



## Species Checklist of *Zeugodacus* (DIPTERA: TEPHRITIDAE: DACINI) in Taiwan

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### ABSTRACT

A revised checklist of Taiwanese *Zeugodacus* species (DIPTERA: TEPHRITIDAE: DACINI) is presented; currently, 14 valid specific names are confirmed. Basic taxonomic information regarding the current specific status, type locality, type deposition, literature, synonyms, and known distribution are provided. In addition, the problematic recording of *Z. caudatus* in Taiwan is addressed.

**Key words:** Fruit flies, TEPHRITIDAE, species checklist, taxonomy, Taiwan

### Introduction

Fruit flies in the family TEPHRITIDAE (DIPTERA) are worldwide ornamental pests of economic importance. Not only do these flies cause serious damage to the fruit and vegetable industries, but they are also highly linked to the quarantine regulations for international agricultural trade and the growing problems of alien species invasion. Scientific evidence of the presence or absence of a fruit fly species is crucial for determining whether a country or area is pest-free (International Standards for Phytosanitary Measures, ISPM 26 (IPPC, 1997)). Applying correct taxonomic data, such as specific names and distribution information, is always the primary consideration in quarantine measures and trade negotiations. This checklist has been prepared with the goal of clarifying the current species occurrences in Taiwan; and the main objective of this paper is to offer an updated

checklist of Taiwanese species for reference in agricultural, quarantine, and invasive biology.

The genus *Zeugodacus* was established by Hendel (1927) and was previously treated as a subgenus under *Dacus* (Drew, 1973) or *Bactrocera* (Drew, 1989). The systematic position of *Zeugodacus* has been revised, as *Bactrocera*, *Dacus*, and the subgenera of the *Zeugodacus* group have different evolutionary histories (Krosch *et al.*, 2012; Virgilio *et al.*, 2015). Molecular data supported the hypothesis of White (2006), who suggested a common ancestry for *Zeugodacus* and *Dacus* (see Hancock and Drew (2015) for a different hypothesis). With phylogenetic studies expanding their scope beyond pest species and the increased use of molecular data, the initial morphology-based classifications clearly required revision. In particular, the large genus *Bactrocera* had to be split into *Bactrocera* and *Zeugodacus* because *Zeugodacus* is more closely related to *Dacus*

(Krosch *et al.*, 2012; Virgilio *et al.*, 2015; San Jose *et al.*, 2018; Dupuis *et al.*, 2017).

*Zeugodacus* species are primarily associated with the fruits and flowers of **CUCURBITACEAE** (White and Elson-Harris, 1992). At least 50% of the species included in the *Zeugodacus* group for which host plant records are available are cucurbit feeders (De Meyer *et al.*, 2015). Because *Zeugodacus* species were previously placed under the genera *Dacus* and *Bactrocera*, and because the gender of both genera is feminine, the specific name with the feminine Latin ending “-a” was used. For gender agreement, the suffixes of the specific names in genus *Zeugodacus* should be changed to the masculine “-us.” All valid names adopted in this article mainly follow Doorenweerd *et al.* (2018).

**Acronyms for type specimen deposition institutions:**

NIAS: Laboratory of Insect Systematics, National Institute of Agro-Environmental Sciences, Kannondai, Tsukuba, Ibaraki Pref. 305, Japan.

DEI: Deutsches Entomologisches Institut, Deutschen Akademie der Landwirtschaftswissenschaften zu Berlin, Schicklerstrasse 5, 13 Eberswalde D-1300, Germany.

NMW: Naturhistorisches Museum Wien, Postfach 417, Burgring 7, Vienna A-1040, Austria.

MCSNM: Museo Civico di Storia Naturale, Corso Venezia 55, Milan 20121, Italy

BMNH: The Natural History Museum, Department of Entomology, Cromwell Road, London SW7 5BD, England, UK.

USNM: United States National Museum of Natural History, United States National Entomological Collection, Washington, DC 20560, USA.

UZMC: University of Copenhagen, Zoological Museums, Department of Entomology, Universitetsparken, Copenhagen DK-2100, Denmark.

