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Specific composition of cotton leafhoppers in Côte d'Ivoire

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Abstract
In recent years, a change in the spatiotemporal profile of leafhopper populations has been observed, resulting in persistent infestations in cotton parcels throughout the crop cycle. The need to investigate the various causes of this change led to the present study, which aimed at identifying the leafhoppers found on cotton in the Ivorian cotton basin. Collections were made in 12 localities of the cotton basin. The identification of these samples revealed the existence of at least three species of leafhoppers. These are *Jacobiasca lybica* (Bergevin & Zanon, 1922), *Empoasca papayae* (Oman, 1937) and *Jacobiella fascialis* (Dworakowska, 1972). The first two species mentioned were not previously known on cotton in Côte d'Ivoire. The three species cohabit in the same cotton parcels, with a predominance of J. *lybica* (70 to 97%). This study thus highlights a probable diversity of leafhopper species present on cotton.

Keywords: Identification, leafhopper, *Jacobiasca lybica*, *Empoasca papayae*, *Empoasca papayae*, cotton

1. Introduction
The main leafhopper found in cotton crops in Côte d'Ivoire was identified as Jacobiella (Empoasca) *fascialis Jacobi*, 1912 [1, 2]. It was known as a minor pest with low economic impact. However, in recent years there has been a change in the spatial and temporal distribution pattern of this pest [3, 4], resulting in severe damage in cotton crops. This pest has become as problematic as carpophagous insects [4]. Their spatial and seasonal distributions have changed considerably. Despite plant protection programs, farmers are faced with the persistence of these pests throughout the growing season. The change in the spatial and temporal distribution pattern and the high abundance in cotton parcels raise some questions. Could the observed changes be related to an adaptation of the *J fascialis* species to climate change? Indeed, the work of [3] showed that jassid damage is considerable when pockets of drought are observed at the beginning of the season (July - August). However, this factor alone cannot explain such an abundance of jassid populations in cotton parcels. This phenomenon could also be due to the appearance of new species of leafhoppers, visibly identical to *J. fascialis*, in the cotton production areas of Côte d'Ivoire.
A better knowledge of the leafhopper species present on cotton is necessary before the development of optimal management strategies.
The objective of this study is to identify the jassids found on cotton in Côte d'Ivoire.

2. Material and Methods
2.1 Study sites
Leafhopper specimens were collected in 12 localities in Côte d'Ivoire: Bouaké, Boundiali, Ferké, Kani, Kong, Korhogo, Madinani, Nambingué, Niakara, Niofoin, Séguela and Tienko in 2021. The sampled localities are located in the cotton production zone which covers the northern half of the country (7°5N to 12°N: 3°W to 8.5°W).

