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Biology of *Elaeidobius Kamerunicus* and *Elaeidobius Plagiatus* (Coleoptera: Curculionidae) Main Pollinators of Oil Palm in West Africa

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Abstract

The pollination of the oil palm is assured mainly by the insects. The most effective are *Elaeidobius kamerunicus* and *Elaeidobius plagiatus*. Declining populations of pollinating insects in the palm oil plantation is often the cause of the low yields observed in the production of seeds. The study of the biology of these beetles has been conducted in the laboratory (27.43 ± 0.74 ° C and 75.16 ± 2.54 HR). The average of life expectancy was of 32.02 ± 12.43 days for *Elaeidobius plagiatus* and 59.18 ± 8.53 days for *Elaeidobius kamerunicus*. The total cycle time was 10.27 ± 0.34 and 8.38 ± 0.12 days respectively for *E. kamerunicus* and *E. plagiatus*. The number of eggs laid by female is of 57.64 ± 8.29 eggs for *E. kamerunicus* against 29.56 ± 5.29 for *E. plagiatus*. Knowledge of the biology of these insects is vital for better management of oil palm yields.

Keywords: *Elaeidobius kamerunicus; Elaeidobius plagiatus;* pollinators; Oil palm

Résumé

La pollinisation du palmier à huile est assurée principalement par les insectes dont les plus efficaces sont *Elaeidobius kamerunicus* et *Elaeidobius plagiatus*. La baisse des populations de ces insectes pollinisateurs dans les palmeraies est bien souvent à l'origine des faibles rendements observés au niveau de la production des graines. L'étude de la biologie de ces coléoptères a été menée en laboratoire (27,43 ± 0,74°C et 75,16 ± 2,54 HR). La durée moyenne de vie a été de 32,02 ± 12,43 jours pour *Elaeidobius plagiatus* et de 59,18 ± 8,53 jours pour *Elaeidobius kamerunicus*. La durée totale du cycle a été de 10,27 ± 0,34 et 8,38 ± 0,12 jours respectivement pour *E. kamerunicus* et pour *E. plagiatus*. Le nombre d'œufs pondus par femelle est de 57,64 ± 8,29 œufs pour *E. kamerunicus* contre 29,56 ± 5,29 pour *E. plagiatus*. La connaissance de la biologie de ces insectes utiles s'avère indispensable pour une meilleure gestion des rendements du palmier à huile.

Motsclés: *Elaeidobius kamerunicus; Elaeidobius plagiatus;* pollinisateurs; palmier à huile.

1. Introduction

In West Africa and South America, pollination of oil palm (*Elaeis guineensis* Jacq.) is essentially entomophilous (Syed, 1979). Twenty species of insects are subservient to the flowers of oil palm (Mariau et al., 1991). They belong to *Elaeidobius* genus. They do not have all the same pollinating power. Four species were distinguished: *E. kamerunicus, E. plagiatus, E. subvittatus and E. singularis*. They provide the largest share of pollination, the first two mentioned species are most active (Mariau, 1991). Their populations vary in a very important way in space and time under the influence of climatic factors. These changes have resulted in fluctuations in the average weight of bunch and hence production. Unfortunately, almost all chemical insecticides used to fight against the pest insects are not saving these useful insects which see their attendance rate declined in plantations. This decrease has a negative impact on the performance of palm groves. The introduction of *E. kamerunicus* in Malaysia in 1981 increased pollination and fruit production from 20 to 30% (Syed, 1982, Basri *et al.*, 1983). However, if the role played by these insects is established, there exist still points to be elucidated on the level of their biology. Indeed, recent studies on the biology of these pollinators conducted by Hussein *et al.* in 1991 failed to obtain laying in laboratory. This study comes to supplement the former studies in order to better determine the biology of these beetles. It will undoubtedly make it possible to better understand the dynamics of the populations of these insects and will facilitate their setting in breeding in laboratory in order to consider released in weak density zones.

