Africa Phytosanitary Programme

(APP) Phase 2 · Train-the-Trainer workshop

23–27 June 2025 · Mpumalanga, South Africa

Survey Guidance *Bactrocera* species

Tertia Grové

ARC- Tropical and Subtropical Crops

ARC • LNR

Exellence in Agricultural Research and Development

Taxonomic position

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Tephritidae
- Subfamily: Dacinae
- Tribe: Dacini
- Genus: *Bactrocera* Macquart
  Zeugodacus Hendel

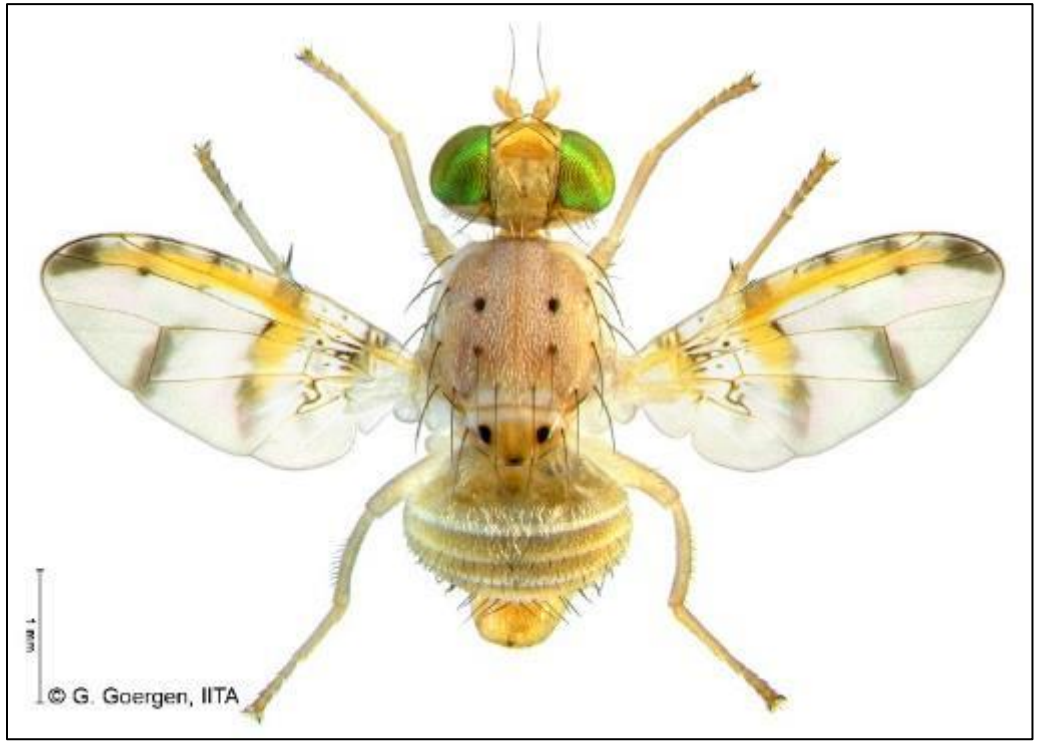
Diptera

- Single pair of wings
- Hind wings evolved into mechanosensory organs: halters

Photo R.S. Copeland

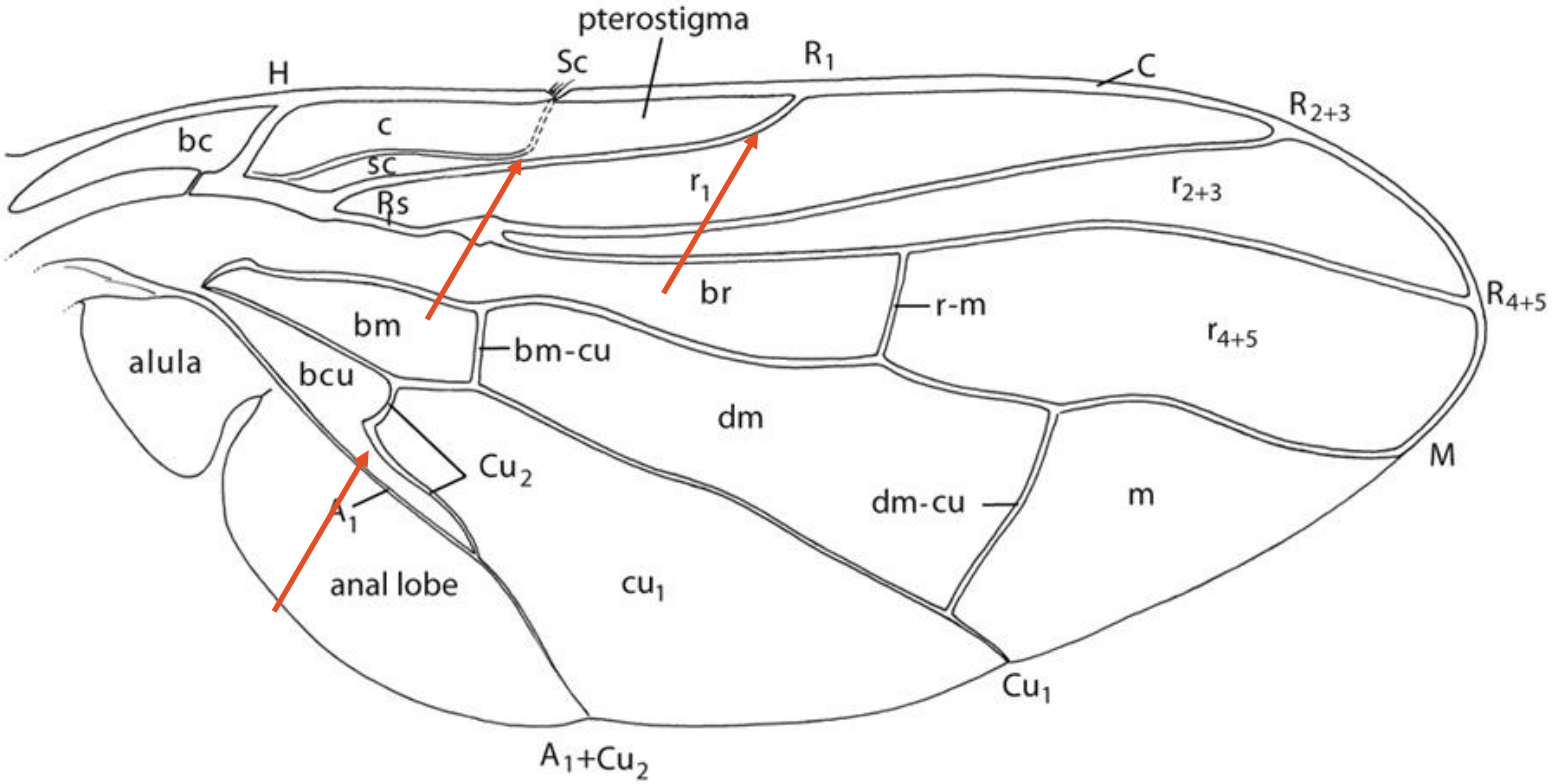
Tephritidae - adults

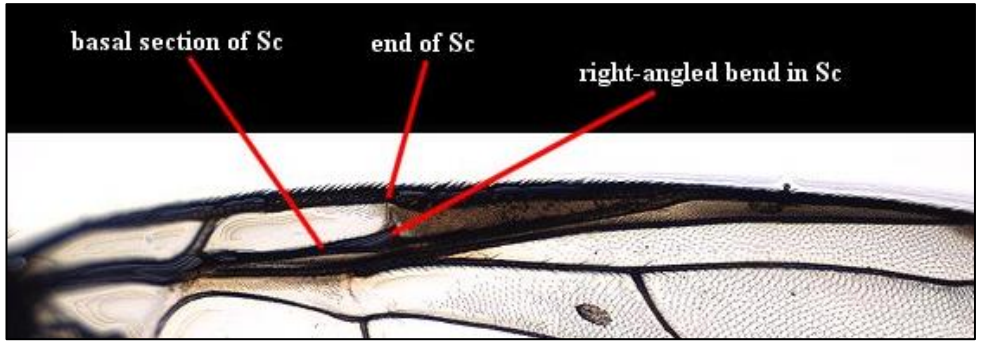
- Small to medium-sized (2.5–10 mm)
- Patterned wings



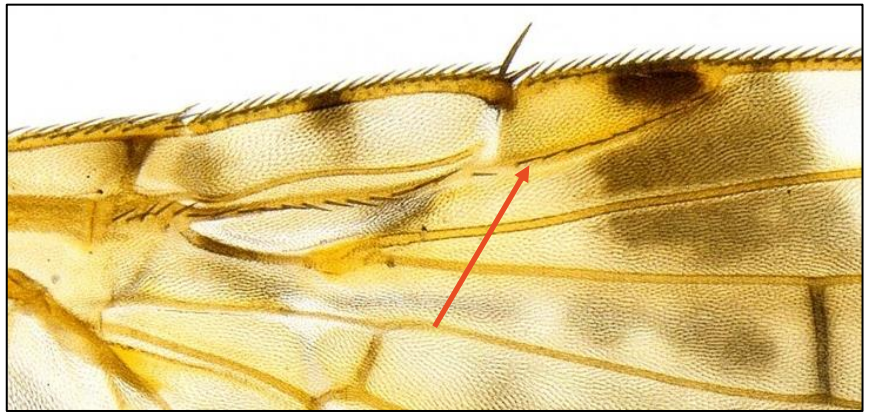
Tephritidae - adults

- Right angled bend near the end subcostal vein
- Vein R_1 with dorsal setulae
- Cell bcu (anal cell or cell cup) pointed extension

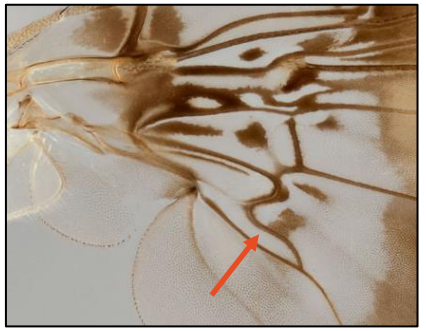




Sc bend



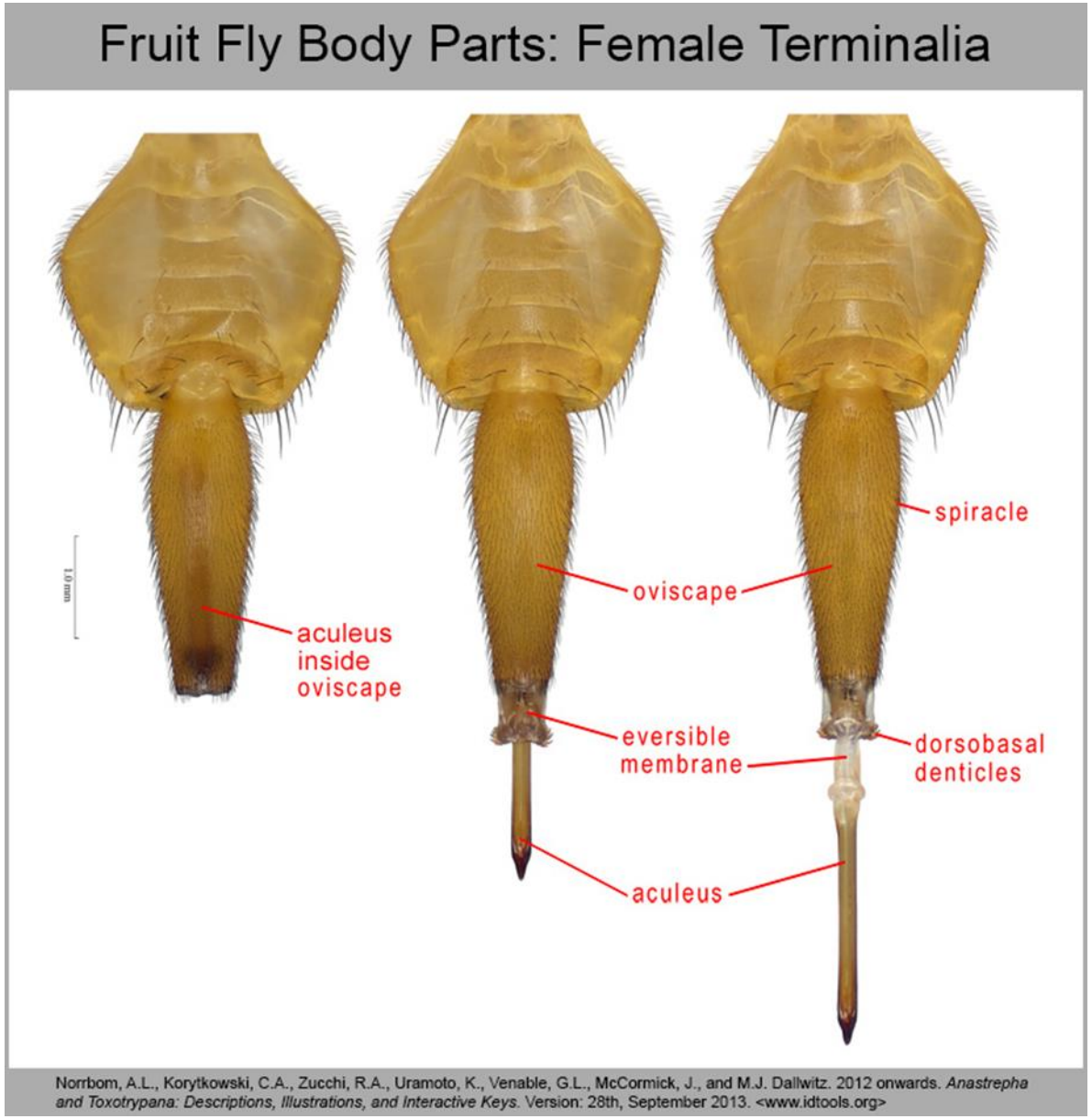
Setulae (small short hairs, bristles)



