Preliminary studies on population trends of the leafhopper *Nzinga palmivora* Wilson (Homoptera: Cicadellidae) in Ghana

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Abstract

Studies were carried out on the population trends of the leafhopper, *Nzinga palmivora* Wilson (Homoptera: Cicadellidae), a suspected vector of Cape Saint Paul Wilt Disease (CSPWD) on coconut palm in four Cape Saint Paul Wilt Disease outbreak areas i.e. Agona Junction, Akwidaa, Dixcove and Princess, all in the Western Region of Ghana from 1996 to 1998. The cumulative record of disease incidence in the various plots were; Agona Junction (29.60%), Akwidaa (21.80%), Dixcove (77.56%) and Princess (0.30%). *N. palmivora* population was high in January and from September to December. Adult population generally showed a falling trend from January to June and a rising trend from August to December. Population was generally low from April to August. Population of *N. palmivora* was significantly higher at Akwidaa compared to the other three areas. The number of nymph and adults showed a steep increasing trend from August to December. The studies provide vital biological information on this new species of *Nzinga*.

Keywords: Population trend, *Nzinga palmivora*, coconut palm, Cape Saint Paul Wilt Disease.

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Introduction

Insects have been suspected to transmit and spread the lethal yellowing disease of coconut palms (known in Ghana as Cape Saint Paul Wilt Disease – CSPWD). Research has narrowed down the vectors to auchenorrhynchous Homoptera based on the phytoplasma agent transmitted to the plant (Dollet *et al.*, 1977; Wilson, 1987, 1988; Harrison *et al.*, 1994).

Auchenorrhynchous Homoptera have been known to transmit both viral and phytoplasma diseases. In recent years molecular techniques have been developed for specific detection and diagnosis of phytoplasma– associated diseases. DNA hybridization analysis using probes developed from cloned random fragments of phytoplasma DNA have been used to detect phytoplasmas specifically in their plant hosts (Bertaccini *et al*., 1990; Diare *et al*., 1992; Davis *et al*., 1992; Harrison *et al*., 1991, 1992) and in their insect vectors (Davis *et al*., 1988; Rahardja *et al*., 1992; Vega *et al*., 1993).

Howard *et al.* (1983) identified *Myndus crudus* van Duzee (Homoptera: Cixiidae) as the vector of lethal yellowing. This insect species has not been identified in Ghana nor in Tanzania amongst other countries where the disease also occur. In Ghana, the upsurge of CSPWD especially in the Central and Western regions since 1981 led to investigation to identify some of the Auchenorrhynchous Homoptera in outbreak areas and transmission studies to identify the vector(s) (Dery *et al*., 1997). Among the insects studied were *Myndus adiopodoumeensis* Synave (Homoptera: Cixiidae), *Nzinga palmivora* Wilson (Homoptera: Cicadellidae) and many other insect species belonging to the family Derbidae which were common on coconut palms.

N. palmivora was hitherto an unknown species in the scientific world. It was first described by Wilson (unpublished). The insect is widely distributed in the Western Region and breeds on oil palm *Elaeis guineensis* Jacquin, coconut *Cocos nucifera* Linnaeus and Manila palm *Veitchia* sp. It is one of the suspected vectors of CSPWD and currently being used in modified transmission studies at Agona Junction in Western Region and Ayensudu in the Central Region. Information on its population trends coupled with its biology which has already been studied (Yawson and Dery, 1998 in press) will help in developing control measures if the transmission studies turn out to be positive. In an earlier study on monitoring Homoptera population using sticky traps in 1993-94, blue sticky traps on the field at Agona Junction and at Dixcove plots caught less *N. palmivora* in April-October than in November (Dery *et al*., 1997). This study therefore sets out to investigate the population trends of the leafhopper, *N. palmivora* in four Cape Saint Paul Wilt Diseased coconut areas from 1996 to 1998.

Materials and methods

The studies were carried out on experimental plots at Agona Junction (3.32 ha), Akwidaa (2.11 ha), Dixcove (2.11 ha) and Princess Town (2.11 ha) for three years (January 1996 to December 1998). Ten coconut palms were selected at random from each plot every year. The trees were tagged and 5 accessible fronds were selected at random from each tree every month for counts of adults, nymphs and egg batches on the leaflets using a counter and a red spot magnifying hand glass lens (75 mm). The cumulative CSPWD trees on each of the plots were recorded during the experimental period, taking into consideration 1995 record.

