

Distribution and host plants of *Bactrocera cucurbitae* in West and Central Africa

Jean-François VAYSSIÈRES^{a*}, Jean-Yves REY^b, Lanciné TRAORÉ^c

^a Cirad, UPR Production fruitière, IITA, Biological Control Center for Africa, 08 BP 0932, Tri postal, Cotonou, Benin
j.vayssieres@cgiar.org

^b Cirad, UPR Production fruitière, ISRA, BP 484, Thies Escale, Senegal

^c Laboratoire de Protection des Végétaux, Foulaya, Kindia, BP 156, Guinea

Distribution and host plants of *Bactrocera cucurbitae* in West and Central Africa.

Abstract — Introduction. The data on *Bactrocera cucurbitae* collected over a large area of West Africa for around the past ten years enables us to make a synthesis, since this economically significant species is now widespread. Fruit samples were collected in the course of various trips to Africa; we focused on looking for the melon fly, *B. cucurbitae* (Coquillett). **Equipment and methods.** The Tephritidae were captured by means of trapping the adults and collecting holed fruit containing larvae. The fruit samples were taken from Cucurbitaceae found in the sub-region, and from other plant families hosting melon fly larvae. Fruit holed by flies were collected from untreated orchards and taken to the laboratory to be weighed, counted and classified by species, variety, date and location. The larvae collected metamorphosed into pupae. After hatching from the pupae, the adults were recovered. **Results and discussion.** The samples taken enabled us to determine the distribution of *B. cucurbitae* in West Africa; this species was found in Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger and Senegal. The fruit collected in these countries enabled us to draw up a list of *B. cucurbitae* host plants in these regions; besides Cucurbitaceae, there were two Anacardiaceae species, two Rutaceae species, one Annonaceae species, one Solanaceae species and one Oxalidaceae species. There were four economically important fruit species among them. Unlike Reunion, where the dietary pattern of the melon fly is oligophagous, in West Africa it appears to be polyphagous instead. **Conclusion.** The data collected from *B. cucurbitae* host plants is subsequently to be validated, and then refined by quantitative analyses for the different West African countries.

West Africa / Central Africa / Réunion / fruits / Tephritidae / *Bactrocera cucurbitae* / fruit flies / surveys / new species / host plants

Distribution et plantes-hôtes de *Bactrocera cucurbitae* en Afrique de l'Ouest et centrale.

Résumé — Introduction. Les données sur *Bactrocera cucurbitae* collectées dans une grande partie de l'Afrique de l'Ouest depuis une dizaine d'années ont permis d'en faire une synthèse alors que cette espèce à fort impact économique est maintenant largement répandue. Des collectes de fruits ont été poursuivies lors de différents déplacements en Afrique ; nous nous sommes focalisés sur la recherche de la mouche du melon, *B. cucurbitae* (Coquillett). **Matériel et méthodes.** Les Tephritidae ont été capturés par piégeage des adultes et par récolte de fruits piqués contenant des larves. Les échantillonnages de fruits ont été réalisés sur les cucurbitacées rencontrées dans la sous-région et sur d'autres familles végétales hébergeant des larves de la mouche du melon. Les fruits piqués par les mouches ont été récoltés dans des vergers non traités et rapportés au laboratoire pour être pesés, comptés et classés par espèce, variété, date et localité. Les larves recueillies se sont métamorphosées en pupes. Après éclosion des pupes, les adultes ont été récupérés. **Résultats et discussion.** Les échantillonnages effectués nous ont permis de déterminer la distribution de *B. cucurbitae* en Afrique de l'Ouest ; l'espèce a été trouvée au Bénin, Burkina Faso, Cameroun, Côte-d'Ivoire, Guinée, Mali, Niger et Sénégal. Les fruits récoltés dans ces pays ont permis d'établir une liste des plantes-hôtes de *B. cucurbitae* dans ces régions ; elle concerne, outre des cucurbitacées, deux espèces d'anacardiées, deux espèces de rutacées, une espèce d'annonacées, une espèce de solanacées et une espèce d'oxalidacées. Quatre essences fruitières d'importance économique figurent parmi elles. Contrairement à l'île de la Réunion où le régime alimentaire de la mouche du melon est oligophage, en Afrique de l'Ouest il serait plutôt polyphage. **Conclusion.** Les données recueillies sur les plantes-hôtes de *B. cucurbitae* seront prochainement confirmées puis précisées par des analyses quantitatives au niveau de différents pays d'Afrique de l'Ouest.

