Studies on the biology of the leafhopper, *Nzinga palmivora* Wilson n.sp. (Homoptera: Cicadellidae: Typhlocybinae) in Ghana

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Abstract

Nzinga palmivora Wilson (Homoptera: Cicadellidae) is one of the homopterans suspected to be a putative vector of the lethal yellowing disease (Cape Saint Paul Wilt Disease) of coconut palms in Ghana. The insect is under investigation in transmission trials under the Coconut Programme of the Oil Palm Research Institute. Because little is known about the insect, an experiment was set up to investigate its biology and its diurnal settlement activities to complement other work and for documentation. The study on the biology was carried out in breathing polyethylene sleeves at Agona Junction in the Western Region of Ghana. Ten coconut palms were randomly selected in the field and tagged. One lower frond of each selected palm was randomly selected and a breathing sleeve containing 10 adult leafhopper couples of unknown ages hanged on it. Each sleeve enclosed three frond leaflets which provided food source and support for the insects in the sleeve. Various aspects of the biology of the insects including adult survival in the sleeve, gestation period of the female insects, incubation period of the eggs and nymph development were then monitored. The diurnal settlement activities of the adult insects on palms were observed and recorded every 3 h starting form 6 a.m. to 6 p.m. on the field on 10 randomly selected fronds of each of five selected coconut palms. The study was carried out on four Fridays in a month every quarter, i.e. March, June, September and December. Temperature and percentage relative humidity were also recorded at the same time on the field. Results showed that *N. palmivora* had gestation period of 19.13 ± 5.8 days, egg incubation period of 11.2 ± 1.0 days and nymph developmental time of 23 ± 1.5 days. There were five instars and mean of eggs per batch laid was 19.0 ± 5.8. The study on quarterly diurnal settlement activities indicated that most of the insects settled on the palms in the evening at about 6 p.m. when relative humidity was between 80 and 90 per cent and temperature 25-28 °C. *N. palmivora* settlement activities were generally low in June but very high in December.

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Introduction

The alarming spread of lethal yellowing disease of coconut in Ghana and other countries worldwide has led to intensive research efforts to bring it under control and management. The disease is caused by phytoplasma (Dollet *et al.*, 1977; Harrison *et al.*, 1984), and insects have been the principal suspect in the spread of the disease. Wilson (1987) reported that most vectors of phytoplasma are auchenorrhyncous homoptera. Studies in Florida (U.S.A.) have proved that a homoptera, *Myndus crudus* van Duzee (Homoptera: Cixiidae) is the vector involved in the transmission and spread of the disease (Howard *et al.*, 1983). *M. crudus* was also found to transmit the palm lethal responsible for the decline of the chrismas palm *Veitchia* species (Howard, Norris & Thomas, 1980). In addition, auchenorrhyncous homoptera (planthoppers and leafhoppers) had been found to spread other plant diseases. For example, *Myndus* species has been found to be the vector of the foliar decay of coconut in Vanuatu (Julia, 1982) and *Recilia mica* Kramer is the vector of the blast disease of young coconut and oil palm in West Africa (Julia, 1979).

The green leafhopper *Nephotettix virescens* Distant is known to transmit the virus disease, *tungro*, to rice plants (Rapussas & Heinrichs, 1987a), and the leafhopper *Graminella nigrifrons* Forbes was found to be the primary vector of the maize chlorotic dwarf virus (Kramer, 1967). The discovery of a new leafhopper, *Nzinga palmivora* Wilson (Homoptera: Cicadellidae), on coconut palms in Ghana while searching for putative vector(s) of the lethal yellowing disease of coconut in disease outbreak areas opened up a new chapter for further investigation of the disease and the insect.

The disease was first reported in Ghana in 1932 by Westwood (1953) at Cape Saint Paul, Woe, in the Volta Region (hence the name Cape Saint Paul Wilt Disease. It was later reported at Cape Three Points in the Western Region in 1964 and at Ayensudu in the Central Region in 1983 (Anon., 1995). The rapid spread of the disease in the latter two regions in the past decade and half led to the search for the vector(s) species in the two regions (Dery *et al.*, 1997). Two homopteran insect species having distribution which matches the pattern of the disease spread came under suspicion and investigation. These are *Myndus adiopodoumeensis* Synave (Homoptera: Cixiidae) which occur abundantly on coconut palms in the Central Region but very rare in the Western Region, and *N. palmivora* which occurs in the Western Region.

