The development of *Pseudohypocera kerteszi* (Diptera, Phoridae), a kleptoparasite in nests of stingless bees (Hymenoptera, Apidae) in Central America

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The larval development of the kleptoparasite *P. kerteszi* has been studied in the nest of the stingless bee *Melipona beecheii*. Development times for the stages of egg, larva and pupa were obtained for conditions in El Salvador and Costa Rica.

**Keywords**: Phoridae, Pseudohypocera, kleptoparasite, development, stingless bees

The widespread *Pseudohypocera kerteszi* (Diptera, Phoridae) is considered the major pest of stingless bees in Central America and often causes failure in colony multiplication by the beekeeper. Adult phorid flies have been reported to invade stingless bee nests and to reproduce inside the nests (Disney, 1994; Nogueira-Neto, 1997, Tóth, 1995), causing damage to food storage and brood nest. Until now, actual development times of the eggs, the larval stage and the pupal stage have not been published. The objective of this paper is to report data about the development of *P. kerteszi* in the nest of the stingless bee *Melipona beecheii*, collected in El Salvador and Costa Rica.

**MATERIAL AND METHODS**

*Pseudohypocera kerteszi* pupae were collected from nests of *M. beecheii* and reared in 14-ml glass vials. Adult males and females obtained from these pupae were transferred to 50-ml bottles containing a mixture of pollen and honey, to induce mating. After two days, females were transferred to 14-ml vials – each vial contained one female – with honey-pollen mixture. The development time of the various stages of the offspring of these females was measured. The development times were taken in the recordings in Costa Rica as the time between the moments that 60% of the total clutch in a specific stage was present in the vial. In El Salvador we measured the development times by two ways. First, the time was taken between the first appearance of a stage and the first appearance of the following stage and secondly the development time was taken similarly as in Costa Rica. The duration of the pupal stage was exclusively recorded individually for each pupa.

**RESULTS**

**Eggs**

Eggs of *P. kerteszi* have a white color and are about 1 mm long. The eggs are banana-shaped and have some elongated bulges on both sides (Fig. 1a). The time from the first egg laying to 60% of the total clutch of eggs takes 13.8 h (n=26). The mean clutch size is 34.7 (±12.7) [11-63] eggs.

**Incubation time of the eggs**

The development time of the eggs from Costa Rica (19.5 h; range: 16-22; n=14) and El Salvador (12.3 h; range: 4-24; n=26) differs significantly (p=0.003, Z= -2.94) (Fig. 2).

**Viability of the eggs**

The viability of the eggs was measured to be in El Salvador and Costa Rica respectively 72.4% [30.6-100] (n=26) and 82.1% [50.7-100] (n=14). This difference is significant (p=0.035).
Figure 1. a: Egg of *Pseudohypocera kerteszi* (length: 1.0 mm); b: Larva of *P. kerteszi* (length of this larva: 4.0 mm).

Figure 2. Development time of the eggs, results from El Salvador and Costa Rica.

Figure 3. Development times for larvae and pupae, results from El Salvador and Costa Rica.
Larvae
The size of the larvae upon hatching is 1.6 mm and full-grown larvae measure 6.0 mm. They have a cigar-shaped body (Fig. 1b) and a dirty white colour.

Development time of the larvae
The development time for larvae in Costa Rica (7.2 days; range: 7-8; n=14) was slightly longer than in El Salvador (6.9 days; range: 5.7-10.0; n=26) (p=0.001, Z= -3.304) (Fig. 3).

Viability of the larvae
In El Salvador 85.4% [61.5-100] of the larvae survived (n=26). In Costa Rica the survival rate did not differ (p=0.422), 86.9% [72.3-100].

Pupae
Pupae are a little smaller (length is about 5 mm) than the full-grown larvae. However, they are slightly wider than the full-grown larvae. Their colour depends on the age of the puparium varying from light brown for young pupae to dark brown for older pupae (Fig. 4).

Development time of pupae
Pupal development time in Costa Rica was also longer than in El Salvador (p=0.018, Z= -0.804) (Fig. 3). Development time in El Salvador is 5.4 [2.9-8.2] days (n=426) and in Costa Rica 8 days (n=7).

Figure 4. Three P. kerteszi pupae of different age; left: young pupa, middle: middle-aged pupa, right: mature pupa.

Figure 5. Pseudohypocera kerteszi female (a), three females with extended ovipositor (b) and a close-up of an ovipositor in retracted position.
Sex ratio of the adult flies

Shortly after the start of the infestation, only female adult flies (Fig. 5) were found inside the nest. However, for the offspring we found an overall sex ratio of 0.79 (44 females and 56 males); not differing significantly from a sex ratio of 1 (50:50) ($\chi^2<3.84$; df=1; $\alpha=0.05$). In Costa Rica we obtained the same results ($\chi^2<3.84$, df=1, $\alpha=0.05$) (n=622).

DISCUSSION

The development time of all three stages, eggs, larvae and pupae, is slightly longer in Costa Rica than in El Salvador. We explain this due to a different influence of abiotic factors (mainly ambient temperature) at these two research sites. Average daily temperature is several degrees lower at the research site in Heredia, Costa Rica, due to the different altitude compared to San Salvador. The survival rates in Costa Rica and El Salvador only differed significantly for the egg stage.

Adult males were never found invading the beehive. Polidori et al. (2001) also never found males entering a hive. We conclude that mating normally takes place outside the beehive (cf. Portugal-Araújo, 1977). However, the obtaining of offspring from enclosed adult pairs indicates that mating in culture bottles is possible (cf. Chaud-Netto, 1980).

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