Results and discussion

The cumulative percentages on these plots from the 1995 to the end of 1998 as given in Table 1 shows that Dixcove had the highest cumulative total of 77.56% at the end of 1998 and Princess the lowest of 0.03%. Though the disease started early in 1988 (Akwidaa unpublished data), progress of the disease spread was slower compared to Dixcove and

Agona Junction in 1998. The disease started in Dixcove in 1989 (unpublished data). Agona Junction plot had first infection in 1996 (0.2%) and the level of the disease for the following two years was very high compared to the other three plots. As at the end of 1998, Dixcove had the highest cumulative percentage disease followed by Agona Junction plot. Princess Town had the lowest diseased trees, first detected in 1998.

Table 1. Cumulative record of CSPWD in the experimental plots (1995-1998)

Location	Percentage (%) level of disease			
	1995	1996	1997	1998
Agona Junction	0.00	0.20	14.3	29.0
Akwidaa	1.58	3.82	8.02	21.80
Dixcove	6.67	73.72	75.96	77.56
Princess Town	0.00	0.00	0.00	0.30

Figure 1a and b show the mean *N. palmivora* population trends at the various site/locations over the three-year period.

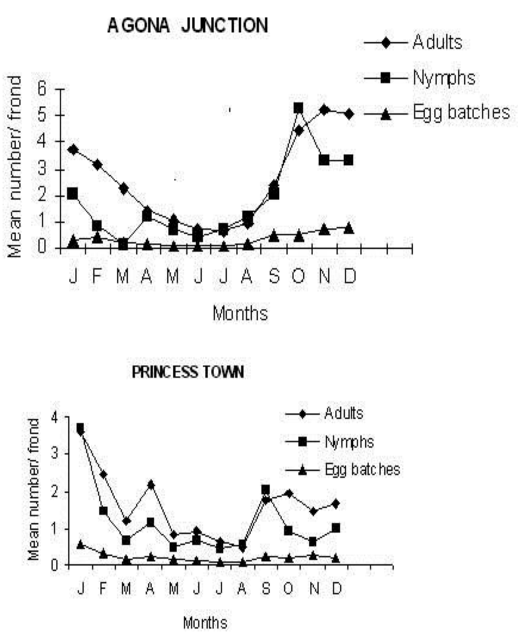

Fig. 1a. Population trends at *Nzinga palmivora*, two CSPWS out-break areas over three-year period (1996-98)

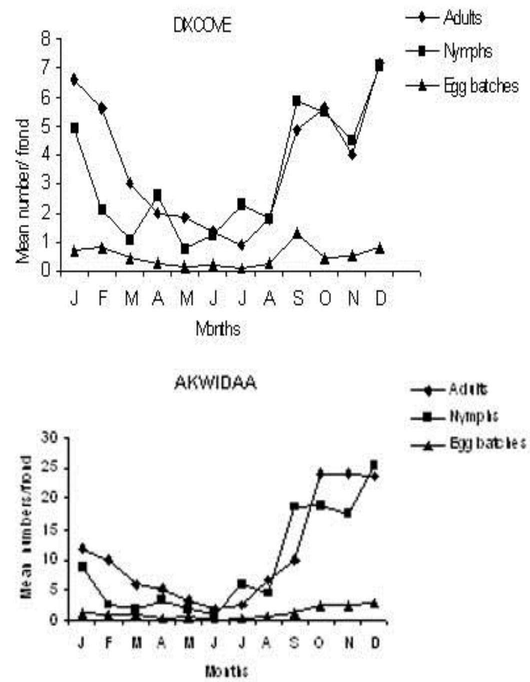

Fig. 1b. Population trends of *Nzinga palmivora* at two CSPWD out-break areas over three-year period (1996-98)

Agona Junction

Adult population showed a uniform decline from January to July and then a steep rise from August to November and a small drop in December (Fig. 1a). The highest adult population occurred in November and the lowest in July. Nymphal population also showed a decline from January to March, a small rise in April and declined in June before increasing rapidly to peak in October. A decline was observed in November and December. Oviposition was highest in December. The number of egg batch production however remained low throughout the year, declining from February to a low in June and showed a rise from July to December.

