

Some Biological Features of *Apthona whitfieldi* Bryant (Coleoptera: Chrysomelidae), an Insect Pest of *Jatropha curcas* L. in Burkina Faso

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Abstract

Apthona whitfieldi Bryant (Coleoptera: Chrysomelidae) is a major insect pest of *Jatropha curcas* L. (Euphorbiaceae) in Burkina Faso and other countries in West Africa. The insect pest feeds on the roots and the leaves of the plant. When the attacks are heavy, the plant may lose all its leaves and die off. Unfortunately, little information is available on the biology of this insect pest. A study was conducted on the biology of this insect pest in the Sissili province, South Burkina Faso and resulted in the knowledge of some of the biological features of the insect pest. *Apthona whitfieldi* was reared from 13th July to 22th October 2015. Larvae and pupae were collected in *J. curcas* plantations near Léo, the capital city of the Sissili province, and brought to the laboratory for rearing. The insects were observed daily and the dimensions and the duration of each stage were recorded. We recorded two larval stages (1st and 3rd): a pre-pupa and a pupal stage. The pupa was free and white milk-like. Both the pre-pupa and the pupal stages lasted for five days. The 1st instar larva was smaller than the third one.

Keywords

Jatropha curcas, *Apthona whitfieldi*, Biology, Burkina Faso

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1. Introduction

Jatropha curcas is a shrub of the Euphorbiaceae family. This shrub originates from Mexico and Central America that are the only places where it has been found in non-disturbed environments [1]. The plant is believed to have been introduced in Africa by Portuguese sailors that brought it to Cape Verde and Guinea Bissau in the 16th century [2]. The *Jatropha* genus contains about 170 known species [1]. Today, it has been domesticated in all tropical and inter-tropical regions. The toxic and anti-nutritional properties of *J. curcas* seeds are used in traditional medicine for disinfections and as a purgative. The plant is also used as living fences to protect crops [1].

Jatropha curcas was introduced in Burkina Faso during the colonization period and is now spread all over the country [3] [4].

Author [5] reporting on the insect pests of *J. curcas* in Burkina Faso showed that beetles of the sub-family *Alticinae* were the most frequent pests (69%) in *J. curcas*' plantations across the country. Authors [6] were the first scientists to show that the species found in Burkina Faso was *Aphthona whitfieldi* B. *Aphthona* spp. is also reported as major insect pests of *J. curcas* in several African countries [6] [7]. But in dryer regions of Africa, like Niger [8], Sudan [9], and Sénégal [10], *Aphthona* spp. is either not reported or mentioned as minor pests. Adults feed on the leaves of the plant and can cause them to die particularly when they are young. *A. whitfieldi* is only found in *J. curcas*' plantations during the wet season [11]. Despite its economic importance, little information about the biology of this insect pest is available. In particular, hardly anything is known for its immature stages, which are supposed to be found in the soil. Therefore, the knowledge of the biology of this insect pest is a prerequisite for the development of effective control methods. This paper presents the results of the investigations on some of the biological features of *A. whitfieldi* in Burkina Faso.

2. Material and Methods

2.1. Study Site

The study was conducted in Léo (11.10°N, 02.10°W), capital city of the Sissili province, South Burkina Faso. The *J. curcas*' plantations that were prospected for larvae and pupae were at least 15 km apart from one another. The Sissili province is located in the South-Sudanian zone, characterized by a dry season from November to April and a wet season from May to October. Mean annual rainfall varies between 900 and 1200 mm. The landscape ranges from tree and bush savannas to shrub savannas composed of *Detarium microcarpum*, *Isobertinia doka*, *Burkea africana*, *Ficus plastyphylla*, *Pilostigma toningii*, and *Daniella oliveri*. The province is an agricultural and animal husbandry zone, and primarily taurine cattle are raised. Agriculture is associated with woody plants such as *Mangifera indica*, *Anacardium occidentale*, *Vitellaria paradoxa*, *Parkia biglobosa*, *Jatropha curcas* and *Tamarindus indica* [12].

