Proceedings of the Eleventh International Conference on Urban Pests 2025
AF-Borgen, Academic Society, Lund, Sweden
William H Robinson, editor

PEST PREVENTION IN HEAT REDUCTION AND SPONGE CITY PROJECTS

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Abstract As a result of climate change and increasingly mild winters, experts expect that a) invasive species will be able to survive better, b) the active season for vector organisms will be longer, c) pathogens will be able to multiply better in vector organisms, and d) more diseases transmitted by vector organisms could occur in Switzerland and the rest of Central Europe. Cities with a high proportion of built-up areas act as heat islands and try to mitigate this effect with heat reduction measures such as greening roofs and facades and planting more trees (green infrastructure). Another consequence of global warming is more frequent and heavier rainfall. Sponge city measures (blue infrastructure) are used to retain rainwater in communities instead of immediately draining it into rivers or sewers. With these measures, we also create more habitats for arthropods and vertebrates. This brings more biodiversity into the cities, but it can be a nuisance to residents, bring damage to infrastructure or food, and/or even lead to the transmission of diseases by vector organisms. We are thus creating a potential conflict between green and blue infrastructure on the one hand and public health and environmental protection on the other. Based on practical examples about the Asian tiger mosquito (*Aedes albopictus*), ticks, rodents, the greenhouse millipede (*Oxidus gracilis*) and springtails (*Collembola*) from our everyday consulting practice at the Urban Pest Advisory Service Zurich, we show how the early inclusion of pest issues in the planning of greening and sponge city projects is useful and successful. Regular maintenance and servicing measures are also very important. In this way, unnecessary biocide applications by residents and pest control companies and health costs can be reduced and biodiversity and the residents' quality of life increased.

Key words climate change, heat mitigation, green infrastructure, health, one health, vector borne disease

INTRODUCTION

Climate change is intensifying the heat island effect in cities and leading to more and heavier rainfall (Field et al., 2012). As cities have a high proportion of sealed soil, this can lead to flooding and overloading of the sewage system. To maintain a good quality of life and protect the health of their residents, cities are trying to find solutions to the problem of overheating and flooding. Heat reduction measures include, for example, greening house facades and roofs and planting more trees in urban areas (green infrastructure). Sponge city measures, in which rainwater is retained at the point where it falls and is not immediately discharged into the sewer system or rivers, are intended to prevent extreme flooding events, and ensure more evaporation within cities. For this purpose, above ground and underground retention basins, evaporation and infiltration basins and areas that can be temporarily flooded in a controlled manner (blue infrastructure) are planned (Veerkamp et al., 2021).

These measures are intended to improve the future quality of life in cities, but from a pest prevention perspective, they can also have a negative impact on city dwellers and the environment. The distance between humans and nature is reduced. Animals and humans come into closer contact, which could lead to an increase in pathogens that can be transmitted from animals to humans. More than two thirds of infectious diseases in humans are of zoonotic origin (Hess et al., 2020). Examples of such zoonotic diseases include ornithosis caused by birds like feral pigeons, chickens or seagulls and leptospirosis caused by brown rats, *Rattus norvegicus*. Examples of vector borne diseases are Lyme disease and TBE caused by the castor bean tick, *Ixodes ricinus,* or dengue and chikungunya fever caused by the Asian tiger mosquito, *Aedes albopictus*. At the same time, the increase in average temperatures resulting from climate change and the increasingly mild winters in large parts of Europe are creating better conditions for vector organisms, i.e. disease transmitting organisms (Coutts and Hahn, 2015; Probst et al., 2023). The active season for vector organisms will be longer, and pathogens will be able to multiply better in the vector (Ogden and Lindsay, 2016). Because of these effects, more diseases transmitted by vector organisms could occur in Switzerland and the rest of Central Europe. The Urban Pest Advisory Service of the City of Zurich (UPAS) follows the 'One Health Approach' in heat mitigation and sponge city projects and aims to recognize animals that can transmit diseases at an early stage and keep them away from the residents. Harmful organisms should therefore be considered as early as possible in the planning of heat mitigation and sponge city measures and incorporated into their implementation.

