Beiträge zur Entomofaunistik	9	67-79	Wien, Dezember 2008

Culicoides surveillance in Austria (Diptera: Ceratopogonidae) – a snap-shot

Franziska Anderle*, Peter Sehnal*, Yvonne Schneemann*, Maria Schindler*, Günther Wöss* & Maria Marschler*

Zusammenfassung

Der bisherige Kenntnisstand über Artenspektrum und Vorkommen der umfangreichen Gnitzengattung *Culicoides* (Diptera: Ceratopogonidae) in Österreich basierte lediglich auf vereinzelten Funden. Eine erste österreichweite Erhebung von *Culicoides* wird seit Anfang Juni 2007 im Rahmen der Bluetongue-Überwachung in Österreich durchgeführt, einem Kooperationsprojekt des BMGFJ (Bundesministerium für Gesundheit, Familie und Jugend) mit der AGES (Agentur für Gesundheit und Ernährungssicherheit) und dem NHMW (Naturhistorisches Museum Wien). Dabei wurden seit Juni 2007 bundesweit einmal wöchentlich 50 (ab Jänner 2008: 54) Standorte mittels Schwarzlichtfallen beprobt. Im Zuge dieser Erhebungen konnten bisher 26 Arten festgestellt werden, 18 davon sind Erstnachweise für Österreich. Eine Liste aller 31 bisher in Österreich nachgewiesenen *Culicoides*-Spezies mit deren derzeit bekannter Verbreitung im gesamten Bundesgebiet wird präsentiert.

Summary

The previous state of knowledge on species composition and distribution of the large genus *Culicoides* (Diptera: Ceratopogonidae) in Austria was based only on isolated findings. A first faunistic survey of *Culicoides* biting midges throughout Austria is carried out within the scope of Bluetongue Surveillance in Austria, a project of the Federal Ministry of Health, Family and Youth (BMGFJ) in cooperation with the Austrian Agency for Health and Food Safety (AGES) and the Natural History Museum Vienna (NHMW). For this purpose, 50 (since January 2008: 54) sites throughout Austria were sampled once a week via blacklight traps since June 2007. In the course of this survey up to now 26 species were recorded, 18 of them new for Austria. A list of all 31 *Culicoides* species known from Austria together with their presently known distributions throughout Austria is given.

Keywords: Ceratopogonidae, *Culicoides*, faunistics, vector surveillance, Austria.

Introduction

The genus *Culicoides* belongs to the Ceratopogonidae ("biting midges"). This dipteran family comprises about 5,000 species in 120 genera worldwide. According to Franz (1989), 13 ceratopogonid genera occur in Austria, of which *Culicoides* is one of three with haematophagous females (the other two being *Leptoconops* and *Forcipomyia*), which need vertebrate blood for the oogenesis (Kampen & Kiel 2006). In the genus *Culicoides*, more than 1,400 species have been described worldwide – 96% are obligatory bloodsuckers of mammals (Mellor et al. 2000). For Austria, Franz (1989) lists 13 species now assigned to the genus *Culicoides*: *C. albicans*, *C. chiopterus*, *C. fascipennis*, *C. nubeculosus*, *C. obsoletus*, *C. pictipennis*,*C. pulicaris*,

* International Research Institute of Entomology, Natural History Museum Vienna, Burgring 7, A-1010 Vienna, Austria.

E-Mail: franziska.anderle@nhm-wien.ac.at (Mag.[a] Franziska Anderle), peter.sehnal@nhm-wien.ac.at (Peter Sehnal), yvonne@myss.de (DI Yvonne Schneemann), maria@libellen.at (Mag.[a] Maria Schindler), g.woess@gmail.com (Günther Wöss), maria.mm@aon.at (Maria Marschler).

