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Distribution and daily fluctuation of *Coelaenomenodera lameensis* (Coleoptera, Chrysomelidae: Hispinae) in the oil palm plantations of La Mé.

Ahou Cyprienne KOUASSI[1,2]*, Akpa Alexandre Moïse AKPESSE[1], Assienin Hauverset N'GUESSAN[2], N'Klo HALA[2], Kouakou Hervé KOUA[1]
[1]University Félix Houphouët-Boigny, UFR Biosciences, Laboratory of Natural Environment and Biodiversity Conservation, Abidjan, Côte d'Ivoire, 22 BP 582 Abidjan 22 Côte d'Ivoire
[2]National Agronomic Research Center (La Mé Station), 13 BP 989 Abidjan 13 Côte d'Ivoire
*Corresponding author: Tel: + 225 0709763064/Email: ahoucypri@gmail.com

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ABSTRACT
Objective: Coelaenomenodera lameensis is an oil palm tree leaf miner. This pest causes extensive damage, which can compromise crops in the event of heavy outbreaks. To manage this pest population, it is very important to know the period of its intense activity during the day.
Methodology and results: Two monthly readings of the population level of *C. lameensis* were carried out on the 5th and 15th day on 3 plots in production at La Mé station of the National Agronomic Research Center. The readings were carried out according to time slots of 2 hours from 7 a.m. to 5 p.m. Results revealed that the population level is higher between 7-9 a.m. on each plot. Likewise, population's level has globally varied between 0 (3-5 p.m.) and 5.5 adults/palm (7-9 a.m.) and has been higher each year in the months of June, July and November with each time slot.
Conclusions and application of findings: These periods should be taken into account for possible insecticide treatments and for flooding releases of natural enemies against this pest. In addition, phytosanitary surveillance of palm groves should be strengthened in order to prevent possible attacks by this pest.
Keywords: *Coelaenomenodera lameensis*, daily distribution, daily fluctuation, oil palm tree, time slots, La Mé

INTRODUCTION
The oil palm tree is the primary source of fatty substances in the world (USDA, 2015). Its oils, palm oil and palm kernel oil are used in the manufacture of many agri-food, cosmetic and biofuel products (Ataga and Van der vossen, 2007). In Africa, only Nigeria generates large quantities of palm oil, with around 960.000 t. In the Ivory Coast, the palm oil sector is ranked fourth in the economy and employs more than one million people in the southern part of the forest area. With 400.000 t of crude palm oil produced per year, Côte d'Ivoire ranks 5th in the world after Malaysia, Indonesia, Nigeria and Colombia. It is the first African exporter and

second African producer behind Nigeria. Ivorian production should then continue to increase to meet the country's own needs, West African demand for oilseeds (Anonymous, 2015) as well as the needs of the rest of the world. However, how do you get there in the face of the ever-growing threat posed by insect pests in oil palm crops?

In fact, oil palm tree cultivation is subject to attack by many insects, the most important of which belong to the order Coleoptera and Lepidoptera (Lespesme, 1947). Among Coleoptera insects, *Coelaenomenodera lamensis* Berti and Mariau 1999 (Coleoptera: Chrysomelidae, Hispinae) is the pest that causes more damage to oil palm in West Africa and in particular in Côte d'Ivoire (Koua *et al.*, 2010; Coffi *et al.*, 2012; Tano *et al.*, 2013; Akpesse, 2015). Both adults and larvae cause the damage. The adults progressively feed on the leaflets from the low palms to the high palms (Philippe, 1990; Mariau, 2001; Tano *et al.* 2013). They make furrows of 12 to 15 mm throughout the thickness of the leaflet. In large numbers, this can lead to partial or even total drying out of the palms. The leaf miner larvae are the most dangerous. In a state of pullulation, several thousand of larvae can be seen per leaf. This causes the direct destruction and almost total drying out of the palm (Mariau and Besombes, 1972). The palm grove appears to be devastated by a fire (Morin and Mariau, 1971) and the palm trees can be defoliated to more than 90% in two or three generations, leading to a drop in production that can reach 30 to 50% over a period of time two to three years (Mariau, 2001; Tano *et al.*, 2013). Numerous control attempts have been made against this pest, but without any real success. It therefore seems important to find new, more effective control methods against this pest. However, the implementation of these control methods requires prior knowledge of the period of intense activity of this pest. It is in this context that this study was carried out with the objective of determining the distribution and daily fluctuation of this pest.