N. palmivora is a newly described insect species (Zebeyou *et al.*, in press) about which little biological information exists. In the light of the rapid spread of the disease especially in the Western Region and in support of transmission studies to identify the vector(s) species, it has become necessary to build up information on the biology so that control measures can be developed rapidly if the insect turns out to be one of the vectors. This study sets out to determine the survival of *N. palmivora* in sleeves as well as some aspects of its biology. It also examines the diurnal settlement activities of the insect on palms in relation to temperature and relative humidity.

Materials and methods

Biology

The studies were carried out at Agona Junction in the Western Region of Ghana. Ten coconut palms were randomly selected on a 2.1 ha plot and one frond from each tree was tagged. Three egg-free leaflets were selected from each tagged frond and enclosed in a 'breathing polyethylene' sleeve measuring 80 cm × 15 cm and kept open internally by three thin rings of about 9 cm diameter made from oil palm rachis outer cover and sewn to the lower, middle and upper three quarters of the sleeve. Ten adult *N. palmivora* couples of unknown age were collected from the field using test tubes (and introduced into each sleeve. The sleeves enclosing the leaflets were closed by stapling the edge to avoid escape and the insects' survival in the sleeves was monitored for 20 days.

After oviposition, an egg batch in each sleeve was selected and the incubation period of the eggs and developmental stages of the nymphs from hatching to adult emergence recorded. Also recorded was the survival of the nymphs at various instars. The number of eggs/batch was determined by carefully cutting out 20 leaf discs of egg batches from leaflets on palms in the field and counting the number of eggs/batch in the laboratory under a microscope (aus JENA GSZ STEREO).

To determine the gestation period, mating pairs were collected from the field with test tubes on different days in the morning between 6.30 a.m. and 10.00 a.m. The females were separated from the males on the day of collection and introduced onto three egg-free leaflets in 'breathing' sleeves on palms. Seven sleeves containing 5, 7, 8, 10, 12 and 15 mated females were set up on 7 different days, each number representing a day's collection. The survival of the insects to first oviposition, gestation period and percentage of surviving females were determined.

Diurnal settlement activities

Five coconut palms were selected at random. An *Ishihara JIS Z8806* thermometer-hygrometers was hanged on the lowest frond of each selected palm on Thursday evenings prior to taking readings on Fridays (four Fridays in a month within a particular quarter in a year, i.e. March, June, September and December). Adult *N. palmivora* were counted on 10 marked fronds per selected palm every 3 h starting trom 6 a.m. to 6 p.m. on Fridays (50 fronds in all per Friday and 200 fronds/quarter). Torchlight was used to aid in counting early in the morning and evening or where cloud cover made visibility poor. Temperature and relative humidity readings were recorded before counting.

Results

Biology

Fig. 1 gives the survival of *N. palmivora* adults in the 10 sleeves. Survival dropped significantly within the first 2 days and then declined gradually to about 30 per cent at the end of the period.

N. palmivora has five distinct instars. Table 1 gives duration of instar development in days of the five instars and percentage survival from one instar to the other.

Table 1 shows that there was no significant difference in survival among the various instars and also close to 70 per cent of nymphs emerged into adult. It was determined that 41.79 per cent of captured mated female *N. palmivora* survived to oviposition and 28.57 per cent of surviving females oviposited.

TABLE 1

Duration of Instar Development and their Survival

Instar number	*Mean duration (days ± SD)*	*Percentage survival*
1st	3.60 ± 0.80	100
2nd	4.10 ± 0.30	98.94
3rd	3.90 ± 0.30	92.55
4th	3.80 ± 0.40	84.04
5th	7.60 ± 0.66	78.72
Adult		

