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# *Cicadulina ghaurii* (Hem., Euscelidae): Distribution, biology and maize streak virus (MSV) transmission

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## Abstract

*Cicadulina ghaurii* has a wide distribution in the rain forest zone but was also recorded from Guinea savanna and middle altitude ecologies in Nigeria and the Republic of Cameroon. The proportion of *C. ghaurii* in the total *Cicadulina* population was rapidly reduced in favour of *C. mbila* at the beginning of the dry season (Nov., Dec.) in the rain forest zone but increased on irrigated maize plants and grasses in the transitional areas adjacent to the southern Guinea savanna. *C. ghaurii* insects collected from the field showed low level of natural infections with maize streak virus (MSV) in comparison with *C. mbila* or *C. triangula* at the same level of maize infection with MSV. Maximum life span of adults was 53 days; the average total fecundity 80.5 (28 °C) and 68.1 eggs (24 °C) per female. The developmental period from egg laying to adult emergence took 22–25 (28 °C) days and 26–30 days at 24 °C. The bioassay conducted under controlled conditions showed that average of 10 % of males and average of 30 % of females are capable of transmitting MSV after 48 h, acquisition access feeding period.

## 1 Introduction

*Cicadulina* spp. leafhoppers are the only known insect vectors of two maize diseases: the maize streak virus (MSV) and the maize mottle/chlorotic stunt virus (Storey 1928; Rossel et al. 1980; Soto et al. 1982; Rose 1983). These diseases are currently to be considered important factors reducing maize yields in sub-Saharan Africa (Fajemisin and Shoyinka 1977; Guthrie 1978; Efron et al. 1981; Fajemisin et al. 1982).

Knowledge in relation to the role of various *Cicadulina* spp. species play in the MSV epidemics and their distribution and population composition is still far from complete. Therefore regular sampling of *Cicadulina* spp. leafhoppers in various ecological zones in Nigeria was started at the International Institute of Tropical Agriculture in 1983 (Dabrowski and Okoth 1985). Significant differences were observed in the species composition of local *Cicadulina* spp. populations in various ecological zones. *Cicadulina mbila* (Naudé) was dominant species in most areas sampled in Nigeria. The proportion of *C. arachidis* China and *C. similis* China never exceeded 15 % of the total in 1983 and 1984. *C. mbila* occupied lowland and mid-altitude ecologies, but not where daily temperature exceeded 28 °C. In warmer areas, the population of *C. triangula* Ruppel increased as a percentage of the total (Dabrowski and Okoth 1985).

In some samples collected during 1985, two new species of *Cicadulina* spp. have been identified which have not been described previously in the literature

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(DABROWSKI 1987). *Cicadulina ghaurii* Dabrowski was abundant in the rainforest zone and *Cicadulina hartmansi* Dabrowski in the transitional belt between the rain forest and southern Guinea savanna zone. Description of some ecological zones in Nigeria are given elsewhere (OKOTH et al. 1987).

*C. ghaurii* adults closely resemble *C. mbila* in size and general coloration and differ only in the presence of a dark, irregular blur on the central part of frons. Abdominal tergites are dark brown, almost black, with narrow cream coloured margins. Aedeagus is slender with a pair of sharply pointed spines on lateral margins. Pygofer processes of the male are slender with two of equal length and sharply pointed spines forming a letter "Y" (DABROWSKI 1987).

The present publication describes distribution pattern, population dynamic, biology and MSV transmission by *C. ghaurii* leafhoppers.

## 2 Materials and methods

### 2.1 Distribution and population dynamic

Monthly samplings of *Cicadulina* leafhoppers were conducted during the 1985 growing season in Nigeria. In addition, sporadic samplings were conducted in the Republic of Cameroon in August and December 1985.

*Cicadulina* adults were obtained from grass covered areas surrounding maize fields; using steel rods at corners; areas of 1 $m^2$ were covered with dark green cotton cloth, one side of which was made of fine transparent netting. The leafhoppers, responding to a light source, moved from the grasses into the net and were easily collected with an aspirator.

