

Identification fruit fly species associated with watermelon plants (*Citrullus lanatus* (Thunb.) Matsum. & Nakai) in South of Sulawesi, Indonesia

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Identification fruit fly species associated with watermelon plants (*Citrullus lanatus* (Thunb.) Matsum. & Nakai) in South of Sulawesi, Indonesia

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Abstract. Fruit fly is an important insect pest of determining low and poor quality of Watermelon (*Citrullus lanatus*) in South of Sulawesi. The purpose of this study was to identify species of fruit flies and other arthropods using attracted Methyl Eugenol and Cue Lure traps. This research was done from September to December 2018 in Bentang Village, Takalar, South of Sulawesi. The fruit fly were collected through the use of 1.5 ml of Methyl Eugenol and Cue Lure attractants every traps with 16 traps each treatment. The application of attractant compounds in ME traps is replaced every 6 days, whereas in the CL trap a compound is replaced every 12 days during observation. The results of this research was found species fruit flies and other arthropods in ME attractants, there are *B. dorsalis* (Hendel), *Bactrocera musae*., *B. umbrosa* (Fabricius), and *Chrysoperla carnea* (Stephens). The Cue lure attractants trap was found *B. Bryoniae* (Tryon), *B. albistrigata* (de Meijere), *Zeugodacus cucurbitae* (Coquillet), *Dacus longicornis* (Weidemann), *Atherigona soccata* (Rodani), and Syrphidae. It is especially the species of *B. bryoniae* (Tryon), which is the first report of its existence in South of Sulawesi.

7 Introduction

Cucurbitaceous vegetables are cultivated throughout the world, from tropical to sub temperate zones. Cucurbit fruits and vegetables are important sources of food and revenue for exporting countries [1] Watermelon (*Citrullus lanatus* (Thunb.) Matsum. & Nakai)) is now cultivated in many parts of the tropics [2-4]. Pests and diseases, among others, limit production of cucurbits, Melon fruit flies (Diptera: Tephritidae) are among the major insect pests of cucurbits It has been reported to damage 81 7-st plant [5]. According to [6] fruit flies damage large quantities of fruits grown in the tropics. Fruit flies cause various losses depending on species, host fruits [7], and geographic location [8]. Number of studies deals with the characteristics of communities including several species, especially those attacking Cucurbitaceae [9]. Fruit flies can cause 40-100% economic losses annually in various crops such as gourds melons and guavas etc. [10]. The melon fly is a major agricultural pest of Asian origin. In the Indo-Malay region, the pest is greatly considered as the most destructive pest of melons.

Understanding populations of fruit flies especially some species associated with watermelon in South of Sulawesi is yet to be explored. This study focuses on identifying species of fruit flies in the watermelon plant and for the implementation of sustainable protection methods against cucurbit fruit flies.



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2. Methodology

A sampling of fruit flies was taken from watermelon plantations, in Bentang Village, south of Galesong District, Takalar Regency South of Sulawesi. This research starting from September to December 2018. The identification morphological characteristics of the species of the fruit fly were based on the adult. The samples were brought to the Insect Ecology Laboratory in the Department of Pests and Plant Diseases, Faculty of Agriculture, Universitas Hasanuddin. This research used Attractant synthetic lure Methyl eugenol (ME) and Cue Lure (CL).

3. Materials and methods

The field experiment was conducted for monitoring the population abundance of fruit flies on in watermelon plantations an area of 1600 m². The determination of the location of traps was done by line transect every 8 meters (distance between traps \pm 8 meters). Each ME and CL trap was placed to \pm 2 meters distance. The number of attractant trap used were 16 for ME and CL.

Fruit fly traps were using bottles of 600 ml mineral water with the outer sides of a few holes as the entrance for fruit flies. In top bottles were hanging the cotton for placed the attractant lure. ME and CL compounds were dropped on cotton as much as 1.5 ml. The trap bottle is given a mixture of 1% water and formalin with volume as high as 1/3 part of the height of the bottle (200 ml) as a liquid trap for fruit flies that are drawn into the trap. The trap bottle was hung on a pole embedded in the ground.

