Aedes aegypti*: risk of introduction in Italy and strategy to detect the possible re-introduction*

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Background

Aedes aegypti Linnaeus, 1762 is a belonging to *Stegomyia* subgenus, native to Africa but now widely spread worldwide. Strictly close to *Aedes albopictus* (Skuse, 1894), in morphology, biology and behavior also *Aedes aegypti* has been accidentally scattered around the world by human activities mainly transport. With many similarities with *Ae. albopictus*, this mosquito represents the main paradigm of the globalization of vectors, and vector-borne disease viruses, being able to transmit important arboviruses such as Yellow Fever, Dengue and Chikungunya viruses. The Ae. aegypti adult is approximately 4 to 7 millimeters with white scales on the dorsal surface of the thorax that form the shape of a lyre, while Ae. albopictus has a white stripe down the middle of the top of the thorax. Each tarsal segment of the hind legs shows white basal bands: the abdomen is generally dark brown to black, but also may possess white scales (1) (see the picture). *Aedes aegypti* occurs in three polytypic forms: domestic, sylvan, and peridomestic: the domestic form breeds in urban habitat, often around or inside houses; the sylvan form in tree holes, generally in forests, and the peridomestic form in environmentally modified areas and farms (2), inhabitated areas (often located between urban and rural zones). Both forms are typical container breeding mosquitoes, because the sites selected for egg laying and larval development are commonly represented by a large variety of human products, such as used tires jars, cans and other containers, able to maintain small amount of fresh water). In warm climates, such as the tropics, eggs may hatch in two days, while in cooler temperate climates, the development can take up to a week (3). *Ae. aegypti* eggs can survive desiccation for months and hatch once submerged by water but despite the similarity with *Ae. albopictus*, *Ae. aegypti,* and its eggs, are not able to survive the winter (4). When in sympatry Ae. albopictus larvae outclass Ae. aegypti larvae for food, and develop at a faster rate (5). It was also suggested that there is a hybridization of the two species in zones where they overlap, producing sterile offspring (6).

Geographic distribution

Having the name from specimens collected in Cairo, Egypt, *Ae. aegypti* occurs worldwide with a cosmopolitan range extending from 40 degrees N to 40 degrees S latitude; mainly throughout the tropical to subtropical world regions (7). This species was vey abundant in the early 20th century in Southern Europe and in harbour cities of the Mediterranean Basin mainly in Syria, Lebanon, Turkey, Greece, Yugoslavia, Italy, Corsica (France) and Spain (8,9); in the last country it was considered very common until the 1950's (10). In Italy *Ae. aegypti* was a very common species until the half of the 1940's (11,12,13) with the last findings in 1944 in Genova and with the exception of a single specimen collected in 1971 in Desenzano del Garda (Lombardia region, Northern Italy) (14). La Face and Raffaele in 1928 reported *Ae. aegypti* at low densities but continuously on the territory in the following regions (and localities): Puglia (Taranto, Brindisi, Bari), Sicilia (Catania, Taormina, Augusta), Calabria (Bovalino, Brancaleone). There is the hypothesis that this species never strongly established, disappearing in winter and incoming transported again in spring every year. This is also confirmed by the yellow fever outbreak occurred in 1804 in Livorno (Toscana region), where the it lasted about four months from August to November, the same lifespan of the species at our latitudes, leading to think that the mosquito was not able to overwinter (15) as it is. After the 50's, *Ae. aegypti* disappeared probably because of the malaria vector control by DDT indoor treatments together with the management of urban water collections and perhaps lower winter climate conditions too. Coming to recent years *Ae. aegypti* has been found in The Netherland, during a routine mosquito surveillance inspection at companies importing used tires; such event has represented the first report of the yellow fever mosquito in this country and therefore it has been unexpected the association of this species with the trade in used tires, more typical way of entry of *Ae. albopictus* (16). Even if the collected specimens were only 13 adults mosquitoes, they were found in association with a larger number of adults and larvae of *Ae. albopictus* and *Ae. atropalpus* Coquillett, 1902 (16) and this show clearly the main role of trading activities in the spreading of mosquito species worldwide. In Portugal, where *Ae. aegypti* was present in the continental regions up to 1956 (17), it was first recorded in 2004-2005 in the Autonomous Region of Madeira, and in 2006 further specimens were collected in the city of Funchal (18). *Ae. aegypti* arrived in the New World by means of slave ships that generally made the passage from Africa to the Americas in four to six weeks. The casks used for shipboard storage of water must have been prolific bre eding sites for the mosquito, and the slaves were an abundant source of blood. With the slaves and the mosquito came the virus, and it was not uncommon for ships to arrive in port with large numbers of dying persons aboard, hence the yellow flag of quarantine (19). In the United States, the species has been recorded from 21 states (Alabama, Arkansas, Florida, District of Colombia, Georgia, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Missouri, Mississippi, New York, North Carolina, Ohio, Oklaho ma, South Carolina, Tennessee, Texas, and Virginia); in many of these, winter temperatures below -20°C are not unusual. Presumably the mosquitoes survive in sheltered sites, for they are not resistant to freezing (19).

