Food and Agriculture Organization of the United Nations

International Plant Protection Convention

中國農業大學 China Agricultural University

# Morphological Identification of Economically Important Fruit Flies

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# Outline

- Basic morphological terminology and identification characteristics of Family Tephritidae
- Morphological identification characteristics of main genera of EIFFs
- Morphological identification characteristics of main species of EIFFs

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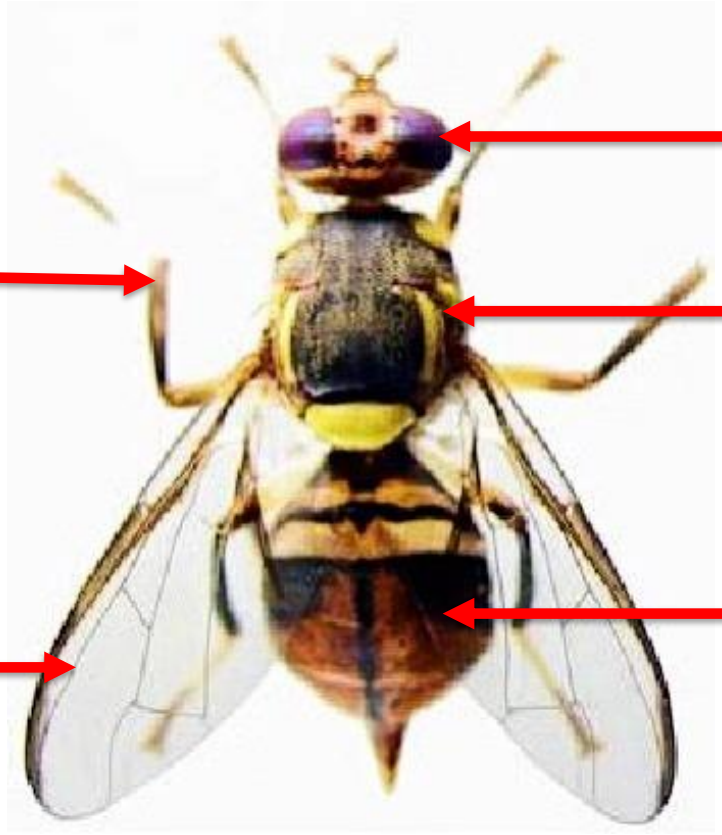
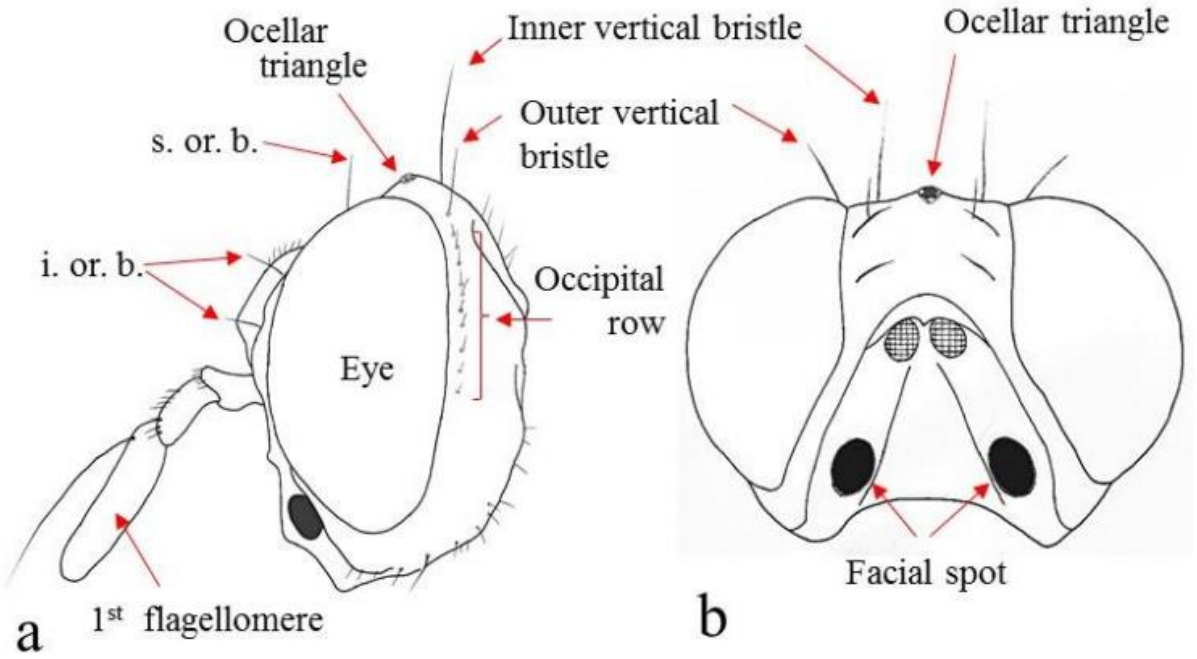
# I. Basic Morphological Terminology and Identification Characteristics of Family Tephritidae


Head
Leg
Thorax
Abdomen
Wing

# Head




- **Compound eye**
- **Ocellar triangle**
- **Vertex**
- **Frons**
- **Face**
- **Antenna**
- **Facial spot**

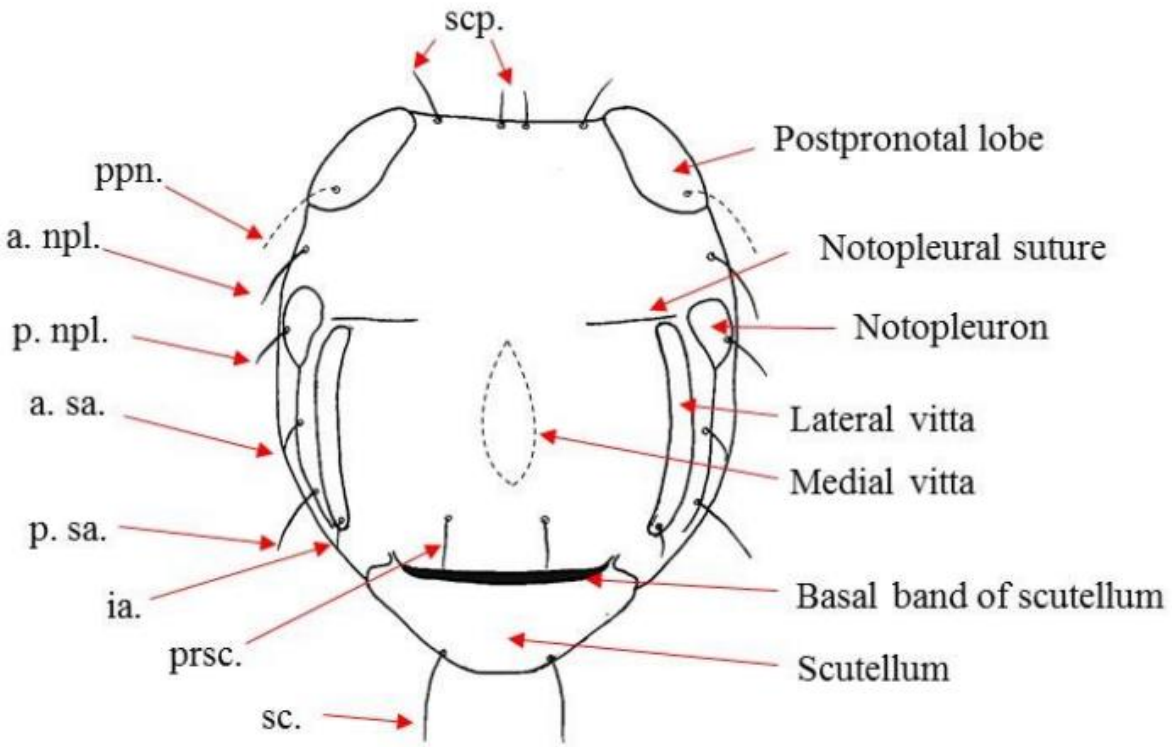
a. **Lateral view of head**
b. **Frontal view of head**

(DP 29 of ISPM 27, 2019)


- **Frons?**
- **Face?**
- **Antenna?**
- **Facial spot?**

(DP 29 of ISPM 27, 2019)

# Thorax




- **Dorsum of mesothorax**
- **Postpronotal lobe**
- **Lateral vittae**
- **Medial vitta**
- **Scutellum**

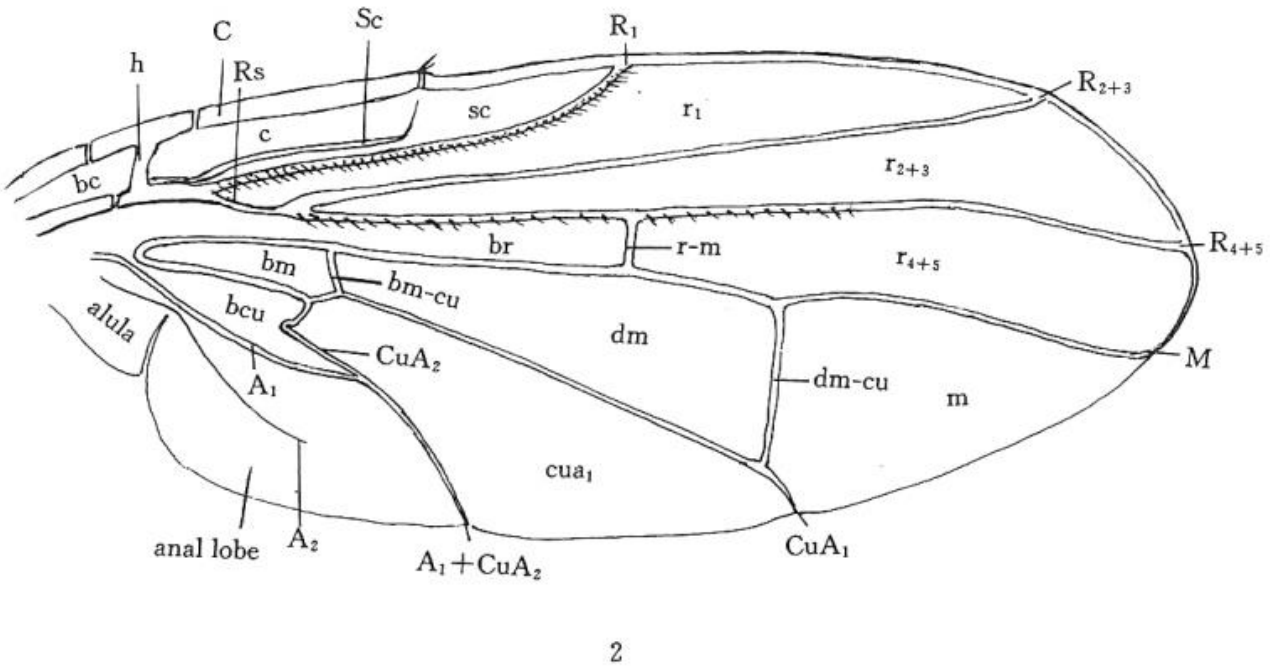
**Dorsal view of thorax**

(DP 29 of ISPM 27, 2019)

- **Postpronotal lobe?**
- **Lateral vittae?**
- **Medial vitta?**
- **Scutellum?**

(DP 29 of ISPM 27, 2019)

# Wing




2

- **Wing venation**
- **Longitudinal veins**
- **Sc**
- **Cross veins**
- **Cells**
- **bm**
- **bcu**

