Original article

Inventory and fluctuations of the catches of Diptera Tephritidae associated with mangoes in Coastal Guinea

Jean-François Vayssières[a*]
Sény Kalabane[b]

[a] Cirad-Flhor,
TA 50 / 04, avenue Agropolis,
34398 Montpellier cedex 5,
France

[b] Laboratoire d'entomologie
du centre de recherches
agronomiques de Foulaya,
Kindia,
B.P. 156,
Guinée Conakry

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Abstract — Introduction. The fruit fly (Diptera, Tephritidae) is a primary pest insect in West Africa where it limits the development of fruit crops. Known facts about the species specific to mango trees in Coastal Guinea and their secondary host plants, as well as their population dynamics, are presented in this document and constitute the first step towards the definition of a control program. **Materials and methods**. The list of the species of Tephritidae specific to mangoes was established after collecting the infested fruit and rearing the pest insects for three consecutive years. The dynamics of their populations was studied after catching the pest insects with traps containing parapheromone and food attractants. The food traps were placed at different heights (2, 4 and 6 m) on three varieties of mango trees: Irwin, Kent and Palmer. **Results**. *Ceratitis rosa* and *C. cosyra* were identified as being the main species of Tephritidae infesting the mango trees. The parapheromone attractants appealed principally to the males of *C. rosa*, *C. anonae* and *C. capitata*, while food attracted both males and females of *C. rosa*, *C. cosyra* and *C. punctata*. The flies of the genus *Ceratitis* were essentially found on the trees at 4 and up to 6 m above the ground and the best catches occurred before and during the fruit maturation of the late-yielding varieties of mango trees. **Discussion and conclusion**. Additional steps such as annual follow-up catches, the definition of economic thresholds and a thorough inventory of the host plants (wild or cultivated) should be considered as a continuation to this study. © Éditions scientifiques et médicales Elsevier SAS

Guinea / *Mangifera indica* / Tephritidae / *Ceratitis* / surveys / traps / identification

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Diptères Tephritidae associés au manguier : inventaire et fluctuation des captures en Guinée maritime.

Résumé — Introduction. En Afrique de l'Ouest, les mouches des fruits (Diptera, Tephritidae) sont des ravageurs primaires qui limitent le développement des cultures fruitières. La connaissance des espèces inféodées au manguier en Guinée maritime, de leurs hôtes secondaires et de la dynamique de leurs populations est la première étape, présentée dans le document, de la mise en œuvre d'une stratégie de lutte. **Matériel et méthodes**. L'inventaire des espèces de Tephritidae inféodées au manguier a été effectué par la collecte et la mise en élevage de fruits piqués, durant 3 ans. La dynamique de leurs populations a été étudiée à l'aide de captures réalisées avec des pièges contenant deux types d'attractifs, l'un paraphéromonal, l'autre alimentaire. Différentes hauteurs d'installation des pièges avec attractif alimentaire ont été testées (2, 4 et 6 m) sur des manguiers appartenant à trois variétés, Irwin, Kent et Palmer. **Résultats**. *Ceratitis rosa* et *C. cosyra* ont été les deux principales espèces de Tephritidae identifiées comme ravageurs des manguiers. Les attractifs paraphéromonaux attirent essentiellement les mâles de *C. rosa*, *C. anonae* et *C. capitata*, tandis que les attractifs alimentaires attirent les mâles comme les femelles de *C. rosa*, *C. cosyra* et *C. punctata*. Les cératites seraient essentiellement présentes de 4 à 6 m, dans les frondaisons. Les captures les plus importantes ont eu lieu principalement avant et pendant la période de maturité des fruits pour les variétés tardives. **Discussion et conclusion**. Le suivi annuel des captures, la définition de seuils économiques et un inventaire le plus complet possible des plantes hôtes (sauvages et cultivées) seraient à envisager dans la poursuite de cette étude. © Éditions scientifiques et médicales Elsevier SAS

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* *Correspondence and reprints*

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1. introduction

The diptera Tephritidae of the genus *Ceratitis* MacLeay damage the most important fruit crops cultivated in tropical Africa. The genus consists of about 65 species present either in humid tropical Africa or in the dry zone of South Africa [1]; these species are classified in four subgenera: *Ceratalaspis* Hancock, *Ceratitis* MacLeay, *Pardalaspis* Bezzi and *Pterandrus* Bezzi. Few publications regarding the Tephritidae present in Africa and especially in the western part of the continent are currently available.

