

Frugivorous fruit flies (Diptera: Tephritidae: Dacini) with an emphasis on an invasive *Bactrocera minax* in Nepal

National Plant Protection Workshop 2022

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The Entrance Café

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Debraj Adhikari^{1*}, Resham Bahadur Thapa¹, Samudra Lal Joshi² and Jason Jinping Du³

¹Agriculture and Forestry University, Nepal

²Nepal Agricultural Research Council, Nepal

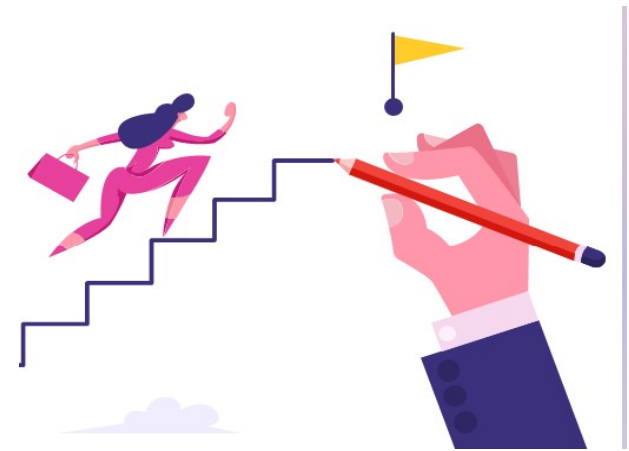
³Beijing Ecoman Biotech Co. Ltd., China

** Plant Quarantine and Pesticide Management Centre, Nepal*

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Presentation outlines

- Introduction
- Fruit fly species reported from Nepal
- Nepal-China Agreement, 2012 declared quarantine concern Nepalese fruit flies to China
- Species authentication of *Bactrocera ?tsuneosis* to *B. minax*
- Invasive fruit fly, *B. minax* (the Chinese citrus fly) to Nepal
- Life cycle of and *B. minax* and its Management (AWCP)
- Conclusion



Introduction

- Fruit flies (Diptera: Tephritidae) are the world's most well-known destructive pests of fruits and vegetables which infest a wide range of fruits, vegetables, flower heads, seeds, leaves, and other plant components (**Prabhakar, Sood, & Mehta, 2012; USDA, 2009**).
- The presence and distribution of fruit flies are influenced by the host plants (**Sari, Affandi, & Hariyanto, 2020**).
- Fruit flies are one of the most common pests of cucurbitaceous vegetables and citrus fruits in Nepal.

Introduction

- This pest, in one hand, is reducing the fruit production and, in other hand, has proven a technical barrier in the worldwide business (**Luciano, Joao, Manoel, & Laura, 2019; Allwood, 1997; Drew & Liloyd, 1987**).
- These pests are so damaging to crops that large management programs have been developed to implement them in various regions of the world (**Vargas, Pinero, & Leblanc, 2015**).
- In Nepal, since the commercialization of the horticultural products, the pestilence of fruit flies has been highlighted.

Introduction

- Protocol-based regular fruit fly surveillance in the citrus orchards of Sindhuli and Syangja districts was initiated in response to the Nepal-China agreement in 2012 to export citrus fruits from Nepal to China with due consideration of quarantine pest regulations on an export commodity (**Adhikari & Joshi, 2018; Adhikari, Tiwari, & Joshi, 2017; PPD, 2014 and Nepal China Agreement, 2012**).

Taxonomic hierarchy of fruit fly

Taxonomic hierarchy of fruit fly according to CABI (2007) is:

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Diptera

Family: Tephritidae

Subfamily: Dacinae

Tribe: Dacini

Genus: *Bactrocera*

Dacus

Zeugodacus

Fruit flies (Diptera: Tephritidae: Dacini)

Dacini is one of the important tribe of subfamily Dacinae under family Tephritidae of Diptera. It has 3 main genera: *Bactrocera*, *Dacus*, and *Zeugodacus* (De Meyer et al., 2015). Around a fifth of all known Tephritidae species belong to the Dacini tribe (Schutze et al., 2017).

The different species of fruit fly reported from Nepal has been listed in this presentation.

