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Diversity of fruit flies (Diptera: Tephritidae) of economic importance and their host plants in the Sudano Guinean plateau of the Adamawa region (Cameroon)

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Abstract
Fruit flies larvae (Tephritidae) parasitize and accelerate rotting process of ripe fruits causing losses in nutritional and economic values. Knowledge about fruit fly species and their related host plant is crucial to understand impact of these insect. These flies have economic importance in the Sudano Guinean Plateau of Cameroon where no protective method to limit their attacks is applied. Little is known on the diversity of fruit flies present in this area. In order to build an efficient control method, the first step is the screening of the fruit flies occurring in this landscape and to observe flies hosts. That is the aim of the present study. Sampling of fruits were made on markets during 12 months pointed out that 4 fruit fly species were frequently collected: *Bactrocera dorsalis* (Hendel), *Ceratitis fasciventris* (Bezzi), *C. cosyra* (Walker), *Dacus punctatifrons* (Karsch). The most abundant species was *B. dorsalis* with 405 flies collected during the year. Six host plants of fruit flies were identified: *Psidium guajava* (Myrtaceae), *Mangifera indica* (Anacardiaceae), *Citrus reticulata* (Rutaceae), *Baillonella toxisperma* (Sapotaceae), *Citrullus vulgaris* (Cucurbitaceae) and *Annona senegalensis* (Annonaceae). The most noxious fly was present in early rainy season. These preliminary data will contribute to ecological and behavioral investigations to identify most efficient control method to be implemented to reduce loss of fruit production in the Sudano Guinean Plateau of Cameroon.

Keywords: Cameroon, fruit flies, sampling, control method, *Bactrocera dorsalis*

1. Introduction
Production of mangoes (*Mangifera indica* L.) is important in fruits exportation in sub-Saharan Africa and has impact in national economy. Mango production is the 6th fruit of the world behind oranges, bananas, grapes, apples and plantains [1]. Mango exports were multiplied by 5 during the last 14 years, from 42 000 tons in 1992 to 210 000 tons in 2006 [2]. Sub-Saharan Africa is a region where the production of tropical fruits is booming. These fruits are largely destroyed by insect pests that significantly reduce their production and marketing [1, 3, 4]. Among these pests, fruit flies attack resources for markets, undermining the peasant economy and paralyze trade (import and export) of fruits at local, regional and international level [5, 6]. These damages are related to major production losses they induce and to risk of infestation that countries receiving fruit are exposed [7, 8]. The family of fruit flies (Diptera: Tephritidae) has 4000 species grouped in 500 genera [8]. Among them, *B. dorsalis* is a species present over 22 African countries infesting more than 30 plants [7, 9, 10]. In Africa, these fruit flies cause losses of 40% of the total production of mangoes [11]. Senegal faces 41 000 tons of mangoes losses on an annual production of 100 000 tons attributed to Tephritidae [12]. Ugandan mangoes' industry lost more than 116 millions of Dollars due to *Bactrocera dorsalis* (Hendel) [13]. Cameroon ranks first among African countries whose mangoes' cargo to the European market were intercepted and destroyed due to the presence of fruit flies [14]. Fruit flies inventories conducted in Cameroon reported the presence of fruit flies of economic importance [15, 16]. The aim of this work is to look for assets that promote the expansion of these flies through the diversity of their host plants.

2. Material and methods
The climate of the region is Sudano Guinean with annual rainfall ranking from 1600 to

1800 mm, with 1084 m of altitude. This climate is favorable to agriculture, particularly fruit production. Many fruit species are produce in the region such as avocado, guava, citrus fruit and mangoes. The rainy season runs from April to October and the dry season from November to March [17]. Fruit were collected on three regional periodic markets: Bantail (07°19 227N. 013°35 709), Bamyanga (07°17 640N.013°34 476 E) and Sabongari (07°19 730N.13°35 098E). Fruit collections were made randomly every month targeting over-ripe fruit, according to their availability from January to December 2010. Brought back to the laboratory, incubation of these fruits follows Vayssières *et al.* [18] protocol which consist of watching fruit, weighing each of them, and rear them separately in bucket containing sterilized sand. Pupae and emerging fruit flies were checked every week. Fruit flies that emerged were kept for identification in ethanol 70%. These flies were then grouped by morphotype using practice key determination of fruit flies of economic importance [8] through observation on binocular microscope (Nikon model C-PS). Then morphotypes were compared to flies identified at Biological Control Center for Africa (IITA-Cotonou, Benin) and insects identification service IITA, (Cameroon's station).

3. Results and discussion

3.1. Emergence of flies

1018 samples of fleshy fruits from 19 species were collected, 514 flies emerged from 10 fruit species. These flies belong to three families; the most represented family was Tephritidae follows by Drosophilidae and Muscidae. Results of fruit rearing are summarized in Table 1.