In the northern part of the continent, the species has been present at least in Florida since the IXX Century: in 1898 a large epidemic of yellow fever involved the local population and the US troops deployed in that region because of the Spanish-American war, that suffered more casualties from yellow fever transmitted by *Ae. aegypti* than from enemy fire (20).This mosquito was a common vector in Florida until the invasion of the Asian tiger mosquito, *Ae. albopictus* in 1985, by way of Texas, when the population of *Ae. aegypti* declined dramatically, but until now it remains at high density still in urban areas of South Florida (20).

Medical importance

Ae. aegypti is a day-light biting mosquito that feed on humans and on a large variety of animals, indoors as well as outdoors. In most of the tropical and subtropical areas where *Ae. aegypti* is endemic, it plays a major role as vector of the yellow fever virus, but it also can transmit dengue and chikungunya viruses (20).

The disease mainly affects West, Central and East Africa, where large severe epidemics have been recorded with tens of thousands of deaths and in South America; Yellow fever epidemics still occur frequently in the tropics, and can occur in temperate regions during summer months, showing fatality rates of clinical cases of 80% (21). More recently mported yellow fever cases have been reported from Germany (22), Belgium (23), Spain, France, the Netherlands and Switzerland (21). Historically a yellow fever outbreak occurred in Wales in the 19th century following importation of *Ae. aegypti* and infected passengers aboard a boat.

The Dengue disease is caused by 4 serotypes of te same virus belonging to Flavivirus genus, family Flaviviridae; it this considered the most important arbovirosis in term of morbosity e di mortality, being almost the half of the population at risk of infection in the world (24). Fever and other symptoms rarely last more than seven days, but convalescence can be prolonged and debilitating, hence the term 'break-bone fever'. Dengue is a dangerous disease due to four different serotypes: although people can obtain immunity to one serotype, they are still susceptible to the others (25). Major dengue fever epidemics, due to *Ae. aegypti*, occur in the Americas, South East Asia and the western Pacific, and the disease is now endemic in more than 100 countries worldwide. Incidence of this disease has increased dramatically and the incidence of the more severe dengue hemorrhagic fever (DHF) has also been increasing (26). *Ae. aegypti* was once endemic in Europe and was responsible for large epidemics of dengue and yellow fever until its disappearance with the last dengue outbreak recorded in Greece in 1927-1928 (27). In Italy the national reference centre on arboviruses at Istituto Superiore di Sanità (ISS) confirms a yearly increasing number of cases of dengue imported infections in tourists coming back from endemic areas (28).

Ae. aegypti and *Ae. albopictus* are vectors of other chikungunya virus, belonging to genus *Alphavirus*, and *Togaviridae* family. Although chikungunya is not endemic in North America, like dengue, the number of cases is steadily increasing and this virus could become a major threat to public health in the United States. Most cases documented in the United States are associated with international travel, but with the spread and resurgence of the yellow fever mosquito and Asian tiger mosquito in the Americas, chikungunya is a very real threat (29). In the last years *Ae. aegypti* was involved as vector in outbreaks in Kenya, the Comoros, India, Mayotte (30). In Italy an outbreak of the disease occurred in Emilia Romagna region in 2007 (31) and the virus was transmitted by local populations of *Ae. albopictus*.