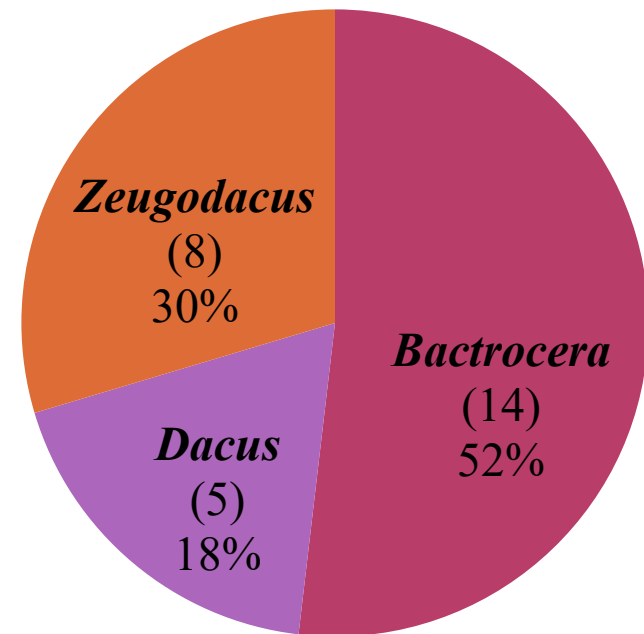


Figure 1. Reported species in different genera of tribe Dacini in Nepal

Fruit fly species reported from Nepal

S N	Fruit fly species	Cited by earlier author/s	Locality in Nepal
1	<i>Bactrocera dorsalis</i> (Hendel, 1912)	Sharma, Adhikari, & Tiwari, 2015; Adhikari & Joshi, 2018; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017; Leblanc, Bhandari, Aryal, & Bista, 2019	Sindhuli, Dhankuta
2	<i>Bactrocera zonata</i> (Saunders, 1842)	Sharma, Adhikari, & Tiwari, 2015; Adhikari & Joshi, 2018; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017, ; Leblanc, Bhandari, Aryal, & Bista, 2019	Sindhuli, Dhankuta
3	<i>Bactrocera correcta</i> (Bezzi, 1916)	Sharma, Adhikari, & Tiwari, 2015; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017; Leblanc, Bhandari, Aryal, & Bista, 2019	Dhankuta,
4	<i>Zeugodacus cucurbitae</i> (Coquillett, 1899)	Sharma, Adhikari, & Tiwari, 2015; Adhikari & Joshi, 2018; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017; Leblanc, Bhandari, Aryal, & Bista, 2019	Sindhuli, Dhankuta
5	<i>Zeugodacus tau</i> (Walker, 1849)	Sharma, Adhikari, & Tiwari, 2015; Adhikari & Joshi, 2018; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017; Leblanc, Bhandari, Aryal, & Bista, 2019	Sindhuli, Dhankuta
6	<i>Zeugodacus scutellaris</i> (Bezzi, 1913)	Sharma, Adhikari, & Tiwari, 2015; Adhikari & Joshi, 2018; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017; Leblanc, Bhandari, Aryal, & Bista, 2019; Kapoor, Malla, & Ghosh, 1979	Sindhuli, Dhankuta, Bandipur, Pokhara, Kathmandu and Lumle
7	<i>Zeugodacus diversus</i> (Coquillett, 1904)	Sharma, Adhikari, & Tiwari, 2015; Leblanc, Bhandari, Aryal, & Bista, 2019	Bhairahawa, Rampur, Bandipur, Pokhara, and Kathmandu

