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An Overview of the Calliphoridae (Diptera) of Saudi Arabia with New Records and Updated List of Species

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ABSTRACT

Despite the species richness of the blow fly (Calliphoridae: Diptera) fauna (1600 species), the relevant environmental, medical, agricultural, and forensic knowledge of these species found in Saudi Arabia is limited. As part of a study on the biodiversity of Diptera of south-western Saudi Arabia a survey of the Diptera fauna of Jazan, Asir and Najran was performed between 2010-2016 at 17 sites, mainly using Malaise traps, sweep nets and baited traps. Eighteen species of Calliphoridae were identified and recorded in this study, seven of which were recorded for the first time. This makes the total number of Calliphoridae species in Saudi Arabia (including 26 species previously recorded and excluding two species which were synonymized namely: *Rhyncomya zumptii* Peris 1952; *Chrysoma regalis* Robineau-Desvoidy 1830) to be 44. A list of all species of Calliphoridae recorded from Saudi Arabia is provided. Images of five species are presented. Biological information on each species (where known) and geographical distribution are included. In addition to the results of the identifications all available literature about Calliphoridae of Saudi Arabia is summarized and analysed. The species recorded in this study are more Afrotropical in origin than they are to other regions. The need for further field and laboratory work and surveillance is highlighted.

Key words: Calliphoridae, Saudi Arabia, afrotropical, new records.

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INTRODUCTION

Calliphoridae is the most common family of higher flies of diverse biology with considerable impact on environment, agriculture and health of human beings and cattles (Deeming, 1995; Dawah & Abdullah, 2009). It is a family of large sized, dull or coppery coloured, shiny and metallic bodied flies, often gleaming green, blue, black, purple or coppery colored thoraces and abdomens (Kettle, 1992). There are about 1600 described species in 150 genera distributed worldwide (Grella et al, 2015; Thompson, 2013). They occur almost all over the world and may be found in tropical rain forests, deserts, oceanic islands, temperate lands and Arctic wastes. Calliphoridae is absent from Antarctica only (Erzinçlioğlu, 1996). There is a dispute over the tribes and the subfamilies of this family. However, at least 12 subfamilies are recognizable, i.e., Calliphorinae, Luciliinae, Chrysomyinae, Toxotarsinae, Melanomyinae, Polleniinae, Helicoboscinae, Ameniinae, Plumosiinae, Aphyssurinae, Bengaliinae and Prosthetosomatinae (Marshall, 2012). The calliphorinae commonly occur around houses in search of breeding material and food and are attracted to meat, carrion, feacal matter and dead animals for egg laying and to cheese for food (Jadav & Sathe, 2014). Adult calliphorids are reported to cluster in dark parts of buildings where they overwinter (e.g. *Pollenia* Robineau-Desvoidy) (Szpila & Draber-Mońko, 2008; Rognes, 1987a; b).

The biology of Calliphoridae has been extensively studied due to its forensic importance but this has been limited to a few genera only. The females are dependent on a protein rich substrate for larvae development, as provided by animal-associated tissues or by-products (Stevens, 2003). The females of the majority of species lay large numbers of whitish rice-like eggs on any decomposing organic matter or flesh, these hatch into larvae rasping the food substrate along with bacteria. However, macrolarviparity occurs in a variety of diverse species of Calliphoridae (Ferrar, 1987). Fully mature larvae pupate in soil (Draber-Mońko, 2004; Marshall, 2012). The larvae of some calliphorid species (e.g. *Chrysomya* Robineau-Desvoidy and *Lucilia* Robineau-Desvoidy) have considerable importance to public health and may be mechanical vectors of pathogens of humans, causing facultative myiasis in animals and humans, as well as being used in studies of legal medicine as forensic science (Zumpt, 1965; Greenberg, 1971, 1991; Furlanetto, Campos, & Harsi, 1984; Guimarães & Papavero, 1999; Thyssen, Moretti, Ueta, & Ribeiro, 2004; Maldonado & Centen, 2013). Calliphoridae are known as the initial colonizers in the faunal succession on human cadavers (Smith, 1986; Vélez & Wolff, 2008; Liu et al, 2011). Therefore, their larvae are very useful in forensic investigations in solving the problems related to postmortem interval/estimations of time of death, murder, suicide, sexual molestation, child neglect and abuse etc., (Greenberg, 1991; Erzinçlioğlu, 1996; Jadav & Sathe, 2015; Roe & Higley, 2015). Many calliphorid species are parasites of earthworms, snails, oothecae of orthopteran insects and Noctuid moths (Deeming, 1996; Rognes, 2010; Coupland & Barker, 2004; Bowser, 2015). Moreover, the species *Chrysomya megacephala* Fabricius is responsible for economic losses in fishery businesses in Southeast Asian countries, where the fish being exposed to the sun to dry (Esser, 1990; 1991). In case of sever infestation, the Calliphoridae can cause an 80%

reduction in mammal population (Parchami-Araghi, 2013). Furthermore, some calliphorid larvae (e.g. *Protocalliphora* Hough) live in birds' nests and feed on the blood of nestlings (Bennet & Whitworth, 1991). Many calliphorid species contaminate food with pathogens (e.g. bacteria, viruses, protozoans and helminthes) which they carry, causing various enteric and other diseases in man. Therefore, such species are of the greatest hygienic importance and pose a permanent threat to human health (Rognes, 1998).

Despite its drawbacks, Calliphoridae has also been utilized for human betterment. The maggots due to their ability to consume flesh appear to possess exceptional healing properties against chronic osteomyelitis, caused by *Streptococci* and *Staphylococci* bacteria (Baer, 1931). The use of maggots for therapeutic purposes has been replaced by antibiotics but, when in vogue, the practice was extensive and, in North America alone, over 5000 cases of osteomyelitis and related disorders were treated with maggots in the early 1930s (Leclercq, 1969). Adult calliphorids were said to have been used therapeutically as a cure for eye ailments and baldness although no record appears to exist as to the efficacy of the treatments (Heath, 1982).

Some calliphorids are regular visitors of certain plants for sugars resulting in cross pollination, but it is not known how their abilities compare with those of bees. Some flowering plants (e.g. *Hedera helix* L.) may be completely dependent on flies for pollination (Faegri & van der Pijl, 1971). There are records of the use of calliphoridae in cages and sleeves as crop pollinators on onions and then in self and cross- fertilization experiments with carrots (Jones & Emsweller, 1934; Clement, Hellier, Elberson, Staska, & Evans, 2007; Vasconcelos & Salgado, 2014). On the other hand, some African and Chines natives used to bury meat to breed maggots (Bodenheimer, 1951). They were said to be very fond of this, to Western stomachs, repulsive delicacy. Calliphoridae maggots have been used as fishing bait in past (Heath, 1982) and still are by freshwater fishermen.

In the Middle East, a single case of myiasis in a 14 year old female was reported (Ansari & Oertley, 1982) followed by 12 cases of myiasis in sheep, both caused by *Chrysomyia bezziana* Villeneuve (AlAhmed, 2002). Calliphoridae are also known from Bahrain, Kuwait, Qatar, Oman, United Arab Emirates, Iraq and Iran (AlAhmed, 2004). Abdul-Rassoul (1976) recorded six species of Calliphoridae from Iraq. Al-Houty (1989) reported five species of Calliphoridae from Kuwait. Deeming (1996; 2008) reported 21 species of Calliphoridae from Oman and 16 species from United Arab Emirates, respectively. Al-Ahmadi & Salem (1999) and Abu-Zoherah, Al-Taher, & Tilkian (1993) listed 22 species of Calliphoridae in combination from Saudi Arabia. Deeming (2008) listed 17 species of Calliphoridae from United Arab Emirates, Oman, Saudi Arabia and Yemen. Dawah & Abdullah (2009) recorded 20 species of Calliphoridae of which 13 were new to Saudi Arabia. Setyaningrum & Aldhafer (2014) recorded 34 species of Calliphoridae from Saudi Arabia. Rognes (2002) listed 43 species of Calliphoridae in Palestine and adjacent areas. The objective of this paper is to present our investigation of Calliphoridae in south-western Saudi Arabia, report new records and provide a checklist of Calliphoridae species recorded from Saudi Arabia, with some biological information, taxonomic remarks and world-wide distribution of species.

