

DISTRIBUTION OF THE *ANNULIPES* GROUP (Diptera: Culicidae) OF EASTERN CROATIA

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Accepted: March 7th 2008

Intensive faunal mosquito research has been carried out in the area of Slavonia and Baranya since 1988. The *annulipes* group comprises mosquitoes characteristic of Palaearctic and Nearctic forests. Out of six mosquito species from the *annulipes* group registered in Croatia, only four have been found in Slavonia and Baranya. These are: *Ochlerotatus cantans*, *Oc. riparius*, *Oc. excrucians* and *Oc. annulipes*. This paper sums up the results of a 19-year investigation into mosquito larvae of the *annulipes* group. The *Oc. cantans* species is the prevalent and most numerous of all the four species discussed in this paper. It has been registered in as many as 42 UTM quadrants, which confirms *Oc. cantans* to be a regular inhabitant of all the forests in Slavonia and Baranya. The other species are less evenly distributed, i.e. *Oc. excrucians* has been registered in 24 and *Oc. annulipes* in 7 UTM quadrants. The characteristic dissemination of the *Oc. riparius* species can be found only in the area of Spačva, i.e. south-eastern Slavonia, comprising 11 UTM quadrants.

***annulipes* group, mosquitoes, distribution, forest, Slavonia and Baranya**

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BOGOJEVIĆ, I. BOCA i Ž. ZAHIROVIĆ¹ - Rasprostranjenje komaraca grupe
annulipes (Diptera : Culicidae) u istočnoj Hrvatskoj. Entomol Croat. 2008,
Vol. 12, Num. 2: 9-23.

Intenzivna faunistička istraživanja komaraca na području Slavonije i Baranje provode se od 1988. Grupa *annulipes* obuhvaća komarce karakteristične za šumska područja palearktičke i neoarktičke zone. Od šest vrsta komaraca iz grupe *annulipes* u Hrvatskoj, samo su četiri vrste pronađene na području Slavonije i Baranje; to su: *Ochlerotatus cantans*, *Oc. riparius*, *Oc. excrucians*

i *Oc. annulipes*. U ovom radu sumirani su rezultati 19-godišnjih istraživanja rasprostranjenja ličinki komaraca iz grupe *annulipes*. Od četiri vrste koje su obrađene u ovom radu, vrsta *Oc. cantans* najbrojnija je i najraširenija vrsta, zabilježena u 42 UTM kvadranta. Za tu vrstu možemo reći da je stalan stanovnik svih šuma u Slavoniji i Baranji. Ostale vrste manje su rasprostranjene *Oc. excrucians*, evidentiran na 24, a *Oc. annulipes* na 7 UTM kvadranta. Karakteristično rasprostranjenje *Oc. riparius* područje je Spačve, tj. jugoistočni dio Slavonije, gdje je registriran u 11 UTM kvadranta.

***annulipes* grupa, komarci, rasprostranjenje, šume, Slavonija i Baranja**

Introduction

Mosquitoes are organisms easily adjustable to various types of habitats. They are disseminated throughout the world, being most numerous in areas with lots of stagnant water since water is necessary for their development (Becker et al., 2003).

Many mosquito species are widespread due to their selection of sites for oviposition or even for living. There is a mosquito group that is, judging by oviposition, closely related to forests, although the specimens may leave the ecosystem after hatching. The group is called the *annulipes* group and it is widely present in the forests of eastern Croatia.

Research into mosquito fauna in the forests of Slavonia and Baranya has revealed an abundance of specimens and species (Merdić, 1995). Forest habitats are appropriate for the development of mosquitoes due to several reasons, including their inability to fly in windy conditions and their need for fairly high relative humidity. Those criteria are met in forests, where strong winds are very rare and relative humidity does not oscillate much (Merdić, 1995).

The *annulipes* group includes mosquitoes characteristic of Palearctic and Nearctic forests. In spring the larvae develop in ponds, ditches and small bodies of water with lots of leaves at the bottom. Usually the group is featured by one generation per year which occurs mostly in early spring, so that is why they are called snowmelt mosquitoes. Those mosquitoes overwinter in the egg stage. They are anthropophilic and very aggressive, annoying people almost always in open spaces, rarely inside their homes. (Gutsevich et al., 1974).