Cell bcu extension

Tephritidae - adults

- Females with a telescopic functional ovipositor



Tephritidae - larvae

- Legless and eyeless, white to yellowish or brown in color
- Body tapered anterior end, blunt posterior end

Photo Jeffery Lotz

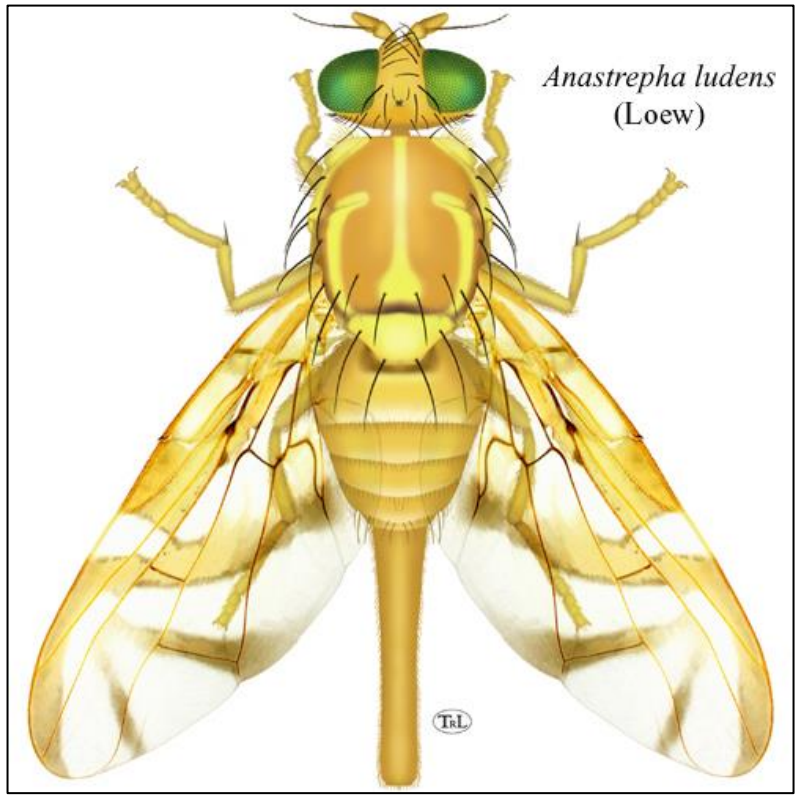
Tephritidae

- 5 000 species worldwide 500 genera
- 1 000 species in Africa 160 genera
- Majority of larvae phytophagous

Photo Paul Leyland

Tephritidae - important genera

- *Anastrepha* - Tropical America



- *Bactrocera* - Asia, Australia, South Pacific regions, few species Africa
- Three invasive species in Africa

Tephritidae - important genera

- *Ceratitis* - Africa

- *Dacus* - Africa

Photo Antoine Franck

Tephritidae - important genera

- *Rhagoletis* - Americas and Europe

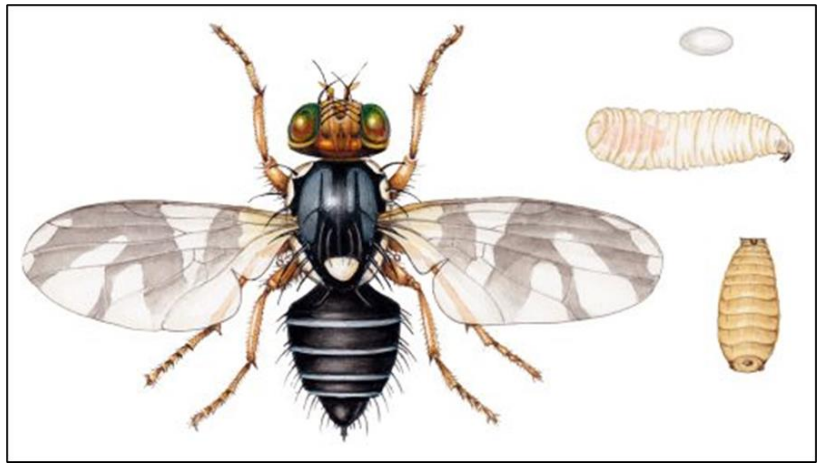


Image Lizzie Harper

- *Zeugodacus* - Asia and Pacific Islands
- One invasive species in Africa

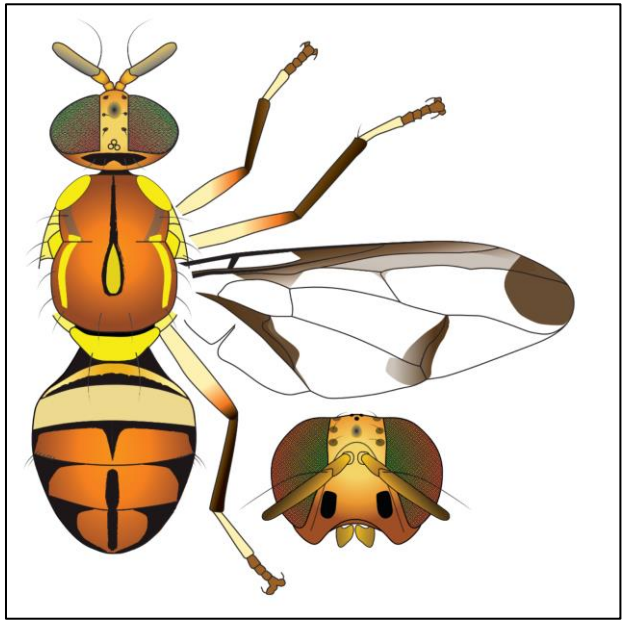


Image Doorenweerd, C., Leblanc, L., Anderson, C. T., San Jose, M., Kim, J. W., Rubinoff, D., Geib, S., Todd, T. and Barr, N. 2025. Adult Bactrocera fruit fly ID (Diptera: Tephritidae: Dacinae: Dacini).

Tephritidae - resource exploitation strategies

Photo Ana Rodriguez

- Opportunistic, broad-range exploiters - *Bactrocera*, *Ceratitis*

  Multivoltine – many generations per year

  Mobile

  High reproductive potential

  No diapause

  Little synchronization between adult emergence and host fruiting phenology

- Specialized exploiters - *Rhagoletis*

  Exhibit long diapause periods in the soil

  Adult emergence is synchronized with host fruiting phenology

Photo Joseph Berger

Tephritidae - diet (host) breadth

- Monophagous (one species)
- Stenophagous (one genus)
- Oligophagous (one family)
- Polyphagous (different plant families)

Photo Paul Leyland

Tephritidae Economic Importance

- Direct damage

  Direct damage begins when female flies puncture the fruit and lay eggs

  Developing larvae cause fruit decay

  Management of fruit flies

- Indirect damage

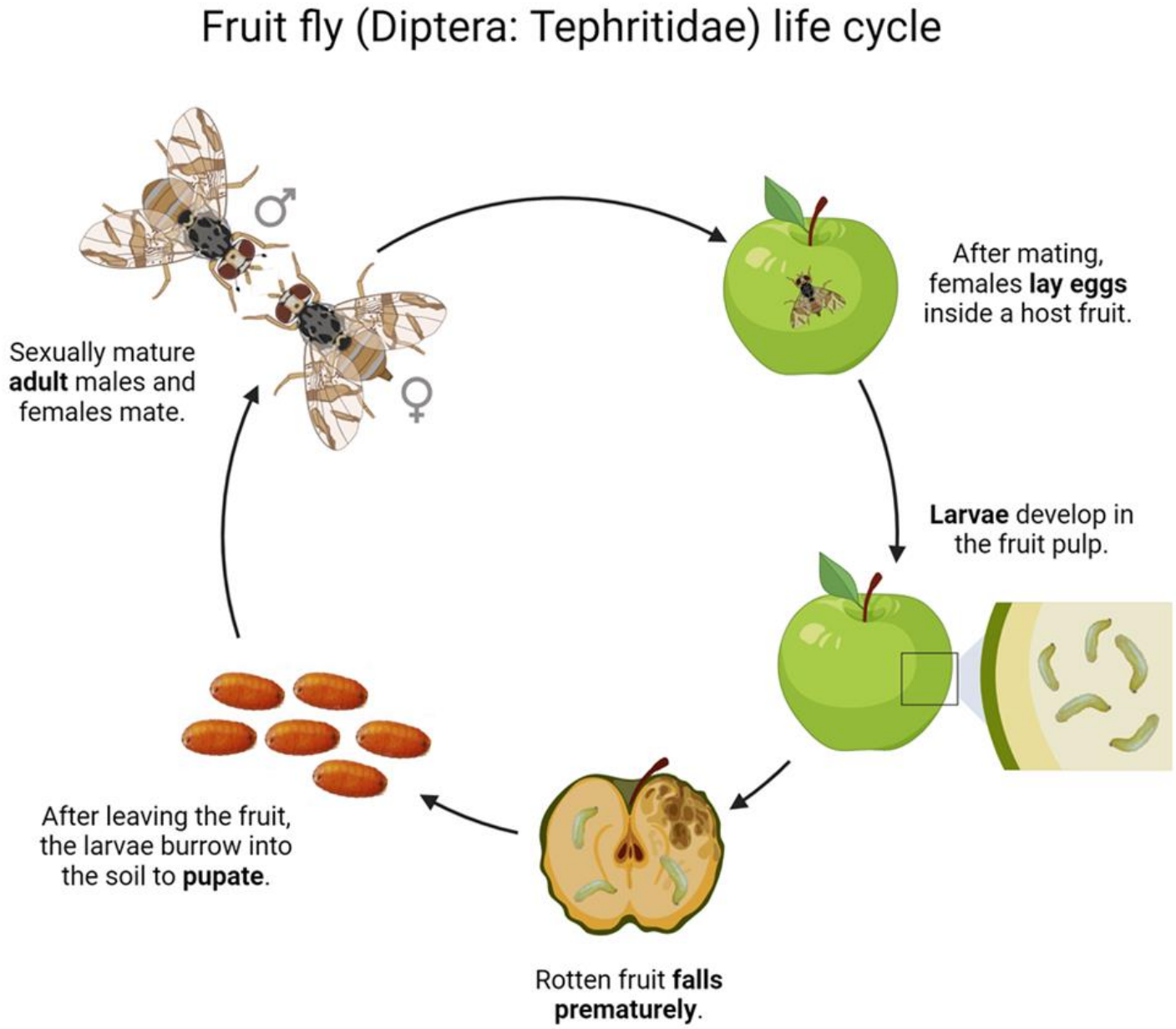
  Many fruit fly species are regarded as quarantine pests