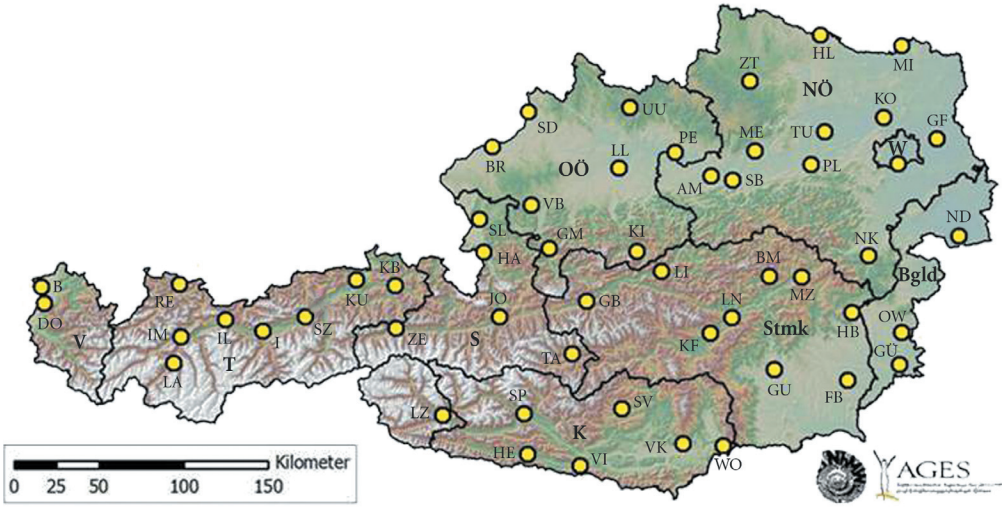

Fig.1: Sampling locations (the names corresponding to their political districts) distributed across Austria with the abbreviations used in the text (**OÖ: Upper Austria,** GM: Gmunden, KI: Kirchdorf an der Krems, LL: Linz-Land, PE: Perg, SD: Schärding, UU: Urfahr-Umgebung, VB: Vöcklabruck; **NÖ: Lower Austria**, AM: Amstetten, GF: Gänserndorf, HL: Hollabrunn, KO: Korneuburg, ME: Melk, MI: Mistelbach, NK: Neunkirchen, PL: St. Pölten-Land, SB: Scheibbs, TU: Tulln, ZT: Zwettl; **W: Vienna**; **Bgld: Burgenland**, GÜ: Güssing, ND: Neusiedl am See, OW: Oberwart; **S: Salzburg**, HA: Hallein, JO: St. Johann im Pongau, SL: Salzburg-Umgebung, TA: Tamsweg, ZE: Zell am See; **Stmk: Styria**, BM: Bruck an der Mur, FB: Feldbach, GB: Liezen-Gröbming, GU: Graz-Umgebung, HB: Hartberg, KF: Knittelfeld, LN: Leoben, LI: Liezen, MZ: Mürzzuschlag; **V: Vorarlberg**, B: Bregenz, DO: Dornbirn; **T: Tyrol**, I: Innsbruck, IL: Innsbruck-Land, IM: Imst, KB: Kitzbühel, KU: Kufstein LA: Landeck, LZ: Lienz, RE: Reutte, SZ: Schwaz; **K: Carinthia**, HE: Hermagor, SP: Spittal an der Drau, SV: St. Veit an der Glan, VI: Villach, VK: Völkermarkt, WO: Wolfsberg).

Abb.1: Verteilung der Probenstandorte (die Namen entsprechen den politischen Bezirken) in Österreich mit den im Text verwendeten Abkürzungen (**OÖ: Oberösterreich,** GM: Gmunden, KI: Kirchdorf an der Krems, LL: Linz-Land, PE: Perg, SD: Schärding, UU: Urfahr-Umgebung, VB: Vöcklabruck; **NÖ: Niederösterreich**, AM: Amstetten, GF: Gänserndorf, HL: Hollabrunn, KO: Korneuburg ME: Melk, MI: Mistelbach, NK: Neunkirchen, PL: St. Pölten-Land, SB: Scheibbs, TU: Tulln, ZT: Zwettl; **W: Wien**; **Bgld: Burgenland**, GÜ: Güssing, ND: Neusiedl am See, OW: Oberwart; **S: Salzburg** HA: Hallein, JO: St. Johann im Pongau, SL: Salzburg-Umgebung, TA: Tamsweg, ZE: Zell am See **Stmk: Steiermark**, BM: Bruck an der Mur, FB: Feldbach, GB: Liezen-Gröbming, GU: Graz-Umgebung, HB: Hartberg, KF: Knittelfeld, LN: Leoben, LI: Liezen, MZ: Mürzzuschlag; **V: Vorarlberg**, B: Bregenz, DO: Dornbirn; **T: Tirol**, I: Innsbruck, IL: Innsbruck-Land, IM: Imst, KB: Kitzbühel KU: Kufstein, LA: Landeck, LZ: Lienz, RE: Reutte, SZ: Schwaz; **K: Kärnten**, HE: Hermagor, SP: Spittal an der Drau, SV: St. Veit an der Glan, VI: Villach, VK: Völkermarkt, WO: Wolfsberg).

C. pumilus (=syn. of *C. minutissimus*), *C. puncticeps* (= syn. of *C. saevus*), *C. stigma*, *C. subfascipennis*, *C. vexans*, and *C. winnertzi* (= syn. of *C. festivipennis*). Additionally, ten species (represented by only a few dried specimens) of *Culicoides* collected from Austrian locations are stored in the Diptera collection of the Natural History Museum

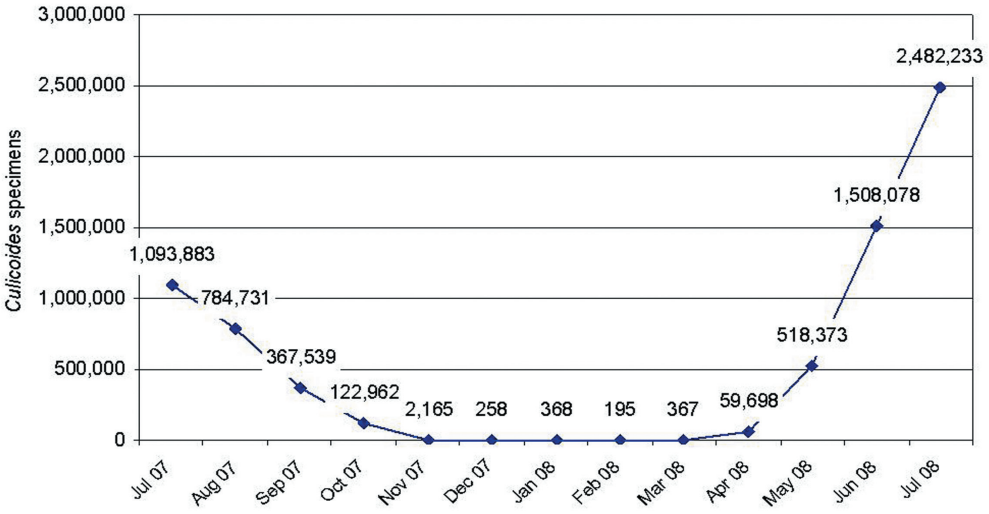

Fig. 2: Total amount of collected *Culicoides* specimens from July 2007 to July 2008.
Abb. 2: Anzahl gesammelter *Culicoides*-Individuen im Zeitraum von Juli 2007 bis Juli 2008.

Vienna (NHMW): *Culicoides albicans*, *C. chiopterus*, *C. fascipennis*, *C. minutissimus*, *C. nubeculosus*, *C. obsoletus*, *C. pictipennis*, *C. pulicaris, C. puncticeps* (= syn. of *C. saevus*), and *C. subfasciipennis.*

Some *Culicoides* species (among these the most abundant C. *obsoletus*) are known to act as vectors for bluetongue virus (BTV). This *Orbivirus* of the family Reoviridae causes an infectious disease called bluetongue disease (BTD) in ruminants – mainly sheep, but cattle and goats may be affected as well. In Europe, bluetongue disease has long since been known in the Mediterranean region, but recently has become also widespread in the northern parts of Europe (e.g. The Netherlands, Belgium, Germany, Northern France and Switzerland, MEHLHORN et al. 2007). So far, there are no cases of bluetongue disease in Austria.