2.2. *Aphthona whitfieldi* Collection and Rearing

To investigate the occurrence of immature stages, three *J. curcas* plantations were prospected three times a week from July to October 2015. These plantations were all associated with food crops like maize, cowpea, sweet potato etc. During each visit, six young plants were randomly inspected. So, a total of 18 plants were investigated each week. Young *J. curcas* heavily infested by *A. whitfieldi* (with the presence of tens of adults on the trees) were selected. The soil of the periphery (about 50 cm) of each selected tree was carefully moved up to 30 cm depth to look for larvae and pupae of the insect pest. *A. whitfieldi* was reared from larvae and pupae collected in farmers' fields. For each tree, larvae and pupae were kept separately in punched lid plastic boxes half-filled with local soil and brought back to the laboratory. All boxes were numbered and dated. A total number of 1188 larvae and 3729 pupae were collected. These insects were reared in the laboratory up to the emergence of adults. The soil in the boxes was humidified when needed. Each adult that emerged was captured and put into a box with a latticed opening. A small leafy branch was used to feed the adult insect pests and was renewed daily. The following climate parameters were recorded in the laboratory:

- Temperature: 25°C ± 3°C;
- Light: 12:12;
- Relative humidity: 65% ± 5%.

The biological characters recorded included:

- duration of larval instars;

- duration of pupal stadium;
- duration of feed or starved adults;
- size of adults.

Adults of the insect pest were also collected in the field during the same period. These adults were put by hundreds into boxes with latticed openings. These insects were fed with *J. curcas*' leaves that were renewed once a week. The soil of the boxes was checked daily for eggs. When found, these eggs were photographed.

2.3. Statistical Analyses

Data were analyzed using the software Statview. 5.0.0.0. Means were separated by the test PLSD (Protected Least Significant Difference) Fischer at the 5% level. Figures were prepared using Excel spreadsheet software Microsoft Office 2007. Data on the number of pupae and larvae with a large number of zero value, were all transformed into $\log(x + 2)$ before analysis.

3. Results

3.1. Life Cycle of *A. whitfieldi*

A. whitfieldi is a holometabolous insect. Its life cycle includes an egg stage, several larval instars, a pre-pupal, a pupal and an adult stage (**Figure 1**). We were not able to record the duration of the larval stages, except for the pre-pupa that lasts 5 days, as the pupa. Adults that were deprived of food and water lived 9 days while fed adults lived in average for 60 days. The emergence rate and death of the pupae collected in the field were 35.59% and 60.41% respectively. Only 36.13% of the larvae became pupae and 63.87% of them died.

3.2. Color Changing

The young adult is white when it develops from the pupa. Its color turns to yellow two days later and to red (**Figure 2**).

