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SHORT COMMUNICATION

THE STATUS OF *Bactrocera dorsalis* AS AN EMERGING PREDOMINANT PEST IN THE COMMERCIAL FRUIT INDUSTRY IN SRI LANKA

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ABSTRACT

Fruit flies (Diptera: Tephritidae) are considered the most serious insect pests in the fruit industry worldwide. However, there are no sufficient studies and information on the pest severity and the dominance levels of fruit flies in the fruit industry in Sri Lanka. Hence, the present study aimed to assess the abundance, dominance status, and potential risk of fruit flies in the local fruit market in Sri Lanka. The study was carried out using randomly selected eight (08) fruit stalls (in Galle, Matara, Wellawaya, Monaragala, Ambilipitiya, Kakirawa, Hambanthota, Lunugamwehera) as two stalls in each bio-climatic zone. Adult fruit flies were collected using methyl-eugenol field traps. Trapped flies were identified using standard taxonomic keys. Simpson Population Dominance Index and the Abundance Index for recorded fruit flies were calculated. Four *Bactrocera* species; *B. dorsalis*, *B. kandiansis*, *B. correcta* and *B. latifrons* were recorded. Among them, *B. dorsalis* showed the highest percentage abundance in all selected fruit stalls and in all bio-climatic zones ($P<0.05$). Out of the four species, *B. dorsalis* recorded the highest dominance index value (0.61) as the high-dominant fruit fly species. As such, there is an emerging pest risk of *B. dorsalis* as the predominant fruit fly in the commercial fruit industry in Sri Lanka. These findings will be helpful for fruit exporters, local sellers, cultivators and agriculture authorities in implementing control measures to secure the commercial fruit industry in Sri Lanka.

Keywords: Abundance, Dominance, Fruit flies, Fruit industry, Pest risk, Sri Lanka

INTRODUCTION

Sri Lanka is a tropical island and it is divided into four major climatic zones; wet, intermediate, dry, and arid based on the rainfall and temperature. These climatic zones turn support the rich ecological diversity with tropical, subtropical, and temperate cultivated fruit crops in Sri Lanka (Peris 2016). Mango, banana, pineapple, guava, papaya and watermelon are several widely cultivated fruits in Sri Lanka especially for commercial purposes. Annually, Sri Lanka loses about 25-30% of its fruit crops due to the damage of insect pests (Raveendranath 1999). The fruit production of Sri Lanka is mainly threatened by insect pests such as fruit flies, leafhoppers and seed weevils. Among them, fruit flies have a highest attention as a serious pest in the fruit industry and their damage is estimated as more than half of the fruit production in Sri Lanka (MSTR 2016). In 2014, the exporting of fruits from Sri Lanka to European countries was banned and after following the revised procedures and instructions it was lifted.

Bactrocera dorsalis Hendel (Diptera: Tephritidae) is well-known as the most virulent pest species in the predominant genus *Bactrocera* Macquart (Clarke 2005). In Sri Lanka, there are records of 24 species of fruit flies in the genus *Bactrocera* (Drew and Romig 2013, 2016; Leblanc *et al*. 2018).

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There are several past studies on the diversity and control measures of fruit flies in Sri Lanka. The applications of control measures for fruit flies in Sri Lanka were reported by Dhanapala 1996; Karunarathna and Karunarathna 2012. The fruit fly infestation in banana cultivation in Sri Lanka was recorded by Ekanayake *et al*. 2002. Ranaweera *et al*. (2017) reported the abundance and species richness of fruit flies in cucurbit growing areas in Anuradhapura, Kurunegala and Kandy Districts in Sri Lanka. Diets variability and management of *B. cucurbitae* were reported by Ranaweera *et al*. (2016) and Bandara *et al*. (2006). A study was conducted on the diversity of fruit flies in the dry zone by Heshani and Sirisena (2017), highlighting *B. correcta* was the dominant fruit fly than *B. dorsalis* at all sites surveyed. Marasinghe *et al*. (2018) also reported that the *B. correcta* was the dominant fruit fly than *B. kandiensis* and *B. dorsalis* in the survey at Kandy District, Sri Lanka. In terms of recent studies on fruit flies in Sri Lanka, Wijekoon *et al*. (2021, 2022) reported the infestation variation of *B. dorsalis* on mango cultivations in different bio-climatic zones of Sri Lanka and the oviposition variation of *B. dorsalis* on `Willard` mango variety in Sri Lanka. Furthermore, in the diversity of Dacine fruit flies in selected mango cultivations in Southern Province, Sri Lanka was recorded by Wijekoon *et al*. (2022) and that study indicated *B. dorsalis* as the highest abundant fruit fly species.

