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THE INFLUENCE OF TEMPERATURE ON THE LIFE-CYCLE OF *DENDROBAENA VENETA* (OLIGOCHAETA)

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Summary—The life-cycle of *Dendrobaena veneta* was studied at 15°C (characteristic of the animal's natural habitat) and at 25°C (at which the life-cycles of other vermicomposting species have been studied in Southern Africa).

At 15°C the life-cycle was completed in 100 days and it took 150 days to complete the cycle at 25°C. At 25°C maturation was quicker, worms started to produce cocoons at a younger age, and more cocoons were produced worm^{-1} day^{-1} than at 15°C. The incubation period of cocoons was also shorter at the higher temperature. The hatching success was, however, higher and the number of hatchlings per cocoon were more at the lower temperature.

INTRODUCTION

Several earthworm species have been identified as detritus feeders that can be reared in large numbers on organic waste material. Some of these epigeic species have been shown to be candidates for vermiculture, where organic waste is transformed into useful compost, e.g. *Eisenia fetida*, *Eudrilus eugeniae* and *Perionyx excavatus* (Hartenstein *et al.*, 1979; Graff, 1974; Haimi and Huhta, 1986; Kale *et al.*, 1982; Reinecke and Venter, 1987).

In order to evaluate the potential of an earthworm species for use in vermiculture, it is necessary to have knowledge of its biology. The biology of *E. fetida*, *E. eugeniae* and *P. excavatus* is well documented and their life-cycles have recently been studied in detail (Venter and Reinecke, 1988; Reinecke and Viljoen, 1988; Viljoen and Reinecke, 1988, 1989; Reinecke and Hallatt, 1989; Hallatt *et al.*, 1990).

Dendrobaena veneta is also referred to in the literature as having a potential to combat organic waste problems and be a producer of worm protein (Lofs-Holmin, 1986). Little information, however, is available on the biology of this earthworm species.

In an endeavor to evaluate the capabilities of *D. veneta* for vermicomposting and to compare this species with the others mentioned above, its life-cycle and reproductive capabilities were studied. This was conducted on an organic nutritive source under controlled environmental conditions.

The life-cycle was studied both at a low temperature (15°C), characteristic of the animal's natural habitat in Europe, and at a higher temperature (25°C) at which the life-cycles of the other vermicomposting species mentioned above have been studied. Quantitative observations were made with regard to growth, maturation, cocoon production, incubation time, hatching success and number of offspring.

MATERIALS AND METHODS

Cocoons obtained from Professor O. Graff of Braunschweig, Germany, were hatched and kept in two batches, one at 15°C and the other at 25°C. Cocoons from these two temperatures were incubated and the hatchlings used for the life-cycle study.

Day old hatchlings were weighed in water and reared in a cattle manure substrate, free of straw or urine and dried, ground and sieved to a particle size of 500 $\leqslant$ 1000 μm. This medium was moistened with distilled water to a moisture content of 75–80%. The worms were kept in climate controlled incubators at 25 and 15°C with a r.h. of 80%.

The worms were weighed every 5 days over a period of 200 days. During this time they were fed regularly with fresh urine-free cattle manure. With every biomass determination, observations were made as to maturation and cocoon production. Cocoons produced were removed from the substrate and incubated in repli-dishes at the same temperatures at which the parent animals were kept. The cocoons were observed daily and the hatchlings removed.

RESULTS

The growth curves for the two temperatures are given in Fig. 1. From this figure it can be seen that the growth rate was higher at the higher temperature, with a highest mean biomass worm^{-1} of 2350 mg and a mean growth rate of 11.9 mg worm^{-1} day^{-1}. The

