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ORIGINAL ARTICLE

Public health and veterinary important flies (order: Diptera) prevalent in Jeddah Saudi Arabia with their dominant characteristics and identification key



Masroor Alikhan^{a,*}, Khalid Al Ghamdi^b, Jazem A. Mahyoub^b, Naima Alanazi^c

^a Public Health Pests Laboratory, Al Amana, Bariman, Jeddah, Saudi Arabia

^b Dept. of Biological Sciences, King Abdul-Aziz University, Jeddah, Saudi Arabia

^c Dept. of Biological Sciences, Hail University, Hail, Saudi Arabia

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Calliphoridae;
Sarcophagidae;
Phoridae

Abstract Order Diptera of class insecta is of immense importance for the public and animal health and hygiene. Many dipteran flies are potential vectors of dreadful diseases. Therefore, it is required to have a simple characterization method and identification key for the field workers and entomologists. The present study fulfill the need and focus on the identification to generate a base line data with the help of original photographs. Nine families with 16 species of dipteran flies (other than mosquitoes) from Jeddah region of Saudi Arabia are included in this work. Major families which are more prevalent and common in this region are Muscidae, Calliphoridae, Sarcophagidae and Phoridae.

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1. Introduction

The order Diptera of class Insecta includes commonly called true flies or two winged flies. Diptera is one of the most diverse insect orders, with estimated 2,40,000 species including Mosquitoes, gnats, midges, black flies, sand flies house flies etc. (Yeats and Wiegmann, 2005). Although about 1,20,000 to 1,50,000 species have been described (Colles and Mc

Alpine, 1991; Brown, 2001; Thompson, 2006). This number of species is based primarily on figures extracted from the 'Bio-Systematic Database of World Diptera' (Evenhuis et al., 2007). There are about 86,000 species of flies other than mosquitoes (Castner, 2009).

This group is of immense importance for human & animal health and hygiene. Mosquitoes, sand flies, black flies and house flies are supposed to be responsible for more human and animal's sufferings some time with fatal results. Many of these flies are potential vectors of dreadful diseases (Carvalho and Mello-Patiu, 2008).

The most important group of Diptera is of the mosquitoes which differ from other biting dipterans in having a long needle shaped piercing and sucking mouth parts and long slender body. Some mosquitoes like *Aedes*, *Anopheles*, *Culex* are medically considered as disease vectors of the following diseases:

* Corresponding author.

E-mail address: alikhansmasroor@hotmail.com (M. Alikhan).

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Aedes: Yellow fever, Dengue fever, Dengue Hemorrhagic fever, other viral fevers.

Anopheles: Malaria and Lymphatic Filariasis.

Culex: Lymphatic Filariasis, Japanese encephalitis and other viral diseases.

Literature is available on the identification of the Mosquito fauna of Jeddah province of Western Saudi Arabia (Mattingly and Knight, 1956; Buttiker, 1981; Abdullah and Merdan, 1995; Al-Ghamdi et al., 2008; Alikhan et al., 2014).

- The focus of this study is to identify and to generate a base line data of the most important flies of public health and veterinary importance other than mosquitoes of Jeddah Province of Saudi Arabia. Although some fragmented literature is available on the flies of the Middle East and Saudi Arabia (Akbarzadeh et al., 2015; Al Ahmadi and Salem, 1999; Al Ahmad et al., 2006; Amoudi, 1989; Amoudi and Lederqc, 1992; Amoudi, 1993; Boorman, 1989 Büttiker et al., 1979; Buttiker, 1980; Crosskey and Buttiker, 1982; Dabbour, 1979a,b; Dabbour and El Dawy, 1981; Dabbour and Hammad, 1982; Dawah and Abdullah, 2006; Deeming, 1996; Doha, 2009; Ibrahim and Abdoon, 2005; Lehrer and Abou Zied, 2008; Lewis and Buttikar, 1980; Magdi et al., 2013; Mashaly, 2014; Setyaningrum and Al Dhafer, 2014; Shalaby, 1961), still there is a need of diagnostic morphological characterization with the help of actual photographs and a simple key for the identification of the flies prevalent in this region which is a commercial center and gateway to Makkah.

The flies are divided into three groups:

(a) Disease causing flies (b) Myiasis causing flies (c) Forensically important flies.

1.1. Disease causing flies

The flies belonging to families Calliphoridae, Sarcophagidae and Muscidae are transmitters of the diseases like poliomyelitis, cholera, typhoid fever, bacillary dysentery, trachoma virus, enteric infections, leprosy, tuberculosis, etc. (Patton, 1922, Patton and Cushing, 1934; Zumpt, 1965; Greenberg, 1973).

1.2. Myiasis

It is defined as the invasion of the organs of humans and other vertebrate.

Animals by dipterous larvae to feed upon the living or dead tissues (Zumpt, 1965).

1.3. Myiasis causing flies

There are following three main families of order diptera causing myiasis in humans and animals.

(a) Calliphoridae (b) Sarcophagidae (c) Phoridae

Some literature is available on Myiasis in humans and animals in Saudi Arabia (Al Ahmad et al., 2006; Badawi, 1994; Hall and Wall, 1995; Khyat, 2002; Omar and Abdullah,



Figure 1 Map of Saudi Arabia showing Jeddah.

1992; Zaglool et al., 2013) but there is no available literature on the identification of different myiasis causing flies of Jeddah, the present work fill up the gaps.

1.4. Forensically important flies

Many dipteran species are associated with forensic ecology, however, only the species of family Calliphoridae, Sarcophagidae, Muscidae and Fanniidae are the most important for forensic investigations (Al-Ghamdi et al., 2015).

2. Material & methods

The flies were collected from different locations of Jeddah (Figs. 1 and 2). The surveillance was done from October

2013 to June 2014. Most of the collection was done by insect sweeping nets or by sticky traps near the garbage boxes. Samples were also collected from slaughter houses, vegetable markets, meat shops, poultry farms, sheep paddocks, stables and fish market. Besides, sticky traps were also used near carcass of cats and rats to collect the necrophagous flies.

Collected flies were brought to the insect laboratory for the morphological identification. Live flies were kept in the freezer for 30–35 min to immobilize them.

Taxonomic keys are of utmost importance in the identification of the species during different research programmes. Although there are a number of taxonomic keys to identify the flies of public health and veterinary importance of different areas/regions, none of them

