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POPULATION DYNAMICS OF AFRICAN PALM *WEEVIL* (*RHYNCHOPHORUS PHOENICIS* F.) ON *BREEDING* SITES OF OIL PALM (*ELAEIS GUINEENSIS JACQ.)* IN NIGER DELTA, NIGERIA

Thomas N. Commander[1]. and Dimkpa O.N. Stanley[2*]
[1]Depatment of Biological Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.
[2]Department of Crop/Soil Science, Rivers State University, Port Harcourt, Nigeria.

ABSTRACT: *Population dynamics of African palm weevil (APW) (Rhynchophorus phoenicis F.) was studied. Four oil palms were randomly selected and sizeable wounds were created, using an axe and cutlass and monitored for arrival of APWs for 21 days. Total number of one hundred and fourty-eighty (n=148) weevils were counted at the breeding sites. The total number of males was 52(35.13%), while the total number of females was 96(64.87%) which corresponds to sex-ratio of 1:1.9. Colonization of the breeding sites commenced with the arrival of few females in the morning (7-9am) followed by the males at noon (1-2pm) and significantly increased in population to peak by 1-3pm till evening and steadily declined at dusk. The population of APWs was significantly higher (P<0.05) in younger oil palms than older palms: Youngest Palm (P_1) had 62, Younger Palm (P_2) had 66 and Older Palm (P_3) had only 20, while the Oldest matured Palm (P_4) had no weevil because the tissues did not decompose. Optimum temperature and relative humidity which favoured the aggregation of R. phoenicis at the breeding site was 30^0C - 31^0C and 75-82% respectively. Also, the population of R. phoenicis at the breeding sites was highly positively and negatively correlated with the temperature (r=0.96) and relative humidity (r=-0.98) respectively. The APWs were sluggish in the morning but became active in feeding, courtship, mating and oviposition of eggs at noon when the temperature of the day become hotter and declined at dusk.*
KEY WORDS: population, *Rhynchophorus phoenicis*, sex-ratio, breeding site, oil palm *Elaeis guineensis*.

INTRODUCTION

The African Palm weevil (*Rhynchophorus phoenicis* (Fabricius, 1801) is a species of the genus *Rhynchophorus* belonging to the order Coleoptera, family Curculionidae referred to as snout-beetles due to the possession of snout-like projection being modified into a rostrum for feeding (Fogoh e*t al.*, 2015). *Rhynchophorus* species are distributed along the tropical regions of the world, numbering up to ten (10) described species that are having similarities in biology and ecology, inspite of differences in host plants (Miguens *et al.*, 2011).

In Africa, the genus *Rhynchophorus* has been recorded as pests of young oil palm (*Elaeis guineensis* Jacq.), date palm (*Phoenix dactylifera L.*) raffia (*Raphia hookeri* Mann and Wendlas) and coconut (*Cocos nucifera* L.) (Gries *et al.*, 1993). There are reports that *R. palmarum* infestation of coconut and date palms occurred in West Indies, tropical regions of Asia, Oceania, the Carribeans, California in United States of America and Europe (Kaakeh,

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2005; Faleiro, 2006; and Ju *et al.*, 2011). Evidently, there is evolutionary diversity of *Rhynchophorus* species in different climatic zones of the world. For instance, the Red palm weevil (*Rhynchophorous ferrugineus* (Olivier) also attacks date palms in Asia and in the Carribeans (Kaakeh, 2005). Generally, the larvae of *Rhynchophorus* species are major secondary pests of these plants as it causes huge damage by drilling holes on wounded parts of the stem which leads to necrosis and yellowing of the leaves and death of the plant (Mariau *et al.*, 1981).

There are several reports on the population dynamics and abundance of the Red palm weevil (*R. ferruginenus*) on date palm plantations in Pakistan (Manzoor *et al.*, 2020) and *R. palmarum* in European palm plantations (Moura *et al.*, 1989). However, there is paucity of information on the population dynamics of African palm weevil (*R. phoenicis*) due to the fact that traditional African cultures appreciate the larvae of this insect as valuable food resource been harvested from the wild and consumed with high esteem. Therefore, there is little effort made to control this insect as pest, rather effort is made towards conservation and breeding it in captivity for sustainable production and consumption (Thomas 2003, Thomas & Dimkpa, 2016). The objective of this study is to estimate the population of palm weevils (*R. phoenicis*) and sex-ratio of males and females in natural population at different times of the day, in relation to the prevailing environmental conditions at the breeding sites of infested oil palms in the Niger Delta area of Nigeria.

