Biting midges of Near East (Diptera: Ceratopogonidae) - separate regional fauna or transitional fauna

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Biting midges (Ceratopogonidae) are a family of small, nematocerous flies (Diptera: Nematocera). In the world fauna this family includes over 6 200 extant species grouped in 111 genera from four subfamilies: Ceratopogoninae (grouped in six tribes: Culicoidini, Ceratopogonini, Heteromyiini, Sphaeromiini, Palpomyiini and Stenoxenini), Dasyheleinae, Forcipomyiinae and Leptoconopinae (ALWIN *et al*. 2016a). The development of larvae of biting midges takes place in terrestrial, aquatic and semi-aquatic habitats, both saline and freshwater (SZADZIEWSKI *et al*. 1997). Females exhibit a wide trophic spectrum: some are nectarivorous, carnivorous or parasitic on other insects, whereas others are haematophagous on wild animals, livestock and also humans. They are very important vectors of many pathogens, like Blue-Tongue Virus – BTV or African Horse Sickness virus – AHSV (LINLEY 1985). In the Middle East region, only the haematophagous genus *Culicoides* Latreille, 1809 has been extensively studied and relatively often reported (126 species).

Despite their nearly worldwide distribution, knowledge of ceratopogonids in different regions is very uneven. Only some 230 species have been reported from the Middle East (ALWIN-KOWNACKA *et al*. 2016a), a small number in comparison with Poland, for example, where 219 species have been recorded (SZADZIEWSKI 2007, ALWIN & SZADZIEWSKI 2013). In addition, different numbers of species have been reported from various Middle Eastern countries.

The Middle East is a geographical region lying between three continents: Asia, Africa and Europe. In the political sense, the Middle East traditionally comprises the following countries: Bahrain, Egypt, Iran, Iraq, Israel with Palestine, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates and Yemen.

From the zoogeographical point of view, the countries of the Middle East have usually been included in the Palaearctic Region, and some in the Afrotropical Region. The latest biogeographical division by HOLT *et al*. (2013) places more countries of the Middle East in the Saharo-Arabian Region. Notwithstanding that these divisions are based mainly on vertebrates, zoogeographical analyses of at least some parts of the Middle East have been based on invertebrates (ALWIN *et al.* 2016d). This was one of the reasons for attempting

a more detailed study and analysis of the data on Ceratopogonidae from this area. Specifically, taxonomic, distributional and chorological analyses of the available data on particular species of Ceratopogonidae recorded from Middle Eastern countries were undertaken.

- ❖ The main objective of the present research was to study the faunistic diversity of biting midges in the Middle East;
  - ➢ The first step was to compile a list of Ceratopogonidae taxa reported from Middle Eastern countries; knowing the species faunistic diversity enabled the state of knowledge regarding biting midges in each country of the region to be established, and their taxonomic diversity in the Middle East to be analysed;
  - ➢ The next step involved taxonomic revisionary studies (morphological and systematic research) of ceratopogonid taxa recorded from the Middle East;
  - ➢ Then, the data relating to the Middle Eastern Ceratopogonidae distributed in the major zoogeographical regions – the Palaearctic, Afrotropical and Oriental of HOLT *et al*. (2013) – were analysed. Chorological analyses of particular species of Ceratopogonidae recorded from the Middle East were also undertaken;
- ❖ The second objective was to attempt find out whether the Ceratopogonidae of the Middle East represent a discrete or a transitional fauna.

To fulfil these requirements, museum and field-collected specimens of Ceratopogonidae as well as the available literature data were studied. The study material came from Israel, Lebanon, Turkey, Iran, Yemen and the United Arab Emirates. The specimens from Yemen and the United Arab Emirates was collected and provided by Professor Antonius van Harten. That part of the material collected from Israel was kindly loaned by Ammon Friedberg from the University of Tel-Aviv. The material from Iran was collected and sent to the Department of Invertebrate Zoology UG by Dr. Mohammad Abdigoudarzi of the Razi Vaccine and Serum Research Institute in Karaj. Specimens from Turkey were collected by Roland Dobosz and donated to the collection of the Department of Invertebrate Zoology and Parasitology UG. The author collected the material from Lebanon herself during two trips to that country in 2012 and 2013. Other available materials relating to Ceratopogonidae in the Collection of Extant Invertebrates, University of Gdańsk (CEIUG) and the collection of the University of Tel-Aviv (TAU) were also used.

