Life cycle of *Lampito mauritii* (Kinberg) in comparison with *Eudrilus eugeniae* (Kinberg) cultured on different substrates

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**Abstract:** Growth (length, biomass and mean growth rate) and reproduction (total duration, ciliated appearance, ciliated completion, cocoon commencement, rate of cocoon production, incubation period, hatching success and mean number of hatching per cocoon) of indigenous *Lampito mauritii* (Kinberg) in comparison with exotic *Eudrilus eugeniae* (Kinberg) cultured on three feed substrates-clay loam soil, cowdung and pressmud (filter cake) have been studied over a period of 360 days under laboratory conditions (30 ± 2°C, 60-65% moisture). There is a positive relationship between length and biomass of both worms cultured on three feed substrates throughout the period of study. The decrease of worm length and biomass observed slightly on 63-70th days in *Lampito mauritii* and 42-49th days in *Eudrilus eugeniae* cultured on three feed substrates are the results of the onset of cocoon production. After 270 days both worms in all these feed substrates show decreasing trends of length and biomass which are due to continued reproduction and aging. Among the three feed substrates, pressmud supports significantly maximum worm length and biomass (between 90-130 days in *Eudrilus eugeniae* and 110-170 days in *Lampito mauritii*), earlier attainment of sexual maturity (between 51-76 days in *Lampito mauritii* and 27-37 days in *Eudrilus eugeniae*), earlier commencement of cocoon production (37.7 ± 0.0 days in *Eudrilus eugeniae* and 76.4 ± 0.10 days in *Lampito mauritii*), shorter incubation periods (16.3 ± 0.28 days in *Eudrilus eugeniae* and 26.7 ± 0.61 days in *Lampito mauritii*), more hatching success (98% in *Lampito mauritii* and 96% in *Eudrilus eugeniae*), more mean number of hatching per cocoon (3.2 ± 0.03 in *Lampito mauritii* and 2.6 ± 0.06 in *Eudrilus eugeniae*) and shorter duration of life cycle (108.8 ± 0.07 days in *Lampito mauritii* and 60.2 ± 0.09 days in *Eudrilus eugeniae*) than cowdung and clay loam soil.

**Key words:** Pressmud, *Lampito mauritii*, *Eudrilus eugeniae*, Growth, Reproduction, Vermiculture, Vermicomposting

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**Introduction**

Earthworm’s growth, maturation, cocoon production and reproductive potential are not only influenced by environmental conditions alone but are also strongly affected by the quality and availability of food. Growth, reproduction, life cycle and environmental requirements of earthworms were studied by Neuhauser et al. (1979) using sludge and horse manure; Loehr et al. (1985) using a mixture of animal and vegetable waste materials, Bano and Kale (1988) and Viljoen and Reinecke (1992) using cowdung; Elvira et al. (1998) using sludges from paper and pulp industries; Amoji et al. (1998) using agricultural organic waste; Manivannan et al. (2004) using sugar industrial wastes and Loh et al. (2005) using cattle and goat manures. Further, the trends of reproduction, the characteristics of cocoons, incubation period, hatching success and fecundity were studied in *E. eugeniae* (Reinecke and Viljoen, 1993), and in Indian earthworms *Ponios cyanus*, *Lampito mauritii*, *Polyperithima elongata*, *Pontoscolex corethrus*, *Euphyoeus gammiae*, *Dichogaster modigianii* and *Drawida nepalensis* (Bhattacharjee and Chaudhuri, 2002; Tripathi and Bhardwaj, 2005). Furthermore, relative population growth in time and space (Kale and Bano, 1991); moisture requirement and reproduction (Hallatt et al., 1992; Dominguez and Edwards, 1997) and temperature relations and their effect on survival growth, maturation and cocoon production (Viljoen and Reinecke, 1992; Biradar et al., 1999) were also well documented. Though earthworm biology reared on various organic wastes have been studied (Reinecke and Viljoen, 1993; Edwards and Bohlen, 1996; Elvira et al., 1998; Bhattacharjee and Chaudhuri, 2002; Manivannan et al. 2004; Loh et al., 2005; Parthasarathi, 2006), till-to-date earthworm biology on their natural habitat has been poorly understood.

