Italian town near Vicenza. Three weeks later, five of the seven members of her household also contracted dengue fever – the viruses were presumably transported by the tiger mosquitoes that are already widespread in northern Italy.

The local health authorities reacted immediately: intense pest control activities to combat mosquitoes were carried out over three days in a 200 m radius of the house and people who had run a fever anywhere in the province in the previous 30 days were tested for traces of dengue viruses. The police distributed information flyers door-to-door and donations of blood and organs in the entire province were screened for the virus. Only then could the all-clear be given: this time, the outbreak had not flared up into a major outbreak. The restrictions that were in force because of the ongoing COVID-19 pandemic possibly contributed to this outcome, along with the watchfulness of health authorities that have already been preparing for the invasion of tropical diseases with a surveillance regime designed to pick up on exotic fevers.

The author

Prof. Dr. Heinz Hänel, born in 1955, is responsible for antidiabetic drugs research and development at Sanofi-Aventis. He studied biology at Goethe University, wrote his Diplom thesis in Canberra, Australia, and gained his doctorate at the Bee Research Institute in Oberursel and in Kuala Lumpur, Malaysia. His habilitation thesis dealt with the penetration of mammalian cells by yeasts. He has been teaching at Goethe University since 1994 and he has held an honorary professorship in zoology at the Faculty of Biological Sciences since 2001. Professor Hänel also serves on the Board of Directors of the Friends and Sponsors of the University of Frankfurt and has chaired Goethe University's Alumni Council since 2008.

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»West Nile fever, hantavirus infections and leishmaniasis will soon become highly relevant diseases in Central Europe«

An interview with the scientist Sven Klimpel, a parasitology and infection biology expert

Markus Bernards: Professor Klimpel, your research is on infectious diseases spread by animals (vectors), typically ticks, mosquitoes, and small mammals like rodents or bats. And you predict that such infectious diseases will increase globally. Why?

Sven Klimpel: According to the current figures from the World Health Organization, about 20 per cent of the infectious diseases known today are vector-borne diseases (VBD). More than 50 per cent of the world's population live in areas where the risk of contracting vector-borne infectious diseases is extremely high. In Europe alone, more than 80,000 people contract such an infectious disease on average each year. The pathogens causing these diseases are not usually transmitted through direct or indirect contact with infected people, as is the case with other disease pathogens such as influenza viruses or SARS-CoV-2. Instead, the pathogens are transmitted and disseminated by other organisms, which we call vectors. Once vectors have picked up a pathogen, they often remain infectious throughout their entire lifespan, but the pahogen does not make them sick and they can thus act as a reservoir for it. Bloodsucking insects like sandflies, blackflies and mosquitoes are the most important vectors globally and in our latitudes, closely followed by rodents, bats and fruit bats. Especially in times of global change, countless new pathogens and vectors are finding their way into new habitats. We are also increasingly discovering novel pathogens, although their arrival in industrialized countries is often delayed. Changes in climate and ecosystems, lifestyles, the environment and host-vector interactions can influence the distribution and behaviour of vectors and open up new habitats for many species. In the coming decades, we can expect many vector-borne diseases to become much more widespread – in our own latitudes and in other parts of the world.

Which vector-borne diseases do you expect to see here in Central Europe in the future?

Since 2010, we have been contributing work in European programmes for the surveillance of vectors and reservoir hosts. We anticipate that the West Nile virus, hantaviruses and *Leishmania* parasites will become more widespread and will have a greater impact in Central Europe in the future. We recorded the first occurrence of sandflies in Hesse, which is the northernmost location they have ever been found. Sandflies are a suitable vector for the transmission of the *Leishmania* parasites that cause leishmaniasis. The West Nile virus has been present in Europe since the 1960s, but we expect to see more autochthonous West Nile virus infections in Europe soon. The virus is already circulating in France, Austria and the Czech Republic. Our mathematical distribution models and ecological niche models show that the pathogen distribution follows the vector distribution after an initial lag phase. We can expect an increase in numbers of autochthonous leishmaniosis cases and West Nile virus infections in the next 10 to 15 years.

