







Evaluating BG-Sentinel trap setting as an effective surveillance tool for mosquito vectors in the Republic of Cyprus

Georgios Balatsos¹ , Vasileios Karras¹, Marco Neira² , Renaud Lancelot³, Christiana Antoniou⁴, Avgoustinos S. Stephanou⁴, Yiannis Pigkeridis⁴, Kyriakos Papazacharia⁴, Giorgos Papazacharia⁴, Marios Violaris⁴, Maria Sakellariou Sofianou¹ , Marina Bisia¹ , Jeremy Bouyer³ , and Antonios Michaelakis^{1,*} 

¹ Laboratory of Insects & Parasites of Medical Importance, Benaki Phytopathological Institute, Kifisia, Greece

² Climate and Atmosphere Research Center (CARE-C), The Cyprus Institute, Nicosia, Republic of Cyprus

³ UMR Astre, Cirad, Inrae, Univ. Montpellier, Plateforme Technologique Cyroi, Ste Clotilde, La Réunion, France

⁴ Medical Entomology Laboratory, Ministry of Health, Republic of Cyprus

Received 8 February 2026, Accepted 21 May 2026, Published online 3 June 2026

Abstract – Effective surveillance of invasive *Aedes* mosquitoes, particularly *Ae. aegypti* and *Ae. albopictus*, is essential for early detection, risk assessment, and optimization of control strategies such as the Sterile Insect Technique (SIT). Although BG-Sentinel 2 traps are widely used in Europe, their performance under eastern Mediterranean conditions remains insufficiently evaluated. We assessed the attractiveness of BG-Sentinel 2 traps baited with BG-Lure, dry ice (CO₂), their combination, and unbaited controls using a Latin square field design in Larnaca and Nicosia, Cyprus. A total of 1,649 mosquitoes were collected. In Larnaca, *Ae. aegypti* occurred at low densities. Male captures were consistently low and unaffected by attractants, while female captures increased significantly only when BG-Lure and CO₂ were combined (RR = 2.7, 95% CI: 1.6–4.5). In Nicosia, *Ae. albopictus* was abundant, but responses were sex-specific. Male captures were significantly reduced by CO₂ alone (RR = 0.297, 95% CI: 0.175–0.467), with a weaker reduction when combined with BG-Lure, while female captures were not significantly affected by any treatment. For *Culex pipiens*, CO₂ strongly increased female captures (RR ≈ 16), irrespective of BG-Lure, whereas males showed only a modest response to BG-Lure alone. Overall, attractant efficacy was highly species- and sex-specific. Standard baiting strategies did not consistently enhance detection of invasive *Aedes* mosquitoes and, in some cases, reduced male captures, with implications for SIT programs. These findings emphasize the need for local validation of surveillance protocols particularly at points of entry.

Key words: Dry ice, BG-lure, *Aedes albopictus*, *Aedes aegypti*, Larnaca, Nicosia.

Résumé – Évaluation des conditions d'utilisation des pièges BG-Sentinel en tant qu'outils de surveillance efficaces des moustiques vecteurs en République de Chypre. Une surveillance efficace des moustiques invasifs du genre *Aedes*, en particulier *Ae. aegypti* et *Ae. albopictus*, est essentielle pour la détection précoce, l'évaluation des risques et l'optimisation des stratégies de lutte telles que la technique de l'insecte stérile (TIS). Bien que les pièges BG-Sentinel 2 soient largement utilisés en Europe, leur performance dans les conditions de la Méditerranée orientale demeure insuffisamment évaluée. Nous avons étudié l'attractivité des pièges BG-Sentinel 2 appâtés avec du BG-Lure, du dioxyde de carbone (CO₂, sous forme de glace carbonique), leur combinaison, ainsi que des témoins non appâtés, à l'aide d'un dispositif expérimental en carré latin à Larnaca et Nicosie (Chypre). Un total de 1 649 moustiques a été collecté. À Larnaca, *Ae. aegypti* était présent à faible densité. Les captures de mâles sont restées faibles et n'ont pas été influencées par les attractifs, tandis que les captures de femelles n'ont augmenté significativement que lorsque le BG-Lure et le CO₂ étaient combinés (RR = 2,7 ; IC à 95 % : 1,6–4,5). À Nicosie, *Ae. albopictus* était abondant, mais les réponses aux attractifs étaient spécifiques au sexe. Les captures de mâles ont été significativement réduites par le CO₂ seul (RR = 0,297 ; IC à 95 % : 0,175–0,467), avec un effet négatif atténué en présence du BG-Lure, tandis que les captures de femelles n'ont pas été significativement affectées par les traitements. Pour *Culex pipiens*, le CO₂ a fortement augmenté les captures de femelles (RR ≈ 16), indépendamment du BG-Lure, alors que les mâles n'ont montré qu'une réponse modeste au BG-Lure seul. Globalement, l'efficacité des attractifs dépendait fortement de l'espèce et du sexe. Les stratégies d'appâtage

Edited by Jean-Lou Justine.

*Corresponding author: a.michaelakis@bpi.gr

standard n'ont pas systématiquement amélioré la détection des *Aedes* invasifs et ont parfois réduit les captures de mâles, un élément critique pour les programmes fondés sur la TIS. Ces résultats soulignent la nécessité de valider localement les protocoles de surveillance, en particulier aux points d'entrée.

Introduction

The global expansion and establishment of *Aedes* invasive mosquito (AIM) species in new geographic areas present a growing threat to public health worldwide due to the role of this species in the transmission of arboviruses such as dengue, chikungunya, Zika, and yellow fever. In recent decades, Europe has increasingly faced challenges with AIM species, introduced primarily through global trade and travel [32, 53]. While several AIM species are sporadically imported, only four have successfully established across Europe: the Japanese bush mosquito (*Aedes (Ae.) japonicus*, Theobald, 1901), the Korean bush mosquito (*Aedes (Ae.) koreicus*, Edwards, 1917), the Asian tiger mosquito (*Aedes (Ae.) albopictus*, Skuse, 1894), and dengue mosquito or yellow fever mosquito (*Aedes (Ae.) aegypti*, Linnaeus, 1762) [15, 24, 32, 53]. These *Aedes* species exhibit high invasive potential, primarily driven by their ecological adaptability, especially their capacity to produce drought-resistant diapausing eggs, while *Ae. aegypti* can additionally persist through quiescence [17, 18, 32, 58]. The pathways of introduction and spread are scale-dependent and closely linked to human activity. At the global level, passive transport via maritime freight, especially in association with goods such as used tires and ornamental plants (e.g., lucky bamboo), is considered the primary route of introduction [28, 33]. Aircraft also contribute significantly to long-distance dispersal. Within Europe, national and regional spread is largely driven by ground transportation, particularly through vehicles and trains, as these species are frequently transported inadvertently with human movement [24, 28, 32, 38, 59].

In addition, the establishment and spread of AIM further highlights the urgent need for strong surveillance systems at high-risk points of entry and rapid emergency response. *Aedes japonicus* has significantly expanded its range and now is established in many European countries, including Austria, Belgium, France, Germany, the Netherlands, Switzerland, Slovenia, and Spain [1, 10, 15, 26, 27, 36]. Similarly, *Ae. koreicus*, although still restricted, has been reported in several European countries including Belgium, Italy, Slovenia, Hungary, and Germany [7, 39, 48].

Among the invasive mosquito species introduced to Europe, *Ae. albopictus* and *Ae. aegypti* are among the most concerning due to their proven roles as vectors of dengue, yellow fever, chikungunya, and Zika arboviruses [29]. *Aedes albopictus* has achieved extensive global distribution, including in North and South America and Europe, representing the widest distribution ever recorded for the species [21, 53]. Since July 2024, *Ae. albopictus* has newly become classified as established in the Republic of Cyprus and Slovakia [54]. Despite its long-standing presence in parts of southern Europe, the species distribution remains dynamic, with continued expansion across the continent. Additionally, sporadic introductions without confirmed establishment have been reported in Czechia, Liechtenstein, the Netherlands and Sweden, highlighting the current risk of further geographical expansion facilitated by human-

mediated transport and increasing climatic suitability [21]. *Aedes aegypti* was widely distributed across southern Europe, the Near East, and North Africa from the late 18th century until the mid-20th century [22, 61]. During this period, the mosquito was responsible for significant disease burden, including a severe dengue outbreak in Athens in 1927–1928 [45]. However, the species largely disappeared from continental Europe by the 1950s. Importantly, *Ae. aegypti* has since re-established populations in the Republic of Cyprus and self-sustaining populations in several outermost EU regions, notably Madeira (Portugal) and La Reunion, France as well as in the neighboring countries Türkiye and Egypt [22, 28, 49, 54]. The Republic of Cyprus, with its warm Mediterranean climate and strategic geographic position, has long been identified as a high-risk area for AIM introduction. Despite early surveillance efforts initiated in 2019, *Ae. albopictus* was not detected until October 2022 in the port area of Limassol, where it was subsequently confirmed in nearby municipalities of Mesa Geitonia and Germasogeia. In parallel, *Ae. aegypti* was recorded in November 2021 in the Larnaca district, marking its first appearance in the Republic of Cyprus since 1959 and its confirmed overwintering in 2022 [40, 54]. Currently in Cyprus, *Ae. albopictus* is established in multiple urban areas, whereas *Ae. aegypti* remains spatially restricted to Larnaca District under active control.

