

REEVALUATION OF THE TAXONOMIC STATUS OF THE *CULICOIDES* SPP. (DIPTERA: CERATOPOGONIDAE) FROM ISRAEL AND THE EASTERN MEDITERRANEAN AND REVIEW OF THEIR POTENTIAL MEDICAL AND VETERINARY IMPORTANCE

YEHUDA BRAVERMAN,¹ NADIA MESSADDEQ,²
CHANTAL LEMBLE³ AND MICHEL KREMER³

ABSTRACT. Fifty-eight *Culicoides* species were recorded in Israel, the Golan Heights, and Sinai. *Culicoides arabiensis* and *C. near iranica* were recorded for the first time. *Culicoides kurensis* was identified instead of the misidentified *C. badooshensis*. Of the *Culicoides* species that appeared as distinct species in previous publications, it is now recognized that *C. subravus* is a synonym of *C. ravus*, *C. cubitalis* is a synonym of *C. kibunensis*, and *C. saevanicus* is a synonym of *C. griseidorsum*. The potential medical/veterinary importance of the vector species is reviewed.

INTRODUCTION

Twenty-eight years of study of *Culicoides* in Israel have yielded 5 faunistic lists and the description of 2 new species (Callot et al. 1969; Braverman et al. 1976, 1981c, 1983a; Kremer et al. 1981, 1991). Of the 8 species first described in Palestine by Austen (1921), *C. puripennis* and *C. tentorius* cannot be recognized today, as it is impossible to compare the old types with existing species owing to their poor condition. Vimmer (1932) described 20 species from Palestine and 2 additional species of Vimmer were recorded in Bodenheimer's (1937) list. Of these species, 8 (*C. biarcuatus*, *C. bodenheimeri*, *C. flavipes*, *C. flavirostris*, *C. mystacinus*, *C. quadrivittatus*, *C. quinquemaculatus*, and *C. simulans*) were categorized by Remm (1988) as doubtful species. Three others of Vimmer's species, (*C. trivittatus*, *C. micromaculatus*, and *C. albonotatus*) could not be confirmed. The synonymy of *C. bipunctatus* and *C. flavitarsis* was established by Goetghebuer and Lenz (1933-34) and that of *C. vavrai* was determined by Edwards et al. (1939). The status of an additional 5 species was established by Kremer et al. (1981), and Szadziewski (1982) determined the synonymy of 2 more species. In Bodenheimer's (1937) list, 5 species (named as *C. subfasciipennis* Hoff. [should be Kieffer, 1919], *C. chiopterus* Meigen, 1830, *C. pumilus* Schrk. [should be Winnertz, 1852], *C. nubeculosus* Meigen, 1830, and *C. cantans* Winn. [?, untraced in the literature]) could not be validated, as no specimens could be found in the Museum of Natural His-

tory in Prague and the collection of the Institute of Parasitology, Strasbourg (IPS). Remm (1988) notes *C. pictipennis* Staeger, 1839 (a senior synonym of *C. guttularis* Kieffer, 1919) in Israel, without giving an appropriate reference. This species probably was taken from Bodenheimer's (1937) list, in which many species are not valid. According to our view, based on the wing-spot pattern and other morphologic similarities, the *C. pictipennis* in Israel is most probably *cataneii* Clastrier, 1957. Remm's (1988) list does not include *C. indistinctus* Khalaf, 1961, *C. hanae* Braverman, Delecolle and Kremer, 1983, *C. navaiiae* Lane, 1983, and *C. oxystoma* Kieffer, 1910, a member of the *schultzei* group, which are all present in Israel. Cornet and Brunhes (1994) found 3 different morphologic types in *C. oxystoma*, *sensu* Arnaud, from Israel. A. L. Dyce (personal communication), who examined the *schultzei* group from Israel, found it to consist of 4 species.