However, information on the diversity, distribution, and pest status of fruit flies in terms of different climatic regions in Sri Lanka is still insufficient due to the lack of recent systematic studies performed on this important insect group. Besides, any aforementioned past studies had not been focused to assess the dominance status and risk level of common fruit flies in the fruit industry in Sri Lanka Since there is a long-felt need for a study on the emergence and behavior patterns of fruit flies in Sri Lanka, the present study is vital to understand the basics of the dominant status of fruit flies and their emerging risk.

Hence, the present study aimed to assess the abundance, dominance status and the potential risk of fruit flies in fruit stalls selected from four main bio-climatic zones in Sri Lanka. Based on the findings of this cross-sectional study, we further attempted to emphasize the emerging pest risk of *B. dorsalis* than other recorded fruit fly species.

MATERIALS AND METHODS

Sites selection

The study was carried out in randomly selected eight small-scale fruit stalls from four main bio-climatic zones (wet zone, dry zone, intermediate zone, and arid zone) of Sri Lanka. The eight (08) small-scale fruit stoles were selected as two fruit stalls from each main bio -climatic zone for this study. The locations and descriptions of the selected eight fruit stalls are shown in Table 01 and Figure 01.

Sampling procedure

The study was conducted from August to December 2020 as a baseline study of a long-term survey. A methyl-eugenol (ME) field trap [5 cm diameter and 10 cm height with two circular opening-(each, 0.5cm×0.5cm), and with a ME coated sponge (3cm×3cm)] was provided to the owner of each fruit stall. The provided trap was hung by the owner (1.5 - 4 m above the ground level) inside the fruit stall for collecting fruit flies. All ME coated sponges were replaced by a new one in each sampling round. All trapped flies in the trap were collected in polythene bags once a month and brought to the laboratory in the Department of Zoology, University of Ruhuna for further identification and confirmation.

Identification of specimens

Collected fruit flies were identified morphologically using standard identification keys for fruit flies in South Asia and Australia (Leblanc *et al*. 2021; Schutze 2012; Prabhakar *et al*. 2012; Choudhary *et al*. 2014; Plant Health Australia 2018; Daud *et al*. 2020). Fruit fly specimens were examined using the Light microscope (Nikon-ECLIPSE-E100) (10×4) to confirm the major discriminating morphological and taxonomical features. Samples of identified species were deposited at the Department of Zoology, University of Ruhuna, Sri Lanka.