In 2007, a project on vector surveillance was started to investigate distributional and seasonal patterns of *Culicoides* in Austria. Commissioned and funded by the Federal Ministry of Health, Family and Youth (Bundesministerium für Gesundheit, Familie und Jugend; BMGFJ), the project was carried out by the Austrian Agency for Health and Food Safety (Österreichische Agentur für Gesundheit und Ernährungssicherheit; AGES) and the Natural History Museum Vienna (NHMW) (LOITSCH et al. 2008, SEHNAL et al. 2008).

Material and Methods

Methods of capture and catch analysis are conform to those used in the Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise (IZS) in Teramo, Italy (GOFFREDO & MEISWINKEL, 2004). Since June 2007 samplings have been carried out once a week with blacklight traps set up in fifty sampling sites across Austria in the vicinity of stables with cattle, sheep, or goats. Four additional traps were added in

January 2008. As there is never more than one trap in each Austrian district, sampling site names are equivalent to the corresponding political district names in this study. The sampling sites (fig. 1) span altitudes of 115 m (Neusiedl am See/Burgenland) to 1190 m (Tamsweg/Salzburg). All individuals were identified in samples that contained less than 500 specimens; subsamples were taken from larger samples (Van Ark & Meiswinkel 1992). For determination, primarily the keys of Delécolle (1985) and Boorman (2006) were used.

The subgenus *Avaritia* Fox, 1955 contains several morphologically similar species, which are often grouped into complexes (e.g. Obsoletus complex). Determination to species level is often only possible on the basis of male genitalia as morphological differences are not reflected in females (Meiswinkel et al. 2004). Thus, the species list and distribution maps of this subgenus are based primarily on male specimens.

Typical specimens of the subgenus *Culicoides* Latreille, 1809 are easy to diagnose on the basis of wing patterns (Lane 1981). Single specimens, however, may show intermediate characteristics (e.g. between the species *C. pulicaris* and *C. lupicaris*), and even male genitalia are not of great help in that case. In addition, the identification of specimens of the Impunctatus group (comprising e.g. *C. impunctatus*, *C. deltus*, *C. grisescens,* and *C. fagineus*) as well as of intermediate specimens between the Impunctatus group and *C. lupicaris* morphologically proves rather difficult. Thus, we will mention only typical specimens of this subgenus in the species list and distribution maps provided below. As the type locality of *C. newsteadi* is in Israel, it is possible that the Austrian specimens are not *C. newsteadi*, but a very similar species. Until the situation is clarified, this species should better be indicated as "species near *newsteadi*" (R. Meiswinkel, pers. comm.).

Some confusion also exists in the subgenus *Wirthomyia* Vargas, 1973 as the species *C. segnis*, *C. reconditus* and *C. riouxi* are sometimes treated as separate species (Delécolle 1985), but also synonymized heterogeneously: Havelka & Aguilar (1999) consider *C. riouxi* as a synonym of *C. reconditus*, while Boorman (2006) treats *C. riouxi* and *C. reconditus* as synonymous. In this study we follow Delécolle (1985) separating these three species on the basis of female abdominal sclerites. Our samples contained distinct specimens of *C. riouxi* and *C. segnis* as well as intermediate specimens; thus, in the distribution map *C. segnis* and *C. riouxi* have not been split up.

The subgenus *Oecacta* Poey, 1853 has apparently been used as junk room for species which do not belong to any other subgenus (Cornet & Brunhes 1994) as many morphologically very distinct species are included in this subgenus. We, however, decided to leave the species within the subgenus *Oecacta* as most commonly accepted (Boorman 2006).

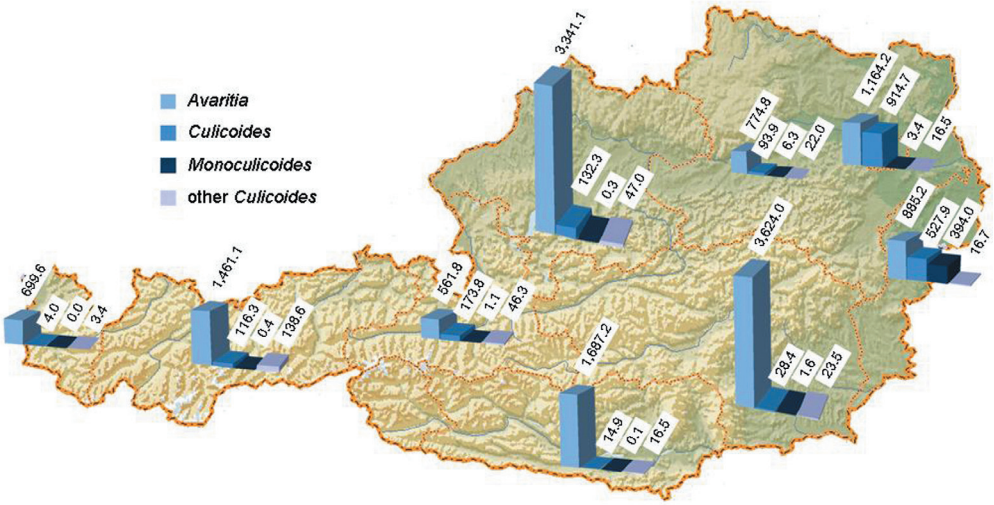

Fig. 3: Means of *Culicoides* specimens (divided into the subgenera *Avaritia*, *Culicoides* and *Monoculicoides*) collected from July 2007 to July 2008 in the different provinces.

Abb. 3: Durchschnittliche Individuenzahl der einzelnen Subgenera (*Avaritia*, *Culicoides* und *Monoculicoides*) im Zeitraum von Juli 2007 bis Juli 2008 in den jeweiligen Bundesländern.

