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Pest categorisation of *Zaprionus indianus*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Zaprionus indianus* (Diptera: Drosophilidae), the African fig fly for the territory of the EU. This species successfully colonised the Indian subcontinent more than four decades ago, and more recently South and North America. Within the EU, the pest occurs in Cyprus, Malta, Portugal (Madeira) and Spain (Canary Islands and Andalusia). *Z. indianus* is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072. The larvae of this fly feed on more than 80 plant species both cultivated and non-cultivated. Females produce around 60–70 eggs. Egg laying mostly occurs in decaying fruit or fruit with injuries or mechanical damage. However, *Z. indianus* can oviposit on undamaged healthy fruit such as figs, strawberries and guavas which provide a potential pathway for entry into the EU. Lower temperature thresholds are around 9–10°C. Optimum development occurs at 28°C. The number of generations per year varies from 12 to 16. Climatic conditions in many EU member states and host plant availability in those areas are conducive for establishment. The introduction of *Z. indianus* is expected to have an economic impact in the EU especially on fig and strawberry production. Damage caused by other fruit flies (Drosophilidae and Tephritidae) could be increased by mixed infestations. Phytosanitary measures are available to reduce the likelihood of entry and further spread. *Z. indianus* satisfies all of the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

Keywords: African fig fly, Drosophilidae, pest risk, plant health, plant pest, quarantine

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Figure 1: © Fera Science Ltd, UK

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1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

1.1.1. Background

The new Plant Health Regulation (EU) 2016/2031, on the protective measures against pests of plants, is applying from 14 December 2019. Conditions are laid down in this legislation in order for pests to qualify for listing as Union quarantine pests, protected zone quarantine pests or Union regulated non-quarantine pests. The lists of the EU regulated pests together with the associated import or internal movement requirements of commodities are included in Commission Implementing Regulation (EU) 2019/2072. Additionally, as stipulated in the Commission Implementing Regulation 2018/2019, certain commodities are provisionally prohibited to enter in the EU (high risk plants, HRP). EFSA is performing the risk assessment of the dossiers submitted by exporting to the EU countries of the HRP commodities, as stipulated in Commission Implementing Regulation 2018/2018. Furthermore, EFSA has evaluated a number of requests from exporting to the EU countries for derogations from specific EU import requirements.

In line with the principles of the new plant health law, the European Commission with the Member States are discussing monthly the reports of the interceptions and the outbreaks of pests notified by the Member States. Notifications of an imminent danger from pests that may fulfil the conditions for inclusion in the list of the Union quarantine pest are included. Furthermore, EFSA has been performing horizon scanning of media and literature.

As a follow-up of the above-mentioned activities (reporting of interceptions and outbreaks, HRP, derogation requests and horizon scanning), a number of pests of concern have been identified. EFSA is requested to provide scientific opinions for these pests, in view of their potential inclusion by the risk manager in the lists of Commission Implementing Regulation (EU) 2019/2072 and the inclusion of specific import requirements for relevant host commodities, when deemed necessary by the risk manager.

1.1.2. Terms of Reference

EFSA is requested, pursuant to Article 29(1) of Regulation (EC) No 178/2002, to provide scientific opinions in the field of plant health.

EFSA is requested to deliver 53 pest categorisations for the pests listed in Annex 1A, 1B, 1D and 1E (for more details see mandate M-2021-00027 on the Open.EFSA portal). Additionally, EFSA is requested to perform pest categorisations for the pests so far not regulated in the EU, identified as pests potentially associated with a commodity in the commodity risk assessments of the HRP dossiers (Annex 1C; for more details see mandate M-2021-00027 on the Open.EFSA portal). Such pest categorisations are needed in the case where there are not available risk assessments for the EU.

When the pests of Annex 1A are qualifying as potential Union quarantine pests, EFSA should proceed to phase 2 risk assessment. The opinions should address entry pathways, spread, establishment, impact and include a risk reduction options analysis.

Additionally, EFSA is requested to develop further the quantitative methodology currently followed for risk assessment, in order to have the possibility to deliver an express risk assessment methodology. Such methodological development should take into account the EFSA Plant Health Panel Guidance on quantitative pest risk assessment and the experience obtained during its implementation for the Union candidate priority pests and for the likelihood of pest freedom at entry for the commodity risk assessment of High Risk Plants.

1.2. Interpretation of the Terms of Reference

Zaprionus indianus is one of a number of pests listed in Annex 1 to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a potential Union quarantine pest for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores, and so inform EU decision-making as to its appropriateness for potential inclusion in the lists of pests of Commission Implementing Regulation (EU) 2019/ 2072. If a pest fulfils the criteria to be potentially listed as a Union quarantine pest, risk reduction options will be identified.

1.3. Additional information

This categorisation was initiated by reports of interceptions and/or outbreaks of the pest notified by the Member States to the European Commission.

2. Data and methodologies

2.1. Data

2.1.1. Information on pest status from NPPOs

In the context of the current mandate, EFSA is preparing pest categorisations for new/emerging pests that are not yet regulated in the EU. When official pest status is not available in the European and Mediterranean Plant Protection Organization (EPPO) Global Database (EPPO, online), EFSA consults the NPPOs of the relevant MS. To obtain information on the official pest status for *Z. indianus*, EFSA has consulted the NPPOs of France, Malta, Portugal and Spain. The results of this consultation are presented in Section 3.2.2

2.1.2. Literature search

A literature search on *Z. indianus* was conducted at the beginning of the categorisation in the ISI Web of Science bibliographic database, using the scientific name of the pest as search term. Papers relevant for the pest categorisation were reviewed, and further references and information were obtained from experts, as well as from citations within the references and grey literature.

2.1.3. Database search

Pest information, on host(s), distribution and official status, was retrieved from EPPO Global Database, the CABI databases and scientific literature databases as referred above in Section 2.1.2.

Data about the import of commodity types that could potentially provide a pathway for the pest to enter the EU and about the area of hosts grown in the EU were obtained from EUROSTAT (Statistical Office of the European Communities).

The Europhyt and TRACES databases were consulted for pest-specific notifications on interceptions and outbreaks. Europhyt is a web-based network run by the Directorate General for Health and Food Safety (DG SANTÉ) of the European Commission as a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. TRACES is the European Commission's multilingual online platform for sanitary and phytosanitary certification required for the importation of animals, animal products, food and feed of non-animal origin and plants into the European Union, and the intra-EU trade and EU exports of animals and certain animal products. Up until May 2020, the Europhyt database managed notifications of interceptions of plants or plant products that do not comply with EU legislation, as well as notifications of plant pests detected in the territory of the Member States and the phytosanitary measures taken to eradicate or avoid their spread. The recording of interceptions switched from Europhyt to TRACES in May 2020.