Afrique occidentale / Afrique centrale / Réunion / fruits / Tephritidae / *Bactrocera cucurbitae* / mouche des fruits / enquête / espèce nouvelle / plante-hôte

* Correspondence and reprints

Fruits, 2007, vol. 62, p. 391–396
© 2007 Cirad/EDP Sciences
All rights reserved
DOI: 10.1051/fruits:2007037
www.fruits-journal.org

RESUMEN ESPAÑOL, p. 396

1. Introduction

Fruit flies (Diptera Tephritidae) are pests with a major economic impact, as they inflict serious losses [1] on horticultural industries in the tropical zones. The genus *Bactrocera*, the majority of whose species live in tropical Asia, the South Pacific and Australia, was relatively rare in West Africa until the end of the 1990s. At that time, the only species that we had captured was *Bactrocera mesomelas*, which was recorded in places in Mali and Guinea either as insects captured by trapping, or as larvae from infested guavas (*Psidium guajava*). This species is an oligophagous pest, above all dependent on Myrtaceae in both West Africa and Central Africa. Ndzana Abanda has found it in infested guavas in Cameroon [2].

Certain genera of the Tephritidae family, such as *Bactrocera*, are a perfect example of emerging pests rapidly colonising new territories due to a number of potential factors (high biotic potential of this group, highly significant increase in international trade, proliferation of tropical crops, lack of information for consumers, customs services leaving something to be desired, etc.).

Having collected data on *B. cucurbitae* over a large area of West Africa for the best part of a decade, we believed it was important to make a synthesis of this data, since this economically significant species is now widespread. The data presented herein was obtained from various missions and trips to West Africa over these years. Therefore, after a work on Dacini which attack cucurbitaceae on Reunion Island [3], we continued to collect fruit on various trips to Africa, focusing on looking for the melon fly, *Bactrocera cucurbitae* (Coquillett). We chose to report this data, as it would seem that, in West Africa, the dietary pattern of *B. cucurbitae* is not dependent on cucurbitaceae alone, as is the case on Reunion Island.

The first samples of *B. cucurbitae* in West Africa were taken in 1999 in Gambia by a team of researchers from the *National Agricultural Research Institute* [4]. However, when we captured our first insects in cue lure traps in the year 2000, we were not informed of the collections of this species that had already been conducted in Gambia.

This first stage of the melon fly study primarily involved the qualitative aspects of *B. cucurbitae* hosts in West Africa. We will subsequently validate these results by quantitative data for each West African country.

2. Equipment and methods

Two investigation methods were most commonly conducted side by side in West Africa: trapping adult Tephritidae with dry and liquid traps, and collecting holed fruit containing larvae. In our case, we used cue lure and Torula to trap *B. cucurbitae* adults. The fruit samples were taken from all the cucurbitaceae found in the eight countries in the sub-region, but sometimes also from other plant families on which we had observed melon fly adults.

Fruit holed by flies was collected from untreated orchards in the course of our different investigation trips and taken to the laboratory to be weighed, counted and classified by species, variety, date and location. After being allocated a sequence number, the fruits were placed under observation on mesh supports mounted on sand, so that the larvae could easily drop into the wet sand and metamorphose into pupae. Each lot was individually identified by species, site and date so as to maintain easy-to-follow traceability in the collection process. Once a week, the sand lining the bottom of the containers was washed and then sieved to collect the week's pupae. The pupae, recovered with flexible tweezers, were then placed, with their sequence number, in small hatching boxes lined with wet blotting paper (depending on the season). The hatchings were monitored, and the adults were recovered.