2. Materials and Methods

2.1. The Study Site

The study was conducted at La Mé station. This station located at 30 km from Abidjan, the economic capital of Cote d'Ivoire (West Africa), belongs to the National Centre for Agronomic Research (CNRA). The plots contain palm trees of *tenera* variety of six years old. In Laboratory, experimentations were conducted at a temperature of 27.43 ± 0.74 and 75.16 ± 2.54 relative humidity.

2.2. Pre-copulation Period and pre-oviposition

One hundred insects of each species were obtained from palm male inflorescences at the end of flowering. These inflorescences were covered with muslin. As of the exit of the adults, 5 series of 10 couples of each species were made up. These couples were introduced into tubes of breeding (18cm of height and 4cm of diameter) with an anthesis spikelet used as food.

Non-flowering inflorescences were found on experimental plots. Once they flower, they were removed from their spathes and covered by muslin to prevent contamination of spikelets.

Flowering inflorescences were fed tubes breeding couples. The date of fledging was noted (Ji) for all couples. These couples were followed to observe the first mating. The date of mating (Ja) was then found and the average of pre-copulation period (dpc) was determined.

$$\mathbf{Jpc= \sum (Ja\text{-}Ji)/n}$$

n = number of couples observed; Ja = date of mating and Ji = date of fledging.

The experiment continued until the observation of the first laying. The date of first laying (J1p) was noted. The average period of preoviposition (Jpo) was determined by the formula:

Jpo= J1p-Ja

2.3. The Laying

Each day, the spikelets extracted in breeding tubes are observed with the binocular magnifying glass in order to count the places of laying. The eggs are characterized by traces of sawdust made by the female to cover the egg after laying. The number of laid egg is obtained by enumeration by opening slightly the spikelets on the level of the places of laying. The number of average egg laid by the female of each species during its life was thus determined.

2.4. The Hatching

The number of hatched larvae was counted using a binocular microscope on the level of the places of laying. The hatching rate (Te) was obtained by the following formula:

Te= 100× (number of larva/ numberof eegs)

2.5. Development Cycle of Insect

The development cycle of each species was obtained by determining the duration of different stages of insect development. These stages, obtained after 5 repetitions, are:

- Egg stage - neonate larvae (Lo)
- Neonate stage - larva 1 (L1)
- L1- larva stage 2 (L2)
- L2 - larva stage 3 (L3)
- L3 - nymph stage (N)
- Nymph- adult stage (A)

2.6. Lifetime

The lifespan of *Elaeidobius kamerunicus* and *Elaeidobius plagiatus* was evaluated in the laboratory at 27.43 ± 0.74 ° C and 75.16 ± 2.54 HR. One hundred newly emerged insects were allowed to make 5 series of 10 couples. Each couple was introduced into a tube of breeding with an anthesis spikelet which is used as food. Every day, former spikelets are replaced by new ones until the death of insects. The average life span was thus determined.

2.7. Statistical Analysis

Data processing was performed using Statistica software version 7.0. An analysis of variance with two factors (ANOVA) followed by the Newman and Keuls test at 5% was used to assess the homogeneity of the samples.

3. Results

3.1. Pre-copulation Period and Pre-oviposition

The average period of pre-copulation was 71.48 ± 0.57 hours or 3 days for *E. plagiatus* and 95, 5 ± 0.27 hours or 4 days for *E. kamerunicus*. There is a significant difference between the periods of pre-copulation of these two species at $\alpha = 0.05$. *E. plagiatus* therefore reached sexual maturity before *E. kamerunicus***.**

The average periods of pre-oviposition were 21.78 hours (0.90 day) for *E. kamerunicus* and 50.74 hours (2.11 days) for *E. plagiatus*.

