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Mosquito control in Poland: pro- and anti-environmental activities

Zwalczanie komarów w Polsce: działania pro- i antyśrodowiskowe

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Keywords: mosquitoes, epidemiological threats, nuisance, biocides, mosquito control**Słowa kluczowe:** komary, zagrożenia epidemiczne, uciążliwość, preparaty biobójcze, zwalczanie komarów**Abstract**

Mosquito control in Poland is still dominated by the use of chemicals. Although it has been 13 years since the flood of the century, only in few cities and towns (Wrocław, Gorzów Wielkopolski and Toruń) various methods of mosquito control such as mapping of larvae development and setting time limits for the imagines occurrence were developed. The problem of mosquito control is not only limited to adult insects, it is also much more a complex issue due to the use of insecticides in the environment that we would rather like to keep unchanged, with a diversity of co-existing species of plants and animals. In addition to eradication of larvae and adult insects, we should also: carry out actions modifying environment so that it becomes less friendly to mosquitoes (e.g. drying wet meadows as a result of land reclamation), protect places where people reside – with the use of insecticide lamps and spatial repellents, as well as catchers for aggressive female mosquitoes. Increasing the share of environmental management methods and public education on preventing to form and eliminating existing places of mosquito larvae development in urban green areas (parks, river overflow areas and drainage ditches) are still an undervalued element of integrated mosquito control in Poland.

Streszczenie

W Polsce w zwalczaniu komarów nadal dominuje zastosowanie preparatów chemicznych. Mimo, iż minęło 13 lat od powodzi stulecia, tylko w kilku miejscowościach (Wrocław, Gorzów Wielkopolski, Toruń) opracowano sposoby zwalczania komarów wykorzystujące kompleksowe działania: mapowanie miejsc rozwoju larw, określenie terminów występowania imagines, zastosowanie różnorodnych metod eliminacji. Zagadnienie zwalczania komarów nie sprowadza się tylko do zwalczania form dorosłych, jest problemem bardziej złożonym ze względu na stosowanie preparatów owadobójczych w środowisku, które chcielibyśmy zachować w postaci jak najmniej zmienionej, z zachowaniem różnorodności współwystępujących w nim gatunków roślin i zwierząt. Należy się także liczyć z tym, że oprócz zwalczania larw oraz owadów dorosłych potrzebne są działania, które sprawią, że środowisko stanie się mniej przyjazne dla komarów (np. osuszanie podmokłych łąk w wyniku melioracji), ochrona miejsc przebywania ludzi – zastosowanie lamp owadobójczych i repelentów przestrzennych, a także pułapek wylapujących agresywne samice komarów. Zwiększenie udziału metod z zakresu zarządzania środowiskowego oraz edukacja społeczeństwa w zakresie zapobiegania powstawania i eliminacji już istniejących miejsc rozwoju larw komarów na terenach zieleni miejskiej (parki, rozlewniska rzek, rowy melioracyjne) stanowią w Polsce nadal niedoceniany element integrowanego zwalczania tych owadów.

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1. INTRODUCTION

Many species of mosquitoes are known for the role that they play in life cycles of certain microorganisms, which are pathogenic to humans. These organisms go through full life cycle in the body of a mosquito (mosquitoes are then active vectors) or may simply be mechanically transferred from one host to another during blood collection.

2. MOSQUITO CONTROL IN POLAND – ELIMINATION OF EPIDEMIC THREATS

In the first years following the end of World War II, the outbreaks of malaria, tularaemia and encephalitis occurred in Poland mainly on the Baltic coast. The role of mosquitoes played as transmitters of the pathogens of two former diseases was widely documented.

As endemic outbreaks of diseases transferred by mosquitoes and insects causing their spreading existed, it was pointed out that mosquitoes in these areas should be controlled. The range of actions leading to limiting and eliminating cases of malaria and other diseases transmitted by arthropods was wide. The most important actions were: identifying outbreaks of malaria and other threats, in which mosquitoes could play a role; identifying existing species of these animals and dwelling places of adult insects and larvae; identifying areas where people were most exposed to mosquito bites; selecting places and methods for mosquito control; carrying out mosquito control actions and assessing the effectiveness of control programs.