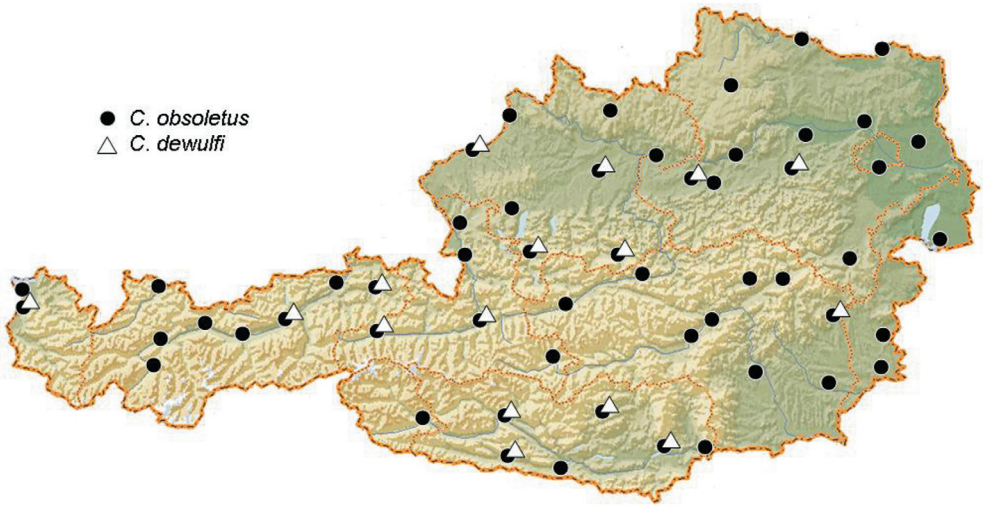

Fig. 4: Distribution of *Culicoides* (*Avaritia*) *obsoletus* and *C.* (*A.*) *dewulfi* in Austria.

Abb. 4: Verbreitung von *Culicoides* (*Avaritia*) *obsoletus* und *C.* (*A.*) *dewulfi* in Österreich.

Results

From July 2007 to July 2008, 2,697 samples were evaluated. A total of 5,841,887 *Culicoides* specimens (fig. 2) out of 26 species were collected, of these 18 represent new records for Austria, bringing the total number of known *Culicoides* species in Austria to 31. The majority of *Culicoides* specimens (89.3%) belong to the subgenus *Avaritia,* followed by the subgenus *Culicoides* (5.8%), and the subgenus *Monoculicoides* (0.8%) (fig. 3). Out of the 4.1% remaining *Culicoides* specimens, the most abundant species (0.8%) was *Culicoides furcillatus*.

Within the subgenus *Avaritia*, the majority (91.5%) of males belong to *Culicoides obsoletus*. *C. scoticus* (7.6%), *C. dewulfi* (0.5%), and *C. chiopterus* (0.4%) are much less abundant.

List of Austrian *Culicoides* species

Species that have not been collected in the course of this study are marked with an asterisk (*).

Species belonging to morphologically difficult species groups and identified only with few specimens are marked with two asterisks (**).

The following abbreviations for Austrian provinces and districts are used (provinces in **bold**, districts in regular letters):

OÖ: Upper Austria

GM: Gmunden	KI: Kirchdorf/Krems	LL: Linz-Land
PE: Perg	UU: Urfahr-Umgebung	VB: Vöcklabruck
SD: Schärding		

NÖ: Lower Austria

AM: Amstetten	GF: Gänserndorf	ZT: Zwettl
HL: Hollabrunn	KO: Korneuburg	TU: Tulln
ME: Melk	MI: Mistelbach	SB: Scheibbs
NK: Neunkirchen	PL: St. Pölten-Land	

W: Vienna

Bgld: Burgenland

GÜ: Güssing	ND: Neusiedl am See	OW: Oberwart

S: Salzburg

HA: Hallein	JO: St. Johann im Pongau	TA: Tamsweg
SL: Salzburg-Umgebung	ZE: Zell am See	

Stmk: Styria

BM: Bruck an der Mur	FB: Feldbach	GU: Graz-Umgebung
GB: Liezen-Gröbming	MZ: Mürzzuschlag	LI: Liezen
HB: Hartberg	KF: Knittelfeld	LN: Leoben

V: Vorarlberg

B: Bregenz	DO: Dornbirn

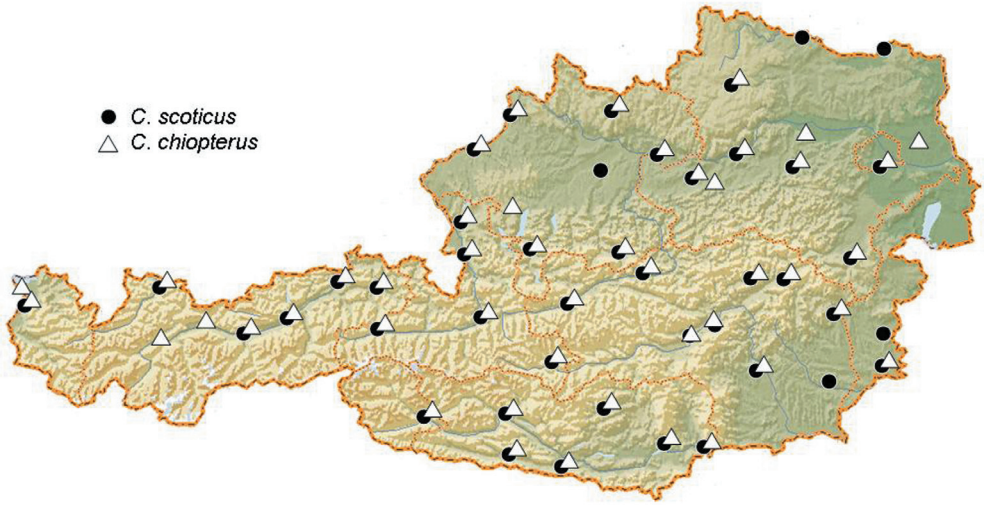

Fig. 5: Distribution of *Culicoides* (*Avaritia*) *scoticus* and C. (*A.*) *chiopterus* in Austria.
Abb. 5: Verbreitung von *Culicoides* (*Avaritia*) *scoticus* und C. (*A.*) *chiopterus* in Österreich.

