have beneficial physical, chemical and biological effects on soil and many researchers have documented that these effects can increase the plant growth and crop yield [1]. Vermicomposting is an eco-biotechnological process that transforms energy-rich and complex organic substances into stabilized humus-like product vermicompost. Some epigeic earthworms: *Lumbricus terrestris*, *Eisenia foetida*, *Eisenia andrei*, *Eudrilus eugeniae* and *Perionyx excavatus* have been appeared as key sources to combat the problems of organic waste disposal on a low-input basis [2-6]. However, the waste decomposition efficiency of *P. excavates* is well documented in literature [2,6,7]. But little is known about the composting use of *Perionyx cressiseptatus.* Therefore, to establish the use of this species for vermicomposting operations, much work is still required, since both species of genus *Perionyx* have distinct morphological characteristics and also possibly waste degradation patterns though they may later enquire much experimental confirmation. However, comparative studies on growth and reproductive efficiencies on these species still need richer literature.

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The comparison of the composting efficiency can be performed by using a common substrate for both species. In most of the previous studies on *Perionyx excavatus*, cattle dung and/or plant-derived wastes were used as substrate material in vermicomposting experiments [7-10].

2. MATERIALS AND METHODS

The cattle manure was obtained from the nearby study site and both species (*Perionyx excavatus* and *Perionyx cressiseptatus*) were procured from the vermicomposting centre of Jiwaji University, Gwalior. The vermicomposting experiments were set-up in triplicate to analyze the effect of the earthworm, while parallel control groups (without earthworms) were also maintained. The culture pots (plastic containers) were left for 15 days prior to experimentation and watering was done on alternate days for precomposting, microbial degradation, softening of waste and thermo stabilization. After 15 days, 50 grams worms of each species were inoculated in the experimental plastic pots. The moisture content was maintained 40-60%. Water logging was avoided to prevent an aerobiosis of the culture media. Culture pots were placed in a shady or moist place. Mulching was done using garden mash clothes to prevent evaporation of water and entry of other species. After 30 days of worms' inoculation total weight and number of adult earthworms, cocoon and juveniles were weighted and counted to evaluate the percentage change in total biomass and bionumber. All four species of worms survived well in the medium and mostly, the number of adult worms showed only marginal change, decrease or increase. Reduction in the number might be due to natural or adverse climatic factor induced death of the worms. But dead individuals were not observed in the medium. This may be due to potent autolysis as several workers have reported that haemocoelomic fluid has strong autolytic activity. Significant increase in the number of adult worms has also been noticed in a number of containers and this is an indication that they have short life cycle and their development is completed in a period of one month.

Perionyx excavatus

The results pertaining to various parameters of reproductive biology of two earthworm species are presented in Tables and Figs. The weight (biomass) and number of adults, cocoons and juveniles of *Perionyx excavatus*, with an initial inoculation of 25 gm of adult worms, showed considerable variation during different months of the year. The biomass (weight) of adult worms varied from 22.3 to 28.3 gm, whereas the number of adult worms after one month also showed variation from 75.66 to 233.66. In most of the months the values were only marginally different then the initial weight and number and no significant change could be observed (Table 1 and 2). The range of change in biomass was found to be 24.5 to 77.6 %, whereas range of change in bio-number was 1464.6 to 3821.5 % (Fig.1and 2).

Observations on the weight and number of cocoons also indicate that *Perionyx excavatus* lay cocoons throughout the year. The numbers of cocoons laid were comparatively higher during summer to rainy seasons (April- September) than other months. The maximum number of juveniles was also noticed during months of April and September (Table 1 and 2)

The enormous increase in bio-number (population density inclusive of adult, babies and cocoons) is clearly due to very high reproductive potential of earthworms and within a short experimental period of one month limited increase in body weight was noticed. The changes in the weight of total (adult+ juveniles+ cocoons) biomass do not match with fluctuations in total bio-number (Fig. 2).