MATERIALS AND METHODS

Collection methods and sites

With the aim of exploring the biodiversity of Diptera in Southwest Saudi Arabia, insect specimens for the present study were collected with Malaise traps, set up by the authors at 17 sites in Jazan, Asir and Najran (Saudi Arabia) (Table 1), during 2010-2016. Malaise trap is a commonly used sampling technique for low flying insects (e.g. Diptera). It does not need to be observered throughout the day, hence it is economical and time saving (Malaise, 1937). Some specimens were also collected sporadically from wild environments, at dams, wadis and road margins using sweeping nets and pooters. The Malaise traps were situated in a variety of habitats, and at various altitudes up to 2685 meters above sea level. The types of habitat were a rather barren coastal plain which was subject to seasonal rains, wadis, mountains with rain at any month of the year resulting in pasture and furthermore supporting cattle, thus have added fertility (Fig. 1). Wherever possible these traps were located in farms where they could be protected. The farms were visited at three week intervals to collect the insects and add more alcohol to the collecting containers fitted in Malaise traps. In addition specimens collected using Malaise traps and sweeping from 2002-2004 are referred to with full information in the text and listed in the table of the sites collection. Calliphorid flies had to be sorted from mixed diptera samples, dried (by passing the specimens through alcohols to absolute to remove water, then into ethyl acetate for few days, then air dry to protect the tomentum on the surface). They were pinned and labelled before being studied. Where species are not recorded for the first time, reference is made to the first published records and others.

Identification and deposition of the of flies

Specimens of Calliphoridae were identified to species level using Zumpt (1965); Crosskey & Lane (1993); Deeming (1996); Rognes (2002) and various papers covering the Palaearctic, Oriental and Afrotropical fauna. Where necessary genitalia dissection were made to establish correct identity. The technique employed for preparation of male and female genitalia which is a prerequisite to identification of some species, was as described by Dawah & Abdullah (2006).Voucher specimens of some species collected have been deposited at the National Museum of Wales, Cardiff (NMWC) and in the Centre for Environmental Research and Studies (CERS), Jazan University (Saudi Arabia).

Distribution and nomenclature

The distribution sections and nomenclature of the species are based on the *Catalogue of the Diptera of the Afrotropical Region* (Pont, 1980) and the *Catalogue of Palaearctic Diptera* (Schumann, 1986) or other references which are listed in the text. The Calliphoridae classification to subfamilies is according to Rognes (2002). Information on biology, distribution and taxonomic remarks on other species of Calliphoridae (Table 2) of Saudi Arabia can be found in Dawah & Abdullah (2009) and Setyaningrum & Aldhafer (2014).

Photography and illustrations

Photographs of five species were taken in the National Museum of Wales, Cardiff, UK (NMWC) using images from a video camera and "Synaptics Automontage" software to produce a montage image of the species.

Table 1. List of sampling localities with coordinates, altitude and methods (Serial number S.N.).

S.N.	Locality	Coordinates	Altitude	Method
1	Asir, Abha, Maraba, Al-Hudaithy fruit farm, mainly mango, banana and wild plants, 60 km south of Abha.	17º51'N42º23'E	0226m	Malaise trap, Sweeping, Sand fly trap
2	Asir, Keratha, Al-Ethrebany fruit farm, mainly mango, banana and wild plants, 38 km south of Abha	18º04'N 42º31'E	0994m	Malaise trap, Sweeping
3	Asir, Abha, Hay Al-Nusub (Abha Farm Centre), various vegetables and wild plants	18º13'N 42º30'E	2199m	Malaise trap, Sweeping
4	Asir, Abha, Hay Al-Menhel, various vegetables and wild plants	18 º13'N42º30'E	2150m	Malaise trap, Sweeping
5	Asir, Al-Souda, BaniMazen, various grasses	18º11'N 42º30'E	2199m	Malaise trap, Sweeping
7	Asir, Abha, Madinate Al-Ameer Sultan, Hay Al-Sad, fruit plants, vegetables, wild plants and grasses	18º17'N 42º37'E	2042m	Malaise trap, Sweeping
8	Khaybar Al-Janob, Hay Al-Salam,	18°47'N42°52'E	1150m	Sweeping
9	Jazan, Abu Aresh, Al-Mahdage Village	17º00'N42º50'E	80m	Malaise trap, Sweeping and Baiting trap
10	Jazan, Fifa, Al-Tatweer Centre	17º17'N43º08'E	800m	Malaise trap, Sweeping
11	Jazan, Harob, Wadi Lajab	17º27'N42º52'E	529m	Sweeping, Malaise trap
12	Jazan, Farasan Island, Al-Maraq	16º41'N 42º05'E	12m	Rearing, Sweeping and Malaise trap
13	Jazan, Sabya, Basahy Farm, Mango farm	17º07'N 42º37'E	29m	Malaise trap
14	Jazan, Sabya, Al Husseini farm	17º15'N 42º68'E	58m	Baiting trap
15	Jazan, Sabya, Al-Sunef Mango farm	17º07'N 42º30'E	60m	Malaise trap
16	Jazan, Beish	17º37'N 42º54'E	81m	Baiting trap
17	Najran, Al-Shurfa, SalehMaqbol Farm	17º31'N 44º15'E	1261m	Malaise Trap and Sweeping

RESULTS

Eigteen species of Calliphoridae were identified and recorded in this study, seven of which were recorded for the first time from south-western Saudi Arabia. This makes the total number of Calliphoridae species in Saudi Arabia (including 26 species previously recorded and excluding two species which were synonymised *Rhyncomya zumptii* Peris 1952; *Chrysoma regalis* Robineau-Desvoidy 1830) to be 44. A list of all species of Calliphoridae recorded from Saudi Arabia is provided. Images of five species are presented. Biological information on each species (where known) and geographical distribution are included. In addition to the results of the identifications, all available literature about Calliphoridae of Saudi Arabia has been summarized (Table 2). The species recorded in this study are more Afrotropical in origin than they are to other regions (Fig. 7).

Table 2. List of Calliphoridae species recorded from Saudi Arabia (Serial number S.N.).

S.N.	Species	References	Origin
Subfamily Rhiniinae			
1	*Cosmina aenea* (Fabricius, 1805)	Abu-Thuraya, 1982	A
2	*Cosmina arabica* Robineau-Desvoidy, 1830	Dawah & Abdullah, 2009; El-Hawagry, et al, 2017	P
3	*Cosmina fishelsohni* Rognes, 2002	This study	A,P
4	*Cosmina fuscipennis* Robineau-Desvoidy, 1830	Dawah & Abdullah, 2009	A
5	*Cosmina prasina* (Brauer and Bergenstamm, 1889)	Dawah & Abdullah, 2009; El-Hawagry, et al., 2017	A, P
6	*Cosmina viridis* (Townsend, 1917)	Abu-Thuraya, (1982); El-Hawagry, et al, 2013; 2017;This study	A, P
7	*Isomyia terminata* (Wiedemann,1830)	Dawah & Abdullah, 2009; El-Hawagry, et al, 2017	A, P
8	*Pararhynchomyia cribriformis* Becker,1910	Abu-Zoherah et al, 1993	A
9	*Rhinia apicalis* (Wiedemann, 1930)	Dawah & Abdullah, 2009; El-Hawagry, et al, 2017	A,O, P
10	*Rhinia nigricornis* (Macquart, 1843)	This study	A.
11	*Rhyncomya aravaensis* Rognes, 2002	This study	P
12	*Rhyncomya bullata* Deeming, 1996	Dawah & Abdullah, 2009	P
13	*Rhyncomya callopis* (Loew, 1856)	This study	P
14	*Rhyncomya cassotis*Walker, 1849	This study	A
15	*Rhyncomya desirtica* Peris, 1951	Abu-Zoherah et al, 1993	A, P
16	*Rhyncomya jordanensis* Peris, 1951	Dawah & Abdullah, 2009	P
17	*Rhyncomya nigripes* (Séguy,1933)	Dawah & Abdullah, 2009	P
18	*Rhyncomya seguyi* (Grunin,1957)	Abu-Zoherah et al, 1993	A
19	*Rhyncomya sinaiensis* Rognes, 2002	Setyaningrum & Aldhafer, 2014	P
20	*Rhyncomya tristis* Séguy,1933	Abu-Zoherah et al, 1993	A
21	*Rhyncomya varifrons* Becker,1910	Abu-Zoherah et al, 1993	A
22	**Rhyncomya zumptii* Peris, 1952	Setyaningrum & Aldhafer, 2014	A
23	*Stomorhina chapini* Curran, 1931	This study	A
24	*Stomorhina cribrata* (Bigot, 1874)	Dawah & Abdullah, 2009	A, P
25	*Stomorhina lunata* (Fabricius, 1805)	Dawah & Abdullah, 2009	A,O, P
26	*Stomorhina rugosa* (Bigot, 1888)	Dawah & Abdullah, 2009; El-Hawagry, et al, 2017	A
27	*Metalliopsis arabica* Deeming, 2008	Deeming, 2008	P
Subfamily Chrysomyinae			
28	*Chrysomya albiceps* (Wiedemann, 1819)	Shalaby, 1962; El-Hawagry, et al, 2013; 2016; 2017; This study	A,O, P
29	*Chrysomya bezziana* Villeneuve,1914	Ansari & Oertley, 1982; Al-Ahmad, 2002	A,P, O
30	*Chrysomya chloropyga* (Wiedemann, 1881)	Büttiker et al, 1979	A, P