GenBank was searched to determine whether it contained any nucleotide sequences for *Z. indianus* which could be used as reference material for molecular diagnosis. GenBank® (www.ncbi.nlm.nih.gov/genbank/) is a comprehensive publicly available database that as of August 2019 (release version 227) contained over 6.25 trillion base pairs from over 1.6 billion nucleotide sequences for 450,000 formally described species (Sayers et al., 2020).

2.2. Methodologies

The Panel performed the pest categorisation for *Z. indianus*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018), the EFSA guidance on the use of the weight of evidence approach in scientific assessments (EFSA Scientific Committee, 2017) and the International Standards for Phytosanitary Measures No. 11 (FAO, 2013).

The criteria to be considered when categorising a pest as a potential Union quarantine pest (QP) is given in Regulation (EU) 2016/2031 Article 3 and Annex I, Section 1 of the Regulation. Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. In judging whether a criterion is met the Panel uses its best professional judgement

(EFSA Scientific Committee, 2017) by integrating a range of evidence from a variety of sources (as presented above in Section 2.1) to reach an informed conclusion as to whether or not a criterion is satisfied.

The Panel's conclusions are formulated respecting its remit and particularly with regard to the principle of separation between risk assessment and risk management (EFSA founding regulation (EU) No 178/2002); therefore, instead of determining whether the pest is likely to have an unacceptable impact, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. Whilst the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018). Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for quarantine pest status. Assessing social impact is outside the remit of the Panel.

Table 1: Pest categorisation criteria under evaluation, as derived from Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest (article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest clearly defined, or has it been shown to produce consistent symptoms and to be transmissible?
Absence/presence of the pest in the EU territory (Section 3.2)	Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.
Pest potential for entry, establishment and spread in the EU territory (Section 3.4)	Is the pest able to enter into, become established in, and spread within, the EU territory? If yes, briefly list the pathways for entry and spread.
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Section 3.6)	Are there measures available to prevent pest entry, establishment, spread or impact?
Conclusion of pest categorisation (Section 4)	A statement as to whether (1) all criteria assessed by EFSA above for consideration as a potential quarantine pest were met and (2) if not, which one(s) were not met.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

Is the identity of the pest clearly defined, or has it been shown to produce consistent symptoms and/or to be transmissible?

Yes, the identity of the species is established and *Zaprionus indianus* Gupta is the accepted name.

Zaprionus indianus Gupta, 1970 is an insect within the order Diptera, family Drosophilidae (Figure 1). It is commonly known as the African fig fly (Gupta, 1970). The species is distributed throughout the entire Afrotropical region (Vilela et al., 2001).

The genus *Zaprionus* is divided into two subgenera that are distinguished by their geographic origin: the subgenus *Anaprionus* which contains 10 species from the Oriental biogeographic region and the subgenus *Zaprionus sensu stricto* including 49 essentially Afrotropical species, among which is *Z. indianus* (Yassin and David, 2010; Commar et al., 2012).

Tsacas (1985) reviewed all of the problems concerning the nomenclature of *Z. indianus* and ponted out that synonymous species names include *Z. inermis* (Séguy, 1983), *Z. paravittiger* (Goodbole and Vaidya, 1972) and *Z. collarti* (Tsacas, 1980).

The EPPO code[1] (Griessinger and Roy, 2015; EPPO, 2019) for this species is: ZAPRIN. (EPPO, online).

Figure 1: *Zaprionus indianus* adult (Source: Fera Science Ltd, UK)

3.1.2. Biology of the pest

The larvae of *Z. indianus* feed on more than 80 plant species both cultivated and non-cultivated and the species was considered ecologically diverse by Yassin and David (2010) and the most polyphagous drosophilid in the Afrotropical fauna (Commar et al., 2012; Pfeiffer et al., 2019). The species has the tendency to attack and feed only on decaying fruit (Joshi et al., 2014); this is related to the inability of females to oviposit on ripe fruit without prior injuries or mechanical damage caused by other insects like *Drosophila suzukii* Matsumura (Bernardi et al., 2017). The co-occurrence of these species has been reported in the United States in *D. suzukii* traps in vineyards (Van Timmeren & Isaacs, 2014; Joshi et al., 2014), in guava crops in Mexico (Lasa & Tadeo, 2015) and, in ripe strawberry fruit in southern Brazil (Bernardi et al., 2017). *Z. indianus* females produce around 60–70 eggs on average during their life (Fartyal et al., 2014). Like many drosophilids, *Z. indianus* adults are frugivorous and mycophagous (Gottschalk et al., 2009) and they are expected to be attracted to fermenting food materials, such as fruit. *Z. indianus* feeds on the bacteria and yeast found in decomposing fruits, principally on the yeast *Candida tropicalis* (Commar et al., 2012). However, the species is able to attack also unripe healthy fruit of species with a natural opening such as an ostiole, found in figs (Commar et al., 2012). In Brazil, it was reported attacking figs, where females oviposit in and around the ostiole and damage is caused by larvae when they penetrate the fruit tissue (Vilela et al., 1999). Bernardi et al. (2017), under laboratory conditions, observed *Z. indianus* laying eggs near the achenes in ripe strawberries, and the larvae were then able to enter and develop in the berries; however, its attacks were more successful, in terms of number of eggs laid and adults developed, if the berries were injured by *D. suzukii* or by mechanical means. *Z. indianus* could also infest healthy guavas but only over-ripened (Fartyal et al., 2014), as well as *Malpighia emarginata* (Barbados cherry) and *Dimocarpus longan* (longan) ripe fruits (Lasa and Tadeo, 2015).

