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Bioecology of *Phonoctonus lutescens* (Guérin Meneville and Percheron) Predator of *Dysdercus voëlkeri* (Schmidt, 1932), Feeding on *Dysdercus voëlkeri* in the Laboratory Conditions in Burkina Faso

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Abstract

The study was conducted at the agricultural experimental station of Farako-Bâ, specifically in the Cotton Program. Insects were collected in Farako-Bâ field and raised in the Cotton Program. *Dysdercus voëlkeri* Schmidt is one of cotton cultivation main pests in Burkina Faso. The control of this devastating cotton bug is based on chemical using. For researching alternative solutions, a part of the biological control method was investigated by using *Phonoctonus lutescens* which is *D. vöelkeri* natural enemy, in order to develop a biological control method. To understand the bioecology of *P. lutescens*, our study has been carried out on this insect under laboratory conditions when it was feed on its prey which is *D. voëlkeri*. The results have demonstrated that the pre-copulation period is 9.33 ± 2.14 days. The oviposition period is 6.97 ± 1.47 days, after which 366.73 ± 27.43 eggs on average are laid with 92.33% ± 4% hatchability. From hatching to adult stage, *P. lutescens* larvae development goes through five stages with variable durations according to the stage. The results showed that the development cycle lasted 57.23 ± 5.81 days at a temperature of 27.5˚C ± 2˚C and a relative humidity of 42% ± 3%. Survival rates ranged from 92% to 97.47%. Males and females lived respectively 87.5 ± 27.99 days and 107.97 ± 24.21 days. These results could permit a better use of *P. lutescens* through a mass rearing and an optimization of *D. voëlkeri* biological control.

Keywords

Cotton, Biological Control, *Phonoctonus lutescens*, *Dysdercus voëlkeri*, Burkina Faso

1. Introduction

In Sahelian countries in general and in Burkina Faso in particular, cotton is one of the most cultivated plants. Burkina Faso is one of the main cotton producers in Africa. The contribution of Burkina Faso in world cotton production was 2.6 percent [1]. The cotton fields are under heavy parasites pressure with a very broad spectrum of pests with more than 70 arthropods species (Aphids, bugs and mites) diplopods and nematodes [2] [3]. Cotton cultivation is being adapted fruitfully and is likely to interest the protection of crop as a whole. This is probably due to the importance of crop losses caused by pest including *Dysdercus voëlkeri* at the end of cotton's cycle [4]. In general, the ability of insects to get around phytosanitary practices explains why scientifics are turning more and more towards the most ecological practices with the use of biological control agents. For example, [5] and [6], in a biological control approach, showed the potential of reduviidae and identified *Rhynocorisalbopilosus* and *P. lutescens* sp Guerin Percheron (Heteroptera) as predators of *Dysdercus* species. However, in Burkina Faso where cotton production is important, very little work exists on this insect which presence was previously announced by several authors. Apart from the summary description and systematic studied by [7] and the measurements made by [8], there are very few studies on the bioecology and its real potential for predation as a biological control agent. However, according to [9], knowledge of biology and predator voracity measurement is an important step in assessing the potential of a biological control. Thus, knowledge of the biological parameters of *P. lutescens* and ecological factors are essential for the elaboration of an integrated control program against *D. voëlkeri* in cotton growing in Burkina Faso. The final objective is to explain the biology mechanisms of *P. lutescens* in cotton farming areas.

2. Methods

2.1. Biological Material

The collection of derived insects was carried out from September 2016 to May 2017, in Farako-Bâ on Bobo-Banfora axis, about 10 km from Bobo-Dioulasso, located at 04˚20'W and 11˚06'E. Strains were manually picked up [10]. The collection was made with 25 cm × 25 cm × 25 cm plastic pots. Larval and adults' individuals of *D. voëlkeri* and *P. lutescens* were killed and placed in alcohol, then identified in CNRST (Centre National de la Recherche Scientifique et Technologique) laboratory by using [11] and [12] determination keys. Some works have been carried out on the subject, including those of [8], on the biology of certain *Phonoctonus* sp in West Africa, and another one on the description and distinction of the larvae and exuvia of *Rhynocoris albopilosus* done by [13] and the studies of [14] on the biology of the reduviidae in North America.

