Host plants associated with tephritidae in Côte d’Ivoire and discovery of a new fruit fly species: *Dacus longistylus*

N’Dépo OR, Minhibo MY, N’Goran A, Hala NF, Coulibaly A, Soro S and Yéboue NL

Abstract

Host plants associated with Tephritidae in Côte d’Ivoire and discovery of a new fruit fly species: *Dacus longistylus*. Fruit flies are a major entomological problem in Côte d’Ivoire. The fruit flies attack wild plants and cultivated plants that are the foci of re-infestations of orchards. The aim of this study is to inventory the host plants and flies associated with them. Various fruit species are collected and incubated in the laboratory. The collected larvae form the fruits are reared and the adult flies emerged are identified. Thirteen species of fruit flies have been identified and associated with twenty-nine fruit species. The fleshy fruits are the most attacked. *Bactrocera dorsalis* is the majority species with an average of 176.87 ± 90.28 individuals, followed by *Ceratitis cosyra* with 50.9 ± 33.76 individuals. The *Bactrocera dorsalis* is strongly represented in the mango. The species *Dacus longistylus* is identified for the first time in Côte-d’Ivoire and is associated only with Sodom Apple. The rate attack of fruit fluctuates between 10 and 100% and the level of fruit infestation varies from one fruit to another.

Keywords: Fruit flies, attack, host plants, *Dacus longistylus*

1. Introduction

West Africa had enormous potential for export crops. Among these export crops, mango (*Mangifera indica* L.) represented the most exportation (Anonymous, 2007) [1]. According to these authors, mango is at the forefront of fruit production in West Africa. For their nutritional and commercial value, fruits contribute to the improvement of social well-being and the health status of populations (Ouedraogo, 2007) [2]. In addition to these nutritional values, mango products are suppliers of employment and important currencies to the actors (N’Dépo et al., 2010) [3]. Unfortunately, these fruits exported are attacked significantly by fruit flies. These dreaded pests attack a wide range of host plants including berries, citrus fruits and wild crops (Mwatawala et al., 2006, Ndiaye 2009, N’Dépo et al., 2015, Niang 2017) [4, 5, 6, 7]. The direct damage to the fruits is materialized by egg-laying under the skin of the fruit followed by rotting and falling fruits. In mango orchards, the damage has increased with the presence of the orientale fruit fly, *Bactrocera dorsalis* (N’Dépo, 2010) [8]. This specie is one of the most devastating in the world and the most dangerous of the genus *Bactrocera* according to Toshiyaki et al. (2016) [9]. Fruit flies are responsible for important damage and many interceptions of infected fruit containers at European ports. In most West African countries, *B. dorsalis* populations are very low to missing in the orchards during the dry season (Vayssières et al., 2015) [10]. These populations reach their peak of growth during the mango production period. It is therefore important to research and characterize the non-preferential areas that harbored flies and serve as the primary source of orchard infestation. The objective of this study was to update the list of host plants for fruit flies in Côte d’Ivoire.

2. Material and Methods

2.1 Study site

The study was conducted from 2005 to 2007, from 2008 to 2009 and from May to June 2017 in four different agro-ecological regions of Côte-d’Ivoire (Figure 1).

- The southern region (subequatorial type climate) with the following localities prospected: Abidjan (Marc Delorme station, 5°20’N - 4°01’W, annual averages of temperature 25.69 ± 3.3°C and 1625 mm of rain), dominant floristic species are the coconut tree with the...
The presence of some fruit trees, Azaguié (fruit production station, 5°37' N - 4°02' W, annual averages of temperature 27 ± 1.4°C and 1500 mm of rain). Azaguié area has been for decades a fruit production area (banana, pineapple, papaya, mango), citrus (orange, lemon, pomelo, mandarin, tangelo) and vegetables. It had prospered in fruit and citrus production under the control of the Research Institute for Fruits and Citrus (IRFA) current CNRA, with its experimental plots sheltered the importance of fruit species and tropical citrus fruits.

