

**Mosquitoes in used tyres in Europe: species list and larval key**

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**Abstract**

Highlighting the increasing risk of introduction and establishment of exotic species in Europe, the author lists the 17 Culicidae species that have been observed up to 2002 in used tyres in Europe, and presents a larval key for their identification

**Introduction**

The risk of accidental spread of mosquitoes by commercial aircraft is rising because of a strong and continuous increase in the speed and frequency of flights since the 1900s (Russel, 1989). Exotic species for Europe have been caught in aircraft cabins (Eritja *et al.*, 2000) and in gangways (Karch *et al.*, 2001). Cases of airport malaria are frequently related to the introduction of species of medical importance (Guillet *et al.*, 1998). Some imported specimens are connected with airfreight (Baixench *et al.*, 1998). Transport of merchandise by sea presents the same risk. It is by this means the Asian mosquito *Aedes albopictus* was introduced to Albania on the mid 1970s, (Adhami & Murati, 1987). It is the transport of used tyres in containers that is the main means of dispersion for this species (Knudsen, 1995; Reiter, 1998). This and other Culicidae were imported to the USA by this means (Craven *et al.*, 1988) and also in the importation of the ornamental plant known as “lucky bamboo” (*Dracaena* spp.). Bromeliad importation could offer an additional means of entry for mosquitoes (Shroyer, 1981; O’Meara & Evans, 1997; Madon *et al.*, 2002).

Following the importation and establishment of *Ae. albopictus* in Albania, slightly more than one decade saw the introduction of three exotic species into four other European countries. *Aeders albopictus* was discovered in Italy in 1990 (Dalla Pozza & Majori, 1992), in France in 1999 (Schaffner & Karch, 2000), in Belgium in 2000 (Schaffner *et al.*, 2003b), and in Serbia & Montenegro in 2001 (Petrić, personal communication<sup>1</sup>). *Ochlerotatus atropalpus* appeared in Italy in 1996 (Romi *et al.*, 1997), and *Oc. japonicus japonicus* was found in France in 2000 (Schaffner *et al.*, 2003a) and Belgium in 2002 (Schaffner *et al.*, 2003c).

Predicted climatic changes could further increase the risk of establishment of accidentally introduced species. Moreover, the increasing mobility of people between arbovirus endemic areas and arbovirus-free areas increases the risk of transmission in those areas to which proven vectors have spread (Guillet & Nathan, 1999; Mitchell, 1995). Additional to the medical risk, there is a risk of greatly increased pest problems with the establishment and expansion of aggressive exotic mosquitoes capable of becoming primary pest species (Nasci, 1995). The mosquito fauna of some countries may suffer dramatic changes due to species introductions: the 7 endemic species of Guam represented no more than 29 % of the mosquito fauna of the island in 1983 (Ward, 1984). Furthermore, introduced species may comprise more efficient vectors of dengue and other disease outbreaks (Metselaar *et al.*, 1980; Ward, 1984).

For all these reasons, surveillance programmes should be implemented in European countries to enable early detection of new introductions and timely implementation of mosquito control operations. The first places surveyed should be stocks of imported used tyres. Identification of mosquitoes discovered is facilitated by newly available software, “The Mosquitoes of Europe” (Schaffner *et al.*, 2001). This is the only identification tool covering all the presently known introduced species.

This article lists the 17 species that have been observed to date in used tyres in Europe and presents a larval key for rapid differentiation between them. This key is complementary to the identification software: it allows rapid identification of larvae likely to be collected in surveillance programmes in field laboratories not equipped with a computer.