MATERIAL AND METHODS

Study site: The study was carried out in the palm groves of La Mé station of the National Agronomic Research Center (Latitude 5 ° 26'N Longitude 3 ° 50'W) in the South-Eastern of the Ivory Coast. The South-Eastern climate is of the humid subtropical type with marked seasons and coastal facies (Rougerie, 1960) with an area of dense evergreen and semi-deciduous forest. It belongs to the Guinean domain and to the shade-loving sector (Chatelain *et al.*, 2004). The majority of this area is today mainly covered with industrial crops (coffee, cocoa, rubber, oil palm, etc.) and food crops (Brou et *al.*, 1998; Chatelain *et al.*, 2004).

Sampling method: The study was carried out on 3 plots (palm groves) in production of 2 ha each from February 2016 to December 2017. The age of the plots was between 9 and 14 years. Two monthly readings of *C. lameensis* adults population levels (Figure 1) were carried out on day 5 and day 15 on each plot. The readings were carried out according to time slots of 2 hours from 7 a.m. to 5 p.m. On each plot, the readings were made in a North-South direction. Thus, 12 trees were chosen per line (4 trees in the North, 4 trees in the Center and 4 trees in the South) and on each tree, 4 palms (a row 17 palm and a low palm) were observed on the underside for the enumeration of *C. lameensis* adults (Table 1). To facilitate observation and enumeration of adults, palms located within 8 m from the ground are lowered with a fork and those located 8 m or beyond are cut by using a sickle. The average index of adults of *C. lameensis* (Iad) was determined from the following formula:

$$Iad = \Sigma ad / N$$

with ad: Number of adults and N: Number of palms checked

Figure 1: Adult of *Coelaenomenodera lameensis*

Table 1: Sampling system on each plot

Observation time slots	Number of readings/month	Number of trees inspected/line	Number of palms inspected/tree
7-9 a.m.	2	12	4
9-11 a.m.	2	12	4
11 a.m-1 p.m.	2	12	4
1-3 p.m.	2	12	4
3-5 p.m.	2	12	4

Data processing: The data obtained was analysed for variance (ANOVA) using Statistica 7.1 software. The Newman-keuls test was performed at the 5% threshold to form the homogeneous groups.

RESULTS

Daily distribution of the average index of *C. lameensis* adults according to time slots : The study of the daily distribution of *C. lameensis* revealed a high density of adults of this pest between 7 a.m. and 9 a.m. on all the plots surveyed. During this time slot, we recorded 3.48 adults/palm, 3.67 adults/palm and 4.05 adults/palm respectively on plot 1, plot 2 and plot 3. Regarding the other time slots, the population level of *C. lameensis* was below 3 insects/palm on each plot. In fact, statistical analysis showed significant differences ($P < 0.05$) between this time slot (7-9 a.m.) and the other time slots with regard to the average of *C. lameensis* adults indexes recorded. However, on the 2nd plot, no significant difference was observed between the 7-9 a.m. and 9-11a.m. time slots (Table 2).

Table 2: Variation of average index of *C. lameensis* adults according to time slots

	Observation time slots				
Plots	**7-9 a.m.**	**9-11 a.m.**	**11 a.m-1 p.m.**	**1-3 p.m.**	**3-5 p.m.**
1st plot	3.48 ± 0.83 a	2.55 ± 1.06 b	1.32 ± 1.12 c	1.42 ± 0.68 c	1.48 ± 0.95 c
2nd plot	3.67 ± 1.04 a	2.85 ± 1.04 a	1.64 ± 0.76 b	1.47 ± 0.59 b	2.25 ± 0.97 b
3rd plot	4.05 ± 0.84 a	2.73 ± 0.75 b	1.52 ± 0.88 c	1.41 ± 0.7 c	1.59 ± 0.7 d

Averages with the same letter on the same line are not statistically different at the 5% level.

Daily fluctuation of the average index of *C. lameensis* adults according to time slots: The analysis of the curves of the daily fluctuations of *C. lameensis* showed globally that on each plot, the population level was each year higher during the months of June, July and November with all time slots hours. During these months, the average index of *C. lameensis* was higher between 7 a.m. and 9 a.m. on all plots. On the 1st plot, the average index of *C. lameensis* adult varied between 0.25 (3-5 p.m.) and 5.3 adults/palm (7-9 a.m.) (Figure 2). On the 2nd plot, the average index of *C. lameensis* adults varied between 0.14 (1-3 p.m.) and 5.29 adults/palm (7-9 a.m.) (Figure 3). On the 3rd plot, the average index of *C. lameensis* adults varied between 0 (3-5 p.m.) and 5.5 adults/palm (7-9 a.m.) (Figure 4).

