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Departamento de Ciências e Engenharia do Ambiente

CabMedMac
MAC/3/A163

Bactrocera dorsalis (ex- invadens) Hendel (Diptera: Tephritidae)

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centre for ecology, evolution and environmental changes

Governo dos Açores
Secretaria Regional da Educação, Ciência e Cultura

Banana imports in European Union (EU)

(Source: FAOstat)

Table 3a. Volumes (1000 t) of imports of fruit into the EU from non-EU countries in 2012

Fruit	1000 t
1. Bananas	4615
2. Pineapples	866
3. Oranges	816
4. Grapes (fresh)	577
5. Apples	504
6. Lemons, limes*	421
7. Melons	353
8. Grapefruit	350
9. Grapes (dried)	320
10. Mandarins*	317
11. Kiwifruit	232

Fruit	1000 t
12. Guavas, mangoes, mangosteens	232
13. Pears	227
14. Avocados	217
15. Watermelons	188
16. Other fruit*	93
17. Plums, sloes	81
18. Dates	73
19. Cherries (incl. sour cherries)	47
20. Figs	40
21. Strawberries	39
22. Peaches (incl. nectarines)	32

Fruit	1000 t
23. Papayas fresh	28
24. Vaccinium	25
25. Raspber., blackber., mulber., loganber.	12
26. Apricots	11
27. Other Citrus	5
28. Quince	4
29. Persimmons	3
30. Black/white/red currants, gooseberry	0,3
31. Durians	0,3

* Short name for the category in Eurostat. See details under Figure 3a.

Banana area in Canary Islands

OPERADORES IGP POR OPP Y SUPERFICIE AMPARADA POR OPP

OPP	Nº OPERADORES PRODUCCIÓN (*)	Nº OPERADORES DE EMPAQUETADO (**)	SUPERFICIE 2019 (ha)
AGRÍCOLA LLANOS DE SARDINA	356	10	1.145
AGRITEN	453	15	1.131
COPLACA	3.059	22	2.947
CUPALMA	2.238	19	1.471
EUROPLÁTANO	687	17	1.156
PLATANEROS DE CANARIAS	814	12	1.060
TOTAL	7.607	95	8.910

Banana production in Canary Islands

DATOS EN TONELADAS DE LA PRODUCCIÓN 2009 -2019

ISLAS	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TENERIFE	154.748	190.531	145.983	159.669	151.738	151.968	174.792	184.391	186.950	162.245	170.354
LA PALMA	131.719	147.181	124.625	131.759	125.866	127.672	131.585	151.327	151.513	143.592	141.794
GRAN CANARIA	69.821	84.724	70.485	77.217	78.022	76.984	78.935	88.837	90.349	77.253	85.755
LA GOMERA	5.475	6.298	5.324	6.023	5.122	4.780	5.208	5.788	5.710	4.673	5.187
EL HIERRO	2.892	3.425	2.613	2.761	2.886	2.738	2.856	3.197	3.124	3.009	2.967
FUERTEVENTURA	0	0	0	0	0	0	0	0	0	48	68
LANZAROTE	179	121	103	99	137	115	114	137	136	105	100
TOTALES	364.834	432.280	349.133	377.528	363.771	364.257	393.490	433.678	437.782	390.925	406.225

Banana exports in Canary Islands

PRODUCCIÓN EN KILOGRAMOS POR ENTIDADES Y DESTINOS 2019

ENTIDAD	PENÍNSULA	EXTRANJERO	MERCADO INTERIOR	RETIRADA DE MERCADO	TOTAL	%
AGRÍCOLA LLANOS DE SARDINA	33.340.902	45.423	7.340.481	624.413	41.351.219	10,18%
AGRITEN	42.456.690	63.180	6.815.366	778.336	50.113.572	12,34%
COPLACA	116.936.426	486.972	11.957.276	2.943.292	132.323.966	32,57%
CUPALMA	59.923.186	79.560	7.648.272	1.325.809	68.976.827	16,98%
EUROPLÁTANO	53.463.370	1.112.420	2.480.409	742.356	57.798.555	14,23%
PLATANEROS DE CANARIAS	50.699.460	59.670	3.813.303	1.088.193	55.660.626	13,70%
TOTALES	356.820.034	1.847.225	40.055.107	7.502.399	406.224.765	100,00%

Fruit area in the Azores

The true importance of this culture in the agricultural area of the Region is verified by **occupying the second place in the area**, just behind the Orange (SREA, 2007).

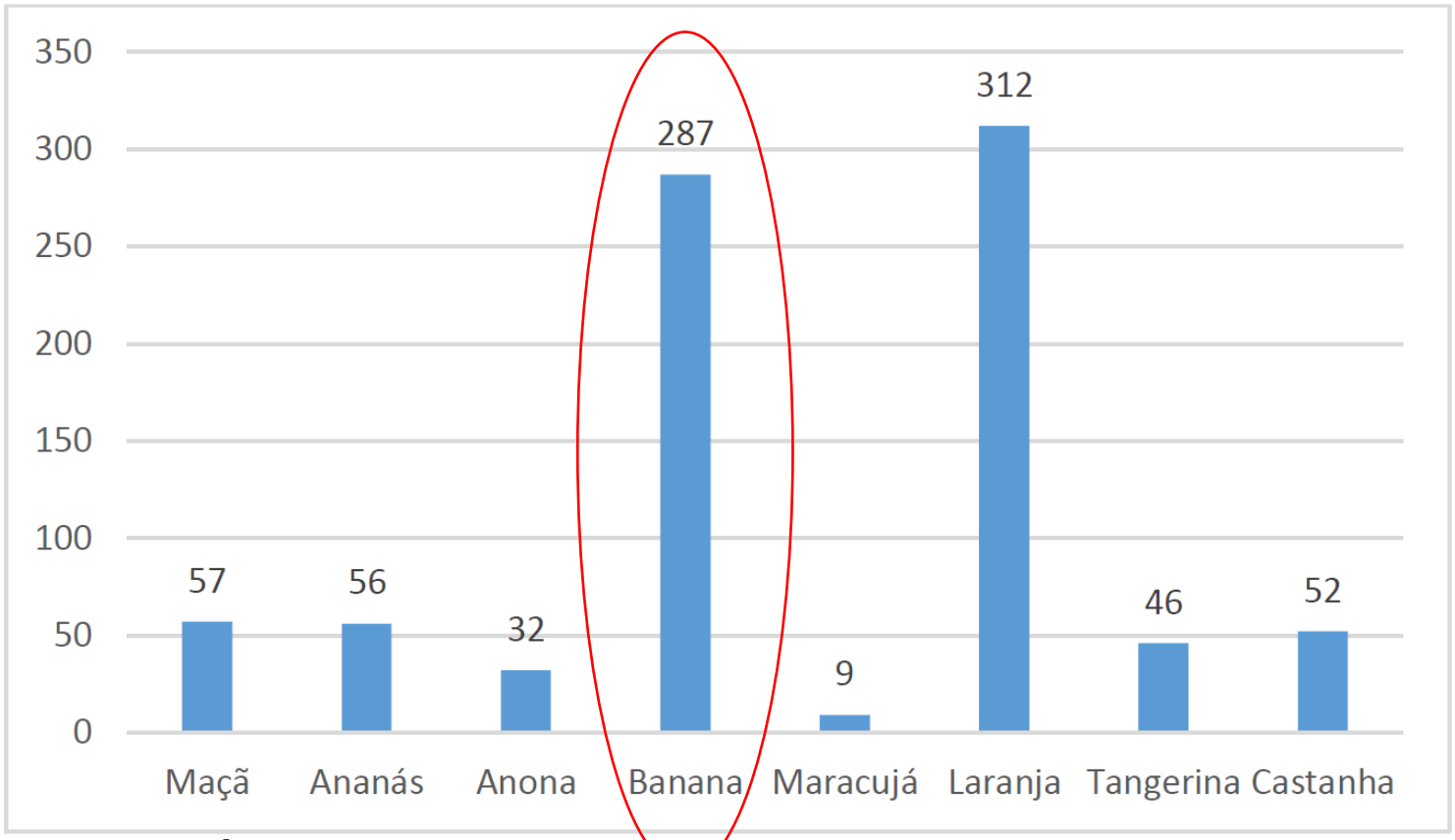

Figura 1 - Área ocupada por culturas frutícolas na região em 2018 (Fonte: SREA)

PROFRUTA, 2019)

Fruit production in the Azores

The true importance of this culture in the agricultural production of the Region is verified when **occupying the first place, in production** (SREA, 2007).

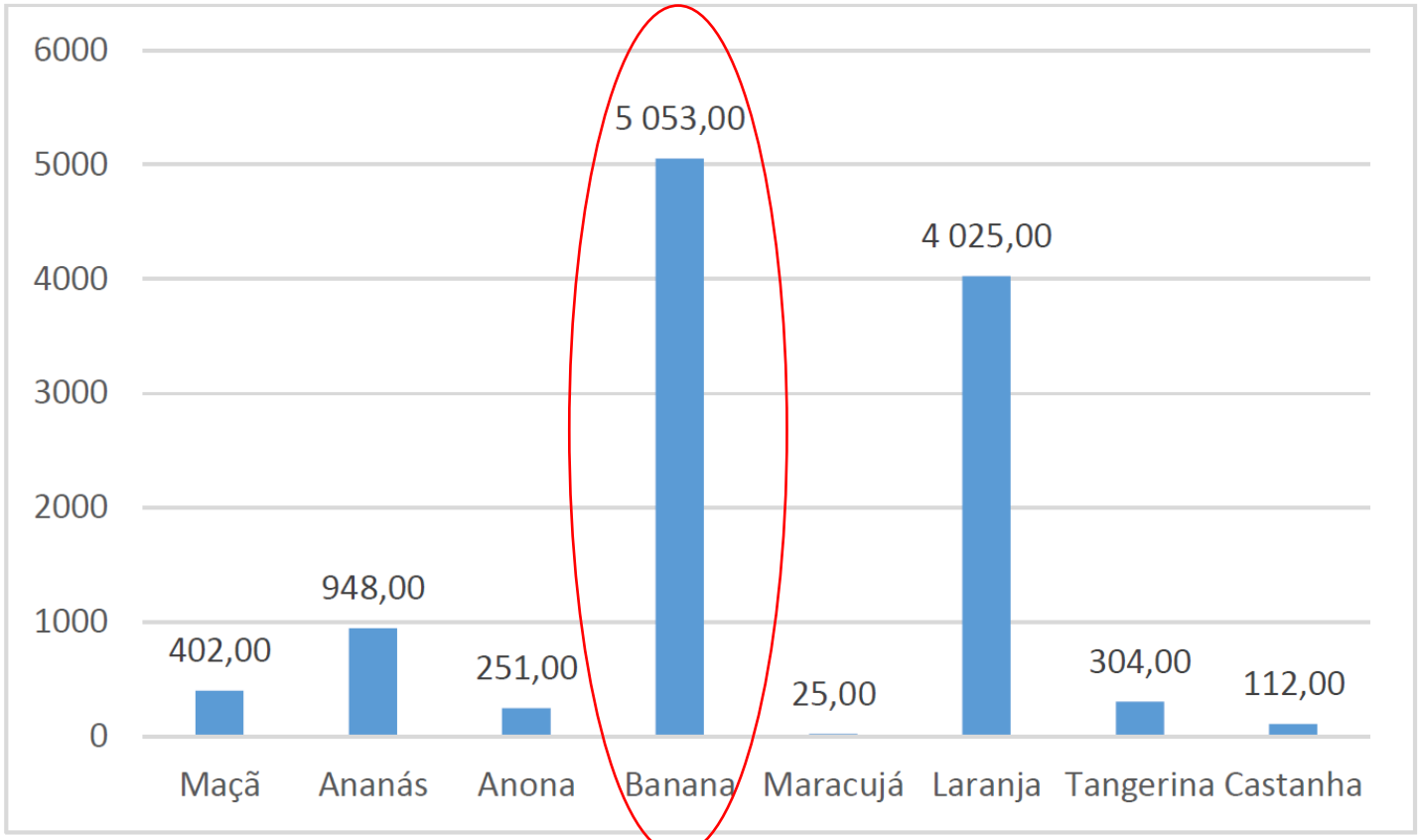

Figura 2 - Produção de culturas frutícolas na região em 2018 (Fonte: SREA)

(PROFRUTA, 2019)

Figure 1: Adult male of Bactrocera dorsalis Hendel (photo of A. Baldé).

Bactrocera dorsalis **Hendel (*ex-invadens*) (Diptera: Tephritidae)** is one of the most danger species for agriculture (San Jose *et al.* 2013), due to the damage it causes in cultivated fruit trees, as well as the care required in the export of products for pest-free regions, such as for Europe and America (EPPO 2009, Goergen *et al.*, 2011).

Waterhouse (1993) identifies it as **one of the five most important agricultural pests** in Southwest Asia.

It is considered a priority **pest for the European community and worldwide**, especially for countries importing fruits from the affected African areas (Goergen *et al.,* 2011).

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Bactrocera dorsalis Hendel

Its color is predominantly yellow, with dark brown spots on the back and has a dark T-shaped band on the abdomen.
It has a gray chest with black spots and the abdomen is streaked with yellow and black bands and transparent wings.

The adult female has a well-developed and easily visible ovipositor

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Phylum: Arthropoda

Subphylum: Uniramia

Class: Insecta

Order: Diptera

Family: Tephritidae

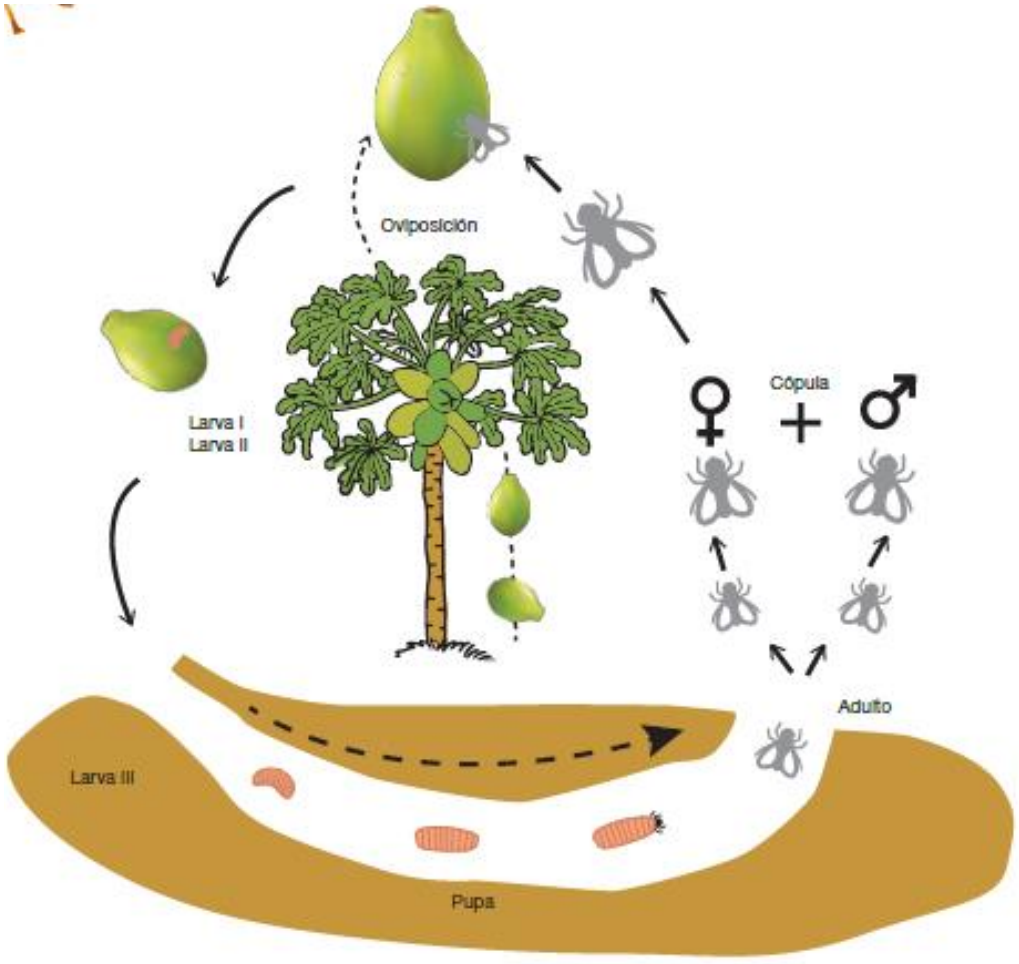
Genus: Bactrocera

Species: ***Bactrocera invadens*** **Drew, Tsuruta & White =** ***Bactrocera dorsalis*** **Hendel**

Life cycle of *Bactrocera dorsalis* Hendel

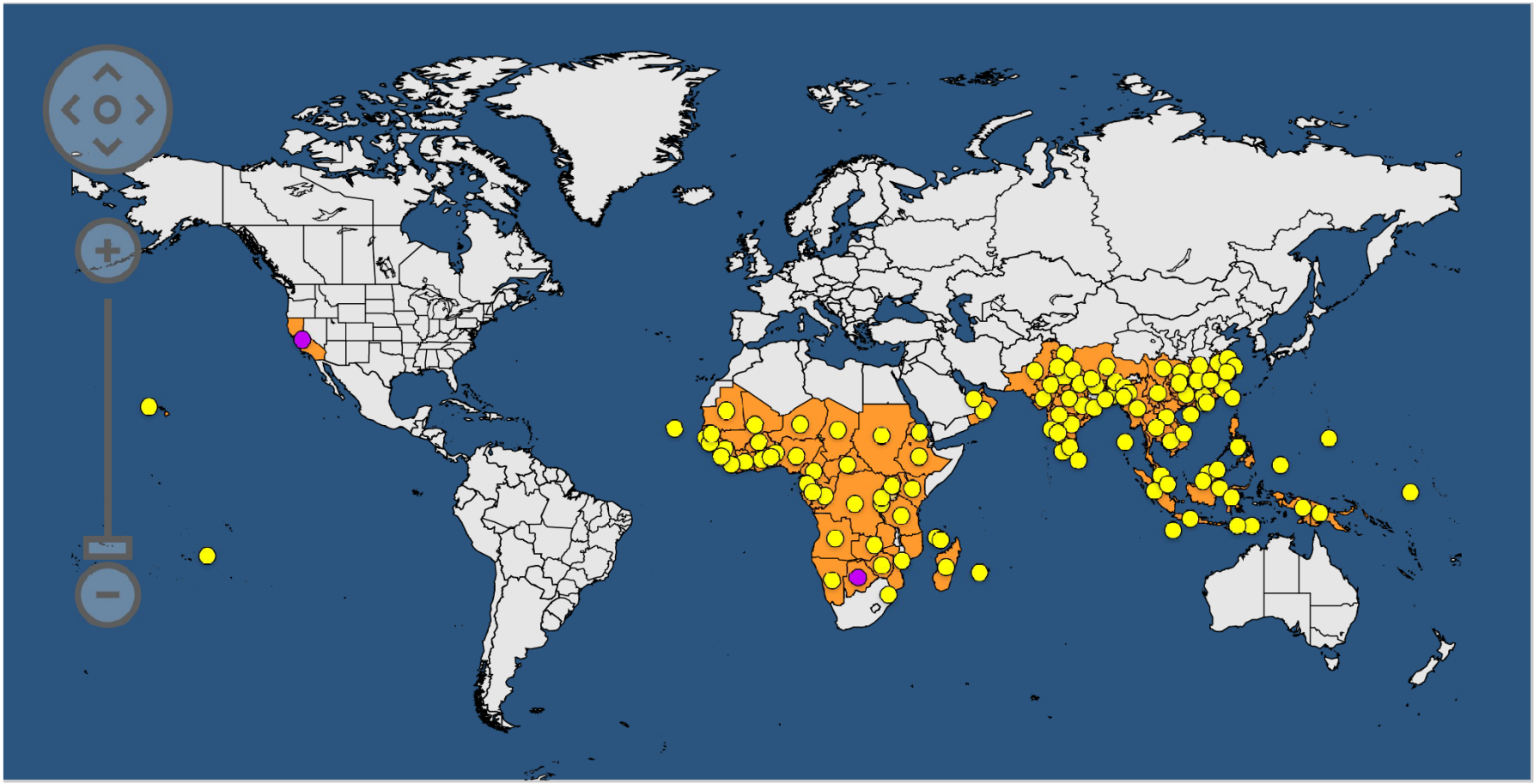
The life cycle of most Tephritidae is similar and **lasts around 40 to 60 days**, it can be divided into four phases:

1. **The first phase** lasts between 2 to 3 days, females lay their eggs on the fruits of the host plant.
2. **The second phase**, lasting between 5 and 10 days, the larvae develop in the fruit pulp, digging galleries. As it ripens, the fruit comes off and falls to the ground.
3. **The third phase** lasts between 9 to 12 days. The larvae leave the fruit for the soil and the pupae that form there develop in the upper part of the soil.
4. **The fourth stage**, the adult insect, after emergence, immediately starts looking for food, mates and the female lays eggs, thus completing its biological cycle.