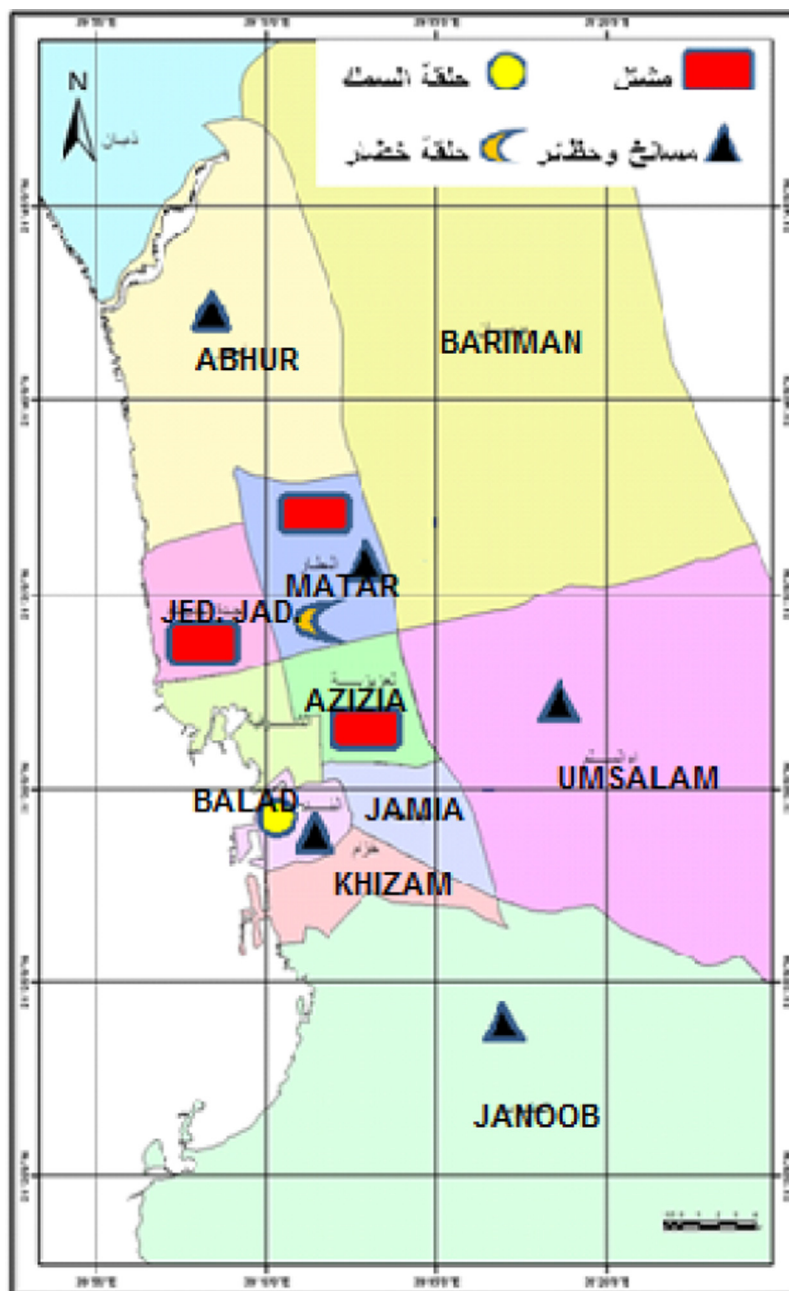
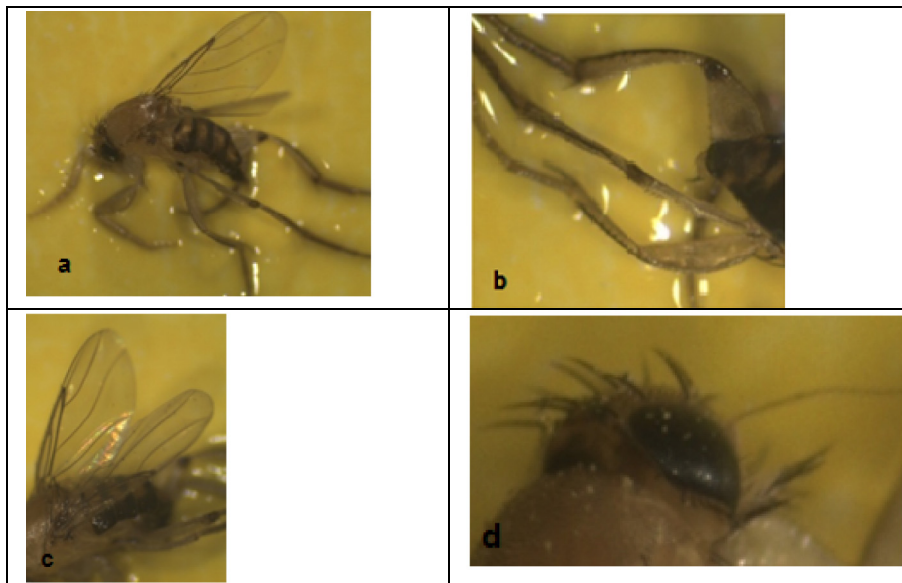
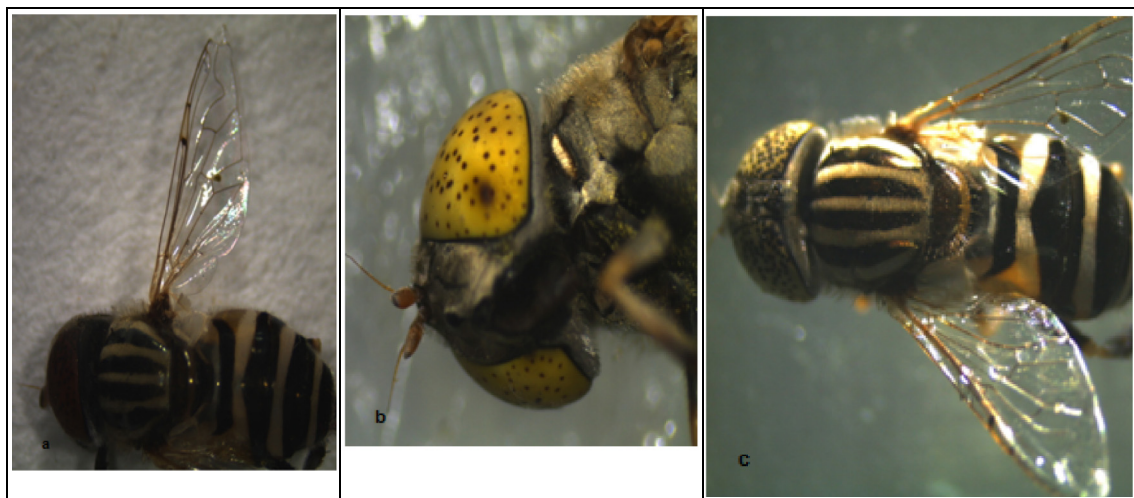


Figure 2 Map of Jeddah showing collection points.



(a) Adult (b) hind legs (c) Wing venation (d) Head

Plate I *Megaselia scalaris*.

(a) Wing

(b) Head

(c) Adult Dorsal view

Plate II *Eristalis taeniops*.

provided the photographs of the species. Therefore, an attempt has been made to prepare a simple key for quick and accurate identification of dominant flies of Jeddah with their photographs for the benefits of field workers of public health and entomologists.

The morphological identification was done by using dichotomous keys available.

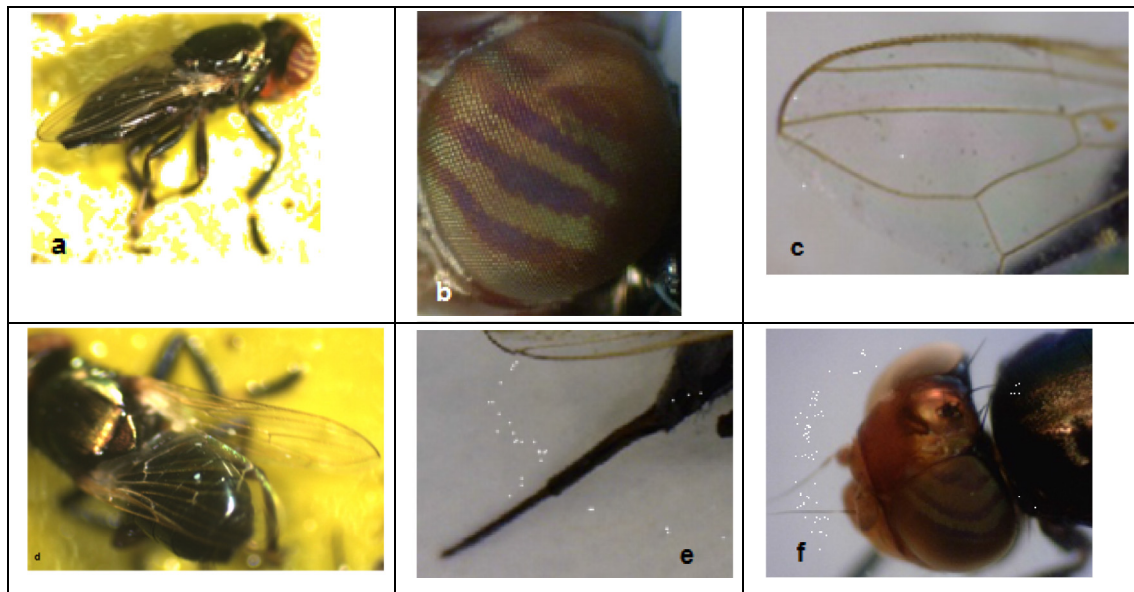
(Carvalho and Mello-Patiu, 2008; Irish et al., 2014; James, 1947; Kamal, 1958; Kurahashi and Afzal, 2002; Zumpt, 1965; Steyskal and El-Bialy, 1967; Shaumar et al., 1989; Shaumar and Kamal, 1982,83; Bei-Bienko, 1988; Mc Alpine, 1989; Morsy et al., 1991; Nazni et al., 2011; Pont, 1991; Erzinçliolu, 1996; Spradbery, 2002; Szpila, 2012; Watson and Dallwitz, 2003; Scudder and Cannings, 2006; Verves, 2005; William and Villet, 2014).

