Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2016; 4(5): 920-922

Received: 01-07-2016
Accepted: 02-08-2016

Fatima Zohra Guerroudj
Laboratory of Biosystematics and Ecology of Arthropods, Faculty SNV, University of Mentouri, Constantine. Algeria

Sélima Berchi
a) Laboratory of Biosystematics and Ecology of Arthropods, Faculty SNV, University of Mentouri, Constantine. Algeria
b) Higher National School of Biotechnology – Constantine, 25000 Algeria

Correspondence
Fatima Zohra Guerroudj
Laboratory of Biosystematics and Ecology of Arthropods, Faculty SNV, University of Mentouri, Constantine, Algeria

Effect of temperature on the development of carrion beetle *Silpha rugosa* (Linnaeus, 1758) (Coleoptera: Silphidae) in Algeria

Fatima Zohra Guerroudj and Sélima Berchi

Abstract
Most forensic entomology researches were conducted on Diptera, because they are the first scavenger insects that reach a dead body. Coleoptera are often overlooked. Yet the beetles can also have a significant role in the determination of the postmortem interval (PMI). At present, some researchers are interested in beetles, in a forensic context to develop new bio-indicators, other than Diptera. In this work we studied the life cycle of the carrion beetle *Silpha rugosa* (Linnaeus, 1758), the species was put in breeding following two different temperatures, one was put in the conditions of the laboratory (23 °C), the other one in a steam room settled in an equal relatively constant temperature (26 °C). The results revealed that the duration of development of *S. rugosa* is shorter under 26 °C than under 23 °C. This study has allowed us to see the influence of temperature on the progress of various stages of *S. rugosa* development. This information would be useful to determine the postmortem interval (PMI) in Algeria.

Keywords: *S. rugosa*, temperature, development, forensic entomology, Algeria

1. Introduction

Silphes are medium-sized Beetles of between 7mm to 45mm [1, 2], they feed on decayed organic matters and most of their sub-species are common to the human corpse. They colonize the remains throughout the boot stage until total dry out [3].

Two sub-families are regularly associated with corpses, Nicrophorinae and Silphinae. In Western Europe, 13 species of Silphinae were identified, most of which are the necrophagous insects [4]. Thanks to their developed olfactive system, the insects get the volatile organic components generated by the body under the effect of the biochemical and physical degradation [5]. The arrival of Silphinae coincides with the development of the Diptera larvae on the corpse given that they feed on decaying tissues and on Diptera larvae, they are necrophiles species.

Silphinae show a preference for the big corpses because they supply a sufficient food resource for these Beetles, which can be present [6]. The Silphidae species get a particular behavior in managing the food resources which is, by occupying various ecological niches and by avoiding the competitive interactions with of other species, present on the same substratum [7, 8]. Having located an appropriate corpse, adult ones couple near it and females lay their eggs in the surrounding ground. Larvae hatch from 2 to 7 days after laying, and go back up towards the remains where they feed exclusively on the left food. They undergo three larval stages and the pupation. The nymph gets buried in the ground from 10 to 30 days after the hatching. The chrysalis takes from 14 to 21 days [9, 10]. According to [11], their life expectancy is not fixed but depends on environmental conditions. For instance, the development of *Thanatophilus micans*, one of the Silphidae families, from the egg stage up to the grown-up stage, takes approximately 22 days under a temperature of 25 °C. Under 20 °C, the mortality of *T. micans* reduces, it corresponds to the optimal temperature of survival [12]; in other words the species reproduces better in this temperature.

The temperature is a determining factor which influences and controls not only the speed of corpse decomposition, but also the activity of necrophagous insects among which Beetles [13, 14].

Numerous studies were carried out on those Nicrophorinae which are common to the corpses [15], however, they do not have a forensic importance if compared with the Silphinae.

In fact, Silphinae are the object of experimental studies to know their cycle of development with regard to the temperature and their geographical distribution as well [11, 16] and so end in a

Possible calculation of the PMI. In Algeria, works on forensic entomology are in their first steps, especially for both Coleoptera on which no work has been done yet. That's why we have chosen to deal with this subject.