Whereas *Ae. albopictus* has been the vector in recent European mosquito-borne disease outbreaks of Dengue and chikungunya, the reestablishment of *Ae. aegypti* poses a higher risk for public health mainly due to the fact that it is considered the primary vector for these diseases [47, 50]. Thus, the recent reintroduction of *Ae. aegypti* and *Ae. albopictus* in the Republic of Cyprus warrants the establishment of an efficient surveillance system for both species, to support the surveillance program and vector control interventions. Following the detection of both species and with the technical guidance of the International Atomic Energy Agency (IAEA), the Republic of Cyprus initiated a coordinated emergency response against *Ae. aegypti* [12, 54]. As a result, in April 2023, a contingency plan was prepared by the IAEA and adopted by the Ministry of Health, aiming to eradicate *Ae. aegypti* from Larnaca District. Among others, the contingency plan recommended the establishment of a national surveillance system, an enhanced vector control program with biocides, a door-to-door campaign, and an environment-friendly control program employing the Sterile Insect Technique (SIT) [12, 54] [4, 5]. The pilot SIT trial was implemented in Kiti, Larnaca district, with promising initial outcomes. Its continuation requires accurate baseline data on the wild population density, and in parallel the assessment of the survival and dispersal of sterile males [3].

Evaluating the performance of commonly used adult traps, such as the BG-Sentinel 2 trap (Biogents, Regensburg, Germany) baited with dry ice and/or BG-Lure, to sample *Ae. aegypti* and *Ae. albopictus* under different environmental settings, is essential for enhancing vector surveillance and control strategies. While several studies have evaluated the performance of the BG-Sentinel 2 trap, such as in La Reunion, no



Figure 1. Map of the Republic of Cyprus showing the study regions and sampling sites. Each region (Nicosia and Larnaca) included two sampling sites, where four trap configurations were deployed at each site. Panels A and B show the locations and distribution of sampling points in Nicosia, specifically in the municipalities of Nicosia and Strovolos. Panels C and D show the locations and distribution of sampling points in Larnaca, specifically in the municipalities of Dromolaxia–Meneou and Larnaca.

studies have been conducted in a Mediterranean country where *Ae. aegypti* and *Ae. albopictus* occur under the same climate and environmental conditions [14, 42, 44]. The results are intended to recommend the most effective monitoring strategy to be used in future SIT interventions in the Republic of Cyprus, where an effective male trapping system is a critical component to estimate the sterile-to-wild male ratio, sterile male survival and distribution in the target area, and program success. Additionally, the results may guide the selection of optimal trap configurations and attractants for entomological surveillance programs in other European countries, particularly at points of entry (PoEs), to enhance the early detection and monitoring of invasive mosquito species and allow a rapid emergency response [35]. This is of paramount importance for European countries implementing active surveillance programs at PoEs that have connections with countries where *Ae. aegypti* is established. Enhancing the early detection of invasive mosquito species by adopting efficient surveillance systems and tools is crucial to implement rapid interventions measures, thereby mitigating the risk of establishment and spread within Europe. Therefore, the present study aimed to validate the efficacy of BG-Sentinel 2 traps using various baiting combinations; BG-Lure (human skin scent mimics), dry ice

(CO₂) and their combination compared to unbaited traps, for the surveillance of adult *Ae. aegypti*, *Ae. albopictus*, and native *Culex (Cx.) pipiens* using a Latin square field design.

Methods

Study areas

Field trials were conducted in the Republic of Cyprus from October 20 to November 14, 2024, in the cities of Nicosia and Larnaca (Fig. 1). This study period was selected because it aligns with the high-density period for *Ae. aegypti* in Larnaca and captures the secondary late-autumn surge of *Ae. albopictus* observed in Nicosia, following its primary peak in late summer (unpublished data). Nicosia (35.1856° N, 33.3823° E) is the capital of the Republic of Cyprus, situated at approximately 160 m above sea level. This city experiences a semi-arid Mediterranean climate with hot, dry summers, and mild winters [23]. Sampling was conducted in urban residential areas characterized by irrigated gardens and domestic water containers, where *Ae. albopictus* has recently established.

Larnaca (34.918394° N, 33.620065° E) is a coastal city located at approximately 0 to 26 m above the sea level, with

Table 1. Descriptions of BG-Sentinel trap configurations tested in the field experiment.

Trap Label	Trap configuration	Attractants
D	Trap baited with dry ice	CO ₂
DL	Trap baited with dry ice and BG Lure	CO ₂ + BG Lure*
L	Trap baited with only BG Lure	BG Lure*
N	Negative control (trap without any bait)	None

*BG Lure cartridge: Commercially available synthetic mosquito attractant (Biogents).

a hot-summer Mediterranean climate, high relative humidity during the warm season, and mild winters [23]. Sampling sites in Larnaca were in residential peripheral (semi-urban/suburban) areas characterized by a low density of inhabitants and numerous potential breeding sites, supporting large populations of container-breeding *Aedes* mosquitoes. Specifically, the Dromolaxia–Meneou and Mackenzie areas are characterized by predominantly detached housing, limited high-rise development, and abundant outdoor spaces such as yards, gardens, and auxiliary structures that favor the presence of artificial containers.

In each location, two study sites with similar environmental conditions were selected, each comprising four BG-Sentinel 2 trap sampling stations, yielding a total of eight trap sampling points. The selected sites shared comparable urban land use, vegetation cover, and climatic conditions. Sampling sites in both Larnaca and Nicosia were selected based on prior surveillance data to maximize the detection density, with locations in Larnaca emphasizing proximity to previously identified *Ae. aegypti* hotspots and those in Nicosia emphasizing areas near known *Ae. albopictus* hotspots. Due to the absence of *Ae. albopictus* in Larnaca and *Ae. aegypti* in Nicosia, mosquito samples were transported to field laboratories in the city where they were collected and processed there, to avoid the risk of introducing either species to areas where they are not currently present.

Study design

The study areas and period (autumn months) were selected to agree with the peak activity of both *Ae. aegypti* and *Ae. albopictus*, based to the available routine surveillance data from the Ministry of Health. Consequently, our samplings ensure that the collected data are representative of the highest population densities and maximize the sensitivity of the study for both male and female mosquitoes.

Four BG-Sentinel 2 trap configurations were evaluated using a Latin square design, as described in Table 1. To avoid cross-contamination of any residual attractants between experimental conditions, all traps were brand new at the beginning of the study, and each trap was only used for a specific type of attractant configuration throughout the study.

At each sampling site, the four trap configurations were deployed simultaneously in a clockwise arrangement, ensuring a minimum inter-trap distance of 90 m to minimize bait interference [19]. Traps were placed in the peri-domiciliary areas of local residences, in shaded, rain-protected, and secure locations with prior consent from residents. To standardize micro-environmental conditions as much as possible, traps were typically positioned near vegetation or other sheltered micro-habi-

tats, avoiding direct sunlight, strong wind exposure, and obvious breeding containers whenever possible. Traps using CO₂ as attractant were loaded with 4 kg of dry ice pellets contained in an insulated cooler bag placed inside the trap. This quantity of dry ice was sufficient to supply CO₂ for 24 h.

Each baiting treatment was rotated among the four trap positions every 24 h according to a Latin square design. This ensured that each trap position received each baiting treatment once during a complete 4-day sampling block. The 4-day rotation was repeated for four consecutive weeks, resulting in a total of 16 observations per trap configuration and position. This design controlled for environmental variation associated with trap location and sampling date, which served as proxies for local habitat conditions and short-term weather factors such as temperature, humidity, and wind [14].

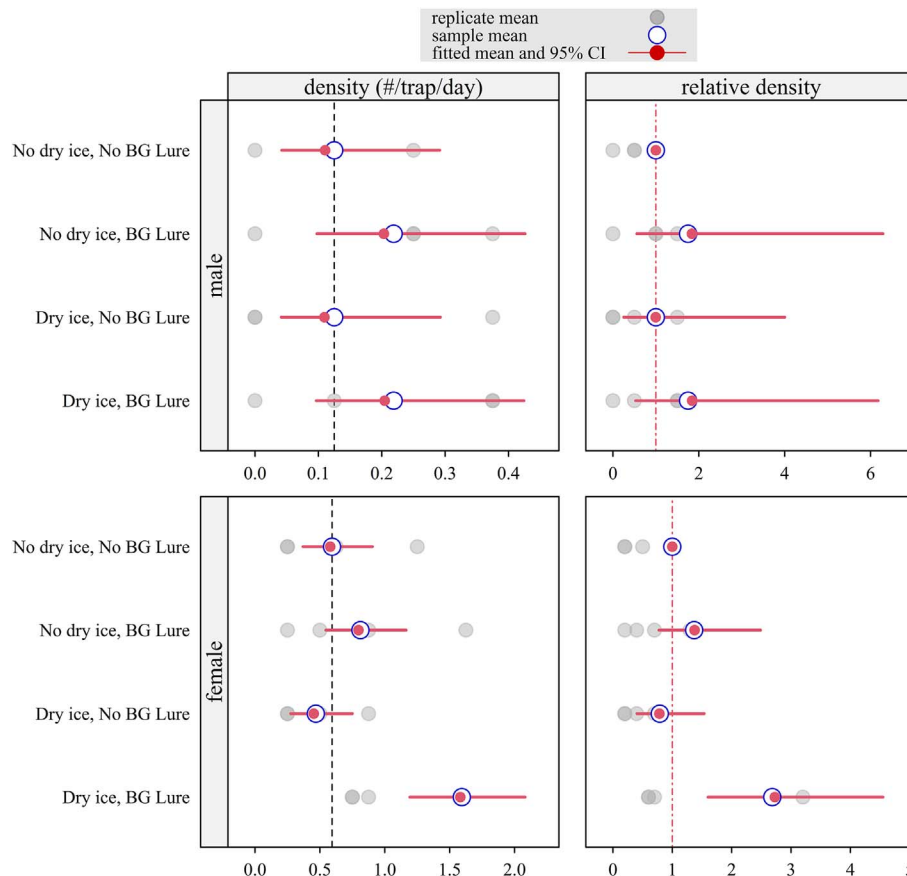
At the end of each 24-hour sampling period, collection nets from the BG-Sentinel 2 traps were retrieved, transported to the respective laboratories, and stored at −20 °C to kill the mosquito specimens. Mosquitoes captured in the traps during the study period were identified to species level using taxonomic keys [9, 16], counted and recorded by sex in a relational database management system for subsequent analysis.