MATERIALS AND METHODS

The population of *R. phoenicis* that colonized four (4) oil palms (*Elaeis guineensis* Jacq.) of different sizes were randomly selected in the zoological garden of Rivers state University, Port Harcourt, Nigeria. The lower regions of the trunks of each palm (about 1 meter) above the ground level was cut-open using cutlass and small axe and created a sizeable wound of approximately 20cm x 10cm x 10cm depth. The age of the palms were estimated as youngest palm P_1 (4-5 years), younger palm P_2 (5-6 years), older palm P_3 (7-8 years) and oldest matured palm P_4 (10 years). The palms were visited at two hours interval from 7am in the morning till 7pm at dusk for visual counting of adult palm weevils. The different palms were monitored daily from Day 1 to the 7^{th} day to know when the first adult weevil arrived. The monitoring continued till 14^{th} day after colonization had occurred, thereby making a study period of 21 days to observe the pattern of fluctuation of the population of adult weevils, under prevailing environmental conditions. The temperature of the breeding sites was taken using a Celsius thermometer inserted into the decomposing tissues of the palm for 10-15 minutes. The thermometer was pushed into 2-5cm depth in the decomposing tissues of the palm in order to take the inner temperature where the larvae were living. The relative humidity of the breeding sites was taken by placing the hygrometer on the surface and also by cutting-open infested tissues and placed the hygrometer on it for about 25-30 minutes. The number of males and female weevils at the breeding sites was counted and the total weevils recorded at 2 hours intervals in all the palms that were studied.

Statistical Analysis

Collected experimental data were subjected to analysis of variance using Minitab software and the significance ($P<0.05$) means of the weevils' populations were separated using Tukey's test

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at 5% probability (Minitab, 2010). Bar-charts were plotted showing the number of male and female weevils that were recorded in the palms, and the fluctuation of the total adult population of *R. phoenicis* were correlated with the temperature and relative humidity at the breeding sites of the oil palms. This study was carried-out from November, 2018 to January, 2019.

RESULTS

The experimental results (Fig. 1a) is showing the sex-ratio of 1:1.9 distributions of males and females of *R. phoenicis* at the breeding sites of the four oil palms which were colonized by weevils at different times of the day which represented 35.13% males and 64.87% females. The sex of the insect and its population significantly differ ($P<0.05$) on the different age of the palms studied as youngest palm P_1 (4-5 years) with a total of 62 weevils, younger palm P_2 (5-6 years) had 66, older palm P_3 (7-8 years) had 20 and P_4 (10 years) oldest matured palm had none. It is noteworthy that there were no palm weevils founds at the prepared breeding site of the fourth oil palm (P_4) because its trunk had developed hard tissues which did not decompose as the younger oil palms. Therefore, there was no infestation observed in the palms within the experimental period.

Similarly, the pattern of the population fluctuation of *R. phoenicis* at the breeding sites in two hours' time intervals of the day was significantly different ($P<0.05$) with a peak population at 1pm followed by 3pm and least at 5pm and 7am each day (Fig. 1b).