3. Results and discussion

3.1. Distribution of *B. cucurbitae* and date of arrival in West Africa

Bactrocera cucurbitae, or the melon fly, is a species originating from Asia. Just over a decade ago, it was only reported in East Africa (Kenya, Tanzania) [1], where it did not seem to be of major economic significance.

However, this was not the case on Reunion Island, where we had found a very great pressure from this pest, primarily on 16 Cucurbitaceae species [3].

The repeated trapping campaigns which we have conducted, along with the collection of fruit holed by Tephritidae, have enabled us to establish the distribution of *B. cucurbitae* over several West African countries. This distribution is far from complete.

We should first report that, from 1991 to 1996, we used a variety of food attractants which could have trapped this species in Guinea, without managing to capture it [5]. So *B. cucurbitae* was probably not present in Guinea before 1996. Now it is widespread there, at least since the year 2000. Therefore, this species appears to have arrived in West Africa, and therefore in Guinea, between 1996 and 1999.

B. cucurbitae is now present throughout West Africa. We recently captured it in Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, Mali [6], Niger and Senegal (table I).

3.2. *B. cucurbitae* host plants in West Africa

Fruit collected in the eight West African countries where the fly was found (table II) enabled us to draw up a list of the *B. cucurbitae* host plants in these regions. However, this list is far from exhaustive and also involves plant species belonging to families other than Cucurbitaceae: two Anacardiaceae species, two Rutaceae species, one Annonaceae species, one Solanaceae species and one Oxalidaceae species (table II).

In the zone under study, fruit trees had only a low infestation level, but we found from 2005 to 2007 in Benin, as well as in Burkina Faso, that four commercially farmed fruit species could host melon fly larvae: the cashew, mango, orange and carambola trees.

3.2.1. Cashew tree

In 2005, and then 2006, we caught *B. cucurbitae* emerging from cashew fruit (*Anacardium occidentale*), which makes this species a completely new host plant for the melon fly. The damage inflicted on the

Table I.

Locations in seven West African countries and one central African country where *Bactrocera cucurbitae* has recently been captured (cuelure traps).

Country (person who found the pest)	Town	Catching date
Benin (J.F. Vayssières)	Cotonou	16 August 2004
	Cotonou	26 September 2004
	Parakou	08 October 2004
Burkina Faso (J.F. Vayssières)	Orodara	14 August 2000
	Bobo Dioulasso	15 August 2000
Cameroon (T. Brévault)	Garoua	September 2002
Côte d'Ivoire (J.F. Vayssières)	Korogho	24 July 2000
	Mbingué	26 July 2000
Guinea (J.F. Vayssières)	Foulaya	20 October 2000
	Conakry	22 October 2000
Mali (J.F. Vayssières)	Waibera	17 July 2000
	Sikasso	08 August 2000
	Bougouni-Madina	26 July 2000
	Bamako-Konyini	15 June 2000
	Bamako-Kita	15 June 2000
Niger (J.F. Vayssières)	Dosso	10 October 2004
	Niamey	15 October 2004
Senegal (J.F. Vayssières)	Dakar	05 November 2003
	Keur Moussa	17 December 2004

fruit was relatively low (four to five pupae per kg of apples), and emergence of this species represented 35% of the total pupae collected from holed apples in 2005 in Benin. In this country, the other Tephritidae species infesting *A. occidentale* were mainly *Ceratitidis cosyra* and, to a lesser degree, *Bactrocera invadens*, *C. quinaria* and *C. silvestrii*. Apples collected in 2006 and 2007 from the same stations as those investigated in 2005 showed that the populations of *B. cucurbitae* were then less abundant. There appears to be no reference in the literature to this host plant. In Burkina Faso, the emergence figure was about the same.

3.2.2. Mango tree

In Benin, we obtained in 2006 and also 2007 *B. cucurbitae* adults from 'Gouverneur', 'Eldon', 'Alphonse de Goa' and 'Keitt' cultivar mangos. It should be noted that the variety

Table II.

