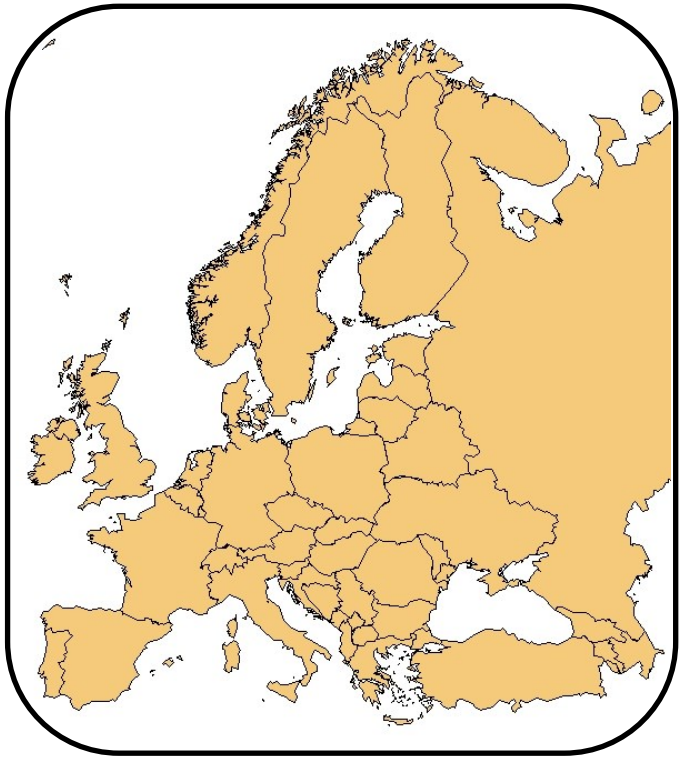


Identification Guide to the

Medically Important Mosquito Species of EUCOM

Bionomics

Diagnostic Morphological Characters

Medical Importance

Distribution

Compiled by David Pecor

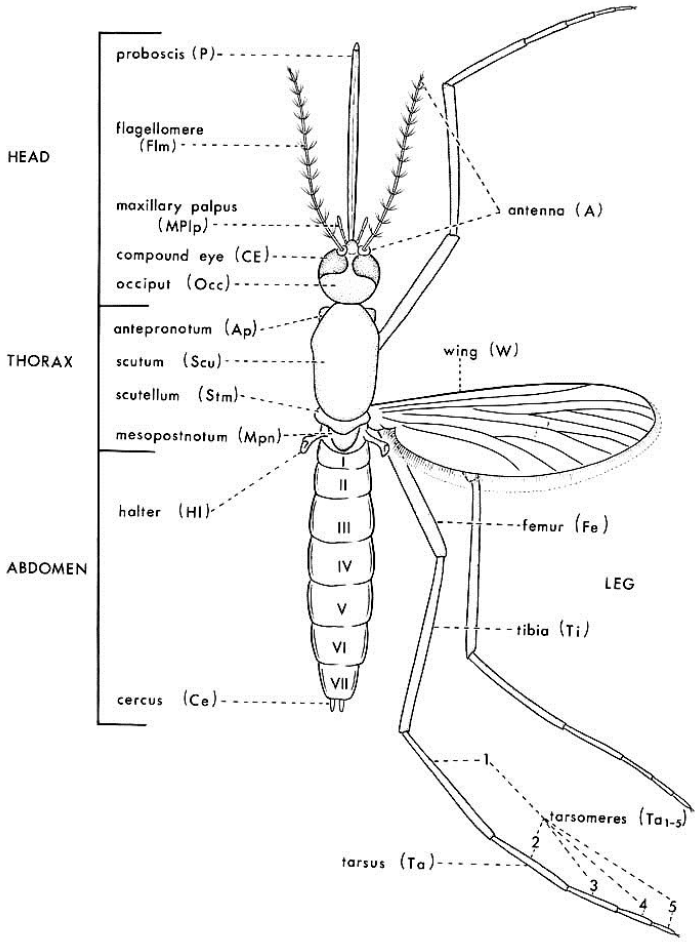
WRBU
Walter Reed Biosystematics Unit
Know the vector, know the threat

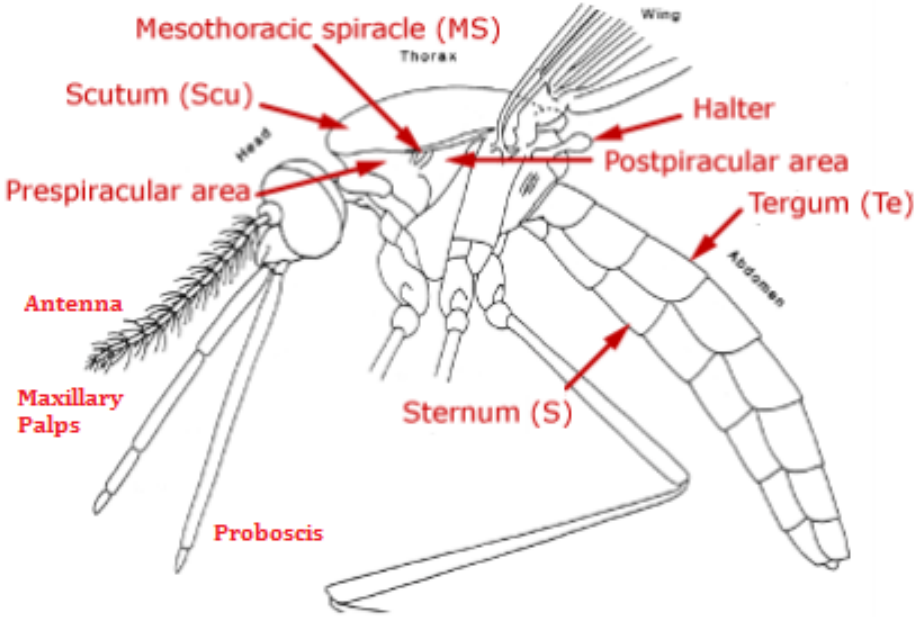
WRAIR
Walter Reed Army Institute of Research
Soldier Health • World Health

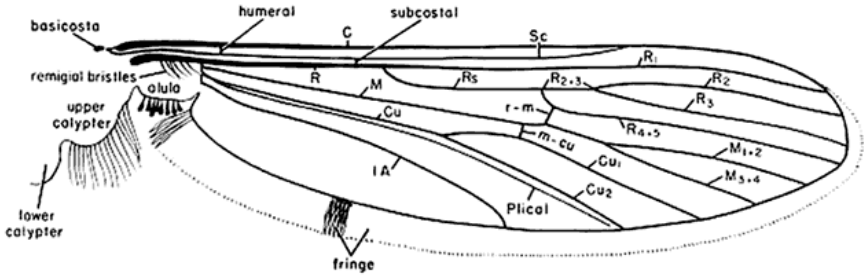
Table of Contents: Medically Important Mosquitoes of EUCOM

Note: This guide is designed to be a printed, desktop reference to assist with the identification of adult mosquitoes. Pages are bound within a 3 ring binder and can be assembled in any order that the user finds most useful. Newly developed and updated pages will be made available via WRBU upon request.