3.2. The Laying

The laying of *E. plagiatus*, gave values above 50 eggs per day in first half of the period of breeding then below 50 eggs per day in other half (Fig. 1). The laying of *E. kamerunicus*, varied from 50 to 100 eggs per day. However, a fall below 50 eggs per day was observed at approximately two weeks and four weeks after the beginning of the breeding. The laying was maximum at the end of the first week, (above 200 eggs/day) and of the fifth week, above 100/jour (Fig. 2). Concerning the quantity of eggs laid, it is higher at *E. kamerunicus* than at *E. plagiatus*. There exists a significant difference between the median number of egg laid by *E. kamerunicus* (57.64 ±8, 29) and that of *E. plagiatus* (29.56 ± 5.29) with $\alpha = 0.05$ during the breeding. The number of egg laid per day is on average of 1.63 for *E. kamerunicus* and 1.23 for *E. plagiatus*.

Figure 1: Evolution of the laying at *E. Plagiatus*

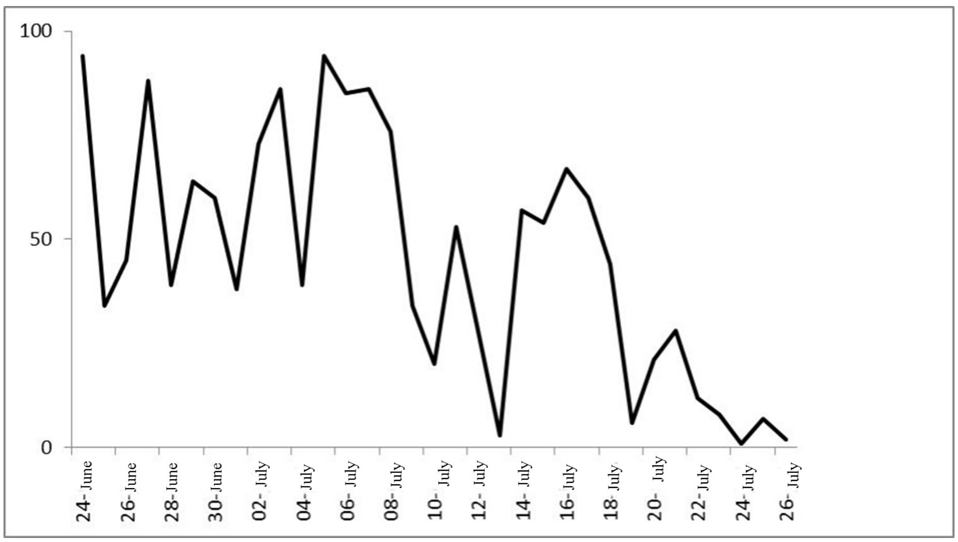
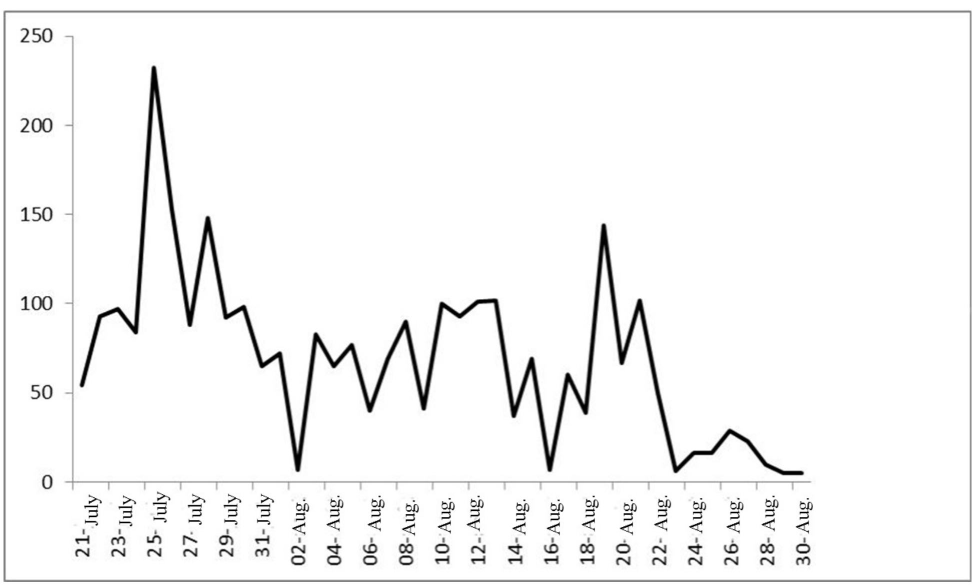