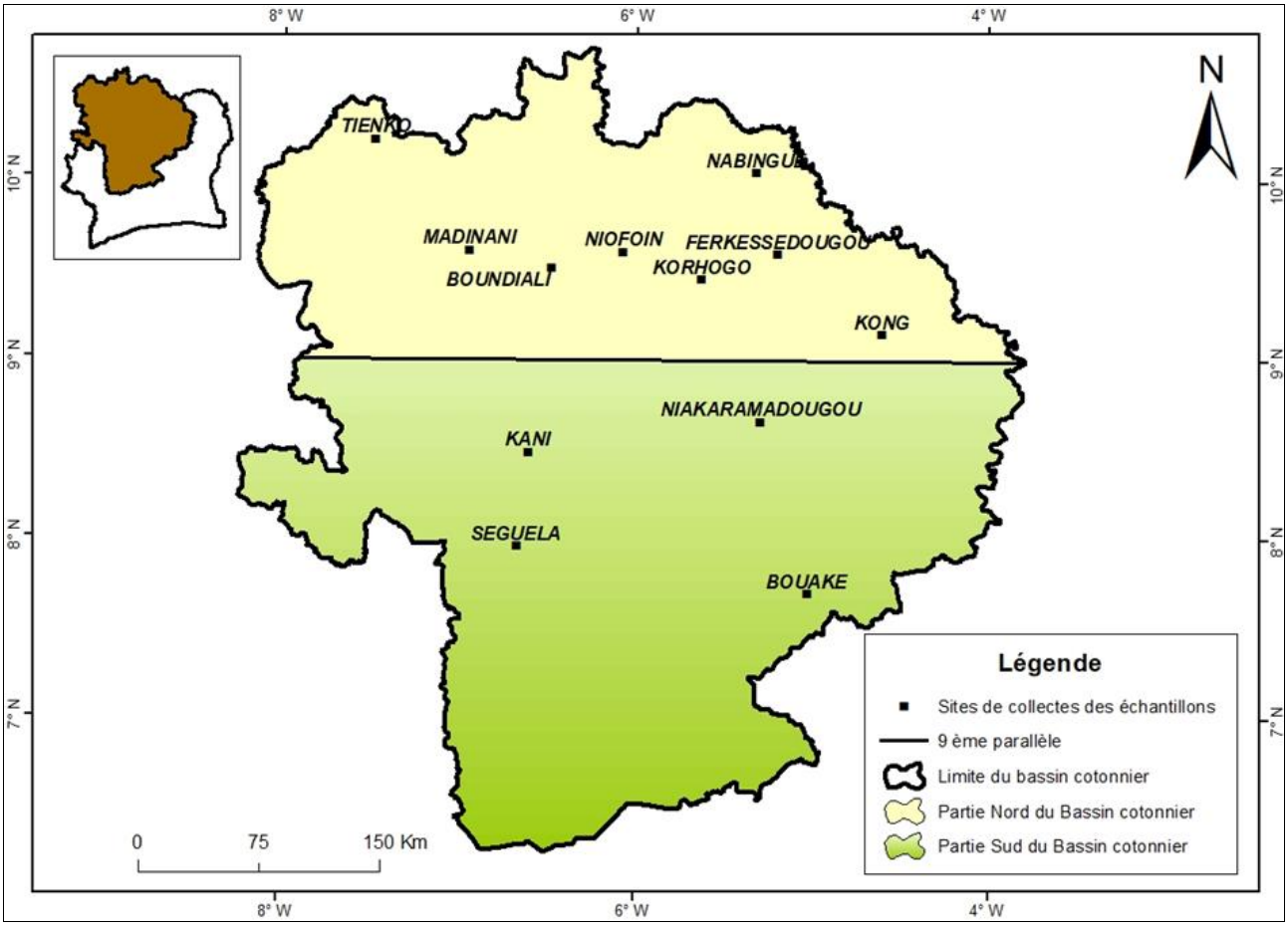

Fig 1: Sample collection sites

2.2 Sample collection
Sample collections were made during the fruiting stage of the cotton plant in October and November of 2020 to 2021. 30 specimens per locality were identified. The collected individuals were kept dry on naphthalene. A total of 360 individuals were studied.

2.3 Identification of specimens
The identification was made based on the keys of *Jacobiasca lybica* (Bergevin & Zanon, 1922), *Empoasca papayae* (Oman, 1937) and *Jacobiella fascialis* (Dworakowska, 1972) described on the site http://dmitriev.speciesfile.org/key.asp?Key = Erythroneura & lng = En&I = 1&keyN= 12, developed by [5]. The individuals were observed from the Motic Panthera microscope at 4X and 10X magnification respectively and from the Motic SMZ-171 magnifying glass. The images of the wings were taken via the Motic Images plus 3.0 software compatible with the Windows operating system.

2.4 Data analysis
The percentage of identified individuals was determined to know the share of each species. The Chi-square test was performed to determine the homogeneity of species distribution. The one-factor analysis of variance was performed to determine the level of variability of the species on all the localities studied. In case of significant difference at the 5% threshold, the post hoc Tukey HSD test was performed to determine the average representation of the species encountered. These statistical analyses were performed using the statistical programming software R 4.1.2.

3. Results
3.1 Specific composition of the collected leafhoppers
The identification of the 360 individuals shows that the species *Jacobiasca lybica* (Bergevin & Zanon, 1922) was the most encountered species (304) with a proportion varying from 70% to 96.7%. It was followed by *Empoasca papayae* (Oman, 1937) with 36 individuals identified for a proportion varying from 0% to 22.6% and *Jacobiella fascialis* (Dworakowska, 1972) with 18 individuals for a proportion varying from 0% to 16.7%. Some individuals could not be identified from the keys used for identification. The unidentified individuals numbered eight, for a proportion varying from 0% to 16.7% (Fig 2).
The chi-square test performed showed a significant difference with $\chi^2 = 48.44$ and $p = 0.0405$. Thus, heterogeneity within the identified jassid populations is observed.

