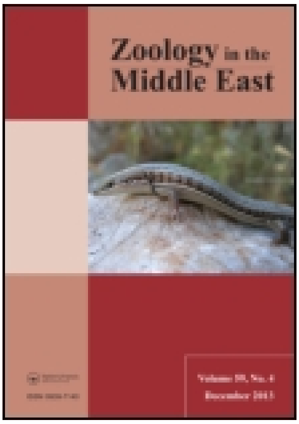

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Zoogeographical affinities and faunal relationships of bee flies (Diptera: Bombyliidae) in Egypt

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Zoogeographical affinities and faunal relationships of bee flies (Diptera: Bombyliidae) in Egypt

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The distributions of 229 beefly (Diptera: Bombyliidae) species across the eight Egyptian ecological zones, together with their faunal affinities to the main zoogeographical regions, were used to test the suggestion of Holt et al. (2013) that the Saharo-Arabian is a distinct region rather than a subregion of the Palaearctic. All Egyptian ecological zones but one have greater affiliation to the Palaearctic and Saharo-Arabian than to the Afrotropical region; the Gebel Elba ecological zone, the south-eastern triangle of Egypt, has greater affinities with the Afrotropics. Affinities to the Saharo-Arabian region were not different from those to the Palaearctic. From its bombyliid fauna, therefore, the Saharo-Arabian region is so closely allied to the Palaearctic as to constitute merely a subregion of it. Sinai shows a high level of endemism reflecting its isolation from other parts of Egypt.

Key words: Palaearctic, Afrotropical, Saharo-Arabian, Egyptian ecological zones, distribution, affiliation.

Introduction

In 1876, Alfred Russel Wallace published the first map of global terrestrial zoogeographic regions (Wallace, 1876), which later became the cornerstone of modern biogeography (Ladle & Whittaker, 2011). Despite being based on limited information and lacking a statistical basis, Wallace's original map is still in use today (Holt et al., 2013). Biogeographic regions are the fundamental units of comparison in many broad-scale ecological and evolutionary studies (Crisp et al., 2009; Loarie et al., 2009) and provide an essential tool for conservation planning (Ladle & Whittaker, 2011). The Palaearctic is by far the largest of the six major regions, encompassing northern Africa, all of Europe and much of Asia, but excluding the southern extremities of the Arabian peninsula, the Indian subcontinent (south of the crest of the Himalayas), southeast Asia, and the southern parts of China. The Afrotropics include all of mainland sub-Saharan Africa and the southernmost parts of Arabia (Stuart et al., 2008). The Afrotropical region is thought to have its northern limits at Gebel Elba, a triangle of land currently politically controlled by Egypt but disputed with Sudan. This contains the critically endangered habitat called "Red Sea fog woodland" (Olson & Dinerstein, 1998), or "mist oasis", where much of the precipitation is contributed in the form of dew, mist and clouds, creating an ecosystem and a biological diversity not found anywhere else in Egypt.

Zoogeographical regions often have definable boundaries due to physical barriers, such as mountains, deserts, or water. However, where no such barriers exist, each region gradually merges with the next, pockets of one extending some way into the other due to variable environmental conditions. Such transitional zones may themselves have certain definable characteristics and are often classified as distinct regions. The desert between the Palaearctic and Afrotropical regions is one such zone, known as the Af-

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roeremic (de Lattin, 1967), eremic (Uvarov, 1938; Greathead, 1980; Larsen, 1984), Saharo-Sindian (of phytogeographers), or the Saharo-Arabian (consisting of the temperate parts of the Sahara, Sinai, Arabia, southern Palestine and lower Mesopotomia (Takhtajan, 1986). Holt et al. (2013) suggested that the Saharo-Arabian is a distinct "realm" and not a subregion of the Palaearctic "realm". The other relevant subregion of the Palaearctic is the Mediterranean, which either does (Krivokhatsky & Emeljanov, 2000) or does not (Holt et al., 2013) include the coastal region of North Africa.

Egypt is an important zoogeographical location between Africa and Asia, combining the characteristics of both Palaearctic and Afrotropical regions. It has generally been considered to belong to the Palaearctic, but there are Afrotropical influences, especially in the southeast in Gebel Elba (Steyskal & El-Bialy, 1967). Egypt as a whole is a part of the Sahara, characterised by a warm and almost rainless climate: it is one of the driest countries in the world with a long-term average precipitation of 51 mm per yr (FAO, 2012). Only the northern coastal strip, Eastern Desert, Gebel Elba, and higher parts of the southern Sinai mountains receive slightly higher rainfall. This is reflected in their floral and faunal composition, and may explain their higher species richness than in other ecological zones of Egypt. Traditionally the Mediterranean subregion is wherever olive trees grow, and in Krivokhatsky & Emeljanov's (2000) maps it includes Cyrenaica and the northern coast of Egypt up to Alexandria, then omitting the Delta, Sinai and southern Israel to reconnect with northern Israel. However, olives grow in the mountainous parts of Sinai, and many northern ("Irano-Turanian") and Mediterranean relict elements are found (e.g. *Juniperus phoenicea* in Gebel Halal) in the flora of Sinai (Danin, 1978).