Amoudi et al. (1991) and Nava et al. (2007) studied the effect of temperature on the fly life cycle. The lower temperature development threshold (TT) and thermal constant (K) values for the egg, larval and pupal stages were 9.7°C and 10.5 degree days (DD); 9.2°C and 148.6 DD, and 10.7°C and 66.25 DD, respectively, for a total thermal constant of 262.2 DD for the egg-adult biological cycle (Nava et al., 2007). When temperature increased from 25°C to 30°C, the mean larval and pupal duration decreased as well as adult longevity, but an increase in mean generation life span (including mean egg incubation period, mean larval and pupal duration periods plus the mean preoviposition period) was observed (i.e. 22.4 days at 25°C and 29.4 days at 30°C). The reduction in mean adult longevity between 25 and 30°C was associated with a significant reduction in mean oviposition period, from 35.8 d to 1.3 days, and in mean fecundity from 112.5 eggs to 1.2 eggs. Besides, all eggs laid at 30°C failed to hatch (Amoudi et al., 1991). Temperatures near 28°C are the thermal optimum, allowing shorter

[1] An EPPO code, formerly known as a Bayer code, is a unique identifier linked to the name of a plant or plant pest important in agriculture and plant protection. Codes are based on genus and species names. However, if a scientific name is changed the EPPO code remains the same. This provides a harmonised system to facilitate the management of plant and pest names in computerised databases, as well as data exchange between IT systems (Griessinger & Roy, 2015; EPPO, 2019).

development time and high viability (Nava et al., 2007). At 18°C, the cycle may extend for up to 1 month (Coutihno-Silva et al., 2017). The number of generations per year varies from 12 to 16 (Karan et al., 2000; Setta and Carareto, 2005; Nava et al., 2007). Field and laboratory studies on Indian populations showed that *Z. indianus* overwinters in the egg stage and to a small extent as pupae (Alawamleh et al., 2016).

3.1.3. Host range/Species affected

Z. indianus feeds on more than 80 plant species (Lachaise and Tsacas, 1983; van der Linde et al., 2006); this polyphagy has contributed to its ability to invade new areas (Commar et al., 2012). While it can attack healthy unripe fruit of species with a natural opening such as figs (Commar et al., 2012), most hosts are fruits that have been injured or have fallen. Although *Z. indianus* has been reported emerging from grape, whether it causes injury, or rather exacerbates injury from other pests, namely *D. suzukii*, needs to be clarified (Pfeiffer et al., 2019). In Brazil, it adapted to *Solanum lycocarpum* attacking fruits throughout the fruit development period (Leão and TIdon, 2004). This plant has edible berries and is the most abundant native fleshy fruited plant in the region of Cerrado (a vast tropical savanna ecoregion in Brazil). Leão and Tidon (2004) found that African fig fly predominated in fresh fruit of that host, but declined markedly in damaged fruit, rising again in severely over-ripe fruit. *Z. indianus* is generally regarded as unable to attack intact fruit (Renkema et al., 2018). Joshi et al. (2014) noted that the African fig fly could become an economic pest in smooth-skinned fruit that are harvested close to ripeness, such as nectarines and grapes. A complete list of hosts is provided in Appendix A.

3.1.4. Intraspecific diversity

Z. indianus is considered a cryptic species of the *indianus* complex together with *Zaprionus africanus* Yassin & David, *Z. gabonicus* Yassin & David and *Z. megalorchis* Chassagnard & Tsacas (Yassin et al., 2008; Yassin and David, 2010).

Geographic genetic variation was investigated in Indian, African and South American populations and revealed latitudinal clines of size except for the introduced American populations (David et al., 2006). A study of wing shape plasticity revealed a progressive elongation of the wing with decreasing temperature (Loh et al., 2008).

Based on studies of populations from Asia, Africa and South America, using mitochondrial DNA (mtDNA) haplotypes of CO-I and CO-II genes, there are two phylogenetic lineages (phylads); phylad I includes some of the African populations and phylad II includes the Atlantic populations, including South and North America, Madeira, Islands of the Pacific Ocean, Middle-East and India. mtDNA was also able to define a distinct phylogeographical pattern, showing the presence of two independent geographical radiation within the cosmopolitan populations of *Z. indianus*: the older to the East, the younger to the West (Yassin et al., 2008).

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?
Yes, there are detection and identification methods for *Z. indianus*.

Detection

Several different baits have been tested to attract *Z. indianus*. A combination of red wine and vinegar, actively fermenting grape juice, a blend of apple cider vinegar and beer (Epsky et al., 2014, 2015; Renkema et al., 2018) were the most successful. Fig juice diluted in water placed in a clear plastic bottle proved also effective (Pasini and Link, 2011) as well as orange traps with brown circles baited with apple cider vinegar (Lasa et al., 2020).

Symptoms

Z. indianus larvae having access and feeding on the interior fruit flesh cause the fruit to become soft and unmarketable.

Identification

The drosophilid genus *Zaprionus* Coquillett, 1902 is characterised by the presence of longitudinal white stripes on the frons and the mesonotum (Yassin, 2010). *Z. indianus* is easily identified because of its unique longitudinal black and white stripes that can be observed with the unaided eye (Pfeiffer et al., 2019).

Eggs are small, white and oblong with four filaments. There are three larval stages. Larvae have white, cylindrical bodies (3.5 mm long when fully grown), tapered anteriorly with posterior spiracles. Pupae are spindle-shaped, reddish brown with two anterior stigmata (EPPO, online; van der Linde et al., 2006; Nava et al., 2007).

Adults are small (between 2.5 and 3.0 mm in length) with a reddish-brown head and thorax, yellow abdomen and red eyes. The dorsal region of the head and thorax has two longitudinal silvery-white stripes, between which run narrow black stripes. The black and white stripes on *Z. indianus* are of equal size with the stripe width maintained over the full length of the head to the thorax (van der Linde, 2010).

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

Z. indianus is an afrotropical species which is now considered to be almost cosmopolitan. It invaded India, where it was first described in 1970, and America starting from the 1990s, with a first published record in 1999 in Brazil which was followed by a rapid expansion in South America. In North America, it was first reported in Chiapas (Mexico) in 2002 and in Florida (USA) in 2005. Its presence has been reported in some countries around the Mediterranean Basin (Yassin et al., 2008; Da Mata et al., 2010; EPPO, online). Figure 2 shows the global distribution of *Z. indianus*.

