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International
Plant Protection
Convention

DEC
2024

ENG

Field survey guidance for *Bactrocera* spp.



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Introduction

Active and regular monitoring and surveillance are critical for countries to establish the presence or absence of plant pests, especially those with severe impacts on food security, the environment, trade, and agricultural productivity. This early warning information is crucial for rapid response, making sound phytosanitary decisions, effectively managing risks, and controlling and protecting borders against pest entry.

This field survey guidance therefore provides easy-to-follow guidelines for technical personnel of national plant protection organizations (NPPOs), to survey for *Bactrocera* spp., a key pest commonly called Fruit fly.

This survey guidance provides a protocol to aid in the monitoring, detection, sample collection, and identification of *Bactrocera* spp., ensuring effective phytosanitary decision-making to manage the pest risk and protect trade in plants and plant products. To simplify identification, this document also provides visuals and guidance on recommended pest traps for the different Fruit fly species.

This field survey protocol was adapted from the United States Department of Agriculture and the California Department of Food and Agriculture guidelines for trapping. It complements the digital tools available to NPPO plant health inspectors, through the Africa Phytosanitary Programme (APP) mobile applications and Geographic Information System (GIS) platforms.

APP is an IPPC initiative designed to transform pest management across Africa by enhancing the capabilities of phytosanitary personnel within NPPOs, to leverage advanced science and modern digital technology for effective and timely pest surveillance, detection, control, and prevention. APP aims to strengthen the resilience of Africa's phytosanitary systems against plant pests of regulatory, economic and environmental significance. Some of the countries involved in APP listed *Bactrocera* spp. as a priority pest in their countries, requiring effective surveillance.

The IPPC implements APP in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and the African Union Department of Agriculture, Rural Development, Blue Economy and Sustainable Development, through its technical unit, the African Union Inter-Africa Phytosanitary Council (AU-IAPSC).

This guide was developed with technical and financial support from the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS).



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The IPPC Secretariat and the IPPC community are grateful to all the institutions that contributed to the production of this technical resource. This document was created with financial support from the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS). This survey guidance was adapted from the United States Department of Agriculture and the California Department of Food and Agriculture guidelines for trapping. The guidance provided in this document was prepared by subject matter experts from USDA APHIS and reviewed by technical officers at the IPPC Secretariat, in the framework of the Africa Phytosanitary Programme (APP). APP is an IPPC initiative implemented in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and the African Union Commission on Agriculture, through its technical unit- the African Union Inter-Africa Phytosanitary Council (AU-IAPSC).

Abbreviations

APHIS	Animal and Plant Health Inspection Service
APP	Africa Phytosanitary Programme
AU-IAPS	African Union Inter-Africa Phytosanitary Council
CDFA	California Department of Food and Agriculture
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information System
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
NPPO	National Plant Protection Organization
USDA	United States Department of Agriculture





Field survey guidance for *Bactrocera* spp.

Scientific name

Bactrocera spp.

Common name

Fruit fly

Type of pest

Fruit fly

Taxonomic position

Class: Insecta

Order: Diptera

Family: Tephritidae

Figure 1: *Bactrocera zonata* adult. © Natasha Wright, Florida Department of Agriculture, www.bugwood.org

Known hosts

Preferred hosts

Fruit flies from the genus *Bactrocera* are highly polyphagous pests of soft-bodied fruit. Preferred hosts vary by species.

Some major commodities targeted by this genus include the sugar apple (*Annona* spp.), jackfruit (*Artocarpus* spp.), cruciferous vegetables (*Brassica* spp.), pepper (*Capsicum* spp.), papaya (*Carica* spp.), citrus (*Citrus* spp.), melon (*Cucumis* spp.), squash (*Cucurbita* spp.), persimmon (*Diospyros* spp.), fig (*Ficus* spp.), strawberry (*Fragaria* spp.), apple (*Malus* spp.), sapodilla (*Manilkara* spp.), mango (*Mangifera* spp.), banana (*Musa* spp.), avocado (*Persea americana*), stone fruit (*Prunus* spp.), guava (*Psidium* spp.), pear (*Pyrus* spp.), tomato (*Solanum* spp.), rose-apple (*Syzygium* spp.) and jujube (*Ziziphus* spp.).