Special attention was paid to the collection of leafhoppers at the IITA high rainfall station at Onne, near Port Harcourt, Rivers State, Nigeria where the first individuals of *C. ghaurii* were collected on 22. 5. 1985. Onne is situated in the Niger Delta, approx. 5° north and 7° east. It is subject to a mean annual rainfall of 2400 mm and annual temperature ranging from 20 °C–35 °C an average. The atmosphere is generally humid, the rainly season being bimodal, lasting 9–10 months a year (Feb./Mar./Nov.). Rainfall peaks are in May/June, and in September, following the so-called "August-break", when there is a fortnight of very little rain in most years. The climax vegetation of the area is tropical rainforest, though it is now largely cleared, owing to the high population density of this part of Nigeria. At Onne, it is possible to grow two crops of maize per year; the first season being from February to July; the second season from August to November. Changes in population density and species composition of collected *Cicadulina* leafhoppers were compared with temperature and rainfall changes during seasons.

### 2.2 Biology

The egg incubation period, nymphal development, adult survival and fecundity were observed under 24° and 28 °C constant temperature in the growing chambers. PVC tubes 10 cm in diameter and 30 cm high with two side openings for aeration were used for rearing. All observations were conducted on insects reared on young maize seedlings (TZB cultivar). *C. ghaurii* females did not accept pearl millet, *Pennisetum americanum* (Linn.) K. Schum. as a host plant (commonly used at IITA for rearing *C. triangula* and *C. mbila*).

Ten actively ovipositing females were confined together with 10 males on young maize seedlings for 24 h using PVC tubes with two sides and a top opening covered by fine nylon for aeration. All adult leafhoppers were later removed and the plants were observed daily for nymph hatching. A total of 5 groups of 10 caged pairs were observed for each temperature.

For both oviposition and longevity, 25 paired females and male insects were transferred every 7 days to fresh maize seedlings. If a male died it was replaced, a fecundity trial was terminated if a female died. Lifespan of individuals was noted daily. To count eggs, host seedlings were dissected under a stereoscopic microscope after each transfer of adults. The number of eggs laid weekly in the life of a female was recorded.



### 2.3 Transmission of maize streak virus

The percentage of active vector transmitters of the maize streak virus (MSV) in the *C. ghaurii* population originated from Onne and Ikenne was determined by means of a simple bioassay developed at IITA (DABROWSKI 1984).

Thirty males and females were kept for 48 h on streak infected maize plants and later individually released on 4 days old maize seedlings of streak susceptible cultivar TZB covered by small transparent acrylic tube cages. Ten days after infestation, the plants were checked for streak symptoms and the extent of actual transmission was estimated by counting number of plants showing maize streak virus symptoms.

Two additional observations were carried out to monitor percentage of *C. ghaurri* adults already infected with MSV under natural field conditions. In August and October 1985, two samples of leafhoppers were taken from the Ikenne Experimental Farm and the Onne Research Station. Individual live leafhoppers collected from the grasses surrounding maize fields were released into 50 PCV cages with susceptible cv. TZB. The plants were carefully checked on 10th day after insect release and the number of plants showing maize streak symptom was noted.

## 3 Results

### 3.1 Distribution and population dynamic

Systematic sampling of grasses surrounding maize fields in various climatic zones in Nigeria und Republic of Cameroon showed presence of large numbers of *C. ghaurii* adults in the humid rainforest zone, specially adjusted to the mangrove swamp areas (Onne, Ikenne, Sapele in Nigeria, table 1 and Duala area in Cameroon, table 2). Fourteen other locations in the rainforest belt visited by us did not show the presence of *C. ghaurii*. In Ibadan area located in the transitional zone between the rainforest and the southern Guinea savanna, *C. ghaurii* was only occasionally identified as the dominant species in the samples (1. 7. 1985, table 1). The population of *C. ghaurii* was also identified from samples collected in the middle altitude zones (Jos Plateau; Sankwala Mountains in Nigeria; Bufussan area in Cameroon, table 2).

Population density of *Cicadulina* adults was low at the beginning of first rainy season starting in 1985 with a significant increase noted in July (figs. 1 and 2). March, April and May samples, *C. ghaurii* was dominant with *C. mbila* individuals constituting 11–17 % of total number of *Cicadulina* leafhoppers.

The portion of *C. ghaurii* in the total *Cicadulina* populations collected at the beginning of dry season (Nov., Dec. 1985) has been rapidly reduced in the favour of *C. mbila* in the rainforest zone but increased in the transitional zone (Ibadan, 30. 11. and 12. 12. 1985) (table 1).

