NAT. CROAT. | VOL 2 | No 1 | 47 - 54 | ZAGREB | 1993

ISSN 1330-0520
UDK 595.771 : 591.5

Original scientific paper
Izvorni znanstveni članak

MOSQUITOES (*DIPTERA, CULICIDAE*) OF THE SPECIAL ZOOLOGICAL RESERVE KOPAČKI RIT (NE CROATIA)

ENRIH MERDIĆ
Pedagoški fakultet Osijek, L. Jagera 9, 54000 Osijek, Croatia

Merdić, E.: Mosquitoes (*Diptera, Culicidae*) of the Special Zoological Reserve Kopački rit (NE Croatia). Natura Croatica Vol. 2, No 1, 1993, Zagreb.

The Danube River has created one of the most beautiful wetlands in Europe - Kopački rit (NE Croatia). Eleven species of mosquitoes have been found there. They breed in the swamps of the Reserve creating enormous populations in favorable conditions. Immediately after floods, the explosion of mosquito populations occur, and the adults begin to migrate. This research, among other things traces one direction of their migration.

Key words: mosquito fauna, Kopački rit, migrations

Merdić, E.: Komarci (Diptera, Culicidae) Specijalnog zoološkog rezervata Kopački rit. Natura Croatica Vol. 2, No 1, 1993, Zagreb.

Rijeka Dunav formira jednu od najljepših močvara u Europi - Kopački rit (SI Hrvatska). U njoj je nađeno jedanaest vrsta komaraca. Njihovim razmnožavanjem u optimalnim uvjetima močvare zoološkog rezervata nastaju goleme populacije. Neposredno nakon poplava naglo se razvija populacija i odrasle jedinke počinju migrirati. Ovaj rad uz ostale podatke upozorava na mogući smjer njihove migracije.

Ključne riječi: fauna komaraca, Kopački rit, migracije

INTRODUCTION

Wetlands are very rare in Europe. Through drainage, areas subject to seasonal flooding have been transformed into fertile agricultural land, producing fruit and other crops. Only a few decades ago the large rivers in Europe created widespread flood areas, but since the construction of thousands of kilometers of dikes and canals such flood areas have almost disappeared. As a result, ecologists and biologists of all countries are making major efforts to protect the wetlands still in existence. Being the largest river in Europe the Danube flows through eight countries. Although it is a long lowland river, it has not created many flood areas. One of the most beautiful wetlands is Kopački rit. Because the diversity of its flora and fauna (MIKUSKA, 1979, TOPIĆ, 1989), the Kopački rit area was declared a Special Zoological Reserve by the Croatian government in 1976. The Special Zoological Reserve of Kopački rit is situated in southeastern Baranya (NE Croatia), in a triangle where the river Drava flows into the Danube River.

Generally speaking, flood areas are convenient for the development of large mosquito population. Warm and shallow water with some vegetation and without predators is ideal

Hrvatski prirodoslovni muzej, Demetrova 1, Zagreb, Croatia

for breeding. Such places are mostly inhabited by *Aedes vexans* whose English name is Inland Floodwater Mosquito. Although this area is well known for mosquitoes, this work is the first contribution to the knowledge of the Kopački rit mosquitoes.

METHODS

For investigation into the mosquitoes of Kopački rit, CDC traps were used (SERVICE, 1976). Carbon dioxide is used as an attractant, imitating emissions from a vertebrate host. The traps were operated for 24 hours, once per month, from May to September of 1990.

The traps usually caught large number of mosquitoes. In determining the number, a subsample volume of 5 ml of mosquitoes was taken and their number was determined. Their exact number was calculated by the multiplication of a subsample value of 5 ml by the total volume caught. In choosing the localities, the idea was to cover all of the characteristic places of the Kopački rit area. Four localities are in the Special Zoological Reserve of Kopački rit, and one is in the Tikveš oak forest, which is the northern border of the Reserve. The localities are:

1. On the bank of Sakadaš Lake
2. Near the Čonakut Canal-willow forest
3. Hordovanj-white poplar forest
4. Kopačko Lake - on an island in the middle of the Lake with willow trees and colony of cormorants (*Phalacrocorax carbo*)
5. Tikveš - Old oak forest.

Locality 6 which appears in **table 1** and **figure 2** is Haljevo. This locality is 15 km from Kopački rit. The investigation in this forest was carried for other reasons (the same method), but the results are used for studying mosquito migrations. Determinations were done by GUTSEVICH et al. (1974) key.