Guinea is a country oriented towards fruit growing, but results have been mixed, this despite the tremendous potential for the cultivation of fruit crops: the diversity of the agro-ecological zones, the presence of deep soil, an extremely favorable climate (Guinea is considered as being 'the water tower of West Africa'), the introduction of well-adapted varieties, and the motivation of growers and nurserymen for fruit cultivation. In Guinea, the mango (*Mangifera indica* L.) is certainly the most important fruit crop. Moreover, this tree reaches its potential even under a system of production where the fruit is manually harvested. Mangoes are mainly produced in two zones: Coastal Guinea united with the city of Kindia, and Upper Guinea, in the region of Kankan; this region which enjoys a Sudanese–Guinean climate [2] is apparently the most favorable for the cultivation of mango trees. In both zones, however, the fruit flies, which are spotted intermittently, cause disastrous damage to the trees and prove to be a limiting factor to fruit production. To increase our knowledge on these pest insects involved in such damage, it seemed essential to identify them as well as to study the dynamics of their populations. Trapping campaigns were conducted so as to estimate the extent of the populations present in the mango trees during fruit growth as well as to determine the species of the flies involved in the damage. These investigations constitute the first part of a more comprehensive study on fruit flies of economic importance in Guinea.

2. materials and methods

The station of Foulaya / Kindia has been for the most part the catalyst in the development of a fruit arboriculture of quality in Guinea since 1948. It is located about 100 km from the capital, at an altitude of 450 m, at 10° 03° lat. N and 52° long. W. The research hereby presented was conducted in an experimental mango orchard of the station attached to the Guinean Institute of Agronomic Research. The species of diptera involved in the damage reported on mango trees were first identified; the insects regularly caught were then examined so as to follow the fluctuations of their populations in relationship with the phenology of the host plant.

2.1. identification of the flies

The inventory of the mango damaging flies was conducted from 1992 to 1995.

To detect most of the species involved in damaging the mango trees in Guinea, all the varieties from the mango collection cultivated in Kindia / Foulaya (about 60 varieties in 1991, and close to 100 in 1995) were regularly monitored during fruit production. For all the production period, the fruit infested with flies was collected, then placed into cages where it remained until the adult flies emerged.

Each cage consisted of a block formed with plastic-coated tubes fitted into each other and covered with a fine gauge mesh. Each cubic cage was placed on a wooden base; a container full of sand was placed in each cage and topped by a wooden frame where the infested fruit was laid.

To complement the study focusing on mangoes, infested fruits observed on other fruit crops (guavas, papayas, etc.) were collected in the area of Kindia / Foulaya as well. The observations were conducted in a very similar way as for the infested mangoes.

2.2. catching flies

Trapping is the technique best adapted for catching adult fruit flies because of its

adaptability (availability of traps and attractants of different types) and its ease of use [3]. The traps used for the experiment were supplied by the entomological laboratory of the Cirad research center located in Bassin-Plat (Reunion island) and the attractants were ordered from Great-Britain (Agrisense). We followed the evolution of the catches for two consecutive years, 1994 and 1995.

The 6 ha of land selected for placing the traps are situated on a deep sandstone soil. On that orchard, the trees were planted 10 m apart. In 1995, the mango trees were about 30 years old. Each variety – Kent, Irwin and Palmer – was planted on a 2 ha plot of land. The three plots corresponding to the three mango varieties were adjacent and easily accessible from the road. The orchard was lined with a secondary forest on one side and with vegetable crops (cucumbers, watermelons, etc.) on its other side.

To gather as much information as possible from this experiment, two types of attractants were used in each Nadel type trap, model Addis [4]: the trimedlure, a parapheromone product attractive to the males of the subgenera *Ceratitis* and *Pterandrus*, and the Buminal (80 mL per trap), a hydrolyzed liquid protein or food attractant mostly appealing to females but to males of numerous species as well. Traps with sexual attractant (trimedlure) are useful indicators to quantify the trapped species flights thanks to the male catch.

To determine the right height for the best positioning of the traps, we placed the food traps at three different levels in one tree (2, 4 and 6 m).

Each plot of about 2 ha, each one of them growing one of the three mango varieties, was divided in two:

– on one side, three trees were chosen at random; in each one of them, a trap was placed at 2 m above the ground. The traps were supplied with a 'magnet' dispenser of trimedlure (Agrisense) in the cup and an insecticide (DDVP) cartridge at its bottom.

– on the other side of the plot, three other mango trees were also chosen at random; in each tree, three food traps were placed at three different heights.

Only one restriction applied for the positioning of the traps: 30 m, the equivalent of three tree rows, was the minimum distance required to separate a parapheromone trap (trimedlure) from a food trap (Buminal).