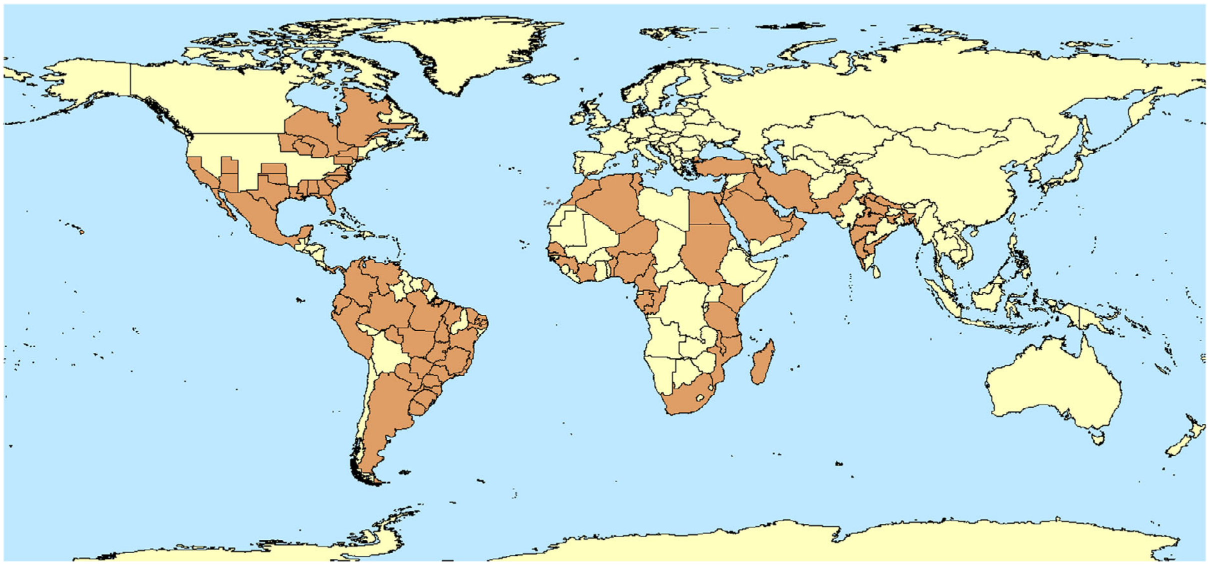

Figure 2: Global distribution of *Zaprionus indianus* (Data source: EPPO Global Database accessed on 20 November 2021)

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.

Yes, *Z. indianus* is present in the EU but not widely distributed.

Z. indianus is present in Cyprus with restricted distribution, in Malta, in Portugal (only Madeira) and in Spain (Canary Islands and Andalusia) (EPPO, online). In France, this insect was captured in 2016 in traps (Kremmer et al., 2017). At that time, its establishment was not expected. Indeed, since 2016, the species has not been caught in the perimeter of the surveillance. Its current status in France is 'absent, pest no longer present'. In Spain, the official pest status is 'present, restricted distribution'. Its presence in the Canary Islands and Andalusia (provinces of Malaga, Huelva and Granada) has been confirmed by the Spanish NPPO. There is no national or regional measure applied or planned to be applied other than surveillance. In Malta, the presence of the pest has been confirmed by the NPPO; no surveys are carried out for the pest. In Portugal, the pest is present only in Madeira, but no detailed information is available; in mainland Portugal, there have been no reports of presence and no surveys are carried out.

Yassin and David (2010) mention Austria and Italy in the list of countries where the pest occurs, but EPPO considers these records unreliable as they are not confirmed by other sources (EPPO, online).

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

Z. indianus is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, an implementing act of Regulation (EU) 2016/2031, or in any emergency plant health legislation.

3.3.2. Hosts or species affected that are prohibited from entering the Union from third countries

Whilst some host species are prohibited (Table 2), these prohibitions do not apply to fruits. Since *Z. indianus* completes development only on fruit, these prohibitions do not prevent the likelihood of pest entry.

Table 2: List of plants, plant products and other objects that are *Zaprionus indianus* hosts whose introduction into the Union from certain third countries is prohibited. (source: Commission Implementing Regulation (EU) 2019/2072, Annex VI)

List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited			
	Description	**CN Code**	**Third country, group of third countries or specific area of third country**
8.	Plants for planting of *Chaenomeles* Ldl.,[. . .]*Prunus* L., *Pyrus* L. and *Rosa* L., other than dormant plants free from leaves, flowers and fruits	see 2019/2072 Annex VI for details	Third countries other than: specified European third countries (see 2019/2072 Annex VI for details)
9.	Plants for planting of [...], Prunus L. and [...], other than seeds		Third countries, other than: specified European third countries, specified countries bordering the Mediterranean Sea, specified Eurasian countries, Australia, Canada, New Zealand, specified parts of Russia, United States other than Hawaii (see 2019/2072 Annex VI for details)
10.	Plants of Vitis L>, other than fruits		Third countries other than Switzerland
11.	Plants of Citrus L. [...] and their hybrids, other than fruits and seeds		All third countries
13.	Plants of *Phoenix* spp. other than fruit and seeds		Algeria, Morocco
18.	Plants for planting of Solanaceae other than seeds [. . .]		Third countries other than: specified European third countries (see 2019/2072 Annex VI for details)

3.4. Entry, establishment and spread in the EU

3.4.1. Entry

Is the pest able to enter into the EU territory? If yes, identify and list the pathways

Yes, *Z. indianus* could enter the EU territory.

Comment on plants for planting as a pathway

Plants for planting are not a pathway, unless such plants are bearing fruits (unlikely).

Pathways are presented in Table 3. The main pathway is fruit.

Table 3: Potential pathways for *Zaprionus indianus* into the EU 27

Pathways	Life stage	Relevant mitigations [e.g. prohibitions (Annex VI), special requirements (Annex VII)) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Fruit	Eggs, larvae, pupae	A phytosanitary certificate is required to import fresh fruits into the EU (2019/2072, Annex XI, Part A) unless exempt by being listed in 2019/2072 Annex XI, Part C. A few *Z. indianus* fruit hosts (Musa L., dates) are in Annex XI, Part C; hence, their introduction does not require a phytosanitary certificate. However, no specific requirements are set for *Z. indianus*. As not all, but only a proportion of imported consignments are liable to be physically inspected, this requirement does not preclude the entry of *Z. indianus* in fruit.

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As of 04 October 2021, there was one record of interception of *Z. indianus* in Austria on *Prunus persica* fruits from Egypt (in 2018) and two records of an outbreak in Cyprus on *Ficus carica* plants (in 2016 and 2017) in the Europhyt and TRACES databases.

Z. indianus has been intercepted in England and Wales on ripe guava, mango, cherry, blueberry and Indian jujube fruit (often damaged or infested by tephritid larvae), imported most frequently from India, Iran and Sri Lanka. *Zaprionus* sp. has been reared from damaged apple imported from Brazil (species not confirmed as only female adults emerged).

EU 27 statistics showing imports of fresh produce hosts for which *Z. indianus* is a primary pest from areas where the pest is present are shown in Table 4.