2.2. *Phonoctonus lutescens* Study Conditions

For this study, eggs and larvae were obtained from spawning pairs in cages kept in captivity. After hatching, the larvae are individualized and kept in captivity in

petri dishes (10 cm × 6 cm), and raised under the same laboratory condition at 25˚C ± 1˚C, 72% moisture and 12:12 photoperiod. Thus, thirty (30) pairs of adults were set to calculate the pre-copulation and pre-oviposition periods. Also, thirty (30) batches of sixty (60) eggs were chosen for the incubation time and eggs hatching rate. Thirty (30) females and Thirty (30) males were selected for the calculation of adults' longevity. Hundred (100) larvae were used for the survival rate. Hundred (100) larvae and Hundred (100) adults were killed and placed in 70% alcohol for morphometric measurements [15], which were performed using the digital caliper of maximum capacity 150 mm and the eye magnifier at 10 × 10 magnification.

2.3. *P. lutescens* Biological Parameters Study

The description of egg was based on its coloring and its size based on the study made on *P. lutescens* description [8]. Larvae and adults measurements were described based on the work on description and distinction of larvae and exuvia of *Rhynocoris albopilosus* done by [13]. The biological characteristics measured were:

- **The mean survival rate:** The mean survival rate was calculated for each larval stage from: larvae variation rate [16].

$$\text{Mean survival rate}(\%) = \frac{\sum \text{sifi}}{\sum \text{fi}} \times 100$$

($\text{si} = \frac{\text{Number of subsequent larvae}}{\text{Number of previous larvae}}$, fi = number of females).

- **Development duration:** The average duration of development combining both the incubation period and the larval duration and was obtained by the following calculation [16]:

$$\text{Average of development cycle duration}(\text{days}) = \frac{\sum(\text{biki})}{\sum \text{ki}}$$

(bi = incubation period, di = larval duration, dim = time from imago to adult and ki = adult number).

- **Sex ratio:** In the adult stage, males and females were identified and counted and the sex ratios were obtained [16].

$$\text{Sex ratio} = \frac{\text{number of males}}{\text{number of females}}$$

- **Pre-copulation:** pre-copulation is the period that separates the imaginable moult from the first mating. The average period of pre-copulation is obtained according to the following calculation: average period of pre-copulation (days) [16].

$$\text{average of pre-copulation}(\text{days}) = \frac{\sum \text{xini}}{\sum \text{ni}}$$

(xi = Ja – Jo (Ja = first mating, Jo = imaginal moult) and ni = number of couple).

- **Pre-oviposition:** Pre-oviposition period is the period that separates the first mating from the first egg laying. The average of pre-oviposition is obtained [16]:

$$\text{average of pre-oviposition}(\text{days}) = \frac{\sum \text{oifi}}{\sum \text{fi}}$$

(oi = Jpp – Ja (Jpp = day of first laying; Ja = date of coupling)).

- **Incubation time of eggs:** The incubation time of eggs corresponds to the period between spawning and hatching. The incubation time is obtained:

$$\text{average rate of fertility}(\%) = \frac{\sum \text{tifi}}{\sum \text{fi}} \times 100$$

($\text{ti} = \frac{\text{eggs number hatches}}{\text{number of egg laid}}$, fi = number of females) [16].

2.4. *P. lutescens* Morphometric Parameters Study

The morphological characters measured were done by [8]:

- **Body length:** maximum body length from the point of the anterior labrum to the point of the most posterior abdomen in dorsal view;
- **Length of the abdomen:** maximum length of the abdomen from the most anterior point of the abdominal sternum II to the most posterior point of the abdominal segment VII;
- **Width of the abdomen:** the greater width of the abdomen;
- **The length of the article of the rostrum:** The maximum length of the rostrum article from the most basal point to the most apical point for each of articles I to III;
- **Width of the head:** maximum Width at eye level;
- **Length of the antennal article:** maximum length of antennal article from the basal point to the most apical point of each of the articles from I to IV;
- **Length of femur:** maximum length of femur from basal point to the most apical point for each article for each of pro, meso and metatibia;
- **Length of tibia:** maximum length of tibia from the basal point to the most apical point for each of pro, meso and metatibia;
- **Length of the tarsal segment:** maximum length of the tarsal segment from the basal point to the most apical point for each of the segments I, II et III of the pro, meso and metatarsus.