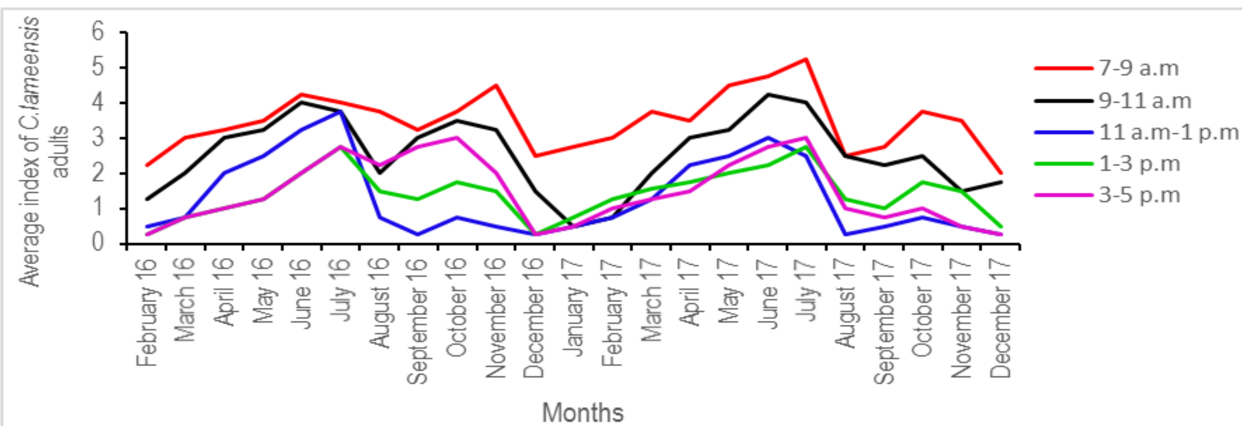

Figure 2: Fluctuation of the average index of *C. lameensis* adults according to time slots over the 1st plot

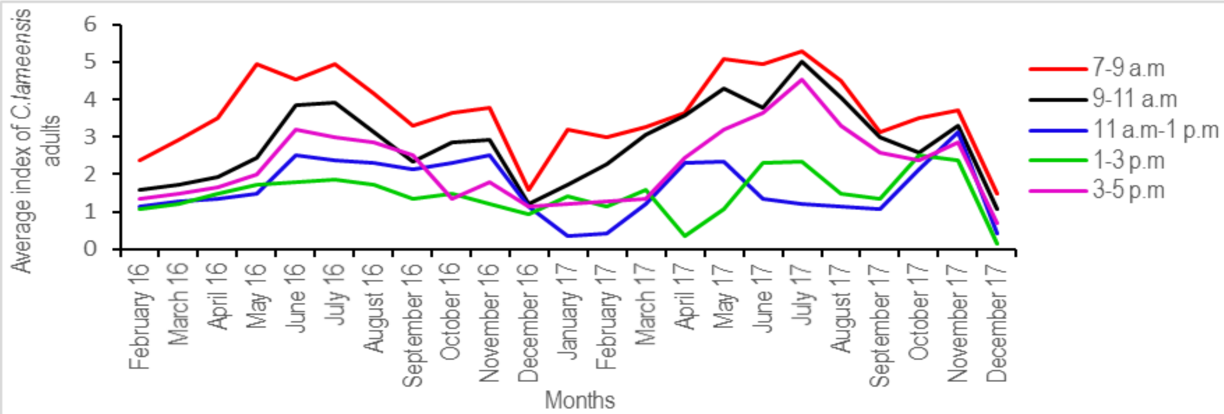

Figure 3: Fluctuation of the average index of *C. lameensis* adults according to time slots over the 2nd plot