Autochthonous outbreaks are outbreaks with local transmission.

Yes, exactly – outbreaks that start from an infection contracted in the region where you live, rather than during a trip abroad. For example, we could pinpoint the areas in Europe where autochthonous Zika virus infections are most likely. Our modelling is remarkably accurate. We were able to predict areas in France where local transmission of the Zika virus subsequently occurred and was recorded.

So the West Nile virus and the Zika virus have both already arrived in Europe?

Yes, but they have not yet spread all that extensively. We are now analysing why this is the case. Reservoir hosts that carry the virus, such as racoons or starlings, are needed. But vectors are also needed: mosquitoes that suck blood from these infected hosts. And then the virus must be able to replicate in the mosquito and be passed on to a person during the next blood meal of the mosquito. We do not yet know exactly how all these factors interact. The transmission mechanisms in Europe are not yet fully understood.

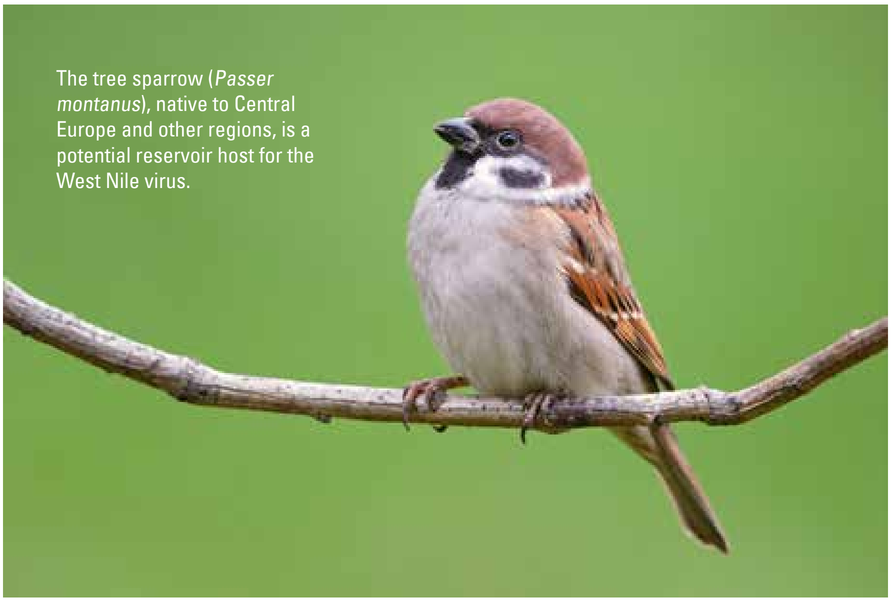
And what about our native mosquito and tick species?

They are also an important part of the equation. In addition to invasive species like the Asian tiger mosquito or the Asian bush mosquito, our native mosquitoes can also act as vectors. Central European mosquito species of the genus Culex, for example, are very well suited as vectors for the West Nile virus. This has been demonstrated in extensive laboratory studies. Their adaptation to our climate is already excellent, but they will benefit from climate change because higher temperatures and more rainfall will suit them well. Favourable conditions will allow them to produce multiple generations per year and this will potentially increase the risk of transmission of infectious diseases to humans and domestic animals.