3. Results & discussion

Following the intensive survey some twenty dipteran species belonging to eight families were identified. A simple guide with actual photographs & important characteristics with an identification key is prepared for accurate identification of medical and veterinary important flies of Jeddah, Saudi Arabia.

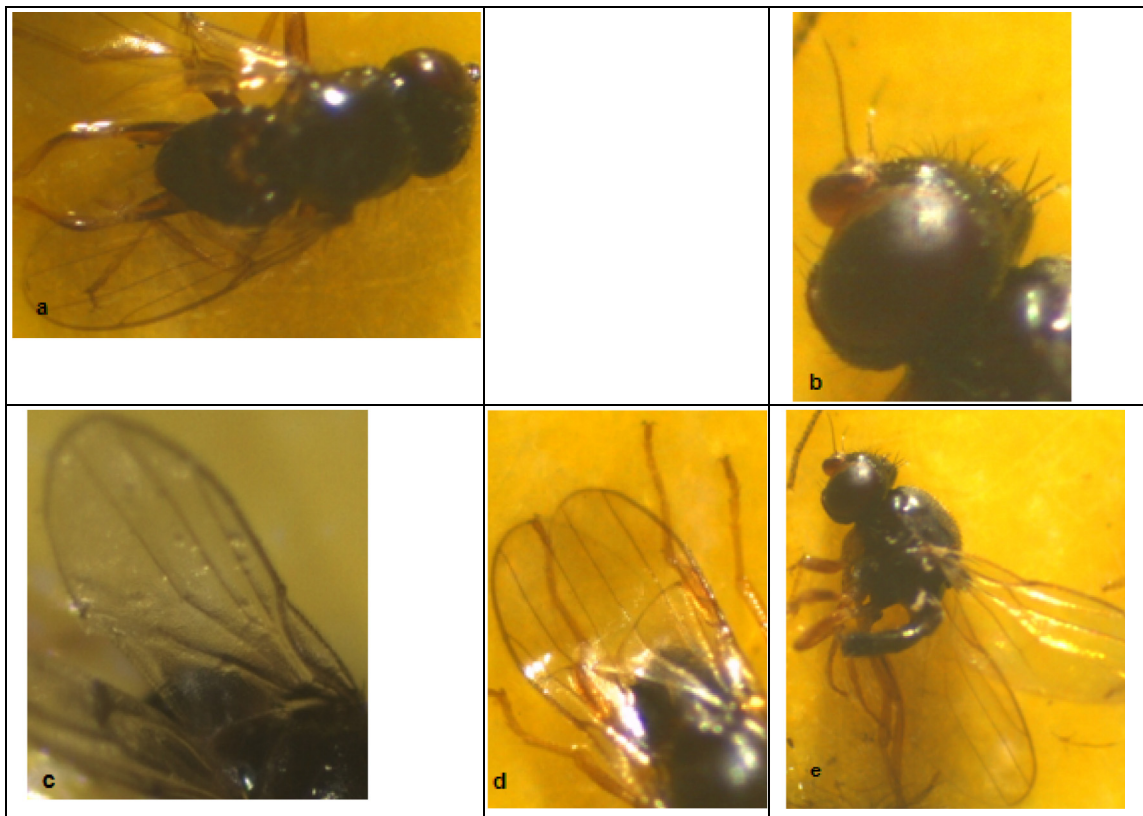
3.1. Family: Phoridae

Small, brownish, black or dark yellow flies, only one segment in the antenna with long arista and thickened radial veins ending at the costa, near the middle of the wing margin, Thorax 'hump- backed, legs are stout and well developed, hind femur laterally compressed.



(a) Adult (b) Compound eye (c) Wing (d) Adult lateral views (e) Female ovi positor (f) Head showing Arista

Plate III *Physiphora alceae*.



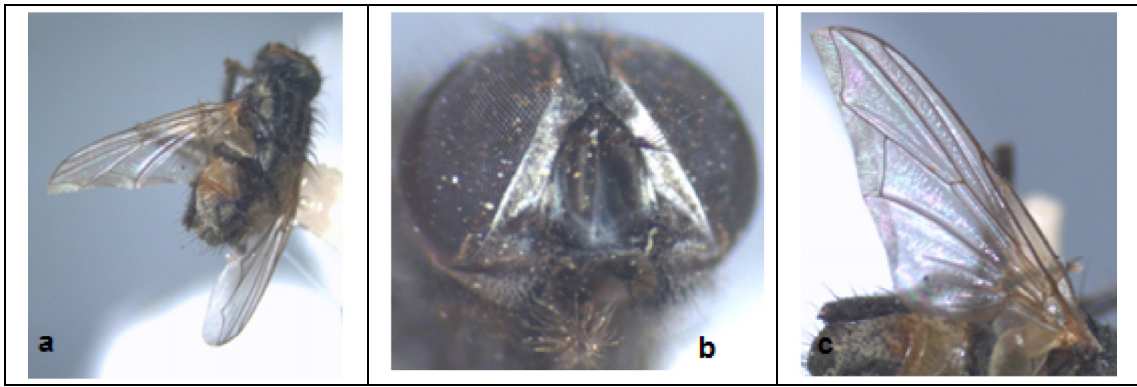
(a) Adult (Dorsal view) (b) Head with antenna (c) wing venation (d) abdomen & legs (e) Adult (Lateral view)

Plate IV *Siphunculina*.

Wing with characteristic venation, markedly thickened toward fore margin, no cross veins. veins are parallel to each other.

(Cause accidental intestinal myiasis and forensic importance)

[*Megaselia scalaris* (Plate I)]