Ciclo biológico de *Bactrocera dorsalis ex invadens*

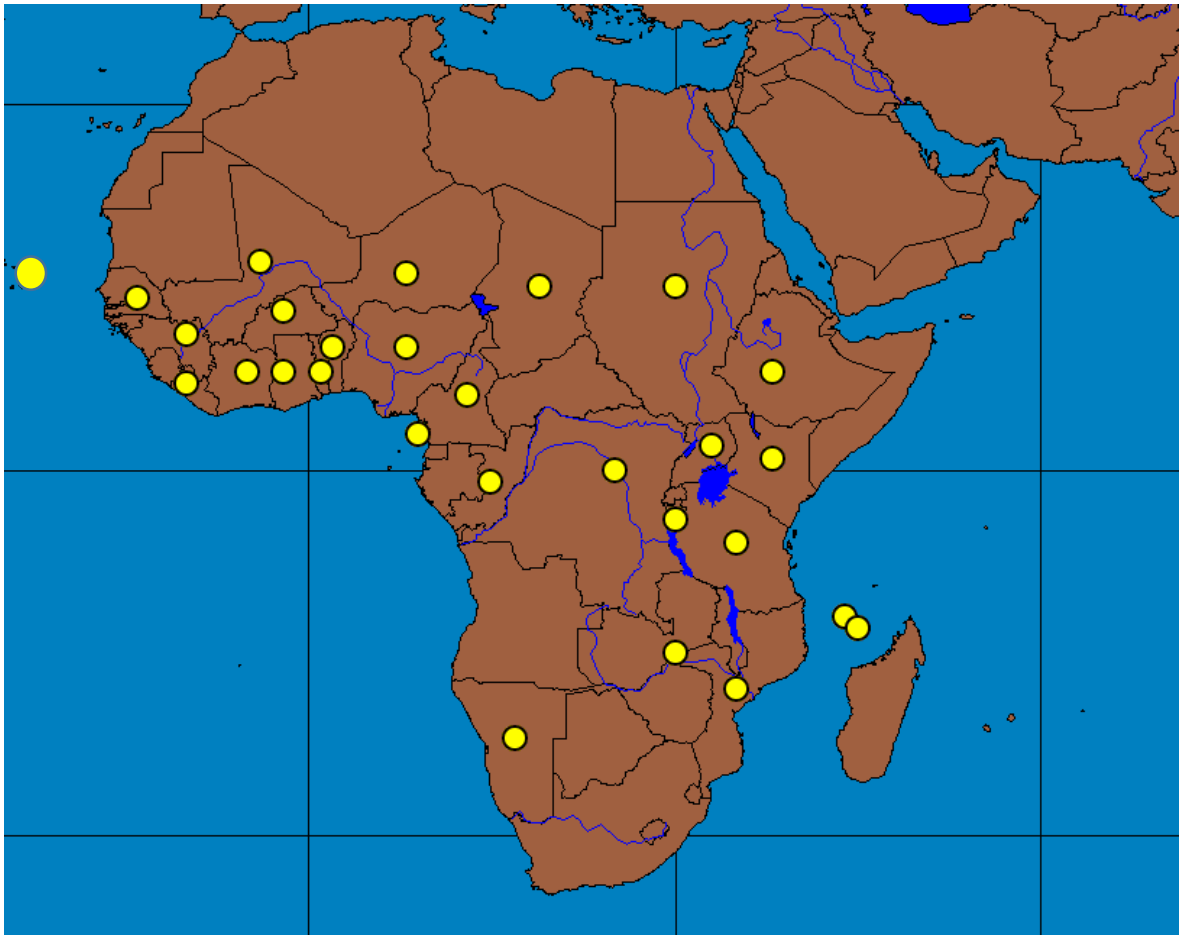
Geographic distribution of *Bactrocera dorsalis (ex-invadens)* Hendel - Situation in 2020



Fonte : EPPO (2020)

Geographic distribution of *Bactrocera dorsalis (ex- invadens)* Hendel in Africa

Today it is marked in more than 20 countries on the continent (EPPO, 2009), namely:
Angola, Benin (2004-06), Burkina Faso, Cameroon (2004-07), Chad, **Congo**, Ivory Coast, Democratic Republic of Congo , Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana (2005-01), Guinea-Conakry, **Guinea Bissau** (2004), Kenya (2003-02), Liberia, Mali, Mauritania, **Mozambique** (2007), Niger, Nigeria (2005 -01), **Senegal** (2004-10), Sierra Leone, Sudan (2004-05), Tanzania (2003-12), Togo (2004-10), Uganda (2004-07), Zambia and **Cape Verde** (2007-09) (De Meyer, *et al.*, 2010).

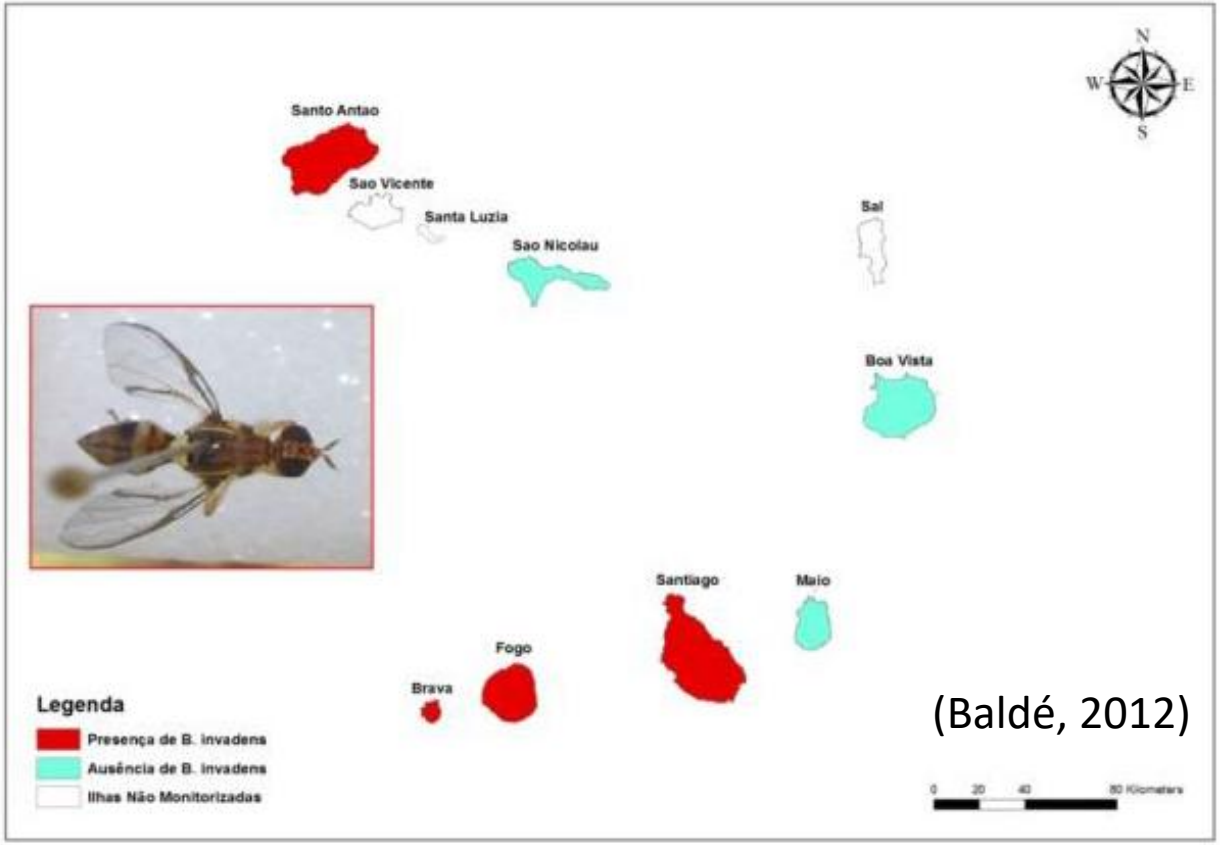


Geographic distribution map of *B. invadens* in Africa (based on White's records, 2006 and references; and unpublished records made available by CIRAD / PRPV, RID / CNEARC, IITA, ICIPE, RMCA and USDA-APHIS)

Geographic distribution of *Bactrocera dorsalis* Hendel in Cape Verde

In studies aiming at the identification of fruit flies **in Cape Verde, *B. dorsalis* was referred on Santiago Island in 2007** and later it was found that it is on other islands in the archipelago (Brava, Fogo and Santo Antão).

Started to appear in Cape Verde affecting fruit production on the island of Santiago the population **peak of adults is usually recorded in June** (Baldé, 2012).



(Baldé, 2012)

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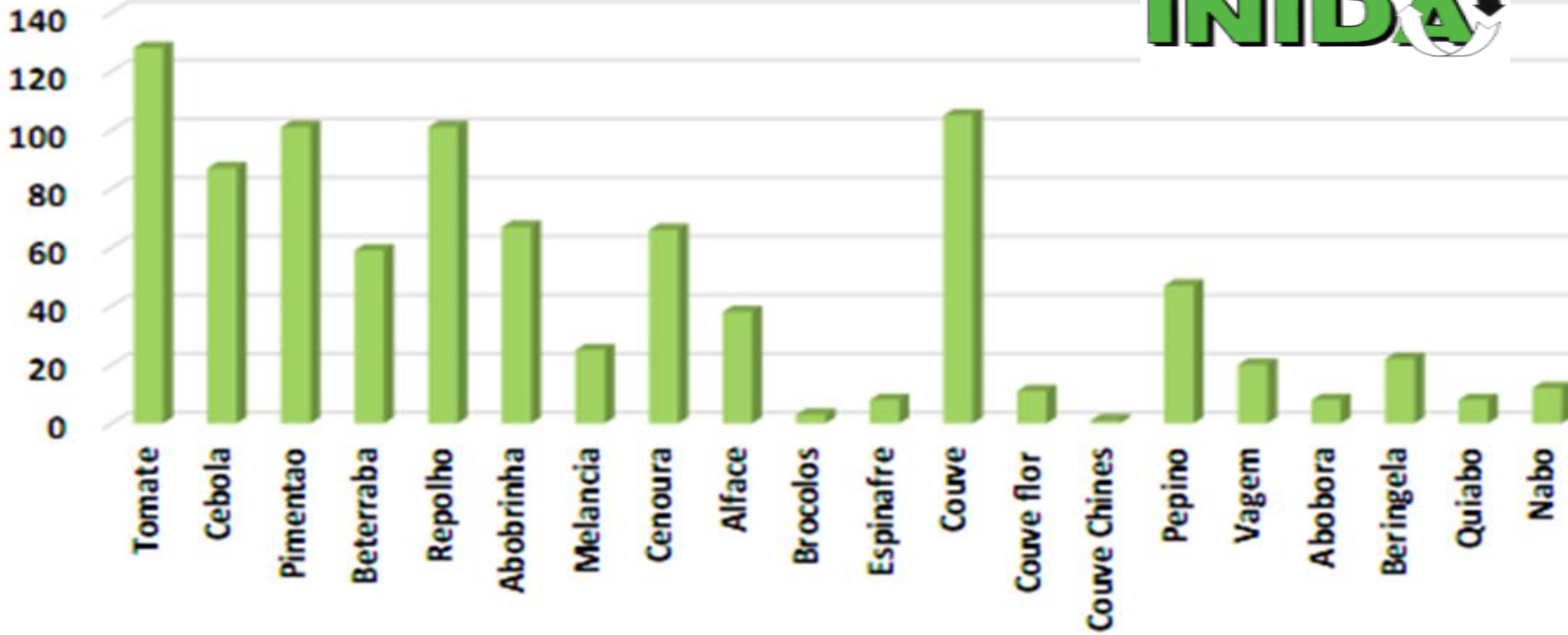
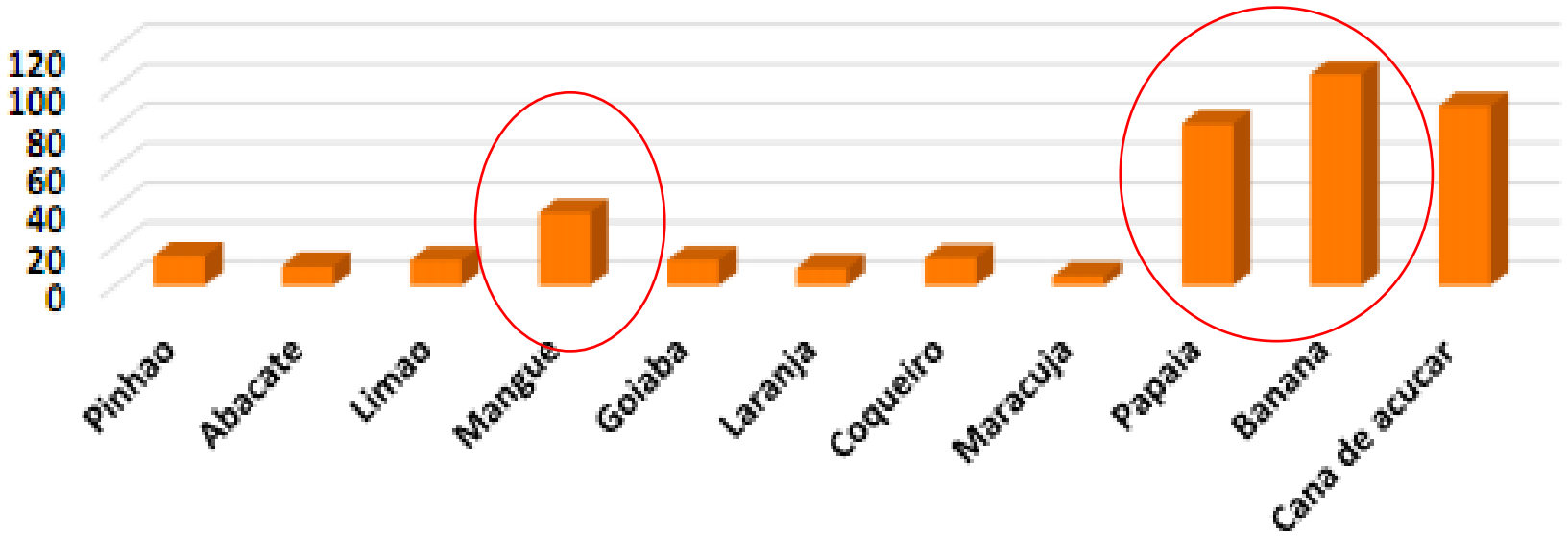


Vegetables produced in Cape Verde

HOST PLANTS

Vegetables, with particular emphasis on courgettes, tomato (*Lycopersicon esculentum),* peppers and chili peppers.



