

## OCCURRENCE AND SPREAD IN ITALY OF *Aedes albopictus*, WITH IMPLICATIONS FOR ITS INTRODUCTION INTO OTHER PARTS OF EUROPE

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**ABSTRACT.** *Aedes albopictus* is considered second only to *Ae. aegypti* in its importance to man as a disease vector of dengue and dengue hemorrhagic fever. The first sighting in 1979 of the vector species in Europe came from Albania; however, it was only when *Ae. albopictus* was introduced into Italy in 1990, through the importation of used tires, followed by its subsequent spread, that the species was considered as a threat to public health. At the close of 1995, *Ae. albopictus* infestations have been reported from 10 Italian regions and 19 provinces. The risk for greater distribution of *Ae. albopictus* in Europe can potentially be projected, based on well-established criteria such as: where the winter monthly mean temperature is 0°C, where at least 50 cm of mean annual rainfall occurs, and where the mean summer temperature is approximately 20°C. Those countries where climatic conditions meet such criteria and that may be vulnerable to a potential introduction of *Ae. albopictus* include Spain, Portugal, Greece, Turkey, France, Albania, and the former Republic of Yugoslavia. The Italian plan of action, established for the surveillance and control of *Ae. albopictus*, is presented in detail.

*Aedes albopictus* (Skuse) ranks second only to *Ae. aegypti* (Linn.) in importance to man as a disease vector of dengue and dengue hemorrhagic fever (DHF) (Knudsen 1995). These flaviviruses place at risk a potential 2.5 to 3 thousand million people living in urban and suburban environments in 100 countries in tropical and subtropical regions around the world (WHO 1996) (Fig. 1).

The first European sighting of *Ae. albopictus* was in Albania in 1979 (Adhami and Murati 1987). Further information regarding the spread of *Ae. albopictus* has been reported by Mitchell (1995). In September 1990, the so-called "tiger mosquito" of Asia was found, in the form of a few adult *Ae. albopictus* mosquitoes at a kindergarten, in the city of Genoa, in the Liguria region of Italy (Sabatini et al. 1990).

The first actual breeding population of *Ae. albopictus* was discovered a year later, on August 26, 1991, following reports of numerous daytime biting mosquitoes in the southern part of the city of Padua, in the Veneto region (Dalla Pozza and Majori 1992). Padua is an ancient Italian city with an estimated population of 230,000 inhabitants, where many industrial and commercial establishments are located. Dalla Pozza et al. (1994) conducted a thorough investigation to determine the source of the Padua introduction. It was hypothesized that the source of the *Ae. albopictus* infestation might be used airplane tires from the United States. Following their study, the authors concluded that they could reasonably state that used tires

imported from Atlanta, GA, USA, were at least one source from which the mosquitoes were derived (Mitchell 1995). The evidence consisted of information concerning at least one load of used tires from Atlanta that reached Maserà (Padua) during the second week of July 1992 and was found to be infested with *Ae. albopictus* eggs. Subsequent rearing to the adult stages confirmed the identification.

It is believed that from this second focus, the dengue vector has gradually spread, principally through the used tire trade, to other districts within the Veneto region and from there to an additional 9 regions, including Liguria, Lazio, Lombardia, Toscana, Emilia-Romagna, Piemonte, Sardegna, Campania, and Friuli in the provinces of Genoa, Padua, Treviso, Venice, Vicenza, Rome, Frosinone, Brescia, Mantova, Pisa, Florence, Bologna, Modena, Forli, Ravenna, Torino, Cagliari, Naples, and Udine (Fig. 2). Thus *Ae. albopictus* breeding foci, some of which are extensive, have been found in 10 regions and 19 provinces by the close of 1995. The largest infestations are found in Liguria, Veneto, Lombardy, and Emilia-Romagna regions, involving mostly small rural towns. However, urban areas of Genova, Brescia, and Padova are also involved.