Fruit fly species reported from Nepal

S N	Fruit fly species	Cited by earlier author/s	Locality in Nepal
8	<i>Zeugodacus caudatus</i> (Fabricius, 1805)	Sharma, Adhikari, & Tiwari, 2015; Leblanc, Bhandari, Aryal, & Bista, 2019; Kapoor, Malla, & Ghosh, 1979	Sunwal, Rampur, and Bhandara.
9	<i>Bactrocera minax</i> (Enderlein, 1920)	Sharma, Adhikari, & Tiwari, 2015; Adhikari & Joshi, 2018; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017; Leblanc, Bhandari, Aryal, & Bista, 2019	Sindhuli, Dhankuta,
10	<i>Zeugodacus yoshimotoi</i> (Hardy, 1973)	Sharma, Adhikari, & Tiwari, 2015; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017; Leblanc, Bhandari, Aryal, & Bista, 2019	Bandipur, Pokhara, Lumle and Kathmandu
11	<i>Bactrocera tsuneonis</i> (Miyake, 1919)	Nepal China Agreement, 2012	-
12	<i>Dacus longicornis</i> (Wiedemann, 1830)	Adhikari & Joshi, 2018; Leblanc, Bhandari, Aryal, & Bista, 2019	Sindhuli, Sunwal
12	<i>Bactrocera nigrofemoralis</i> White & Tsuruta, 2001	Tiwari, 2016	Lalitpur
14	<i>Bactrocera latifrons</i> (Hendel, 1915)	Tiwari, 2016	Lalitpur
15	<i>Zeugodacus artifiacis</i> (Perkins, 1938)	Tiwari 2016; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017	Lalitpur
16	<i>Bactrocera tuberculata</i> (Bezzi, 1916)	Tiwari 2016; Bhandari, Ansari, Joshi, Subedi, & Thakur, 2017; Leblanc, Bhandari, Aryal, & Bista, 2019	Sunwal, Bandipur, Pokhara and Kathmandu

Fruit fly species reported from Nepal

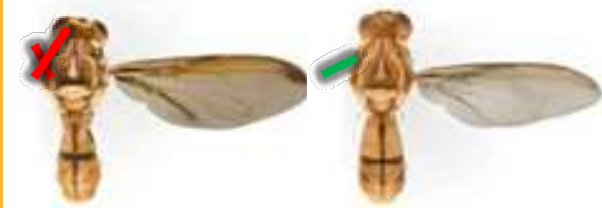
S N	Fruit fly species	Cited by earlier author/s	Locality in Nepal
17	<i>Dacus ciliatus</i> Loew, 1862	Tiwari, 2016	Lalitpur
18	<i>Bactrocera abbreviata</i> (Hardy, 1974)	Leblanc, Bhandari, Aryal, & Bista, 2019	Rampur, Bandipur, Pokhara and Kathmandu
19	<i>Bactrocera aethriobasis</i> (Hardy, 1973)	Leblanc, Bhandari, Aryal, & Bista, 2019	Sunwal
20	<i>Bactrocera digressa</i> (Radhakrishnan, 1999)	Leblanc, Bhandari, Aryal, & Bista, 2019	Sunwal, Rampur, Bandipur and Pokhara
21	<i>Dacus feijeni</i> White, 1998	Leblanc, Bhandari, Aryal, & Bista, 2019	Bandipur
22	<i>Bactrocera nigrifacia</i> Zhang, Ji and Chen 2011	Leblanc, Bhandari, Aryal, & Bista, 2019	Bhairahawa, Sunawal, Rampur, Bhandara
23	<i>Bactrocera rubigina</i> (Wang and Zhao 1989)	Leblanc, Bhandari, Aryal, & Bista, 2019	Bhairahawa, Sunawal, Rampur, Bhandara
24	<i>Bactrocera syzygii</i> White and Tsuruta 2001	Leblanc, Bhandari, Aryal, & Bista, 2019	Rampur, Bandipur
25	<i>Zeugodacus duplicatus</i> (Bezzi 1916)	Leblanc, Bhandari, Aryal, & Bista, 2019	Bhairahawa
26	<i>Dacus maculipterus</i> Drew and Hancock 1998	Leblanc, Bhandari, Aryal, & Bista, 2019	Lumle
27	<i>Dacus trimacula</i> Wang 1990	Leblanc, Bhandari, Aryal, & Bista, 2019	Bandipur, Pokhara

Nepalese fruit flies of status of plant quarantine to China

S. N.	Quarantine Pest	Common Name
1	<i>Bactrocera dorsalis</i> (Hendel, 1912)	Oriental fruit fly
2	<i>Bactrocera zonata</i> (Saunders, 1842)	Peach fruit fly
3	<i>Bactrocera correcta</i> (Bezzi, 1916)	Guava fruit fly
4	<i>Zeugodacus cucurbitae</i> (Coquillett, 1899)	Melon fruit fly
5	<i>Bactrocera tsuneonis</i> (Miyake, 1919)*	Japanese citrus fly