Data analysis

In this study, we addressed the primary question of which combination of dry ice and BG-Lure maximizes BG-Sentinel 2 trap performance (*i.e.*, the optimized baiting configuration). We fitted a separate Bayesian mixed-effect Poisson model for each combination of species (*Ae. albopictus*, *Ae. aegypti* or *Cx. pipiens*) and sex (male or female), the latter because males and females are not attracted to the traps for the same cues: seeking hosts for females, mating for males. Each model had the same fixed effects: dry ice (coded yes/no), BG Lure (coded yes/no), and their interaction. Two random effects – assumed to be independently and identically distributed, were associated with the model intercept, to account for random fluctuations in mosquito density by replicate and location. Posterior distributions of the fitted values were used to estimate relative risks (RR) compared with the unbaited control configuration. Posterior distributions from the Bayesian mixed-effects models were used to estimate the expected number of mosquitoes captured per trapping session for each baiting configuration. In this study, we refer to this model-based expected count as the density of mosquitoes, expressed as the predicted mean number of individuals collected per BG-Sentinel 2 trap per 24-hour trapping session. We use the term density in a relative ecological sense, as an index of local mosquito abundance rather than an absolute estimate of population size per unit area

Table 2. Total number of mosquitoes captured per species in each study area (Nicosia and Larnaca) from October 20 to November 14, 2024 (Cx. = *Culex*, Ae. = *Aedes*, Cs. = *Culiseta*).

Study area	Mosquito species/sex (total number)											Shannon Evenness	
	Cx.	Cx.	Cx.	Cx.	Cx.	Ae.	Ae.	Ae.	Ae.	Ae.	Cs.	Index (H')	(E)
	<i>pipiens</i> females	<i>pipiens</i> males	<i>theileri</i> females	<i>theileri</i> males	<i>perexiguus</i> females	<i>aegypti</i> females	<i>aegypti</i> males	<i>caspius</i> females	<i>albopictus</i> females	<i>albopictus</i> males	<i>longiareolata</i> females		
Nicosia	659	43	5	0	4	0	0	0	266	155	4	0.729	0.453
Larnaca	247	102	9	5	5	111	22	5	0	0	0	0.798	0.496

**Figure 2.** Model-estimated density and relative density of *Aedes aegypti* fitted with a Bayesian Poisson model with data collected during a field trial with a Latin square design in Larnaca (Cyprus), October–November 2024 ($n = 8$ trapping sessions for each grey dot). Separate models were fitted for males and females. Density represents the posterior mean expected number of mosquitoes captured per BG-Sentinel 2 trap per 24-hour trapping session. Relative density represents the ratio of this expected count to that of the control group (no dry ice, no BG-Lure), which was set to 1. Red segments indicate 95% CI. For relative density, intervals crossing the vertical dashed red line at 1 indicate that the null hypothesis of no difference from the control cannot be rejected ($\alpha = 0.05$).

(Table S1). These RR quantified the change in expected mosquito captures when BG-Sentinel 2 traps were baited with dry ice alone, BG-Lure alone, or both attractants combined. Data analysis, was performed within the R software environment for statistical computing and graphics [43]. Bayesian models were fitted using the integrated Laplace approximation (inla) of the Markov chain process [46]. Throughout this study, we set $\alpha = 0.05$. For completeness, fitted model coefficients are shown in the Supplementary Material.

Furthermore, ecological community parameters were calculated using standard biodiversity indices. Species richness was estimated using the Margalef index, diversity using the Shan-

non index (H'), and dominance using the Simpson index, all computed with the vegan package in R (Oksanen et al., 2013) [37]. Pielou's evenness index was calculated as $E_h = H'/\ln S$, where H' is the Shannon diversity index and S is the number of species [41].

In addition, weather data during the sampling period were obtained from the Department of Meteorology of the Republic of Cyprus. Data were collected from the Automatic Weather Stations (AWS) located in Athalassa (Nicosia) ($35^\circ 08' 27.50''$ N, $33^\circ 23' 47.85''$ E), and at the Larnaca Airport ($34^\circ 52' 24.71''$ N, $33^\circ 37' 02.57''$ E). Both stations are located approximately 3.5 km from the corresponding city's sampling

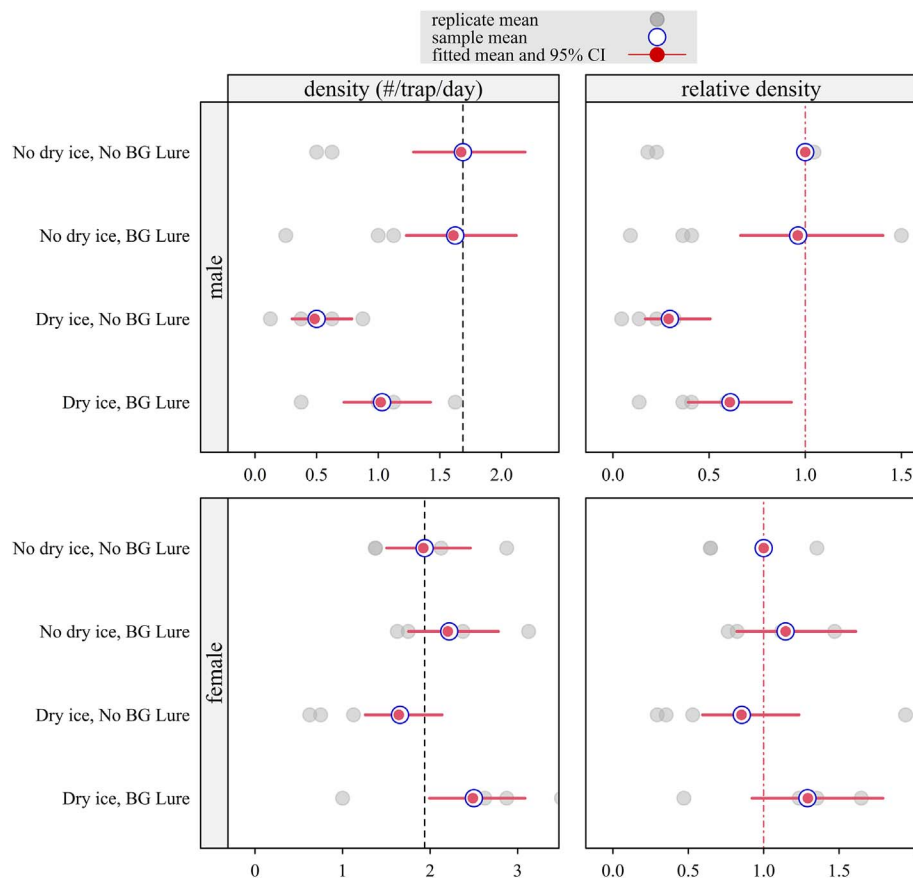


Figure 3. Model-estimated density and relative density of *Aedes albopictus* fitted with a Bayesian mixed-effect Poisson model (males), or a Bayesian marginal negative binomial model (females) of attractiveness implemented in a field trial with a Latin square design in Nicosia (Cyprus), October–November 2024 ($n = 8$ trapping sessions for each combination of sex, dry ice, and lure). Separate models were fitted for males and females. Density represents the posterior mean expected number of mosquitoes captured per BG-Sentinel 2 trap per 24-hour trapping session. Relative density represents the ratio of this expected count to that of the control group (no dry ice, no BG-Lure), which was set to 1. Red segments indicate 95% CI. For relative density, intervals crossing the vertical dashed red line at 1 indicate that the null hypothesis of no difference from the control cannot be rejected ($\alpha = 0.05$).

blocks. We collected data on environmental variables known to influence mosquito activity (and consequently trap catch variability), including temperature, humidity, and wind speed.