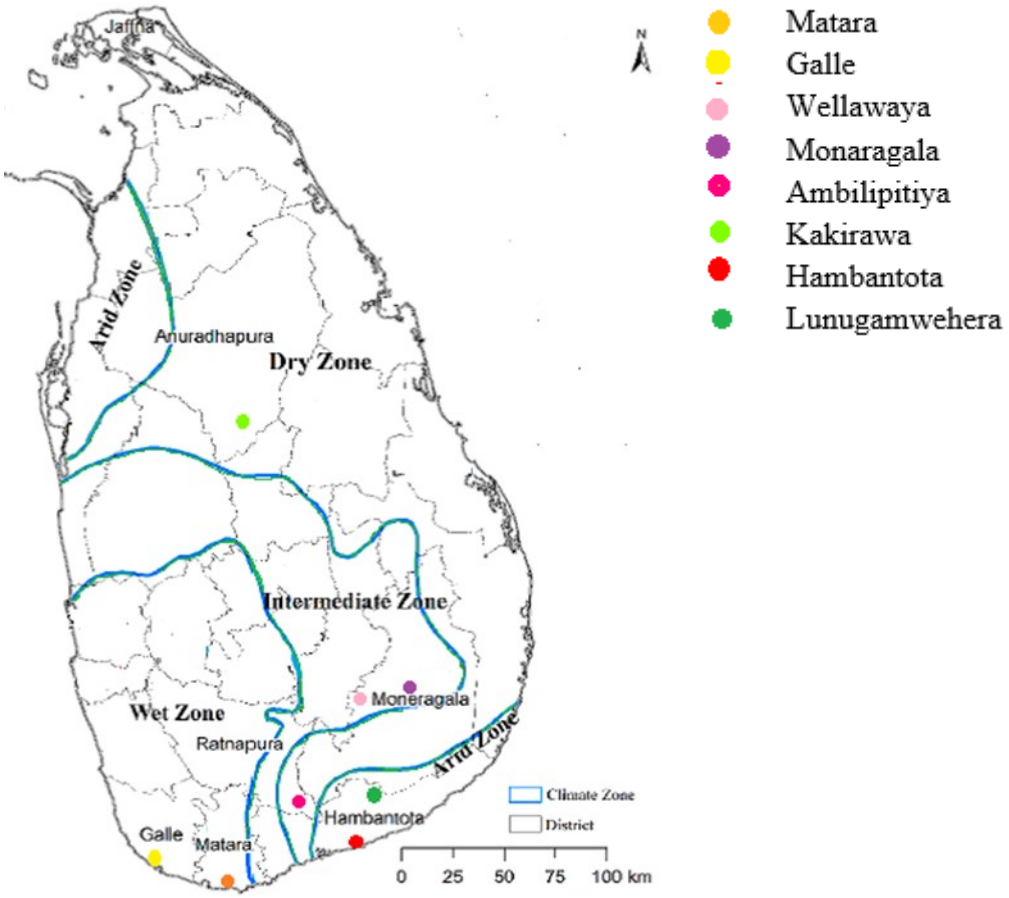

Figure 01: Selected study sites in four each bio-climatic zones of Sri Lanka (Modified the basic map derived from Alahacoon and Edirisinghe 2021)

Table 01: The description of study sites

Bio-climatic zone	Location of the fruit stalls	Gps location	Description of fruit stalls
Wet	Matara	5° 57' 17" N, 80° 33' 17" E	mango + water melon+ Papaya+ guava
	Galle	6°04'14"N, 80°15'12"E	mango +banana+ water melon
Intermediate	Wellawaya	6° 43' 17" N 81° 7' 13" E	Mango+ banana+ water melon+ guava
	Monaragala	6°46'11"N, 81°16'12"E	mango+ water melon
Dry	Ambilipitiya	6°21'24" N, 80°52'34" E	mango+ banana+ guava
	Kakirawa	8°3'32.45"N, 80°33'36.1"E	mango+ water melon+ guava
Arid	Hambanthota	6° 8' 26" N, 81° 7' 5" E	mango+ water melon
	Lunugamwehera	6°18'62"N,81°12'62"E	mango+ guava+ water melon

Data analysis

The fruit fly abundance and dominance were calculated using the recorded number of trapped flies of each species in each trap.

a) **Population Dominance:** The dominance index for each fruit fly species was calculated using the following formula (Ludwig and Reynold 1988):

$$D = \sum_{i=1}^{S} \left[\frac{ni}{N}\right]^2 \qquad \text{……..Eqn 01}$$

D = Simpson Dominance index
S = the total number of species
ni = the total number of organism of species –i
N = the total number of organisms of all species
Pi = ni/N = proportion of total abundance represented by species –i

The degree of dominance is divided into 3 categories (Maesyorah *et al*. 2018):
0.01–0.30 = low dominance;
0.31–0.60 = moderate dominance;
0.61–1.00 = high dominance

b) **Population Abundance:**
Fruit fly abundance was calculated using the following formula (Brown *et al*. 1998):

$$A = \frac{a}{b} \times 100\% \qquad \text{……Eqn 02}$$

A = abundance
a = number of i species in location X
b = total population of all species observed in location X

Statistical analysis
Data were entered into a database in MS excel (2010 version) and transferred to the Statistical Package for the Social Sciences (IBM SPSS, 20.0 version) software. The normality of the data set was tested using the Anderson-darling test. The mean, standard error and percentages were calculated. The significance levels in the variations of species abundance among species and bio-climatic zones were compared using the one-way ANOVA test.