2.5. *P. lutescens* Bioecological Parameters Study

The ecological parameters measured were essentially focused on temperature and relative humidity.

2.6. Statistical Analysis

For statistical analysis, the data collected was analyzed with the XL STAT software version 2007.7.02. The mean separation was performed by the Fisher test (LSD) at 5% probability level.

3. Results

P. lutescens Biological Parameters Study

1) Eggs

The newly eggs of *P. lutescens* are light brown in color and dark 24 hours after laying They have a soft appearance and slightly glued to each over. The eggs are elongated but have a rounded posterior pole and an anterior pole truncated right and occupied by a hatching operculum. Eggs are more or less asymmetrical. Variance analysis reveals a highly significant difference between the length and width of eggs. The measures done on 100 eggs indicate 1.29 mm for width and 2.97 for length (Table 1). Analysis of the incubation times showed that it was between 9 and 12 days and an average of 10.5 ± 1.41 days at a temperature of 25˚C ± 1˚C and a relative humidity of 72 ± 3 percent. The results of observations from the experiment showed staggered hatching with a mean hatching estimated at 92 percent in laboratory.

2) Development Cycle of *P. lutescens*

The results have indicated significant difference between the duration of larval stage. The life cycle synthesis, based on the number of eachlarval stages duration and duration of development cycle are expressed in days. Observations on development cycle showed it takes 6.97 ± 1.47 days for female to lay eggs. 10.5 ± 1.41 days are required to go from egg to stage L1, 7.48 ± 0.57 days from L1 to L2, 6.96 ± 1.10 days from L2 to L3. 7.05 ± 99 days from L3 to L4, 7.42 ± 0.49 days from L4 to L5 and 18.07 ± 3.45 days from L5 to the adult (Figure 1).

3) Size of Individuals of Different Stages of *Phonoctonus lutescens*

Measurement of each larval stage length gave 3.40 ± 4.29 mm for L1, 7.62 ± 4.29 mm for L2, 9.78 ± 4.29 mm for L3 and respectively 12.44 ± 4.29 mm and 15.81 ± 4.29 mm for L4 and L5. Measurements of *P. lutescens* different development stages articles showed highly significant differences. L2 body length is 2.22 times greater than that of L1. That of L3 is 1.28 time greater than that of L2. L4 and L5 body lengths are 1.27 times greater than that of L3 (Table 2).

Table 1. Measurement of length and width realized on hundred eggs of *P. lutescens*.

Size of the eggs	Estimated mean ± standard deviation
Length	2.7 ± 0.2a
Width	1.29 ± 0.14b
Pr > F	<0.0001
Signification	HS

HS: Highly significant, Averages (±standard deviation) with the same letters in the same column do not differ significantly at the threshold of 5%.