The *Culicoides* fauna from other parts of the Mediterranean has been studied by several researchers (Clastrier 1957; Khalaf 1957; Nagaty and Morsy 1960; Mesghali 1963; Callot et al. 1964; Boorman 1974a, 1974b; Kremer et al. 1979; Dik and Dincer 1992; Dik 1993). The most extensive contribution was made by Boorman (1989).

Up to the present study, the *Culicoides* fauna of Israel consisted of 52 species, among which were important vector species such as *C. imicola* Kieffer, 1913, *C. obsoletus* Meigen, 1918, *C. schultzei* group, and *C. pulicaris* Linnaeus, 1758. As the prospects for regional veterinary cooperation are growing, it is important to elucidate the taxonomic status of the various animal disease vectors.

The present study was undertaken in order to reevaluate the taxonomic status and medical importance of the *Culicoides* fauna of Israel and the eastern Mediterranean, with comments on

¹ Kimron Veterinary Institute, P. O. B. 12, Bet Dagan 50250, Israel.

² Institut d'Histologie, Universite Louis Pasteur, Faculte de Medecine, 67000 Strasbourg, France.

³ Institut de Parasitologie et Pathologie Tropicale, Universite Louis Pasteur, Faculte de Medecine, 3, rue Koeberle, 67000 Strasbourg, France.

the synonymy and variations of some recorded species.

MATERIALS AND METHODS

The trapping of insects was carried out in various zoogeographical areas in Israel, the Golan Heights, and Sinai. Descriptions of the various zones were given in a previous article (Braverman et al. 1981c). The sampling localities and dates of collection of the newly recorded species are given in Table 1. Insects were collected by several types of suction light traps as described by Braverman et al. (1981c). Specimens were cleared in phenol, mounted, and dissected in a mixture of Canada balsam and phenol (Wirth and Marston 1968). Voucher specimens of the various species were kept at the IPS and at the Kimron Veterinary Institute, Israel.

RESULTS

Table 1 shows that *C. arabiensis* was found only in Sinai, whereas *C. near iranica* was found only in the Golan Heights.

Table 2 lists the 58 species found in Israel, the Golan Heights, and Sinai; it follows the nomenclature of the Afrotropical and Palaearctic catalogs (Wirth et al. 1980, Remm 1988) and details their medical/veterinary importance. It also includes the 2 newly recorded species found in the present study.

Taxonomic comments: *Culicoides badooshensis* has sensillae coeloconica on the 15th antennal segment whereas they are absent in *C. kurensis* (Boorman 1989). All our specimens from Israel and Morocco have the characteristics of *C. kurensis* and there are no specimens corresponding to *C. badooshensis*.

In the specimens determined as *C. langeroni*, the spermathecae are more or less elongated and larger than those of *C. pseudolangeroni*. There are specimens showing shapes intermediate between the two.

Culicoides azerbaijdzhanicus and *C. arabiensis* are related species. In *C. azerbaijdzhanicus* the wings lack spots and there is no cibarial armature, whereas *C. arabiensis* has very faint wing markings and a cibarial armature of 2 or 3 teeth. Of the specimens studied, some are typical *C. arabiensis*, that is, they show faint wing markings, a cibarial armature, and an elongated 3rd palpal segment, whereas some are nearer to *C. azerbaijdzhanicus*, that is, they lack wing spots and a cibarial armature. The 3rd palpal segment is short and very swollen; in some cases it is so swollen as to raise the question of whether these specimens are actually a new species. Some specimens are intermediate, with

Table 1. Localities and dates of collection of the newly recorded *Culicoides* species.

Species	Region	Collection locality or site	Date
<i>C. arabiensis</i> Boorman, 1989	Sinai	E-Tur (28°16'N, 33°38'E)	June 1979
		Hammam Saidna Moussa (28°16'N, 33°36'E)	June 1979
		Khirba (31°01'N, 32°53'E)	Oct. 1978
		Nahal Yam (31°01'N, 33°10'E)	April 1979
		Wadi Sa'al (28°46'N, 34°15'E)	Oct. 1979
		E-Shira el Gharkana (28°08'N, 34°15'E)	June 1979; Nov. 1980
<i>C. near iranica</i> Navai, 1971	Golan Heights	Marsa Abu Zabab (28°46'N, 34°27'E)	June 1979
		Maale Gamla (32°53'N, 35°42'E)	Oct. 1988

Table 2. List of *Culicoides* spp. found in Israel and their veterinary/medical importance.