Vector organisms and others will profit from greener cities. With more green facades and flat roofs, more arthropods such as various insect species, mites, and vertebrates such as birds, rats and mice can colonize them (Oloś, 2023; Lin and Chen, 2022; Wooster et al., 2021). We know from our consulting practice that some people use insecticide sprays against every insect or arthropod in their home or on their patio. This can have negative effects on the health of residents and the environment. Some people will want to know exactly what kind of arthropods they have in their home, whether they are pests or harmless outdoor animals. It can be assumed that the need for advice among the population will increase and that UPAS will need more employees to meet this demand. This will lead to higher costs for the city.

Presented here are some examples from our consulting work on pest problems that could lead to conflicts in the implementation of heat mitigation and sponge city projects and suggest possible solutions. The examples include species that are considered alien and invasive in Europe as well as native species. Some of the species can transmit pathogens to humans and animals and some simply cause nuisance.

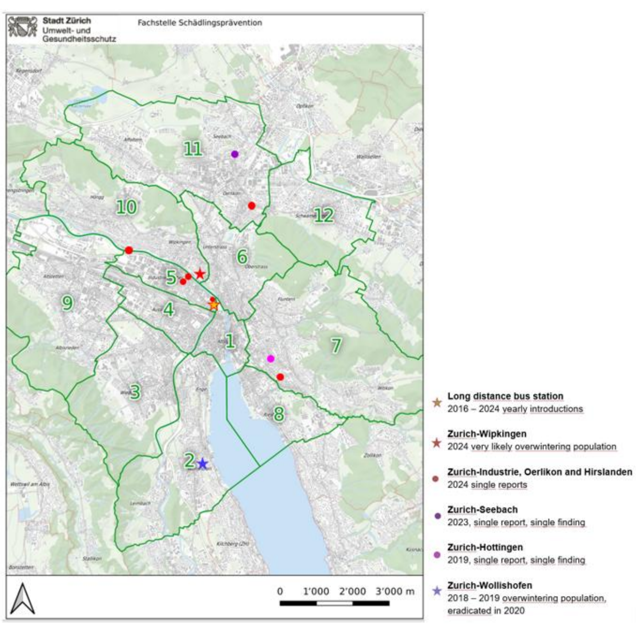

Figure 1. Reports of *Aedes albopictus* in the City of Zurich, 2016 – 2024, green lines and numbers: city districts.

MATERIALS AND METHODS

The City of Zurich has a department responsible for pest prevention and control (UPAS) since 1930. The UPAS is part of the Health and Environment Department (Landau et al., 1999). One of its main tasks is to provide free advice on problems with pests to the public and municipal authorities and to identify arthropods for pest control companies (Landau Luescher et al., 2008). Since 1990, all inquiries have been recorded in a Microsoft Dynamics 365 database, which includes more than 57,000 data recordings (Brimblecombe et al., 2023). The following examples are drawn from this database and the consulting experience.

EXAMPLES OF POSSIBLE CONFLICTS

Asian tiger mosquito, *Aedes albopictus*

Aedes albopictus is an invasive mosquito species that originates from Southeast Asia and can transmit more than 20 pathogens. Therefore, it poses a threat to public health. In addition, it can spoil your stay in the garden because it bites during the day and is not easy to swat away. It has spread rapidly in Europe over the last 20 years (Medlock et al., 2015). It develops in small pools of water and is considered as one of the 100 world's worst invasive alien species (Lowe et al., 2004).

In Switzerland, it was found for the first time in 2003 in the canton of Ticino in southern Switzerland. Since then, it has spread along the main traffic routes (Flacio et al., 2016). In 2023, it was detected in 21 out of 26 Swiss cantons. In the three cantons of Basel Stadt, Geneva, and Ticino, it is widely established (Swiss Mosquito Network, 2023). Experts assume that due to global warming it could settle throughout the Swiss Plateau in the future (Cao and Feng, 2024; Federal Office for the Environment, 2020; Kraemer et al., 2019). In the city of Zurich, *Ae. albopictus* eggs were found for the first time in September 2016 at the long-distance bus station. From 2017 to 2024, the city and canton of Zurich invested approximately CHF 285,000 in training employees, monitoring and controlling *Ae. albopictus* and informing the public (Figure 1).