3.1. Fruit fly trapping

The research was preceded by a survey of the presence of fruit flies in the field with three times population monitoring. Further research was carried out by installing attractant traps Methyl Eugenol and Cue Lure on watermelon plantations aged 38 days after planting (DAP) or plants in the young fruiting phase. Application or replacement of each lure of a compound for ME traps is carried out every 6 days and CL traps every 12 days.

Traps were hung vertically at a height of 50-100 cm above ground level. Fruit flies attracted to the trap were taken using a small smooth brush and stored in a container that has been coated with silica gel and wipes. Subsequently, sample container was marked with the information regarding the time, location and date of sampling. The sample of fruit flies were then taken to the laboratory for identification. Sampling was done every week, by following the development of plant phenology, which starts before the flowering period to harvest.

3.2. Morphological identification of fruit fly

The fruit flies captured in traps baited with methyl eugenol and cue lure were collected and identified following the available taxonomic keys, insect descriptions, and comparative images. Specimens were preserved following methods describe by White and Elson-Harris [10]. The identification of fruit flies was done presented by White and Elson-Harris [11], Drew and Meredith [12] and PHA [13]. USB Digital Microscope Camera, Jusion 40-1000X Portable Magnification Endoscope was used to take photos.

4. Results and discussion

4.1. Species identification

Number of fly species attracted with the trap of ME were *Bactrocera dorsalis* (Hendel), *Bactrocera musae* (Tryon), and *Bactrocera umbrosa* (Fabricius) and attracted with trap of Cue Lure were *Bactrocera albistrigata* (de Meijere), *Zeugodacus cucurbitae* (Coquillett), *Dacus longicornis* (Wiedemann), and *Bactrocera bryoniae* (Tryon) (table 1). Although these kinds of fly species are found in the tropical areas [3, 14-16], the fly species are never reported in the chili and watermelon farms in Takalar Regency, South of Sulawesi. *Z. cucurbitae* and *D. longicornis* species are commonly found in cucurbit plants [7, 17-19].

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Table 1. Insect species attracted to Methyl eugenol and Cue lure

<i>Family</i>	<i>Species</i>	<i>Attractant</i>
<i>Tephritidae</i>	<i>Bactrocera albistrigata</i>	CL
	<i>Zeugodacus cucurbitae</i>	CL
	<i>Dacus longicornis</i>	CL
	<i>Bactrocera bryoniae</i>	CL
	<i>Bactrocera dorsalis</i>	ME
	<i>Bactrocera musae</i>	ME
	<i>Bactrocera umbrosa</i>	ME
<i>Syrphidae*</i>	<i>Un Identify</i>	CL
<i>Muscidae*</i>	<i>Atherigona soccata</i>	CL
<i>Chrysopidae*</i>	<i>Chrysoperla carnea</i>	ME

* non group of fly species

Table 1 shows that species of insect attracted in ME trap were green lacewing *Chrysoperla carnea* (Stephenwes) (Neuroptera: Chrysopidae), and in CL trap *Atherigona soccata* (Rodani) (Diptera: Muscidae) and the Syrphid fly (Diptera: Syrphidae). The attendance of the Syrphid fly was not found to be in the trap, but its presence was found around (outside) the trap contained cue lure compound.

4.2. Fruit flies species

In general, morphological identification uses face, facial spots, antenna, scutum, scutellum, mesonotum, postpronotal lobes, basal band, vittae, lateral vittae, medial vittae, mesonotal suture and setae (thorax); lateral presutural vitae, medial and lateral postsutural vitae (thorax); terga, tergum 1-5 and pecten (abdomen) and femur and tibia (leg); costal cells, microtricia, costal band (Wings).

4.2.1. Melon fly ²³ *eugodacus cucurbitae* (Coquillett). The melon fruit fly is a pest of Asian original. This species is previously known as *Bactrocera ar* ⁸ has changed the name to *Zeugodacus cucurbitae* [16], and synonymous name *Chaetodacus cucurbitae* (Coquillett), *Dacus cucurbitae* Coquillett, *Strumeta cucurbitae* (Coquillett) and *Zeugodacus cucurbitae* (Coquillett) [19]. Morphological Identification of the specimen shown in figure 1.

