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DATA RELEASE

AIMSurv: First pan-European harmonized surveillance of *Aedes* invasive mosquito species of relevance for human vector-borne diseases

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ABSTRACT

Human and animal vector-borne diseases, particularly mosquito-borne diseases, are emerging or re-emerging worldwide. Six *Aedes* invasive mosquito (AIM) species were introduced to Europe since the 1970s: *Aedes aegypti*, *Ae. albopictus*, *Ae. japonicus*, *Ae. koreicus*, *Ae. atropalpus* and *Ae. triseriatus*. Here, we report the results of AIMSurv2020, the first pan-European surveillance effort for AIMs. Implemented by 42 volunteer teams from 24 countries. And presented in the form of a dataset named "AIMSurv Aedes Invasive Mosquito species harmonized surveillance in Europe. AIM-COST Action. Project ID: CA17108". AIMSurv2020 harmonizes field surveillance methodologies for sampling different AIMs life stages, frequency and minimum length of sampling period, and data reporting. Data include minimum requirements for sample types and recommended requirements for those teams with more resources. Data are published as a Darwin Core archive in the Global Biodiversity Information Facility- Spain, comprising a core file with 19,130 records (EventID) and an occurrences file with 19,743 records (OccurrenceID). AIM species recorded in AIMSurv2020 were *Ae. albopictus*, *Ae. japonicus* and *Ae. koreicus*, as well as native mosquito species.

Subjects Ecology, Biodiversity, Taxonomy

DATA DESCRIPTION

Background

Vector-borne diseases (VBDs) are caused by a pathogen transmitted by vectors (often an arthropod) between hosts. Emerging or re-emerging VBDs in humans and animals are of increasing concern for public health worldwide [1], particularly mosquito-borne viral diseases such as chikungunya, dengue, West Nile fever and Zika [2, 3].

Some mosquitoes capable of transmitting pathogens are relevant invasive species at the global scale [4, 5]. They are usually introduced into new areas by global trade (for example, used tires, plants) [6–8] and have spread within Europe through human-assisted pathways favored by environmental and climate change [9–11].

In Europe, six *Aedes* invasive mosquito (AIM) species [12, 13] have been introduced since the 1970s: the yellow fever mosquito *Aedes* (*Stegomyia*) *aegypti* (Linnaeus, 1762, NCBI:txid7159); the Asian tiger mosquito, *Aedes* (*Stegomyia*) *albopictus* (Skuse, 1894, NCBI:txid7160); the Japanese bush mosquito *Aedes* (*Hulecoeteomyia*) *japonicus* (Theobald, 1901, NCBI:txid140438); the Korean bush mosquito *Aedes* (*Hulecoeteomyia*) *koreicus* (Edwards, 1917, NCBI:txid586676); the American rock pool mosquito *Aedes* (*Georgecraigius*) *atropalpus* (Coquillett, 1902, NCBI:txid28624) and the American tree-hole mosquito, *Aedes* (*Protomacleaya*) *triseriatus* (Say, 1823, NCBI:txid7162).

Aedes aegypti is a major vector of yellow fever, dengue and chikungunya viruses and is commonly found in tropical and subtropical areas [14]. Recent re-establishment of this species in Europe was recorded on Madeira (Portugal) [15], in parts of southern Russia, Georgia and Turkey [16–18], as well as in Fuerteventura (Canary Islands, Spain) [19], from where it was successfully eradicated in 2019. This species has also been detected at several Western European locations such as the Netherlands [20], where it has not established.

The Asian tiger mosquito originates from Southeast Asia and is currently widespread throughout large areas of Africa, Europe, Australia, the Americas, and the Middle East [14, 21]. It is one of the most invasive species in the world, according to the Invasive Species Specialist Group of the International Union for the Conservation of Nature (IUCN) [4]. In Europe, *Ae. albopictus* was first detected in Albania in 1979 [22]; nowadays this species is found in more than 27 countries. Since 2007, the Asian tiger mosquito has been linked to several outbreaks of arboviral diseases, such as dengue and chikungunya, which were introduced by travelers in different areas of Europe (for example, Italy, France, Croatia, and Spain) [5, 23]. In laboratory trials, *Ae. albopictus* is a competent vector of more than 26 arboviruses [24]. It is also a nuisance to humans, especially because of its outdoor daylight feeding behavior [25].