Most studies made in our laboratory on corpses decomposition, revealed that the most abounding Beetle on a decaying mammal substratum is *S. rugosa*, this species is present since the first days of the deposit of the corpse. In this context, we chose this Beetle as an object of study.

2. Material and methods

2.1 Study period and place

This study was conducted in the spring season, from 27/03/2013 to 02/05/2013. It was carried in the laboratory of Biosystematics and Ecology of Arthropods, located in Constantine in the north east of Algeria (36°20'16.20"N; 6°37'33.32"E) at the altitude of 571 m.

2.2 Method of breeding

The male and female adults of *S. rugosa* were taken from pitfall traps baited with a piece of meat and put in breeding in boxes in Plexiglas (25.5 × 15.5 × 7.5) with screen cover. The bottom of boxes is covered with the wet soil (5cm) on which one piece of meat (50g) was put as food. The water requirement is supplied a moistened cotton swab. The breeding was realized on two groups of adults (male and female) of 17 individuals each. For the 1st group, we worked in the conditions of the laboratory where the existing average temperature is of 23 °C with an average relative humidity of 32%. For the 2nd group, the breeding was led in a steam room settled in a temperature of 26 °C with a relative humidity of 70%. In each breeding the individuals were placed in a tub on which we put a label with the name of the species and the number of individuals. The tub 1 (conditions of the laboratory) was prepared on 27/03/2013 whereas the tub 2 (steam room) was prepared on 31/03/2013. Hence, the breeding was followed until the emergence of the adults.

2.3 Morphometric analysis

A preliminary study on the morphometric characterization is proposed. The measures taken on the eggs diameter and length of larvae by means of a metallic rule are realized every two days to estimate better the growth of larvae.

2.4 Data Analysis

Total data was subjected to Excel statistical analysis for drawing the Growth curve of *S. rugosa* larvae at 23 °C and 26 °C.

3. Results

During the breeding, the following stages of development were identified: eggs, three larval stages (L1, L2 and L3) then the nymph and finally the imago. In 23 °C, the life cycle of *S. rugosa* (From the first larval stage until the emergence of the adults) took place on 28 days, while the breeding in steam room took only 16 days.

Concerning the duration of the egg stage, we noted that after 4 days, the 1st larvae appear in the same conditions of temperatures (23 °C and 26 °C) (Table 1 and 2)

The passage from a larval stage to another follows the process of ecdysis, our observations reveal 3 larval stages. These stages evolve in parallel for both temperatures. Nevertheless, the nymphal stage records a clear distinction between both temperatures. Under 23 °C, it took 9 days to reach the nymphal stage while in the steam room took only 2 days.

Table 1: Observation of daily development of *S. rugosa* reared in laboratory conditions (23 °C) and humidity (32%)

Days	Observation	Stage
From day 1 to day 4	Adults mating	/
From day 5 to day 8	Presence of eggs having a diameter of 1 to 2 mm and length of 1.5 to 2 mm	Egg
Day 9	Larvae of 4 mm in length	Larval
Day 12	Larvae 6 mm in length	Larval
Day 15	Larvae 14 mm in length	Larval
Day 18	Larvae 16 mm in length	Larval
Day 22	Larvae 20 mm in length	Larval
Day 25	Larvae 22 mm length	Larval
From day 28 to day 36	Nymphs presence at the bottomTray	Nymphal
Day 37	Emergence of new adults	Adult

Table 2: Observation of daily development of *S. rugosa* put in the steam room (26 °C) and humidity (70%).

