Mosquitoes and exotic infectious diseases in Germany

Exotic mosquitoes such as the Asian rock pool mosquito (Ochlerotatus japonicus) and the Asian tiger mosquito (Aedes albopictus) are invading many countries around the world, including European ones. This is a direct result of rising temperatures and increasing international travel and transport of goods. These insects carry exotic viruses, and their arrival leads to an elevated risk of dangerous tropical infectious diseases spreading in Europe. Entomologists, virologists and tropical medicine experts are working together on a number of projects aimed at monitoring the distribution of mosquitoes across Europe and reducing the risk of disease transmission.

As temperatures in spring and summer are reaching higher levels, massive swarms of mosquitoes are making the lives of many people in the Upper Rhine area more and more uncomfortable; outdoor activities such as walking through the meadows and forests or just being out in the garden become increasingly unbearable. As long as 35 years ago, the “Kommunale Aktionsgesellschaft zur Bekämpfung der Schnakenplage e.V.” (KABS; engl.: German Mosquito Control Association - GMCA) was set up to control the spread of mosquitoes. GMCA involves 98 cities, villages and administrative districts as well as the Baden-Württemberg government represented by the Freiburg District Council.

Mosquito control in the Upper Rhine valley

GMCA is focused on the control of mosquitoes in their breeding grounds along the Rhine between the Kaiserstuhl mountain range in the south and the city of Bingen in the north. The control of mosquitoes involves the use and introduction of an agent containing endotoxins from the bacterium Bacillus thuringiensis israelensis (BTI) into water courses. The BTI-containing agent is taken up by the
mosquito larvae and activated in their intestines, which leads to their death. This has led to a 99% reduction in the number of mosquitoes in the areas treated.

GMCA’s headquarters are in Waldsee, a city part way between Ludwigshafen and Speyer. GMCA is a great deal more than just an association of communes. In cooperation with the World Health Organisation (WHO), GMCA supports global mosquito control programmes. In addition, it also carries out own research projects. Under the leadership of entomologist Dr. Norbert Becker, scientific director of GMCA, the association investigates the environmental compatibility and efficiency of control methods in the field and in the laboratory. It also focuses on the biology, distribution and transmission potential of different mosquito species in the Upper Rhine valley. Outstanding specialised knowledge is required, as sibling species, which are very difficult to differentiate from each other, frequently occur in the region.

Imported blood suckers as transmitters of disease

In cooperation with zoologists from Universität Heidelberg, where Becker is a lecturer, and the Bernhard Nocht Institute for Tropical Medicine (BNI), the list of German mosquito fauna recently became a little longer thanks to the addition of a new South Asian mosquito: Ochlerotatus japonicus – Asian rock pool mosquito – and now comprises 48 species of mosquito. However, this piece of news in itself would not have been too alarming had the virologists not identified three viruses in German mosquitoes, all of which cause serious human diseases. These viruses (Sindbis, Batai and Usutu virus) had not previously been known to cause diseases in Germany. As a result of this, the researchers therefore emphasise the importance of keeping an eye on the viruses transmitted by exotic insects and investigating in detail their medical significance for the German population.
In early 2011, the Leibniz Association announced its decision to grant funding to the interdisciplinary research project “Prevalence and vector competence of mosquitoes in Germany”. Over the last few years, experts from the GMCA and other research institutions (including the Senckenberg German Entomological Institute Müncheberg) have set up traps along the Rhine, the Elbe, the Danube and the Isar rivers as well as the Chiemsee lake and the Lake of Constance. They have so far caught and analysed around 500,000 mosquitoes. Becker reports that the results have provided them with a comprehensive overview of the prevalence of Anopheles plumbeus, a mosquito that is also known to cause malaria. Although A. plumbeus has been found in numerous rural villages in southern Germany, the GMCA and BNI researchers do not currently expect a malaria epidemic to occur due to the excellent state of medical care in Germany.

Combating the tiger mosquito
As a result of global warming and the increasing international transport of goods as well as the floods of tourists, it is to be expected that a growing number of exotic disease-transmitting mosquitoes will become endemic to Germany. A particular threat is the advance of the tiger mosquito *Aedes albopictus*, which is now found across Albania and Italy and is spreading into France and Belgium. Using specific “ovitraps”, which attract female mosquitoes to lay their eggs, GMCA researchers have already identified the eggs of the small black-and-white striped mosquito in the Rhine valley. *Aedes albopictus* is a competent vector for numerous human viral diseases. The spread of the mosquito is facilitated through the import of plants, in particular the import from China of lucky bamboo, which is a popular present.

Professor Dr. Peter Lüthy, President of the European Mosquito Control Association (EMCA), believes that it is only a matter of time before the next Chikungunya epidemic breaks out, which will hopefully be contained within a restricted geographical area. The disease, which is caused by the Chikungunya virus, is characterised by fever and joint pain that persists for weeks or months, or occasionally for several years. In the majority of cases, the disease is benign and does not cause any serious illness. Dengue fever, which is transmitted by the same mosquitoes, is far more dangerous. In severe cases, the disease leads to internal bleeding (haemorrhaging) and Dengue shock syndrome.

Although cases of Dengue fever reported in Germany are usually due to an infection occurring during a stay in malaria-endemic countries, their number is nevertheless increasing. In 2010, around 500 cases of Dengue fever were registered in Germany. “In contrast to malaria, Dengue fever has a much greater potential for distribution,” said the virologist PD Dr. Jonas Schmidt-Chanasit from the BNI explaining that malaria pathogens can spread by way of infected human hosts whereas Dengue fever is transmitted via eggs and larvae (quote from “DIE ZEIT”, 18.11.10).

Like the closely related hepatitis C virus, the Dengue virus is a single-strand RNA virus. It is not a retrovirus. The structure of its genome, its replication cycle and the expression of viral proteins are being investigated at Universität Heidelberg in the Department of Molecular Virology, directed by Prof. Ralf Bartenschlager, a leading hepatitis virus expert (see BIOPRO article “Against chronic liver inflammation and liver cancer”). In a second project, carried out in cooperation with zoologists from the Universität Heidelberg, GMCA is investigating the “thermal ecology of the Asian tiger mosquito”. These research projects are aimed at ensuring that Germany is not included on the long list of Dengue fever disease-endemic countries.
Transnational networks aiming to control mosquitoes

Since the bloodsucking vectors of infections easily cross national borders and geographical barriers, it is important to coordinate international mosquito control efforts. For this purpose, the EMCA was established in 2000 in the city of Waldsee, where GMCA is also headquartered. The EMCA follows the model of the American Mosquito Control Association, which has existed for many years. Dr. Norbert Becker is the executive director of EMCA and the driving force behind the intercontinental World Mosquito Control Association.

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