Results

A total of 1,649 mosquitoes were collected during the field trials. In Nicosia, the mosquito populations were dominated by *Cx. pipiens* ($n = 702$, females: 58.0% / males: 3.8%) and *Ae. albopictus* ($n = 421$, females: 23.4% / males: 13.6%). In Larnaca, *Cx. pipiens* ($n = 349$, females: 48.8% / males: 20.2%) and *Ae. aegypti* ($n = 133$, females: 21.9% / males: 4.3%) were the predominant species. Other species identified included *Cx. theileri*, *Cx. perexiguus*, and *Culiseta longiareolata* in Nicosia, while *Cx. theileri*, *Cx. perexiguus*, and *Ae. caspius* were present in Larnaca (Table 2 and Table S2). Notably, *Ae. cretinus* was not detected in either study area during this period.

The species composition differed between the two study areas. In Nicosia, the community was strongly dominated by *Cx. pipiens* and *Ae. albopictus*, resulting in a Shannon diversity index of $H' = 0.729$. Although Nicosia had a higher total mosquito abundance, its lower evenness ($E = 0.453$) reflects the

marked dominance of these two species. In contrast, Larnaca exhibited slightly higher diversity ($H' = 0.798$) and evenness ($E = 0.496$), supported by a more balanced distribution among *Cx. pipiens*, *Ae. aegypti*, and several secondary species (Table 2). Subsequently, we focused on evaluating the attractiveness of baited BG-Sentinel 2 traps to (i) *Ae. aegypti* in Larnaca, (ii) *Ae. albopictus* in Nicosia, and (iii) *Cx. pipiens* in both regions.

Aedes aegypti (Larnaca)

The surveillance efficacy for *Ae. aegypti* is summarized in Figure 2. For males, the density remained consistently low across all trap configurations, with a mean capture rate ranging from 0.13 (95% CI: 0.04–0.3; dry ice only) to 0.2 (95% CI: 0.1–0.4; dry ice + lure). No significant differences were observed between trap configurations for males.

In contrast, female densities were significantly higher. A synergistic effect was observed when combining dry ice and BG-Lure, resulting in a significant increase in capture efficacy with an RR of 2.7 (95% CI: 1.6–4.5) compared to the unbaited control.

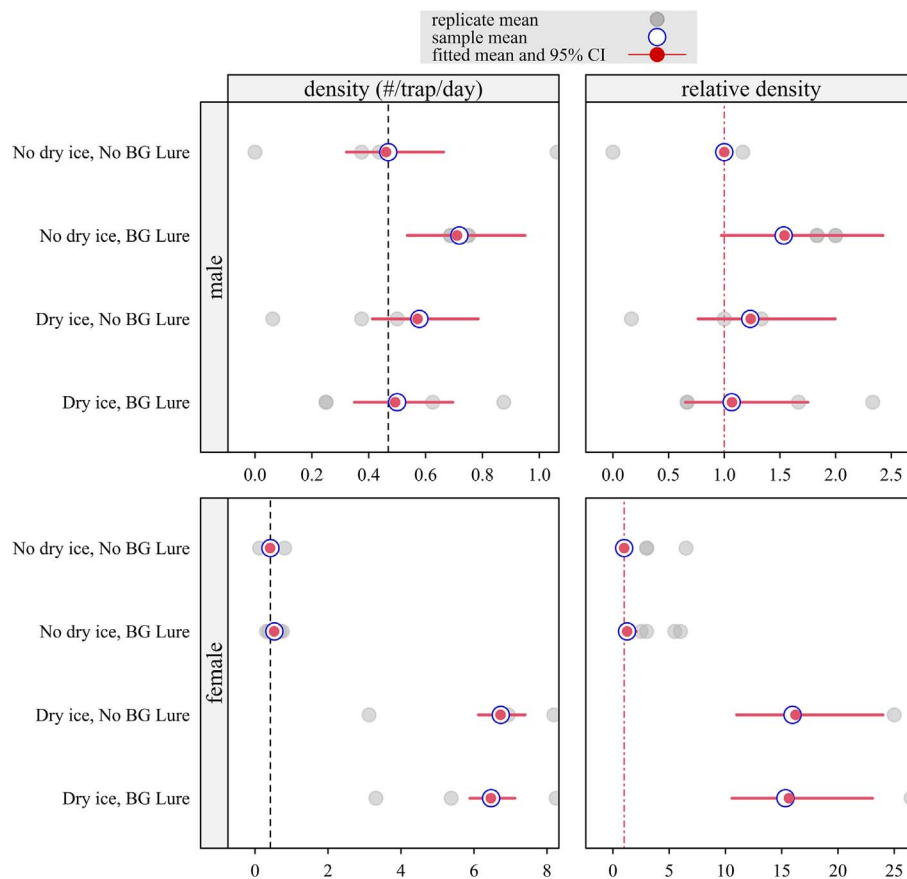


Figure 4. Density and relative density of *Cx. pipiens* fitted with a Bayesian mixed-effect Poisson model of BG-Sentinel 2 trap attractiveness on data collected during a field trial with a Latin square design in Larnaca and Nicosia (Cyprus), October–November 2024 ($n = 8$ trapping sessions for each combination of sex, dry ice, and lure). Separate models were fitted for males and females. Density represents the posterior mean expected number of mosquitoes captured per BG-Sentinel 2 trap per 24-hour trapping session. Relative density represents the ratio of this expected count to that of the control group (no dry ice, no BG-Lure), which was set to 1. Red segments indicate 95% CI. For relative density, intervals crossing the vertical dashed red line at 1 indicate that the null hypothesis of no difference from the control cannot be rejected ($\alpha = 0.05$).

Aedes albopictus (Nicosia)

Due to the high capture rates of *Ae. albopictus*, separate Bayesian models were utilized (Mixed-effect Poisson for males; Marginal Negative Binomial for females) (Fig. 3). For *Ae. albopictus*, sex-specific differences in response to attractants were observed. In males, the use of dry ice alone had a significant negative effect on capture efficacy (RR = 0.297, 95% CI: 0.175–0.467). This negative impact persisted, though less severely, when dry ice was combined with BG-Lure (RR = 0.612, 95% CI: 0.427–0.844). In contrast, no significant differences were detected between any of the attractant combinations and the control group for female *Ae. albopictus* in this trial.

Culex pipiens (Nicosia and Larnaca)

The response of *Cx. pipiens* showed distinct sexual dimorphism regarding attractant preference (Fig. 4). In males, the effects of dry ice were negligible; however, BG-Lure used alone resulted in a small but statistically significant increase in capture

efficacy (RR = 1.533, 95% CI: 1.131–2.031). This positive effect was not observed when BG-Lure was combined with dry ice, suggesting that the presence of carbon dioxide neutralized the lure's contribution. In contrast, females showed a strong and statistically significant positive response to dry ice, regardless of whether BG-Lure was present. Relative risks reached 15.95 (95% CI: 14.50–17.54) for dry ice alone and 15.32 (95% CI: 13.91–16.86) for the combined treatment. The addition of BG-Lure did not significantly improve performance beyond that achieved with dry ice alone.

Environmental conditions

Throughout the sampling period, average temperatures in Nicosia remained stable between 20 and 24 °C, with humidity ranging from 40% to 80%, and wind speeds ranging from 1 Bft (average 0.9 m/s) to almost 2 Bft (average 2.9 m/s) (Figs. 1 and 2). In Larnaca, temperatures were similarly stable at approximately 20 °C, humidity ranged from 40% to 80%, and wind speeds showed greater variation, reaching up to 4 Bft (average 5.6 m/s) (Figs. 5 and 6).

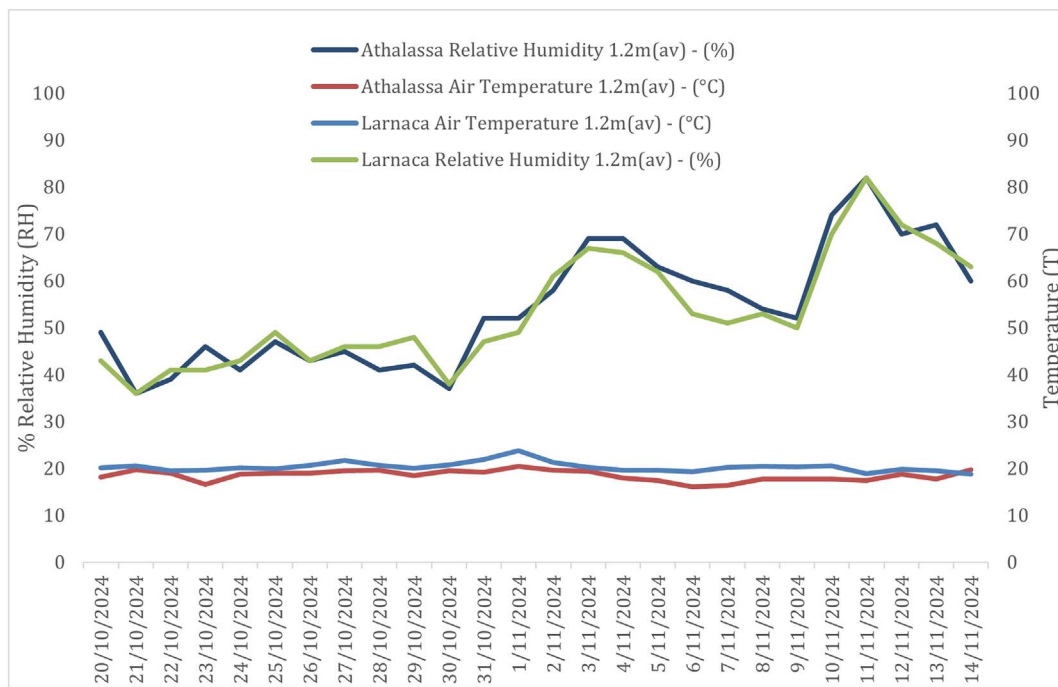


Figure 5. Environmental conditions in Nicosia and Larnaca during the sampling period. The graph shows the daily average temperature (°C) and relative humidity (%) recorded at the Athalassa and Larnaca airport, Automatic Weather Station. In Nicosia, the temperatures remained relatively stable between 20 and 24 °C, while humidity ranged from 40% to 80%. In Larnaca, the temperatures remained stable at approximately 20 °C, while humidity ranged from 40% to 80%.