  Loss of markets

  Disinfestation treatment

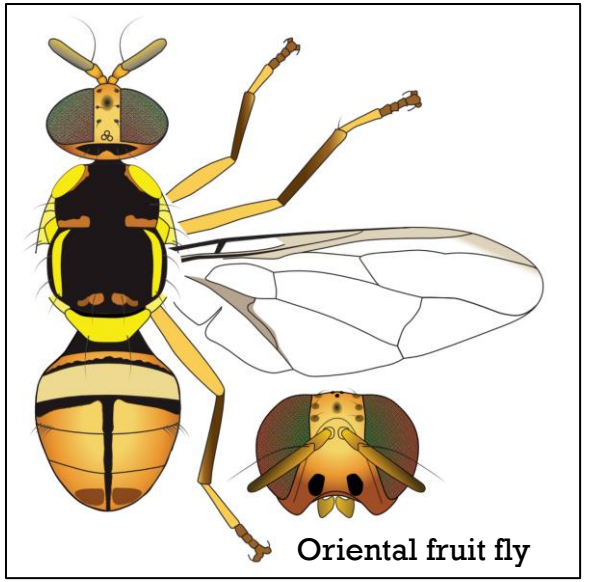
Tephritidae – life cycle

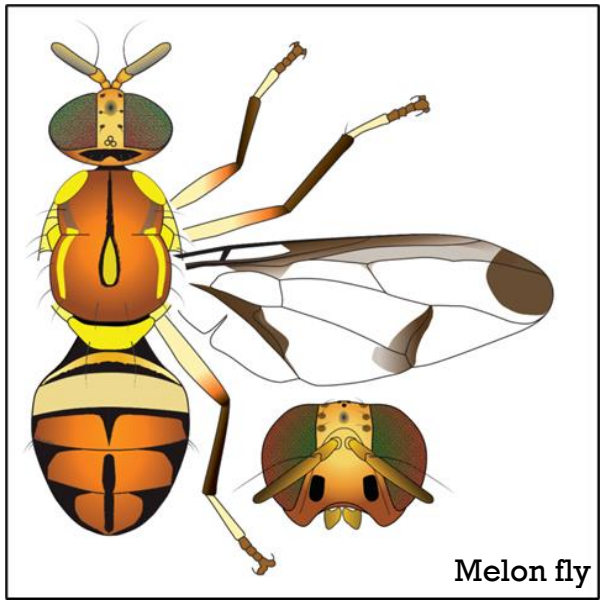
Lifecycle 3-4 weeks under optimal conditions (25-28°C)

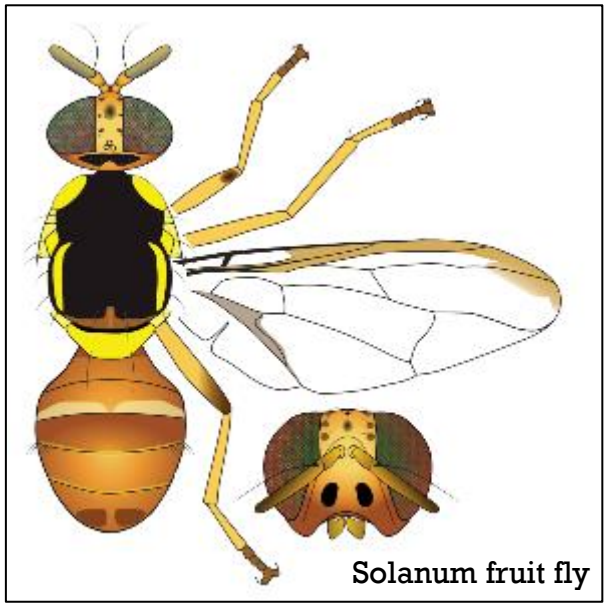


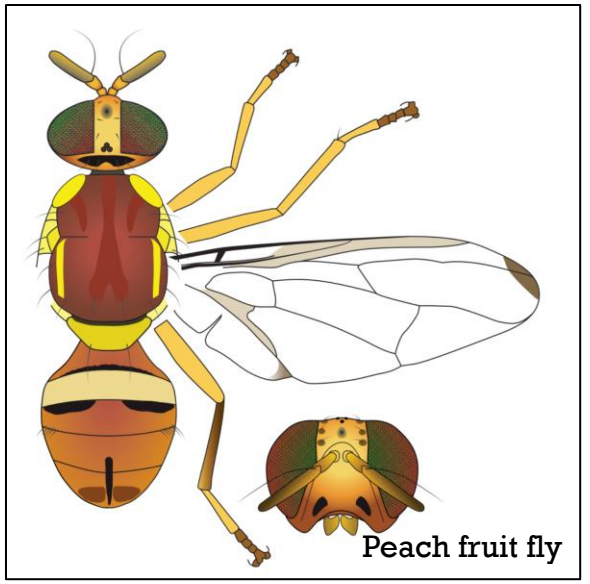
Invasive *Bactrocera* and *Zeugodacus* species in Africa

- Oriental fruit fly - *Bactrocera dorsalis* (Hendel)
- Solanum fruit fly - *Bactrocera latifrons* (Hendel)
- Peach fly fruit - *Bactrocera zonata* (Saunders)
- Melon fly - *Zeugodacus cucurbitae* (Coquillett)


Oriental fruit fly


Melon fly

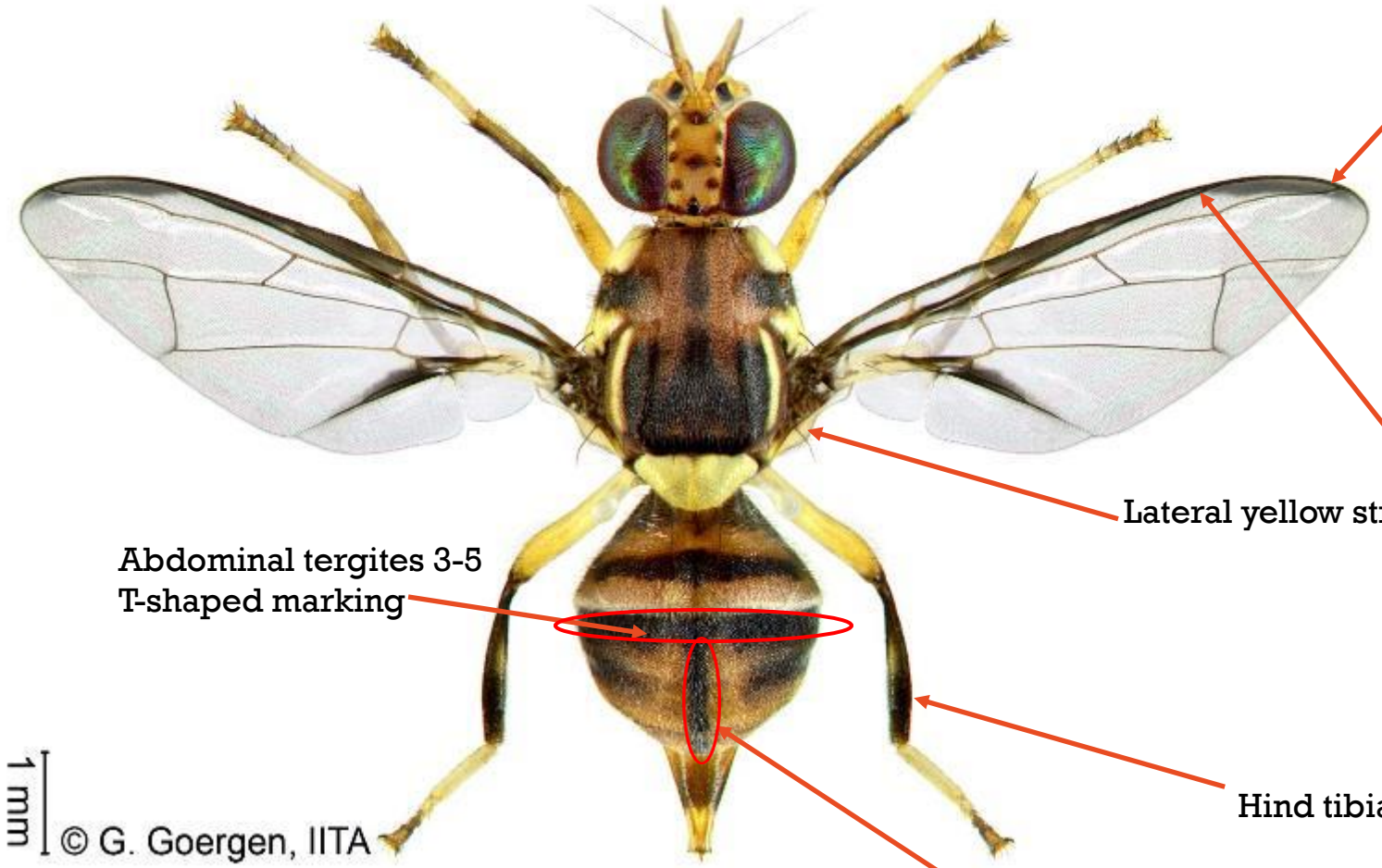

Solanum fruit fly


Peach fruit fly

Images Doorenweerd, C., Leblanc, L., Anderson, C. T., San Jose, M., Kim, J. W., Rubinoff, D., Geib, S., Todd, T. and Barr, N. 2025. Adult Bactrocera fruit fly ID (Diptera: Tephritidae: Dacinae: Dacini).