Aedes japonicus originates from eastern Asia and is established in North America, Central Europe and areas of southern Europe (such as Spain and Italy) [26–28]. It breeds in artificial containers, so its means of introduction and dispersal are like those of *Ae. albopictus* [27]. Although laboratory trials showed it to be a competent vector of West Nile virus, among others, it is not considered a major vector of VBDs in nature [29].

Aedes koreicus originates from Korea, Japan, and northeast China and is present in some regions of Austria, Belgium, Germany, Hungary, Italy, Slovenia and the Swiss–Italian border [30–37]. It is not considered a major vector of VBDs, although field evidence suggests it is a potential vector of Japanese encephalitis virus [38], and laboratory trials have showed low-level transmission of chikungunya and Zika viruses [39, 40]. Moreover, it is likely to be a competent vector of *Dirofilaria immitis* [41].

Aedes atropalpus is an invasive mosquito species originating from North America, which has been detected in European countries like Italy, France and the Netherlands without any evidence of prolonged establishment [42–45]. It is not considered to be a major vector, but in laboratory trials it is a competent vector of viruses such as West Nile [46].

Finally, *Aedes triseriatus*, which originates from North America, was detected in a single incursion in France in 2004 and was successfully eradicated [44]. La Crosse [47] and West Nile [46] viruses have been detected in field-collected mosquito adults in the USA.

Context

Different EU initiatives exist to map the distribution of invasive mosquitoes. The European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA) have established VectorNet, a community network for medical entomologists and public health experts. VectorNet produces and periodically updates distribution maps of invasive mosquitoes in Europe [48]. These maps result from the analysis of literature records on the distribution of AIM species in Europe and the contribution of public, academia and research institutions that freely share their data with the VectorNet community. Another initiative is Mosquito Alert [49], a Spanish-originated citizen science campaign to monitor and map *Aedes* invasive species.

Early detection and surveillance of invasive mosquito species are challenging in terms of coordination and resources. Detection of AIM species may include different means and roles, from national surveillance programs to detect invasive species at points of entry, and to establish early warning rapid response systems to monitor AIM populations. Surveillance is commonly organized at the local and regional levels by public agencies, universities and research institutions [50], leading to different methodologies and strategies for sampling life stages of AIM (eggs, larvae/pupae and adults). Valuable guidelines for conventional surveillance have been produced by the ECDC and the World Health Organization Europe regional Office (EU-WHO) [51]. However, to date, they have never been harmonized and used simultaneously by different entomologist teams across Europe.

To increase harmonization between European entomologists, the *Aedes* Invasive Mosquito species (AIM) COST Action [52] was initiated in 2018. It had three major objectives: (i) to develop pan-European networking and collaboration in monitoring and surveillance of AIM species; (ii) to increase preparedness and capacity to fight against AIMs by triggering optimization and innovation in AIM control strategies; and (iii) to disseminate, customize and communicate the AIM-COST Action outcomes.

The AIM-COST Action aims to promote data sharing and harmonization. A particularly important objective is to ensure that vector sampling is consistent and compatible throughout Europe to enable an accurate continental picture of vector distributions. For this, AIM-COST organized a training course in Cyprus in January 2020 on harmonizing AIM surveillance across Europe. As a result of this course, trainers and trainees developed a protocol for surveying AIM species that can be applied across Europe. Forty-two teams from 24 countries (23 from Europe and one from North Africa) agreed to participating in the first ever pan-European surveillance of AIMs using a harmonized protocol [53]. The AIMSurv protocol was first implemented in 2020, then extended to 2021 and 2022. The main aim was to provide longitudinal data enabling comparison of seasonality and abundance across Europe and, in a subsequent phase, to compare field data with reports obtained by citizen science (for example, the Mosquito Alert App [54], the data of which has also been published in GBIF [55]). Accordingly, both the presence and absence results of AIMs species were considered equally important to improve the information at the continental level.

METHODS

The sampling protocol for pan-European surveillance of AIM species (AIMSurv) harmonized the sampling methods, frequency, minimum length of the sampling period and the form of reporting. A minimum requirements protocol (MRP) was established for different samples (for example, eggs in ovitraps), number of sampled sites, number of traps and frequency of collecting samples. For teams with more resources, a recommended protocol (RP) was also established to either increase the number of samples and/or to sample life stages other than eggs, such as adults.