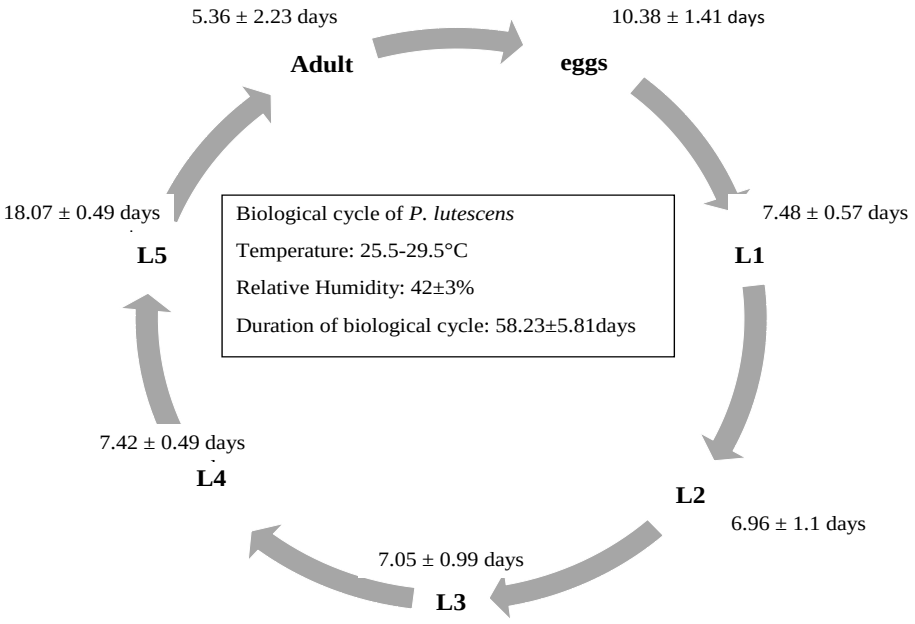

Figure 1. *P. lutescens* development cycle.

Table 2. Measurements of morphometric characteristic of different stages of *P. lutescens* in millimeters ± standard deviation.

Morphometric characters	L1	L2	L3	L4	L5	Pr > F	Signification
length of body	3.40 ± 429^{e}	7.62 ± 4.29^{d}	9.78 ± 4.29^{c}	12.44 ± 4.29^{b}	15.81 ± 4.29^{a}	<0.0001	HS
length of abdomen	1.09 ± 2.22^{e}	3.70 ± 2.22^{d}	4.92 ± 2.22^{c}	6.17 ± 2.22^{b}	7.24 ± 2.22^{a}	<0.0001	HS
width of abdomen	0.87 ± 1.53^{e}	2.48 ± 1.53^{d}	3.14 ± 1.53^{c}	3.99 ± 1.53^{b}	5.17 ± 1.53^{a}	<0.0001	HS
length of rostrum	1.12 ± 0.63^{e}	1.63 ± 0.63^{d}	1.98 ± 0.63^{c}	2.54 ± 0.63^{b}	2.81 ± 0.63^{a}	<0.0001	HS
length of head	0.83 ± 0.32^{d}	0.93 ± 0.32^{d}	1.53 ± 0.32^{c}	2 ± 0.32^{b}	2.33 ± 0.32^{a}	<0.0001	HS
width of head	0.75 ± 0.64^{e}	0.84 0.64^{d}	1.08 ± 0.64^{c}	1.36 ± 0.64^{b}	1.49 ± 0.64^{a}	<0.0001	HS
Antennae length	5.27 ± 2.82^{e}	6.77 ± 2.82^{d}	8.80 ± 2.82^{c}	10.20 ± 2.82^{b}	12.97 ± 2.82^{a}	<0.0001	HS
length of front femur	2.16 ± 1.43^{e}	3.03 ± 1.43^{d}	3.82 ± 1.43^{c}	4.93 ± 1.43^{b}	6.14 ± 1.43^{a}	<0.0001	HS
length of medium femur	2.28 ± 1.32^{e}	2.71 ± 1.32^{d}	3.57 ± 1.32^{c}	4.70 ± 1.32^{b}	5.73 ± 1.32^{a}	<0.0001	HS
length of rearfemur	2.82 ± 1.9^{e}	3.78 ± 1.9^{d}	5.02 ± 1.9^{c}	6.52 ± 1.9^{b}	8.00 ± 1.9^{a}	<0.0001	HS
length of front tibia	2.23 ± 1.37^{e}	2.92 ± 1.37^{d}	3.76 ± 1.37^{c}	4.88 ± 1.37^{b}	5.97 ± 1.37^{a}	<0.0001	HS
length of medium tibia	2.25 ± 1.31^{e}	2.92 ± 1.31^{d}	3.65 ± 1.31^{c}	4.74 ± 1.31^{b}	5.86 ± 1.31^{a}	<0.0001	HS
length of rear tibia	3.02 ± 2.27^{e}	4.47 ± 2.27^{d}	5.63 ± 2.27^{c}	7.44 ± 2.27^{b}	9.39 ± 2.27^{a}	<0.0001	HS
length of front tarse	0.23 ± 0.16^{e}	0.31 ± 0.16^{d}	0.39 ± 0.16^{c}	0.52 ± 0.16^{b}	0.66 ± 0.16^{a}	<0.0001	HS
length of medium tarse	0.27 ± 0.17^{d}	0.30 ± 0.17^{d}	0.4 ± 0.17^{c}	0.52 ± 0.17^{b}	0.71 ± 0.17^{a}	<0.0001	HS
length of rear tarse	0.31 ± 0.19^{d}	0.32 ± 0.19^{d}	0.46 ± 0.19^{c}	0.55 ± 0.19^{b}	0.79 ± 0.19^{a}	<0.0001	HS

HS: Highly significant. Averages (±standard deviation) with the same letters in the same column do not differ significantly at the threshold of 5%.