- The central region (transitional climate between the subequatorial climate and the Sudanese climate) these are the localities of Yamoussoukro (6°48' N - 5°17' W, annual averages of temperature 27.14 ± 2.53°C and 1100 mm of rain), Katiola (8°08' N-5°06' W, annual averages of 27.2 ± 3.1°C and 1000 mm of rain). The vegetation is dominated by grassy savanna with the presence of rhun palms commonly named Borassus flabellifer and rattan palms. There are also crops trees: mango, cocoa, coffee, cashew and some citrus (Orange, mandarin, grapefruit).

- The northern region (Sudanese type climate), the main export mango production area with the localities of Korhogo (Lataha station, 9°34' N - 5°37' W, annual averages of temperature 24.42 ± 0.5°C and 928.85 mm of rain) and Sinematiali (9°55' N - 5°22' W, annual averages of temperature 24.42 ± 0.5°C and 928.85 mm of rain). The vegetation is savanna wooded type. There are also varieties of mango trees (Kent, Amelie, Brooks, Palmer, Smith, Valencia etc.), citrus trees, papayas, cashew trees, African locust bean, shea and other wild fruit trees.

- The western central region with Daloa (6°55' N - 6°30' W, annual average temperatures between 21°C and 36°C and 1000 to 1500 mm of rain) has the same climate as the center. The vegetation is a dense forest with a regressive evolution. There are cash crops including cocoa, coffee, oil palm, cashew and rubber. During this study, the fruits collection was done lasting the rainy season.

### 2.2 Material

#### 2.2.1 Vegetal material

Various fruits are collected. The number of trees visited is a function of the diversity, density and the fruits availability during collection (Table 1).

![Fig 1: Prospected localities during fruits sampling in Côte d’Ivoire](image)

<table>
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<tr>
<th>Localities</th>
<th>Fruit species</th>
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<td>Azaguié</td>
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<td>Star fruit</td>
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<td>Sour sop</td>
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<td><em>Citrus sinensis</em></td>
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<td>Grapefruit</td>
<td><em>Citrus x paradisi</em></td>
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<td>Wild mango</td>
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<td>Combava</td>
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<td>Malay apple</td>
<td><em>Syzygium malaccense</em></td>
<td>Myrtaceae</td>
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Table 1: Sampled fruit species and their areas of origin
2.2.2 Incubation and breeding equipment of fruit flies
It consists of plastic basins, sand sterilized by heating in an oven, muslin cloths and breeding boxes.

2.2.3 Fly identification equipment
It’s a binocular loupe brand "MOTIC" with 10 X 20 magnification and fruit fly identification guide (Ekesi and Billah, 2007) [11].

2.3 Methods
2.3.1 Fruit collection, incubation and breeding fruit fly
The ripe fruits were essentially selected, those bearing attack traces and those dragging on the ground. Fruit collection is done every two weeks. The fruits are classified by variety and attack of the different fruits are subjected to an analysis of variance (ANOVA) at the threshold of 5% using the software STATISTICA v.7.1. The averages obtained are classified according to the Student Newmann Keuls test. The host-plant and fruit fly relationship is analyzed by Correspondence Factor Analysis after a transformation of the data with the square root function.

3. Results and Discussion
3.1 Results
3.1.1 Inventory of emerged fruit flies
Thirteen (13) fruit fly species have been identified in the fruits. These include Zeugodacus cucurbitae, Bactrocera dorsalis, Ceratitis anonae, Ceratitis cosyra, Ceratitis capitata, Ceratitis punctata, Ceratitis rosa, Dacus bivittatus, Dacus punctatiprons, Dacus langi, Dacus longistylus, Dacus vertebratus, and Trirhithrum coffeae. Among these species, B. dorsalis is mostly represented with an average of 176.87 ± 90.28 individuals. It’s followed by C. cosyra with an average of 50.9 ± 33.76 individuals and C. punctata with 28.03 ± 13.78 flies. The other species were minority with a relative abundance fluctuating between 0.05 ± 0.03 and 4.35 ± 3.06 flies (Figure 2). Statistical treatments reveal a highly significant difference (P ≤ 0.01) between species abundance. At the level of the minority species, D. longistylus has been identified for the first time in Côte d’Ivoire and found on a single fruit species the Sodom apple (Calotropis procera) belonging to the family Apocynaceae (Figure 3).
3.1.2 Description of *Dacus longistylus* (Wiedemann, 1830)