* Presently, species changed to *B. minax* (Source: Adhikari & GC, 2020)

Species authentication of *B. ?tsuneosis* to *B. minax*



Bactrocera minax *Bactrocera tsuneonis*
व्याक्ट्रोसैरा मिन्याक्स व्याक्ट्रोसैरा सुनेओनिस

- The Chinese citrus fly (*B. minax*) resembles to the Japanese fruit fly (*B. tsuneonis*) in morphology (**Drew & Romig, 2013**); however it lacks anterior supra-alar setae (**EPPO, 2021**). As a result, the previous specimen was mistakenly assumed to be *B. tsuneonis* instead of *B. minax* (**EPPO/CABI, 1996**).
- In December 1984, *B. minax* was first collected from a sweet orange in Helambu, Sindhupalchok district of Nepal (**Joshi & Manandhar, 2001**), and it was identified as *B. ?tsuneonis*. Dr. Gary J. Steck, Curator of Diptera, Florida State Collection of Arthropods, Florida, USA verified the specimen, *B. ?tsuneonis*, of the National Entomological Research Centre, NARC to *B. minax* on September 26, 2007 (**Paudyal, Shrestha, & Regmi, 2016; Joshi, 2019**).

Species authentication of *B. ?tsuneosis* to *B. minax*

- At the same time, he identified the fruit fly specimens collected from sweet oranges in Dhankuta dated 27 April 2007 as *B. minax*.
- Changing species status of *B. tsuneosis* to *B. minax* in Nepal informed to the NPPO-China from the National Plant Protection Organization of Nepal (NPPO-Nepal) and needed to be officially proceed ahead.

Fruit fly species of citrus orchard, Sindhuli

FIELD IDENTITIES OF DIFFERENT SPECIES OF FRUIT FLIES IN SWEET ORANGE (*CITRUS SINENSIS*) ORCHARDS IN SINDHULI, NEPAL

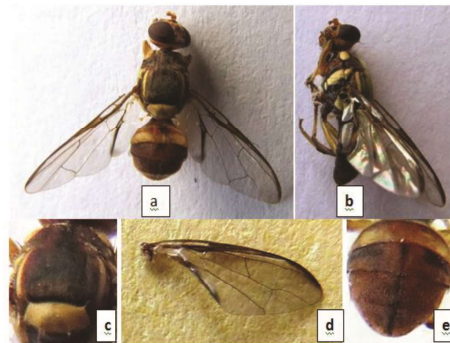


Plate 1: Field identifiable morphological structures in *Bactrocera dorsalis*
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

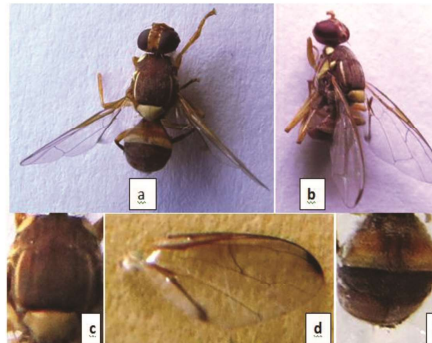


Plate 2: Field identifiable morphological structures in *Bactrocera zonata*

a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

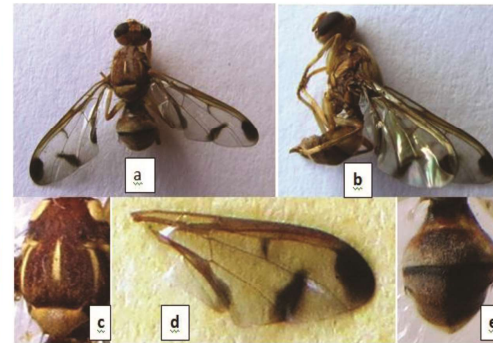


Plate 3: Field identifiable morphological structures in *Bactrocera cucurbitae*

a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

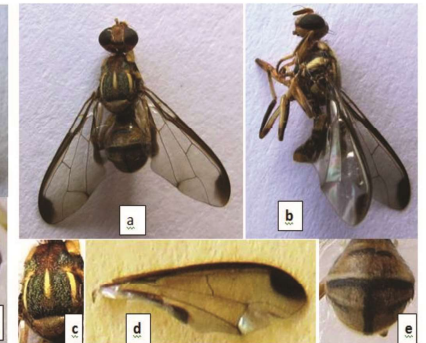


Plate 4: Field identifiable morphological structures in *Bactrocera tau*
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