Fruits produced in Cape Verde

HOST PLANTS

***B. dorsalis* has a high reproductive power and aggressive behaviour with other fruit flies (eg *Ceratitis corsyra*)** (Ekesi *et al.,* 2009), **resulting in the built of rapid high population densities.**

***B. dorsalis* is highly invasive, polyphagous, with more than 40 known hosts**

As host plants of great economic or social importance in Africa, it appears in mango (*Mangifera indica),* guava *(Psidium guajava),* cashew (*Anacardium occidentale*), loquat (*Eriobotrya japonica) Citrus spp.,* papaya (*Carica papaya), Musa spp. and Anona spp.*

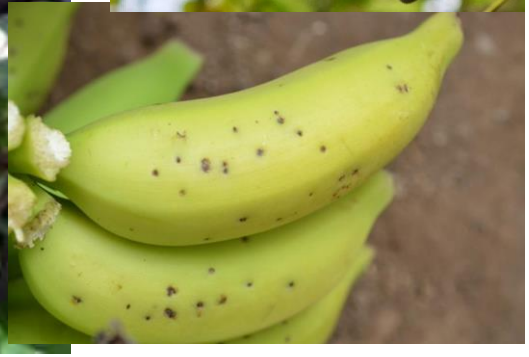
In Cape Verde, host plants include **mango, banana, pine fruit** (*Annona muricata*), **anona**, **cashew and guava**

The most affected **mango varieties in Cape Verde** have been 'Bijagó ',' Keitt 'and' Kent ‘







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Hosts plants of *B. dorsalis* known in Africa

	Common name	Scientific name	Country, Reference
Anacardiaceae	Cashew	Anacardium occidentale	Benin, Goergen *et al.*, 2011
	Mango	Mangifera indica	Western Africa, Goergen *et al.*, 2011; Tanzania 2003, MRAC collection data ; Kenya, Rwomushana et al., 2008a
	Marula plum	Sclerocarya birrea	Ekesi *et al.*, 2006, Benin, Goergen et al., 2011; Kenya, Rwomushana et al., 2008a
		Sorindeia madagascariensis	Tanzania, Mwatawala et al., 2006
	Jew plum	Spondias cytherea	Benin, Goergen *et al.*, 2011
	Tropical plum	Spondias mombin	Benin, Goergen *et al.*, 2011
Annonaceae	Cherimoya	Annona cherimola	Kenya, Rwomushana *et al.*, 2008a; Tanzania, Mwatawala *et al.*, 2009
		Annona diversifolia	Ivory Coast, N'Depo *et al.*, 2010
		Annona montana	Ivory Coast, N'Depo *et al.*, 2010
	Wild custard apple	Annona senegalensis	Western Africa, Vayssières *et al.*, 2009a,
		Annona squamosa	Kenya, Rwomushana *et al.*, 2008a
	Soursop	Annona muricata	Ekesi *et al.*, 2006; Vayssières *et al.*, 2009a; Tanzania, Mwatawala et al., 2006
Apocynaceae		Landolphia sp.	Western Africa, IITA data
	Saba nut	Saba senegalensis	Cameroon, Goergen *et al.*, 2011
	Lucky nut	Thevetia peruviana	Tanzania, Mwatawala *et al.*,2009
Boraginaceae		Cordia sp. cf *myxa*	Kenya, Rwomushana *et al.*, 2008a
Caesalpiniaceae	Cayor pear tree	Cordyla pinnata	Western Africa, Vayssières *et al.*, 2009a
Capparaceae		Maerua duchesnei	Benin, Goergen *et al.*, 2011
Caricaceae	Papaya	Carica papaya	Western Africa, Goergen *et al.*, 2011; Tanzania, SUA data

Fonte: http://www.africamuseum.be/fruitfly/AfroAsia.htm

Hosts plants of *B. dorsalis* known in Africa

Fonte: http://www.africamuseum.be/fruitfly/AfroAsia.htm

	Common name	Scientific name	Country, Reference
Clusiaceae	Chewing stick	Garcinia mannii	Cameroon, Goergen *et al.*, 2011
Combretaceae	Tropical almond	Terminalia catappa	Ekesi *et al.*, 2006; Benin, Vayssières *et al.*, 2008b; Tanzania 2006, MRAC/SUA data
Cucurbitaceae	Egusi	Citrullus colocynthis	Benin, Goergen *et al.*, 2011
	Watermelon	Citrullus lanatus	Tanzania, Mwatawala *et al.*, 2006; Western Africa, Goergen et al., 2011
		Cucumis figarei	Tanzania, Mwatawala *et al.*, 2006 based on single specimen reared
	Cucumber	Cucumis sativus	Tanzania, Mwatawala *et al.*, 2006, Western Africa, Goergen et al., 2011
	Pumpkin	Cucurbita maxima	Western Africa, Goergen *et al.*, 2011
	Gourd	Cucumis pepo	Western Africa, Goergen *et al.*, 2011
	Bottle gourd	Lagenaria siceraria	Benin, Goergen *et al.*, 2011
	Bitter melon	Momordica charantia	Western Africa, Goergen *et al.*, 2011
Dracaenaceae		Dracaena steudneri	Kenya 2004, BMNH collection data
Ebenaceae	Japanese persimmon	Diospyros kaki	Western Africa, IITA data
	Mountain persimmon	Diospyros montana	Benin, Goergen *et al.*, 2011
Flacourtiaceae	Governor's plum	Flacourtia indica	Tanzania, Mwatawala *et al.*, 2006
Irvingiaceae	African wild mango	Irvingia gabonensis	Western Africa, Vayssières *et al.*, 2009a
Lauraceae	Avocado	Persea americana	Kenya, Ekesi *et al.*, 2006; Tanzania, Mwatawala *et al.*, 2006; Wetsern Africa, Goergen et al., 2011
Moraceae		Ficus cf. ottoniifolia	Benin, Goergen *et al.*, 2011
Myrtaceae	Pitanga cherry	Eugenia uniflora	Benin, Goergen *et al.*, 2011
	Jambolan	Syzygium cumini	Tanzania, Mwatawala *et al.*, 2009
	Rose apple	Syzygium jambos	Tanzania, SUA unpublished data; Benin, Goergen et al., 2011
	Malay apple	Syzygium malaccense	Benin, Goergen *et al.*, 2011

Hosts plants of *B. dorsalis* known in Africa

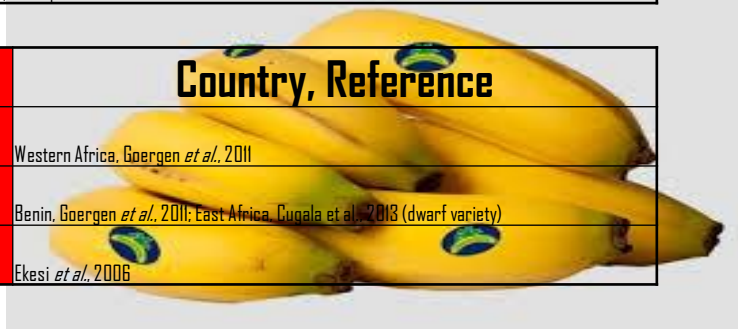
	Common name	Scientific name	Country, Reference
Myrtaceae	Java apple	Syzygium samarangense	Western Africa, IITA data
	Strawberry guava	Psidium littorale	Tanzania, Mwatawala *et al.*, 2009
	Guava	Psidium guajava	Ekesi *et al.*, 2006; Benin, Goergen et al., 2011; Cameroon 2004, MRAC collection data; Tanzania 2004, Mwatawala et al., 2006; Kenya, Rwomushana et al., 2008a
Oxalidaceae	Carambola, starfruit	Averrhoa carambola	Western Africa, Vayssières *et al.*, 2009a
Punicaceae	Pomegranate	Punica granatum	José *et al.*, 2013
Rhamnaceae	Jujube	Ziziphus mauritiana	Benin, Goergen *et al.*, 2011
Rosaceae	Loquat	Eriobotrya japonica	Tanzania, Mwatawala *et al.*, 2006; Cameroon, Goergen et al., 2011
	Apple	Malus domestica	Tanzania, Mwatawala *et al.*, 2009
	Peach	Prunus persica	Tanzania, Mwatawala *et al.*,2006
Rubiaceae	Arabica coffee	Coffea arabica	Tanzania, SUA unpublished data
	Robusta coffee	Coffea canephora	Tanzania, Mwatawala *et al.*, 2009
	African peach	Sarcocephalus latifolius	Westen Africa, Vayssières*et al.*, 2009a
Rutaceae	Sour orange	Citrus aurantiaum	Western Africa, IITA data
	Pomelo	Citrus grandis	Tanzania, Mwatawala *et al.*, 2009
	Lemon	Citrus limon	Ekesi *et al.*, 2006; Tanzania, Mwatawala et al., 2009; Benin, Goergen et al., 2011
	Grapefruit	Citrus paradisi	Tanzania, Mwatawala *et al.*, 2006; Western Africa, Vayssières et al., 2009a
	Tangerine	Citrus reticulata	Western Africa, Goergen *et al.*, 2011; Tanzania, Mwatawala et al., 2006; Kenya, Rwomushanaet al., 2008a
	Sweet orange	Citrus sinensis	Western Africa, Goergen *et al.*, 2011; Kenya, Rwomushana *et al.*, 2008a; Tanzania, Mwatawala *et al.*, 2009
	Tangelo	Citrus tangelo	Western Africa, Vayssières *et al.*, 2009a
	Kumquat	Fortunella margarita	Tanzania, Mwatawala *et al.*, 2010

Fonte: http://www.africamuseum.be/fruitfly/AfroAsia.htm

Hosts plants of *B. dorsalis* known in Africa

	Common name	Scientific name	Country, Reference
Sapindaceae	Ackee	Blighia sapida	Benin, Goergen *et al.*, 2011
Sapotaceae		Achra sapota	Ivory Coast, N'Depo *et al.*, 2010
	White star-apple	Chrysophyllum albidum	Benin, Goergen *et al.*, 2011
		Chrysophyllum Cainito	Ivory Coast, N'Depo *et al.*, 2010
	Bully tree	Manilkara zapota	Western Africa, Vayssières *et al., 2009a*
		Richardella campechiana	Ivory Coast, N'Depo *et al.*, 2010
	Sheanut	Vitellaria paradoxa	Western Africa, Vayssières *et al., 2009a*
Solanaceae	Bell pepper	Capsicum annuum	Western Africa, Vayssières *et al.*, 2005
	Chili pepper	Capsicum frutescens	Western Africa, Vayssières *et al.*, 2009a
	Tomato	Lycopersicon esculentum	Ekesi *et al.*, 2006; Mziray *et al.*, 2010; Western Africa, Goergen et al., 2011
	African eggplant	Solanum aethiopicum	Tanzania, Mwatawala *et al.*, 2009
	African eggplant	Solanum anguivi	Tanzania, Mziray *et al.*, 2010
		Solanum incanum	Tanzania, Mziray *et al.*, 2010
	Black nightshade	Solanum nigrum	Tanzania, Mziray *et al.*, 2010
	Sodom apple	Solanum sodomeum	Tanzania, Mziray *et al.*, 2010
Strychnaceae		Strychnos mellodora	Kenya 2003, R.S. Copeland data

	Common name	Scientific name	Country, Reference
Musaceae	Plantain	Musa x paradisiaca	Western Africa, Goergen *et al.*, 2011
	Cavendish banana	Musa acuminata	Benin, Goergen *et al.*, 2011; East Africa, Cugala et al., 2013 (dwarf variety)
		Musa sp.	Ekesi *et al.*, 2006



Fonte: http://www.africamuseum.be/fruitfly/AfroAsia.htm

Damage of *Bactrocera dorsalis* on Banana (Santiago Island, Cape Verde)

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Damage of *Bactrocera dorsalis* on Banana (Santiago Island, Cape Verde)

Regarding bananas, the work of Cugala *et al.* (2014) in the laboratory, which point to the fact that the **green banana does not allow the development of *B. dorsalis* larvae, contrary to what was observed in the field, on the island of Santiago**, in Cape Verde

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Damage on Mango from *Bactrocera dorsalis* Hendel

Cultivars of mango	Losses in % in 2005	Losses in % in 2006	Average losses in % for 2005 and 2006
Gouverneur	14.8	15.8	15.3
Eldon	44.0	49.4	46.7
Amelioree	50.5	47.3	48.9
Dabschar	50.7	47.9	49.3
Kent	51.6	47.5	49.6
Smith	54.5	55.5	55.0
Keitt	62.8	60.8	61.8
Alphonse	65.0	64.2	64.6
Brooks	65.5	73.1	69.3

Table 1: losses on mango production in Benin expressed in percentages for different varieties for the years 2005 and 2006, experiment performed by JF Vayssières.

(Vayssières *et a*l., 2006)

Fonte: pesticideguy.org

Fonte: www.cbp.gov

Damage on Mango from *Bactrocera dorsalis* Hendel

Damage appearance of *Bactrocera dorsalis* on mangoes

Damage appearance of *Bactrocera dorsalis* on mangoes (Fonte: CIRAD, 2008).

Cicatriz de oviposición (izquierda) y pulpa de membrillo afectada por larva (derecha)

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Economic consequences:

- Decrease in production in the producing country or region
- and inhibiting exports outside those countries

- For Vayssières et al. (2007), the losses due to the introduction of *B. dorsalis* and reached 50% in the middle of the mango harvest season in **Benin** and exceed 60% for the "Brooks" variety.
- On the other hand, in **Mali** the annual production of mangoes is estimated at 100,000 tons, but due to the structural and internal control problems of this pest as well as due to **phytosanitary barriers in the destination countries**, it is unable to export more than 1% of its production.
- **Senegal** alone exports 150.00 tonnes of fruit, 60.000 tonnes of mango and 6.000 tonnes to the European Union (figure 1.3.2).
- Vayssières et al. (2014) refer to the **breaks observed in exports due to the presence of this pest** and, in this particular case, by the fact that the populations of *B. dorsalis* very high in all agroecological zones producing mangoes.
- **This pest is present at ¾ the height of mango production** in **Sudan**, but throughout that time of production in the rainforest, **Guinean** savanna and in the **Sahelian states** (**Mali, Nigeria, Algeria, Burkina Faso, Chad**).
- Another example of the negative economic impact caused by the introduction of *B. dorsalis* is that of **Côte d'Ivoire** where, since 2005, but mainly after 2007/2008, these losses have become very important, causing **high falls in exports of mangoes** observed by that country (figure 1.3.2) (Vayssières et al., 2014).

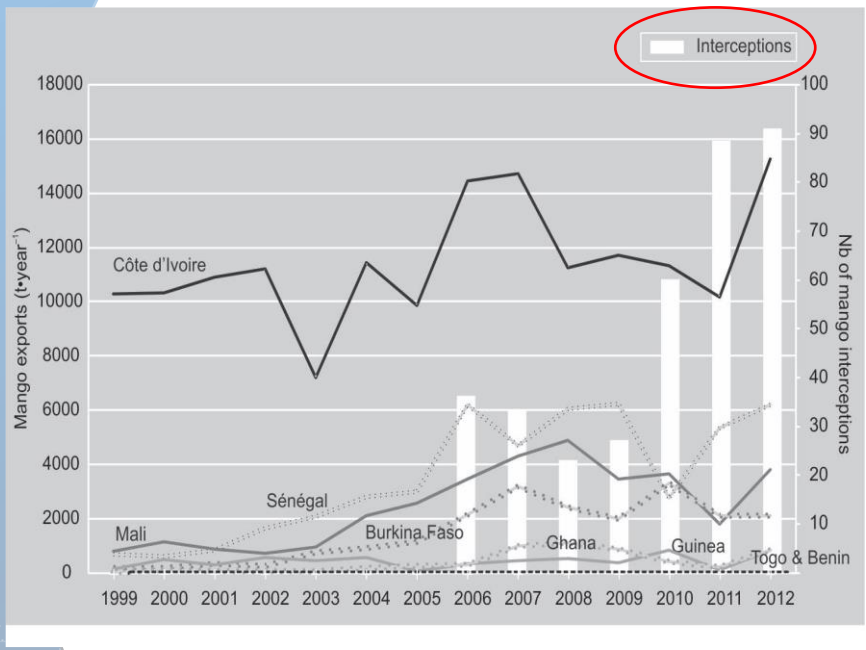
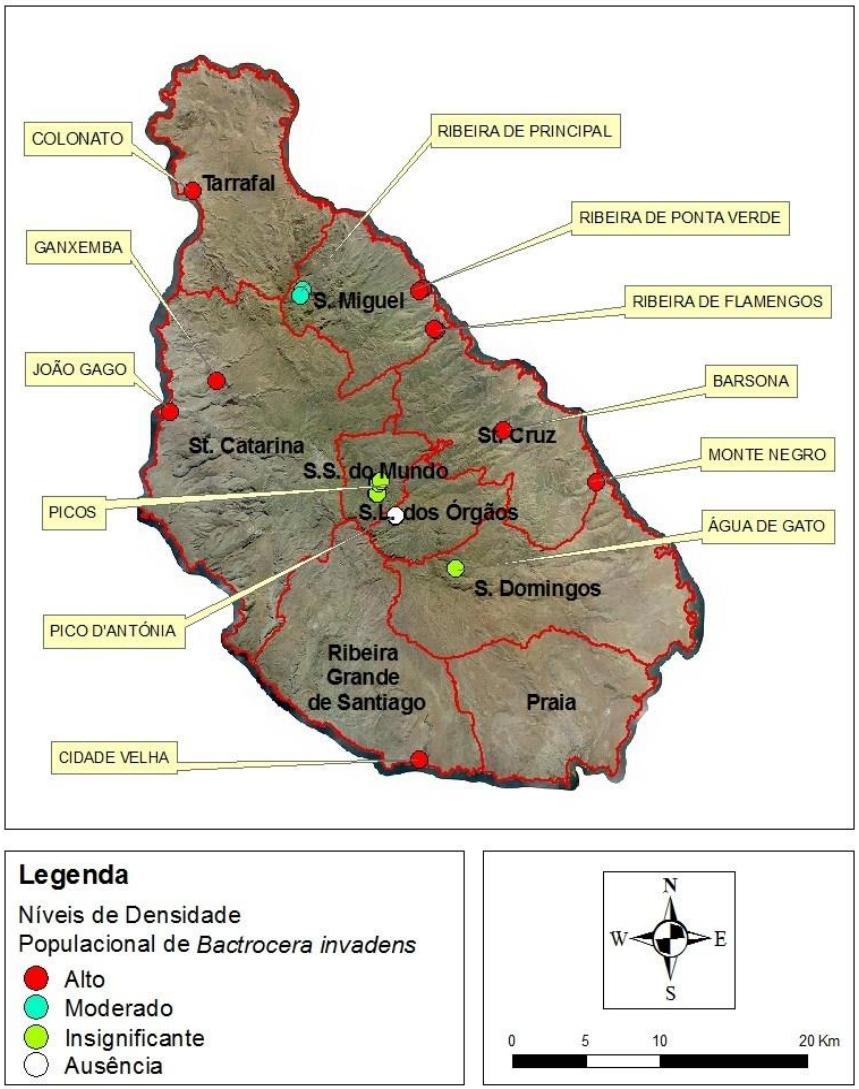


Figure 1.3.2 - Evolution of mango exports from West Africa to the European Union, with an indication of the amounts of interceptions of mangoes infested with fruit flies, from 1999 to 2012 (adapt. De Vayssières et al., 2014).