Table 4: Annual EU 27 imports of selected* hosts of *Zaprionus indianus* from Africa, Asia, Canada, USA and Latin America 2016–2020 (hundreds of kg) (Eurostat – Accessed 21 October 2021)

Commodity	HS Code	2016	2017	2018	2019	2020
Guavas(1)	0804 5000	2,410,060	2,691,703	3,090,655	3,193,710	3,378,588
Figs	0804 2010	13,489	14,648	16,364	15,977	17,802
Strawberries	0810 1000	223,612	286,323	261,453	301,723	283,847

(1): Guavas, mangoes.
*: Selected based on the fact that *Z. indianus* is a primary pest.

3.4.2. Establishment

Is the pest able to become established in the EU territory?

Yes. Given the known invasive nature of *Z. indianus*, it appears that the pest can transfer to new hosts when introduced to new areas. Indeed, as *Z. indianus* has established in some parts of the EU (see Section 3.2.2), it could probably establish in most of the warmer southern EU MSs; Scandinavian and Baltic EU MSs are mostly unsuitable for establishment.

Climatic mapping is the principal method for identifying areas that could provide suitable conditions for the establishment of a pest taking key abiotic factors into account (Baker et al., 2000, Baker, 2002). Availability of hosts is considered in Section 3.4.2.1. Climatic factors are considered in Section 3.4.2.2.

3.4.2.1. EU distribution of main host plants

The harvested area in the EU 27 between 2016 and 2020 of the hosts directly damaged by the pest (figs and strawberries) is shown in Tables 5 and 6. Appendix B provides an extensive list of hosts and plants affected.

Table 5: Harvested area of figs in EU 27, 2016–2020 (thousand ha). (Source: Eurostat, Code: F2100 X 1,000 ha) (Accessed on 20/10/21)

MS/Year	**2016**	**2017**	**2018**	**2019**	**2020**
EU 27	23.74	24.63	24.99	25.59	27.21
Spain	12.61	13.56	13.98	14.60	15.72
Portugal	4.10	4.13	4.13	3.81	3.81
Greece	3.79	3.82	3.77	3.99	4.40
Italy	2.39	2.26	2.23	2.15	2.06
France	0.38	0.40	0.44	0.44	0.44
Croatia	0.35	0.27	0.27	0.42	0.57
Cyprus	0.10	0.16	0.14	0.16	0.17
Slovenia	0.01	0.01	0.01	0.02	0.02
Bulgaria	0	0	0	0.01	0.03

Table 6: Harvested area of strawberries in EU 27, 2016–2020 (thousand ha). (Source: Eurostat, Code: S0000) (Accessed on 20/10/21)

MS/Year	**2016**	**2017**	**2018**	**2019**	**2020**
EU 27	103.78	103.76	106.42	100.93	84.14
Poland	50.78	49.84	49.18	49.90	33.20
Germany	14.30	14.16	14.00	13.20	12.86
Spain	6.87	6.82	7.03	7.26	7.35
Finland	6.30	6.89	10.16	4.40	4.44
Italy	4.88	4.86	4.72	4.74	4.62
France	3.34	3.37	3.35	3.35	3.33
Romania	2.72	3.25	3.27	3.30	3.29
Sweden	2.01	1.97	2.07	1.96	2.08
Belgium	1.90	1.98	1.97	1.97	1.60
Netherlands	1.72	1.69	1.62	1.64	1.52
Greece	1.49	1.47	1.47	1.61	1.72
Denmark	1.17	1.16	1.15	1.11	1.07
Austria	1.14	1.14	1.21	1.19	1.18
Hungary	0.79	0.79	0.73	0.73	0.88
Lithuania	0.78	0.84	0.83	0.88	0.94
Czechia	0.71	0.69	0.71	0.68	0.46
Bulgaria	0.68	0.66	0.73	0.71	0.74
Latvia	0.50	0.50	0.50	0.49	0.50
Estonia	0.44	0.53	0.62	0.63	0.66
Portugal	0.39	0.31	0.32	0.32	0.81
Croatia	0.37	0.37	0.25	0.25	0.30
Ireland	0.19	0.19	0.19	0.18	0.18
Slovakia	0.17	0.12	0.17	0.27	0.21
Slovenia	0.11	0.11	0.12	0.11	0.14

MS/Year	2016	2017	2018	2019	2020
Cyprus	0.04	0.06	0.05	0.05	0.05
Luxembourg	0.01	0.01	0.01	0.01	0.01

3.4.2.2. Climatic conditions affecting establishment

Z. indianus has great adaptability to a range of environmental conditions with the ability to establish in different ecological niches in new areas of invasion, with different temperature regimes (da Mata et al., 2010). This makes this species a fully invasive one (Lavagnino et al., 2020). Several morphological traits have shown variation with latitude and elevation, suggesting genetic adaptation to different environmental conditions (Karan et al., 2000).

Z. indianus is known to occur in countries where BSh (hot semi-arid), BSk (cold semi-arid) Cfa (humid subtropical), Cfb (oceanic), Cfc (oceanic-subpolar), Csa (hot-summer Mediterranean), Csb (warm-summer Mediterranean) and Csc (cold-summer Mediterranean) Köppen-Geiger climatic zones (Kottek et al., 2006) occur, these climate types also occur in the EU (Figure 3). We assume, based on literature data that the subarctic climate, though, is not suitable for the development of this pest. As a consequence, climatic conditions would not limit the ability of *Z. indianus* to establish in the EU, with Scandinavian and Baltic EU MSs being mostly unsuitable and warmer southern MSs mostly suitable.