Perionyx cressiseptatus

The total weight of adult worms varied from 19.6 to 27.0 gm. The Significant ($P > 0.05$) decrease in the biomass was noticed only during the months of March (20.0), April (19.9) and May (19.6) (Table 3). The range of change in biomass was found to be 8.9 to 48.4 % (Fig.3).

The number of adult worms demonstrated variation from 53.0 to 99.3. In throughout the year the values were lower than the initial number. Only in February (64.3), and May (53.0) the number was significantly decreased than the initial ones.

The results of the weight and number of cocoons showed that *Perionyx cressiseptatus* lays cocoons throughout the year. The number of cocoons laid were comparatively higher during post-rainy (August and September) than other months. The maximum number of juveniles was also noticed during Pre to post-rainy (July to October) months (Table 4). The range of change in bio-number was 900.0 to 2304.4 % (Fig.4).

The difference between rates of cocoons production could be related to the biochemical quality of the feeds which is an important factor in determining the time taken to reach sexual maturity and onset of reproduction. The differential rate of hatching and development and variation in the incubation time during different seasons due to changes in the climatic factors, particularly during extreme winter and summer may be responsible for differential pattern of the parameters.

3. RESULTS AND DISCUSSION

Numerous organic materials have been evaluated for growth and reproduction of earthworms as these materials directly affect the efficacy of vermicompost. In most of the previous studies, different type of organic wastes was used as a substrate, whereas in the present study, only cattle dung has been used.

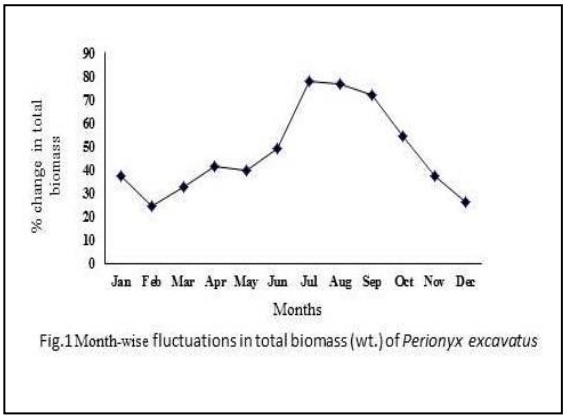

Fig.1 Month-wise fluctuations in total biomass (wt.) of *Perionyx excavatus*

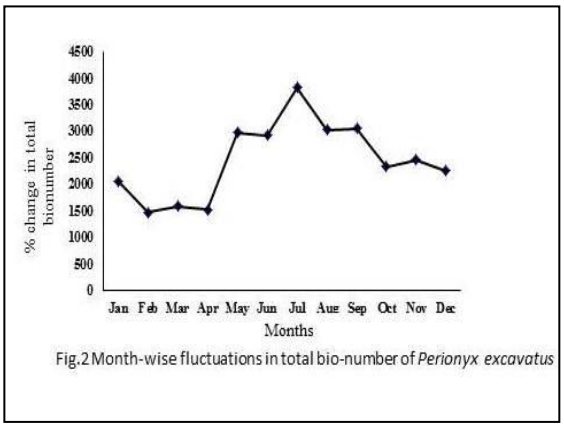

Fig.2 Month-wise fluctuations in total bio-number of *Perionyx excavatus*

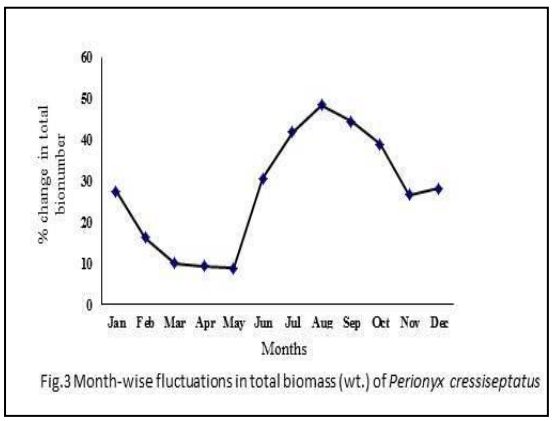

Fig.3 Month-wise fluctuations in total biomass (wt.) of *Perionyx cressiseptatus*