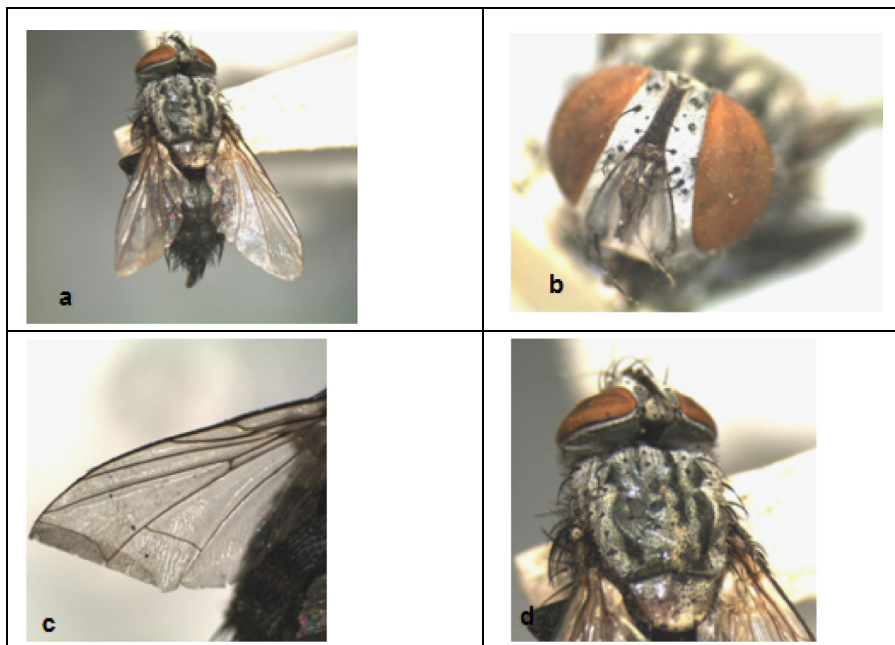


(a) Adult

(b) Head

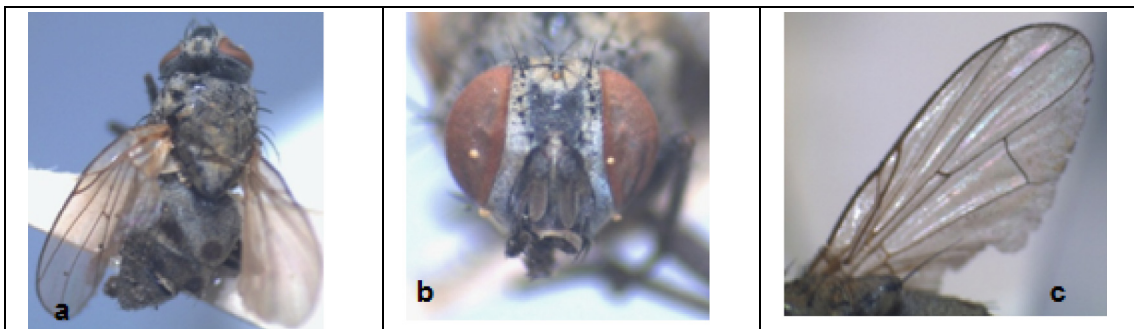
(c) wing

Plate V *Musca domestica*.



(a) Adult (b) Head (c) Wing (d) Thorax

Plate VI *Musca sorbens*.



(a) Adult

(b) Head

(c) Wing

Plate VII *Haematobia irritans*.

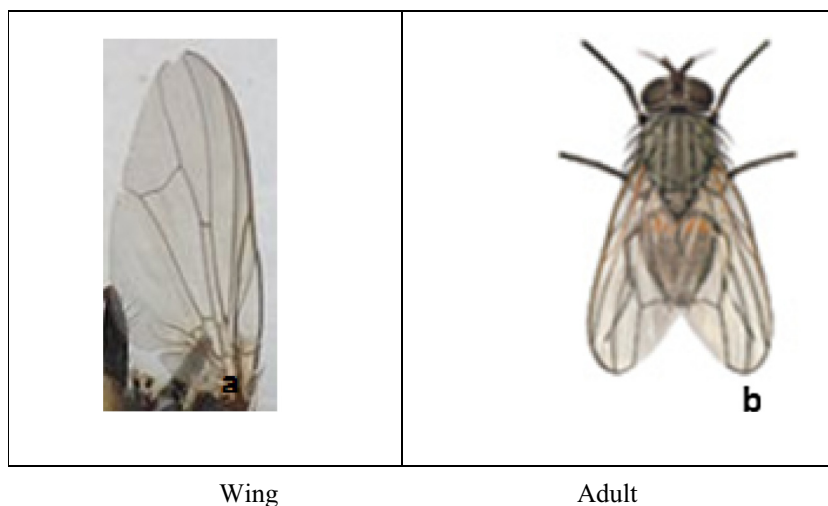
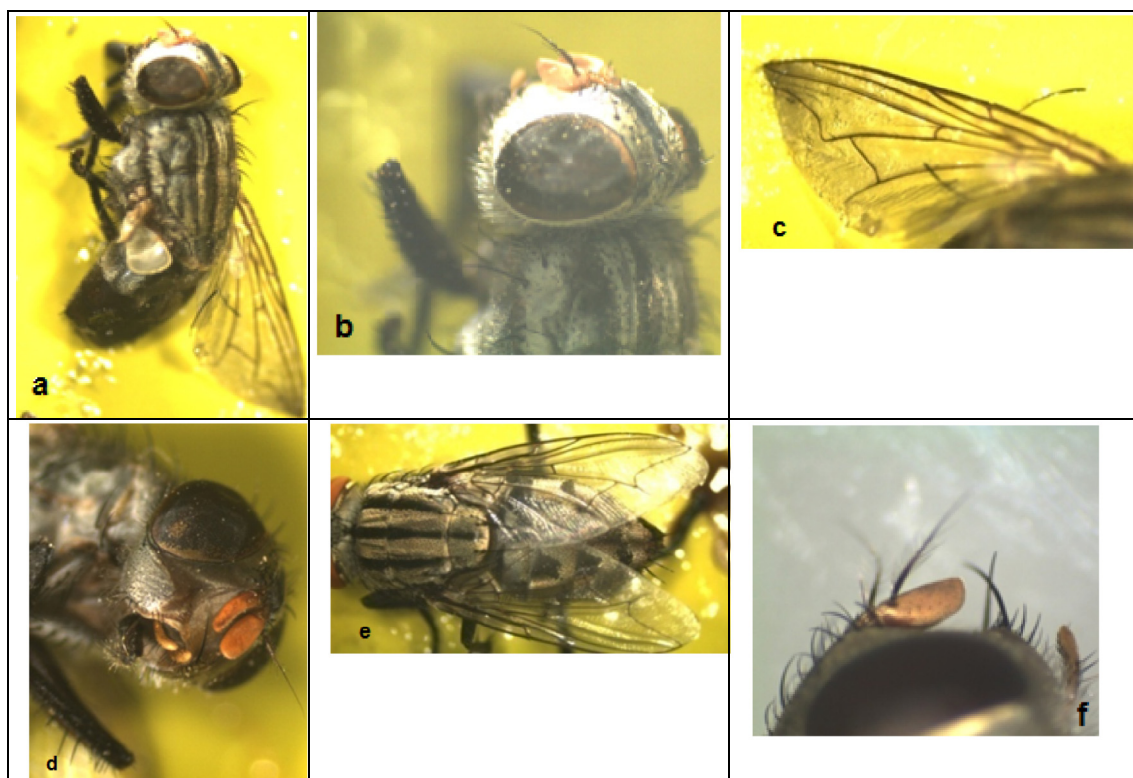


Plate VIII *Fannia canicularis* (Original photographs could not be taken due to damaged specimen).



(a) Adult (b) Head (c) wing (d) Head (front view) (e) Adult (dorsal view) (f) Antenna with arista

Plate IX *Parasarcophaga ruficorni*.

3.2. Family: Syrphidae

Spurious vein present between R & M, anal cell up to wing margins.

Eyes are marbled in black, short brownish yellow hair on thorax and 1st abdominal segment.

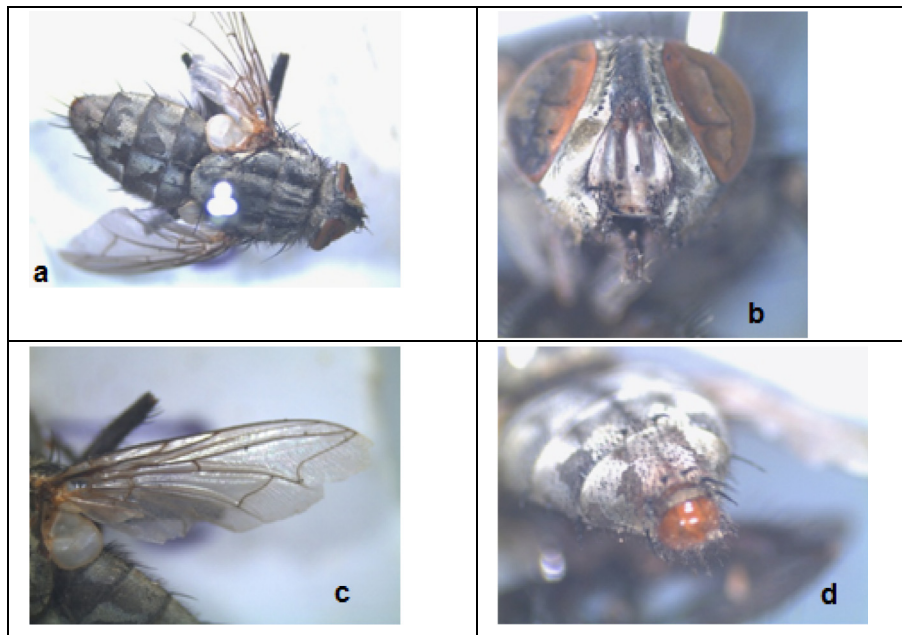
(Cause accidental myiasis, larvae may be ingested with salad or with dirty water)