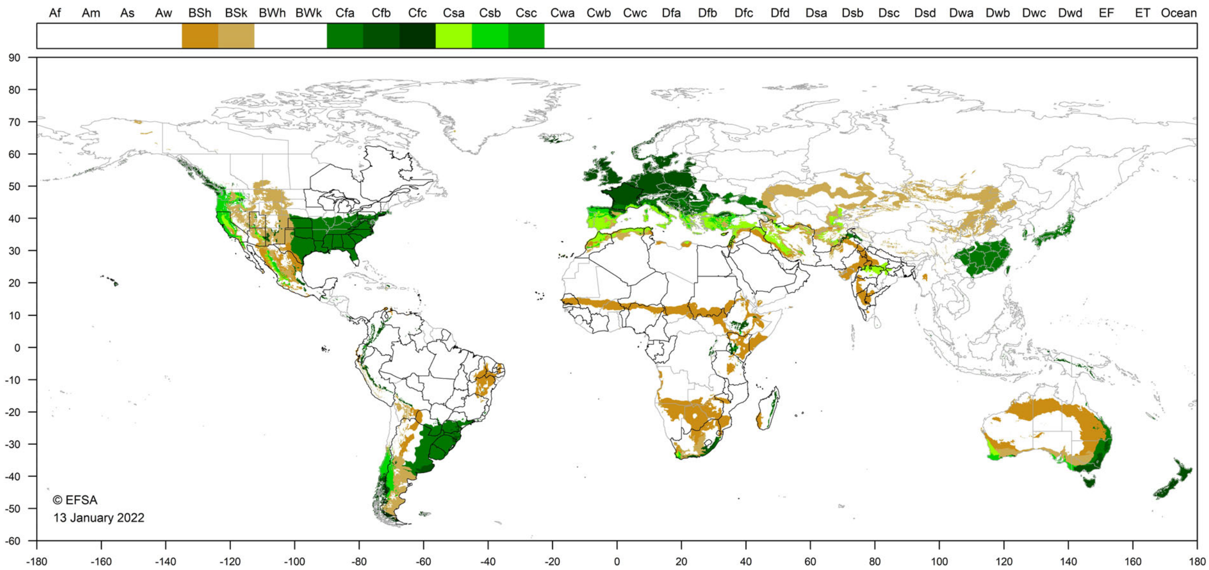

Figure 3: Occurrence of BSh, BSk, Cfa, Cfb, Cfc, Csa, Csb and Csc Köppen-Geiger climate types in the world

3.4.3. Spread

Describe how the pest would be able to spread within the EU territory following establishment?
Z. indianus adults are able to fly, and long-distance dispersal is possible on air currents as well as with trade. Indeed, transportation of commercial infested fruits may greatly contribute to spread.
Comment on plants for planting as a mechanism of spread
Plants for planting are not a pathway for spread, unless such plants were bearing fruits (unlikely).

Z. indianus is known to be a highly vagile fly, capable of spreading from Brazil to the USA in less than 10 years (van der Linde et al., 2006). Data on esterase loci polymorphisms in Brazilian populations show that *Z. indianus* spread throughout the country, probably together with the transportation of commercial fruits by way of the two main Brazilian freeways (Galego and Carareto, 2010; Yassin et al., 2009). Aided by international trade and commerce, *Z. indianus* has been introduced to a wide variety of localities outside of its native range including North and South America, Europe and Asia (Westphal et al., 2008; Hulme, 2009).

Studies have been carried out in Brazil to better understand the invasion history of *Z. indianus*. It is hypothesised that it first arrived in Sao Paulo state with air transport of fruit from Africa. It then further spreads within the country by natural means and more importantly by road transportation of commercial fruit (EPPO, online).

Wind-assisted long-distance dispersal has been demonstrated in a closely related species, *Drosophila melanogaster* (Leitch et al., 2021).

3.5. Impacts

Would the pests' introduction have an economic or environmental impact on the EU territory?

Yes. Although no specific report of damage by *Z. indianus* in the EU is known, considering the damage caused to figs in South America, the species establishment and spread could thus have significant economic consequences in Europe where about 60,000 tons of figs are produced per year.

The capacity of *Z. indianus* to damage crops directly has been observed on figs, which is an important crop around the Mediterranean Basin. Its interactions with other drosophilids or true fruit flies (Tephritidae, like *Ceratitis capitata* (Wiedemann)) might enhance the negative impacts of the latter on cultivated fruit crops (EPPO, online). In Brazil, *Z. indianus* was responsible for 50% of fig losses because it can feed on this fruit while it is still on the tree (Dettler et al., 2021). Heavy losses were observed on figs in Jordan, but they were not quantified.

3.6. Available measures and their limitations

Are there measures available to prevent pest entry, establishment, spread or impact?

Yes, a phytosanitary certificate is required to import fresh fruits and nuts into the EU (see Sections 3.3.2 and 3.4.2). Fruits could be further sourced from areas free of *Z. indianus* (see Section 3.6.1).

3.6.1. Identification of potential additional measures

Phytosanitary measures are currently applied to fruits. Therefore, this entry pathway can be considered as open and regulated.

Additional potential risk reduction options and supporting measures are shown in Sections 3.6.1.1 and 3.6.1.2.

3.6.1.1. Additional potential risk reduction options

Potential additional control measures are listed in Table 7.

Table 7: Selected control measures (a full list is available in EFSA PLH Panel, 2018) for pest entry/establishment/spread/impact in relation to currently unregulated hosts and pathways. Control measures are measures that have a direct effect on pest abundance

Control measure/Risk reduction option (Blue underline = Zenodo doc)	RRO summary	Risk element targeted (entry/establishment/spread/impact)
Require pest freedom	Used to mitigate likelihood of infestation by specified pest at origin, hence, to mitigate entry	Entry/Spread
Biological control and behavioural manipulation	pest control such as: a) Biological control Various hymenopteran parasitoids have been documented parasitising *Z. indianus* in Brazil, though with low levels of parasitisation (2–4%) (Marchiori et al., 2003, Marchiori and Silva, 2003, Silva et al., 2004). Bacterial isolates are considered promising for the formulation of toxic baits (Geisler et al., 2019).	Entry/Spread/Impact