The *annulipes* group comprises 10 mosquito species (Becker et al, 2003), six of which have been registered in Croatia: *Ochlerotatus cantans*, *Oc. riparius*, *Oc. behningi*, *Oc. excrucians*, *Oc. annulipes* and *Oc. flavescens* (Merdić et al., 2004).

The *annulipes* group mosquitoes are large, only occasionally medium-sized. Their color varies, but in most cases they are brown with yellow, white or rusty-brown scales. Tarsi contain pale basal rings which engulf half a segment at least on some tarsomeres. Tarsal claws are curved. Wings are dominated by dark scales. All the species of the *annulipes* group are similar, so their identification in the adult (imago) stage is very difficult and often leads to mistakes. Therefore, the most precise identification is conducted by using fourth stage larvae.

When identifying fourth stage larvae especial attention should be paid to the appearance of head antennae, the number and shape of comb teeth, the number and gap of pecten teeth, the length and width of the siphon, the siphon tuft, the number of precratal tufts and the length of anal papillae.

There are some differences between the larvae of the *annulipes* group. The *Oc. annulipes* larvae are very similar to those of *Oc. cantans*. The *Oc. cantans*, *Oc. riparius*, *Oc. excrucians* and *Oc. annulipes* species have antennae shorter than the head, and the antennal seta is positioned in the middle of the antennal shaft, the species *Oc. cantans* being an exception with the antennal tuft slightly inserted beyond the middle of the antennal shaft. The inner frontal seta has 2-5 branches with *Oc. cantans* having the largest number of branches. The median frontal seta has 2 branches, rarely 3, which can be found in *Oc. cantans*. *Oc. cantans* and *Oc. excrucians* have more expressed outer frontal seta with 6-8 branches. The number of comb scales is usually 35, arranged in 2-6 irregular rows. The siphonal index ranges between 3.0 and 5.0. The pecten has 14-30 teeth. All the species have the siphonal tuft inserted distally to the last pecten tooth somewhere in the middle of the siphon. The species *Oc. riparius* has the least number of branches (4-6) on the siphonal tuft, as the species *Oc. cantans* has the largest number (5-12). The saddle does not encircle the anal segment and covers three quarters of its lateral sides. The saddle seta may have different forms (prominent, long, spherical) and in most cases are simple. Usually, 4-6 precratal tufts are present. The anal papillae are usually as long as or longer than the saddle (Becker et al., 2003).

The distinguishing features of larvae, by means of which identification according to Gutsevich et al. 1974 has been carried out, are the following:

Oc. excrucians

- Saddle well developed. Gills at least half as long as the saddle. Index of siphon at least 3

- Hairs at the apex of the posterior valves of the stigmal plate hook-shaped and thickened

- Comb with 30-40 (usually 32-36) scales. Postclypeal hairs with 2-3 thin, short branches. Hairs at the apex of the posterior valves of the stigmal plate strongly thickened

Oc. cantans

- Four or five shorter tufts before the tin, not situated on the common base

- Fin with 18-19 tufts situated on the common base. The posterior appendage of the stigmal plate, in addition to the usual 2 branches with a different median branch between them

Oc. annulipes

- Fin with at most 16 tufts situated on the common base

Oc. riparius

- Surface of body bare, without small spines

- Comb on the 8th abdominal segment usually with 6-9 large scales arranged in irregular row

- Median and inner frontal hairs with 2-3 branches. Index of siphon 3.5-4.0

Material and methods

For 19 years we have been investigating the forests of Slavonia and Baranya and sampling the mosquito larvae of the *annulipes* group.

The mosquito larvae were collected using a 25 cm diameter net. When dealing with small bodies of water the larvae were sampled using a small glass.

The larvae were processed in two ways. Some larvae were made into permanent preparations: these are terminated with 50% ethanol. The preparation starts with the larvae being put first into 70% then 96% alcohol and finally into xylol. After that, the larvae were placed on a microscope slide in a drop of Canada balsam where they were transected transversally along the middle of the abdomen, then dried and covered with a cover plate. Other larvae were left to emerge into adult mosquitoes. The adult mosquitoes were killed with cigarette smoke

and then prepared. The adult mosquitoes were mounted on entomological pins. transect

Identification was performed according to the following keys: Gutsevich et al. 1974, Schaffner et al. 2001 and Becker et al. 2003.