The use of a common platform for data collection was also suggested: the VECMAP® App system [56] (Avia-GIS, Zoersel, Belgium), which was made freely available by Avia-GIS to all participants during AIMSurv activities.

Minimum requirements protocol

For the MRP, all teams performed the survey in three sampling sites separated by 10 km or more. Five oviposition traps (ovitraps) per site were placed and separated by 15–100 m.

The type of ovitrap was selected by each team according to their availability in the region, but usually consisted of 250 to 1000-ml capacity black containers filled with tap water. One scratched wooden tongue depressor (1.7 × 15 cm) per ovitrap was used as a substrate for oviposition. Some teams used similar sized pieces of Masonite board (when part of a pre-existing surveillance network was in place).

The selected sampling sites shared a similar ecology, when possible, in urban and/or suburban areas (e.g., a garden of single-family houses in residential urban/suburban areas, public parks near residential areas, recreational areas). The frequency of sample collection was biweekly over a minimum of 3 months, which included the population peak of the targeted AIM species (e.g., in Spain: from September to November for *Ae. albopictus*).

The following parameters were recorded: latitude and longitude of the position of each trap; the name of municipality/county/district (according to the country) and locality; start and end date of each trapping event (e.g., a period of 14 days for ovitraps); land use categories (urban, suburban and others); count of each life stage collected (egg and adult), including absences (0 values).

Recommended protocol

The more ambitious RP sampling included additional sampling sites sampled by five ovitraps per site, weekly sampling frequency and sampling length during the whole seasonality of the AIM species including start, peak and end of the mosquito season (e.g., May to November in Central Europe for *Ae. albopictus*). In addition, sampling adults using one BG-Sentinel™ (Biogents, Germany) trap baited with BG-Lure™ (Biogents, Germany) and/or CO_2 per site under a sampling frequency of one trap/night per week was also included. The use of VECMAP® (AVIA-GIS, Belgium) to report the data was also suggested in the RP. Parameters to record were the same as for the MRP, plus the daily or weekly record of meteorological parameters (maximum, minimum, average temperature) per site, collected using data loggers or local weather stations (data not included in the current dataset).

The trap status per trapping event was recorded as follows: 'Valid' when the trap (either oviposition or BG-Sentinel) was fully functional during the sampling event; 'Trap altered' when oviposition trap was found dry or turned over, or objects or animals, such as snails and lizards, were found inside, but the sample could still be collected. 'Trap altered' also referred to BG-Sentinel traps when they were found unplugged or with the battery switched off, or if the funnel was blocked, but the sample could still be collected.

To process samples, eggs of AIM species collected were counted. When needed, for every location a subsample (two out of five ovitrap substrates per locality) of eggs was reared to confirm the species by larva/adult morphology, particularly in areas where several AIM species are present (i.e., *Ae. albopictus* and *Ae. japonicus*). Alternatively, when possible and depending on the team's resources, species were identified using: matrix-assisted laser desorption ionisation–time of flight mass spectrometry (MALDI-TOF MS) or molecular methods (e.g., DNA sequencing).

Adults of AIM species collected in BG-Sentinel™ traps were identified by morphology, and sexed and counted. Suggested identification keys were ECDC (2012) [51] and MosKeyTool V2.1 [57]. Samples of adults were preserved in 96% ethanol and/or cold preserved at −20/−80 °C to confirm identification if needed (e.g., via molecular tools).

DATA VALIDATION AND QUALITY CONTROL

All participants in AIMSurv reported data using a harmonized template. All data reported has been curated and the terminology has been homogenized. Data has been validated using the validator available at the Global Biodiversity Information Facility (GBIF) [58].

REUSE POTENTIAL

Records presented here represent the first pan-European data on field surveillance of AIM species conducted with harmoniously methodologies and time scales across 24 countries. The records allow the accurate comparison of AIM surveillance, abundance, and seasonality between countries and/or regions. Data can also be compared with other sampling strategies of AIM species, such as citizen science.

DATA AVAILABILITY

The data supporting this article are published through the Universitat de les Illes Balears IPT and are available under a CC0 waiver from GBIF [58]. We kindly ask users to give appropriate credit and attribution if you use this data.