List of plants identified as *Bactrocera cucurbitae* hosts in West African countries, and comparison of average infestation levels of host plants by the pest in West Africa and on Reunion Island.

Family	Genus and species	Common name	Country of West Africa	Mean number of pupae of <i>B. cucurbitae</i> per kg of fruits	
				In West Africa	On Reunion Island
Anacardiaceae	<i>Anacardium occidentale</i> L.	Cashew nut	Benin, Burkina	1–25	–
	<i>Mangifera indica</i> L.	Mango	Benin, Mali	1–25	–
Annonaceae	<i>Annona senegalensis</i> Pers.	Wild custard apple	Benin, Burkina, Mali	1–25	–
Cucurbitaceae	<i>Cucurbita pepo</i> L.	Spaghetti Squash	All of them	26–50	> 100
	<i>Cucurbita maxima</i> Duch.	Pumpkin	All of them	51–75	> 100
	<i>Cucumis melo</i> L.	Melon	Burkina, Côte-d'Ivoire, Guinea, Senegal	26–50	51–75
	<i>Cucumis sativus</i> L.	Cucumber	All of them	26–50	> 100
	<i>Cucumeropsis mannii</i> Naud.	Bitter cucumber	Benin	26–50	–
	<i>Citrullus lanatus</i> (T.) Mats	Water melon	Côte-d'Ivoire, Guinea, Mali, Senegal	26–50	26–50
	<i>Momordica charantia</i> L.	Bitter melon	All of them	76–100	> 100
	<i>Lagenaria siceraria</i> (M.) Standl	Water-bottle	All of them	1–25	76–100
	<i>Luffa cylindrica</i> (L.) Roen	Smooth luffa	Côte-d'Ivoire, Guinea, Mali	26–50	> 100
	<i>Telfairia occidentalis</i> Hook	Grooved pumpkin	Côte-d'Ivoire	1–25	–
Oxalidaceae	<i>Averrhoa carambola</i> L.	Carambola	Benin, Côte-d'Ivoire	1–25	–
Rutaceae	<i>Citrus sinensis</i> (L.) Osbeck	Sweet orange	Benin, Burkina	1–25	–
	<i>Citrus reticulata</i> Blanco	Tangerine	Benin	1–25	–
Solanaceae	<i>Capsicum frutescens</i> L.	Pepper	Benin, Burkina, Mali	1–25	–

known by the name 'Alphonse de Goa' in collections from West African mango trees is known locally as 'Alphonse', but is nothing to do with the better known 'Alfonso' variety. The damage inflicted on the fruit was found to be low (two pupae per kg of fresh fruit) and localised. Emerging melon flies represented 3% of the total pupae collected from holed mangos in 2007, from a few orchards in the northern area of Parakou. Four other main fly species were identified in these fruits: *C. cosyra*, *C. quinaria*, *C. sivestrii* and *B. invadens* [7]. We also got the melon fly from this host in Mali. In the literature, the mango has already been mentioned as an occasional melon fly host [8, 9].

3.2.3. Orange tree

In 2006 in Benin, we obtained melon fly adults from sweet oranges from several mixed orchards in Borgou but also, more

rarely, from orchards located in the departments of Zou and Le Plateau. The orange tree has already been reported as a host for this Dacini species [1]. So *B. cucurbitae* would appear to be a sweet orange pest in Benin, just like the new invading species *B. invadens*, but at a lower level for the melon fly. It would be useful to determine the respective distributions of these two economically significant pests for the main citrus species present in the sub-region. It would appear that *B. cucurbitae* is more based in the Guinean areas, and more particularly the Sudanian areas. We also got the melon fly from this host in Burkina.

3.2.4. Carambola tree

Of the eight fruit samples taken in 2006 from carambola trees in Benin, only two samples recovered *B. cucurbitae* adults. In these

samples, there was low fruit damage (six pupae per kg of apples). The carambola has already been mentioned as an occasional host [1, 9]. We also got it from this host in Côte d'Ivoire.