Such a complex operation was performed extensively in tourist resorts and the surrounding areas, located on the Baltic coast,

considering that a combination of factors such as: plague of mosquitoes in endemic foci of malaria, tularaemia, encephalitis and a large movement of population can increase the risk of epidemic. Since the late 1940s, mosquito fauna of the spas in the west coast of the Baltic Sea has been extensively studied to determine the dominant, most vexing species and develop methods of controlling them. Several papers were devoted to species of mosquitoes found in Swinoujście [Łukasiak, 1967; Burkiewicz et al., 1981], Miedzyzdroje [Łukasiak, 1960], on the island of Wolin and Uznam [Skierska, 1974]. In 1956, on Karsibor island, control methods including environmental and mosquito fauna studies were carried out [Bosak et al., 1961]. In the following years, seven mosquito control actions were carried out in seven holiday settlements, camp fields and 16 scout camps in the coastal lane of the province of Szczecin. These actions included activities against both larvae and adult individuals. Larvae control methods included measures of prevention such as: elimination and change of place of their development in order to prevent it (irrigation, drainage, covering the surface of shallow, small tanks with layers of oily substances and using chemical insecticides). Methods of adult mosquitoes control were: scanning of vegetation, using residual insecticides in places of their resting and wintering, aerial spraying during insect's activity. Insecticides for mosquitoes control were organochlorine: DDT, gamma-HCH, dieldrin and less frequently – just entering – pyrethrins. Thanks to large-scale mosquito control actions (especially in areas where transmission diseases were present) and correlated activities of medical services, in the 1960s Poland was recognized as the country free of malaria by the World Health Organization. On the occasion, it was also noted that the use of such large-scale organochlorine insecticides, often in excessive doses, leads to degradation of biological life on the treated areas [Bojanowska, arch. material NIH].

3. CONTROL OF MOSQUITO NUISANCE IN POLAND – CONTEMPORARY PROBLEMS

In the 1970s and 1980s, mosquitoes in Poland were started to be perceived as nuisance insects rather than carriers of diseases and, therefore, large spatial action, financed from the state budget to control them, were abandoned. After a disastrous flood in 1997, on the flooded areas favourable conditions appeared for the development of aggressive anthropophilic mosquito species *Aedes vexans*. Their mass appearances were controlled by chemical adulticides. In June and July 2010, as in 1997, many

parts of the country experienced floods of different scales. In these areas in many communities at the request of their residents, control methods of nuisance mosquito species were carried out. The aerial application of chemical insecticide was done. In the example of Legionowo district, it was estimated that as a result of the operation the population of adult mosquitoes was reduced to approximately 53.8%. Since the areas of Natura 2000 and its neighbourhoods were not sprayed, insects from protected areas flew to those sprayed [Gliniewicz et al., 2011]; therefore, the method using only chemical insecticides did not appear to be effective. It brought a noticeable but short-lived effect, but it also contributed to the increase of chemicals in the environment and became a threat to biodiversity since chemical insecticides usually have a broad spectrum of action and eliminate beneficial insects as well.

In Poland, mosquito control is still dominated by the use of chemicals. Even though it has been 13 years since the flood of the century, only few cities (including Wrocław, Gorzów Wielkopolski and Toruń) have developed comprehensive measures of mosquito control. These are: mapping places of larvae development, setting time limits for the occurrence of imagines, using various methods of elimination [Terek, 2010]. Biocides used to control mosquitoes are authorized to be sold in Poland after the registration procedure at the Office for Registration of Medicinal Products, Medical Devices and Biocidal Products (URPL). Registration can take place according to the so-called European procedure, which requires reports from manufacturers/distributors of the product on environmental risk assessment, impact on non-target organisms as well as reports on effectiveness and risk assessment for humans. In the so-called "transition period" that was set by the European Commission till 31 December 2024, products entering the Polish market can also be registered according to a simplified national procedure (less expensive), in which the manufacturer/distributor of the product is required to submit a URPL reports demonstrating the efficacy of the biocidal product, but does not need to present data on the environmental risk assessment and impact on non-target organisms and humans.

Table 1 shows the biocidal products for control of mosquito larvae in Poland.

