European Mosquito Bulletin ***30*** *(2012), 72-78*
Journal of the European Mosquito Control Association
ISSN 1460-6127; www.e-m-b.org
First published online 4th May 2012

The fauna and seasonal activity of mosquitoes (Diptera: Culicidae) in the Curonian Spit (Russia, Lithuania)

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Abstract

The Curonian Spit, characterized by the highest drifting sand dunes in Europe, is a 98 km long, thin, curved sand dune peninsula located in the East of the Baltic Sea. The northern stretch of the Spit belongs to Lithuania, while the rest is part of Russia. Investigations on birds and on bird haemosporidian parasites are carried on in this region. Bloodsucking dipterous insects are specific vectors of these parasites, so it is important to know the fauna and the abundance of mosquitoes in this region. Adult mosquitoes were collected by entomological net, and bloodsucking females were collected from people and birds in May–June and in August (2006–2007). Material collected by light trap in 2002 in two localities was also used. Six localities were investigated. Sixteen mosquito species were determined. The greatest diversity of mosquitoes was detected in the surroundings of the Biological station "Fringila" (D = 0.544, 8 mosquito species) and the lowest diversity was detected in Lesnoje village (D = 0.833, 5 species). Dominant species varied in different localities and during the season. The mosquito diversity was similar in June and August. *Ochlerotatus cataphylla* and *Oc. cantans* dominated in June and *Culex pipiens* and *Aedes vexans* dominated in August. The highest abundance of attacking mosquitoes in June was detected in Rybachy village. The lowest abundance of mosquitoes was in Lesnoje and in Smiltyne villages in June and August. Mosquitoes of all 16 species were collected from humans and 8 species were collected from biting birds.

Keywords: Mosquitoes, Lithuania, Kaliningrad, Vectors, Curonian Spit.

Introduction

The Curonian Spit is a 98 km long, thin, curved sand dune peninsula located in the east of the Baltic Sea. It separates the Curonian Lagoon from the Baltic Sea. The Curonian Spit is characterized by the highest drifting sand dunes in Europe (Povilanskas *et al*., 2006). Their average height is 35 m, but some attain the height of 60 m. The northern 52 km long stretch of the Curonian Spit peninsula belongs to Lithuania, while the rest is part of the Kaliningrad district, Russia (Fig. 1). Both Russian and Lithuanian parts of the Spit are national parks. Since 2000, the Curonian Spit is a UNESCO World Heritage Site shared by the two countries. The width of the Spit varies from a minimum of 400 m in Russia (near the village of Lesnoje) to the maximum of 3,800 m in Lithuania (just north of Nida).

Annually during autumn migration, over 10 million land birds of various species that avoid sea crossings during daytime, use the Curonian Spit as a bridge for their flight. In 1901 a famous German ornithologist Johanness Thienemann established the world's first ornithological station, in Rossitten "Vogelwarte Rossitten" (now Rybachy) for the study of bird migration. This station is now known as the Biological station of the Zoological institute of Academy of Sciences of Russia in the Curonian Spit.

Investigations on birds and on bird haemosporidian parasites (Haemosporida) are carried on in this station (Valkiūnas & Jezhova, 2001; Valkiūnas *et al*., 2006; 2008; 2009; Palinauskas *et al*., 2009; Križanauskiene *et al*., 2010). Bloodsucking dipteran insects (Culicidae, Ceratopogonidae, Simuliidae, Hyppoboscidae) are vectors of these parasites, which cause diseases in birds and other vertebrates all over the word, including the Baltic region. Vector species, which transmit certain haemosporidian species remain insufficiently investigated. Knowledge on the fauna of bloodsucking dipteran insects in the Curonian Spit is very poor. There are some data published on the fauna of biting midges (Ceratopogonidae) in the Curonian Spit (Glukhova & Valkiūnas, 1993; Trukhan *et al.,* 2003; Bernotiene, 2006). The lack of rivers in the Curonian Spit leads to the very low abundance of blackflies (Simuliidae) in the Spit. Only a few blackflies have been collected in this region in sites located nearby the cost (Juodkrante) in 2002.