The extent of these findings ranges from latitude 39°N in the south to latitude 46°N in the north. The present distribution of *Ae. albopictus* extends from the Veneto region in the northernmost part of Italy to the southern tip of the island of Sardinia, at Cagliari, and from the Adriatic coast on the east of the Mediterranean coast on the west, a longitudinal distance exceeding 800 km.<sup>3</sup> All infestations have been traced to used tire depots.

<sup>3</sup> Calculation based on the earth's circumference of 24,875 mi., divided by 360°, divided by 0.6 mi. per km, or 115.16 km per degree.

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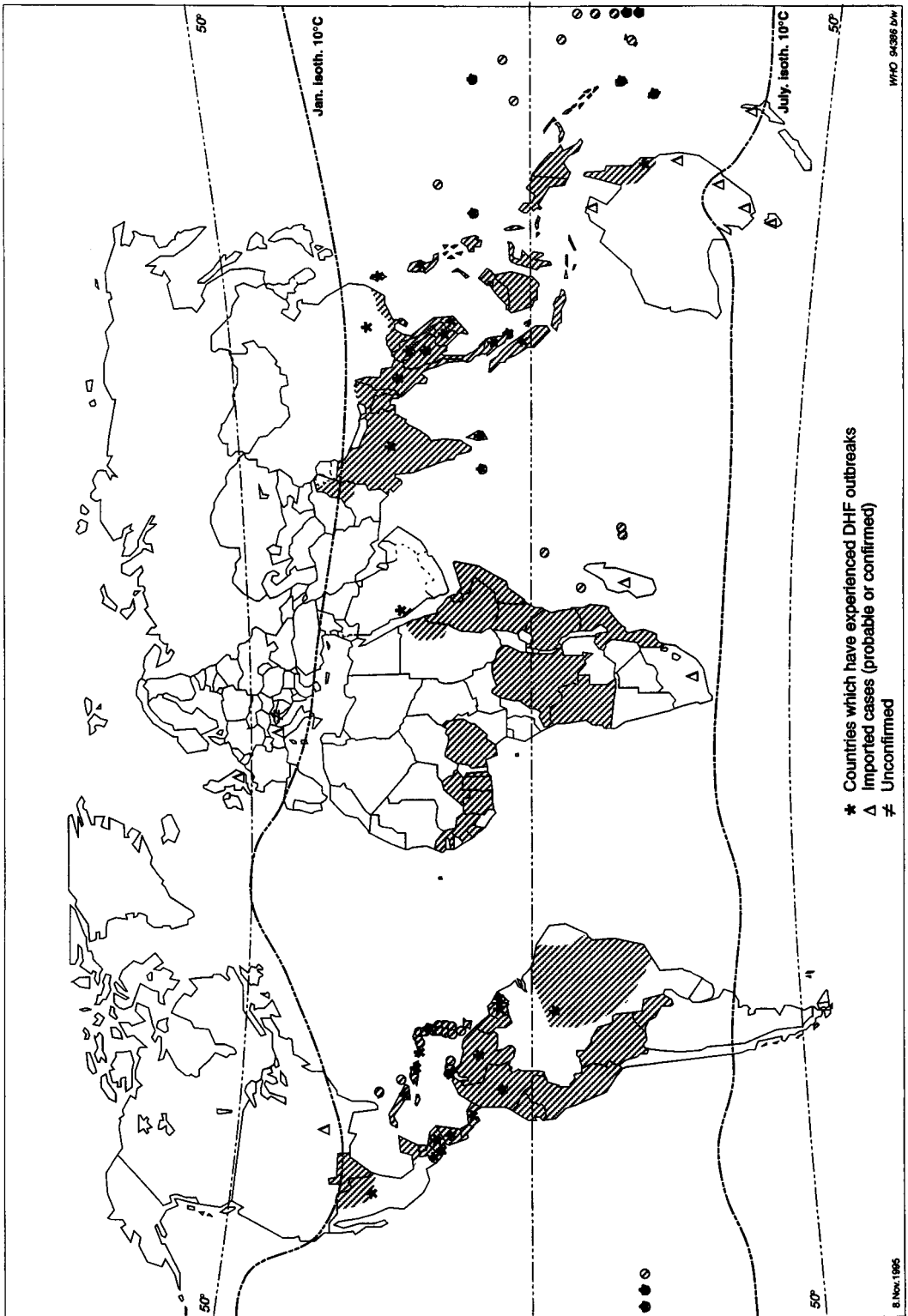