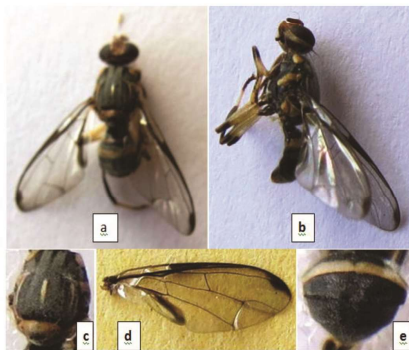


Plate 5: Field identifiable morphological structures in *Bactrocera scutellaris*
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen



Plate 6: Field identifiable morphological structures in *Dacus longicornis*
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

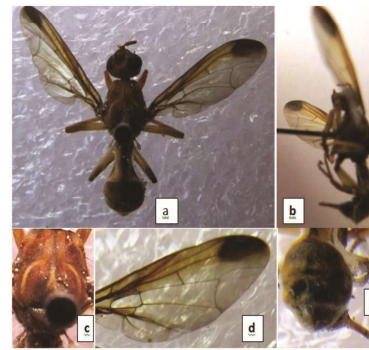


Plate 7: Field identifiable morphological structures in *Bactrocera minax*
a. Holistic view, b. Lateral view, c. Dorsal thorax, d. Wing, e. Dorsal abdomen

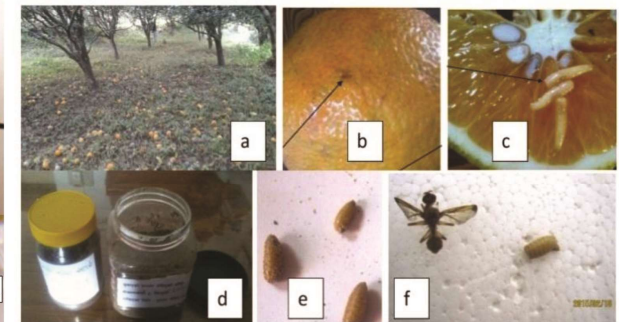


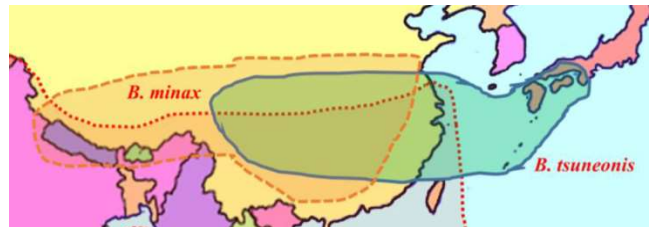
Plate 8: Sweet orange devastation incurred due to *B. minax* infestation in citrus orchard, Sindhuli district.
a. Massive fruit drops b. Oviposited site on the fruit-rind c. Mature maggots inside a cut-opened fruit d. Fruit fly rearing e. Pupae f. Adult emerged from a pupa.

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Government of Nepal, Ministry of Agriculture and Livestock Development, Prime Minister Agriculture Modernization Project
Project Implementation Unit, Junar Superzone, Sindhuli, Phone No. 047-692027, Email: junarsuperzone@gmail.com, Website: sindhulijunar.pmamp.gov.np

The Chinese citrus fly

- *Bactrocera minax* (Enderlein)
(Diptera: Tephritidae)
- This is one of the most destructive insect pests of citrus in the Asian region from southwestern China to Nepal, India (Sikkim, West Bengal) and Bhutan (**Bhandari et al., 2017, Wang et al., 2016 and Drew et al., 2013**).
- Larger sized, oligophagous, univoltine, longer diapause, not attract in para-pheromone.