Z. cucurbitae of morphological characteristics as follows: facial spots with the dark ³ colour on the face above the mouthparts large in oval shape (a); (thorax) scutum red-brown colour or golden to red-brown with darker markings (b), with narrow medial vittae (c), and lateral ³ yellow post sutural vittae (d); (wing) *Z. cucurbitae* has wing features, there are black-brown bands rounded at the apex or costal band expanding into a semicircular spot at wing apex (e) and transverse brown bands on the dm-cu (f); (abdomen) the abdomen is reddish-brown, the longitudinal medial line is present in terga 3-5, and males have pecten (g); (leg) the legs on the femur (h) and tibia (i) are yellow-brown. The morphological characteristics were similar to those described by Drew and Romig [12]. The result of the experiment indicated fruit flies specimens were attracted only by cue lure compound in the trapping.

Distribution of ¹⁶ is species in Asia is widely from middle east, southern China and Indian subcontinent [21]. It is abundant throughout Central and East Asia (including Indonesia, Bangladesh, India, Philippines, Pakistan, Nepal, and China) and Oceania (including Mariana Islands and the New Guinea) [3, 9, 18]. Host range *Z. cucurbitae* including Cucurbitaceae, Oxalidaceae Solanaceae Anacardiaceae, Fabaceae, Malvaceae [3]. But most preferred hosts include Cucurbitaceae: cucumber, pumpkin, squash, and watermelon [7, 20, 22].



Figure 1. *Z. cucurbitae*: (a) facial spots dark colour and ovale shape, (b) scutum red brown colour, (c) narrow medial vitae, (d) lateral postsutural vittae, (e) black bands at the apeks, (f) infuscation on dm-cu, (g) abdomen terga 3-5 with “T” band, (h) femur, (i) tibia.

4.2.2. *White striped fruit fly Bactrocera albistrigata* (4 Meijere). Distribution of area *B. albistrigata* species spread in Southeast Asia; Adaman Island, central to southern Thailand, Peninsular Malaysia, East Malaysia, Singapore, and Indonesia: Kalimantan, Sulawesi, Lombok, Java, and Sumatera. *B. albistrigata* is the most similar species to *Bactrocera frauenfeldi* complex [13, 23].

The result showed morphology characteristics of *B. albistrigata* in figure 2. (Head) on the head, there are large oval-shaped face spots (a), (Thorax) scutum mostly black (b), yellow bands on the lateral side or postpronotal lobes yellow (d), (wings) transverse brownish-black bands on rm and dm-cu (e), a band across the wing (f), (leg) femur with black spot yellow and brown color (g), tibia without spot (h), and (abdomen) a large black pattern on the lateral side of the abdomen (i). The results showed that *B. albistrigata* was interested in Cue Lure compound in watermelon plant, and [13, 25] reported cue lure compounds attracted for specific fruit flies [29] luding *B. albistrigata*.

Host range *B. albistrigata* has been recorded 12 hosts from 7 families including Anacardiaceae, Clusiaceae, Moraceae, Sapotaceae [13]. Major host *Aglaia argentea*, *Artocarpus [23] terophyllus* Lam. (Jackfruit) *Averrhoa carambola* L. *Calophyllum inophyllum* L. *Mangifera indica* [27] *Psidium guajava* L., *Scolopia spinosa* Warb. N/A *Syzygium aqueum* (Burm. F.) *Syzygium samarangense* (Blume) Merr. & L. M. Perry (Java-apple), and *Terminalia procera* Roxb [25].