4) Measurement on Female and Male Bodies Parts of *P. lutescens*

The statistical analysis reveals three levels of significance for all parts of *P. lutescens* female and malebodies. Also, it reveals a highly significant difference (P = 0.0001) in measurements made on the body length, the abdomen and the three pairs articles of legs in female and male. There is also a significant difference (P = 0.004) in the length of rostrum and that of the average femur (P = 0.009). On the other hand, it does not reveal any significant difference between the articles for head, antenna and different parts of the tarsusdimension measurements, the femur length average (P = 0.355) (Table 3).

5) Larval Survival Rates and Sex Ratio of *P. lutescens*

A significant difference was not noticed between larval survival stages (Figure 2). But an increase on larval survival rate was observed from L1 to L4; a rate of 92 percent was observed for L1, 93.5 percent for L2, 94.2 percent for L3. The best survival rates are observed at stage L4 and L5 with almost equal proportions of 97.5 percent (Figure 2).

But at the adult stage, our study showed that the obtained sex ratio is 0.57 in favor of females No significant different observed between female and male (Table 4).

Table 3. Measurements of morphometric characteristic of females and malesof *P. lutescens*.

Morphometric characters (millimeters)	Females (±standard deviation)	Males (±standard deviation)	Pr > F	Signification
length of the body	22.66 ± 1.77^a	19.53 ± 1.77^b	<0.0001	HS
length of abdomen	11.87 ± 1.32^a	9.73 ± 1.32^b	<0.0001	HS
width of abdomen	6.79 ± 0.96^a	5.28 ± 0.96^b	<0.0001	HS
length of rostrum	3.61 ± 0.38^a	3.28 ± 0.38^b	<0.0045	S
length of the head	2.53 ± 0.26^a	2.53 ± 0.26^a	<0.9379	NS
width of the head	1.65 ± 0.23^a	1.57 ± 0.23^a	<0.2598	NS
length of the antenna	15.45 ± 1.89^a	14.42 ± 1.89^a	<0.0869	NS
length of front femur	7.03 ± 0.50^a	6.46 ± 0.50^b	<0.0001	HS
length of medium femur	6.63 ± 0.53^a	6.20 ± 0.53^b	<0.0098	S
length of rear femur	10.36 ± 0.7^a	9.55 ± 0.70^b	<0.0001	HS
length of front tibia	6.98 ± 0.60^a	6.13 ± 0.60^b	<0.0001	HS
length of medium tibia	6.90 ± 0.58^a	6.12 ± 0.58^b	<0.0001	HS
length of rear tibia	11.46 ± 1.12^a	10.09 ± 1.12^b	<0.0001	HS
length of front tarsus	1.82 ± 0.28^a	1.73 ± 0.28^a	<0.3407	NS
length of medium tarsus	1.74 ± 0.23^a	1.67 ± 0.23^a	<0.3554	NS
length of rear tarsus	2.05 ± 0.27^a	1.88 ± 0.27^a	<0.0616	NS

HS: Highly significant. Averages (±standard deviation) with the same letters in the same column do not differ significantly at the threshold of 5%.

