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MONITORING AND CONTROL ACTIONS AGAINST *AEDES ALBOPICTUS* (DIPTERA: CULICIDAE) IN URBAN AREAS IN THE NETHERLANDS

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Abstract In the Netherlands, besides the detection at Lucky bamboo and used tire sites, introductions of *Aedes albopictus* have been notified by citizens since 2016 in urban areas. Intensive surveillance and mosquito control followed the confirmation of the species identity in the laboratory. In many cases, inspections discovered early stages of local foci of *Ae. albopictus*, being mainly immature stages breeding in artificial containers in the backyards of private houses. To eliminate the foci, door-to-door mosquito control was implemented based on intensive source reduction and the use of larvicides. To date, all detected *Ae. albopictus* foci have been successfully confined, containing the spread of the species to surrounding urban areas. Also, the majority of the detected breeding populations have been eradicated in one or two seasons. This work stress the importance of rapid mosquito control interventions to eliminate emerging small populations in new areas with the aim of prevent the establishment of *Ae. albopictus* as long as possible**.**

Key Words *Aedes albopictus*, invasive species, urban areas, Netherlands

INTRODUCTION

Since the foundation of the Dutch Centre for Monitoring of Vectors (CMV) of the Netherlands Food and Consumer Product Safety Authority (NVWA), the non-native mosquito species *Aedes albopictus, Ae. atropalpus, Ae. aegypti, Ae. japonicus, Ae. flavopictus, and Aedes koreicus* have been reported during surveillance activities at Points of Entry (Scholte et al., 2007, Scholte et al., 2009, Brown et al., 2011, Ibañez-Justicia et al., 2019, Ibañez-Justicia et al., 2020, NVWA 2021). However, in 2016 *Ae. albopictus* was for the first time notified by citizens in two different urban areas (Ibañez-Justicia 2019). Mosquito control based on the use of larvicides was immediately applied to eliminate these foci.
The policy of the Netherlands is to prevent (or to postpone) the establishment of *Aedes* invasive mosquitoes as long as possible. This manuscript will focus on the approach implemented in the Netherlands for the elimination of detected foci of *Ae. albopictus* in urban areas, with special emphasis on methodology, and on the significance of the achieved results.

MATERIALS AND METHODS

Citizen notifications informing of the presence of *Ae. albopictus* are commonly received in The Netherlands by the NVWA with a filled online form available at https://www.nvwa.nl/onderwerpen/muggen-knutten-en-teken/aziatische-tijgermug. The form includes the possibility of adding photographs of the specimens to be evaluated by CMV personnel trained in mosquito identification. In case of photographs of suspected *Aedes* invasive mosquito species, the CMV contact the citizen and immediately plan a visit to collect the mosquito specimens and inspect the surroundings of the finding. Samples taken in the field during the inspection are labelled with a unique code, sealed, and sent to the CMV laboratory for species identification. In the CMV laboratory, all specimens from the samples are counted and morphologically identified using the keys of Becker et al. (2020) and Schaffner et al. (2001).

If *Ae. albopictus* is confirmed in the samples, door-to-door intensive inspections are initiated within an area of at least 100 meter radius from the finding and with a maximum of around 200 meters. This area is delimited using ArcGIS and when possible, the limits follow roads or streets present in available topographic maps. In this area ("100+ area"), all present potential larval habitats for container-breeding *Aedes* are sampled and subsequently removed. If larval habitats cannot be removed, then are these treated with larvicide. Larvicide used is Bti– *Bacillus sphaericus* Neide granules

(Vectomax FG; Valent BioSciences). Larval searches are performed using fine-mesh aquarium nets. At least four BG-Sentinel traps (BGS; Biogents AG, Regensburg, Germany) are also placed in this area. One BGS at the finding location and at least three BGS's in suitable places covering the 100+ area. The BGS trap is used with a specific dispenser (BG-Lure cartridge; Biogents AG, Regensburg, Germany), which contains a lure that is a combination of volatile compounds that are also present on human skin (ammonia, lactic acid, and caproic acid).

A second area is defined from the limits of the 100+ area until 500 meter radius from the *Ae. albopictus* finding location. Within this "500m area" only public potential larval habitats are treated with larvicide. Public potential larval habitats include mostly street catch basins and storm drains. At least one larval habitat is sampled at each street, and potential breeding site locations such as cemeteries or allotments are also sampled. At least three BGS traps are also placed in this area with the aim of monitoring possible further spread of *Ae. albopictus* from the 100+ area.

If *Ae. albopictus* is detected during the surveillance within the 100+ or 500-m areas, both sampling areas are increased by including a new circular search area of 100 and 500-m radius from the new finding site. Sampling and subsequent removal of potential larval habitats for container breeding *Aedes* is performed in the increased area. Also additional BGS traps are deployed in the additional areas. The increase of the sampling area stop when no more *Ae. albopictus* specimens are detected in the areas. All BGS traps are sampled weekly until the end of the season. Larviciding is repeated every three weeks until the end of October, when ambient conditions for *Ae. albopictus* become unfavourable in The Netherlands.

RESULTS AND DISCUSSION

Since 2016 introductions with confirmed specimens of *Ae. albopictus* have been notified by citizens to the NVWA in 16 municipalities: Aalten, Alblasserdam, Arnhem, Dieren, Doorn, Eindhoven, Hoek van Holland, Hoogeveen, Neerkant, Oud-Beijerland, Sittard, Uithoorn, Valkenburg, Veenendaal, Weert, Westervoort.

In the locations Arnhem and Dieren, after initial CMV intensive larval and adult searches, *Ae. albopictus* was not detected, and it was decided not to implement mosquito control. Samples received from the traps present also confirmed the absence of breeding populations. Citizens that notified the findings to the NVWA recently returned by car from South European regions with presence of the species, and also reported that suffered *Ae. albopictus* nuisance at these locations.

At the rest of the locations, door-to-door mosquito control was implemented. *Aedes albopictus* was detected only during one season in 2016 at the location Veenendaal, in 2018 in Eindhoven and Westervoort, and in 2019 in Alblasserdam, Hogeveen, Neerkant and Uithoorn. *Aedes albopictus* was detected during two seasons at the location Aalten (2017 and 2018), and Valkenburg (2019 and 2020). At the location Weert it was detected during four seasons (2016-2019). At the location Sittard it was detected in 2020 and also in 2021. In 2021 *Ae. albopictus* was for the first time detected at the locations Doorn, Hoek van Holland and Oud-Beijerland.

To date, following the monitoring and control strategy, all detected *Ae. albopictus* foci have been successfully confined in The Netherlands, containing the spread of the species to surrounding urban areas. Also, the majority of the detected breeding populations have been eradicated in one or two seasons.

CONCLUSIONS

This work stress the importance of rapid mosquito control interventions to eliminate emerging small populations in new areas with the aim of prevent the establishment of *Ae. albopictus* as long as possible. As shown, *Ae. albopictus* introductions can occur giving the opportunity to proliferate and establish populations at locations not included at the CMV risk-based surveillance. Prompt communication on the presence of *Ae. albopictus* to the NVWA is crucial because of the possible increase of these introductions facilitated by the ability of *Ae. albopictus* to travel with human passive transport (e.g. cars), and the presence of established populations in neighbouring countries.

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