See [USDA National Exotic Fruit Fly Detection Trapping Guidelines](#):

<https://www.aphis.usda.gov/sites/default/files/fruitfly-trapping-guidelines.pdf> or [Invasive Fruit Fly Pests in Africa](#): <https://www.aphis.usda.gov/sites/default/files/fruitfly-trapping-guidelines.pdf> for host lists for individual *Bactrocera* species.

Survey protocol

Target life stage

Adult flies

Time of year to survey

Surveyors can trap fruit flies year-round or on a seasonal basis. Seasonal trapping cycles should be based on the availability of fruit on host plants. In general, fruit flies prefer mature fruits, so placing traps near ripe fruits is critical to fruit fly detection.

Avoid trapping during times of the year when flies are not active. Typically, this is during the hottest and driest parts of the year or during cooler weather.

Trapping

Survey site selection

Surveys should target any locations where hosts are common, including farms and orchards, production areas such as nurseries, and unmanaged natural and urban environments. When deciding between two or more potential trap locations, use the site with more host trees and plants, mature fruits and suitable foliage. Surveyors should move traps to new locations when fruits at the trap site are gone.

Recommended traps

There are three types of traps recommended to effectively capture *Bactrocera* fruit flies.

1. Jackson traps

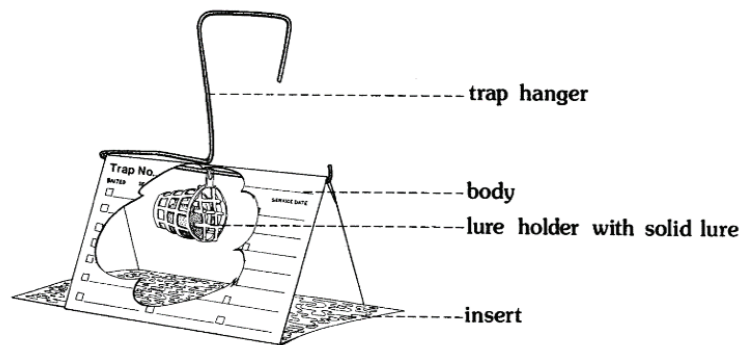


Figure 2: Jackson trap diagram and placement in a host tree. Source: Adapted from the California Department of Food and Agriculture (CDFA) insect trapping guidelines.

Note for Jackson traps: These cardboard traps require the addition of a sticky insert to catch any flies that are attracted to the lure. Typically, the lure acts as a pheromone, which attracts male fruit flies, and it contains some pesticide to stun the fruit fly and cause it to fall to the sticky insert.

2. McPhail traps



Figure 3: McPhail trap diagram and placement in a host tree. Source: Adapted from USDA, 2015 .

3. Multilure traps



Figure 4. Multilure trap in a host tree and view of the trap interior.

Source: Adapted from CDFA and USDA trapping guidelines.

Note for McPhail and multilure traps: These two traps contain a liquid reservoir to trap and drown flies. A 10 percent solution of propylene glycol diluted with water is recommended for the reservoir. It evaporates slowly and may enhance the attractiveness of the lures. Surveyors should replace the propylene glycol solution every 6 weeks or sooner if heavy evaporation occurs. Propylene glycol is toxic: wear gloves when changing it and pour leftover liquid into a bucket for proper disposal. Do not pour it on the ground or near the roots of the host plant.

While these three traps are recommended, there are other options to capture fruit flies, including homemade traps using everyday items such as plastic water bottles (see [How to build a fruit fly trap](https://www.fao.org/family-farming/detail/en/c/1618016/) by FAO: <https://www.fao.org/family-farming/detail/en/c/1618016/>).

Recommended lures

The effectiveness of these lures will vary across the genus, but many *Bactrocera* species are attracted to the following compounds:

- ◆ methyl eugenol (4-allyl-1,2-dimethoxybenzene)
- ◆ cuelure (4-(p-acetoxyphenyl)-2-butanone)
- ◆ torula yeast
- ◆ trimmed

Select the best lure to use for the target fruit fly species, as different fruit fly species react with varying intensity to different lures. See Table 1 for species-specific guidance on trap and lure choices.

CAUTION

Surveyors should follow all product labels and handle all lures, insecticides and traps with proper protective equipment. Place traps in areas that will minimize interactions with other people, children or animals.