[*Eristalis taeniops* (Plate II)]

3.3. Family: Ulidiidae (Otitidae)

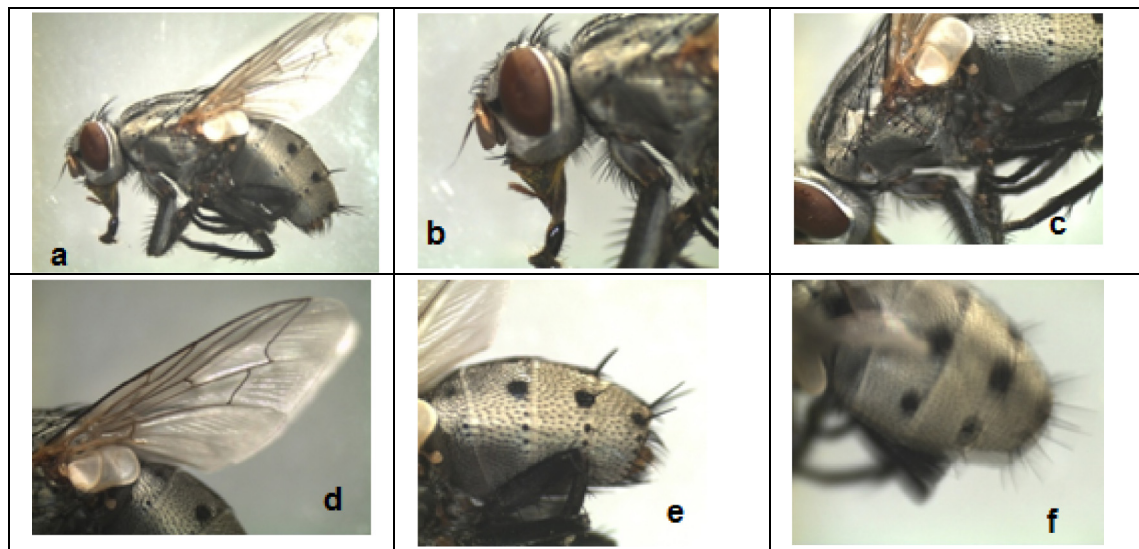
Mesonotal suture absent or incomplete, female ovipositor prominent, clypeus broad, oral vibrissae absent, subcosta complete. Free from radius and ending in costa.

Thorax dark green with incomplete transverse sutures. Lower calypter reduced or absent. Head with 3 ocelli, vibrissae absent. Wing with discal cell and a closed anal cell, 4th vein reach to the end of the wing. Eyes with colored stripes.



(a) Adult (b) Head with Antenna (c) Wing (d) Abdomen

Plate X *Sarcophaga hemorrhoidalis*.



(a) Adult (b) Head (c) Thorax (d) Wing (e) Abdomen (Lateral view) (f) Abdomen (Dorsal view)

Plate XI *Wohlfahrtia nuba*.

(May transport various disease-causing organisms to food material, breed in human corpses)
 [*Physiphora alceae* (Plate III)]

(Mechanical transmission of conjunctivitis & yaws)
 [*Siphunculina* (Plate IV)]

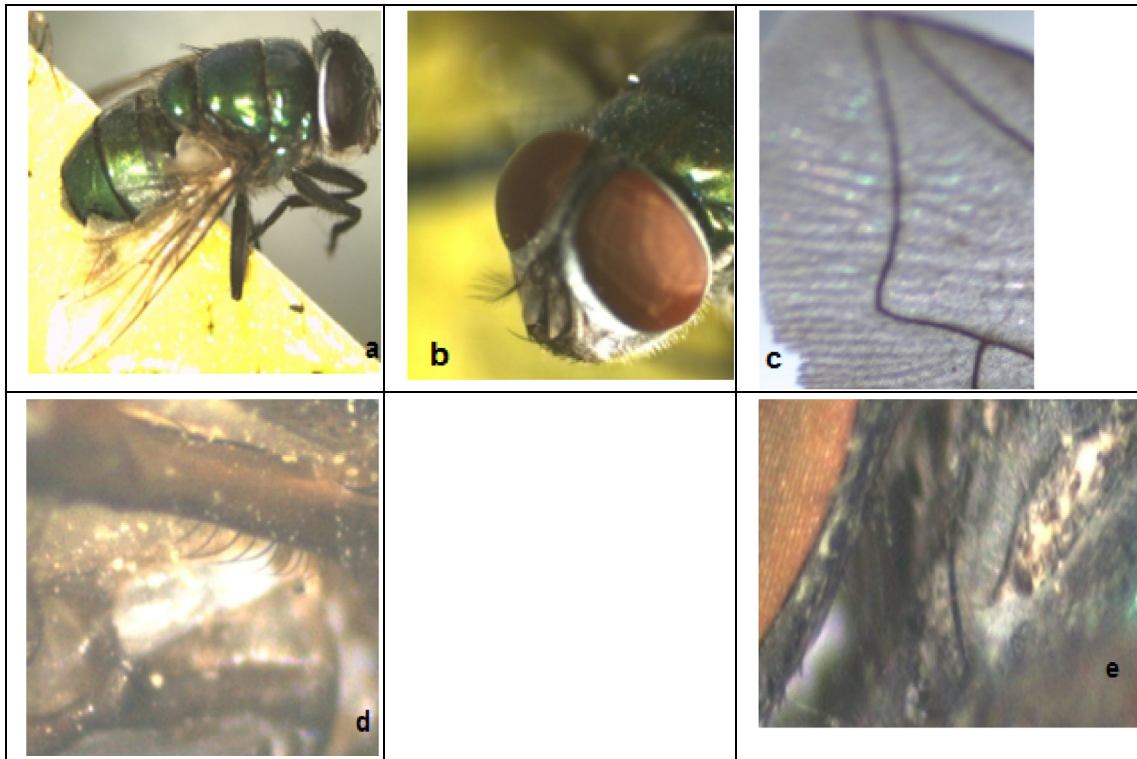
3.4. Family: Chloropidae

Oral vibrissae absent, arista bare or with short hairs, wings without any marking, 6th longitudinal vein and anal vein absent.

Subcosta not visible beyond humeral cross vein. Mesonotum shining black, ocellar triangle with seate, fronto orbital plates black and 2/3 without bristles.