RESULTS

Tab. 1. The number of mosquitoes caught in CDC traps baited with dry ice in Kopački rit.

MONTHS SITES	MAY	JUNE	JULY	AUGUST	SEPT.
1. SAKADAŠ	35	8800	8800	463	25
2. ČONAKUT	10	32500	6300	5000	186
3. HORDOVANJ	0	40500	32000	11000	750
4. KOPAČKO L.	33	7800	15800	2100	6
5. TIKVEŠ	2	228	10700	35000	37
6. HALJEVO	15	182	87	12000	-

Kopački rit is well known for its birds, but the insect world has not been adequately researched (MERDIĆ, 1991). The only known fact about mosquitoes has been that one cannot enter Kopački rit because of them. In the five localities (five one-day samples at each locality) about 230,000 specimens of mosquitoes were caught in the traps **(Tab.1)**. Out of this material 11 species were determined. Thay are:

1. *Anopheles messeae* (FALERONI, 1926)
2. *Anopheles hyrcanus* (PALLAS, 1771)
3. *Culiseta annulata* (SCHRANK, 1776)
4. *Coquillettidia richiardii* (FICALBI, 1889)
5. *Aedes caspius* (PALLAS, 1771)
6. *Aedes excrucians* (WALKER, 1856)
7. *Aedes sticticus* (MEIGEN, 1838)
8. *Aedes vexans* (MEIGEN, 1818)
9. *Aedes geniculatus* (OLIVIER, 1791)
10. *Aedes cinereus* (MEIGEN, 1830)
11. *Culex pipiens* (LINNAEUS, 1758)

The number of mosquitoes caught during the experiment varied from 0 to 40,500 specimens per sample **(Tab. 1)**. *Cs. annulata, Ae. geniculatus, Ae. excrucians* and *Cq. richiardii* were caught only in the Tikveš forest **(Tab. 2)**. The large number of mosquitoes can also be correlated with the water level **(Fig. 1)**.

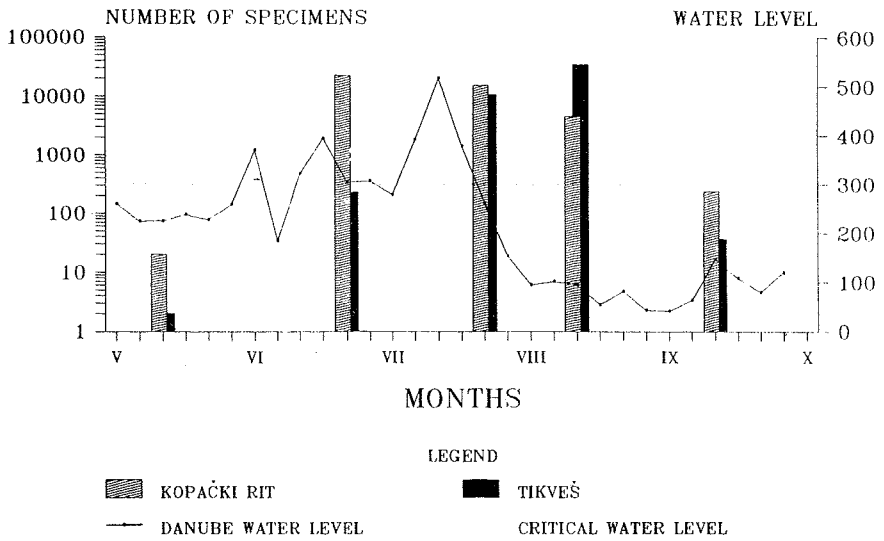

Fig. 1. Comparison of number of mosquitoes caught in Kopački rit (average) and Tikveš forest (bars), correlated with the water level of the Danube (critical water level: the point when the Danube River water starts to fill Kopački rit area)

Tab. 2. Composition of mosquitoes (5 ml sample) at five localities in Kopački rit.

