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Monitoring and mapping invasive insect species: Results of the project ProgRAMM

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Abstract

The federal project ProgRAMM had the objective to develop a computer model that is capable of predicting the probability of establishment and the damage potential of climate sensitive invasive pest insects in Germany. The Agricultural Research Center (LTZ) in Karlsruhe conducted a nationwide monitoring of six selected species in order to feed the model with actual occurrence data. The monitoring includes data collected by trapping, visual observations, screening of scientific and non-scientific publications as well as citizen science. Observed species relevant for German fruit growers were the Brown marmorated stink bug (Halyomorpha halys), Southern green stink bug (Nezara viridula), Mediterranean fruit fly (Ceratitis capitata) and the European pear scale (Epidiaspis leperii). All mentioned species highly differ in their mode of dispersal, possibility of establishment after introduction and availability of effective monitoring tools. In this short communication we present the monitoring results, how the data were collected and how they have to be interpreted.

Keywords: *Ceratitis capitata*, *Epidiaspis leperii*, *Halyomorpha halys*, *Nezara viridula*, invasive pests, pest risk analysis

Introduction

Non-indigenous species that are being introduced into new habitats with suitable conditions in terms of the availability of host plants, preferred climate conditions and overwintering shelter are prone to become pests. Especially when effective natural enemies are missing. An uncontrolled reproduction, spreading and invasive occurrence may be the result. Traits like a broad host range, high reproduction capacity and damage potential enhance this risk.

Driven by global trade and supported by the climate change, many neozoa have established populations in regions that have become more suitable in the last decade. Thus the number of invasive pest insect in Germany has increased, generating the need of new tools to perform quick and reliable pest risk analysis (PRAs).

The project “ProgRAMM” (2019 – 2021) had the objective to develop a computer model that is able to predict the probability of establishment, distribution and economical threat of new insect pest species, also considering possible impacts of the ongoing climate change and shift in cultured host plants in Germany in the next decades (Heß et al., 2022).

Six model species with highly different sets of biological and ecological features, four of them relevant for fruit growers, were selected for the monitoring to feed the model with actual data of their occurrence data. Two invasive stink bugs, *Halyomorpha halys* and *Nezara viridula* (Heteroptera: Pentatomidae), are already established and are spreading all over Germany. *N. viridula* is sensitive to cold temperatures, *H. halys* is overwintering in protected urban structures. As a hitchhiking species, human infrastructure enables *H. halys* to spread over large distances, whereas *N. viridula* mostly spreads by own means. In contrast the Mediterranean fruit fly (*Ceratitis capitata*; Diptera: Tephritidae) is not yet able to survive german winter conditions. It is regularly introduced via infested fruits and can only develop local and seasonal populations. The European pear scale (*Epidiaspis leperii*; Hemiptera: Diaspididae) is established in Southwestern Germany for at least 100 years and relies almost entirely by passive distribution of the mobile larval stages by wind, birds and propagation material. Accordingly, a slow further spreading of this species can be observed.

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Material and Methods

For the monitoring, we activated and expanded the nationwide network of plant protection advisors. We provided them with traps and pheromones (available for *H. halys* and *C. capitata* only) and informed them on how to conduct an effective visual monitoring of each targeted species. Additionally, we raised public awareness with several publications and oral presentations. For further refinement, we regularly screened scientific and non-scientific publications and also used apps, websites and biodiversity databases like iNaturalist, Lepiforum.de and GBIF.org. All Data from non-scientific sources, also known as “citizen sciences” (CS), were individually checked for validity. Finally, these data are used to feed the new computer model to increase its accuracy. They also allowed us to create maps that show the spatial distribution of each monitored species from past to present.

Results and Discussion

Regarding the four species, a total of 8229 valid occurrences in Germany had been recorded. Numbers of occurrences and the impact of CS highly differed between the monitored species. The stink bugs *H. halys* and *N. viridula* contributed the large majority of 8050 (97,8 %) occurrences to the dataset. *H. halys* was slightly more frequent (4807) than *N. viridula* (4243) and CS contributed 48,5 % and 41,7 % respectively to the data. Both species are easily noticed due to their appearance and behavior, also infesting plants in private gardens and e.g. on balconies. *H. halys* is also seeking shelter in large groups for overwintering, which draws even more attention on them.

Accomplishing an effective monitoring outside of their main distribution was much easier for *H. halys* than for *N. viridula,* since there are effective pheromones available for trapping. Hotspots like train stations, harbors and truck stations can easily get controlled for *H. halys* with traps. This species also shows a very strong preference for Catalpa trees (*Catalpa bignonioides*) that have an indicator function. This allowed a highly effective monitoring (Heß et al. 2022, Weber et al. 2022). Pheromone blends for *N. viridula* had been tested but were not effective and no preferred host plants are known. Both stink bugs increased their population size and area of dispersal and are almost omnipresent in the warmer regions of Germany, e.g. in the Rhine Valley and around Lake Constance. While *N. viridula* seems to struggle outside of these regions, *H. halys* is currently building up established populations even in northern cities like Hannover, Berlin or Hamburg.

108 occurrences could be recorded for *C. capitata*. Since 75 % of the records were gathered by our monitoring partners via trapping, most of the observations were located in their areas of action. There is little public awareness for this colorful species, but still 6,5 % of the observations were achieved by CS. An effective nationwide monitoring would require an excessive amount of traps and workforce. Despite *E. leperii* is permanently established in the southern part of the Upper Rhine Valley, it could not spread over long distances. This changed during the last decades and by now, *E. leperii* occurs in orchards all along the Upper Rhine Valley, in the Neckar Region and also parts of East Germany. Since this species lives hidden under a layer of algae and lichens, it is detected almost exclusively by trained staff that performs an adapted monitoring by scratching the bark with a knife. In total, we could gather 71 occurrences of *E. leperii* in Germany. Regarding the distribution in the Upper Rhine Valley and the Neckar Region, this number seems to be underestimated.

This project part focused on the monitoring data showed that long-term observation, including citizen science awareness, should be implied for potentially invasive insects that are new to Germany and that each species requires a different approach to its monitoring strategy.

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