In spite of the fact that many typical habitats for the development of mosquito larvae (several lakes, many temporary marshes) are located in the Curonian Spit, data on the fauna of mosquitoes from Curonian Spit remain unpublished. Only one mosquito species (*Ochlerotatus cataphylla* (Dyar, 1916)) is known from this region (Bernotiene, 2006). Mosquitoes are specific vectors of *Plasmodium* spp. So, it is very important to know the fauna and the abundance of mosquitoes in this region, so important for the investigation of bird haemosporidian parasites as well as characterized by very specific habitats.

Material and Methods

Adult mosquitoes were collected by entomological net. Bloodsucking mosquito females were collected from human bait and some species of Passeriformes birds using a pooter. Mosquitoes were collected from people with a pooter (at least three samples were collected from a locality per day) within a 10-min period after 5 min of waiting in order to determine the abundance of attacking mosquitoes in different localities. This investigation was carried out 1-3 hours before sunset. The material was collected in 2006 and 2007 twice per year: from the end of May till the beginning of June and in the first part of August.

The material was compared with the material collected by light trap in June and August of 2002 (supervised by P. Ivinskis) in two localities of the Spit in Lithuania: Juodkrante and Smiltyne. In order to determine the mosquito diversity, Simpson's index (D) was calculated.

Fig. 1. Location of the Curonian Spit. The Baltic sea – BS, Lithuania – LT, Russia – RS, arrow shows Kaliningrad district in Russia.

List of localities

Smiltyne (55°42`28N 21°06`29E) – the Northern point of Curonian Spit, pine (*Pinus sylvestris*) forest.
Juodkrante (55°32`48N 21°07`22E) – located 21 km South from the Northern point of Curonian Spit, pine (*Pinus sylvestris*) and alder (*Alnus glutinosus*) forest, nearby lagoon.
Rybachy (55°09`15N 20°51`32E) – located 68 km South from the Northern point of Curonian Spit, alder forest with reeds (*Fragmites* sp.) nearby lagoon.
Locality nearby the lake Chayka (55°09`08 N 20°44`03E) – located 71 km South from the Northern part of the Curonian Spit, spruce (*Picea abies*) and alder forest.
Biological station "Fringila" (55°05`22N 20°44`03E) – located 80 km South from the Northern point of Curonian Spit, pine forest.
Lesnoje (55°01`07N 20°37`14E) – located 92 km South from the Northern point of Curonian Spit, alder forest.

Results

Species composition and diversity

Sixteen mosquito species were determined in the Curonian Spit:
Anopheles (Anopheles) maculipennis Meigen, 1818.
Aedes (Aedes) cinereus Meigen, 1818.
Aedes (Aedimorphus) vexans (Meigen, 1830).
Coquillettidia (Coquillettidia) richiardii (Ficalbi, 1889).
Culex (Culex) pipiens Linnaeus, 1758.
Culiseta (Culicella) morsitans (Theobald, 1901).
Culiseta (Culicella) ochroptera (Peus, 1935).
Culiseta (Culiseta) alaskaensis (Ludlow, 1906).
Ochlerotatus (Finlaya) geniculatus (Olivier, 1791)
Ochlerotatus (Ochlerotatus) annulipes (Meigen, 1830)
Ochlerotatus (Ochlerotatus) behningi (Martini, 1926)
Ochlerotatus (Ochlerotatus) cantans (Meigen, 1818)
Ochlerotatus (Ochlerotatus) cataphylla (Dyar, 1916)
Ochlerotatus (Ochlerotatus) excrucians (Walker, 1856)
Ochlerotatus (Ochlerotatus) intrudens (Dyar, 1919)
Ochlerotatus (Rusticoidus) rusticus (Rossi, 1790)

Differences in study sites

In spite of the fact that 15 out of 16 mosquitoes species were determined in Rybachy village, the Rybachy was characterised by the low mosquito diversity (Simpson`s index D = 0.739). Two mosquito species, *Oc. cantans* and *Oc. cataphylla,* took the dominant position in surroundings of this village. The greatest mosquito diversity was detected in the Biological station "Fringila" (D = 0.544, 8 mosquito species). A bit lower mosquito diversity was determined in surroundings of the lake Chayka (D = 0.671, 7 mosquito species). The lowest diversity was detected in Lesnoje village (D = 0.833, 5 mosquito species).

