Estimating the Fertility of Earthworm Cocoons
(Eisenia Foetida)

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Parallel with applying the earthworms /Eisenia foetida/, as organic waste decomposers and as laboratory animals, more detailed investigations have been started in order to obtain a basic knowledge of earthworm reproduction.

Fertility of this species is mainly affected by the total number of cocoons produced, by the number of fertile cocoons and by the number of hatchlings in one cocoon. The fertility and the role of environmental factors affecting it can be estimated by recording these data.

Most of the investigations were carried out periodically by counting cocoons, the empty cocoon shells and hatchlings /BENGTSSON, 1986; PUSKÁS, 1986; VAIL, 1974/. This type of data collection is very time-consuming, moreover if hatching is going on in manure media it is laborous. The occurrence of errors can hardly be eliminated when counting the cocoons in manure day by day.

The aim of the present study was to elaborate a quick and labour-saving method of estimation. The collection of cocoons and their incubation in the laboratory /REINECKE and VENTER, 1985/ serves this purpose, though the estimation of fertility takes about 30 days.

Materials and methods

Investigations were conducted at the Research Centre for Animal Production and Nutrition, Department of Rabbit and Fur Animal Breeding, in autumn 1988. Incubation was carried out in laboratory /25 $^{\circ}$C temperature, using distilled water/ on cocoons collected from rabbit manure.

Two experiments were set up each with 100 cocoons. The number of fertile cocoons and the number of young worms or that of earlier stages in embryonic development per cocoon were estimated by stereo electronic microscope as the first step in both experiments. In the following steps the two methods differed.

In experiment I 5 cocoons were put in each Petri dish and poured up with distilled water to get 20 of incubation unity. After incubation at constant temperature of 25 $^{\circ}$C the number of hatchlings was checked day by day. At the end of the experiment the number of hatched worms, empty cocoons

shells, those failed to hatch and non-fertile cocoons were recorded. The results obtained were compared with the estimated data.

In experiment II the fertile cocoons were grouped according to the stage of their embryonic development, as follows:

Age-group "A": cocoons in which the development of earthworms reached the placula phase;

Age-group "B": cocoons in which the individuals showed the ringed or tissued phase;

Age-group "C": cocoons in which the young worms were just before hatching, having a ready blood-vascular system;

Age-group "M": cocoons in which at least two different developmental stages of worms were found;

Age-group "E": cocoons which were considered to be non-fertile.

Moreover, in every age-group we grouped the cocoons containing 1, 2, 3, 4 and more than 4 formations. A special synthetic container was put into the incubator with cocoons and distilled water.

The data obatined at the start, during and end of the investigations were recorded. Experimental data were compared to the estimated values. Simple statistical methods were used to evaluate data.

Results

Table 1 gives data of Experiments I and II. Results show that the determined values correspond with the estimated ones, regarding all traits. It can also be seen that there are some differences between the determined data of the two experiments, in every respect.

Table 1

Estimated and determined cocoon fertility in Experiments I and II

Traits	Experiment I.		Experiment II.	
	Estimated	Determined	Estimated	Determined
Fertility /%/	80	80	85	87
Number of hatchlings	222	228	305	279
Average number of hatchlings per cocoon	2.8	2.8	3.6	3.2

Remarks: in Experiment I 12, whereas in Experiment II. 2 cocoons failed to hatch. Not considering these, the average number of hatchlings per cocoon was 3.35 and 3.4, respectively.

Further results were achieved in Experiment II, which do not refer to the effectivity of the estimation method. These are the following:
- proportion of hatchlings per cocoon collected from the same place at the same time /Fig. 1/,
- the proportion of cocoons in different stages of development in the sample /Fig. 2/ and
- relation between hatching period and stage of development /Fig. 3/.
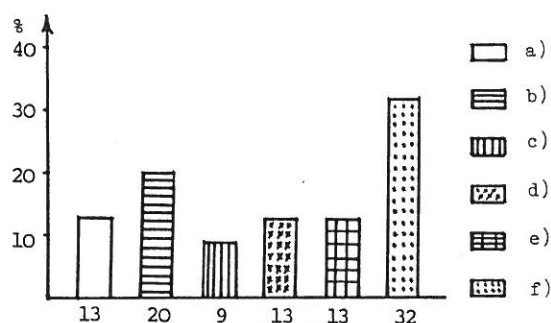
Fig. 1