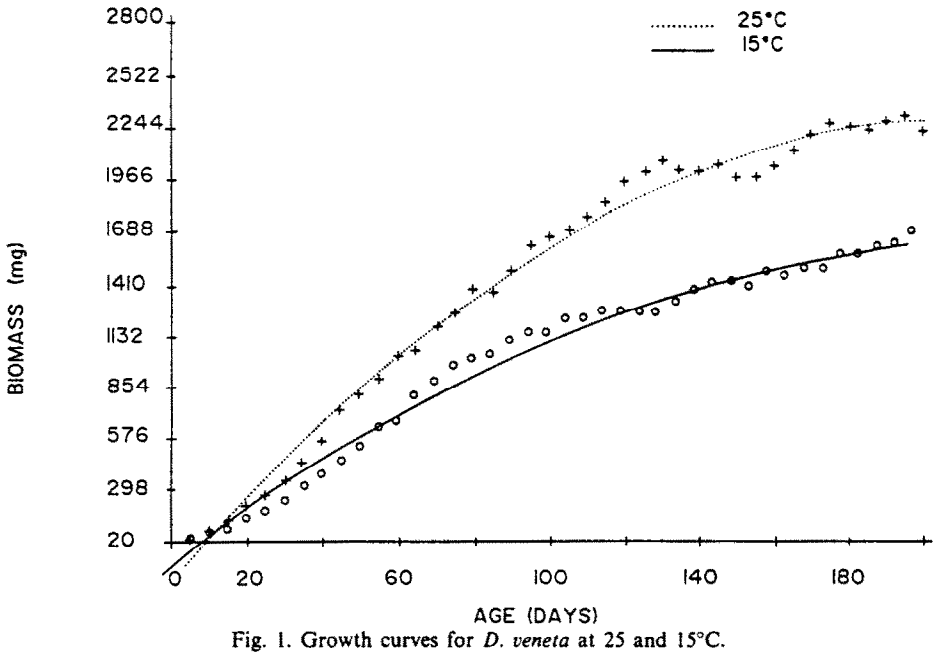

Fig. 1. Growth curves for *D. veneta* at 25 and 15°C.

highest mean biomass at 15°C was 1700 mg with a mean growth rate of 9.7 mg worm^{-1} day^{-1}.

Maturation was quicker at 25°C with 100% maturation after 130 days, while 100% maturation was not attained at 15°C over the whole 200 day period (Fig. 2).

Figure 3 shows that more cocoons were produced worm^{-1} day^{-1} at 25°C (i.e. a mean of 0.28 cocoons worm^{-1} day^{-1}) than at 15°C where 0.17 cocoons worm^{-1} day^{-1} were produced. This tendency was maintained from day 60 when cocoon production commenced until day 200 when the observations were

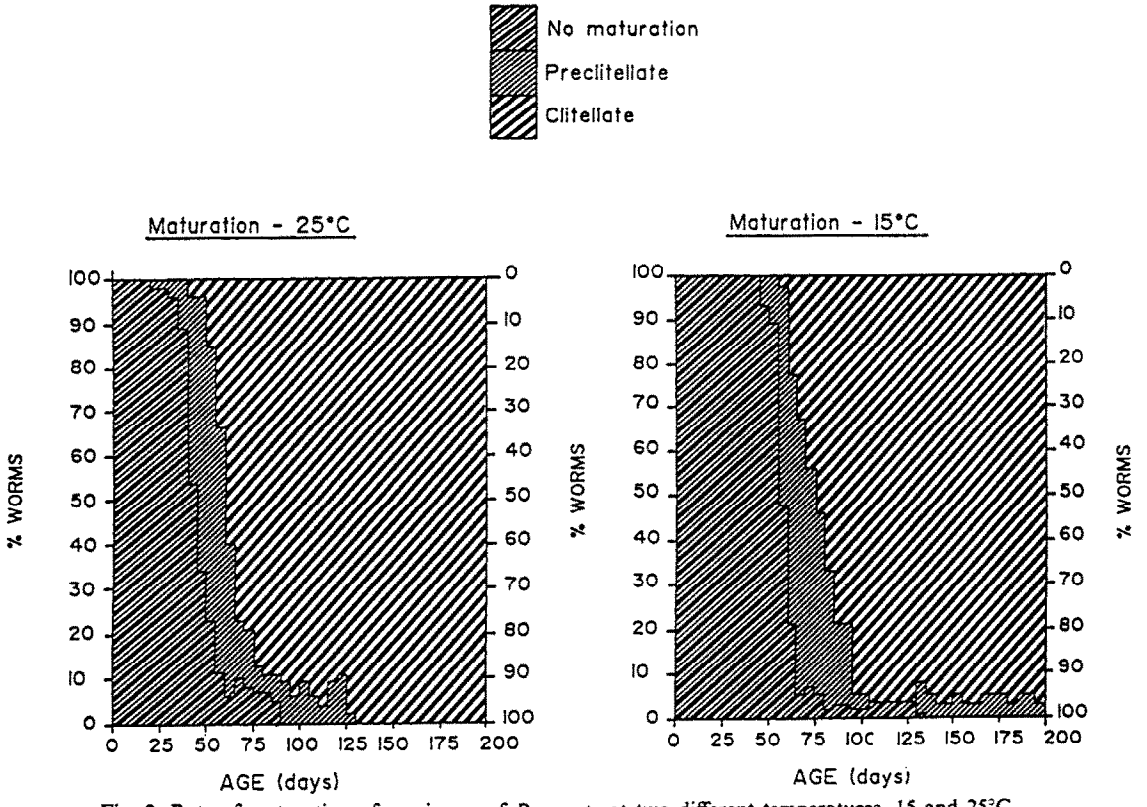

Fig. 2. Rate of maturation of specimens of *D. veneta* at two different temperatures, 15 and 25°C.