Control measure/Risk reduction option (Blue underline = Zenodo doc)	**RRO summary**	**Risk element targeted (entry/ establishment/ spread/impact)**
	b) Mass trapping Several different baits have been tested to attract *Z. indianus* (Epsky et al., 2014, 2015; Renkema et al., 2018), as well as different traps (Pasini and Link, 2011; Renkema et al., 2018; Lasa et al., 2020).	
Chemical treatments on crops including reproductive material	Used to mitigate likelihood of infestation of pests susceptible to chemical treatments. Organophosphates, pyrethroids and spinosyns have been effective when applied by foliar spraying. A possible alternative to foliar spraying is the use of toxic baits or low-volume, reduced-risk sprays in conjunction with feeding attractants (Andreazza et al., 2016).	Entry/ Establishment/ Spread/Impact
Chemical treatments on consignments or during processing	Use of chemical compounds that may be applied to plants or to plant products after harvest, during process or packaging operations and storage. Possible treatments are: a) fumigation; b) spraying/dipping pesticides; c) surface disinfectants; d) process additives; e) protective compounds Used to mitigate likelihood of infestation of pests susceptible to chemical treatments	Entry/Spread
Physical treatments on consignments or during processing	Used to mitigate likelihood of infestation of pests susceptible to physical treatments Washing, brushing and other mechanical cleaning methods can be used to reduce the prevalence of the pest in the consignments to be exported or to be planted.	Entry/Spread
Waste management	Care of disposal of contaminated fruit may be necessary through waste management, (e.g. deep burial, composting) in authorised facilities and official restriction on the movement of waste.	Entry/ Establishment
Heat and cold treatments	Several fresh fruit commodities can be managed using hot water treatments, others such as guava, could undergo cold treatment (Lin et al., 2020).	Entry/Spread
Conditions of transport	Specific requirements for mode and timing of transport of commodities to prevent escape of the pest and/or contamination. a) physical protection of consignment b) timing of transport/trade Used to mitigate likelihood of entry of pests that could otherwise infest material post-production	Entry/Spread
Controlled atmosphere	Treatment of plants by storage in a modified atmosphere (including modified humidity, O_2, CO_2, temperature, pressure). Used to mitigate likelihood of infestation of pests susceptible to modified atmosphere (usually applied during transport) hence to mitigate entry. Controlled atmosphere storage can be used in commodities such as fresh and dried fruits, flowers and vegetables.	Entry/Spread

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 8.

Table 8: Selected supporting measures (a full list is available in EFSA PLH Panel, 2018) in relation to currently unregulated hosts and pathways. Supporting measures are organisational measures or procedures supporting the choice of appropriate risk reduction options that do not directly affect pest abundance

Supporting measure (Blue underline = Zenodo doc)	RRO Summary	Risk element targeted (entry/establishment/ spread/impact)
Inspection and trapping	Inspection is defined as the official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (ISPM 5). The effectiveness of sampling and subsequent inspection to detect pests may be enhanced by including trapping and luring techniques. Several different baits have been tested to attract *Z. indianus* (Epsky et al., 2014, 2015; Renkema et al., 2018), as well as different traps (Pasini and Link, 2011; Renkema et al., 2018; Lasa et al., 2020). Used to mitigate likelihood of infestation by specified pest at origin	Entry/Spread
Phytosanitary certificate and plant passport	An official paper document or its official electronic equivalent, consistent with the model certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (ISPM 5) a) export certificate (import) b) plant passport (EU internal trade) Used to attest which of the above requirements have been applied	Entry

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- The species develops only inside fruits. Therefore, it might be difficult to detect and identify unless fruit are cut open.
- The species is difficult to identify and could be confused with other non-regulated fruit flies
- Wide range of potential hosts (high volume to inspect)

3.7. Uncertainty

The main uncertainties refer to (1) the lack of information about potential additional hosts that can be attacked without previous injury; (2) whether the capacity to infest strawberries will be maintained under field conditions; (3) extending host range which could include new plant species in newly colonised areas. These uncertainties, though, do not affect the conclusion of this categorisation.

4. Conclusions

Z. indianus satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest. Table 9 shows the summary of the PLH Panel conclusions.

Table 9: The Panel's conclusions on the pest categorisation criteria derived from Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of *Z. indianus* has been established.	None
Absence/presence of the pest in the EU (Section 3.2)	*Z. indianus* is present in the EU but not widely distributed in Cyprus, Malta, Portugal and Spain.	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*Z. indianus* could enter into, establish in, and spread within the EU territory. The main pathway is host fruit.	None
Potential for consequences in the EU (Section 3.5)	Although no specific report of damage by *Z. indianus* in the EU is known, it can contribute to damage caused by other pests and directly harm figs.	None
Available measures (Section 3.6)	There are measures available to prevent the likelihood of entry into the EU (i.e. import of fruit and nuts is subject to certification).	None
Conclusion (Section 4)	*Z. indianus* satisfies all of the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.	
Aspects of assessment to focus on/scenarios to address in future if appropriate:		

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention

ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
PZ	Protected Zone
TFEU	Treaty on the Functioning of the European Union
ToR	Terms of Reference

Glossary

Containment (of a pest)	Application of phytosanitary measures in and around an infested area to prevent spread of a pest (FAO, 2018)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2018)
Degree day	Degree days (DD) are a measurement of heat units over time, often calculated from the average daily temperature above a threshold. For example, above a threshold temperature of 10oC, a 24-hour period with an average temperature of 16oC would represent 6 DD
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO, 2018)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2018)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2018)
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Hitchhiker	An organism sheltering or transported accidentally via inanimate pathways including with machinery, shipping containers and vehicles; such organisms are also known as contaminating pests or stowaways (Toy and Newfield, 2010).
Impact (of a pest)	The impact of the pest on the crop output and quality and on the environment in the occupied spatial units
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO, 2018)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2018)
Phytosanitary measures	Any legislation, regulation or official procedure having the purpose to prevent the introduction or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO, 2018)
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2018)
Risk reduction option (RRO)	A measure acting on pest introduction and/or pest spread and/or the magnitude of the biological impact of the pest should the pest be present. A RRO may become a phytosanitary measure, action or procedure according to the decision of the risk manager
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO, 2018)

Appendix A – *Zaprionus indianus* host plants/species affected (fruit)

Source: EPPO Global Database (EPPO, online) and CABI Crop Protection Compendium (CABI CPC, online) [Accessed on 20 October 2021].