Adult Mosquito Anatomy

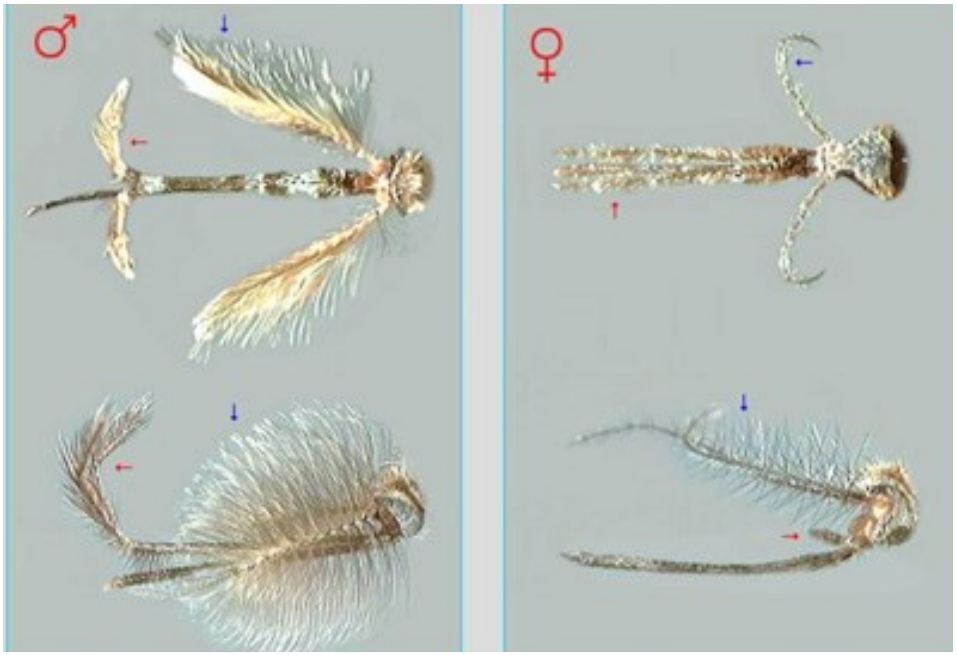


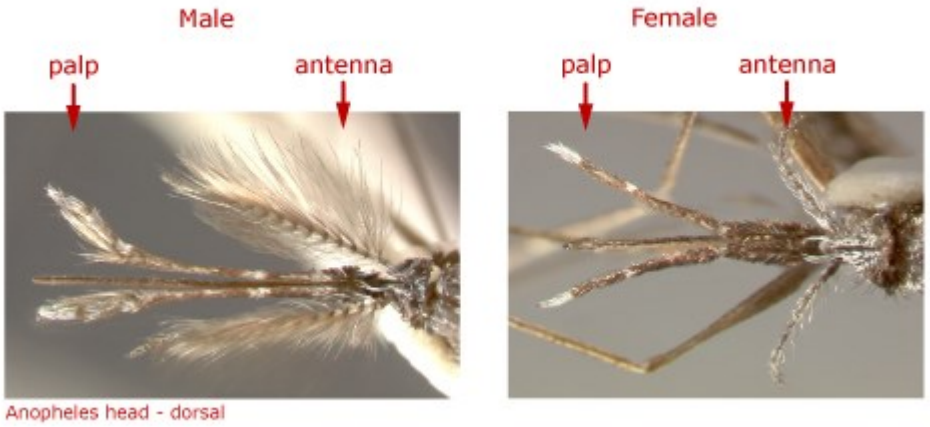




Diagrams sourced from Azari-Hamidian and Harbach, 2009 and Darsie and Ward, 2004

Adult Mosquito Anatomy





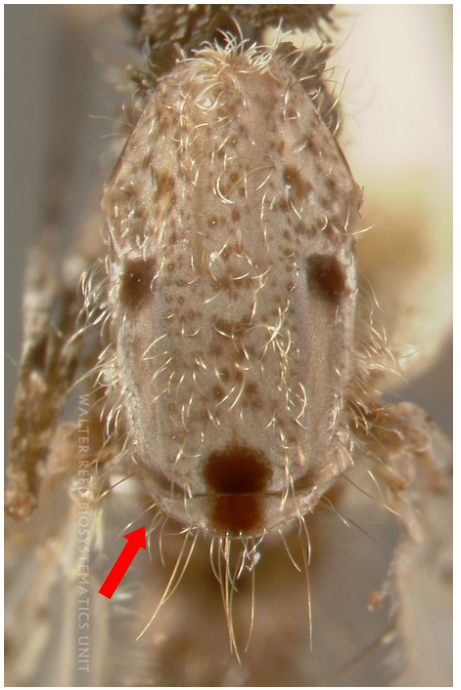
How to distinguish between male and female mosquitoes:

Male mosquitoes have bushy, plumose antennae, by contrast females have sparse, thin antennae.

Medically Important Mosquito Genera

Anopheles

Adult *Anopheles* spp. can be distinguished from other genera using the following characters:



Head (Lateral view):

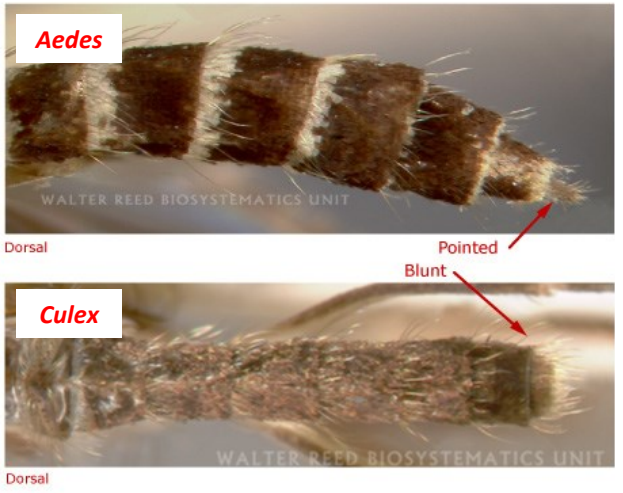
Maxillary palps are as long or slightly longer than proboscis

Thorax (Dorsal view):

The scutellum of *Anopheles* sp. are rounded and setae are evenly spaced

Aedes

Adult *Aedes* spp. can be distinguished from other genera using the following characters:



Thorax (Lateral view):

If postspiracular setae are present, than specimen is *Aedes* spp.

Abdomen (Dorsal view):

If abdomen is pointed apically specimen is *Aedes* spp.

Medically Important Mosquito Genera

Culex

Adult *Culex* spp. can be distinguished from other genera using the following characters:

Thorax (Lateral view):

Postspiracular setae are absent

Tarsus (Lateral view):

The hindungues is large and conspicuous

AND

Foretarsomere 5 (Ventral view):

Pulvilli are present

Aedes (*Adm.*) *vexans* (Meigen, 1830)

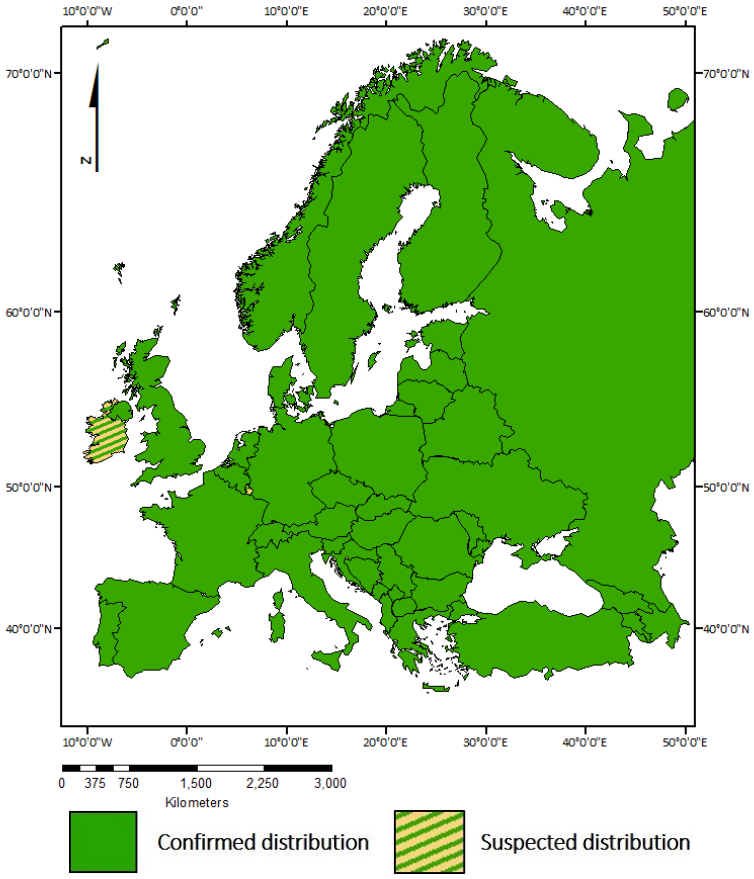
Bionomics:

Immatures of *Aedes vexans* are found in unshaded fresh water flood pools in secondary scrub, but have also been collected in ditches, swamps and rice fields. Habitats usually have little aquatic vegetation or algae. Females are night biters and readily feed on humans and cattle (Reinert, 1973). *Aedes vexans* is suspected to comprise a species complex (Linton, Pers comm).