Scientific Name	Common Name	McPhail trap baited with torula yeast	Multilure trap baited with torula yeast	Jackson trap baited with methyl eugenol	Jackson trap baited with cuelure
<i>B. albistrigata</i>	White striped fruit fly	x	x		x
<i>B. correcta</i>	Guava fruit fly	x	x	x	
<i>Zeugodacus (formerly Bactrocera) cucurbitae</i>	Melon fruit fly	x	x		x
<i>B. dorsalis complex</i>	Oriental fruit fly	x	x	x	
<i>B. facialis</i>	Tonga fruit fly	x	x		x
<i>B. latifrons</i>	Solanum fruit fly	x	x		

Table 1. Recommended trap and lure combinations for some species of *Bactrocera* fruit flies.

Source: Adapted from the USDA fruit fly trapping guidelines.

Trap placement and spacing

Follow the guidance below when placing traps:

- ◆ Hang traps on branches in foliage that offers shade (i.e. no full sunlight at any time).
- ◆ Place traps in the upper third to upper half of the tree canopy, and halfway to two-thirds of the distance from the trunk to the outer edge of the foliage.
- ◆ Surround the trap with foliage and ripening fruits but maintain an open space of 30 cm to 46 cm around the trap (i.e. do not place traps in dense foliage).
- ◆ Do not hang traps below the foliage canopy or closer than 1.2 m to the ground (Figure 5).



**CORRECT
PROPER HEIGHT**



**INCORRECT
PLACED TOO LOW**

Figure 5. Jackson trap diagram and placement in a host tree.

Source: Adapted from the California Department of Food and Agriculture (CDFA)

Trap servicing

Trap inspection

JACKSON TRAPS

- ◆ Inspect every 1 to 3 weeks, depending on season.
- ◆ Examine the sticky insert for captured flies.
- ◆ If suspect flies are captured, remove sticky insert and bring it in for confirmation identification. (See Figure 6 for the collection technique.)
- ◆ If no flies are detected, remove any leaves or debris from the insert.
- ◆ Replace the insert if it is no longer sticky to ensure the trap will continue to capture flies.

MCPHAIL OR MULTILURE TRAPS

- ◆ Inspect weekly.
- ◆ Pour trap liquid into a bucket through a strainer to collect any drowned insects.
- ◆ Place any possible detections in 70 percent alcohol for future identification.
- ◆ Replace the trap liquid and dispose of used liquids safely.

REPLACING LURES

Jackson trap: Lure dispensers for methyl eugenol and cuelure will need to be changed every 4 to 6 weeks, depending on temperature. Daytime highs of 32 °C or higher, or periods of high winds, require more frequent replacement.

McPhail or multilure trap: For traps using lure dispensers, replace the lures at the recommended intervals and replace the trap liquid at the same time. McPhail traps using torula yeast as an attractant will need to be changed every week.

Sample collection

Place any captured fruit flies from McPhail or Multilure traps in at least 70 percent alcohol for future identification. Removing flies captured on the sticky trap will damage them and make identification difficult. A suggested method for collecting flies from a Jackson trap insert is depicted below (Figure 6). Bend the long corners of the insert inward, fold the insert and use a rubber band to hold it closed. Check first to see that the specimen will not be damaged using this method. Put the insert in a plastic bag before sealing it in a box for mailing. Alternate methods (such as covering with plastic wrap) may be necessary, depending upon the location of the specimen on the insert. Be sure the insert is dry before putting it in plastic bag or covered with plastic wrap.

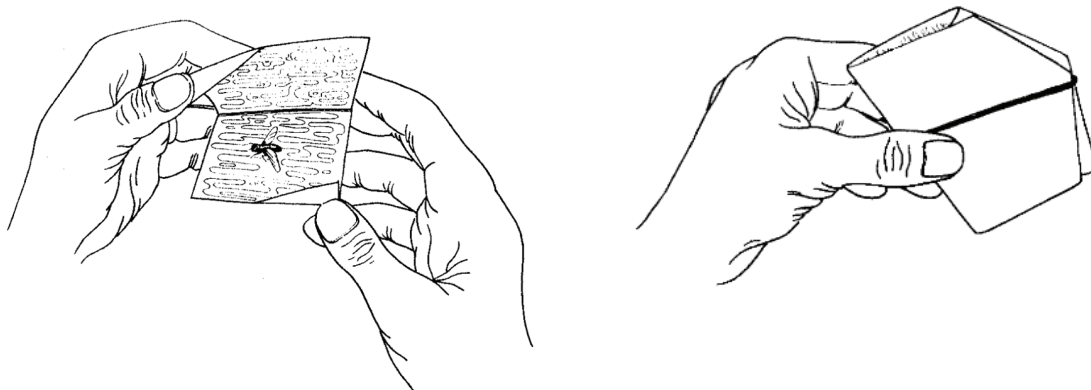


Figure 6. Folding technique for Jackson trap sticky insert if it needs to be shipped for identification.