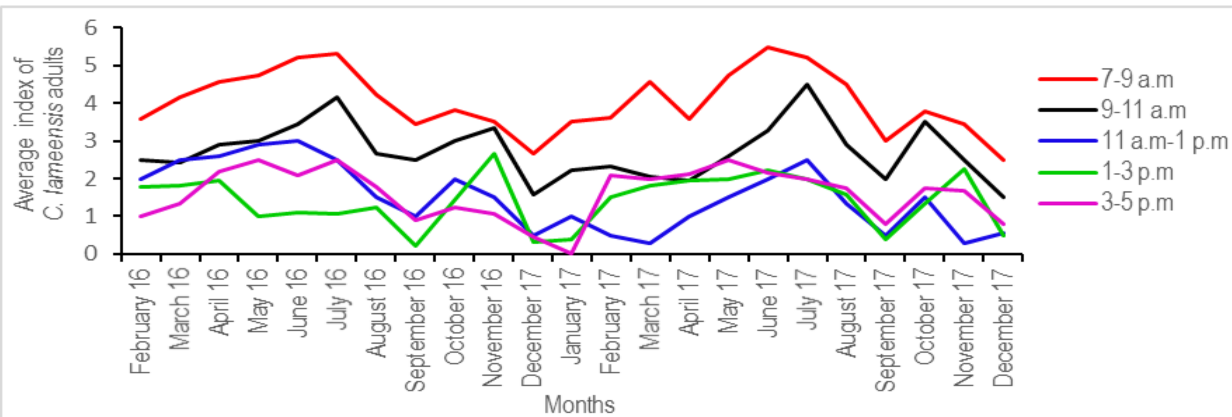

Figure 4: Fluctuation of the average index of *C. lameensis* adults according to time slots over the 3rd plot

DISCUSSION

The study of the distribution and daily fluctuations of *Coelaenomenodera lameensis* revealed a high population level of this pest between 7 a.m-9 a.m. Similar results were obtained by Tchuenguem Fohouo *et al.* (2014) who reported that the daily period of optimal insect activity is in the morning between 8 a.m-9.am and 10 a.m-11a.m. Koné (2020), indicated that the peak daily activity of bees, *Apis mellifera* and *Linum interruptum*, is between 5 a.m. and 6 a.m., when the resources collected by these species are available. Indeed, the first hours of the morning correspond to the period when the flowers produce a maximum of pollen and nectar. Benachour and Louadi (2011) reported that *Apis melifera* and *Ceratina curcurbitina* are active throughout the day on cucumber flowers, but their visits are especially intense during the morning when the pollen is released. According to Mariau *et al.* (1991) and Tuo (2013), the activity of pollinating insects on female oil palm inflorescences is intense during the morning due to the strong scent of anise emitted by these inflorescences during this period. The high population level of *C. lameensis* during the morning is also linked to climatic factors. Indeed, climatic factors would have favoured insect activity during this period. According to Lysyk (1995), the activity of stomoxes *Stomoxys calcitrans* (Diptera: Muscidae) whether it be flight or feeding, is very strongly linked to temperature variations. Thus, temperature, the most important climatic factor insofar as it has the greatest effect on the biology of insects (Brodeur *et al.,* 2013), would have played an active part in the activity of *C. lameensis*. Regarding temperature, Cachan (1960) and Moiroux *et al.* (2014), had pointed out that insects are ectothermic organisms and therefore have a poor ability to regulate their body temperature so that the ambient temperature determines all of their biological activities. The work of Albano and Salvano (2000), reported that at a low temperature, between 20 and 25 ° C and a constant relative luminosity, the flowers take on a state of blooming with easily extracting substances, which increases the bees activity. Thus, a high temperature has a negative effect on the foraging of bees (Blazyte-Cereskiere *et al.*, 2010). In addition, the work of Charlwood and Sama (1996) indicated that in hot or tropical regions, the daily activity of Stomoxes is bimodal. Indeed, two peaks of activity were observed, one early in the morning and one in the late afternoon. The morning temperature is therefore favourable for the activity of *C. lameensis*, the morning being generally cool, calm and weakly sunny. Relative humidity was also believed to have somehow influenced the activity of adults of *C. lameensis* throughout the study. According to Mariau and Lecoustre (2000), relative humidity plays a very determining role in the activity of *C. lameensis*. Indeed, the drier the air, the lower the fertility of *C. lameensis*, which can become almost zero. This would mean that *C. lameensis* requires a high relative humidity for laying. Therefore, during this study, the relative humidity that prevailed during the morning, precisely between 7 am and 9 am, would certainly be higher than that of other periods and would have favoured the activity of *C. lameensis*. Thus, this humidity would have made the leaves fresher and more appetizing for insects. Similarly, *C. lameensis* females would have landed on these fresh leaves at this time of day to lay eggs. According to Rouet (2011), high relative humidity favours the activity of *Stomoxys calcitrans* (Diptera: Muscidae). McGregor's works (1976) had shown that high humidity in the morning favoured the activity of various Apoids. This author had indicated that during this time of day, the moisture content of *Zea mays* pollen is maximum. This is favourable to the agglutination of its grains and to its harvest by bees, whose visit rates are higher during this period.

CONCLUSION AND APPLICATION OF RESULTS

Daily monitoring of the population level of adults of *C. lameensis* in the palm groves of La Mé revealed a high density of this pest during the morning, between 7 a.m. and 9 a.m. on all the plots surveyed. This period appears to be its period of intense activity and could therefore be recommended for possible control trials against this pest.

APPRECIATION

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CONFLICT OF INTERESTS

The authors declare that they do not have any competing interests for the publication of this article.

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