Medical Importance:

BATV, BAV, CHAOV, EEEV, LCV, POTV, SLEV, TAHV, TVTV, USUV, WEEV, WNV

Distribution:



Aedes (*Adm.*) *vexans* (Meigen, 1830)

Abdomen
(Dorsal view):
Basal pale bands, slightly indented medially

Tarsus
(Lateral view):
Tarsomeres 4-5 entirely dark

Aedes (*Dah.*) *geniculatus* (Olivier, 1791)

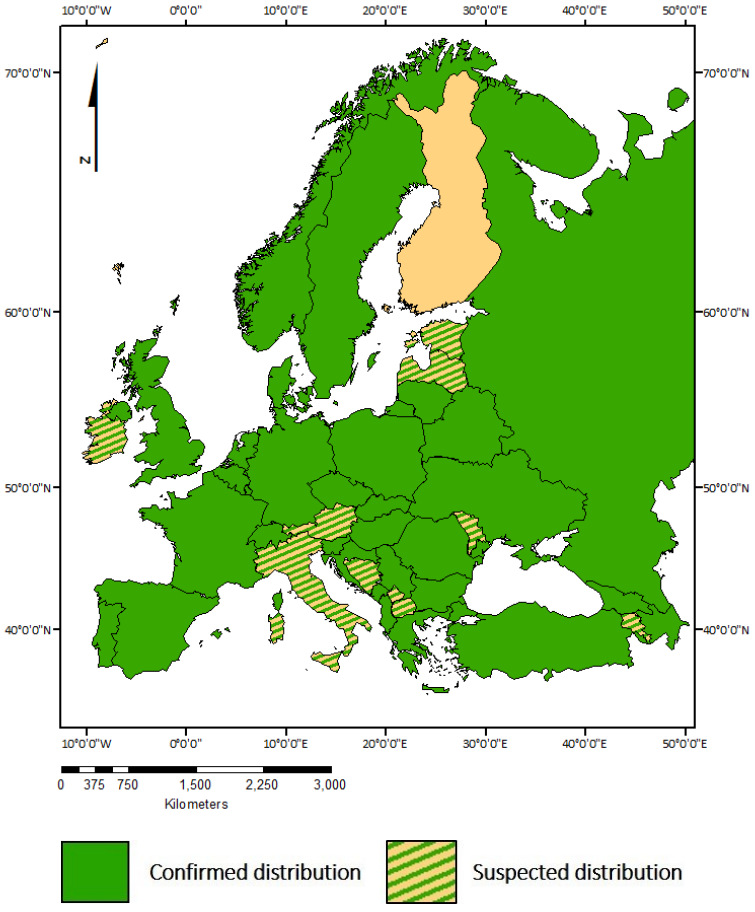
Bionomics:

Aedes geniculatus is primarily a tree-hole breeding species occurring in deciduous forest areas (Dahl, 2001); (Schaffner, 2001). However, this species reportedly uses artificial containers as well (Schaffner, 2011).

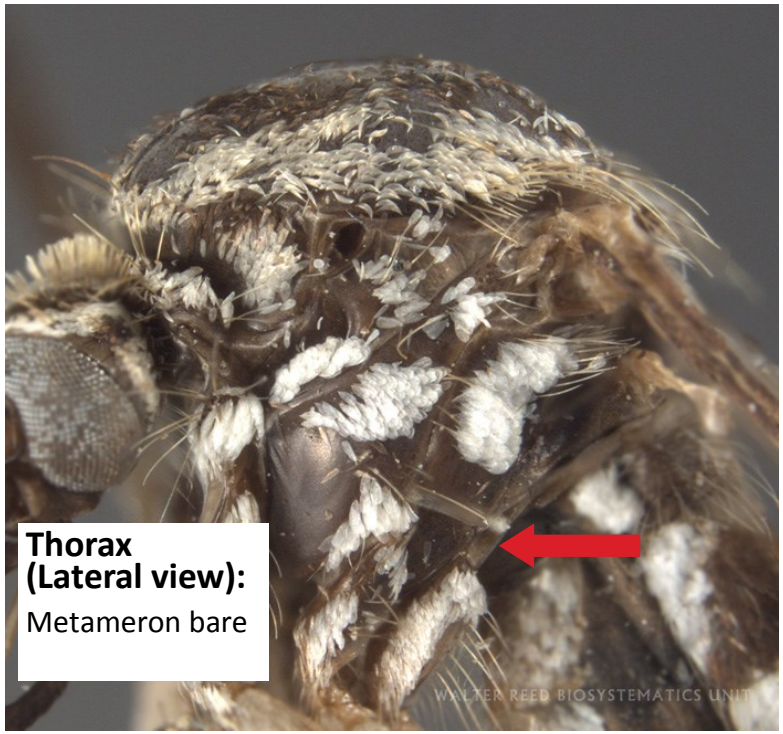
Medical Importance:

EEEV, WEEV, YFV

Distribution:

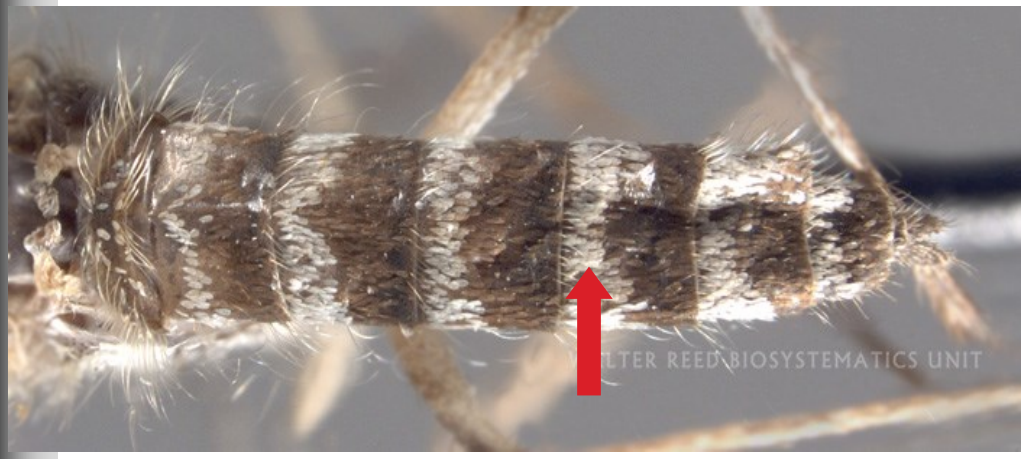


Aedes (*Dah.*) *geniculatus* (Olivier, 1791)



Thorax (Lateral view):

Metameron bare



Abdomen: (Dorsal view):

Abdominal terga with basolateral pale patches only

Thorax (Dorsal view):

Scutellum with at least a few narrow pale -yellow scales usually more numerous on lateral lobes. **Note: the yellow coloration of scales has dulled over time for the specimen in this photograph**

Aedes (*Och.*) *caspius* (Pallas, 1771)

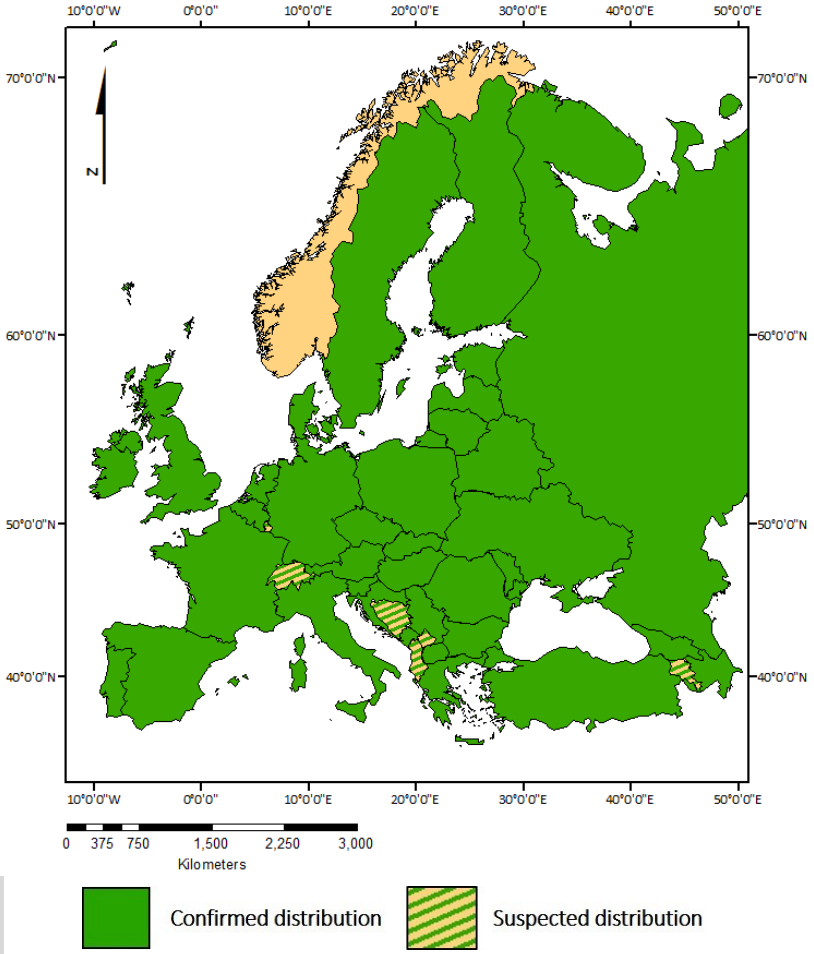
Bionomics:

Immature *Aedes caspius* utilize shallow brackish pools with little or no shade and are usually associated with irrigation runoff. Adult females *Aedes caspius* are day-time biters with a preference for sheep and humans (Kenawy, 1987).