A total of over 2.5 thousand specimens was studied, including 57 species belonging to 14 genera: *Allohelea* Kieffer, 1917, *Atrichopogon* Kieffer, 1906, *Bezzia* Kieffer, 1899, *Brachypogon* Kieffer, 1899, *Ceratopogon* Meigen, 1803, *Culicoides* Latreille, 1809, *Dasyhelea* Kieffer, 1911, *Forcipomyia* Meigen, 1818, *Kolenohelea* de Meillon et Wirth, 1981, *Leptoconops* Skuse, 1889, *Palpomyia* Meigen, 1818, *Serromyia* Meigen, 1818, *Sphaeromias* Curtis, 1829 and *Stilobezzia* Kieffer, 1911. The largest number of specimens belonged to the genera *Culicoides*, *Forcipomyia* and *Dasyhelea* (more than 60% of the total number examined).

During the research the following results were obtained:

1. **15 new species** were described: *Allohelea israelensis* Szadziewski et Alwin, 2016; *Bezzia libanensis* Alwin et Szadziewski, 2016; *Bezzia sharjahi* Alwin et Szadziewski, 2016; *Brachypogon freidbergi* Dominiak, Alwin et Giłka, 2014; *Ceratopogon azari* Dominiak, Alwin et Giłka, 2014; *Dasyhelea antonii* Dominiak, 2013 in DOMINIAK & ALWIN 2013; *Dasyhelea avia* Dominiak, 2013 in DOMINIAK & ALWIN 2013; *Dasyhelea libanensis* Dominiak, 2013 in DOMINIAK & ALWIN 2013; *Dasyhelea nauta* Dominiak, 2013 in DOMINIAK & ALWIN 2013; *Dasyhelea sandrageorgei* Dominiak, 2013 in DOMINIAK & ALWIN 2013; *Forcipomyia borkenti* Alwin et Szadziewski, 2016; *Forcipomyia siverekensis* Alwin et Szadziewski, 2016; *Kolenohelea levantica* Szadziewski et Alwin, 2016; *Palpomyia freidbergi* Alwin et Szadziewski, 2016; *Serromyia galilaeae* Szadziewski et Alwin, 2016 (DOMINIAK & ALWIN 2013; DOMINIAK *et al.* 2014; ALWIN *et al*. 2016a, b, c);
2. **5 new synonyms** were proposed: the genus *Boreohelea* Clastrier et Delécolle, 1990 was taken to be a junior synonym of *Allohelea* KIEFFER, 1917, *Alluaudomyia nilogenes* (Kieffer, 1925) a junior synonym of *Alluaudomyia melanosticta* (Ingram et Macfie, 1922), *Bezzia aegyptia* Kieffer, 1925 a junior synonym of *B. albicornis* (Meigen, 1818), *Bezzia omanensis* Boorman et van Harten a junior synonym of *B. pachypyga* Remm, 1974 and *Dasyhelea labinoda* Mazumdar et Chaudhuri, 2009 a junior synonym of *D. deemingi* Boorman et van Harten, 2002 (DOMINIAK & ALWIN 2013; ALWIN *et al*. 2016a, c);
3. As a consequence of inaccurate descriptions precluding unequivocal identification, and the non-existence (non-preservation) of holotypes (and possibly paratypes as well), **13 species are listed as doubtful taxa** (*nomina dubia*). These include 4 species described by VIMMER (1928) from Tel-Aviv, for which no specimens could be found.

The types described by KIEFFER from Egypt (1918, 1921, 1925) are also unavailable because Kieffer never preserved specimens that were not borrowed from a museum. The proposed *nomina dubia* are: *Atrichopogon isis* Kieffer, 1925; *Atrichopogon osiris* Kieffer, 1925; *Dasyhelea flaviscapula* Kieffer, 1918 *Dasyhelea distalis* Kieffer, 1918; *Dasyhelea scutellaris* Kieffer, 1918; *Dasyhelea trifasciata* Kieffer, 1918; *Forcipomyia brachypetiolata* Vimmer, 1928; *Forcipomyia flavomaculata* Vimmer, 1928; *Forcipomyia nilicola* (Kieffer, 1925); *Forcipomyia niligena* Kieffer, 1921; *Forcipomyia imaculata* Vimmer, 1928; *Forcipomyia ochraceus* Vimmer, 1928; *Forcipomyia urnigera* Kieffer, 1925 (DOMINIAK & ALWIN 2013; ALWIN *et al*. 2016b);