Trapping was conducted from March – period during which the mangoes, depending on the varieties, are 3 to 6 cm long – to early July, end of the fruiting stage. During the first three weeks of March, period during which both the attractants and the system were tested, we were able to obtain preliminary results; according to these results, some modifications proved to be necessary for improving the trapping system.

The traps were collected twice a week, on Tuesday and Friday, to gather all the accumulated flies (dead or still alive). The flies caught in the Buminal traps were washed with water before being isolated in a case containing 70° alcohol while the flies caught in the trimedlure traps were placed directly in the case containing the 70° alcohol. Each catch was labeled inside and outside the case. The food attractants were renewed after each collection (twice a week) while the trimedlure / DDVP combination was replaced only once a month.

Identification and counting initiated in Foulaya were continued in Montpellier with the help of persons from other institutions [1].

3. results

The Tephritidae species of economic importance in Guinea not only colonize mangoes but guavas as well. Among them, certain species even damage vegetable crops. While the Tephritidae are the main primary pest insects of the mango, a lepidopteran of the family Tortricidae, *Cryptophloebia leucotreta* Meyr, appears to be the main primary pest insect of the orange trees [5]. The two species of the genus *Ceratitis* found in the infested oranges we collected had indeed caused less damage to oranges than mangoes (at least during the period of the study, from 1992 to 1995).

[1] The different persons involved were:
G. Delvare and J.M. Maldès, Cirad (Centre de coopération internationale en recherche agronomique pour le développement, France); M. De Meyer, KMMA (Koninklijk Museum voor Nidden Africa, Tervuren, Belgium); I.M. White, IIE / Cab International (International Institute of Entomology, UK); L. Matile, MNHN (Museum national d'Histoire naturelle, France); D.L. Hancock, QDPI (Queensland Department of Primary Industries, Australia) and A. Freidberg, TAU (Tel Aviv University, Israel).

3.1. climatic data

According to an analysis of the African bioclimates [2], Kindia is located in the zone of coastal Guinean or Subguinean climate; this climate is characterized by a pronounced dry season from November to March and a wet season from April to October. The hydrothermal abacus of Kindia shows a water deficit particularly high from December to March [6].

The temperature and pluviometry data for the years 1994–1995 helped evaluate the relationship between specific climatic conditions and the fluctuations of the number of flies caught.

3.2 inventory of the Tephritidae species specific to mangoes

After observing the adult fruit flies present on the infested mangoes we collected, we identified five species of *Ceratitis* of economic importance: *C.* (*Pterandrus*) *rosa* Karsch, *C.* (*Ceratalaspis*) *cosyra* Walker [syn. nov. with *C.* (*Ceratalaspis*) giffardi Bezzi], *C.* (*Pterandrus*) *anonae* Graham, *C.* (*Pardalaspis*) *punctata* Wiedemann, *C.* (*Ceratitis*) *capitata* Wiedemann. Other species of the same genus were also present but in small quantities: (*Pardalaspis*) bremii Guerin, *C.* (*Pterandrus*) *flexuosa* Walker, *C.* spp.

The varieties of mango trees most attractive to Tephritidae were in decreasing order of importance: Smith, Miami Late, Palmer, Kent, Amélie, Eldon and Irwin.

3.3. distribution of the different species of *Ceratitis* identified

In Guinea, *C. rosa* also called the Natal fruit fly is, by far, the largest and most damaging species to mango trees. We collected them on guavas (*Psidium guajava* L.) and papayas (*Carica papaya* L.) as well. This species is very common in East Africa [7], Central Africa, South Africa [8], and in the Mascarene islands [1]. Until now, this particular species had only been reported once in West Africa after being caught in Mali in the 1980s (it is now part of the collection kept in the faunal laboratory of the Cirad). Its identification had always been subject to controversy among taxonomists because of the small number of adult flies found in just one site, but with our records, the presence of this species in West Africa is now confirmed.

The species *C. cosyra* is present in many localities of Guinea on mango trees. We also found it on guava trees and on some undetermined wild tropical fruit trees. This species had already been caught and reared on mangoes in Ivory Coast (in Korhogo) in 1994 (N'Guetta Kouamé, personal comment) as well as in Cameroon [9]. It is also a pest insect of economic importance on mangoes in Kenya [7] as well as in South Africa [8].

C. anonae are found in larger quantities in the savanna zone of Kankan (Upper Guinea) than in the secondary forests of Kindia (Coastal Guinea). It was found in Guinea on mangoes, guavas, orange trees planted from seeds (*Citrus* sp.), and avocados (*Persea americana* Mill.). This species appears to be present all over Africa, except for South Africa and it is a major problem on mangoes in Cameroon [9, 10].