Medical Importance:

RVFV, TAHV, WNV

Distribution:



Aedes (*Och.*) *caspius* (Pallas, 1771)

Tarsus (Lateral view):
Tarsomere 5 pale

Abdomen (Dorsal view):
Abdomen with extensive yellow scales forming a mid-dorsal line

Anopheles (*Ano.*) *claviger* s.l. Meigen, 1804

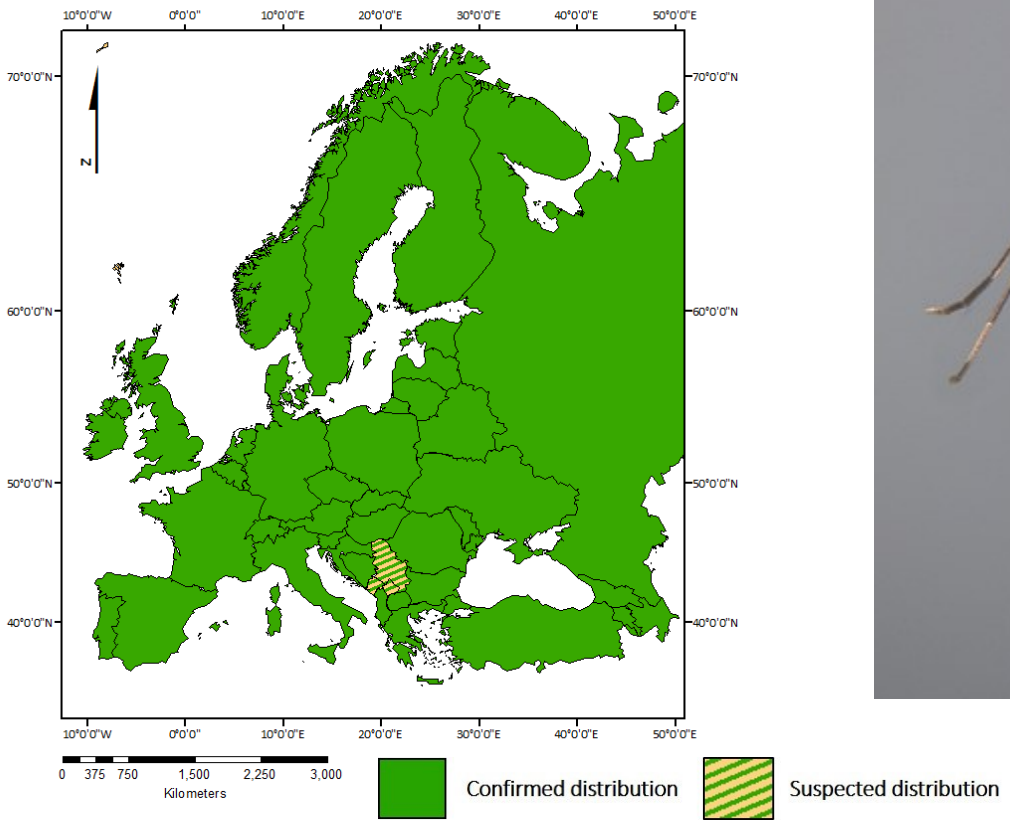
Bionomics:

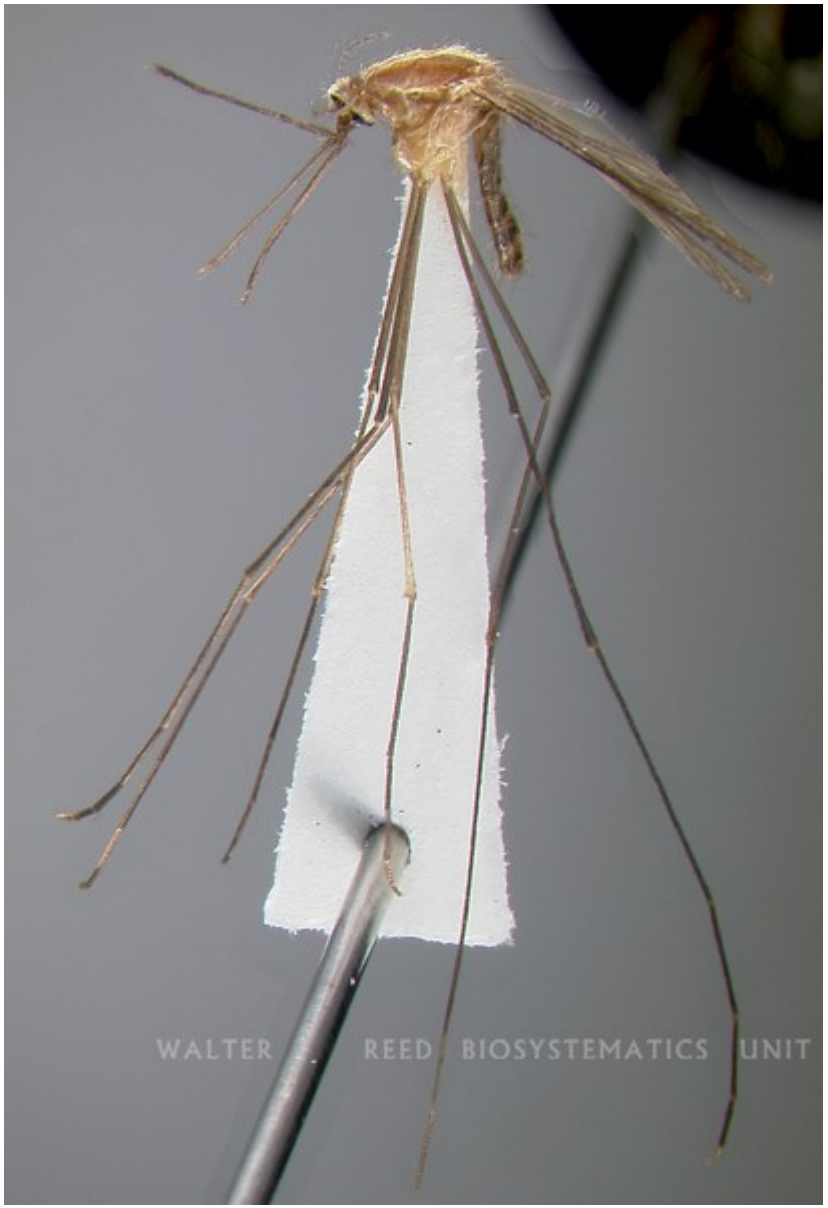
In higher latitudes the larvae of *Anopheles claviger* are found in permanent pond and lake margins especially where shade is present. In southern parts of its range the species is restricted to cool spring-fed pools and similar habitats (Bates, in Boyd 1949). It is important to note that there are at least two other species within the *Anopheles claviger* complex and that are indistinguishable by adult morphology alone. Described members *An. claviger* s.s. and *An. petragnani have been differentiated* based on morphologic characteristics of larvae and DNA (Kampen et al, 2003).

Medical Importance:

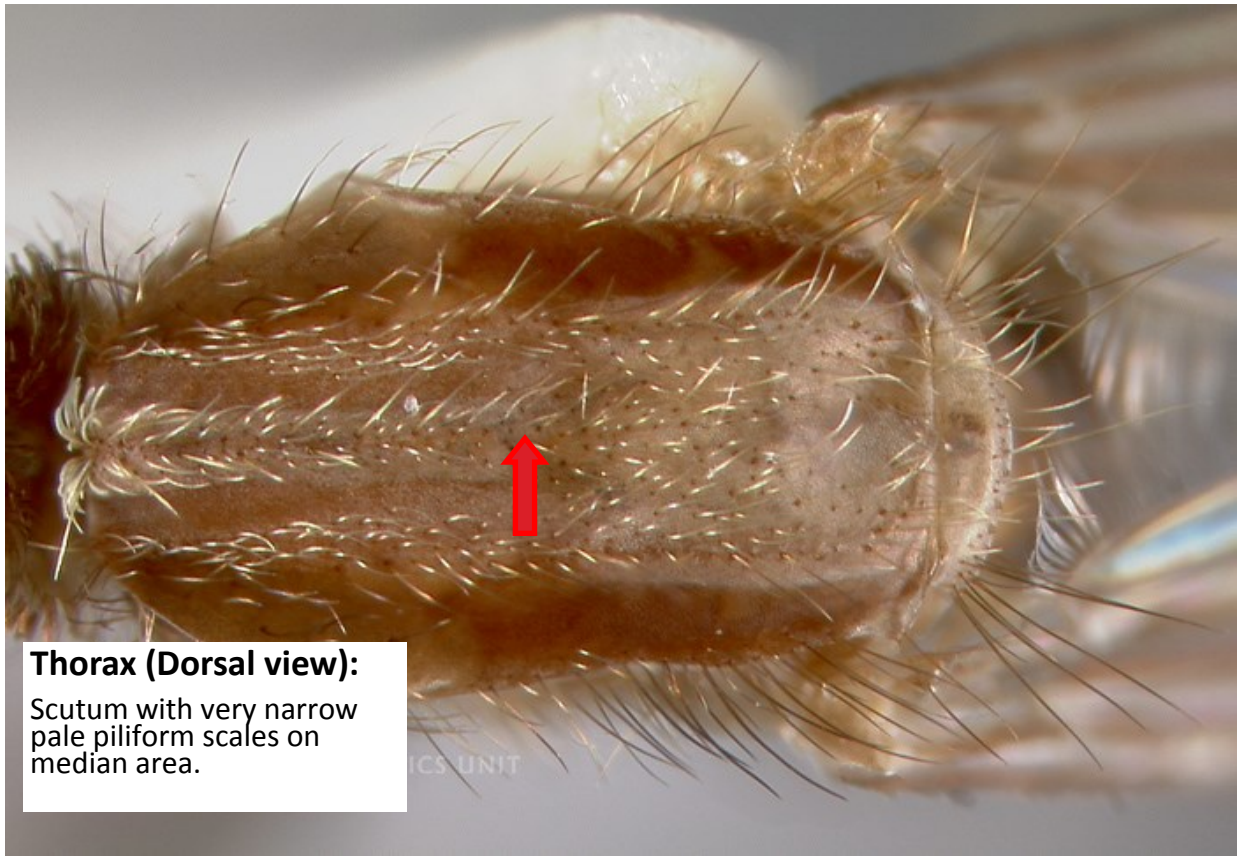
***Plasmodium vivax*, BATV, RVFV**

Distribution:



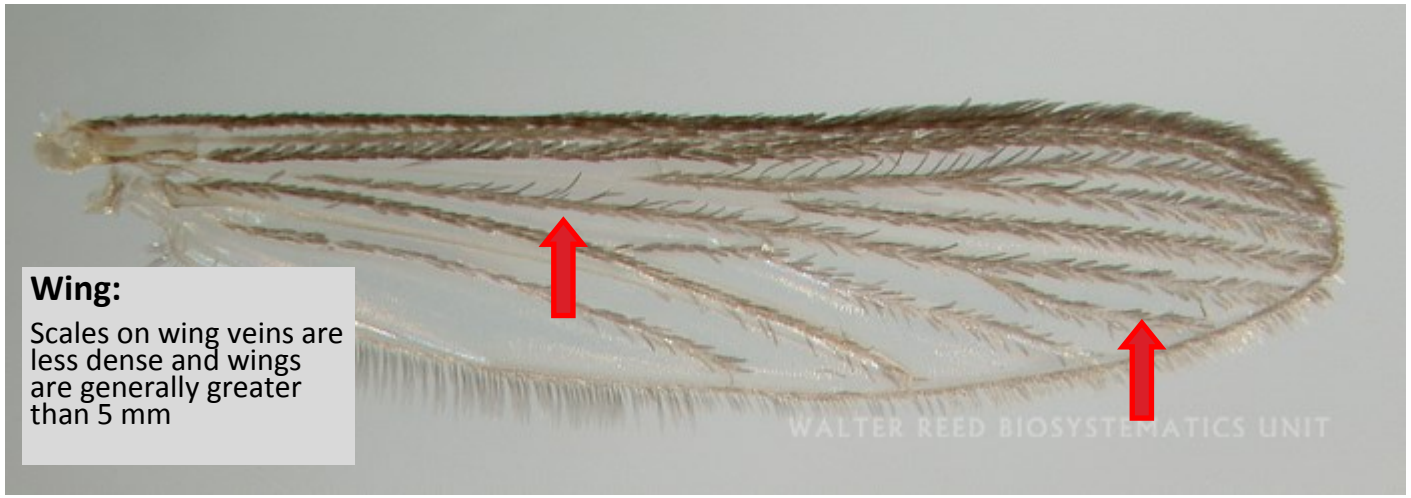


Anopheles (*Ano.*) *claviger* s.l. Meigen, 1804



Thorax (Dorsal view):

Scutum with very narrow pale piliform scales on median area.



Wing:

Scales on wing veins are less dense and wings are generally greater than 5 mm

Anopheles (*Ano.*) *plumbeus* Stephens, 1828

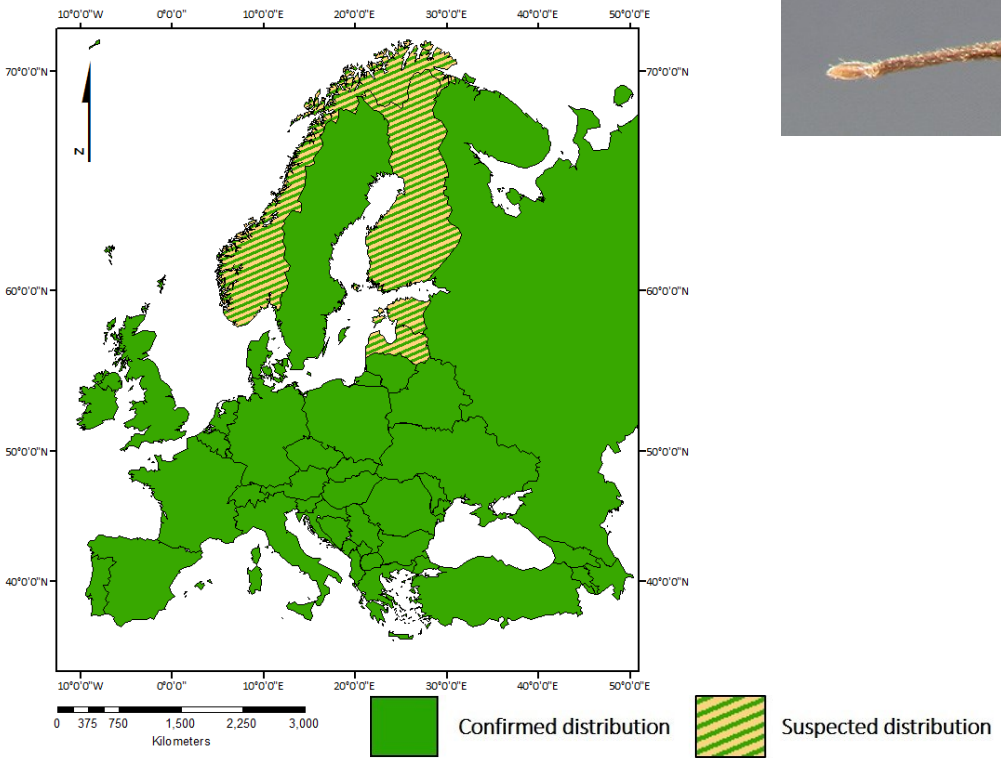
Bionomics:

Anopheles plumbeus immatures are found in tree-holes, however can also be found in artificial containers. This species readily bites humans and other mammals, reptiles and birds. Adult females bite predominantly at dusk, however have been known to bite during the day as well (Bueno-Mari, 2011).