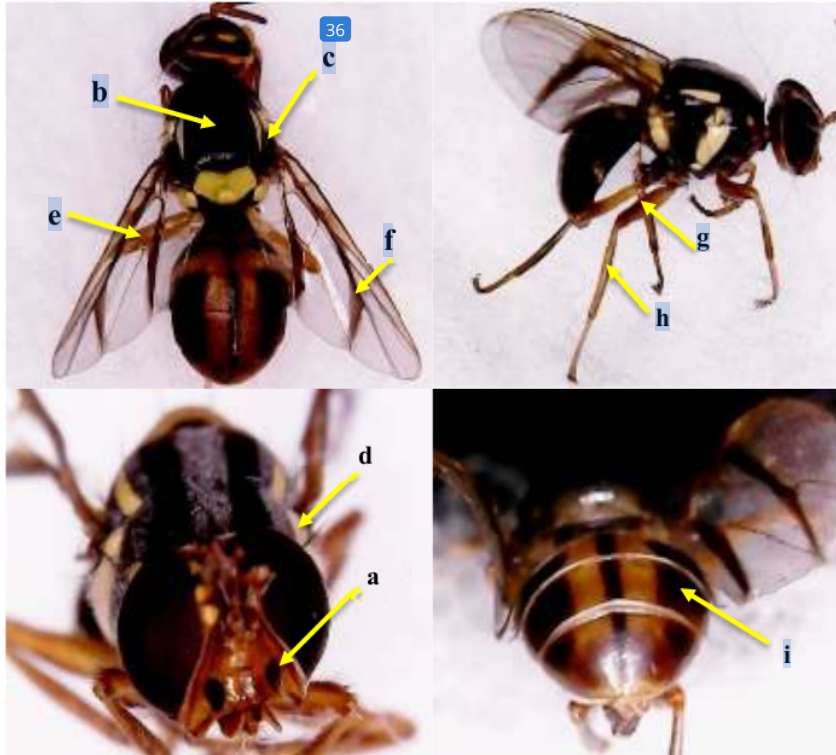


Figure 2. *B. albistrigata*: (a) facial spots, (b) scutum glossy black, (c) lateral vitae tapered, (d) post pronotal lobe, (e) broad anal streak, (f) transverse band across wing, (g) femur, (h) tibia, and (i) abdomen with medial line and dark lateral marking.

4.2.3. *Bactrocera bryoniae* (Tryon). The resulting experiment, on watermelon plants (Cucurbitaceae) was founded flies *B. bryoniae* on cue lure traps in South of Sulawesi and it is the first report of the presence *B. bryoniae* in South Sulawesi. PHA data explained, in Asia this species is only found in Papua and widespread in Oceania: Papua New Guinea an every province except Bougainville and Manus and Australia (Northern Western Australia, Northern Territory, east coast south to Sydney, New South Wales, and the Torres Strait Islands) as endemic pest [13, 26].

Identification *B. bryoniae* with morphological characteristics explained through feature in figure 3. (Head) a large spots an oval-shaped face (a): (Thorax) *B. bryoniae* has a thoracic feature on the black scutum (b) and a yellow band on the lateral vitae (c), (Abdomen) terga 3-5 with thicker T pattern (d); (Wing) The wings have a brown-black band on the rib line to R4+5 from the base to the apex but in cell bc and c only on outside (e) and there is also a brown band on the anal (f), the femur segment with yellow-brown band. Species *B. bryoniae* was found a large body size on the watermelon plant in the South of Sulawesi. *B. bryoniae* species similar to *Bactrocera dorsalis* complex species, the specimen has a black scutum and "T" on the abdomen.

The species previous scientific names: *Chaetodacus bryoniae*, *Strumeta bryoniae*, and *Dacus (Strumeta) bryoniae* [26]. This flies as polyphagous insect, host range recorded from 9 hosts

including Cucurbitaceae, Musaceae, Passifloraceae, Loganiaceae, Chili and Solanaceae and mostly attracted in cue lure trap [13].