The dominant species differed in different localities. The Southest study site, Lesnoje village, was dominated by *Oc. cataphylla* and *Cx. pipiens* (Fig. 2). Biological Steady-state station "Fringila" was dominated by *Oc. cantans* and *Cs. morsitans. Oc. cantans, Oc. cataphylla* and *Ae. vexans* dominated in Rybachy village as well as in surroundings of the lake Chayka. According to data collected by light trap two villages in Lithuanian part of the Curonian Spit were dominated by *Cx. pipiens* and *Ae. vexans* (Smiltyne) and by *Cx. pipiens* and *Oc. cataphylla* (Juodkrante) (Fig. 2).

Seasonal activity

Dominant species differed during the season. *Oc. cataphylla* and *Oc. cantans* dominated in May – June forming up to 70% of mosquitoes collected during this period. *Cx. pipiens* and *Ae. vexans* dominated in August forming up to 61% of mosquitoes collected during this period (Fig. 2). The mosquito diversity was similar in June (D = 0.718, 12 species) and in August (D = 0.769, 9 species).

The material collected by light traps from middle April till end of September in Juodkrante have shown that number of mosquito species differed during the season from 2 species in September to 12 species in June. The highest numbers of species were detected in June (12 species) and in August (9 species) (Fig. 3).

Some mosquito species were detected from May till middle August, but some species were collected only in May – June and were not detected in August. In most cases these species were rare species in the investigated territory, such as *Cs. alaskaensis, Oc. geniculatus*. Some mosquito species were not determined as very rare, but these species were collected only in the beginning of summer (*Oc. annulipes, Oc. behningi, Oc. intrudens)*. This can be related with the fact that some mosquito species have one generation per year (Becker *et al*., 2003).

Attacking mosquitoes

The highest abundance of attacking mosquitoes in June was detected in Rybachy village in the first part of June (Fig. 4). The lowest abundance of mosquitoes was determined in Lesnoje and in Smiltyne villages (Fig. 4) and it does not changed comparing with the abundance detected in the same locality in August. The mosquito abundance in June was higher comparing with abundance in August only in Rybachy village. This can be explained by the decrease of the most abundant mosquito species such as *Oc. cantans* and *Oc. cataphylla*.

Mosquitoes of all 16 species were collected from humans, so they can be called anthropophylic. Mosquitoes of 8 species were collected biting the bird. These species were *Ae. cinereus, Ae. vexans, Cx. pipiens, Oc. annulipes, Oc. cantans, Oc. cataphylla, Oc. excrucians* and *Oc. intrudens*.