**Genus *Zeugodacus* Hendel 如寡毛實蠅屬**

*Zeugodacus* Hendel, 1927, in Lindner, *Fliegen palaearkt. Reg.* 49: 26. Type species *Dacus caudatus* Fabricius, 1805, by original designation.

**Checklist of Taiwanese *Zeugodacus* species**

**1. *Zeugodacus ambiguus* Shiraki, 1933**

臉斑如寡毛實蠅

*Zeugodacus ambiguus* Shiraki, 1933, Mem. Fac. Sci. Agric. Taihoku Imp. Univ. 8: 85. Type locality: Koshun (= Henchun, Pingtung County), Taiwan (holotype male in NIAS).

**Synonyms:**

*Dacus (Zeugodacus) paulei* Tseng *et al.*, 1992: 72 (synonymized by Drew and Romig, 2013).

*Bactrocera (Zeugodacus) ambigua*- Norrbom *et al.*, 1998: 101.

**Distribution:** Taiwan.

**2. *Zeugodacus arisanicus* Shiraki, 1933**

阿里山如寡毛實蠅

*Zeugodacus arisanicus* Shiraki, 1933, Mem. Fac. Sci. Agric. Taihoku Imp. Univ. 8: 81. Type locality: Arisan (= Mt. Alishan, Chiayi County), Taiwan (holotype male in NIAS).

**Synonyms:**

*Bactrocera (Zeugodacus) arisanica*- Norrbom *et al.*, 1998: 102.

*Dacus (Zeugodacus) parvifoliaceus* Tseng *et al.*, 1992: 71 (synonymized by Drew and Romig, 2013).

*Bactrocera (Parazeugodacus) arisanica* (Shiraki, 1933)- Drew and Romig, 2013: 244.

**Distribution:** Taiwan, Thailand.

**3. *Zeugodacus cilifer* (Hendel, 1912)**

細帶 (如寡毛) 實蠅

*Dacus cilifer* Hendel, 1912, Suppl. Entomol.: 15. Type locality: Koshun (= Henchun, Pingtung County), Taiwan (syntypes in DEI and NMW).

**Synonyms:**

*Dacus (Strumeta) cilifera*- Hardy and Adachi, 1954: 162.

*Dacus (Zeugodacus) tenuifinis* Hardy, 1983: 42 (synonymized by Drew and Romig, 2013).

*Bactrocera (Zeugodacus) cilifera*- Norrbom *et al.*, 1998: 102.

*Bactrocera (Parasinodacus) cilifera* (Hendel)- Drew and Romig, 2013: 227.

**Distribution:** China, Indonesia, Laos, Malaysia, Taiwan, Thailand, Vietnam.

4. *Zeugodacus cucurbitae* (Coquillett, 1899) 瓜實蠅

*Dacus cucurbitae* Coquillett, 1899, Entomol. News 10: 129. Type locality: Honolulu, Oahu, Hawaii, USA (Lectotype female and two paralectotypes (one male and one female) in USNM (Froggatt, 1909: 84)).

**Synonyms:**

*Bactrocera cucurbitae*- Bezzi, 1913: 96.

*Chaetodacus cucurbitae*- Bezzi, 1916: 109; Hendel, 1915: 426, 1927: 28; Shiraki, 1933: 73.

*Strumeta cucurbitae*- Perkins, 1938: 127.

*Dacus (Strumeta) cucurbitae*- Hardy and Adachi, 1954: 164; Hardy, 1973: 38, 1974: 27.

*Dacus (Zeugodacus) cucurbitae*- Drew, 1973: 23; Hardy, 1977: 57, 1982: 203, 1983: 36.

*Dacus aureus* Tseng and Chu, 1982: 85 (synonymized by Drew and Romig, 2013).

*Bactrocera (Zeugodacus) cucurbitae*- Drew, 1989: 212, lectotype designation.

*Dacus yuiliensis* Tseng *et al.*, 1992: 84 (new name for *aureus* preoccupied by May, 1951: 10). Record of original synonymy unknown, see Norrbom *et al.*, 1998: 102.