EDITOR'S NOTE

This paper is part of a series of Data Release articles working with GBIF and supported by the Special Programme for Research and Training in Tropical Diseases (TDR), hosted at the World Health Organization [59].

DECLARATIONS

LIST OF ABBREVIATIONS

AIM: Aedes invasive mosquito; COST: European Cooperation in Science and Technology; ECDC: European Centre for Disease Control; EFSA: European Food Safety Authority; EU: European Union; EU-WHO: World Health Organization Europe regional office; IUCN: International Union for the Conservation of Nature; MALDI-TOF MS: matrix-assisted laser desorption ionization–time of flight mass spectrometry; MRP: minimum requirements protocol; RP: recommended protocol; VBD: vector-borne disease

ETHICAL APPROVAL

Not applicable.

CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTIONS

MAM and AdT conceived this work; MAM, AM, WW, DP and FS designed this work; CB, DA, XA, KB-L, GB, MB, PB, KB, MB, DB-B, VČ, BC, MC, SD, RE, OF-F, MF, EF, EMF-C, HPF, ALG-P, PG, SG, FG, MAG, MG, RG-L, CH, AI-J, VJ, PK, KK, MK, AK, KK, JL, RL, SM, GM, AFM, AM, AM, TM, FM, SM, NM-B, PM, GN, HCO, JAO, KO, IP, JRBP, SP, CR, CR, ER, IR-A, IS-C, NS, KS, KS, CS, MS, NiS, ZS, TS, JŠ, ST, AV, MIV, EV, AM, DP, FS collected the samples and reported results; MAM wrote the original draft and coordinated AIMSurv data compilation and curation; AdT coordinated AIM-COST Action. All authors read, revised, and approved the final manuscript.

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REFERENCES

1 **World Health Organization (WHO)**. A Global Brief on Vector-borne diseases. Geneva: WHO, 2014; http://apps.who.int/iris/bitstream/handle/10665/111008/WHO_DCO_WHD_2014.1_eng.pdf?sequence=17/v41a17.pdf?sequence=1WHD_2014.1_eng.pdf.

2 **Conway MJ**, **Colpitts TM**, **Fikrig E**. Role of the vector in arbovirus transmission. ***Annu. Rev. Virol.***, 2014; **1**: 71–88. doi:10.1146/annurev-virology-031413-085513.

3 **Näslund J**, **Ahlm C**, **Islam K et al.** Emerging Mosquito-Borne viruses linked to *Aedes aegypti* and *Aedes albopictus*: global status and preventive strategies. ***Vector-Borne Zoonotic Dis.***, 2021; **21**(10): 731–746. doi:10.1089/vbz.2020.2762.

4 **Lowe S**, **Browne M**, **Boudjelas S et al.** 100 of the World's Worst Invasive Alien Species A selection from the Global Invasive Species Database. 2000; http://www.iucngisd.org/gisd/pdf/100English.pdf.

5 **Schaffner F**, **Medlock JM**, **Van Bortel W**. Public health significance of invasive mosquitoes in Europe. ***Clin. Microbiol. Infect.***, 2013; **19**(8): 685–692. doi:10.1111/1469-0691.12189.

6 **Tatem AJ**, **Huang Z**, **Das A et al.** Air travel and vector-borne disease movement. ***Parasitology***, 2012; **139**(14): 1816–1830. doi:10.1017/S0031182012000352.

7 **Lounibos LP**. Invasions by insect vectors of human disease. ***Annu. Rev. Entomol.***, 2002; **47**: 233–266. doi:10.1146/annurev.ento.47.091201.145206.

8 **Schaffner F**. Mosquitoes in used tyres in Europe: species list and larval key. ***Eur. Mosq. Bull.***, 2003; **16**: 7–12.

9 **Gould EA**, **Higgs S**. Impact of climate change and other factors on emerging arbovirus diseases. ***Trans. R. Soc. Trop. Med. Hyg.***, 2010; **103**(2): 109–121. doi:10.1016/j.trstmh.2008.07.025.Impact.

10 **Wilke ABB**, **Beier JC**, **Benelli G**. Complexity of the relationship between global warming and urbanization – an obscure future for predicting increases in vector-borne infectious diseases. ***Curr. Opin. Insect Sci.***, 2019; **35**: 1–9. doi:10.1016/j.cois.2019.06.002.