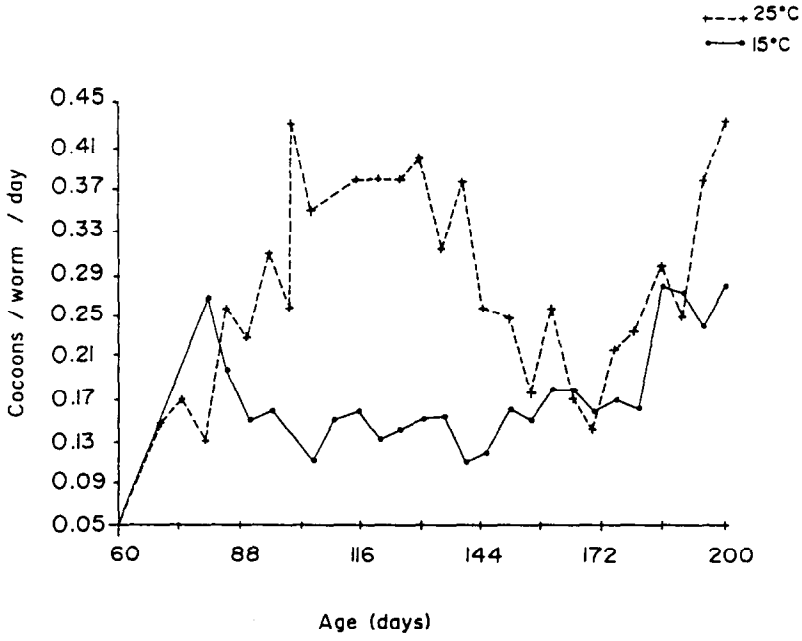

Fig. 3. Cocoon production of *D. veneta* specimens over a period of 200 days at 25 and 15°C.

terminated. It took *D. veneta* a mean of 107 days to complete its life-cycle at 25°C and a mean of 151 days at 15°C.

The mean incubation period of cocoons was 42 days at 25°C and 71 days at 15°C (Fig. 4). The hatching success, however, was higher at the lower temperature (37.8%) and the mean number of hatchlings per cocoon slightly more (1.2) than at 25°C where the hatching success was 19.6% and the mean number of hatchlings per cocoon 1.1. Only one or two hatchlings ever hatched per cocoon at 25°C, whilst three hatchlings per cocoon were sometimes found at 15°C.

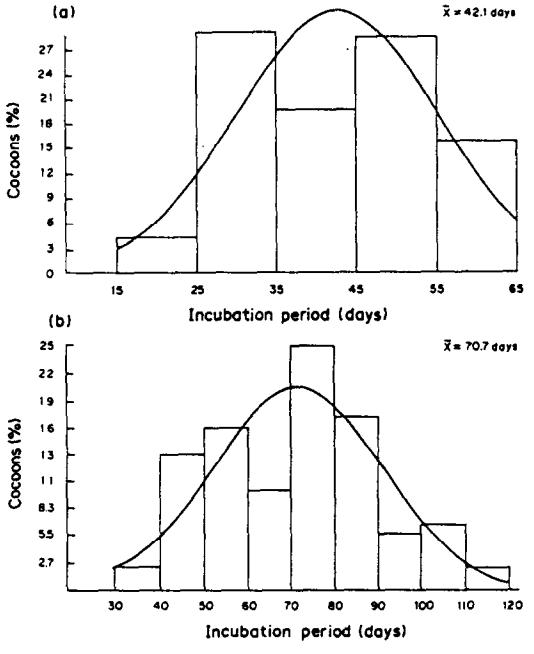

Fig. 4. Incubation period of cocoons of *D. veneta* (a) at 25°C and (b) at 15°C.

DISCUSSION

From the above data it is clear that *D. veneta*, in comparison with other epigeic species, has a long life-cycle with a low reproductive rate when reared on an organic substrate. Other epigeic species reared on the same type of organic substrate had life-cycles of 65–85 days (*Eisenia fetida*), ≈60 days (*Eudrilus eugeniae*) and ≈56 days (*Perionyx excavatus*), and a respective reproductive rate of ≈2.7, 1.7 and 1.1 cocoons worm^{-1} day^{-1} (Venter and Reinecke, 1988; Viljoen and Reinecke, 1989; Hallatt *et al.*, 1990). The worms performed better at the higher temperature, especially with regard to growth and cocoon production and the complete life-cycle at this temperature was about 35% shorter than at the lower temperature. Maturation was also quicker at the higher temperature and the worms started to produce cocoons at an earlier age. Only with regard to hatching success and number of hatchlings per cocoon were the numbers higher at the lower temperature.

It would therefore seem that, although *D. veneta* performed reasonably well at a temperature that is higher than that to which it is normally adapted in its natural environment, some reproductive functions are marred by the higher temperatures. Although a temperature of 25°C therefore seems quite favourable, the time required by this species to complete its life-cycle at 25°C is still much longer than that of

other vermicomposting species reared at the same temperature.

When comparing the overall reproductive capacity and growth potential of *D. veneta* with that of other detritus feeding species, e.g. *E. fetida*, *E. eugeniae* and *P. excavatus* (Venter and Reinecke, 1988; Viljoen and Reinecke, 1989; Hallatt *et al.*, 1990), it seems to be less suitable for vermiculture. This study clearly showed that temperature has a major influence on the life-cycle and fecundity of this earthworm species—an area which needs to be investigated further to understand the species' biology and possible application in vermiculture.

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