Mosquito fauna (Diptera: Culicidae) of five different towns in Poland with special reference to the occurrence of human disease vectors

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Abstract: The mosquito fauna has been studied in five Polish towns: Szczecin (31 species recorded), Świnoujście (23), Gdańsk (26), Warsaw (36) and Wrocław (18). In all five towns 38 mosquito species have been recorded. Thirteen species were present in each of the study towns - Anopheles maculipennis s.l., Aedes cinereus, Ae. vexans, Culex pipiens, Culiseta annulata, Ochlerotatus annulipes, Oc. cantans, Oc. caspius, Oc. cataphyllus, Oc. communis, Oc. dorsalis, Oc. flavescens and Oc. leucomelas. Eight species were recorded in four towns: Anopheles claviger, Coquillettidia richiardii, Culiseta morsitans, Culex torrentium, Ochlerotatus excrucians, Oc. geniculatus, Oc. punctor and Oc. sticticus. The results are coincident with observations from several other European towns of Russia, Czech Republic and Hungary. Species typical of Polish towns occur commonly in comparative European towns. All of the competent mosquito vectors of human diseases known in Poland were registered in urban fauna (34.2% species recorded) - most of them occurred numerously. It must be a factor, which increases the epidemiological hazard of mosquito-borne diseases in towns.

Key words: mosquito, Culicidae, Poland, human disease vectors, urban fauna

INTRODUCTION

The development of urban entomology and pest management is closely related to the growth of urban centres and the hazards of the introduction of exotic pests as well as human pathogens. World urbanization grows at an alarming rate, an estimated 56.5% of the world population will be living in urban centres by 2010, the fastest growth occurring in developing countries (Robinson, 1996). In Europe the process is more advanced. Polish urban population grew from 31.8% in 1946 to 61.8% in 2002. The growth regards primarily great and medium Polish towns. In Western Europe the urbanization is even more distinct, since it started earlier. By 1900 the urban population of Germany had reached 56% and France – 41%. According to the prognoses, in 2010 greater than 80% of the residents of these countries will live in urban areas (Robinson, 1996). In Great Britain 89% of the population already lived in towns in 2005 (GB info). Thus there is a real need to learn more about mosquito species, which can develop in different urban biotopes, and especially those, which are vectors of human diseases. This will assume greater importance as global warming raises the epidemic hazard of emerging and re-emerging diseases – such as malaria, dengue, West Nile fever and Chikungunya (Ramsdale & Snow 2000; Reiter 2001). During the last decade several outbreaks of mosquito-borne diseases in European and American towns were observed (Hubalek & Halouzka 2000; CDC, 2007). It has been discovered that the epidemiological hazard is higher in towns than in rural areas. Smith et al. (2004) pointed out that the reason is the presence of a great number of people i.e. crowding of the mosquito vector’s hosts. But the prerequisite for transmission of a pathogen is a presence of efficient vector species.
The aim of the study was to show the prevalence of vector species in the urban mosquito fauna as well as the species richness of the fauna in general.

In Poland 49 mosquito species have been recorded so far. Thirteen of them are known to be competent vectors of human diseases, namely: Anopheles maculipennis s.l (An. messeeae and An. atroparvus) and An. claviger (malaria parasite), as well as Aedes cinereus, Ae. vexans, Coquillettidina richardi, Culex pipiens, Cx. modestus, Culiseta annulata, Ochlerotatus cantans, Oc. caspius, Oc. dorsalis, Oc. sticticus (arboviruses – Tahyna, Sindbis, West Nile, etc). These are species common in Europe, and most of them tend to occur in mass numbers. Mosquitoes cause serious problems in many towns situated in the seaside regions or in the lowland river valleys.

MATERIAL AND METHODS

The mosquito fauna has been examined by different studies in five Polish towns: Szczecin, Świnoujście, Gdańsk, Warsaw and Wroclaw. Świnoujście and Gdańsk are seaside towns. Świnoujście occurs right at the open sea and Gdańsk at the Gdańsk Bay. Szczecin lays at the lower Oder River close to its mouth into Szczecin Bay (Oder estuary). Warsaw and Wroclaw lie inland in the lowland areas upon the greatest Polish rivers – Vistula and Oder, respectively (see Fig. 1).