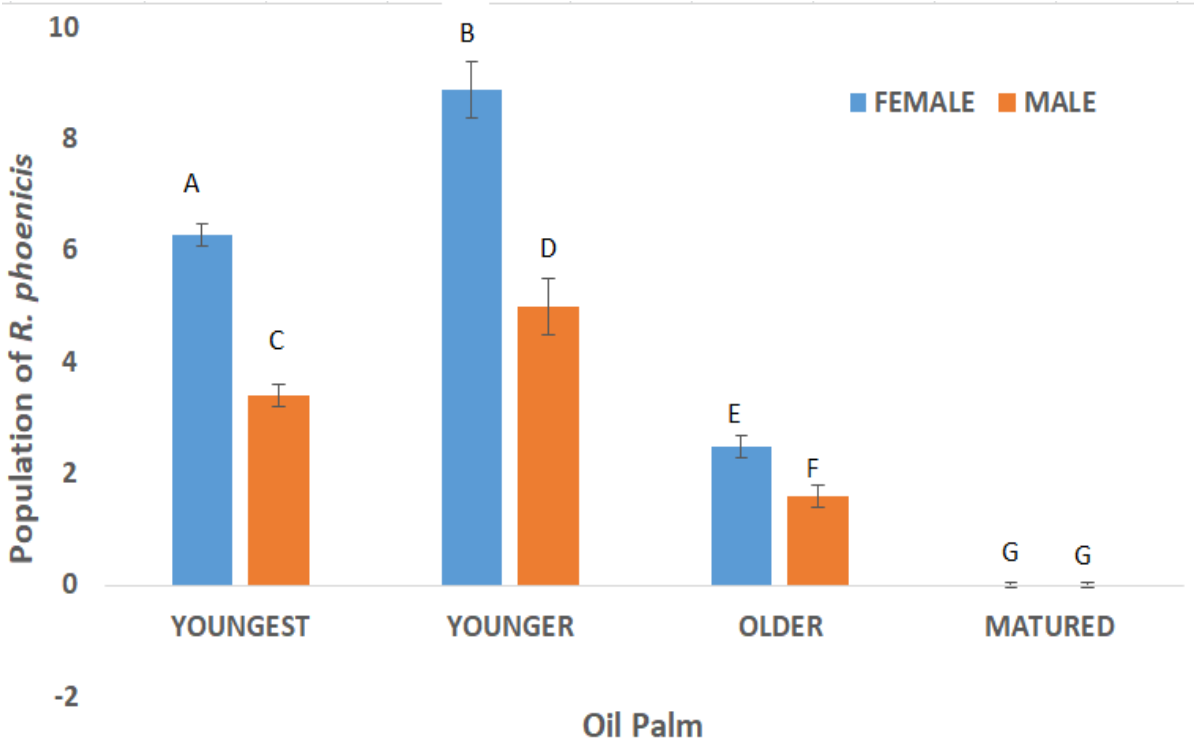

Fig. 1a: Sex-ratio of Male and Female *R.phoenicis* on the four oil palms. Bars with different letters are statistically different Tukey's test at 5% probability.

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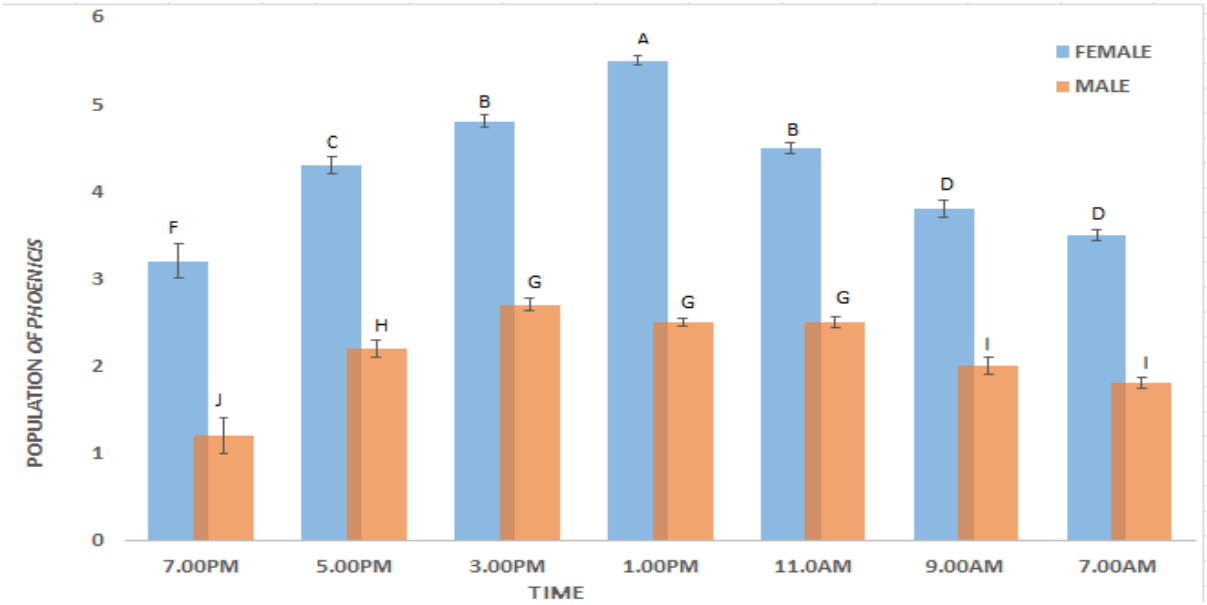

Fig. 1b: Fluctuation of *R.phoenicis* population in infested oil palms within two hours' time of the day. Bars with different letters are statistically different Tukey's test at 5% probability.