As results from the data in Table 1, products registered in Poland for mosquito larvae control primarily contain chitin synthesis inhibitors (diflubenzuron) and insect hormone analogues (methoprene and pyriproxyfen). Such formulations are relatively safe for vertebrates, but damage all insects' larvae. If they are used in natural water reservoirs, it is expected that they will cause damage to the

Table 1. Biocidal products for control of mosquito larvae in Poland

	Product	Active ingredient	Place the application (according to the label)
Non-selective larvicides (biocidal effect on the larvae of various insects)	Aedex	Methoprene	Ditches, wetlands, ponds, stagnant waters
	Aquatain AMF	Polydimethylsiloxane	Large and small water reservoirs
	Flubex Comprese	Diflubenzuron	Puddles, sewers, fountains, manholes
	Flubex Flow	Diflubenzuron	Lakes, stagnant waters, marshes, ditches and edges of canals, waste water, puddles
	Pyrilav	Piriproxyfen	Stagnant and flowing waters, natural and artificial reservoirs, rainwater reservoirs, tanks
	Radikal against larvae	Diflubenzuron	Drains, puddles, sewers, fountains, post-floods areas Do not use in natural waters
Selective larvicides (action only on the larvae of mosquitoes and black flies)	Vectobac 12 AS	<i>Bacillus thuringiensis</i> var. <i>israelensis</i>	Backwaters, roadside ditches, drainage channels, ponds, brackish water

fauna of aquatic invertebrates whose larvae develop in the same environment as the larvae of mosquitoes. The review of records of the use of these larvicides shows that only in the case of two products labels contain clauses limiting their use only to artificial and small water reservoirs. In case of Aquatain AMF, the active ingredient reduces the surface tension, which prevents air intake of mosquito larvae and nymphs, but also other aquatic insects using the same method of breathing and the surface tension of water to remain on the surface. This formulation is approved for use in "large and small water reservoirs" regardless of whether they are artificial or natural. On the other hand, Vectobac 12 AS containing the toxin of *Bacillus thuringiensis* var. *israelensis* acts selectively on the larvae of mosquitoes and black flies.

Table 2 presents the formulations registered in Poland to control adult mosquitoes in Poland.

There are a variety of means at our disposal in Poland to control adult mosquitoes, including biocides controlling flying insects. On the label, they all contain the phrase "mosquito control" (Table 2). It should, however, be taken into account that first of all these are products eliminating flying insects indoors or on the exterior walls of buildings. These formulations, with a few exceptions (e.g. Aqua-K-Othrine, Komaropren) are not intended to be sprayed over large spatial areas. No environmental or non-target organisms risk analysis has been performed for them. Out of 20 biocides for professionals to control flying insects, including mosquitoes, each one contains a warning label that they are "DANGEROUS FOR THE ENVIRONMENT" and safety data sheets tell us not to use close to waters and that they are dangerous to bees. Some of these products have been approved for use against mosquitoes and ticks out on plots and in home gardens. Such application raises, however, a question of keeping grace periods and appropriate distance from fruits and vegetables grown in gardens. Generally, grace periods do not apply for bio-

cides, because they are not designed for use on or near crops. Products used for pest control containing the same active ingredient in similar concentrations contain phrases concerning grace period for food crops on labels.

4. ORGANIZATIONAL ISSUES RELATED TO MOSQUITOES CONTROL IN POLAND

In Poland, mosquito control is the responsibility of the city council officers and municipalities staff who often perform this operation parallelly with other daily professional duties. That naturally limits the possibility of their full commitment to effective implementation and/or coordination of this process [Rydzanicz, 2010]. Technical issues related to application of insecticides are performed by pest control companies that emerge through tenders organized by city councils where the primary criterion is the low price of the service, instead of, necessary in this case, experience and availability. Unfortunately, expecting high efficiency while maintaining the lowest prices for specific activities such as mosquito control often results in using the cheapest methods and measures (mainly chemicals). Meanwhile, contemporary expectations for selection of pest control companies (except permits to use biocides) should take into account their environmental awareness and monitoring studies on the dynamics of local populations of mosquitoes. Such studies will allow them to use methods of mosquito control and biocides with a high degree of safety for people and the environment. This is particularly important if such activities are conducted in the areas of urban green areas or such areas are included in the Natura 2000 network. Moreover, in many city councils the tenders are organized too late (because of the procedures associated with the announcement of the tender and appeals on the results of tenders) or concern organizing single action leading to suppress nuisance mosquitoes in areas