*D. longistylus* has a color ranging from light brown to dark brown through to dark brown for other individuals. The head has antennas consisting of three segments each and three triangle-shaped ocelli at the top of the head with a pale silvery yellow front. The wings are transparent with a characteristic apical spot at the Sub-costal vein (Figure 4a). There are no spots on the anal stripe of wing. The thorax is devoid of thoracic features. There is a typical triangle-like (dark yellow or pale yellow) spot at the base of the scutum that extends almost one-third of its length (Figure 4b). The scutellum is pale yellow to dark yellow with two yellow marking (katatergite and anatergite) on each side of the thorax. The legs are colored pale yellow with black spots at each femur and terminated with claws (Figure 4c). The abdomen has tergites (segments) colored with brown bands and merged at their ends. In the female, it is terminated by a slender ovipositor and disproportionate hence the name "longistylus" (Figure 4d)

**Fig 2**: Average number of flies per species in all fruits from June 2005 to May 2007 and September 2008 to August 2009 and May to June 2017

ANOVA to 5% dl= 12 F= 0.31 P= 0.0001
Averages followed by the same letter are not statistically significant

Fig 3: Damage of *Dacus longistylus* on the Sodom apple

a: Egg laying of *Dacus longistylus* on the apple Sodom
b: Larvae of *Dacus longistylus* in the Sodom apple

c: Spotted legs
d: Disproportionate Ovipositor

**Fig 4**: Few traits of recognition of *Dacus longistylus*
3.1.3 Fruit flies host plants’ inventory
A total of 3,436 fruits divided in seventeen (17) families and thirty-five (35) species were collected and incubated. 21,793 fruit flies emerged from twenty-nine (29) fruit species on 35 fruit species collected. They are divided into thirteen (13) species of fruit flies belonging to four genera which are Ceratitis, Bactrocera, Dacus and Trirhithrum (Table 2).

Only Rose-apple (Syzygium jambos), Granadilla (Passiflora edulis), douka (Tieghemella africana), bilimbi (Averrhoa bilimbi), Mangosteen (Garcinia mangostiana) and Jew plum (Spondias dulcis) have not hosted fruit flies. B. dorsalis is the majority species (Figure 5) and is strongly represented in mango (83.45%) followed by C. cosyra with 15.15%. It has been found in 23 fruit species. The other species, although minor in comparison with the latter, have higher or lower proportions in the fruits collected, including C. punctata with 98.45% in the "eggfruit. D. longistylus is present only in Sodom apple (C. procera) (100%). The infestation status of fruit flies to certain fruit species has been brought out by factorial correspondence analysis. This analysis shows that T. coffeae is associated to coffee, C. cosyra is in cattle stick, custard apple and Mango. C. punctata is associated to eggfruit, Citrus, Sapodilla and wild custard apple. D. bivittatus is present in Papaya and pumpkin and B. dorsalis is strongly associated with Mango (Figure 6).

Table 2: Abundance of fruit flies in the various species of collected fruits

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NB: - : Absence de mouches des fruits

Fig 5: Proportion of flies in fruits
3.1.4 Attack and fruit infestation rate

Fruits bearing fruit flies have a rate of attack and load (infestation) varying from one plant to another depending on their availability and the quantities collected. At the level of attacks, this rate fluctuates between 10 and 100%. Statistical treatments reveal a highly significant difference ($P \leq 0.01$, $F=4.28$) between fruit attacks. Except the other fruits, the coffee and yellow mombin have the lowest attack rates 14.28% and 10% respectively (Figure 7). The other fruit species present a strong attack rate varying between 52.67 and 100% (Figure 7). Two groups are distinguished regarding to the level of infestation or fruit infestation loads. The first have low infestation rate ranging from 0.065 to 32.35 pupae / kg. fruit and the second group of fruit varieties with an infestation rate of more than 50 pupae / kg. fruit. Among these latter, the sodom apple, cattle stick, wild apple, eggfruit and soursop have loads of 708.91 pupae, 456.82 pupae, 352.38 pupae, 165.5 pupae and 112.41 pupae / kg. fruit respectively (Figure 8). Statistical treatments reveal a highly significant difference ($P \leq 0.01$, $F=1.91$) between fruit infestations.