Table 1: Abundance and diversity of flies on incubated fruits

	Plant		Files	
	Name	**Family**	**Total**	**Family**
1	*Anacardium occidentale*	Anacardiaceae	0	
2	*Annona senegalensis*	Annonaceae	3	Tephritidae
3	*Baillonella toxisperma*	Sapotaceae	2	Tephritidae
4	*Capsicum frutescens*	Solanaceae	0	
5	*Carica papaya*	Caricaceae	0	
6	*Citrus sinensis*	Rutaceae	0	
7	*Citrus* sp.	Rutaceae	0	
8	*Citrus limon*	Rutaceae	0	
9	*Citrus reticulata*	Rutaceae	15	Tephritidae
10	*Citrus grandis*	Rutaceae	0	
11	*Citrullus vulgaris*	Cucurbitaceae	3	Tephritidae
12	*Dacryodes edulis*	Burseraceae	0	
13	*Lycopersicum esculentum*	Solanaceae	34	Drosophilidae, Muscidae
14	*Mangifera indica*	Anacardiaceae	70	Drosophilidae, Tephritidae
15	*Musa* sp.	Musaceae	33	Drosophilidae
16	*Persea americana*	Lauraceae	1	Drosophilidae
17	*Psidium guajava*	Myrtaceae	332	Tephritidae
18	*Solanum melongena* spp.	Solanaceae	21	Drosophilidae, Muscidae
19	*Vitex doniana*	Verbenaceae	0	
Total			514	

These emergence were distributed as follows: 332 from *P. guajava*, 70 from *M. indica*, 34 from *L. esculentum*, 33 from *Musa* sp., 21 from *S. melongena* spp., 15 from *C. reticulata*, 3 from *C. vulgaris*, 3 from *A. senegalensis*, 2 from *B. toxisperma* and 1 from *P. americana*.

Fruit flies use fruit as a support to lay their eggs. According to fly species and ecological areas, Tephritidae attack several families of plants including: Anacardiaceae, Annonaceae, Caricaceae, Cucurbitaceae, Lauraceae, Myrtaceae, Musaceae, Oxalidaceae, Alliaceae, Polygalaceae, Rubiaceae, Rutaceae, and Sapotaceae [18]. Some species are able to infest even toxic plant [19]. These fruits, cultivated or wild, yielded their larvae and thus are reservoirs allowing these pests to operate year round [10, 20, 21]. None emergence was observed on *C. sinensis*, *Citrus* sp., *C. limon*, *C. frutescens*, *C. papaya*, *A. occidentale*, *V. doniana*, *D. edulis*. This negative result also observed by N'dépo *et al.* [22] where justified by the physicochemical conditions that are unfavorable for fruit fly larvae development.

3.2. Fruit flies diversity and host plants

After identification, we grouped Tephritidae into species (Figure 1.a). *Bactrocera dorsalis* was the dominant species with 405 flies. It is the invasive species identify on the continent in 2003 [23]. In terms of numerical importance *C. fasciventris* was the second species with 9 flies follow by *Ceratitis cosyra* and *Dacus punctatifrons* with respectively 3 and 2 flies. The native species *C. cosyra* which is associated to mango is seen to be excluded by the invasive one. Demographic parameter of these two pests showed advantage that invasive species *B. dorsalis* has on the native species when observed on the same conditions [24]. *Dacus punctatifrons* is an economically important fly already reported in Cameroon [25].