**Distribution:** Africa (widely distributed across northern Africa), Asia (widely distributed across Asia from the Middle East through the Indian subcontinent, Southeast Asia, and southern China), North America (California, USA), Oceania (Queensland, Australia; Papua New Guinea; Mariana Islands; Solomon Islands; Nauru; Kiribati; Guam; and Hawaii, USA) (CABI, 2019).

5. *Zeugodacus depressus* Shiraki, 1933

扁如寡毛實蠅

*Zeugodacus depressus* Shiraki, 1933, Mem. Fac. Sci. Agric. Taihoku Imp. Univ. 8: 90. Type locality: Kiso-fukushima, Nagano-ken, Japan (lectotype male in NIAS, designated by Drew and Romig, 2013).

**Synonyms:**

*Zeugodacus bezzianus* Hering, 1941: 26 (synonymized by Han *et al.*, 2017).

*Paradacus depressus*- Shiraki, 1968: 12.

*Dacus (Paradacus) depressus*- Tseng *et al.*, 1992: 52.

*Bactrocera (Paradacus) depressa*- White and Elson-Harris, 1992: 252.

*Bactrocera (Zeugodacus) depressa*- Drew and Romig, 2013: 282.

*Bactrocera (Zeugodacus) bezziana*- Drew and Romig, 2013: 272.

*Zeugodacus (Zeugodacus) bezzianus*- De Meyer *et al.*, 2015 (suppl.): 3.

**Distribution:** Japan (Ryukyu Is.), Korea, Taiwan.

**Remarks:** Drew and Romig (2013) treated *B. (Z.) bezziana* (Hering) (= *Z. bezzianus*) as an isolated species in the *Z. tau* species complex. However, Hardy and Adachi (1954) considered it a synonym of *D. hageni* de Meijere, and Hardy (1973) made *B. bezziana* and *D. hageni* synonyms of *D. (Z.) tau* (presently *Z. tau*). In this checklist, I adopt the suggestion of Han *et al.* (2017) that *Z. bezzianus* is a synonym of *Z. depressus*, and *D. hageni* is a synonym of *Z. tau* by Drew and Romig (2013).

6. *Zeugodacus diaphorus* (Hendel, 1915)

黑條 (如寡毛) 實蠅

*Chaetodacus diaphorus* Hendel, 1915, Anns. Hist. Nat. Mus. Natl. Hung. 13: 425. Type localities: Tapani and Suisharyo (= Yuching (?), Tainan City and Shuisheliao, Chiayi County), Taiwan (Syntypes male and female in BMNH and NMW).

**Synonyms:**

*Chaetodacus ater* Chen, 1940: 131-Preoccupied by *atra* Malloch, 1938: 113. Liang *et al.*, 1993: 139 (synonym).

*Dacus (Strumeta) diaphorus*- Hardy, 1973: 40.

*Dacus (Bactrocera) diaphorus*- Hardy, 1977: 49; Tseng *et al.*, 1992: 28.

*Dacus (Zeugodacus) lunulatus* Tseng *et al.*, 1992: 66 (synonymized by Drew and Romig, 2013).

*Dacus (Zeugodacus) guangxianus* Chao and Lin, 1993b: 137 (synonymized by Drew and Romig, 2013).

*Dacus (Zeugodacus) sicienti* Chao and Lin, 1993a: 77, new name for *ater* Chen, 1940. Record of original synonymy unknown, see Norrbom *et al.*, 1998: 102.

*Bactrocera (Zeugodacus) diaphora*- Wang, 1996: 68; Norrbom *et al.*, 1998: 102.

*Bactrocera (Zeugodacus) proprediaphora* Wang *et al.*, 2008 in Wang *et al.*, 2008: 73

(synonymized by Drew and Romig, 2013).