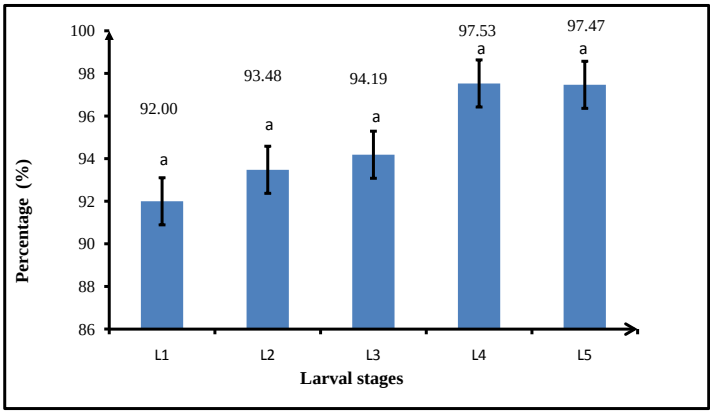

Figure 2. larval survival of *P. lutescens*.

Table 4. Sex ratio of females of *P. lutescens*.

Sex	Mean
Female	16.33 ± 5.03[a]
Male	9.33 ± 4.04[a]
Sex-ratio	0.57
Pr > F	<0.1335
Signification	NS

HS: Highly significant. Averages (±standard deviation) with the same letters in the same column do not differ significantly at the threshold of 5%.

6) Mean Time of Pre-Copulation and Pre-Oviposition of Female

A significant difference was observed between mean period of pre-copulation time that was 9.33 ± 2.14 days after imaginal moult, and the average pre-oviposition time estimated at 6.97 ± 1.47 days (Table 5).

7) Adult's Longevity and Eggs Laid Per Female

For the follow up of eggs laid, females were observed from the first hatching to the last one. Mean number eggs laid have been estimated at 366.73 ± 27.43 with 38.1 ± 9.21 as mean frequency of eggs laid per female (Table 6). Analysis of variance reveals that female life is significantly longer than that of male. Females and males lived respectively 107.97 ± 24.21 days and 87.5 ± 27.99 days (Table 7).

8) Influence of Temperature and Relative Humidity on the *P. lutescens* Biological Cycle

The temperature and relative humidity data that prevailed in the cages during the rearing period (from September 2016 to January 2017) indicated the maximum temperature during October and November respectively with 30.2˚C and 28.7˚C (Figure 3). Unlike in October, January was the warmest month with an average temperature of 25.6˚C; relative humidity ranged from 18.44 to 63.2 percent. The analysis performed on the correlation between the influence of temperature and relative humidity on *P. lutescens* development cycles showed a high level of significance ($P < 0.0001$) between cycles. It is noted that for the cycle of 61, 62, 63, 64, 65, 66 et 67, the temperature varied between 25˚C and

26.5˚C. Followed cycles 55, 56, 57, 58, 59 and 60 days with a temperature variation between 27˚C - 28.5˚C and 29.5˚C for cycles 48, 49, 50, 51, 52, 53 and 54 days. The experience on the development cycles has established a mean cycle of 58.23 ± 5.81 days. Above 26.5˚C, the temperature seems to influence the development time of the cycles thus giving several cycles with a duration inferior or equal to 60 days. Regarding the moisture content when it is 42 percent, there are several cycles with a large variation in the number of days ranging from 48 to 60 days. On the other hand, at 35 percent fewer cycles are observed with longer development times.

Table 5. Mean period of pre-copulation and pre-oviposition.

Duration of period	Mean ± standard deviation
Pre-copulation time	9.33 ± 2.14[a]
Pre-oviposition time	6.97 ± 1.47[b]
Pr > F	Pr < 0.0001
Signification	HS

HS: Highly significant, Averages (±standard deviation) with the same letters in the same column do not differ significantly at the threshold of 5%.

Table 6. Number and frequency of eggs laid per female.

Females	Mean
Number of eggs laid	366.73 ± 27.43
Frequency of egg laid	38.1 ± 9.21

Table 7. Longevity of female and male of *Phonoctonus*.

Sex	Longevity (days) ± standard deviation
Female	107.97 ± 24.21[a]
Male	87.5 ± 27.99[b]
Pr > F	0.004
Signification	S

HS: Highly significant. Averages (±standard deviation) with the same letters in the same column do not differ significantly at the threshold of 5%.