Discussion

The current study evaluated the performance of different baits for BG-Sentinel 2 traps in detecting medically important mosquito species under field conditions representative of south-eastern Mediterranean urban environments. Our findings provide critical data for designing effective surveillance strategies and vector control programs including SIT, especially in newly colonized regions with limited historical data.

For *Ae. aegypti*, male capture rates were consistently low across all baiting treatments and no attractant combination produced statistically supported improvements relative to the unbaited control. Female capture rates were higher and the combination of dry ice and BG-Lure was associated with a statistically supported increase in trap catches compared with the control. These results suggest that, under the study conditions, combined host-associated cues can enhance female *Ae. aegypti* captures, whereas male detection remains challenging. From a surveillance perspective, low male capture rates imply that absence of captures cannot be interpreted as absence of the species when trap density is limited. Consequently, higher trap densities or complementary surveillance tools may be required, particularly during early invasion or post-suppression phases. The addition of dry ice as bait did not increase trap attractiveness for male *Ae. aegypti* in our study, a result that contrasts with previous research showing enhanced BG-Sentinel 2 trap performance when carbon dioxide is used as an attractant [8, 14, 60]. This discrepancy may reflect differences in local mosquito density, trap location, environmental conditions, and host availability, all of which can influence the strength and dispersion of attractants and thus mosquito responses in the field. It

may also indicate that the uncontrolled and temporary flow of CO₂ is not as attractive as continuous controlled release, which is possible with compressed CO₂ [14].

Although dry ice alone did not significantly increase *Ae. aegypti* captures, its combination with BG-Lure did enhance female trap performance. This finding contrasts with other studies which report increased effectiveness of BG-Sentinel traps when baited with carbon dioxide [30, 42]. Considering that both *Ae. aegypti* and *Ae. albopictus* were absent from the Republic of Cyprus until very recently (and therefore the populations currently established on the island did not have much time to build up), the lack of benefit attributable to CO₂ observed in our study might be partially explained by a low population density of these species, especially for *Ae. albopictus* which has already been established for many years in other Mediterranean countries. In the case of *Ae. aegypti*, the observed population levels are relatively low considering that the Cyprus Ministry of Health has implemented an immediate response, following its first detection, including door-to-door actions and SIT applications [13]. In addition, trap location may have influenced attractant performance, as mosquito host-seeking and resting behavior in these newly established populations is still being characterized under local environmental conditions.

Another factor that could affect the overall efficiency of the baits in Larnaca is the relatively windy conditions prevailing in this area, which during the sampling period reached up to 5.6 m/s, and never dipped below 2 m/s (Fig. 6). Wind speeds at this level can affect the linearity of the plume of attractant and reduce its efficiency. Importantly, previous studies have reported that wind speeds as low as 0.5 m/s can reduce mosquito trap catches

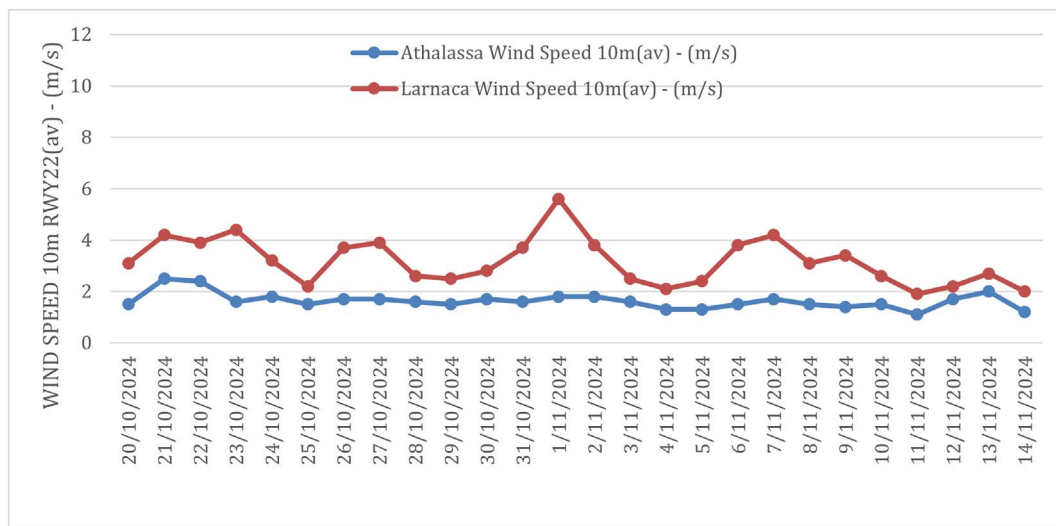


Figure 6. Wind conditions in Nicosia and Larnaca during the sampling period. The graph shows the recorded wind speeds, ranging from 1 Bft (average 0.9 m/s) to almost 2 Bft (average 2.9 m/s), measured at the Athalassa Automatic Weather Station. In Larnaca, the recorded wind speeds, which exhibited greater variation than in Nicosia, reaching up to 4 Bft (average 5.6 m/s), were measured at the Larnaca Airport Automatic Weather Station.

by up to 50% [11]. Therefore, our results suggest that attractant effectiveness may vary across environmental contexts and highlight the importance of localized trap validation before implementation. Detailed information on habitat features, such as vegetation density, proximity to alternative hosts or breeding sites, and small-scale structural variation was not systematically recorded. These factors can influence BG-Sentinel 2 trap performance for *Ae. aegypti* and *Ae. albopictus* [51], and their inclusion in future studies could help further refine the interpretation and applicability of our findings.

Unlike *Ae. aegypti*, the detection of male *Ae. albopictus* was better explained by the full Poisson model, which revealed significant effects of the attractant type. Dry ice alone had a strong and statistically significant negative effect on trap attractiveness, whereas BG-Lure had a weaker, non-significant negative effect. These results imply a complex behavioral response of male *Ae. albopictus* to synthetic host cues, potentially influenced by competing environmental factors or local adaptation. These findings are particularly relevant for SIT programs, where accurate estimation of male abundance is essential for measuring sterile-to-wild ratios, which is fundamental to guide the field releases of sterile males. Therefore, BG Sentinel 2 traps are an appropriate tool for estimating sterile-to-wild male ratios, as a complementary approach to the human landing collection method [55]. A 2022 study from La Réunion reported that adding CO₂ markedly increased male *Ae. albopictus* detection in BG-Sentinel traps, while BG-Lure provided no additional benefit [14]. These findings contrast with our results, where dry ice alone reduced male captures and the CO₂–BG-Lure combination only partially improved performance. Several factors may explain these discrepancies, including differences in CO₂ delivery systems (cylinders vs. dry ice), the environmental conditions between study sites, and potential strain-specific behavioral variation. Such differences highlight the need to better understand how attractant type and local ecological context influence male *Ae. albopictus* trap responsiveness, particularly

for SIT applications. For female *Ae. albopictus*, neither attractant alone nor in combination significantly influenced trap catch, reinforcing the need for alternative or supplementary monitoring tools when targeting female *Ae. albopictus*. They also challenge the assumption that standard attractant-baited BG-Sentinel 2 traps are universally effective across mosquito taxa and sexes.

In parallel, *Cx. pipiens*, although native to Europe, remains a key target for surveillance due to its role in transmitting West Nile virus and other encephalitic arboviruses, and it is consistently the most abundant species detected in entomological surveillance. Its widespread presence, behavioral plasticity, and potential for overlapping habitats with *Aedes* species necessitate its inclusion in integrated vector surveillance programs [20, 52]. Moreover, the species occurs as two ecologically distinct biotypes, *pipiens* and *molestus* and their hybrids, which differ in host preference, diapause behavior, and reproductive strategies, thereby influencing pathogen transmission dynamics [25, 31]. In the surveillance of *Cx. pipiens* in Europe, the two forms are rarely distinguished and identified only using molecular techniques. The ornithophilic *pipiens* form sustains enzootic cycles of avian viruses, while the anthropophilic and autogenous *molestus* form, along with hybrids, may act as bridge vectors, facilitating spillover to humans and other mammals [2, 56, 57]. Its ability to exploit a broad range of larval habitats, including organically enriched urban environments, further supports its dominance in both rural and urban settings. Consequently, surveillance of *Cx. pipiens* not only provides essential insights into arbovirus dynamics, but also complements monitoring of invasive *Aedes* species within integrated vector management frameworks across Europe [20].