### 3.2 Biology

Preliminary trials to maintain a population of *C. ghaurii* on pearl millet, *Pennisetum americanum* (Linn. K. Schum.) failed. Pearl millet plants have been successfully used for rearing *C. mbila*, *C. triangula* and *C. arachidis*. We also observed that *C. ghaurii* required higher humidity in the rearing chambers than the other three species referred to above.

Large colony of *C. ghaurii* was established in June 1985 from insects collected in Onne Station, using maize seedlings for rearing this species.

Eggs developed between 6–7 days at 28 °C and 8–9 at 24 °C of constant temperature. First adults were observed after 16–19, with the average of 17.2 days of nymphal development under 28 °C and 17–25 days with the average

*Table 1.* Appearance of *C. ghaurii* in samples collected in Nigeria (av. number of *Cicadulina* adults/m² and species composition) in 1985

| Vegetative zone and location | Date | Av. No/ m² | Species composition (in %) *C. ghaurii* | *C. mbila* | *C. triangula* | *C. arachidis* | *C. similis* | *C. hartmanni* | undescribed |
|---|---|---|---|---|---|---|---|---|---|
| Rain Forest | | | | | | | | | |
| Ikenne | 12. 3. | 1.0 | 72.0 | 38.0 | | | | | |
| | 18. 5. | 1.8 | 81.7 | 18.3 | | | | | |
| | 19. 6. | 2.2 | 74.2 | 22.7 | 3.1 | | | | |
| | 17. 7. | 2.4 | 81.5 | 18.5 | | | | | |
| | 3. 8. | 3.5 | 85.2 | 11.8 | 3.0 | | | | |
| | 30. 8. | 8.9 | 94.1 | 5.9 | | | | | |
| | 5. 9. | 6.2 | 88.4 | 11.6 | | | | | |
| | 17. 10. | 4.3 | 92.1 | 7.9 | | | | | |
| | 12. 11. | 3.4 | 50.8 | 34.3 | 14.9 | | | | |
| | 14. 12. | 2.8 | 12.5 | 87.5 | | | | | |
| Sapele | 4. 9. | 1.2 | 100 | | | | | | |
| Umuahia | 23. 10. | 3.8 | 8.3 | 18.9 | 64.5 | 8.3 | | | |
| Transitional zone | | | | | | | | | |
| Ibadan | 1. 7. | 2.0 | 66.7 | 33.3 | | | | | |
| (IITA) | 20. 10. | 2.3 | 2.0 | 34.0 | 4.0 | 13.0 | 5.0 | 42.0 | |
| | 8. 11. | 2.8 | 3.4 | 20.7 | 13.8 | 3.4 | | 58.7 | |
| | 20. 11. | 3.2 | 12.0 | 15.6 | | 5.4 | 11.0 | 56.0 | |
| | 30. 11. | 1.2 | 40.0 | 40.0 | 20.0 | | | | |
| | 5. 12. | 1.2 | 57.0 | 24.0 | 9.0 | | 10.0 | 20.0 | |
| | 12. 12. | 1.0 | 35.0 | 30.0 | 9.5 | | 12.5 | 13.0 | |
| | 19. 12. | 0.7 | 9.0 | 50.7 | 30.3 | | | 10.0 | |
| Ilowa | 21. 11. | 6.3 | 5.0 | 77.0 | | | 2.2 | 8.8 | 6 |
| Ikom | 8. 11. | 2.2 | 33.4 | 66.6 | | | | | |
| Mid-altitude | | | | | | | | | |
| Bukuru (Jos Plateau) | 9. 8. | 3.8 | 32.5 | 32.5 | | 5.0 | 22.5 | | |
| Bogene (Sonkwala Mtns.) | 13. 11. | 6.3 | 5.6 | 83.3 | | | 11.1 | | |

*Table 2.* Appearance of *C. ghaurii* in samples collected in Cameroon (Av. number of *Cicadulina* adults/m² and species composition) in 1985

| Vegetative zone and location | Date | Av. No./m² | Species composition *C. ghaurii* | *C. mbila* | *C. triangula* | *C. arachidis* |
|---|---|---|---|---|---|---|
| Rain Forest | | | | | | |
| Douala | 9. 8. | 0.6 | 100.0 | | | |
| Transitional | | | | | | |
| Yaounde | 12. 8. | 0.7 | 78.0 | 22.0 | | |
| | 12. 12. | 2.4 | 47.6 | 19.0 | 28.6 | 4.8 |
| Mid-altitude | | | | | | |
| Bafussah | 11. 8. | 0.9 | 37.0 | 63.0 | | |