The Chinese citrus fly

Sweet Orange Losses from Chinese Citrus Fly in Sindhuli

Fruit loss = Economic loss The Problem/Challenge

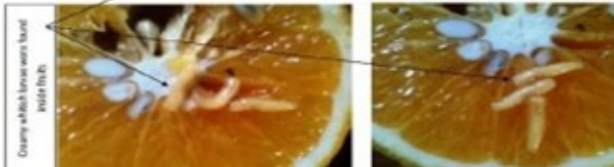


Insect larvae were observed in Junar fruit [Tinkanya VOC, Sindhuli] 2nd Nov., 2014

Damage by Fruit fly in Citrus (Sweet orange) Sindhuli, Nov., 2015
in the orchard of Mr. Puna Mashrangi at Toshramkhola 2 Sindhuli, 9744063209 9801602768



Function (small hole) was observed in the outer part of fruit.



Crumpy which larvae were found inside fruit.

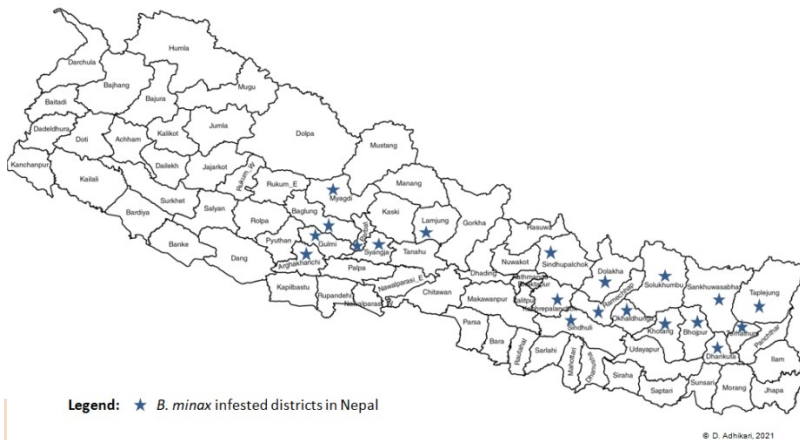


Collection and buring dropped fruits is a good sanitation operation.

The Chinese citrus fly

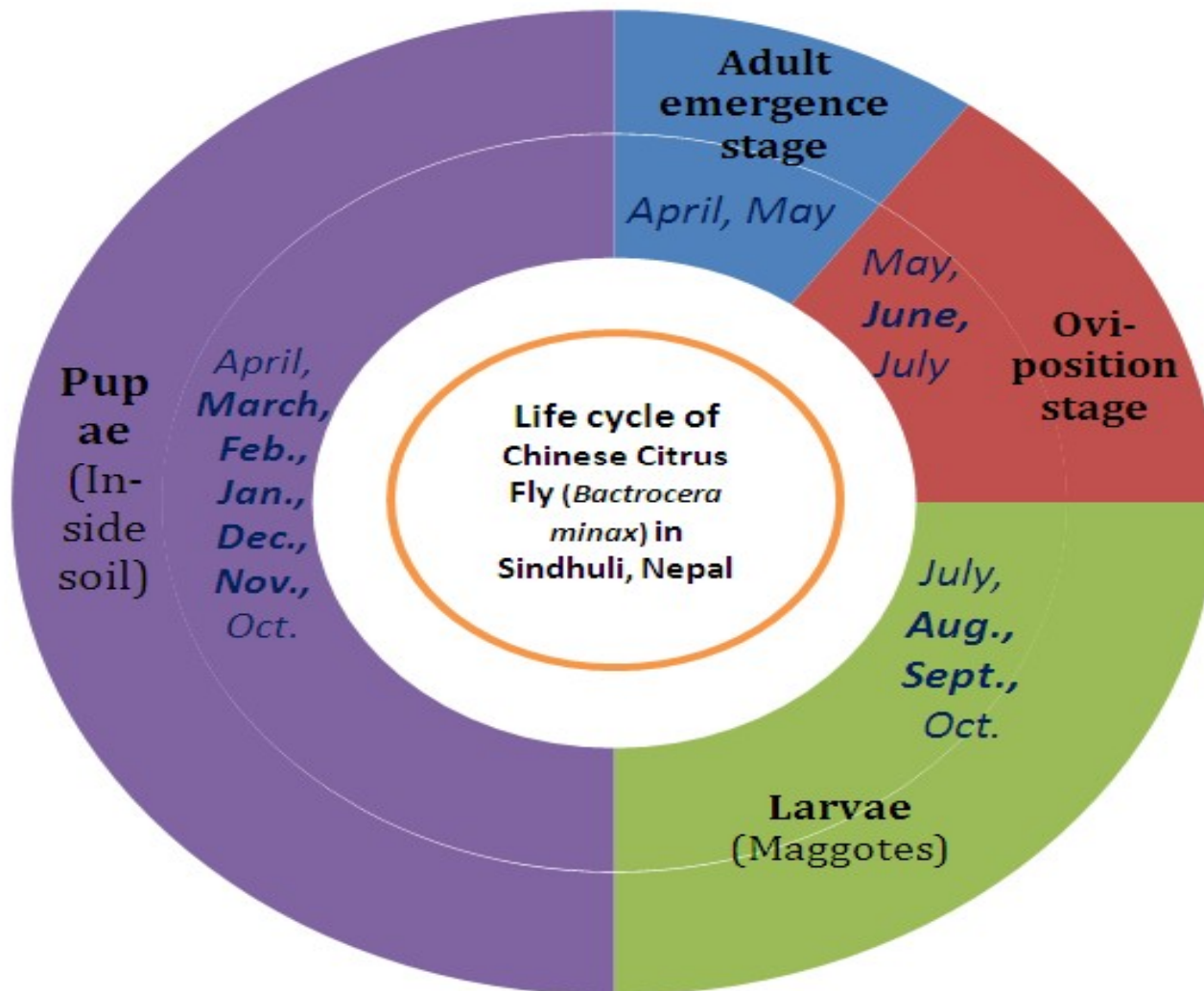
- Presently, it is distributed not only in the citrus orchards located in the eastern to central hilly areas of the country, but also extended to the western citrus growing districts of Nepal.
- The harshness of *B. minax* in the eastern citrus orchards is still persisted (Acharya and Adhikari, 2019) while *B. minax* originated problem is extending to the citrus orchards of central and western Nepal (Joshi, 2019).