3.3. The dietary pattern of *B. cucurbitae*

On Reunion Island, the species *B. cucurbitae* was found to be oligophagous, dependent primarily on the cucurbitaceae family (table II), although we very occasionally obtained this species from collected tomatoes and passion fruits [3]. In West Africa, four other plant families were identified as host plants of this pest (table II), and the various samples were taken from various countries of the area, confirming the validity of the data collected. It is interesting to observe that the average number of *B. cucurbitae* adults obtained per kg fresh fruit for each Cucurbitaceae species was less in West Africa than those obtained on Reunion Island (averages over 1997–1998). Might it be possible to find an explanation for this?

The melon fly is not the only pest to make use of these same Cucurbitaceae in West Africa, since *Dacus ciliatus*, *D. bivittatus*, *D. punctatifrons*, *D. vertebratus*, *D. humeralis*, *D. diastatus*, *D. langi*, *D. congoensis*, *D. guineensis*, *D. pleuralis*, *D. bakagiliensi* and *Dacus* sp. were also obtained there [10]. There is a large complex of *Dacus* species linked with Cucurbitaceae crops (commercial and wild as well). Of course, this inventory is far from complete. So there could be a situation of great inter-species competition in this pest family, which may have led to the melon fly having to diversify its dietary pattern. So, although strictly oligophagous on Reunion Island, for example, this dietary pattern appears to be tending towards polyphagy in West Africa.

Under the relatively optimum conditions of the African context (mosaic of highly varied agro-ecological areas, presence of a great number of host plants all year round, marked seasonal differences, low impact of natural enemies, etc.), the melon fly has been able initially to expand its area of influence very quickly throughout West Africa.

Nonetheless, the various ecological niches were already exploited before its arrival by several well-established indigenous fly species. The introduction of a non-indigenous species (*i.e.*, invasive species) may lead to two types of behaviour: in the case of strict hierarchical competition, one of the species dominates and excludes the other, while, in a second situation, the two species cohabit, simultaneously exploiting different ecological niches. With the introduction of *B. cucurbitae* in West Africa, it is the second case which appears to be in evidence, as with *B. invadens* [7]. The main biological characteristics of each species are the determining factors in their population dynamic. Longevity, reproduction rate, fertility, range of host plants and speed of development of the juvenile stages as a function of abiotic factors are what actually determine the result of possible inter-species competition [11] for sympatric Tephritidae species.

It will be necessary to expand this initial data by collecting more infested fruit in the different West African countries. A quantitative analysis of infestation levels in different host plants will then be conducted for all the West African countries.

4. Conclusion

The competing colonising species of the genus *Bactrocera*, such as *B. cucurbitae*, have found a choice habitat by establishing themselves in Africa. Given their biological characteristics, controlling species belonging to this genus is likely to be a long and problematic process. The latest example that we have is that of the invasion, and then rapid expansion, of *B. invadens* throughout sub-Saharan Africa within a few years. While the melon fly indisputably has an oligophagous dietary pattern centred on Cucurbitaceae on Reunion Island, the same does not appear to apply in West Africa, where the dietary pattern of this species seems to be tending towards polyphagy. This preliminary data will need to be validated both over time and space in West Africa; it will also need to be compared with that from East African melon fly populations.

Acknowledgements

We would like to extend our heartiest thanks to Mrs. Kadiatou Touré Gamby (Mali) and Mr. Thierry Brévault (Cameroon) for the assistance they provided us with in this information note. Many thanks also for Ian White's confirmation of the determination of the melon fly.