RESULTS AND DISCUSSION

a) Recorded species
A total of 849 fruit fly specimens were examined. These all specimens belonged to four (04) species of the genus, *Bactrocera*; *B. dorsalis* (Hendel), *B. kandiansis* (Drew and Hancock), *B. correcta* (Bezzi) and *B. latifrons* (Hendel) (Figure 02).

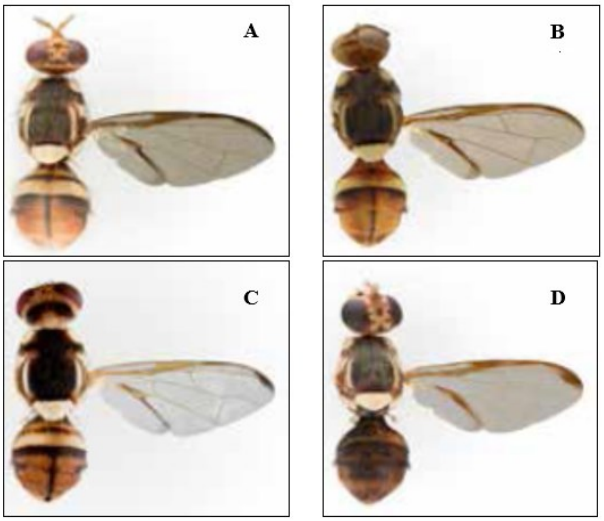

Figure 02: Dorsal view of (a) *B. dorsalis*, (b) *B. kandiansis*, and (c) *B. correcta* (d) *B. latifrons* (Photos@ Plant Health Australia 2018)

b) Percentage abundance
Among the four species recorded, *B. dorsalis* (77.85±1.86) showed a significantly high abundance in fruit stalls ($P<0.05$) than other recorded fruit fly species. The lowest abundance was recorded for *B. latifrons* (2.23±1.04) and *B. kandiansis* showed a moderate abundance (14.13±0.93) in all studied sites (Fig. 03). The findings of Duyck *et al*. (2006) and Vargas *et al*. (2015) supported our results, that *B. dorsalis* shows a highly competitive behavior to establish quickly in their habitat by becoming the dominant pest species.

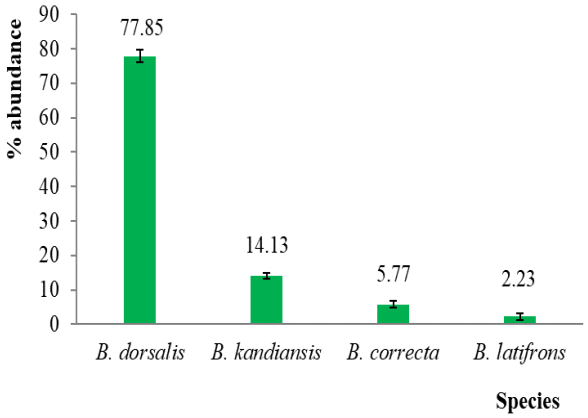

Figure 3: The variation of percentage abundance of four fruit fly species recorded

Among the four species, *B. dorsalis* recorded as the dominant species in all four bio-climatic zones. Comparatively, *B. correcta* and *B. latifrons* showed a very low abundance in all bio-climatic zones (Figure 04).