*Co: Cosmopolitan; A: Afrotropical; P: Palaearctic; O: Oriental. Notes for*Chrysoma regalis; **R. zumpti*; see text under *C. marginalis* and *R. tristis*.

Table 2. Continued.

S.N.	Species	References	Origin
31	*Chrysomya marginalis* (Wiedemann, 1830)	Büttiker et al, 1979; This study	A,O, P
32	*Chrysomya megacephala* (Fabricius, 1794)	Ramadan & Al-Bihari, 1980; This study	CO
33	*Chrysomya putoria* (Wiedemann, 1830)	Abu-Zoherah et al., 1993 as: *C. chloropyga*; El-Hawagry, et al, 2016; 2017	A
34	**Chrysoma regalis* Robineau-Desvoidy, 1830	Dabbour, 1979; El-Hawagry, et al, 2013; 2016; 2017	A, P
Subfamily Calliphorinae			
35	*Bengalia minor* Malloch, 1927	Abu-Thuraya, 1982; This study	
36	*Calliphora croceipalpis* Jaennicke, 1867	Abu-Zoherah, et al, 1993; El-Hawagry, et al., 2016; 2017; This study	A
37	*Calliphora vicina* Robineau-Desvoidy, 1830	Abu-Zoherah, et al, 1993; El-Hawagry, et al, 2016; 2017; This study	CO
38	*Hemipyrellia pulchra* (Wiedemann, 1830)	This study	A
Subfamily Luciliinae			
39	*Lucilia cuprina* (Wiedemann, 1830)	Büttiker et al, 1979; El-Hawagry, et al, 2017; This study	CO
40	*Lucilia sericata* (Meigen, 1826)	Walker & Pittaway, 1987; El-Hawagry, et al, 2013; 2016; 2017; 2018; This study	CO
41	*Pericallimyia greatheadi* Zumpt, 1971	Setyaningrum & Aldhafer, 2014; This study	A
Subfamily Auchmeromyiinae			
42	*Cordylobia anthropophagi* (Blanchard &Berenger –Féraud, 1872)	Büttiker et al., 1979; This study	A, P
Subfamily Polleniinae			
43	*Pollenia dasypoda* Portschinsky, 1881	Dabbour 1979	P
44	*Pollenia hungarica* Rognes, 1987	Setyaningrum & Aldhafer, 2014; El-Hawagry, et al, 2013; 2016	P
45	*Pollenia pediculate* Macquart, 1834	Dawah & Abdullah, 2009	CO
46	*Pollenia rudis* (Fabricius, 1794)	Dawah & Abdullah, 2009; El-Hawagry, et al, 2016; 2017	CO

*Co: Cosmopolitan; A: Afrotropical; P: Palaearctic; O: Oriental. Notes for*Chrysoma regalis; **R. zumpti*; see text under *C. marginalis* and *R. tristis*.

Species Account

Subfamily Rhiniinae

Cosmina aenea (Fabricius, 1805)

Dictya aenea Fabricius, 1805: *Systema antliatorum secundum ordines*, *genera*, *species adiectis synonymis*, *locis*, *observationibus*, *descriptionibus*: 328.

Distribution: This species was first recorded from Saudi Arabia by Abu-Thuraya (1982). It was described from Guinea. A widespread in the Afrotropical Region (Pont, 1980).

Remarks: Biology unknown.

Cosmina arabica Robineau-Desvoidy, 1830

Cosmina arabica Robineau-Desvoidy, 1830: *Essai sur les Myodaires*, 2: 424.

Material examined: Saudi Arabia: 2♂♂, 2♀♀, Asir, Karatha, Al-Ethrebany Fruit Farm, 01-25.05.2013, Malaise trap, H.A. Dawah (CERS); 14♂♂, 8♀♀, Asir, Maraba, Al-Hudaithy Fruit Farm, 01-17.06.2003, Malaise trap, H.A. Dawah (NMWC; CERS).

Distribution: This species was first recorded from Saudi Arabia by Dawah & Abdullah (2009); El-Hawagry, Abdel-Dayem, El-Sonbati, & Al-Dhafer (2017). A species described from the Arabian Peninsula and is recorded from Oman, United Arab Emirates and Yemen (Pont, 1980; Schumann, 1986; Deeming, 1996; 2008).

Remarks: *C. arabica* is not known from Israel (Rognes, 2002). Other published records from Israel such as the one in Pont (1980: 780) stem from Peris (1951) and are based on misidentification which is explained in Rognes (2002: 27).

Fig. 1. The most sampled sites: (a) Jazan, Abu Aresh, Al-Mahdag village; (b) Jazan, Fifa, Al-Tatweer Centre, (photo by Habib Khemira); (c) Asir, Maraba, Al-Hudaithy Fruit Farm (d) Asir, Abha, Hay Al-Nusub; (e) Asir, Abha, Madenate Al-Ameer Sultan (f) Asir, Al-Souda, Bani Mazen (photo by Othman Abdullah).

***Cosmina fishelsohni* Rognes, 2002**

Cosmina fishelsohni Rognes, 2002: *Entomologica Scandinavica* (=*Insect Systematics & Evolution*) supplement, 59: 21-24.

Material examined: Saudi Arabia: 1♂, Jazan, Abu Aresh, Al-Mahdag Village, 01.02-03.04.2011, Malaise trap, H.A. Dawah (CERS).

Distribution: This is first record from Saudi Arabia. The species was described from Israel and Palestine and is further recorded from United Arab Emirates (Deeming, 2008).

***Cosmina viridis* (Townsend, 1917)**

Synamphoneuropsis viridis Townsend, 1917: *Record of the Indian Museum* (=*Records of the Zoological Survey of India*),13: 199.

Material examined: Saudi Arabia: 1♂, Jazan, Abu Aresh, Al-Mahdag Village, 21.02.2013, Malaise trap, H.A. Dawah (CERS); 1♂, same data but, 01.07-30.08.2010 (CERS); 2♂♂, 3♀♀, Jazan, Sabya, Al-Sunef Mango Farm, 08.05.-17.06.2003, H.A. Dawah (NMWC; CERS).

Distribution: This species was first recorded from Saudi Arabia by Abu-Thuraya (1982); El-Hawagry, Khalil, Sharsf, Fadl, & Aldawood, 2013; El-Hawagry et al, 2017). It was described from India. Known from the Palaearctic Region: Iran; Afrotropical Region: Ethiopia, Oman and Yemen; Oriental Region: India (Pont, 1980; Schumann, 1986; Deeming, 1996; 2008). In addition there are some specimens in NMWC collected from Gambia, Mali and Yemen.

Remarks: Biology; unknown.

***Isomyia terminata* (Wiedemann, 1830)**

Musca terminata Wiedemann, 1830: *Aussereuropäischen Zweiflügeligen Insekten*, 2: 414.

Material examined: Saudi Arabia: 1♂, Jazan, Abu Aresh, Al-Mahdag Village, 01.02-03.04.2011, Malaise trap, H.A. Dawah (CERS); 1♂, 1♀, Asir, Abha, Madenate Al-Ameer Sultan, 25.02-25.05.2002, Malaise trap, H.A. Dawah (CERS).

