

## **SURVEILLANCE AND CONTROL OF *Aedes albopictus* (DIPTERA: CULICIDAE) IN SWITZERLAND**

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**Abstract** In 2003 the invasive Asian tiger mosquito, *Aedes albopictus* arrived in Southern Switzerland for the first time. It has since then been continuously surveyed and controlled using ovitraps for monitoring alongside targeted applications of larvicides (*Bti* and diflubenzuron) and larval source reduction. Until recently the focus of activities was on surveillance and control in the Canton of Ticino (Southern Switzerland) and less attention was drawn on its potential introduction to the northern parts of the country. As this mosquito has been reported from neighbouring Southern Germany and Northern France we examined whether *A. albopictus* is also being introduced north of the Alps. Here, mosquitoes were monitored by ovitraps placed along motorways, ports and major airports across Switzerland. Collected mosquito eggs were identified using recently developed protein profiling methodology. This study shows that *A. albopictus* is occasionally introduced to Switzerland even north of the Alps along motorways though the results suggest no firm establishment of the mosquito in those areas.

**Key words** Vector entomology, Asian tiger mosquito, MALDI-TOF MS, ovitraps.

### **INTRODUCTION**

The Asian tiger mosquito, *Aedes (Stegomyia) albopictus* (Skuse, 1894), originally native to South-East Asia has been passively spread across the globe mainly through the used tyre trade to the United States, Latin America, Europe and several Pacific and Indian Ocean islands (Reiter and Sprenger, 1987; Paupy et al., 2009). Within continental Europe the mosquito is mainly passively dispersed through adults trapped in vehicles. Since 2003 *A. albopictus* is also present in Switzerland (Flacio et al., 2004).

According to the Global Invasive Species Database *A. albopictus* is among the 100 of the world's worst invasive alien species (ISSG, 2013) and a competent vector of chikungunya and dengue virus and several other disease agents, such as West Nile virus, encephalitis and dirofilaria worms (Paupy et al., 2009). *A. albopictus* poses a threat to human health also in continental Europe as the chikungunya outbreak in Italy (Rezza et al., 2007) and autochthonous cases of dengue in metropolitan France (La Roche et al., 2010) and Croatia (Schmidt-Chanasit et al., 2010) have shown. Systematic surveillance and control of *A. albopictus* is, therefore, needed to keep mosquito populations at densities below risk of disease outbreak.

In Switzerland surveillance and control has been restricted to the geographic area of the Canton of Ticino (Wymann et al., 2008), a region located south of the Alps at the border to Italy. Data from France suggest, however, that *A. albopictus* is progressively migrating along the Rhone valley to the North (Anonymous, 2012) and it is only a matter of time for it to arrive in Geneva,

Switzerland, where the climate would be favourable enough for the mosquito to settle (Neteler et al., 2013). *A. albopictus* has also been reported from Southern Germany, to where it has likely been introduced by cars coming from southern Europe (Pluskota et al., 2008; Werner et al., 2012).

Switzerland being at the northern tip of *A. albopictus* distribution in Europe has motivated us to initiate a pilot study to monitor the introduction of this highly invasive species. We set up traps to collect eggs from gravid females – so called ovitraps - along the main traffic routes across the country at motorway service stations, airports and ports during the summer of 2013 and determined present eggs to species level using matrix assisted laser desorption/ionisation time of flight mass spectrometry (MALDI-TOF MS). Here, we demonstrate, for the first time, the introduction of *A. albopictus* to Switzerland north of the Alps.