ANOVA at $5\%$ $dl=16$ $F=4.28$ $P=0.000$

Averages followed by the same letter are not statistically significant

Fig 7: Fruit attack rate
3.2 Discussion
Various fruit fly species have been identified on a wide range of collected fruit-hosts. Most of these species except Dacus longistylus have already been observed in other parts of Africa (Mwatwala et al., 2004, Vayssières et al., 2004 and 2005, DAAF, 2013) [13, 14, 15, 16] and also in Côte d’Ivoire (Hala, 2001) [17]. These polyphagous insects attack host fruits with a presence rate depending of plants species. Indeed, the high abundance of B. dorsalis in a fruit-host would explain the preferential host status compared to the circumstantial hosts. This is the case of the mango with a strong infestation of B. dorsalis and C. cosyra because mango orchards during production, are invaded by a large population of fruit flies so that the fruits are strongly attacked. Also B. dorsalis goes an important distance for searching host plants Our results were similar to those of Vayssières et al. (2015) [10] in Benin and Keita et al. (2016) [16] in Mali, who observed during their work an important population of B. dorsalis and C. cosyra in mango orchards. B. dorsalis was lies found on 23 fruit species in addition to mango. This could be explained by its status as polyphagous insect and super competitor and its great ability to adapt to environmental conditions. Indeed, this important range of host plants would serve as reservoirs and refuges to fruit flies’ populations. Our results were similar to the result of Ndiaye (2009) [5], Ouedraogo et al. (2010) [19], Simde and Dakouo (2017) [20] in Burkina-Faso, where they showed the major role played by alternative host plants in the fruit fly proliferation in non-production periods and consequently the re-infestation of mango orchards at the appropriate time. According to Ducky et al. (2004) [21] an intense interspecific competition between B. dorsalis and other native species would cause displacement of other species to other host plants and ecological niches and consequently increase the number of host fruit species. Also, circumstantial host plants would play a key role in the re-infestation cycle of mango orchards and other orchards. As for the newly identified sodom apple tree as a potential host of Tephritidae, it did not host any other fruit fly species except D. longistylus. This may be due to its high toxicity (Maroyi, 2012; Sylvie 2013) [22, 23] which inhibits the development of eggs and larvae of sensitive flies. Indeed, all parts of the plant are toxic, however, the white sap in which the contents are higher, contain a complex mixture of chemical compounds, among which cardiotonic glycosides (cardenolides) some of which are steroidal cardiac poisons (Sylvie, 2013, AISAGARDEN, 2010-2018, Anonymous, 2018a, Anonymous, 2018b) [23, 24, 25, 26]. Thus, Anonymous (2018b) [26] confirms the toxicity of said plant by administering the latex to a mammal. This latex, administered experimentally, was lethal in goats, at the rate of 1 ml / kg per os or 0.005 ml / kg parenterally. The high abundance of D. longistylus in the sodom-apple would explain it by an exceptional adaptation and a resistance to the toxicity of this plant.

4. Conclusion
Thirteen fruit fly species have been emerged in the fruits in Côte d’Ivoire. Among them the specie D. longistylus has been identified for the first time. Twenty-nine fruit species were identified the fruit flies’ host plants in Côte d’Ivoire. The specie B. dorsalis is mostly represented in fruits and it’s strongly associated with Mango. The attack rate of fruit fluctuates between 10 and 100%. The level of fruit infestation varies from one fruit to another. Fruit flies activity could compromise the agricultural sector in Côte d’Ivoire.

5. References


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