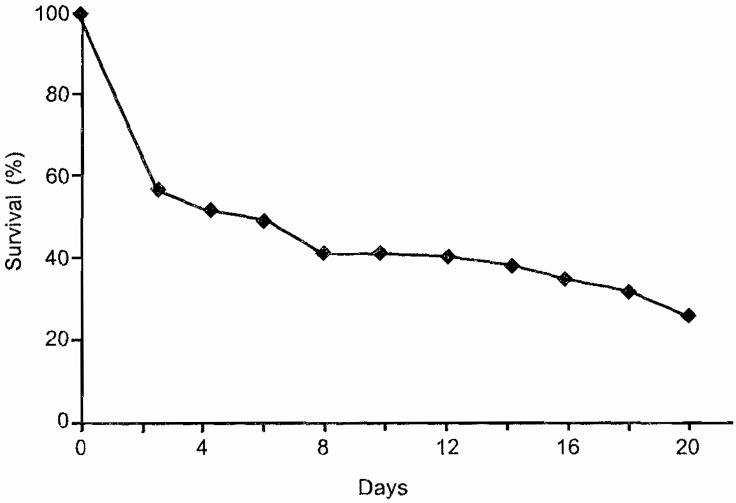

Fig. 1. Survival curve of *N. palmivora* adults in sleeve

Diurnal settlement on palms

Fig. 2 shows the temperature and diurnal settlement of the insects on palms. Insects'settlement on palms was generally low in June but very high in December. In March and December, insects' settlement rose from 6 a.m. to 12 noon closely following the temperature trend and then fell at 3 p.m. before rising to 6 p.m. Temperature, however, showed a downward trend after 12 noon. In June, when temperature showed a rise from 6 a.m. and peaked at 3 p.m., insect settlement on palms showed a downward trend with the lowest settlement at 3 p.m. More insects settled on the palms after 3 p.m. when temperature dropped. In September, when mean temperature rose from 23.20 °C at 6 a.m. to 27.45 °C at 3 p.m. and dropped from 3 p.m. to 25.35 °C at 6 p.m. insect settlement on the palms dropped till 9 a.m. More insects then started settling on the palms from 9 a.m. till 12 noon after which more insects flew away than settled on the palms causing

TABLE 2

Reproductive Parameters of N. palmivora *(days ± SD) Parameter*

Number of eggs/batch	*Gestation period*	*Incubation period*	*Development time from eclosion to adult emergence*
19.0 ± 5.8	19.1 ± 5.8	11.2 ± 1.0	23.0 ± 1.5