C. punctata was reported on mangoes but only in small quantities; we also found it on the Purple Granadilla (*Passiflora edulis* Sims) in Foulaya (Coastal Guinea). This species is widely distributed in tropical Africa [11] and is reported on mangoes in Cameroon and East Africa [12].

C. capitata also called the Mediterranean fruit fly was collected on mangoes, guavas, and oranges (*Citrus sinensis* Osbeck) in Middle Guinea; on coffee trees (*Coffea canephora* Pierre) in the forested zone of Guinea; on *Coffea arabica* L. in Middle Guinea and on the 'strangler fig tree' (*Ficus* sp.) in Coastal Guinea. This species is cosmopolitan.

C. flexuosa was found in small quantities; it had been previously reported in West Africa and Uganda on mangoes [12].

C. bremii, collected on infested mangoes and reared in small quantities, is for the first time referred to as being a mango pest insect [13].

C. giffardi, referred to as a good species in the literature until 1998, has been synonymous with *C. cosyra* since then [14].

3.4. differences in the catches depending on the attractants used

The results obtained after trapping the Tephritidae species specific to mangoes from March to July of 1994 and 1995 revealed the specificity of each attractant.

3.4.1. traps with a parapheromone lure (trimedlure)

The trimedlure traps placed in the three mango varieties grown in the experimental orchard caught mostly male insects from the three following species: *C. rosa*, *C. capitata* and *C. anonae*.

C. rosa, representing about 90 % of the insects trapped during both campaigns (*table I*), is the predominant species. It was mostly observed on the Kent variety (about 40 % of the totality of the insects caught on all the mango varieties during these two years of observation), the Palmer variety (36 % of the insects), and the Irwin variety (24 % of the insects).

In 1994 and 1995, the species was present as soon as trapping was initiated on Irwin mangoes and was later reported on the other two later-yielding varieties (*figures 1, 2*). In 1994, the highest number of flies collected daily per trap for each one of the mango varieties studied oscillated between four and six (*figure 1*); in 1995, the figure remained the same for the Irwin variety but went up to 10 to 12 flies daily per trap for the Kent and Palmer varieties (*figure 1*).

At the end of the two years of study, *C. capitata* represented slightly over 8 % of the insects caught while only a small number of *C. anonae* was reported in 1995. *C. capitata* would start colonizing the mango trees earlier than *C. anonae* observed between late June and late July of 1995 (*figures 1, 2*).

3.4.2. food traps with a liquid attractant (Buminal)

The Buminal traps are highly effective as for the number of flies they catch and the diversity of species they attract (*figures 3, 4*). These traps were mostly attractive to female individuals even though some males were also caught. During the years 1994 and 1995, we mostly trapped five species of the genus *Ceratitis* (*C. rosa*, *C. cosyra*, *C. punctata*, *C. capitata*, and *C. anonae* (*table I*)). We also trapped other species such as *C. bremi*, *C. flexuosa*, *Ceratitis* spp., *Dacus* spp.

In 1995, the catches of *C. rosa* (males and females) on the Kent and Palmer varieties were particularly substantial (*figure 4*) when compared to those of 1994 (*figure 3*). These results match the results obtained with the trimedlure traps the same year (1995, *figure 2*). Conversely, the capture record of male and female individuals of *C. cosyra*, a predominant species in 1994 (*figure 3*), was less important in 1995 (*figure 4*) most likely because of the presence of large populations of *C. rosa* that same year.

The efficiency of Buminal on the pest insects was particularly evident with *C. punctata* (males and females). The males of *C. capitata*, were mostly attracted by trimedlure.

Table I.
Percentages (%) of the species of *Ceratitis* trapped in Coastal Guinea on mango trees (Irwin, Kent, and Palmer varieties) depending on the two types of attractants used: the trimedlure (a parapheromone) and the Buminal (a food attractant).

Year of observation	*C. anonae*		*C. capitata*		*C. cosyra*		*C. punctata*		*C. rosa*	
	Trimedlure	Buminal	Trimedlure	Buminal	Trimedlure	Buminal	Trimedlure	Buminal	Trimedlure	Buminal
1994	0	1	7	2	0	55	0	22	93	20
1995	4	1	10	3	0	29	0	13	86	54

In 1994, at 6 m above the ground (*figure 3*), the species *C. cosyra* was the most prevalent species of *ceratitis* as well as the earliest. The trap records showed a population peak in April for the Irwin and Kent varieties and in June for the three varieties of mango trees combined. *C. punctata* appeared later than *C. cosyra* and colonized mostly the Irwin variety. The largest catch on both the Irwin and Kent varieties occurred in June. As for the species *C. rosa*, less abundant than the species *C. cosyra* and *punctata*, the records showed a peak in May on the Irwin variety.