11 **Brugueras S**, **Fernández-Martínez B**, **Martínez-de la Puente J et al.** Environmental drivers, climate change and emergent diseases transmitted by mosquitoes and their vectors in southern Europe: A systematic review. ***Environ. Res.***, 2020; **191**: 110038. doi:10.1016/j.envres.2020.110038.

12 **Medlock JM**, **Hansford KM**, **Schaffner F et al.** A review of the invasive mosquitoes in Europe: ecology, public health risks, and control options. ***Vector-Borne Zoonotic Dis.***, 2012; **12**(6): 435–447. doi:10.1089/vbz.2011.0814.

13 **Johnson N**, **Fernández de Marco M**, **Giovannini A et al.** Emerging Mosquito-Borne threats and the response from European and Eastern Mediterranean countries. ***Int. J. Environ. Res. Public Health***, 2018; **15**(12): 2775. doi:10.3390/ijerph15122775.

14 **Kraemer MUG**, **Sinka ME**, **Duda KA et al.** The global distribution of the arbovirus vectors *Aedes aegypti* and *Ae. albopictus*. ***Elife***, 2015; **4**: e08347. doi:10.7554/eLife.08347.

15 **Almeida AP**, **Gonçalves YM**, **Novo MT et al.** Vector monitoring of *Aedes aegypti* in the autonomous region of Madeira, Portugal. ***Wkly Releases***, 2007; **12**(11): e071115.6. doi:10.2807/esw.12.46.03311-en.

16 **Riabova TE**, **Iunicheva IV**, **Markovich NI et al.** Detection of *Aedes* (Stegomyia) *aegypti* L. mosquitoes in Sochi city. ***Med. Parazitol. (Mosk)***, 2005; (3): 3–5.

17 **Akiner MM**, **Demirci B**, **Babuadze G et al.** Spread of the Invasive Mosquitoes *Aedes aegypti* and *Aedes albopictus* in the black sea region increases risk of chikungunya, Dengue, and Zika Outbreaks in Europe. ***PLoS Negl. Trop. Dis.***, 2016; **10**: e0004664. doi:10.1371/journal.pntd.0004664.

18 **Yunicheva Y**, **Ryabova T**, **Markovich N**. First data on the presence of breeding populations of the *Aedes aegypti* L. mosquito in Greater Sochi and various cities of Abkhazia. ***Med. Parazitol. (Mosk)***, 2008; **3**: 40–43.

19 **CCAES**. Resumen de la situación y conclusiones EVALUACIÓN RÁPIDA DE RIESGO Identificación del mosquito *Aedes aegypti* en Fuerteventura. 2017; https://www.sanidad.gob.es/profesionales/saludPublica/ccayes/alertasActual/docs/20171226_Aedes-aegypti_en_Fuerteventura_ERR.pdf.

20 **Ibáñez-Justicia A**, **Smitz N**, **Den Hartog W et al.** Detection of exotic mosquito species (Diptera: Culicidae) at international airports in Europe. ***Int. J. Environ. Res. Public Health***, 2020; **17**(10): 3450. doi:10.3390/ijerph17103450.

21 **Bonizzoni M**, **Gasperi G**, **Chen X et al.** The invasive mosquito species *Aedes albopictus*: Current knowledge and future perspectives. ***Trends Parasitol.***, 2013; **29**(9): 460–468. doi:10.1016/j.pt.2013.07.003.

22 **Adhami J**, **Reiter P**. Introduction and establishment of *Aedes* (Stegomyia) *albopictus* skuse (diptera: culicidae) in Albania. ***J. Am. Mosq. Control Assoc.***, 1998; **14**: 340–343.

23 **Caputo B**, **Russo G**, **Manica M et al.** A comparative analysis of the 2007 and 2017 Italian chikungunya outbreaks and implication for public health response. ***PLoS Negl. Trop. Dis.***, 2020; **14**(6): e0008159. doi:10.1371/JOURNAL.PNTD.0008159.

24 **Paupy C**, **Delatte H**, **Bagny L et al.** *Aedes albopictus*, an arbovirus vector: From the darkness to the light. ***Microbes Infect.***, 2009; **11**(14–15): 1177–1185. doi:10.1016/j.micinf.2009.05.005.