Egypt is divided into eight ecological zones: Coastal Strip, Lower Nile Valley (including the Delta), Upper Nile Valley, Fayoum Basin, Eastern Desert, Western Desert, Sinai and Gebel Elba (Figure 1) (e.g. Boulos, 1999-2005; Larsen, 1990), recognising heterogeneity among the areas of Egypt. Holt et al.'s (2013) map of the zoogeographic regions puts the majority of Egypt in the Saharo-Arabian region, except for Gebel Elba which was placed in the Afrotropical region. That map also appears to place part of the Eastern Desert in the Afrotropics, something not expressly stated elsewhere in the study. Here, using the Bombyliidae (Diptera), we test the suggestion of Holt et al. (2013) that the Saharo-Arabian is a distinct region rather than a subregion of the Palaearctic.

Material and Methods

Data from a rich collation of various materials was used, including museum specimens and individuals collected by one of the authors (MEH) during a large series of collecting trips to various localities in all of the eight Egyptian ecological zones from 1991 to 2012. We believe the data to be reasonably complete: the species discovery curve for the Sinai region (Figure 2), for example, demonstrates that the asymptote was reached for MEH's collecting trips and methods to the sites he visited in Sinai. However, the regions are large, and one cannot visit every possible site, so undoubtedly there are more species to be found. These data were augmented by a great deal of information for local distribution and richness examined from the literature (Efflatoun, 1945; El-Hawagry, 2011). The data as a whole were used to map the presence/absence of beefly species in the ecological zones and hence to estimate species richness. The global distributions and faunal affinities of Egyptian beefly species to the main zoogeographical regions were matched to the taxonomies provided by Evenhuis and Greathead (1999) and El-Hawagry (2011), and thus each species was classified according to its region of faunal affinity. We assigned the species according to their affinities to three zoogeographical regions (Palaearctic, Afrotropical and Saharo-Arabian), considering the last as a distinct region, as Holt et al. (2013) suggested. The species recorded only from Egypt, and that therefore appear to be endemic, were considered to have undetermined affinities.

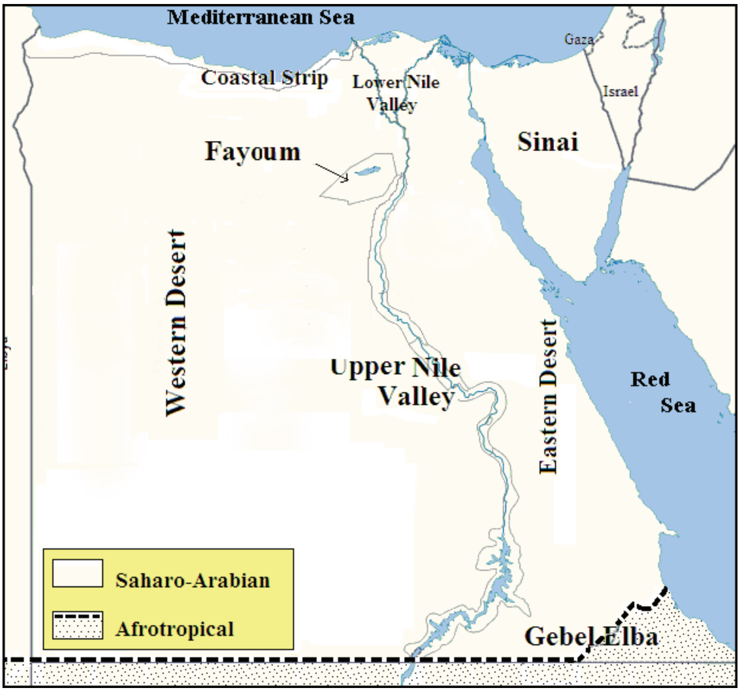

Figure 1. Map of Egypt showing the ecological zones. In some designations the coastal strip forms the southernmost part of the Mediterranean subregion (e.g. Krivokhatsky & Emeljanov, 2000). The northern boundary of the Afrotropical region may include Gebel Elba (see text), but the rest of its boundary in the region is unclear in the literature: it may not follow the political boundary between Egypt and Sudan.

The affinities of species with zoogeographical regions and their occurrence in ecological zones was tested using AnoSim (Clarke, 1993) implemented in Community Analysis Package 4 (Pisces Conservation Ltd., Hampshire, UK). This uses the Bray-Curtis index of similarity together with 1000 randomizations to determine the significance of differences among groups. Clustering of ecological zones was accomplished using Ward's method and Euclidean distances, again implemented by the Community Analysis Package 4.

To study the similarity of species composition among ecological zones we used the Lennon index: $S_{12} = a / \min(N_1, N_2)$, where a = number of species shared in the two zones, N_1 = total number of species in zone 1, and N_2 = total number of species in zone 2.

Results

A distribution analysis of 229 beefly species based on their occurrence in each Egyptian ecological zone (Table 1, Appendix 1) showed a high species richness in Eastern Desert, Sinai and Coastal Strip. Species richness in Lower Nile Valley & Delta and Gebel Elba was moderate, while species richness in the Upper Nile Valley, Fayoum Basin and Western Desert were the lowest. The Egyptian distributions of two species, *Chalcochiton bisalbifrons* and *Desmatoneura aegypticola* have not yet been determined.