Distribution: This species was first recorded from Saudi Arabia by Dawah & Abdullah (2009); El-Hawagry et al (2017). It was described from Sierra Leone. Known from West Africa to Congo basin (the sedimentary basin of the Congo River) and Uganda (Pont, 1980; Deeming, 1996). There are specimens in NMWC collected from Oman and Yemen.

Remarks: Biology; unknown.

***Pararhynchomyia cribriformis* Becker, 1910**

Pararhynchomyia cribriformis Becker, 1910: *Denkschriften der Wissenschaften Wien*, 71: 143.

Distribution: This species was first recorded from Saudi Arabia by Abu-Zoherah et al (1993). This species was described from Socotra and further recorded from Kenya and Tanzania.

***Rhinia nigricornis* (Macquart, 1843)**

Idia nigricornis Macquart, 1843: *Mémoires de la Société* (*Royale*) *de Sciences de l' Agriculture et des Arts à Lill*e 1842, 2(2): 281.

Material examined: Saudi Arabia: 1♀, Asir, Maraba, Al-Hudaithy Fruit Farm, 16.09.2014, sweeping trap, H.A. Dawah (CERS).

Distribution: This is the first record from Saudi Arabia. It was described from Senegal. It is widespread in the Afrotropical Region (including Madagascar), though first recorded in region from Arabia and United Arab Emirates by Deeming (2008).

***Rhyncomya aravaensis* Rognes, 2002**

Rhyncomya aravaensis Rognes, 2002: *Entomologica Scandinavica* Supplement, 59: 35.

Material examined: Saudi Arabia: 1♂, Asir, Abha, Madenate Al-Ameer Sultan, 01-20.11.2013, Malaise trap, H.A. Dawah (CERS).

Distribution: This is the first record from Saudi Arabia. The species was described from a desert region of southern Palestine (Rognes, 2002).

Remarks: Though *R. aravaensis* and *R. cassotis* (Walker) appear to be closely related, they can easily be separated by the structure of the male fifth (pregenital) sternite. Rognes (2002: 94; Fig 105) shows that the lateral lobes of *R. aravaensis* to be short, with a pair of short blunt tooth-like projections on the truncate apices medially situated. In *R. cassotis*, however, the apices as figured by Zumpt (1958: 182; Fig. 60) are very deeply concave with a single long projection at their medial end, where as it is not so in *R. aravaensis.*

***Rhyncomya bullata* Deeming, 1996**

Rhyncomya bullata Deeming, 1996: *Fauna of Saudi Arabia*, 15: 270.

Material examined: Saudi Arabia: 1♀, Asir, Maraba, Al-Hudaithy Fruit Farm, 01-30.05.2004, Malaise trap, H.A. Dawah (NMWC); 2♂♂, Jazan, Farasan Island, Al-Maraq, 1.06.2016, Malaise trap, H.A. Dawah (CERS).

Distribution: This species was first recorded from Saudi Arabia by Dawah & Abdullah (2009). It was described from Oman and further recorded from United Arab Emirates (Deeming, 1996; 2008).

***Rhyncomya callopis* (Loew, 1856)**

Idia callopis Loew, 1856: *Programm Koniglichen Realschule zu Meseritz*, 1856: 49.

Material examined: Saudi Arabia: 1♂, Khybar Al-Janob, Hay Al-Salam, 01-15.01.2011, sweeping trap, M. Al-Shahrany (CERS).

Distribution: This is the first record from Saudi Arabia. This species was described from Egypt and further recorded from Algeria, Egypt, Europe (widespread), Iran, Israel, Morocco, Tunisia and Western Sahara (Spanish Sahara) (Zumpt & Tsacas, 1976; Schumann, 1986; Deeming, 1996).

Remarks: Rognes (2002) split off from *R. callopsis* of authors three good species, being *negevi*, *sinaiensis* and *yahavensis*. The species description and very good figures 117-131 in Rognes (2002: 96-99) of the male genitalia of *R. callopis* clearly separate it from the related species in the same paper.

Rhyncomya cassotis (Walker, 1849) (Fig. 2)

Tachina cassotis Walker, 1849: *List of the specimens of dipterous insects in the collection of the British Museum*, 4: 761.

Material examined: Saudi Arabia: 1♂, Jazan, Harob, Wadi Lajab, 08.06.2015, sweeping, H.A. Dawah (CERS).

Distribution: This is the first record from Saudi Arabia. This species was described from Sierra Leone and is further recorded as being widespread on the Afrotropical mainland (Pont, 1980).

Rhyncomya desertica Peris, 1951

Rhyncomya desertica Peris, 1951: *Eos*, *Revista Española de Entomologia*, 27: 243.

Distribution: This species was first recorded from Saudi Arabia by Abu-Zoherah et al (1993). It was described from Algeria and is further recorded from the Palaearctic Region: Egypt, Libya, Palestine and Tunisia: Afrotropical Region; Chad, Mauritania, Niger, Saudi Arabia, and United Arab Emirates (Peris, 1952; Zumpt & Tsacas, 1976; Pont, 1980; Schumann, 1986; Abu-Zoherah et al, 1993; Deeming, 1996; 2008).

Fig. 2. *Rhyncomya cassotis* Walker 1849. Male.

Rhyncomya jordanensis Peris, 1951

Rhyncomya jordanensis Peris, 1951: *Eos*, *Revista Española de Entomologia*, 27: 242.

Material examined: Saudi Arabia: 2♂♂, Jazan, Fifa, Al-Tatweer Centre, Malaise trap, 07-28.01.2016, H.A. Dawah (CERS); 1♀, Asir, Maraba, Al-Hudaithy Fruit Farm, 01-30.05.2004, Malaise trap, H.A. Dawah (NMWC).

Distribution: This species was first recorded from Saudi Arabia by Dawah & Abdullah (2009). This species was described from Jordan and is further recorded from Egypt, Israel, Oman, United Arab Emirates and Yemen (Schumann, 1986; Deeming, 1996; 2008; Rognes, 2002).

Remarks: Biology: Unknown.

***Rhyncomya sinaiensis* Rognes, 2002**

Rhyncomya sinaiensis Rognes, 2002: *Entomologica Scandinavica* (=*Insect Systematics & Evolution*) supplement, 59: 49-51.

Distribution: This species was first recorded from Saudi Arabia by Setyaningrum & Aldhafer (2014). It was described from Egypt (Sinai) and is further recorded from Palestine (Rognes, 2002).

Remarks: Rognes (2002: 50) found in two females of *R. sinaiensis* that he dissected a large uterine first instar larva filling the whole length of the abdomen. Such macrolarviparous reproduction is found in tsetse flies (Glossinidae), in which the larva is protected within the uterus of its parent, being fed on an oil-bearing solution until it is as large as its mother and when finally deposited immediately pupates (Pollock, 1992). A similar strategy is found in the chloropid genus *Pachylophus* Loew (Deeming, 2018) and Hippoboscidae.

***Rhyncomya tristis* Séguy, 1933**

Rhyncomya tristis Séguy, 1933: *Memórias e Estudosdo Museu Zoológico da Universidade de Coimbra*, 67: 67.

Material examined: Saudi Arabia: 3♂♂, Jazan, Abu Aresh, Al-Mahdag Village, 05-20.06.2011, Malaise trap, H.A. Dawah (CERS); 3♂♂, same data but, 01.02-03.04.2011, Malaise trap, H.A. Dawah (CERS).

Distribution: This species was first recorded from Saudi Arabia Abu-Zoherah et al (1993). This species was described from Mozambique. An afrotropical species known from Botswana, Chad, Rhodesia and South Yemen (Pont, 1980).

Remarks: Setyaningrum & Aldhafer (2014) recorded recently *Rhyncomya zumpti* Peris, 1952 from Saudi Arabia. *R. zumpti* has been placed under synonymy of *R. tristis* (see Zumpt & Stimie, 1965: 9-11; Pont 1980: 786 also K. Rognes; pers. Comm; 2016). Abu-Zoherah et al (1993: 227) recorded *R. tristis* from Saudi Arabia.

***Rhyncomya varifrons* Becker, 1910**

Rhyncomya varifrons Becker, 1910: *Denkschriften der Wissenschaften Wien*, 71: 141.