**$A_1$**, 1st of anal vein; **$A_1$+$CuA_2$**, 2nd branch of anterior cubital vein and 1st of anal vein; **alula**, axillary lobe; **bc**, basal costal cell; **bcu**, basal cubital cell; **bm**, basal 4th medial cell; **bm-cu**, basal medial-cubital vein; **br**, basal 5th radial cell; **C**, costa; **c**, distal costal cell; **$CuA_1$**, 1st branch anterior branches of cubital vein; **$CuA_2$**, 2nd branch anterior branches of cubital vein; **dm**, discal medial cell; **dm-cu**, discal-medial-cubital crossvein; **h**, humeral cross-vein; **M**, medial vein; **m**, medial cell; **r-m**, radial-medial cross-vein; **$R_s$**, radial sector; **$R_1$**, anterior branch of radial vein; **$R_{2+3}$ and $R_{4+5}$**, sectoral posterior branches of radial vein; **$r_{2+3}$ and $r_{4+5}$**, sectoral radial cell; **Sc**, sub costal vein; **sc**, subcostal cell;

(Wang, 1996)


- **Sc?**
- **bm?**
- **bcu?**

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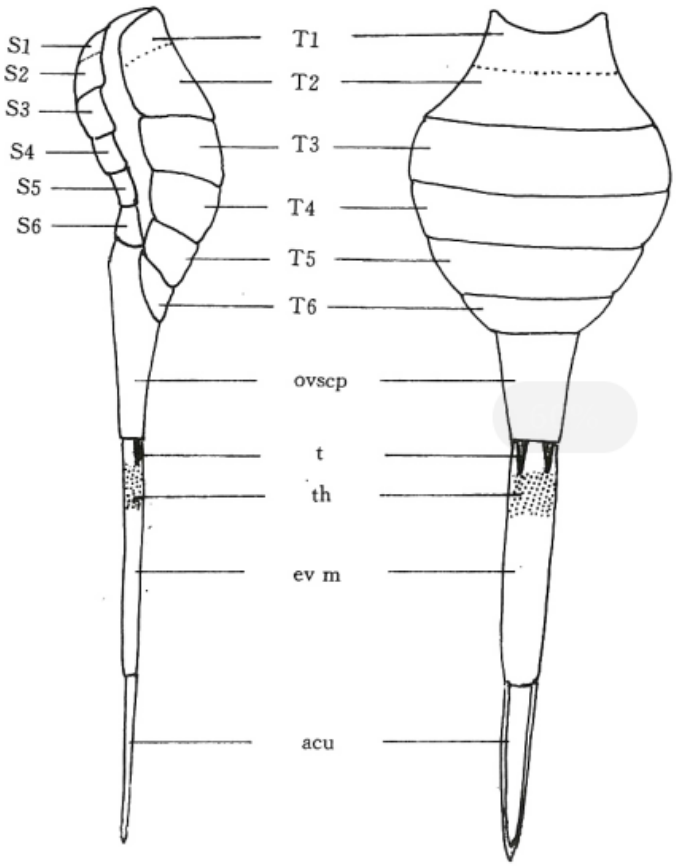
# Abdomen

Ovipositor

Female

Male

# Abdomen (Female)



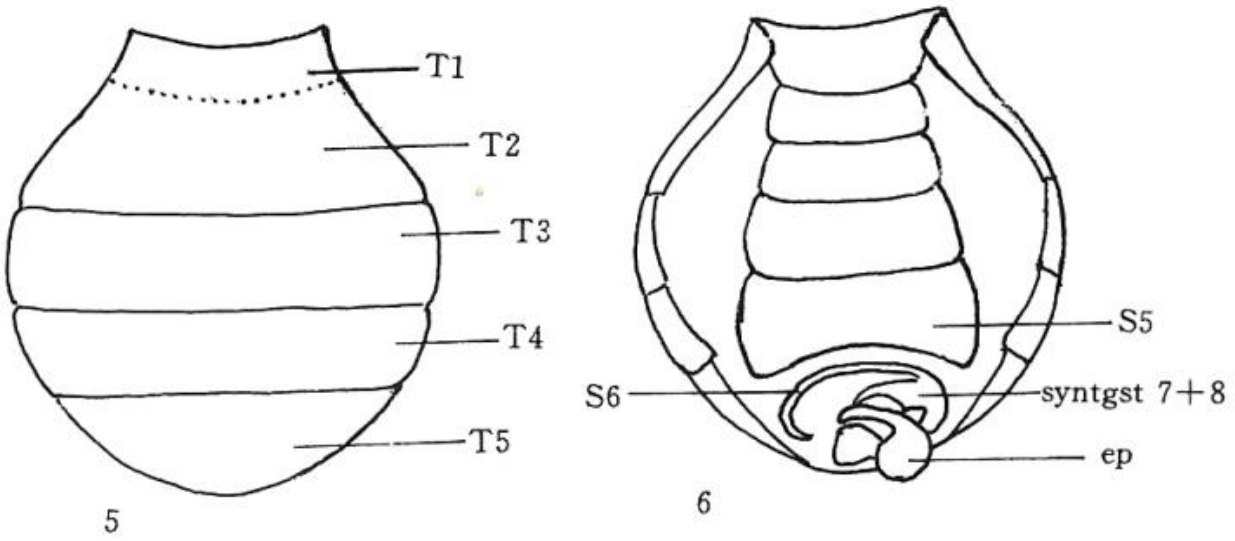

- abdominal tergite 1-6 (lateral view)
- abdominal segment 1-6 (dorsal view)
- segment 7-9 as ovipositor
- acu, aculeus (T9)
- ev m, eversible membrane (T8)
- ovscp, oviscap (ovipositor sheath, basal segment of ovipositor, T7)

abdominal tergite 1-6 (lateral view)

abdominal segment 1-6 (dorsal view)

(Wang, 1996)

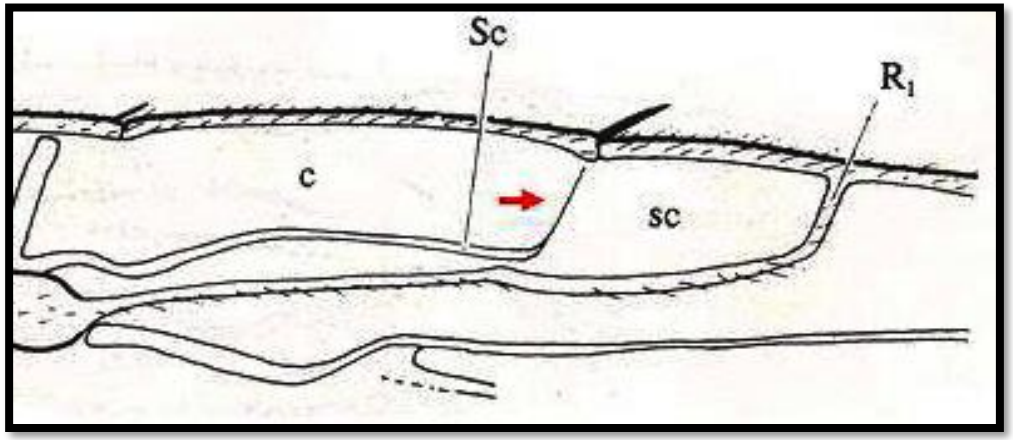
# Abodomen (Male)




- **abdominal tergite 1-5 (dorsal view)**
- **abdominal segment 1-5 (ventral view)**
- **segment 6-9 male genitalia**
- **T1-T6, tergites of abdominal segments 1-6**
- **S1-S6, sternites of abdominal segment 1-6**
- **syntgst 7+8, syntergosternite 7+8**

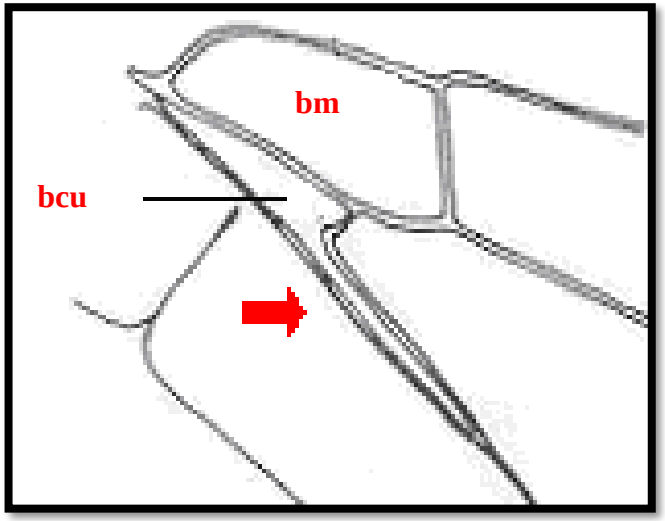
(Wang, 1996)

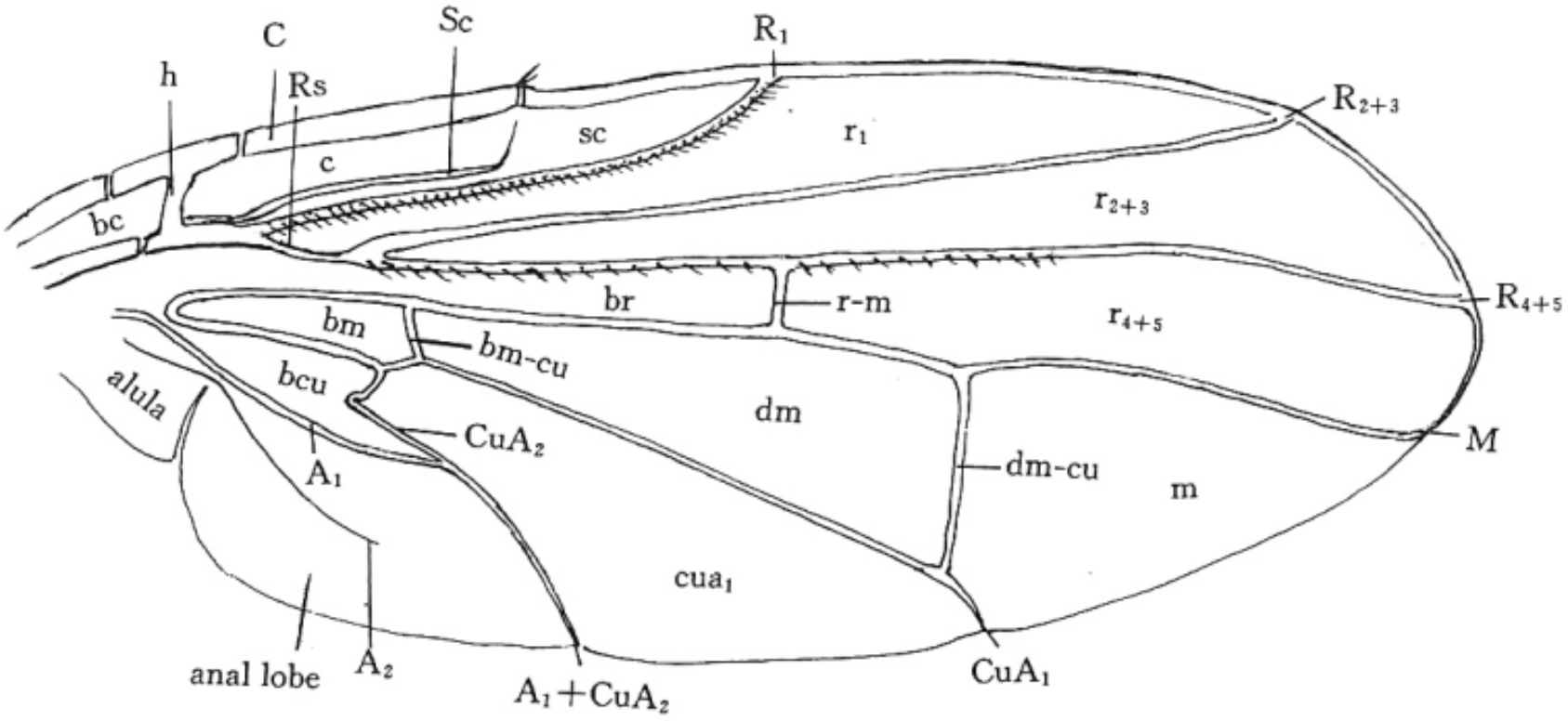
# Identification characteristics of Tephritidae