The mosquito fauna of Szczecin was studied in 1949 and again in 1976–1977 (Lachmajer, 1949; 1954; Skierska et al., 1982) whilst the mosquitoes of Świnoujście – three times – the first time by Lachmajer (1949, 1954), then Łukasiak (1967) studied an outbreak of mosquitoes in August 1965. Last studies were carried out in Świnoujście port area in 1978 and 1979 (Burkiewicz & Grablis, 1981). There is also a record from Świnoujście given by Peus (1929) who studied Culicidae of the region in 1920-s.

The mosquitoes of Gdańsk were studied several times from 1910s up to the present (Martini, 1920; Skierska & Lachmajer, 1960; Kubica-Biemat et al., 2007). The mosquito fauna of Warsaw has been examined as often and thoroughly as that of Gdańsk. At first only malaria mosquitoes were studied (Tarwid 1938). In the 1950s and 1960s Łukasiak (1956, 1965) examined the whole mosquito fauna of Warsaw very thoroughly then in the 1970s Wegner (1982) studied Culicidae fauna in different habitats typical of urban areas. In the period 2001–2005 a study was carried out at Wilanów – the southern district of Warsaw (Wegner, unpubl.). Material is still occasionally collected.

The material collected in all of the towns mentioned above comprises both larval stages and adult mosquitoes captured in different natural habitats as well stables, sheds, cellars etc. Also specific studies concerning sibling species of Anopheles maculipennis group were carried out and the data of the occurrence of An. messeeae and An. atroparvus are available for these four towns. Another situation can be observed in Wroclaw. The study of mosquitoes of Wroclaw (1998–2000) started after the flood in 1997 and it has been carried out along with the monitoring of larval breeding sites (Rydzanicz & Lonc, 2003). It focused on the problem of species which cause nuisance, and was supplemented by the author’s occasional search for adult mosquitoes conducted during several visits to Wroclaw (Wegner, 2007). There is no material from stables and sheds (except for only one cellar) as well as no data regarding species of the Anopheles maculipennis group.

The town seems to provide differentiated and very favourable conditions for mosquitoes since Wroclaw lies upon five rivers, which tend to overflow every year, and the area is rich in seminatural wet habitats. In addition the climate is very mild in the region of Lower Silesia, of which Wroclaw is the capital.

The analysis has been made on the basis of data from the aforementioned literature.
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RESULTS

In the five study towns 38 mosquito species have been recorded: in Szczecin – 31 species, in Świnoujście – 23 species, in Gdańsk – 26 species, in Warsaw – 36 species and in Wrocław – 18 species (Table 1). There are three species, which cannot be distinguished from other similar species on the basis of characters of larva or adult females and therefore in routine faunal studies they had not been registered separately from other species of the group: i.e. \textit{Anopheles messeae} and \textit{An. atroparvus} were most often considered as \textit{An. maculipennis} s.l. and \textit{Aedes rossicus} was considered together with \textit{Ae. cinereus}. Thus for some sites there is a lack of data – marked in the table with question mark.

Thirteen species were recorded in all five study towns – the malaria mosquito \textit{Anopheles maculipennis} s.l., both synanthropic species known in Poland (\textit{Culex pipiens} and \textit{Culiseta annulata}), three common temperate region snow-melt species (\textit{Ochlerotatus communis}, \textit{Oc. cataphylla} and \textit{Oc. leucomelas}), two flood-water species (\textit{Aedes vexans} and \textit{Ae. cinereus}), as well as \textit{Oc. cantans}, \textit{Oc. annulipes} and \textit{Oc. flavescens}. Also termophilous \textit{Oc. caspius} and \textit{Oc. dorsalis} have been recorded in all of the towns. Eight species have been recorded in four towns. Only three of them have not been recorded in Świnoujście – \textit{Coquillettidia richardi}, \textit{Ochlerotatus
Table I. Check list of mosquito species recorded in five Polish towns: Szczecin, Świnoujście, Gdańsk, Warsaw and Wroclaw. Vector species bold and underlined. The members of the Maculipennis group can be distinguished from other species of the group exclusively on a basis of the characteristics of eggs and therefore often were recorded as a complex of species: i.e. Anopheles messeae and An. atroparvus are considered as An. maculipennis s.l. in Wroclaw eggs of anophelines have never been examined and there is a lack of data. Aedes rossicus was often recorded as Aedes cinereus. Thus for some sites there is a lack of data – in the table marked with question mark.