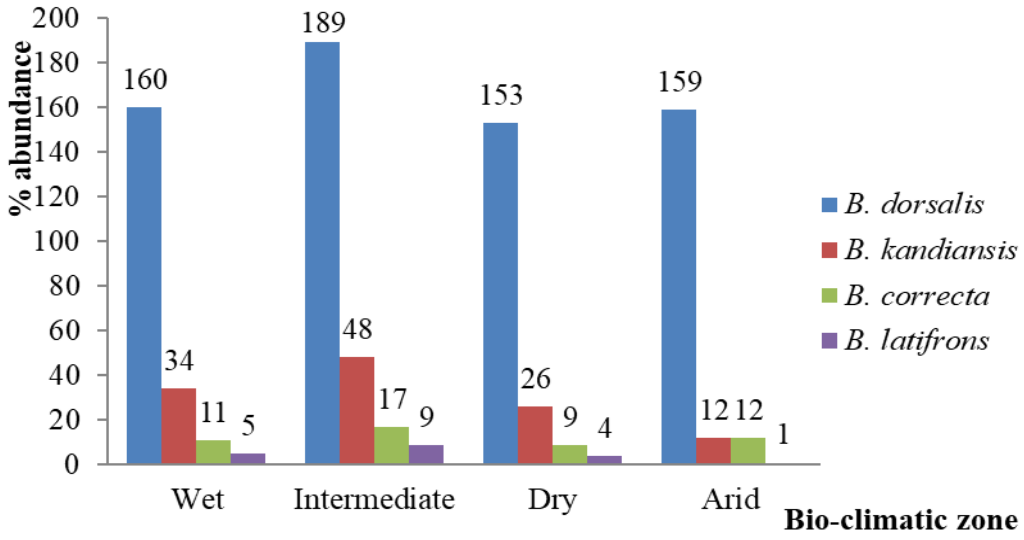

Figure 4: The variation of percentage abundance of fruit flies among four main bio-climatic zones

c) **Dominance index**

Bactrocera dorsalis showed a high dominance index (0.61) belonging to the `High dominant' category. As such, *B. dorsalis* was reported as the high-dominance fruit fly species in all stalls surveyed in all bioclimatic zones of Sri Lanka during the study period (Table 02). Evidently, there is a high possibility of fruit flies to become a dominant species when the decreasing the number of species in a particular site (Riastiwi *et al*. 2021). The study results significantly indicate the predominance of *B. dorsalis* over other recorded three species, and these findings could be linked with the previous records of *B. dorsalis* because this species have been recorded as the predominant fruit fly species in several other countries like China (Li 2016) and Indonesia (Zulida and Tati 2016; Kartika and Tati 2016). *Bactrocera dorsalis* (mango fruit fly) is well known to cause a severe damage on mango industry worldwide (Drew and Hancock 1994; Kapoor 2006) and especially in South Asia (Wan *et al*. 2012).

The study findings further indicated the status of *B. kandiansis* as a moderate dominant fruit fly species belonging to the `Low` dominance category. Both *B.correcta* and *B. latifrons* showed a very low abundance and a lowest dominance index values. As such, they belonged to the `Non dominance' category (Table 02). Ricklefs, (1978) reported that the non-dominant fruit fly species are rarely found and they showed a less abundance.

Table 02: The dominance index and criteria of recorded fruit flies

Recorded species	Total No.	Dominance Index	Dominance category
*B. dorsalis**	661	0.61	High
B. kandiansis	120	0.02	Low
B. correcta	49	0.003	Non dominance
B. latifrons	19	0.0005	Non dominance

