

## COMPARISON OF MOSQUITO FAUNA IN KOPAČKI RIT IN THE PERIOD 1990–1998

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Research into the flora and fauna of Kopački rit, the flood area of the Danube and Drava rivers, was not possible in the period between 1991–1997, due to ongoing hostilities. The research into the mosquitoes in Kopački rit started in 1990 was continued in 1998. The research results obtained in 1998 were compared to the 1990 results (MERDIĆ, 1993). The total number of mosquitoes collected in 1998 was 7788, which is approximately 25 times smaller than the total number of mosquitoes collected in 1990 (199952). The mosquito fauna is characterised by species that have their breeding sites in the marsh itself, among which *Aedes vexans* is dominant, and by species whose breeding sites can be found in the oak forest, the *Genisto elate* – *Quercetum roboris* community, in the nearby Nature Park. The dynamics of the mosquito population, which is in correlation with the water level of Danube, are significantly different in 1990 and 1998, but we do not suppose this was due to the influence of the war, but rather to the different ecological conditions in 1998.

**Key words:** mosquitoes, Kopački rit Special Zoological Reserve, population dynamics, impact of war on nature

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Istraživanja flore i faune u Kopačkom ritu, poplavnom području rijeke Dunava i Drave, nisu bila moguća od 1991. do 1997. godine, zbog ratnih djelovanja. Proučavanja komaraca Kopačkog rita započeta 1990. nastavljena su u sezoni 1998. godine. Rezultati dobiveni istraživanjem faune komaraca Kopačkog rita 1998. godine uspoređeni su sa rezultatima iz 1990. (MERDIĆ, 1993). Ukupan broj jedinki komaraca prikupljenih 1998. godine iznosio je 7788, što je približno 25 puta manje od ukupnog broja komaraca prikupljenih 1990. godine (199952). Faunu komaraca karakteriziraju vrste koje svoja legla imaju u samom poplavnom području, među kojima dominira vrsta *Aedes vexans*, te vrste čija legla možemo naći u hrastovoj šumi zajednice *Genisto elate* – *Quercetum roboris* u obližnjem Parku prirode. Dinamika populacija komaraca, koja je u korelaciji s vodostajem Dunava, značajno se razlikuje 1990. i 1998. godine, ali ipak pretpostavljamo da se ne radi o utjecaju rata na faunu komaraca nego o razlici u ekološkim uvjetima u 1998. godini.

**Ključne riječi:** komarci, Specijalni zoološki rezervat »Kopački rit«, dinamika populacija, utjecaj rata na prirodu

## INTRODUCTION

Kopački rit is one of the few marshes in Europe. The value of such areas is, first of all, in their biodiversity. With respect to fauna, Kopački rit is famous for its birds, and is protected by the Ramsar Convention, one of four such areas in Croatia. Although fauna and bird ecology are among the most frequently studied, there have been several articles on the diversity, value and specific qualities of other faunas of mammals, nematodes, roundworms and insects. After being untouched for many years, Kopački rit became a centre of military activities during the war. The first line of defence ran right through the very heart of the special zoological reserve. Devastation was unavoidable. Big game was the first target, being shot at from all kinds of weapons. The bird fauna also suffered heavy losses due to extraordinary harassment. During the military activities of 1991–1995, the major part of Kopački rit was mined and thus made inaccessible. After the reintegration of the occupied area in 1997, research teams entered Kopački rit (1998), finding significant eutrophication. As well as a changed picture due to the eutrophication, the researchers came across a number of mines that prevented them from pursuing further research. The research into mosquitoes started in 1990 (MERDIĆ, 1993) and continued in 1998. It was hypothesized that changes must have occurred, particularly with respect to insects that spend most of their lives in water. The aim of the 1998 research was to note the differences in the states before and after the war, and determine the causes that might have led to those changes. This research needs to be continued for the collection of data on this valuable ecological flood system.