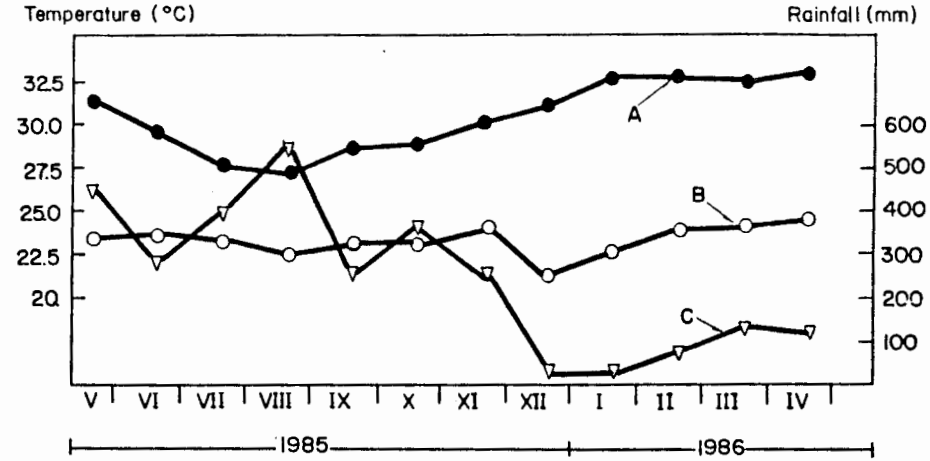


*Fig. 1.* Some climatic parameters at IITA Onne Station (Port Harcourt) in 1985 and 1986; A: Av. maximal and B: Av. minimal monthly temperature; C: Total monthly rainfall

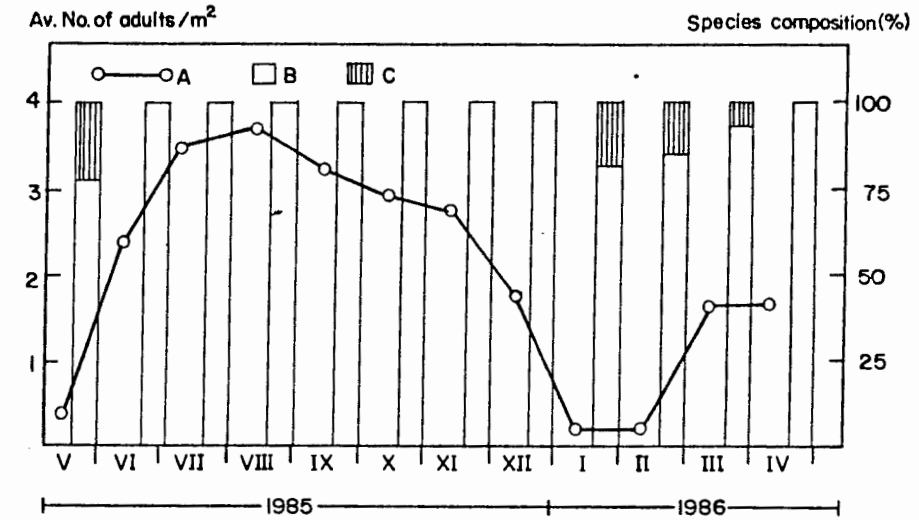


*Fig. 2.* Population dynamic of *Cicadulina* spp. leafhoppers on grasses adjoining maize fields in 1985 and 1986 in IITA Onne Station (Port Harcourt); A: Av. number of adults/m²; B: portion of *C. ghaurii*; C: portion of *C. mbila*

of 22.7 days under 24 °C. The total developmental period from egg laying to adult emergence took 26–31 days under constant temperature of 24 °C and 22–25 days under 28 °C.

The paired females laid 17–85 eggs (av. 68.1/female) during their maximum lifespan of 53 days under 24 .021C constant temperature. The increase in temperature of 28 °C only slightly modified the values, with the fecundity varying between 28 and 164 eggs/female (av. 80.5/female) and a maximum lifespan of 53 days. The daily average fecundity varied from 3–6 eggs at 24 °C and 6–10 eggs/female at 28 °C.

