*European Mosquito Bulletin, **27** (2009), 10-17.*
*Journal of the European Mosquito Control Association*
*ISSN 1460-6127; w.w.w.e-m-b.org*
*First published online 1 October 2009*

# Recent introductions of aedine species (Diptera: Culicidae: Aedini) into new geographic areas

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## Abstract

Information on introductions to new geographic areas of species in the aedine generic-level taxa *Aedimorphus*, *Finlaya*, *Georgecraigius*, *Halaedes*, *Howardina*, *Hulecoeteomyia*, *Rampamyia*, *Stegomyia*, *Tanakaius* and *Verrallina* is provided.

**Key words:** *Aedimorphus*, *Finlaya*, *Georgecraigius atropalpus*, *Halaedes australis*, *Howardina bahamensis*, *Hulecoeteomyia japonica japonica*, *Rampamyia notoscripta*, *Stegomyia aegypti*, *Stegomyia albopicta*, *Tanakaius togoi*, *Verrallina*

## Introduction

As indicated in the series of papers on the phylogeny and classification of mosquitoes in tribe Aedini (Reinert *et al*., 2004, 2006, 2008), some aedine species have been introduced into new geographical areas in recent times. Species of Aedini found outside of their natural ranges are listed below with their literature citations.

## Introductions of Aedine Species to New Areas

*Stegomyia aegypti* (Linnaeus) represents the oldest species of Aedini with recorded information on introductions to new geographic areas. Christophers (1960) in his book on this species reported "It has been suggested that the original home of *A. aegypti* was the New World. Dyar (1928), however, notes that there are no nearly related species in the American continent, but many such in the Old World, especially in Africa, and he considered that it was probably the African continent from which the species originated". Christophers also noted that "The species is almost the only, if not the only, mosquito that, with human agency, is spread around the whole globe. But in spite of this wide zonal diffusion its distribution is very strictly limited by latitude and as far as present records go it very rarely occurs beyond latitudes of 45$^{o}$ N. and 35$^{o}$ S." Dyar (1928) stated "In the early days of navigation, with long voyages and water conserved in open wooden receptacles, the species readily bred on board ship, and was carried wherever the vessel went". Dyar also suggested that the species was brought to America in the

early days, perhaps by Columbus himself. Mattingly (1957) tended to favor the southern Palaearctic Region over Africa south of the Sahara as the possible sites of origin of *St. aegypti*. Belkin (1962), however, reported that this species is undoubtedly a native of the Ethiopian Region (currently known as the Afrotropical Region) where the majority of the other members of the group are found. He also indicated that "The dispersal of *aegypti* may very well have been started by the Portuguese in their circuitous route to the Indies, which included stops in West Africa and eastern Brazil before rounding the Cape of Good Hope. Belkin *et al*. (1970) stated "The ubiquitous and universally known *aegypti* is an African species now widely distributed throughout the world within the $20^{o}$ C isotherms, usually in close association with human settlements". Powell *et al*. (1980) reported on a multivariate discriminant analysis that was based on sequences of *St. aegypti* from 34 populations collected in Africa, Asia, the Caribbean, North America and South America. Their results indicated that these populations were sufficiently genetically differentiated to allow a strong inference of the geographical origin of a population. Tabachnick (1991) provided insights on introductions, reintroductions and multiple introductions of *St. aegypti* into various areas of the world based primarily on the genetic composition of the various populations. It is noted that evaluation of the sources and times of population introductions to the New World has been complicated by the attempts during the 1960s to eradicate previous *St. aegypti* populations from much of this geographical area. During recent decades, the range and prevalence of *St. aegypti* have been reduced in a number of areas such that the species is now apparently absent around much of the Mediterranean basin and has become scarce or localized in the southern United States of America (USA) (see O'Meara *et al*., 1993) partly due to competitive displacement by the more recently invasive *St. albopicta*.

*Stegomyia albopicta* (Skuse), a species of probable Asian origin, has been introduced into many areas of the world by the used tire trade, as summarized by Mitchell (1995) and Reiter (1998). Ventrillon (1904) first reported this species in Madagascar but the wider current distribution in this country is provided by Fontenille & Rodhain (1989). Examples of introductions of this species during the recent past have been reported from the USA (e.g., Sprenger & Wuithiranyagool, 1986; O'Meara *et al*., 1993; Reiter, 1998; Madon *et al*., 2002, 2003), Brazil (Forattini, 1986), Albania (Adhami & Murati, 1987; Adhami & Reiter, 1998), Italy (Sabatini *et al*., 1990; Dalla Pozza & Majori, 1992), Fiji Islands (Laille *et al*., 1990; Mitchell, 1995), Australia (Kay *et al*., 1990; Ritchie *et al*., 2006), South Africa (Hunt *et al.*, 1990; Cornell & Hunt, 1991), Nigeria (Savage *et al*., 1992), Dominican Republic (Pena, 1993), New Zealand (Laird *et al*., 1994), Mexico (Ibáñez-Bernal & Martínez-Campos, 1994; Casas-Martínez & Estrata, 2003), Papua New Guinea (Mitchell, 1995), Guatemala (Ogata & Samayoa, 1996), Argentina (Rossi *et al*., 1999), Cuba (Broche & Borja, 1999), France (Schaffner & Karch, 2000; Schaffner *et al*., 2001), Cameroon (Toto & Fontenille, 2001), Equatorial Guinea (Toto *et al*., 2003), Serbia and Montenegro (Schaffner, 2003), Trinidad, West Indies (Chadee *et al*., 2003),

Belgium (Schaffner *et al*., 2004), Nicaragua (Lugo *et al*., 2005), Croatia (Klobucar *et al*., 2006; Merdic *et al*., 2009), Spain (Aranda *et al*., 2006), the Netherlands (Scholte *et al*., 2007, 2008), Gabon (Coffinet *et al*., 2007), Lebanon and Syria (Haddad *et al*., 2007), Germany (Pluskota *et al*. 2008), and other countries as listed by Reiter (1998), i.e. Barbados, Bolivia, Cayman Islands, Columbia and El Salvador. These countries are only a partial listing of those recently inhabited by this species, which poses a risk to human health as a potential vector of pathogens. The article by Enserink (2008) "A mosquito goes global" records how rapidly this species has spread throughout new areas.