Oriental fruit fly – *Bactrocera dorsalis*

- Part of a species complex of over 50 similar species



No apical spot

Costal band of anterior margin of wing narrow

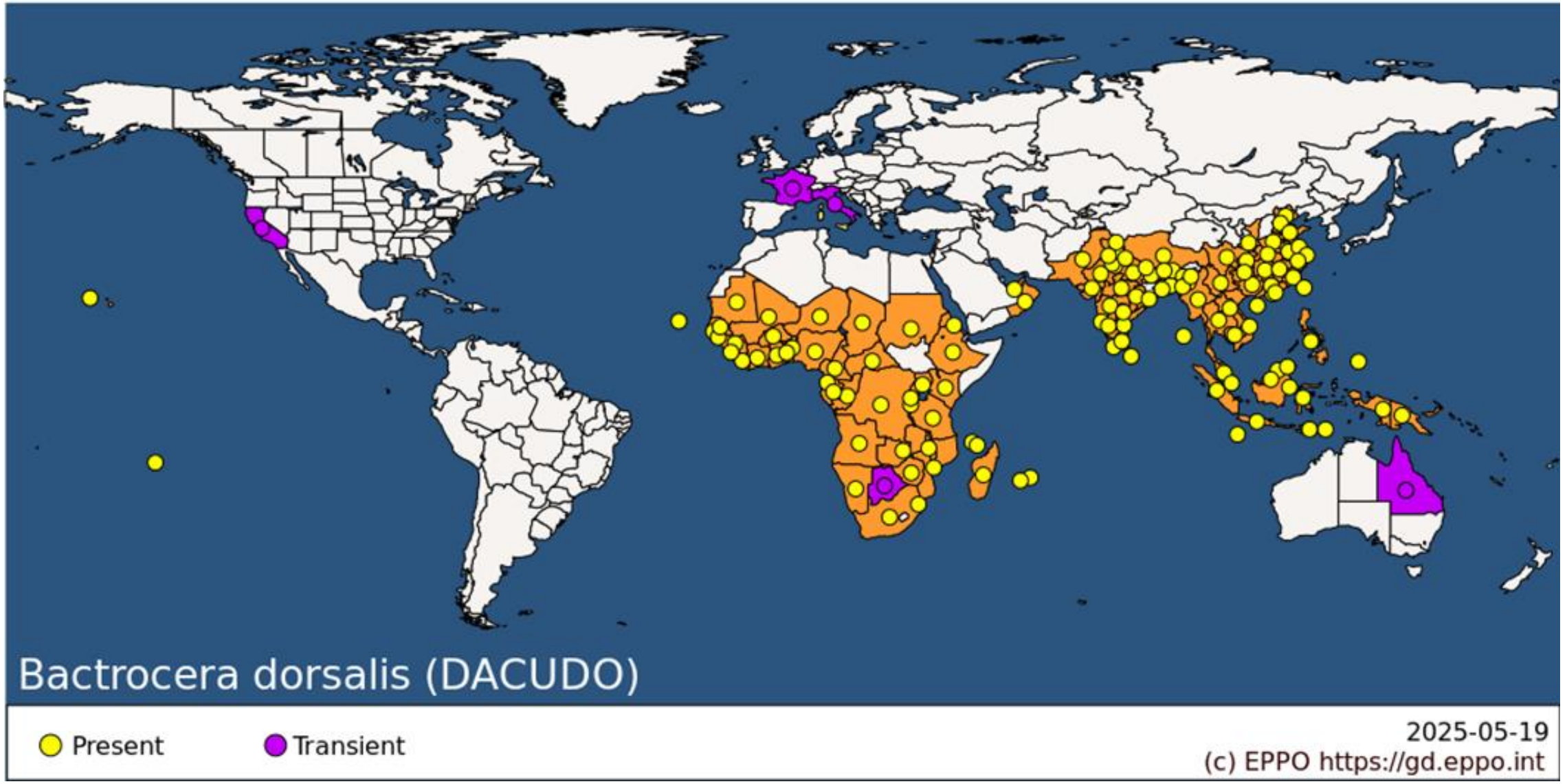
Lateral yellow stripes

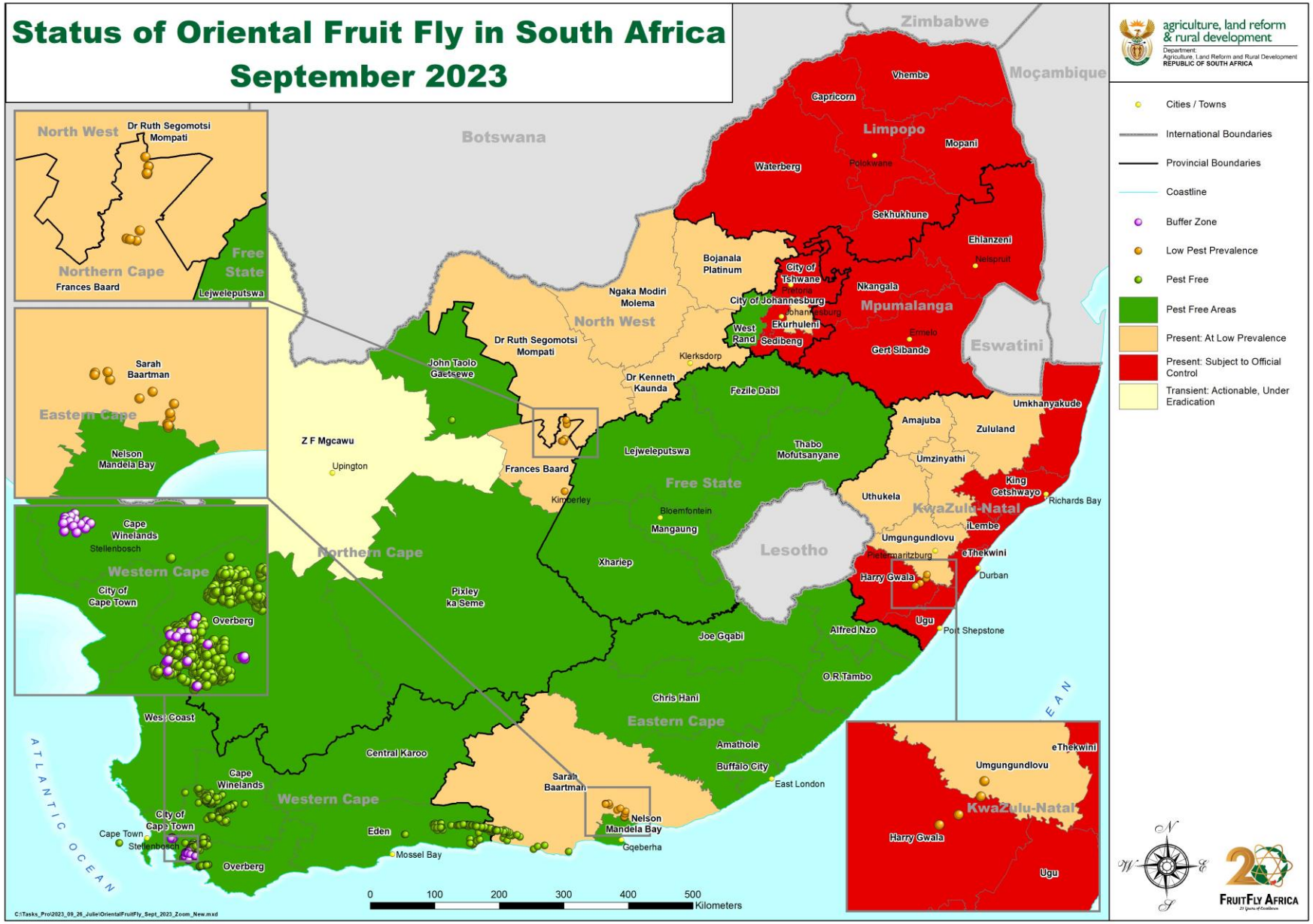
Abdominal tergites 3-5
T-shaped marking

Hind tibia darker

Tergites 4-5 dark lateral marking

Oriental fruit fly detected in 2003 at the cost in Kenya




Status of Oriental Fruit Fly in South Africa
September 2023
agriculture, land reform & rural development
Department: Agriculture, Land Reform and Rural Development
REPUBLIC OF SOUTH AFRICA
Cities / Towns
International Boundaries
Provincial Boundaries
Coastline
Buffer Zone
Low Pest Prevalence
Pest Free
Pest Free Areas
Present: At Low Prevalence
Present: Subject to Official Control
Transient: Actionable, Under Eradication
Zimbabwe
Moçambique
Botswana
Eswatini
Lesotho
Limpopo
Vhembe
Capricorn
Mopani
Waterberg
Polokwane
Sekhukhune
Mpumalanga
Ehlanzeni
Nkangala
Gert Sibande
Bojanala Platinum
City of Tshwane
City of Johannesburg
Ekurhuleni
West Rand
Sedibeng
North West
Ngaka Modiri Molema
Dr Ruth Segomotsi Mompati
John Taolo Gaetsewe
Dr Kenneth Kaunda
Klerksdorp
Free State
Fezile Dabi
Thabo Mofutsanyane
Lejweleputswa
Frances Baard
Kimberley
Bloemfontein
Mangaung
Xhariep
Northern Cape
Z F Mgcawu
Upington
Pixley ka Seme
KwaZulu-Natal
Umkhanyakude
Zululand
Amajuba
Umzinyathi
Uthukela
King Cetshwayo
Richards Bay
iLembe
Umgungundlovu
Pietermaritzburg
eThekwini
Durban
Harry Gwala
Ugu
Port Shepstone
Alfred Nzo
Joe Gqabi
O.R.Tambo
Chris Hani
Eastern Cape
Amathole
Buffalo City
East London
Western Cape
Cape Winelands
Stellenbosch
City of Cape Town
Overberg
West Coast
Central Karoo
Eden
Mossel Bay
Sarah Baartman
Nelson Mandela Bay
Gqeberha
North West
Dr Ruth Segomotsi Mompati
Northern Cape
Frances Baard
Lejweleputswa
Free State
Eastern Cape
Sarah Baartman
Nelson Mandela Bay
Western Cape
Cape Winelands
Stellenbosch
City of Cape Town
Cape Town
Overberg
KwaZulu-Natal
eThekwini
Umgungundlovu
Harry Gwala
Ugu
ATLANTIC OCEAN
EAN
0 100 200 300 400 500 Kilometers
C:\Tasks_Pro\2023_09_26_Julie\OrientalFruitFly_Sept_2023_Zoom_New.mxd
FruitFly Africa

Oriental fruit fly

- Host plants

Polyphagous 450 host plants worldwide

Mango preferred hosts

- Economic importance

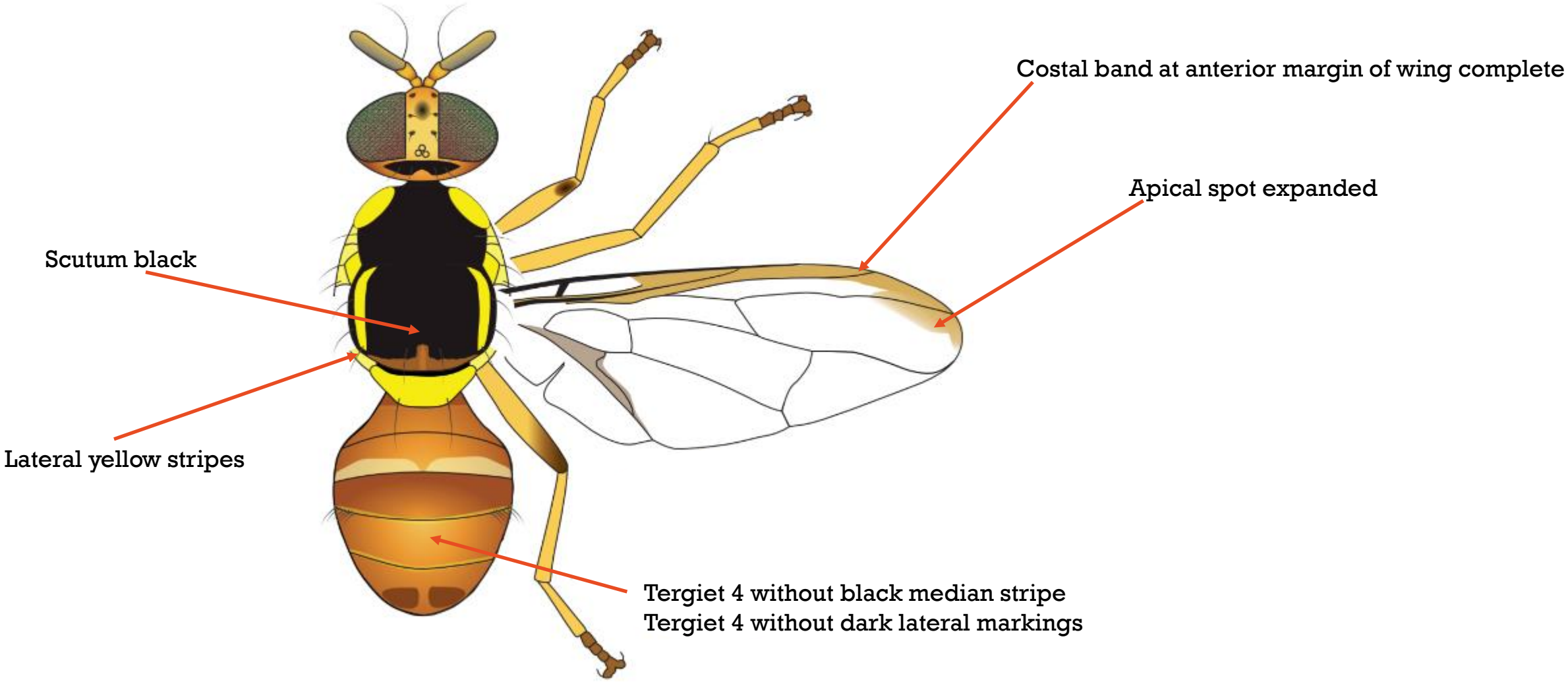
Significant economic impact

- Trapping

Males - methyl eugenol (ME)

Both sexes - protein-based attractants

Solanum fruit fly – *Bactrocera latifrons*



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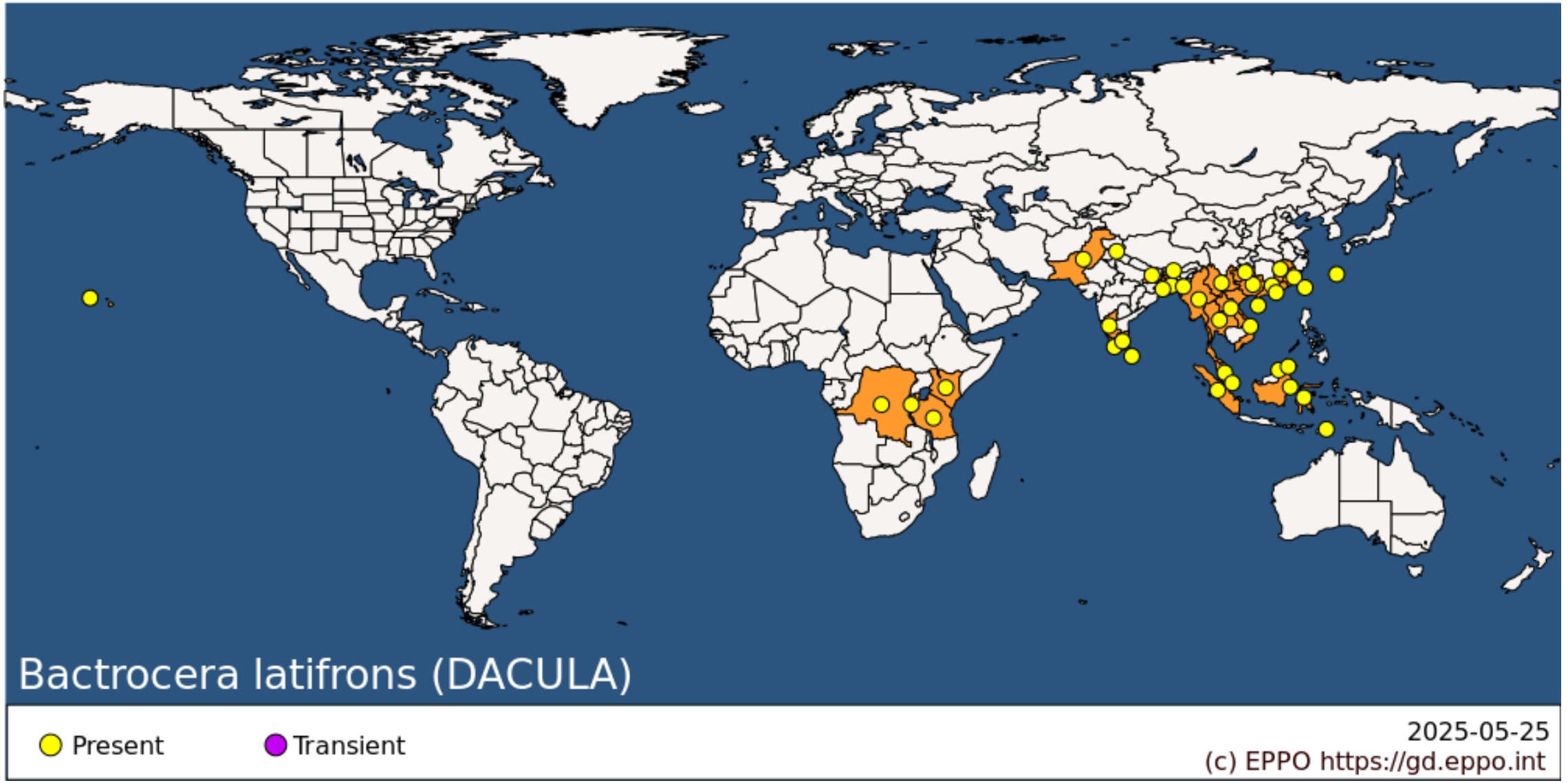
Solanum fruit fly detected in 2010 in Tanzania