## MATERIALS AND METHODS

Mosquitoes were collected in Kopački rit with the same methods as in 1990, from May to September 1998, at one-month intervals and in the second half of each month. CDC traps were set in four locations: 1. Čonakut (next to the canal leading to the central lake), 2. Hordovanj (the elevated part next to the lake), 3. Kopačko Lake (in the centre of the lake, below the colony of cormorants), 4. Tikveš (north of the special zoological reserve within the Nature Park, in the oak forest, *Genisto elate* – *Quercetum roboris* community Hor. 1938, RAUŠ *et al.*, 1985). A total of 7788 mosquitoes were collected. The mosquitoes were caught in CDC traps, using dry ice as the attractant. CDC traps were made following the instructions of SERVICE (1976). The trap includes a plastic tube of 10 cm diameter, inside which there is a fan for the suction of mosquitoes. The lid that is attached to it is used to increase the suction space and to stop the trap from falling. Mosquitoes are sucked into a net that is fastened to the plastic tube. The fan uses 6 V batteries, type ICE R25. To make the trap efficient, the attractant used was dry ice, about 8 kg per trap. Traps were operational 22–24 hours a day.

All mosquitoes collected at each location were determined using the key of GUTSEVITCH *et al.* (1974) and stored in the entomological collection of the Institute of Biology at the Faculty of Education in Osijek.

## RESULTS

During 1998, 7788 mosquitoes were caught and 12 different species were determined. *Aedes vexans* Meigen, 1818; is the dominant species, it makes up from 87% to 52% of the mosquito fauna at particular locations. It is followed by *Aedes cinereus* Meigen, 1830; *Coquillettidia richardii* Ficalbi, 1889; *Anopheles maculipennis* Meigen, 1818 complex, *Aedes cantans* Meigen, 1818; *Aedes sticticus* Meigen, 1838; *Aedes caspius* Pallas, 1771; *Culex pipiens* Linnaeus, 1758; *Aedes excrucians* Walker, 1856; *Anopheles plumbeus* Stephanus, 1828; *Aedes rossicus* D.G.M. 1830 and *Anopheles claviger* Meigen 1804 (Tab. 1).

**Tab. 1.** Mosquito fauna in Kopački rit in particular locations in 1998.

Species	Čonakut		Hordovanj		Tikveš		K. jezero		TOTAL	
		%		%		%		%		%
<i>Aedes vexans</i>	893	72,13	3591	87,56	361	52,55	1441	81,79	6286	80,71
<i>Aedes cinereus</i>	201	16,24	380	9,27	6	0,87	139	7,88	726	9,32
<i>Coquillettidia richardii</i>	71	5,74	2	0,05	173	25,18	24	1,36	270	3,47
<i>Anopheles maculipennis</i> c.	24	1,94	65	1,58	19	2,77	49	2,78	157	2,02
<i>Aedes cantans</i>	2	0,16	–	–	86	12,52	1	0,06	89	1,14
<i>Aedes sticticus</i>	29	2,34	20	0,49	16	2,33	21	1,19	86	1,10
<i>Aedes caspius</i>	2	0,16	10	0,24	–	–	69	3,91	81	1,04
<i>Culex pipiens</i>	15	1,21	28	0,68	12	1,75	17	0,96	72	0,92
<i>Aedes excrucians</i>	–	–	5	0,12	9	1,31	–	–	14	0,18
<i>Anopheles plumbeus</i>	–	–	–	–	4	0,58	–	–	4	0,05
<i>Aedes rossicus</i>	1	0,08	–	–	–	–	1	0,06	2	0,03
<i>Anopheles claviger</i>	–	–	–	–	1	0,15	–	–	1	0,01
TOTAL	1238		4101		687		1763		7788	

The number of mosquitoes noted during 1998 was not particularly high, the highest figure being recorded at the Hordovanj site, followed by Čonakut, Kopačko Lake and Tikveš. The mosquito activity was the most intensive in July, when a total of 3036 mosquitoes were caught at all four locations (Tab. 2).

**Tab. 2.** The number of mosquitoes at four locations in Kopački rit in 1998.

Site	Date	26. V.	29. VI.	25. VII.	27. VIII.	25. IX.	TOTAL
Čonakut		198	677	0	360	3	1238
Hordovanj		237	1400	2000	463	1	4101
Tikveš		101	247	320	17	2	687
K. Jezero		234	581	716	231	0	1762
Total		770	2905	3036	1071	6	7788

The participation of species in the total number is different for different locations. Whereas at locations in Kopački rit itself, only flood species were caught, among which *Aedes vexans* was the dominant one, followed by *Aedes sticticus* and *Aedes cinereus*, the Tikveš location the species that breed in such type of forest were noted. This refers first of all to *Aedes cantans*, *Aedes excrucians* and *Anopheles plumbeus*.

