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Elżbieta WEGNER

Preliminary study of mosquitoes (*Diptera: Culicidae*) of the Narew National Park in Poland

Abstract: The study of mosquitoes (*Diptera: Culicidae*) was carried out in 2000 in Narew National Park (NPN), in two strictly protected areas under development and in the manor park at Kurowo. Mosquitoes were also collected indoors. A total of 21 species were registered (about 44.7% of the mosquito species in Poland or ca 58% of species recorded in lowland Poland). The species commonly or frequently recorded from lowland Poland make up the majority (86%) of the species recorded. 14% are species rarely found in Poland (*Ochlerotatus euedes* was recorded from all the study areas in NPN and constituted an essential component of the mosquito community in spring; two other species, *Cx. torrentium* and *Cx. territans*, were captured as wintering females). A great proportion (43%) of the species prefer bodies of water in open areas for their larvae to develop, whereas 28% of them have no special habitat preferences; their larvae develop either in bodies of water in woodland or in open areas. Only 19% were those preferring bodies of water in woodland and in brushwood. Two species had specific habitat requirements for development of their larvae; *Oc. riparius* and *Coquillettidia richiardii*. In late spring and in summer, *Ae. cinereus*, *Oc. cantans* and *Oc. annulipes* were the most abundant species recorded in nature while malaria mosquitoes (*Anopheles maculipennis*) were the most numerous in buildings. *Culex pipiens* was clearly dominant among wintering mosquitoes. In summer, no mass occurrence of the flood species *Ae. vexans* and *Oc. sticticus* was recorded. The mosquitoes of NPN included nine species from among ten potentially effective vectors of human diseases in Poland. Four of these species belong to the most abundant mosquitoes in this area.

Key words: mosquitoes, Culicidae, wetlands, Narew National Park, Poland

Author's address: Museum and Institute of Zoology PAS, Wilcza 64, 00-679 Warszawa, POLAND; e-mail: wegner@robal.miiz.waw.pl

INTRODUCTION

All over Europe, marsh habitats are gradually disappearing as a result of human activities (mainly soil drainage practises). At present, however, more and more wetlands are designated protected areas because they are refugia of many rare plant and

animal species. Well-preserved and almost natural marshlands can still be found in the eastern regions of Poland. These areas are the subject of comprehensive research aimed at determining the species composition and the structure of the flora and fauna. Results of the studies will help to develop effective guidelines for protection of these areas. The marshland valley of the river Narew is one of the most valuable wetlands in Poland. A large part of the valley, situated between the villages of Suraż and Rzędziany and covering 7350 ha, is under protection and known as Narwiański Park Narodowy (Narew National Park, NPN in the text) (Figure). Phytosociologists have distiguished 46 plant associations there, including rushes and aquatic plants of exceptionally high diversity (SOLON *et al.* 1990). Yet despite its value to naturalists, the area is relatively poorly known in respect of the fauna, and of invertebrates in particular. Although mosquitoes are a typical component of the wetland fauna there are no data on these insects from this area. Mosquitoes are also a very important element because, on the one hand, they are the source of food for many species of freshwater and terrestrial vertebrate and invertebrate predators and, on the other, some of them are vectors of human and animal diseases.

Figure. Location of the Narew National Park in Poland.

Up till now, investigations into the mosquitoes of Poland have been conducted mainly in forest habitats. Data on the fauna of natural river valleys with vast grassy habitats are rather scarce.

The objective of the present study was to catalogue the mosquito species of NPN against a background of the fauna of the neighbouring areas, and to assess their epidemic and epizootic impact.

STUDY AREA, MATERIALS AND METHODS

The present study of the species composition of mosquito communities was carried out in NPN in 2000 within the framework of a larger project designed to work out a plan for protection of the natural resources of the Narew valley. The material was collected at two localities situated in natural habitats: "Grobla pod Kurowem" and "Rynki" (both are to be strictly protected areas) and also in the park round the manor house at Kurowo (seat of NPN) and in the buildings of the manor complex.

"Grobla pod Kurowem" covers 49.62 ha in the valley of the Kurówka, a left tributary of the Narew. Most of the area is given over to forest associations and shrubs of the class *Alnetea glutinosae – Carici elongatae-Alnetum* and *Salicetum pentandro-cinereae*. There also are associations of the rushes *Phragmitetum australis, Caricetum elatae, Glycerietum*

maximae, Acoretum calami and an association dominated by *Calamagrostis stricata* (KOŁOS & MATOWICKA 1992). The samples were taken both in the forest and in the grassland.