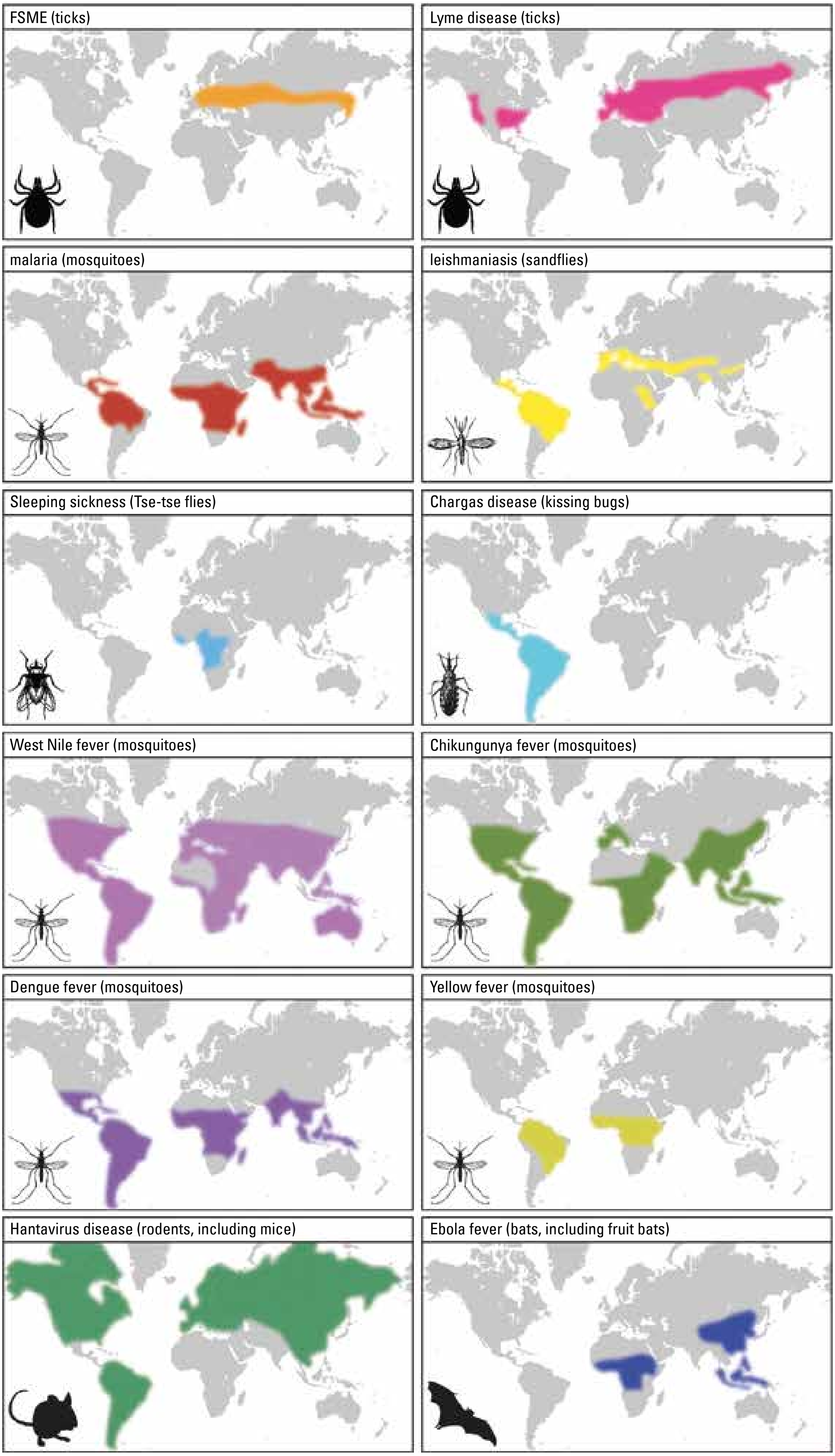
We are still in the middle of the SARS-CoV-2 pandemic. What lessons should we learn from it?

That is not easy to answer, because we are still in the middle of an evolving situation. The complex dynamics of the disease are not yet sufficiently understood. Many serious infectious diseases such as HIV/AIDS, tuberculosis and malaria have been pushed into the background because SARS-CoV-2 poses such an immediate threat to the health of so many people and because so much money is at stake in the race for vaccines. But we should not close our eyes to the fact that 38 million people worldwide are currently infected with HIV and suffering from AIDS. Two-thirds of them have no access to medication. Antibiotic resistance and multi-resistant pathogens also pose a major future threat. Large pharmaceutical companies have almost completely abandoned research on genuinely novel antibiotics. This regrettable state of affairs could lead to extreme challenges for health-care systems and to a significant reduction of the global population in the near future. We should act carefully now and avoid putting all our resources into COVID-19 research. We need to maintain a broader focus and set up and support relevant structures in various disciplines. Infection biology can contribute by clarifying whether viruses and other pathogens are transmitted by vectors and survive persistently in reservoir hosts. Essential questions that can be addressed include, for example: What ecological niches do these animals occupy? How can we control them? How quickly do they reproduce? In what ways do pathogens survive in these animal populations? Insights into these kinds of questions make it possible to tackle infectious diseases on multiple fronts. In addition to combating pathogens using medical science, we can also work to understand and control their vectors, hosts and reservoir hosts – all the animals that play a role in the chain of transmission.