25 **Delatte H**, **Desvars A**, **Bouétard A et al.** Blood-feeding behavior of *Aedes albopictus*, a vector of chikungunya on la réunion. ***Vector-Borne Zoonotic Dis.***, 2010; **10**(3): 249–258. doi:10.1089/vbz.2009.0026.

26 **Cunze S**, **Kochmann J**, **Klimpel S**. Global occurrence data improve potential distribution models for *Aedes japonicus japonicus* in non-native regions. ***Pest. Manag. Sci.***, 2020; **76**(5): 1814–1822. doi:10.1002/ps.5710.

27 **Koban MB**, **Kampen H**, **Scheuch DE et al.** 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***, 2019; **12**: 109. doi:10.1186/s13071-019-3349-3.

28 **Montarsi F**, **Martini S**, **Michelutti A et al.** The invasive mosquito *Aedes japonicus japonicus* is spreading in northeastern Italy. ***Parasites Vectors***, 2019; **12**: 120. doi:10.1186/S13071-019-3387-X.

29 **Kaufman MG**, **Fonseca DM**. Invasion biology of *Aedes japonicus japonicus* (Diptera: Culicidae). ***Annu. Rev. Entomol.***, 2014; **59**: 31–49. doi:10.1146/annurev-ento-011613-162012.

30 **Versteirt V**, **De Clercq EM**, **Fonseca DM et al.** Bionomics of the established exotic mosquito species *Aedes koreicus* in Belgium, Europe. ***J. Med. Entomol.***, 2012; **49**(6): 1226–1232. doi:10.1603/ME11170.

31 **Hohmeister N**, **Werner D**, **Kampen H**. The invasive Korean bush mosquito *Aedes koreicus* (Diptera: Culicidae) in Germany as of 2020. ***Parasites Vectors***, 2021; **14**: 575. doi:10.1186/s13071-021-05077-7.

32 **Montarsi F**, **Martini S**, **Dal Pont M et al.** Distribution and habitat characterization of the recently introduced invasive mosquito *Aedes koreicus* [*Hulecoeteomyia koreica*], a new potential vector and pest in north-eastern Italy. ***Parasites Vectors***, 2013; **6**: 292. doi:10.1186/1756-3305-6-292.

33 **Suter T**, **Flacio E**, **Fariña BF et al.** First report of the invasive mosquito species *Aedes koreicus* in the Swiss-Italian border region. ***Parasites Vectors***, 2015; **8**: 402. doi:10.1186/S13071-015-1010-3/TABLES/1.

34 **Kurucz K**, **Kiss V**, **Zana B et al.** Emergence of *Aedes koreicus* (Diptera: Culicidae) in an urban area, Hungary. ***Parasitol. Res.***, 2016; **115**: 4687–4689. doi:10.1007/s00436-016-5229-5.

35 **Kalan K**, **Šušnjar J**, **Ivović V et al.** First record of *Aedes koreicus* (Diptera, Culicidae) in Slovenia. ***Parasitol. Res.***, 2017; **116**: 2355–2358. doi:10.1007/s00436-017-5532-9.

36 **Fuehrer H-P**, **Schoener E**, **Weiler S et al.** Monitoring of alien mosquitoes in Western Austria (Tyrol, Austria, 2018). ***PLoS Negl Trop Dis.***, 2020; **14**(6): e0008433. doi:10.1371/journal.pntd.0008433.

37 **Gradoni F**, **Bertola M**, **Carlin S et al.** Geographical data on the occurrence and spreading of invasive *Aedes* mosquito species in Northeast Italy. ***Data Br.***, 2021; **36**: 107047. doi:10.1016/J.DIB.2021.107047.

38 **Miles JA**. Some ecological aspects of the problem of arthropod-borne animal viruses in the Western Pacific and South-East Asia regions. ***Bull. World Health Organ.***, 1964; **30**(2): 197–210.

39 **Ciocchetta S**, **Prow NA**, **Darbro JM et al.** The new European invader *Aedes* (*Finlaya*) *koreicus*: a potential vector of chikungunya virus. ***Pathog. Glob. Health***, 2018; **112**(3): 107–114. doi:10.1080/20477724.2018.1464780.

