EPPO Datasheet: *Bactrocera dorsalis*

Last updated: 2021-04-28

IDENTITY

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Preferred name: *Bactrocera dorsalis*
Authority: (Hendel)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Diptera: Tephritidae
Other scientific names: *Bactrocera invadens* Drew, Tsuruta & White, *Bactrocera papayae* Drew & Hancock, *Bactrocera philippinensis* Drew & Hancock, *Chaetodacus dorsalis* (Hendel), *Chaetodacus ferrugineus dorsalis* (Hendel), *Chaetodacus ferrugineus okinawanus* Shiraki, *Chaetodacus ferrugineus* (Fabricius), *Dacus dorsalis* Hendel, *Dacus ferrugineus dorsalis* Hendel, *Dacus ferrugineus okinawanus* Shiraki, *Dacus ferrugineus* Fabricius, *Strumeta dorsalis* (Hendel)
Common names: oriental fruit fly
view more common names online...
EPPO Categorization: A1 list
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EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: DACUDO

Notes on taxonomy and nomenclature

B. dorsalis forms part of a species complex, within which over 50 species have been described in Asia. Many earlier records of *B. dorsalis* from Southern India, Indonesia, Malaysia, the Philippines and Sri Lanka are based on misidentifications of what are now (Drew & Hancock, 1994) known to be other species. However, some of these taxa previously described as distinct taxa, i.e. *B. invadens*, *B. papayae*, and *B. philippinensis* are considered as being synonymous (see Schutze *et al.*, 2014). Part of the literature prior to 2015 will have been published under the junior names in particular with reference to studies in Africa under *B. invadens*. Some researchers (Drew & Romig, 2013; 2016), however, still consider *B. papaya* and *B. invadens* to be valid species, different from *B. dorsalis*.

HOSTS

B. dorsalis is one of the most polyphagous fruit fly species, recorded from close to 450 different hosts worldwide, belonging to 80 plant families. In addition, it is associated with a large number of other plant taxa for which the host status is not certain. The USDA Compendium of Fruit Fly Host Information (CoFFHI) (Liquido *et al.*, 2019) provides an extensive host list with detailed references. While some fruits (e.g. banana, mangosteen, papaya) are listed as a hosts, it was shown that factors such as ripeness or condition (damaged versus undamaged) can affect the oviposition success of females and the survival of larvae (Cugala *et al.*, 2013, 2017; Unahawutti *et al.*, 2014).