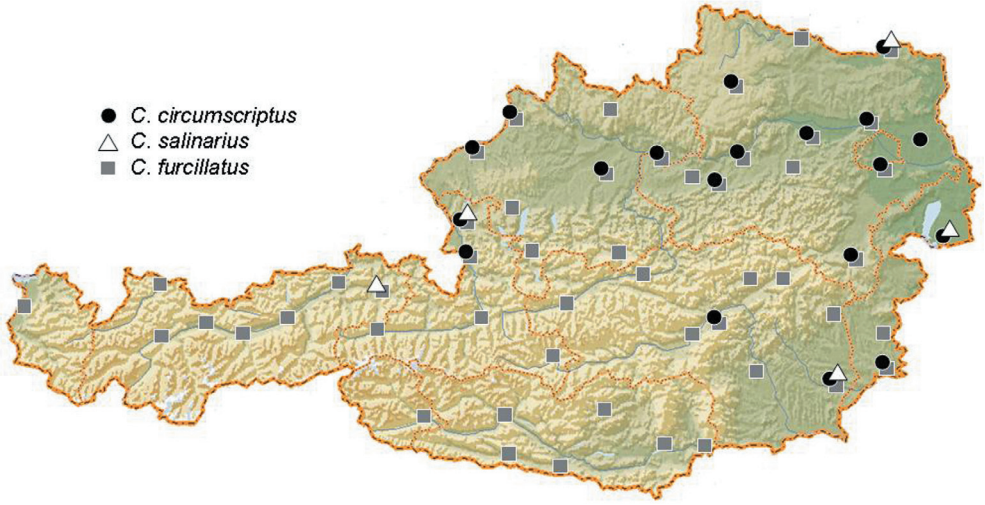

Fig. 6: Distribution of *Culicoides* (*Beltranmyia*) *circumscriptus*, *C.* (*B.*) *salinarius* and *C.* (*Oecacta*) *furcillatus* in Austria.

Abb. 6: Verbreitung von *Culicoides* (*Beltranmyia*) *circumscriptus, C.* (*B.*) *salinarius* und *C.* (*Oecacta*) *furcillatus* in Österreich.

T: Tyrol

I: Innsbruck	IL: Innsbruck-Land	SZ: Schwaz
IM: Imst	KB: Kitzbühel	RE: Reutte
KU: Kufstein	LA: Landeck	LZ: Lienz

K: Carinthia

HE: Hermagor	SP: Spittal an der Drau	WO: Wolfsberg
SV: St. Veit an der Glan	VI: Villach	VK: Völkermarkt

Subgenus *Avaritia* Fox, 1955

- *C. obsoletus* (Meigen, 1818): found in all sampling sites; see fig. 4
- *C. dewulfi* Goetghebuer, 1936: new record for Austria; see fig. 4
- *C. scoticus* Downes & Kettle, 1952: new record for Austria; see fig. 5
- *C. chiopterus* (Meigen, 1830) : see fig. 5

Subgenus *Beltranmyia* Vargas, 1953

- *C. circumscriptus* Kieffer, 1918: new record for Austria; see fig. 6
- *C. salinarius* Kieffer, 1914: new record for Austria; see fig. 6

Subgenus *Culicoides* Latreille, 1809

- *C. pulicaris* (Linnaeus, 1758): found in all sampling sites; see fig. 7
- *C. lupicaris* Downes & Kettle, 1952: new record for Austria; see fig. 8
- *C. newsteadi* Austen, 1921 ("species near *C. newsteadi*"): new record for Austria; see fig. 8
- *C. punctatus* (Meigen, 1804): new record for Austria; see fig. 7
- ** *C. grisescens* Edwards, 1939: new record for Austria (**S:** JO; **T:** KB)
- ** *C. deltus* Edwards, 1939: new record for Austria (**OÖ:** GM; **T:** KB)

Subgenus *Monoculicoides* Khalaf, 1954

- *C. nubeculosus* (Meigen, 1830): see fig. 9
- *C. riethi* Kieffer, 1914: new record for Austria; see fig. 9
- *C. stigma* (Meigen, 1818): see fig. 9

Subgenus *Silvaticulicoides* Glukhova, 1977

- *C. fascipennis* (Staeger, 1839): see fig. 10
- * *C. subfasciipennis* Kieffer, 1919: two dried specimens (**T:** „Tirolis Jenbach/11.8.[18]85/Mik"; female: „Austria/Alte Sammlung") in the Diptera collection of the Natural History Musem Vienna

Subgenus *Wirthomyia* Vargas, 1973

- *C. reconditus* Campbell & Pelham-Clinton, 1960: new record for Austria; see fig. 11
- *C. segnis* Campbell & Pelham-Clinton, 1960: new record for Austria; see fig. 11
- *C. riouxi* Callot & Kremer, 1961: new record for Austria; see fig. 11
- * *C. minutissimus* (Zetterstedt, 1855): one dried specimen from **NÖ:** "Brühl/16.7.[18]81/Handl." in the Diptera collection of the Natural History Musem Vienna

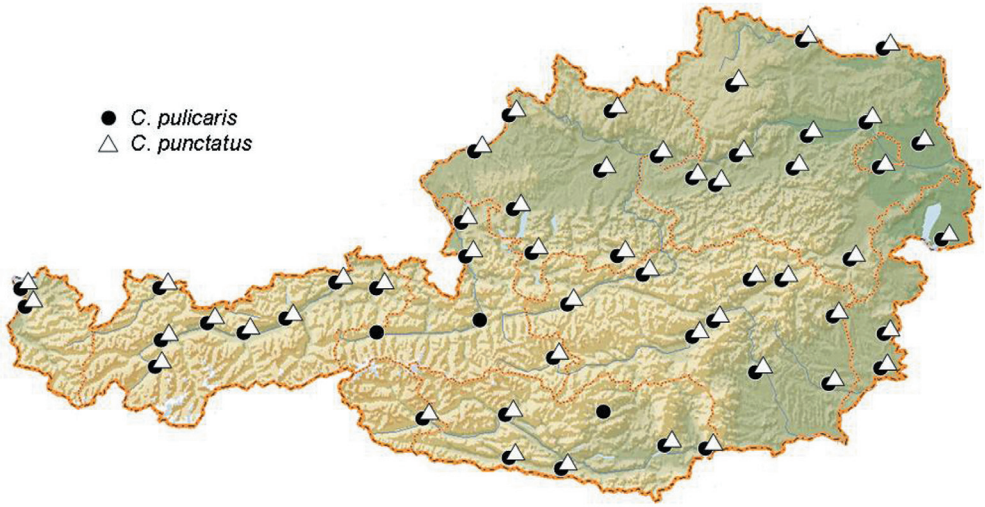

Fig. 7: Distribution of *Culicoides* (*Culicoides*) *pulicaris* and *C.* (*C.*) *punctatus* in Austria.
Abb. 7: Verbreitung von *Culicoides* (*Culicoides*) *pulicaris* und *C.* (*C.*) *punctatus* in Österreich.