Species	Veterinary/medical importance	Authority
<i>C. arabiensis</i> Boorman, 1989		
<i>C. azerbaijdzhanicus</i> Dzhafarov, 1962		
<i>C. begueti</i> Clastrier, 1957		
<i>C. brunnicans</i> Edwards, 1939		
<i>Ca. calloti</i> Kremer, Delecolle, Bailly-Choumara and Chaker, 1979		
<i>C. cataneii</i> Clastrier, 1957		
<i>C. catharinae</i> Kremer, Delecolle and Braverman, 1991		
<i>C. circumscriptus</i> Kieffer, 1918	Vector of <i>Leucocytozoon caulleryi</i> .	Morii and Kitaoka (1968)
<i>C. derisor</i> Callot and Kremer, 1965		
<i>C. distinctipennis</i> Austen, 1912	Vector of <i>Dipetalonema perstans</i> .	Nicholas et al. (1953)
<i>C. faghghi</i> Navai, 1971		
<i>C. fagineus</i> Edwards, 1939		
<i>C. fascipennis</i> Staeger, 1839		
<i>C. firuzae</i> Dzhafarov, 1958		
<i>C. geigelensis</i> Dzhafarov, 1964		
<i>C. griseidorsum</i> Kieffer, 1918		
<i>C. hanae</i> Braverman, Delecolle and Kremer, 1983	Nuisance to humans and dogs.	Kremer (1965), Mezennev (1990)
<i>C. haranti</i> Rioux, Descous and Pech, 1959		
<i>C. imicola</i> Kieffer, 1913		
<i>C. indistinctus</i> Khalaf, 1961	Vectors of viruses: bluetongue, African horse sickness, Akabane, Nyabira virus; replicated experimentally; causal agent of hypersensitivity in horses, cattle, sheep and donkeys.	Braverman and Swanepoel (1981), Braverman et al. (1981b, 1983b), Blackburn et al. (1985), Yeruham et al. (1993)
<i>C. near iranica</i> Navai, 1971		
<i>C. jumineri</i> Callot and Kremer, 1969		
<i>C. kibunensis</i> Tokunaga, 1937		
<i>C. kingi</i> Austen, 1912	Nuisance to humans. Bovine ephemeral fever virus was isolated from a pool containing this species and <i>C. oxystoma</i> ; a virus related to epizootic hemorrhagic disease of deer was isolated; vector of the filaria <i>Onchocerca guttorosa</i> .	Burylova (1975) Davies and Walker (1974), El Sinnary and Hussein (1980), Mellor et al. (1984)
<i>C. kurensis</i> Gutsevich, 1960		

Table 2. Continued.