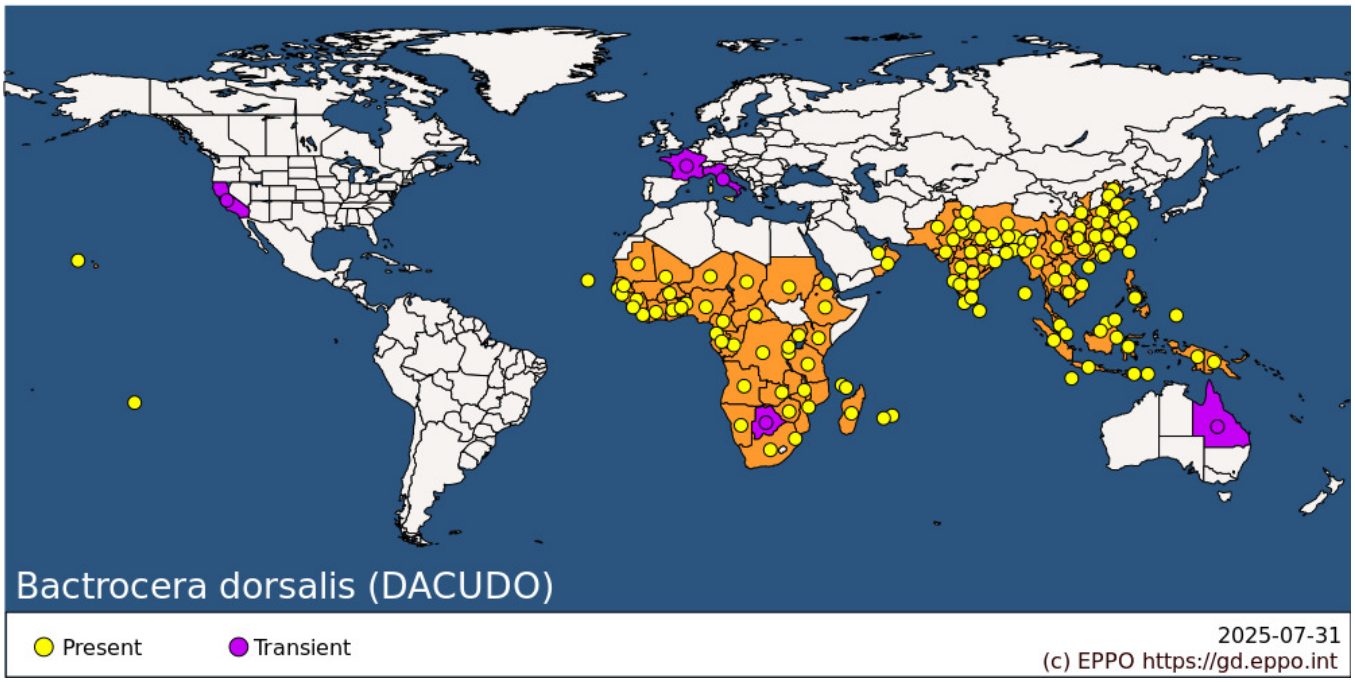
Host list: *Abelmoschus esculentus, Actinidia fulvicoma, Adenanthera pavonina, Adenia cissampeloides, Adonidia merrillii, Aegle marmelos, Afzelia xylocarpa, Alangium chinense, Alangium salviifolium, Alpinia mutica, Anacardium occidentale, Ananas comosus, Annona cherimola, Annona glabra, Annona macroprophyllata, Annona montana, Annona muricata, Annona reticulata, Annona senegalensis, Annona squamosa, Antiaris toxicaria, Antidesma ghaesembilla, Aphloia theiformis, Aporosa villosa, Ardisia crenata, Areca catechu, Arenga engleri, Arenga pinnata, Arenga westerhoutii, Artabotrys monteiroae, Artabotrys siamensis, Artocarpus altilis, Artocarpus chama, Artocarpus elasticus, Artocarpus heterophyllus, Artocarpus integer, Artocarpus lacucha, Artocarpus lanceifolius, Artocarpus nitidus, Artocarpus odoratissimus, Artocarpus rigidus, Artocarpus sericicarpus, Averrhoa bilimbi, Averrhoa carambola, Azadirachta excelsa, Baccaurea angulata, Baccaurea motleyana, Baccaurea racemosa , Baccaurea ramiflora, Bactris gasipaes, Balakata baccata, Barringtonia edulis, Benincasa hispida, Bischofia javanica, Blighia sapida, Borassus flabellifer, Bouea macrophylla, Bouea oppositifolia, Breynia racemosa, Bridelia stipularis*