Fig. 1. General distribution of dengue and dengue hemorrhagic fever, 1975-95. The shaded area represents countries or areas where dengue has been reported.



Fig. 2. Distribution of *Aedes albopictus* in Italy by regions and provinces (1995).

Reiter and Sprenger (1987) reported that between 1978 and 1985, 82,031 tires were exported from the USA to Italy. Current information received from the National Institute of Statistics, Rome, indicated that between January 1990 and September 1993, 61,018,700 kg of used tires were imported, the bulk of which came from within the European Economic Community countries. Table 1 is a breakdown by year of such used tire imports. If one assumes an average weight per tire of 12 kg, this represents a

total of 5,084,892 imported used tires, of which 1.2%, or 61,018 used tires were from sources outside of Europe, including the USA, during the past approximately 4 years.

Public health officials on the European continent have indicated their concern for the spread of *Ae. albopictus* to neighboring countries, including editorials and articles by Rodhain (1993), Grist (1993), and Ward and Burgess (1993). In terms of the potential public health risk, as indicated by breeding and overwintering

Table 1. Annual importation of used tires into Italy (January 1990–September 1993).

Year	Quantity (kg)	% from European Economic Community	% from elsewhere
1990	19,012,000	98.5	1.5
1991	16,497,500	99.8	.2
1992	16,709,600	99.0	1.0
1993	8,799,600	96.8	3.2
Totals	61,018,700 <sup>1</sup>	98.5	1.5

<sup>1</sup> Equals 134,240,920 lb or 66,121 tons.

Table 2. Number of imported dengue cases, Italy, 1990–94.<sup>1</sup>

Year	No. suspect cases	No. confirmed cases
1990	12	9
1991	3	2
1992	4	3
1993	13	6
1994	8	3
Total	40	23

<sup>1</sup> As reported by L. Nicoletti, Arbovirus Unit, Laboratory of Virology, Istituto Superiore di Sanità, Rome, Italy.

populations of *Ae. albopictus*, a danger exists for the introduction of one or more dengue serotypes into Italy. During 1990 to 1994, 40 blood specimens were examined from Italian nationals who had travel histories to dengue endemic countries, all of whom returned with fevers of unknown origin (Table 2). Sera from 23 of the travelers were serologically positive for dengue. Twenty-one had traveled to Southeast Asia, mainly to Thailand and India. The other 2 seropositive individuals had returned from Central America, one of which had visited Haiti. Twenty-four percent of *Ae. albopictus* of the Genoa strain that fed upon a dengue blood meal were infected, demonstrating good vector competence for the dengue virus.<sup>4</sup>

The conditions suitable for the increased distribution of *Ae. albopictus* into virgin European territory are related to photoperiodicity, temperature, rainfall, and humidity. North of 30°N latitude, it appears that *Ae. albopictus* is seasonally affected by day length and a 0°C January isotherm as well as a 20°C July isotherm, which delineates the main areas at risk for supporting established populations of the species.

However, it is clear that the maximum potential range of *Ae. albopictus* is greater than that of the 10°C isotherm that restricts the spread of *Ae. aegypti* (Fig. 3). *Aedes albopictus* has exhibited a distinct overwintering capacity by going through diapause in temperate climates, as demonstrated by its presence as far north as Chicago, IL, USA (Rightor et al. 1987). An annual rainfall of 50 cm or more is sufficient to provide this species with a variety of rainwater-dependent breeding habitats.