sub costal vein (Sc) bent almost 90 degrees and then reduced to a fold

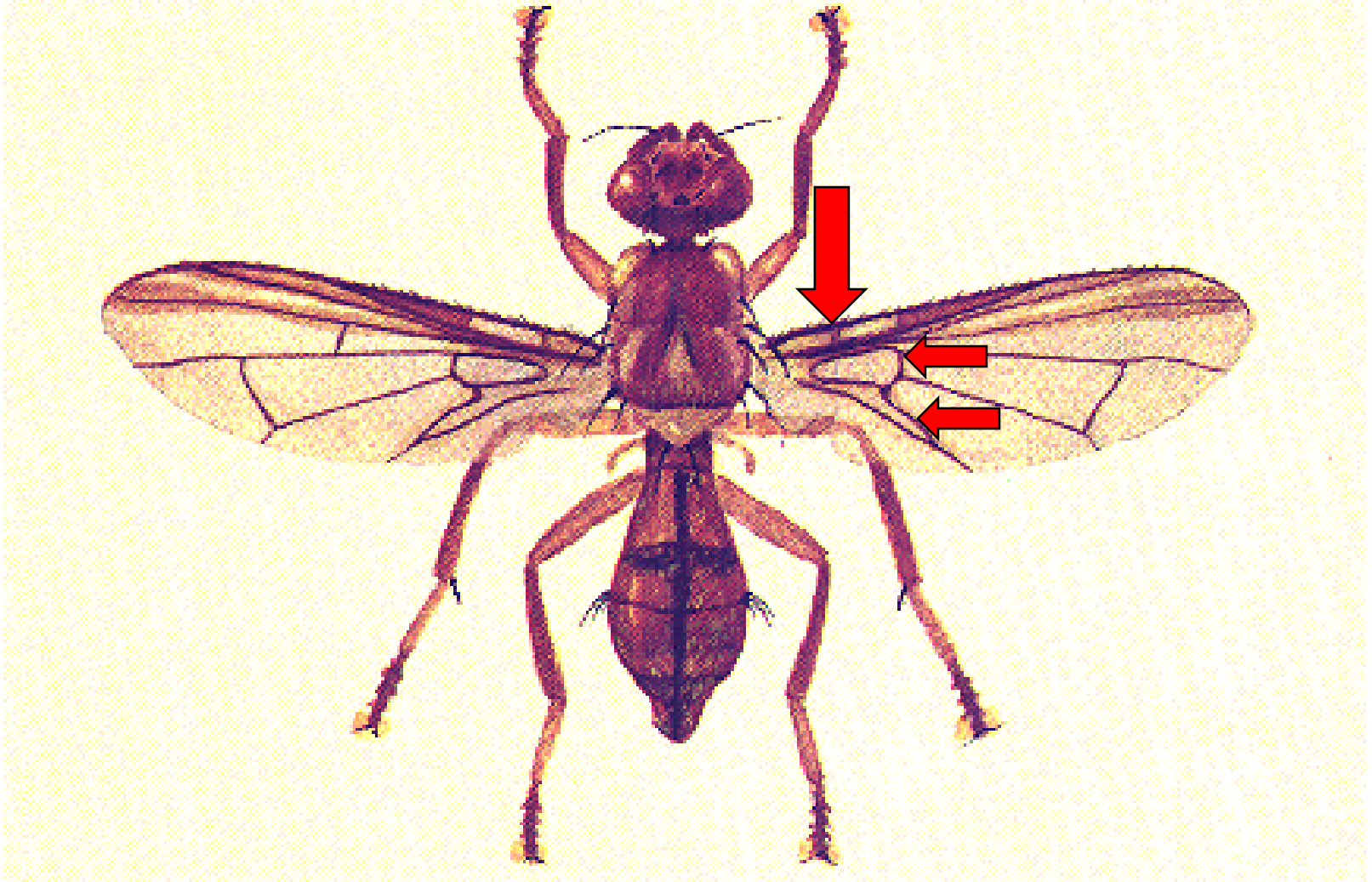
with basal 4th medial cell (bm), basal cubital cell (bcu) with an acute extension




C
Sc
R1
h
Rs
R2+3
sc
r1
c
bc
r2+3
br
r-m
R4+5
bm
r4+5
bm-cu
bcu
alula
dm
M
CuA2
dm-cu
A1
m
cua1
anal lobe
A2
A1+CuA2
CuA1

(Wang, 1996)

# *Is it Tephritidae?*



(Wang, 1993)

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# II. Morphological Identification Characteristics of Main Genera of EIFFs

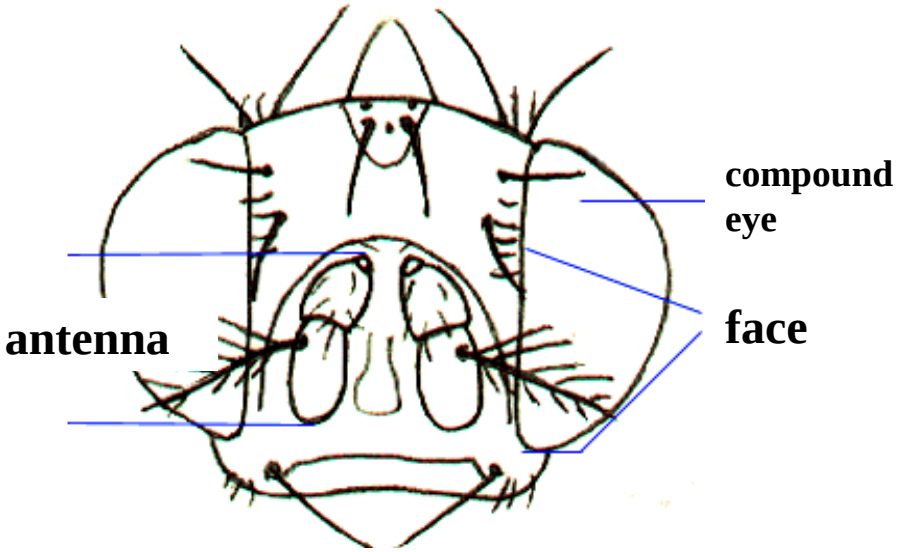
# Main Genera of EIFFs

- ***Anastrepha:*** *A. ludens* etc.
- ***Bactrocera:*** *B. dorsalis* etc.
- ***Ceratitis:*** *C. capitata* etc.
- ***Dacus:*** *D. ciliates* etc.
- ***Rhagoletis:*** *R. pomonella*

  etc.
- ***Zeugodacus:*** *Z. tau* etc.

# Main morphological characteristics in *Anastrepha*

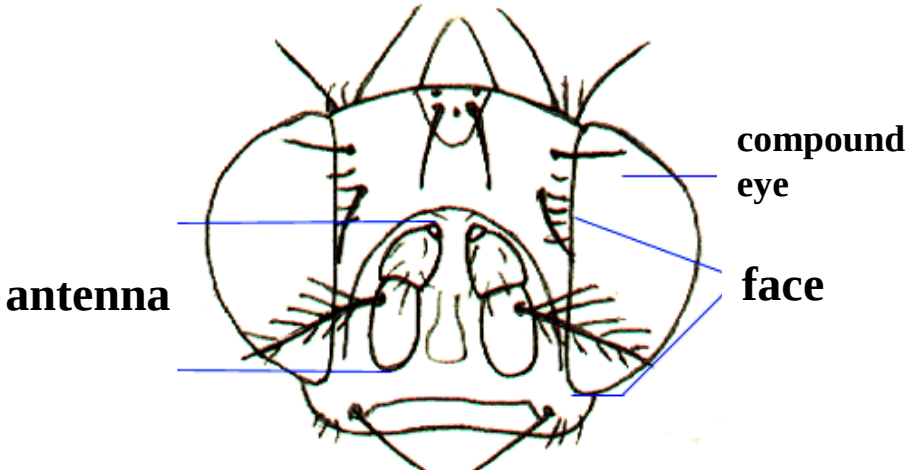
- antenna shorter than face
- with S-band and reverse V-band

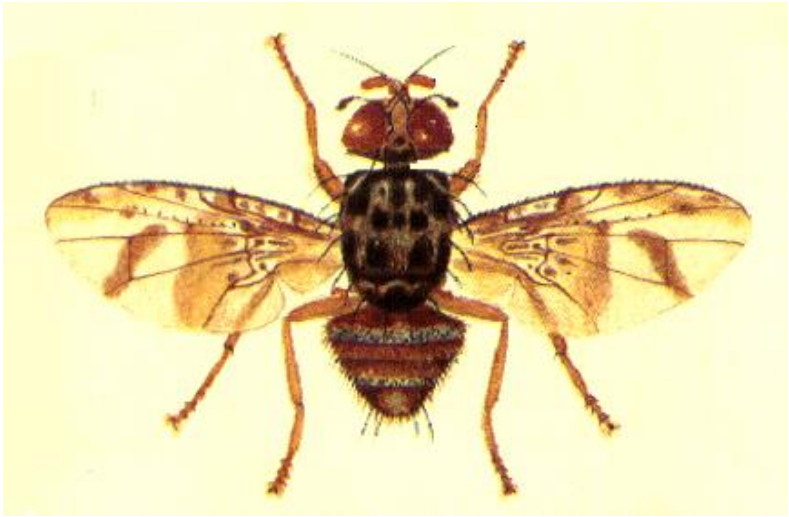



(Wang, 1993)