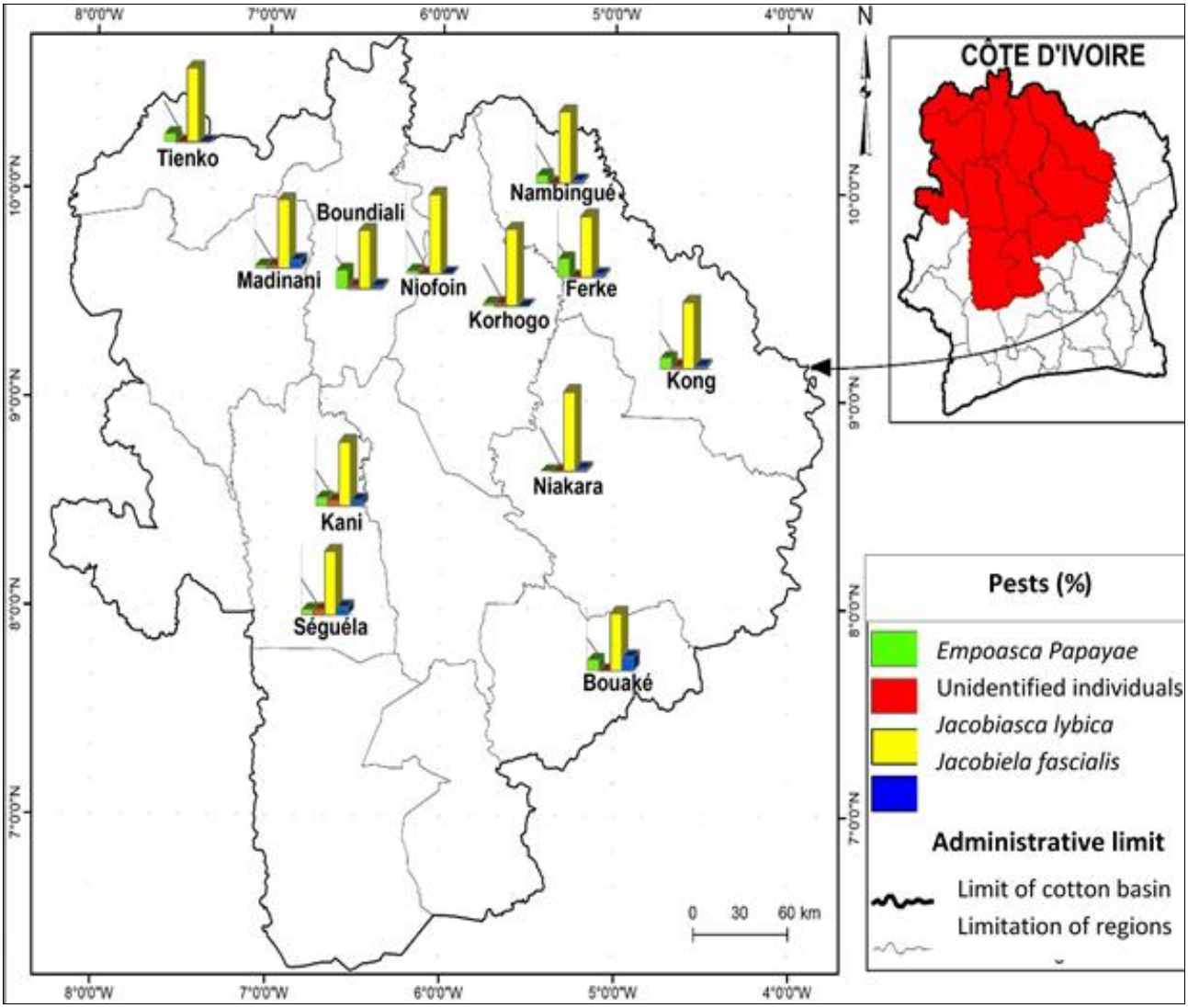

Fig 2: specialization of the composition of the identified species

3.2 Geographic variation in species diversity

The analysis of variance showed a highly significant difference (F = 412.32 and p = 2.2e-16 ***). This highly significant difference shows a high variation in the represent ability of species in the parcels. The most highly represented species was *Jacobiasca lybica* with an average percentage representation of 83.14%. This percentage shows the probability of presence of this species on a cotton parcel (Table 2). It was survived by the species *Empoasca papayae* with a probability of presence of 9.77%.

