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Breeding of *Ochlerotatus japonicus japonicus* (Diptera: Culicidae) 80 km north of its known range in southern Germany

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Abstract

The invasive species *Ochlerotatus japonicus* (Theobald, 1901) originates in Asia and is reported to transmit some harmful arboviruses. After becoming established in many states of North America, the subspecies *Oc. j. japonicus* was recently found reproducing in European countries. In southern Germany a previous study recorded this subspecies only near the border with Switzerland. Here records are reported of this subspecies 80 km north of the known distribution in Germany. Apparently, this mosquito has already become established over a larger area than previously believed.

Keywords: Asian bush mosquito, *Aedes japonicus*, *Hulecoeteomyia japonica*, vector, alien, neozoon, invasive.

Introduction

The Asian bush mosquito or Japanese rock pool mosquito *Ochlerotatus japonicus* (Theobald, 1901) (sensu Reinert, 2000), also referred to as *Aedes japonicus* and *Hulecoeteomyia japonica* (sensu Reinert *et al*., 2006), has its native range in Asia. The subspecies *Oc. j. japonicus* is quite common in parts of Japan and Korea, and can also be found in the southeast of Russia. It is geographically separated from the other three subspecies of *Oc. japonicus*, which occur in the Oriental Region (Southern China, Taiwan and the south of the Ryukyu Archipelago, Japan; see Tanaka *et al.*, 1979, Gutsevich & Dubitskiy, 1987).

The subspecies *Oc. j. japonicus* is listed as an invasive species in the Global Invasive Species Database (ISSG, 2011). It was first discovered outside its native range in two states of the USA in 1998, New York and New Jersey (Peyton *et al*., 1999). Within seven years, it was found in 22 states (see Saenz *et al.,* 2006). Recently, the subspecies has also reached Central Europe. There are records of breeding populations in Belgium (Versteirt *et al*., 2009), Switzerland (Schaffner *et al*., 2009) and southern Germany (Schaffner *et al*., 2009, Becker *et al.,* 2011). In Germany *Oc. j. japonicus* has been recorded within an area of about 2,200 km^2 along the border to Switzerland (Becker *et al*., 2011). Here records of *Oc. j. japonicus* north of its hitherto known range are reported.

Material and Methods

In August 2010, five cemeteries and one camping site in Baden-Württemberg (southern Germany) were searched for *Oc. j. japonicus*. The six collection sites were aligned from north to south over a distance of almost 20 km. The airport of Stuttgart was about 10 km from the northernmost site. The southernmost site was about 80 km north of the published records in Germany.

The preferred breeding sites of *Oc. japonicus* are rock holes; however, larvae also can be found in different types of natural and artificial containers (Tanaka *et al*., 1979). Therefore, cemetery vases, stone basins and a rain barrel were checked for larvae and pupae. Samples were taken from containers with potential immature stages of *Oc. j. japonicus*. Some of the larvae were reared to adults. The fourth instar larvae and reared female imagines were determined by using the key, species descriptions and drawings of tibia ornamentations of the subspecies by Tanaka *et al*. (1979).

Results

At five of the six sampled sites, the subspecies *Oc. j. japonicus* was recorded (Fig. 1). Both larvae and pupae were found in cemetery vases and stone basins. Additionally, emerging imagines were recorded in a rain barrel. Furthermore, *Oc. j. japonicus* was the dominant mosquito species where it was present.