The Egyptian ecological zones vary in their compositional similarity to each other (Table 2). The highest similarities were among the Coastal Strip, Lower Nile Valley and Delta, Upper Nile Valley, Fayoum Basin, Eastern Desert and Western Desert, although that between the Coastal Strip and the Lower Nile Valley was only moderate and

Table 1. Beefly species recorded in each Egyptian ecological zone divided according to their zoogeographical affinity. AF = Afrotropical, PA = Palaearctic, SA = Saharo-Arabian, Endemic = only recorded from Egypt or unknown. The Lower Nile Valley includes the Delta; the Upper Nile Valley begins south of Giza province, not at Assiout.

	The total number of recorded beefly species					Number of collection trips
	PA	AF	SA	Endemic	Total	
Coastal Strip	47	4	40	11	102	33
Lower Nile Valley	32	7	24	15	78	38
Upper Nile Valley	13	4	7	2	26	26
Fayoum Basin	20	3	12	4	39	26
Eastern Desert	48	13	38	21	120	38
Western Desert	19	5	14	5	43	34
Sinai	35	8	31	29	103	45
Gebel Elba	15	31	13	2	61	28
total	**229**	**75**	**179**	**89**	**572**	**263**

Table 2. Similarity of beefly faunas in the Egyptian ecological zones. The total number of species in each zone is given in bold; the number of species shared between each pair of zones is given in the lower half of the table; the Lennon index of similarity between each pair of zones is given in the upper half of the table.

		CS	**LN**	**UN**	**FB**	**ED**	**WD**	**SI**	**GE**
Coastal Strip	CS	**102**	0.61	0.85	0.72	0.6	0.72	0.42	0.43
Lower Nile Valley	LN	48	**78**	0.92	0.87	0.7	0.84	0.44	0.45
Upper Nile Valley	UN	22	24	**26**	0.96	0.77	0.58	0.77	0.50
Fayoum Basin	FB	28	34	25	**39**	0.72	0.51	0.67	0.49
Eastern Desert	ED	61	55	20	28	**120**	0.72	0.55	0.6
Western Desert	WD	31	36	15	22	31	**43**	0.46	0.35
Sinai	SI	43	34	20	26	57	20	**103**	0.46
Gebel Elba	GE	26	28	13	19	36	15	28	**61**

distinctly lower. Similarities were lower between Gebel Elba and any of other zones except the Eastern Desert, and between Sinai and each of the Coastal Strip, Lower Nile Valley & Delta and Western Desert.

The affiliation of the Egyptian ecological zones to the global zoogeographical regions (Table 1–2, Figure 3) shows that all Egyptian ecological zones except Gebel Elba have greater affiliation to the Palaearctic than to the Saharo-Arabian or the Afrotropical regions. Palaearctic elements were substantial, comprising 44-51% of all zones except Sinai (34%). Saharo-Arabian elements comprised less than 32% (except the Coastal Strip at 39%), while Afrotropical elements were always less than 10%. In strong contrast, Gebel Elba had a greater affiliation to the Afrotropical (51%) than to the Palaearctic (25%) or Saharo-Arabian region (21%). There were considerable numbers of

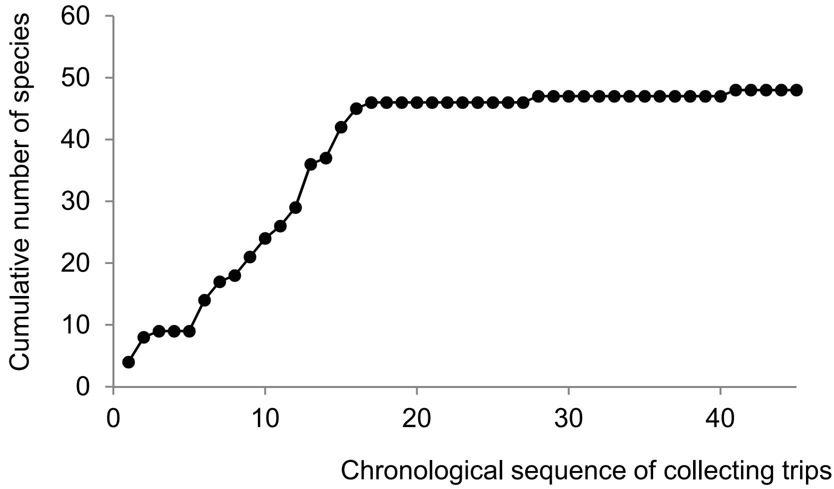

Figure 2. Species discovery curve for collecting trips to the Sinai region by one of the authors (MEH) between 1991 and 2012.

undetermined elements (mostly endemic to Egypt) recorded in all zones, highest in Sinai (28%). Sinai, the Eastern Desert and the Coastal Strip are similar to one another, forming one cluster, while the Nile Valley, Fayoum and the Western Desert all have similarities to one another, forming the other cluster (Figure 3). The species in common between Gebel Elba and the rest of Egypt show more similarity to this latter cluster than to the former, perhaps indicating a lack of faunistic continuity between the mountains of the Eastern Desert and those of Gebel Elba. The clustering pattern constitutes merely a statistical representation of the similarities as calculated, and is not claimed as a true or highly accurate depiction of reality.