<sup>1</sup> See the Motax web site, <http://www.sove.org/motax/>

# List of mosquito species collected in tyres in Europe up to 2002

<u>Species</u>	<u>Main larval sites; Distribution; Human biting</u>
<u>References</u>	
<i>Aedes (Stegomyia) albopictus</i> (Skuse, 1894)	<p>Tree holes and artificial sites; Asia, parts of Africa and offlying islands (imported), Australasia and Pacific Islands (imported), South and Central America, including the Caribbean Islands (imported), USA (imported), Europe: (imported into Albania, Belgium, France, Italy and Serbia &amp; Montenegro; Bites man.</p> <p><u>Adhami &amp; Murati, 1987; Laird et al., 1994; Salvan &amp; Mouchet, 1994; Mitchell, 1995; Adhami &amp; Reiter, 1998; Frilli &amp; Zamburlini, 2000; Romi et al., 1999; Schaffner &amp; Karch, 2000; Petric, pers. comm., 2001; Schaffner et al., 2001, 2003a, 2003b</u></p>
<i>Anopheles (Anopheles) claviger</i> (Meigen, 1804)	<p>Natural sites, occasionally artificial sites, with preference for sites with plants or algae; Whole of Europe; Bites man</p> <p>Fauran et al., 1998; Frilli &amp; Zamburlini, 2000; Schaffner &amp; Karch, 2000; Schaffner et al., 2001, 2003a.</p>
<i>Anopheles (Ano.) maculipennis</i> s.l. Meigen, 1818	<p>Complex of 8 Palaearctic species, 7 of which occur in Europe; Natural sites, rarely in artificial sites, with preference for sites containing vegetation or algae; Whole Europe; Host preference depending on the species.</p> <p>* Frilli &amp; Zamburlini, 2000</p>
<i>Anopheles (Ano.) petragani</i> Del Vecchio, 1939	<p>Artificial or natural sites; Western Mediterranean region; Non Biting.</p> <p>Personal observations, 2001*.</p>
<i>Anopheles (Ano.) plumbeus</i> Stephens, 1828	<p>Dendrolimnic, occurs also in tyres containing large quantities of organic material and tannin (brown water); Whole of Europe; Bites man</p> <p>Adhami &amp; Murati, 1987; Adhami &amp; Reiter, 1998; Frilli &amp; Zamburlini, 2000; Karch, 1995; Schaffner &amp; Karch, 2000; Schaffner et al., 2001, 2003a, 2003b.</p>
<i>Culex (Cux.) theileri</i> Theobald, 1903	<p>Semi-natural sites; Southern Europe; Bites man</p> <p>Adhami &amp; Reiter, 1998.</p>
<i>Culex (Cux.) torrentium</i> Martini, 1925	<p>Artificial or semi-natural sites; Whole of Europe where cool climatic conditions prevail; Non biting.</p> <p>Personal observations, 1987*.</p>
<i>Culex (Maillotia) hortensis hortensis</i> Ficalbi, 1889	<p>Artificial or semi-natural sites; Whole Europe; Non biting.</p> <p>Adhami &amp; Reiter, 1998; Fauran et al., 1998; Frilli &amp; Zamburlini, 2000; Schaffner &amp; Karch, 2000; Schaffner et al., 2001, 2003a.</p>
<i>Culex (Neoculex) territans</i> Walker, 1856	<p>Natural or semi-natural sites; Whole Europe except Mediterranean region; Non biting.</p> <p>Adhami &amp; Reiter, 1998.</p>

*Culiseta (Allotheobaldia) longiareolata* (Macquart, 1838)

Artificial sites; Most of Europe (except northern countries); Non biting.

Fauran *et al.*, 1998; Frilli & Zamburlini, 2000; Personal observations, 2000\*.

*Culiseta (Culiseta) annulata* (Schrank, 1776)

Artificial or natural sites; Whole of Europe; Bites man.

Adhami & Reiter, 1998; Frilli & Zamburlini, 2000; Schaffner & Karch, 2000; Schaffner *et al.*, 2001, 2003a.

*Culiseta (Cus.) glaphyoptera* (Schiner, 1864)

Artificial or semi-natural sites; Northern and eastern Europe; Non biting.

Personal observations, 1987\*.

*Ochlerotatus (Finlaya) geniculatus* (Olivier, 1791)

Dendrolimnic, in tyres in water containing large quantities of organic material and tannin (brown water); Whole of Europe; Bites man

Adhami & Murati, 1987; Adhami & Reiter, 1998; Frilli & Zamburlini, 2000; Schaffner & Karch, 2000; Schaffner *et al.*, 2001, 2003a, 2003b.

*Ochlerotatus (Fin.) japonicus japonicus* (Theobald, 1901)

Small artificial and natural sites; Japan, Korea, USA and Canada (imported), Europe: imported in France and Belgium; Bites man.

Schaffner *et al.*, 2003a; 2003c.

*Ochlerotatus (Ochlerotatus) atropalpus* (Coquillett, 1902)

Rock pools and artificial sites; North America, Europe: imported in Italy; Bites man

Romi *et al.*, 1997; Romi *et al.*, 1999.

*Orthopodomyia pulcripalpis* (Rondani, 1872)

Dendrolimnic, in tyres which contain large quantities of organic material and tannin (brown water); Temperate Europe; Non biting.

Personal observations, 2002\*.

\* Author's personal observations: the date indicates the first observation.

**Other species not yet been observed, but which may be encountered in tyres**

*Dendrolimnic species: Ae. (Ste.) cretinus* Edwards, 1921; *Oc. (Och.) berlandi* (Séguy, 1921); *Oc. (Fin.) echimus* (Edwards, 1920); *Oc. (Fin.) gilcolladoi* (Sánchez-Covisa, Rodríguez & Guillén, 1985) and *Oc. (Och.) pulcristarsis pulcristarsis* (Rondani, 1872).

??Already established or potential immigrant species with wide exotic distributions??: *Ae. (Ste.) aegypti* (Linnaeus, 1762), *Cx. (Cux.) impudicus Ficalbi*, 1890 and *Cs. (Cus.) subochrea* (Edwards, 1921).

**Other species which have been observed only once, in very specific conditions (e.g. abandoned tyre in natural breeding places)**

*Cs. (Culicella) morsitans* (Theobald, 1901) (France; S. Chouin, pers. comm.); *Oc. (Och.) caspius caspius* (Pallas, 1771) (Greece; A. Samanidou, personal communication).