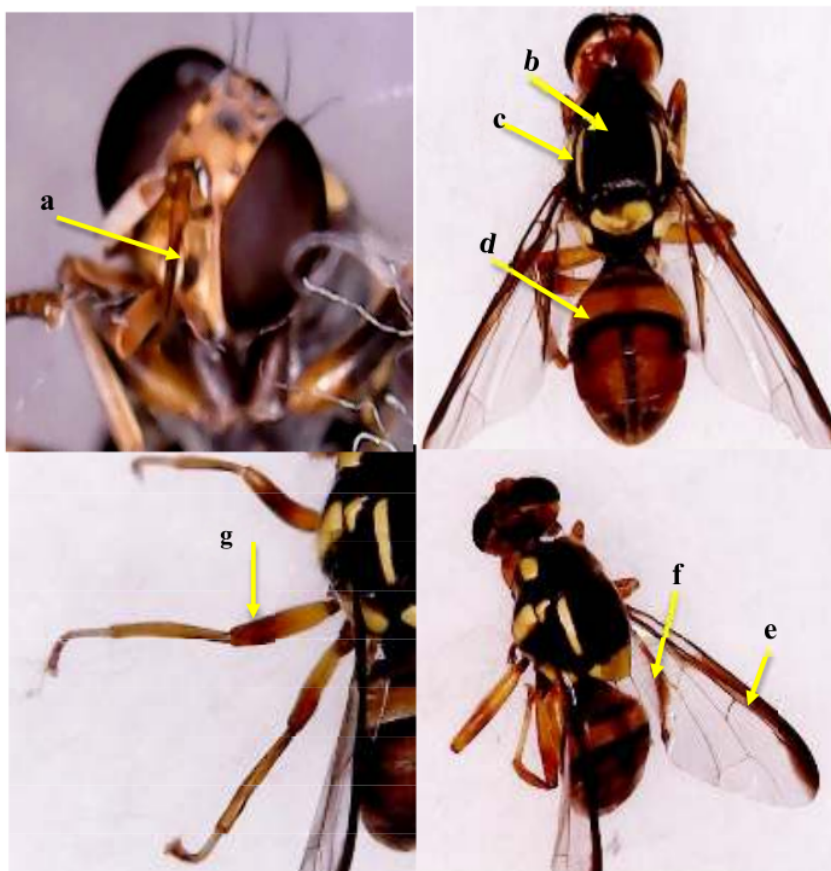


Figure 3. *B. bryoniae*: (a) a large facial spots, (b) scutum with black colour, (c) yellow band on lateral vitae, (d) terga 3-5 with thicker T pattern, (e) costal band overlap R4+5, (f) broad anal streak, (g) yellow-brown band on femora.

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4.2.4. **Oriental fruit fly *Bactrocera dorsalis* (Hendel).** The resulting study that fruit flies *B. dorsalis* was found in high populations during the study which only interested in ME traps and not for CL traps (table 1). Methyl eugenol compound (ME) has been reported as an attractant trap for *B. dorsalis* complex [27].

This study was found in various species of host plant 6 in ecosystem watermelon. That causes the increasing population of *B. dorsalis* during observation. The oriental fruit fly has been recorded from 478 kinds of fruit and vegetables, including apricot, avocado, banana, citrus, coffee, fig, guava, loquat, mango, rose apple, papaya, passion fruit, peach, pear, persimmon, pineapple, Surinam cherry, and tomato. However, avocado, mango, and papaya are the most commonly attacked [23, 27]. *B. dorsalis* flies are a common pest found in Indonesia and are widespread in Asia, Australia and the Pacific Island [5, 27, 28].

The result showed morphology characteristics of *B. dorsalis* morphology are shown in figure 4. The wing of the *B. dorsalis* with cells bc and c colourless, narrow coastal band in R2+3 (a), a narrow pale fuscous cubital streak (b), scutum black to red-brown colour (c), postpronotal lobes, notopleura and lateral vittae yellow (d), legs with tibia segments fore and hind dark colour (e), facial spots with a pair of medium-sized circular black spots (f), abdominal terga 3-5 with a black 'T' pattern.



Figure 4. *B. dorsalis*: (a) wings with costal band dark in R2+3, (b) narrow anal streak; (c) Scutum with black colour; (d) postpronotal lobes, notopleura and lateral vittae yellow; (e) fore and hind tibia dark colour; (f)) facial spots with medium sized circular black spots; (g) abdominal terga 3-5 with a black 'T' pattern.