Analysis of these patterns using AnoSim showed highly significant differences ($r=0.178$, $p<0.001$). In pairwise tests, it is obvious that it is the distributions of Afrotropical species that are different from both Palaearctic ($r=0.367$, $p<0.001$) and Saharo-Arabian ($r=0.404$, $p<0.001$), but the distributions of Palaearctic and Saharo-Arabian species are not significantly different ($r = -0.023$, n.s.).

Discussion

Insect species richness is usually positively correlated with plant diversity, and Egypt is no exception. Our results demonstrate that the Egyptian ecological zones vary in their beefly species richness, probably reflecting varying climatic factors and vegetation patterns (El-Hawagry, 2011). All of the Egyptian ecological zones except Gebel Elba had greater affiliation to the Palaearctic region (*sensu* Holt et al., 2013: *i.e.* Europe and much of Asia, excluding Arabia, India, southeast Asia, and the southern parts of China) than to the Saharo-Arabian region (*sensu* Holt et al., 2013: *i.e.* North Africa, Arabia, southern Palestine and Lower Mesopotomia). Moreover, about 50% of the species affiliated to the Saharo-Arabian region were represented not only in it but also had considerable representation in the Palaearctic Region as well. Coupled with the lack of any detectable difference between the two leads us to conclude that, from the standpoint of the Bombyliidae, the Saharo-Arabian is merely a subregion of the Palaearctic (*sensu*

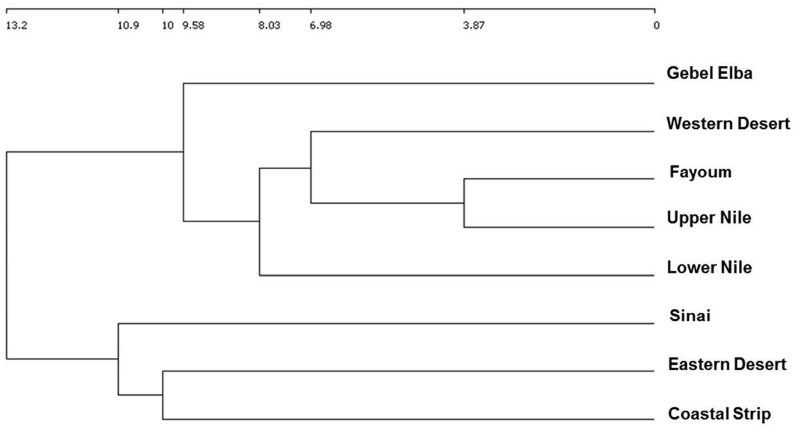

Figure 2. Dendrogram of similarity in species composition of the ecological zones.

Wallace, 1876), as Takhtajan (1986) proposed. The affinities of beefly species to the Palaearctic (including Saharo-Arabia) ranged from 64% to 85% across seven Egyptian ecological zones, but only 46% in Gebel Elba.

There were strong contrasts in beefly species richness among regions. For example, there were 120 species recorded from the Eastern Desert, but only 43 from the Western Desert. This was not caused by any sampling bias, since the total number of collecting trips to the Eastern Desert was not substantially different from those to the Western Desert (Table 1): thus we do not think that the recording patterns are artefacts of sampling bias. Instead, habitat diversity is much greater in the Eastern Desert, and rainfall is also greater. In fact, levels of rainfall are higher in the areas with more beefly species, and hence Egypt's regions clearly straddle the minimum rainfall requirements for many species.

While zoogeographical regions often have definable boundaries, where these do not exist the regions often merge gradually. Although the Palaearctic generally has an extensive land connection with the Afrotropical region, there is generally relatively little mixing of the faunas due to the barrier to dispersal formed by the Sahara and Arabian deserts (Stuart et al., 2008). However, we think Gebel Elba is just such an area of gradual mixing, belonging to the Afrotropics but gradually merging with the Palaearctic and extending some way into it. Probably the mist oasis habitat allows Afrotropical elements to extend their range northwards.

The number of endemic species has been used as an indicator of the geographic isolation (Sadler, 1999). The higher percentage of "undetermined" species (i.e. endemics without any zoogeographical affinity, 28% of all recorded species) in Sinai that seem to be endemic in Sinai may reflect a degree of isolation of Sinai from other parts of Egypt. This is logical because Sinai is a peninsula separated from other parts of Egypt.

It is interesting to note the fauna of the Lower Nile Valley, which is clearly different from that of the adjacent Coastal Strip. The clustering of similarity puts its affinities with the Upper Nile Valley, while the Coastal Strip is placed with Sinai and the Eastern Desert. This is probably because of arid-specialist eastern Palaearctic elements colonising from the East along the Mediterranean coast, which did not penetrate into the Delta and Lower Nile Valley. However, the association of the faunas of the coastal strip, Sinai and the Eastern Desert could also reflect a Mediterranean fauna invading southwards. It would now be interesting to study Egyptian zoogeography and the border of the Afrotropical region using other taxa.

Supplementary Material

Appendix 1 is available as supplementary information via the "Supplementary" tab on the article's online page (http://dx.doi.org/10.1080/09397140.2014.892339).