, Broussonetia kaempferi, Broussonetia papyrifera, Callicarpa longifolia, Calophyllum inophyllum, Calotropis sp., Camonea vitifolia, Cananga odorata, Canarium album, Canarium indicum, Capparis duchesnei, Capparis sepiaria, Capparis tomentosa, Capsicum annuum, Capsicum frutescens, Carallia brachiata, Careya arborea, Carica papaya, Carissa carandas, Carissa spinarum, Caryota mitis, Cascabela thevetia, Casimiroa edulis, Castanopsis sp., Cayratia japonica, Celtis tetrandra, Chionanthus parkinsonii, Choerospondias axillaris, Chrysobalanus icaco, Chrysophyllum cainito, Chukrasia tabularis, Cinnamomum yabunikkei, Cissus repens, Citrullus colocynthis, Citrullus lanatus, Citrus depressa, Citrus maxima, Citrus natsudaidai, Citrus reticulata, Citrus swinglei, Citrus trifoliata, Citrus x amblycarpa, Citrus x aurantiifolia, Citrus x aurantium var. clementina, Citrus x aurantium var. deliciosa, Citrus x aurantium var. paradisi, Citrus x aurantium var. sinensis, Citrus x aurantium var. unshiu, Citrus x aurantium, Citrus x latifolia, Citrus x limon var. meyerii, Citrus x limon, Citrus x limonia var. jambhiri, Citrus x nobilis, Citrus x tangelo, Clausena lansium, Clusia rosea, Coccinia grandis, Coccoloba uvifera, Coffea arabica, Coffea canephora, Cordia alba, Cordia sp., Cordyla pinnata, Crescentia cujete, Crinum asiaticum, Cucumis melo, Cucumis prophetarum, Cucumis sativus, Cucurbita argyrosperma, Cucurbita maxima, Cucurbita moschata, Cucurbita pepo, Cydonia oblonga, Dacryodes edulis, Desmos chinensis, Dillenia obovata, Dimocarpus longan, Diospyros abyssinica, Diospyros areolata, Diospyros castanea, Diospyros dasyphylla, Diospyros diepenhorstii, Diospyros discolor, Diospyros glandulosa, Diospyros japonica, Diospyros kaki, Diospyros malabarica , Diospyros maritima, Diospyros mespiliformis, Diospyros mollis, Diospyros montana, Diospyros morrisiana, Diospyros nigra, Diospyros sandwicensis, Diospyros tutcheri, Diplocyclos palmatus, Donella lanceolata, Dovyalis hebecarpa, Dracaena reflexa, Dracaena steudneri, Drypetes floribunda, Durio zibethinus, Dysoxylum parasiticum, Ehretia microphylla, Elaeocarpus hygrophilus, Elaeocarpus serratus, Eriobotrya japonica, Erycibe subspicata, Eugenia dombeyi, Eugenia palumbis, Eugenia uniflora, Excoecaria agallocha, Fagraea berteroana, Fagraea ceilanica, Feijoa sellowiana, Fibraurea tinctoria, Ficus auriculata, Ficus benjamina, Ficus carica, Ficus chartacea, Ficus erecta, Ficus fistulosa, Ficus hirta, Ficus hispida, Ficus lepicarpa, Ficus microcarpa, Ficus obpyramidata, Ficus polita, Ficus pumila, Ficus racemosa, Ficus religiosa, Ficus sagittata, Ficus septica, Ficus sp., Ficus sycomorus, Ficus virgata, Flacourtia indica, Flacourtia rukam, Flueggea virosa, Fortunella hindsii, Fortunella japonica, Fortunella margarita, Fragaria chiloensis, Gambeya albida, Garcinia atroviridis, Garcinia celebica, Garcinia costata, Garcinia cowa, Garcinia dulcis, Garcinia griffithii, Garcinia intermedia, Garcinia mangostana, Garcinia mannii, Garcinia parvifolia, Garcinia prainiana, Garcinia subelliptica, Garcinia venulosa, Garcinia xanthochymus, Garuga floribunda, Glycosmis pentaphylla, Gmelina elliptica, Gmelina philippensis, Gnetum sp., Grewia asiatica, Gynochthodes umbellata, Haematostaphis barteri, Hanguana malayana, Hexalobus monopetalus, Heynea trijuga, Holigarna kurzii, Horsfieldia irya, Icacina oliviformis, Inga laurina, Inocarpus fagifer, Irvingia gabonensis, Irvingia malayana, Ixora javanica, Ixora macrothyrsa, Juglans hindsii, Juglans nigra, Juglans regia, Kaempferia sp., Kedrostis leloja, Knema globularia, Lagenaria siceraria, Landolphia heudelotii, Lansium domesticum, Lepisanthes alata, Lepisanthes fruticosa, Lepisanthes rubiginosa, Lepisanthes tetraphylla, Lindera oxyphylla, Litchi chinensis, Litsea glutinosa, Litsea salicifolia, Luffa acutangula, Luffa aegyptiaca, Lycianthes biflora , Machilus thunbergii, Maclura cochinchinensis, Malpighia emarginata, Malpighia glabra, Malus domestica, Malus sylvestris, Mammea siamensis, Mangifera caesia, Mangifera caloneura, Mangifera casturi, Mangifera foetida , Mangifera griffithii, Mangifera indica, Mangifera lalijiwa, Mangifera laurina, Mangifera odorata, Mangifera pajang, Mangifera quadrifida, Manilkara jaimiqui, Manilkara zapota, Melastoma dodecandrum, Melicope pteleifolia , Microcos tomentosa, Mimusops coriacea, Mimusops elengi, Mitrephora maingayi, Momordica balsamina, Momordica charantia, Momordica cochinchinensis, Monoon longifolium, Monoon simiarum, Morinda citrifolia, Morinda coreia, Morus alba, Morus nigra, Muntingia calabura, Murraya paniculata, Musa acuminata, Musa balbisiana, Musa basjoo, Musa troglodytarum, Musa x paradisiaca, Myrianthus arboreus, Myrica rubra, Myxopyrum smilacifolium, Nauclea latifolia, Nauclea orientalis, Neolamarckia cadamba, Neolitsea sericea, Nephelium cuspidatum, Nephelium lappaceum, Noronhia emarginata, Notelaea sandwicensis, Ochreinauclea maingayi, Ochrosia mariannensis, Olax scandens, Opilia amentacea, Opuntia ficus-indica, Palaquium maingayi, Pandanus odorifer, Pandanus tectorius, Parinari anamensis, Parkia biglobosa, Parkia speciosa, Passiflora caerulea , Passiflora edulis, Passiflora foetida, Passiflora incarnata, Passiflora laurifolia, Passiflora ligularis, Passiflora quadrangularis, Passiflora suberosa, Passiflora tripartita, Persea americana, Phaleria macrocarpa, Phaseolus vulgaris, Phoenix dactylifera, Phyllanthus acidus, Phyllanthus emblica, Phyllanthus littoralis, Physalis minima, Physalis peruviana, Pimenta dioica, Piper nigrum, Planchonella duclitan, Pometia pinnata, Potentilla indica, Pouteria caimito, Pouteria campechiana, Pouteria sapota, Pouteria viridis, Premna serratifolia, Prunus armeniaca, Prunus avium, Prunus campanulata, Prunus cerasifera, Prunus cerasoides, Prunus cerasus, Prunus davidiana, Prunus domestica, Prunus mume, Prunus persica, Prunus phaeosticta, Prunus salicina, Pseudocydonia sinensis, Psidium cattleyanum, Psidium guajava, Punica granatum, Pyrus calleryana, Pyrus communis, Pyrus pyrifolia, Rhaphiolepis williamtelliana, Rhizophora sp., Rhodocactus grandifolius, Rhodomyrtus tomentosa, Rollinia mucosa, Rubus leucanthus, Rubus reflexus, Rubus rosifolius, Rubus sumatranus, Saba comorensis, Saba senegalensis , Salacca zalacca, Salacia verrucosa, Sambucus javanica, Sandoricum koetjape, Santalum paniculatum, Sauropus androgynus