Days	Observation	Stage
From day 1 to day 4	Adults mating	/
From day 5 to day 8	Presence of eggs having a diameter of 0.5 to 1 mm and length of 1 to 2 mm	Egg
Day 9	Larvae of 5 mm in length	Larval
Day 10	Larvae 7 mm in length	Larval
Day 12	Larvae 15 mm in length	Larval
Day 15	Larvae 19 mm in length	Larval
Day 18	Larvae 24 mm in length	Larval
From day 23 to day 24	Nymphs presence at the bottom Tray	Nymphal
Day 25	Emergence of new adults	Adult

We tried to analyze the stages of development of *S. rugosa* for both temperatures (Figure 1), we notice that larvae subject to both temperatures (23 °C and 26 °C) do not present the same sizes. The embryonic development subjected to both temperatures presents a difference of size.

The larvae put in breeding in the steam room developed quickly; their size is slightly superior to that of the larvae in the conditions of the laboratory (23 °C). The maximal length is of 22mm for larvae put in 23 °C and of 24mm in the steam room (26 °C) (Figure 1).

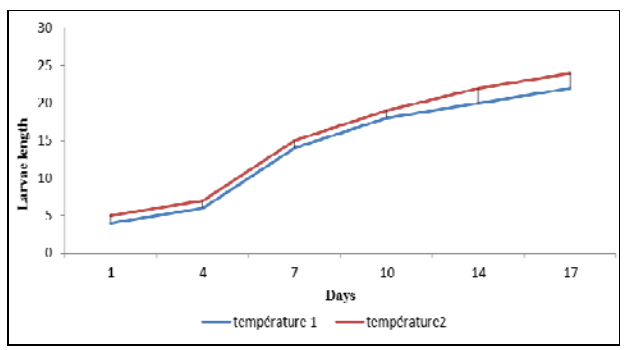

Fig 1: Growth curve of *S. rugosa* larvae at 23 °C and 26 °C.

4. Discussion

During our study we noticed that under the temperature of 23 °C and a humidity of 32%, the life cycle from the first larval stage until the emergence of the adults of *S. rugosa* lasted 28 days. This cycle, recorded after a breeding put in the steam room (26 °C) under a relative humidity of 70% lasted 16 days. Since this species has not been the object of deep studies, we shall try to analyze this aspect of development by comparing it with other species of Silphinae of forensic interest. So, [8] reports the results of the complete development of the *Thanatophilus sinuatus* species which lasted 42.79 days in the conditions of breeding, under a controlled temperature of 23 °C and a relative humidity fixed to 70%. It is not about the same species as we followed, certainly, but it would seem that a higher rate of humidity than that expressed in our case would maybe have extended the life cycle of *S. rugosa*. Would the humidity have an impact on the activity of larvae? If we consider our experiment, the duration of development of *S. rugosa* is shorter under 26 °C than under 23 °C. According to the curve of growth, the duration of larval stages takes place simultaneously. However, we recorded a difference in the length of larvae. Indeed, larvae put under the conditions of the laboratory (23 °C) have a maximal length of 22 mm, while those under 26 °C have the maximal length of 24 mm. The nymphal stage is shorter in the steam room than under the conditions of laboratory. So, the development of *S. rugosa* would be proportional in the temperature. However, [17] reports that in higher temperatures, the embryonic mortality increases. After the reproduction, we observed that the female lays its eggs in cluster; the embryonic development ends with the appearance of the first larval stage, after 4 days. This observation is mentioned in the works of [18]. The embryonic development for the temperatures 26 °C and 23 °C vary respectively from 10 to 17 days. We notice that it has 6 day gap for the appearance of the nymph. This latter finishes its cycle of development by digging the ground where it mobilizes until the emergence of the adult. The new adults are observed after 2 days under 26 °C and 9 days after the pupation under 23 °C.

5. Conclusion

The study of *S. rugosa* life cycle in two different temperatures, (in the conditions of the laboratory (23 °C) and in a steam room settled in an equal relatively constant temperature (26 °C), has revealed that the temperature is an important factor which influences and controls not only the speed of a corpse decomposition, but also the activity of necrophagous insects among which Beetles. This information would be useful to determine the postmortem interval (PMI) in Algeria. The use of scavenging beetles is a new technique to date the death of a living being, that’s why, it is important to generate the study of all carrion species life cycle.

6. References

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