Solanum fruit fly

- Host plants

Primarily Solanaceae

- Economic Importance

Mainly a pest on Solanaceae

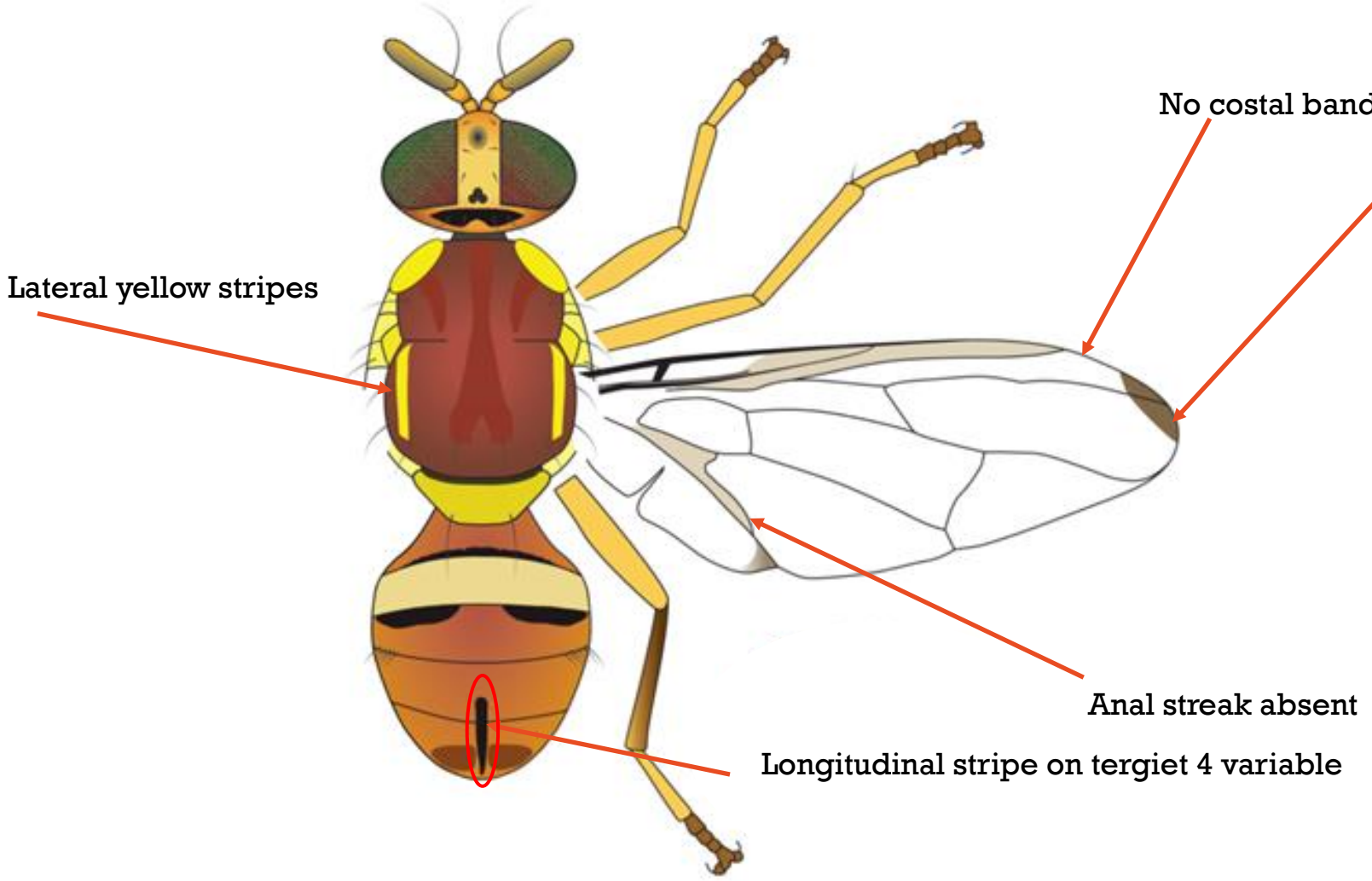
- Trapping

Males - latilure enhanced with cade oil

Both sexes - protein-based attractants

Photo USDA-ARS

Peach fruit fly – *Bactrocera zonata*



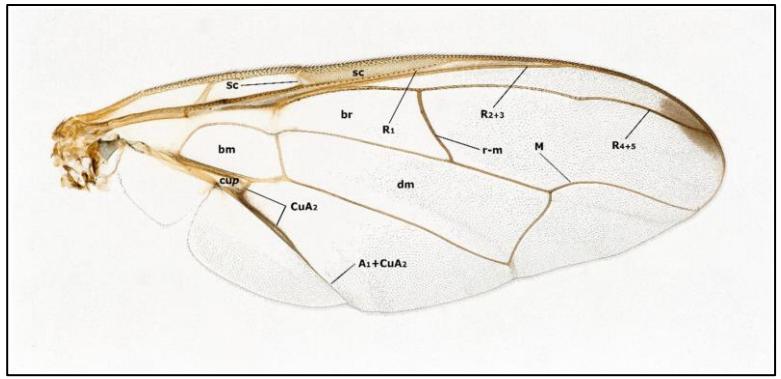
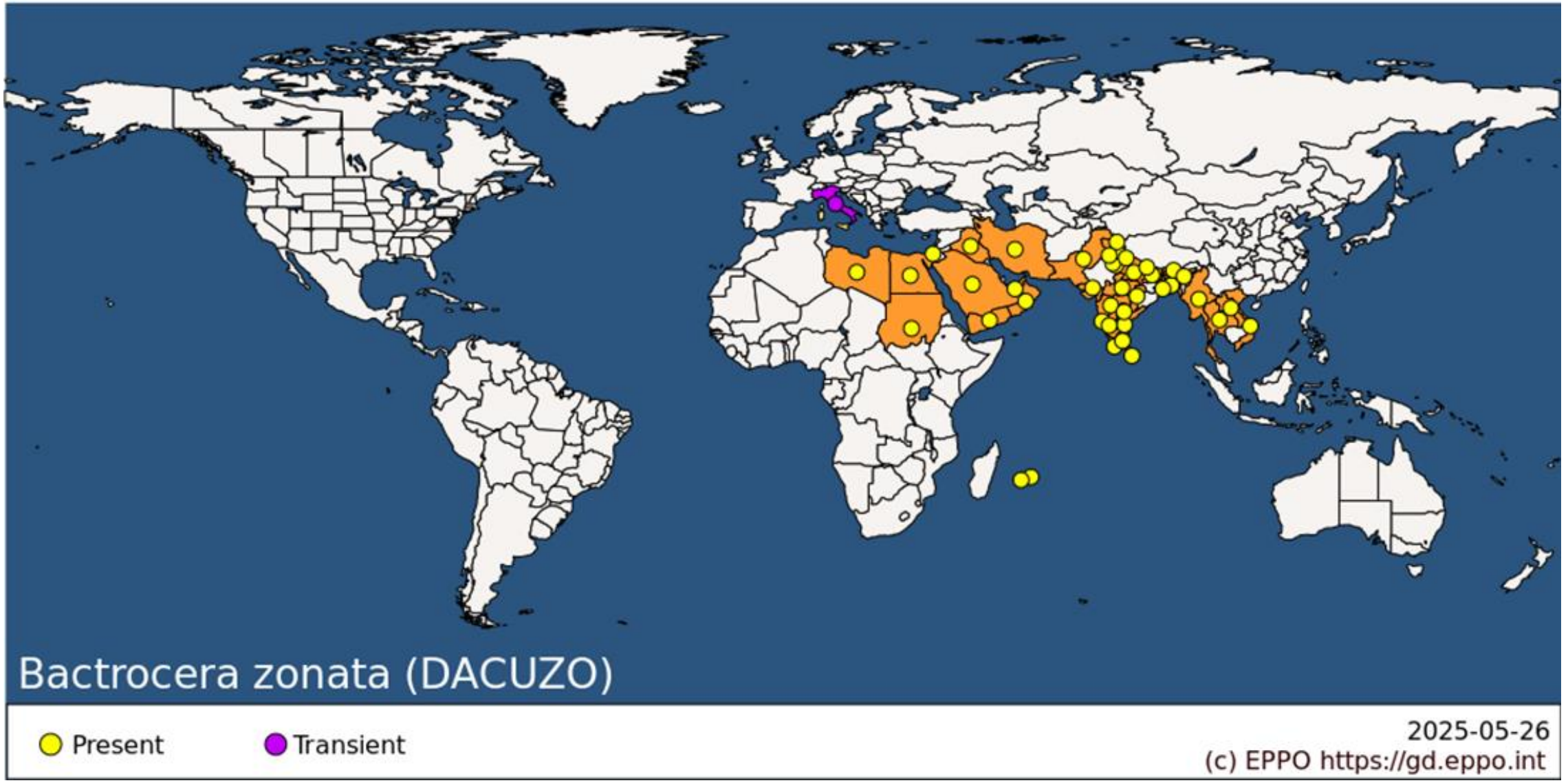


Image EPPO

Images Doorenweerd, C., Leblanc, L., Anderson, C. T., San Jose, M., Kim, J. W., Rubinoff, D., Geib, S., Todd, T. and Barr, N. 2025. Adult Bactrocera fruit fly ID (Diptera: Tephritidae: Dacinae: Dacini).