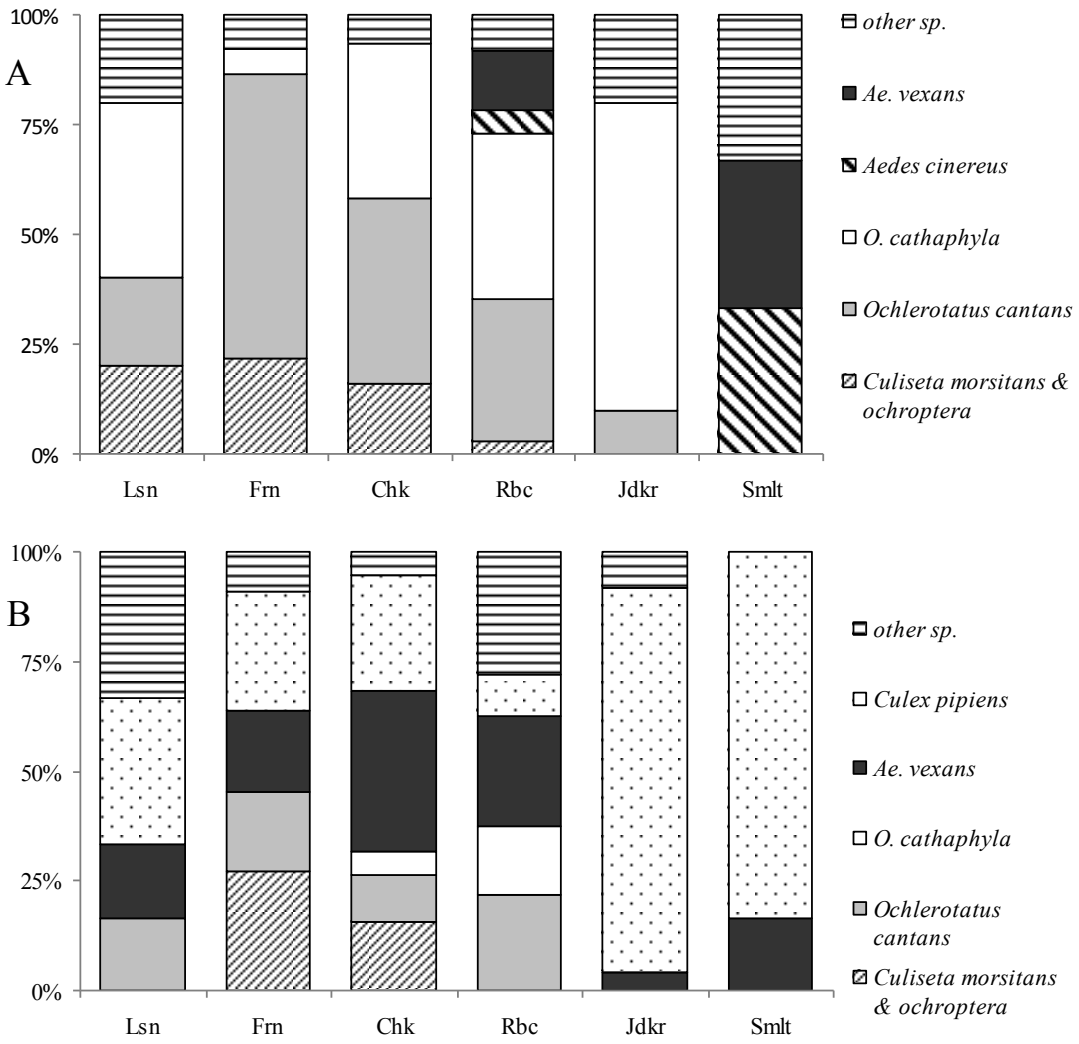

Fig. 2. Relative abundance of mosquito species in different study sites in May-June (A) and in August (B). Lsn – Lesnoje, Frn - Biological station "Fringila", Chk – the lake Chayka surroundings, Rbc – Rybachy, Jdkr – Juodkrante, Smlt – Smiltyne.

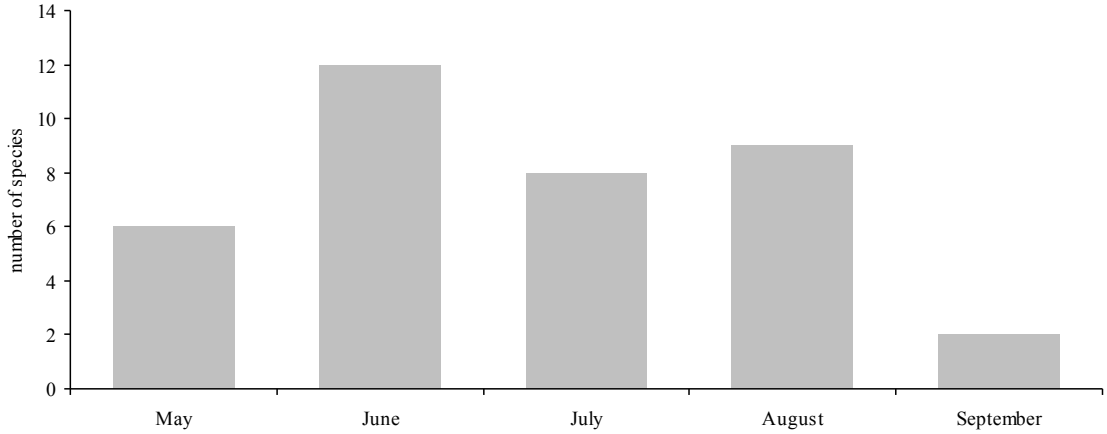

Fig. 3. The number of mosquito species from May to September in Juodkrante in 2002. The material was collected by light trap.