# Main morphological characteristics in *Ceratitis*

- antenna shorter than face
- scutellum convex and shiny

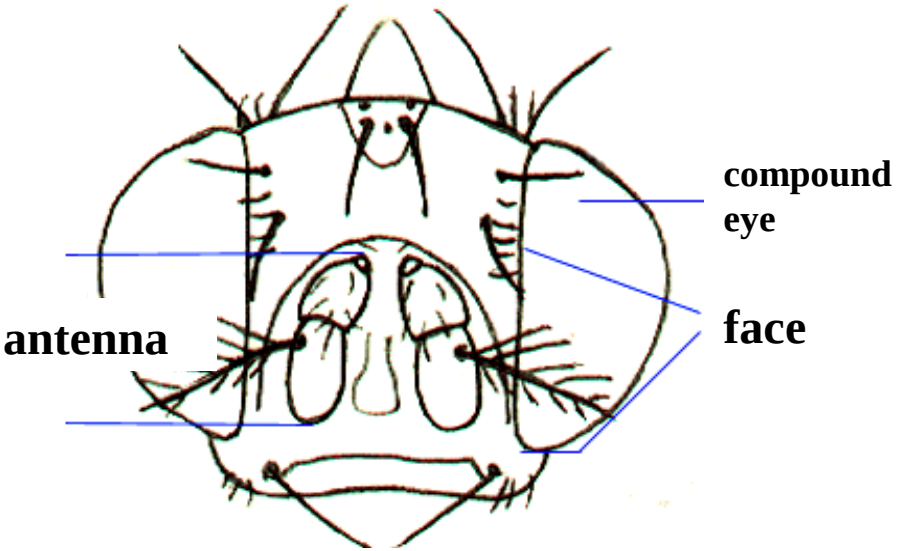


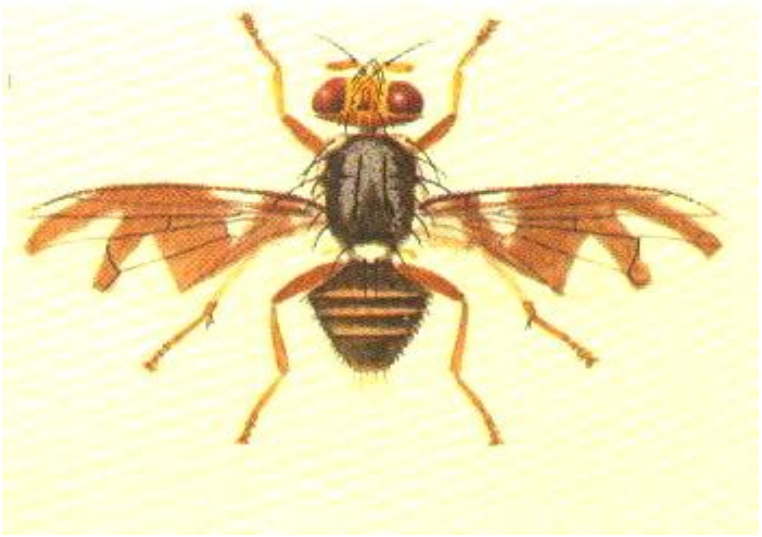



(Wang, 1993)

# Main morphological characteristics in *Rhagoletis*

- antenna shorter than face
- scutellum fairly flat and not shiny

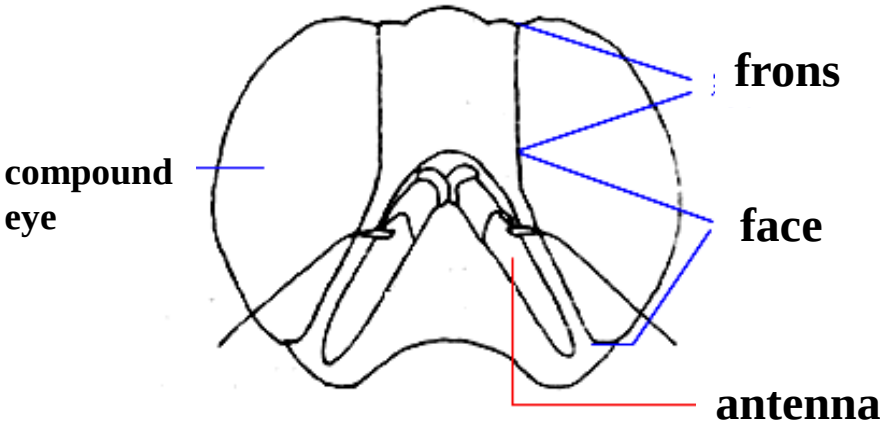


(Wang, 1993)

# Main morphological characteristics in *Dacus*

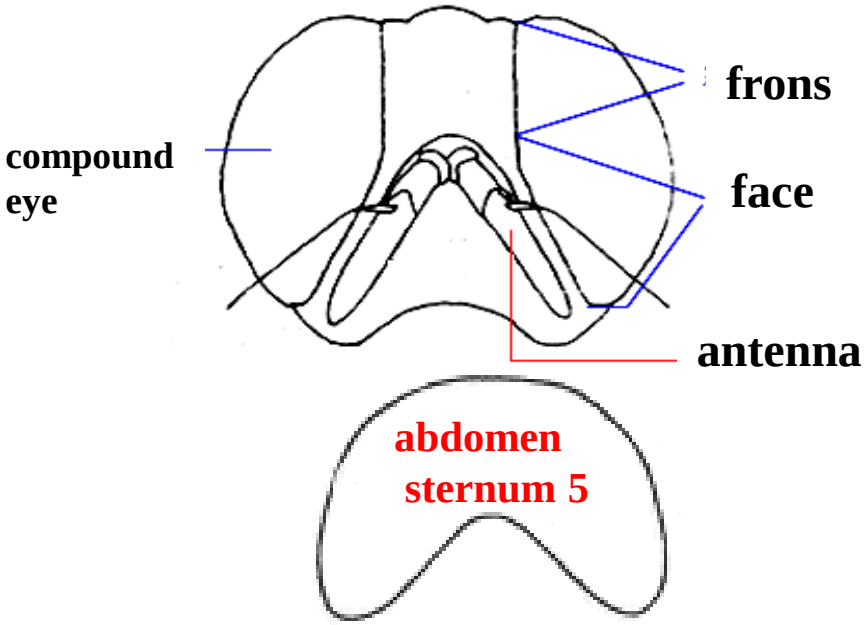
- antenna longer than face
- abdomen with all tergites fused into a single plate




(https://www.forestryimages.org/)

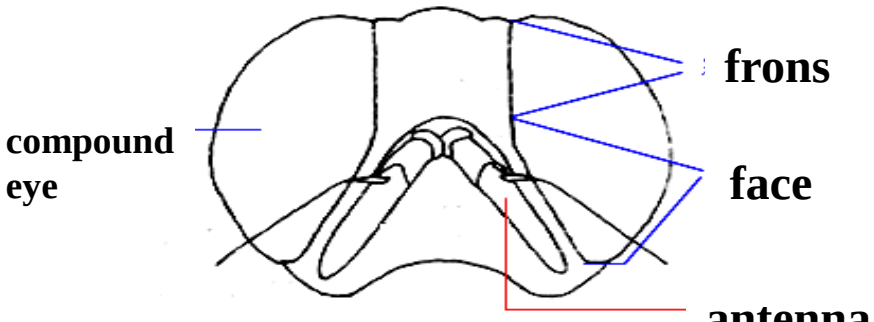
# Main morphological characteristics in *Bactrocera*

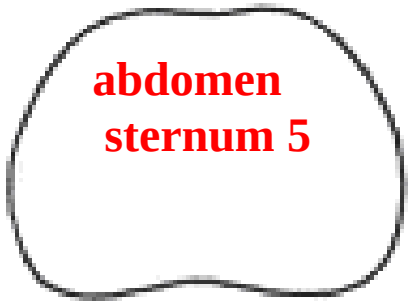
- antenna longer than face
- abdomen with all tergites separate
- abdomen sternum 5 of male with a deep concavity on posterior margin




# Main morphological characteristics in *Zeugodacus*

- antenna longer than face
- abdomen with all tergites separate
- abdomen sternum 5 of male with a slight concavity on posterior margin




(Wu, 2009)

# Diagnostic key to 6 genera of EIFFs?

1. antenna shorter than face..... 2
– antenna longer than face..... 4
2. wing pattern with S-band and V-band..... *Anastrepha*
– wing pattern without S-band and V-band..... 3
3. scutellum convex and shiny..... *Ceratitis*
– scutellum fairly flat and not shiny..... *Rhagoletis*
4. abdomen with all tergites fused into a single plate..... *Dacus*
– abdomen with all tergites separate..... 5
5. abdomen sternum 5 of male with a deep concavity on posterior margin
..... *Bactrocera*
– abdomen sternum 5 of male with a slight concavity on posterior margin
..... *Zeugodacus*

# Can you identify these genera of Tephritidae?

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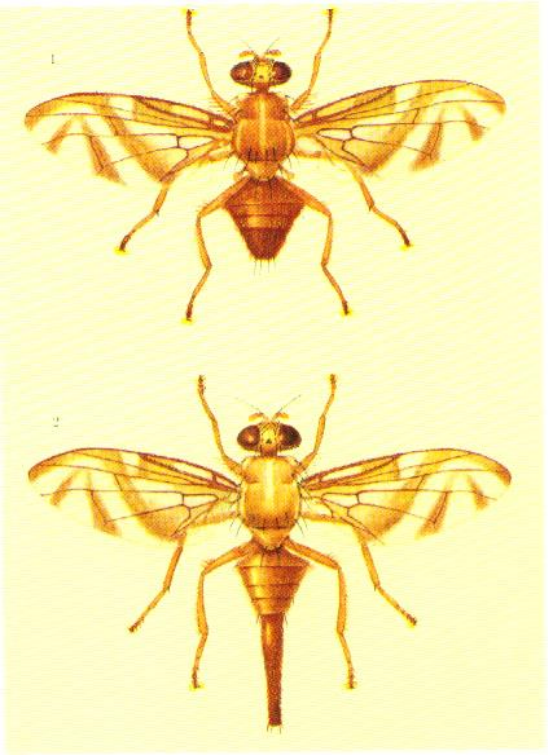
# III. Morphological Identification Characteristics of Main Species of EIFFs

# *Morphological identification of 2 similar species of Anastrepha*

# *Anastrepha ludens* (Loew) Mexican fruit fly

- The body is predominantly yellow to orange-brown and the setae are red-brown to dark-brown.
- Wing: reverse V-band not connected to S-band
- Abdomen: tergites yellow to orange-brown, without dark-brown markings. Oviscape straight, 3.4-6.3 mm long.

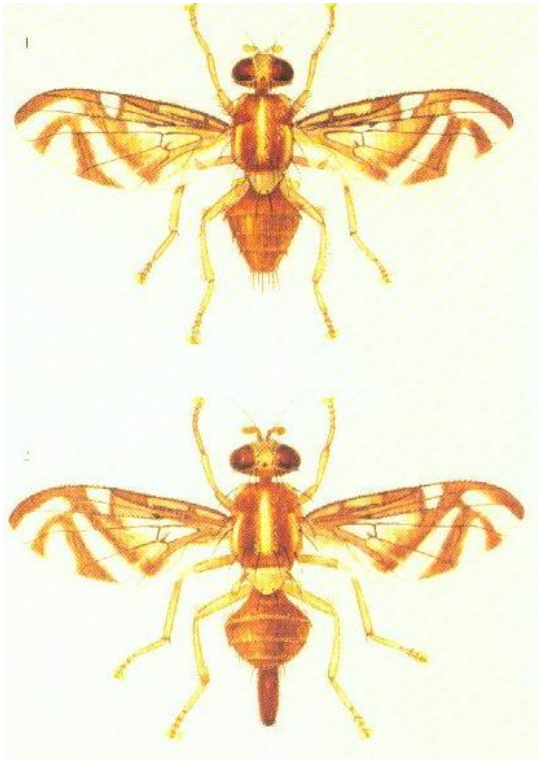


(Wang, 1993; Wu, 2009)


(CAUPQL, 2015)

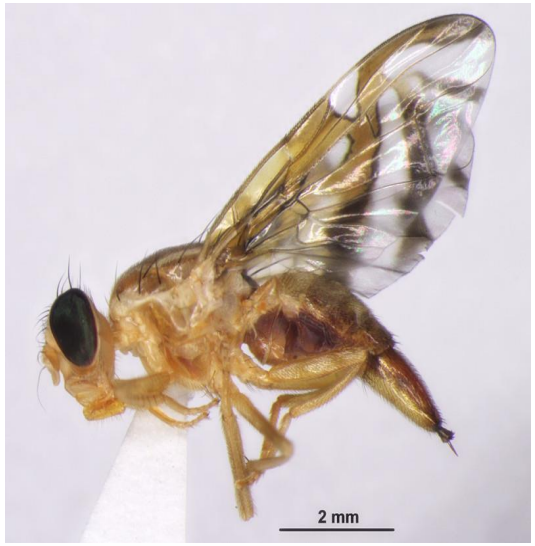
# *Anastrepha obliqua* (Macquart)
# West Indian fruit fly

- The body is predominantly yellow to orange-brown, and the setae are red-brown to dark-brown.
- Wing: V-band connected to S-band.
- Abdomen: tergites yellow to orange-brown, without dark-brown markings. Oviscape straight, 1.6-1.9 mm long.