Peach fruit fly - Egypt established in 1993



Peach fruit fly

- Host plants

Polyphagous species

Mango, citrus, guava, papaya, peach

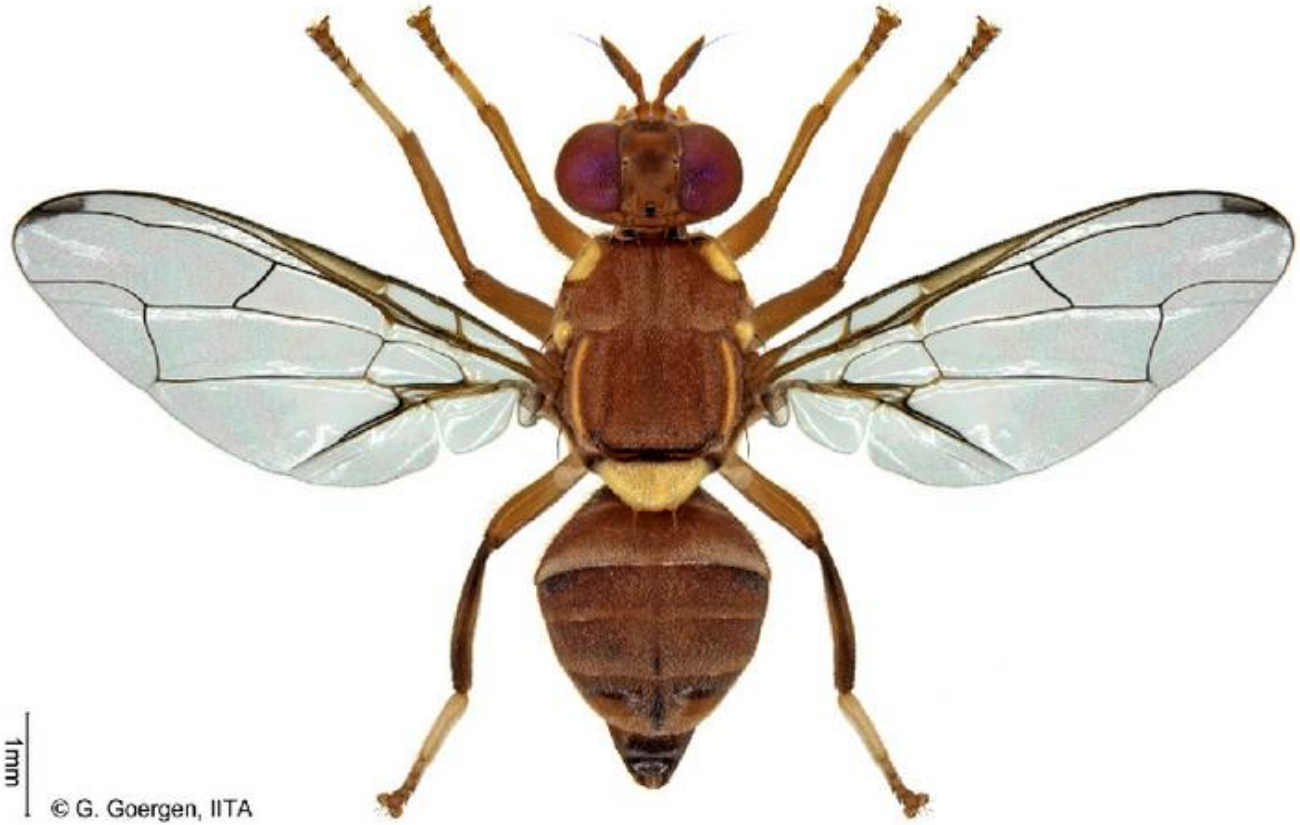
- Economic importance

Substantial losses mango and peach

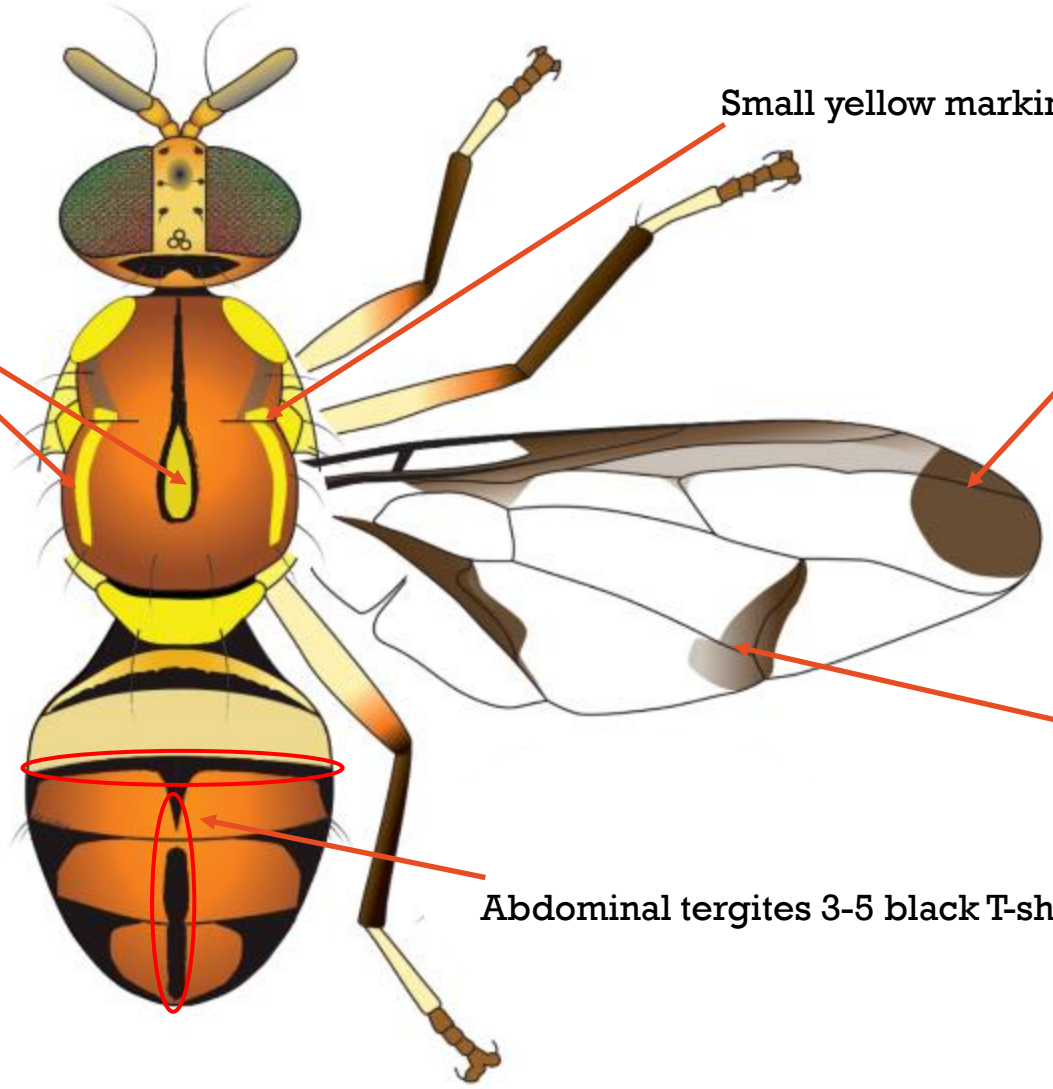
- Trapping

Males - methyl eugenol (ME)

Both sexes - protein-based attractants



Melon fly – *Zeugodacus cucurbitae*



Small yellow marking anterior to the transverse suture

Median and lateral yellow stripes

Costal band expand into a broad apical spot

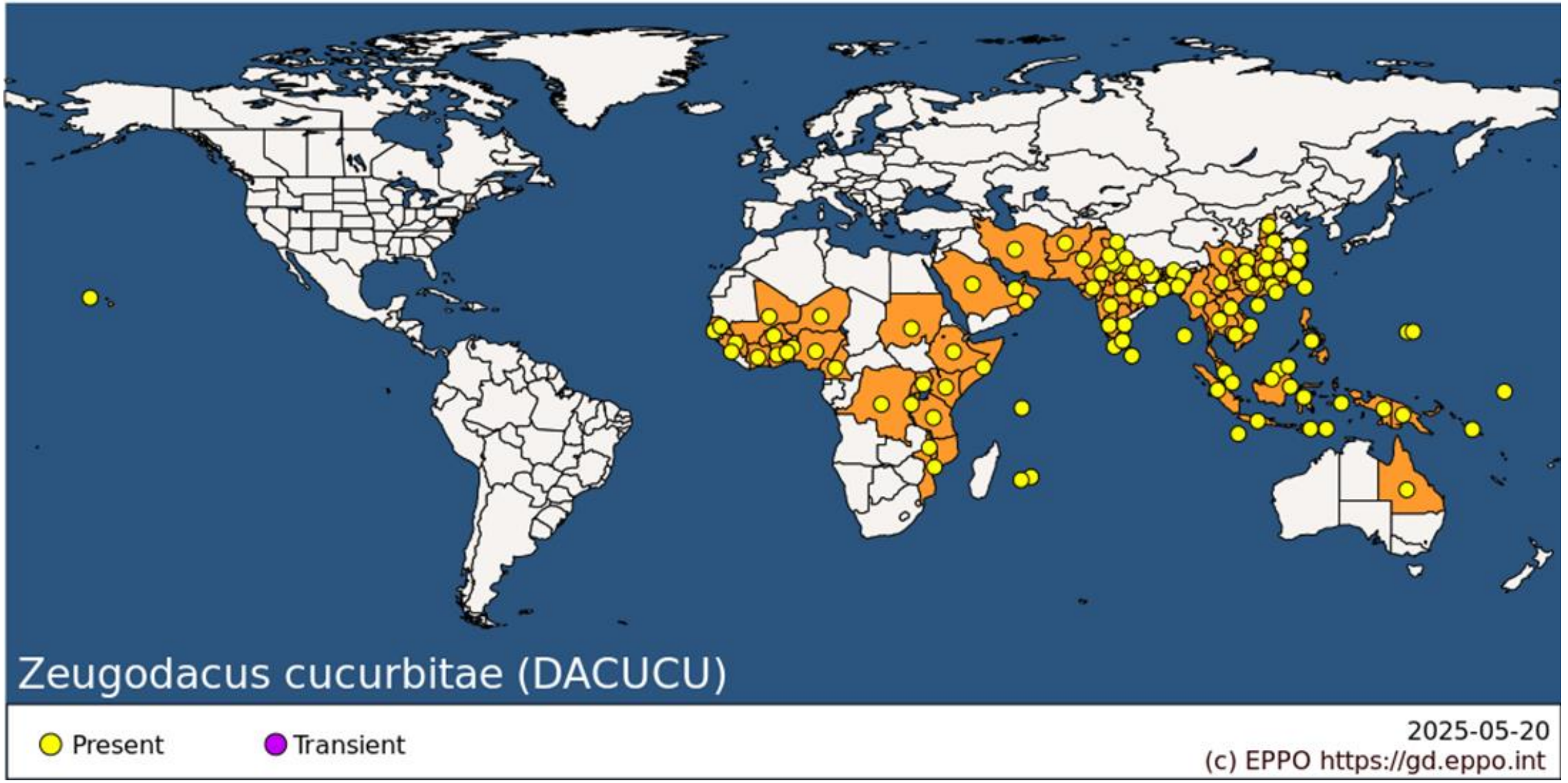
Photo Fruit fly ID Australia

Pre-apical cross band

Abdominal tergites 3-5 black T-shaped marking

Images Doorenweerd, C., Leblanc, L., Anderson, C. T., San Jose, M., Kim, J. W., Rubinoff, D., Geib, S., Todd, T. and Barr, N. 2025. Adult Bactrocera fruit fly ID (Diptera: Tephritidae: Dacinae: Dacini).

Melon fly – Records in Africa dates to 1930's



Melon fly

- Host plants

Primarily Cucurbitaceae

Other host plants

- Economic importance

Serious pest of Cucurbitaceae

- Trapping

Males - Cuelure

Both sexes - protein-based attractants

Photo R.S. Copeland

ID tools

- Mobile application for adult flies

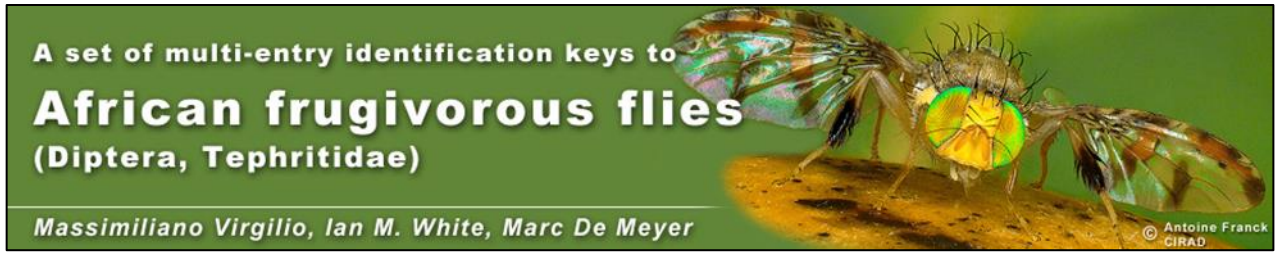
Key African fruit flies of economic significance

29 Economic important species in Africa

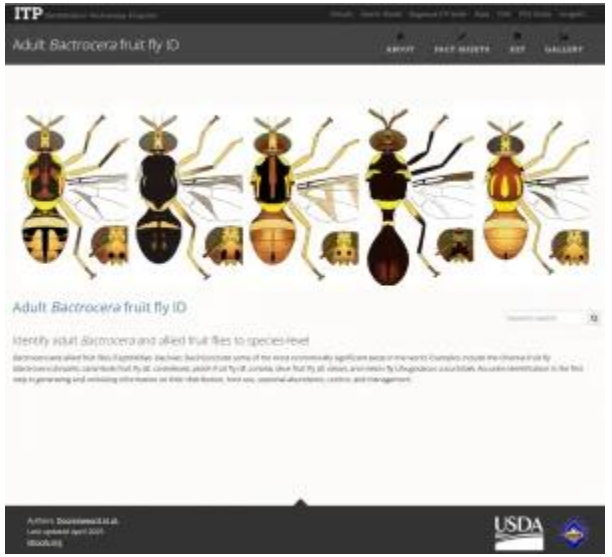
- Online keys for adult fruit flies

A set of multi-entry identification keys to African frugivorous flies (Diptera, Tephritidae)

394 species



ID tools



- *Identification Technology Program*

Adult *Bactrocera* fruit fly ID (Diptera: Tephritidae: Dacinae: Dacini)