So we should take a more interdisciplinary approach to pandemics and epidemiological challenges?



The tree sparrow (*Passer montanus*), native to Central Europe and other regions, is a potential reservoir host for the West Nile virus.



The global distribution of infectious diseases and their vectors

Source: Koch, Dörge, Klimpel: Vektorassoziierte Infektionskrankheiten, Pharmakon 3/2020.

Of course. That is essential. I would advocate for One Health approaches (adapted for specific pathogens) that can bring together experts from medicine and the life sciences with, for example, experts from business, economics and law to develop strategies for the economy and the legislative process. I believe that the German Federal Communicable Diseases Act (*Infektionsschutzgesetz*) needs to be revised and adapted, and we need psychologists to understand the impacts at the level of the individual. A holistic approach would be effective in the long term. This should be one takeaway from the current crisis. Only pumping huge amounts of funding into research when an epidemic or a pandemic is emerging or already underway is very short-sighted and will always be one step behind events. It is important that we do not just take a reactionary approach to developments, but take proactive and targeted steps at an earlier stage.

How can we prevent further tropical diseases which may be on their way to us from emerging here?

We cannot prevent their arrival. We can only work on relevant topics as early as possible. And we should focus on regions where the pathogens that cause these infectious diseases are already present. In my view, it is essential to build up and expand the health-care systems in these countries and improve the training there. This would be a targeted form of development aid and support with lasting effects. Fighting infectious diseases in the countries where they originate would reduce the threat of their spreading around the world. Our efforts to date are not enough.

Stories in the media about diverse tropical pathogens are becoming more common: Zika, Chikungunya, Dengue, Chagas, Usutu and so on. Are stories like these making people more nervous?

People are indeed noticing stories about novel pathogens or first-time discoveries of exotic diseases and disease vectors in new places more frequently and more quickly than they used to, because SARS-CoV-2 is currently in the media everywhere. However, I also believe that people now want to know more about infectious diseases. There has been an increasing interest in tropical and subtropical infectious diseases, and people want to know how they are transmitted and how likely they are to become a threat in our latitudes. I think this increased level of interest is a positive sign. People are becoming better informed because information is flowing, and that in turn means that they can understand the new information better and make more sense of the details.

Thank you for this interview, Professor Klimpel.

About Sven Klimpel

Prof. Dr. Sven Klimpel has been a Professor of Integrative Parasitology and Zoophysiology (IPZ) at Goethe University since 2010 and he heads the Medical Biodiversity and Parasitology research unit at the Senckenberg Biodiversity and Climate Research Centre (SBiK-F). Born in 1973, Klimpel studied biology at the University of Kiel and the Helmholtz Centre for Ocean Research Kiel (GEOMAR) and went on to complete a doctorate at the Institute for Zoomorphology, Cell Biology and Parasitology at the University of Düsseldorf, where he subsequently directed the research group »Aquatic and Terrestrial Parasitology«. In 2008, he gained his habilitation (venia legendi) in Parasitology and Infection Biology. This was followed by countless stays abroad for research purposes (including Chile, USA, Indonesia). In 2010, Klimpel took up a professorship at Goethe University. Between 2011 and 2013, he also managed the Senckenberg German Entomological Institute, a Leibniz Institute, as its Director. Between 2014 and 2017, he headed the Institute for Ecology, Evolution and Diversity within Faculty 15 – Biological Sciences, a faculty he has led as Dean since 2017. His research focus areas include the identification of new pathogens and vectors (and of pathogens and vectors that are becoming increasingly significant), the determination of their present distribution, and research on aspects including the genetic evolution of their dispersal capabilities, climatic tolerance, and vector competence (infection paths).

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