Proportion of cocoons in the sample with different numbers of worms. a/ Empty cocoons; Cocoons with: b/ 1 worm; c/ 2 worms; d/ 3 worms; e/ 4 worms; f/ more than 4 worms
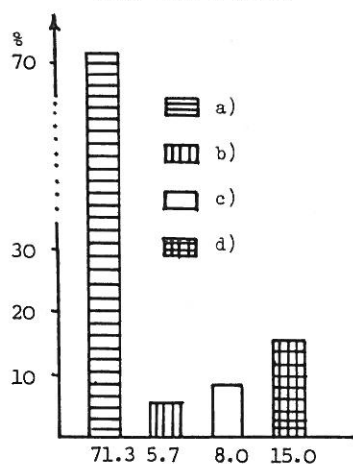

Fig. 2

Proportion of cocoons in the sample with worms in different stages of development /n = 87/. a/ Placula; b/ tissued; c/ blood-vascularized stadium; d/ worms in different stages of development
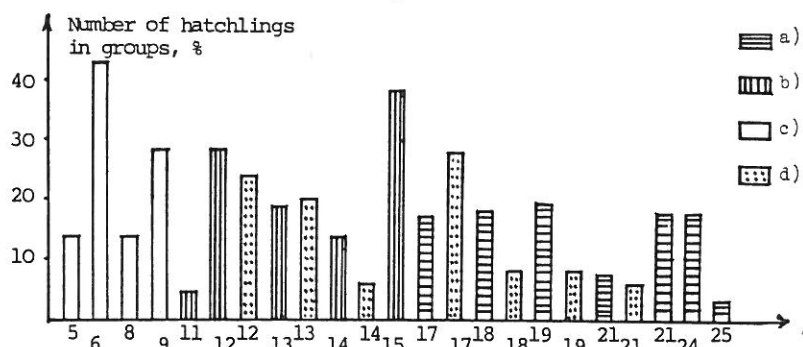

Fig. 3

Hatching period of cocoons containing worms in different stages of development. Embryos in:a/ placula stadium /n = 195/; b/ tissued stadium /n = 21/; Embryos with: c/ blood-vascular system /n = 7/; d/ worms in different stages of development /n = 50/

Conclusions

It is known, that the external factors influence the number and mass of cocoons produced /REINECKE and VENTER, 1987/, furthermore their fertility /REINECKE and VENTER, 1985, 1987; VAIL, 1974/ and the period of hatching /BENGTSSON, 1986; REINECKE and VENTER, 1987/.

In our two experiments the fertility of cocoons was 80 and 87%, respectively. It is higher than the results reported in the scientific literature /70-80%/ /REINECKE and VENTER, 1987; VAIL, 1974/. The average number of young worms per cocoon was 3.35 and 3.4 in our experiments while that of the literature was a bit lower, 1.9, 2.1 and 2.3 /REINECKE and VENTER, 1987/.

Two other external factors affecting fertility of earthworms have already been studied. The relationship between the pH of the hatching media and the number of hatchlings was recorded in other species of earthworm /BENGTSSON, 1986/. The moisture content of the hatching media may also influence the number of hatchlings per cocoon, but this correlation has not been proved yet /REINECKE and VENTER, 1987/.

Our method of estimation by microscope is rather simple, quick and exact. It can be used for similar investigations. With this method the proportion of cocoons failing to hatch can be estimated as well. This method has not been reported in the literature yet.

Hatching period is defined by the authors between 29.7-30.9 days. The time necessary for emerging can also be estimated by this method, based on the stage of development of worms in the cocoon.

Factors influencing the hatching time can be studied by the standard method of incubation in distilled water. Results are more precise if the method is connected with microscopic observation and the different stages of development are also taken into consideration.

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