BG-Sentinel 2 traps are an operational tool for estimating sterile-to-wild male ratios in *Ae. albopictus* SIT programs, as shown in a Tirana mark-release-recapture (MRR) study where they achieved similar recapture performance to human landing catches (HLC) with 2.36% vs 1.57% [55]. However, the results

may vary under different conditions, so they should be locally validated. It is also recommended that BG-Sentinel 2 trap ratios be complemented with HLC and egg hatch rates to better evaluate field competitiveness and program impact. Additionally, the outcomes from the current study demonstrate no significant effect of attractants on all species male (*Cx. pipiens* and *Aedes* spp.). Conversely, females showed a statistically significant positive response to dry ice, while BG-Lure had a weaker, non-significant effect for *Cx. pipiens*. These results suggest the use of CO₂-baited traps for monitoring female *Cx. pipiens* populations, particularly in the context of West Nile virus risk assessment.

The biodiversity indices further highlight ecological differences between the two study areas that may influence mosquito surveillance outcomes [6]. Although overall mosquito abundance was higher in Nicosia, the lower Shannon diversity ($H' = 0.729$) and evenness ($E = 0.453$) indicate a community strongly dominated by *Cx. pipiens* and *Ae. albopictus*. In contrast, Larnaca exhibited slightly higher diversity ($H' = 0.798$) and evenness ($E = 0.496$), reflecting a more balanced distribution of species, but with the presence of more *Ae. aegypti* than *Ae. albopictus*. Areas with lower evenness are typically characterized by dominance of a few highly adapted species, which may intensify interspecific competition and influence host-seeking behaviour, and trap encounter rates. Conversely, more even communities may reflect a broader range of ecological niches and host-use patterns, potentially affecting how different species respond to synthetic attractants [34].

In conclusion, our results suggest that attractant efficacy is both species- and sex-specific and can be modulated by environmental factors. Therefore, reliance on standardized trap configurations may compromise the sensitivity of surveillance efforts. This is particularly relevant for *Ae. aegypti*, which is currently under re-establishment in the Republic of Cyprus after decades of absence. Under such low-population conditions, the probability of detection remains limited. This outcome should not be recorded only as a constraint, since it may simulate an invasion at an early stage at PoEs, offering valuable information for the available surveillance and control tools under introduction scenarios [3]. Additionally, this is particularly important for evaluating the suppression and potential eradication efforts in SIT programs currently targeting *Ae. albopictus*, and in the future, potential expansion of *Ae. aegypti* across Europe and the Mediterranean region.

Acknowledgements

We are grateful to Evangelia Zavitsanou for her valuable support in map creation.

Funding

This study was supported by the projects: A) IDAlert (<https://idalertproject.eu>, accessed on September 18, 2024) with grant No. 101057554. IDAlert is part of the EU climate change and health cluster (<https://climate-health.eu>, accessed on September 18, 2024), B) the project “E4Warning: Eco-Epidemiological Intelligence for early Warning and response to mosquito-borne disease risk in Endemic and Emergence settings” (<https://www.e4warning.eu>) financed by Horizon Europe grant No. 01086640 and C) “A systematic surveillance of vector

mosquitoes for the control of mosquito-borne diseases in the Region of Attica”, financed by the Region of Attica, Greece.

Research activities on the surveillance and control of *Aedes* vectors of arboviruses conducted by JB & RL were supported by the Interreg PRERISK_OI project funded by the Réunion Region and the European Regional Development Fund (ERDF) under agreement 2024-1402-006701. Europe is committed to Réunion with INTERREG.

This study was also supported by resources provided through the IAEA’s Technical Cooperation project CYP5021 “Preventing the Spread of *Aedes albopictus* and *Aedes aegypti* Mosquitoes”.

Conflicts of interest

The authors declare that they have no conflict of interest. The funders had no role in the design of the study, in the collection, analysis, or interpretation of data, nor in writing of the manuscript, or in the decision to publish the results.

Author contribution statement

A.M. and J.B. planned the research; G.B., J.B., V.K., C.A., A.S.S., and A.M. designed the research; G.B., V.K., C.A., A.S.S., Y.P., K.P., G.P., M.V., M.S.S., and M.B. performed the research; R.L., G.B., M.N., and J.B. analyzed the data; G.B., M.N., V.K., C.A., A.S.S., M.S.S., and M.B. interpreted the data; G.B., M.V., C.A., A.S.S., and A.M. handled project administration; M.V. and A.M. acquired funding; G.B., J.B., A.M., and R.L. wrote the first version of the paper; All authors corrected the final version of the paper.

Supplementary material

Supplemental File: (Model coefficients) Mixed-effect “Poisson model of density of male *Aedes aegypti*” and Mixed-effect “Poisson model of density of female *Aedes aegypti*”.

Table S1: Density and relative density of *Aedes aegypti* fitted with a Bayesian mixed-effect Poisson model, with data collected during a field trial with a Latin square design in Larnaca (Cyprus), October–November 2024.

Table S2: Number of mosquitoes collected with each trap configuration in Larnaca and Nicosia, Cyprus.

The supplementary material of this article is available at <https://www.parasite-journal.org/10.1051/parasite/2026033/olm>.

References

- Anderson JF, McKnight S, Ferrandino FJ. 2012. *Aedes japonicus japonicus* and associated woodland species attracted to Centers for Disease Control and prevention miniature light traps baited with carbon dioxide and the Trapttech[®] mosquito lure. *Journal of the American Mosquito Control Association*, 28, 184–191.
- Balatsos G, Beleri S, Tegos N, Bisia M, Karras V, Zavitsanou E, Papachristos DP, Papadopoulos NT, Michaelakis A, Patsoula E. 2024. Overwintering west Nile virus in active *Culex pipiens* mosquito populations in Greece. *Parasites & Vectors*, 17, 286.
- Balatsos G, Blanco-Sierra L, Karras V, Puggioli A, Osório HC, Bellini R, Papachristos DP, Bouyer J, Bartumeus F, Papadopoulos NT, Michaelakis A. 2024. Residual longevity of recaptured sterile mosquitoes as a tool to understand field performance and reveal quality. *Insects*, 15, 826.
- Balatsos G, Karras V, Puggioli A, Balestrino F, Bellini R, Papachristos DP, Milonas PG, Papadopoulos NT, Malfacini M, Carrieri M, Kapranas A, Mamai W, Mastronikolos G, Lytra I, Bouyer J, Michaelakis A. 2024. Sterile Insect Technique (SIT)

