Nowadays, outbreaks of dengue and chikungunya fever have been reported in the European region. The emergence of this arthropod-borne viral diseases has emphasised a serious and growing problem of public health that is affecting not only the EU but also the rest of the world. The introduction of this tropical illness to the European continent is principally due to the global expansion and establishment of its vectors, mosquito species Aedes aegypti and Aedes albopictus. Other possible factors driving its geographical spread are the increasing volume of travel and international movements involving climate change. Therefore, surveillance and control methods of this invasive mosquitoes are fundamental to prevent future outbreaks and reduce the risk of local transmission in vector colonised areas.

**Arboviruses**

**Dengue virus**
- Single-stranded positive sense RNA virus
- Family: Flaviviridae, genus: Flavivirus

**Chikungunya virus**
- Single-stranded positive sense RNA virus
- Family: Togaviridae, genus: Alphavirus

According to WHO, it is estimated that nearly 75% of the global population is exposed to dengue, especially in the tropics and subtropics, where it is also considered the leading cause of illness and death (2).

Chikungunya virus has also caused a number of epidemics involving 5-10 million people and exploding hundreds of millions at risk (3).

**Drivers of the emergence of arboviruses**

They are biotic and abiotic parameters that have allowed and promoted the large colonisation of invasive mosquitoes species (IMs) and consequently the introduction of several arboviruses in different ecological niches (temperate regions) (10).

**Intrinsic factors**
- They module infective vector and human host and the efficiency of transmission (1).
- Breeding and dissemination: choice and behavior (9).
- Vector competence: anisopliae.
- Vector and human immunity.
- Exophagic and exophilic mosquito.
- Breeding: mitochondrial behavior.
- Vector population: exophilic mosquito.
- Commitment vector: exophilic and exophilic behavior.
- Breeding: human bite behavior.
- Breeding: feeding and avian behavior.

**Extrinsic factors**
- They allow the physical proximity between vector-human host (1).
- Climate change (temperature and rainfall).
- International trade and travel.

**Competent vectors**

Aedes mosquitoes are aggressive, daytime biting insects with a preference for human blood (anthrophilic) and a high invasive potential (1,11). The principal species of this genus are the following:

- **Aedes aegypti**
  - Strongly anthrophilic and endophilic (preference for being indoors)
  - Commonly found in urban and urban-sub-areas
  - Confined within the tropics and sub-tropics
  - Re-established only in specific areas in the European continent (Madeira, Portugal)

- **Aedes albopictus**
  - More opportunistic and exophilic (preference for being outdoors)
  - Traditionally found in rural areas
  - Globally spread (also in temperate regions)
  - Established throughout Southern Europe (Figure 1)

**Autochthonous cases in the EU**

Table 1: Most relevant outbreaks in Europe in the last decade. Adapted from (5).

<table>
<thead>
<tr>
<th>Outbreak</th>
<th>Country</th>
<th>Euro</th>
<th>Virology</th>
<th>Attack rate</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chikungunya fever</td>
<td>India</td>
<td>25</td>
<td>India</td>
<td>10.4%</td>
<td>2015</td>
</tr>
<tr>
<td>Palma (Roman, July 2003)</td>
<td>Spain</td>
<td>0</td>
<td>India</td>
<td>0%</td>
<td>2003</td>
</tr>
<tr>
<td>Montpellier (France, Jul 2013)</td>
<td>France</td>
<td>12</td>
<td>Cameroon</td>
<td>100%</td>
<td>2013</td>
</tr>
<tr>
<td>Dengue fever</td>
<td>India</td>
<td>2</td>
<td>India</td>
<td>2%</td>
<td>2013</td>
</tr>
<tr>
<td>Fez (Morocco, Mar 2015)</td>
<td>Morocco</td>
<td>3</td>
<td>Cameroon</td>
<td>100%</td>
<td>2015</td>
</tr>
<tr>
<td>Palma (Roman, July 2013)</td>
<td>Spain</td>
<td>2</td>
<td>Cameroon</td>
<td>100%</td>
<td>2013</td>
</tr>
<tr>
<td>Madrid (Spain, Oct 2012)</td>
<td>Spain</td>
<td>1</td>
<td>Cameroon</td>
<td>100%</td>
<td>2012</td>
</tr>
</tbody>
</table>

**Prevention/surveillance/control measures for invasive mosquitoes**

**Personal protection methods**
- Effective in bite prevention.
- Repellents; mosquito screens or treated clothes.

**Chemical methods**
- Chemical insecticides.
- Insect growth regulators (larvicides) and acaricides (adulticides) are the unique chemicals used in Europe.

**Environmental methods**
- Consists in removing or turning over water containers that could be used as potential mosquito breeding sites.

**Biological methods**
- Entomopatogenic fungi:
  - Used for its adulticides, larvicides and ovicides effects.
  - Mostly commonly employed: Beauveria bassiana and Metarhizium anisopliae.
- Copepods:
  - Used as natural predators of mosquito larvae.
- Bactillus thuringiensis var. israelensis (Bt):
  - Used as a microbial larvicide due to its toxic effects.
- Purification:
  - Based on the introduction of genetically modified bacteria in mosquitoes where they express effector molecules causing different damaging effects in the insects.

**Wolf-beach-induced ectoplastic incompatibility**
- Based on a reproductive alteration causing embryonic mortality in matings between Aedes species with different Wolbachia infection status.

**Genetic methods**
- Sterile Insect Technique (SIT)
  - Relies on the release of large numbers of sterile males to suppress natural populations of mosquitoes.

**Release of insects with Dominant Lethality (RDL)**
- Consists in the generation of transgenic males with a dominant lethal gene expressed by a female-specific promoter.

**Future prospects & conclusions**

- Nowadays, outbreaks of severe exotic arboviruses, such as dengue and chikungunya viruses, have dangerously increased their frequency in Europe, facilitated by the establishment and adaptation of their competent mosquito vectors Aedes aegypti and Aedes albopictus in the region. Travellers returning from disease-endemic environments have also contributed to the introduction of this new viruses. Thus, in vector colonised areas where these arboviruses are also present, there is a genuine risk of local transmission of dengue and chikunguya fever.
- Knowing the factors of this phenomenon is essential to understand the epidemic dynamics, assess and predict the potential risk of transmission of this tropical diseases in new zones and implement control measures.
- There is no effective vaccine for chikungunya and dengue fever yet, therefore, vector-control measures are indispensable to reduce the abundance of this invasive mosquito species and prevent further incursions and outbreaks of the disease they can transmit.
- Finally, there are still a lot of questions that remain unclear and need to be answered, such as: a better understanding of the biology of both vectors and the ecology and evolution of DENV and CHIKV in their original syphatic cycle; the identification of other factors that could influence the transmission between humans and the determination whether autochthonous mosquito species could be a competent vector for DENV and CHIKV and others arboviruses as well.

Relevant references


**Figure 1: current known distribution of A. albopictus in Europe (January 2017).** Source: http://wiki.eku.edu