## Larval identification key

### 1. Genera

- |   |  |                                   |
|---|--|-----------------------------------|
| 1 | Siphon absent .....  | <i>Anopheles</i>                  |
|   | Siphon well developed .....                                    | 2                                 |
| 2 | Pecten absent .....  | <i>Orthopodomyia pulcripalpis</i> |
|   | Pecten present .....   | 3                                 |
| 3 | Siphonal setae (1-S) consisting of 3 or more pairs. ....       | <i>Culex</i>                      |
|   | Siphonal setae (1-S) consisting of a single pair. ....         | 4                                 |
| 4 | Siphonal setae (1-S) inserted near base of siphon. ....        | <i>Culiseta</i>                   |
|   | Siphonal setae (1-S) inserted nearer to middle of siphon ..... | <i>Aedes, Ochlerotatus</i>        |

### 2. *Aedes* and *Ochlerotatus* species

- |   |   |                        |
|---|---|------------------------|
| 1 | Abdominal lateral setae (Setae 6 and 7) on segments II – VI strong, II – VI stellate; pecten spines long and closely approximated ..... | <i>Oc. geniculatus</i> |
|   | Abdominal lateral setae (Setae 6 and 7) on segments II – VI not stellate, pecten with short and normally spaced spines. ....            | 2                      |
| 2 | Pecten spine all evenly spaced. ....  | <i>Ae. albopictus</i>  |
|   | Pecten with one or two of the distal most spines more widely spaced. ....   | 3                      |
| 3 | Frontal setae 5-C et 6-C simple, single. ....   | <i>Oc. atropalpus</i>  |
|   | Frontal setae 5-C et 6-C multiple <sup>1</sup> (branched ?) .....   | <i>Oc. japonicus</i>   |

### 3. *Anopheles* species

- |   |  |                              |
|---|--|------------------------------|
| 1 | Frontal setae 4,5 and 6-C simple and small .....                           | <i>An. plumbeus</i>          |
|   | Frontal setae 4,5 and 6-C plumose and large .....                          | 2                            |
| 2 | Outer clypeal setae 3-C with numerous branches .....                       | <i>An. maculipennis</i> s.l. |
|   | Outer clypeal setae 3-C simple or slightly branched .....                  | 3                            |
| 3 | Antepalpmate setae 2-IV with 2-3 branches (if 3: median branch shorter) .. | <i>An. petragrani</i>        |
|   | Antepalpmate setae 2-IV with 3-6 branches (if 3 all equally long) .....    | <i>An. claviger</i> s.s.     |

### 4. *Culex* species

- |   |   |   |
|---|---|---|
| 1 | Siphon index (length/width at mid-length) < 6 .....       | 2   |
|   | Siphon index > 6. ....                                    | 3   |
| 2 | Abdominal segment VIII with blunt-ended comb-scales. .... | <i>Cx. pipiens, Cx. torrentium</i> <sup>2</sup> |
|   | Abdominal segment VIII with pointed comb-scales. ....     | <i>Cx. theileri</i>                             |
| 3 | Subapical siphonal setae 1-S short and straight. ....     | <i>Cx. territans</i>                            |
|   | Subapical siphonal setae 1-S hook-like .....              | <i>Cx. hortensis</i>                            |

<sup>2</sup> The larval stages of these two species cannot be separated, but species can be easily identified on the basis of male genitalia characters.

## 5. *Culiseta* species

- 1 Pecten with only short spines ..... *Cs. longiareolata*  
Pecten with basically short spines and apically long and hair-like spines .. 2
- 2 Mid frontal setae 6-C with 5-6 branches ..... *Cs. glaphyroptera*  
Mid frontal setae 6-C with at most 3 branches ..... 3
- 3 Distance between post-clypeal setae 4-C  $\geq$  distance between inner frontal  
setae 5-C ..... *Cs. annulata*  
Distance between post-clypeal setae 4-C < distance between inner frontal  
setae 5-C ..... *Cs. subochrea*

## Acknowledgments

We are very grateful to K. Snow, C. Ramsdale and R. Harbach for critical reading of the manuscript. This work was supported by the French Health Ministry, Health General Direction, Surveillance programme of *Ae. albopictus*.

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## Definitions of Types

More and more, the study of mosquitoes involves defining species, and those involved in the study of these insects may need to refer to articles describing species and sub-species. The following definitions have been compiled and may be useful to non-taxonomists reading mosquito descriptions. The list only includes those kinds of type specimens that are regulated by the *International Code of Zoological Nomenclature*.

### **Holotype**

The single specimen selected by the original author(s) of a species or subspecies to be the name-bearing reference specimen for the new name.

### **Paratype**

Each specimen, except the holotype, of a series of specimens used by an author(s) to formally describe and name a new species or subspecies.

### **Syntype**

Each of two or more specimens used to describe a new species or subspecies where neither a holotype nor lectotype has been designated. Each and all equivalent to holotype.

### **Lectotype**

A syntype designated as the single name-bearing specimen sometime after the original description of a new species or subspecies. Equivalent to holotype.

### **Paralectotype**

Each specimen of a syntype series remaining after the designation of a lectotype. Equivalent to paratype.

### **Neotype**

A single specimen designated as the name-bearing type of a nominal species or subspecies as a replacement for a holotype, syntype series or lectotype thought to be non-existent. Proxy type.

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