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Supplementary Material to:

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Magdi El-Hawagry and Francis Gilbert

Appendix 1

Distribution and zoogeographical affinities of 229 Bombyliidae in Egypt. AF = Afrotropical, PA = Palaearctic, SA = Saharo-Arabian, Undet. = undetermined/endemic; CS = Coastal Strip, LN = Lower Nile Valley (including the Delta), UN = Upper Nile Valley (beginning south of Giza province, not at Assiout), FB = Fayoum Basin, ED = Eastern Desert, WD = Western Desert, SI = Sinai, GE = Gebel Elba.

Species	**Affinity**	**Ecological zones**							
		GE	**SI**	**WD**	**ED**	**FB**	**UN**	**LN**	**CS**
Subfamily USIINAE Becker									
Tribe APOLYSINI Evenhuis									
Apolysis eremophila Loew, 1873	PA				*				
Apolysis ornata (Engel, 1932)	SA								*
Tribe USIINI Evenhuis									
Parageron gratus (Loew *in* Rosenhauer, 1856)	PA								*
Parageron lutescens (Bezzi, 1925)	PA			*	*			*	*
Usia (*Micrusia*) *aurata* (Fabricius, 1794)	PA								*
Usia (*Usia*) *bicolor* Macquart, 1855	PA				*				
Usia (*Usia*) *deserticola* Efflatoun, 1945	Undet.		*		*				
Usia (*Usia*) *efflatouni* Venturi, 1948	Undet.				*				
Usia (*Usia*) *elbae* Efflatoun, 1945	AF	*	*						
Usia (*Usia*) *flavipes* Efflatoun, 1945	Undet.		*						
Usia (*Usia*) *grisea* Efflatoun, 1945	AF	*							
Usia (*Usia*) *ignorata* Becker, 1906	SA			*				*	*
Usia (*Usia*) *inornata* Engel, 1932	AF	*							
Usia (*Usia*) *minuscula* Efflatoun, 1945	AF	*							
Usia (*Usia*) *parvula* Efflatoun, 1945	AF	*							
Usia (*Usia*) *tewfiki* Efflatoun, 1945	AF	*							
Subfamily PHTHIRIINAE Becker									
Tribe PHTHIRIINI Becker									
Phthiria gaedii Wiedemann *in* Meigen, 1820	PA								*

*Corresponding author. Email: elhawagry@gmail.com

Species	**Affinity**	**Ecological zones**							
		GE	**SI**	**WD**	**ED**	**FB**	**UN**	**LN**	**CS**
Phthiria minuta (Fabricius, 1805)	PA								*
Phthiria salmayensis Efflatoun, 1945	Undet.		*						
Phthiria tricolor Bezzi, 1924	Undet.				*				
Phthiria unicolor Bezzi, 1925	SA				*				
Phthiria xanthaspis Bezzi, 1925	Undet.							*	*
Subfamily TOXOPHORINAE Schiner									
Tribe GERONTINI Hesse									
Geron (*Geron*) *efflatouni* Greathead *in* Evenhuis & Greathead, 1999	SA		*						
Geron (*Geron*) *erythropus* Bezzi, 1925	Undet.	*	*		*	*		*	*
Geron (*Geron*) *garagniae* Efflatoun, 1945	Undet.		*		*				*
Geron (*Geron*) *halteralis* Wiedemann *in* Meigen, 1820	PA		*		*			*	*
Geron (*Geron*) *intonsus* Bezzi, 1925	Undet.				*			*	*
Geron (*Geron*) *longiventris* Efflatoun, 1945	PA			*	*				*
Geron (*Geron*) *macquarti* Greathead *in* Evenhuis & Greathead, 1999	PA		*						
Tribe TOXOPHORINI Schiner									
Toxophora aegyptiaca Efflatoun, 1945	SA	*	*		*			*	
Toxophora bezzii Paramonov, 1933	SA				*				
Toxophora epargyra Hermann, 1907	PA		*		*				
Toxophora fasciculata (Villers, 1789)	PA	*	*	*	*	*	*	*	*
Toxophora leyladea Efflatoun, 1945	AF	*							
Subfamily HETEROTROPINAE Becker									
Heterotropus aegyptiacus Paramonov, 1929	SA	*			*			*	
Heterotropus bisglaucus Bezzi, 1925	Undet.							*	
Heterotropus elephantinus Séguy, 1929	AF				*				
Heterotropus maculiventris Bezzi, 1925	Undet.		*	*	*			*	
Heterotropus magnirostris Bezzi, 1926	Undet.							*	
Heterotropus nigritarsis Engel, 1933	Undet.				*				
Heterotropus sabulosus Paramonov, 1929	PA				*				
Heterotropus stigmaticus Bezzi, 1926	AF	*			*			*	
Heterotropus xanthothorax Efflatoun, 1945	AF	*							
Subfamily BOMBYLIINAE Latreille									
Tribe BOMBYLIINI Latreille									
Anastoechus aegyptiacus Paramonov, 1930	Undet.							*	
Anastoechus aurifrons Efflatoun, 1945	PA		*		*				
Anastoechus bahirae Becker, 1915	SA	*	*		*				*
Anastoechus exalbidus (Wiedemann *in* Meigen, 1820)	PA	*	*		*			*	
Anastoechus nivifrons (Walker, 1871)	SA	*	*		*	*	*	*	*
Anastoechus stramineus (Wiedemann *in* Meigen, 1820)	PA	*			*				*
Anastoechus trisignatus (Portschinsky, 1881)	PA	*			*				*