The following suggestions are from the report, summary, and recommendations arising from the workshop<sup>5</sup> on the "Geographic spread

of *Aedes albopictus* in Europe and the concern among public health authorities" (Knudsen 1995). In Europe, those countries that are potentially at risk for future introduction of *Ae. albopictus* can be defined and identified based on several criteria, as detailed by Mitchell (1995). These include countries or parts thereof where the winter monthly mean temperature is  $\leq 0^\circ\text{C}$ , where at least 50 cm of mean annual rainfall occurs, and where there is a monthly mean summer temperature of  $\geq 20^\circ\text{C}$ .

Based upon such criteria, it has been suggested that European countries that are at highest risk include Italy, Spain, Portugal, Greece, Turkey, portions of France, Albania, and the former Republic of Yugoslavia. Those countries that climatically and geographically are at moderate risk might include Switzerland, Austria, and Germany; whereas those considered to be at less risk are the United Kingdom, Belgium, the Netherlands, Luxembourg, Ireland, and Denmark (Fig. 4). Other highly relevant factors that might be of importance in consideration of the possible introduction of *Ae. albopictus* include type of industrial infrastructure, location of seaports, airports, and tire dumps, and regional climatic variations.

Egg-infested used tires are incupated for the further spread of the mosquito elsewhere in Europe. However, in the United Kingdom, no part of entry surveillance program exists for the monitoring of imported insect species through used tires or other types of shipments. Although the United Kingdom has a lower potential risk for the introduction of *Ae. albopictus*, risk for transmission of flaviviruses such as dengue still remains, even on a seasonal basis. For example, in 1990, there were 153 laboratory-confirmed, imported cases of dengue among British residents who had travel histories from Southeast Asia, India, Pakistan, and the West Indies.

Should *Ae. albopictus* be introduced and survive in the United Kingdom and even briefly

<sup>4</sup> F. Rodhain, Pasteur Institute, Paris, France, unpublished data.

<sup>5</sup> Rome, Italy, December 19–20, 1994.