4.2.5. *Banana fruit fly Bactrocera musae (Tryon)*. Identification *B. musae* with morphological characteristics explained through feature in figure 5, The body a medium size of *Bactrocera musae* has black band wings on the costa to anal line, costal band dark and overlapping R2+3 (a); thorax on the brownish-red scutum (b); postpronotal lobe, notopleuron and lateral scutum are the yellow colour (lateral vittae) (c); legs with segments fulvous except hind tibiae dark fuscous (d), facial spot a medium size and oval-shaped (e), the abdomen is reddish-brown in color, abdomen terga 3-5 orange-brown with narrow anterolateral dark marking (f), abdomen shining spots orange-brown on terga 4-5 (g).

This species attacks bananas (*Musa* spp) and has occasionally been bred from a few other plants. In Indonesia, it has been attacked *Inocarpus fagifer* (Parkinson) taken from maros South of Sulawesi [29]. In Australia, was found 12 host species have been recorded, from 10 genera and 9 families, but the majority of records are from bananas. In Papua New Guinea, it has been bred from eating and cooking bananas (*Musa x paradisiaca*) and once from papaya (*Carica papaya*). In Australia, 12 host species have been recorded, from 10 genera and 9 families, but the majority of records are from bananas [13, 23]. Widespread and very common of Queensland, Australia, and was recorded widespread in Bismarck Archipelago (PNG), Solomon Islands and Vanuatu, It's reared from banana [30].

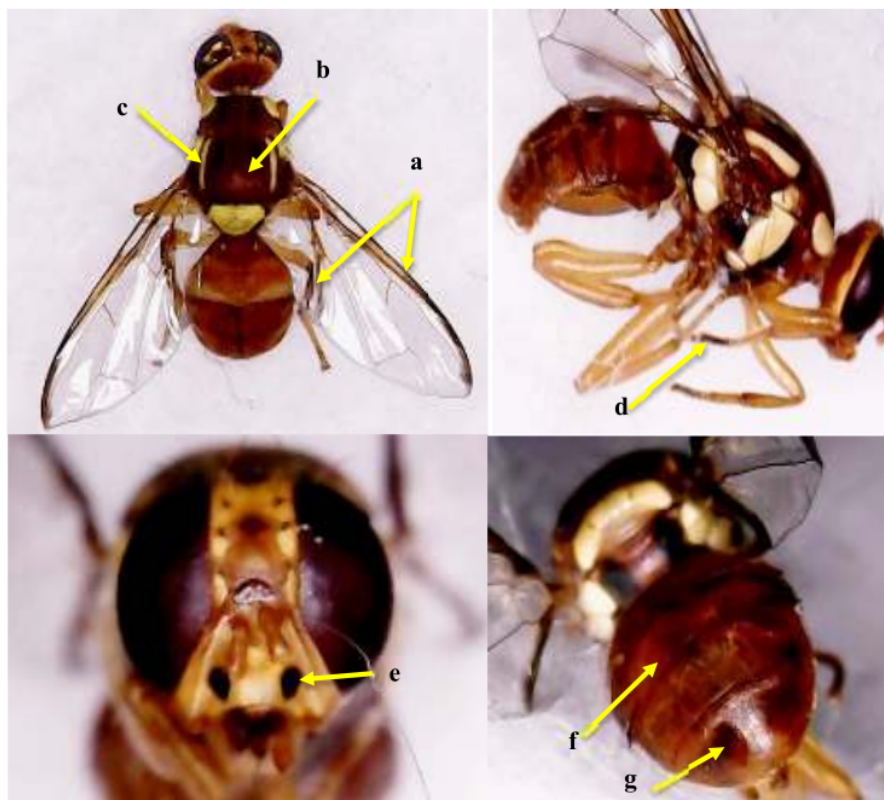


Figure 5. *B. musae* (a) Costal and 1st transverse distinctly overlapping R2+3, (b) black skutum, (c) lateral vitae yellow colour and slightly taper (d); legs with segments fulvous except hind tibia dark fuscous (e) facial spot oval and medium size (f, g) abdomen.