Source: Adapted from the California Department of Food and Agriculture (CDFA) *Insect Trapping Guide*.
https://www.cdfa.ca.gov/plant/PDEP/insect_trapping_guide/docs/Insect_Trapping_Guide_web.pdf

Pest identification and diagnostics

Identifiers with expertise in Tephritid fruit flies should verify the morphological identification. Species from the *Bactrocera dorsalis* complex are morphologically indistinguishable and require DNA analysis to confirm identification.

Pest description

Bactrocera fruit flies range in length from 5 mm to 8 mm, with various colour patterns on the body and wings. Figure 7 shows adults of several prominent *Bactrocera* species that may be of interest for the survey. These images are meant to be a helpful guide, but taxonomic keys or other confirmatory tools will be necessary to properly identify the genus or species. See the “Identification resources” section in what follows for keys and identification methods.



Bactrocera albistrigata



B. correcta



Zeugodacus (formerly Bactrocera) cucurbitae



B. dorsalis



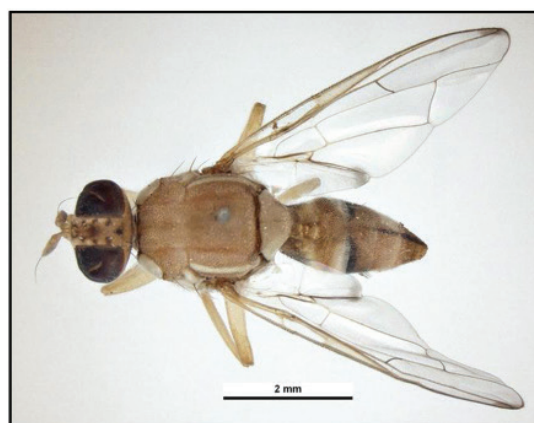
B. facialis



B. latifrons



B. tryoni



B. zonata

Figure 7. Images of adult flies from eight species of the genus *Bactrocera*.

Source: All taken from Bugwood.org, except for *B. facialis*, which comes from CABI.org Bioscience

Identification resources

De Meyer, M., Mohamed, S. & White, I.M. 2014. *Invasive fruit fly pests in Africa*. Cited 12 July 2023. <https://www.africamuseum.be/fruitfly/AfroAsia.htm>

Ekese, S. & Billah, M.K., eds. 2006. *A field guide to the management of economically important Tephritid fruit flies in Africa*. Nairobi, ICIPE Science Press. pp. 118 http://www.icipe.org/system/files_force/j17-2006%20a%20field%20guide%20to%20the%20management%20of%20economically%20importanttephritid%20fruit%20flies%20in%20africa%20.pdf

Hancock, D.L., Freidberg, A. & Friedman, A.L.L. 2021. *Tephritidae*. In: A.H. Kirk-Spriggs & B.J. Sinclair, eds. *Manual of Afrotropical Diptera, volume 3: Brachycera – Cyclorrhapha, excluding Calyptratae – Higher Diptera*. Suricata No. 8, 1669–1734. Pretoria, South African National Biodiversity Institute Publishing.

ISPM 27. Annex 29. 2019. *Diagnostic protocols for Bactrocera dorsalis*. IPPC Secretariat, Rome, FAO. <https://www.ippc.int/en/publications/87022/>

Doorenweerd, C., Anderson, C.T., Leblanc, L., San Jose, M., Rubinoff, D., Geib, S. & Barr, N. 2022. *Adult fruit fly identification of Bactrocera and allied genera using the Lucid multi-entry key platform (Diptera: Tephritidae: Dacinae: Dacini)*. United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ). Cited 12 July 2024. <https://idtools.org/tools/2103/index.cfm>

White, I.M. & Elson-Harris, M.M. 1994. *Fruit flies of economic significance: Their identification and bionomics*. Wallingford, UK, CAB International.