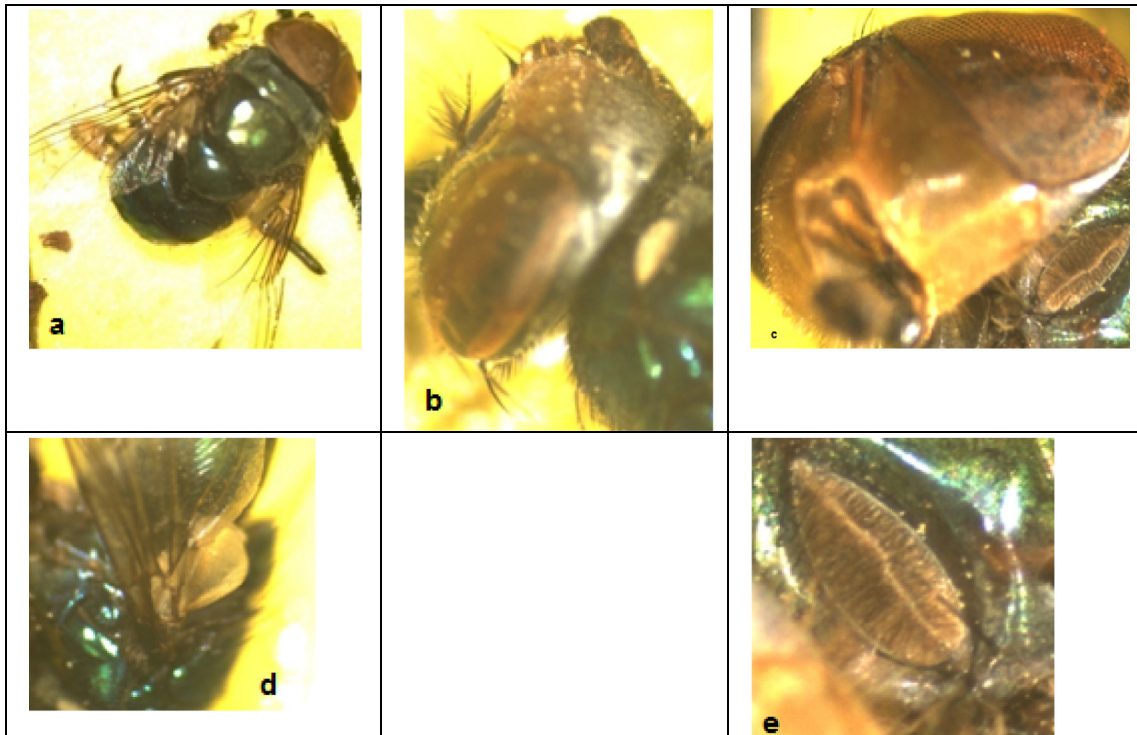
3.5. Family: Muscidae

Thorax and abdomen is dull, thorax with 4 black stripes, sides of abdomen are usually pale, more than one sterno-pleural bristles, scutellum without hair on it under surface. Antennae 3 segmented with aristae which are plumose up to the tip. Wing with subcostal vein reaching costal vein, nearly in straight angle. Vein R2 branched, A1 + Cu A2 and A2 in different shape curve not in sigmoid curve. A2 not reaching up to



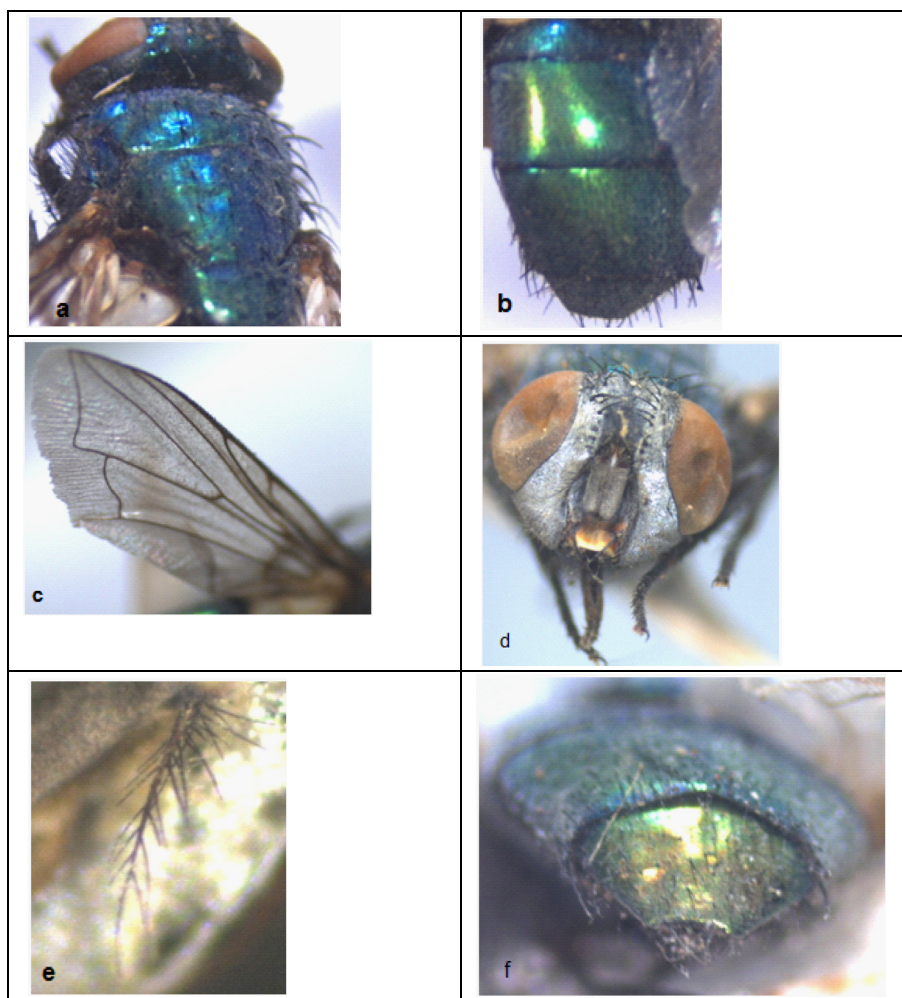
(a) Adult (b) Head with arista (c) Wing (d) Stem vein with setae (e) Thoracic anterior spiracle

Plate XII *Chrysomya albiceps*.



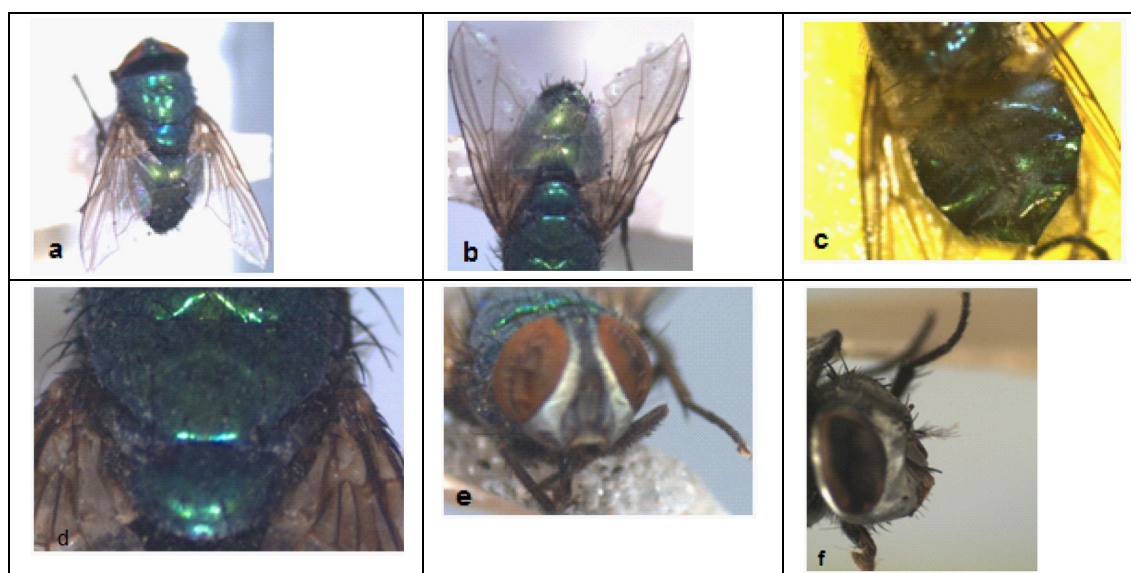
(a) Adult (b) Head (c) Compound eyes (with upper & lower facet enlarged) (d) Calypter (e) Thoracic spiracle

Plate XIII *Chrysomya megacephala*.