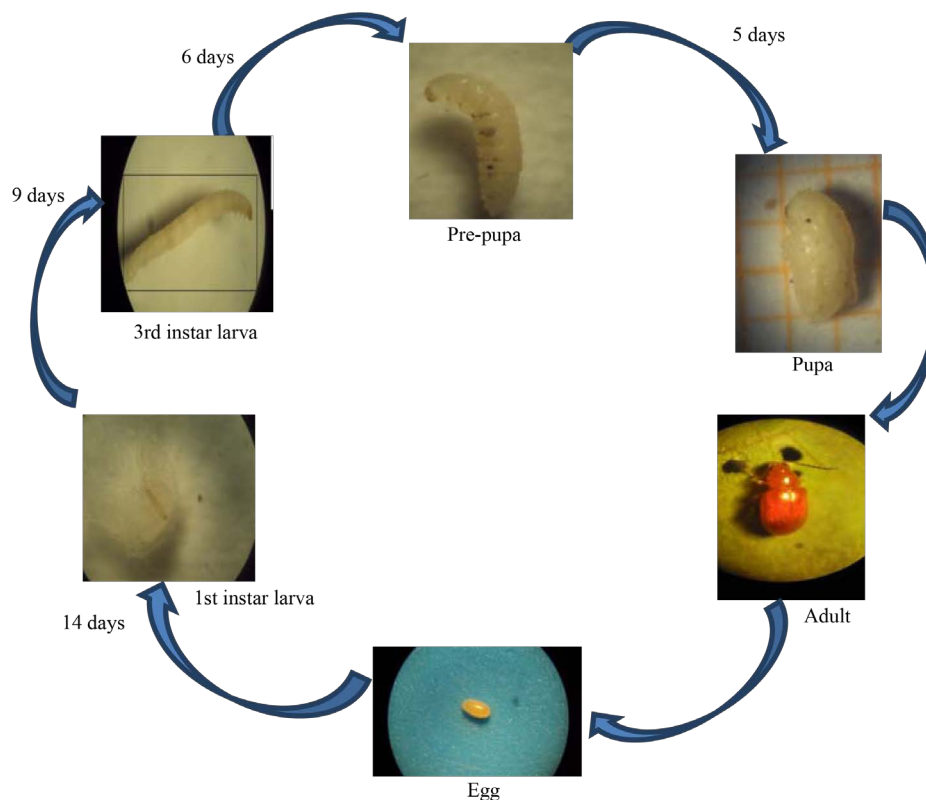


Figure 1. Partial life cycle of *A. whitfieldi*.

3.3. The Egg

A. whitfieldi's egg is small (less than 1 mm). It is ovoid, yellow and translucent (**Figure 3**). Eggs are laid in groups but they are not welded. We found the eggs on leaves but, in reality, they are most probably laid in the soil to allow the larvae to reach the roots.

3.4. The Larva

The larva of *A. whitfieldi* is creamy white and is found at around the rootlets of the plant at about 10 cm in depth (**Figure 4**). The larva feeds on the rootlets. As other *Aphthona* spp., it probably undergoes three instars before pre-pupation [13]. However, we did not observe the 2nd instar. We examined 36 specimens. We observed 1st instar larva from eggs laid in the laboratory but we were not able to rear them further. The larvae that we found in the field around the rootlets are probably 3rd, last instars. Feeding 3rd instar larvae measured 5.9 ± 0.59 mm in length, 0.68 ± 0.13 mm in thickness. Later, they became pre-pupae and measured 3.57 ± 0.56 mm in length and 1.04 ± 0.27 mm in thickness. The abdomen of *A. whitfieldi* includes 11 segments on each dorsal silks are seen. The anterior part of the abdomen bears three pairs of paws.

3.5. The Pupa

Thirty six specimens were measured. The pupa measures 3.10 mm in length and 1.69 mm in width. It is milky white except for the eyespots that are brown (**Figure 5**). The pupa is free and motionless although for some abdominal crunches that allow it to move sometimes.