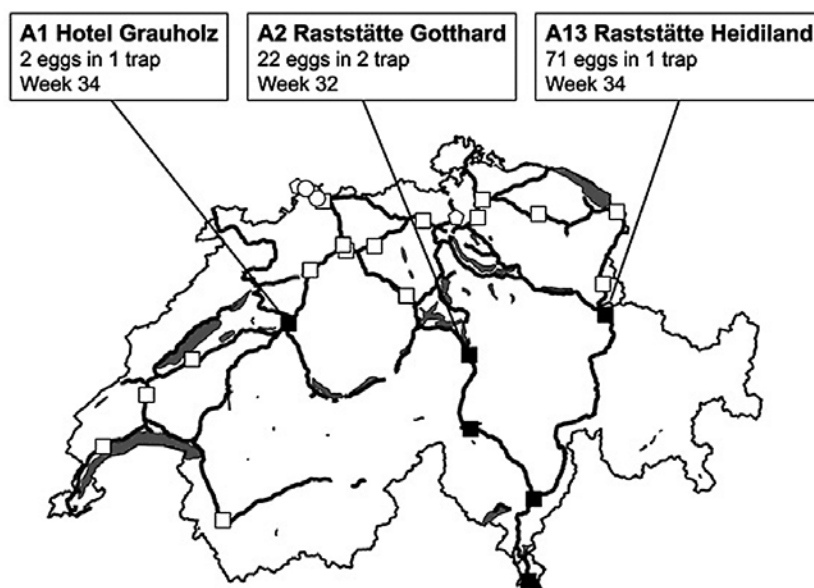
## MATERIAL AND METHODS

We set up traps at 30 locations at motorway service stations, major airports (Basel-Moulhouse-Freiburg, Geneva and Zürich) and at the Rhine ports in Basel between June and September 2013, covering the peak season of *A. albopictus*. We used ovitraps to collect eggs as these tend to be more sensitive than traps for sampling adult mosquitoes (ECDC, 2012). Ovitrap traps mimic breeding sites, attracting gravid females to deposit their eggs. Our traps consisted of 1.5 litre, black plastic flower pots, filled with tap water. The eggs were then collected on a wooden slat that was partially submerged and partially stuck out of the water. *A. albopictus* females would naturally deposit their eggs near the water surface. In order to prevent the ovitraps from becoming potential breeding sites we added larvicide granules of *Bacillus thuringiensis* var. *israelensis*. The slats were then replaced every fortnight. At the motorway service stations we set up three traps on each serviced side of the road and six traps at each airport and port. Detected eggs were examined visually for morphological species specific features under a stereo microscope and matrix-assisted laser desorption-ionisation time of flight mass spectrometry (MALDI-TOF MS) similar to Kaufmann et al. (2012) and Müller et al. (2013) using reference spectra that were established at Mabritec AG in collaboration with the Institute of Parasitology in Zürich, Switzerland. Where ovitraps were positive for *A. albopictus* we also set up BG sentinel traps with BG lure (Biogents, Germany) in an attempt to also attract adult mosquitoes.

## RESULTS AND DISCUSSION

*A. albopictus* eggs were present at all trapping locations in Ticino (Figure 1) which is not unexpected giving the results of the ongoing local surveillance and control programme (data not shown). In August we also detected two eggs at the motorway service station A1 Raststätte Grauholz in the Canton of Bern and 22 eggs at A2 Raststätte Gotthard in the Canton of Uri, north of the Alps. In September we identified another 72 eggs north of the Alps at the service station A13 Raststätte Heidiland in the Canton of St. Gallen (Figure 1).

This study is the first account of *A. albopictus* introduction into Switzerland north of the Alps. All cases outside Ticino were, however, singular. The results fit well together with earlier accounts of *A. albopictus* in southern Germany and underline the continuous introduction of this invasive species through motorway traffic. Interestingly, while *A. albopictus* has repeatedly been found in Germany just across the border from Basel (Werner et al., 2012) none of the traps set up in and around Basel have been found positive in this study.



**Figure 1.** Locations positive for *Aedes albopictus* during the 2013 Swiss national survey. Filled squares (motorway service stations) and the triangle (train station) show the locations with ovitraps positive for *A. albopictus*. Empty symbols represent locations that were sampled but negative for *A. albopictus*.

The presence of *A. albopictus* in Ticino, with the exception of the positive site at the motorway service station A2 San Gotthardo, located north in the canton, are not unexpected and corroborate the patterns being repeatedly observed from the on-going local surveillance programme.

## CONCLUSION

The present study shows that *A. albopictus* is being introduced to Switzerland also north of the Alps along the motorways. Encouragingly, the results from this study suggest no firm establishment of the mosquito in those areas yet. It is recommended to continue the surveillance program and establish a national action plan for its control, particularly for areas such as Geneva where environmental conditions for an establishment of *A. albopictus* are already favourable.

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## REFERENCES CITED

- Anonymous. 2012.** Extension of the settlement area of *Aedes albopictus* in the Mediterranean. Bulletin de Veille Sanitaire.
- Bundesamt für Gesundheit. 2011.** Tabellen zu Dengue und Chikungunya in der Schweiz (Stand 10.2.2011). Bull BAG 17: 382–384.