Species	Veterinary/medical importance	Authority
<i>C. langeroni</i> Kieffer, 1921		
<i>C. leucostictus</i> Kieffer, 1911		
<i>C. longipennis</i> Khalaf, 1957		
<i>C. marileti</i> Callot, Kremer and Basset, 1968		
<i>C. maritimus</i> Kieffer, 1924		
<i>C. mesghalii</i> Navai, 1973		
<i>C. montanus</i> Schakirzganova, 1962		
<i>C. navaiae</i> Lane, 1983		
<i>C. newsteadi</i> Austen, 1921		
<i>C. obsoletus</i> Meigen, 1918		
	Bites cattle and horses.	Boorman (1989)
	Vector of <i>Onchocerca reticulata</i> , <i>Onchocerca cervicalis</i> , bluetongue virus, African horse sickness virus; causal agent of hypersensitivity in horses and sheep; bites cattle, birds; nuisance to humans.	Steward (1933), Hearle (1938), Kremer (1965), Messersmith (1965), Mellor and Pitzolis (1979), Connan and Lloyd (1988), Olbrich and Liebisch (1988), Szadziewski and Kubica (1988), Mellor et al. (1990), Anderson et al. (1991), Yeruham et al. (1993)
<i>C. odiatius</i> Austen, 1921		
<i>C. odibilis</i> Austen, 1921		
	Nuisance to man; suspected vector of <i>Leucocytozoon caulleryi</i> in poultry	Morii and Kitaoka (1968)
<i>C. oxystoma</i> Kieffer, 1910		
	Vector of the nematode <i>Onchocerca gibsoni</i> ; viruses: bluetongue (in laboratory) Akabane and Kasba	Buckley (1938), Kurogi et al. (1987), Miura et al. (1988), Mellor (1990), Jusa et al. (1994)
<i>C. pallidicornis</i> Kieffer, 1919		
<i>C. picturatus</i> Kremer and Deduit, 1961		
<i>C. pseudolangeroni</i> Kremer, Chaker and Delecolle, 1981		
<i>C. pseudopallidus</i> Khalaf, 1961		
<i>C. pulicaris</i> Linnaeus, 1758		
	Vector of viruses: lymphocytic choriomeningitis type 1719 and African horse sickness and <i>Onchocerca cervicalis</i> ; causal agent of hypersensitivity in horses and nuisance to humans, cattle, and dogs; <i>Francisella tularensis</i> was isolated from.	Steward (1993), Karpov et al. (1943), Gutsevich and Vigovskii (1960), Mellor and McCaig (1974), Boorman (1989), Mellor et al. (1990), Mezenev (1990)
<i>C. punctatus</i> Meigen, 1804		
	Isolation of ephemeral fever group virus, nuisance to people, horses and cattle.	Kaneko et al. (1986), Szadziewski and Kubica (1988), Olbrich and Liebisch (1988), Wulfsberg (1989) ¹

Table 2. Continued.

Species	Veterinary/medical importance	Authority
<i>C. puncticollis</i> Becker, 1903	Opportunistic human biter; a suspected causal agent of hypersensitivity in farm animals.	Gutsevich (1973), Braverman et al. (1976), Yeruham et al. (1993)
<i>C. ravus</i> de Meillon, 1936	Bites camels.	Boorman (1989)
<i>C. sahariensis</i> Kieffer, 1923	Vector of the protozoon <i>Leucocytozoon cauleryi</i> and viruses: Issyk-Kul, epizootic hemorrhagic disease of deer, and Palyam; a suspected causal agent of hypersensitivity in farm animals.	Morii et al. (1965), Boorman (1988), Menova et al. (1989), Yeruham et al. (1993)
<i>C. schultzei</i> group		
<i>C. seifadinei</i> Dzhabarov, 1958		
<i>C. semimaculatus</i> Clastrier, 1957		
<i>C. sergenii</i> Kieffer, 1921		
<i>C. shaklawensis</i> Khalaf, 1957		
<i>C. simulator</i> Edwards, 1939		Wulfsberg (1989) ¹
<i>C. subfascipennis</i> Kieffer 1919		
<i>C. subneglectus</i> Vimmer, 1932		
<i>C. univittatus</i> Vimmer, 1932		
<i>C. vidourlensis</i> Callot, Kremer, Molet and Bach, 1968	<i>Leucocytozoon</i> sp. was isolated.	Braverman et al. (1981b)
<i>C. vitreipennis</i> Winnertz, 1852		

¹ Wulfsberg, S. 1989. Field observation on the infestation of horses by biting midges (Diptera: Ceratopogonidae) in northern Germany. Thesis. Tierärztlichen Hochschule Hannover, Germany. [In German.]

wing markings but without a cibarial armature. *Culicoides arabiensis* might be confused with *C. tibialis*, whose sensillae are incorrectly drawn by Glukhova (1989), but are correctly differentiated in the text.