SITES / SPECIES	SAKADAŠ	ČONAKUT	HALJEVO	KOPAČKO LAKE	TIKVEŠ
Anopheles maculipennis	53 (6.23%)	15 (2.22%)	6 (0.48%)	21 (4.04%)	-
Anopheles hyrcanus	3 (0.35%)	-	-	5 (0.96%)	-
Culiseta annulata		-	-	-	1 (0.17%)
Coquillettidia richiardii	-	-	-	-	4 0.69%)
Aedes caspius	38 (4.45%)	-	-	36 (6.92%)	8 (1.39%)
Aedes excrucians	-	-	-	-	3 (0.52%)
Aedes sticticus	-	-	7 (0.57%)	-	1 (0.17%)
Aedes vexans	726 (85.1%)	611 (90.38%)	1209 (98.13%)	420 (80.77%)	555 (95.69%
Aedes geniculatus	-	-	-	-	6 (1.03%)
Aedes cinereus	9 (1.06%)	1 (0.15%)	2 (0.16%)	13 (2.50%)	-
Culex pipiens	24 (2,81%)	49 (7.25%)	8 (0.66%)	25 (4.81%)	2 (0.34%)
UKUPNO	853	676	1232	520	580

The greatest number of these mosquitoes belong to the species *Ae. vexans*. Variation in the numbers of *Ae. vexans* caught in each locality indicate that this species migrates (Fig. 2). That is, mosquitoes originating in Kopački rit move to other areas. This accounts for the large number of mosquitoes noted in the Tikveš forest in July, one month later, and in Haljevo forest in August, two months later. This is actually emigration because the mosquitoes did not return to Kopački rit.

DISCUSSION

The Faunal investigation in Kopački rit showed that 11 species of mosquitoes are present, seven of which are typical wetland species that produce large populations. The most numerous species is *Ae. vexans* for which the breeding conditions are ideal in Kopački rit. Two other species of genus *Aedes*, *Ae. sticticus* and *Ae. cinereus*, occur together with *Ae. vexans*.