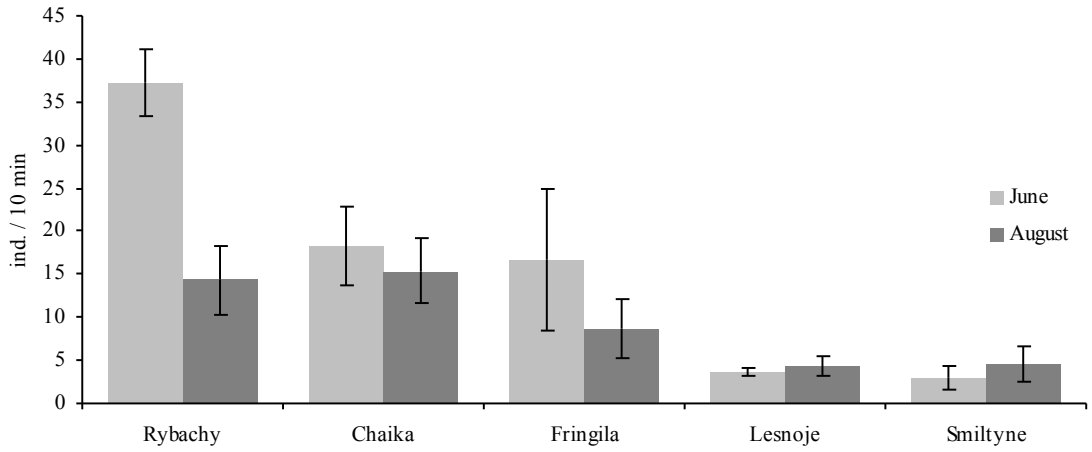

Fig. 4. Abundance of mosquitoes attacking a person per 10 minutes in different study sites in June and in August.

Disscussion

Study sites were located from 3 to 45 km from each other. Differences in the abundance and in the relative abundance of different mosquito species in study sites were detected. The highest abundance of attacking mosquitoes was determined in study sites characterised by presence of temporary or semi-permanent water bodies (Rybachy, surroundings of the lake Chayka). Mosquito abundance was low in localities characterised by absence of water bodies and by dry and sandy ground (Smiltyne, Lesnoje).

Differences of dominant mosquito species in study sites can be explained by different habitats. Larvae of *Oc. cataphyla* usually develop in alder forest pools with neutral to alkaline water (Becker *et al*., 2003). These mosquitoes dominated in study sites located in alder forest (Rybachy, Lesnoje & Juodkrante). *Ochlerotatus cantans* larvae develop in open permanent or semi-permanent meadow, deciduous or mixed forest pools (Becker *et al*., 2003). Mosquitoes of this species dominated in Rybachy, in study site near the lake Chayka as well as near Biological station "Fringila". *Culex pipiens* mosquitoes were collected in all localities investigated. It is known that larvae of *Cx. pipiens* are able to inhabit nearly every kind of water collection (Becker *et al*., 2003). The abundance of these mosquitoes was similar in all study sites. *Culex pipiens* dominated in localities with very low densities of other mosquito species (Smiltyne, Lesnoje).

Differences in seasonal activity were even more perceptible: *Oc. cantans* and *Oc. cataphylla* were the dominant mosquito species in June and *Ae. vexans* and *Cx. pipiens* were the dominant mosquito species in August in the Curonian Spit. It seems that all snow melt mosquitoes were monocyclic in the Curonian Spit even though some facts on the capability of a bicyclic development of some mosquito species in East Lithuania (unpublished data) as well as in neighbouring Poland (Wegner, 1999) were known.

It was known that *Cx. pipiens* is an ornithophylic species and *Ae. vexans* was known to be a mammalophylic mosquito species. *Aedes cinereus* was known to bite humans (Becker *et al*., 2003). All the collected mosquito species were from people, but 8 species were collected biting birds. These mosquito species can be potential vectors of bird haemosporidians in the Curonian Spit, especially *Oc. cantans* and *Oc. cataphylla* during the first part of the summer and *Ae. vexans* and *Cx. pipiens* during the second half of the summer.

Acknowledgements

Special thanks are extended to Gediminas Valkiūnas, Tatjana Jezhova and Anatoly Shapoval for acquaintance with the Curonian Spit and help during this investigations. The author is thankful to Povilas Ivinskis for the material collected by light traps in Juodkrante and to all researches of Biological station "Fringila" for advice and support.

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