Monitoring zones established on Santiago Island by the CABMEDMAC project



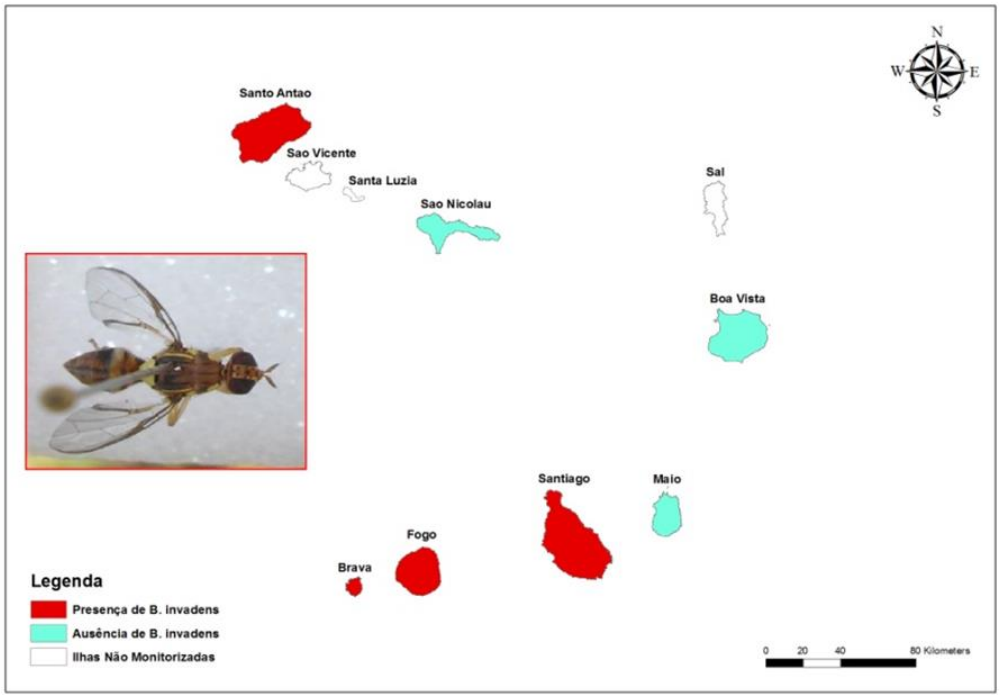
(Baldé, 2012)

Monitoring zones established on Santiago Island by the CABMEDMAC project

- Monte Negro (bananas – East)
- Barsona (mango – East) -
- Ribeira da Barca (mango – West)
- Cidade Velha (mango – South)

(Baldé, 2012)

Monitoring zones established on Santiago Island by the CABMEDMAC project



Spatial distribution of adults of *Bactrocera dorsalis* Hendel, in the different islands of the Cape Verde Archipelago (Baldé, 2012).

- The islands of Maio, Boavista and S. Nicolau are the only ones that seem to be free from *Bactrocera dorsalis*.
- Among these two species of flies present in the archipelago, ***B. dorsalis*** is the most representative and has the **highest population densities and therefore constitutes the greatest threat to national fruit production.**

Traps and adult collection

Use of ABT traps with Creolax (creolin) as an attraction in monitoring adults of *B. dorsalis* and their monthly collection and manual counting

(Baldé, 2012)

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Testing of other traps and of more effective attractants - ex: methyleugenol => better measurement of populations level present in the field

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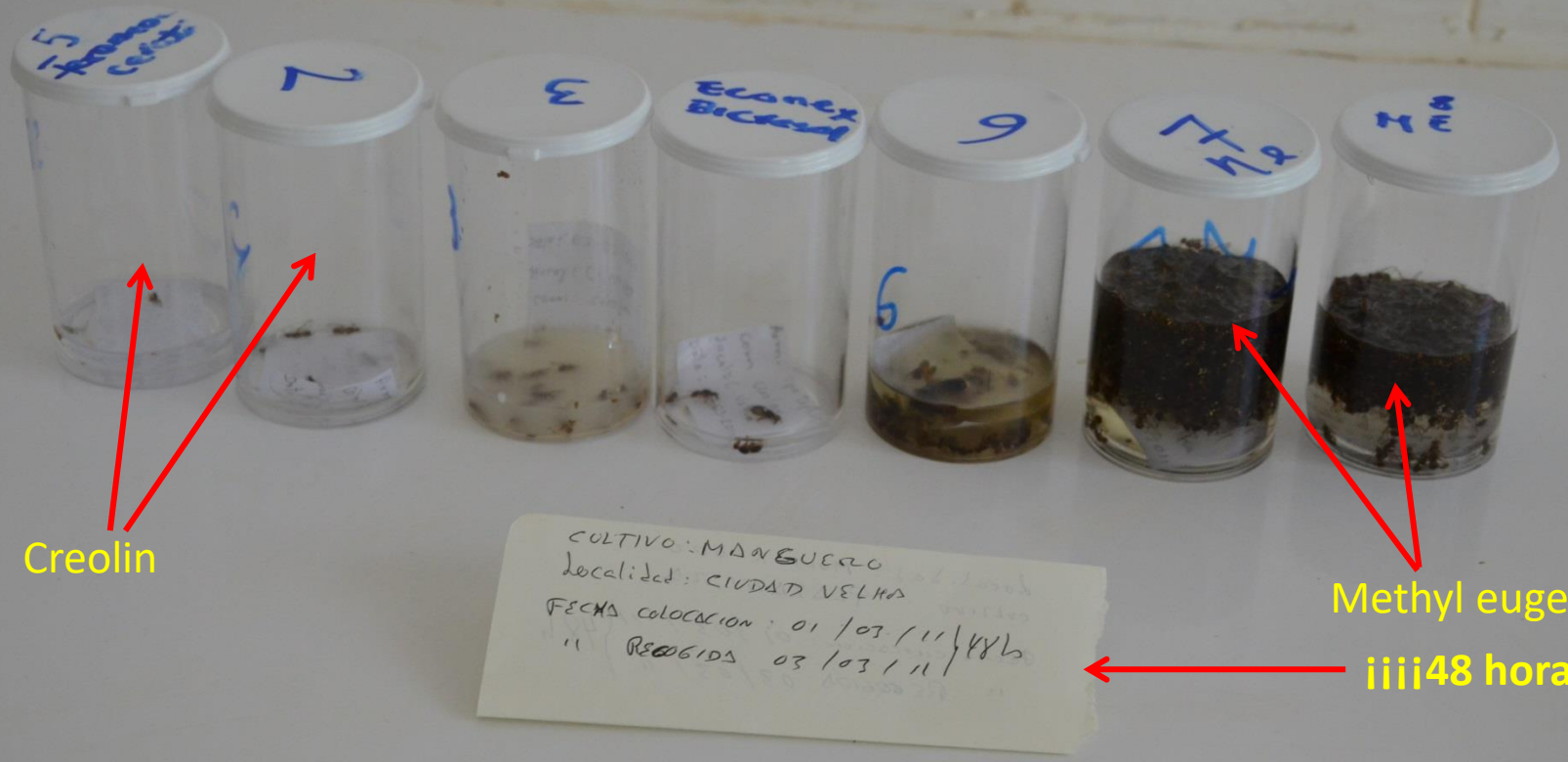
CABMEDMAC PROJECT - Activity 7: Testing of alternatives to combat the *Bactrocera* fruit fly

- Trials with different attractions and traps on the island of Santiago, in Cape Verde (2011/2012)

Testing of methyl eugenol compared to creoline (creolax) in three different types of traps

CabMedMac MAC/3/A163 FEDER MAC 2007 - 2013

Attractiveness tests - 2011



Mango Cidade Velha

Comparison of catches using the current attraction (**creolin**) and other attractions such as **methyl eugenol** tested in two different types of traps

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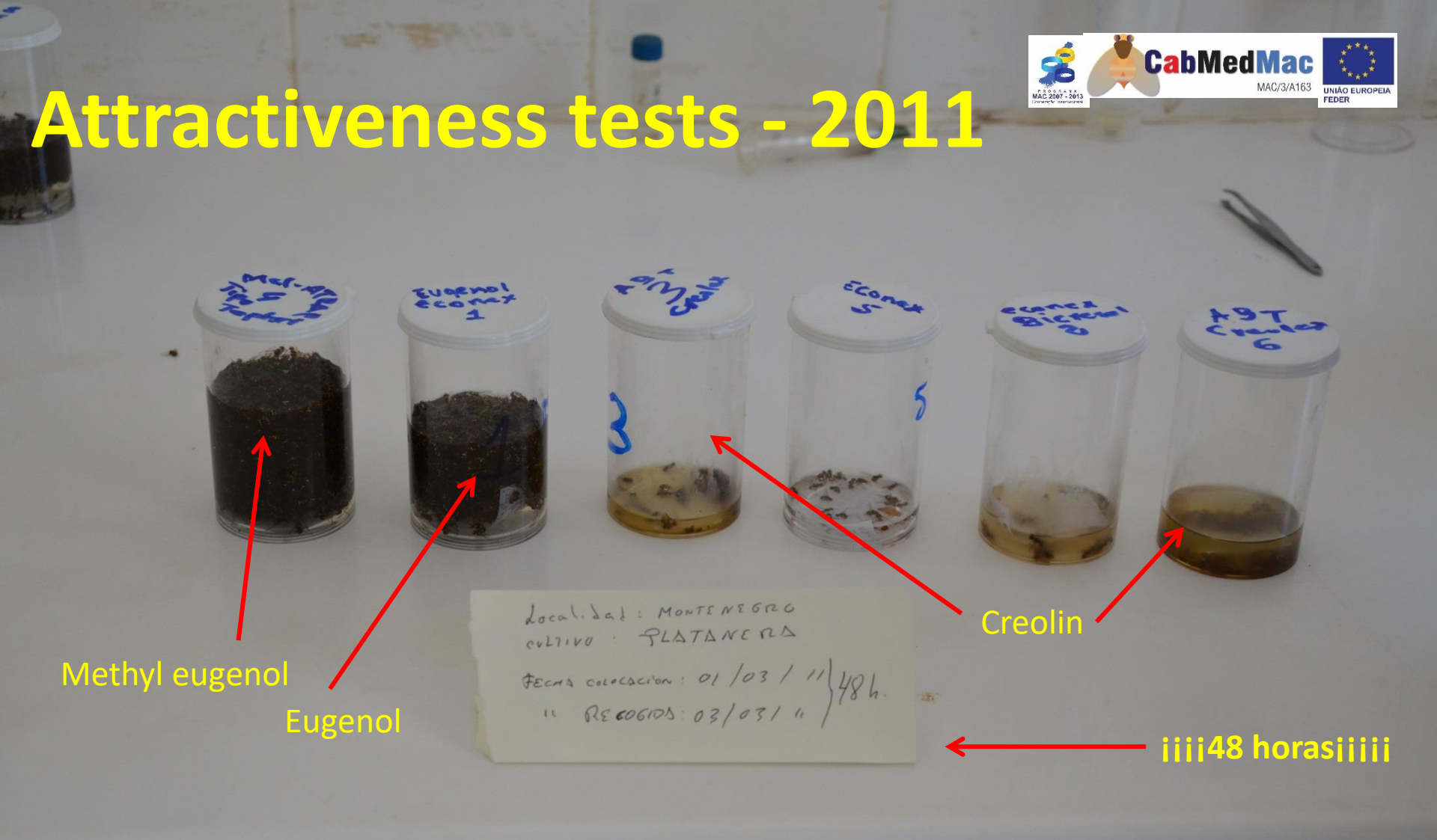
Attractiveness tests - 2011



Bananas Montenegro

Comparison of catches using the current attraction (**creolin**) and other attractions such as **methyl eugenol** tested in two different types of traps

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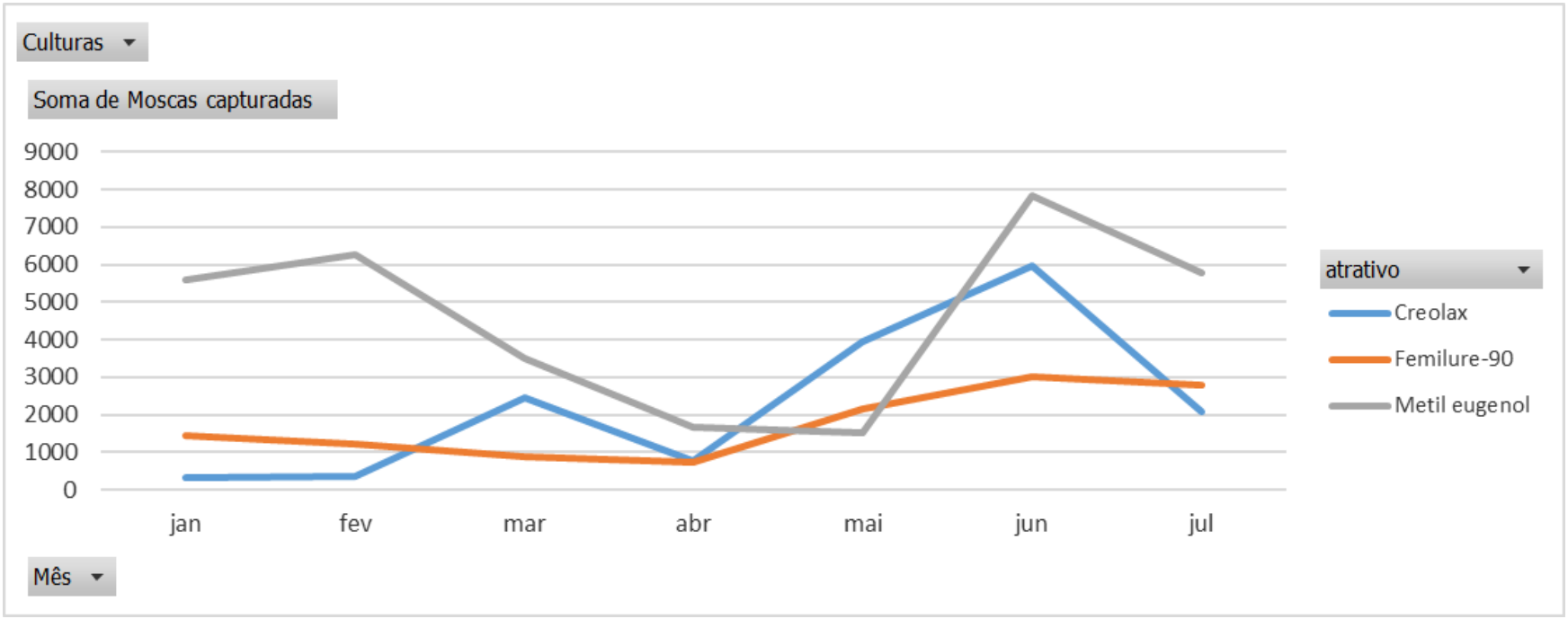
Evolution of adult catches of *Bactrocera dorsalis* Hendel regarding attractive differences



The problem posed by the presence of *Bactrocera dorsalis* Hendel in Cape Verde and CABMEDMAC project

- In 2011, within the activities of the research project CabMedMac (MAC/3/A163), an Macaronesia wide alert was issued through the official channels concerning the need to create and implement **phytossanitary measures for the population limitation in Cape Verde and to prevent the spread to other countries, especially to the Mediterranean zone, as a way of entering Europe**.

- The main objective of all the work done on this project concern **to know the *B. dorsalis* adults population densities on the island of Santiago** in two of the island's main fruit crops, mango and banana, which are the basis for feeding their populations and, in the case of Banana, an important source of income for its scarce producers.