- field trial targeting the suppression of *Aedes albopictus* in Greece. *Parasite*, 31, 17.
5. Balatsos G, Puggioli A, Karras V, Lytra I, Mastronikolos G, Carrieri M, Papachristos DP, Malfacini M, Stefopoulou A, Ioannou CS, Balestrino F, Bouyer J, Petrić D, Pajović I, Kapranas A, Papadopoulos NT, Milonas PG, Bellini R, Michaelakis A. 2021. Reduction in egg fertility of *Aedes albopictus* mosquitoes in Greece following releases of imported sterile males. *Insects*, 12, 110.
 6. Bálint M, Domisch S, Engelhardt CHM, Haase P, Lehrian S, Sauer J, Theissing K, Pauls SU, Nowak C. 2011. Cryptic biodiversity loss linked to global climate change. *Nature Climate Change*, 1, 313–318.
 7. Ballardini M, Ferretti S, Chiaranz G, Pautasso A, Riina MV, Triglia G, Verna F, Bellavia V, Radaelli MC, Berio E, Accorsi A, De Camilli M, Cardellino U, Fiorino N, Acutis PL, Casalone C, Mignone W. 2019. First report of the invasive mosquito *Aedes koreicus* (Diptera: Culicidae) and of its establishment in Liguria, northwest Italy. *Parasites & Vectors*, 12, 334.
 8. Barrera R, Mackay AJ, Amador M. 2013. An improved trap to capture adult container-inhabiting mosquitoes. *Journal of the American Mosquito Control Association*, 29, 358–368.
 9. Becker N, Petrić D, Zgomba M, Boase C, Madon MB, Dahl C, Kaiser A. 2020. *Mosquitoes: Identification, Ecology and Control*. Springer International Publishing: Cham.
 10. Becker N, Schön S, Klein A-M, Ferstl I, Kizgin A, Tannich E, Kuhn C, Pluskota B, Jöst A. 2017. First mass development of *Aedes albopictus* (Diptera: Culicidae) – its surveillance and control in Germany. *Parasitology Research*, 116, 847–858.
 11. Bidlingmayer WL, Day JF, Evans DG. 1995. Effect of wind velocity on suction trap catches of some Florida mosquitoes. *Journal of the American Mosquito Control Association*, 11, 295–301.
 12. Charnley GEC, Alcayna T, Almuedo-Riera A, Antoniou C, Badolo A, Bartumeus F, Boodram L-L, Bueno-Marí R, Codeço C, Coelho FC, Costa F, Cox H, Haddad N, Hamid NA, Kittayapong P, Korukluoğlu G, Michaelakis A, Maciel-de-Freitas R, Montalvo T, Muñoz J, Oliveras SS, Palmer JRB, Pizard CJB, Ribeiro GS, Lowe R. 2025. Strengthening resilience to emerging vector-borne diseases in Europe: lessons learnt from countries facing endemic transmission. *Lancet Regional Health – Europe*, 53, 101271.
 13. Cholvi M, Moretti R, Osório HC, L'Ambert G, Seixas G, Kavran M, Michaelakis A, Stephanou AS, Antoniou CP, Martinou AF, Roiz D, Calvitti M, Bueno-Marí R. 2026. Present and future of mosquito-borne disease control in Europe with a specific focus on the Mediterranean. *Insects*, 17, 254.
 14. Claudel I, Brouazin R, Lancelot R, Gouagna L-C, Dupraz M, Baldet T, Bouyer J. 2022. Optimization of adult mosquito trap settings to monitor populations of *Aedes* and *Culex* mosquitoes, vectors of arboviruses in La Reunion. *Scientific Reports*, 12, 19544.
 15. Cunze S, Koch LK, Kochmann J, Klimpel S. 2016. *Aedes albopictus* and *Aedes japonicus* - two invasive mosquito species with different temperature niches in Europe. *Parasites & Vectors*, 9, 573.
 16. Darsie RF, Samanidou-Voyadjoglou A. 1997. Keys for the identification of the mosquitoes of Greece. *Journal of the American Mosquito Control Association*, 13, 247–254.
 17. Denlinger DL, Armbruster PA. 2014. Mosquito Diapause. *Annual Review of Entomology*, 59, 73–93.
 18. Diniz DFA, Romão TP, Helvécio E, Carvalho-Leandro D de, Xavier M do N, Peixoto CA, Melo Neto OP de, Melo-Santos MAV de, Ayres CFJ. 2022. A comparative analysis of *Aedes albopictus* and *Aedes aegypti* subjected to diapause-inducing conditions reveals conserved and divergent aspects associated with diapause, as well as novel genes associated with its onset. *Current Research in Insect Science*, 2, 100047.
 19. European Centre for Disease Prevention and Control. 2012. Guidelines for the surveillance of invasive mosquitoes in Europe. Publications Office: LU.
 20. European Centre for Disease Prevention and Control (ECDC). 2020. *Culex pipiens* – Factsheet for experts. European Centre for Disease Prevention and Control (ECDC).
 21. European Centre for Disease Prevention and Control (ECDC). 2025. *Aedes albopictus* – current known distribution: June 2025. European Centre for Disease Prevention and Control (ECDC).
 22. European Centre for Disease Prevention and Control (ECDC). 2025. *Aedes aegypti* – current known distribution: June 2025. European Centre for Disease Prevention and Control (ECDC).
 23. Giannakopoulos C, Hadjinicolaou P, Kostopoulou E, Varotsos KV, Zerefos C. 2010. Precipitation and temperature regime over Cyprus as a result of global climate change. *Advances in Geosciences*, 23, 17–24.
 24. Giunti G, Becker N, Benelli G. 2023. Invasive mosquito vectors in Europe: From bioecology to surveillance and management. *Acta Tropica*, 239, 106832.
 25. Gutiérrez-López R, Yan J, Gangoso L, Soriguer R, Figuerola J, Puente JM la. 2024. Are the *Culex pipiens* biotypes *pipiens*, *molestus* and their hybrids competent vectors of avian *Plasmodium*? *PLoS ONE*, 19, e0314633.
 26. Kavran M, Konjević A, Petrić D, Čupina AI. 2023. The introduction and establishment of four invasive insect species in Serbia. *Insects*, 14, 728.
 27. Koban MB, Kampen H, Scheuch DE, Frueh L, Kuhlisch C, Janssen N, Steidle JLM, Schaub GA, Werner D. 2019. The Asian bush mosquito *Aedes japonicus japonicus* (Diptera: Culicidae) in Europe, 17 years after its first detection, with a focus on monitoring methods. *Parasites & Vectors*, 12, 109.
 28. Kraemer MU, Sinka ME, Duda KA, Mylne AQ, Shearer FM, Barker CM, Moore CG, Carvalho RG, Coelho GE, Van Bortel W, Hendrickx G, Schaffner F, Elyazar IR, Teng H-J, Brady OJ, Messina JP, Pigott DM, Scott TW, Smith DL, Wint GW, Golding N, Hay SI. 2015. The global distribution of the arbovirus vectors *Aedes aegypti* and *Ae. albopictus*. *eLife*, 4, e08347.
 29. Kraemer MUG, Reiner RC, Brady OJ, Messina JP, Gilbert M, Pigott DM, Yi D, Johnson K, Earl L, Marczak LB, Shirude S, Davis Weaver N, Bisanzio D, Perkins TA, Lai S, Lu X, Jones P, Coelho GE, Carvalho RG, Van Bortel W, Marsboom C, Hendrickx G, Schaffner F, Moore CG, Nax HH, Bengtsson L, Wetter E, Tatem AJ, Brownstein JS, Smith DL, Lambrechts L, Cauchemez S, Linard C, Faria NR, Pybus OG, Scott TW, Liu Q, Yu H, Wint GRW, Hay SI, Golding N. 2019. Past and future spread of the arbovirus vectors *Aedes aegypti* and *Aedes albopictus*. *Nature Microbiology*, 4, 854–863.
 30. Le Goff G, Damiens D, Ruttee A-H, Payet L, Lebon C, Dehecq J-S, Geier M, Gouagna L-C. 2017. Comparison of efficiency of BG-Sentinel traps baited with mice, mouse-litter, and CO2 lures for field sampling of male and female *Aedes albopictus* mosquitoes. *Insects*, 8, 95.
 31. Leisnham PT, LaDeau SL, Saunders MEM, Villena OC. 2021. Condition-specific competitive effects of the invasive mosquito *Aedes albopictus* on the resident *Culex pipiens* among different urban container habitats may explain their coexistence in the field. *Insects*, 12, 993.