Distribution: This species was first recorded from Saudi Arabia Abu-Zoherah et al (1993). It was described from Socotra (Pont, 1980).

***Villeneuviella seguyi* Grunin, 1957**

Villeneuviella seguyi Grunin, 1957: *Entomologicheskoe Obozrenie*, 36: 543.

Distribution: This species was first recorded from Saudi Arabia by Abu-Zoherah et al (1993). This species was described from Iran and is further recorded from Iran,

Israel, Oman, Saudi Arabia, United Arab Emirates and Yemen (Pont, 1980; Schumann, 1986; Deeming, 1996; 2008).

Remarks: The synonomy of the genus *Villeneuviella* Austen as being a junior synonym of *Rhyncomya* Robineau-Desvoidy as proposed by Pont (1980) is not accepted by Schumann (1986), nor Rognes (2002), nor Deeming (1996) and are followed here. The justification given by Deeming (1996: 274) are based upon highly unusual larval characters.

Stomorhina chapini Curran, 1931

Stomorhina chapini Curran, 1931: *American Museum Novit*, 506:16.

Material examined: Saudi Arabia: 1♀, Jazan, Fifa, Al-Tatweer Centre, 16.12.2015-06.01.2016, Malaise trap, H.A. Dawah (CERS).

Distribution: This is the first record from Saudi Arabia. This species was described from Zaire. This species is widespread in West and East Africa.

Stomorhina rugosa (Bigot, 1888)

Rhinia rugosa Bigot, 1888: *Bulletin de la Société Zoologique de France*, 12(5-6) (1887): 591.

Material examined: Saudi Arabia: 1♀, Asir, Maraba, Al-Hudaithy Fruit Farm, 13.01.2013, Malaise trap, H.A. Dawah (CERS); 1♀, Asir, Abha, Madenate Al-Ameer Sultan, 25.02.-25.05.2002, Malaise trap, H.A. Dawah (NMWC).

Distribution: This species was first recorded from Saudi Arabia by Dawah & Abdullah (2009); El-Hawagry et al (2017). It was described from Sierra Leone. It is known from South Africa and Guinea (Pont, 1980).

Remarks: Females were reported to oviposit in freshly excavated termite mounds and the eggs hatched immediately (Cuthbertson 1934, as *S. mitis* Curran "sic").

Metalliopsis arabica Deeming, 2008

Metalliopsis arabica Deeming, 2008: *Arthropod Fauna of the UAE*, 1: 726.

Material examined: Saudi Arabia: 2♂♂, Asir, Maraba, Al-Hudaithy Fruit Farm, 15.04.2014, Malaise trap, H.A. Dawah (CERS; NMWC); 1♀, same data but, 17.06.2003, H.A. Dawah (CERS).

Distribution: This species was first recorded from Saudi Arabia by Dawah & Abdullah (2009). It was described from the United Arab Emirates and Saudi Arabia (Deeming, 2008).

Subfamily Chrysomyinae

Chrysomya albiceps (Wiedemann, 1819) (Fig. 3)

Musca albiceps Wiedemann, 1819: *Zoologisches Magazin*. *Kiel*, 1(3): 38

Material examined: Saudi Arabia: 1♂, Asir, Abha, Hay Al-Nusub (Abha Farm Centre), 13.03-02.04.2015, Malaise trap, H.A. Dawah (CERS); 1♀, same data but, 03-06.2001 (CERS); long series of ♂ and ♀, Jazan, Abu Aresh, Al-Husseini Farm, baited traps, 15.04.2013; same but 13.02.2014, N.M. Gamal and M.F. Sallam (KSU, CERS).

Distribution: This species was first recorded from Saudi Arabia by Shalaby (1962); Dawah & Abdullah (2009); El-Hawagry et al, 2013; El-Hawagry, Abdel-Dayem, Elgharbawy, & Al-Dhafer, 2016; El-Hawagry et al, 2017). This species was described from South Africa and further recorded from the Afrotropical Region: Angola, Benin, Botswana, Burkino Faso, Burundi, Cameroun, Cape Verde Islands, Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Guinea, Ivory Coast, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Nigeria, Madagascar, Mauritius, Mauritania, Mozambique, Oman, Ruanda, Réunion, Rodriguez, St Helena, Senegal, Seychelles, Sierra Leone, Socotra, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, United Arab Emirates, Yemen, Zambia and Zimbabwe; Palaearctic Region: Afghanistan, Albania, Algeria, Armenia, Austria, Azerbaijan, Azores, Bahrain, Bosnia, Herzegovina, Bulgaria, Canary Islands, Croatia, Cyprus, Czech Republic, Egypt, France, Germany, Greece, Hungary, Iran, Iraq, Israel, Italy, Jordan, Kazakhstan, Kyrgyzstan, Lebanon, Libya, Macedonia, Madeira, Malta, Moldova, Montenegro, Morocco, Palestine, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Switzeland, Syria, Tajikistan, Tunisia, Turkey, Turkmenistan, Ukraine, Uzbekistan and Western Sahara; Oriental Region: India and Pakistan; Neotropical Region: Argentina, Bolivia, Brazil, Ecuador, Paraguay, Peru and Puerto Rico (Shalaby, 1962; Pont, 1980; Verves, 2003; 2004; Harten, 2005; Deeming, 2008).

Remarks: Larvae necro- and coprophilous, predators of larvae of other Diptera (e.g., *Musca stabulans* Fallén, 1817) (Omar, 1995). It is very closely related to *C. rufifacies* (Macquart) and may be confused with it by inexperienced taxonomists (Verves, 2004). *C. albiceps* prefers hot and moist conditions (Büttiker, Attiah, & Pont, 1979). It is reported to breed in carrion (e.g., leopard, dog and porcupine) and dung (e.g., sheep and goats) and produces facultative cutaneous myiasis in livestock, goats, donkey, sheep, camels and men (Greenberg, 1971; 1973), following an initial strike by *Lucilia* species. Adults could be a nuisance in houses, markets, food shops, hospitals and slaughter-houses (Büttiker et al, 1979). Summarized information on biology, distribution and synanthropic significance of *C. albiceps* can be found in Zumpt (1965); Madeira (2001); Rognes (2002); Verves (2004); Hall & Smith (1993: 449) and Dawah & Abdullah (2009).

Chrysomya bezziana Villeneuve, 1914 (Fig. 4)

Chrysomya bezziana Villeneuve, 1914: *Revue Zoologicalique Africaine*, 3: 430.

Material examined: Saudi Arabia: 2♂♂, 2♀♀, Jazan, Beish, baited traps, 15.06.2013, N.M. Gamal and M.F. Sallam (CERS).

Distribution: This species was first recorded from Saudi Arabia by Ansari & Oertley (1982) and AlAhmed (2002). It was described from Africa. It is widespread in Asia, tropical Africa, the Indian sub-continent and Southeast Asia from Taiwan in the north to Papua New Guinea in the south (Pont, 1980).

Remarks: This species is more common in India than in Africa (Zumpt, 1965). The female lays 150-500 eggs at a time at wound sites or in body orifices (nose, mouth, ear and orbit) of live mammals as obligate parasitic flies requiring a host to complete

their development (Hall & Smith, 1993). The larvae feed on host tissue, attracted to blood and after completing their developments they drop to the ground to pupate. The adults are rarely found in the field (Zumpt, 1965). The adults feed on decomposing corpses, decaying matter, excreta and take nectar from flowers. Therefore the adult flies can be a mechanical vector for pathogens because of their diet. This species has not been used in maggot therapy because the larvae aggressively burrow through living tissue and can cause permanent tissue-damage. It is not suitable for use in forensics because it can cause myiasis on a live mammal and this means the time of colonization is not always concurrent with the time of death (Sukontason et al, 2005).

Fig. 3. *Chrysoma albiceps* (Wiedemann, 1819). Male.

Fig. 4. *Chrysomya bezziana* Villeneuve, 1914. Female.

***Chrysomya chloropyga* (Wiedemann, 1881)**

Musca chloropyga Wiedemann, 1881: *Zoologisches Magazin*, 1(2): 44.