(Wang, 1993)

(Wu, 2009)




(CAUPQL, 2015)

# *Can you identification the 2 similar species of Anastrepha?*



(CAUPQL, 2015)

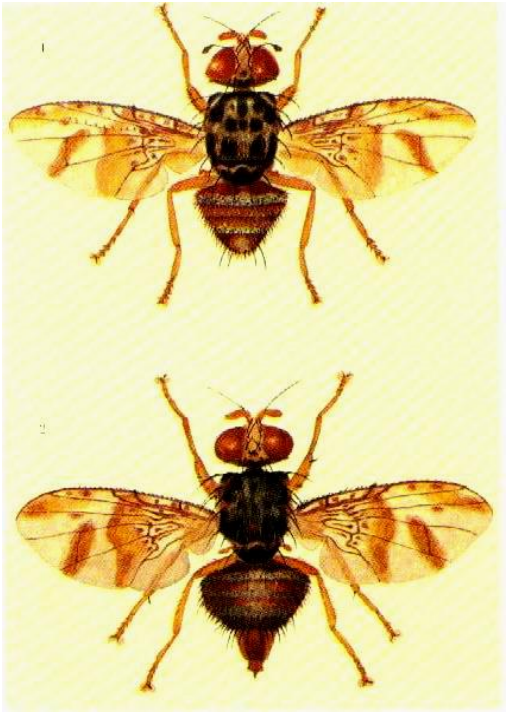
# *Morphological identification of 3 similar species of Ceratitis*

# *Ceratitis capitata* (Wiedemann)

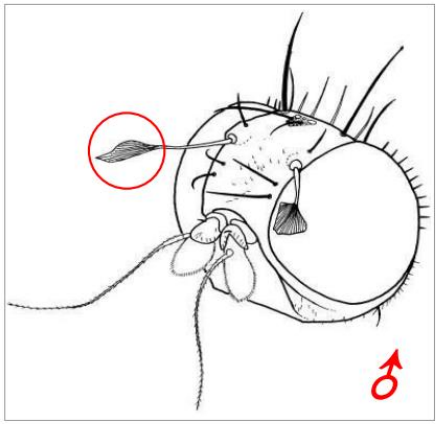
## Mediterranean fruit fly

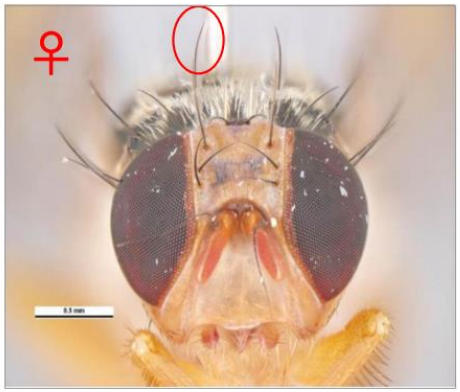
- Scutum : Postpronotum white, with distinct black spot. Mesonotal pattern: ground colour black, microtrichiae pattern silvery with ashgrey shine, spots black except sutural white spots.
- Scutellum: The apical of the scutellum being entirely black.
- Head: the males have a characteristically shaped pair of lower orbital setae, the apex black and diamond-shaped.


(CAUPQL, 2015)



(Wang, 1993)





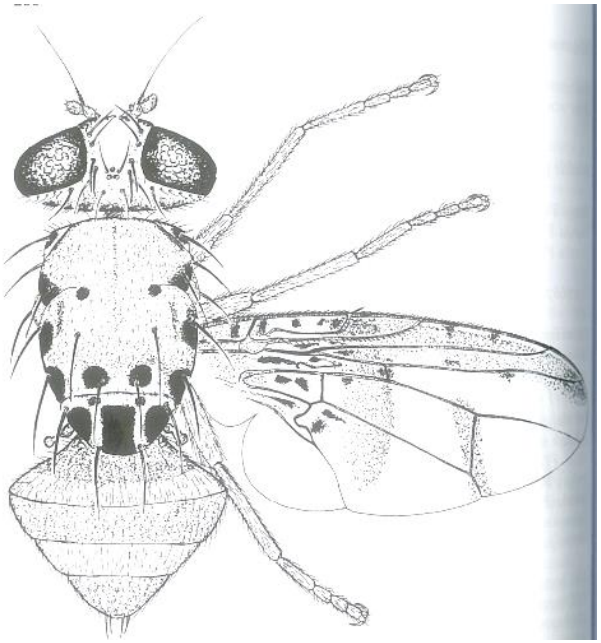
(White and Elson-Harris, 1992)

## *Ceratitis cosyra* (Walker)

## Marula fly

- Scutum: predominantly yellow with small separate black sopts
- Scutellum: with 3 large and separate apical dark marks
- Wing： with yellow crossbands, costal band and discal crossbands separate, and costal band continuous.


(CAUPQL, 2015)



(White and Elson-Harris, 1992)

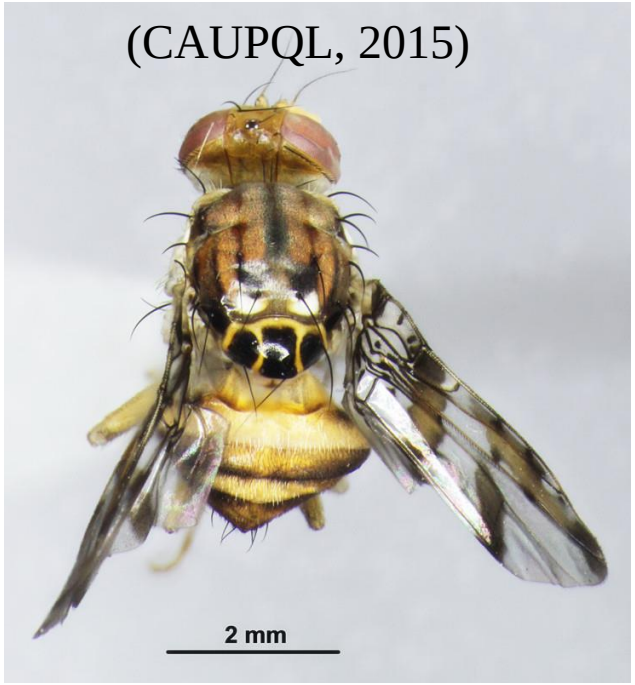

(CAUPQL, 2015)

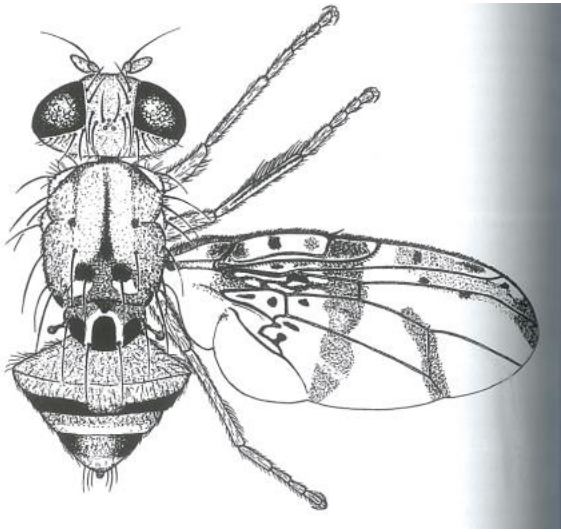
# *Ceratitis rosa* Karsch

## Natal fruit fly

- Scutum: ground colour greyish-brown with orange tinge, with 2 pairs of separate black spots.
- Scutellum yellowish-white, apically with 3 separate black spots
- Wing: interruption between costal band and discal band near vein R1 clear and complete
- Leg: male midleg tibia moderately broadened with black feathering dorsally.

(CAUPQL, 2015)

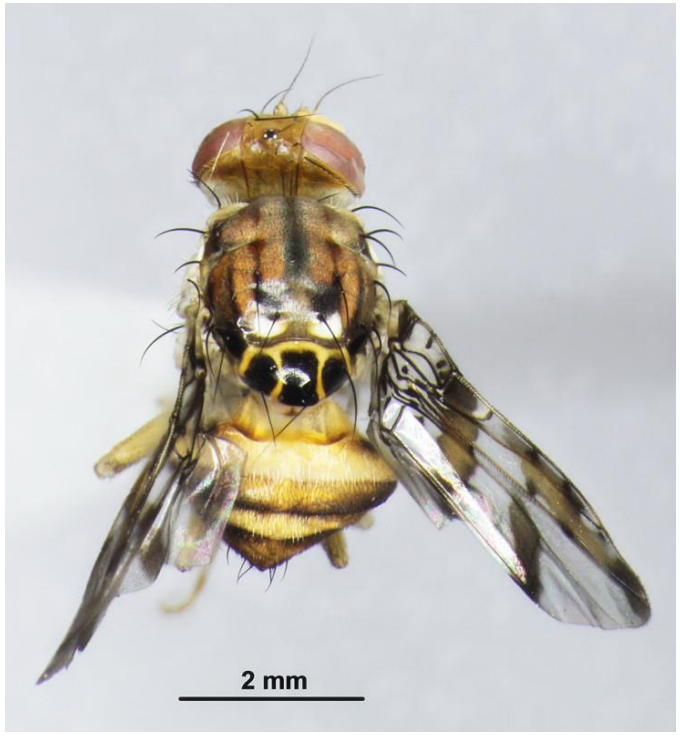


(White and Elson-Harris, 1992)


# *Can you identification the 3 similar species of Ceratitis?*




(CAUPQL, 2015)

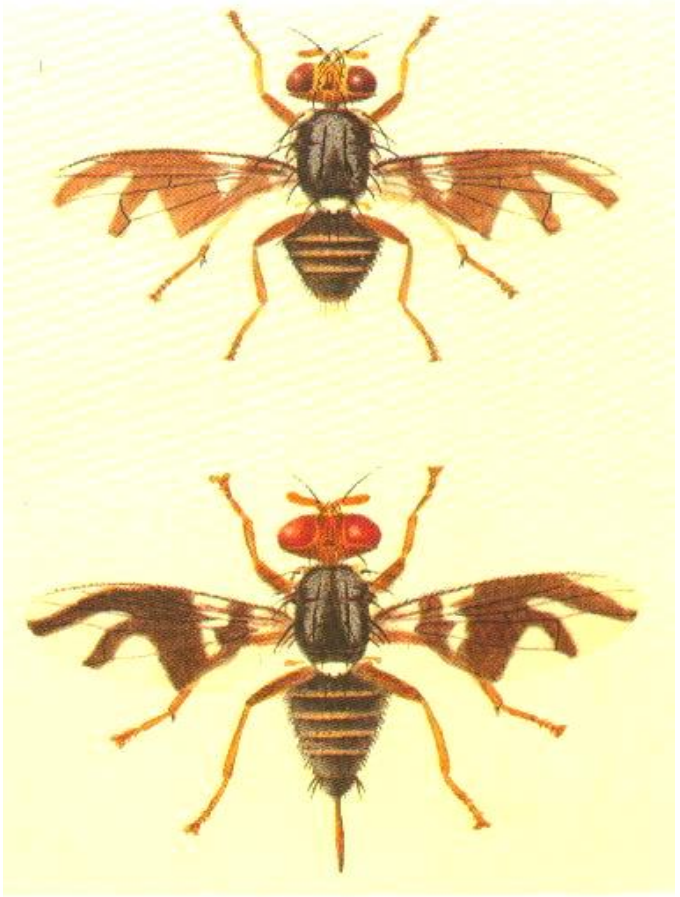
# *Morphological identification of 2 similar species of Rhagoletis*

# *Rhagoletis pomonella* (Walsh)

## Apple maggot fly

- The body is generally black with a yellowish head and legs
- Wing: four irregular or zig-zag black bands on the wings with the three distal bands forming an F-shape.
- Abdomen: male has 3 white bands on the abdomen and the female has 4 similar white bands.