The mapping of the *annulipes* group distribution was carried out in accordance with the UTM system. The UTM (Universal Transverse Mercator) is a cartographic and kilometric projection of basic fields. Every basic field is marked with two letters and represents a 100X100 km quadrant. Moreover, the basic fields are divided into 100 quadrants, each 10X10 km in size and marked with numbers from 0 to 9 in the west-east and south-north direction. In 1976, a basic map of Croatia with a UTM network was made. The dissemination of the species stated hereinabove is shown on blind maps which present only the borders of Slavonia and Baranya and the quadrants of the UTM network. The presence of the species is marked with a circle.

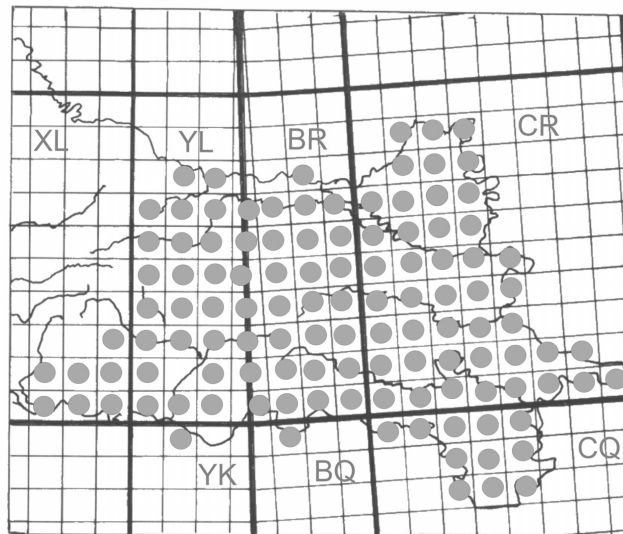


Figure 1. Map of Slavonia and Baranya with UTM squares where the investigation took place

The sampling was done at a great number of stations throughout Slavonia and Baranya. Figure 1 presents a blind map which singles out the quadrants where the sampling was performed, altogether 115 UTM quadrants.

Results

In Slavonia and Baranya four species of the *annulipes* group have been identified:

1. *Ochlerotatus annulipes* (Meigen, 1830)
2. *Ochlerotatus cantans* (Meigen, 1818)
3. *Ochlerotatus excrucians* (Walker, 1856)
4. *Ochlerotatus riparius* (Dyar & Knab, 1907)

Out of the total of 115 covered quadrants, the *annulipes* group mosquitoes were noted in 49 quadrants. Figure 2 displays a UTM map of the localities where the *annulipes* group mosquitoes were found. Regardless of UTM quadrants, the material was collected at 69 localities indicated in Figure 1.

The prevalent species is *Oc. cantans*, which was found in 53 forest localities and registered in 42 UTM quadrants (Fig 3). It is followed by *Oc. excrucians*, found in 33 localities and registered in 24 UTM quadrants (Fig 4). After that, the

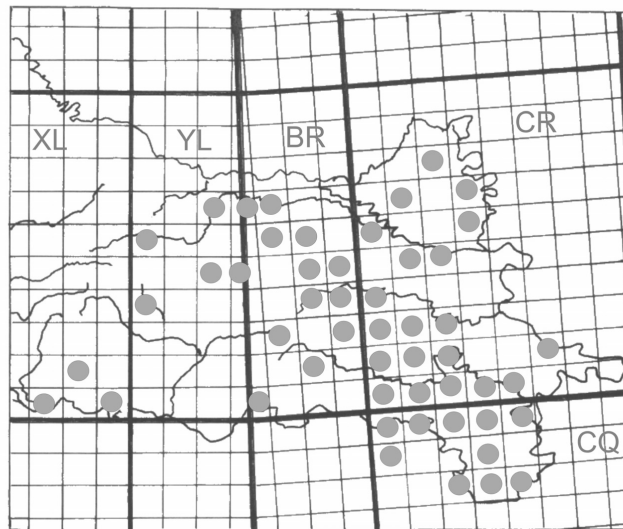


Figure 2. Map of Slavonia and Baranya with UTM squares where we found *annulipes* group mosquitoes

