

Title:

Life cycle of the earthworm *Octodrilus complanatus* (Oligochaeta, Lumbricidae)

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Abstract

The earthworm *Octodrilus complanatus* (Dugès, 1828) is a large-sized species often found in grasslands and pastures, with a wide distribution area in Europe and North Africa. In order to determine the characteristics of its life cycle, earthworms of this species were cultured from hatching until they reached maturity. Development rates, cocoon production and incubation period were recorded under controlled conditions. On average, individuals of *O. complanatus* reared in isolation from hatching reached maturity at day 150 and body weight at maturity ranged between 6 and 8 g. The cocoon incubation period was 66 days, and only one individual hatched from each cocoon, with a mean hatchability of 55%. Reproductive rate showed by *O. complanatus* after mating was of 52 cocoons per earthworm per year. The results showed that the life cycle of *O. complanatus* was characterized by both low growth rates and low fecundity. Specific features in life history traits of *O. complanatus* were compared with those of species of the genus *Octodrilus* and other related earthworms.

Keywords: Earthworms; *Octodrilus complanatus*; Life history; Growth rate; k-selected species

1. Introduction

Earthworms account for the main part of the faunal biomass found in soil ecosystems and they act as key species of the decomposition and nutrient cycling processes [1]. However, in spite of their ecological importance and the high number of described species, there is still a lack of knowledge about the general biology and ecology of most earthworms. In the soil system, large-sized earthworm species play an important role in determining the soil structure and composition through their burrowing activity and surface cast deposition, both in natural and cultivated ecosystems [2,3]. *Octodrilus complanatus* (Dugès, 1828), a large-sized earthworm found often in grasslands and pastures, is a holandric species of the family Lumbricidae, with a wide distribution area in Europe and North Africa [4]. Large populations of this earthworm species are abundant in maize fields of north western Spain (pers. obs.), so the knowledge of both its life cycle and reproductive potential are important in order to evaluate the magnitude of its effects on agroecosystems.

2. Materials and methods

Mature individuals of *Octodrilus complanatus* were obtained by soil sorting from a maize field in Cesantes (Galicia, Spain) and kept in 1 L plastic containers filled with field-collected soil and fed with cow manure added to the surface. Soil moisture content was maintained at 25% with tap water twice a week. Cocoons were hand-sorted weekly from these initial stocks, measured their weight and size, and then incubated at 20±2 °C until hatching. Hatchlings were kept individually in 250 mL plastic vessels with soil and fed with cow manure *ad libitum*; the vessels were maintained in a

scientific incubator at 20 ± 2 °C. The weight of the earthworms and their sexual maturation were recorded weekly; we considered the earthworms attained sexual maturation when the clitellum was fully developed. Results were analyzed by Student's t test. Data are shown as means \pm SE.

3. Results

The growth of *O. complanatus* followed a sigmoid curve, with a slow initial phase (1.03 ± 0.03 g of weight in 75 days) and a rapid phase until sexual maturation (5.1 ± 0.2 g of weight in 75 days) (Fig. 1). Earthworms matured sexually after 150 days with a mean weight of 6 g, and the stationary phase of growth was reached after 210 days with a mean weight of 8 g. The growth rate of earthworms was significantly higher before than after sexual maturity, 44 and 28 mg day⁻¹ respectively (t student; $t = 5.74$, d.f. = 29, $P < 0.0001$).

Cocoon production started 34 ± 3 days after mating and reproduction rate was 0.82 ± 0.14 cocoons per earthworm per week. Cocoons were characterized by a mean mass of 92 ± 4 mg and a size of 6.9 ± 0.1 mm (length) and 4.8 ± 0.3 mm (wide). Incubation time (at 20 °C) of these cocoons was 66 ± 2 days (range 50 to 70; $n = 30$), but hatchability was only 55% under culture conditions. Only a single hatchling emerged from each cocoon with a mean biomass of 82 ± 3 mg (range 60 to 100 mg; $n = 30$).

4. Discussion

In laboratory conditions *O. complanatus* showed an unexpected high growth rate according to their ecological type, characterized by lower growth rates and maturation time [5,6,7]. This unexpected growth was probably due to the increased food

availability and temperature, since Lee [3] reported an optimal thermal range for european lumbricids between 10-15 °C; these results are supported by lower growth rates in *Lumbricus terrestris* at 10-15 °C than at 20 °C reported by Butt et al [6]. Apparently, there is a contradiction between the high rates of growth and reproduction we found at 20 °C in this work and the halt in reproduction this species experiences during summer. In fact, analysis of mature individuals of *O. complanatus* obtained from field populations revealed that in summer the ovaries were not well developed; the size of the seminal vesicles was smaller than during the rest of the year, and the spermathecae were empty showing a reduced diameter [8,9]. These characteristics were the result of the combination of low moisture conditions and high temperatures, which does not occur in laboratory conditions. Therefore, there is need for further research on variation of the life traits of this species in a range of temperatures and moistures in order to apply our knowledge to field conditions.

The life cycle of *O. complanatus*, showed in figure 2, is more similar to those of other large anecic or endogeic earthworms like *Lumbricus terrestris*, *L. friendi* and *Allolobophora caliginosa* (k-selected species) than to the life cycles of epigeic earthworms like *Eisenia fetida*, *E. andrei*, *Eudrilus eugeniae* and *Perionyx excavatus*, with shorter sizes, fast growth and higher reproductive rates (r-selected species) [10]. Thus, similar growth rates were found by Butt [5] and Butt et al. [6] for *L. terrestris* (6 g of weight in 5 months at 20 °C), even though they were higher than the growth rates of *Allolobophora longa*, *Octolasion cyaneum* and *Allolobophora carpathica*, other deep-burrowing species [5,7]. The rate of cocoon production (52 cocoons per earthworm per year) places *O. complanatus* together with species like *L. terrestris*, *A. longa*, *A. carpathica* and *O. cyaneum* (38, 18, 10 and 32 cocoons per earthworm per year respectively); however cocoon incubation time, over 60 days, and hatchability (55%)

were slightly lower than those recorded in *L. terrestris* and *O. cyaneum* and similar to *A. longa* ones [5,7].