>800 species *Bactrocera* and its closely allied genera in the tribe Dacini

- Fruit Fly Identification Australia

65 species of Dacine flies

- Diagnostic protocols

ISPM 27 Diagnostic protocols for regulated pests. DP 29: *Bactrocera dorsalis*

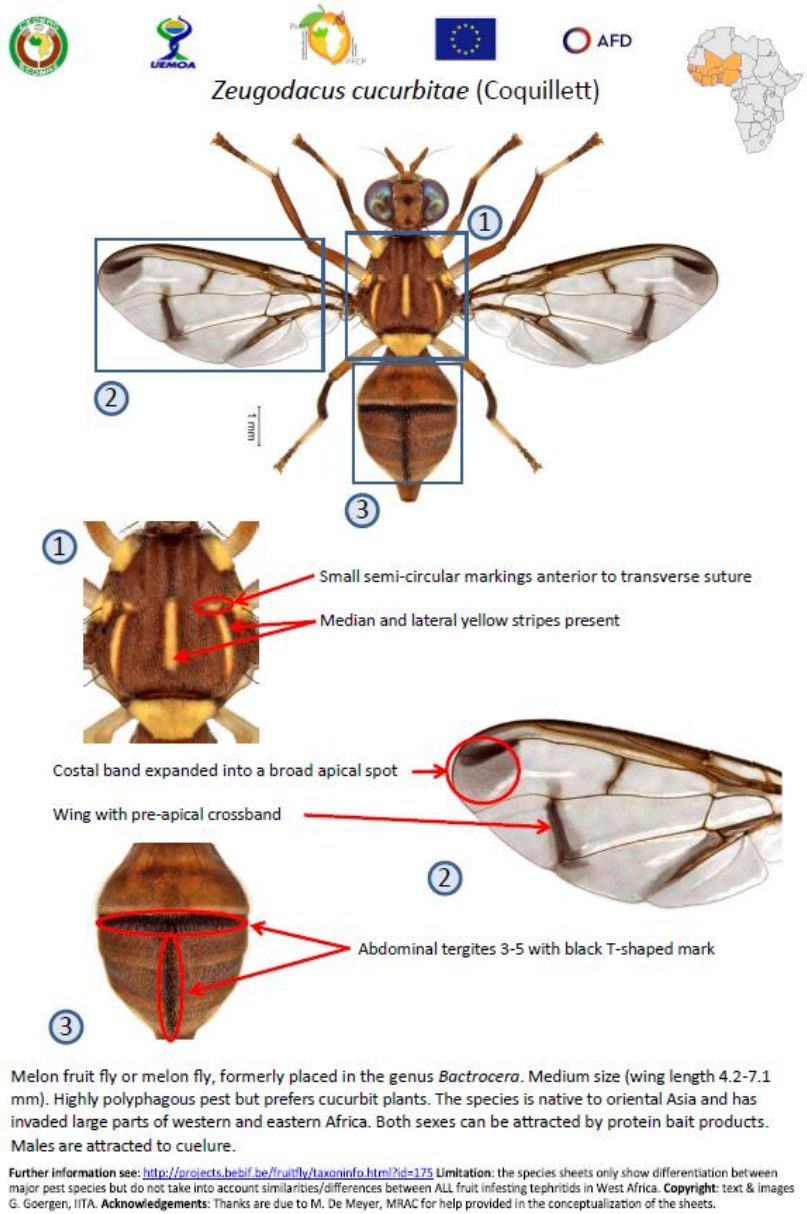
EPPO Global Database

Information on molecular identification

ID tools

- Identification Sheets

https://fruitflies.africamuseum.be/outputs/identification_tools_ID_sheets



ID tools

- Confirm identification by expert
- Molecular identification
- Preserve fruit flies in 70% alcohol

Photo Peter Stephan

Means of dispersal

- Adult flight
- Transport of infested fruit

Photo CABI

Detection survey protocol

- Trapping – target adults

- Fruit surveys – target immatures

Photo NBAIR

Detection Surveys Protocol

- Guidelines

FAO/IAEA. 2018. Trapping Guidelines for Area-Wide Fruit Fly Programmes, Second edition, by Enkerlin, W.R. and Reyes- Flores, J. (eds). Rome, Italy. 65 pp.

FAO/IAEA. 2019. Fruit Sampling Guidelines for Area-Wide Fruit Fly Programmes, by Enkerlin W.R., Reyes, J. and Ortiz, G. (eds). Vienna, Austria. 38 pp.

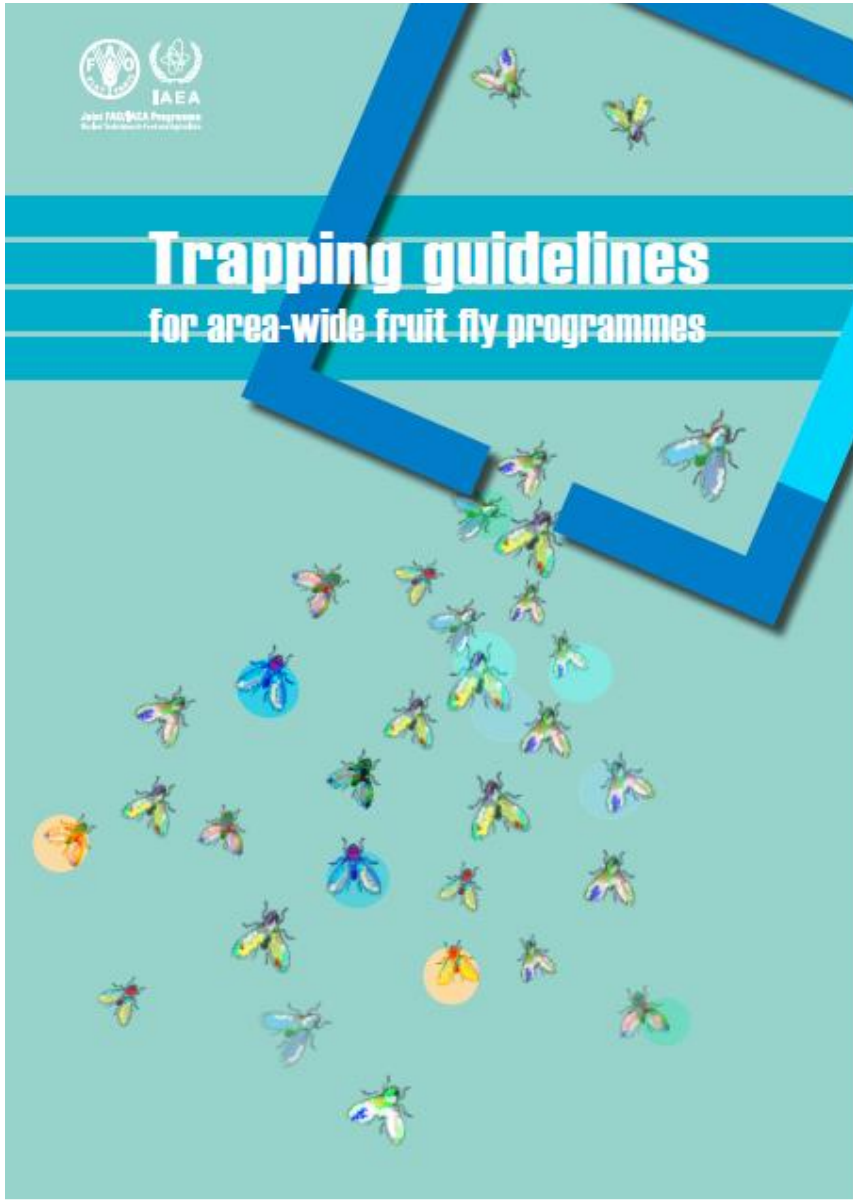
ISPM 26 Establishment of Pest Free Areas for Fruit Flies (Tephritidae)

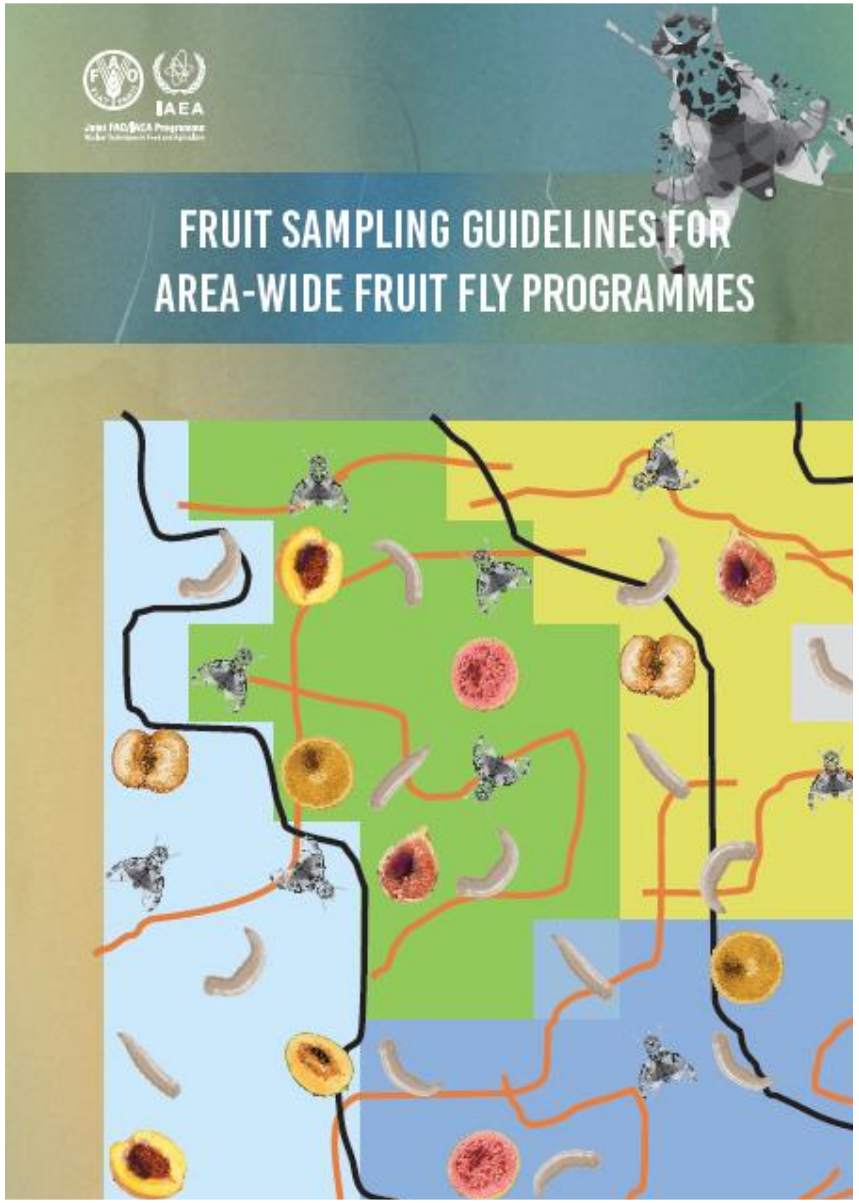
ISPM 27 Diagnostic protocols for regulated pests. DP 29: *Bactrocera dorsalis*

ISPM 30 Establishment of Areas of Low Pest Prevalence for Fruit Flies (Tephritidae)

ISPM 35 Systems approach for pest risk management of fruit flies (Tephritidae)

ISPM 37 Determination of host status of fruit to fruit flies (Tephritidae)


IAEA
Trapping guidelines
for area-wide fruit fly programmes


IAEA
FRUIT SAMPLING GUIDELINES FOR
AREA-WIDE FRUIT FLY PROGRAMMES

Trapping objectives

Monitoring	To verify characteristics of a pest population
Detection	To determine the presence of a pest
Delimiting	To determine boundaries of an infested or pest free area
Verification	Survey to confirm pest status after eradication procedures

Pest situations where trapping may apply

- Scenario A: uncontrolled pest subject to monitoring surveys
- Scenario B: pest under suppression subject to monitoring surveys ;
- Scenario C: pest under eradication subject to monitoring and then verification surveys ;
- Scenario D: no pest, detection surveys including intensive trapping for exclusion in a PFA
- Scenario E: incursion detected through ongoing detection surveys, therefore additional implementation of delimiting survey;
- Scenario F: pest outbreak under eradication requiring verification of pest eradication

Trapping	A	B	C	D	E	F
Monitoring	X	X	X			
Detection				X		
Delimiting					X	
Verification			X			X

Components of a trapping system

1. Attractant

(pheromone, parapheromone, food attractant)

2. Killing agents

dry trap with sticky material (physical action) or toxicant (with chemical action)

wet trap with liquid (physical action) and a preservative

3. Trap

device for retaining the flies

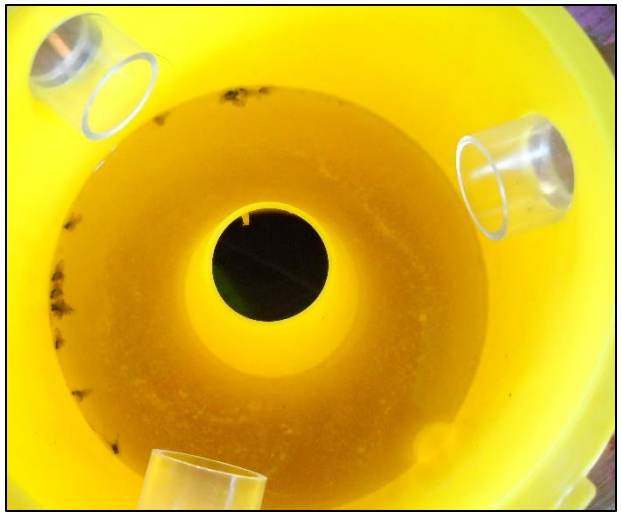
Attractants

1. Male-specific attractants (pheromones or parapheromones)

- TRIMEDLURE (TML) – *Ceratits* spp. (*C. capitata, C. rosa, C. quilicii*)
- METHYL EUGENOL (ME) – *Bactrocera* spp. (*B. dorsalis, B. zonata, B. carambolae, B. Musae)*
- CUE LURE (CUE) – *Bactrocera* spp., *Zeugodacus* spp., *Dacus* spp. (*B. trynoi, Z. cucurbitae*, *Z. tau, D. bivittatus , D. punctatifrons*)