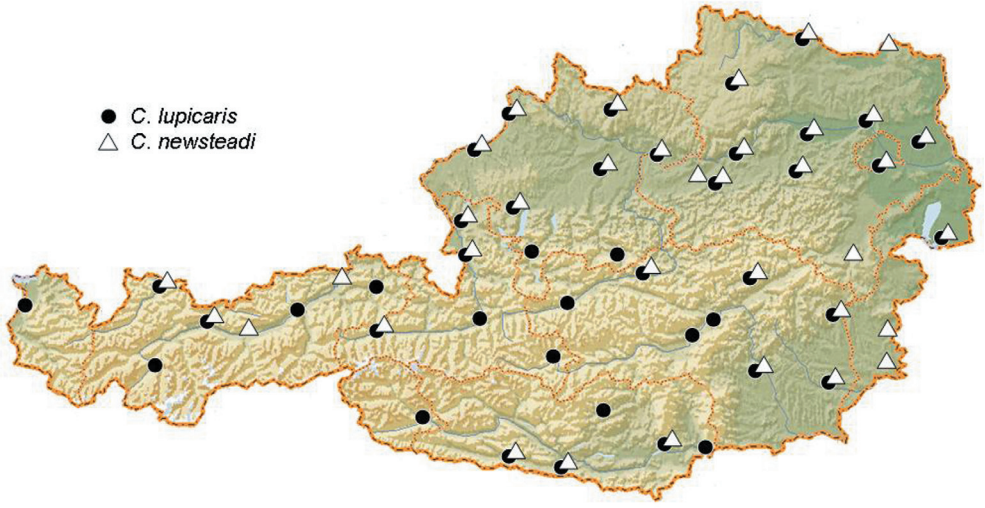

Fig. 8: Distribution of *Culicoides* (*Culicoides*) *lupicaris* and *C.* (*C.*) *newsteadi* in Austria.
Abb. 8: Verbreitung von *Culicoides* (*Culicoides*) *lupicaris* und *C.* (*C.*) *newsteadi* in Österreich.

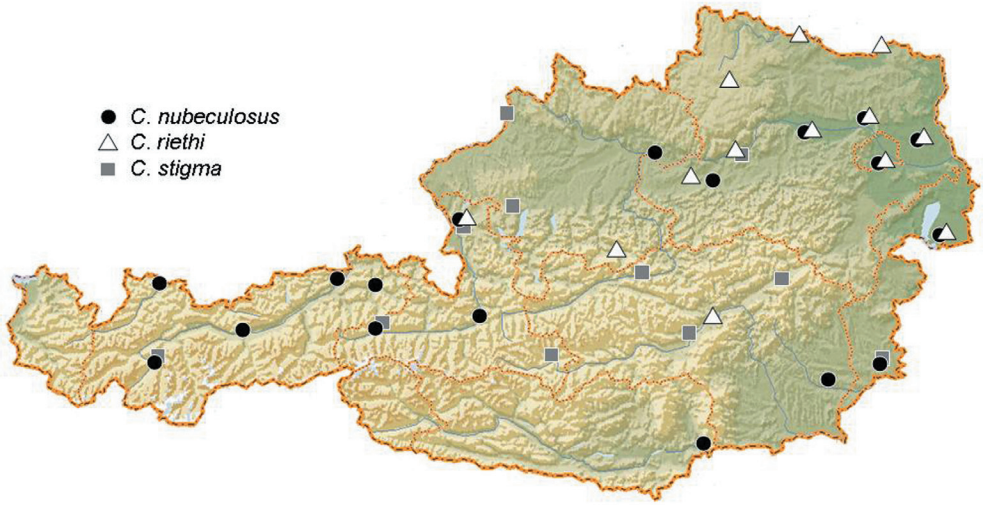

Fig. 9: Distribution of *Culicoides* (*Monoculicoides*) *nubeculosus*, C. (*M.*) *riethi* and *C.* (*M.*) *stigma* in Austria.

Abb. 9: Verbreitung von *Culicoides* (*Monoculicoides*) *nubeculosus*, C. (*M.*) *riethi* und *C.* (*M.*) *stigma* in Österreich.

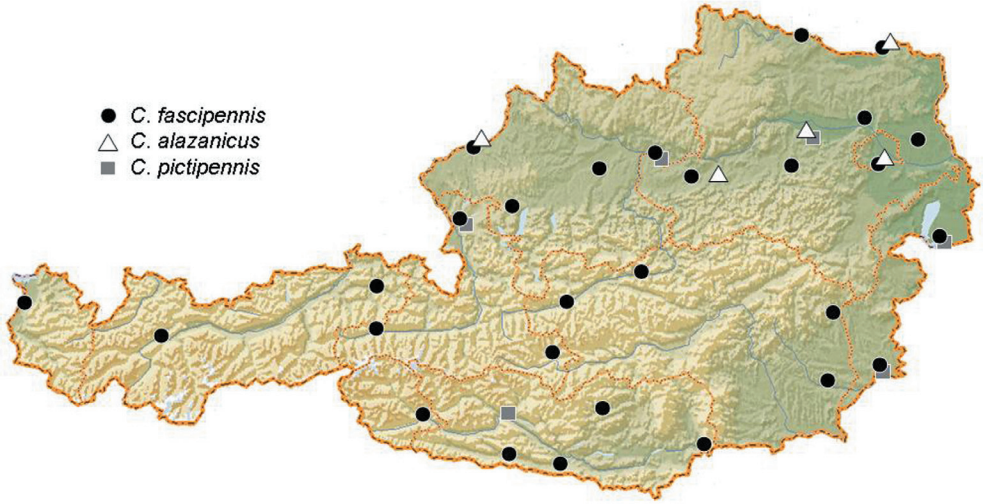

Fig. 10: Distribution of *Culicoides* (*Silvaticulicoides*) *fascipennis*, C. (*Oecacta*) *alazanicus* and *C.* (*O.*) *pictipennis* in Austria.