The results (Figs. 2a, 2b and 3a, 3b) revealed an optimum relative humidity and temperature ranges of 75-82% and 30-32^{o}c respectively which favoured the aggregation of the weevils. There was regular rise in temperature from 30^{0}C to 31^{0}C which coincides significantly ($P<0.05$) with an increase in the population of *R. phoenicis* and indicated a high positive correlation of r=0.96. On the contrary; the relative humidity was observed to be negatively highly correlated (r=-0.98) to increase in population of the palm weevils at the breeding sites. The results also showed that the average relative humidity declined from 82 – 63% as the number of weevils significantly ($P<0.05$) increased at the breeding sites of the infested palms.

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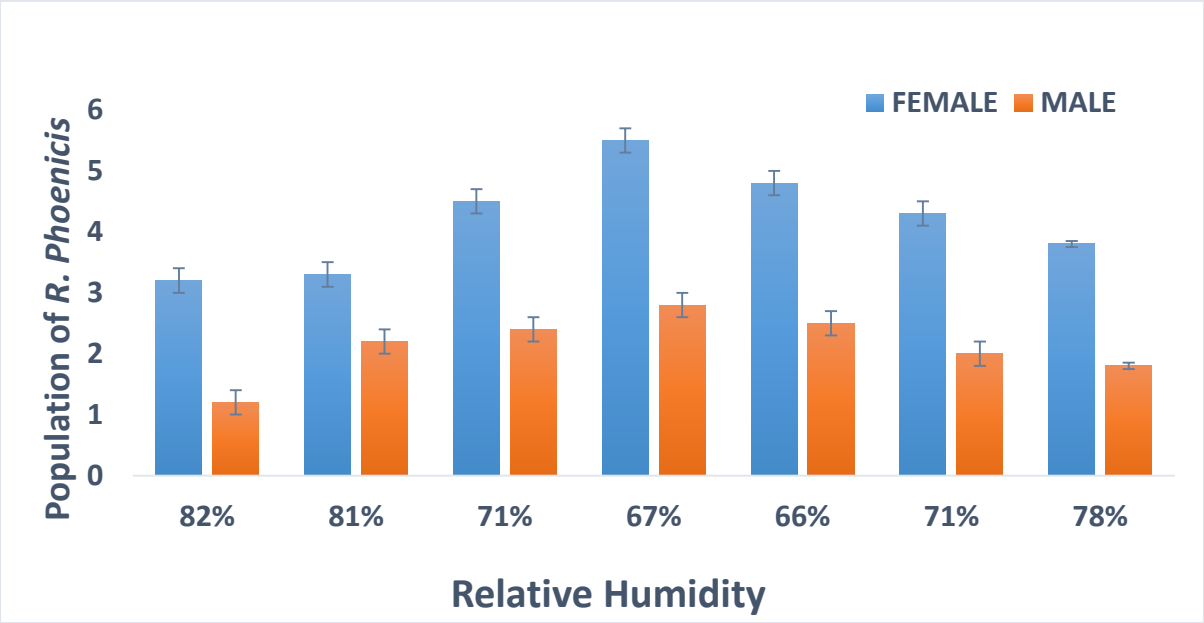

Fig. 2a: Fluctuation of *R.phoenicis* population in infested oil palms at different relative humidity.