CabMedMac
MAC/3/A163

PROGRAMA MAC 2007 - 2013

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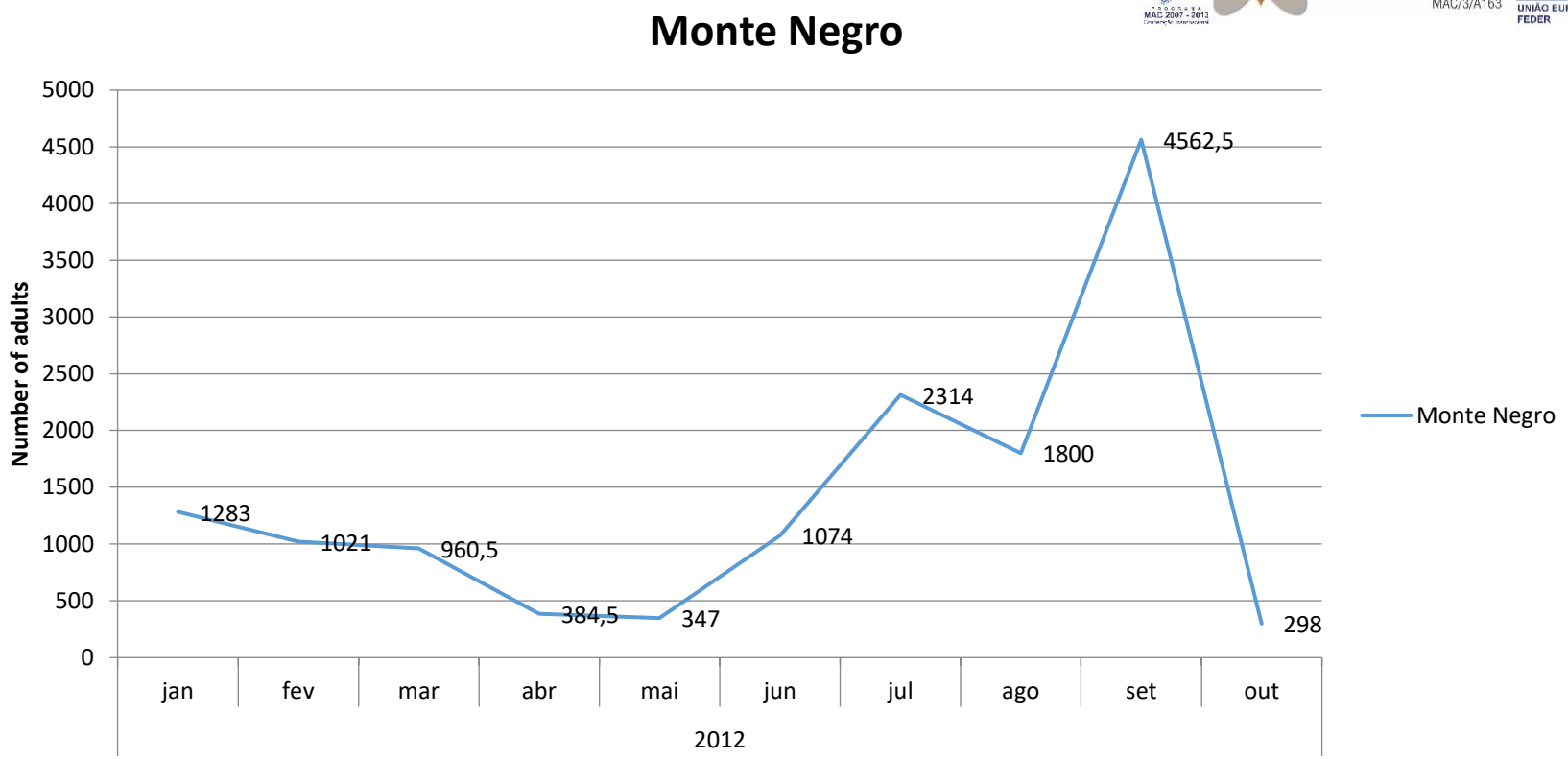
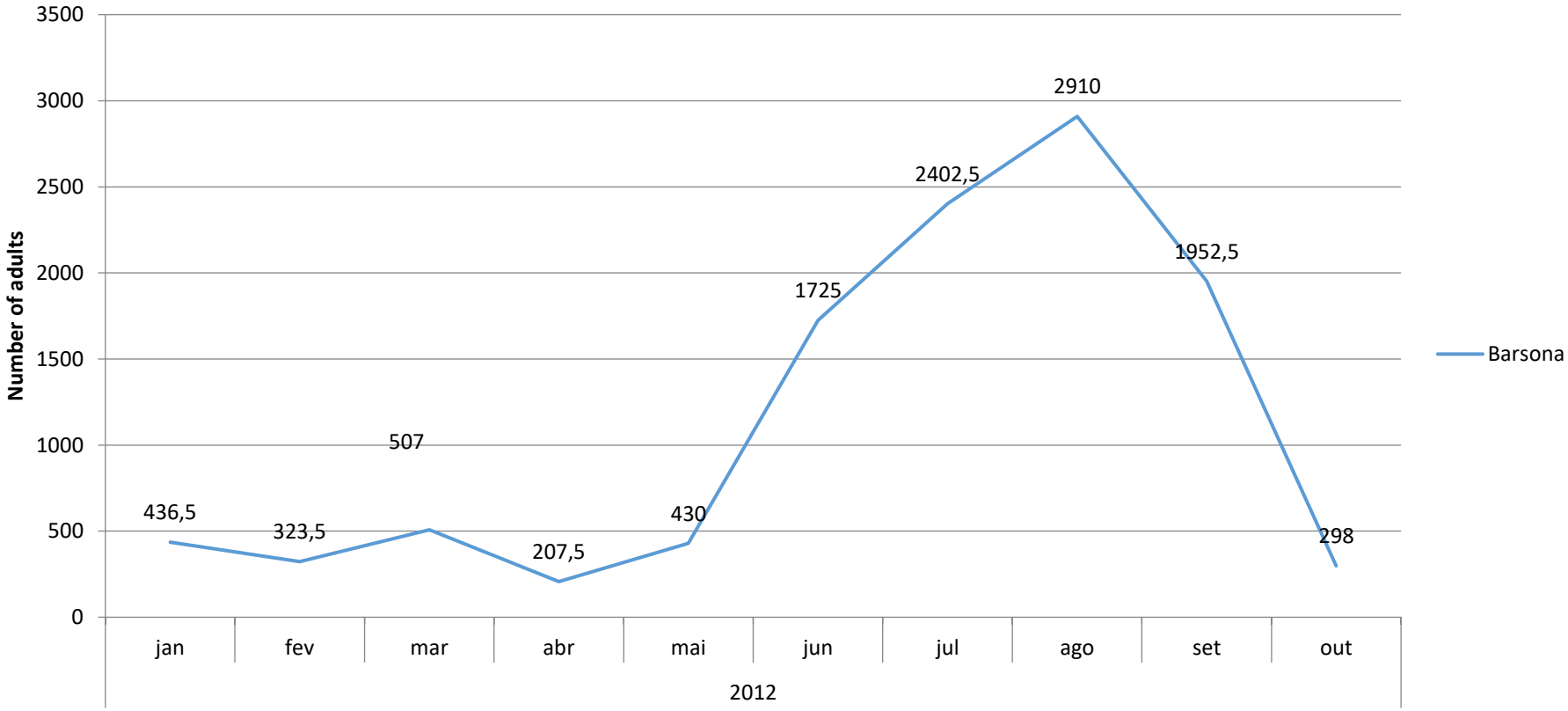
Evolution of adult catches of *Bactrocera dorsalis* Hendel



The population peak in **bananas** in this area appears in September (eastern zone)

It reaches more than 4,500 adults per trap per month, the highest value of all monitored areas and in an important host.

Evolution of adult catches of *Bactrocera dorsalis* Hendel



The population peak coincides with the maturation season of the **mango fruits** that is in August (East zone)

Reaches an average of **captures more than 2,900 adults per trap**

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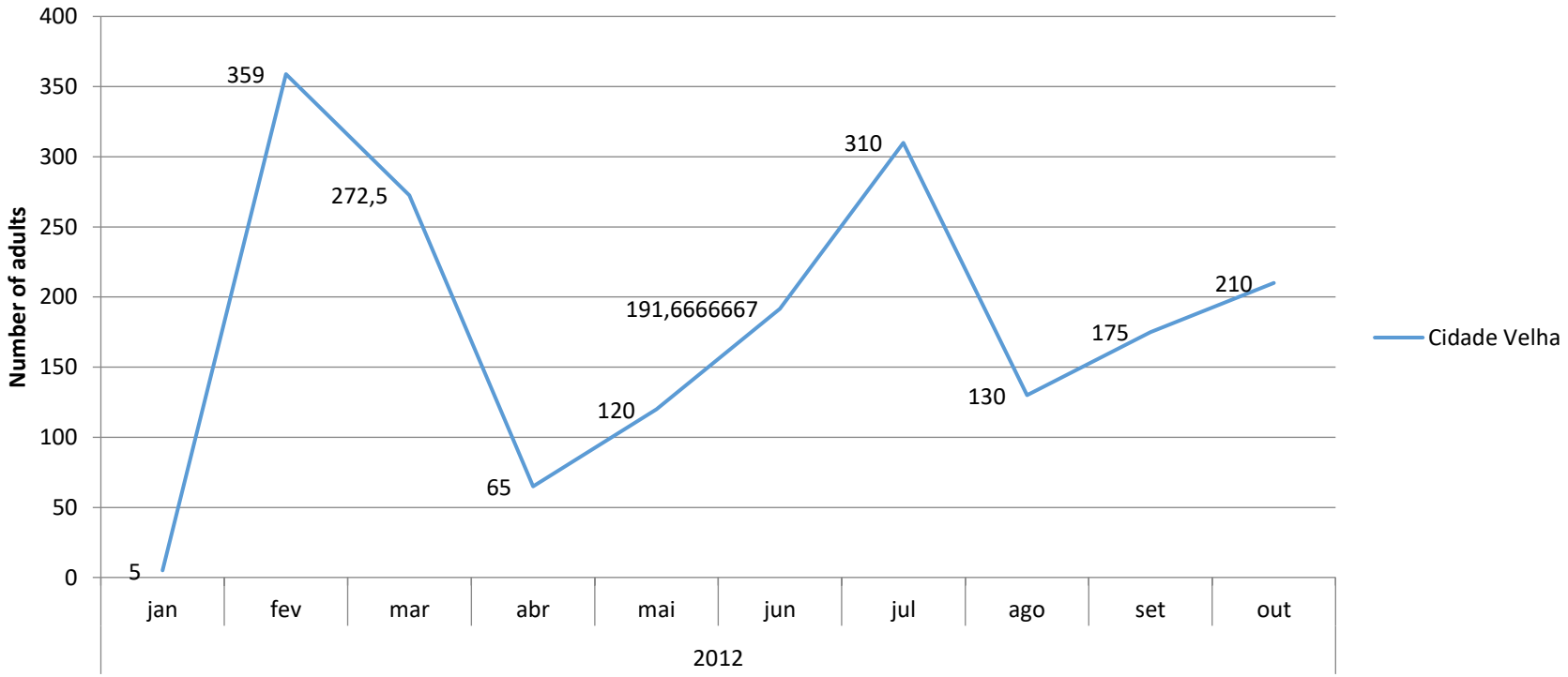
Evolution of adult catches of *Bactrocera dorsalis* Hendel



There are **two population peaks**, **slightly out of phase (1 month)** from the time of maturation of the mango fruits that is located in August, which may be due to the specificities of the area and the exposure (South zone - mango)

Reaches **more than 300 adults on average per trap**, the existence of two peaks should be a aim to study this situation

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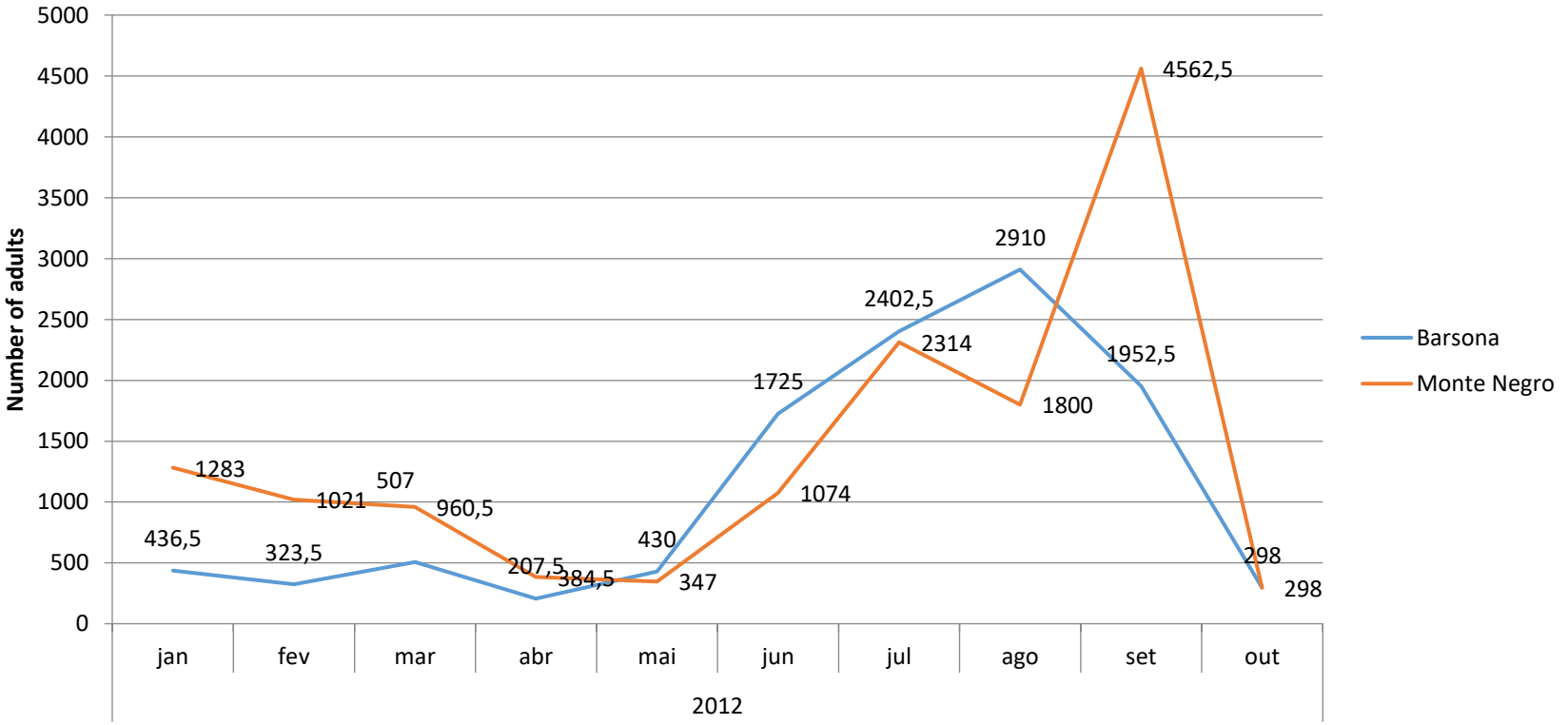
Evolution of adult catches of *Bactrocera dorsalis* Hendel



Analyzing, the exposure regardless of culture shows that in the eastern part of the island (Barsona - mango trees and Montenegro – banana orchards) is where the highest values of catches of adults of *B. dorsalis* are registered in the whole island.

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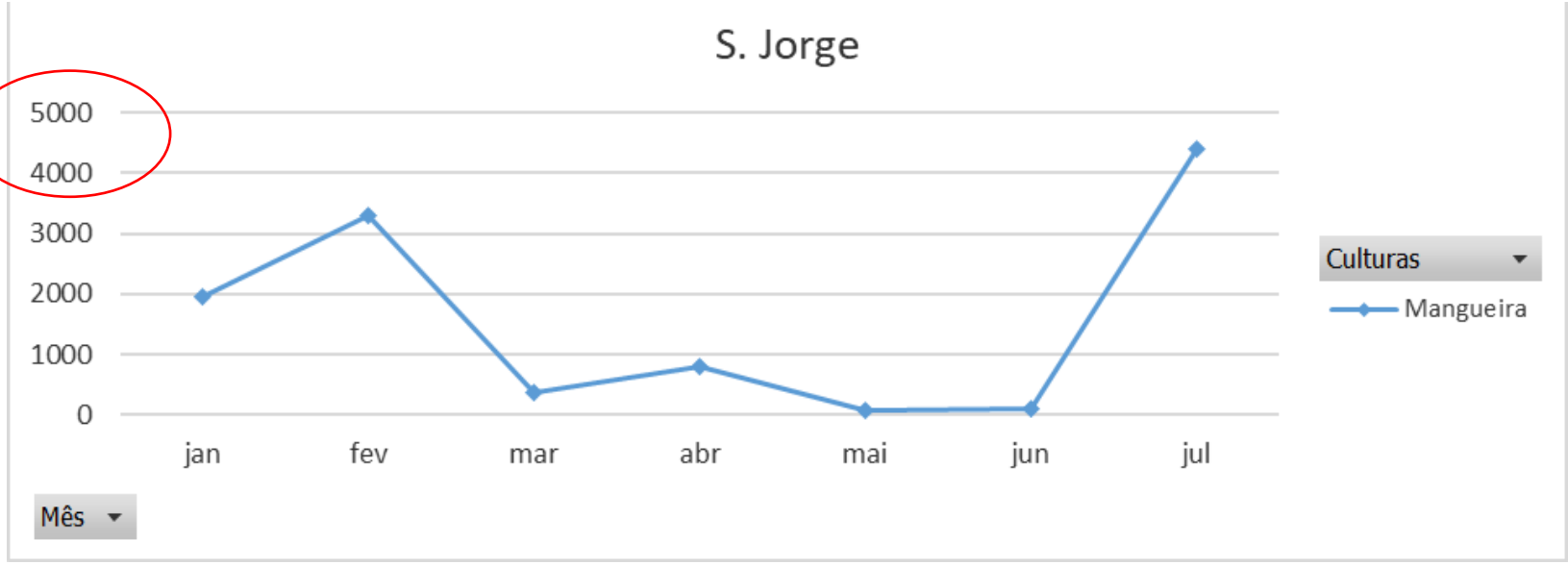
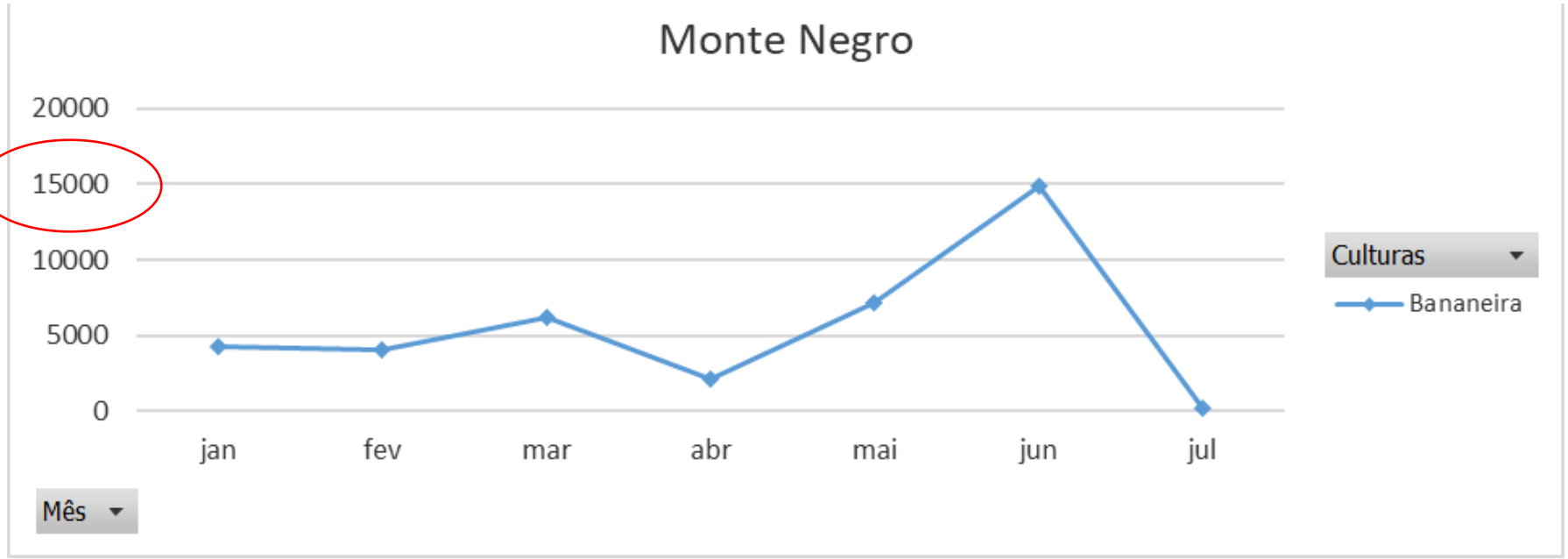
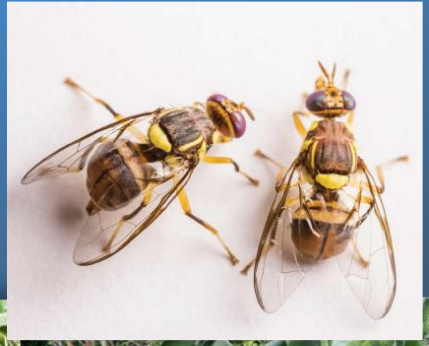
Evolution of adult catches of *Bactrocera dorsalis* Hendel in Mango 2017



Evolution of adult catches of *Bactrocera dorsalis* Hendel in Banana 2017



Farmer’s sensibilization



The constant high amount of captures of this pest in Santiago Island (Cape Vert) is worrying, as it shows that it found very suitable conditions to sustain and increase its population density levels.