If in the future more underground cisterns are built in residential areas, these could serve as breeding grounds for *Ae. albopictus*, but also for other mosquito species. This is known from Italy and in Switzerland from the canton of Ticino (Lukas Engeler, pers. comm.). In addition, the poor accessibility of these cisterns can make it challenging to control mosquito larvae with a biological larvicide.

Residents will not simply stop visiting their gardens if more mosquitoes appear in a residential area due to newly created breeding grounds but will buy insecticide sprays and other biocides and try to control the mosquitoes themselves. Using the biocides incorrectly, the residents can harm themselves, the biodiversity in the garden and the environment. The municipality must, for public health reasons, treat the sewer holes with biological larvicides against *Ae. albopictus* larvae. If a traveler infected with dengue, chikungunya or zika virus returns to an area with an *Ae. albopictus* population, the public health authorities may order treatments of the surrounding area with an insecticide against adult mosquitoes within a radius of 100 m to prevent local transmission. This is a major and costly effort and will also affect many other insects in the area. For this reason, it is better to preventively remove breeding sites when *Ae. albopictus* is found in an area and to treat water accumulations that cannot be removed with a biological larvicide. This protects the health of the residents, the environment and biodiversity.

Other sponge city measures, such as the seepage of water in retention basins on the surface, are not a problem if the water seeps away within one week (Swiss Water Association, 2024). If underground cisterns are unavoidable, the water outlet must be at the lowest point so that no puddles remain at the bottom of the cistern. In addition, regular checks must be made by mosquito experts to see whether mosquito larvae are developing in the cistern and what species they are. Underground cisterns should have an easily accessible opening so that any necessary treatment with larvicides against mosquito larvae can be applied without great effort. The Swiss Water Association has created an information platform called 'sponge-city.info', where you can find examples of good practice as well as a fact sheet in German, French and Italian with best practices for avoiding mosquito problems in sponge city measures (Swiss Water Association, 2024). North Carolina State University Extension offers guidance for homeowners in choosing and placing rainwater harvesting systems, including a fact sheet about the control of mosquitoes in rainwater harvesting systems (Hunt, 2021).

Ticks, e.g. *Ixodes ricinus*

In Europe, the castor bean tick, *Ixodes ricinus* (Acari: Ixodidae), is the most common tick. It can transmit tick-borne encephalitis (TBE), Lyme borreliosis (LB), and other tick-borne diseases (TBD). It is not only found in or near forests but can also be transported with wild animals, e.g. birds, mice, and hedgehogs, in city parks and private gardens (Jantzén et al., 2024; Klaus et al., 2016). In Zurich, for example, *I. ricinus* ticks were found on the grounds of a large cemetery, which is also used as a recreational area by the residents (Tischhauser, 2024). It prefers to live in places with high humidity, e.g. in the undergrowth, on low bushes or under trees whose branches reach the ground (Tischhauser et. al., 2022).

If flat roofs are planted with dense shrubbery and are used at the same time by residents as recreational and leisure areas, increased contact between humans and ticks can occur, and tick-borne diseases may increase. This can be prevented by cutting off the lowest branches of trees and shrubs so that the air can circulate well without the accumulation of high humidity. Furthermore, bird feeding on flat roofs that are also used for recreation could be prohibited to prevent close contact between birds, their parasites, and humans.