<table>
<thead>
<tr>
<th>No</th>
<th>Species</th>
<th>Szczecin</th>
<th>Świnoujście</th>
<th>Gdańsk</th>
<th>Warsaw</th>
<th>Wroclaw</th>
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<tr>
<td>1</td>
<td>Aedes (Aedes) cinereus Meigen, 1818</td>
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<td>2</td>
<td>Aedes (Aedes) rossicus Dolbeskin, Gorickaja &amp; Mitrofanova, 1930</td>
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<td>3</td>
<td>Oc. (Ochlerotatus) geniculatus (Olivier, 1791)</td>
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<td>4</td>
<td>Oc. (Ochlerotatus) annulipes (Meigen, 1830)</td>
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<td>5</td>
<td>Oc. (Och.) cantans (Meigen, 1818)</td>
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<td>6</td>
<td>Oc. (Och.) capitus (Pallas, 1771)</td>
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<td>7</td>
<td>Oc. (Och.) exustus (Dyar, 1919)</td>
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<td>8</td>
<td>Oc. (Och.) leucocda (Meigen, 1804)</td>
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<td>9</td>
<td>Oc. (Och.) nigripes (Eckstein, 1918)</td>
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<td>10</td>
<td>Oc. (Och.) punctatus (Kirby, 1837)</td>
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<td>11</td>
<td>Oc. (Och.) riparius (Dyar &amp; Knab, 1907)</td>
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<td>12</td>
<td>Oc. (Och.) sticticus (Meigen, 1838)</td>
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<td>13</td>
<td>Oc. (Rusticoidus) rusticus (Rossi, 1790)</td>
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<td>14</td>
<td>Anopheles (Anopheles) claviger (Meigen, 1804)</td>
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<td>15</td>
<td>An. (Ano.) maculipennis s.l. Meigen, 1818</td>
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<td>16</td>
<td>An. (Ano.) atroparvus van Thiel, 1927</td>
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<td>17</td>
<td>An. (Ano.) messeae Falleroni, 1926</td>
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<td>18</td>
<td>An.(Ano) plumbeus Stephens, 1828</td>
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<td>19</td>
<td>Coquillettia (Coquillettia) richardii (Ficalbi, 1889)</td>
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<td>20</td>
<td>Culiseta (Culiseta) alaskanensis (Ludlow, 1906)</td>
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<td>21</td>
<td>Culiseta (Culiseta) ochroptera (Peus, 1935)</td>
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Number of species | 31 | 23 | 26 | 36 | 18 | (37)
Mosquito fauna (Diptera: Culicidae) of five towns in Poland

geniculatus and Oc. sticticus. Four other species were not recorded in Wroclaw (Anopheles claviger, Ochlerotatus punctor, Culex torrentium and Culiseta morsitans) and one species in Gdansk (Ochlerotatus exerucians). Seven species have been met in only one of the study towns: Oc. detritus in Szczecin and six species in Warsaw – Anopheles plumbeus, Ochlerotatus rusticus, Oc. eueudes, Culex modestus, Culiseta ochroptera and Cs. subochrea (Table 1). Five of the species were collected last time in suburbs of Warsaw (Wegner, unpubl.), the sixth one was recorded almost fifty years ago by Łukasiak (1965), also in suburbs.

All of the species which can transmit human diseases recorded in Poland have been registered in study towns (they make 34.2% of all species registered in towns). An. maculipennis (An. meseae and An. atroparvus) and An. claviger – are vectors of the malaria parasite, while Cx. modestus, Cx pipiens, Cs. annulata, Ae. vexans, Ae. cinereus, Oc. cantans, Oc. caspius, Oc. dorsalis, Oc. sticticus, and Cs. richiardii – of arboviruses. Eight of these species (21% of all species registered in towns) occurred in all of the study towns, three species (Oc. sticticus, An. claviger and Cq. richiardii) – in four towns and Cx. modestus has been registered in Warsaw only.