**Distribution:** Bhutan, China, India, Indonesia, Malaysia, Sri Lanka, Taiwan, Thailand, Vietnam.

**7. *Zeugodacus lipsanus* (Hendel, 1915)**

凹額如寡毛實蠅

*Chaetodacus lipsanus* Hendel, 1915, Annls. Hist. Nat. Mus. Natl. Hung. 13: 427. Type localities: Koshun (= Henchun, Pingtung County), Suisharyo (= Shuisheliao, Chiayi County) and Tainan, Taiwan (syntypes male and female in MNM).

**Synonym:**

*Bactrocera (Zeugodacus) lipsanus*- Norrbom *et al.*, 1998: 103.

**Distribution:** Taiwan.

**Remarks:** Type localities for this species in Taiwan were probably mistakenly noted in the catalog of Delfinado and Hardy (1977) as Tapani (= Yuching, Tainan City) and Kankan (= Kankou (?), New Taipei City).

**8. *Zeugodacus mundus* (Bezzi, 1919)**

潔如寡毛實蠅

*Chaetodacus mundus* Bezzi, 1919, Philipp. J. Sci. 15 (5): 429. Type localities: Luzon, Laguna: Los Banos; Mindanao, Davao. Los Banos, Laguna, Philippines (syntypes male and female in MCSNM).

**Synonyms:**

*Chaetodacus mundus* Bezzi, 1919: 429.

*Zeugodacus tibialis* Shiraki, 1933: 96; Hardy and Adachi, 1954: 193.

*Dacus (Zeugodacus) mundus*- Hardy, 1969b: 481, lectotype designation invalid; Hardy, 1974: 52.

*Bactrocera (Zeugodacus) munda*- Norrbom *et al.*, 1998: 103.

**Distribution:** Philippines (Batbatan Is., Davao, Los Banos, Luzon Is., Paete, Palawan, Panay Is., Mindanao Is.), Taiwan.

**9. *Zeugodacus nigrifacies* Shiraki, 1933**

黑臉如寡毛實蠅

*Zeugodacus nigrifacies* Shiraki, 1933, Mem. Fac. Sci. Agric. Taihoku Imp. Univ. 8: 99. Type localities: Arisan (= Mt. Alishan, Chiayi County), and Tamaru (Rota) (= unknown locality in Yilan County), Taiwan (lectotype male and paralectotype female in

NIAS).

**Synonyms:**

*Bactrocera (Zeugodacus) nigrifacies*- Norrbom *et al.*, 1998: 103.

**Distribution:** Taiwan.

**10. *Zeugodacus okunii* Shiraki, 1933**

大國氏如寡毛實蠅

*Zeugodacus okunii* Shiraki, 1933, Mem. Fac. Sci. Agric. Taihoku Imp. Univ. 8: 104. Type locality: Kotosho (= Lanhsu (Orchid Is.), Taitung County), Taiwan (lectotype male and paralectotype female in NIAS, designated by Drew and Romig, 2013).

**Synonym:**

*Bactrocera (Zeugodacus) okunii*- Norrbom *et al.*, 1998: 103.

**Distribution:** Taiwan.

**11. *Zeugodacus scutellatus* (Hendel, 1912)**

黑楯板 (如寡毛) 實蠅

*Dacus scutellatus* Hendel, 1912, Supplta Entomol. 1: 20. Type locality: Koshun (= Henchun, Pingtung County), Taiwan (holotype male in DEI).

**Synonyms:**

*Dacus trivittatus* Matsumura, 1916: 411.

*Dacus (Chaetodacus) bezzii* Miyake, 1919: 146; Shiraki 1933: 85.

*Dacus (Zeugodacus) scutellatus*- Kanmiya, 1986: 25; Kwon, 1994: 293; Suh and Kwon, 1995: 125; Kwon *et al.*, 1996: 249.

*Dacus (Zeugodacus) pseudoscutellatus* Tseng *et al.*, 1992: 74 (synonymized by Drew and Romig, 2013).

*Bactrocera scutellata*- Baba, 1990: 78; Han and Kwon, 2000: 24; Miyatake *et al.*, 2000: 1274; Mun *et al.*, 2000: 89; Ohno *et al.*, 2006: 7; Kim *et al.*, 2010: 299; Jeon, 2011; Jeon *et al.*, 2012: 485; Lim *et al.*, 2012: 1; Han *et al.*, 2014: 116; Vargas *et al.*, 2015: 301; Kim *et al.*, 2017.