Chinese citrus fly (*Bactrocera minax*) invasion extension in Nepal



Maggots' infestation in mandarin

The Chinese citrus fly: Life cycle



The Chinese citrus fly: Life cycle



The Chinese citrus fly: Management

Area Wide Control Program (AWCP) has been initiated to manage the pestilence of *B. minax* in sweet orange orchards in Sindhuli, Nepal. In an aqueous bait spray, protein hydrolysate in the form of GREAT Fruit Fly Bait (protein hydrolysate 25% and 0.1 percent Abamectin) was applied. For ten weeks, fifty (50) ml of aqueous solution containing one part GREAT Fruit Fly Bait and two parts water was sprayed to a 0.5 to 1 m² area under the leaf of a citrus tree @ 7-8 spots/ropani/week. The AWCP includes sanitation to prevent maggots from pupation. (Adhikari, Thapa, Joshi, Liang, & Du, 2020a; Adhikari, Thapa, Joshi, Du, & Acharya, 2020b; Adhikari, Joshi, Thapa, Pandit, & Sharma, 2020c).

The Chinese citrus fly: Management

The AWCP campaign considered stakeholder consultation, clustering of orchards for the spray plan, orientation to spray persons, spray monitoring, and observation and feedback. The AWCP of Chinese citrus fly (*B. minax*) proved efficient in reducing *B. minax* maggot infestation in sweet oranges. Citrus growers in Nepal's Sindhuli district and its surrounding districts have enthusiastically adopted this *B. minax* control technique.

(Adhikari, Thapa, Joshi, Liang, & Du, 2020a; Adhikari, Thapa, Joshi, Du, & Acharya, 2020b; Adhikari, Joshi, Thapa, Pandit, & Sharma, 2020c).

Area Wide Control Program



Figure 2. Protein bait application on lower leaf surface (Left) and sanitation of orchard collecting dropped infested fruits (Right)

Conclusion

- Nepalese fruit fly Dacini fauna comprises of 27 species belonging to 3 genera, namely *Bactrocera*, *Dacus* and *Zeugodacus*.
- The Chinese citrus fly (*Bactrocera minax*) is a devastating pest of the citrus orchards in Nepal.
- Implementation of Area Wide Control Program - integration of protein bait application along with the sanitation of maggots infested fruits in orchards succeeded to reduce fruit loss.



Thank you