Princess town

N. palmivora population on this plot (Fig. 1a) was the lowest among the four plots. The highest adult and nymph population occurred in January. Trend of adult and nymph population were similar though adult number was generally higher. Both declined from January to March, followed by a rise and fall fluctuation from April to July. Adult population then rose from August to October before falling in October and rising slighting in December. Nymphal population rose from August to September and declined in November before showing a small increase in December. Oviposition was low throughout the year with the highest occurring in January.

Dixcove

Adult population (Fig. 1b) showed a decline from January and remained low from April to July. The population trend showed a peak in January, October and December with the highest adult population occurring in December. The nymphal population in a similar manner to adult population was significantly high in January, September and December. It showed a sharp drop from January to March, rose in April, droped in May before rising in September. A decline of population was observed in October and November before increasing to its highest point in December. Egg production was low throughout the year. It declined from February to July and was high in September. The highest number of eggs occurred in September, Dixcove had the second highest population trend among the four plots.

Akwidaa

Akwidaa plot (Fig. 1b) had the highest *N. palmivora* population throughout the year among the four experimental plots studied. Adult population declined from January to June followed by an increasing trend from July to October with the population remaining very high in October, November and December. In the case of the nymphs, there was a steep rise in population from August to September, a small fall in November followed by a rise in December. There were more nymphs in December than adults. The number of eggs remained generally low throughout the year. However a rising trend in egg availability was observed from August to a peak in December.

The population trends in the four selected areas show a bimodal feature:

1. a falling trend from January to June
2. a rising trend from July to December

High adult population in January on the four plots may be due to high number of nymphs in the latter months of the previous year i.e. November and December developing into adults. The factors that led to a falling population trend from January and subsequent low population figure from April to August are yet to be investigated. It is possible that the fall in population may be due to death of the old generation from the previous year. Experiment on biological studies in sleeves have shown that *N. palmivora* lives for at least 3 months after hatching before experiencing increased mortality (Yawson, unpublished data). Such deaths may be due to some influence of fungal attack though simple linear correlation coefficient between the population and dead insects on the leaflets indicates a very low figure of 0.065 (Yawson, unpublished data). Rainfall data of 1998 obtained from the Meteorological Services Department indicates that mean daily rainfall had very little effect on population trends (correlation coefficient of 0.005) in those areas.

Host preference may however play a significant role and account for the low population on coconut palm from June to August. For unknown reasons, it was noticed that more *N. palmivora* do occur on oil palm during this period than on coconut. Data collected on some selected oil palm and coconut palms on occurrence of *N. palmivora* showed that oil palm had mean number of 8.88, 5.04 and 5.2 in June, July and August respectively, whilst coconut had a mean of 0.88, 0.64 and 0.76 respectively during the same period (Yawson,unpublished data). It is also possible that intense predation pressure on eggs and nymphs may keep the population low from April to June or July. Most eggs laid in July - August hatch in the same month or in the beginning of the following month hence a build up of nymphal population from August onwards. A drop in nymphal population may generally be due to more nymphs emerging into adults.

Dery *et al.* (1997) observed similar population fluctutions of another suspected insect vector *M. adiopodoumeensis* at Ayensudu in the Central Region. It is to be noted that although Dixcove had the highest diseased trees over the years (Table 1) of which many had since died, the disease spread at Agona Junction and Akwidaa are very recent and have been very rapid since 1996. Princess had the first diseased tree in 1998. Polymerase Chain Reaction analysis is being used as part of the transmission trial underway to determine whether *N. palmivora* is capable of acquiring and transmitting CSPWD when inoculum is introduced in an area. Indeed, some *N. palmivora* samples have tested positive in PCR using mollicute-specific primers (Quaicoe, personal communication). Further work however is needed to ascertain whether the DNA concerned originated from CSPWD-phytoplasma or not. The presence of phytoplasma in the insect does not necessarily mean a vector of that pathogen because the insect may not be able to transmit the pathogen concerned. Such a finding would however give the direction for future work on the insect.

Conclusion

The study on population trend, coupled with the biological investigation, provide a useful information which can be used to monitor the insects. Investigation into their host preference and disease transmission will enable scientists to develop strategies to control them if investigation implicates the insect as a vector of CSPWD.