The studies on growth, reproduction and life cycle of the wide spread Indian megasolcoid worm, *Lampito mauritii* – one among the four endemic species - are very scanty. It can withstand wide range of temperature, soil moisture and various other physical factors (Kale, 1988) and with wide choice of habitats and food preferences it has the highest frequency of distribution (Kale and Bano, 1992). Only cocoon morphology, hatching and emergence pattern in this worm have been studied by Bhattacharjee and Chaudhuri (2002). A thorough understanding of the reproductive biology and growth of a worm is a prerequisite before subjecting the worm to any experimentation in the laboratory and more particularly in the agro-industrial practices. This paper describes the growth pattern and reproduction of *Lampito mauritii* when cultured on different substrates – clay loam soil, cowdung and pressmud, in comparison with *Eudrilus eugeniae*.

**Materials and Methods**

**Preparation of feed substrates:** Clay loam soil (S) and cowdung (C) collected from the agricultural experimental farm of Annamalai
University, and two months old, cured and dried pressmud (P) obtained from E.I.D. Parry Sugar Mill at Nellikuppam, Tamil Nadu were used as feed substrates. Press mud, a by product of sugar industry, is rich in OM (53%), OC (31%), protein (12-16%), sugar (10-14%), micro and macro nutrients, enzymes and microbes (Parthasarathi and Ranganathan, 1998, 1999; Parthasarathi, 2004; Parthasarathi et al., 2006). They have shown P to be an ideal medium for vermiculture and is vermicomposted into good organic manure. The feed substrates (S, C and P) were powdered and passed through a 1 mm mesh sieve to obtain 1 mm particle sized substrates. 1000 g of each substrate at 65-70% moisture were provided to support the growth of 10 worms for 15 days. The substrates were left over for 48 hr to stabilize before the experimental animals were introduced into them.

Cocoon incubation, hatching inoculation and worm culture maintenance Cocoon of L. mauritii and E. eugeniae were collected from the stock culture and incubated at room temperature (28±1°C) in petridishes containing sun dried, fine particle dungs and moistened by sprinkling required quantity of water. Newly emerged hatchings were carefully removed using a fine paint brush and placed in petridish containing distilled water. One kg of 48 hr stabilized hatchings were carefully removed using a fine painting brush and placed in petridish containing distilled water. The trays were covered with nylon mesh and maintained in the provided to support the growth of 10 worms for 15 days. The passed through a 1 mm mesh sieve to obtain 1 mm particle sized stage of worms, by leaving the worm on a graduated and laminated discermible, followed by an increase thereafter. After 270 days, both cultured in S, C and P, it is evident that both worms showed slow and between 50 and 80 days for after 63 days, and 10.40 cm (S), 17.56 cm (C) and 18.35 cm (P) in E. eugeniae after 42 days. Thereafter the growth rates were gradual and after 170 to 240 days in L. mauritii and 130 to 270 days in E. eugeniae, decreasing trends in growth rates were discernible, followed by an increase thereafter. After 270 days, both worms showed declining trends in their body lengths.

From the analysis of results on growth parameters – body length, biomass and mean growth rate, and life cycle parameters – duration, clitellum appearance, clitellum completion, cocoon commencement, rate of cocoon production, incubation period, hatching success and mean number of hatchings / cocoon of L. mauritii in comparison with E. eugeniae cultured on three different feed substrates – Clay loam soil(S), cowdung(C) and pressmud(P) are given in Fig. 1-4(a-h). A schematic diagrams of life cycle of both worms are depicted in Fig. 5 (i-vi).

The mean body length (Fig. 1) of newly hatched (one day old) L. mauritii and E. eugeniae cultured in S, C and P were 0.32 and 0.34 cm, 0.43 and 0.48 cm, and 0.51 and 0.55 cm, respectively. Both worms in all the cultural media exhibited slow growth during the first (or initial) 14 days, followed by an accelerated growth and attained the body lengths of 8.61 cm (S), 14.8 cm (C) and 15.34 cm (P) in L. mauritii after 63 days, and 10.40 cm (S), 17.56 cm (C) and 18.35 cm (P) in E. eugeniae after 42 days. Thereafter the growth rates were gradual and after 170 to 240 days in L. mauritii and 130 to 270 days in E. eugeniae, decreasing trends in growth rates were discernible, followed by an increase thereafter. After 270 days, both worms showed declining trends in their body lengths.