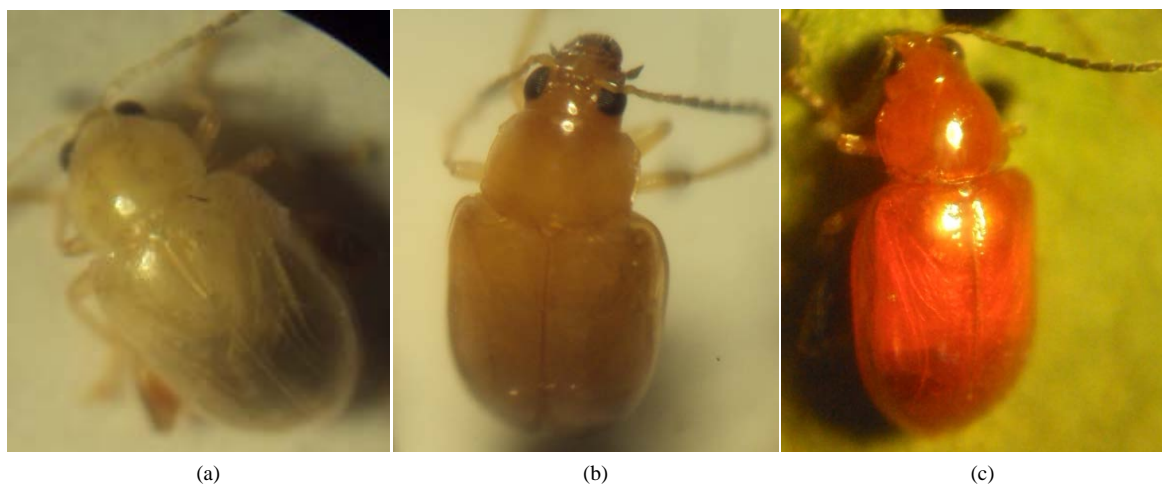


Figure 2. Different colors of *A. whitfieldi* B. White (a), Yellow (b) and Red (c).



Figure 3. Egg of *A. whitfieldi*.



Figure 4. Larva of *A. whitfieldi*. (a) 3rd instar larva. (b) pre-pupa.

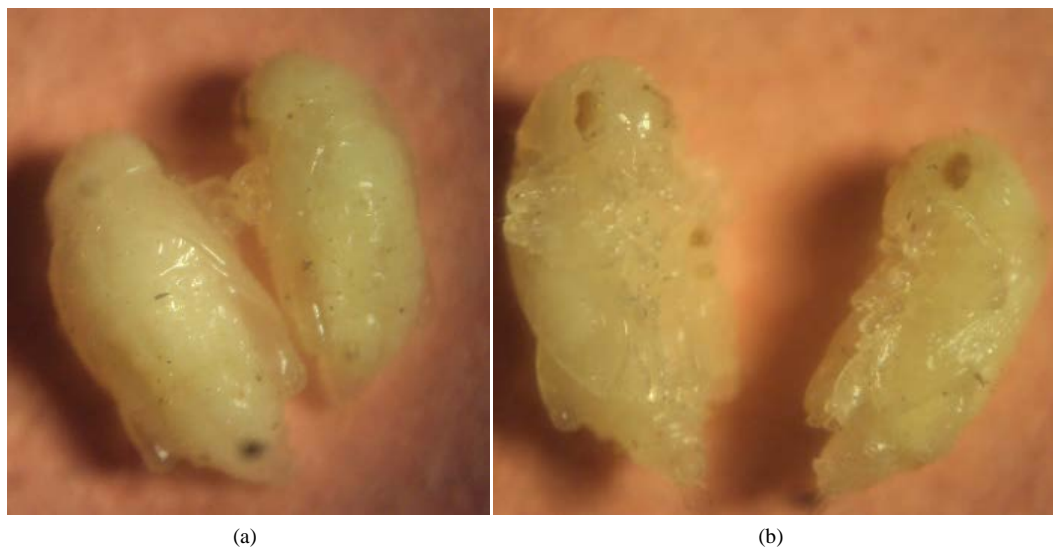


Figure 5. Pupa of *A. whitfieldi* B. (a) dorsal view; (b) ventral view.

3.6. The Adult

It is very difficult to distinguish the male from the female because there is no visible sexual dimorphism between the sexes. In the male as in female, head, pronotum and abdomen are well separated (**Figure 6**). Statistical analyzes made on the various measured morphological characters show that there is no significant difference between male and female. The measurements made on different body parts of the insect are reported in **Table 1**.