References

- [1] White I.E., Elson-Harris, M.M., Fruit flies of economic significance: their identification and bionomics, CAB International, Wallingford, UK, 1992, 601 p.
- [2] Ndzana Abanda F.X., Quilici S., Vayssières J.F., Kouedikong L., Woin N., Inventaire des espèces de mouches des fruits sur goyave dans la région de Yaoundé au Cameroun, Fruits 63 (2008) (à paraître).
- [3] Vayssières J.F., Les relations insectes-plantes chez les Dacini (Diptera, Tephritidae) ravageurs des Cucurbitaceae à La Réunion, MNHN, thèse, Paris, France, 1999, 241 p.
- [4] Sanyang S., Announcement: new found pest in West Africa, BioNet-Int. (2001) 3.
- [5] Vayssières J.F., Kalabane S., Inventory and fluctuations of the catches of Diptera Tephritidae associated with mangoes in Coastal Guinea, Fruits 55 (2000) 259–270.
- [6] Vayssières J.F., Sanogo F., Noussourou M., Inventaire des espèces de mouches des fruits (Diptera: Tephritidae) inféodées au manguier au Mali et essais de lutte raisonnée, Fruits 59 (2004) 3–16.
- [7] Vayssières J.F., Goergen G., Lokossou O., Dossa P., Akponon C., A new *Bactrocera* species in Benin among mango fruit fly (Diptera: Tephritidae) species, Fruits 60 (2005) 371–377.
- [8] Harris E.J., Takara J.M., Nishida T., Distribution of melon fly, *Dacus cucurbitae*, (Diptera Tephritidae), and host plants on Kauai, Hawaiian Islands, Environ. Entomol. 15 (1986) 507–512.
- [9] Dhillon M.K., Singh R., Naresh J.S., Sharma H.C., The melon fly: *Bactrocera cucurbitae*: a review of its biology and management, J. Insect Sci. 5 (40) (2005) 1–16.
- [10] White I.M., Taxonomy of the Dacina (Diptera Tephritidae) of Africa and the Middle East, Afr. Entomol. (Memoir 2) 1–156.
- [11] Duyck P.F., David P., Quilici S., A review of relationships between interspecific competition and invasions in fruit flies (Diptera, Tephritidae), Ecol. Entomol. 29 (2004) 461–469.

Distribución y plantas hospedantes de *Bactrocera cucurbitae* en el África occidental y central.

Resumen — Introducción. Los datos sobre *Bactrocera cucurbitae* colectados en una gran parte del África occidental desde hace cerca de diez años permitieron realizar un resumen mientras que esta especie de interés económico se halla ahora muy expandida. Se pretendió coleccionar frutos durante los diferentes desplazamientos a África; nos focalizamos en la investigación de la mosca del melón, *B. cucurbitae* (Coquillett). **Material y métodos.** Se capturaron Tephritidae mediante instalación de trampas para los adultos y mediante cosecha de frutos picados que contenían larvas. Se realizaron los muestreos sobre las cucurbitáceas encontradas en la sub-región, así como sobre otras familias vegetales que albergaban adultos de la mosca del melón. Se cosecharon los frutos picados por las moscas en vergeles no-tratados, se llevaron al laboratorio para pesarlos, contarlos y clasificarlos según especie, variedad, fecha y localidad. Las larvas colectadas se metamorfosearon en pupas. Tras eclosión de las pupas se recuperaron los insectos. **Resultados y discusión.** Los muestreos efectuados nos permitieron determinar la distribución de *B. cucurbitae* en el África occidental; esta especie se encontró en Benin, Burkina Faso, Camerún, Côte-d'Ivoire, Guinea, Malí, Níger y Senegal. Los frutos cosechados en estos países permitieron establecer una lista de las plantas hospedantes de *B. cucurbitae* en estas regiones; concierne, aparte de a las cucurbitáceas, a dos especies de anacardiáceas, a dos especies de rutáceas, a una especie de anonáceas, a una especie de solanáceas y a una especie de oxalidáceas. Figuran entre éstas cuatro esencias fruteras de importancia económica. Contrariamente a la isla de la Reunión, en donde el régimen alimenticio de la mosca del melón es oligófago, en el África occidental se trataría más bien de un régimen polífago. **Conclusión.** Los datos compilados sobre las plantas hospedantes de *B. cucurbitae* se confirmarán próximamente; y, a continuación, se precisarán mediante análisis cuantitativos a nivel de diferentes países del África occidental.

África Occidental / Africa Central / Reunión / Tephritidae / *Bactrocera cucurbitae* / mosca de la fruta / encuestas / especies nuevas / plantas huéspedes