Material examined: Saudi Arabia: 1♂, 1♀, Asir, Abha, Hay Al-Nusub, (Abha Farm Centre), 03.06.2001, Malaise trap, H.A. Dawah (NMWC; CERS); 1♂, 1♀, same data but, 03-30.05.2014 (MNWC); 3♀♀, same data but, 03-24.07.2014 (NMWC); 1♀, same data but, 19.06.-09.07.2013 (CERS); 1♂, 1♀, Asir, Abha, Hay

Al-Menhel, 12.05.-03.06.2015, Malaise trap, H.A. Dawah (NMWC); 1♂, same data but, 23.05.-12.06.2013 (CERS).

Distribution: This species was first recorded from Saudi Arabia by Büttiker et al (1979); Abu-Zoherah et al (1993). It was described from Cape of Good Hope in South Africa (Vorgebirge der guten Hoffnung) andfurther recorded from the Afrotropical Region; Cameroon, Democratic Republic of Congo (Zaire), Ethiopia, Kenya, Lesotho, Saudi Arabia, South Africa, Tanzania, Yemen and Zimbabwe: Palaearctic Region; Canary Islands, Egypt: and Neotropical Region (Schumann, 1986; Rognes & Paterson, 2005).

Remarks: All the south-western Saudi Arabian specimens of *C. chloropyga* were collected from Asir, which is above 2600m. These differ from other specimens of *C. chloropyga* in NMWC from Nigeria, Kenya and Ethiopia in having a broad line extending from lower eye margin to mouth margin which is almost completely shiny in contrast to the surrounding grey-dusted gena. In characters of development of aedeagus and cerci they exactly fit *chloropyga*, rather than *putoria*. In terms of mesonotal markings they are rather indistinct, having a dark blue mesonotal ground colour.

Chrysomya marginalis (Wiedemann, 1830)

Musca marginalis Wiedemann, 1830: *Aussereuropäischen Zweiflügeligen Insekten*, 2: 395.

Material examined: Saudi Arabia: 1♂, Asir, Maraba, Al-Hudaithy Fruit Farm, 13.01.2013, Malaise trap, H.A. Dawah (CERS); 1♂, same data but, 01-30.05. 2004, Malaise trap, H.A. Dawah (CERS).

Distribution: It was described from South Africa and first recorded from Saudi Arabia by Büttiker et al (1979); Dawah & Abdullah (2009); El-Hawagry et al (2013; 2016; 2017 as *C. regalis*). It is widespread within the Afrotropical Region (Pont, 1980; Rognes, 2002). In the Middle East, it was recorded from Bahrain, Egypt, Oman, Pakistan, Palestine, Syria, United Arab Emirates and Yemen (Deeming, 1996; 2008; Harten, 2005).

Remarks: *C. marginalis* breeds carrion breeder. It is well established in Israel (Rognes, 2002) and Egypt (Schumann, 1986). Zumpt (1965: 96) reported that the breeding record of larvae found in the malformed horns of a dying ox in Kenya as being the only reliable one for *C. marginalis*. *C. regalis* Robineau-Desvoidy was recorded from Saudi Arabia by Dabbour (1979), but this species has been placed in synonymy of *C. marginalis* (Rognes, 2002: 13).

Chrysomya megacephala (Fabricius, 1794)

Musca megacephala Fabricius, 1794: *Entomologia Systematica*, 4: 317.

Material examined: Saudi Arabia: 2♂♂, Asir, Maraba, Al-Hudaithy Fruit Farm, 13.01.2013, Malaise trap, H.A. Dawah (CERS); 1♂, same data but, 25.07.2013, H.A. Dawah (CERS).

Distribution: This species was first recorded from Saudi Arabia by Ramadan & Al-Bihari (1980). It was described from South Africa and is further recorded from the Afrotropical Region: Angola, Benin, Botswana, Burkino Faso, Burundi, Cameroun,

Cape Verde Islands, Congo, Djibuti, Equatorial Ghana, Eritrea, Ethiopia, Gabon, Gambia, Guinea, Ivory Coast, Kenya, Lesotho, Liberia, Malawi, Mali, Madagascar, Mauritius, Mauritania, Mozambique, Namibia, Niger, Nigeria, Oman, Ruanda, Réunion, Rodriguez, Senegal, Sierra Leone, Somalia, South Africa, Saudi Arabia, Sudan, Tanzania, Togo, Uganda, United Arab Emirates, Yemen, Zambia and Zimbabwe; Palaearctic Region: Afghanistan, Canary Islands, China, Egypt, Iran, Japan, Libya, Korea, Russia; Oriental Region: Bangladesh, Borneo, Brunei, Cambodia, China, India, Indonesia, Japan (Ryukyu Island), Laos, Malaysia, Malaya, Myanmar, Nepal, Pakistan, Phillippines, Busuanga, Cebu, Leyte, Lozon, Mindanao, Negros, Palawan, Pany, Samar, Sulu Arch, Singapore, Thailand, Taiwan, Vietnam; Australsian/Oceanian Region: Admiralty Islands, Australia, Belaug, Bonin Island, Christmas Island, Cook Island, Easter 1, Eastern Somoa, Fiji, French Polynesia, Hawaiian Island, Henderson and Rapa Island, Marquesas Island, Society Island, Tuamotu Arch, Tubai Island, Marianas, Marshall Island, Micronesia, Kiribati, New Caledonia, New Zealand, Niue, Norfolk 1, Palau, Papau New Guinea, Pitcairn Island, Solomon Island, Tongo, Vanuatu, Vokano Island, Western Samoa; Nearctic Region: USA; Neotropical Region: Brazil, Equador, Honduras and Puerto Rico (Deeming, 1996; 2008; Hall & Smith, 1993; Pont, 1980; Verves, 2003). One of us (HAD) has examined specimens of *C. megacephala* in NMWC collected from Oman and the United Arab Emirates.

Remarks: This species is a widespread and common scavenger breeding in dung, decaying meat, carrion, corpses of pigs, dogs, toads, rats, frogs, essentially saprophagous, breeding in decomposing animal matter (Verves, 2003). It is occasionally a causative agent of cutaneous myiasis of different living mammals and man (Zumpt, 1965; Hall & Smith, 1993). It is known as the Oriental latrine-fly. It is of little use in forensics because it can cause myiasis in the absence of necrotic tissue and therefore, it can be difficult to determine the time of colonization (Sukontason et al, 2005). It is a nuisance when it is present in large number in fish markets, slaughterhouses and open-air meat markets (Hall & Smith, 1993). Adults swarms on meat and sweets, with notable attraction to fish. Under insanitary conditions, it is likely to transmit enteric pathogens and parasites (Zumpt, 1965; Greenberg, 1971; 1973; Kurahashi, 1982; Kurahashi & Chowanadisai, 2001).

***Chrysomya putoria* (Wiedemann, 1830)**

Musca putoria Wiedemann, 1830: *Aussereuropaischen Zweiflugeligen Insekten*: 403.

Distribution: This species was first recorded from Saudi Arabia by Abu-Zoherah et al (1993: 227) as *C. chloropyga* form *putoria* (Wiedemann, 1881); (El-Hawagry et al 2016, 2017). It was described from Sierra Leone and further recorded from Botswana, Cameroon, Democratic Republic of Congo (Zaire) Gambia, Ghana, Kenya, Madagascar, Mauritius, Réunion, Seychelles, South Africa, Swaziland, Tanzania and Zambia (Rognes & Paterson, 2005).

Remarks: *C. putoria* is recorded from Saudi Arabia by Büttiker et al (1979) but this species has been placed as a junior synonym of *C. chloropyga* (see Pont, 1980: 788). Rognes & Paterson (2005) revised the taxonomic status of *C. chloropyga*, *C. putoria*

and formally re-established them as being two different species on the charactersof adult external morphology and the genitalia.

Subfamily Calliphorinae

***Bengalia minor* Malloch, 1927**

Bengalia minor Malloch, 1927: *Annals and Magazine of Natural Histor*y, (9) 20: 408.

Material examined: Saudi Arabia: 3♂♂, 4♀♀, Jazan, Fifa, 03-24.11.2015, Malaise trap, H.A. Dawah (CERS; NMWC); 1♂, Asir, Maraba, Al-Hudaithy Fruit Farm, 06-27.08.2013, Malaise trap, H.A. Dawah (NMWC).