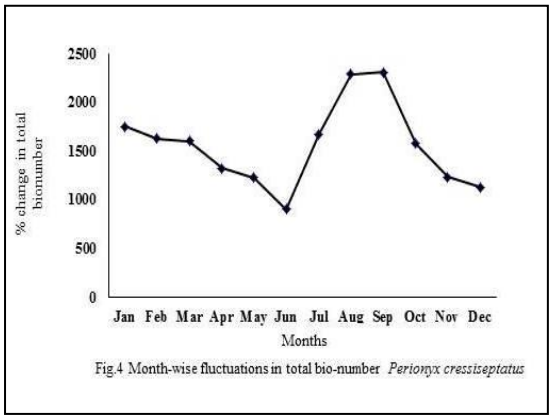

Fig.4 Month-wise fluctuations in total bio-number *Perionyx cressiseptatus*

Therefore, the difference in the percent change in the total biomass and bio-number between the studied species could be related to the substrate chemistry, nature of the feeding material and species-specific feeding behavior as well as specific reproductive and growth performance. The potential of earthworms as waste processors has been well documented by various authors [11]. Nutrition is an essential factor to determine the maximum growth of an organism. The optimal growth, maturation, cocoon production and reproductive potential of earthworms have been reported to depend on the quality and quantity of the available feed and various physicochemical parameters. Besides effect of weather parameters such as profound influence of temperature on growth and development of worms age of the worm bed moisture and types of food substrate also determine hatching success [12,13,14].

Reinecke and Venter (1987) observed that the increase in biomass is dependent upon the feeding activity of the worms. Ismail (1997) has reported that biomass production by compost worms depends on the type and quality of organic substrates used as worm feed. It was demonstrated that earthworm biotechnology greatly reduces the waste amount, besides improving the nutrient pool status of converted biomass for its utilization for one or the other purposes in agricultural production [15].

To conclude the present study it could be inferred that *Perionyx excavatus* exhibited better reproductive traits than *Perionyx cressiseptatus* and environment appeared to exert influence on reproductive potential and development of the earthworm species in Chambal region of M.P.

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Table 1-2**.** Showing results of changes in weight and number of adults, cocoons and juveniles of *Perionyx excavatus* maintained in plastic containers during different months of year.

Months		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean Average
Initial weight		25±0	25±0	25±0	25±0	25±0	25±0	25±0	25±0	25±0	25±0	25±0	25±0	25
Final weight (gm)	Adults	26.33 ±0.88	23.00 ±0.86	24.00 ±0.76	23.33 ±0.88	25.33 ±1.45	27.66 ±1.59	28.33 ±1.42	25.66 ±0.92	24.90 ±0.86	22.30 ±1.00	23.80 ±0.72	24.66 ±0.88	24.9
	Cocoons	5.42 ±0.23	5.59 ±0.26	5.76 ±0.17	8.30 ±0.25	7.44 ±0.17	7.44 ±0.22	12.09 ±0.41	14.35 ±0.44	13.85 ±0.64	12.4 ±0.50	7.67 ±0.39	4.08 ±0.22	8.69
	Juveniles	2.55 ±0.13	2.55 ±0.07	3.46 ±0.14	3.73 ±0.11	2.24 ±0.12	2.22 ±0.11	3.98 ±0.13	4.11 ±0.15	4.24 ±0.16	3.88 ±0.17	2.91 ±0.11	2.79 ±0.12	3.22