Figure 2: Evolution of the laying at *E. kamerunicus*



3.3. The Hatching

As well at *E. plagiatus* as at *E. kamerunicus*, the number of hatched eggs is approximately equal to the number of laid egg. The average hatching during the breeding is 97.82 ± 1.67 for *E. kamerunicus* and 98.23 ± 2.74 for *E. plagiatus* (Table 1 and 2). There is no significant difference between the average outbreak of *E. plagiatus* and that of *E. kamerunicus* at α = 0.05.

3.4. Development Cycle

On the level of the development cycles of the insects, as well for the species *E. kamerunicus* as for the species *E. plagiatus*, 6 stages were distinguished:

Egg stage - neonate larva (Lo); Neonate stage - Larva 1 (L1)
L1 stage - Larva 2 (L2); L2 stage - Larva 3 (L3);
L3stage - Nymph (N); N stage - Adult stage (A)

The total cycle time is 10.27 ± 0.34 days for *E. kamerunicus* and 8.38 ± 0.12 days for *E. plagiatus*. This difference is observed at the prepupal stage. Indeed the passage of the larvae stage 3 to stage nymph is 4.96 ± 0.11 for *E. kamerunicus* and 2.63 ± 0.05 for *E. plagiatus.* Other stages have submitted substantially the same duration. Comparison of terms revealed a significant difference at α = 0.05 between *E. kamerunicus* and *E. Plagiatus*.

Table 1: Duration of the developmental stages at *E. Kamerunicus* and *E. Plagiatus*

Stages	*E. Kamerunicus*	*E. Plagiatus*
Egg - L0 (hours)	5.84 ± 0.06	5.39 ± 0.09
Lo - L1 (hours)	18.16 ± 0.06	12.07 ± 0.13
L1 - L2 (day)	1.24 ± 0.12	0.51 ± 00
L2 - L3 (day)	1.08 ± 0.1	2.90 ± 0.04
L3 -N (day)	4.96 ± 0.11	2.63 ± 0.05
N - Ad (day)	2.03 ± 0.037	1.67 ± 0.08
Total cycle duration (day)	**10.27 ± 0.34**	**8.38 ± 0.12**

Sexual maturity is 71.48 ± 0.57 hours or 3 days for *E. plagiatus* and 95, 5 ± 0.27 hours or 4 days for *E. kamerunicus* (Table 9 and 10). There is a significant difference between the maturity periods of these two species at α = 0.05. *E. plagiatus* therefore reached sexual maturity before *E. kamerunicus*. By adding the period of sexual maturity at larval stage duration, we obtain 14.27 ± 0.35 days for *E. kamerunicus* and 11.38 ± 0.14 days for *E. plagiatus*.

3.5. The life Expectancy

The average life span for each species is of 32.02 ± 12.43 days for *Elaeidobius plagiatus* and 59.18 ± 8.53 days for *Elaeidobius kamerunicus*. In terms of gender was 31.22 ± 6.47 for females of *E. kamerunicus* and 27.96 ± 2.99 for males. At *E. plagiatus* was 17.54 ± 5.95 for females and 14.48 ± 6.71 for males. There is a significant difference between the average lifespan in *E. plagiatus* and in *E. kamerunicus* at α = 0.05. By cons, in this gender difference is not significant. Males and females in each of the two species have substantially the same lifetime.