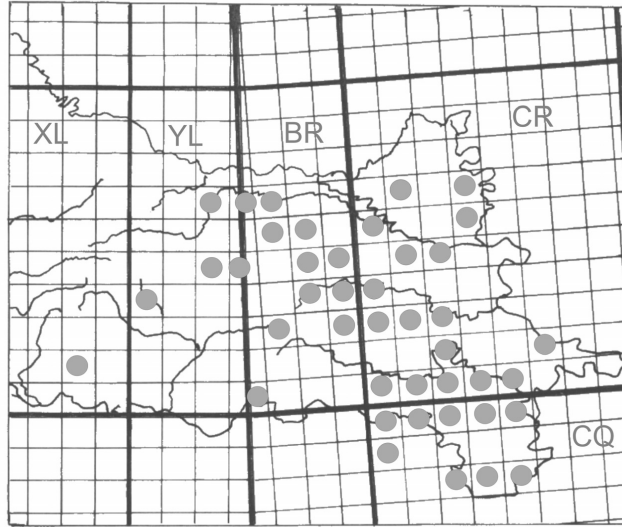


Figure 3. Distribution the species of *Oc. cantans* in forests in Eastern Croatia

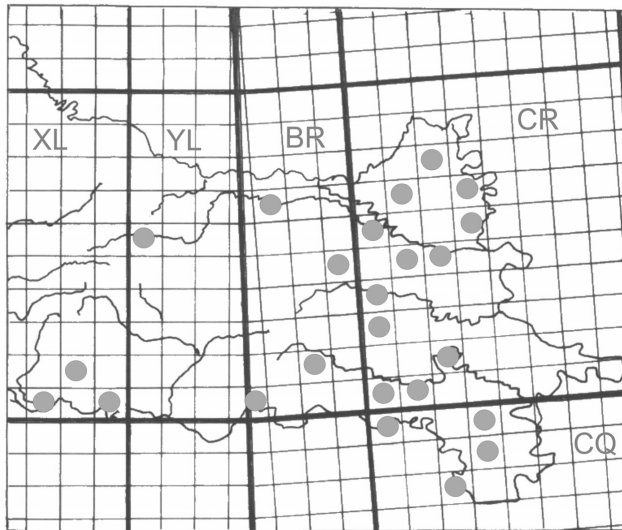


Figure 4. Distribution the species of *Oc. excrucians* in forests in Eastern Croatia

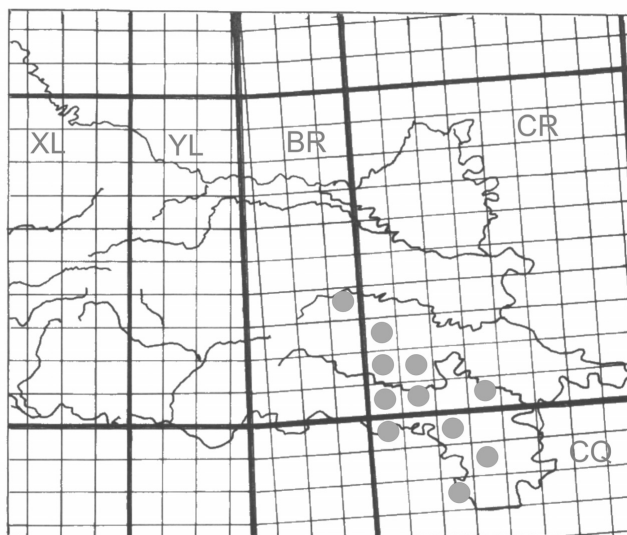


Figure 5. Distribution the species of *Oc. riparius* in forests in Eastern Croatia

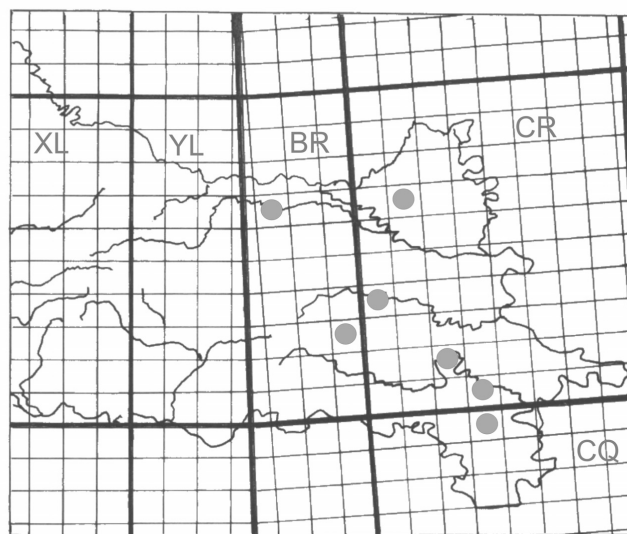


Figure 6. Distribution the species of *Oc. annulipes* in forests in Eastern Croatia