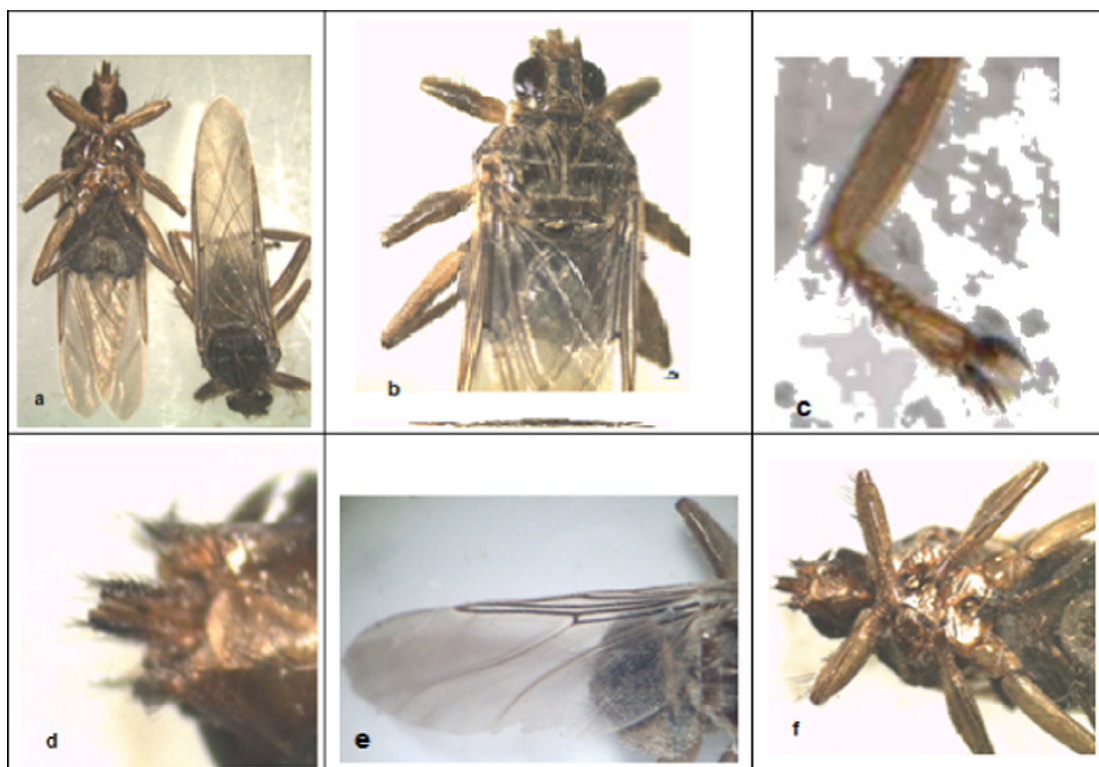
a. Thorax b. Abdomen c. Wing d. Head e. Arista f. Abdomen

Plate XIV *Lucilia sericata*.



a. adult b. Abdomen (Dorsal view) c. Abdomen (ventral view) d. Thorax e. Head f. Arista

Plate XV *Lucilia cuprina*.



(a) Adult (Ventral & Dorsal view) (b) Thorax (c) Legs with bifed claws (d) Mouth Parts (e) wing (f) Thorax & Head (Ventralview)

Plate XVI *Pseudolynchia canariensis*.

wing margin. Hind legs without strong seta at lower base of first tarsomere. Calypter well developed.

Thorax gray in color with 4 black stripes, transverse sutures complete, abdomen yellow below the wings, Wings 4th vein angled with discal cell, sub-apical cell and a close anal cell.

(mechanical transmitter of cholera, typhoid, dysentery diseases. Also cause accidental myiasis of intestine and Urino-genital organs.)

[*Musca domestica* (Plate V)]

commonly named as filth fly or face fly. Characterized by a gray color, and usually grows to a size of 6 mm in length. Thorax with two dark 'Y' shaped stripes. Transverse sutures complete. Abdomen yellow. Wings with discal cell, sub-apical cell and a closed anal cell.

(Both in man and animals act as biological or mechanical vectors of pathogens)

[*Musca sorbens* (Plate VI)]

Maxillary palps sub-equal in length to proboscis, hairs of bucca golden, 3rd antennal segment with rounded corners.

(attack man and animals and suck blood, is an irritant to livestock, skin irritation and wounds invite myiasis producing flies)

[*Haematobia irritans* (Plate VII)]

3.6. Family: *Fanniidae*

Female with gray thorax and 3 faint brown stripes. Abdomen base is yellow in color. Head silvery in color in front of the eyes. White bordered eyes meet in male. Female with one out curved bristle on each side of frons. Vein 2 is lighter in color and strongly curved. 4th vein straight. 6th vein short

(Intestinal and urino-genital myiasis, possible disease carriers, (ingested with cheese, milk or with meat)

[*Fannia canicularis* (Plate VIII)]

3.7. Family: *Sarcophagidae*

Gray or brown flies with at least 3 dark longitudinal stripes on thorax. Antenna black with white hair on gennae Arista never plumose to the tip, but only 2/3 of arista is plumose. Thorax scutum with 3 conspicuous black stripes on a silver or yellowish gray back ground. Abdomen with gray/black checker board. Sixth tergite of the female red in color, separated dorsally with row of strong bristles at the edge. Wing with the sharp angled 4th vein. Orange brown epandrium, long bristles on hind margins of protandrial segment.

Antennae yellowish orange/red. Male is slightly larger than female. White hairs on genae below eyes. Abdomen with gray/black checker board. Wings with sharp angled 4th vein.

KEY FOR DOMINANT FLIES OF PUBLIC HEALTH AND VETERINARY IMPORTANCE IN
JEDDAH SAUDI ARABIA

1. Antennae longer than thorax and with more than eight similar segments with 2 basal segment, arista absent.....**Sub-order: Nematocera**3
(Only two families of nematocera:- Simuliidae and Psychodidae are discussed here)
 - Antennae shorter than thorax.....2
2. Antennae with fused 3 segmented, 3rd segment generally larger than the other two, arista dorsally positioned.....**Sub-order Cyclorhapa**
 - 2nd antennal segment without seam or groove.....**Section: Acalypetrate**....5
 - 2nd antennal segment with a seam or groove.....**Section: calypetrate**.....18
3. Antenna composed of cylindrical and compact segments and never plumose
.....**Fam: Simuliidae** 4
 4. Costa usually with spicules, simple radial sector, wing vein R is one third of wing length
And with dorsal hair, basal cell of the wing is absent, 2nd hind tarsal segment with deep pediculus..... *Simulium* sps.
-- Not as above.....5
5. wings short and broad but narrow at apex, hairy & with parallel veins.
..... **Fam: Psychodidae** 6
6. Body hairy, flagellar segment of antenna pyriform, proboscis elongate, wing venation with two longitudinal veins R₂₊₃ and M₁₊₂, eyes black.....*Phlebotomus papasi*
 - Wings long , narrow rounded at apex..... **Fam: Culicidae** (Not discussed)
7. Oral vibrissae present.....8,11,13
 - Oral vibrissae absent.....14, 16
8. Wing veins thickened on the fore margins of the wing, no cross veins.....**Fam:Phoridae** 9
9. Radial vein thickened ending at Costa near the middle of wing, antenna short with one segmented long arista, hair like process between the facet of compound eyes, hind femur laterally compressed..... *Megaselia scalaris*
10. Incomplete costal vein, 2 breaks in costal vein.....**Fam: Drosophilidae** 11
11. Pale yellow with red eyes female 25 mm long male slightly smaller with dark back, a sex comb on the tarsus of first leg present.*Drosophila melanogaster*
12. Sub-costa not visible beyond humeral cross vein, 6th vein long and anal vein absent.....
.....**Fam: Chloropidae** 13
13. Mesonotum shining black, ocellar triangle with setae, fronto-orbital plates black and 2/3 is without bristles.....*Siphunculina* sps.
14. Spurious vein present between R & M , anal cell up to wing margin. **Fam: Syrphidae** 15
15. Wings large, eyes are marbled black, short brownish yellow hair on thorax and first segment of abdomen..... *Eristalis taeniops*
16. No spurious vein, sub-costa complete free from radius and ending in costa, clypeus broad.....**Fam: Ulidiidae(Otitidae)** 17
17. Thorax with incomplete transverse suture, lower calypter reduced or absent, head with 3 ocelli, wings with discal cell and a close anal cell, 4th vein reach to the margin of the wing, eyes with colored stripes..... *Physiphora alceae*
18. 4th vein angled, vein 6 shorter never reach wing margin, more than one sternopleural bristles, scutellum without hair on its undersurface, hypopleura without bristles below the spiracle.....**Fam: Muscidae** 19,20,21