Results and Discussion

Data on growth – length, biomass and mean growth rate, and life cycle parameters – duration, clitellum appearance, clitellum completion, cocoon commencement, rate of cocoon production, incubation period, hatching success and mean number of hatchings / cocoon of L. mauritii and E. eugeniae in comparison with E. eugeniae cultured on three different feed substrates – Clay loam soil(S), cowdung(C) and pressmud(P) are given in Fig. 1-4(a-h). A schematic diagrams of life cycle of both worms are depicted in Fig. 5 (i-vi).

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**Fig. 1:** Growth (length) of *L. mauritii* and *E. eugeniae* cultured on different substrates for a period of 360 days

**Fig. 2:** Growth (biomass) of *L. mauritii* and *E. eugeniae* cultured on different substrates for a period of 360 days
different fed substrates. Many researchers have established such a relationship among earthworms in general (Edwards, 1967; Patra and Dash, 1973; Mishra and Dash, 1980).

A generalized growth pattern was evident in L. mauritii and E. eugeniae cultured in S, C and P from 14 to 360 days: (a) an increase in growth rate up to pre-reproductive period of 63 days in L. mauritii and 42 days in E. eugeniae, (b) a decrease of the same (even though mean biomass continued to increase) during the active reproductive period up to 190 days in L. mauritii and 150 days in E. eugeniae and (c) a very slow growth rates and regression of biomass during post – reproductive period. These findings agree with the conclusions arrived by Michon (1957), Avel (1959) and Nowak (1975) on different species of earthworms. They reported three phases of growth: (a) a rapid increase of growth rate during pre-productive phase followed by (b) a phase of steady decrease after attainment of sexual maturity and (c) a post-productive phase of very slow growth and decrease in body weight in senescent worms. The present findings of accelerated growth rate during the pre-reproductive phase of L. mauritii and E. eugeniae cultured in three fed substrates were more or less similar with the findings of Mba (1983) and Viljoen and Reinecke (1989b) who observed an accelerated growth in E. eugeniae upto 50 days from hatching.

The mean biomass of one day old (newly hatched) L. mauritii and E. eugeniae cultured in S, C and P were 3.2 and 3.3 mg, 4.4 and 4.6 mg, and 5.1 and 5.2 mg, respectively. Similar to mean body length, both worms in all the cultural media exhibited slow growth (body biomass) during the first 14 days, followed by an accelerated biomass and attained the biomass of 236.4 mg (S), 792.4 mg (C) and 864.2 mg (P) with a mean growth rate of 3.74 mg/dw(S), 17.01 mg/dw(C) and 14 mg/dw (P) in L. mauritii after 63 days, and biomass of 1002.8 mg (S), 1948.7 mg (C) and 2353.6 mg (P) with a mean growth rate of 27.08 mg/dw(S), 60.4 mg/dw (C) and 90.4 mg/ dw (P) in E. eugeniae after 42 days (Fig. 2 and 3). Thereafter the rate of biomass and mean growth rate were gradual, and after 170 days to 240 days in L. mauritii and 130 to 270 days in E. eugeniae, decreasing trends in rate of biomass and mean growth rate were discernible, followed by an increase thereafter. After 270 days, both worms showed declining trends in their biomass and mean growth rate.

The decrease of worm biomass observed during 63-70 day in L. mauritii and 42-49 day in E. eugeniae in three fed substrates were the result of the onset of cocoon production. This is in accordance with the findings of Graff (1981), Mba (1983) and Viljoen and Reinecke (1994) in E. eugeniae, who reported the decrease in worm biomass due to the requirement of large amount of energy for cocoon production and also for copulation and the last phase of decrease in worm biomass due to continued reproduction and aging.