Species	**Affinity**	**Ecological zones**							
		GE	**SI**	**WD**	**ED**	**FB**	**UN**	**LN**	**CS**
Beckerellus androgynus (Loew, 1855)	PA				*				
Bombylella atra (Scopoli, 1763)	PA			*				*	
Bombylisoma sinaiticum (Efflatoun, 1945)	Undet.		*						
Bombylisoma tripunctatum (Macquart, 1840)	SA	*	*	*	*			*	*
Bombylius (*Bombylius*) *bedouinus* Efflatoun, 1945	Undet.		*						
Bombylius (*Bombylius*) *cinerascens* Mikan, 1796	PA				*				*
Bombylius (*Bombylius*) *efflatounbeyi* Hesse, 1961	Undet.		*						
Bombylius (*Bombylius*) *elbayensis* Efflatoun, 1945	AF	*							
Bombylius (*Bombylius*) *fimbriatus fimbriatus* Meigen, 1820	PA			*				*	*
Bombylius (*Bombylius*) *flavipes* Wiedemann, 1828	PA		*			*	*	*	*
Bombylius (*Bombylius*) *fulvescens* Wiedemann *in* Meigen, 1820	PA		*						
Bombylius (*Bombylius*) *major* Linnaeus, 1758	PA								*
Bombylius (*Bombylius*) *medius* Linnaeus, 1758	PA								*
Bombylius (*Bombylius*) *modestus* Loew, 1873	PA	*			*			*	*
Bombylius (*Bombylius*) *montanus* Efflatoun, 1945	Undet.		*						
Bombylius (*Bombylius*) *moussayensis* Efflatoun, 1945	Undet.		*						
Bombylius (*Bombylius*) *mus* Bigot, 1862	PA		*						
Bombylius (*Bombylius*) *numidus* Macquart, 1846	SA					*		*	*
Bombylius (*Bombylius*) *posticus* Fabricius, 1805	PA			*					*
Bombylius (*Bombylius*) *seminiger* Becker, 1906	SA								*
Bombylius (*Bombylius*) *wadensis* Efflatoun, 1945	AF	*			*				
Bombylius (*Zephyrectes*) *cinerarius* Pallas & Wiedemann *in* Wiedemann, 1818	PA	*						*	
Dischistus blanchei (Efflatoun, 1945)	Undet.		*						
Dischistus efflatounbeyi (Francois, 1961)	SA		*						
Dischistus grandis (Efflatoun, 1945)	Undet.		*		*				
Dischistus perniveus (Bezzi, 1925)	SA				*				*
Dischistus separatus (Becker, 1906)	SA		*						*
Efflatounia aegyptiaca Bezzi, 1925	SA				*			*	
Gonarthrus longibarbus (Efflatoun, 1945)	SA	*		*	*				*
Neobombylodes multisetosus (Loew, 1857)	PA		*		*				*
Systoechus ctenopterus (Mikan, 1796)	PA		*						
Systoechus gradatus (Wiedemann *in* Meigen, 1820)	PA				*				
Systoechus sinaiticus Efflatoun, 1945	Undet.		*						
Tribe CONOPHORINI Becker									
Conophorus aegyptiacus Bezzi, 1925	SA								*
Legnotomyia fascipennis (Bezzi, 1925)	Undet.			*	*			*	
Legnotomyia leyladea Efflatoun, 1945	Undet.		*						
Prorachthes longirostris Bezzi, 1925	SA								*
Subfamily CROCIDIINAE Hull									
Crocidium aegyptiacum Bezzi, 1925	SA								*
Crocidium nudum Efflatoun, 1945	Undet.		*						*

Subfamily MARIOBEZZIINAE Becker

Species	Affinity	Ecological zones							
		GE	SI	WD	ED	FB	UN	LN	CS
Mariobezzia catherinae Efflatoun, 1945	Undet.	*	*	*	*			*	*
Mariobezzia lichtwardti Becker, 1913	PA				*				
Subfamily CYTHEREINAE Becker									
Amictus aegyptiacus Paramonov, 1931	Undet.				*			*	*
Amictus gebeli Efflatoun, 1945	PA		*						
Amictus pulchellus Macquart, 1846	PA			*				*	*
Amictus setosus Loew, 1869	PA							*	*
Amictus shafiki Efflatoun, 1945	Undet.		*						
Amictus tener Becker, 1906	SA			*				*	*
Chalcochiton argyrocephalus (Macquart, 1840)	SA		*						*
Chalcochiton bisalbifrons Bezzi, 1922	SA								
Cyllenia marginata Loew, 1846	PA		*						
Cytherea albolineata (Bezz, 1925)	SA		*		*				*
Cytherea alexandrina (Becker, 1902)	SA	*	*		*	*	*		*
Cytherea aurea Fabricius, 1794	SA								*
Cytherea barbara Sack, 1906	SA		*		*				*
Cytherea delicata (Becker, 1906)	SA	*	*			*	*	*	*
Cytherea maroccana (Becker, 1903)	SA		*		*				
Cytherea nucleorum (Becker, 1902)	SA		*						*
Cytherea thyridophora (Bezzi, 1925)	SA								*
Cytherea wadensis Efflatoun, 1945	SA		*		*				
Sinaia kneuckeri Becker, 1916	Undet.		*						
Subfamily LOMATIINAE Schiner									
Tribe LOMATIINI Schiner									
Anisotamia ruficornis Macquart, 1840	SA								*
Subfamily ANTONIINAE Hull									
Antonia gabalensis El-Hawagry, 2009	Undet.		*						
Antonia suavissima Loew, 1856	AF	*	*		*				
Subfamily ANTHRACINAE Latreille									
Tribe ANTHRACINI Latreille									
Anthrax aethiops ssp. *bezzii* (Paramonov, 1957)	SA		*		*				*
Anthrax aygulus Fabricius, 1805	AF	*							
Anthrax binotatus Wiedemann *in* Meigen, 1820	PA								*
Anthrax candidapex Austen, 1937	SA		*	*					
Anthrax chionanthrax (Bezzi, 1926)	SA		*		*			*	
Anthrax dentata (Becker, 1906)	PA	*	*	*	*	*		*	*
Anthrax galali El-Hawagry, 2002	Undet.		*						
Anthrax greatheadi El-Hawagry, 1998	Undet.		*						
Anthrax johanni Zaitzev, 1997	AF	*							
Anthrax lucidus (Becker, 1902)	SA	*	*	*	*	*		*	