**DISCUSSION AND CONCLUSIONS**

The seven species found only in one of the study towns: Oc. detritus in Szczecin and six species of Warsaw – An. plumbeus, Oc. eueudes, Oc. rusticus, Cx. modestus, Cs. ochroptera and Cs. subochrea need commentary. The occurrence of Oc. detritus in Szczecin seems quite natural – the species needs brackish water for its larvae to develop, which is present in Szczecin’s Bay (the water of Oder estuary is slightly brackish). Moreover it seems that Oc. detritus is at the edge of its range in western Poland since it had not been found east of the Oder estuary despite the fact that it has been specially looked for along the Baltic coast (Skierska, 1974). Most of the remaining species have not been recorded in the town earlier – the possible reason is: the first species needs tree-holes, but lately it has adapted to use artificial containers as breeding sites (Schaffner, 2003) and became more common in anthropogenic habitats. Ochlerotatus rusticus, Oc. eueudes, Culex modestus and Culiseta ochroptera were lately recorded in suburbs, in the seminatural habitats of Warsaw. However, the presence of Cs. subochrea needs verification. The presence in Warsaw’s fauna of Culex modestus – the bridge vector which is a competent transmitter of West Nile virus – may have important epidemic consequences.

Szczecin’s fauna shows characteristics of both inland and seaside mosquito fauna. Expected additions to its faunal list especially in suburbs are: Anopheles plumbeus, Ochlerotatus rusticus, Oc. eueudes, Culiseta alaskaensis and Culex modestus.

The list of mosquito species recorded in Gdansk and Warsaw seems to be almost complete – in these towns faunal studies have been periodically repeated for nearly 100 years. One could expect two or three more species there. In Gdansk it could be Anopheles plumbeus, Ochlerotatus exerucians and Culex modestus. Warsaw’s fauna seems to be complete, only Cs. ochroptera, which was recorded by Łukasiak (1965) only once almost fifty years ago, now could be extinct in those areas due to the transformation of the environment of the town under urban pressure. Thus, its presence in urban environment needs verification. In remaining towns the species has not been recorded. On the other hand, there are more and more seminatural areas covered with a programme of nature protection in Polish towns. Some of them are favourable for different mosquito species. They may enrich the urban fauna with the species typical of wetlands.

The faunal list of mosquito species of Świnoujście seems to be incomplete although the study in the town has been carried out three times. Future faunal study should show the occurrence at least of Coquillettidia richiardii, Culex modestus and Ochlerotatus detritus there (all of the species were recorded in Wolin and Uznam Islands where Świnoujście is situated.
Ochlerotatus sticticus in very small numbers occurs in the islands, but as a species found typical in great lowland river valleys, it would be unusual to find it in Świnoujście, unless a flood occurs. Another situation can be observed as regards the tree-hole mosquito Ochlerotatus geniculatus. The species has not been recorded either in Świnoujście or in the region’s islands. This phenomenon needs explanation since it seems that the region provides favourable habitat conditions for the species.

Wrocław seems to be as rich in habitats favourable to mosquitoes as Szczecin, but its mosquito fauna at the moment seems the poorest one of the five studied. The team for the monitoring of larval stages in the pools of Wrocław recorded only eight of the most common species: Anopheles maculipennis, Aedes vexans, Culex pipiens, Culiseta annulata, Ochlerotatus cantans, Oc. communis, Oc. excrucians and Oc. sticticus (Rydzanicz & Lonc, 2003). The study of adult mosquitoes conducted during 5 visits in Wrocław confirmed the presence of seven species of the eight known before and showed 10 more species (Wegner, 2007). Thus mosquito fauna of Wrocław must be rich and differentiated and any future study of fauna should show at least 10 more mosquito species in the town.