19. Thorax grey with four black stripes, transverse suture complete, short dark bristles in pro-pleural depression, 5th wing vein angled with discal cell, subapical cell and a close anal cell.....*Musca domestica*
20. Thorax with two dark 'Y' shaped stripes. Transvers sutures complete, Abdomen yellow wings like *Musca domestica*..... *Musca sorbens*
21. Maxillary palps sub-equal in length to proboscis, hairs of bucca golden, 3rd antennal segment with rounded corners.....*Haematobia irritans*
- Hypopleura with bristles below the spiracle.....24
22. Vein 2 is lighter in color and strongly curved, hind tibiae with dorsal bristles, vein 7 is strongly curved towards wing tip, sub costal vein smooth..... **Fam: Fanniidae** 23
23. 4th vein straight, 6th vein short, head silvery in color in front of the eyes. Abdomen base is yellow in color.....*Fanniia canicularis*
24. Four notopleural bristles with gray body & three black thoracic stripes.
.....**Fam: Sarcophagidae** 25,26,27
- Only two notopleural bristles with metallic green/blue body28
25. Antennae yellowish orange/red. White hairs on genae below eyes. Abdomen with grey/ black checker board..... *Para sarcophaga ruficornis*
26. Antenna black with white hair on genae. Sixth tergite of the female red in color, separated dorsally with row of strong bristles at the edge..... *Sarcophaga haemorrhoidalis*
27. Abdomen is also grey with 3 black round spots at the end of each segment. Head with bare arista or with very short hairs. Less hairs on the head than other members of Sarcophagid flies..... *Wohlfahrtia nuba*
28. No dark stripes on the thorax, abdomen uniformly colored. Arista plumose up to tip.
Wing vein M strongly curved.....**Fam: Calliphoridae**
- Stem vein of the wing with a row of dorsal setae..... 29
- Stem vein of the wing without setae..... 31,32,33
29. Metallic green with narrow dark lines on the rear edge of abdominal segments, anterior thoracic spiracle white/ pale yellow, head with silvery or white hairs... *Chrysomya albiceps*
30. Genial dilation and bucca with golden/ orange with orange setae. Arista plumose. Blackish/brown thoracic anterior spiracle..... *Chrysomya megacephala*
31. Dark almost black, compact body, antennae and ground of head reddish in color, Calypters brown, basicota yellowish brown.....*Calliphora (erythrocephala) vicini*
32. Femora of prothoracic leg dark Metallic blue or black, central occipital area with 6-8 setae (may be more), pollinose ventrally. Three pairs of acrostichals bristles on the mesothorax.
Mouth parts yellowish. Head small and cheeks silvery and smooth..... *Lucilia sericata*
33. Abdomen strongly coppery, Femora of prothoracic leg is metallic green, Sternite & edges of tergite with bunches of long thick hairs. No silver tomentum (Pollinose) in female.....
..... *Lucilia cuprina*
34. Head small, dorso-ventrally flattened, leathery texture, stout claws in the legs.
..... **Fam Hippobocidae** 34
35. wings of normal shape used for flight and with only one cross vein,
apical tooth of claw bifid and strong..... *Pseudolynchia canariensis*

(It is a well known flesh fly species of medical importance, both as myiasis producing agent and forensic importance [*Parasarcophaga ruficornis* (Plate IX)]

Antenna black with white hair on gennae. Abdomen with gray/black checker board. Sixth tergite of the female red in color, separated dorsally with row of strong bristles at the

edge. Wing with the sharp angled 4th vein. Orange brown epandrium, long bristles on hind margins of protandrial segment. Arista with long hair.

(Serve as a mechanical vector for disease, has also been found to carry polio virus, produce myiasis on necrotic or dead flesh in both humans and animals.)

[*Sarcophaga haemorrhoidalis* (Plate X)]

Thorax gray in color with 3 black stripes. Abdomen is also gray with 3 black round spots at the end of each segment.

Head with bare arista or with very short hairs. Less hairs on the head than other Sarcophagids. Calypter present. Wing venation showing 4th vein sharply angled.

(An occasional secondary invader of wounds in camel, can cause severe myiasis, forensically important)

[*Wohlfahrtia nuba* (Plate XI)]

3.8. Family: Calliphoridae

Body is metallic blue, green, bronze or brown yellow in color. No dark stripes on thorax, mesonotum some time with three dark stripes. Abdomen uniformly colored. Arista plumose up to tip, antennae three segmented. Wing vein M strongly curved. Branched R₂ vein. Calypters are well developed.

Body bright metallic green colored. Thorax with complete transverse sutures. With narrow dark lines on the rear edge of the abdominal segments. No prostigmatic bristles. Thoracic anterior spiracle white/pale yellow. Wing vein 4 has sharp bend. Ocellar bristles present. Wing basal stem vein with setae. Arista plumose. Head silvery or white in color with many white hairs. Ocelli 3 in number. Post ocular setae well developed.

(Cause specific myiasis in wounds, sores and nasal cavities.

It is of great medical and sanitary importance, being associated with myiasis, also of importance in forensic science)

[*Chrysomya albiceps* (Plate XII)]

Shining metallic blue/green thorax and abdomen with complete transverse sutures. Thick setae on meron. Wing vein 4th has sharp bend. Stem vein setose. –Large red eyes. Male frons very narrow (nearly touching eyes). Genial dilation and bucca with golden/orange with orange setae. Arista plumose. Blackish/brown thoracic anterior spiracle. Lower calypter well developed dark white at base only.

(serves as a potential vector of many diseases due to its close association with human dwellings. It is also considered important in medical, veterinary and forensic sciences)

[*Chrysomya megacephala* (Plate XIII)]

Sub costal sclerite with stiff black setulae, abdomen varying from bright green to coppery, frontal stripe twice as wide as parafrontal. Femora of prothoracic leg dark Metallic blue or black, central occipital area with 6–8 setae (may be more), pollinose ventrally. Three pairs of acrostichal bristles on the mesothorax. The back is hairy and the overall diameter is about 8–10 mm. The squamae at the base of the wings are hairless. Mouth parts yellowish. Head small and cheeks silvery and smooth.

(It is an important species to forensic entomologists, it is responsible for myiasis in sheep and vector for pathogens. It is also used as a biosurgery agent)

[*Lucilia sericata* (Plate XIV)]

Abdomen strongly coppery, frontal stripe equal to parafrontal. Femora of prothoracic leg is metallic green, central occipital area with usually 1 or 2 setae. Sternite & edges of tergite with bunches of long thick hairs. No silver tomentum (Pollinose) in female.

[*Lucilia cuprina* (Plate XV)]

3.9. Family: Hippoboscidae

Head small, dorso-ventrally flattened, leather texture, stout claws in the legs, wings present on two species attacking birds & camels.

Body brown in color, dorso-ventrally flattened, wings of normal shape used for flight.

Apical tooth of claw bifid and strong, wings with only one cross vein,

(Vector of pigeon malaria)

[*Pseudolynchia canariensis* (Plate XVI)]

5. Conclusion

The present key is prepared for the quick morphological characterization and identification of the dominant flies of public health & veterinary importance for the benefit of field workers and entomologist. The list of prevalent fly species is not complete. With the evolving environment and climate change with emerging disease threats and outbreaks there is a need for more intensive survey to trap and register different species not recorded here. Future studies should be focused on the molecular studies for accurate identification of different species and their siblings.

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