The problem posed by the presence of *Bactrocera dorsalis* Hendel in Cape Verde and its extension to other countries and other regions (Canaries, Madeira, Azores) or even the European continent

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Need of monitoring *B. dorsalis* in Cape Vert

MONITORING GUIDELINES
for *Bactrocera dorsalis*

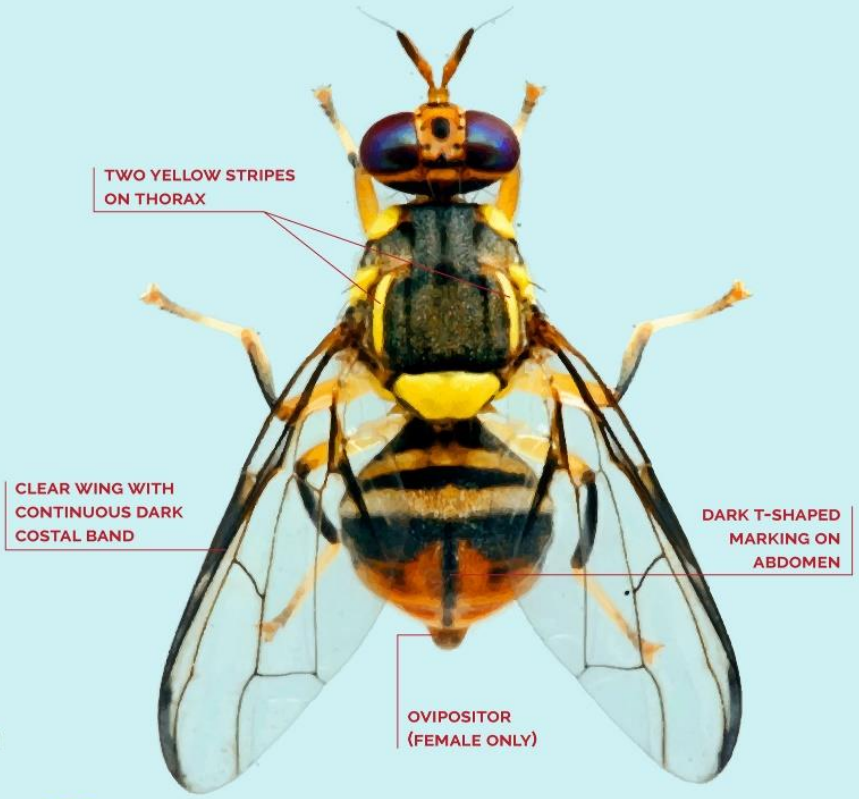
Abbr.
Bactrocera dorsalis - BD
FruitFly Africa - FFA
Methyl Eugenol - ME
Production Unit Code - PUC

WHY MONITOR
- BD is a quarantine pest
- Monitoring data is required for special program registration
- Pro-active eradication/ control

HOW MANY TRAPS NEEDED
BD not present
- 1/PUC
- 1/100 ha

BD present
- 1/PUC
- 1/25 ha

WHICH TRAP
- Bucket trap
- Lure: ME Dispenser
- Be cautious of cross contamination when handling ME.
- Insecticide: Dichlorvos strip
- Coat support wire with sticky ant barrier or Vaseline



NOTIFICATION
If in a BD free area:
- Notify FFA; Eloise du Plessis (eloise@fruitfly.co.za or 021 882 9541)
- Send specimen in vial to FFA

PLACEMENT
- In the orchard
- In the host tree
- 1,5 m above ground
- Place in shade
- Clear of leaves
- Additional trap in home garden

MONITORING
- Monitor all year
- Bi-weekly

REPLACE ATTRACTANT
- Every 6 – 8 weeks

RECORD KEEPING
Datasheet with the following details:
- Province and region
- Farm Name
- PUC
- Host/ cultivated crop
- Orchard number
- Date
- GPS coordinates
- Keep records

HORTGRO
Growing Fruit IQ

Monitoring *B. dorsalis* in Santiago Island -2017

(Santiago Island, June 2017)

PERVEMAC

FORMACIÓN EN CAMPO

"Medidas de Protección de Cultivos"

CABO VERDE

Farmer's sensibilization Cape Verde 2017

Risk of introduction

Bactrocera dorsalis is a highly invasive species.

The potential risk of its introduction into a new area is facilitated by the increase in tourism and international trade and is influenced by changes in climate and land use.

After introduction, it disperses easily, as it has a high reproductive potential, high biotic potential (short life cycle, up to 10 generations per year, depending on the temperature), a fast dispersion capacity and a wide variety of hosts.

B. dorsalis proved to be highly competitive in relation to native fruit flies in the regions where it was established, quickly becoming the dominant pest (Duyck et al., 2004; Vargas et al., 2007; Vayssières et al., 2015).

Many countries, such as the **USA, prohibit the importation of susceptible fruits** without the exporter having **applied a restricted post-harvest treatment**. This can involve **fumigation, heat treatment (hot steam or hot water), cold treatments, immersion in insecticide or irradiation** (Armstrong & Couey, 1989). **Irradiation is not accepted** in most countries and many have already banned fumigation with methyl bromide. **Heat treatment** tends to reduce the shelf life of most fruits and, therefore, the most effective method of regulatory control is preferably to **restrict imports** of a particular fruit only to areas free from fruit fly attack.

The economic impact for countries where this pest is found, results from the loss of export markets and the onerous requirement for quarantine restrictions and eradication measures. In addition, its establishment would have a serious impact on the environment after the start of chemical control programs.

Possible ways of entry for *Bactrocera dorsalis* Hendel

- arrival or **entry of fruits**, **in the most frequent hosts**, exported from countries where this pest is present;
- arrival or entry of fruits, **in less frequent hosts**, exported from countries where this pest is present;
- fruits taken or **transported by passengers** from countries where this pest is present;
- **natural dissemination** => dissemination prediction models (CLIMEX)
- **branches cut with fruits** used as decorative elements in countries where this pest is not present;
- **growth medium** (substrate, soil) with non-host plants for planting in countries where this pest is present;
- **export of land** (soil) from countries where this pest is present;
- **soil adhering to machinery** from countries where this pest is present;
- **transported inadvertently** with other things from countries where this pest is present;

(EPPO, 2009)

Risk of introduction

The main risk of introduction comes from the import of fruits containing larvae, as part of the cargo, or through fruits in the luggage or passenger mail of airlines.

For example, in **New Zealand**, Baker & Cowley (1991) recorded **7-33 interconnections of fruit flies per year in cargo and 10-28 per year in passenger luggage**. Individuals who successfully smuggle fruit are likely to discard that fruit when they discover it is rotten.

This method of introduction probably explains the discovery of at least one fly in a methyl eugenol trap in California, USA every year (Foote et al., 1993), although **the immediate implementation of eradication action plans** has ensured that this fly it has never been able to establish an adequate reproductive population, a view that has been contested in recent years (Papadopoulos et al., 2013).

B. dorsalis is known to have the **potential to easily establish populations in various tropical and subtropical areas**.

The **dispersal of adults and the transport of infested fruits** are the main means of dispersion to areas previously not infested.

Introductions /Detections of *Bactrocera dorsalis*

The flight of adult forms and the transport of infested fruits are the most important means of movement and dispersion of B. dorsalis to non-infested areas.

In **Japan, Osaka airport**, it was the most intercepted terfritid in 80% of the detected vegetable introductions;

In **France, Roissy airport**, 273 notifications, with 39 from *B. dorsalis*;

The **French interceptions of *B. dorsalis*** between 2007 and 2010 had the **following origins / distributions:** 19 in 2010 from Cameroon and Togo; 39 in 2009 from Senegal, Mali, Kenya, Burkina Faso, Côte d'Ivoire, Togo and Cameroon; 18 in 2008 from Cameroon, Ivory Coast, Mali, Burkina Faso and Senegal; one in 2007 from Cameroon

Switzerland recently intercepted *B. dorsalis* on mangoes from Cameroon

Since 2006, the **United Kingdom** (Beast) has intercepted and detected **ten introductions**. One in 2010 in *Psidium guajava* from Sri Lanka (9) in mangos from Senegal (5), Gambia (2), Ghana (1) and Kenya (1)

White & Elson-Harris (1992) report that many outbreaks of fruit flies are attributed to **undetected introductions of few carried fruits** and normally detected in the luggage of air travelers.

Austria – 2016 **Italy** - 2018

South of France - 2018

(EPPO, 2009)

First Record of an Invasive Fruit Fly Belonging to *Bactrocera dorsalis* Complex (Diptera: Tephritidae) in Europe

Francesco Nugnes•
Elia Russo•
Gennaro Viggiani•
Umberto Bernardo•

Abstract
Emerging pests are increasingly threatening fruit orchard health across the Mediterranean area. Tephritidae, representing serious threats for Europe, are numerous, and the fruit flies *Bactrocera zonata* and those belonging to *Bactrocera dorsalis* complex are among the most alarming species. These species are highly polyphagous and B. zonata has already spread to some Mediterranean countries. Due to these ongoing threats, in the Campania Region (southern Italy), a survey with traps and infested fruits analysis was performed with the aim of detecting the presence of species of *Bactrocera dorsalis* complex. In two mixed fruit-trees fields, some adults belonging to a species of *Bactrocera* were captured in traps baited with the highly attractive male lure (methyl eugenol). They were distinguished from similar-looking *Bactrocera* spp. by morphological and molecular comparative analyses. Considering the existing morphological keys, specimens were tentatively identified as B. dorsalis but molecular characterization with COI split them into two clades. Some specimens were grouped with *B. dorsalis* similar to *B. kandiensis* and others in a clade including *B. dorsalis* and *B. invadens (syn. B. dorsalis).* ITS1 sequences instead confirmed morphological identification. The integrative approach allowed identifying all the specimens collected as belonging to the B. dorsalis complex. This finding represents the first field interception in Europe of a member of one of the most dangerous groups of fruit flies

•December 2018
•Insects 9(4)
•DOI:
•10.3390/insects9040182

•Project:
•Monitoring and biological control of tephritids

Invasive Fruit Flies of economic importance in Austria - monitoring activities 2016

Alois Egartner; Christa Lethmayer (AGES)

Abstract

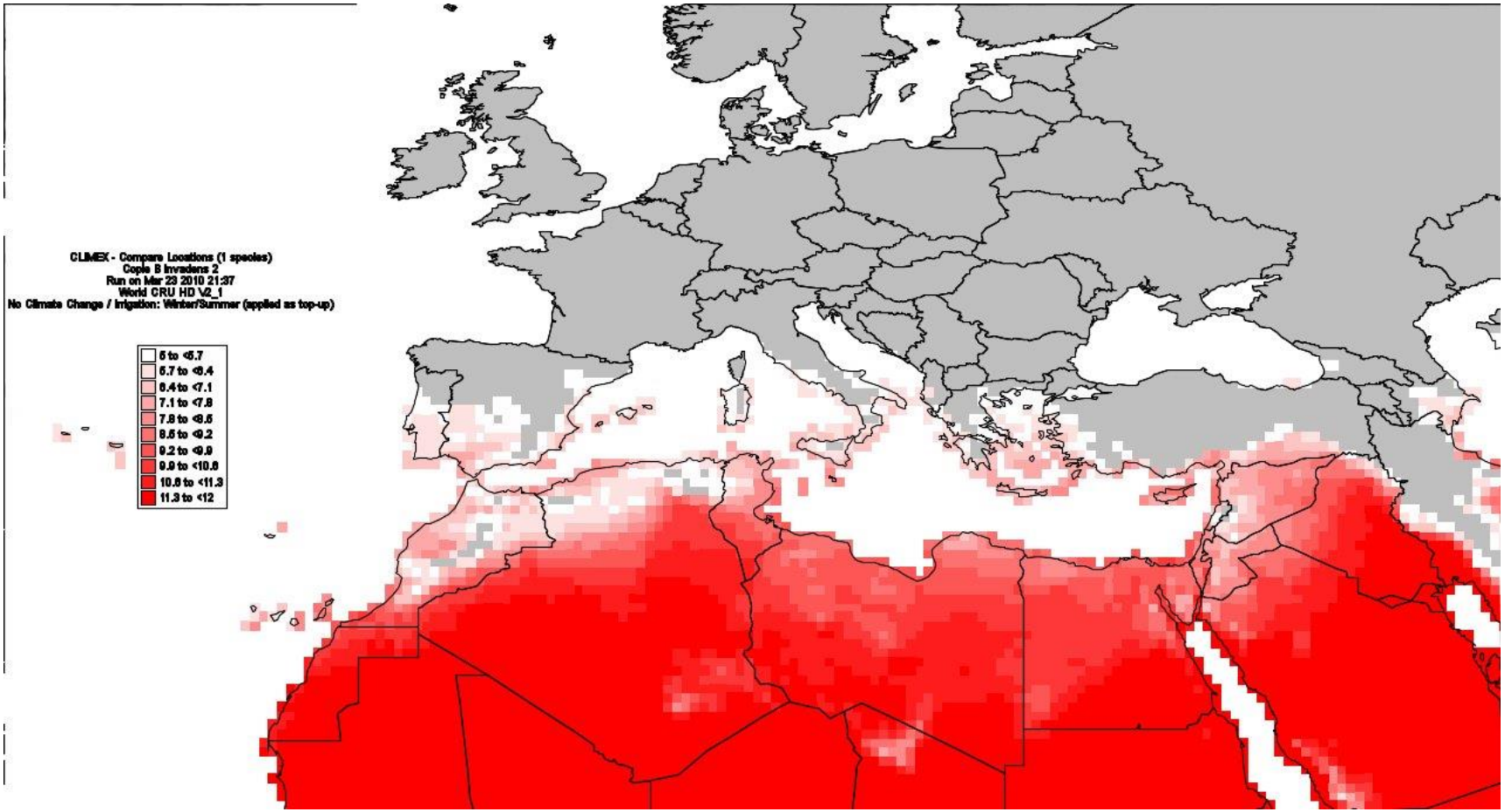
Fruit fly species (Diptera: Tephritidae) of the genera *Ceratitis* and *Bactrocera* are among the most serious orchard pests worldwide. Due to the increase of fruit fly interceptions in Europe in the last decade the status of different species of those genera was in focus of a monitoring in Austrian peach orchards. A total of 68 fruit fly traps was employed in the main part of the fruit production area of Austria and in the city of Vienna during the first season of the survey (2016). A total of 766 specimens of *Ceratitis capitata*, one specimen of *Bactrocera zonata* and one specimen of *Bactrocera dorsalis* species complex were caught. While C. capitata is considered to be established in parts of Vienna, it is assumed that the findings of single specimen of both *Bactrocera* species are due to accidental introductions. The confirmation of the sources of the findings is still in progress.

Possible establishment of *Bactrocera dorsalis* Hendel in the Mediterranean basin

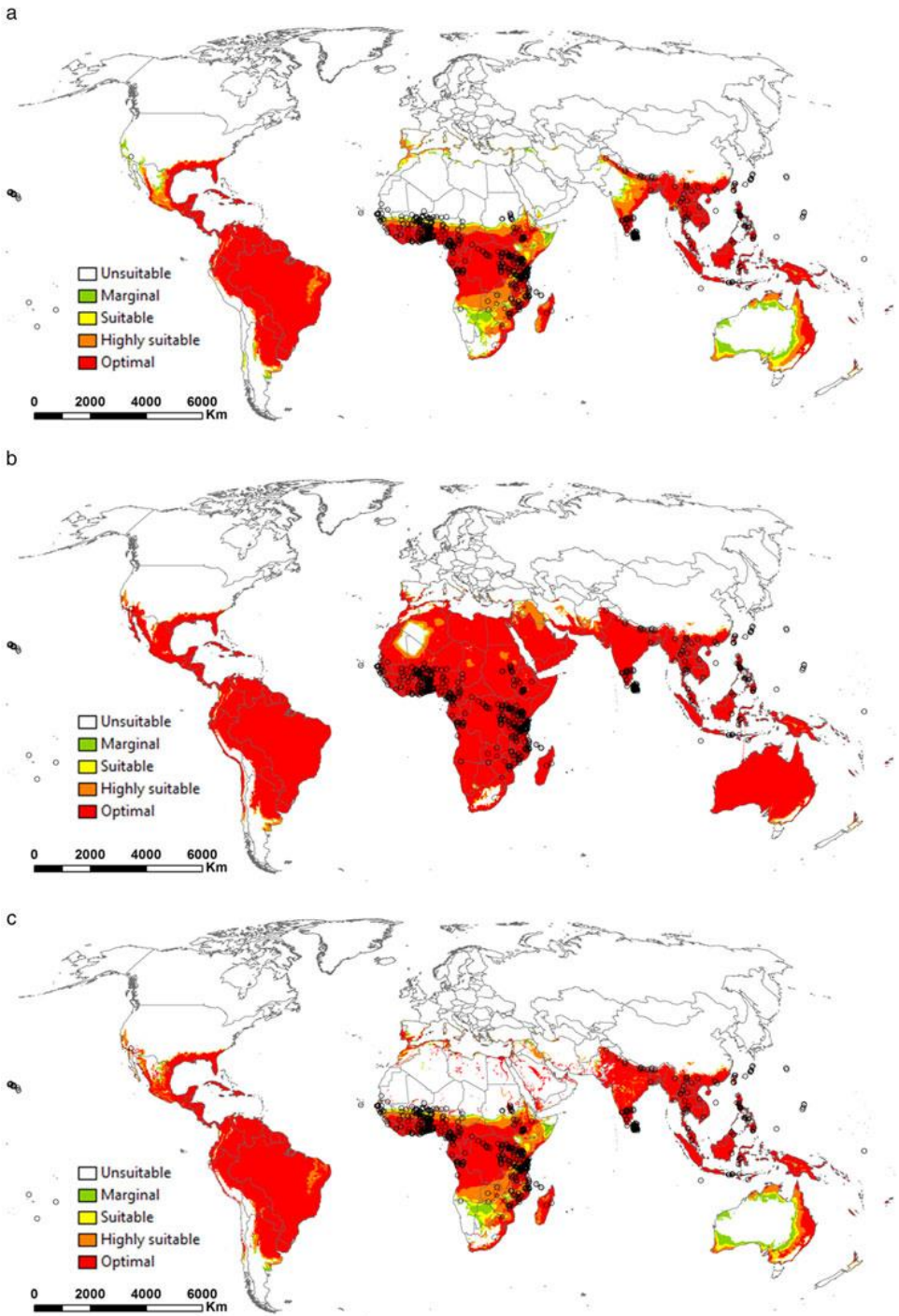
- As records of the spread of this species continue to be reported, the limits of its climatic tolerance are not well studied.
- **The hottest and coldest parts of the Mediterranean basin**, more or less correspond to the citrus production areas, are considered to be exposed to the highest risk of this spread
- **It is important:**
  - identification of hosts;
  - dissemination routes;
  - measures restricting their proliferation;
  - possible countries of entry;
  - conditions of suitability for this pest establishment

(EPPO, 2009)

Use of the **CLIMEX program** to develop different scenarios for the expansion / dissemination of *Bactrocera dorsalis* Hendel to countries in the Mediterranean basin (EPPO, 2009)



The results of the simulation obtained, for an irrigation scenario, from the CLIMEX program point to countries at risk regarding the establishment of *B. dorsalis*: Algeria, Egypt, Jordan, Israel, Libya, Morocco and Tunisia (EPPO, 2009).