- Caminade, C., Medlock, J.M., Ducheyne, E., McIntyre, K.M., Leach, S., Baylis, M., and Morse, A.P. 2012.** Suitability of European climate for the Asian tiger mosquito *Aedes albopictus*: recent trends and future scenarios. *Journal of The Royal Society Interface*, 9(75): 2708–2717.
- European Centre for Disease Prevention and Control. 2012.** Guidelines for the surveillance of invasive mosquitoes in Europe, Stockholm: ECDC.
- Flacio, E., Lüthy, P., Patocchi, N., Guidotti, F., Tonolla, M., and Peduzzi, R. 2004.** Primo ritrovamento di *Aedes albopictus* in Svizzera. *Bollettino della Società ticinese di Scienze Naturali* 92: 141–142.
- Invasive Species Specialist Group. 2013.** Global Invasive Species Database. <http://www.issg.org/database/species/search.asp?st=100ss&fr=1&str=&lang=EN>
- Kaufmann, C., Schaffner, F., Ziegler, D., Pflüger, V., and Mathis, A. 2012.** Identification of field-caught *Culicoides* biting midges using matrix-assisted laser desorption/ionization time of flight mass spectrometry. *Parasitology* 139(2): 248–258.
- Müller, P., Pflüger, V., Wittwer, M., Ziegler, D., Chandre, F., Simard, F., and Lengeler, C. 2013.** Identification of cryptic *Anopheles* mosquito species by molecular protein profiling. *PLoS ONE* 8(2): e57486.
- Neteler, M., Metz, M., Rocchini, D., Rizzoli, A., Flacio, E., Engeler, L., Guidi, V., Lüthy, P., and Tonolla, M. 2013.** Is Switzerland Suitable for the Invasion of *Aedes albopictus*? *PLoS ONE* 8(12): e82090.
- Paupy, C., Delatte, H., Bagny, L., Corbel, V., Fontenille, D. 2009.** *Aedes albopictus*, an arbovirus vector: from the darkness to the light. *Microbes Infect* 11(14-15): 1177-1185.
- Pluskota, B., Storch, V., Braunbeck, T., Beck, M. and Becker, N. 2008.** First record of *Stegomyia albopicta* (Skuse) (Diptera: Culicidae) in Germany. *European Mosquito Bulletin* 26: 1-5.
- Reiter, P. and Sprenger, D., 1987.** The used tire trade: a mechanism for the worldwide dispersal of container breeding mosquitoes. *Journal Amer. Mosquito Control Assoc.*, 3(3): 494–501.
- Rezza, G., Nicoletti, L., Angelini, R., Romi, R., Finarelli, A.C., Panning, M., Cordioli, P., Fortuna, C., Boros, S., Magurano, F., Silvi, G., Angelini, P., Dottori, M., Ciufolini, M.G., Majori, G.C., and Cassone, A.; CHIKV study group. 2007.** Infection with chikungunya virus in Italy: an outbreak in a temperate region. *Lancet*, 370(9602): 1840–1846.
- La Ruche, G., Souarès, Y., Armengaud, A., Peloux-Petiot, F., Delaunay, P., Desprès, P., Lenglet, A., Jourdain, F., Leparç-Goffart, I., Charlet, F., Ollier, L., Mantey, K., Mollet, T., Fournier, J.P., Torrents, R., Leitmeyer, K., Hilairet, P., Zeller, H., Van Bortel, W., Dejour-Salamanca, D., Grandadam, M., and Gastellu-Etchegorry, M. 2010.** First two autochthonous dengue virus infections in metropolitan France, September 2010. *Euro Surveillance* 15(39): 19676.
- Schmidt-Chanasit, J., Haditsch, M., Schoneberg, I., Gunther, S., Stark, K., and Frank, C. 2010.** Dengue virus infection in a traveller returning from Croatia to Germany. *Euro Surveillance* 15(40): 19677.
- Werner, D., Kronefeld, M., Schaffner, F., and Kampen, H. 2012.** Two invasive mosquito species, *Aedes albopictus* and *Aedes japonicus japonicus*, trapped in south-west Germany, July to August 2011. *Euro Surveillance* 17(4): 20067.
- Wymann, M.N., Flacio, E., Radczuweit, S., Patocchi, N., and Luthy, P. 2008.** Asian tiger mosquito (*Aedes albopictus*) - a threat for Switzerland? *Euro surveillance* 13(10).