Medical Importance:

***Plasmodium vivax*, WNV**

Distribution:



Anopheles (*Ano.*) *plumbeus* Stephens, 1828

Head (Dorsal view):

Pale scales on vertex and anterior promontory are pure white and well developed

Wing (Lateral view):

Scales on wings are dense and dark

Anopheles (*Cel.*) *pulcherrimus* Theobald, 1902

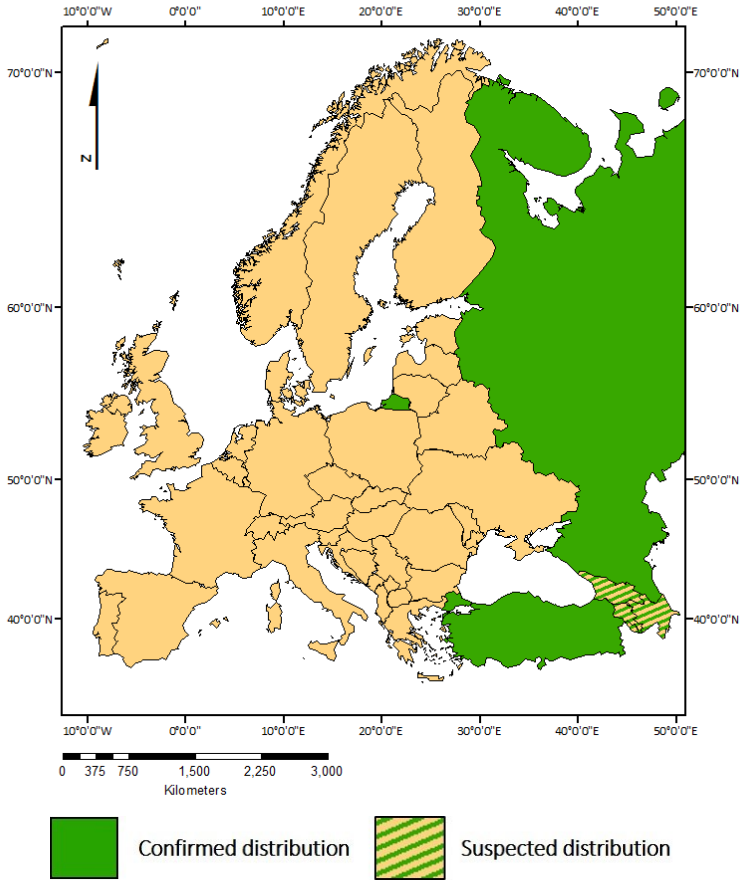
Bionomics:

Larvae of *Anopheles pulcherrimus* are found in warm, sunny, stagnant habitats with abundant submerged vegetation. Where sufficiently warm, rice fields are used. Females readily bite humans and animals (Beklemischev, in Boyd 1949).

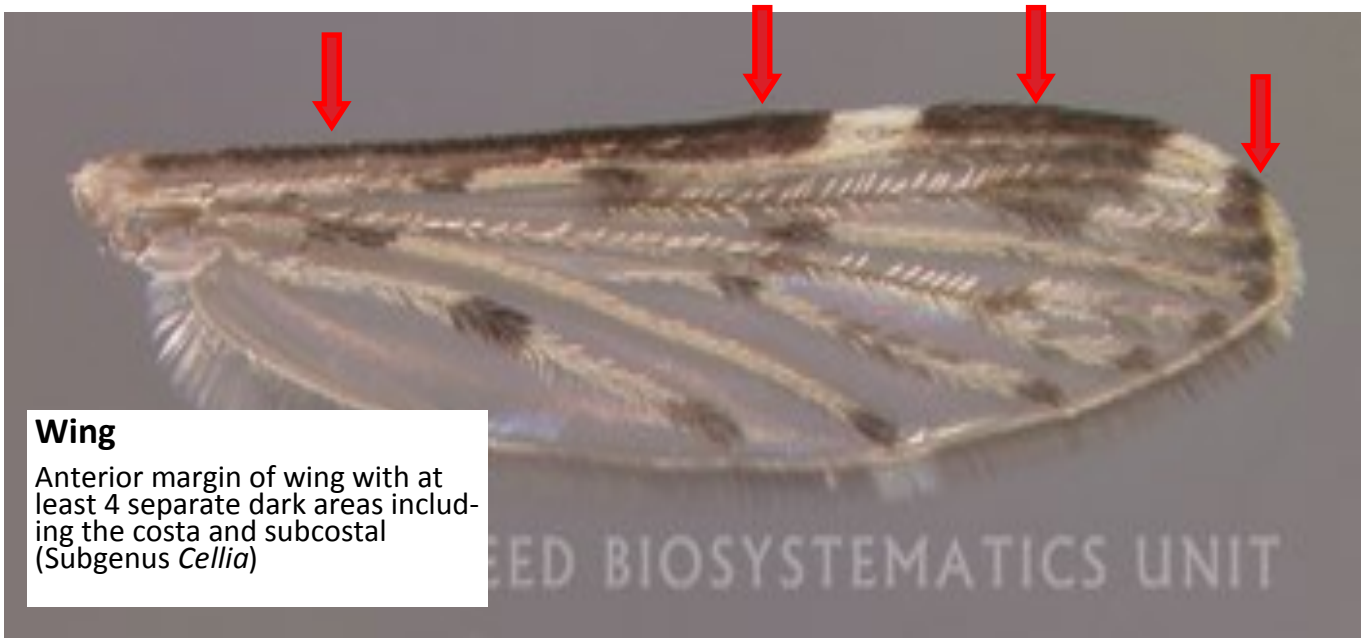
Medical Importance:

Plasmodium vivax

Distribution:

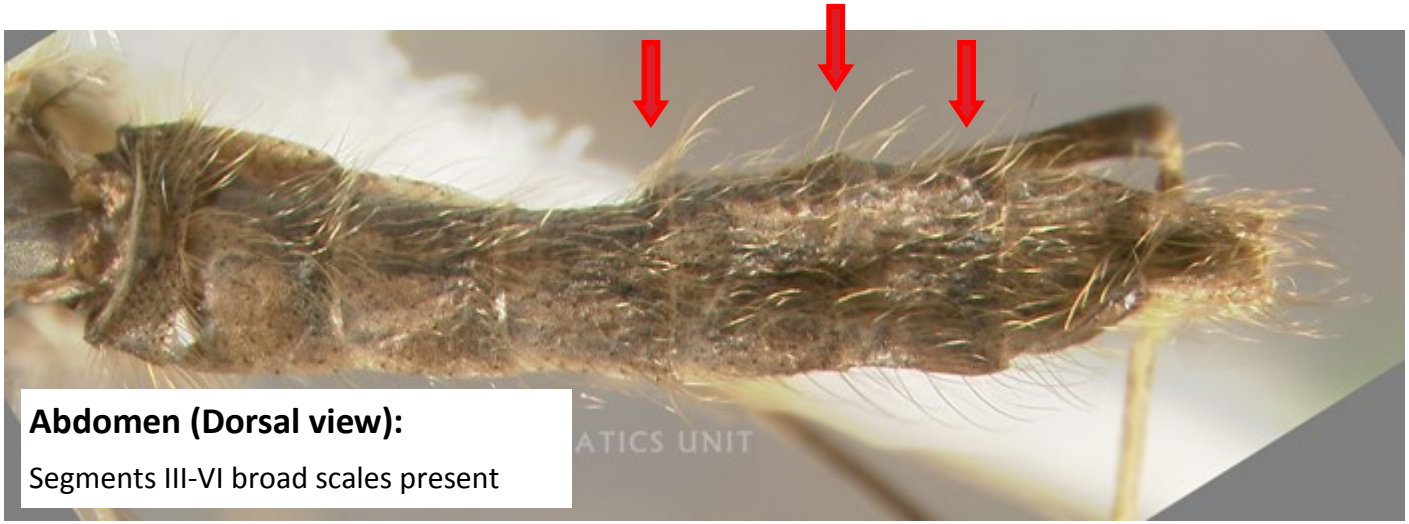


Anopheles (*Cel.*) *pulcherrimus* Theobald, 1902



Wing

Anterior margin of wing with at least 4 separate dark areas including the costa and subcostal (Subgenus *Cellia*)



Abdomen (Dorsal view):

Segments III-VI broad scales present

Anopheles (*Cel.*) *sergentii* (Theobald, 1907)

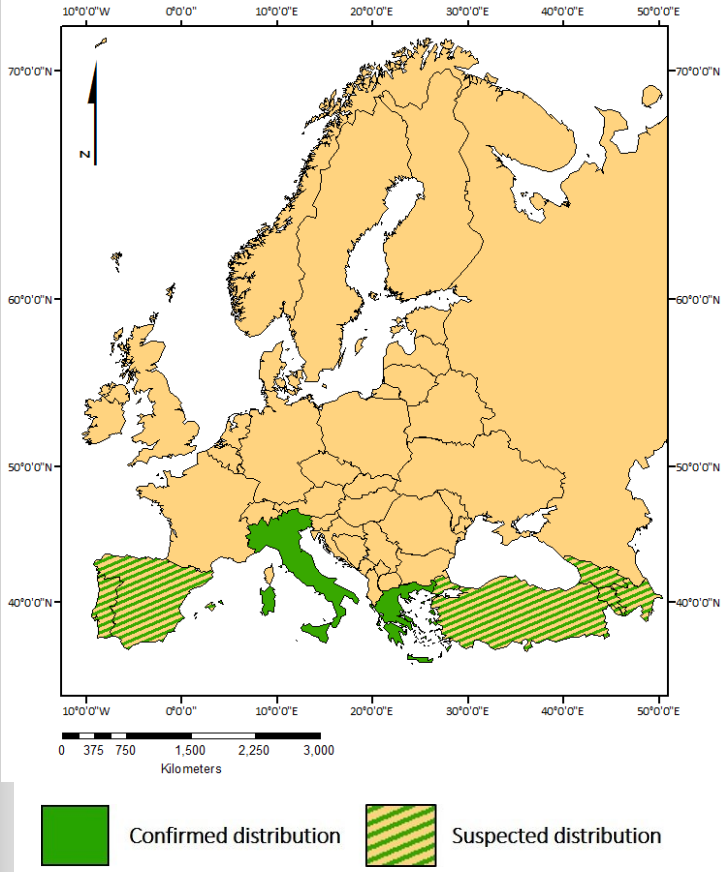
Bionomics:

Larvae of *Anopheles sergentii* occur in irrigated areas in many types of water, shaded and unshaded, with and without vegetation. Females enter houses and readily bite man (Gillies and de Meillon, 1968).