*Bactrocera (Zeugodacus) scutellate*- White and Elson-Harris, 1992: 278; Liang *et al.*, 1993: 138; Wang, 1998: 71; Allwood *et al.*, 1999: 22; Norrbom *et al.*, 1998: 103; Lin *et al.*, 2005: 843; Drew *et al.*, 2007: 11; Drew and Romig, 2010: 154; Drew and Romig, 2013: 342; Sueyoshi, 2014: 572.

*Zeugodacus (Zeugodacus) scutellatus*: De Meyer *et al.*, 2015: 3.

**Distribution:** Japan (Honshu to Ryukyu Is.), southern China, Taiwan.

12. *Zeugodacus synnephes* (Hendel, 1913)

巨斑 (如寡毛) 實蠅

*Dacus synnephes* Hendel, 1913, Entomol. Mitt. 2: 40. Type locality: Fuhosho (= Wucheng, Nantou County), Taiwan (holotype female in DEI).

**Synonyms:**

*Zeugodacus synnephes* var. *dobaensis* Shiraki, 1933: 95.

*Dacus synnephes*- Hardy, 1968: 113 [misspelling].

*Dacus (Zeugodacus) ubiquitous* Hardy, 1973: 71 (synonymized by Drew and Romig, 2013).

*Dacus (Zeugodacus) stenomus* Wang and Zhao, 1989: 213 (synonymized by Drew and Romig, 2013).

*Bactrocera (Zeugodacus) synnephes*- Norrbom *et al.*, 1998: 103.

**Distribution:** China, Indonesia (Bali, Flores, Java, Lombok, Rakata, Sulawesi, Sumbawa), peninsular Malaysia, Philippines, Taiwan, Thailand.

13. *Zeugodacus tappanus* (Shiraki, 1933)

達邦如寡毛實蠅

*Chaetodacus tappanus* Shiraki, 1933, Mem. Fac. Sci. Agric. Taihoku Imp. Univ. 8: 76. Type locality: Tappan (= Tapan (Wufeng), Chiayi County), Taiwan (holotype male in NIAS).

**Synonyms:**

*Strumeta tappanus*- Perkins, 1938a: 122.

*Dacus (Bactrocera) tappanus*- Hardy, 1977: 52.

*Dacus (Bactrocera) tappanus* [misspelling of *Dacus*]- Tseng *et al.*, 1992: 46.

*Dacus (Bactrocera) paratappanus* Tseng *et al.*, 1992: 38 (synonymized by Drew and Romig, 2013).

*Bactrocera (Bactrocera) tappanus*- Wang, 1996: 56; Norrbom *et al.*, 1998: 95.

**Distribution:** Taiwan.

14. *Zeugodacus tau* (Walker, 1849) 南瓜實蠅

*Dasyneura tau* Walker, 1849, List Dipt. Colln Br. Mus. 4: 1074. Type localities: Jiangxi, Foochow [Fuzhou], China and unknown locality (syntype male in BMNH).

**Synonyms:**

*Dacus hageni* de Meijere, 1911: 375.

*Dacus caudatus* var. *nubilus* Hendel, 1912: 16 (synonymized by White and Wang, 1992).

*Dacus nubilus* ssp. *femoralis* Hendel, 1934: 11.

*Dacus (Zeugodacus) tau*- Hardy, 1977: 60.

*Bactrocera (Zeugodacus) tau*- Wang, 1996: 72; Norrbom *et al.*, 1998: 104.

*Dacus (Zeugodacus) elegantis* Tseng *et al.*, 1992: 61 (synonymized by Drew and Romig, 2013).

*Dacus (Zeugodacus) flavus* Tseng *et al.*, 1992: 63 (synonymized by Drew and Romig, 2013).

**Distribution:** Oriental region (widely distributed from India, Sri Lanka, East and southern China, Taiwan to Indonesia (Java and Sulawesi)) (CABI, 2019).