In 1995, at the same height (*figure 4*), *C. rosa* was by far the dominant species. It started infesting the trees in May, as in 1994, but the largest number of insects trapped was recorded in June, first on the Palmer variety (the most attractive, with three to

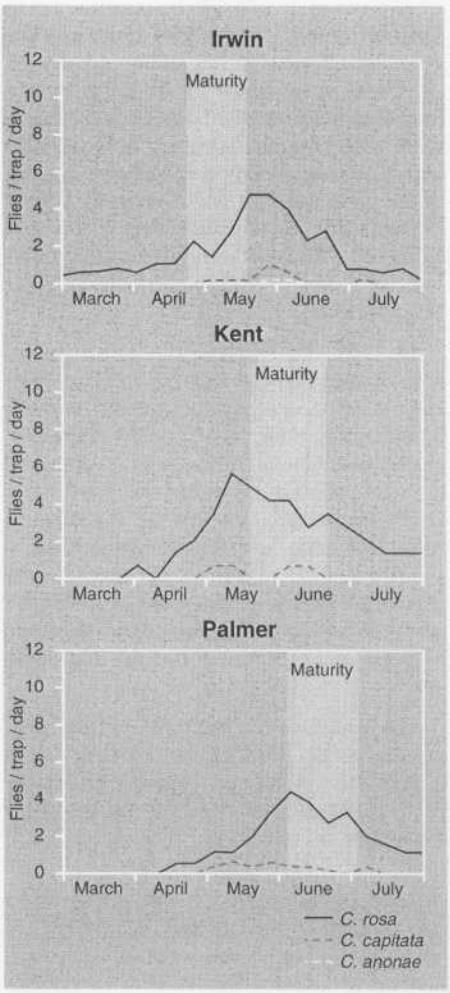

Figure 1.
Comparative study of the variation in the number of flies of the genus *Ceratitis* caught in 1994 on three mango varieties: Irwin, Kent, and Palmer (Agronomic Research Center of Foulaya in Guinea) with traps containing a parapheromone attractant (trimedlure).

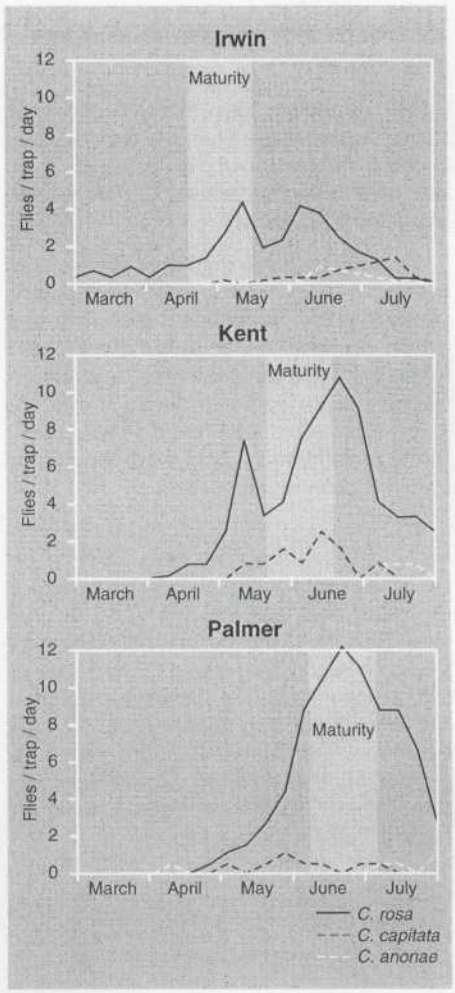

Figure 2.
Comparative study of the variation in the number of flies of the genus *Ceratitis* caught in 1995 on three mango varieties: Irwin, Kent, and Palmer (Agronomic Research Center of Foulaya in Guinea) with traps containing a parapheromone attractant (trimedlure).

four flies per trap daily), then on the Kent variety (with two or three flies at the same period of time). As in 1994, infestations by *C. cosyra* were the first ones to be observed with a similar high capture record. As for *C. punctata*, the number of flies caught in 1995 was as low as in 1994.

The analysis of the differences in catches of the various species depending on the type of attractants used and the different mango varieties confirmed that the trimedlure was the best attractant for the males of *C. rosa* (*table II*) [15, 16] while the hydrolyzed protein was more effective with the majority of the females. The same sexual differentiation observed with *C. capitata* confirmed previous studies [17].