Table 1. Finding sites of *annulipes* group mosquitoes in forests of Eastern Croatia

Localities	UTM	<i>Oc. cantans</i>	<i>Oc. annulipes</i>	<i>Oc. excrucians</i>	<i>Oc. riparius</i>
Novi Varoš	XL70			+	
Medari	XL81	+		+	
Orubica	XL90			+	
Toranj Požeški	YL03	+			
Macute	YL05			+	
Orahovačko jezero	YL24	+			
Orahovica	YL24	+			
Čađavica	YL26	+			
Feričanci	YL34	+			
Slavonski Brod	BR60	+		+	
Kapelačka šuma 2	BR66	+			
Borovik	BR72	+			
Boljara	BR75	+			
Đurđenica	BR75	+			
Dubrava	BR76	+	+	+	
Dubrava 2	BR76	+	+		
Karaš	BR76	+			
Karaš-Ivanovo	BR76	+			
Jasik	BR76	+			
Polom	BR76	+			
Titorić	BR76	+		+	
Majar	BR81			+	
Podgorač	BR83	+			
Koška	BR84	+			
Marijanska šuma	BR85	+			
Šuma Glog	BR85	+			
Selci Đakovački	BR92	+	+		
Budimci	BR93	+			
Josipovac	BR93	+			+
Poganovci	BR94	+		+	
Gundinci	CR00	+		+	+
Muško ostrvo	CR01				+
Široko Polje - šuma	CR02	+		+	+

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Široko Polje	CR03	+	+	+	
Petrijevci	CR05	+		+	
Cerna - Banov dol	CR10			+	+
Merolino	CR10	+		+	
Ivankovo	CR11			+	
Muško ostrvo	CR11			+	+
Vođinci	CR11			+	
Durgutovica	CR12	+			
Osijek - Gornji Grad	CR14	+		+	
Čeminac	CR16		+	+	
Haljevo	CR16	+		+	
Zapadne klisure	CR20	+			
Andrijaševci	CR21			+	
Kunjevci	CR21	+	+	+	
Šomod - Topolovac	CR22	+			
Osijek - Donji Grad	CR24	+		+	
Zmajevac	CR27			+	
Otok - Lože	CR30	+			+
Otok - Slavir	CR30	+	+		+
Čonakut	CR35	+		+	
Hordovanj	CR35			+	
Kopačko jezero	CR35	+			
Tikveš	CR36	+		+	
Žirište	CR40	+			
Panjić	CR51	+			
Zib šuma	CQ08	+			
Babina Greda	CQ09	+		+	+
Štitar	CQ19	+			
Gunja - Trizlovo	CQ27	+		+	+
Posavski Podgajci	CQ27			+	
Županja - Kraguj.	CQ29	+			+
Rađenovci	CQ37	+			
Vrbanja	CQ38			+	+
Spačva	CQ39	+	+	+	
Krnjić - Pašt šuma	CQ47	+			
Topolovac	CQ49	+			

species *Oc. riparius* was isolated in 12 forest localities and registered in 11 UTM quadrants (Fig 5). The rarest species is *Oc. annulipes*, registered in only 7 UTM quadrants and characterized by the smallest number of localities – 8 (Fig 6) and table 1.

Discussion

Out of four mosquito species of the *annulipes* group registered in Slavonia and Baranya, two are Holarctic (*Oc. excrucians* and *Oc. riparius*), i.e. they inhabit Eurasia and North America while the other two are Palearctic (*Oc. cantans* and *Oc. annulipes*), and they populate only Eurasia (Gutsevich et al., 1971). As well as in Croatia *Oc. cantans* and *Oc. annulipes* have been registered in Sweden, Finland, Germany, the Czech Republic, Poland, Switzerland, Rumania, Ukraine, Russia, Lithuania, Latvia and Estonia. The species *Oc. cantans* is also present in: Great Britain, Ireland, Norway, France, Spain, Belgium, the Netherlands, Austria, Slovakia, Italy, Serbia, Slovenia, Greece, Hungary, Bulgaria and Belarus while *Oc. excrucians* can also be seen in Norway, Austria, Slovakia, Serbia, Slovenia, Turkey, Hungary and Bulgaria, and finally *Oc. riparius* inhabits Norway as well. To sum up, *Oc. cantans* has been registered in 30 European countries, *Oc. excrucians* in 23, *Oc. annulipes* in 27, and *Oc. riparius* in 15 (Ramsdale & Snow, 1999).