Table 2: Average representation of species on a cotton parcel

Species	Average percentage of observations
Empoasca papayae (Oman, 1937) [25]	9.766667 [b]
Inconnu	2.166667 [c]
Jacobiasca lybica (Bergevin & Zanon, 1922) [24]	83.141667 [a]
Jacobiella fascialis (Dworakowska, 1972) [26]	4.916667 [bc]

4. Discussion

Identification of leafhoppers present on the cotton plant undertaken revealed at least three species. These include *Empoasca papayae* (Oman, 1937), *Jacobiasca lybica* (Bergevin & Zanon, 1922) and *Jacobiella fascialis* (Dworakowska, 1972). The species identified were present on the same parcel, reflecting cohabitation. This observation is supported by that made by [6-8]. Indeed, these authors noted the cohabitation of two of these species, *J. lybica* (Bergevin & Zanon, 1922) and *J. fascialis* (Dworakowska, 1972) in cotton crops. These two species have been identified in Mali and Burkina Faso, countries bordering Côte d'Ivoire. However, the species *J. lybica* (Bergevin & Zanon, 1922) had not yet been reported on cotton in Côte d'Ivoire.

The species *J. lybica* (Bergevin & Zanon, 1922) is considered an invasive species. Indeed, when it appeared in Algeria on grapevine, it quickly took over the other existing species [9]. It is considered a dangerous pest for the host plants that harbor it [9-11]. The appearance of this species in cotton crops in Côte d'Ivoire could be due to fraudulent seed exchanges. The fraudulent exchanges are mostly made by farmers looking for new species with better agronomic characteristics. Of course, pest outbreaks vary according to regions and climatic factors, but also according to the species cultivated [12]. Indeed, the introduction of a varietal species on a territory brings with it its pest parade. However, fraudulent trade is partly with

neighboring countries such as Mali and Burkina Faso where this species has been identified on cotton. Its identification on cotton in Côte d'Ivoire could also be explained by migration. Indeed, leafhoppers are mobile insects, and these countries are also major cotton producers in the West African sub-region. *Jacobiasca lybica* is also found on other host plants such as okra, eggplant, grapevine, sesame, etc. [10, 13-17]. The practice of growing food crops (okra and eggplant) near cotton parcels or the association of these host crops with cotton cultivation could be the cause of the transfer of this pest to cotton. Indeed, it is a mobile species that could move from one plant to another.

The species *Empoasca papayae* is known as an insect infested with papaya. However, it is identified on cotton for the first time in Côte d'Ivoire by [18]. It is a vector of many phyto plasmas [19-22]. It is a species whose presence is a potential source of disease for host plants.

The species *Jacobiella fascialis* is considered as a species that appears early in the cotton crop [23] but disappears during the first insecticide treatments. Insecticide treatments therefore succeed in curbing the outbreak of this species. It could therefore be more sensitive to active ingredients. This would explain its low presence in the samples collected.

The observed species diversity would explain in part the persistence of leafhoppers throughout the growing season.

5. Conclusion

The present study conducted to understand the change in the distribution pattern of leafhoppers and to provide knowledge that could lead to decision making, identified at least three species. These include *Empoasca papayae* (Oman, 1937), *Jacobiasca lybica* (Bergevin & Zanon, 1922) and *Jacobiella fascialis* (Dworakowska, 1972). *E. papayae* (Oman, 1937) and *J. lybica* (Bergevin & Zanon, 1922) are two new species identified in this study on cotton. The three species identified cohabit on the same plot. They show the existence of a genetic diversity. This diversity would explain in part the persistence of jassids throughout the cotton growing season.

Collections at each phenological stage of the cotton plant within the framework of morphological identification will make it possible to identify the periods of appearance of these species. Better, the characterization of leafhoppers from molecular markers will allow to deepen the knowledge of the genetic diversity of leafhoppers.

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