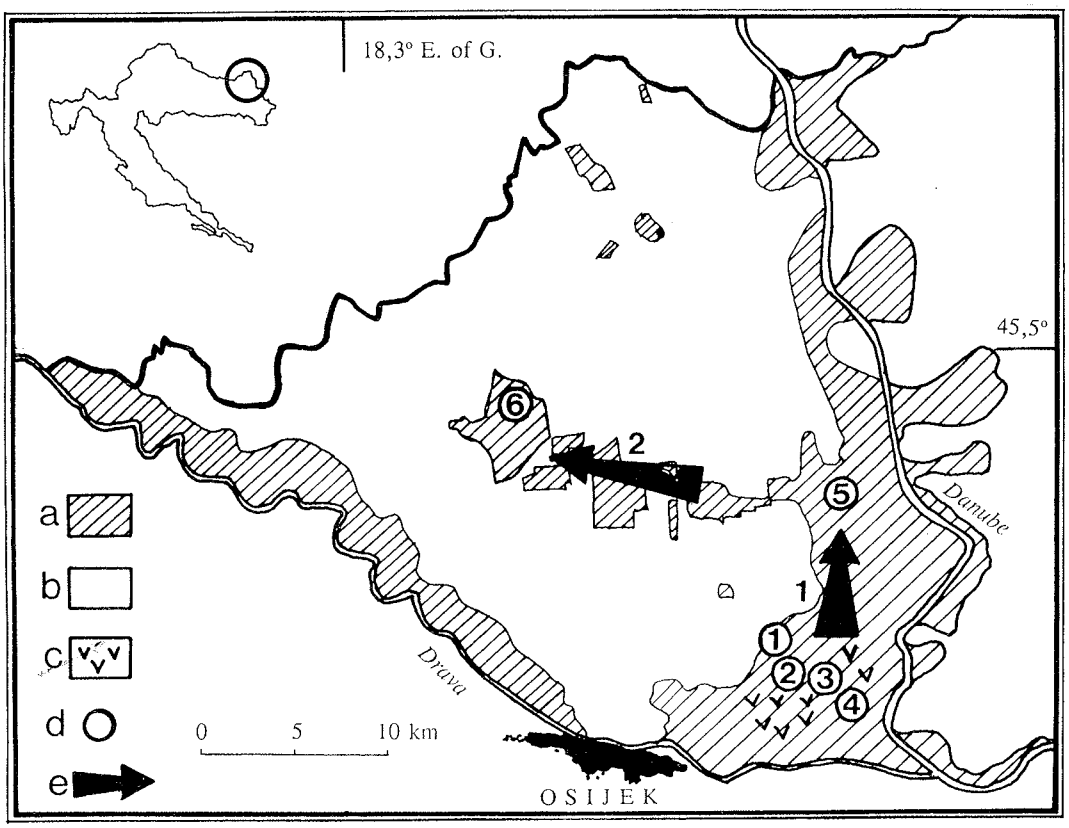

Fig. 2. Emigration of mosquitoes from Kopački rit. The dotted line indicates the border of The Special Zoological Reserve.
Legend: a= forests; b= agricultural land; c= wetlands; d= localities: 1-Sakadaš, 2-Čonakut, 3-Hordovanj, 4-Kopačko jezero, 5-Tikveš, 6-Haljevo; e= direction of migration.

The *Anopheles maculipennis* complex is represented by *An. messeae*, which prefers the breeding environment that Kopački rit provides. *Cx. pipiens* is present in relatively large number because of the abundance of food. Food is more important for this species than for others because it can breed in almost any kind of water habitat. *Ae. caspius* is not numerous here but is present throughout the May-September season. Its usual habitat is in the more saline swamps. *An. hyrcanus* is a rare species that has not been recorded before in northeastern Croatia (ADAMOVIĆ & PAULUS, 1983).

Four species obtained in the Tikveš forest have special breeding requirements (larval habitats). *Ae. excrucians* and *Cs. annulata* were found in small bodies of water such as

waterfilled ruts caused by tractors. For *Cq. richiardii* vegetation in the water is important, so this species breeds in deeper waters such as canals bordering forests.

In 1990, mosquitoes first became extremely abundant in June, which is later than usual. Most of the mass of mosquitoes caught were *Ae. vexans* species. This species finds ideal breeding conditions in the Kopački rit, shallow swamps with or without vegetation and with enough sunlight. *Ae. vexans* is an autogenous species (HORSFALL et al. 1988), which probably accounts for its making up 95% of the mosquito population in the area. Water is the most important factor for mosquito development. Water enters Kopački rit when the level at the measuring station, in the village of Apatin, is above 300 cm. At the beginning of June 1990 a 370 cm high wave passed down the Danube. The water that entered Kopački rit then was sufficient to create small and medium-sized swamps, but they were too shallow to support the ordinary predators of mosquito larvae (fish, *Odonata* etc.). The development of mosquitoes started about June 3rd. By June 4th the water level at Apatin measured only 191 cm, and the water began to drain slowly from Kopački rit, creating ideal conditions for the growth of extremely large populations of *Ae. vexans* and other species. The traps sat on June 29th caught exceptionally high number of mosquitoes in all locations except in the Tikveš forest as, by that date their development had been completed and adults were flying. The small number of mosquitoes recorded in the Tikveš forest was due to the fact that the amount of flood water was too small to reach the level of the forest. That happens only when the water level is very high (500 cm or more).

In the Tikveš forest the number of mosquitoes increases from June to August, and decreases in Kopački rit from June to September. This is because immediately after the emergence of the adult mosquitoes they begin migrating (BIDLINGMAYER, 1985), proceeding in several steps, depending upon such factors as wind direction and velocity, the reserves of the mosquitoes and meteorogical conditions. Mosquitoes slowly leave the swampy areas and enter the Tikveš forest, where ecological conditions (relative humidity, temperature, wind, food) are more favorable. Some remain there, but others continue their flight to other forested areas as much as 30 km away. My data from the Haljevo forest (part of another investigation) may be proof to this.

CONCLUSION

Kopački rit, the area of great faunal and floral diversity in the floodplain of the Danube River in northeastern Croatia, is protected as Special Zoological Reserve by Croatian law. Owing to its climate, its position at the confluence of two big rivers, its relief, vegetation, and other ecological factors; this area is exceptionally suitable for development of large population of mosquitoes. The mosquitoes were collected with CDC traps with CO_2 as attractant. Five samples were taken once a month from May to September, for 24 hours each and at five localities within the Kopački rit area. About 230,000 mosquitoes were collected. The following 11 species were found: *An. messeae, An.*

hyrcanus, Cs. annulata, Cq. richiardii, Ae. caspius, Ae. excrucians, Ae. sticticus, Ae. vexans, Ae. geniculatus, Ae. cinereus and *Cx. pipiens.*

Seven of these species are habitual in wetlands or floodplains. Thanks to the ideal breeding conditions and because its females are autogenous, *Ae. vexans* makes up about 95% of the mosquito population in Kopački rit. At the beginning of June 1990, the area was partly and temporarily flooded, creating favorable conditions for the growth of large population of mosquitoes. Upon their emergence from the pupae, adult mosquitoes begin to migrate. This work shows that mosquito migrations exist and hey follow the direction that was traced in this investigation (Kopački rit-Tikveš-Haljevo).