The most common habitats of the *annulipes* group mosquitoes are forests, due to their suitable ecological conditions. The distribution of the group overlaps with the forests of Slavonia. Although they establish their breeding sites mostly in forests, the adult mosquitoes may be noticed fairly distant from them. Being skilful flyers, such mosquitoes can take a significant position in urban fauna, an example of which is Osijek where in early spring fauna *Oc. cantans* and *Oc. excrucians* play an important role (Merdić & Sudarić Bogojević 2005).

The species *Oc. cantans* is the most widespread species. Figure 3 shows that most research sites have registered the presence of the species, its specimens thus being the most regular inhabitants of the forests of Slavonia and Baranya. The species is most distributed in the heart of Slavonia and Baranya (Osijek – Našice - Đakovo) and some southern parts thereof (Vinkovci - Gunja). The area of the largest distribution of the species *Oc. excrucians* stretches from northern Baranya to southern Slavonia, particularly near Županja.

The species *Oc. annulipes* and *Oc. riparius* are the most sparsely distributed species in the research area. The habitat of the species *Oc. riparius* is the forests of northern Europe, sometimes even the tundra. Towards the south of Europe the populations become less dense. These findings prove that their area may stretch to the south, to the borders of the Pannonian Plain, which, then, supports the thesis that this is a relict species that has been preserved only in the area of the Spačva Basin. As the climate gets warmer, the area of the species moves to the north (Merdić, 1992). Besides, in spring the larvae develop in ponds, open-space habitats and forest edges, usually in peat bogs (Gutsevich et al., 1974), which is the reason why *Oc. riparius* has been registered in only 11 UTM quadrants. The species *Oc. annulipes* may be defined as a rare species with respect to Slavonia and Baranya since it has been found in only 7 UTM quadrants.

Although the rarest species according to this research, *Oc. annulipes* was the first species registered in the mosquito fauna of Croatia (Langhoffer, 1916). The second species of the *annulipes* group registered was observed in Osijek during World War II (Baranov, 1943), and 47 years after that, *Oc. excrucians* species documented (Merdić, 1990). The last species to be registered in the fauna of Croatia was the *Oc. riparius* species (Merdić, 1992).

At the end of the 20th century all the four species were mentioned in numerous research papers related to the area of eastern Croatia. Above all, the first documentation of *Oc. riparius* represents a relevant contribution to the knowledge of the species' distribution (Merdić, 1992). Since the Kopački rit Nature Park is covered with oak forests in its northern part, precise research into that area has shown the presence of *annulipes* group mosquitoes, among which *Oc. annulipes* has a special role (Merdić, 1993). Large-scale research into forest mosquito fauna has established the significance of each species of the *annulipes* group in the total mosquito fauna of the four forest species (Merdić, 1995). During research into high-altitude mosquito distribution on Mt Papuk (Merdić, 1995), some mosquitoes of the *annulipes* group were found to reach even the highest localities on Papuk (up to 900 m). The urban areas of Osijek, Slavonski Brod and Vinkovci are affected by a significant proportion of those species, particularly in spring due to the single one generation and because their habitats – forests – are situated near the towns (Merdić, 1996; Merdić et al 2003, Merdić et al., 2004).

These four species of the *annulipes* group make only 8 % of the 50 registered mosquito species in Croatia (Merdić S et al., 2004, Klobučar et al., 2006, Žitko

& Merdić 2006). However, their significance is great in forest mosquito fauna where in early spring people are often annoyed by their activity and frequency.

Conclusions

In Eastern Croatia, 4 species of *annulipes* group of mosquitoes have been identified.

The prevalent species is *Oc. cantans*, registered in 42 UTM quadrants. It is followed by *Oc. excrucians*, registered in 24 UTM quadrants. The species *Oc. riparius* has been registered in 11 UTM quadrants and the rarest species is *Oc. annulipes*, registered in only 7 UTM quadrants.

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