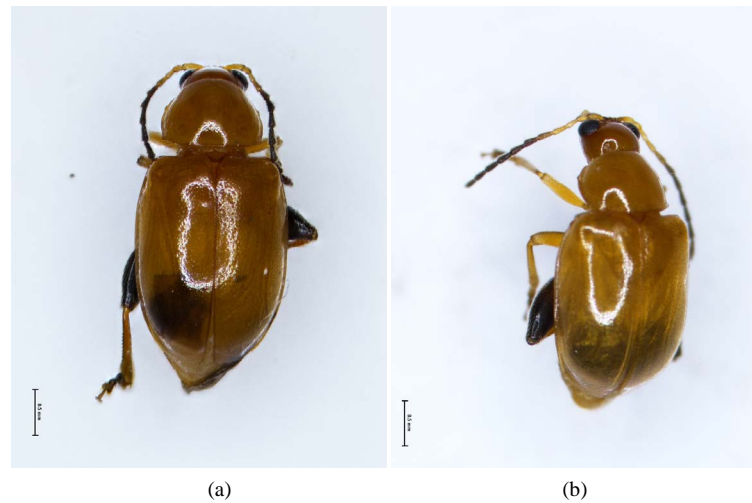


Figure 6. Adult of *A. whitfieldi* (a) female; (b) male.

Table 1. Morphological characters of *A. whitfieldi*.

Measured morphological characters	Mean (mm) \pm standard deviation	
	Male	Female
Length of the body	3.09 \pm 0.30	3.25 \pm 0.17
Width of the body	1.56 \pm 0.13	1.6 \pm 0.16
Length of the head	0.76 \pm 0.08	0.79 \pm 0.08
Width of the head	0.63 \pm 0.04	0.64 \pm 0.03
Length of the pronotum	0.79 \pm 0.07	0.80 \pm 0.04
Width of the pronotum	1.02 \pm 0.06	1.03 \pm 0.09
Length of the antennae	1.94 \pm 0.13	1.78 \pm 0.13
Length of the elytre	2.11 \pm 0.09	2.15 \pm 0.18
Width of the elytre	0.89 \pm 0.14	0.94 \pm 0.13
Length of the femur	0.79 \pm 0.05	0.81 \pm 0.11
Length of the tibia	1.02 \pm 0.05	0.98 \pm 0.08
Length of the tarsus	0.58 \pm 0.05	0.57 \pm 0.04

3.7. Average Number of Larvae and Pupae Collected in the Field

Statistical analysis on the number of pupae and larvae (**Figure 7** and **Figure 8**) shows a significant difference by month for the larvae ($F = 17.568$; $P < 0.0001$) and pupae ($F = 10.250$; $P < 0.0001$).

4. Discussion

These results are the first ones on the immature biology of *A. whitfieldi*. The insect most probably lays its eggs at the base of the stem of *J. curcas*; the larva migrates into the soil and feeds on the roots of the plant. Pupation and the emergence take place in the soil and it is only at adult stage that the insect feeds on the leaves of the plant. Morphometric measurements on adults of *A. whitfieldi* indicated an average length and width of 3.25 mm and 1.6 mm for the female and 3.09 mm and 1.56 mm for the male. These results are similar to those reported by [6] on the same species. According to the latter author, the male measures between 2.32 and 3.20 mm and the female between 2.60 and 3.32 mm.

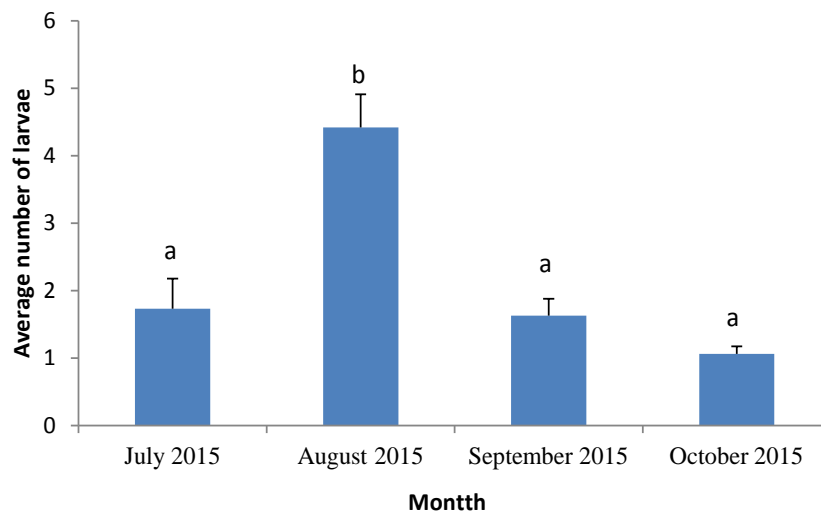


Figure 7. Average number of larvae by month under 18 trees.