(Wu, 2009)



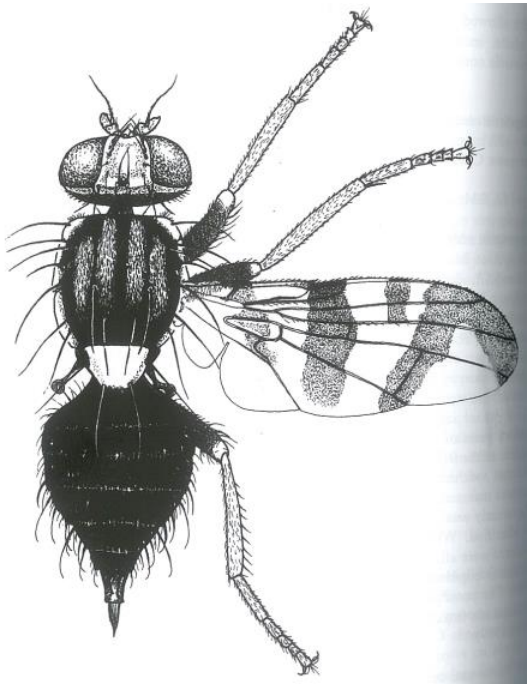
(Wang, 1993)

# *Rhagoletis cerasi* (Linnaeus)

## European cherry fruit fly

- The body predominantly black
- Wing: with characteristic wing markings
- Scutellum: lacks a black basal mark.

(https://www.gbif.org/)



(White and Elson-Harris, 1992)

# *Can you identification the 2 similar species of Rhagoletis?*

# *Morphological identification of 2 similar species of Zeugodacus*

# *Zeugodacus cucurbitae* (Coquillett)

## Melon fruit fly

- Body predominantly orangish to brown.
- Scutum predominantly reddish brown, with 3 postsutural yellow vittae, the median one small and short.
- Wing has a broad brown band over crossvein dm-cu and usually a narrow, short brown mark just on r-m. Costal band confluent with vein $R_{4+5}$ and greatly expanded into a large spot at apex.

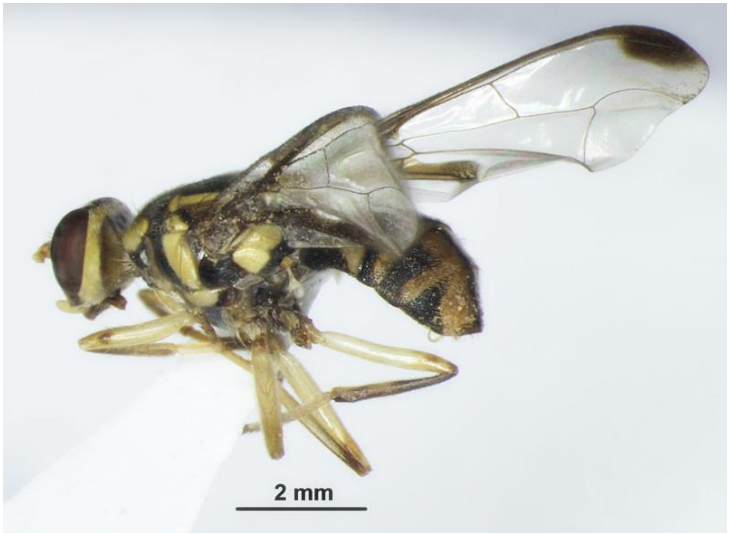


(CAUPQL, 2015)

## *Zeugodacus tau* (Walker)

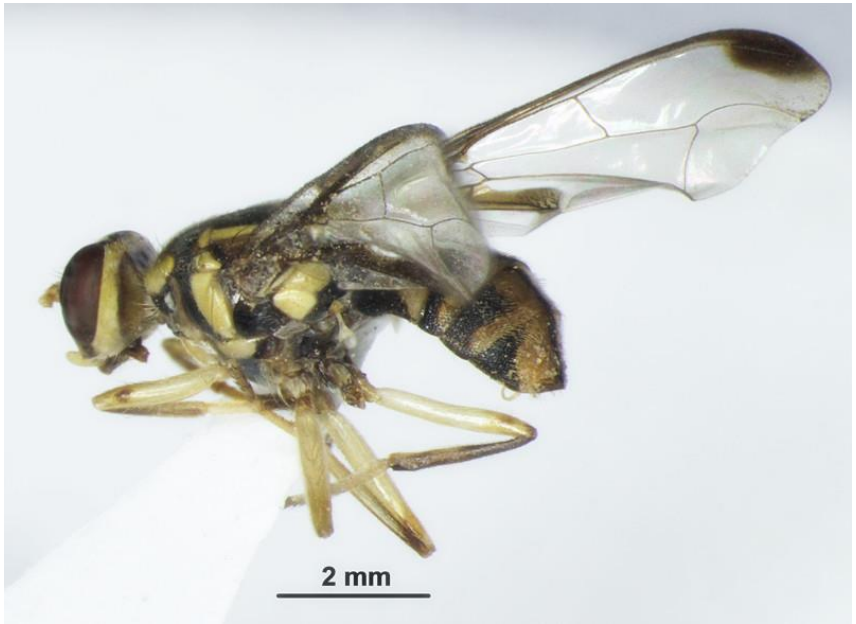
## Pumpkin fruit fly

- Body a balanced mixture of black and yellow.
- Scutum yellowish brown in ground color, with large black patch. 3 postsutural yellow vittae and the median one big and long.
- Wing: the costal band distinctly expanded into a large brown apical spot at apex, occuping about upper 1/2 of cell $r_{4+5.}$ No band over crossvein dm-cu.


(CAUPQL, 2015)

# *Can you identification the 2 similar species of Zeugodacus?*


(CAUPQL, 2015)

# *Morphological identification of 1 species of Dacus*

## *Dacus ciliatus* Loew

## Ethiopian fruit fly

- Predominantly orange
- Scutum lack of yellow vittae
- Scutellum： the yellow spot in each haltere base being small and separated from the scutellum
- Wing with a costal band that is expanded apically to form an apical spot

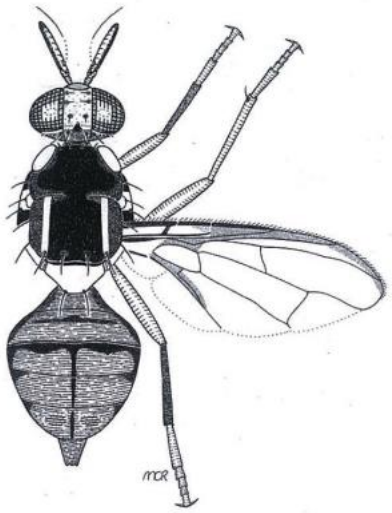
(https://www.forestryimages.org/)

# *Morphological identification of 8 similar species of Bactrocera*

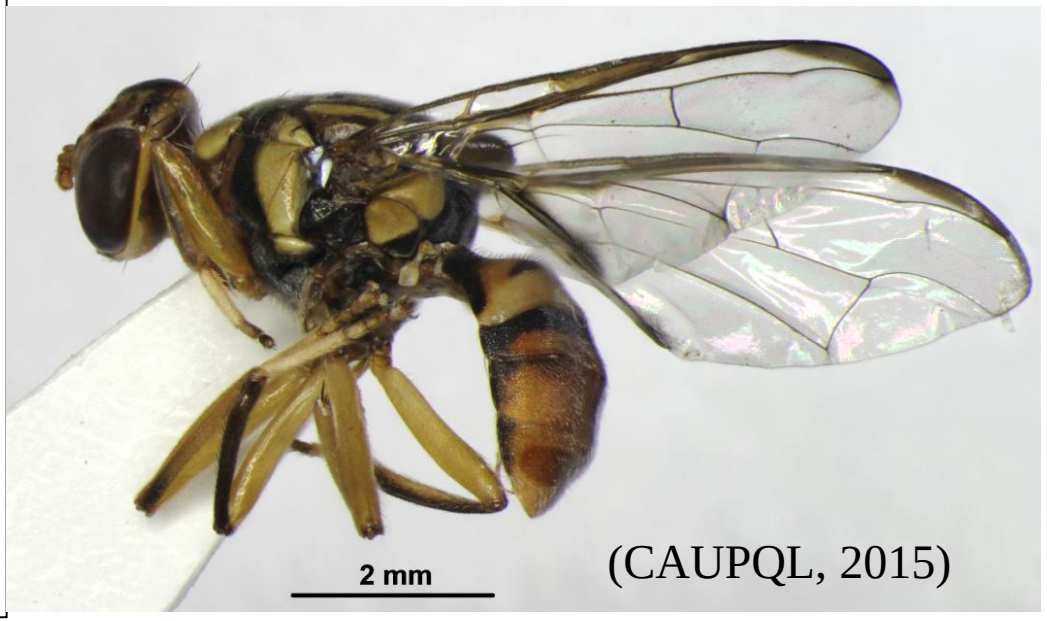
# *Bactrocera dorsalis* (Hendel)

## Oriental fruit fly

- Head: round or oval facila spots.
- Scutum entirely black except for 2 lateral postsutural yellow vittae.
- Wing with a rather narrow costal band extending to apex overlap of $R_{4+5}$
- Abdomen yellow to yellowish brown. "T" band, tergite 3 with a transverse black band across anterior margin, a median longitudinal black stripe extending over tergites 3-5.