Relatively speaking, the trimedlure also appears to be the best attractant for *C. anonae* and, by catching males only, it

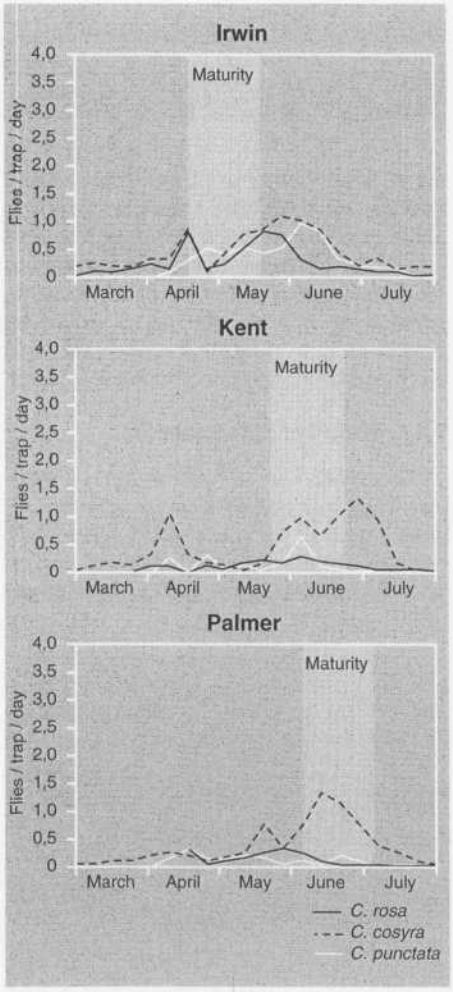

Figure 3.
Comparative study of the variation in the number of flies of the genus *Ceratitis* caught in 1994 with traps containing a food attractant (Buminal); these traps were placed at 6 m above the ground in three mango varieties: Irwin, Kent, and Palmer (Agronomic Research Center of Foulaya in Guinea).

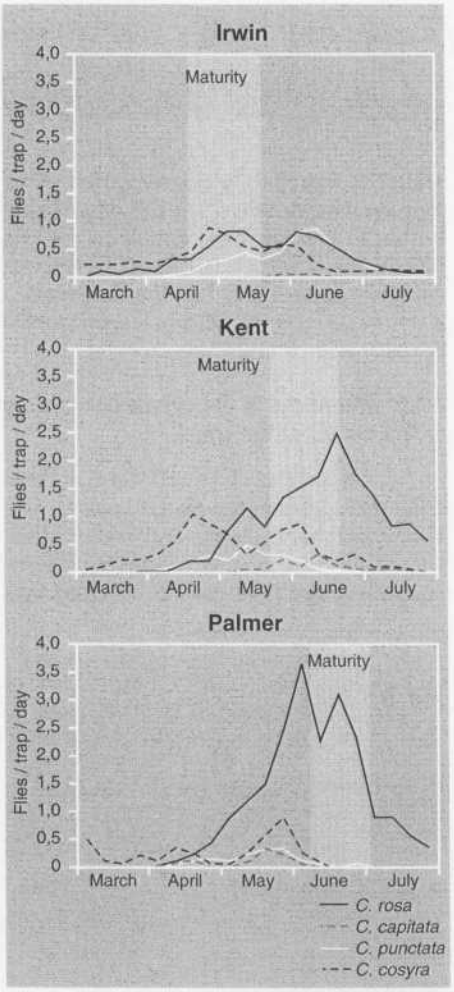

Figure 4.
Comparative study of the variation in the number of flies of the genus *Ceratitis* caught in 1995 with traps containing a food attractant (Buminal); these traps were placed at 6 m above the ground in three mango varieties: Irwin, Kent, and Palmer (Agronomic Research Center of Foulaya in Guinea).

Table II.
Percentages (%) of the species of *Ceratitis* trapped in Coastal Guinea in 1994 and 1995 depending on the mango varieties as well as the type of attractants used: the trimedlure (a parapheromone) or the Buminal (a food attractant).

Variety of mango tree	Trap attractant	*C. anonae*	*C. capitata*	*C. cosyra*	*C. punctata*	*C. rosa*
Irwin	Buminal	0	2	44	28	26
	Trimedlure	1	7	0	0	92
Kent	Buminal	0	1	68	16	15
	Trimedlure	1	6	0	0	93
Palmer	Buminal	0	0	66	16	18
	Trimedlure	1	9	0	0	90

makes it easier to precisely differentiate *C. rosa*. The Buminal, on the other hand, seems to be the best attractant for the females of *C. cosyra* (63 % of the species caught) as well as for the females of *C. punctata* (56 % of the insects represented).