**Remarks:** *Z. signatus* (Hering, 1941) (formerly *B. (Z.) signata*) (Norrbom *et al.*, 1998) and *Z. heinrichi* (Hering, 1941) (= *Z. nubilus* ssp. *heinrichi*) (formerly *B. (Z.) heinrichi*) (Hardy, 1973) were considered as synonyms of *Z. tau*, but Drew and Romig (2013) treated them as isolated species. Also, Hardy and Adachi (1954) treated *Z. heinrichi* as a synonym of *D. hageni*, which is now a synonym of *Z. tau*.

**Problems recording *Zeugodacus caudatus* in Taiwan**

*Zeugodacus caudatus* (Fabricius, 1805)

長尾如寡毛實蠅

*Dacus caudatus* Fabricius, 1805, Syst. Antliat. 14: 276. Type locality: Java, Indonesia (lectotype female in UZMC).

**Synonyms:**

*Bactrocera maculipennis* Doleschall, 1856, Natuurk. Tijdschr. Ned.-Indic 10: 412 (synonymized by Hardy, 1973).

*Dacus (Zeugodacus) caudatus* – Hardy and Adachi, 1954:186; Hardy, 1973: 60, lectotype designation by inference of holotype; Hardy, 1983: 35.

*Bactrocera (Zeugodacus) caudata* – Norrbom *et al.*, 1998: 102.

**Distribution:** Brunei, China (Hainan), India (Madhya Pradesh, Madras, West Bengal), Indonesia (Sumatra, Java), Malaysia, Myanmar, Sri Lanka, Thailand,

Vietnam.

The previous recording of this species in Taiwan was based on the publication of “The name list of Taiwan Diptera” (as *B. (Z.) caudatus* on p. 69 of Lin and Chen, 1999), and the aforementioned information was cited from “A catalog of the Diptera of the Oriental region, Vol. 3” by Delfinado and Hardy in 1977 (as *B. (Z.) caudatus* on p. 57). However, Hendel (1912) mentioned that the species in Taiwan should be treated as a subspecies (or variety) named *D. caudatus* var. *nubilus* Hendel, 1912 on the basis of the specimens collected by H. Sauter in 1902 (specimens now deposited in NMW). *D. caudatus* var. *nubilus* was then treated as a synonym of *B. tau* (Walker, 1849) by White and Wang, (1992: 278.)

Our data also show that the Chinese specimen (Foochow, China; Coll. G. J. Lay; 1845) — previously recorded as *nubilus* Hendel — deposited in the Bishop Museum in Hawaii, United States, is a synonym of *B. tau* (det. D. E. Hardy in 1954) (International Collaboration and Promotion of Taiwan e-Learning and Digital Archives Program: Digitization of Historic Museum Collections of Taiwan Deposited in Foreign Countries, 2011). The Taiwanese recording was actually the subspecies *B. caudatus* var. *nubilus* and had already been treated as a synonym of *Z. tau* (previously *B. (Z.) tau*) (<http://dhmct.digital.ntu.edu.tw/insect/>). Because *Z. caudatus* can be attracted by cue lure-based traps (Drew and Romig, 2013), according to over 20 years of island-wide surveillance data of cue lure traps in Taiwan (Chen *et al.*, 2007), I believe *Z. caudatus* does not occur in Taiwan, but instead only *Z. tau* occurs and in an extremely restricted area.

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# 台灣產如寡毛實蠅屬 (*Zeugodacus*) (雙翅目：果實蠅科：寡毛實蠅族) 物種名錄

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## 摘 要

本文重新修訂台灣產如寡毛實蠅屬物種名錄，迄今共計確認有 14 個有效物種名。文中提供包括物種地位、模式產地及存放地、文獻、異名及已知地理分布等相關分類資訊。此外，特別針對長尾如寡毛實蠅 (*Zeugodacus caudatus*) 之前在台灣的有問題紀錄提出說明。

**關鍵詞：**果實蠅科、物種名錄、分類學、台灣