The total number of mosquitoes showed an increase in June and July, and a small decrease in August, but the values never surpassed 2000 individuals. This correlates with the water level of the Danube, which provides the water for Kopački rit. Fig. 1 shows the fluctuation of the number of mosquitoes in Kopački rit. The Tikveš location is presented separately to enable the comparison with the 1990 data. It is necessary to draw attention to the very high water level at the end of September and October 1998, which triggered the development of a higher number of mosquito larvae in October. In 1998, at the Tikveš location a maximum of 320 individuals was caught after the water level at Apatin reached the critical level of 300 cm, i.e. when it was 385 cm.

The comparison of the number of mosquitoes caught by CDC traps in the area of Kopački rit and the corresponding water level of the Danube at Apatin is shown in Fig. 2. During the two-year research period, 15 mosquito species were determined, with differences in the composition of species over the period (Tab. 3).

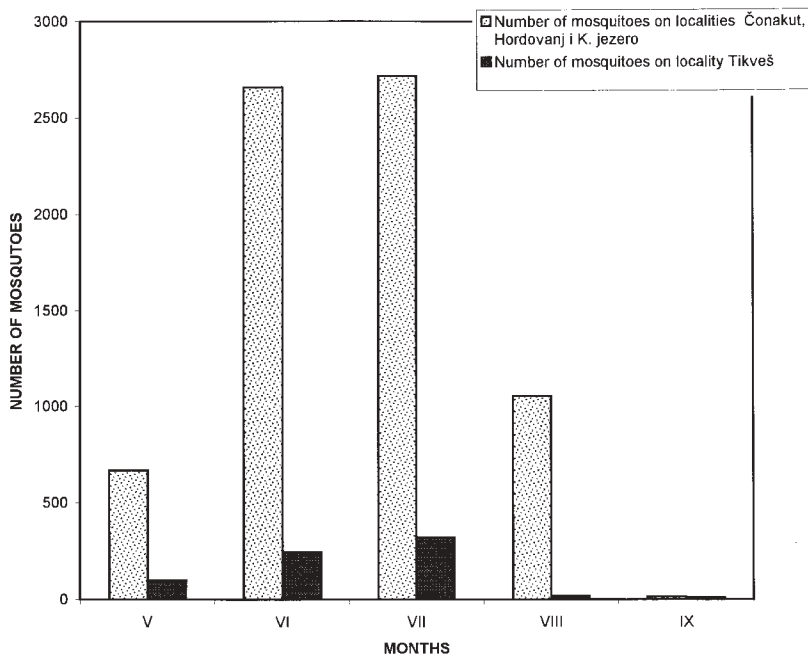


Fig. 1. The number of mosquitoes in Kopački rit (Čonakut, Hordovanj and Kopačko Lake) and Tikveš.