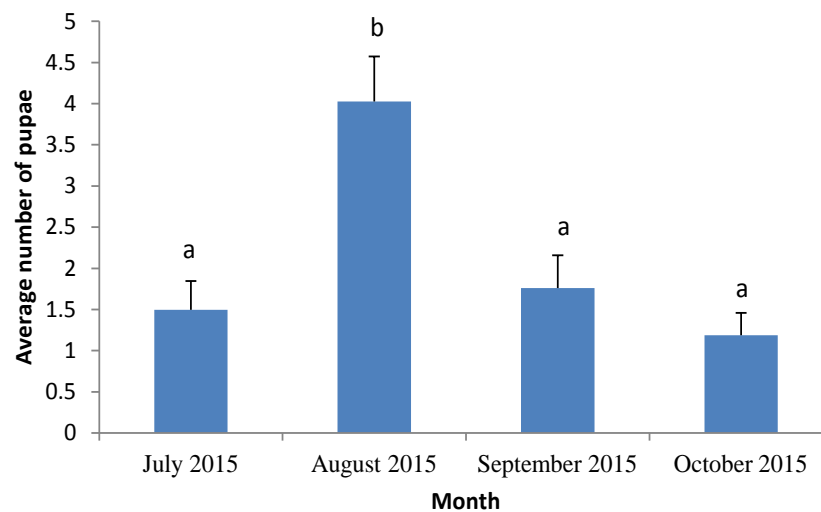


Figure 8. Average number of pupae by month under 18 trees.

A. whitfieldi is a pest that affects *J. curcas*' plantation during the rainy season. During the dry season it is very rare to find the adult pest, neither on *J. curcas*, nor on other surrounding plants. Therefore, the question is in which form the insect pest is preserved during the dry season. The first 3rd instar larvae were observed in mid-July only whereas these arch periods lasted from February to October 2015. We conclude that the presence of larvae or pupae depends on rainfall. The insect probably needs high relative humidity for its development. Other data on the life cycle of *Aphthona* spp. were all gathered in temperate regions. In these conditions, most species overwinter in the last larval instar, or more exactly as prepupa, before pupating in spring. This is the case of *A. lacertosa*, *A. russica*, *A. nigriscutus*, *A. cyparissiae*, *A. flava* and *A. czwalinae* [13]-[15]. Other species, e.g. *A. abdominalis* and *A. pygmaea*, overwinter in the adult stage [14]. There is no information available regarding tropical *Aphthona* spp. and we do not know how *A. whitfieldi* spends the dry season. If it was in the last larval instar or pupal stage, we would surely have found some before July. It is unlikely that adults are able to spend the dry season without feeding, and our adults in the laboratory survived only about two months, even when fed. Thus, the only possibilities are that *A. whitfieldi* spends the dry season in the egg stage or as young larvae in the rootlets.

Statistical analysis on the number of pupae and larvae collected in the field revealed a significant difference in abundance between months. The shape of the histogram on the average number of larvae and pupae by month showed the same trend. We observed an increase in the number of pupae and larvae from July to August and a drop in the pre-imaginal stages of the insect from August to October. The maximum number of larvae (858) and

pupae (783) was recorded in August. August is the wettest month of the year in Burkina Faso. In a previous work, we had shown that there was a peak of the adult populations during the second half of the rainy season [11]. These new results confirm our assertion made above about the relationship between the abundance of the insect pest populations and rainfall and relative humidity.

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