*The mean difference is significant at the 0.05 level

When comparing the present findings on the predominance of *B. dorsalis* with the past two studies by Heshani and Sirisena (2017) and by Marasinghe *et al*. (2018), they have been recorded *B.correcta* as the dominant fruit fly than *B. dorsalis*. Whereas several recent findings of fruit flies (Wijekoon *et a*l. 2021, 2022) have recorded a high abundance of *B. dorsalis* than other *Bactrocera* fruit flies in different climatic regions in Sri Lanka. These findings further support to strength the present study results on the predominance of *B. dorsalis* than *B. kandiansis, B.correcta* and *B. latifrons* in main bioclimatic zones of Sri Lanka. Further in our study showed a notably low abundance of *B. correcta* in all studied sites, compared to *B. dorsalis.* Hence it is clear that *B. dorsalis* has emerged very recently as a highly dominant fruit fly species in all bioclimatic zones of Sri Lanka. As such it is very crucial to estimate and understand the possible alarming future risk of *B. dorsalis* as a serious pest in the local fruit market in Sri Lanka. Future studies are recommended to get an overall picture of the Island wide distribution of *B. dorsalis* and then to develop efficient management systems to enhance the income of fruit deals by minimizing fruit fly damage-related fruit wastes.

CONCLUSIONS

Bactrocera dorsalis is an emerging serious pest in the commercial fruit industry of Sri Lanka. It is the predominant fruit fly compared to the other *Bactrocera* species recorded in all sites studied in the main bio-climatic zones of Sri Lanka. The presence of the high population and the dominance of *B. dorsalis* over all bioclimatic zones reveal the severity of their future alarming threat on the commercial fruit industry in Sri Lanka. Hence the present findings are vital to plan future control measures and management programs for *B. dorsalis* to strengthen the commercial local fruit market in Sri Lanka.

CONFLICTS OF INTEREST

The authors would like to declare that there are no conflicts of interest in undertaking this research.

AUTHOR`S CONTRIBUTION

WMCDW conducted field surveys, data collection, data entering, data analysis and writing the manuscript, GASMG, HCEW and SPV supervised the research and reviewed the manuscript.

REFERENCES

Alahacoon N, Edirisinghe M 2021 Spatial variability of rainfall trends in Sri Lanka from 1989 to 2019 as an indication of climate Change, ISPRS International Journal of Geo-Information, 10 (2) 84: 1-18. DOI: https://doi.org/10.3390/ijgi10020084

Bandara KANP, Kudagamage C,.Senadeera DP and Prathapasignha GS 2006 Development of an Effective Integrated pest Management System for Melon fly, *Bactrocera cucurbitae* Infesting Commercial Cultivation of Gherkin, Cucumis sativus. Annals of Sri Lanka Department of Agriculture, 8:11-18.

Brown J, Zar JH and von Ende CN 1998 Field and laboratory method for general ecology. Edition 4th. McGraw Hill Publication, Los Angeles.

Choudhary JS, Naaz N, Prabhakar CS, Das B, Maurya S and Kumar S 2014 Field guide for identification of Fruit fly species of Genus *Bactrocera* prevalent in and around mango orchards. Technical booklets No.: R-43/Ranchi-16. ICAR Research Complex for Eastern Region, Research Centre, Ranchi, 1-16pp.

Clarke AR, Armstrong KF, Carmichael AE, Milne JR, Raghu S, Roderick GK, Yeates DK 2005 Invasive phytophagous pests arising through a recent tropical evolutionary radiation: The *Bactrocera dorsalis* complex of fruit flies. Annual Review of Entomology, 50:293-319.

Daud ID, Melina, Dayanara HK, Mustika T 2020 Fruit fly identification from fruits and vegetables of Turikale Maros, South Sulawesi, Indonesia Advances in Biological Sciences Research, International Conference and the 10th Congress of the Entomological Society of Indonesia (ICCESI 2019), 8: 94-100.

Dhanapala MG 1996 Control of fruit flies using methyl eugenol traps. *Second* International Congress of Entomological Scienc-

es at PARC. Islamabad, Pakistan. 64-65pp. DOI: http://doi.org/10.21608/EAJBSA.2022.228576

Drew RAI and Romig MC 2016 Keys to the tropical fruit flies of South-East Asia. CABI, Wallingford, 487 p.

Drew RAI, Hancock DL 1994 The *Bactrocera dorsalis* complex of fruit flies (Diptera:Tephritidae: Dacinae) in Asia. Bulletin of Entomological Research, Supplement, 2: 1-68.

Drew RAI, Romig MC 2013 Tropical fruit flies of South-East Asia. CABI, Wallingford, p. 655.