Culicoides iranica (Navai 1971) is certainly present, but the specimens are morphologically quite variable. Some resemble the original description in most of their characteristics, but their wings are more intensely marked with light spots. Other specimens show varying degrees of deviation from the original description. This species needs to be redescribed.

Of the list of species in Table 2 the following, which in previous publications (Braverman et al. 1976, Braverman et al. 1981a) were recorded as separate species, are synonyms. *Culicoides subravus* is a synonym of *C. ravus* (Boorman 1979), *C. cubitalis* is a synonym of *C. kibunensis* (Edwards 1939), and *C. saevanicus* is a synonym of *C. griseidorsum*. According to the rule of precedence the name mentioned 2nd (the species described at the earlier date) in each of the above pairs should prevail.

DISCUSSION

Exotic pathogens such as Kasba virus, reported to be isolated or transmitted in other zoogeographic areas by *Culicoides* spp. existing in the Middle East, could be imported via animals to this area. It is, therefore, important to detail the full list of potential pathogens associated with Mediterranean species (Table 2).

Of the species listed in Table 2, the following may be considered as mammal feeders on the basis of their feeding records or their sensillae coeloconica distribution: *C. derisor*, *C. fagineus*, *C. fascipennis*, *C. imicola*, *C. kingi*, *C. montanus*, *C. newsteadi*, *C. obsoletus*, *C. oxystoma* (*schultzei* group), *C. pulicaris*, *C. punctatus*, *C. puncticollis*, and *C. shaklawensis* (Braverman et al. 1971, 1981a; Braverman and Hulley 1979). These species might be associated with vectored mammal diseases. The following species are known or suspected to be bird feeders: *C. begueti*, *C. brunnicans*, *C. cataneii*, *C. circumscriptus*, *C. geigelensis*, *C. griseidorsum*, *C. haranti*, *C. indistinctus*, *C. kibunensis*, *C. leucostictus*, *C. maritimus*, *C. odiatu*, *C. odibilis*, *C. pseudopallidus*, and *C. univittatus* (Kitaoka and Morii 1964; Braverman et al. 1977, 1981a; Braverman and Hulley 1979). These species might be associated with vectored bird diseases.

Of the mammal feeders, *C. imicola*, is a proven and most important vector of bluetongue and African horse sickness, and a suspected vector of Akabane and bovine ephemeral fever in our area; these viruses have been isolated from pools

of these insects (DuToit 1944, Braverman et al. 1981b, Blackburn et al. 1985). This information should be interpreted cautiously, as *C. imicola* is thought to be a complex of several species (Wirth and Dyce 1985) and it is not certain from which member of the complex the isolations were made. *Culicoides obsoletus*, which is less common than *C. imicola* in our area, is a suspected vector of bluetongue; the virus has been isolated from these insects in Cyprus (Mellor and Pitzolis 1979). Three viruses were isolated from *C. oxystoma*, a common species in the Mediterranean area: Akabane, Kagoshima, and Issyk-kul (Kurogi et al. 1987, 1989; Menova et al. 1989). In a later study, Jusa et al. (1994) determined that the Kagoshima and Chuzan viruses are actually an orbivirus named Kasba. *Culicoides oxystoma* has been infected with bluetongue virus in the laboratory (Mellor 1990), and it is a suspected field vector of this virus (Walker 1977, Braverman et al. 1981b) and of bovine ephemeral fever (Boorman 1989). *Culicoides newsteadi*, *C. pulicaris*, and *C. punctatus* were found in our area, in close association with livestock; they are known to bite both cattle and horses and, therefore, have a potential to transmit pathogens to these animals. Of the bird feeders, *C. circumscriptus* is considered to rank 2nd in importance as a vector of *Akiba caulleryi* in Japan (Morii and Kitaoka 1968). In Israel, *C. distinctipennis* was found to be a relatively frequent feeder in poultry and turkey runs (Braverman et al. 1977) and, therefore, has a potential to transmit avian pathogens.

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