40 **Jansen S**, **Cadar D**, **Lühken R et al.** Vector competence of the invasive mosquito species *Aedes koreicus* for arboviruses and interference with a novel insect specific virus. ***Viruses***, 2021; **13**(12): 2507. doi:10.3390/v13122507.

41 **Montarsi F**, **Ciocchetta S**, **Devine G et al.** Development of *Dirofilaria immitis* within the mosquito *Aedes* (*Finlaya*) *koreicus*, a new invasive species for Europe. ***Parasites Vectors***, 2015; **8**: 177. doi:10.1186/S13071-015-0800-Y/TABLES/3.

42 **Romi R**, **Di Luca M**, **Majori G**. Current status of *Aedes albopictus* and *Aedes atropalpus* in Italy. ***J. Am. Mosq. Control. Assoc.***, 1999; **15**: 425–427.

43 **Scholte EJ**, **Dik M**, **Ibaňez-Justicia A et al.** Findings and control of two invasive exotic mosquito species, *Aedes albopictus* and *Ae. atropalpus* (Diptera: Culicidae) in the Netherlands, 2011. ***Eur. Mosq. Bull.***, 2012; **30**: 1–14.

44 **ECDC: Mosquito factsheets**. Fact sheets. 2020; https://www.ecdc.europa.eu/en/disease-vectors/facts/mosquito-factsheets. Accessed 7 Feburary 2022.

45 **Scholte EJ**, **Den Hartog W**, **Braks M et al.** First report of a North American invasive mosquito species *Ochlerotatus atropalpus* (Coquillett) in the Netherlands, 2009. ***Euro Surveill.***, 2009; **14**(45): 19400. doi:10.2807/ESE.14.45.19400-EN.

46 **Turell MJ**, **Sardelis MR**, **Dohm DJ et al.** Potential North American vectors of West Nile virus. ***Ann. NY Acad. Sci.***, 2001; **951**: 317–324. doi:10.1111/J.1749-6632.2001.TB02707.X.

47 **Leisnham PT**, **Juliano SA**. Impacts of climate, land use, and biological invasion on the ecology of immature *Aedes* mosquitoes: implications for La Crosse emergence. ***Ecohealth***, 2012; **9**: 217–228. doi:10.1007/S10393-012-0773-7.

48 **ECDC: Mosquito maps**. https://www.ecdc.europa.eu/en/disease-vectors/surveillance-and-disease-data/mosquito-maps. Accessed 7 Feburary 2022.

49 **Palmer JRB**, **Oltra A**, **Collantes F et al.** Citizen science provides a reliable and scalable tool to track disease-carrying mosquitoes. ***Nat. Commun.***, 2017; **8**: 916. doi:10.1038/s41467-017-00914-9.

50 **ECDC**. Organisation of Vector Surveillance and Control in Europe. Stockholm. 2021; https://doi.org/10.2900/853486.

51 **ECDC**. Guidelines for the Surveillance of Invasive Mosquitoes in Europe. Stockholm. 2012; https://doi.org/10.2900/61134.

52 **AIM COST**. https://www.aedescost.eu.

53 **AIMSurv - Aedes field surveillance**. https://www.aedescost.eu/aimsurv.

54 **Mosquito Alert**. https://www.mosquitoalert.com/.

55 **Južnič-Zonta Ž**, **Sanpera-Calbet I**, **Eritja R et al.** Mosquito alert: leveraging citizen science to create a GBIF mosquito occurrence dataset. ***GigaByte***, 2022; https://doi.org/10.46471/gigabyte.54.

56 **VECMAP**. https://www.avia-gis.com/vecmap.

57 **Gunay F**, **Picard M**, **Robert V**. MosKeyTool, an interactive identification key for mosquitoes of Euro-Mediterranean. 2018; https://www.medilabsecure.com/moskeytool.html. Accessed 7 February 2022.

58 **Miranda Chueca MÁ**, **Barceló Seguí C**. AIMSurv Aedes Invasive Mosquito species harmonized surveillance in Europe. AIM-COST Action. v2.2. Universitat de les Illes Balears. Dataset/Samplingevent. 2022; https://doi.org/10.15470/vs3677.

59 Vectors of human disease series. GigaByte. 2022; https://doi.org/10.46471/GIGABYTE_SERIES_0002.

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