# Egg hatching at different temperatures and relative humidities in *Idaea inquinata* (Scopoli) (Lepidoptera: Geometridae)

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Abstract

*Idaea inquinata* (Scopoli) feeds mainly on dried plants, nevertheless, it is also a potential pest of stored products as it is able to develop on cereal products. The few references on the biology of this species do not deal with the influence of temperature and relative humidity on egg hatching. To fill this gap, groups of 100 eggs, 24-48 hours old, were exposed to five constant temperatures (17, 21, 26, 29 and 34±1°C), two relative humidities (35 and 70±5%) and a photoperiod of 0:24 (light:dark); ten tests were carried out. Each test was replicated four times and egg hatching was observed daily. The highest mean number of hatched eggs was observed at 26 and 29±1°C, 70±5% r.h. with 91.5 and 91.0 eggs, respectively. The lowest mean number of hatched eggs was 61.5 observed at 17°C and 70±5% r.h. The mean numbers of hatched eggs, 83.5, 77.5, 78.5 and 79.8 were similar at 21, 26, 29 and 34±1°C, 35±5% r.h., respectively. Eggs hatched between the sixth and the eighth day at all the temperatures tested, except for 17±1°C and 35±5% r.h., where hatching started on the twelfth day. At this temperature, the duration of the hatching period increased with increasing humidity: 11 d at 35% r.h. and 15 d at 70% r.h.

Keywords: Egg, Hatching, Temperature, Relative humidity, Rusty wave moth

## *1. Introduction*

The rusty wave moth, *Idaea inquinata* (Scopoli) (Lepidopitera: Geometridae) develops on dried plants with a preference for medicinal species that can be heavily damaged and made unsuitable to essential oil extraction. In Southern Italy, Candura (1931a, b) studied I. inquinata from April to October in a warehouse. He observed two generations on hay, and three generations on chamomile and leguminous plants. On average, each female laid one hundred eggs within a week. Oviposition started on the fourth and lasted until the eleventh day after eclosion. Eggs were laid singly or in pairs, and hatching occurred between 4-15 d, depending on season and weather, in a temperature range of 19-28°C. The length of larval development time varied between 60 to 333 d, dependent on the dried plant species.

In the last few years, *I. inquinata* has proven to be a potential pest of stored products, as it can also develop on bran, maize meal, wheat kernels and rice (Locatelli et al., 2005). This species can be a serious pest in warehouses where spices, dehydrated plants and cereals are stored. Since larvae penetrate the substrate and adults have low activity, it is difficult to detect infestations in warehouses.

There are few references to the biology of this species. The purpose of the study is to determine the incubation and hatching time of eggs of I. inquinata at different temperatures and relative humidities.

## *2. Materials and methods*

*Idaea inquinata* has been reared continuously for 5 years, on an artificial diet consisting of 62 g bran, 8 g corn flour, 7 g wheat flour, 4 g wheat germ, 3 g dried yeast, 9 g glycerine and 7 g honey (Stampini and Locatelli, 2007). The diet was stored in polyethylene bags at 6°C until needed. Insect cultures were maintained in a thermostatic chamber at 26±1°C, 70±5% r.h. and photoperiod of 16:8 (light:dark).

Groups of 100 eggs, 24-48 h old, were placed in 6-cm diameter Petri dishes at different temperatures and relative humidities. Tests were carried out at 17, 21, 26, 29 and 34±1°C with two relative humidities (35 and 70±5%) and a photoperiod of 0:24 (light:dark). Each combination of temperature and humidity was replicated four times and egg hatching was observed daily. Eggs were considered hatched when the young larvae successfully chewed emergence holes in the chorion and left the egg shell. Data were submitted to Duncan's multiple range test, Student's t-test and two-way ANOVA (SPSS 17.0 for Windows and Microsoft Excel 2003).

*3. Results*

The lowest mean number of hatched eggs was 64.7 observed at 17°C and 35% r.h. ($F_{4,15}$=8.275, P<0.01) during a long hatching period of 12-23 d (Table 1). The mean numbers of hatched eggs (83.5, 77.5, 78.5 and 79.8) were not significantly different at 21, 26, 29 and 34±1°C, 35±5% r.h., and the hatching periods were shorter and similar.