Viljoen and Reinecke (1988, 1989 a and b, 1994) reported a decrease in biomass in 55 day old E. eugeniae cultured on cattle manure. But in the present study, similar decrease was observed...
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Fig. 4(a-c): Reproductive parameters of L. mauritii and E. eugeniae cultured on different substrates for a period of 360 days.
d) Cocoon commencement

![Graph showing cocoon commencement across different substrates.](image)

- F = 2.63
- p < 0.05

e) Rate of cocoon production

![Graph showing rate of cocoon production across different substrates.](image)

- F = 297.61
- p < 0.05

f) Incubation period

![Graph showing incubation period across different substrates.](image)

- F = 4.53
- p < 0.05

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Fig. 4(d-f): Reproductive parameters of *L. mauriti* and *E. eugeniae* cultured on different substrates for a period of 360 days
The development of clitellum in *E. eugeniae* cultured in S, C and P appeared on 39, 31 and 27 days, respectively. This was manifested by a slight change in colour in the clitellar region from reddish to yellow and afterwards, the clitellar region swelled progressively to a fully developed state of 53, 42 and 38 days, respectively during which periods the worms become clitellated and productively active. Unlike *E. eugeniae*, *L. mauritii* exhibited days for the development of clitellum were 67.5 (S), 59.6(C) and 51.3(P), respectively. This was manifested by a change in colour from brown to pale white in the clitellar area, and subsequently the clitellum swelled progressively to a fully developed state on 86.7, 81.2 and 76.2 days, respectively. A sexual mature *L. mauritii* showed pale–brown clitellum (Fig. 4b, c).

The formation of first cocoon in *E. eugeniae* and *L. mauritii* cultured in S, C and P were 53 and 86.7 days, 42 and 81 days and 37.7 and 76 days, respectively and continued up to 300 days in *E. eugeniae* and 360 days in *L. mauritii*. The mean cocoon production
Fig. 5: Life cycle of Lampito mauritii (A) and Eudrilus engeniae (B) Cultured on different substrates

AS: L. mauritii cultured on clay loam soil
BS: E. engeniae cultured on clay loam soil
AC: L. mauritii cultured on cowdung
BC: E. engeniae cultured on cowdung
AC: L. mauritii cultured on pressmud
BP: E. engeniae cultured on pressmud
of *E. eugeniae* and *L. mauritii* cultured in S, C and P were 0.9 and 0.22, 1.4 and 0.39 and 1.5 and 0.52 cocoon/wd, respectively between 39-53 and 68-87, 31-42 and 60-81 and 27-28 and 51-76 days, respectively (Fig. 4d, e).

The mean incubation period of cocoon of *L. mauritii* and *E. eugeniae* cultured in S, C and P were 31 and 20, 28 and 17 and 27 and 16 days, respectively (Fig. 4f) and showed their hatching success were 63 and 53, 90 and 79 and 98 and 86 percent, respectively (Fig. 4g). The mean number of hatchlings per cocoon in both worms cultured in S, C and P were 1.4 and 1.3, 2.2 and 2.4 and 3.2 and 2.6, respectively (Fig. 4h). *L. mauritii* showed significantly longer incubation period of cocoon, hatching success and more mean number of hatching / cocoon than *E. eugeniae*. Among the three cultural media, P exhibited significantly short incubation period, more hatching success and more mean number of hatching / cocoon in both worms (Fig. 4f-h).

The nutritive superiority of feed substrate stimulate the time of sexual maturity in earthworms (Bohlen, 2002). The time of attainment of sexual maturity varied in different species of earthworms as well as in the same species when cultured on different substrates. The attainment of sexual maturity in *E. eugeniae* was reported between 35-45 days (Viljoen and Reinecke, 1999b, 1994) and between 35-49 days (Neuhauser et al., 1979) cultured on cattle manure and after 56 days on sludges and cattle manure (Graft, 1981). In the present study, *L. mauritii* attained sexual maturity between 67-87 days in S, 60-81 days in C and 51-76 days in P and *E. eugeniae* attained sexual maturity between 39-53 days in S, 31-42 days in C and 27-38 days in P. *E. fetida* cultured in cattle manure attained sexual maturity after 60 days (Venter and Reinecke, 1988), 7-8 weeks in farm waste (Edwards et al., 1985) and 10 weeks in sludge (Neuhauser et al., 1979). The earlier sexual maturity of *L. mauritii* and *E. eugeniae* cultured in P than in C and S and also the earlier maturity of *E. eugeniae* cultured in P when compared to the value of the same species cultured on other substrates such as cattle manure, farm waste, sludge etc., confirm the nutritional superiority of P and indicate a possible positive stimulatory effect of P on sexual maturity of both species of worms.