Male specific attractants are generally volatile and can be used with a variety of traps

Attractants



1. Female-biased (food attractants)

- Liquid protein (PB)

Capture different fly species

Capture both female and male

Generally, not as sensitive as the male-attractants

Capturing high percentage non-targets

- Food-based synthetic attractants

Food-based synthetic attractants (3C, 2C) using ammonia and its derivatives

Last 6–10 weeks

Captures few non-target insects and captures fewer male flies

Suited for SIT programmes

Different formulations of attractants

- METHYL EUGENOL

Liquid

Polymetric plug

Other

- CUE LURE

Liquid

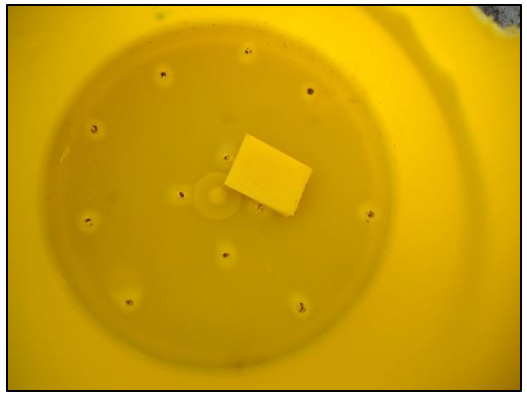
Polymetric plug

Food-based

Torula yeast boraks - Pallets

Patches

Killing agents



- Sticky material

- Toxicant - dichlorvos, malathion, spinosad and pyrethroids (deltamethrin)

- Liquid is the killing agent

When liquid protein attractants used, 1.5 to 2 g of borax is added to preserve the fruit flies There are protein attractants that are formulated with borax, and thus no additional borax is required.

When water is used, 10% propylene glycol is added to preserve captured flies

Devices for trapping

- Dry traps.

The fly is caught on a sticky material board or killed by a chemical agent

Jackson/Delta, Lynfield

- Wet traps. The fly is drowned in the attractant solution or in water with surfactant

McPhail trap

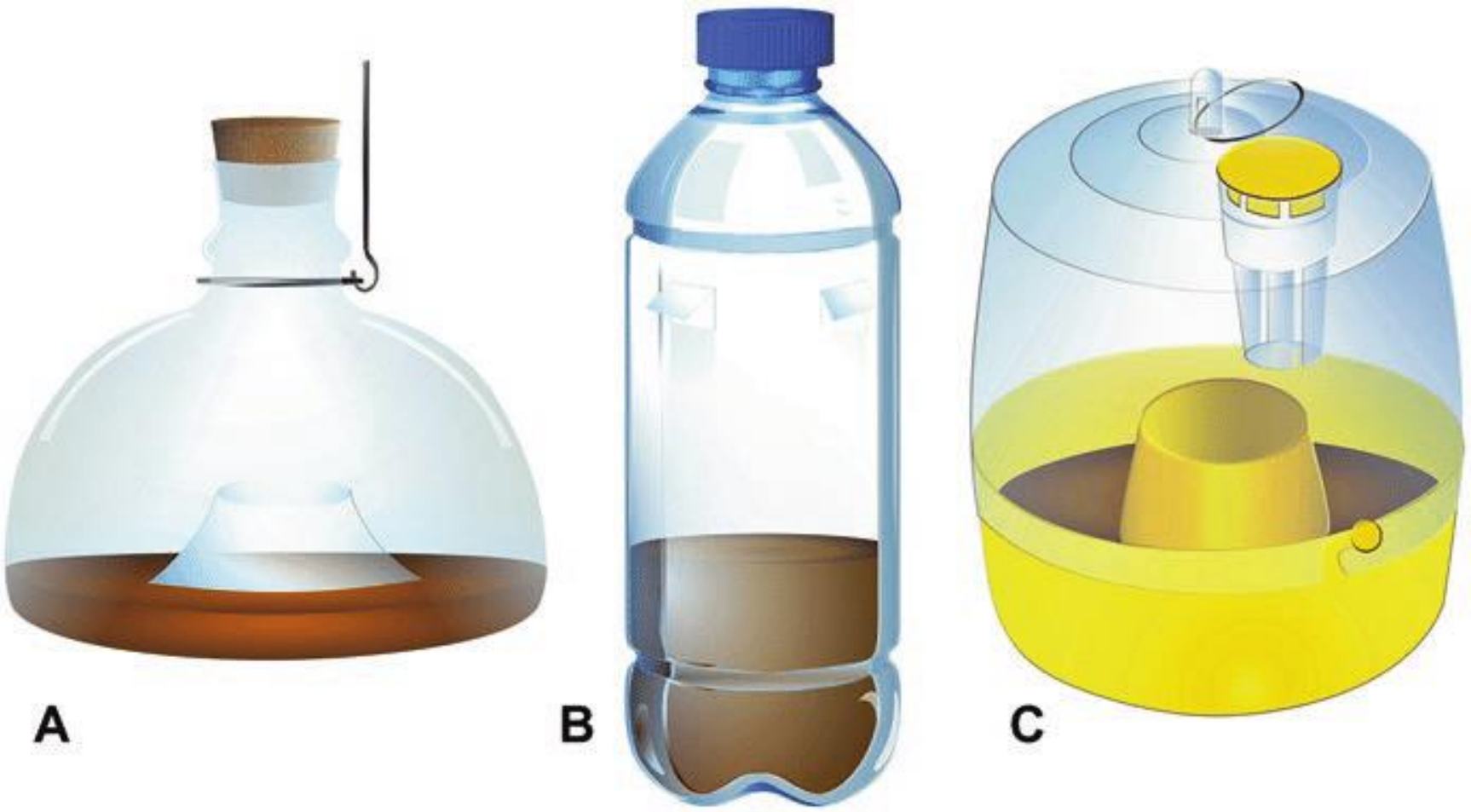
- Dry or wet traps. These traps can be used either dry or wet

Multilure trap and Tephri trap

Traps

- Jackson trap and sticky insert

Traps



A: McPhail B: Home-made C: Multilure

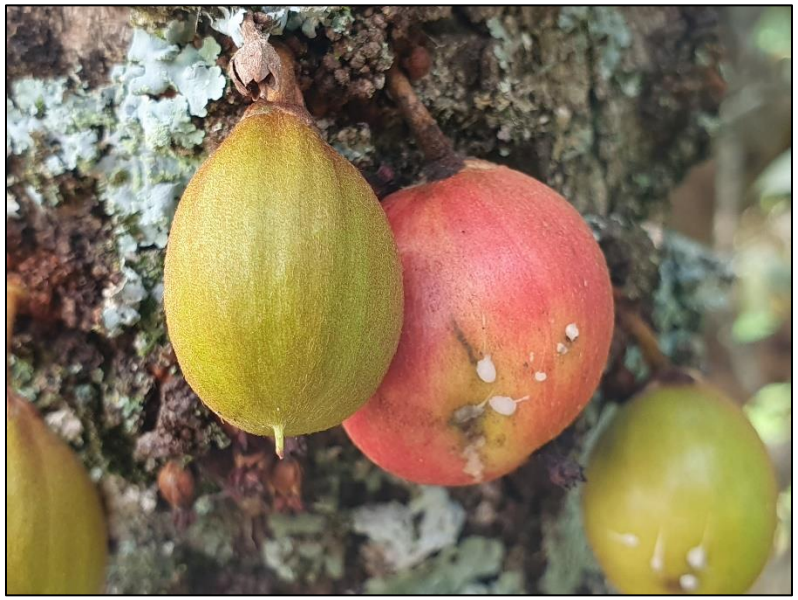
Image Hernández-Ortiz, V., Hernández-López, M., and Dzul-Cauich, J. (2021). Sampling Methods of True Fruit Flies (Tephritidae).

Trap layout and densities

- In suppression and eradication programmes - extensive trapping
- In continuous commercial orchards and in urban and suburban areas where hosts - grid system
- In areas with scattered commercial orchards, rural areas and in marginal areas where commercial and wild hosts exist - traps are distributed along roads
- For early detection of invasive fruit flies - traps are placed in high-risk areas such as points of entry, fruit markets and urban areas

Trap deployment

- Host information
- No host plants - deployed in plants that can provide shelter
- Middle to the top part of the host plant
- Not exposed to direct sunlight
- The trap entrance clear



Trap servicing

- Inspection intervals can range from 1-30 days.
- Trap servicing intervals are specific to each trap system
- Avoid spillage
- Avoid contamination

Fruit flies per trap per day

Flies per trap per day is a population index that indicates the average number of flies of the species captured per trap per day during a specified period

$$FTD = \frac{F}{T \times D}$$

where,

F = total number of flies

T = number of inspected traps

D = average number of days traps were exposed in the field.

Trap records

- To keep proper trapping records:

trap location,

plant where the trap is placed,

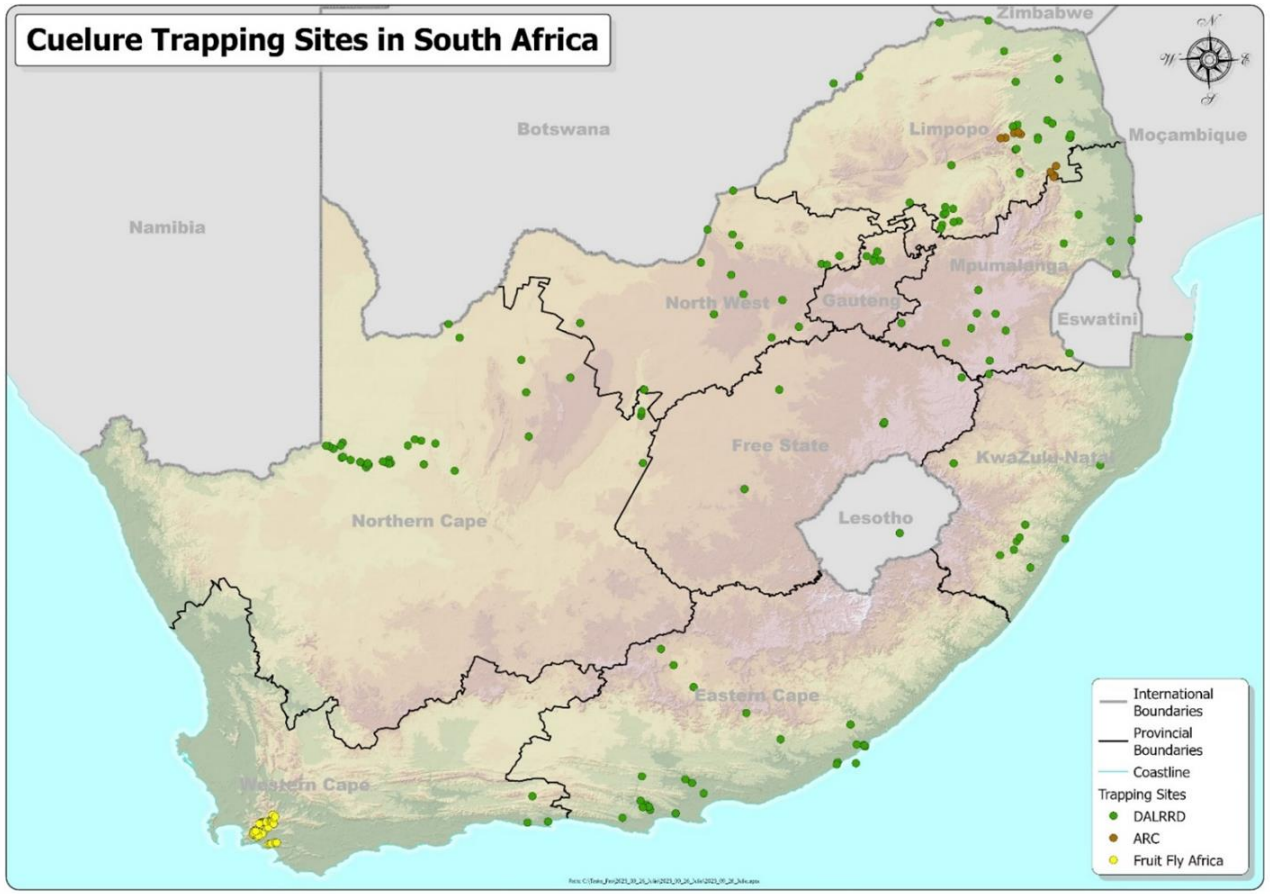
trap and attractant type,

servicing and inspection dates,

number of target fly capture

Trap mapping

- It is recommended that the location of traps should be geo-referenced with use of the global positioning system (GPS)



Africa Phytosanitary Programme

Train-the-Trainer workshop

Thank you

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