Distribution: This species was first recorded from Saudi Arabia by Abu-Thuraya (1982). It was described from Democratic Republic of the Congo and is further recorded from Mali (Pont, 1980).

***Calliphora croceipalpis* Jaennicke, 1867**

Calliphora croceipalpis Jaennicke, 1867: *Abhandlungen herausgeben von der Senckenbergischen Naturforschenden Gesellschaft*, 6: 376.

Material examined: Saudi Arabia: 3♀♀, Asir, Abha, Hay Al-Menhel, 07-31.12.2014, Malaise trap, H.A. Dawah (CERS); 1♂, Asir, Abha, Hay Al-Nusub (Abha Farm Centre), 03-24.07.2013, Malaise trap, H.A. Dawah (CERS).

Distribution: This species was first recorded from Saudi Arabia by Abu-Zoherah et al (1993); El-Hawagry et al (2016, 2017). It was described from Ethiopia and is further recorded as being widespread from East Africa to southern Africa as well as Gough I., St Helena, Yemen, and Subantarctic islands (Pont, 1980).

***Calliphora vicina* Robineau-Desvoidy, 1830**

Calliphora vicina Robineau-Desvoidy, 1830: *Mémoires Présentés par divers* Savants *a l' Académie Royale des Sciences de l' Institut de France*, 2: 435.

Material examined: Saudi Arabia: 1♂, Asir, Abha, Hay Al-Nusub (Abha Farm Centre), 20.04.2013, Light trap, H.A. Dawah (CERS).

Distribution: This species was first recorded from Saudi Arabia by Abu-Zoherah et al (1993); El-Hawagry et al (2013, 2016, 2017). This species was described from USA (Philadelphia) and further recorded from the Palaearctic Region: Canary Islands, China, Mongolia and Japan; Afrotropical Region: Mauritius and South Africa; Nearctic Regions: Oriental Region: Northern India; Australiasian Region: Australia and New Zealand. It is a holarctic species and found in association with humans elsewhere (Pont, 1980; Schumann, 1986; Deeming, 1996).

***Hemipyrellia pulchra* (Wiedemann, 1830)**

Musca pulchra Wiedemann, 1830: *Aussereuropaischen Zweiflügeligen Insekten*, 2: 406.

Material examined: Saudi Arabia: 1♀, Jazan, Sabya, Basahy Farm, 24.07.2013, Malaise trap, H.A. Dawah (CERS); 1♀, Asir, Maraba, Al-Hudaithy Fruit Farm, 01-16.03.2013, Malaise trap, H.A. Dawah (CERS);1♂, Jazan, Abu Aresh, Al-Mahdag Village, 09-30.12.2013, Malaise trap, H.A. Dawah (CERS); 4♂♂, Jazan, Fifa, Al-Tatweer Centre, 14.04-06.05.2014, Malaise trap, H.A. Dawah (CERS); 1♀, same data but, 01-18.07.2013 (CERS).

Distribution: This is first record for Saudi Arabia. This species was described from Egypt?. It is widespread in West Africa to East Africa, Sudan: Oriental Region; India (Pont, 1980; Schumann, 1986).

Remarks: It may be an insect of forensic importance. In Thailand, a low percentage of this species was found among carrion calliphorids (Moophayak et al, 2014).

Subfamily Luciliinae

Lucilia cuprina (Wiedemann, 1830) (Fig. 5)

Musca cuprina Wiedemann, 1830: *Aussereuropaischen Zweiflügeligen Insekten*, 2: 654.

Material examined: Saudi Arabia: 1♂, Asir, Karatha, Al-Ethrebany Fruit Farm, 19.02.2014 Malaise trap, H.A. Dawah (CERS); 1♂, Asir, Abha, Hay Al-Nusub (Abha Farm Centre), 03.06.2015, sweeping trap, H.A. Dawah (CERS); 7♂♂, same data but, 19.02.2014 (CERS).

Distribution: The species was described from China and first recorded from Saudi Arabia by Büttiker et al (1979); El-Hawagry et al (2017). It has been recorded from Afrotropical Region: Madagascar, Mauritius, Réunion; Mediterranean Region to Oriental Region: Australasian Region: Nearctic Region and Neotropical Region (Büttiker et al, 1979; Pont, 1980; Rognes, 1994). In the Middle East it is known from Egypt.

Remarks: Most species in the genus *Lucilia* Robineau-Desvoidy are saprophagous in vertebrate carrion, with some tending primarily to attack live sheep and one (possibly more) that attacks live Amphibia (Ferrar, 1987). Ferrar (1987) reported that *L. cuprina* is the sheep blowfly, particularly of Australia and South Africa, where it is a major veterinary pest in sheep-raising areas. It causes primary myiasis of previously uninjured sheep and this damage may then be secondarily invaded and enlarged upon by other Calliphoridae. The species breeds in carrion to a much lesser extent, but is principally an agent of myiasis. The flies are attracted to sheep which have areas of soiled fleece or are suffering from bacterial decomposition of the fleece in fleece rot. The female lays her eggs in sores or cuts in the sheep's skin and the larvae develop there, eating the sheep's flesh away with alarming rapidity. Heavy infestations may kill sheep. The adults feed on fallen fruit, nectar, the honeydew of aphids but also on faeces of sheep and other animals to obtain a protein meal, which is important for maturing the eggs (Webber, 1958). The larvae rarely develop in faeces and the adults only occasionally land on man to feed on sores or secretions (Hall & Smith, 1993). Kettle (1992: 249) summarised existing knowledge of the biology, behaviour, bionomics and the effect of *L. cuprina* on sheep.

Fig 5. *Lucilia cuprina* (Wiedemann, 1830). Male.

Lucilia sericata (Meigen, 1826)

Musca sericata Meigen, 1826: *Systematische Beschreibung der Bekannten Europaischen Zweiflügeligen Insekten*, 5: 53.

Material examined: Saudi Arabia: long series of ♂♂ and ♀♀, Jazan, Abu Aresh, Al-Husseini Farm, baited traps, every month from April 2013-March 2014, N.M. Gamal and M.F. Sallam (KSU).

Distribution: This species was described from Austria. It is Holarctic species (Northern Hemisphere) found throughout the world (Büttiker et al, 1979). It is widespread in Afrotropical, Palaearctic, Oriental, Australasian, Nearctic and Neotropical Regions (Pont, 1980). It is recently recorded in Australia and in several South and Central American countries (Rueda, Ortega, Segura, Acero, & Bello, (2010). In the Middle East, it has been first recorded from Saudi Arabia by Shalaby (1962); El-Hawagry et al (2013; 2016; 2017); El-Hawagry, Abdel-Dayem, & Al Dhafer, 2018): Kuwait (Hira et al, 2004) and Iran (Youssefi, Rahim, & Marhab, (2012).

Remarks: There are several factors which play a role in development of *L. sericata* including the temperature, food source and humidity (Tarone & Foran, 2006). The adults are diurnal and are attracted by the solid or wet fleece of sheep, open wounds, carrion and to a lesser degree by faeces, in which the larvae can also complete their development. Adults are very fond of sweet or fermenting materials and are found on flowering plants. The females need a protein meal for the development of the eggs (Büttiker et al, 1979). After mating, females lay up to 200 eggs at a time, on the host or carcass. *L. sericata* plays an important role in: (a) veterinary medicine as feeding by larval *L. sericata* can cause a form of myiasis known as a sheep strike or blowfly strike, mainly in Northern and Central Europe with substantial losses in animals and production (Strikewise, 2007), (b) medical treatment using the larvae of *L. sericata* to heal injuries by not only eating the decomposing tissue but also secreting and producing antimicrobial enzymes while in the wound (Horobin, Pritchard, & Shakessheff, 2002; Rueda et al, 2010), (c) forensic science as the larvae help to determine the period of insect colonization, as it relates to the time of death, aiding

law enforcement in their investigations (Rueda et al, 2010).

***Pericallimyia greatheadi* Zumpt, 1971**

Pericallimyia greatheadi Zumpt, 1971: *Novos Taxa Entomologicos*, 99: 3.