, Schoepfia fragrans, Sclerocarya birrea, Sechium edule, Selenicereus undatus, Sesbania grandiflora, Shirakiopsis indica, Simarouba glauca, Siphonodon celastrineus, Solanum aculeatissimum, Solanum aethiopicum, Solanum americanum, Solanum anguivi, Solanum betaceum, Solanum capsicoides, Solanum donianum, Solanum erianthum, Solanum granuloso-leprosum, Solanum incanum, Solanum lasiocarpum, Solanum linnaeanum, Solanum lycopersicum, Solanum mauritianum, Solanum melongena, Solanum muricatum, Solanum nigrum, Solanum pimpinellifolium, Solanum pseudocapsicum, Solanum seaforthianum, Solanum sessiliflorum, Solanum stramoniifolium, Solanum torvum, Solanum trilobatum, Sorindeia madagascariensis, Spondias dulcis, Spondias mombin, Spondias pinnata, Spondias purpurea, Staphylea ternata, Streblus asper, Strychnos mellodora, Strychnos nux-vomica, Syzygium acuminatissimum, Syzygium aqueum, Syzygium aromaticum, Syzygium borneense, Syzygium coarctatum, Syzygium cumini, Syzygium formosanum, Syzygium grande, Syzygium jambos, Syzygium levinei, Syzygium lineatum, Syzygium malaccense, Syzygium nervosum, Syzygium samarangense, Terminalia bellirica, Terminalia catappa, Terminalia chebula, Terminalia citrina, Theobroma cacao, Trichosanthes costata, Trichosanthes pilosa, Trichosanthes scabra, Triphasia trifolia, Uvaria grandiflora, Uvaria littoralis, Vaccinium reticulatum, Vangueria infausta, Viburnum japonicum, Vitellaria paradoxa, Vitis amurensis, Vitis vinifera, Voacanga africana, Wikstroemia phillyreifolia, Wikstroemia uva-ursi, Willughbeia coriacea, Willughbeia edulis, Xanthophyllum flavescens, Ximenia americana, Xylotheca kraussiana, Zanthoxylum asiaticum, Zehneria mucronata, Zehneria wallichii, Ziziphus jujuba, Ziziphus mauritiana, Ziziphus mucronata, Ziziphus nummularia, Ziziphus oenopolia, x Citrofortunella floridana, x Citrofortunella microcarpa