32. Lühken R, Brattig N, Becker N. 2023. Introduction of invasive mosquito species into Europe and prospects for arbovirus transmission and vector control in an era of globalization. *Infectious Diseases of Poverty*, 12, 109.
33. Miranda MÁ, Barceló C, Arnoldi D, Augsten X, Bakran-Lebl K, Balatsos G, Bengoa M, Bindler P, Boršová K, Bourquia M, Bravo-Barriga D, Čabanová V, Caputo B, Christou M, Delacour S, Eritja R, Fassi-Fihri O, Ferraguti M, Flacio E, Frontera E, Fuehrer H-P, García-Pérez AL, Georgiades P, Gewehr S, Goiri F, González MA, Gschwind M, Gutiérrez-López R, Horváth C, Ibáñez-Justicia A, Jani V, Kadriaj P, Kalan K, Kavran M, Klobucar A, Kurucz K, Lucientes J, Lühken R, Magallanes S, Marini G, Martinou AF, Michelutti A, Mihalca AD, Montalvo T, Montarsi F, Mourelatos S, Muja-Bajraktari N, Müller P, Notarides G, Osório HC, Oteo JA, Oter K, Pajović I, Palmer JRB, Petrinic S, Răileanu C, Ries C, Rogozi E, Ruiz-Arroondo I, Sanpera-Calbet I, Sekulić N, Sevim K, Sherifi K, Silaghi C, Silva M, Sokolovska N, Soltész Z, Sulesco T, Šušnjar J, Teekema S, Valsecchi A, Vasquez MI, Velo E, Michaelakis A, Wint W, Petrić D, Schaffner F, Torre A della, Suchentrunk C, Zechmeister T, Gruber E, Orehounig G, Altgayer G, Lex F, Lebl I, Zezula D, Petermann JS, Oberleitner F, Zittra C, Brenner T, Zimmermann K, Klocker L, Eigner B, Wortha L, Pree S, Jäger S, Schwerte T, Wieser C, Heimbürg H, Gunczy J, Paill W, Jerrentrup H, Pree S, Daroglou E, Eigner B, Shahi-Barogh B, Wortha LN, Svitok M, Svitková I, Oboňa J, Barbušinová E, Micocci M, Albani M, Serini P, Cobre P, Canals M, Bellés R, Erguler K, Neira M, Kelemenis N, Vlachos G, Karagiannis A, Barandika JF, Cevidanes A, Vázquez P, Stroo A, Horvat Z, Stranj M, Ignjatović-Ćupina A, Dondur D, Bogdanović S, Srdić V, Francuski Z, Žunić A, Posavec MC, Poje D, Pismarovic T, Markó G, Inama E, Manica M, Rizzoli A, Athanasiou K, Muja A, Qollaku H, Amaro F, Guerreiro N, Alten B, Gunay F, Eryigit OY, Yildirim B, Yilmaz SO, Pehlivan S, Neumann U, Tauchmann O, Vasic A, Busmachiu G, Lange U, Schmidt-Chanasit J, Angelidou I, Panayiotou C, Konstantinou I, Sino G, Mema H, Veliko A, Kollia D, Mourafetis F, Karras V, Bisia M, Bender C, AIM-COST/AIM-Surv C. 2022. AIMSURV: First pan-European harmonized surveillance of *Aedes* invasive mosquito species of relevance for human vector-borne diseases. *GigaByte*, 2022, gigabyte57.
34. Möhlmann TWR, Wennergren U, Tälle M, Favia G, Damiani C, Bracchetti L, Koenraadt CJM. 2017. Community analysis of the abundance and diversity of mosquito species (Diptera: Culicidae) in three European countries at different latitudes. *Parasites & Vectors*, 10, 510.
35. Mouchtouri B, Michaelakis A, Ibáñez-Justicia A, Bellini R, Kourentis L, Christoforidou E, Anagnostopoulos L, Plenge-Bönig A, Dirksen-Fischer M, Militzer K, Velayudhan R, Hadjichristodoulou C. 2022. Recommendations for standard operating procedures (SOPS) development for vector (mosquito) surveillance and control activities at ports and airports. *EU Healthy Gateways* (2022).
36. Müller P, Engeler L, Vavassori L, Suter T, Guidi V, Gschwind M, Tonolla M, Flacio E. 2020. Surveillance of invasive *Aedes* mosquitoes along Swiss traffic axes reveals different dispersal modes for *Aedes albopictus* and *Ae. japonicus*. *PLoS Neglected Tropical Diseases*, 14, e0008705.
37. Oksanen J, Blanchet FG, Kindt R, Legendre P, Minchin P, O'Hara R, Simpson G, Solymos P, Stevens M, Wagner H. 2013. *Vegan: Community Ecology Package*. R Package Version. 2.0-10. CRAN.
38. Pabst R, Sousa CA, Essl F, García-Rodríguez A, Liu D, Lenzner B, Schertler A, Zêzere JL, Capinha C. 2025. Global invasion patterns and dynamics of disease vector mosquitoes. *Nature Communications*, 16, 9127.
39. Pfitzner WP, Lehner A, Hoffmann D, Czajka C, Becker N. 2018. First record and morphological characterization of an established population of *Aedes (Hulecoeteomyia) koreicus* (Diptera: Culicidae) in Germany. *Parasites & Vectors*, 11, 662.
40. Piccinno R, Fiorenza G, Vasquez MI, Bouyer J, Notarides G, Gomulski LM, Meletiou S, Akiner M, Michaelakis A, Forneris F, Maga G, Gasperi G, Malacrida AR. 2025. On the tracks of an uninvited guest, the Asian tiger mosquito, *Aedes albopictus* in Cyprus. *Parasites & Vectors*, 18, 39.
41. Pielou EC. 1966. The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology*, 13, 131–144.
42. Pombi M, Jacobs F, Verhulst NO, Caputo B, Torre A della, Takken W. 2014. Field evaluation of a novel synthetic odour blend and of the synergistic role of carbon dioxide for sampling host-seeking *Aedes albopictus* adults in Rome, Italy. *Parasites & Vectors*, 7, 580.
43. R Core Team. 2025. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. <https://www.r-project.org/>.
44. Roiz D, Duperier S, Roussel M, Boussès P, Fontenille D, Simard F, Paupy C. 2016. Trapping the tiger: Efficacy of the Novel BG-Sentinel 2 with several attractants and carbon dioxide for collecting *Aedes albopictus* (Diptera: Culicidae) in Southern France. *Journal of Medical Entomology*, 53, 460–465.
45. Rosen L. 1986. Dengue in Greece in 1927 and 1928 and the pathogenesis of dengue hemorrhagic fever: New data and a different conclusion. *American Journal of Tropical Medicine and Hygiene*, 35, 642–653.
46. Rue H, Riebler A, Sørbye SH, Illian JB, Simpson DP, Lindgren FK. 2017. Bayesian computing with INLA: A Review. *Annual Review of Statistics and Its Application*, 4, 395–421.
47. Santé publique France (SPF) 2024. Chikungunya, dengue et zika – Données de la surveillance renforcée en France hexagonale 2024. Santé Publique France.
48. Scholte E-J, Jacobs F, Linton Y-M, Dijkstra E, Franssen J, Takken W. 2007. First record of *Aedes (Stegomyia) albopictus* in the Netherlands. *European Mosquito Bulletin*, 22, 5–9.
49. Seixas G, Salgueiro P, Bronzato-Badial A, Gonçalves Y, Reyes-Lugo M, Gordicho V, Ribolla P, Viveiros B, Silva AC, Pinto J, Sousa CA. 2019. Origin and expansion of the mosquito *Aedes aegypti* in Madeira Island (Portugal). *Scientific Reports*, 9, 2241.
50. Sousa CA, Clairouin M, Seixas G, Viveiros B, Novo MT, Silva AC, Escoval MT, Economopoulou A. 2012. Ongoing outbreak of dengue type 1 in the Autonomous Region of Madeira, Portugal: preliminary report. *Eurosurveillance*, 17, 20333.
51. Staunton KM, Crawford JE, Cornel D, Yeeles P, Desnoyer M, Livni J, Holeman J, Mulligan FS, Snoad N, Ritchie SA. 2020. Environmental influences on *Aedes aegypti* catches in Biogents Sentinel traps during a Californian “rear and release” program: Implications for designing surveillance programs. *PLoS Neglected Tropical Diseases*, 14, e0008367.
52. Stiles PC, Balatsos G, Liyanage P, Baron JN, Sakellariou Sofianou M, Bisia M, Karras V, Bärmighausen T, Patsoula E, Rocklöv J, Michaelakis A, Bunker A. 2025. Three-year assessment of integrated vector management in Attica, Greece: results from surveillance and control activities. *Communications Biology*, 8, 1533.
53. Swan T, Russell TL, Staunton KM, Field MA, Ritchie SA, Burkot TR. 2022. A literature review of dispersal pathways of *Aedes albopictus* across different spatial scales: implications for vector surveillance. *Parasites & Vectors*, 15, 303.

54. Vasquez MI, Notarides G, Meletiou S, Patsoula E, Kavran M, Michaelakis A, Bellini R, Toumazi T, Bouyer J, Petrić D. 2023. Two invasions at once: update on the introduction of the invasive species *Aedes aegypti* and *Aedes albopictus* in Cyprus – a call for action in Europe. *Parasite*, 30, 41.
55. Velo E, Balestrino F, Kadriaj P, Carvalho DO, Dicko A, Bellini R, Puggioli A, Petrić D, Michaelakis A, Schaffner F, Almenar D, Pajovic I, Beqirllari A, Ali M, Sino G, Rogozi E, Jani V, Nikolla A, Porja T, Goga T, Fălcuă E, Kavran M, Pudar D, Mikov O, Ivanova-Aleksandrova N, Cvetkovikj A, Akiner MM, Mikovic R, Tafaj L, Bino S, Bouyer J, Mamai W. 2022. A Mark-release-recapture study to estimate field performance of imported radio-sterilized male *Aedes albopictus* in Albania. *Frontiers in Bioengineering and Biotechnology*, 10, 833698.
56. Vogels CB, Göertz GP, Pijlman GP, Koenraadt CJ. 2017. Vector competence of European mosquitoes for West Nile virus. *Emerging Microbes & Infections*, 6, 1–13.
57. Vogels CBF, Fros JJ, Göertz GP, Pijlman GP, Koenraadt CJM. 2016. Vector competence of northern European *Culex pipiens* biotypes and hybrids for West Nile virus is differentially affected by temperature. *Parasites & Vectors*, 9, 393.
58. Westby KM, Medley KA. 2020. Cold Nights, City Lights: Artificial light at night reduces photoperiodically induced diapause in urban and rural populations of *Aedes albopictus* (Diptera: Culicidae). *Journal of Medical Entomology*, 57, 1694–1699.
59. Wilke ABB, Benelli G, Beier JC. 2020. Beyond frontiers: On invasive alien mosquito species in America and Europe. *PLoS Neglected Tropical Diseases*, 14, e0007864.
60. Wilke ABB, Carvajal A, Medina J, Anderson M, Nieves VJ, Ramirez M, Vasquez C, Petrie W, Cardenas G, Beier JC. 2019. Assessment of the effectiveness of BG-Sentinel traps baited with CO₂ and BG-Lure for the surveillance of vector mosquitoes in Miami-Dade County, Florida, *PLoS ONE*, 14, e0212688.
61. Wint W, Jones P, Kraemer M, Alexander N, Schaffner F. 2022. Past, present and future distribution of the yellow fever mosquito *Aedes aegypti*: The European paradox. *Science of the Total Environment*, 847, 157566.

Cite this article as: Balatsos G, Karras V, Neira M, Lancelot R, Antoniou C, Stephanou AS, Pigkeridis Y, Papazacharia K, Papazacharia G, Violaris M, Sofianou MS, Bisia M, Bouyer J & Michaelakis A. 2026. Evaluating BG-Sentinel trap setting as an effective surveillance tool for mosquito vectors in the Republic of Cyprus. *Parasite* 33, 31. <https://doi.org/10.1051/parasite/2026033>.



An international open-access, peer-reviewed, online journal publishing high quality papers on all aspects of human and animal parasitology

Reviews, articles and short notes may be submitted. Fields include, but are not limited to: general, medical and veterinary parasitology; morphology, including ultrastructure; parasite systematics, including entomology, acarology, helminthology and protistology, and molecular analyses; molecular biology and biochemistry; immunology of parasitic diseases; host-parasite relationships; ecology and life history of parasites; epidemiology; therapeutics; new diagnostic tools.

All papers in Parasite are published in English. Manuscripts should have a broad interest and must not have been published or submitted elsewhere. No limit is imposed on the length of manuscripts.

Parasite (open-access) continues **Parasite** (print and online editions, 1994-2012) and **Annales de Parasitologie Humaine et Comparée** (1923-1993) and is the official journal of the Société Française de Parasitologie.

Editor-in-Chief:
Jean-Lou Justine, Paris

Submit your manuscript at
<https://www.editorialmanager.com/parasite>