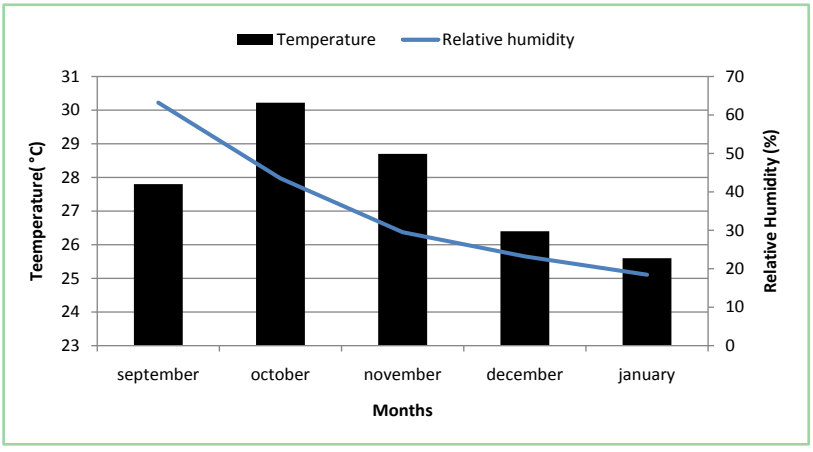

Figure 3. Temperature and Relative humidity from September 2016 to January 2017.

4. Discussion

The observation on average incubation time during the experiment was 10.5 ± 1.41 days. This observations on incubation time differ from those of several authors Sahayaraj and Paulraj (2001) [17], Swadener and Yonke (1973) [18]. Vennison and Ambrose (1992) [19] observed for *Rhynocorismarginatus* with 6.81 ± 0.10 days. This difference could be explained by the fact that it is not the same species and fed on different diet. Although it is also known that the minimum period of life would accelerate the multiplication process of the predatory insect which average time are shorter. Eggs measurements gave 1.29 ± 0.14 mm for the width and 2.97 ± 0.25 mm for the length. These results are similar to those found by Stride (1956) [8] on *P. lutescens* and Tano *et al.*, ((2008) [5] on *Rhynocoris albopilosus*. These authors observed that eggs dimensions varied between 1.5 mm and 1.6 mm for the width and 2.98 mm and 3.15 mm for the length. The larval stages in the life cycle necessarily involve five larval stages Stride (1956) [8] and Kwadjo *et al.*, (2012) [13]. Several authors Putshkov et Moulet (2009) [20], Moulet (2002) [21], Selvamuthu and Ambrose (1992) [22], Readio (1931) [23] have described other fields strains that were reared in laboratory (eggs, larval stages and adults) and concluded at the end of their work that the life cycle of these species went through three distinct evolutionary phases including the egg phase, the phase of the five larval stage and the adult phase. The description of the characteristics features of *P. lutescens*' body is consistent with those observed by Stride (1956) [8] who described head width 0.85 mm for stage L1, and variation between 1.03 mm and 1.08 mm for stage L2, 1.25 mm and 1.30 mm for the third stage, 1.60 mm and 1.65 mm for the fourth stage and 1.93 mm and 2 mm for the fifth instar stage. There is a similarity between our results and those of Kwadjo *et al.* (2012) [13] who worked on *P. lutescens* and *R. albopilosus*, concluded at the end of their study an appearance of a pair of wing draft at the level of mesonotum and metanotum at the end of the third instar. For the increase in size, an extension of the body of *P. lutescens* observed when passing from one stage to another. This increase in size could be related to a consumption of *D.voëlkeri* which increases with the age of the larvae to reach the fifth stage, the maximum of its consumption since the larvae of last stage need to accumulate reserves for the following stages moult and adult (stopping moult and reducing intake at the adult stage) Vargas (1970) [24], Quiroz (1976) [25] and Bogorni, (1999) [26]. The larval survival rate ranged from 92 percent for L5 suggesting an increase in survival from one stage to another. This observation differs from that made by Muthupandi *et al.*, (2014) [27], who reported decreasing survival rates in *Panthous bimaculatus*, ranging from 87.71 percent for stage L1 to 12.5 percent for stage L5. The difference between our two studies could lie in the fact that individuals in our studies were exclusively fed with *Dysdercus* contrary to the cited study where individuals were fed with three species of lepidoptera that may be potentially nutritionally valuable less interesting than *Dysdercus* Vennison and Ambrose (1992) [19]. An average time of 58.23 ± 5.81 days was observed for the life