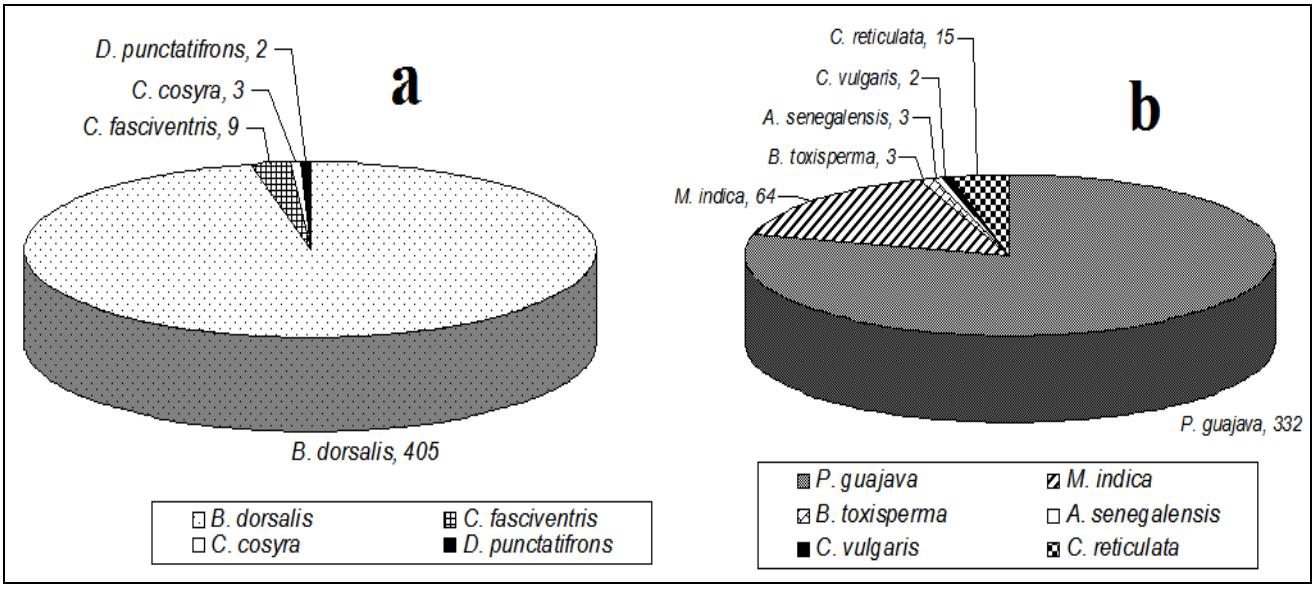

Fig 1: Diversity and abundance of fruit flies and their host

All these Tephritidae emerged from six plant species: *P. guajava*, *C. reticulata*, *B. toxisperma*, *M. indica*, *A. senegalensis* and *C. vulgaris* (Figure 1.b). These pests were most abundant on *P. guajava* (332 flies). In this area it is the primary host of fruit flies. In the center region of Cameroon *P. guajava* was also reported as host of Tephritidae of economic importance [15]. This abundance could be linked to the abundance of fruits in the agro-ecological zone [26, 27]. Mango was the second most affected fruit with 64 fruit flies collected this justify why it is mentioned as one of the preferred host plants of many fruit fly species [9, 28]. Following these two fruits, *C. reticulata* was infested but to a lesser extent with 15 flies. Other fruit species were less infested with fruit fly larvae. *A. senegalensis*, *B. toxisperma*, *C. vulgaris* respectively with 3, 3 and 2 flies. Duyck *et al.* [29] and Vayssières *et al.* [30] justified the low rate of emergence on infested fruit as the action of abiotic (temperature) and biotic (larval competition) factors. The competition among Tephritidae species which occur when larvae of several species co-infested the same fruit can also lead to this reduction [27].

3.3. Annual Fluctuation of fruit flies infestation

Host plants of fruit flies have been research year round. Fly species identified emerged from six hosts and infest them according to their availability. During the period from May to October we recorded all host plants and associated species of Tephritidae (Table II).

Table 2: Annual abundance of fruit flies on their hosts

Month	Fruit flies abundance				Host plants
	B. dorsalis	*C. fasciventris*	*C. cosyra*	*D. punctatifrons*	
January	100				*P. guajava*
February					
March					
April					
May	100				*P. guajava ; M. indica*
June	89.2	4.1	6.8		*P. guajava; M. indica; A. senegalensis*
July	96.5	3.5			*P. guajava ; M. indica*
August	95.5	4.4			*P. guajava ; B. toxisperma*
September	95.2			4.8	*P. guajava ; C. vulgaris*
October	100				*P. guajava ; C. reticulata*
November	100				*P. guajava*
December					

Apart from these months during January and November, only a single host plant was observed (*P. guajava*) with only one species of fly (*B. dorsalis*). Vayssières *et al.* [1], Ivan *et al.* [31] and Mayamba *et al.* [25] concluded that fruit maturity influences the distribution of Tephritidae during the year. During February, March, April and December, none fruit fly emergence was observed, this result could be justified by exploitation of wild hosts [30]. *Bactrocera dorsalis* was the predominant fruit fly species during emergence on incubated fruits and the most present. It was the only species present during January, May and October. Other occurrences of this pest were associated with that of other species: *C. fasciventris* in June, July and August; *D. punctatifrons* in September. *Bactrocera dorsalis* was also associated with two species *C. cosyra* and *C. fasciventris* in June. Even in the presence of other fruit fly species, *B. dorsalis* remained the dominant species. N'dépo *et al.* [22] also observed the dominance of this species over all other native species. *Bactrocera dorsalis* is a major pest of tropical fruits [32]. It was reported present in Benin, Mali, Nigeria, Senegal, Sudan, Tanzania, Togo, Uganda, Equatorial Guinea, the Comoros, Mozambique, Indian Ocean and Cameroon [15, 23, 33]. Among cultivated

fruits, mango is the primary host [7]. The invasion of this fly follows the theory Duyck *et al.* [29]. This theory suggests that if a polyphagous species of Tephritidae is introduced into an area already occupied by another polyphagous species, it results in interspecific competition with niches reduction of the old species without its extinction. At Senegal and Ivory Coast *B. dorsalis* settled and is competing with the native species *C. cosyra* [7].

4. Conclusion

Four species of fruit flies emerged from fruit collected: *B. dorsalis, C. fasciventris, C. cosyra* and *D. punctatifrons*. They emerged from six plants: *P. guajava*, *M. indica*, *C. reticulata*, *B. toxisperma*, *C. vulgaris* and *A. senegalensis*. *Bactrocera dorsalis* was the most abundant fly on fruit. It develops preferentially on *P. guajava* around the beginning of the rainy season. Survey of this pest will be a contribution to define the best time to apply different management techniques.

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