Introductions continue as exemplified by the discovery of *Hulecoeteomyia japonica japonica* (Theobald) in the eastern USA (Peyton *et al*., 1999), 21 states in the USA and Canada (Widdel *et al*., 2005), Washington, USA (Roppo *et al*., 2004, Sames & Pehling, 2005), Hawaii, USA (Larish & Savage, 2005), Oregon, USA (Irish & Pierce, 2008), France and Belgium (Schaffner *et al*., 2003) and Switzerland (Schaffner & Mathis, 2009). Fonseca *et al*. (2001) attempted to identify the putative source of populations in the eastern USA of *Hl. japonica*. Also, *Tanakaius togoi* (Theobald) was introduced into the Pacific southwest of Canada and northwest of the USA (Meredith & Phillips, 1973; Trimble & Wellington, 1979; Wood *et al*., 1979; Belton, 1980; Belton & Belton, 1990; Sames *et al*., 2004); *Georgecraigius atropalpus* (Coquillett) was introduced into Italy (Romi *et al*., 1997) and *Howardina bahamensis* (Berlin) was introduced into Florida, USA (Pafume *et al*., 1988; O'Meara *et al*., 1995).

Two aedine species that have been introduced into the Hawaiian Islands, *St. aegypti* (widespread by 1892) and *St. albopicta* (numerous in 1902), were noted by Usinger (1944). Ward (1984) provided a case history of mosquitoes, including species of Aedini, introduced onto the western Pacific island of Guam (Mariana Islands). Laird *et al*. (1994) discuss the importation of the following exotic species into New Zealand: *Halaedes australis* (Erichson), *Hulecoeteomyia japonica*, *Rampamyia notoscripta* (Skuse) and *Stegomyia albopicta*. Belkin (1962) provided interesting observations on the "Bionomics and Dispersal" of mosquitoes (p. 46) and "Mosquitoes and Human Migrations" (p. 65). In the latter section (pp. 65−66) he discussed the spread of aedine species in the southern Pacific islands of the following generic-level taxa: *Aedimorphus* Theobald, *Finlaya* Theobald, *Rampamyia* Reinert, Harbach & Kitching, *Stegomyia* Theobald and *Verrallina* Theobald.

**Acknowledgements**

Appreciation is expressed to Ralph E. Harbach (The Natural History Museum, London, UK) and Graham B. White (Department of Entomology and Nematology, University of Florida, Gainesville, FL) for critically reviewing the manuscript and providing valuable comments, and to Kenneth J. Linthicum and Gary G. Clark (CMAVE) for providing research facilities.

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Ae. albopictus possesses a high ecological potency and can rapidly adapt to new habitats due to its genetic plasticity. This species has spread from tropical regions to areas with temperate climates which do not allow a constant follow-up of generations, e.g. during winter periods. As a consequence, the species goes through a winter diapause during which the larvae in the eggs are not able to hatch and remain in the eggshell until the living conditions allow further development. Introduced species that become established and spread beyond the place of introduction are considered "naturalized". The process of human-caused introduction is distinguished from biological colonization, in which species spread to new areas through "natural" (non-human) means such as storms and rafting. The impact of introduced species is highly variable.Â  By definition, a species is considered "introduced" when its transport into an area outside of its native range is human mediated. Introductions by humans can be described as either intentional or accidental. Culicidae are the most prolific disease vectors within the order Diptera, and can transmit a range of parasites (e.g. Plasmodium relictum), viruses (alphaviruses, flaviviruses, etc. From: Advances in Marine Biology, 2019. Related terms: Genus.Â  Culicines are organized into 10 tribes, the most diverse of which are Aedini and Sabethini in terms of numbers of genera and species worldwide. The 14 genera in North America north of Mexico, and the number of species in each, are Anopheles (16), Aedes (7), Ochlerotatus (69), Psorophora (15), Culiseta (8), Coquillettidia (1), Mansonia (2), Orthopodomyia (3), Wyeomyia (4), Uranotaenia (4), and Toxorhynchites (1) (Darsie and WardÂ  The most recent comprehensive treatments of North American species are Wood et al. Aedes aegypti (Diptera: Culicidae): new perspectives for an insect-bacteria association Desiely Silva Gusmo, Ado Valmir Santos, Danyelle Cristine Marini*, rica de Souza Russo, Anelise Maria Dias Peixoto, Maurcio Bacci Jnior**, Marlia Amorim Berbert-Molina, Francisco Jos Alves Lemos/+ Laboratrio de Biotecnologia, Universidade Estadual do Norte Fluminense Darcy Ribeiro, Av.Â  The yeast species identified was Pichia caribbica. Key words: Aedes aegypti - gut diverticulum - microbiota - Serratia sp. Aedes aegypti (Diptera: Culicidae, Aedini) is the. main urban vector for the human diseases yellow fever and dengue fever (Nasci & Miller 1996).