GEOGRAPHICAL DISTRIBUTION

Bactrocera dorsalis is an Asian species distributed from the Indian Subcontinent eastwards towards Southeast Asia. It has been introduced into different parts of Oceania, and while it has been eradicated in some of these areas it became established in others. Vargas *et al.* (2015) gives an overview of the distribution and invasion history. The species has also been introduced in Africa where it was detected for the first time in 2003 in Kenya. It subsequently spread throughout the whole continent below the Sahara (De Villiers *et al*., 2016) as well as several islands in the western part of the Indian Ocean. It has been recently detected in the EPPO region (France: Mouttet & Balmès, 2020; Italy: Nugnes *et al.*, 2018) although there is currently no evidence that it has become established there.



EPPO Region: France (mainland), Italy (mainland)
Africa: Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Congo, The Democratic Republic of the, Cote d'Ivoire, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Senegal, Sierra Leone, South Africa,

Sudan, Tanzania, United Republic of, Togo, Uganda, Zambia, Zimbabwe
Asia: Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China (Anhui, Aomen (Macau), Beijing, Chongqing, Fujian, Guangdong, Guangxi, Guizhou, Hainan, Hebei, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Shaanxi, Shandong, Shanghai, Sichuan, Xianggang (Hong Kong), Xizhang, Yunnan, Zhejiang), Christmas Island, East Timor, India (Andaman and Nicobar Islands, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Nagaland, Odisha, Punjab, Rajasthan, Sikkim, Tamil Nadu, Telangana, Uttarakhand, Uttar Pradesh, West Bengal), Indonesia (Irian Jaya, Java, Kalimantan, Nusa Tenggara, Sulawesi, Sumatra), Lao People's Democratic Republic, Malaysia (Sabah, Sarawak, West), Myanmar, Nepal, Oman, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, United Arab Emirates, Vietnam
North America: United States of America (California, Hawaii)
Oceania: Australia (Queensland), French Polynesia, Palau, Papua New Guinea