"Rynki" covers 280 ha in the Narew valley, south-east of the village of Uhowo. It has been established in order to protect that part of the Narew valley which harbours a variety of associations of rushes, herbs and shrubs reflecting the natural plant systems of marshy valleys of large lowland rivers. Alder stands along the north-eastern edge of the Rynki forest range are one of the best preserved forests in NPN. Forest and shrub associations of the classes *Alnetea glutinosae: Carici elongatae-Alnetum, Salicetum pentandro-cinereae* and *Betulo-Salicetum repentis* occupy about 50% of the area. Non-forest associations include *Caricetum elatae, Caricetum appropinquatae, Caricetum gracilis, Phragmitetum communis, Acoretum calami, Sedo-Scleranthea* and *Nardo-Callunetea* (KOŁOS & MATOWICKA 1993). There was one site in the forest and one in the open area.

The manor house at Kurowo is situated at a meander of the Kurówka on the western edge of the Narew valley. It is surrounded by an old park established at the beginning of the 19th century. There are wetlands to the north, east and south of the park. The habitat conditions in the park are very good; the tree stand comprises 35 species of trees and 29 species of shrubs (DEPTUŁA 1998) – and the microclimate is due to close proximity to water. Such conditions are extremely favourable to mosquitoes, both to the development of larvae and to the existence of imagines.

The scope of this preliminary study was limited to determining the species composition. Sampling in the field was performed four times: in the middle of June, July, August and September, in the commonest habitat types. Thus, the material does not comprise the early spring fauna (snow-melt mosquitoes). Some of these mosquitoes were captured in June, but the material is not representative enough to characterise early spring mosquito fauna.

Adult females were captured by baiting; a man sitting quietly acted as bait. The material was supplemented with that collected by "stalking", a method employed to catch females of species non-aggressive to man, and males. Mosquito imagines were also collected at places where these insects rest during the day. In January 2001, mosquitoes wintering in the manor cellars and in other buildings were caught, too. Moreover, larvae were collected in the bodies of water within NPN. The total material comprised over 450 females captured by human bait (22 samples) and nearly 210 specimens collected by other methods. The material is rather scarce due to low abundance of mosquitoes in the field – the mean sample was ca 50 individuals per 30' in June and ca 35 individuals/sample in July. The samples taken during the next months were very small (2–10 individuals per sample). The material was worked out using the taxonomic division of Culicidae after REINERT (2000).

RESULTS

A total of 21 mosquito species was recorded at the study sites (Table). This number corresponds to about 44.7% of the mosquito species in Poland (or to ca 58% in comparison with the number of species recorded in lowland Poland only).

Table. Mosquito species caught in the Narew National Park, their abundance and ecological characteristics. Abundance: +++ very abundant in the field, ++ abundant, + not abundant, (I) – recorded only inside buildings. Ecological characteristics (based on literature date): larvae developing in bodies of water: P – in different habitats, W – in forests, O – in open areas, S – in a specific habitat. i.e. peat bog; CP – common, known as a plague species; CA – common, often very abundant, CN – common, usually not abundant, FA – frequently recorded, often abundant, FN – frequently recorded, usually not abundant, RR – rarely recorded. The species are given according to the new classification of REINERT (2000).

No	Species	Abundance in Narew National Park	Ecological characteristics	
			Habitat requirements	Type of occurrence in Poland
	Anophelini			
1.	*Anopheles (An.) maculipennis* MEIGEN, 1818	+++(I)	O	CA
	Aedini			
2.	*Aedes (Aedes) cinereus* MEIGEN, 1818	+++	P	CP
3.	*Ae. (Aedimorphus) vexans* (MEIGEN, 1830)	+	O	CP
4.	*Ochlerotatus (Ochlerotatus) annulipes* (MEIGEN, 1830)	++	P	CA
5.	*Oc. (Och.) cantans* (MEIGEN, 1818)	++	W	CA
6.	*Oc. (Och.) cataphylla* (DYAR, 1916)	+	O	CP
7.	*Oc. (Och.) communis* (DE GEER, 1776)	+	P	CP
8.	*Oc. (Och.) euedes* (H. D. K., 1913)	+	O	RR
9.	*Oc. (Och.) excrucians* (WALKER, 1856)	+	O	CN
10.	*Oc. (Och.) flavescens* (MUELLER, 1764)	+	O	FN
11.	*Oc. (Och.) intrudens* (DYAR, 1919)	+	W	FA
12.	*Oc. (Och.) leucomelas* (MEIGEN, 1804)	+	O	FA
13.	*Oc. (Och.) punctor* (KIRBY, 1837)	+	P	CP
14.	*Oc. (Och.) riparius* (DYAR & KNAB, 1907)	+	S	FN
15.	*Oc. (Och.) sticticus* (MEIGEN, 1838)	+	W	CP
16.	*Culex (Culex) pipiens* LINNAEUS, 1758	+++(I)	P	CP
17.	*Cx. (Cx.) torrentium* MARTINI, 1925	+(I)	O	RR
18.	*Cx. (Neoculex) territans* WALKER, 1856	+(I)	O	RR
19.	*Culiseta (Culiseta) alaskaensis* (LUDLOW, 1906)	+	W	FN
20.	*Cs. (Cs.) annulata* (SCHRANK, 1776)	+(I)	P	CP
21.	*Coquillettidia (Coquillettidia) richiardii* (FICALBI, 1889)	+	S	FN