Table 2. Biocidal products for control of adult mosquitoes in Poland

Product	Active ingredient	Place of application (according to the label)
Afanisep 20 WP	Permethrin	Used against mosquitoes around buildings
Alfa-Star (Alfa-Hit, Alpha-Complex) (pesticide)	Alpha-cypermethrin	Scrubs, bushes, vegetation, thuja, wetlands, ponds
Aqua K-Othrine	Deltamethrin	Open areas, house gardens, parks, gardens, squares
Aspermet 200 EC	Permethrin	Against mosquitoes outside, on plots and kitchen gardens
Cipex 10E Cipex 10E	Cypermethrin	Outer walls of buildings, foot of hedges and shrubs
Deadya Deadya	Cypermethrin	Terraces, walls of buildings, sidewalks
Deltrina 7,5 S.C.	Deltamethrin	Areas adjacent to buildings, foundations, patios, sidewalks, parking lots
Deltrina 2,5 EC	Deltamethrin	Areas adjacent to buildings, foundations, patios, sidewalks, parking lots
Duracid EC	Permethrin, PBO	Against mosquitoes outside buildings
Fendona 6 SC	Alpha-cypermethrin	Against mosquitoes and ticks outside buildings
Ficam 80 WP	Bendiocarb	Against mosquitoes outdoors
Komaron	Cypermethrin	Facades, scrubs, tall grass, thuja
Komaropren	Etofenprox	Against mosquitoes outside
Komaropren PBO	Etofenprox + PBO	Aerial spraying of large areas
Permeth 22 E	Permethrin, tetramethrin, PBO	Exterior patios, driveways, sidewalks
Tick-out set against mosquitoes and ticks	Aspermet (permethrin + adjuvant)	External surfaces
Trebon Mega 10 SC	Etofenprox	Coastal scrub
Trebon Mega 20 WP	Etofenprox	Coastal scrub

of urban green. While in some areas single actions are sufficient, in other areas that are rich in natural reservoirs where mosquito larvae develop or flooded areas, there is a need for efficient organization of large-scale larviciding operations. This is the only way to avoid nuisance mosquitoes belonging to the "post-flood" species, which can migrate a distance of about 10–20 km from breeding sites. Neglecting reasonable period of application of microbial larvicides causes the need to replace them with chemical insecticides. This, in addition to the fact that it needs to be used on vast surfaces, it also requires the right weather conditions: rainless and not very hot; chemical insecticides also operate on non-target organisms and may cause resistance of target insects. For these reasons, it is necessary for city councils to work out a fast, pro-environmental response system for sudden appearance of larvae and adult mosquitoes in mass quantities. This applies to the need to provide the adequate number of activities and people for organization and implementation of mosquito control measures in communities. And also to simplify tender procedures for selecting companies, for example, long-term contracts for companies and institutions responsible for implementation of monitoring studies and /or application of insecticides. It is also necessary to create legal and financial agreements between municipalities located in areas where mosquitoes are very troublesome and the institutions in towns and cities where mosquitoes hatch en masse (for example, military units and national forests) in terms of creating a united front against mosquitoes. Increasing

the share of methods in the field of environmental management and public education on preventing to form and eliminating existing places of development of mosquito larvae in the areas of urban green areas (parks, river overflow areas, drainage ditches) are still an undervalued element of the integrated control of those insects in Poland.

5. SUMMARY

The problem of mosquito control is not only limited to control adult insects but this is also a much more complex issue due to the use of insecticides in the environment that we would like to keep diversified, with a variety of co-existing plants and animal species. You should also acknowledge the fact that in addition to eradication of larvae and adult insects, we also need actions making the environment less friendly to mosquitoes (e.g. drying wet meadows as a result of land reclamation); we need to protect places where people reside – using insecticide lamps and spatial repellent, as well as aggressive female mosquitoes catchers. Annual organization of efficient and effective campaigns against mosquitoes in tourist areas is not only important in social dimension associated with improvement of the quality and standard of living tied with lack of negative impact on the environment but also from economic dimension in the form of profits from tourism or functioning of restaurants in spring and summer season [Rydzanicz, 2010].

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