Abb. 10: Verbreitung von *Culicoides* (*Silvaticulicoides*) *fascipennis*, C. (*Oecacta*) *alazanicus* und *C.* (*O.*) *pictipennis* in Österreich.

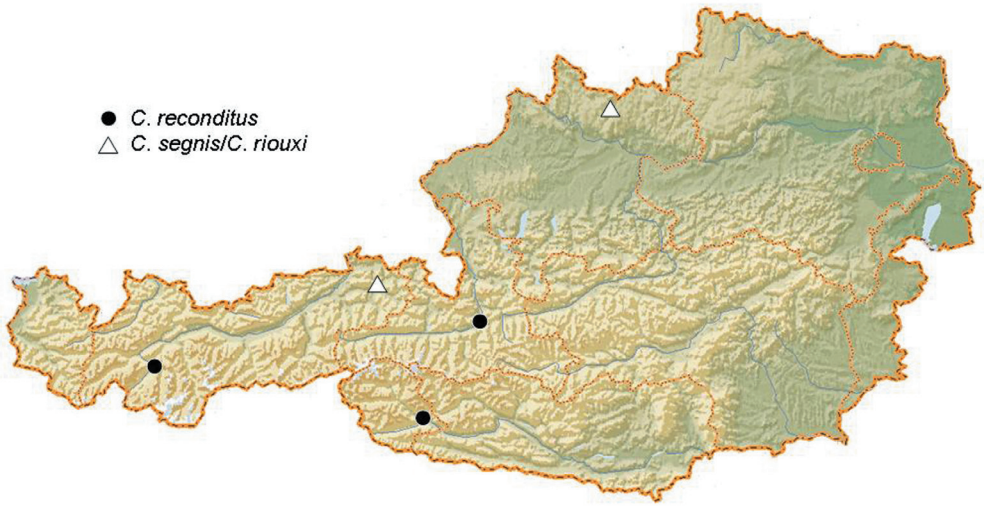

Fig. 11: Distribution of *Culicoides* (*Wirthomyia*) *reconditus*, *C.* (*W.*) *segnis* and *C.* (*W.*) *riouxi* in Austria. Due to intermediate specimens between *C.* (*W.*) *segnis* and *C.* (*W.*) *riouxi*, these species have not been split up in the map.

Abb. 11: Verbreitung von *Culicoides* (*Wirthomyia*) *reconditus*, *C.* (*W.*) *segnis* und *C.* (*W.*) *riouxi* in Österreich. Aufgrund von Übergangsformen zwischen *C.* (*W.*) *segnis* und *C.* (*W.*) *riouxi* wurden diese beiden Arten in der Karte nicht aufgetrennt.

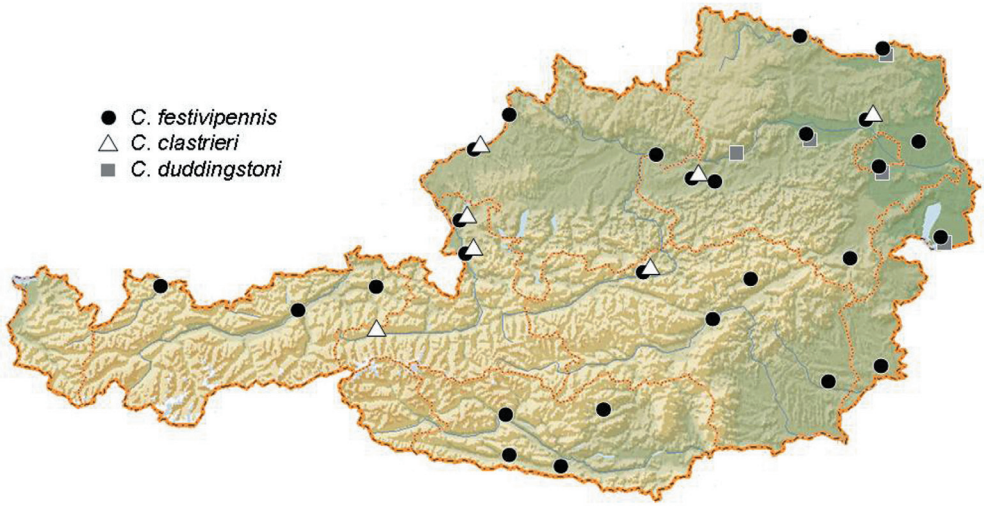

Fig. 12: Distribution of *Culicoides* (*Oecacta*) *festivipennis*, C. (*O.*) *clastrieri* and *C.* (*O.*) *duddingstoni* in Austria.

Abb. 12: Verbreitung von *Culicoides* (*Oecacta*) *festivipennis*, C. (*O.*) *clastrieri* und *C.* (*O.*) *duddingstoni* in Österreich.

Subgenus *Pontoculicoides* Remm, 1968

- * *C. saevus* Kieffer, 1922: one female specimen (holotype of *C. puncticeps* Goetghebuer, 1934 = syn. for *C. saevus*, mounted on a slide) from **W** in the collection of the Natural History Museum Vienna

"Subgenus *Oecacta* Poey, 1851»

- * *C. albicans* (Winnertz, 1852): 3 dried specimens (male: „Austria/Alte Sammlung"; two specimens from **NÖ**: "Austr. inf./Mödling/5.[18]89/Mik") in the Diptera collection of the Natural History Musem Vienna; one specimen from **NÖ**: Hainburg (Franz 1989)
- *C. festivipennis* Kieffer, 1914: see fig. 12
- *C. clastrieri* Callot, Kremer & Deduit, 1962: new record for Austria; see fig. 12
- *C. duddingstoni* Kettle & Lawson, 1955: new record for Austria; see fig. 12
- *C. alazanicus* Dzhafarov, 1961: new record for Austria; see fig. 10
- *C. furcillatus* Callot, Kremer & Paradis, 1962: new record for Austria; see fig. 6
- *C. pictipennis* (Staeger, 1839): see fig. 10
- ** *C. vexans* (Staeger, 1839): **S:** JO

Comocioculatus group

- ** *C. comosioculatus* Tokunaga, 1956: new record for Austria (**OÖ:** GM; **T:** KB)

Discussion

The highest amounts of total individuals were recorded in June and July 2008. However, it has to be considered that from June 2007 to September 2007 not all of the traps were yet put into operation. As from October the total amount of collected *Culicoides* decreased considerably, increasing again in March 2008 (fig. 2).