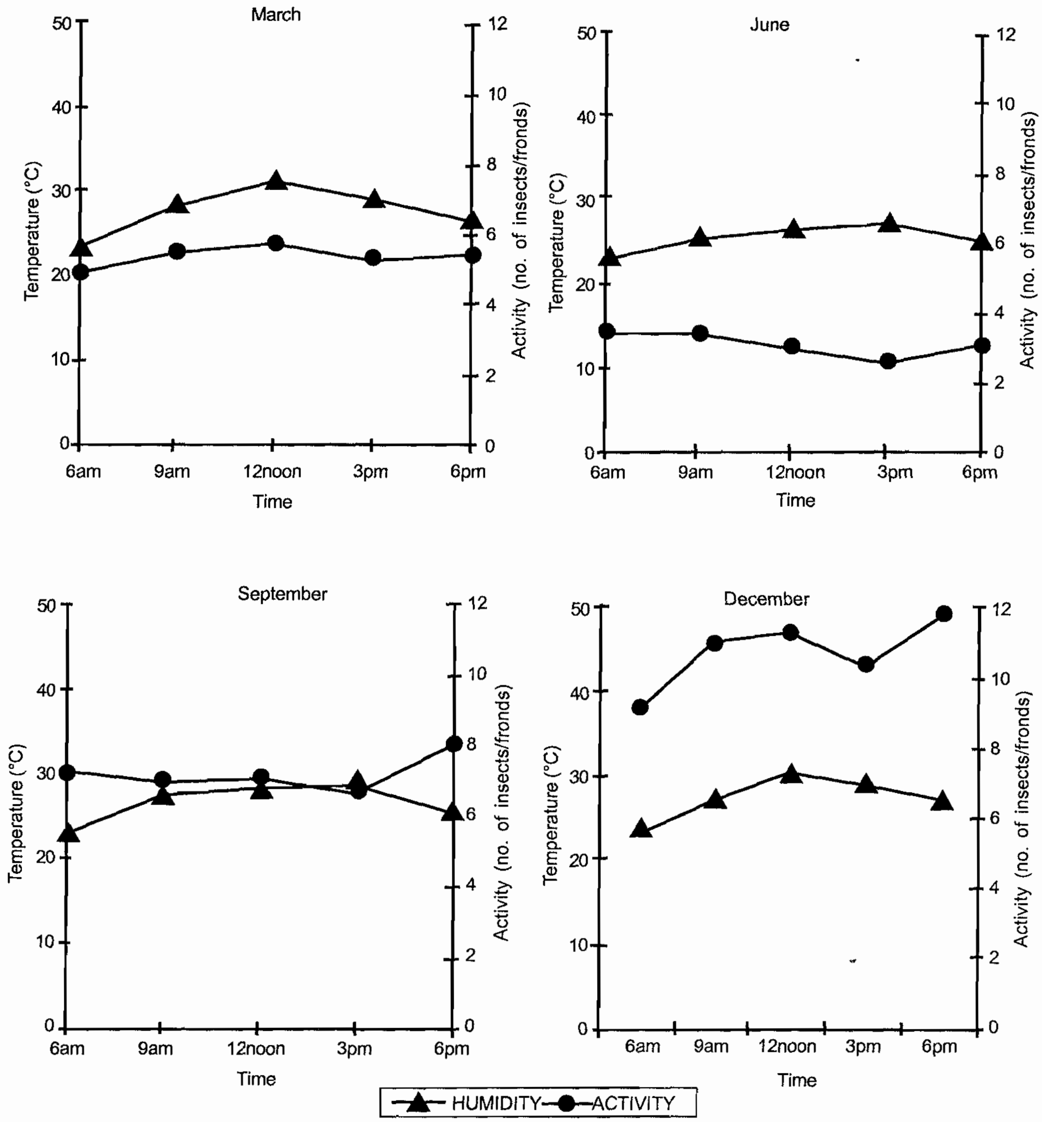

Fig. 2. Temperature and quarterly diurnal settlement activity curves of *N. palmivora* for the period 1997

a slight drop in settlement by 3 p.m. From 3 p.m, more insects settled again on fronds leading to high settlement and low flight activities at 6 p.m.

Fig. 3 shows that the relative humidity had a downward trend from 100 per cent at 6 a.m. to a minimum of 71.35 and 80.55 per cent at 12 noon in March and December, respectively, and then rose afterwards to 88 and 85.7 per cent