In a bibliography there are several papers dealing with the urban mosquito fauna of European towns of Russia: Leningrad = Petersburg (Fedorov, 1983), Moscow (Gornostaev & Danilov, 1999), Volgograd (Fyodorova et al., 2006); of Czech Republic – Prague (Ryba & Rettich, 1999), and Szeged in Hungary (Szepesszentgyörgyi & Rentsendorj, 2006). The number of species recorded there is comparable with Polish observations: i.e. 24 mosquito species in Moscow, 26 species in Petersburg, 21 species in Prague, 20 species in Volgograd and 17 species in Szeged. Most of the Polish typical urban species have been recorded in all of the study European towns: Aedes cinereus, Ae. vexans, Anopheles maculipennis s.l., Culex pipiens, Culiseta annulata and Ochlerotatus flavescens or in most of them: An. claviger, Oc. cantans, Oc. dorsalis, Oc. excrucians, Oc. sticticus and Coquillettidia richardi. Several species typical for a colder climate commonly occur in Polish towns as well as in Moscow, Petersburg and Prague: Oc. cataphylla, Oc. communis, Oc. punctor, Cs. morsitans and Cs. alaskaensis while termophilous Oc. caspius and Cx. modestus are numerous in Southern towns (Volgograd and Szeged). Thus, urban species typical of Northern and Southern Europe are found in the towns of Poland and at the same time most of them are competent vectors of human diseases.

During the last decade Wroclaw and Gdańsk were subjected to flooding – Wroclaw in 1997 and Gdańsk in 2001. In Gdańsk the mosquito fauna was studied just before flooding and it was observed that after the disaster the density of Cx. pipiens grew greatly and its percentage rose from 23.8% (prior to 2001) reaching more than 97% of all mosquitoes occurring in the town (Kubicza-Bień et al. 2007). Moreover, the situation lasted for some time after the flood, although the percentage of Cx. pipiens gradually decreased (76.5% in 2002). Also in Wroclaw Cx. pipiens heavily predominated in the urban habitats subjected to inundation in 1997. The phenomenon could have epidemic consequences since the species is a competent vector of West Nile Virus and other arboviruses. It has been incriminated as the main WNV vector in the outbreaks of WNE in Romania (Bucarest), Russia (Volgograd) and America. In Poland WN fever is not distinguished, but epidemic statistics show 3–5 fold increase of the frequency of aseptic meningitis in the areas flooded in 1997 and 2001, which is correlated with plague occurrence of Cx pipiens (Wegner, 2004). Vector competence for West Nile virus of six more species typical of urban fauna (Aedes cinereus, Ae. vexans, Ochlerotatus cantans, Oc. caspius, Oc. dorsalis, Oc. sticticus, Coquillettidia richardi) has also been proved.

There is a high percentage of competent vectors of human diseases in urban fauna (34.2% of all species registered in towns) and most of them occur regularly as an element of the fauna. Also considering that they occur numerous must altogether certainly be an important factor.
affecting the circulation of human pathogens in urban environment, and must also increase the epidemiological hazard of mosquito-borne diseases in towns. The knowledge of the species composition of mosquito fauna would be very helpful in estimating this hazard in different urban agglomerations.

REFERENCES


Streszczenie

[Fauna komarów (Diptera: Culicidae) pięciu miast Polski ze szczególnym uwzględnieniem występowania w miastach gatunków będących wektorami chorób ludzi]

W pięciu miastach Polski zarejestrowano 38 gatunków komarów (Diptera: Culicidae): w Szczecinie – 31 gatunków, w Świnoujściu – 23, w Gdańsku – 26, w Warszawie – 36 i we Wrocławiu – 18 gatunków. We wszystkich pięciu miastach występuje 13 z nich: Anopheles maculipennis s.l., Aedes vexans, Ae. cinereus, Culex pipiens, Culiseta annulata, Ochlerotatus communis, Oc. cataphylla, Oc. leucomelas, Oc. cantans, Oc. anulipes, Oc. flavescens, Oc. caspius i Oc. dorsalis. W 4 miastach stwierdzono: An. claviger, Coquillettidia richiardii, Oc. geniculatus, Oc. excrucians, Oc. sticticus, Oc. punctor, Cs. morsitans and Cx. torrentium. Wszystkie gatunki komarów będące skutecznymi wektorami chorób ludzi występujące w Polsce zanotowane były w miastach (stanowiły 34,2% fauny miast, przy czym większość z nich występuje w dużych liczebnościach). Jest to z pewnością czynnik istotnie zwiększający ryzyko zachorowania na choroby transmisjne przenoszone przez komary w miastach w porównaniu do terenów poza miastami.

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