Greenhouse millipede, *Oxydus gracilis*

Oxidus gracilis (Diplopoda: Polydesmia) was originally introduced to Europe from Asia via the plant trade. The first report in the UPAS database is from 2006 from the canton of Zurich. Until the end of 2024 we had 67 reports (Figure 2). Initially, it was mainly found in greenhouses and botanical gardens, but since 2017 it has also been increasingly found outdoors (Zimmermann and Oelhafen, 2022). Normally, this species is not a nuisance, but is even useful as decomposer of organic material. However, during heavy rainfall or hail, thousands of them can move upwards along the walls of houses, even entering buildings through closed doors and windows. This can cause a great deal of inconvenience to the residents and lead to severe psychological stress and, in individual cases, to an impairment of their mental well-being.

In the rainy summer of 2021, we had a report from a hospital where *O. gracilis* had climbed up the wall from an attached lower building with a flat roof and invaded an operating room. This could not be tolerated due to the possible spread of pathogens. The hospital commissioned a pest control company to control the millipedes on the flat roof and on the facade. Unfortunately, this company treated the facade extensively with insecticides. This was not much use, because the millipedes did not die immediately of the insecticide and still entered the operating room where they died. Zimmermann (2017) recommends among other measures the installation of a 7 cm wide slippery plastic tape to the house wall, in a small distance from the ground which inhibits the millipedes from climbing up the wall (Figure 3).

In this case, in addition to the hygiene problem, there were also several unnecessary applications of biocides before the responsible person turned to UPAS for advice. Heat reduction measures must, therefore, be adapted to the intended use of the building. High hygiene requirements, such as in health care facilities, food processing or pharmaceutical manufacturing facilities must be considered during planning.

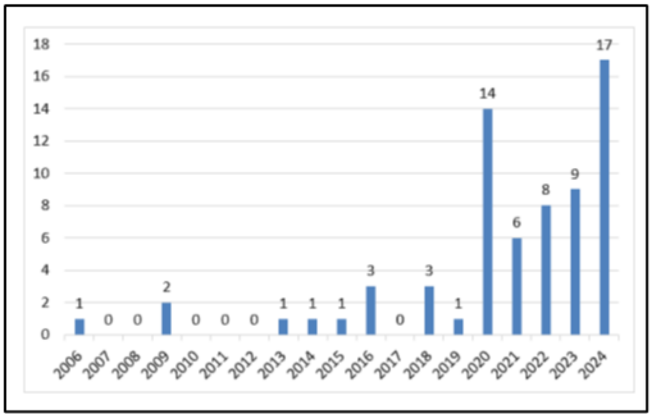

Figure 2. Reports of *Oxidus gracilis* (2006-2024)

Figure 3. Plastic tape on house wall to inhibit millipedes like *O. gracilis* from climbing up
picture: K. Zimmermann

Springtails, Collembola

Springtails are small wingless insects that need high humidity for their development and feed on plant material, algae, and fungi. There are around 6500 species worldwide, 800 of them in Central Europe and about 250 in Switzerland (Balmelli et al., 2011). Between 1992 and 2024 we had 314 reports about Collembola (Figure 4). Many Collembola species have a jumping apparatus (furca) at the ventral part of their body with which they can jump to safety in case of danger (Oliveira and Smith, 2024). In spring, when conditions are ideal for mass reproductions with lots of rain and days of intense sun in between, they jump down onto balconies or even enter rooms below via closed skylights. This usually happens when the skylights are older, and the seals are no longer properly tight.