(Drew, 2016)

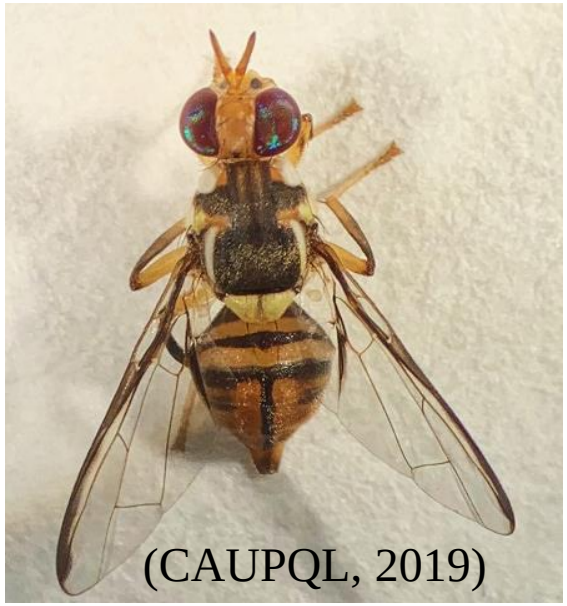



(CAUPQL, 2015)

# *Bactrocera carambolae* Drew & Hancock

## carambola fruit fly

- Head: round or oval facila spots.
- Scutum entirely black except for 2 lateral postsutural yellow vittae.
- Wing: costal band narrow, slightly overlapping R2+3, moderately broad around apex and overlap $R_{4+5}$
- Abdomen terga 3-4 with a moderately broad medical longitudal dark band



(CAUPQL, 2019)


(DP 29 of ISPM 27, 2019)

# *Bactrocera tryoni* (Froggatt)
# Queensland fruit fly

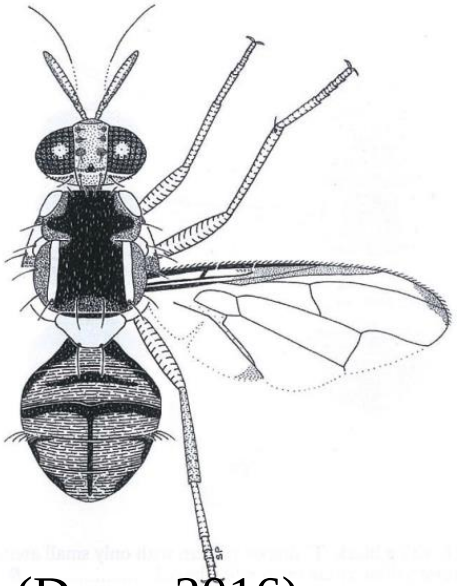
- Head: round or oval facila spots.
- Thorax color: Predominant colour of scutum red-brown.
- Scutum with lateral postsutural vittae (yellow/orange stripes), which do not extend anterior to suture, are tapered, and reach to the posterior supra-alar seta.
- Wing: with a complete costal band which may extend below $R_{2+3}$, but not to $R_{4+5}$; not expanded into a spot at apex.

# *Bactrocera correcta* (Bezzi)

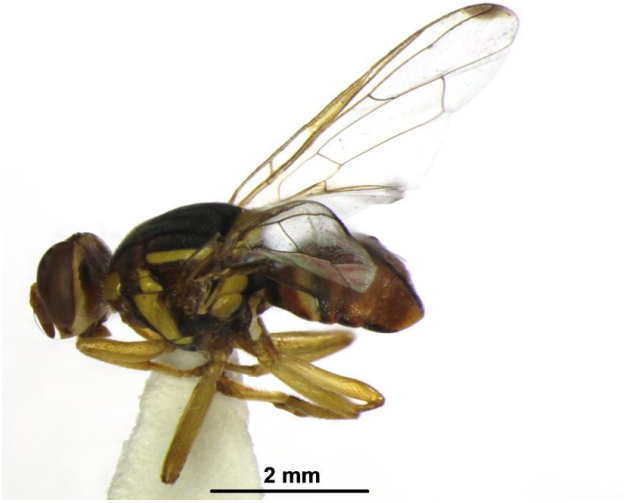
## Guava fruit fly

- Head: Face with a narrow transverse black band
- Wing: a small brown spot at lower apex of cell $r_{2+3}$ and upper apex of cell $r_{4+5}$
- Scutum entirely black except for 2 lateral postsutural yellow vittae.
- Abdomen have patterned "T"

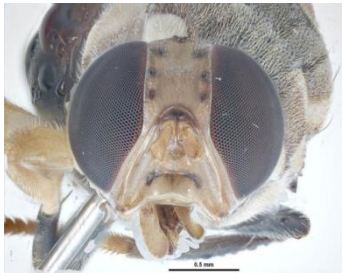
(Wu, 2009)



(Drew, 2016)



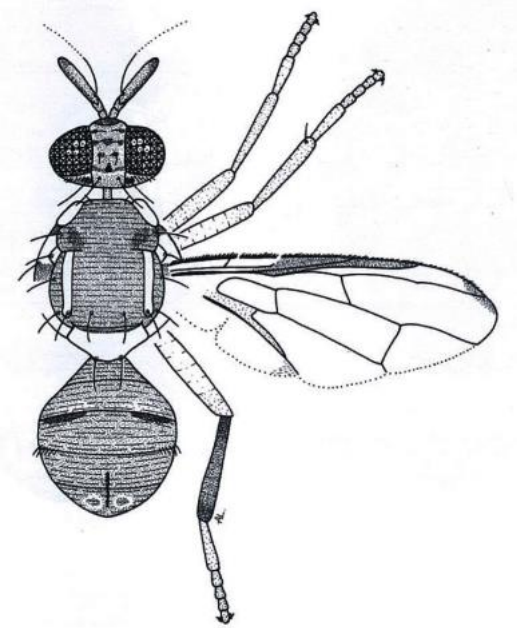

(CAUPQL, 2015)



# *Bactrocera zonata* (Saunders)

# peach fruit fly

- Body in brown to reddish brown
- Head: round or oval facila spots (a dark spot in each antennal groove rather than a broken transverse line)
- Scutum: a red brown scutum (rather than almost black)
- Wing: lack a complete costal band (that is reduced to an apical wing spot)

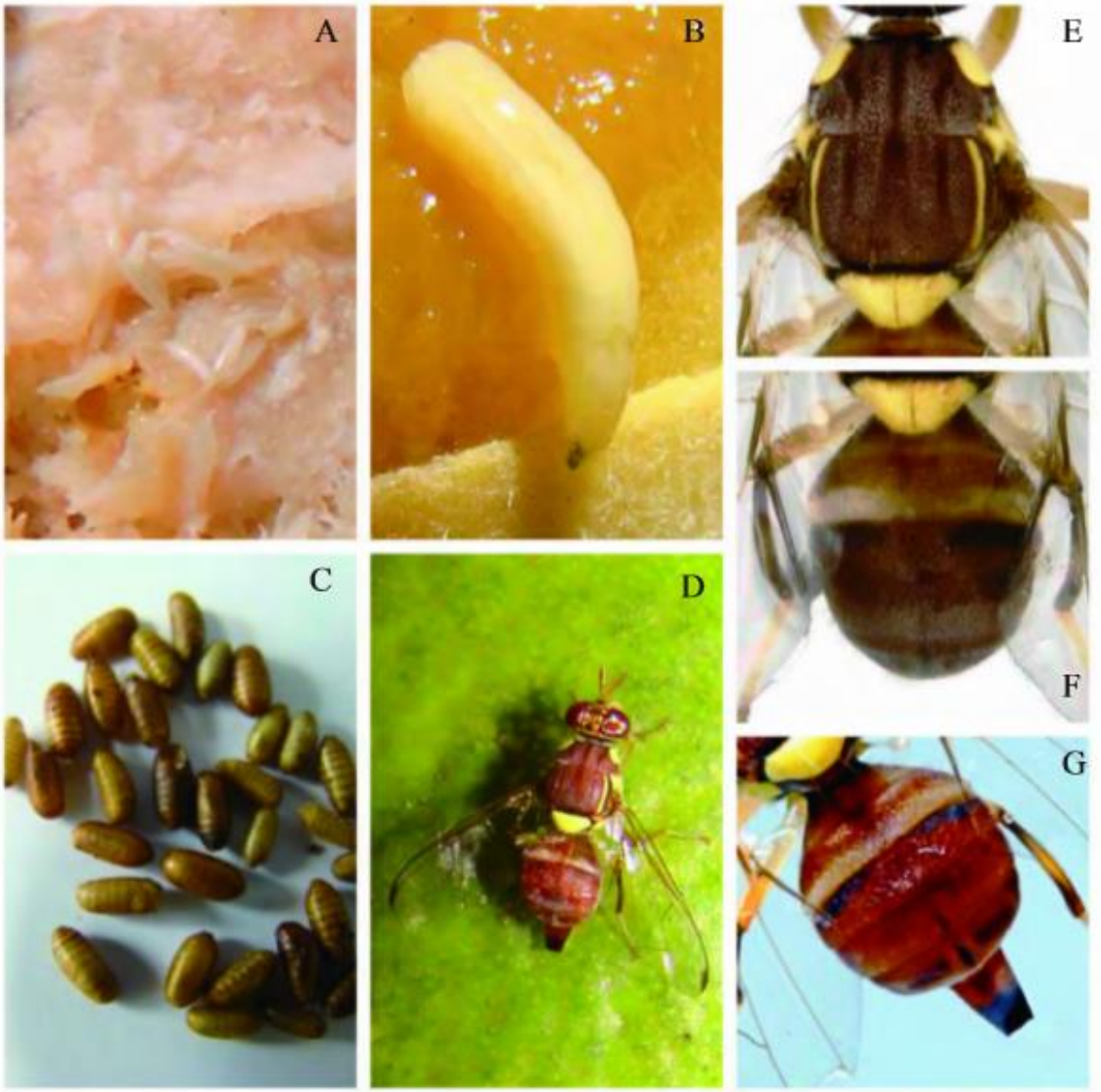


(Wu, 2009; Drew, 2016)


(CAUPQL, 2015)

(DP 29 of ISPM 27, 2019)

# *Bactrocera zonata* (Saunders)

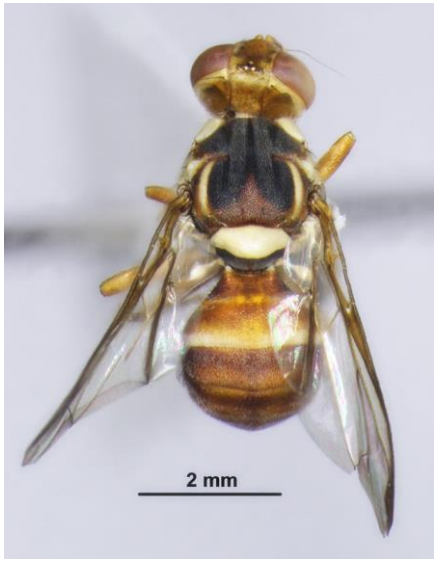



(Zhang et al, 2019)

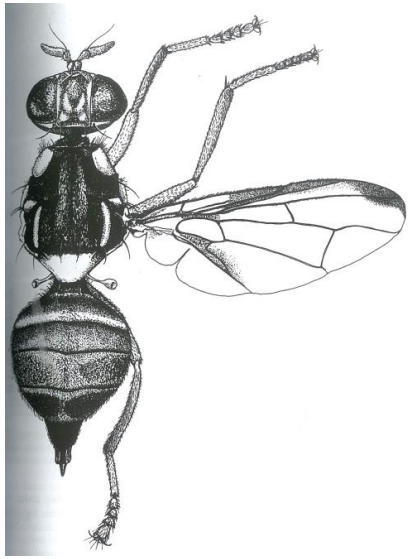
# *Bactrocera latifrons* (Hendel)

## Solanum fruit fly

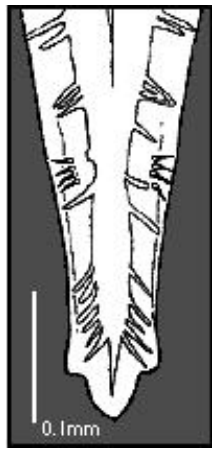
- Head: round or oval facila spots.
- Wing: Costal band expanded into a distinct spot at apex of wing
- Abdomen: predominantly reddish brown, usually lack prominent dark markings. Aculeus trilobed at apex.