Easily mistaken species

Species of *Bactrocera* can be easily mistaken for other fruit fly genera, including *Anastrepha*, *Ceratitis* and *Rhagoletis*. See Figure 8 for basic morphological differences across the different genera of fruit flies. **Note the differences in the wing banding among the major genera.**

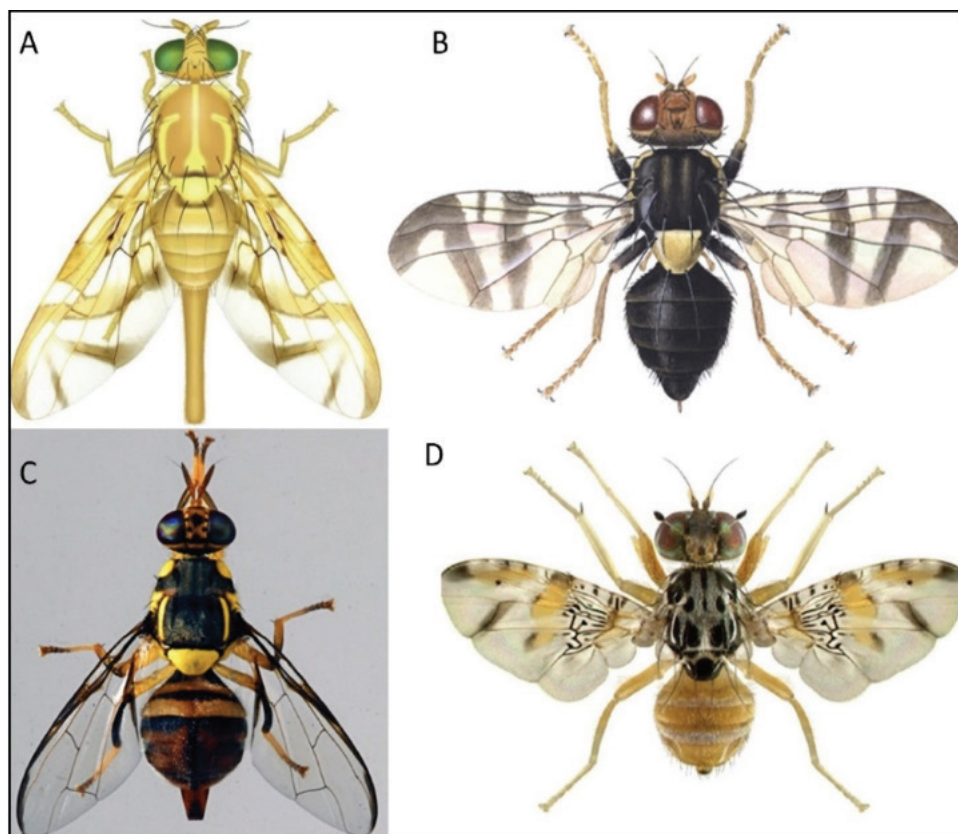


Figure 8. General appearance of four fruit fly genera: (a) *Anastrepha ludens*; (b) *Rhagoletis cerasi*; (c) *Bactrocera dorsalis*; and (d) *Ceratitis capitata*. Source: (a) Taina Litwak/USDA-ARS, Bugwood.org; (b) Arthur D. Cushman / USDA; (c) IAEA image bank; (d) G. Gerogen/IITA.

Additional resources

If you require additional information regarding fruit fly surveys or how to deal with fruit fly infestations after detection, there are resources available, including [ISPM 26 \(Establishment of pest free areas for fruit flies \(Tephritidae\)\)](#), [ISPM 35 \(Systems approach for pest risk management of fruit flies \(Tephritidae\)\)](#), the [USDA National Exotic Fruit Fly Detection Trapping Guidelines](#) and the [CDFA Insect Trapping Guide](#).

IPPC

The International Plant Protection Convention (IPPC) is an international plant-health agreement that aims to protect global plant resources and facilitate safe trade. The IPPC vision is that all countries have the capacity to implement harmonized measures to prevent pest introductions and spread, and minimize the impacts of pests on food security, trade, economic growth, and the environment.

Organization

- » There are over 180 IPPC contracting parties.
- » Each contracting party has a national plant protection organization (NPPO) and an official IPPC contact point.
- » Ten regional plant protection organizations have been established to coordinate NPPOs in various regions of the world.
- » The IPPC Secretariat liaises with relevant international organizations to help build regional and national capacities.
- » The secretariat is provided by the Food and Agriculture Organization of the United Nations (FAO).

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