BIOLOGY

The general life cycle is similar to those of other *Bactrocera* species infesting fruits: eggs are laid below the skin of the host fruit. Three larval stages develop inside the fruit, feeding on the plant tissue. Once mature the third instar larva will leave the fruit, dig down into the soil and turn into a pupa enclosed in a puparium. The adult fly will emerge from the puparium. *Bactrocera dorsalis* can complete its life cycle in about 37 days at 25°C (Vargas *et al.*, 1984). Adults can live up to 11 weeks (Vargas *et al*., 1984). Females start laying eggs between 18 and 48 days after adult emergence depending on prevailing temperatures (Vargas *et al.*, 2000). The larval duration of *B. dorsalis* varies from 7 to 36 days at 35°C and 15°C respectively (Rwomushana *et al*., 2008b). An adult fly emerges from the pupa after 9 to 34 days at temperatures ranging from 30°C to 15°C (Ekesi *et al*., 2006; Rwomushana *et al.*, 2008b). In places where *Bactrocera dorsalis* has been invasive, it is known to outcompete native or previously introduced fruit flies (Vargas *et al.*, 2007; Ekesi *et al.*, 2009).

DETECTION AND IDENTIFICATION

Symptoms

Attacked fruit have tiny oviposition punctures, but these and other symptoms of damage are often difficult to detect in the early stages of infestation. Considerable damage may occur inside the fruit before symptoms are visible externally, often as networks of tunnels accompanied by rotting.

Morphology

Larva

Fruit fly larvae in general have a typical shape, i.e., cylindrical maggot-shape, elongate, anterior end narrowed and somewhat recurved ventrally, with anterior mouth hooks, and flattened caudal end. Their length varies from 5 to 15 mm. Identification to species level is not possible based on larvae. The 3rd-instar larvae have been described by White & Elson-Harris (1992) in detail. The same work provides a key to 3rd-instar larvae which is useful for an identification to genus level.

Adult (after diagnostic description given by Drew & Romig, 2013. Additional character states of the female after Drew & Hancock, 1994. Also included are variable states as listed under *B. invadens* and *B. papayae* as they are considered synonymous in this datasheet)

Male

Face fulvous with a pair of medium-sized to large circular to oval black spots; postpronotal lobes and notopleura yellow; scutum black with extensive areas of red-brown to brown below and behind lateral postsutural vittae, around notopleural suture, between postpronotal lobes and notopleura, and inside postpronotal lobes; broad parallel-sided lateral postsutural yellow vittae ending at or behind intra-alar seta; medial postsutural yellow vitta absent; mesopleural stripe reaching midway between anterior margin of notopleuron and anterior notopleural seta dorsally;

scutellum yellow; legs with femora entirely fulvous; fore tibiae pale fuscous and hind tibiae fuscous, mid tibiae fulvous with a small area of dark fuscous basally; wing with cells bc and c colourless, microtrichia in outer corner of cell c only; a narrow fuscous costal band confluent with R2+3 and remaining very narrow around apex of wing (occasionally there can be a very slight swelling around apex of R4+5); a narrow pale fuscous anal streak; supernumerary lobe of medium development; abdominal terga III-V orange-brown with variable pattern but normally with the basic 'T' shaped pattern consisting of a narrow to broad transverse black band across anterior margin of tergum III, a narrow to medium-width medial longitudinal black band over all three terga, narrow anterolateral fuscous to dark fuscous corners on terga IV and V; a pair of oval orange-brown to pale fuscous shiny spots on tergum V; abdominal sterna dark coloured.

Female

As for male in the general body colour patterns. Pecten absent from abdominal tergum III. Ovipositor basal segment orange-brown, dorsoventrally compressed and tapering posteriorly in dorsal view; ratio of length of oviscape to length of tergum V varies from 0.7:1 to 1.2:1; aculeus apex needle shaped.

Remark: differentiation between this species and closely related species within the *B. dorsalis* species complex (see Drew & Hancock, 1994) is difficult and needs expert confirmation. See ISPM 27 DP 29 (IPPC, 2019) for details on how to differentiate between the main species of commercial importance belonging to the species complex. Aculeus length has been used to differentiate between *B. dorsalis* and *B. papayae* but see Schutze *et al.* (2014) for review on the intra-specific variability of this aspect.

DNA barcoding

The molecular identification of *B. dorsalis* through DNA barcoding proves to be problematic as this species cannot be properly distinguished from a number of closely related species, including species from the *B. dorsalis* species complex (see Drew & Hancock 1994; Drew & Romig 2013; Schutze *et al.* 2014). Additionally, the presence of unidentified / possibly misidentified reference sequence in the Barcoding Index Number Systems (BINs) in which this species is represented, might also bias its molecular identification.