Global projection of climatic suitability for the establishment of *Bactrocera dorsalis* Hendel:

(a) without irrigation;
(b) with 2.5 mm of soil surface irrigation;
(c) scenarios with the combined irrigation risk (areas without irrigation where the EI mapped is the one related to natural precipitation and with areas with irrigation where the irrigation EI is mapped), using the CLIMEX program.
(adapted from Suthers et al., 2007).

6. The spread of Bactrocera dorsalis (ex-invadens) Hendel and possible actions to be taken to prevent its introduction in Europe and the Azores

David João Horta Lopes[1]; Reinaldo Pimentel[1] & António M.M. Mexia[2]

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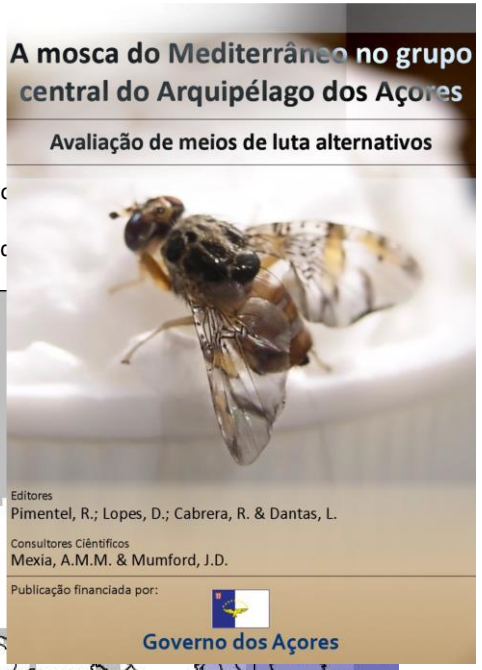
[2]Universidade de Lisboa, Instituto Superior de Agronomia, Departamento de Ciências e Engenharia de Biosistemas (DCEB), Tapada da Ajuc



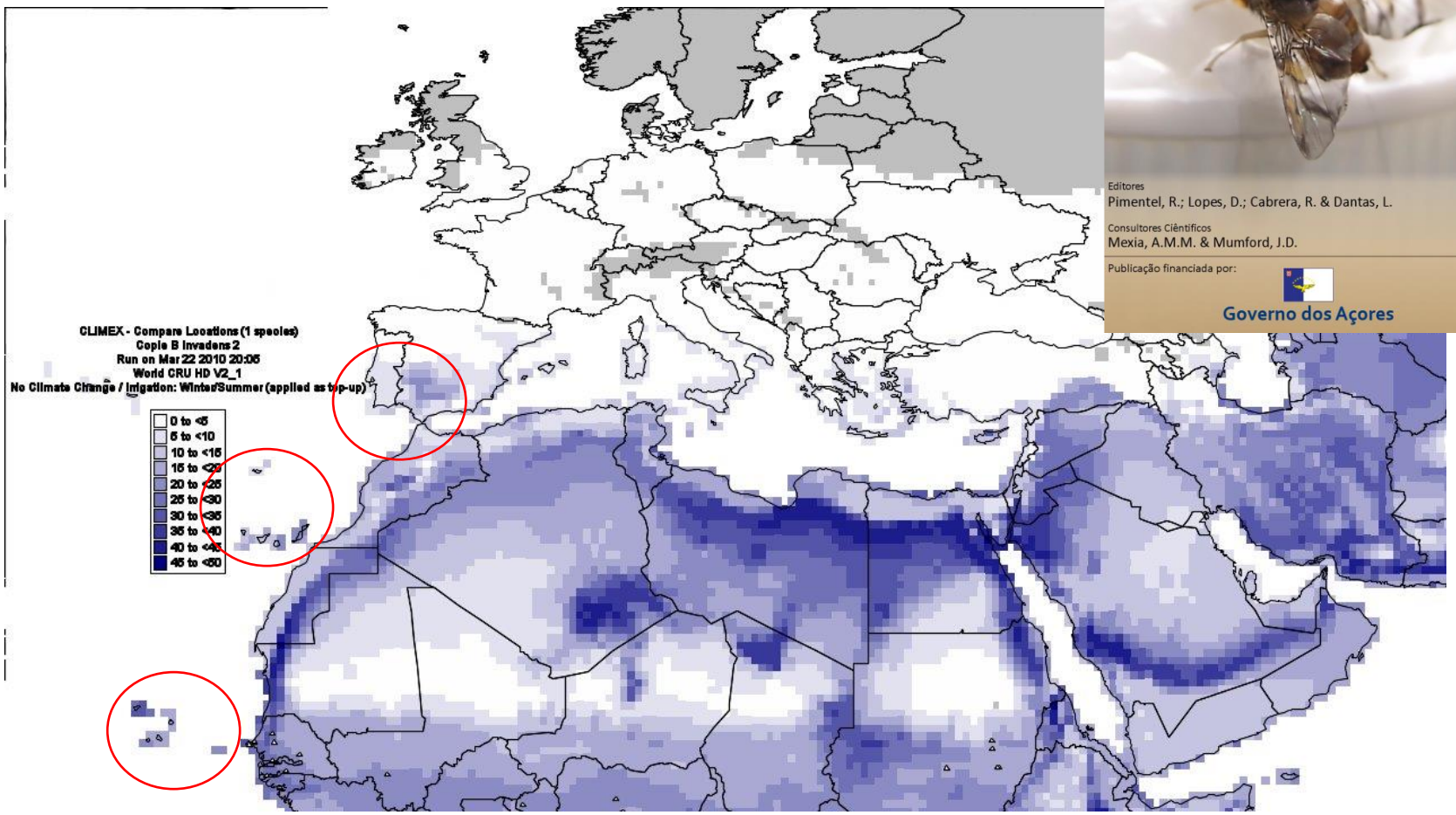


Figure 6.1 - Growth index *Bactrocera dorsalis* Hendel in the Mediterranean basin (Ecoclimatic index), in a scenario with irrigation, given by the CLIMEX program (adapted from EPPO 2010b).

Major factors that can influence the entry of *Bactrocera dorsalis* Hendel in European countries

- many of the cultivated hosts are present in the southern part of the OEPP;
- the presence of a succession of fruits from suitable hosts throughout the year;
- existence of adequate climatic conditions in at least some parts of the OEPP countries;
- there are few active substances available for the control of tefritids and current methods of combat do not prevent the establishment of *B. dorsalis*;

The eradication of this pest in the countries of introduction has proved to be very difficult without an early detection and a rapid emergency response.

In addition to all this, *B. dorsalis* is endowed, like most tefrithids, with a high fertility and a short life cycle which favors the constitution of high populations quickly.

(EPPO, 2009)

Smaller hosts and the impact of *B dorsalis* on them

The impact of *B. dorsalis* on plant hosts considered of lesser importance for this pest such as apples, cucurbits (melon, watermelon, pumpkin), peaches and peppers are low, but these yields are high throughout the OPEC region

Commodity	Production in the EPPO region in tonnes in 2007
Lycopersicon esculentum (Tomatoes)	36,593,790
Malus domestica (Apples)	18,888,307
Citrullus lanatus (Watermelon)	11,301,569
Cucumis sativus (Cucumbers & gherkins)	7,943,042
Capsicum spp. (Chillies and peppers, green)	5,626,987
Prunus persica (Peaches & nectarines)	5,307,329
Cucurbita spp.& *Cucumis pepo* (Pumpkins, squash & gourds)	3,839,177
Musa spp. (Bananas)	567,062
Persea americana (Avocados)	243,851

Fonte: FAOSTAT.

Smaller hosts and the impact of *B dorsalis* on them

Ollier et al. (2009) refer to the fact that among these less important hosts the European Union has 206957 Ha of **peaches**, mostly in **Greece, Spain, France and Italy** and 67,369 Ha of **apricots** mostly in **Spain, France and Italy**.

It is expected, in case of introduction in Europe and in particular in the Mediterranean basin of this pest, the **peaches and other fruits called "core" may become the largest hosts of *B. dorsalis***

Crops particularly at risk are: **mangoes, citrus fruits, papaya**, and their impact on what are now considered smaller hosts such as **bananas, watermelons, peppers, avocados, apples, and tomatoes**, among others, is uncertain.

The general uncertainty from the point of view of **economic impact is considered medium to high** (EPPO, 2009).

Entry and establishment of *Bactrocera dorsalis* Hendel in the Mediterranean Basin

- **Southern Spain** is particularly exposed to this risk of introduction, even greater if we keep in mind that **from populations established in Morocco**, this species can easily fly about 20km across the Strait of Gibraltar and constitute populations that use this ecological corridor annually, generating up to **6 annual populations** of *B. dorsalis*
- *B. dorsalis* is able to develop **5 generations in Albania, France (Corsica), Cyprus, Croatia, Greece (Crete), Italy (Sardinia, Sicily), Lebanon, Portugal, Spain, Syria and Turkey.**
- The tolerance of its populations to conditions of low and high temperatures is unknown, and **this specie can adapt to the new conditions in the Mediterranean area** and thus have a spread and reach population levels and concomitant **damage higher than projected**.

(EPPO, 2009)

Measures to be implemented to prevent introductions of *B. dorsalis*

The transport of infested fruits is one of the most important means of introducing *B. dorsalis* to non-infested areas.

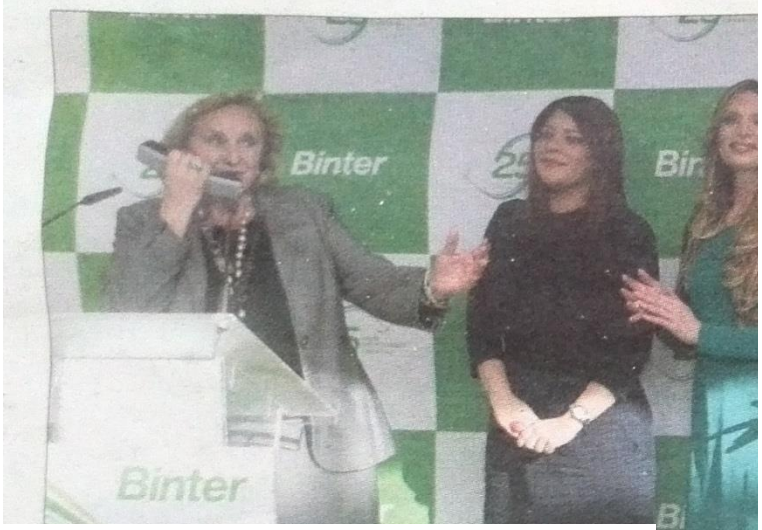
Because of that should therefore:

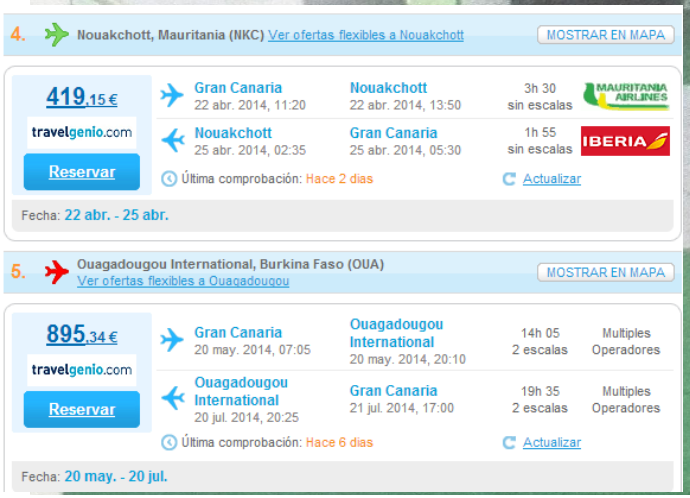
- **legislation should be implemented for these exits** to be accompanied by a **phytosanitary certificate**;
- **sensitization of people and agents** to the dangers of leaving and inadvertently transporting them
- **appealing publicity** be drawn up at ports and airports, hotels, **on the risks of introducing pests**, or fines and incentives.

(EPPO, 2009)

Flights Cape Vert /Azores /Boston

Entry of Cape Verde products with *Bactrocera dorsalis* Hendel in other regions/countries - Case of direct flight to Azores



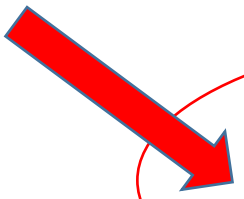


Entry of products from African countries with *Bactrocera dorsalis*
Case of the Canary Islands and Lisbon

Binter conecta Los Rodeos con Senegal en su 25 aniversario. Binter Canarias inauguró ayer la nueva ruta aérea que unirá una vez por semana Tenerife Norte con Dakar, dentro de los actos programados para celebrar el 25 aniversario de la compañía. La aerolínea ya opera dos vuelos semanales entre Gran Canaria y la capital senegalesa desde octubre de 2013, en una conexión que desde ayer se amplía con un vuelo desde Tenerife Norte. Durante los actos conmemorativos que tuvieron lugar en la Isla, una de las azafatas que trabajaban en aquel momento –a la izquierda, en la imagen– recreó sus primeras palabras a los pasajeros. Páginas 18 y 19

Entry of products from Africa countries with *Bactrocera dorsalis* Hendel in other regions/countries - Case of Mainland Portugal

One of the measures taken with a record of presence in Cape Verde was the **prohibition in Portugal of the entry of products from African countries** due to the possible presence of *Bactrocera dorsalis (ex-invadens)* Hendel this action has already resulted in the **detection of some accidental attempts at introduction**, the fruits



AT autoridade tributária e aduaneira

Proc.: FS (1)

Direção de Serviços de Regulação Aduaneira

Divisão de Circulação de Mercadorias

Instrução de Serviço N.º: 15 021/2012, Série I Entrada Geral: N.º Identificação Fiscal (NIF): Sua Ref.ª: Técnico:	Alfândegas Delegações Aduaneiras Postos Aduaneiros

Assunto: CONTROLO DE BAGAGEM DE PASSAGEIROS NOS AEROPORTOS E PORTOS. PROIBIÇÃO DE IMPORTAÇÃO DE ALGUNS FRUTOS DE PAÍSES AFRICANOS.

1. Tolerâncias para viajantes

1.1. Todos os vegetais destinados à plantação (cuja importação não é proibida), muitos frutos e algumas partes de vegetais, sementes, flores de corte, grãos e solo aquando da importação têm de vir acompanhados de certificado fitossanitário emitido no país de origem.

2. Proibição de importação

2.1. Todavia, torna-se necessário impedir a introdução e dispersão no nosso país de um organismo de quarentena, o inseto ***Bactrocera invandens***, que existe no continente africano e que provoca graves estragos em plantações e culturas, podendo originar elevados prejuízos económicos ao nosso país.

Suggested measure => Awareness and training of customs agents or phytosanitary inspectors when leaving Cape Verde

Suggested measure => Elaboration of publicizing material for the population

- ***Bactrocera dorsalis*** **notice delivered to National and Regional producers and phytosanitary authorities => direct flights entering Lisbon and Azores where is a community of people from Cape Verde**

A nova mosca invasora (*Bactrocera invadens* Drew) é nativa do sudeste da Ásia e nos últimos anos difundiu-se rapidamente para a maior parte do Continente Africano. Esta praga, atualmente não está presente na Região Autónoma dos Açores. No entanto existe um risco eminente de esta mosca atingir os Açores. Esta mosca é altamente invasiva, polífaga (muitos hospedeiros) e poder reprodutivo elevado. Conhece-se mais de 80 espécies de plantas que são vulneráveis a esta mosca, causando sérios prejuízos e destas destacam-se a manga, goiaba, pinha, toranjas, laranja, melancia, melão, mamão, pepino, ananás, abacate, banana e outras

Adulto de *Bactrocera invadens* Drew.

Fêmea adulta de *Bactrocera invadens* Drew sobre uma banana verde.

Adultos de *Bactrocera invadens* Drew.

Adultos de *Bactrocera invadens* Drew sobre uma banana madura.

frutas tropicais, afetando tanto fruto verde como o maduro.

O adulto tem um tamanho médio de 5-7 mm com o tórax de cor variável de vermelho-marrom ao preto com listras amarelas laterais e asas transparentes. A fêmea adulta tem uma extensão visível do abdómen que serve para depositar ovos dentro do fruto.

O seu ciclo de vida é semelhante à mosca-da-fruta (*Ceratitis capitata* Wiedemann). A fêmea adulta põe os ovos dentro do fruto, do qual emergem larvas que se alimentam da polpa. Essas larvas na fase final do seu desenvolvimento, saem da fruta para o chão onde se enterram a poucos centímetros somente para pupar. Destas pupas emergem os novos adultos que iram iniciar um novo ciclo.

Adulto de *Bactrocera invadens* Drew.

Fêmea adulta de *Bactrocera invadens* Drew sobre uma banana verde.

Detalhe das posturas de ovos de *Bactrocera invadens* Drew.

Polpa de banana afetado por larvas de *Bactrocera invadens* Drew.

Esta praga é de quarentena, ou seja, a sua presença em num território impediria a exportação de fruta para países onde não é declarado a presença da praga. Não se esqueça que esta praga é muito mais agressiva que a mosca-da-fruta pois ataca muitas culturas mesmo quando estas ainda não estão maduras.

A entrada deste inseto na Região Autónoma dos Açores poderá ocorrer através da introdução de frutos infestados por esta praga quer seja por importação ou por como uma curiosidade em sacos ou em forma de presentes, pelo que os controlos fitossanitários em portos e aeroportos são essenciais para prevenir introdução desta praga na Região Autónoma dos Açores. A deteção precoce pode apoiar o sucesso programas de erradicação!

Se observou este inseto ou verificou a existência de alguns dos danos provocados por este insecto, avise imediatamente os Serviços Agrícola da sua ilha!