Material examined: Saudi Arabia: 1♀, Asir, Abha, HayAl-Nusub (Abha Farm Centre), 19.06-09.07.2014, Malaise trap, H.A. Dawah (CERS); 1♂, same data but, 20.04.2013 (CERS); 4♂♂, Asir, Abha, Hay Al-Menhel, 19.02.2014, Malaise trap, H.A. Dawah (CERS); 2♂♂, Al-Baha, Hay Al-Dhofair, 03.11.2015, Malaise trap, H.A. Dawah (CERS)

Distribution: This species was first recorded from Saudi Arabia by Setyaningrum & Aldhafer (2014). This species was described from Eritrea and is further recorded from Saudi Arabia (Pont, 1980; Setyaningrum & Aldhafer, 2014).

Remarks: Deeming (1996) recorded it breeding in the tree-snail *Euryptyxis latireflexa* (Reeve) in Dhofar, Oman, and described the puparium.

Subfamily Auchmeromyiinae

***Cordylobia anthropophaga* (Blanchard and Berenger-Féraud in Larrey, 1872) (Fig. 6)**

Ochromyia anthropophaga Blanchard and Berenger-Féraud in Larrey, 1872: *Comptes rendes Hebdomadaires des seances de l"Academie des Sciences*: 1133-1134.

Material examined: Saudi Arabia: 4♂♂, 6♀♀, Jazan, Abu Aresh, Al-Mahdag Village, 21.01.2015, Malaise trap, H.A. Dawah (CERS); 1♂, 2♀♀, same data but, 03.03.2015 (CERS); 1♂, 2♀♀, same data but, 10.11.2014 (CERS); 1♂, same data but, 26.11.2014 (CERS); 1♂, 2♀♀, same data but, 30.06.2010 (CERS); 1♂, same data but, 01.06.2013 (CERS); 1♀, Asir, Al-Souda, Bani Mazen, 27.05.2014, Malaise trap, H.A. Dawah (CERS).

Distribution: It was first recorded from Saudi Arabia (Büttiker, Habayeb, & Zumpt, 1980; Dawah & Abdullah, 2009; Setyaningrum & Aldhafer, 2014). It was described from Senegal and it is widespread in mainland Afrotropical Region (Pont, 1980).

Remarks: Known as the Tumbu fly, the larva of this species causes subcutaneous myiasis in humans, dogs and other domestic and wild animals (the rats form the main reservoirs of the fly in the field) in many parts of the Afrotropical Region. Roberts, Boyce, & Lyerly, (1982) reported a technique for rearing larvae of *C. anthropophaga*. Blacklock & Thompson (1923); Zumpt (1965) and Dawah & Abdullah (2009) gave a good account of the life history, biology and pathogenesis of the Tumbu fly.

Fig. 6. *Cordylobia anthropophaga* (Blanchard and Berenger-Féraud 1872).

***Pollenia hungarica* Rognes, 1987**

Pollenia hungarica Rognes, 1987: Syste*matic Entomology*, 12: 483.

Distribution: This species was first recorded from Saudi Arabia by Setyaningrum & Aldhafer (2014); El-Hawagry et al (2013, 2016). This species was described from Hungary (Albertirsa). It is known from the Palearctic Region: Austria, Norway, Sweden and Switzerland (Rognes, 1987a; b). Based on the known distribution of this species it would seem prudent to confirm the identification of this species from Saudi Arabia using photographs of the hind tibial vestiture and genitalia.

Remarks: This species has been reared from the earthworm *Eisenia rosea* Savingy (Lumbricidae) by Professor Zicsi (HNHM) (Rognes, 1987b: 484). Adults are on the wing in the field most of the year (February to November). In Central Europe this species has been captured at altitude up to 1600m (Rognes, 1987b: 485).

DISCUSSION

Eighteen known species of Calliphoridae were identified and recorded in this study, seven of which were recorded for the first time. This makes the total number of Calliphoridae species in Saudi Arabia (including 26 species previously recorded and excluding two species which were synonymized namely: ***Rhyncomya zumptii*** Peris, 1952; ***Chrysoma regalis*** Robineau-Desvoidy, 1830) to be 44. A list of all species of Calliphoridae recorded from Saudi Arabia is provided. A checklist is essential for (1) biodiversity studies, by providing them with: (a) useful information about regional biodiversity (comparison of species numbers in a group with other regions) and general distribution of species, (b) to give indications of which species have expanded their range and how quickly they did so by comparing recent and old checklists of the same country (Siepel, Bink, Broekhuizen, Stumpel, & van Wingerden, 1993), (2) faunistics studies by defining species by their recent names including synonyms or misidentifications,

information about where the describer published the description of species, page number and the location of the type specimens and distribution, (3) nature conservation studies as they provide information to determine species under threat or a target species, by the comparison of checklists (species composition) of one country with other countries.

The species recorded in this study are more Afrotropical in origin than ther are to other regions. Dawah & Abdullah (2009) found the situation of Calliphoridae in the southwest of Saudi Arabia is almost the reverse as the Palaearctic element prevails, with some species from the Afrotropical and Oriental regions. Although it is tempting to draw assumptions from these percentages of species distribution (Fig. 7), it must be acknowledged that all parts of Saudi Arabia have not been surveyed to the same extend, with some areas having had very little sampling. Therefore, further collecting, surveying and trapping of insects from the North (Palaearctic) (at the border with Jordan; most of Saudi Arabia, including northern and eastern Jeddah), Oriental Region (the southeastern area and a part of the eastern provinces of Al-Hassa and Al-Dammam are considered as representing the Oriental Region, to develop a better picture of the zoogeographical affinity of the Calliphoridae of Saudi Arabia.

Some species of Calliphoridae (e.g., *C. anthropophaga*; *Chrysomya albiceps*; *I. terminata*) were found living at unexpected levels of both high and low altitude in Jazan and Asir. Such insects demonstrate that they have a successful adaptation. Decreased oxygen availability and lower temperatures make life at such altitudes challenging though many species have adapted successfully. Such adaptations (which depend on morphology and phylogeny) include oxygen uptake and better oxygen delivery to tissues (Mani, 1968; Mani & Giddings, 1980; Hodkinson, 2005). It is not easy to determine whether a given insect is a true high altitude species. The difficulty is in part also due to the vagueness of the expression “high altitude” (Mani & Giddings, 1980; Hodkinson, 2005). It is evident from examination of a large number of Malaise trap samples from different altitudes in Jazan, that introductions of species from elsewhere succeed in establishing populations more readily at higher altitudes. It is well known that Saudi Arabia is situated in the transitional zone of three zoogeographic regions (Palaearctic, Afrotropical and Oriental). The highlands of Asir and Najran are of great entomological interest and as it is here that insects blown in from other regions are brought by convection currents and deposited.

A notable feature of the Calliphoridae fauna of Saudi Arabia is the frequency of so called tramp species (six species: or 14% of the species listed in table 2) that have been dispersed around the world through the agency of man. Arabia has always been involved in trade and interchanges with distant nations. These movements have increased out of all proportion in the last hundred years. Not only has the ancient trade in frankincense been eclipsed by the modern oil trade but the pilgrimage to Makkah by Muslims has brought ever increasing numbers by aeroplanes from every corner of the globe. All this increases the opportunities for the transport of small insects to and from Arabia. In our present state of knowledge, it is frequently not possible to assess the likely original distribution of the tramp species. The future use of molecular phylogenetics may be able to provide the answers. This study has added new

records to the Saudi Arabia checklist of Calliphoridae which will provide the basis for systematic studies and fauna analyses of future works on Calliphoridae. The Saudi Arabian Diptera list continues to increase in line with recording effort and is clearly far from complete, even for long-established native species.

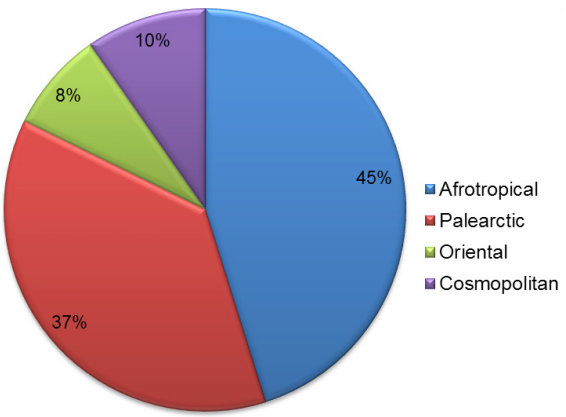

Fig. 7. Distributional elements in the *Calliphoridae* found in Saudi Arabia.

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