4. Discussion

Numbers of laying were spread out during all the life of the insects in a sinusoidal form. The insects thus tend to rest after each laying. The median number of egg laid by the female of *E. kamerunicus* was of 57.64 ±8.29 against 29.56±5.29 for *E. plagiatus*. These results differ notably with regard to *E. kamerunicus* from those obtained by Hussein *et al* (1991) who obtained 35 eggs on average per female during her lifetime. The difference is certainly in the methods used. Indeed the author the study met its investigations on 50 introduced insects in groups of spikelets on the field. On the average number of egg laid by a female per day (1.63 egg / female / day, these results do not differ statistically from those of Seed (1982) gets 2 eggs per female per day.

The percentages of hatching obtained were particularly high (97, 82% for *E. kamerunicus* and 98.23 for *E. plagiatus*). This could be explained by the strong protection of eggs that are covered with sawdust just after spawning by females and bio-climatic conditions favorable.

Many larvae die however during the breeding. Hussein *et al.* (1991) obtained 60% of mortality in the larvae during the breeding of *E. kamerunicus*, with the highest death rate in the larvae of stage 1. This larval mortality is due to the operations of dissection of spikelets and the transfer of the larvae during the breeding. Larvae during this study have not undergone enormous disruption. Indeed, the places of laying were marked and larvae were observed inside the spikelets clearing the sawdust used by the female to protect the eggs. Other share, the former studies consisted in introducing several couples of insects on spikelets and dissecting those to count eggs and to follow the evolution of the larvae. The laying of eggs at the laboratory could not carried out starting from this method.

For the development cycle, this work has yielded a cycle time of 14.27 ± 0.35 days for *E. kamerunicus* and 11.38 ± 0.14 days for *E. plagiatus*. Mariau *et al.,* (1991) had obtained a 15 days cycle for *E. kamerunicus* and 9 days for *E. plagiatus*. Syed (1982) obtained 19 days for *E. kamerunicus* against 15 days for Hussein *et al.,* (1991). Apart from the results of Syed (1982), the other development cycle durations of these pollinating insects are almost similar.The results obtained on the life of pollinators are different from those obtained by Allou (2004). Indeed, he obtained 38.3 ± 0.9 days of life for *E. kamerunicus* and 29.6 ± 0.5 for *E. plagiatus*. On the level of the sexes, he obtained 37.3 days for males of *E. kamerunicus* and 39.3 for females. For *E. plagiatus* he obtained 25.6 days in males and 33.6 days in females. This study and that conducted by Allou show that females live longer than males.

5. Conclusion

The average life expectancy in weevils studied, varies from one species to another. It is of 32.02 ± 12.43 days for *Elaeidobius plagiatus* and 59.18 ± 8.53 days for *Elaeidobius kamerunicus*. On the level of sexes, variation in the average length of life is not significant ($\alpha = 0.05$). Indeed, this study revealed 31.22 ± 6.47 days for females and 27.96 ± 2.99 for males of *E. kamerunicus*. For *E. plagiatus*, the values were 17.54 ± 5.95 days for females and 14.48 ± 6.71 for males.

Oviposition was higher at *E. kamerunicus* (57.64 ± 8.29) than at *E. plagiatus* (29.56 ± 5.29) at $\alpha = 0.05$. The number of eggs laid per day by the two species was almost identical: it is an average of 1.63 for *E. kamerunicus* and 1.23 for *E. plagiatus*. During this test, the number of egg laid in each case did not differ in the number of hatched larvae. The hatching rate was 97.82 ± 1.67 for *E. kamerunicus* and 98.23 ± 2.74 for *E. plagiatus*. The development of the larvae is slower at *E. kamerunicus* than at *E. plagiatus*, the development cycle is thus longer at *E. kamerunicus* than at *E. plagiatus*. This study shows that it is thus possible to raise in mass these pollinating insects with the laboratory more especially as death rate remains very weak and the high laying.

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