PRESENT DANGER => Bananas entering the Azores region from countries with this pest namely Angola

Suggested measure => Elaboration of publicizing material for the population

Bactrocera dorsalis **notice delivered to National and Regional producers and phytosanitary authorities => direct flights entering Canary Islands**

Suggested measure => Elaboration of publicizing material for the population

Bactrocera dorsalis **notice delivered to National and Regional producers**

BACTROCERA DORSALIS EX INVADENS

Introducción

La mosca de la fruta ***Bactrocera dorsalis ex invadens*** **(Diptera: Tephritidae)** es originaria del sudeste asiático. En África se encontró por primera vez en Kenia en 2003 y actualmente se encuentra dispersa por casi todo el continente y las Islas de Cabo Verde. Aunque inicialmente se pensó que era una especie distinta a *Bactrocera dorsalis*, tomando el nombre de *Bactrocera invadens* debido a su alta capacidad de dispersión, en la actualidad se ha podido comprobar que no es una especie diferente.

Adulto hembra de *Bactrocera dorsalis ex invadens*

Vista dorsal del abdomen de *Bactrocera dorsalis ex invadens*.

A) Línea negra longitudinal;
B) Segmento III abdominal.
Fuente: MRAC 2007

La hembra tiene un apéndice ovopositor bien destacado, ubicado en el extremo apical del abdomen, con el que pica y deposita los huevos en el interior de los frutos. Puede llegar a poner 150 huevos por día.

Adulto hembra (izquierda) y macho (derecha) de *Bactrocera dorsalis ex invadens* (no presente en Canarias)

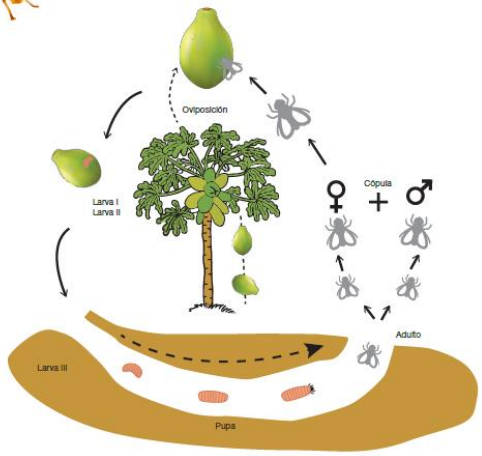
Adulto de *Ceratitis capitata* (presente en Canarias)

Puesta de huevos en papaya

Las larvas son ápodas (sin patas) y ligeramente curvadas y anilladas de color crema. Las pupas tienen forma de barril y presentan coloración oscura o marrón claro.

Ciclo biológico

El ciclo biológico de *Bactrocera dorsalis ex invadens* es similar al de otras moscas de la fruta como la *Ceratitis capitata*. La hembra pica el fruto con su apéndice ovopositor y deposita los huevos en su interior. Posteriormente emergen las larvas que se alimentan del fruto causando los daños. Una vez las larvas finalizan su desarrollo salen del fruto y caen al suelo, donde se entierran algunos centímetros para completar ahí la fase de pupa. Finalizada esa fase emergerán nuevos adultos y dará comienzo un nuevo ciclo.



Ciclo biológico de *Bactrocera dorsalis ex invadens*

Hospederos

Actualmente, en África, existen más de 80 especies en las que hay constancia de ataque de *Bactrocera dorsalis ex invadens*. Entre ellas destacan por su importancia para Canarias los frutos de mango, guayaba, chirimoya, papaya, plátano, melón, sandía, calabaza, aguacate, carambola, membrillo, manzana, melocotones, tomate, café, cítricos y otros frutales tropicales y templados.

Síntomas y daños

Como en el resto de moscas de la fruta, el daño se origina en el fruto a partir de la puesta y el consiguiente desarrollo larvario. Los frutos atacados presentan signos de picaduras de puesta, y en el caso de frutos con alto contenido en azúcares, alrededor del sitio de puesta se produce una exudación de azúcares líquidos que generalmente solidifican.

Los daños causados por *Bactrocera dorsalis ex invadens* son producidos por la oviposición en el fruto, tanto verde como maduro, y por la alimentación de la larva y la descomposición de los tejidos de la planta por microorganismos secundarios.

Cicatriz de oviposición en plátano. Fuente: R. Cabrera

Daños externos en plátano. Fuente: R. Cabrera

Cicatriz de oviposición (izquierda) y pulpa de membrillo afectada por larva (derecha)

Hembra de *Bactrocera dorsalis ex invadens* ovipositando en papaya

Dispersión

Los adultos pueden volar pero no hay datos sobre su capacidad de vuelo. La vía principal de su dispersión es el movimiento de material vegetal infestado (frutas). Actualmente, **las Islas Canarias tienen comunicaciones aéreas regulares con varios países africanos afectados por esta plaga**, motivo por el que hay que estar alerta, ya que una detección temprana es fundamental para poder erradicar la plaga, si se llegara a detectar en el archipiélago.

Recomendaciones

Si observa daños en fruta similares a los producidos por *Ceratitis capitata*, pero las características de la mosca adulta coincide con las descritas en esta publicación, póngase en contacto de manera urgente con el Servicio de Sanidad Vegetal del Gobierno de Canarias o las Agencias de Extensión Agraria adscritas a los Cabildos Insulares.

Suggested measure => Elaboration of publicizing material for the population *Bactrocera dorsalis* notice delivered to National and Regional producers

PARA MÁS INFORMACIÓN:

Dirección General de Agricultura
Servicio de Sanidad Vegetal
Consejería de Agricultura, Ganadería, Pesca y Aguas del Gobierno de Canarias
Teléfono: 922 47 52 00 Fax: 922 47 78 86
sva.cagpa@gobiernodecanarias.org
www.gobiernodecanarias.org/agricultura/agricultura/temas/sanidad_vegetal/

Agencias de Extensión Agraria de los Cabildos Insulares

GMR Canarias SAU
Teléfono: 922 23 60 48 Fax: 928 36 99 08
info@gmrcanarias.com
www.gmrcanarias.com

Measures to be implemented to prevent introductions of *B. dorsalis*

Other measures that are possible to implement and important to limit the dispersion and increase of B. dorsalis populations and fruit infestations indicated by the EPPO (2009), are:

- **Implement trap networks** since this method is particularly important in the **early detection of outbreaks of the appearance** of this pest and should be used as a component of the early warning system in the risk area (PRA-Pest Risk Analysis). In this component, methylene traps should be used to monitor the presence of this invasive pest;
- **Maintain a network of traps around ports and airports** (a measure never implemented, for example, in the Cape Verde archipelago on any of its islands) in countries even without the presence of *B. dorsalis* such as some states in the USA and New Zealand (CABI, 2007) (**situation that should be faced by Portugal and the Canary Islands that have direct flights with this country**);

If any detection is recorded, the **immediate implementation of a contingency plan** with the objective of eradication, although this measure does not prevent the establishment of this pest.

These measures, if complemented "in loco" with the **appropriate training of people** in the goods section and the "**check-in" of passengers or exit surveillance**, would **allow or prevent the exit of any fruits or vegetables** from that country, thus preventing the its entry, even stealthy, in Portugal and other countries with no record of the presence of *B. dorsalis* and with which Cape Verde, in particular, has commercial relations and direct flights.

Measures to be implemented to prevent introductions of *B. dorsalis*

- Chapter 5.4.1 Implementation of an operational program to control *Bactrocera dorsalis* increase of adult populations and dissemination

- **As in Kenya,** with the **creation and implementation in Cape Verde** of a program called **African Fruit Fly Programme (AFFP) – Sustainable Fruit Fly Management, Practices at the Farm level**.

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Sustainable Fruit Fly Management Practices at The Farm Level

African Fruit Fly Programme

(Programme Africain de la Mouche de Fruit)

Sunday Ekesi and Samira A. Mohamed
African fruit fly programme (AFFP)
icipe, Nairobi, Kenya

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African Insect Science for Food and Health

Bactrocera invadens impact

- Direct damage on mango (40-80%), citrus (8-34%).
- Quarantine restrictions have been enormous (e.g. US federal order 2008, Mauritius, S/Africa, Japan etc)
- Interceptions in the EU have been on the rise
- Socio-economic implications – food insecurity, loss of jobs, income etc

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Program Operational Block

- Block 1: Bio-ecological studies
- Block 2: Monitoring and Detection
- Block 3: IPM technologies (bait sprays, biopesticides, sanitation etc)
- Block 4: Biological control (Classical & Predatory ant)
- Block 5: Post harvest treatment (Cold & heat treatment)
- Block 6: Trainings & technology transfer (Sensitization, hands-on etc)

African Fruit Fly Programme

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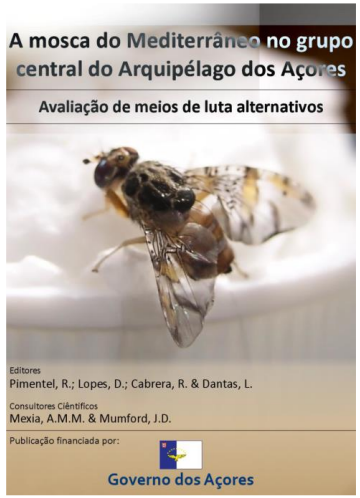
Measures to be implemented to prevent introductions of *B. dorsalis*

Chapter 5.4.1 **Implementation of an operational program to control *Bactrocera dorsalis*** increase of adult populations and dissemination



From all the work carried out in Cape Verde, under the CABMEDMAC project, there is an urgent need to **move forward in the construction of an operational program to control *Bactrocera dorsalis* in this country:**

- based on the principles of integrated pest management;
- that allows not only the true knowledge of the scale of distribution and population levels of this pest in the Archipelago;
- allowing the monitoring and control of its populations at the level of agricultural holdings;
- providing for the establishment of phytosanitary measures that prevent its spread to other countries and regions.

Measures to be implemented to prevent introductions of *B. dorsalis*

Chapter 6.4.1 Implementation of an **operational program to control *Bactrocera dorsalis*** increase of adult populations and dissemination

This plan must have a set of operational contingency blocks that involve the following main themes or activities to be developed:

- **bioecological studies** (distribution, abundance, hosts, infestation rates); monitoring and detection (early warning, early reaction to incursions, rapid response actions);
- **implementation of technologies in the biotechnical and chemical measures**, ensuring the implementation of the necessary phytosanitary measures, emphasizing **cultural control measures, the use of attractions and "Bait stations", biopesticides, MAT, bagging; Sterile Insect Technique (SIT) or Application of attractants (ATA or deterrents (neem).**
- **biological control measures**, analyzing the interaction between pest species and species of natural enemies; **testing and use of parasitoids and predators**, identification and testing of the effectiveness of entomopathogenic organisms);
- **post-harvest treatments** (cold and heat treatments and possible fumigation of fruits for export);
- **training of phytosanitary technicians and inspectors** to ensure export inspection;
- and **transfer of research technology to the producer or agricultural entities** in the country (dissemination; training of farmers).

Measures to be implemented to prevent introductions of *B. dorsalis*

Chapter 5.4.1 Implementation of an **operational program to control *Bactrocera dorsalis*** increase of adult populations and dissemination

- To this end, **trap networks around the ports and airports of all islands must be urgently implemented** and these are regularly monitored.
- Particular attention should also be paid to the **entry and exit of possible fruit hosts** for this pest.

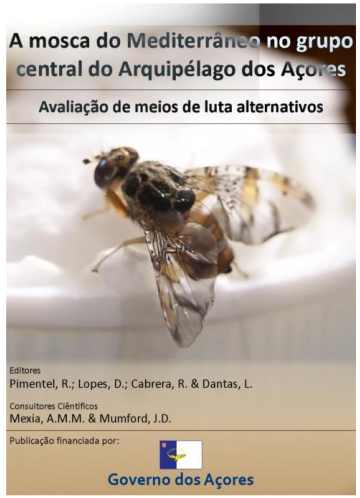
- In the event that **any detection is recorded**, it is necessary to proceed immediately with the implementation of the **integrated contingency plan**, which should previously be prepared.
- **The objective of de plan should be eradicating, or drastically reducing the detected populations**, although this measure does not prevent the establishment of this pest

Measures to be implemented to prevent introductions of *B. dorsalis*

Chapter 5.4.1 **Implementation of a state monitoring program** with the setting up of a monitoring network of *B. dorsalis* adults

- Adoption, by farmers, of **the use of traps (bait stations or in mass capture)** as a monitoring tool in fruit crop locations as a way to serve as a preventive warning and signaling tool for insecticide treatments;
- The **setting of traps in the field on vegetables crops** of economic interest and other parcels of crops;
- **Attractiveness tests** to determine the attractive effectiveness of **methyleugenol** in particular to be used in monitoring adults of *B. dorsalis*;
- **Test other types of commercial traps** (delta, easy trap, funnel, etc.) and therefore constitutes an easier alternative for farmers to implement.

Measures to be implemented to prevent introductions of *B. dorsalis*



Chapter 5.4.2 **Training of phytosanitary inspectors** and safeguarding the country's exports

Fruit crops can easily acquire some potential to increase production areas for export, the phytosanitary authorities and the Cape Verde Ministry of Agriculture should create **a plan for the eradication and phytossanitary control in the country** and from abroad to ensure no presence of this pest in all products that leave the country.

This phytosanitary control should be **supported by the technical training of the phytosanitary inspectors responsible for the inspection** mainly at the exit, but also at the entrance of agricultural products, either by air or by sea, thus **ensuring that this pest does not spread into other's islands and out of Cape Verde**.

Protective means to be used to control *Bactrocera dorsalis* Hendel

- **Pre-harvest strategies using lures and traps with lures mixed with insecticides** (Vayssières et al., 2009), such as the combination of methylugenol and malathion, with the objective of reducing male populations in a strategy called **males annihilation technique (MAT)** (Hanna et al., 2008);
- **Use of predators such as the ant *Oecophylla longinoda*** (Van Mele et al., 2007);
- **The application of biopesticides such as the fungus *Metharhizium anisopliae*** (Eseki et al., 2007; Cugala et al., 2012);
- **Implementation of technologies in the biotechnical and chemical measures**, such as the use of attractions and "Bait stations", biopesticides, MAT, bagging; Sterile Insect Technique (SIT) or Application of attractants (ATA or deterrents (neem).
- **Pocketing of fruits and orchard health involving destruction and burial or destruction of fruits by feeding animals (for example cows, horses, pigs and chickens)** (Eseki et al., 2006);
- **Post-harvest** disinfestation treatment as **the cold treatment of fruits** (Grout et al., 2011; Ware et al., 2012)

Patch exploitation behaviour of the tephritid parasitoid *Fopius arisanus*,

a candidate for the biological control of mango flies

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Fighting means:

- Cultural
- Biotechnical
- Biological - Parasitoids
- Combination of biotechnical and chemical control means
- Combination of biotechnical and biological control means

CUARENTAGRI

INVESTIGACIÓN
IDENTIFICACIÓN DE PLAGAS
FORMACIÓN




CUARENTAGRI PROJECT 2020-2023

David João Horta Lopes
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Tenerife - Canárias

UNIVERSIDADE DOS AÇORES

FCAA
FACULDADE DE CIÊNCIAS AGRÁRIAS E DO AMBIENTE
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cE3c
centre for ecology, evolution and environmental changes

Universidad de La Laguna

MAC 2014-2020
Cooperación Territorial

Interreg
Fondo Europeo de Desarrollo Regional

Departamento de Ciências e Engenharia do Ambiente

GEOGRAPHICAL SCOPE

PROJECT'S GOAL

Identification of quarantine and regulated non-quarantine pests due to the importation of vegetables and movements of people between the study regions, and carrying out risk analyzes to establish mitigation measures, with the objective of protecting agricultural production

Fotos: Alfonso Peña Darias

1. Pests at risk of being introduced:

- African citrus psila (*Trioza erytr*eae (Del Guercio))
- *Xyllella fastidiosa* bacteria
- Potato moth (*Tecia solanivora*)
- Chestnut gall wasp (*Dryocosmus kuriphilus* Yasumatsu);
- Eastern Fruit Fly - *Batrocera dorsalis (ex-invadens)* Hendel (Diptera: Tephritidae)

ACTIVITIES TO BE CARRIED OUT

2 **Development of early detection methods and establishment of warning networks for selected pests in the regions under study => Cape Verde**

Establishment of an alert network for quarantine pests or selected non-quarantine regulated pests for the Macaronesian Region => *B. dorsalis*

In summary the main measures to be implemented in Cape Verde

- **Training of phytosanitary inspectors** and safeguarding the country's exports

- **Adequate monitoring of *B. dorsalis* adults** => implementation of a state monitoring program with the setting up of a monitoring network

- **Prospecting for parasitoids or testing imported biological material** => prospecting for the existence of *Fopius arisanus* (Sonan) (Hymenoptera: Braconidae) or any endemic species of *B. dorsalis* parasitoid.

- **Disclosure of information about this pest and implementation of legislative measures** => elaboration and disclosure, through leaflets and placard notices at ports and airports, of the danger it poses to infested fruits
- **In inter-island transport and abroad** => legislative measures such as the mandatory inspection of exports, and if necessary their fumigation and prevent any departure of fruits in the hold or hand luggage of tourists or travelers by air and sea.

CONCLUSIONS

The constant high amount of captures of this pest in Santiago Island (Cape Verde) is worrying, as it shows that it found very suitable conditions to sustain and increase its population density levels

Fruits infestation also indicates that this species does not only damage ripened fruits but as well as the ones still in growing status like green bananas.

The entry of *B. dorsalis* into other countries may occur through the introduction of infested fruits, whether by import or transport in baggage, whereby phytossanitary checks at ports and airports are essential to prevent the exit and subsequent introduction of this pest in Countries with which there are regular air links.

That is why *B. dorsalis* poses a serious threat to the fruit and horticultural production of Cape Verde islands and to other countries in Europe.

Despite the Macaronesia wide alert issued by CabMedMac project work (MAC/3/A163), additional measures should be placed in action to prevent its invasion to the other archipelagos or even to the possibility to invade countries in the Mediterranean basin and by enter in Portugal or Spain (trough Canary Islands) and rapidly disperse to other European countries

PROGRAMA
MAC 2007 - 2013
Cooperação Transnacional

CabMedMac
MAC/3/A163

UNIÃO EUROPEIA
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Thank you for your attention

Parceiros

SRA
SECRETARIA REGIONAL DO AMBIENTE E RECURSOS NATURAIS

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Universidad de La Laguna

CABILDO DE TENERIFE

INIDA

CE3C
Centre for Ecology, Evolution and Environmental Changes

CE3C – Centre for Ecology, Evolution and Environmental Changes / Azorean Biodiversity Group and Universidade dos Açores - Departamento de Ciências Agrárias, 9700-042 Angra do Heroísmo, Açores, Portugal