(CAUPQL, 2015)



(Drew, 2016)

# Diagnostic key

## to 6 species of subgenus *Bactrocera* of gennus *Bactrocera?*

1. Costal band expanded into a distinct spot at apex of wing..... 2 `

— Costal band not expanded into a distinct spot at apex of wing..... 4

2. Face with a narrow transverse black band..... ***B. correcta***

— Face with a pair separately facial spots..... 3

3. Abdomen usually lack prominent dark markings, aculeus trilobed at female apex..... ***B. latifrons***

— Abdomen has prominent dark markings, aculeus not trilobed at female apex..... ***B. zonata***

4. lateral postsutural vittae extend anterior to suture..... ***B. tryoni***

— lateral postsutural vittae not extend anterior to suture..... 5

5. Costal band slightly overlapping $R_{2+3}$, moderately broad around apex of wing, Abdomen terga 3-5 with a moderately broad medical longitudal dark band ..... ***B. carambolae***

— Costal band confluent with R2+3, narrow to moderately broad around apex of wing, abdomen terga 3-5 without dark band..... ***B. dorsalis***

# *Can you identification the 6 similar species of Bactrocera (Bactrocera)?*

# Two species of subgenus *Tetradacus* of gennus *Bactrocera*

***Bactrocera minax* (Enderlein), Chinese citrus fly**

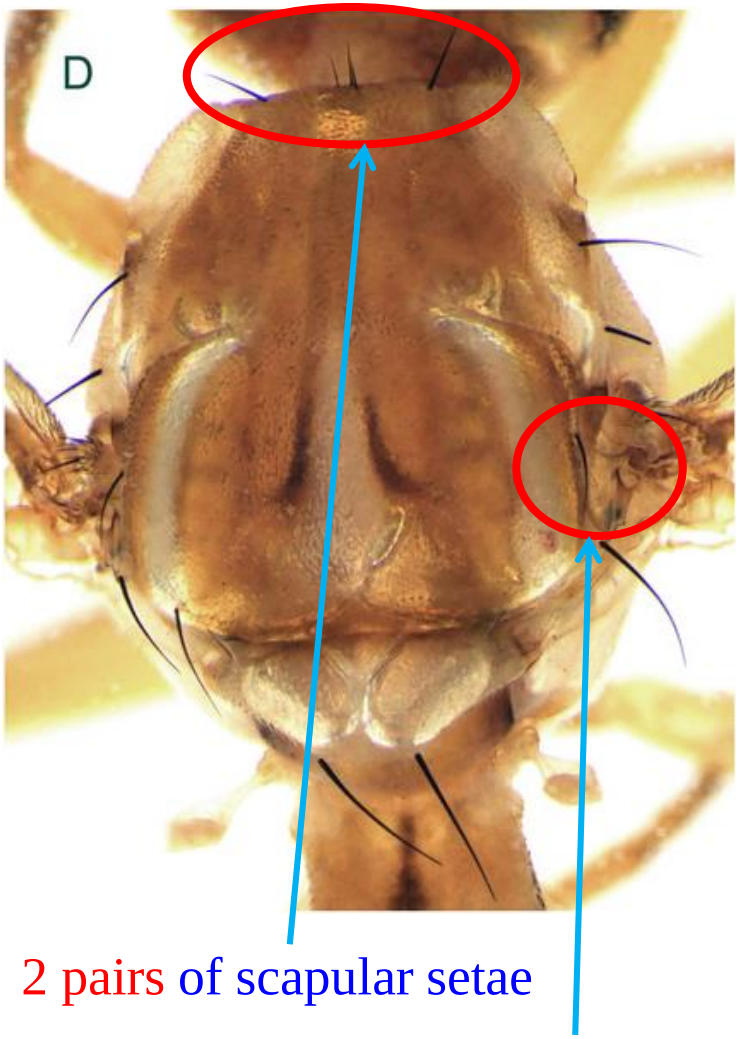
(Zhang et al, 2019)

- Abdomen: oviscape is equal in length to tergites 2-6, aculeus sharply pointed at apex.

- Abdomen: oviscape about as long as tergites 5-6, aculeus obviously trilobed at apex.

***Bactrocera tsuneonis* (Miyake), Japanese fruit fly**

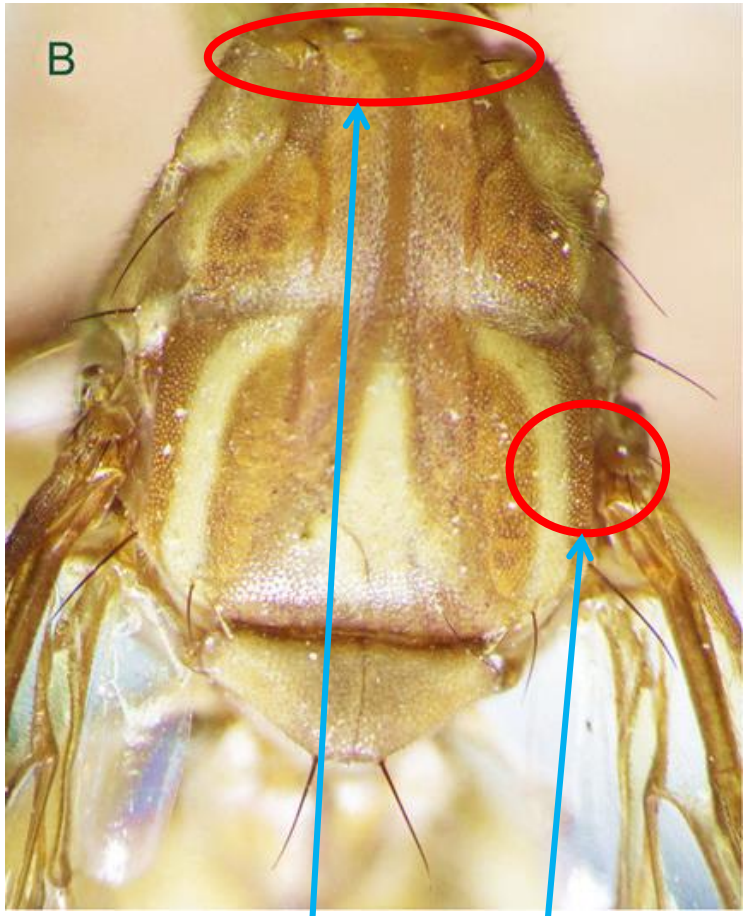
## *B. tsuneonis*




2 pairs of scapular setae

1-2 pairs of postsutural supra-alar setae

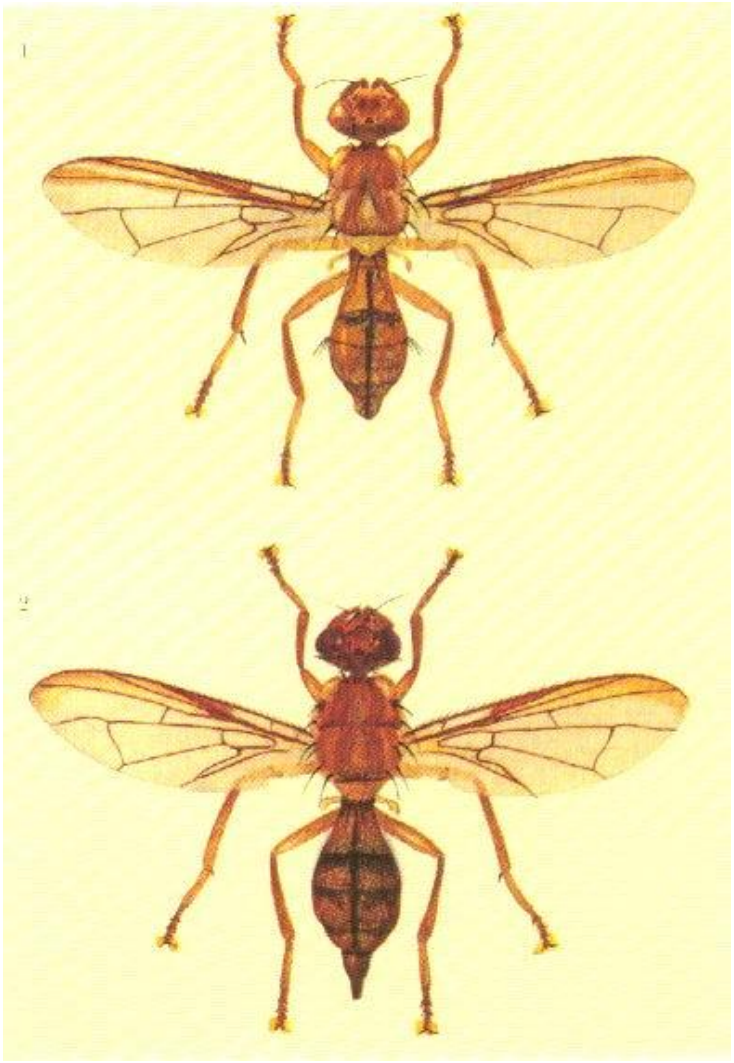
## *B. minax*

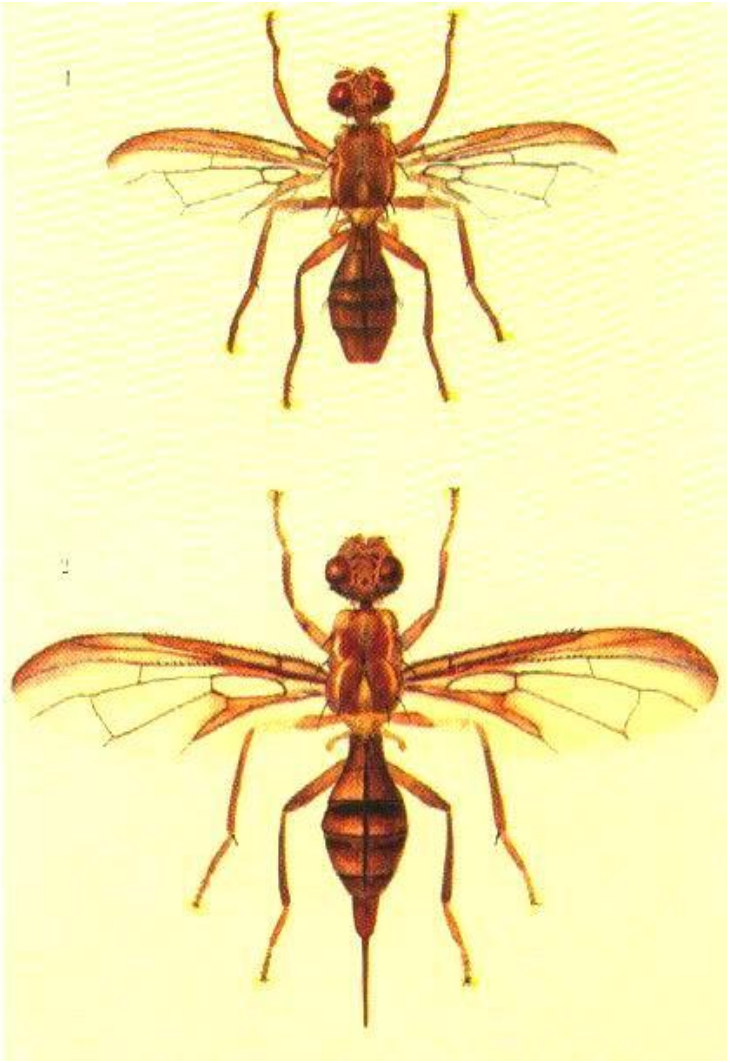



1 pair of scapular setae

absence of postsutural supra-alar setae

# *Can you identification the 2 similar species of Bactrocera (Tetradacus)?*





(Wang, 1993)

# *Can you identification this species of Bactrocera (Tetradacus)?*

（Yunnan Zhaotong Plant Protection Station, May 2019）

# Outline

- Basic morphological terminology and identification characteristics of Family Tephritidae
- Morphological identification characteristics of main genera of EIFFs
- Morphological identification characteristics of main species of EIFFs


LOOKING FORWARD TO MORE COLLABORATIONS
AND PROGRESS ON PREVENTION AND CONTROL OF EIFFS!