Sequences (both under ***Bactrocera dorsalis*** and ***Bactrocera invadens***) are available in the Barcode of Life Data Systems (BOLD). Sequences for *Bactrocera dorsalis* are available in **EPPO-Q-Bank.**

Detection and inspection methods

Males are efficiently attracted to methyl eugenol. Both sexes can be monitored by traps baited with protein-based attractants. Detection is also possible by examination of fruit for oviposition punctures and then rearing the larvae through to the adult stage.

PATHWAYS FOR MOVEMENT

Transport of infested fruits is the main means of movement and dispersal to previously uninfested areas. Adult flight can also result in dispersal but previous citations of long (50-100 km) dispersal movements for *Bactrocera* spp. are unsubstantiated according to a recent review by Hicks *et al.* (2019). Dispersal up to 2 km is considered more typical.

PEST SIGNIFICANCE

Economic impact

Losses incurred by *Bactrocera dorsalis* can be substantial, especially on mango. Significant damage can also be caused on guava and citrus (Ekesi *et al.*, 2006; Goergen *et al.*, 2011; Rwomushana *et al.*, 2008a; Vayssieres *et al.*, 2009).

Control

Management for this species includes the general control measures for *Bactrocera* spp. (see Vargas *et al.* 2015 for an overview of management options). These include sanitation (to gather all fallen and infested host fruits and destroy them). Insecticidal protection is possible by using a cover spray or a bait spray. Bait sprays work on the principle that both male and female tephritids are strongly attracted to a protein source from which ammonia emanates. Bait sprays have the advantage over cover sprays in that they can be applied as a spot treatment so that the flies are attracted to the insecticide and there is minimal impact on natural enemies and other beneficials. Male annihilation technique (MAT) using methyl-eugenol as main attractant, has been used in several eradication programs against *B. dorsalis* (for an overview, see Vargas *et al.* 2014). Sterile Insect Technique (SIT) has been used as a component in an area-wide integrated pest management (IPM) program to suppress the species in Thailand (Chinvinijkul *et al.*, 2016). See Enkerlin (2005) for a review on SIT programs worldwide against this and other tephritid pest species.

Phytosanitary risk

Bactrocera dorsalis is a known pest of several commercial fruit crops in the area where it is present. It can be moved in trade with infested fruit. Several studies have been made on climatic suitability of different regions in the world for this species (see Stephens *et al.* 2007; De Meyer *et al.*, 2010; Liu *et al.*, 2011; De Villiers *et al.*, 2016). For the EPPO region EFSA (2020) made a projection of potential establishment within the EPPO region, concluding that the species can potentially become established in the Mediterranean coastal areas, as well as the whole of Spain and Portugal, and the Atlantic coast in France. The EFSA Panel on Plant Health, in their Pest Categorization of non-EU Tephritidae (EFSA, 2020) placed *B. dorsalis* on the list of fruit flies that satisfy the criteria to be regarded as a potential Union quarantine pest for the EU.

PHYTOSANITARY MEASURES

Consignments of fruits from countries or regions where *B. dorsalis* occurs should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae. Possible measures include that such fruits should come from an area where *B. dorsalis* does not occur, or from a place of production found free from the pest by regular inspection in the 3 months before harvest. Plants transported with roots from countries or regions where *B. dorsalis* occurs should be free from soil, or the soil should be treated against puparia. The plants should not carry fruits. Cold treatment, hot water immersion, high temperature forced air, vapour heat treatment and fumigation can be performed on fruit commodities. Detailed information on these treatments and possible combinations of treatments for different species of fruits is available in USDA treatment manual (USDA, 2021). Annex 32 of ISPM 28 Phytosanitary treatments for regulated pests (FAO, 2018) describes a vapour heat treatment for *Bactrocera dorsalis* on *Carica papaya*.

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