3.4.3. differences in the catches according to the height of the traps

The positioning of the food traps at three different heights in the mango trees (Irwin, Kent and Palmer varieties) revealed that the traps placed at 2 m above the ground were not sufficiently high enough to effectively catch large numbers of Ceratitini of any species (*table III*). The traps placed at 4 m above the ground appeared to be the best placed for catching the species *C. rosa* and *C. punctata*. On the other hand, with the same type of traps, *C. cosyra* would be caught with an equal number whether these were placed at 4 or 6 m above the ground.

3.4.4. evolution of the catches

The number of *C. rosa* caught in trimedlure traps was non-existent or very low for early March (a period of water deficiency), exceeded two males per trap daily for late April–early May (beginning of the wet sea-

Table III.
Percentages (%) of the species of *Ceratitis* caught in Coastal Guinea on different mango varieties (Irwin, Kent, and Palmer) with food traps (Buminal) placed at different heights.

Variety of mango trees	Height of the traps (m)	*C. capitata*		*C. cosyra*		*C. punctata*		*C. rosa*	
		1994	1995	1994	1995	1994	1995	1994	1995
Irwin	2	0	0	11	6	13	13	8	6
	4	24	40	41	54	44	46	50	54
	6	76	60	48	40	43	41	42	40
Kent	2	22	5	8	13	16	16	14	12
	4	56	62	6	54	50	39	50	50
	6	22	33	46	33	34	45	36	38
Palmer	2	–	12	9	5	17	14	12	10
	4	–	20	38	55	56	54	56	47
	6	–	68	53	40	27	32	32	43

son), and progressively increased afterwards (*figures 1, 2*). There is therefore a definite relationship between the first significant precipitation and the catches.

The largest catches on the Irwin mango trees (an early-fruiting variety) occurred after the maturation of the fruit. On the later-yielding varieties of mango trees, such as Kent and especially Palmer, the populations of Tephritidae culminated during fruit maturation.

C. cosyra, a relatively precocious species, seemed to be the only species capable of infesting mango varieties such as Irwin at the end of their maturation stage, late April–early May (*figures 3, 4*).

3.4.5. presence of flies from the tribe Dacini

Besides the flies of the genus *Ceratitis*, the food traps attracted and caught individuals belonging to four species of Tephritidae of the genus *Dacini* also known as the 'vegetable-fruit' fly. The presence of these pest insects could be a consequence of the cultivation of Cucurbitaceae, especially watermelons and cucumbers, at the periphery of the 6 ha of experimental land. These insects most likely use the trees as safety and support when they are not laying eggs on their host plants, the Cucurbitaceae. The most reported fly on these vegetable crops is *Dacus ciliatus* Loew, also called the 'Cucurbitaceae Ethiopian fly'. It was found in relatively large quantities in the traps placed in the mango trees.

4. discussion and conclusion

The genus *Ceratitis* might well be native to Africa. The multivoltine Mediterranean fly (*C. capitata*) is the best known species and is found all over the world (except for the United States) on a very wide range of host plants [1]. The Natal fly (*C. rosa*) has very similar bio-ecological characteristics, except that it tolerates higher altitudes and is mostly distributed in tropical Africa.

On the African continent, the genus *Ceratitis* seems to be mostly associated with mango trees even though it is also reported on other fruit trees; on the other hand, it is not represented very well in the New World where the genus *Anastrepha* is well established in Central and Latin America with its numerous mango damaging species. *C. capitata* is the only *Ceratitis* present on mangoes in Central America and has little incidence on the devaluation of the fruit in comparison with the species of the genus *Anastrepha* [18–20].

When experimenting in Guinea, we noticed that the Mediterranean fly was moderately represented in the entomofauna of the mango trees. Our observation agrees with N'Guetta Kouamé's studies in Ivory Coast [21] as well as Quilici's in Reunion [22]. *C. rosa* and *C. cosyra* were the two main pest insects of economic importance reported on our fruit production in Coastal Guinea; our trap records enabled us to differentiate their respective population peaks. The rearing of these species confirmed that *C. cosyra* adults emerged earlier than *C. rosa*; this fact was verified when observing the trapping with Buminal. The larvae of *C. cosyra* are the first to damage the fruit, sometimes even when immature. On the other hand, *C. rosa* would rather lay its eggs on the fruit as it begins to mature. According to our studies conducted in Guinea, *C. capitata* appears to be present throughout the entire year, with a predominance during the dry season, on various wild or cultivated host plants.

Also, the first 'useful rains' appeared to be directly related to the increase in number of the adult flies caught in the traps. This phenomenon also coincides with the time when the fruit of the early maturing varieties is at the phenologic stages most appealing to the sexually mature females of *Ceratitis*.