### 3.3 Transmission of maize streak virus

Field observations showed that in both stations, the level of natural streak infections was low and ranged from 4–7 % for various maize fields with the higher values for later planting in August and September.

When *C. ghaurii* adults were directly collected from the Onne station no single susceptible test plant produced the MSV symptoms. *C. ghaurii* adults collected from Ikenne showed higher level of insects having been already infected with MSV under field conditions and producing symptoms on 4–7 % of test plants in August and October 1985.

The bioassay conducted under controlled conditions, where adult leafhoppers of *C. ghaurii* colonies originated from Onne and Ikenne area were kept on streak infected plants for 48 h of acquisition access period, showed significant differences between sexes in the MSV transmission rate. Virus infected males produced MSV symptoms on 6–12 % (av. 10 %) and females on 28–34 % (av. 30 %) of testing susceptible maize plants between 7 and 10 days after release.

## 4 Discussion

*Cicadulina ghaurii* is a newly identified and widely distributed species in the rainforest zones of Nigeria and the Republic of Cameroon. *C. ghaurii* adults closely resemble *C. mbila* in size and general coloration of body. In contrast to *C. mbila*, they do not accept pearl millet as the host plant. The larger colonies of *C. ghaurii* were only established on young maize seedlings. they also required higher humidity in the climatic chambers than other species reared at IITA, Ibadan: *C. mbila*, *C. triangula* and *C. arachidis*.

The parameters of *C. ghaurii* biology are similar to those described for other species (Rose 1973; Ammar 1977; van Rensburg 1982; Dabrowski 1985). Only their total fecundity was higher than observed for *C. ghaurii* (60–80 eggs/female) on maize plants. There are probably other better, alternative host plants for this species in the rainforest zone. Both in 1985 and 1986, *C. ghaurii* population showed a rapid increase after the start of new rainy season. Because this species is capable of transmitting maize streak virus it may play a significant role in the epidemics of MSV disease in the rainforest zone.

In some ecological zones, *C. ghaurii* and *C. mbila* occupied the same areas. Because of their differences in biology it is essential to be cautious in collecting adult leafhoppers from the field to initiate a new colony for mass rearing for MSV resistance screening. Recently, the maize research program in Cameroon showed interest in developing facilities for mass rearing of *Cicadulina* leafhoppers for artificial infestation for MSV resistance screening in North Western Cameroon. Total *Cicadulina* leafhopper population density was much higher in valleys than in higher altitudes. The collection of insects, therefore, would be easier in valleys than in other areas. As *C. ghaurii* is unsuitable for mass rearing and resistance screening, but has frequently randomly mixed with *C. mbila*, correct species identification is essential for the careful and effective selection of colonies of *C. mbila*. The importance of correct species identification for the selection of *Cicadulina* species for mass rearing was described elsewhere (Dabrowski 1984).



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## Zusammenfassung

*Cicadulina ghaurii (Hem., Euscelidae): Verbreitung, Biologie und Übertragung des Mais-Streifenvirus*

*Cicadulina ghaurii* hat ein großes Verbreitungsgebiet in der Regenwaldzone, tritt aber auch in der Savanne von Guinea und in mittleren Höhenlagen von Nigeria und der Republik von Kamerun auf. Zu Beginn der Trockenzeit (November, Dezember) ging in der Regenwaldzone der Anteil von *C. ghaurii* an der gesamten *Cicadulina*-Population zugunsten von *C. mbila* deutlich zurück, stieg aber auf bewässerten Maisfeldern und auf Weiden in den Randgebieten der südlichen Savanne von Guinea an. *C. ghaurii*, die im Freiland gesammelt wurden, wiesen im Vergleich zu *C. mbila* oder *C. triangula* eine geringere natürliche Infektionsrate mit dem Mais-Streifenvirus auf. Die maximale Lebensdauer der Adulten betrug 53 Tage; die durchschnittliche Gesamtfekundität der Weibchen betrug bei 28 °C 80,5 und bei 24 °C 68,1 Eier. Die Entwicklungszeit von der Eiablage bis zum Schlüpfen der Adulten betrug 22–25 Tage bei 28 °C bzw. 26–30 Tage bei 24 °C. Versuche unter kontrollierten Bedingungen ergaben, daß i. M. 10 % der Männchen und 30 % der Weibchen nach 48 h Fraßzeit das Mais-Streifenvirus übertragen konnten.

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