REFERENCES

ADAMOVIĆ, Ž. & PAULUS, R., 1983: *Anophelinae mosquitoes* (*Diptera, Culicidae*) in Podravina, Croatia. — Acta Ent. Jugosl., **19**(1-2), 9-17.

BIDLINGMAYER, W. L., 1985: The measurement of adult mosquito population changes - some considerations. — J. Am. Mosq. Control Assoc. **1**(3), 328-348.

GUTSEVICH A. V., MONCHADSKII, A. S. & SHTAKELBERG, A. A., 1974: Fauna of the USSR. *Diptera.* III, 4, Jerusalem, 381 pp..

HORSFALL, W., FOWLER, H. W., MORETTI, L. J. & LARSEN J. R., 1988: Bionomics and embryology of the floodwater mosquito *Aedes vexans.* University of Illinois Press, Urbana-Chicago-London p. 55-59.

MERDIĆ, E., 1991: Faunistička, ekološka i biometrijska istraživanja komaraca (*Diptera, Culicidae*) u Slavoniji i Baranji. Disertacija, Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu, p. 17-47 Zagreb.

MIKUSKA, J., 1979: Ekološke osobine i zaštita specijalnog zoološkog razervata Kopački rit s posebnim osvrtom na ekologiju kralješnjaka. Disertacija, Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu, Zagreb.

SERVICE, M. W., 1976: Mosquito ecology. Field sampling methods. Applied science publishers, London, p. 306-375.

TOPIĆ, J., 1989: Vegetation of the Special Zoological Reserve of Kopački Rit. — Hydrobiologia, **182**, 149-160.

Received January 15, 1993

SAŽETAK

Komarci (*Diptera, Culicidae*) Specijalnog zoološkog rezervata Kopački rit

E. Merdić

Poplavna područja u Europi su uglavnom zaštićena zakonima zemalja u kojima se nalaze. Dunav, kao najduža Europska rijeka čini mnoga poplavna područja. Jedino od

najljepših, je smješteno na mjestu gdje se Drava ulijeva u Dunav, a to je Kopački rit. Kopački rit je mjesto gdje živi veliki broj močvarnih biljaka i životinja, te je zbog toga zakonom zaštićen kao Specijalni zoološki rezervat. Zbog svojih klimatskih karakteristika, reljefa, utjecaja dviju velikih nizinskih rijeka ovo područje pruža izuzetno povoljne uvjete za razvoj velikih populacija komaraca.

Faunistička istraživanja obavljena su tijekon 1990 godine. Komarci su uzorkovani metodom CDC klopka uz suhi led kao mamac (atraktant). Klopke su bile postavljene na 6 postaja: četiri u samom Kopačkom ritu, jedna u Tikveškoj šumi (sjeverna granica rita) i jedna u šumi Haljevo sjeverozapadno od rita. Uzorkovano je pet puta i to jedanput mjesečno po 24 sata. Uhvaćeno je oko 230,000 jedinki komaraca.

Iz navedenog materijala utvrđena je prisutnost 11 vrsta komaraca: *An. messeae, An. hyrcanus, Cs. annulata, Cq. richiardii, Ae. caspius, Ae. exrucians, Ae. sticticus, Ae. vexans, Ae. geniculatus, Ae. cinereus i Cx. pipiens.* Sedam od navedenih su vrste sklone poplavnim područjima. Zahvaljujući idealnim uvjetima za legla i činjenici da je autogena vrsta (polaganje prvih jaja bez krvnog obroka) jedinke vrste *Aedes vexans* čine oko 95 % od ukupne mase komaraca. U godini u kojoj je istraživano, početkom lipnja naišao je jedan val vode i djelomično poplavio rit. To je bilo dovoljno da se stvore male barice, idealna legla za komarce. Velika masa komaraca koja se izlegla ovdje počela je migrirati. Jedno od mogućih trasa emigracije zabilježeno je u ovom radu, a to je iz Kopačkog rita prema sjeverozapadu.