Host status	Host name	Plant family	Common name	Reference
Cultivated host	*Actinidia chinensis*	Actinidiaceae	Chinese gooseberry, golden kiwifruit	EPPO
	Aleurites moluccanus	Euphorbiaceae	Candle nut, Indian walnut	EPPO
	Anacardium occidentale	Anacardiaceae	Cashew, cashew apple	EPPO
	Annona glabra	Annonaceae	Pond apple, alligator apple	EPPO
	Averrhoa carambola	Oxalidaceae	Star fruit, caramba	EPPO
	Butia capitata	Arecaceae	Jelly palm, butia palm	CABI CPC
	Campomanesia aromatica	Myrtaceae	Strawberry guava, wild guava	EPPO
	Capsicum frutescens	Solanaceae	Chilli, bird chilli	EPPO
	Carissa macrocarpa	Apocynaceae	Carissa, natal palm	EPPO
	Citrus	Rutaceae	–	EPPO
	Citrus sinensis	Rutaceae	Sweet orange	EPPO
	Dimocarpus longan	Sapindaceae	Dragon's eye, longan	EPPO
	Diospyros kaki	Ebenaceae	Chinese date plum, Chinese persimmon	EPPO
	Eriobotrya japonica	Rosaceae	Japanese medlar, loquat	EPPO
	Fragaria x ananassa	Rosaceae	Strawberry	EPPO
	Ficus carica	Moraceae	Common fig	EPPO
	Genipa americana	Rubiaceae	Genip, marmelade box	EPPO
	Malpighia glabra	Malpighiaceae	Barbados cherry	EPPO
	Mangifera indica	Anacardiaceae	Mango	EPPO
	Musa	Musaceae	Banana	EPPO
	Myrciaria cauliflora	Myrtaceae	Jaboticaba, Brazilian grape	CABI CPC
	Olea europaea	Oleaceae	Common olive, olive	EPPO
	Olea europaea subsp. europaea	Oleaceae	European olive	CABI CPC
	Persea americana	Lauraceae	Avocado	EPPO
	Phoenix dactylifera	Arecaceae	Date-palm, common date palm	EPPO
	Prunus armeniaca	Rosaceae	Apricot	EPPO
	Prunus cerasus	Rosaceae	Sour cherry, amarello cherry	EPPO
	Prunus persica	Rosaceae	Peach	EPPO
	Prunus persica var. nucipersica	Rosaceae	Nectarine	EPPO
	Psidium guajava	Myrtaceae	Yellow guava, guava	EPPO
	Punica granatum	Lythraceae	Pomegranate	EPPO
	Rubus idaeus	Rosaceae	European red raspberry	EPPO
	Solanum lycopersicum	Solanaceae	Tomato	EPPO
	Spondias tuberosa	Anacardiaceae	Imbu	EPPO
	Syzygium jambos	Myrtaceae	Malabar plum	EPPO
	Vaccinium	Ericaceae	–	EPPO
	Vitis vinifera	Vitaceae	Grape vine	EPPO
	Ziziphus jujuba	Rhamnaceae	Chinese date, common jujube	EPPO
	Ziziphus spina-christi	Rhamnaceae	Christ's thorn jujube	EPPO

Appendix B – Distribution of *Zaprionus indianus*

Distribution records based on EPPO Global Database (EPPO, online).

Region	Country	Subnational (e.g. State)	Status
Africa	Algeria		Present, restricted distribution
	Benin		Present, no details
	Cameroon		Present, no details
	Cape Verde		Present, no details
	Comoros		Present, no details
	Congo		Present, no details
	Cote d'Ivoire		Present, no details
	Egypt		Present, no details
	Gabon		Present, no details
	Guinea		Present, no details
	Kenya		Present, no details
	Madagascar		Present, widespread
	Malawi		Present, no details
	Mauritius		Present, no details
	Mayotte		Present, no details
	Morocco		Present, no details
	Mozambique		Present, no details
	Niger		Present, no details
	Nigeria		Present, no details
	Reunion		Present, no details
	Saint Helena		Present, no details
	Sao Tome & Principe		Present, no details
	Senegal		Present, no details
	Seychelles		Present, no details
	South Africa		Present, no details
	Sudan		Present, no details
	Tanzania		Present, no details
	Tunisia		Present, restricted distribution
America	Argentina		Present, no details
	Brazil		Present, no details
		Amazonas	Present, no details
		Bahia	Present, no details
		Ceara	Present, no details
		Distrito Federal	Present, no details
		Goias	Present, no details
		Maranhao	Present, no details
		Mato Grosso	Present, no details
		Mato Grosso do Sul	Present, no details
		Minas Gerais	Present, no details
		Para	Present, no details
		Paraiba	Present, no details
		Parana	Present, no details
		Pernambuco	Present, no details
		Rio de Janeiro	Present, no details
		Rio Grande do Norte	Present, no details

Region	Country	Subnational (e.g. State)	Status
		Rio Grande do Sul	Present, no details
		Rondonia	Present, no details
		Santa Catarina	Present, no details
		Sao Paulo	Present, no details
		Tocantins	Present, no details
	Canada		Present, few occurrences
		Ontario	Present, few occurrences
		Québec	Present, few occurrences
	Cayman Islands		Present, no details
	Colombia		Present, widespread
	Dominican Republic		Absent, unreliable record
	Ecuador		Present, no details
	French Guiana		Present, no details
	Martinique		Present, no details
	Mexico		Present, no details
	Panama		Present, no details
	Paraguay		Present, no details
	Peru		Present, no details
	United States of America		Present, restricted distribution
		Alabama	Present, no details
		Arizona	Present, no details
		California	Present, no details
		Connecticut	Present, no details
		Florida	Present, no details
		Georgia	Present, no details
		Hawaii	Present, widespread
		Kansas	Present, no details
		Louisiana	Present, no details
		Michigan	Present, no details
		Minnesota	Present, few occurrences
		Mississippi	Present, no details
	United States of America	New York	Present, no details
	United States of America	North Carolina	Present, no details
	United States of America	Oklahoma	Present, no details
	United States of America	Pennsylvania	Present, no details
	United States of America	South Carolina	Present, no details
	United States of America	Texas	Present, no details
	United States of America	Virginia	Present, no details
	United States of America	Wisconsin	Present, no details
	Uruguay		Present, no details
	Venezuela		Present, no details
Asia	Bangladesh		Present, restricted distribution
	India		Present, no details
		Andhra Pradesh	Present, no details
		Chandigarh	Present, no details
		Delhi	Present, no details
		Haryana	Present, no details
		Jharkand	Present, no details
		Karnataka	Present, no details

Region	Country	Subnational (e.g. State)	Status
		Kerala	Present, no details
		Madhya Pradesh	Present, no details
		Maharashtra	Present, no details
		Uttarakhand	Present, no details
		Uttar Pradesh	Present, no details
	Iran		Present, no details
	Iraq		Present, no details
	Israel		Present, no details
	Jordan		Present, no details
	Lebanon		Present, no details
	Nepal		Present, no details
	Oman		Present, no details
	Pakistan		Present, no details
	Saudi Arabia		Present, no details
	Turkey		(Özbek Çatal et al., 2019)
	United Arab Emirates		Present, no details
Europe	Austria		Absent, unreliable record
	Cyprus		Present, restricted distribution
	France		Absent, pest no longer present
	Italy		Absent, unreliable record
	Malta		Present, no details
	Portugal	Madeira	Present, restricted distribution Present, no details
	Spain	Canary Islands	Present, restricted distribution (Andalusia) Present, no details