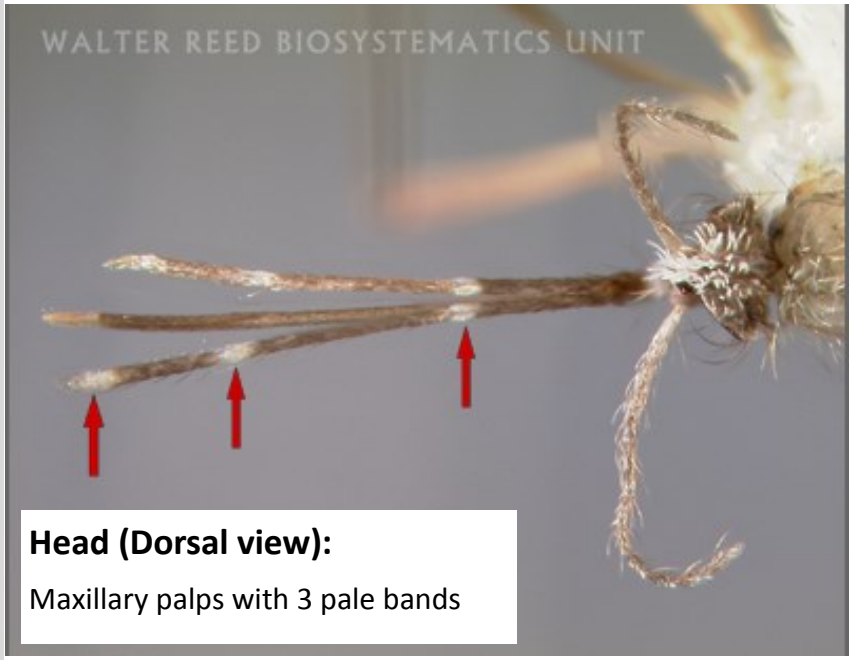
Medical Importance:

***Plasmodium* spp.**

Distribution:

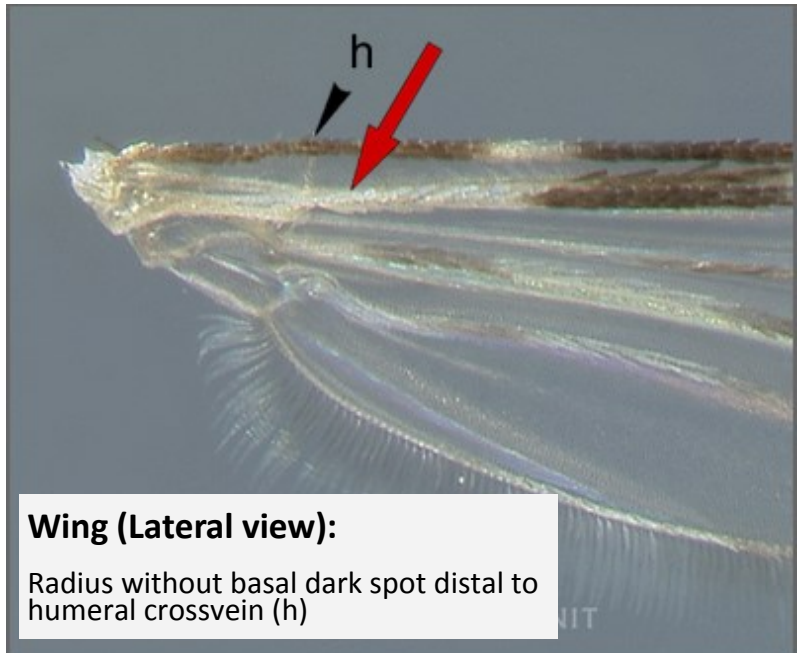


Anopheles (*Cel.*) *sergentii* (Theobald, 1907)



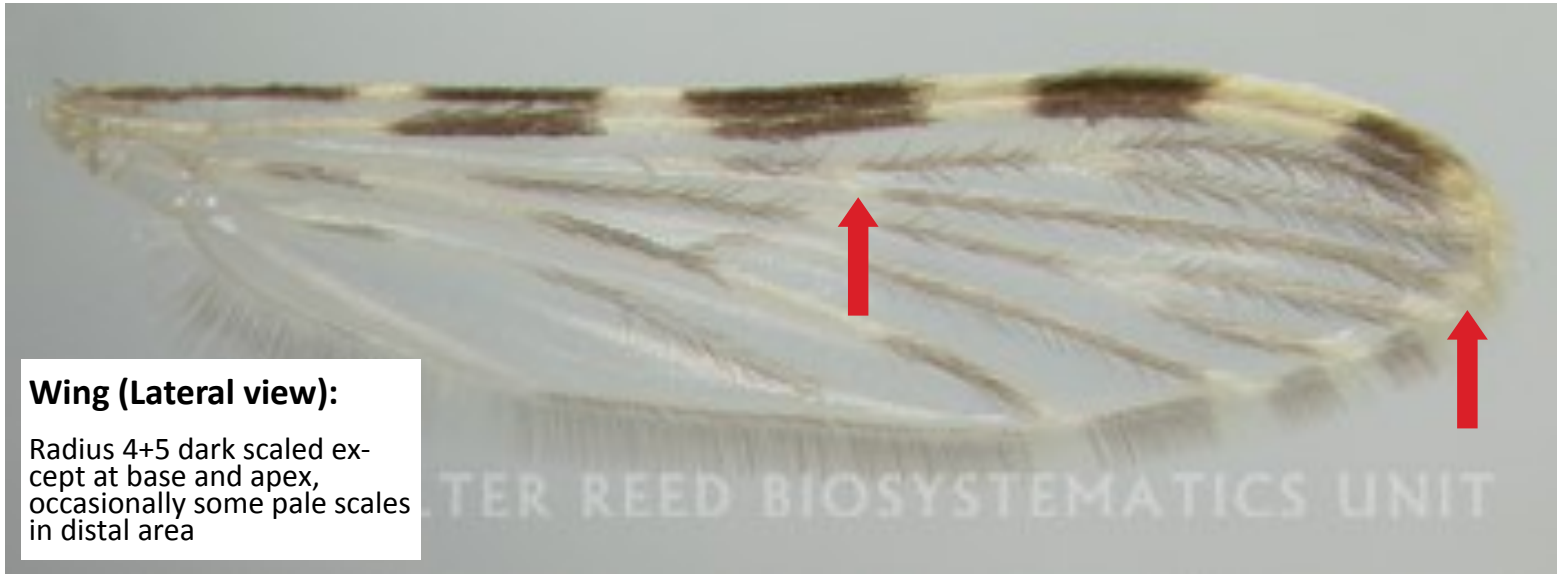
Head (Dorsal view):

Maxillary palps with 3 pale bands



Wing (Lateral view):

Radius without basal dark spot distal to humeral crossvein (h)



Wing (Lateral view):

Radius 4+5 dark scaled except at base and apex, occasionally some pale scales in distal area