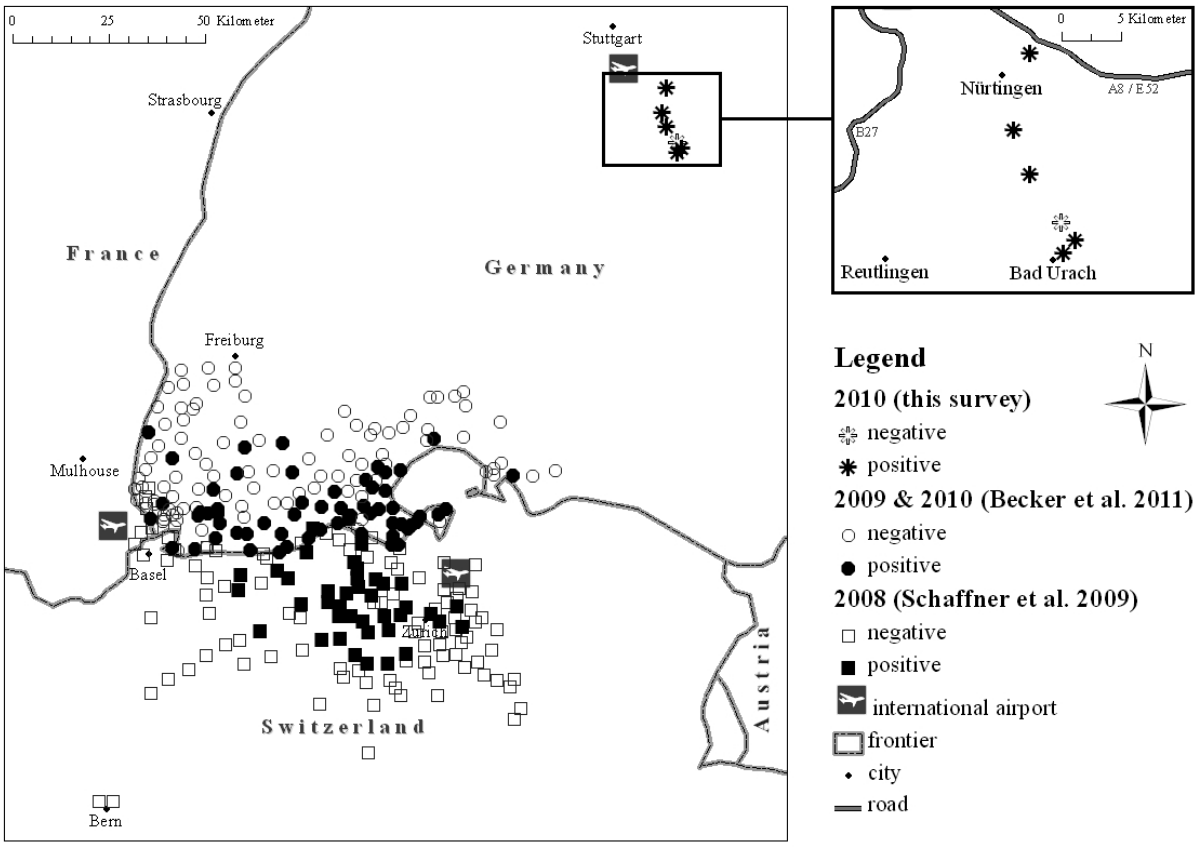

Fig. 1: Sites with and without records of *Oc. j. japonicus* in Southern Germany. The map combines records published by Becker *et al.* (2011, modified) and Schaffner *et al.* (2009, modified) in 2008 to 2010 with own records in 2010.

Discussion

The larvae, pupae and emerging adults of *Oc. j. japonicus* in a rain barrel indicate that the development from eggs to adults has occurred ≈80 km north of the hitherto known range of the subspecies in Germany. This shows clearly that the range of *Oc. j. japonicus* is still expanding. However, the source and extent of the new population or populations remains unclear. Active migration from the southern populations is unlikely, as the mosquito is considered to have a short dispersal range (Fonseca *et al*., 2001). Passive transport either from the southern populations or from

other sources (for example the nearby international airport of Stuttgart; Fig. 1) may explain the present records. However, Schaffner *et al.* (2009) did not find evidence that the Swiss populations spread from an airport. Furthermore, they could not find many larvae in and around tyre yards. Nevertheless, infested tyres are suggested to be a common way of transportation of this species (Laird *et al*., 1994, Peyton *et al*., 1999, Andreadis *et al*., 2001).

As in this study, Andreadis & Wolfe (2010) and Schaffner *et al*. (2009) found *Oc. j. japonicus* to be the most abundant subspecies in natural and artificial breeding sites. This dominance of immature stages in breeding containers confirms laboratory studies which show that the larvae of this species are competitive (Armistead *et al*., 2008, Alto *et al*., 2011).

Kutz *et al.* (2003) noted that this subspecies might serve as a vector for the West Nile virus. The species is also reported to be a competent vector for some other harmful viruses at least in the laboratory (Takashima & Rosen, 1989, Sardelis & Turell, 2001, Turell *et al*., 2001, Sardelis *et al*., 2002a, Sardelis *et al*., 2002b, Sardelis *et al*., 2003). Although Tanaka *et al*. (1979) described the species *Oc. japonicus* as "reluctant to bite man", one third of collected blood-fed females of the subspecies *Oc. j. japonicus* from New Jersey contained blood meals from humans (Molaei *et al*., 2009). Therefore, this subspecies is a potential thread for human health. Altogether, the origin of *Oc. j. japonicus* from a temperate climate (Tanaka *et al*., 1979), its ability to breed in various types of natural and artificial containers (Tanaka *et al*., 1979, Andreadis *et al*., 2001) and the ongoing discovery of introduced populations make it likely, that *Oc. j. japonicus* is spreading across Central Europe. Thus, extensive monitoring of this subspecies is necessary to provide information about the range, spread and abundance of the potential vector of arboviruses.

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