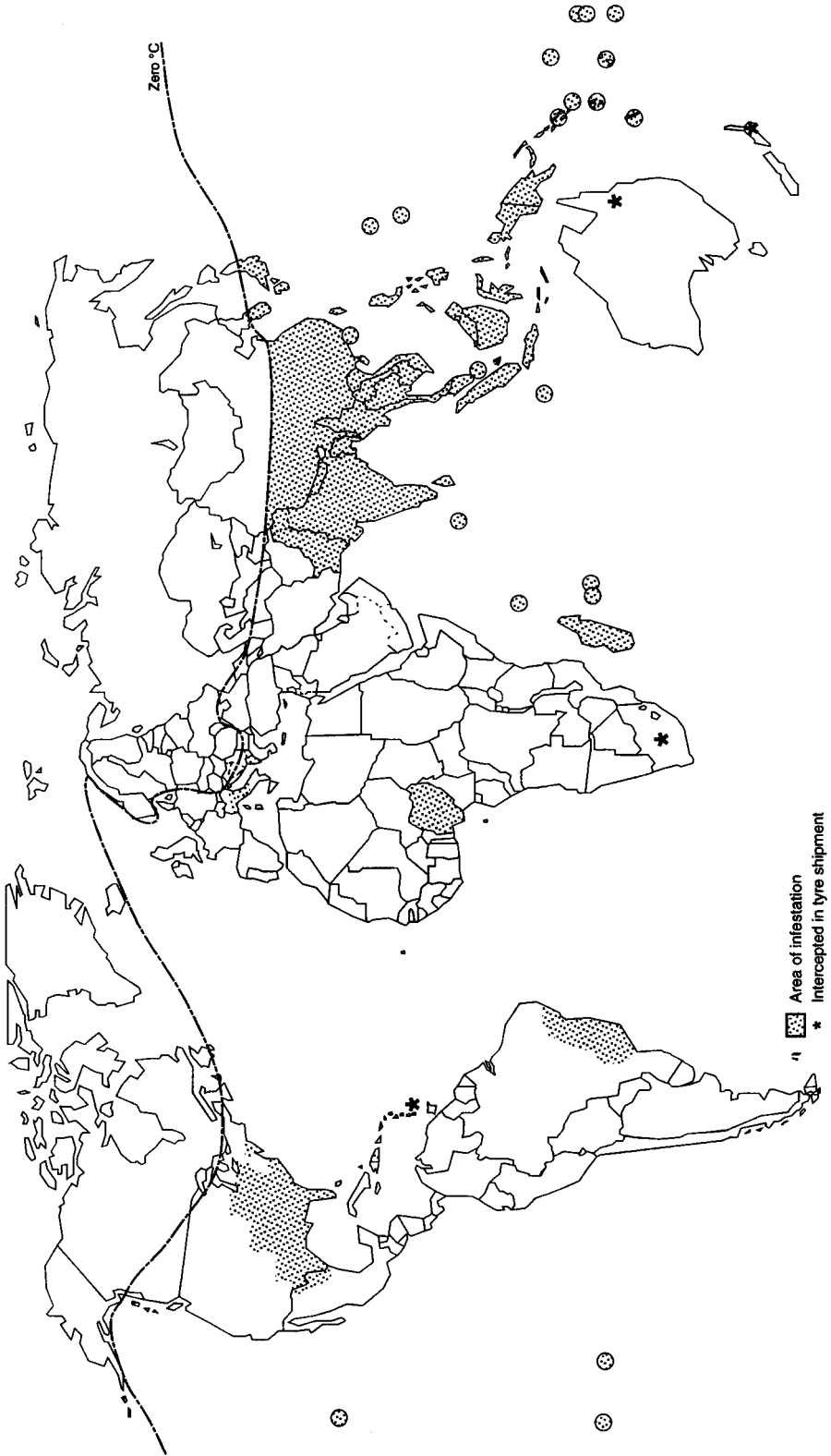


Fig. 3. Countries where *Aedes albopictus* is reported to be present.