Possible surveillance strategy for an early detection of Aedes aegypti *in Italy*

By the light of which above exposed and also after the recent first report of *Ae. koreicus* (Edwards, 1917), another Asiatic mosquito species in Veneto region in North Eastern Italy (32)occurred in this summer, it appear evident how important is to imagine a national plan aimed to an early detection of the possible incoming of *Ae. aegypti* (and also potential allochtonous vectors such as *Ae aegypti* and *Ae. japonicus* Theobald, 1901). This mosquito formerly present in Italy along the coastal neighbourhoods of harbour areas, there could be re-introduced by trading good of different origin, from plants to used tires or other. Therefore the accidental incoming could be followed by a local stabilization of this mosquito, allowed by the mild climate in autumn and spring along with the very short periods at low temperatures in winter typical of the current years. Aim of this paper is to propose a shared strategy aimed to prevent and face a possible event of entry and spreading of new invasive mosquito species of medical importance as *Ae. aegypti.* This objective may be a*chieved* through several steps, pointed out as follows.

- The identification of study areas, i.e. the selection of "at risk" sites where to start the active inquiry or to implement surveillance measures already working for *Ae.albopictus* monitoring. In each selected study area, the sites at higher risk for introduction of allochtonous potential vectors should be censed and mapped, starting from harbours, airports and principal railroad stations and their surroundings. A specific attention should be paid to the surroundings of the harbours in Liguria, Toscana, Sicilia, Calabria and Puglia, the regions where the species was present in the past and where could be plausible to expect a possible accidental re-introduction.

- The implementation of field-operating teams of multi-disciplinary experts, selected at local level, in order to be charged with the specific task of collecting data needed to define the most at risk sites and way of possible entry, and those of possible stabilization of invasive species, such as the storage areas of international trade companies that import tropical ornamental plants or used tires. Data would be entered in a data-base shared among all the involved health authorities and analyzed in order to define the specific sites on the basis of their environmental, climatic, characteristics, with deserve of a major surveillance.

- The training for personnel from regional public health services, as further step, should be carried out in order to supply the personnel of the essential skills for planning and implementing specific surveillance networks and or for improving those already working, within the context of the a multidisciplinary local task force. This procedure could allow to promote at different levels an operational plan of vector surveillance by transfer expertise to Public Health Officers- Such personnel should become able to plan surveillance and control activities in their respective areas of competence, implementing a multi-disciplinary task force as part of a national network of surveillance, coordinated at central level by ISS.

- Guide-lines to be realized. To provide the local health authority with expertise across different disciplines. In particular the production of specific guidelines for a common strategy aimed to the early detection of the invasive species, should be provided. Field techniques of both active (direct inspections) and passive (by using of adult tarps) surveillance should be standardised.

- A specific standardization of the procedures aimed at rapidly eliminating new foci of infestation and at facing possible mosquito borne diseases outbreaks, should be realized throughout the production of guidelines and specific protocols for control activities, adapted to the different situations in agreement with local public health authorities. Besides, laboratory and field tests should be carried out in order to select the most effective adulticide and larvicide active ingredients, their best performing formulations and the modality of intervention.

Conclusion

In conclusion, the possible establishment of *Ae. aegypti* in Europe and in Italy raises concerns about the arbovirus transmission such as Dengue. The rapid spread of *Ae. albopictus* in our country along with the recent experience of Chikungunya outbreak in Northern Italy in 2007 and the ongoing circulation of West Nile virus in different regions strengthen the need of an active surveillance of mosquito species everywhere, as that the incoming of arboviruses and vectors is a firm actuality now. In fact if different European countries have been suitable environments for *Ae. albopictus,* probably Italy and the landscape variety of its regions could offer again an appropriate habitat also for *Ae. aegypti* as the past recall us.

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