To effectively control the dynamics of these insect populations, each host-plant, whether wild or cultivated, must be identified. An additional step would consist in supervising the dynamics of the catches over a year, or even better, over a period of two or three consecutive years.

Our studies constitute a first step towards the improvement of an integrated control program against fruit flies in Coastal Guinea;

they contribute to a better understanding of these diptera by identifying the main species involved and analyzing the fluctuation of their populations. The next step to this project would consist in defining an economic damage threshold by taking into account certain criteria: number of infested fruit, cultivated variety, agroclimatic zone, etc. In that same context, some limiting values have already been determined as well as tested on *Ceratitini* in different environments such as the island of Reunion for example, but cannot be applied to the Guinean mango tree orchards.

After defining this threshold, it should be possible to set up a well-thought-out control program by using specific interventions to go beyond the limited values as defined. The use of specific treatments, especially the use of a mixture of hydrolyzed protein and insecticide, could maintain the populations of fruit flies as well as their damage below the reference economic threshold previously defined [23].

To increase the number of insects trapped, it could be interesting to use a wider range of attractants. One attractant, the Torula yeast (food attractant, Deutsche Hefewerke Gmbh), tested on the island of Reunion with Mac Phail traps, resulted in improved catches of *C. capitata* and *C. rosa* [24]. This attractant could be tested in the agronomic research center of Foulaya (Guinea) and compared with the results obtained with the trimedlure and Buminal attractants. The terpinyl acetate (food attractant, International Pheromone System) should also be tested regarding certain *Ceratitis* species.

The compliance with certain basic farming methods, such as the selection of the appropriate variety when planting new crops, could also lead to a better management of the fruit flies. The removal of certain wild fruit trees growing nearby which could be secondary hosts for this pest insect is recommended as well as the immediate gathering and disposal of the fruit that falls on the ground. The planting of only one mango variety per plot of land, sufficient planting intervals, and sanitary harvesting on the trees with infested fruit are additional recommendations which could limit the development of populations of fruit flies in an orchard.

Finally, the use of early-fruiting mango varieties could be useful for two reasons: they produce fruit during the dry season (February and March in Guinea), a commercial period while the fruit production might have a high added value, and they produce during a time when there is less phytosanitary pressure, whether entomologic as far as the low density of fruit fly populations is concerned or phytopathologic when dealing with the anthracnose.

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Dípteros Tephritidae asociados al mango: inventario y fluctuación de las capturas en la Guinea marítima.

Resumen — Introducción. En el oeste de África, las moscas de frutas (Diptera, Tephritidae) son insectos parásitos primarios que limitan el desarrollo de las fructiculturas. El conocimiento de especies afiliadas al mango en la Guinea marítima, de sus huespedes secundarios y de la dinámica de sus poblaciones son la primera etapa de la realización de una estrategia de lucha, presentada en el documento. **Material y métodos**. El inventario de las especies de Tephritidae afiliadas al mango se ha ejecutado durante trés años gracias a la colecta y a la crianza de las frutas dañadas. La dinámica de sus poblaciones se ha estudiado con la ayuda de capturas, realizadas con trampas que contenían dos tipos de atrayentes: una paraferomona y uno

atrayente alimenticio. Se provaron diferentes alturas para la instalación de las trampas con el atrayente alimenticio (2 m, 4 m y 6 m). Éstos se colocaron en mangos de trés variedades: Irwin, Kent y Palmer. **Resultados**. *Ceratitis rosa* y *C. cosyra* fueron las dos especies principales de Tephritidae que furon identificadas como insectos parásitos del mango. Las paraferomonas atraen esencialmente a los machos de *C. rosa*, *C. anonae* y a los de *C. capitata*. Sin embargo, los atrayentes alimenticios atraen tanto a los machos como a las hembras de *C. rosa*, *C. cosyra* y *C. punctata*. La mosca de frutas simple se presentaría esencialmente desde los 4 m a los 6 m, en el follaje. Las capturas más importantes tienen lugar principalmente antes y durante el periodo de madurez de frutas, sólo cuando se trata de las variedades tardías. **Discusión y conclusión**. Se debería considerar, en la búsqueda de este estudio, los siguientes puntos más detalladamente: los seguimientos anuales de captura, la definición de los niveles económicos de daño y un inventario lo más completo posible de las plantas huespedes (salvajes y cultivadas). © Éditions scientifiques et médicales Elsevier SAS

Guinea / *Mangifera indica* / tephritidae / *Ceratitis* / encuestas / trampas / identificación