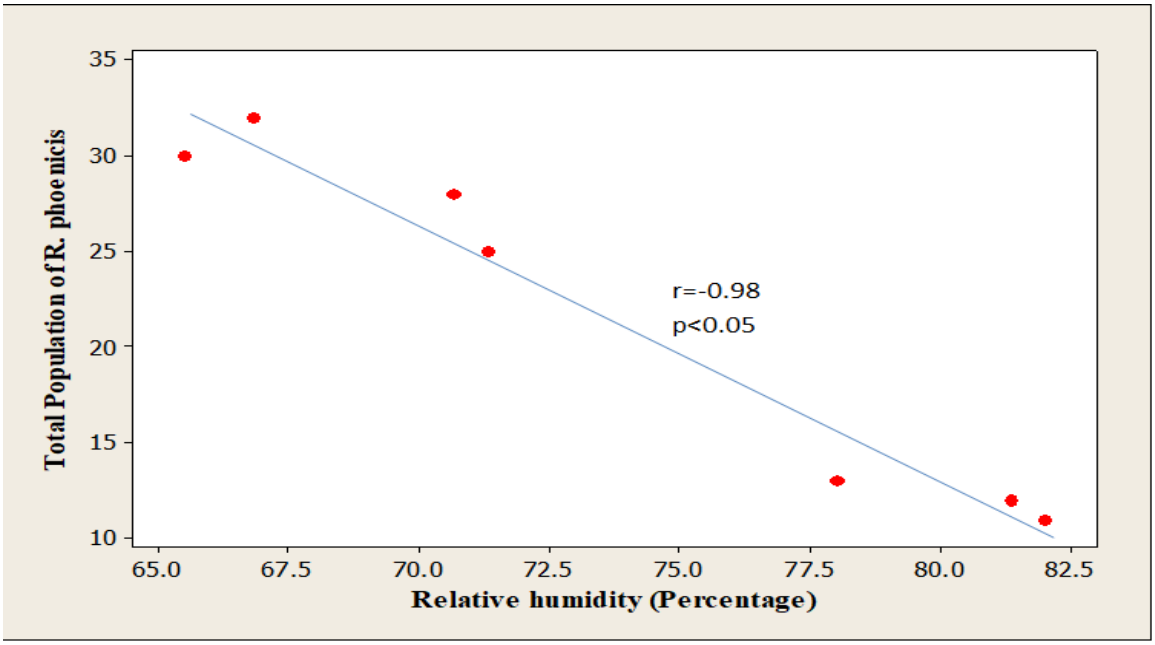

Fig. 2b: Regression of *R. phoenicis* population in infested oil palms with different Relative humidity showed high significant negative correlation

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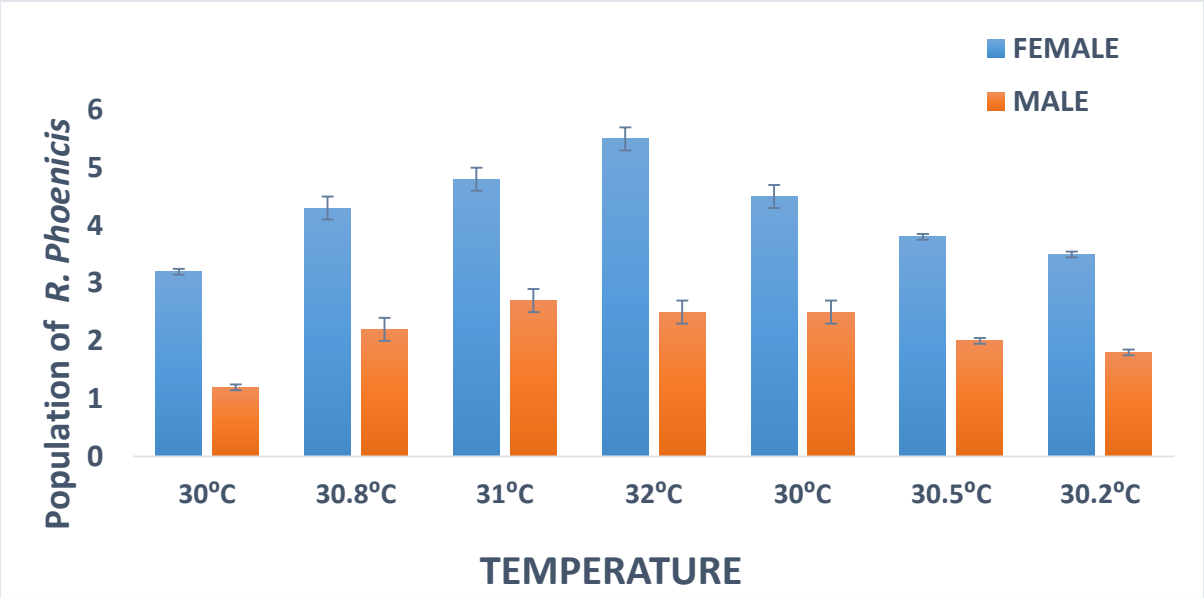

Fig. 3a: Fluctuation of *R.phoenicis* population in infested oil palms at different temperature.