The commencement of cocoon production was earlier and more in number in *E. eugeniae* cultured on P than in *L. mauritii* cultured on the same substrate. Reinecke et al. (1992) observed production of cocoons in *E. eugeniae* at the age of 46 days at 25°C in fresh urine-free cattle manure. The observed commencement of cocoon production in *E. eugeniae* on C and P in the present study was earlier than *E. fetida* cultured on cattle manure where cocoon production started only at 70 days after hatching (Venter and Reinecke, 1988). The cocoon production of *E. eugeniae* in C and P agree with the earlier findings on the mean cocoon production of 1.3 cocoons/wd in the same species cultured on cattle dung (Viljoen and Reinecke, 1994). The present results also support the findings of Elvira et al. (1998), Dominguez et al. (2001) and Loh et al. (2005) who reported an earlier commencement of cocoon production and more mean number of cocoon production in *E. andrei* and *E. fetida* with vermiprocessing of sludges from paper-dairy industrial wastes and cattle - goat manure.

The P exhibited shorter incubation period of cocoon in *E. eugeniae* (16.2 days) followed by *L. mauritii* (22.7 days) This observation is comparable with the values reported for *E. eugeniae* cultured in cattle dung by Viljoen and Reinecke (1994) and Dominguez et al. (2001). However, the incubation period of *E. eugeniae* found in the present study was shorter than the periods reported for *E. fetida* and *P. excavatus* cultured on urine free cattle manure (Reinecke et al., 1992). In *L. mauritii*, Dash and Senapati (1985), reported an incubation period of 28-30 days in cocoons cultured in house hold garbage. Similarly, P supports more hatching success for *L. mauritii* (98.2%) followed by *E. eugeniae* (86%) when compared with the worm cultured in C (90.10% and 79.4%) and S (62.5% and 52.5%). Reinecke and Viljoen (1988) reported cocoon hatching success of 84% in *E. eugeniae* cultured on cattle manure. The present study revealed for the first time a 100% cocoon hatching success for *L. mauritii* cultured on P followed by C (90%) and S (63%). More mean number of hatchlings per cocoon was discernible in the present study for *L. mauritii* (3.2) than for *E. eugeniae* (2.6) cultured on P, followed by C (2.4 for *L. mauritii* and 2.2 for *E. eugeniae*) and S (1.4 for *L. mauritii* and 1.3 for *E. eugeniae*), Such mean numbers of hatching per cocoon obtained from P was found to be higher than other species of earthworms : *E. fetida* with 2.7 cultured on cattle manure (Venter and Reinecke, 1987, 1988), *P. excavatus* with 1.1 and *P. hawaiiyana* with 1.2 on liquid municipal sludges (Loehr et al., 1985) and *E. eugeniae* with 2.6 on cattle dung (Viljoen and Reinecke, 1994).

The total duration and the different stages of life cycle of *E. eugeniae* cultured on P are shorter than other fed substrates like C and S. In the present study *L. mauritii* when compared to *E. eugeniae* showed a longer duration of life cycle.

Finally, it is concluded that *E. eugeniae* is a suitable species for vermiculture and vermicomposting due to its rapid growth rate, larger size, quick attainment of sexual maturity, high rate of cocoon production, shorter incubation period and short life cycle. On the other hand, *L. mauritii* due to its higher rate of hatching success, high number of hatchlings production and tolerance to a wide range of environmental conditions (personal observation) could be preferred as an alternative species for vermiculture and vermicomposting.

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