Species	**Affinity**	**Ecological zones**							
		GE	**SI**	**WD**	**ED**	**FB**	**UN**	**LN**	**CS**
Anthrax melanista (Bezzi, 1925)	Undet.				*				
Anthrax moursyi El-Hawagry, 1998	Undet.		*						
Anthrax pharaonis Paramonov, 1935	Undet.								*
Anthrax sticticus Klug, 1832	PA		*						
Anthrax trifasciatus Meigen, 1804	PA		*						
Anthrax zohrayensis El-Hawagry, 2002	Undet.		*						
Spogostylum bisniphas (Bezzi, 1925)	Undet.				*				
Spogostylum candidum (Sack, 1909)	PA	*	*		*	*			
Spogostylum efflatouni Paramonov, 1957	Undet.				*				
Spogostylum griseipenne (Macquart, 1850)	SA			*		*		*	
Spogostylum hamadnallahi El-Hawagry, 2002	Undet.		*						
Spogostylum hippolyta (Wiedemann, 1828)	AF	*		*					*
Spogostylum incisurale (Macquart, 1840)	AF	*	*	*	*	*	*	*	*
Spogostylum isis (Meigen, 1820)	PA		*		*			*	*
Spogostylum niphas (Hermann, 1907)	PA				*			*	*
Spogostylum ocyale (Wiedemann, 1828)	SA		*		*	*	*	*	*
Spogostylum sordidum Sack, 1909	PA		*		*				*
Spogostylum tripunctatum (Pallas *in* Wiedemann 1818)	PA					*		*	
Spogostylum ventrale Bezzi, 1924	AF	*	*						
Anthrax volitans Wiedemann, 1828	AF	*							
Tribe APHOEBANTINI Becker									
Aphoebantus wadensis Bezzi, 1925	SA		*		*				
Cononedys bilobatoides El-Hawagry, 2007	Undet.		*						
Cononedys dichromatopa (Bezzi, 1925)	SA		*						*
Cononedys efflatouni (Bezzi, 1925)	SA		*		*				*
Cononedys escheri (Bezzi, 1908)	SA								*
Tribe EXOPROSOPINI Becker									
Exoprosopa ammophila Paramonov, 1931	AF	*							
Exoprosopa biguttata (Macquart, 1834)	AF	*	*						
Exoprosopa circeoides Paramonov, 1928	SA				*			*	
Exoprosopa decrepita (Wiedemann, 1828)	AF	*		*	*			*	
Exoprosopa disrupta Walker,1871	AF	*							
Exoprosopa efflatounbeyi Paramonov, 1928	AF	*			*				
Exoprosopa efflatouni Bezzi, 1925	SA		*		*			*	
Exoprosopa minoana Paramonov, 1928	Undet.							*	
Exoprosopa minos (Meigen, 1804)	PA		*	*	*	*	*	*	*
Exoprosopa nigrifera Walker, 1871	Undet.		*						
Exoprosopa pharaonis Paramonov, 1928	AF	*			*				
Exoprosopa zanoni Bezzi, 1922	SA								*
Heteralonia (Acrodisca) serpentata (Loew, 1854)	AF	*	*	*	*	*	*	*	*
Heteralonia (Homolonia) aegina (Wiedemann, 1828)	PA		*	*	*	*	*	*	*
Heteralonia (Homolonia) megerlei (Meigen, 1820)	PA	*	*	*	*	*	*	*	*
Heteralonia (Homolonia) vesperugo (Costa, 1893)	SA				*				*
Heteralonia (Isotamia) spiloneura Bezzi, 1926	Undet.					*	*	*	