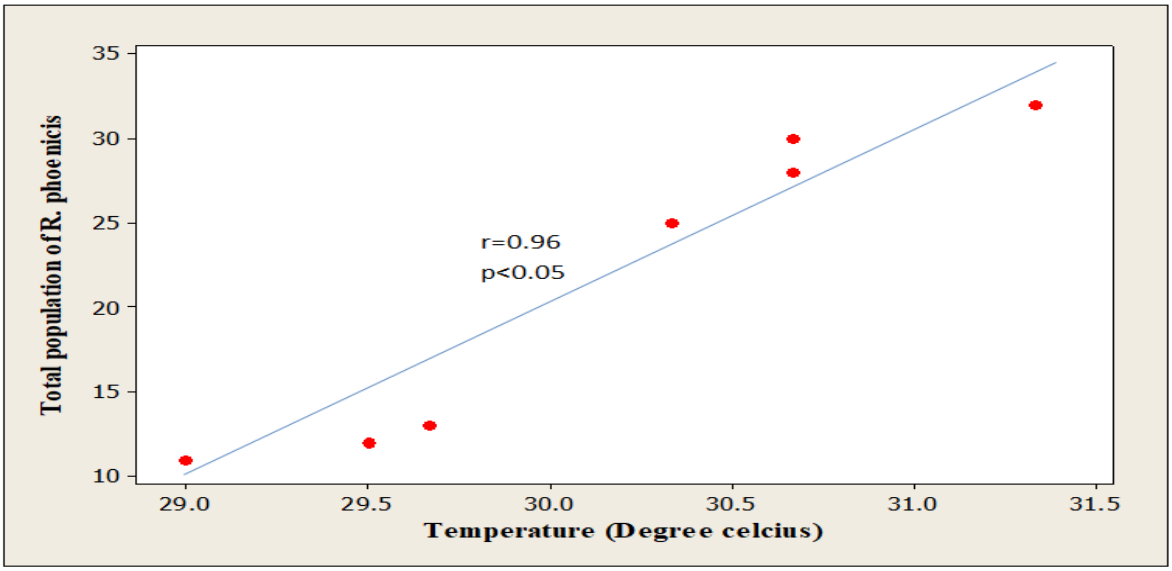

Fig. 3b: Regression of *R. phoenicis* population in infested oil palms with different temperature showed high significant positive correlation.

DISCUSSION

The results (Fig. 1a) showed that the total number of male weevils were fifty two (52) corresponded to 35.13% of the overall population of weevils found at the breeding sites of the oil palms; while the total number of female weevils almost doubled that of the males because the females were ninety-six (F=96) which corresponded to 64.87% of the total population of weevils that were counted at the breeding sites of the three young oil palms (P_{1-3}) that were infested. These figures gave a sex ratio of 1:1.9 males to females in oil palms studied. This

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finding agrees with the earlier reports of Chang and Curtis (1972) which stated that males are usually fewer than females in insect populations, especially in *Rhynchophorus* species because the males usually secret aggregation hormones that attracts the female to the breeding site. The members of the subfamily *Rhynchoporinae* which have the potential of producing female aggregation pheromones include *R.phoenicis*, *R.palmarum* and *R.cruentatus* (Moura *et al.*, 1989; Rochat *et al.,* 1991a and Weissling *et al.,* 1993). Other species of insects which are related to the *Rhynchophorinae* that also secrets female-aggregation pheromones are *R.vulneratus, Cosmopolites sordidus* and *Sitophilis* spp. (Hallett *et al.,* 1993).