**Table 1** Mean number (SD) of eggs of Idaea inquinata (Scopoli) hatched at 17, 21, 26, 29, 34°C and 35% r.h. and hatching period

| Temperature(°C) | 35% r.h. | | |
|---|---|---|---|
| | Mean number of eggs (SD) | Number of eggs min-max | Hatching period (days) |
| 17 | 64.7 (7.8) a | 57-72 | 12-23 |
| 21 | 83.5 (3.9) b | 79-88 | 8-10 |
| 26 | 77.5 (3.9) b | 72-81 | 8-12 |
| 29 | 78.5 (3.5) b | 75-82 | 6-8 |
| 34 | 79.8 (4.3) b | 74-83 | 6-9 |

Values followed by the same letter in a given column are not significantly different (Duncan multiple range test, $F_{4,15}$=8.275, P<0.01).

At 70% r.h., the lowest number of hatched eggs 61.5 was observed at 17°C (Table 2) ($F_{4,15}$=12.3, P<0.01). The highest numbers of hatched eggs 91.5 and 91.0 were observed at 26±1°C and 29±1°C, 70±5% r.h., respectively. Eggs hatching started between 6-8 d, the hatching period was 3-4 d at 26, 29 and 34°C, while at 17 and 21°C egg hatching lasted longer at 15 and 7 d, respectively.

**Table 2** Mean number (SD) of eggs of Idaea inquinata (Scopoli) hatched at 17, 21, 26, 29, 34°C and 70% r.h. and hatching period

| Temperature (°C) | 70% r.h. | | |
|---|---|---|---|
| | Mean number of eggs (SD) | Number of eggs min-max | Hatching period (days) |
| 17 | 61.5 (11.1) a | 51-73 | 6-20 |
| 21 | 73.7 (7.2) b | 63-79 | 8-14 |
| 26 | 91.5 (2.4) c | 89-94 | 7-9 |
| 29 | 91.0 (6.5) c | 84-97 | 6-8 |
| 34 | 81.7 (5.9) bc | 73-86 | 6-9 |

Values followed by the same letter in a given column are not significantly different (Duncan multiple range test, $F_{4,15}$=12.3, P<0.01).

The mean numbers of hatched eggs at the two relative humidities were compared for each temperature considered (t-Student test). At 17, 21 and 34°C, there were no significant differences between the effects of the two relative humidities (t-values of 0.47, 2.36, 0.54, df=5, NS, respectively), while at 26°C (t-value of 6.16, df=5, P=0.001) and 29°C (t-value of 3.39, df=5, P=0.01) the differences were significant.

The results were confirmed by two-way ANOVA where temperature effects were significant (F=16.59, df=4, P<0.01), but relative humidities were not (F=2.52, df=1, P=0.122); however, the interaction of the two variables was significant (F=5.42, df=4, P<0.01).

*4. Discussion and conclusions*

*Idaea inquinata* tolerates low relative humidity and high temperatures. In fact, high percentages of eggs hatched even at 34°C at both 35 and 70% r.h. This is in contrast to many other insects that require high relative humidity with high temperatures. In the laboratory, Lee (1988) observed lower numbers of hatching eggs of *Ostrinia nubilalis* (Hübner) (Lepidoptera: Pyralidae) at 22 and 27°C with 35% and 55% than with 75% r.h. A significantly higher number of hatched eggs was observed at 26° and 29°C at 70% r.h. In contrast, Kamel and Hassanein (1967) observed that relative humidity in the range 40-80% did not influence egg hatch in a temperature range of 24-32°C for *Corcyra cephalonica* (Stainton) (Lepidoptera: Galleridae), but relative humidity lower than 20% inhibited hatching.

With 35% and 70% r.h., the hatching period was similar at 29 and 34°C but shorter at 17, 21, and 26°C. In the case of *Ephestia kuehniella* Zeller (Lepidoptera: Pyralidae), Jacob and Cox (1977) found that "humidity has little influence on egg development and developmental periods increase only at very low relative humidities". Other authors observed a gradual decrease in time with an increase of temperature. The incubation period of eggs of *Dasyses rugosella* Stainton (Lepidoptera: Tineidae) decreased with an increase of temperature in the range 25-35°C (Iheagwam and Ezike, 1989; Ashamo and Odeyemi, 2004). At 17°C and both 35 and 70% r.h., a lower egg hatch and longer hatching period was observed. Comparison of model predictions made by Subramanyam and Hagstrum (1993) "indicated that temperature greatly influenced development times, followed by relative humidity, and diet".

Further research on *I. inquinata* is required with determining egg hatching at lower and higher temperatures in order to identify the thermal limits of this species. These results will be useful for the safe storage of foods.

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