A large majority of the species, i.e. 18 (86%) are those commonly (57%) or frequently (29%) recorded from lowland Poland. The remaining three (14%) are species rarely found in Poland (Table). One of these, *Ochlerotatus euedes (Ae. beklemishevi)*, was recorded from all the study areas in NPN and constituted an essential component of the mosquito community in spring. The other two species, *Cx. torrentium* and *Cx. territans*, were captured as wintering females.

A great proportion (43%) of the species recorded prefer bodies of water in open areas for their larvae to develop, whereas 28% of them had no special habitat preferences. The larvae of the latter develop in bodies of water situated either in woodland or in open areas. Only 19% of the species were those preferring bodies of water in woodland and in brushwood. Two species (nearly 10%) had very definite habitat requirements for the development of their larvae; *Oc. riparius* is a species typical of peatbogs (in NPN, it was recorded only from the "Rynki" peatbog) and

larvae of *Coquillettidia richiardii* develop in the ponds overgrown with aquatic vascular plants. The larvae attach to the aerial systems of the plants with their respiratory siphons.

In late spring and in summer, *Ae. cinereus*, *Oc. cantans* and *Oc. annulipes* were the most abundant species recorded from this area. During spring and summer, in buildings, malaria mosquitoes (*Anopheles maculipennis*) were the most numerous, whereas *Culex pipiens* clearly dominated among wintering mosquitoes. In summer, no mass occurrence of the flood species *Ae. vexans* and *Oc. sticticus* was recorded.

DISCUSSION

In nature, mosquitoes occur from early spring to autumn. In late autumn or in winter, there may still be found wintering females or wintering larvae of certain species. However, most mosquito species winter as eggs. In this form they may survive long periods (even several years) unfavourable to their development. The growing season of 2000 was such an unfavourable time. The disastrous drought, alarming even in early spring, grew progressively worse till the end of the season. Data from NPN show that during the spring of 2000, the water level in some arms of the Narew fell by over 0.5 m. The water level read from the water-level indicator on the Kurówka in May 2000 was 40 cm lower than that in May 1998. In the spring and autumn of 2000, the water level kept falling, and reached the minimum in October. Due to the drought some arms of the Narew dried up; e.g. the water-level indicator at Kruszewo read a water level below "0" from June to the end of the year. The water level in the Narew has been falling for a few years, and relatively low precipitation is one of the reasons for the state of affairs. Alas, there are no earlier data because water-level indicators were installed in the Park only in November of 1997. No doubt, the latest retention reservoir at Siemianówka is another important factor affecting the condition of the habitat of the Narew valley. Such hydro-technical structures exert a particularly strong, multiple, permanent and, ultimately, destructive impact on the natural habitat of river valleys (WIŚNIEWSKI 1998a), and uniformization of originally diverse terrestrial and aquatic habitats is one of the signs of that (WIŚNIEWSKI 1998b). Due to the fact that the water level in the river keeps falling and the amplitude of the water-level fluctuations definitely decreases many low-current river beds become overgrown. Marsh ecosystems, very valuable naturalistically and typical of this area, which are periodically partly or completely inundated and which provide habitats for the development of many mosquito species gradually disappear.

Species fairly rare in Poland but recorded from NPN included *Ochlerotatus euedes (Ae. beklemishevi)*, *Cx. torrentium* and *Cx. territans*. The first of these had previously been recorded only from the vicinity of Warsaw and from Kampinos National Park near Warsaw (WEGNER in prep.). In Europe, this species has been recorded only from Finland, Lithuania and the European part of the former Soviet Union (SNOW & RAMSDALE 1999). The other two, *Cx. torrentium* and *Cx. territans*, do not attack people and generally are recorded to be not abundant. *Cx. torrentium* is a species closely related to *Cx. pipiens* L., its larvae develop in the same habitats: in small ponds, puddles,

ditches, artificial containers (SERVICE 1968) but also, unlike *Cx. pipiens*, in tree holes (ONEYKA 1980 after BRADSHAW & HOLZAPFEL 1992). *Cx. torrentium* attacks mainly birds while *Cx. territans* prefers amphibians.