Acknowledgements

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Figure captions

Fig. 1. Growth of *Octodrilus complanatus* at 20 ± 2 °C and fed *ad libitum* with cow manure (Means \pm SE, $n=30$). Time to reach sexual maturity and stationary phase of growth are remarked.

Fig. 2. Life cycle of *Octodrilus complanatus* reared in its parent soil and fed *ad libitum* with cow manure at a temperature of 20 °C.

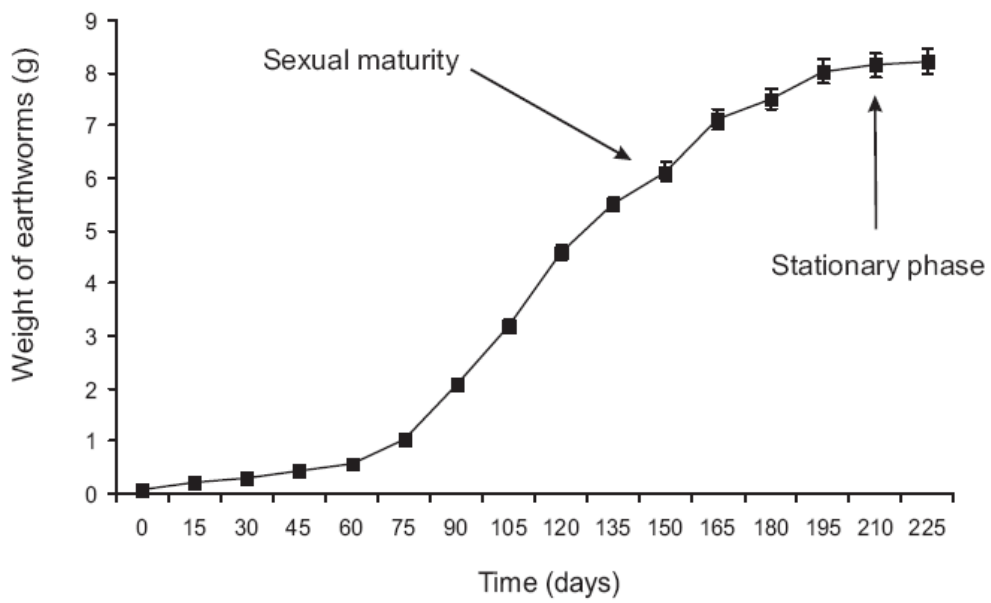


Figure 1

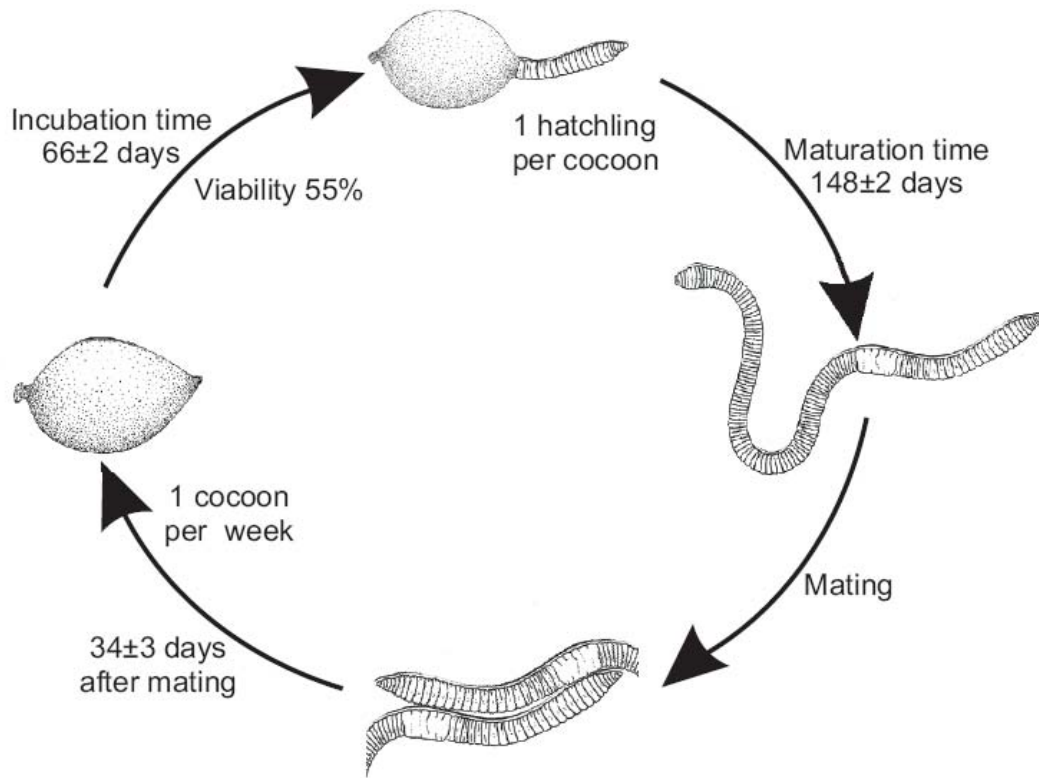


Figure 2