The reason for starting the project was to gain knowledge on the distribution of potential bluetongue vector species, all of them within the species groups Obsoletus, Pulicaris and Nubeculosus (corresponding to the subgenera *Avaritia*, *Culicoides* and *Monoculicoides*). Thus, the main focus of the incoming material within the routine operation was on these subgenera, not till then specimens of other groups could have been worked on. While most of these specimens could be assigned to a certain species, some turned out to belong to morphologically difficult species groups. A time-consuming identification (mainly based on tarsal spines or maxillary palpus elements) was possible only in few specimens. For these species no distribution maps are available. Hence, several specimens are still undetermined, so these results should be regarded as a snap-shot. Amendments to the list with possibly further new records for Austria should be expected.

The taxonomic problems within some species groups still remain a challenge. Species were mainly determined on the base of Delécolle's (1985) identification key; current nomenclature, however, was taken from Boorman (2006), Borkent (2007), Havelka & Aguilar (1999) and Tóthová & Knoz (2006).

Acknowledgments

We would like to thank our colleagues Markus Sehnal and Harald Bruckner for assistance in treating sampled material as well as Mag. Christoph Hörweg (NHMW) for literature support. To Dr. Rudy Meiswinkel we are deeply grateful for valuable and inspiring discussions and to Maria Goffredo (Istituto Zooprofilattico Sperimentale, Teramo, Italy) for training and support, especially in the initial stage of the project. DI Dr. Klemens Fuchs (AGES) kindly provided the map indicating the sampling sites. We are also indebted to Dr. Peter Schiefer, Mag. Alexander Hoskovec and Mag. Cornelia Gabler (Statistik Austria) for their great help with the sampling site selection and to Andrew Short (University of Kansas) for linguistic improve of the manuscript.

References

Boorman, J. 2006: A Guide to the British *Culicoides*. – Institute for Animal Health: Bluetongue in Northern Europe: http://www.iah.bbsrc.ac.uk/bluetongue/culicoides/index_species.html

Borkent, A. 2007: World Species of Biting Midges (Diptera: Ceratopogonidae), pp. 1–237. http://www.inhs.uiuc.edu/cee/FLYTREE/CeratopogonidaeCatalog

Cornet, M. & Brunhes, J. 1994: Révision des espèces de *Culicoides* apparentées à *C. schultzei* (Enderlein, 1908) dans la région afrotropicale (Diptera, Ceratopogonidae). – Bulletin de la Société entomologique de France 99: 149-164.

Delécolle, J.-C. 1985: Nouvelle contribution à l'étude systématique et iconographique des espéces du genre *Culicoides* (Diptera: Ceratopogonidae) du Nord-Est de la France. – Thesis at the Université Louis Pasteur de Strasbourg, U.E.R sciences «vie et terre», 239 pp.

Franz, H. 1989: Familie Ceratopogonidae. In: Franz, H. (Hrsg.): Die Nordost-Alpen im Spiegel ihrer Landtierwelt - eine Gebietsmonographie. VI/1. Diptera Orthorapha. – Universitätsverlag Wagner, Innsbruck, pp. 179-186.

Goffredo, M. & Meiswinkel, R. 2004: Entomological surveillance of bluetongue in Italy: methods of capture, catch analysis and identification of Culicoides biting midges. – Veterinaria Italiana 40(3): 260-265.

Havelka, P. & Aguilar, M. 1999: Ceratopogonidae. In: Schumann, H., Bährmann, R. & Stark, A. (Hrsg.): Checkliste der Dipteren Deutschlands. – Studia dipterologica, Supplement 2: 33-38.

Kampen, H. & Kiel, E. 2006: Ceratopogoniden in Deutschlands aus (veterinär)medizinisch-entomologischer Sicht mit besonderer Berücksichtigung ihrer Rolle als Überträger des Blauzungenvirus. – Nutztierpraxis aktuell 19: 48-56.

Lane, R.P. 1981: A quantitative analysis of wing pattern in the *Culicoides pulicaris* species group (Diptera: Ceratopogonidae). – Zoological Journal of the Linnean Society 72: 21-41.

Loitsch, A., Sehnal, P., Herzog, U. & Köfer, J. (Red.) 2008: Durchführung der Bluetongue Überwachung in Österreich. Abschlussbericht 2007. – Österreichische Agentur für Gesundheit und Ernährungssicherheit GmbH, Wien, 52 pp.

Mehlhorn, H., Walldorf, V., Klimpel, S., Jahn, B., Jaeger, F., Eschweiler, J., Hoffmann, B. & Beer, M. 2007: First occurrence of *Culicoides obsoletus*-transmitted Bluetongue virus epidemic in Central Europe. – Parasitology Research 101(1): 219-228.

Meiswinkel, R., Gomulski, L.M., Delécolle, J.-C., Goffredo, M. & Gasperi, G. 2004: The taxonomy of *Culicoides* vector complexes - unfinished business. – Veterinaria Italiana 40(3): 151-159.

Mellor, P., Boorman, J. & Baylis, M. 2000: *Culicoides* Biting Midges: Their Role as Arbovirus Vectors. – Annual Review of Entomology 45: 307-340.

Sehnal P., Schweiger S., Schindler M., Anderle, F. & Schneemann, Y. 2008: Bluetongue: Vector Surveillance in Austria in 2007. – Wiener Klinische Wochenschrift 120 (Suppl. 4): 34-39.

Tóthová, A. & Knoz, J. 2006: A revised check-list of the biting midges (Diptera, Ceratopogonidae) of the Czech Republic and Slovakia. – Studia Dipterologica 13(1): 103-114.

Van Ark, H. & Meiswinkel, R. 1992: Subsampling of large light-trap catches of *Culicoides* (Diptera: Ceratopogonidae). – Onderstepoort Journal of Veterinary Research 59: 183-189.