Species	Affinity	Ecological zones							
		GE	SI	WD	ED	FB	UN	LN	CS
Heteralonia (Mesoclis) pygmalion (Fabricius, 1805)	SA	*							
Heteralonia (Zygodipla) algira (Fabricius, 1794)	PA					*			*
Heteralonia (Zygodipla) bagdadensis (Macquart, 1940)	SA			*	*			*	
Heteralonia (Zygodipla) bezzii (Paramonov, 1928)	SA				*				
Heteralonia (Zygodipla) mucorea (Klug, 1832)	PA		*	*	*	*	*	*	*
Heteralonia (Zygodipla) olivierii (Macquart, 1840)	SA	*						*	*
Heteralonia (Zygodipla) rivulosa (Becker, 1902)	PA		*	*	*	*	*	*	*
Ligyra helena (Loew, 1854)	AF						*		
Micomitra pharao (Paramonov, 1928)	Undet.				*				
Micomitra stupida (Rossi, 1790)	PA	*	*		*	*		*	
Pterobates chalybaeus (Röder, 1887)	SA		*						
Pterobates chrysogaster (Bezzi, 1926)	Undet.				*				
Tribe PROROSTOMATINI Hull									
Stomylomyia aegyptiaca Bezzi, 1925	Undet.			*		*		*	
Stomylomyia europaea Loew, 1869	PA				*			*	*
Stomylomyia nigrirostris Bezzi, 1925	SA			*	*	*		*	*
Stomylomyia pusilla Bezzi, 1925	PA			*		*		*	
Tribe VILLINI Hull									
Caecanthrax arabicus Macquart, 1840	PA		*						
Exhyalanthrax afer (Fabricius, 1794)	PA	*			*				*
Exhyalanthrax autumnalis (Becker, 1916)	PA				*				
Exhyalanthrax irrorellus (Klug, 1832)	SA			*	*			*	*
Exhyalanthrax leucotaeniatus (Engel, 1936)	AF	*							
Exhyalanthrax muscarius (Pallas *in* Wiedemann, 1818)	PA				*				
Exhyalanthrax stigmulus (Klug, 1832)	PA				*				*
Exhyalanthrax unicolor (Becker, 1902)	SA				*				
Hemipenthis pauper (Becker, 1916)	SA			*	*				*
Laminanthrax chionophorus (Bezzi, 1925)	AF	*			*			*	
Oestranthrax alfierii Paramonov, 1931	Undet.		*		*				*
Oestranthrax brunnescens (Loew, 1857)	PA								*
Pachyanthrax albosegmentataus (Engel, 1936)	SA		*		*				
Pachyanthrax circe (Klug, 1832)	SA		*		*				*
Thyridanthrax elegans elegans (Wiedemann *in* Meigen, 1820)	PA				*			*	*
Thyridanthrax fenestratus (Fallen, 1814)	PA	*	*		*	*			*
Thyridanthrax griseolus (Klug, 1832)	SA			*	*			*	*
Thyridanthrax incanus (Klug, 1832)	PA		*		*				*
Thyridanthrax lotus (Loew, 1869)	PA				*			*	
Thyridanthrax obliteratus (Loew, 1862)	PA				*				*
Thyridanthrax perspicillaris perspicillaris (Loew, 1869)	PA								*
Veribubo angusteoculatus (Becker, 1902)	PA								*
Veribubo anus (Wiedemann, 1828)	SA			*	*	*			
Veribubo latonus (Wiedemann, 1828)	AF	*			*			*	
Veribubo misellus (Loew, 1869)	PA				*				*

Species	**Affinity**	**Ecological zones**							
		GE	**SI**	**WD**	**ED**	**FB**	**UN**	**LN**	**CS**
Veribubo semifuscus (Engel, 1936)	AF	*							
Veribubo tabaninus (Bezzi, 1925)	SA		*		*				
Villa aegyptiaca Engel, 1937	Undet.				*				
Villa bivirgata Austen, 1937	SA				*	*	*	*	*
Villa cana (Meigen, 1804)	PA			*	*	*	*	*	*
Villa efflatouni El-Hawagry & Greathead, 2006	Undet.				*			*	*
Villa micrargyra (Walker, 1871)	SA		*	*	*			*	*
Villa paniscoides Bezzi, 1912	AF	*	*		*				
Villa stenozoides El-Hawagry & Greathead, 2006	Undet.			*		*	*	*	*
Tribe XERAMOEBINI Hull									
Desmatoneura aegypticola (Paramonov, 1935)	Undet.								
Desmatoneura albifacies (Macquart, 1840)	PA	*	*	*	*	*	*	*	*
Desmatoneura nivea (Rossi, 1790)	PA		*		*	*	*	*	
Petrorossia albula Zaitzev, 1962	PA		*						
Petrorossia hespera (Rossi, 1790)	PA	*	*	*	*	*	*	*	*
Petrorossia letho (Wiedemann, 1828)	PA	*	*	*	*	*	*	*	*
Petrorossia liliputiana Bezzi, 1925	SA	*	*			*	*	*	*
Pipunculopsis bivittata Bezzi, 1925	PA		*	*	*	*	*	*	
Prothaplocnemis anthracina (Becker, 1902)	SA	*			*	*	*	*	*
Xeramoeba ramsesi (Paramonov, 1935)	SA		*						
Xeramoeba rubicunda (Bezzi, 1925)	AF	*	*	*	*	*	*	*	*
Xeramoeba sabulonis (Becker, 1906)	PA		*		*			*	*
Xeramoeba salwae El-Hawagry, 2001	Undet.		*		*				
Xeramoeba semirufa (Sack, 1909)	PA				*				