The present study was a preliminary research, and conducted in a season unfavourable to mosquitoes. Officers and foresters of Narew National Park say that the numbers of mosquitoes in 2000 were unusually low.Therefore the 21 species recorded in NPN are indicative of great wealth of the culicid fauna there, which in turn is evidence of huge diversity of wet habitats. For the sake of comparison, during repeated studies in Białowieża primeval forest (on both sides of the Polish-Belarussian border) 29 species were recorded (SKIERSKA 1960; WEGNER 1999), and in the Mazovian Lowlands seven researchers recorded 37 species in the span of 60 years (WEGNER 1982, WEGNER in prep.). On this basis, one may hypothesize that at least a few more mosquito species occur in NPN; the most probable ones are those recorded both from Białowieża primeval forest and from the Mazovian Lowlands, namely *Anopheles claviger, An. plumbeus, Ochlerotatus geniculatus, Oc. diantaeus, Oc. cyprius, Oc. dorsalis, Culiseta morsitans, Cs. ochroptera* and *Cs. fumipennis*. Since *An. plumbeus* and *Oc. geniculatus* are tree-hole mosquitoes whose larvae develop in water-filled holes in deciduous trees, these two species might be expected to live in old tree stands, e.g. in the manor park at Kurowo. However, neither was recorded there because the summer drought had ruled out formation of their breeding places. DAHL & BLACKMORE (2001), while analysing factors limiting the occurrence of *Oc. geniculatus*, have stated that "drought is probably a greater threat in central Europe than habitat loss". No doubt, it was due to the drought of 2000 that high numbers of the summer plague species *Ae. vexans* and *Oc. sticticus* were not recorded.

Moreover, the development of the above-mentioned species of the genus *Culiseta*, which winter as larvae, largely depends on the temperature and hydrological conditions during autumn and winter. These species will probably be recorded from NPN during years more favourable to mosquitoes.

The species recorded from NPN included nine of ten, known from Central Europe, potentially effective vectors of parasitic diseases (malaria) and viral diseases both in man and animals (SIN, WNV, TAH, INK) or only in animals (BAT, SSH, LED) (WEGNER 2000); half of them occur in high numbers. Since they can produce many generations during one season they are known to breed, under favourable conditions, into plague numbers. *An. maculipennis* is a well-known vector of malaria, *Cx. pipiens, Ae. cinereus, Oc. cantans, Oc. punctor, Oc. sticticus, Ae. vexans, Culiseta annulata and Coquillettidia richiardii* are competent vectors of arboviruses. The first four species belong to the most abundant mosquitoes in this area.

The character of the landscape radically influences the species composition of the culicid fauna. At the same time, basing on the species composition of mosquito communities, one may characterize the landscape (DĄBROWSKA-PROT 1979). According to this thesis mosquitoes are perfect indicators of the degree of environment transformation in large areas, especially when water relations change. The phenomenon of varying parameters of a mosquito community concomitant with habitat modification due to progressing drainage has been being observed in

Kampinos Forest for 60 years (DĄBROWSKA & TARWID 1954, WEGNER 1979, 1998). It would therefore be greatly desirable to monitor the parameters of mosquito communities developing in the Narew valley, an area which has only recently been subjected to a radical alteration to the water regime. It seems that qualitative changes in the communities are still relatively insignificant, and this probably suggests that the modification of the habitats in the valley is reversible. However, this can only be proved by further investigations.

CONCLUSIONS

1. The great specific richness of the culicid fauna recorded from the study area reflects the very great diversity of wet habitats in the Narew valley.
2. This also proves that the natural character of the wet habitats of the Narew valley has largely been preserved. The species recorded in NPN are indicative of great wealth of the culicid fauna there, which in turn is evidence of huge diversity of wet habitats.
3. Studies of the mosquitoes of NPN merit continuation.
4. Nine species of ten in Central Europe are considered to be potentially effective vectors of human and animal diseases; half of them occur in high numbers. Therefore these insects may have a considerable impact on the health of wild animals (especially of birds), on that of people living near the Park and tourists.