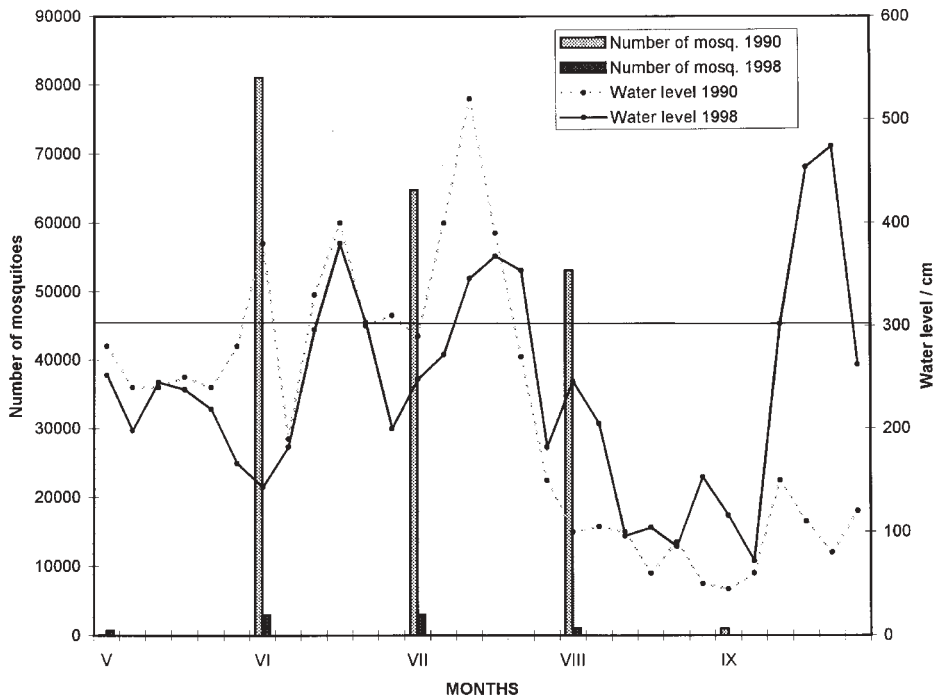


Fig. 2. The number of mosquitoes in 1990 and 1998 as correlated with the water level of the Danube at Apatin in 1990 and 1998.

Tab. 3. Comparison of the mosquito fauna in 1990 and 1998.

No.	Species	1990	1998
1	<i>Aedes cantans</i> (Meigen, 1818)		+
2	<i>Aedes rossicus</i> (D. G. M., 1830)		+
3	<i>Anopheles claviger</i> (Meigen, 1804)		+
4	<i>Anopheles plumbeus</i> (Stephanus, 1828)		+
5	<i>Aedes caspius</i> (Pallas, 1771)	+	+
6	<i>Aedes cinereus</i> (Meigen, 1830)	+	+
7	<i>Aedes excrucians</i> (Walker, 1856)	+	+
8	<i>Aedes sticticus</i> (Meigen, 1838)	+	+
9	<i>Aedes vexans</i> (Meigen, 1818)	+	+
10	<i>Anopheles maculipennis c.</i> (Meigen, 1818)	+	+
11	<i>Coquillettidia richardii</i> (Ficalbi, 1889)	+	+
12	<i>Culex pipiens</i> (Linnaeus, 1758)	+	+
13	<i>Aedes geniculatus</i> (Olivier, 1791)	+	
14	<i>Anopheles hyrcanus</i> (Pallas, 1771)	+	
15	<i>Culiseta annulata</i> (Schrank, 1776)	+	

## DISCUSSION

In normal conditions, the increased water level in the marsh is a result of the melting of snow in the Alps, i.e. it occurs in spring (MIKUSKA, 1979). In 1998, the spring wave did not take place, but occurred only as a minimum short-term increase of 385 cm at the end of June. The very specific water-level situation for the given year is characterised by an extraordinarily high water level in the autumnal period, which reached its maximum in November, 632 cm. The autumnal rise in the water level in September triggered a great development of mosquito larvae, which resulted in the appearance of adult mosquitoes at the beginning of October. Since it had been planned to make records only till the end of September, the traps were not set in October, so this mosquito invasion was not recorded.

If we compare the results obtained in 1998 with those from 1990, it is easy to note a significant difference. In 1990, at the Hordovanj location, in June alone the total number of mosquitoes caught (40500) was higher than in the whole of 1998 at all four locations (7788). The number of mosquitoes in 1990 was 25 times greater than in 1998, although the schedule of the appearance and the reduction of the number was the same during the season. It can clearly be seen that the water level regime was similar, only it was lower in 1998 and, unlike in 1990, the high water level occurred at the end of the season. Furthermore, the water level in 1990 surpassed the critical level of 300, which causes the flooding of the marsh, more than once (and for longer). Except for the above, the maximum water level in 1990 was 520 cm in July, and in 1998, 632 cm in November (Fig. 2).