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References

Bertaccini, A., Davis, R. E, Lee, I-M., Conti, M., Dally, E. L. and Douglas, S. M. 1990. Detection of chrysanthemum yellows mycoplasma–like organism by dot hybridization. *Plant Dis.* **74**: 40-43.

Daire, X., Boudon-Padieu, E., Berville, A., Schneider, B. and Caudwell, A. 1992. Cloned DNA probes for detection of grapevine *Flavescence doree* mycoplasma – like organism [MLO]. *Ann. Appl. Biol.* **121**: 95-103.

Davis, R. E., Lee, I-M., Douglas, S. M., Dally, E. L. and Dewitt, N. 1988. Cloned nucleic acid hybridization probes in detection and classification of mycoplasma-like organisms (MLOs). *Acta Horti.* **234**: 115-122.

Davis, R. E., Sinclair, W. A., Lee, I-M., and Dally, E. L. 1992. Cloned DNA probes specific for detection of mycoplasma-like organism associated with after yellows. *Mol. Plant Microbe Interac.* **5**: 163-169.

Dery, S. K., Philippe, R. and Mariau, D. 1997. Preliminary observations on auchenorrhyncha (Homoptera): suspected vectors of Cape St. Paul Wilt disease in Ghana, pp. 269–276. In: *Proceedings of an International Workshop on Lethal Yellowing-like Disease of Coconut*, Elmina, Ghana. S. J. Eden-Green and F. Ofori (Eds.). Natural Resources Institute, Chatham, UK.

Dollet Giannotti, J., Renard, J. L. and Ghosh, S. K. 1977. Study of lethal yellowing of coconut in Cameroun: Kribi disease. Observation of mycoplasma - like organisms. *Oleagineux* **32**: 317-322.

Harrison, N. A., Bourne, C. M., Cox, R. L., Tsai, J. H. and Richardson, P. A. 1992. DNA probes for detection of mycoplasma-like organism associated with lethal yellowing of palms in Florida. *Phytopathology* **82**: 216-224.

Harrison, N. A., Richardson, P. A., Jones, P., Tymon, A., Eden-Green, S. J. and Mpunami, A. 1994. Comparative investigation of MLOs associated with Caribean and African coconut lethal decline disease by DNA hybridization and PCR assays. *Plant Dis.* **78**: 57-511.

Harrison, N. A., Tsai, J. H., Bourne, C. M. and Richardson, P. A. 1991. Molecular cloning and detection of chromosomal and extrachromosomal DNA of mycomplasma-like organism associated with witches' broom disease of pigeon peas in Florida. *Mole. Plant Microbe Interact*. **4**: 300-307.

Howard, F. W., Norris, R. C. and Thomas, D. L. 1983. Evidence of transmission of palm lethal yellowing agent by a planthopper, *Myndus crudus* (Homoptera: Cixiidae). *Trop. Agric.* (Trinidad) **60**: 186-171.

Rahardja, U., Whalom, M. E., Garcia-Salazar, C. and Yan, Y. T. 1992. Field detection of X-disease mycoplasma-like organism in *Paraphlepsius irroratus* (Say) (Homoptera: Cicadellidae) using a DNA probe. *Environ. Entomol.* **21**: 81-88.

Vega, F. E., Davis, R. E., Barbosa, P., Dally, E. L., Purcell, A. H. and Lee, I-M. 1993. Detection of a plant pathogen in a non-vector insect species by the polymerase chain reaction. *Phytopathology* **83**: 621-624.

Wilson, M. R. 1987. African Derbidae (Homoptera: Fulgoroidea): taxonomic notes with description of new species collected mainly from coconut. *J. Nat. Hist.* **21**: 567 – 595.

Wison, M. R. 1988. Records of Homoptera Auchenorrhyncha from palms and association with disease in coconut *Oleagineux* **43**: 247 – 253.

Yawson and Dery, S. K. 1998. Studies on the biology of the leafhopper *Nzinga palmivora* Wilson n.sp. (Homoptera: Cicadellidae: Typhlocybinae) in Ghana. Paper presented at the first biennial National Agricultural Research System workshop, 16-20 November, 1998, Accra, Ghana.