4.2.6. Breadfruit fruit fly *Bactrocera umbrosa* (Fabricius). *B. umbrosa* has other scientific names, *Strumeta umbrosa* (Fabricius), *Strumeta umbrosa* (Fabricius), *Strumeta conformis* Walker, 1856, *Dacus umbrosus* Fabricius, *Dacus frenchi* Froggatt, *Dacus diffusus* Walker, *Dacus conformis* Walker, *Chaetodacus umbrosus*, *Bactrocera fasciatipennis* Doleschall, *Bactrocera (Bactrocera) umbrosa* (Fabricius) and preferred name *Bactrocera umbrosa* (Fabricius) [12].

The result showed morphology characteristics of *B. umbrosa* was explained through a feature in figure 6. (Wings) Species *B. umbrosa* has the characteristics of three transverse bands on the wing (a)

1 This is one of the most distinctive of all *Bactrocera* spp. Its wing has three stripes across it, in addition to the costal band and anal streak; this is unique amongst the pest species and even amongst the non-pests only *B. bifasciata* (Hardy), from Sulawesi [41], could possibly be mistaken for it.; (thorax) yellow bands on both lateral sides (lateral vitae) (b); postpronotal lobe entirely pale yellow or orange (c) with black scutum (d); On the limbs the femur (e) and tibia (f) are yellow-brown in color, there are black oval spots on the face (g), and abdomen III-V abdomen reddish brown with black on the lateral side, males have pecten, black widens on the lateral side (h).

In general host range *B. umbrosa* species only attacks *Artocarpus* spp., this species oligophagous status [26]. The species widespread and only specifically in Borneo. However, given that this fly is in Malaysia, Papua New Guinea, and the Philippines, it is reasonable to assume it is very widespread in Indonesia [31].



Figure 6. *B. umbrosa*: (a) three bands across wing, (b) lateral vitae with yellow bands, (c) postpronotal lobe, (d) skutum, (e) femur, (e) tibia, (f) spot wajah, (g) black oval spots on the face, (h) abdomen III-V abdomen reddish brown, males have pecten.

4.2.7. *Dacus longicornis* (Wiedemann). The result showed morphology characteristics of *D. longicornis* morphology are shown in figure 7. *D. longicornis* has a wing characteristic with a black band extending beyond R4 + 5 from the base to the apex (a), thorax there is a yellow triangular band on the anterior margin (b), there is a yellow band on the lateral side of the scutum (c). The legs on the femur (d) and tibia (e) are reddish brown in colour and there are yellow rings on the waist (f). There is a medium-sized facial spot on the head (g) and the abdomen looks pale yellowish in the middle of IV and V (h). According to Sivi et al. [31] *D. longicornis* has the characteristic that there are round face spots in the antenna cavity, the dominant body is yellow-brown with an abdominal shape such as a

wasp's waist. The costa line has a black band extending beyond R4 + 5 from the base to the apex of the wing. Both sides of the third III ma³ abdomen have pecten. This species similar species to *D. Axanus* but differs in facial spot and the mid femora pale basally and Similar to *D. s³omonensis* but differs on tergum 5 and elongate abdomen [13]. *D. longicornis* was distributed in Asia: Indonesia, Malaysia, Laos, Myanmar, Thailand, China, Philippines, India, Bhutan, Vietnam, and Bangladesh [31] and it is very widespread in Indonesia [12].



Figure 7. *D. longicornis*: (a) Costal band between R4+5 and M, (b) scutellum with broad basal band and all brown, (c) lateral and medial postsutural yellow vittae, (d, e) all femora and tibia dark, except midfemora, (f) abdomen strongly petiolate with yellow ring (terga 1), (g) facial spot very small, (h) abdomen pale colour centrally on terga 4 and 5.

5. Conclusion

Various species of fruit flies were found in association with watermelon plants in South Sulawesi, Indonesia using ME and CL. Commonly found species include *Zeugodacus cucurbitae* (Coquillett), *Bactrocera dorsalis* (Hendel), *B. bistrigata* (de Meijere), *B. musae*, *umbrosa* (Fabricius), and *D. longicornis* (Weidemann). And the species *B. bryoniae* (Tryon), was found as the first report of its existence in South of Sulawesi. Other insects not fruit flies were found attracted through Cue Lure include Syrphidae, *Artherigona soccata* (Rodani), and *Crysoperla carnea* (Stephens) in Methyl Eugenol lure.

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