cycle from the egg stage to the adult stage with a longer L5 stage. Until full development stage, male have a lifespan of 87.5 ± 27.99 days and females 107.97 ± 24.21 days. The development cycle observed by Muthupandi *et al.*, (2014) [27] on *P. bimaculatus* showed a 34 days difference greater than the cycle of the individuals in our study. Four our study a sex ratio of 1:0.57 was observed in favor of females. The statement seems to corroborate the sex ratio obtained by Muthupandi *et al.*, (2014) [27] in *P. bimaculatus* in the laboratory on three diets obtained respectively with 1:0.71, 1:0.65 and 1:0.55. But it should also be pointed out that a difference seems to emerge from a sex relationship observed in laboratory reared reduviids such as *Coranussiva* and *Brassivolahystrix* and that it favors *S. reclinatus* Vennison and Ambrose (1992) [19]. The periods of pre-copulation and pre-oviposition obtained during rearing were respectively 9.33 ± 2.14 et 6.97 ± 1.47 days, and therefore shorter. These results are consistent with the results of Ambrose (1999) [28], who reported a pre-oviposition period of 6.7 days in Salvatinae and 7.0 days in Ectrichodrinae. It should be noted that this same author also obtained longer pre-oviposition times for a number of reduviids such as *Rhyncoris marginatus* at 33.30 days, *Rhynocoris kumarii* at 26 days, *Rhynocoris longifrons* will live at 11.80 days, Stenopodainae at 14 days, Triatominae at 14.83 days, reduvinae at 30.4 ± 14.71 days, Peiratinae at 16.86 ± 4.36 days and 12.3 days for *P. bimaculatus*. The difference in pre-oviposition times maybe due to the use of several species when we have used only one species. The calculation of the life table could suggest that *P. lutescens* is a slow growing species, which could explain the fact that predator populations are generally few in natureas shown by Duviard (1977) [29], Babin (2009) [30]. In our study, the larvae were raised under optimal conditions, protected in particular from their natural enemies, and it is likely that the survival rates we obtained do not reflect the true survival capabilities of the larvae in the wild Cahan, P. (1961) [31]. Regarding the correlation between the development cycle and temperature, longer cycle of 61, 62, 63, 64, 65, 66 and 67 days are observed, under temperature varying between 25˚C and 26.5˚C. The study of the variation of the biological characters of an insect depends on temperature and humidity. The dependence may show that the variation of biological character is related to the evaporation phenomenon but that the importance of this depends to a large extent of temperature Brown *et al.* (2004) [32].

It has been observed that above 26.5˚C, the temperatures influence the duration of development thus giving several cycles with duration inferior or equal to 60 days. According to Porter *et al.* (1991) [33], a small change in temperature can alter the metabolic activity of insects and result in significant change that can affect their development, survival, reproduction and behavioras reported by Bale (2002) [34], Angilleta *et al.* (2004) [35] and Parmesan, C. (2006) [36].

5. Conclusion

The rearing presented in this study allowed us to maintain *P. lutescens* population for almost one year. The results suggest that changes in reproduction para-

meters may account for a significant portion of the population dynamics of *P. lutescens* in the field. It isevident that in the wild, *P. lutescens* populations are influenced by a wide range of factors related to the cotton growing environment and to human intervention. These factors affect the ability to develop and propagate populations and consequently their density in fields. The knowledge obtained on *P. lutescens* biology opens up avenues for the development of agro-ecological management strategies of this predator. A new study is therefore needed to determine the role of *P. lutescens* survival in its natural habitat.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Illustrations

(a) Eggs (b) First instar L1 (c) Second instar L2

(d) Third instar L3 (e) Fourth instar L4 (f) Fifth instar L5

(g) copulation of adults of *P. lutescens*

Photo 1. Development of *P. lutescens*. (a) Egg = 2.7 mm, (b) L1 first instar body length = 3.40 mm, (c) L2: second instar body length = 7.62, (d) L3: third instar body length = 9.78 mm, (e) L4: fourth instar body length = 1.44 mm, (f) L5: fifth instar body length = 15.81 mm and (g) copulation of adults of *P. lutescens.*