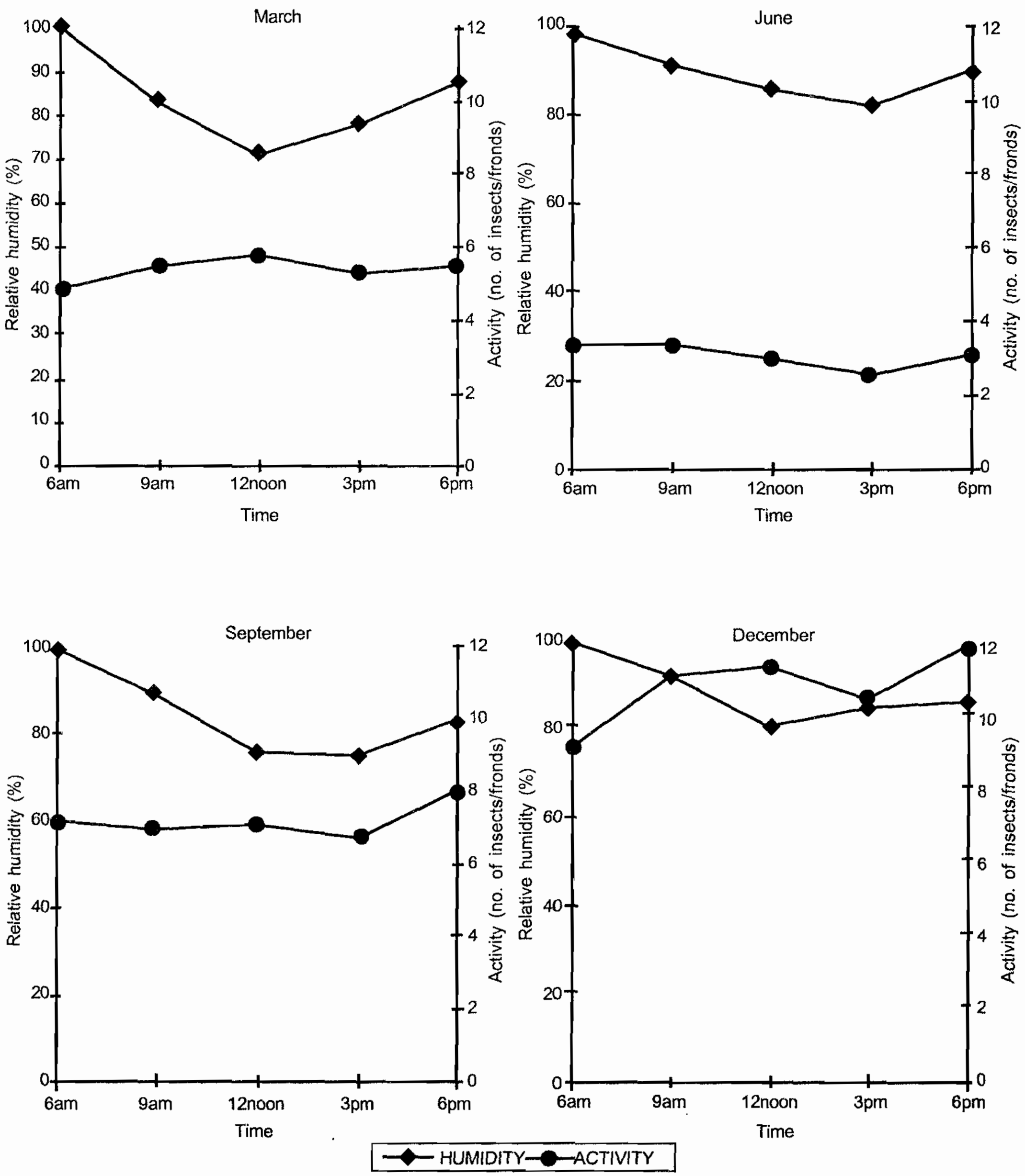

Fig. 3. Relative humidity and quarterly diurnal settlement activity curves of *N. palmivora* for the period 1997

respectively, at 6 p.m. In September, relative humidity fell continuously from 100 per cent at 6 a.m. to a minimum of 71.5 per cent at 3 p.m. before rising to 83.25 per cent at 6 p.m. Insect settlement activities were generally high at the minimum relative humidity of the months of March and December whereas it was low in June but showed a downward trend from 6 a.m. to 3 p.m., closely following the same trend as the relative humidity which was generally high. Both trends showed a minimum at 3 p.m. and rose afterwards.

Discussion

The high nymp survival is explained by the fact that *N. palmivora* after oviposition stays and guards the egg batch and nymph colonies until adult emergence and dispersal. This protective behaviour of the female ensured that eggs and large number of nymphs survive to adult emergence and added protection was received from the screening of the sleeves from predators.

The low percentage of 28.57 per cent of the original captured mated females which oviposited during the study on gestation period shows that not all mated female *N. palmivora* under stress become gravid and successfully oviposit. It is possible that most of the gravid *N. palmivora* aborted before oviposition was due. The separation of mating pairs in the collection process also might have disrupted insemination. Stress might also delay oviposition as in one case the gravid female oviposited after 31 days. The significant drop in survival to around 56 per cent in the second day (Fig. 1) may be due to handling during capture and sorting which may have weakened the insects before introduction. It was also noticed that some of the insects were trapped in the folds of the sleeves and, thus, died of starvation.

The study of quarterly diurnal settlement activities on palms (Fig. 2 and 3) during the year shows that most of the insects are found settled on the palms in the evening around 6 p.m. when temperature is between 25-28 °C and relative humidity 80-90 per cent. This indicates low flight activity. In general, *N. palmivora* population was low in June as observed in earlier study (Yawson & Dery, 1997). The insect settlement activities in March and December follow similar trend and the months of June and September also have similar trend. Generally, insect settlement shows a drop at 3 p.m. in all the months in which studies were carried out. It is possible that this is a favourable time for most insects to fly around to probe other host plants or to search for mates. At this time relative humidity is at its lowest.

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