Duyck PF, David P and Quilici S. 2006 Climatic niche partitioning following successive invasions by fruit flies in La Réunion. Journal of Animal Ecology, 75: 518 –526.

Ekanayake HMRK, Wekadapola WWMSN and Bandara KANP 2002 Studies on fruit fly infestation in Banana Cultivars in Sri Lanka. Annals of the Sri Lanka Department of Agriculture, 4: 269-274.

Heshani DKA, Sirisena UGAI 2017 Diversity of fruit flies (Diptera: Tephritidae) in selected locations in the dry zone of Sri Lanka. Symposium on crop protection and improvement, p.68.

Kapoor VC 2006 Taxonomy and biology of economically important fruit flies of India (Diptera:Tepritidae). p. 459-475. In: Freidberg, A. (ed.). Biotaxonomy of Tephritoidea. Israel Journal of Entomology 35 (36): 1-599.

Kartika AP, Tati SS 2016 Fruit fly infestation on wax apple (*Syzygium samarangense*) at North Sumatera, Indonesia. In 1st Symposium of Tephritid Workers of Asia, Australia and Oceania, p.93.

Karunaratne MMSC and Karunaratne UKPR 2012 Factors influencing the responsiveness of male oriental fruit fly, *Bactrocera dorsalis*, to methyl eugenol (3, 4 dimethoxyalyl benzene), Tropical Agricultural Research and extention, 15 (4):92-97.

Leblanc L, Doorenweerd C, Jose MS, Sirisena UGAI, Hemachandra KS and Rubinoff D 2018 Description of a new species of *Dacus* from Sri Lanka, and new country distribution records (Diptera, Tephritidae, Dacinae). ZooKeys 795: 105 –114. DOI: https://doi.org/10.3897/zookeys.795.29140

Leblanc L, Hossain MA, Momen M, Seheli K 2021 New country records, annotated checklist and key to the dacine fruit flies (Diptera: Tephritidae: Dacinae: Dacini) of Bangladesh. Insecta Mundi 880: 1–56.

Li Z 2016 On the way: A review on the prevention and control of fruit flies of economic importance in China. In 1st Symposium of Tephritid Workers of Asia, Australia and Oceania, 31p.

Ludwig JA and Reynolds JF 1988 Statistical Ecology: a Primer on Methods and Computing. John Wiley & Sons, New York.

Maesyorah SS, Dewi TK, Tustiyani I, and Mutakin J 2018 Keberadaan dan keanekaragaman serangga pada tanaman jeruk siam (Citrus nobilis l.). Jurnal Pertanian. 9 (2): 113–119.

Marasinghe JP, Madugalle S, Nugapitiya CAK, Harischandra YRN and Hettiarachchi AK. 2018 The seasonal abundance of fruit fly species in Sri Lanka and the male annihilation technique as a control measure for fruit flies; two case studies. Tropical Agriculturist,166 (4): 33-50

Ministry of Science Technology & Research (MSTR) 2016 *Destroying the fruit fly*- "Vidya", The official newspaper of the Ministry of Science Technology & Research, p 06. www.daily news.lk/vidya.

Peris K 2016 The mango in the democratic socialist republic of Sri Lanka, Mango Tree Encyclopaedia 19: 337-370.

Plant Health Australia 2018 The Australian handbook for the identification of fruit flies. Version 3.1.Plant Health Australia. Canberra, ACT. 1-162pp.

Prabhakar CS, Sood P, Mehta PK 2012 Pictorial keys for predominant *Bactrocera* and *Dacus* fruit flies (Diptera:Tephritidae) of north western Himalaya. Arthropods. 1 (3):101-111.

Ranaweera PH, Galaniha LD, Ranathunga M, Nishantha KMDWP, Siriwardhana M and Nugaliyadde L 2016. Effect of Natural and Artificial Diets on the Life Hostory Parameters of Melon-Fruit Fly, Bactrocera Cucurbitae (Diptera:Tephritidae). Annals of Sri Lanka Department of Agriculture,

18: 40-42.