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STRESZCZENIE

[Tytuł: Wstępne badania komarów (*Diptera: Culicidae*) Narwiańskiego Parku Narodowego]

Badania nad fauną komarów Narwiańskiego Parku Narodowego prowadzono w okresie późnej wiosny, lata i jesieni roku 2000 w ramach opracowywania planu ochrony NPN. Materiał zbierano w dwóch projektowanych rezerwatach: „Grobla pod Kurowem" i „Rynki", w parku otaczającym pałac w Kurowie, gdzie mieści się siedziba dyrekcji NPN oraz w piwnicach pałacowych i innych zabudowaniach na terenie parku. W zbiornikach wodnych w okresie jesieni łowiono też larwy. Stwierdzono występowanie 21 gatunków komarów. Liczba ta stanowi około 45% gatunków znanych z terenu naszego kraju lub ok. 57% gatunków notowanych na Niżu Polski (Tabela).

Większość gatunków – 18 (86%) są to gatunki pospolicie (57%) lub często (29%) spotykane na niżu Polski. Pozostałe trzy, stanowiące 14%, należą do rzadziej u nas spotykanych – *Ochlerotatus euedes* (*Ae. beklemishevi*) w Polsce notowany był dotychczas tylko w okolicach Warszawy i w Puszczy Kampinoskiej. W Europie wykazywany był tylko z Finlandii, Litwy i europejskiej części byłego ZSRR. Na terenie NPN spotykany był na wszystkich stanowiskach i stanowił istotny składnik zespołu komarów wiosennych. Pozostałe dwa gatunki – *Cx. torrentium* i *Cx. territans* – zostały złowione jako zimujące samice. Nie atakują one ludzi (pierwszy atakuje głównie ptaki, drugi preferuje płazy) i zazwyczaj notowane bywają w niewielkich liczebnościach.

Analiza preferencji siedliskowych larw występujących tu gatunków wykazała, że duży ich odsetek (43%) preferuje zbiorniki wodne położone w terenach otwartych, a tylko 19% gatunków wybiera zbiorniki położone w lasach i zaroślach. 28% gatunków nie ma szczególnych preferencji w odniesieniu do środowiska i ich larwy rozwijają się w zbiornikach zarówno leśnych jak i zlokalizowanych w terenach otwartych, czy przejściowych. Dwa gatunki narwiańskie mają bardzo określone wymagania siedliskowe dotyczące miejsca rozwoju larw – *Oc. riparius* jest gatunkiem typowym dla torfowisk (w NPN notowany był tylko na torfowisku „Rynki"), a larwy *Coquillettidia*

richiardii rozwijają się w zbiornikach zarośniętych wodną roślinnością naczyniową. Podłączają się one syfonami oddechowymi do systemu powietrznego tych roślin.

W okresie późnej wiosny i lata najliczniej na tym terenie występowały: *Ae. cinereus, Oc. cantans i Oc. annulipes.* Wiosną i latem w pomieszczeniach najliczniejsze były widliszki malaryczne (*Anopheles maculipennis*), a wśród komarów zimujących zdecydowanie przeważał *Culex pipiens.* W okresie lata nie obserwowano masowego wystąpienia letnich gatunków plagowych: komara rennego – *Ae. vexans* i *Oc. sticticus.*

Wśród gatunków stwierdzonych na terenie NPN występuje 9 gatunków, zaliczanych do dziesięciu występujących w Polsce potencjalnie najskuteczniejszych wektorów chorób ludzi: *An. maculipennis* (przenosi zarodźca malarii) oraz *Cx. pipiens, Ae. cinereus, Oc. cantans, Oc. punctor, Oc. sticticus, Ae. vexans, Culiseta annulata* oraz *Coquillettidia richiardii* (w naszym klimacie przenoszą wirusy patogenne dla ludzi: Tahyna, Sindbis, West Nile). Cztery pierwsze gatunki komarów należą do najliczniej na tym terenie występujących.

Charakter krajobrazu w sposób zasadniczy wpływa na skład gatunkowy fauny *Culicidae*, a poprzez skład gatunkowy zespołów komarów można charakteryzować krajobraz. Zgodnie z tą tezą komary nadają się doskonale do oceny stopnia przekształcenia środowiska na dużych obszarach zwłaszcza przy zmieniających się stosunkach wodnych. Zatem ze wszech miar pożądane byłoby monitorowanie parametrów zespołów komarów formujących się na terenie Doliny Narwi, która dopiero od niedawna podlega istotnej zmianie reżymu wodnego. Wydaje się, że zmiany jakościowe w tych zespołach są stosunkowo jeszcze nieznaczne, co mogłoby sugerować, że odkształcenie środowiska doliny jest odwracalne. Jednakże konieczne są dalsze badania aby to udokumentować.