The results (Figs. 1b) of this study have revealed that the diurnal population of *R.phoenicis* at the breeding sites of young oil palms began with the emergence of few females from the axils of the palm fronds in the morning (7-9:00 am) and increased steadily to peak in the afternoon when the temperature was highest, but low relative humidity. However, there was tendency for slight fluctuation of the population which lasted till 3-5:00 pm in the evening before finally declined to zero at dusk when most of the weevils retired to the axils and under surfaces of the palm fronds. This finding agrees with earlier reports which stated that *Rhynchophorus* species naturally live under the axils of healthy palms (Weissling and Giblin-Davis, 1993). The population of weevils was higher in the younger palms where P_1 had 62 weevils and P_2 had 66 weevils. Therefore, the combination of P_{1+2} had a total of 128 weevils. The older and taller palms (P_3) had only 20 weevils and P_4 had no weevils. The piths of the younger palms was soft and underwent rapid decomposition which emitted stronger odour that attracted more females to lay eggs at the breeding site of the palm; whereas the hardened tissues of the older palm underwent mild decomposition to emit slight odour which attracted a small number of weevils. Earlier findings reported that fermentation takes place more rapidly in the soft saps of younger palms and produces volatile compounds such as ethanol, plus host plant kairomones like ethyl-acetate, ethyl-propionate, ethyl-butyrate and ethyl-isobutyrate for different species of weevils (Gries *et al.*, 1994). The older palms having harder tissues could not undergo fermentation to attract males' weevils which produces the pheromones; hence the population of weevils are always fewer in older palms than the younger palms (Chittenden, 1902; Hagley, 1963). Furthermore, it was reported that most fermenting tissues of various species of palms, fruits, sugarcane and pineapples are similarly attractive to palm weevils (Diegado and Moreno, 1986 and Giblin-Davies *et al.*, 1994).

Impact of Environmental Factors on Population of *R. phoenicis*

During the colonization of the breeding sites of the oil palms by *R.phoenicis*, the results (Figs. 2a and 3a) revealed an optimum relative humidity and temperature ranges which favoured the aggregation of the weevils was 75-82% and 30-32^{o}c respectively. The palm weevils which were sluggish as they emerged from the axils in the morning became more active in courtship, mating, hole drilling and oviposition of eggs at noon till evening. There was regular rise in temperature from 30^0C to 31^0C which coincides with an increase in the population of *R. phoenicis* to peak in the afternoon (11-2pm) when the weather was hottest in tropical climate. At this time, the males and females became more actively engaged in feeding, courtship and mating. However, there was exponential rise in temperature from 30^0C to 37^0C when the larvae developed to final instar at the 3-4th week of the life cycle in the infested oil palm. The temperature later reduced to the normal range of 30 - 31^0C when the larva enters into the pupal stage by forming cocoon around it and became inactive. The exponential rise in temperature at

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the advanced stage of development of the larvae of *R. phoenicis* could be attributed to the voracious feeding and increased metabolism by the larvae thereby caused rapid decomposition of the soft tissues of the young palm which generates heat, Co_2, water and other by-products in the trunk of the infested palm. On the contrary; the relative humidity was observed to be negatively related to increase in population of the palm weevils, rise in temperature and increase in biological activities of the weevils at the breeding sites. The results also showed that the relative humidity declined from 82 – 63% in the palms as the number of weevils significantly increased at the breeding sites of the infested palms which is highly negatively correlated. General observations in this study also revealed that the relative humidity increased from 80-88% at the later stages of the life cycle of *R. phoenicis* when the larvae pupates in cocoons and developed to adult for emergence to the outside environment.

RECOMMENDATION AND CONCLUSION

The findings of this study has revealed that there were higher numbers of females palm weevils (F=96/*64.87%* than males (M=52/35.13%) found in the breeding sites of younger oil palms between the ages of 5-6 years in the studied palms. Temperature from 30^0C to 31^0C favour the breeding of *R. phoenicis* and positively correlate with increase in the population of *R. phoenicis* while the relative humidity was revealed to be negatively highly correlated to increase in population of the palm weevils at the breeding sites.

In order to obtain greater aggregation of the adult palm weevils as a way of controlling it as pest; or most importantly, to capture large numbers of *R.phoenicis f*or conservation and mass-rearing for sustainable production as food for consumption by humans and utilization of the bio-wastes for feed formulation by agro-environmentalists; it is recommended that scientists should combine the natural aggregation pheromones secreted by the males plus host kairomones with volatile compounds emitted by the fermentation of the sap of young oil palms, be synergized with appropriate baits in modern trapping of the weevils, to yield higher numbers of *R.phoenicis* in the Niger Delta Wetland ecosystem of southern Nigeria. The findings of this study has confirmed that the best time to capture more adults of *R.phoenicis* for rearing and other studies in the laboratory is in the afternoon when the weather is hottest in the tropics.

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