4. The following **36 species were recorded for the first time** from particular countries: *Atrichopogon bai* Remm, 1980 (Israel); *Atrichopogon bullus* Remm, 1980 (Iran); *Atrichopogon infuscus* Goetghebuer, 1928 (Israel); *Atrichopogon luteicollis* (Becker, 1903) (Israel); *Atrichopogon rostratus* (Winnertz, 1852) (Iran); *Atrichopogon winnertzi* Goetghebuer, 1922 (Israel); *Bezzia albicornis* (Meigen, 1818) (Israel, Lebanon); *Bezzia flavicornis* (Staeger, 1839) (Israel); *Bezzia fuliginata* Clastrier, 1962 (Israel, Lebanon); *Brachypogon aethiopicus* (Clastrier, Rioux et Descous, 1961) (Israel, Lebanon); *Brachypogon vitiosus* Winnertz, 1852 (Israel); *Dasyhelea tibestiensis* Clastrier, Rioux et Descous (Israel); *Dasyhelea modesta* (Winnertz, 1852) (Israel); *Dasyhelea flava* Carter, Ingram et Macfie, 1921 (Lebanon); *Dasyhelea flaviventris* (Goetghebuer, 1910) (Iran); *Dasyhelea alboverrucosa* Remm, 1967 (Lebanon); *Dasyhelea bicrenata* Kieffer, 1923 (Lebanon); *Dasyhelea bifida* Zilahi-Sebess, 1936 (Lebanon); *Dasyhelea deemingi* Boorman et Harten, 2002 (Yemen); *Dasyhelea europaea* Remm, 1962 (Lebanon); *Dasyhelea similaris* Remm, 1972 (Lebanon); *Dasyhelea turficola* Kieffer, 1925 (Lebanon); *Forcipomyia psilonota* (Kieffer, 1911) (Israel); *Forcipomyia ashantii* Ingram et Macfie, 1924 (UAE); *Forcipomyia bipunctata* (Linnaeus, 1767) (Israel, Turkey); *Forcipomyia dichromata* Remm, 1968 (Israel, Turkey, Yemen); *Forcipomyia nigra* (Winnertz, 1852) (Israel, Turkey); *Forcipomyia pallidipes* Santos Abreu, 1918 (Iran); *Forcipomyia sahariensis* Kieffer, 1923 (Turkey); *Forcipomyia suberis* Clastrier, 1956 (Israel, Turkey); *Forcipomyia pulcherrima* Santos Abreu, 1918 (Israel, Lebanon); *Forcipomyia murina* (Winnertz, 1852) (Israel); *Palpomyia flavipes* (Meigen, 1804) (Israel); *Palpomyia schmidti* Goetghebuer, 1934 (Turkey); *Serromyia diabolica* Dominiak et Mathieu, 2015 (Israel) and *Sphaeromias pictus* (Meigen, 1818) (Israel) (DOMINIAK & ALWIN 2013; DOMINIAK *et al.* 2014; ALWIN *et al*. 2016a, b, c).

The distribution of these Middle Eastern species was analysed based on the data from the specimens examined and revised literature data. Each species recorded was attributed to the zoogeographic region(s) according to the division by HOLT *et al*. (2013). As this division is a large-scale one, a more detailed, chorological attribution of each species is also given.

At present, 269 Ceratopogonidae species have been recorded in the Middle East from the subfamilies Ceratopogoninae, Dasyheleinae, Forcipomyiinae and Leptoconopinae. Ninety-three of them were found to be present exclusively in the Saharo-Arab Region of HOLT *et al*. (2013). There are large numbers of species from the Palaearctic (107) and the Afrotropical Region (44). Twenty-one cosmopolitan species (present in more than two of the regions delineated by HOLT *et al*. 2013) were recorded in the countries of the Middle East,

Saharo-Sindian (71 species), Mediterranean (47), Western Palaearctic (44) and Sudanese chorological elements (41 species) make up the largest contribution to the Middle Eastern fauna. Other chorological elements are represented in smaller numbers: 25 species were identified as Irano-Turanian, 11 as Euro-South Siberian, 9 as Palaearctic and 8 as Holarctic and Geopolitical. Only two species were classified as European elements. Single species were identified as Anatolian, Euxine-Caucasian and Lebanese Montane chorological elements (ALWIN *et al.* 2016d). The numbers of Ceratopogonidae species representing narrow chorological elements are definitely seriously underestimated. It should be stressed that the results of the chorological analysis presented above do not necessarily reflect the real proportions of particular chorological elements, as the available data are scarce.

As result of this study 15 new species were described, 5 synonyms were specified, and 13 taxa were found to be *nomina dubia*; in addition, 36 species were recorded for the first time in the countries of the Middle East. Despite the many reservations resulting from the scarcity and unevenness of the available faunistic and distributional data, one can tentatively state that the ceratopogonid fauna of the Middle East does contain elements characteristic of the region (35%) – more or less widely distributed.