The 1990 research determined 11 mosquito species (MERDIĆ, 1993), compared to 12 in 1998. There is no difference in the composition of the fauna. Eight mosquito species appeared in both research years. This refers first of all to mosquitoes that have their breeding sites within the flood area of the marsh. Those are *Aedes vexans*, *Aedes sticticus*, *Aedes cinereus*, *Culex pipiens*, *Coquillettidia richiardii* and *Anopheles maculipennis*, and the species *Aedes caspius* that requires saltier habitats and *Aedes excrucians*, whose breeding sites are mostly in oak forests. The only difference between the species that have breeding sites within the marsh is the presence of *Aedes rossicus* in 1998. Since the individuals of this species are not numerous, they were probably not caught in the first year of research. The difference in the composition of fauna in the years of research is related mostly to the Tikveš location, where there is the oak forest, the *Genisto elate* – *Quercetum roboris* community. In 1990, the *Aedes geniculatus* species, that has its breeding sites in the trunks of trees, was recorded, whereas at the same location in 1998, the species *Anopheles plumbeus* was found. These two species do not exclude each other, but they can be found in the given forest community throughout Slavonia (MERDIĆ, 1995), and individuals of the *Anopheles hyrcanus* and *Anopheles claviger* species are very rare in this part of the Pannonian plain (MINAR, 1986).

A comparison of the data obtained before and after the war revealed differences in the number and composition of the mosquito fauna. The differences in number are the result of the different water level regimes in the years of research, and the differences in composition of the mosquito fauna are the result of the different dy-

namics of populations of some mosquito species, which in certain ecological conditions have a larger (or smaller) number, and thus a bigger (or smaller) possibility of getting caught. The differences observed are related to the on-going process of eutrophication that eliminated the breeding sites at lower water levels, a higher water level being needed now to start the development of a larger number of mosquitoes. The invasion of mosquitoes in October is a proof that there are mosquitoes in the marsh.

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## SAŽETAK

### Usporedba faune komaraca Kopačkog rita u razdoblju 1990.–1998.

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Istraživanja komaraca kao dio istraživanja biodiverziteta Specijalnog zoološkog rezervata obavljala su se prije Domovinskog rata u različitim oblicima i intenzitetu. Sustavna istraživanja obavljena su tijekom 1990. godine, da bi zbog ratnih zbivanja 1991–1995(7) na ovom području bila prekinuta. Tijekom rata Kopački rit bio je linija razdvajanja i u samom ritu obavljane su neke vojne operacije. U tom razdoblju u sam rit su postavljene mnoge mine, koje još i danas otežavaju slobodno kretanje. Prestankom ratnih djelovanja i reintegracijom tog područja u ustavno-pravni poređak Republike Hrvatske, omogućen je pristup i daljnja istraživanja u tom izuzetno vrijednom ekološkom sustavu.

Istraživanja komaraca su obavljena 1998. od svibnja do rujna metodom CDC klopki uz suhi led kao atraktant. Uzorkovanja su obavljena jedanput mjesečno u trajanju od 24 sata, identično kao i 1990. godine.

Sveukupno je uhvaćeno 7788 jedinki komaraca od kojih je determinirano 12 vrsta komaraca. Najveći broj komaraca zabilježen je u srpnju, potom je opadao prema kraju sezone. Postaja u kojoj je uhvaćeno najviše komaraca bila je Hordovanj. Najbrojnija vrsta je *Aedes vexans* s ukupnim udjelom od 80.71 %, uz nju treba spomenuti *Aedes cinereus* s udjelom od 9.32%. Sve ostale vrste čime udio od 9.97%. Uspoređujući podatke dobivene 1998. godine s onima iz 1990. vidi se da je broj uhvaćenih komaraca u 1990. oko 25 puta veći, i da se razlikuje faunistička slika (Tab. 3). Glavni razlog toj razlici su različiti ekološki uvjeti, prije svega vodostaj u samom Kopačkom ritu koji je u 1990. puno bolje odgovarao razvoju ekstremno velikih populacija komaraca (pojava visokog vodostaja u travnju). Tijekom 1998. izostao je proljetni val visoke vode, te nije pokrenut razvoj komaraca u proljeće ili ljeto, nego tek nakon pojave visokog vodostaja krajem rujna koji je rezultirao velikim brojem komaraca u listopadu. Razlika u sastavu vrsta odnosi se prije svega na postaju Tikveš gdje je klopka postavljena u hrastovoj šumi zajednice *Genisto elate* – *Quercetum roboris*, a sve vrste koje su tamo pronađene utvrđene su već prije u toj šumskoj zajednici (MERDIĆ, 1995).