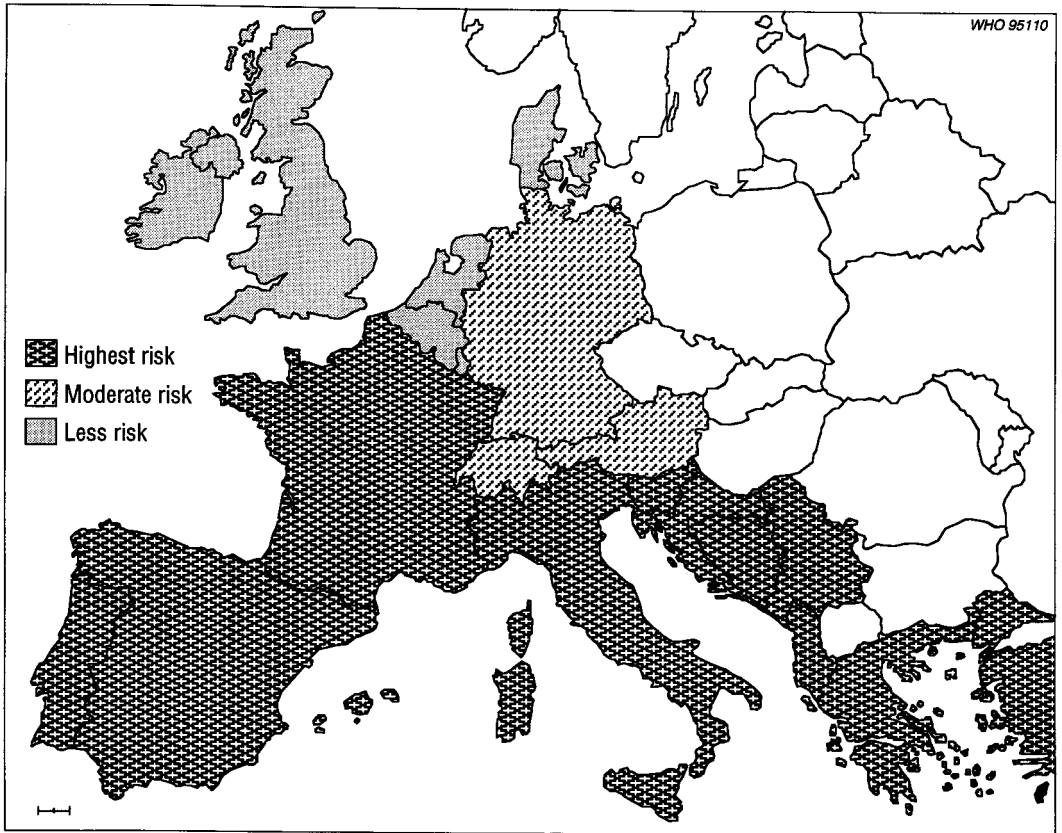


Fig. 4. European countries at risk for the introduction of *Aedes albopictus*.

breed, it could present a risk to public health. Approximately 49 million people pass through Heathrow Airport's gates annually, many of whom originate from or are returning from dengue-endemic areas of the globe. Surveillance for the tiger mosquito is being conducted in France along the Nice coast, but to date no infestations have been discovered.

Other countries and territories outside of Asia, the Americas, and Europe have indicated a concern regarding the introduction of *Ae. albopictus* in relationship to the risk of disease transmission. Maguire (1994) indicated that serological evidence showed that Ross River and dengue viruses had probably been introduced into New Zealand by viremic travellers. Although there is no field evidence that local mosquitoes can transmit these viruses, the accidental introduction of a new vector mosquito, in particular *Ae. albopictus*, could pose a threat in view of the high percentage of susceptible New Zealand residents.

A plan of action for the surveillance and control of *Ae. albopictus* in Italy has been established to control present and future infestations

of the species. The program is being implemented by stages over a 3-year period, 1995-97, as part of the country's national health plan. The plan's general objective is to control *Ae. albopictus* infestations, so that the mosquito cannot become an important public health problem. The specific objectives of the plan are to establish an efficient surveillance system throughout the country, reduce vector densities in those areas where stable and large colonies are present, eradicate the vector from those areas where limited foci are present, and define the vector competence of *Ae. albopictus* for arboviruses in Italy.

From these observations regarding the fairly rapid spread of *Ae. albopictus* in Italy, it is highly likely that further dissemination will occur outside of Italy into other southern European countries where conditions are suitable for introduction of the species. One of the recommendations that stemmed from the 1994 workshop on *Ae. albopictus* in Italy was that "In light of: (i) the introduction of *Aedes albopictus* into Italy in 1990, the first such major infestation in Europe; (ii) the rapid spread of the mosquito into

new regions of the country; (iii) the associated risk to public health; that it was suggested that vector and disease surveillance and monitoring be increased within Italy, and in those countries which share a border common with Italy, or those countries which might incur infestations of egg positive tires or from other types of egg positive containers which are widely involved in commerce between such countries.”

Indeed, if there is to be hope of preventing or containing the further spread of *Ae. albopictus* into other European countries, those countries facing the highest risk must increase communication, collaboration, and networking. Surveillance must be increased at those sites where introduction may occur, including seaports and airports and used tire depots. There must be national and international cooperation and perhaps legislative means of guarding against the introduction of mosquito species through the used tire trade. Above all information must be disseminated to keep concerned public health authorities current on recent developments.

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