Months		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean Average
Initial number		97.0 ±5.0	138.6 ±12.0	187.3 ±5.5	235.0 ±4.0	78.0 ±1.6	98.0 ±2.5	89.6 ±5.3	122.0 ±4.5	118.3 ±5.0	108.6 ±5.78	102.4 ±4.0	91.0 ±1.0	122.1
Final number	Adults	97.00 ±3.05	142.0 ±7.03	205.80 ±10.42	233.66 ±8.77	75.66 ±2.96	102.66 ±3.93	88.00 ±4.16	117.66 ±3.93	110.60 ±6.03	103.50 ±5.78	98.00 ±4.62	91.33 ±3.48	122.1
	Cocoons	1372.66 ±30.41	1406.00 ±42.82	1954.66 ±56.59	2242.00 ±121.14	1826.66 ±93.97	2178.60 ±71.44	2545.00 ±107.71	2783.33 ±113.3	2512.70 ±106.16	1638.80 ±51.08	1430.03 ±45.22	1362.00 ±46.97	1937.7
	Juveniles	624.66 ±29.84	620.66 ±26.79	983.00 ±30.57	1329.50 ±72.10	491.66 ±14.25	674.80 ±23.88	880.66 ±27.12	915.00 ±31.26	1102.70 ±55.13	896.70 ±30.78	1087.00 ±56.95	683.33 ±25.74	857.4

Table 3-4. Showing results of changes in weight and number of adults, cocoons and juveniles of *Perionyx cressiseptatus* maintained in plastic containers during different months of year.

Months		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean Average
Initial weight		25	25	25	25	25	25	25	25	25	25	25	25	25
Final weight (gm)	Adults	24.66 ±1.01	22.33 ±0.72	20.00 ±0.57*	19.90 ±0.57*	19.66 ±0.88*	24.33 ±0.88	26.33 ±1.20	27.00 ±1.52	26.50 ±1.18	25.90 ±1.00	25.20 ±1.05	25.66 ±1.20	23.9
	Cocoons	3.84 ±0.13	3.92 ±0.18	4.04 ±0.23	4.09 ±0.19	4.21 ±0.12	4.75 ±0.15	5.22 ±0.30	5.24 ±0.15	5.40 ±0.20	5.41 ±0.16	3.23 ±0.13	2.74 ±0.15	4.34
	Juveniles	3.36 ±0.06	2.83 ±0.12	3.47 ±0.10	3.34 ±0.17	3.34 ±0.11	3.58 ±0.15	3.93 ±0.16	4.86 ±0.18	4.24 ±0.23	3.42 ±0.12	3.22 ±0.17	3.65 ±0.10	3.6

Months		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Mean Average
Initial number		76.6 ±7.6	87.6 ±7.2	77.3 ±3.2	87.3 ±3.2	88.3 ±0.72	102.6 ±1.0	85.6 ±2.3	87.6 ±0.54	91.2 ±3.38	94.2 ±2.31	88.7 ±9.00	80.1 ±1.15	87.2
Final number	Adults	67.00 ±2.51	64.33* ±1.85	67.66 ±3.53	86.00 ±3.05	53.00* ±2.64	99.33 ±2.96	73.00 ±3.21	84.00 ±2.89	82.20 ±4.62	80.90 ±2.34	80.03 ±2.90	70.80 ±2.51	75.6
	Cocoons	866.50 ±37.85	931.20 ±27.43	865.20 ±26.03	760.0 ±30.5	652.1 ±26.7	511.0 ±16.6	860.00 ±27.57	1192.6 ±50.07	1170.6 ±51.37	830.60 ±25.19	700.10 ±35.16	678.20 ±33.16	834.8
	Juvenile	483.00 ±16.94	520.00 ±19.03	381.60 ±15.19	393.7 ±12.5	467.6 ±21.0	415.7 ±15.0	582.2 ±24.2	818.0 ±26.4	940.1 ±28.4	669.8 ±38.5	401.66 ±12.72	235.76 ±12.73	525.7