Ranaweera PH, Ranathunga M, Nugaliyadde L, Hemachandra KS, Rajapakshe M, Erabadupitiya HRUT, Wijesekara LK and Edirisinghe EMRD 2017. Abundance and Species Richness of fruit flies (Diptera: Tephritidae) in Major cucurbit growing areas in Anuradhapura, Kurunegala and Kandy District in Sri Lanka and farmers' perception on recommended management methods. Annals of Sri Lanka Department of Agriculture, 19: 98-112.

Raveendranath S 1999 Eco-friendly pesticides. Sri Lanka Association for the Advancement of Science, Seminar on pest control in the next millennium, University of Ruhuna, Matara, pp.47-53.

Riastiwi I, Paradisa YB, Mambrasar YM, Marlin MR, Urip P, Slamet DV, Nurul FS, Sulistiyani TR and Leberina KI 2021 Diversity of fruit flies (Diptera: Tephritidae) attracted by me lure in csc-bg germplasm carambola plantation, Journal Hama Dan Penyakit Tumbuhan Tropika, 21(2): 151-157. DOI : http://doi.org/10.23960/j.hptt.221151-157

Ricklefs RE 1978 *Ecology.* Chiron Press Inc., NewYork.

Schutze M K 2012 Population structure of *Bactrocera dorsalis ss*, *B. papayae* and *B. philippinensis* (Diptera: Tephritidae) in southeast Asia: evidence for a single species hypothesis using mitochondrial DNA and wing-shape data. BMC Evaluation Biology. 12, (130). DOI: https://doi.org/10.1186/1471-2148-12-130.

Vargas RI, Pinero JC, Leblanc L 2015 An overview of pest species of *Bactrocera* fruit flies (Diptera: Tephritidae) and the integration of biopesticides with other biological approach-es for their management with a focus on the Pacific region. Insects 6: 297–318. DOI: https://doi. org/10.3390/insects6020297.

Wan XW, Liu YH, Zhang B 2012 Invasion history of the oriental fruit fly, *Bactrocera dorsalis*, in the Pacific-Asia region: two main invasion routes. Public Library of Science One 7:e36176.

Wijekoon WMCD, Ganehiarachchi GASM, Wegiriya HCE and Vidanage SP 2022 Records of fruit flies (Diptera: Tephritidae: Dacinae: Dacini) in a selected mango (*Mangifera indica* L.) (Karutha kollomban) cultivation in Ambalanthota, Sri Lanka, Proceedings of the International symposium of Agriculture and the environment, University of Ruhuna, p.56.

Wijekoon WMCD, Ganehiarachchi GASM, Wegiriya HCE and Vidanage SP 2022 The variation of abundance and fruit damage of *Bactrocera dorsalis* on two commercial varieties of *Mangifera indica* in main Bio-climatic Zones of Sri Lanka. Sri Lankan Journal of Agriculture and Ecosystems, 4(1),149–164. DOI: http://doi.org/10.4038/sljae.v4i1.75

Wijekoon WMCD, Ganehiarachchi GASM, Wegiriya HCE and Vidanage SP 2022 Oviposition Preference and Performance of *Bactrocera dorsalis* Hendel, (Diptera: Tephritidae) on Four Colour Types of Willard mango (*Mangifera indica* L) Egyptian Academic Journal of Biological Science (A. Entomology) 15(1):91-103. DOI: http://doi.org/10.21608/EAJBSA.2022.228576

Wijekoon WMCD, Ganehiarachchi GASM, Wegiriya HCE and Vidanage SP 2021 Infestation and emergence of *Bactrocera dorsalis* (Diptera: Tephritidae) on two varieties of *Mangifera indica* from selected locations in wet zone and dry zone of Sri Lanka, International conference of Applied and Pure Sciences, University of Kelaniya, p.18.

Zulida S, Tati SS 2016 Fruit fly diversity and its parasitoid in coffee orchard at Takengon-Central Aceh, Indonesia. In 1st Symposium of Tephritid Workers of Asia, Australia and Oceania, 87p.