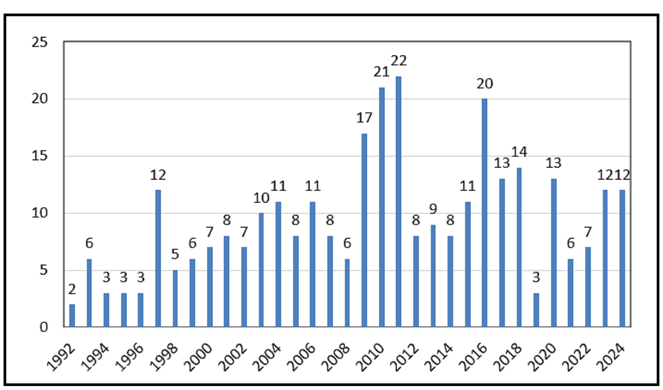

Figure 4. Reports of Collembola per year, 1992 - 2024

In a case from 2000, springtails got into the showroom of a company. This was reported to the property management, who sent the janitor to the roof to control the springtails with insecticides. At the same time, he used herbicides to control the vegetation on the flat roof. This is particularly worrying as this approach did not solve the problem of increased moisture and brittle seals on the skylights and the biocides could get directly into the environment. Such cases can be prevented by ensuring that no standing water collects around skylights. In addition, an approximately 50 cm wide strip without vegetation should be laid out around skylights with coarse gravel only and the seals of skylights checked regularly and replaced if they show signs of wear.

Invasive Ant Species And Soil Termites

To date, we have discovered large-scale outdoor occurrences of two invasive ant species in the city of Zurich: *Lasius neglectus* (Van Loon, Boomsma and Andrásfalvy, 1990) (Landau et al., 2017) and *Tapinoma magnum* (MAYR, 1861) (Schmidt et al., 2022). Both species can be introduced in the root ball and growing substrate of imported plants. These species need to be controlled before the colonies become too big. Once established for a couple of years they become very difficult and expensive to eliminate. This also applies to soil termites. An infestation of *Reticulitermes grassei* Clément was discovered for the first time in north-eastern Switzerland in 2018. One of the possible introduction paths could have been with the soil in the roots of an olive tree imported from the Mediterranean region that was planted ten years earlier (Mueller and Aufranc, 2022). This is particularly alarming because of adaptation to climate change more heat-adapted plants are being imported from this region. Imported plants, including those from within the European Union, should therefore be strictly monitored for invasive organisms in the soil of the root ball. Blight and Rabitsch (2024) recommend good measures to improve European biosecurity policy on ants.

Risk Reduction

In general, plants and shrubs should not be cultivated directly next to a building facade, but a 50 cm wide strip of coarse gravel should be laid out. Fine sand is not suitable for this strip because ants can settle in it and enter the building via the facade. A gravel strip directly next to the building also prevents rodents from settling directly next to the house wall. It is important that no standing water accumulates along house facades.

People are very different from each other in their attitudes towards arthropods in their homes. That is why the installation of good quality insect screens is recommended on buildings where a green facade is planned. The screens should be easy to open, allowing residents to decide for themselves whether the screens should be open or closed and facilitating the window cleaning. Comprehensive and peer-reviewed examples of measures to keep pests out of structures instead of providing them shelter can be found in the guidelines of Geiger and Cox (2012). This very helpful guideline also includes a table with maximum mesh sizes/maximum opening sizes for the exclusion of different pests, from insects/arthropods to birds and mammals.

DISCUSSION

The examples from our consulting services show how heat reduction and sponge city measures can negatively affect the quality of life of residents and the environment. This list is not exhaustive, and more examples are described in Lõhmus and Balbus, 2015.

As global warming progresses and travel and global trade remain at a high level, further new, sometimes invasive harmful organisms may spread in Switzerland and other parts of Europe. Examples are the red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera:

Formicidae), which was found for the first time in Europe in Sicily in 2023 (Menchetti et al., 2023) or new termite species. The costs of controlling such alien invasive organisms are very high and eradication is only possible in the initial stages (Courchamp et al., 2014; Cuthbert et al., 2022; Heringer et al., 2024). Any control of harmful organisms in the environment also damages biodiversity. Preventive consideration of this issue in greening and sponge city measures is therefore highly recommended.

It is important to emphasize that we are by no means against heat reduction or sponge city measures, nor are we against more biodiversity in cities. We simply want to ensure that potential conflicts are identified and prevented at the early planning stage of such projects. This can save costs and protect human and animal health as well as the environment (Fournet et al., 2024; Luque et al. 2014).

ACKNOWLEDGEMENTS

We thank Niels Verhulst and Mathias Wenger for their helpful comments on the manuscript, the citizens of Zurich and the Swiss pest control companies for valuable observations and reports.

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