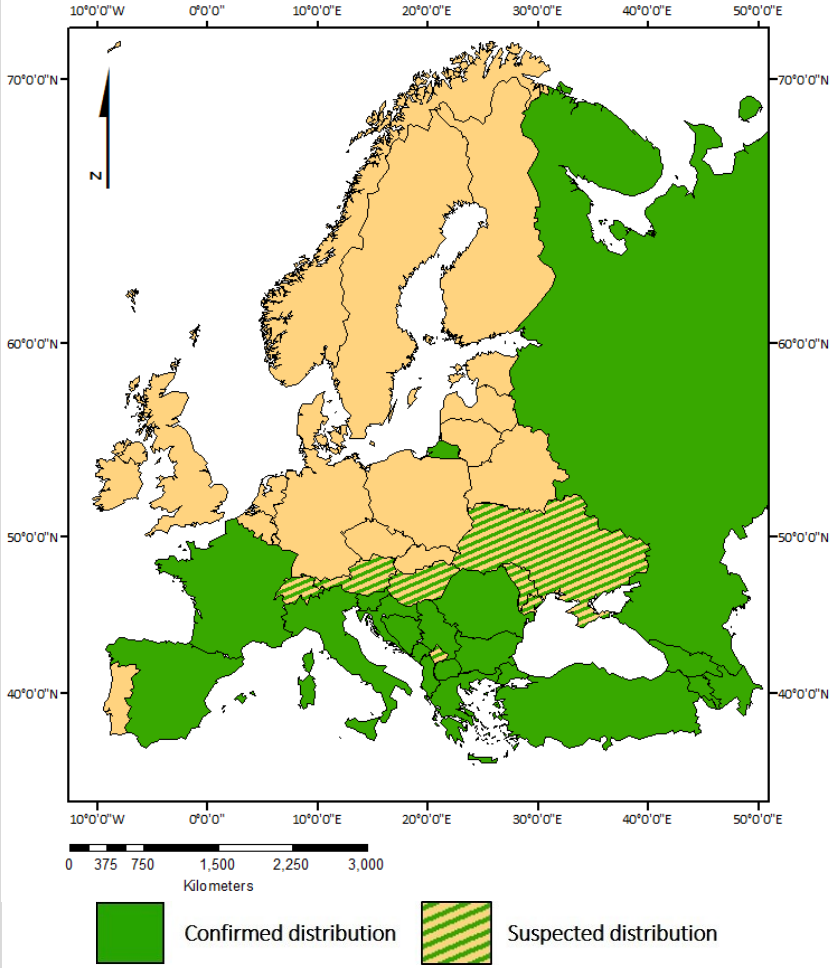
Anopheles (*Cel.*) *superpictus* Grassi, 1899

Bionomics:

Larvae of *Anopheles superpictus* are found in flowing water, including streams, rivers and irrigation channels in hilly and mountainous areas. Adults readily enter houses to bite humans (Barraud, 1933).

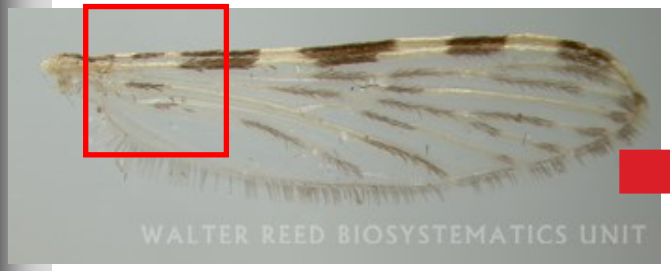
Medical Importance:

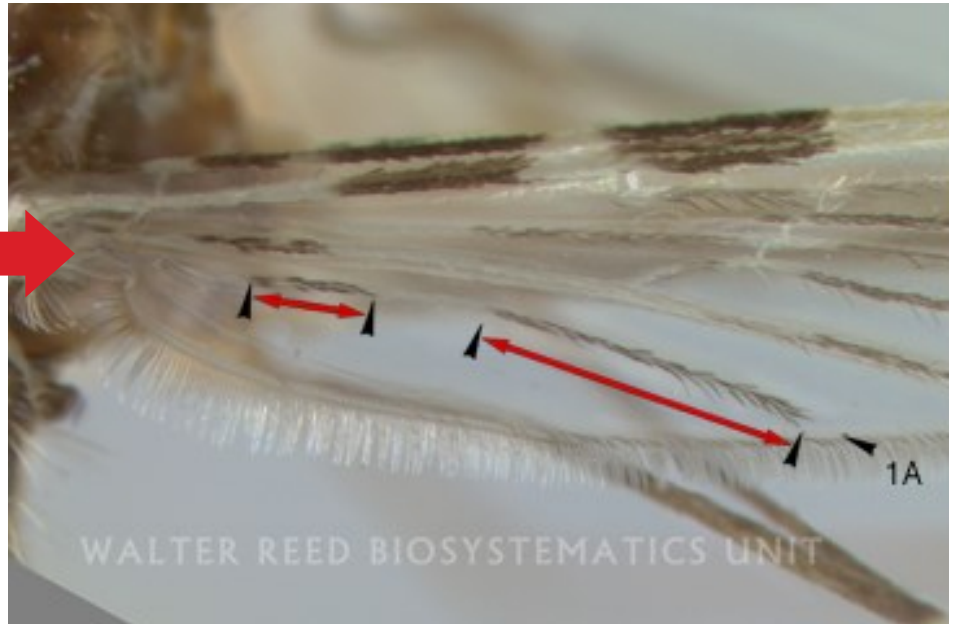
***Plasmodium* spp.**



Distri-

Anopheles (*Cel.*) *superpictus* Grassi, 1899





Wing (Lateral view):

Anal vein with 2 dark spots, distal spot longer

Legs, mid and hind (Lateral view):

Femora and tibiae not spotted

Culex (*Cux.*) *pipiens* s.l. Linnaeus, 1758

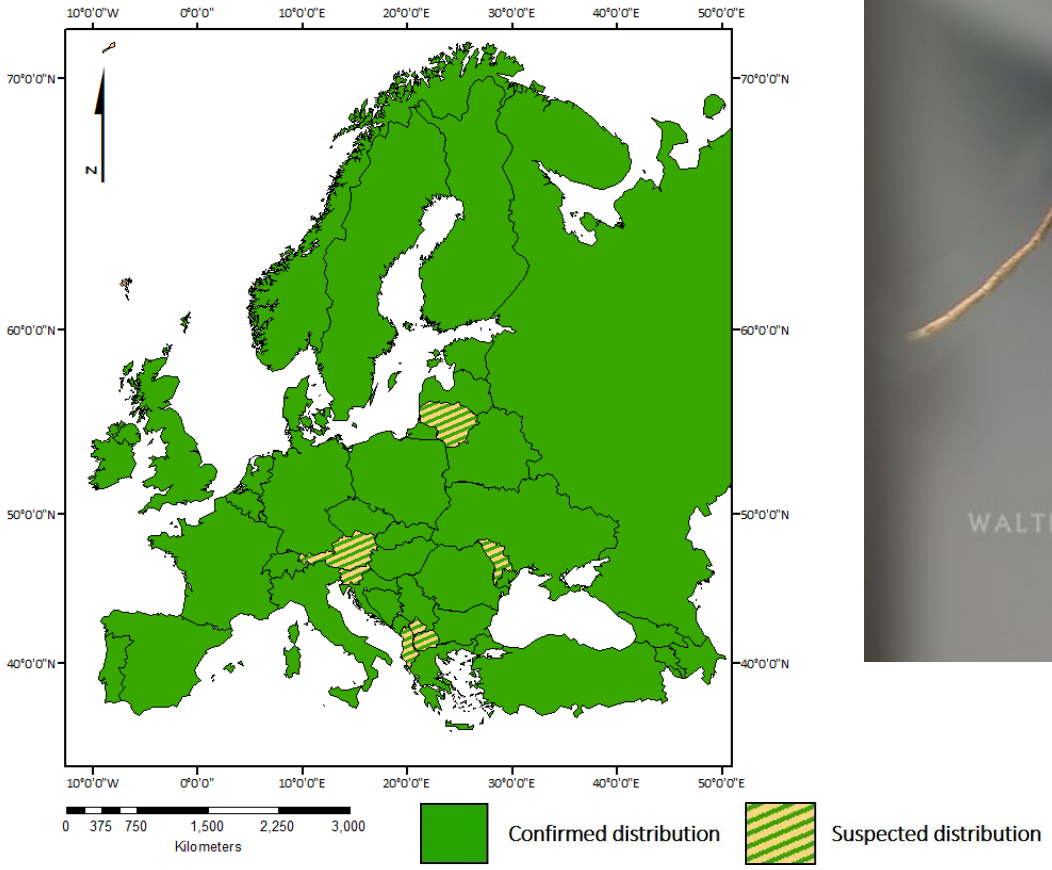
Bionomics:

Larvae of *Culex pipiens* s.l. are found in numerous and variable breeding places ranging from highly polluted cesspits to clear water pools and containers. This species usually breeds in stagnant water in either shaded or unshaded situations. Females readily attack man both indoors and outdoors (Harbach, 1988). Note: In Europe, adult females with these morphological traits are also found including *Culex pipiens pipiens*, *Culex pipiens modestus*, and *Culex quinquefasciatus* (if collected in Turkey).

Medical Importance:

EEV, JEV, OCKV, RVFV, SINV, TAHV, USUV, WEEV

Distribution:



Culex (Cux.) pipiens s.l. Linnaeus, 1758

Thorax (Lateral view):
Post spiracular scales absent

Wing:
Costa with all dark scales

Culex (*Cux.*) *theileri* Theobald, 1903

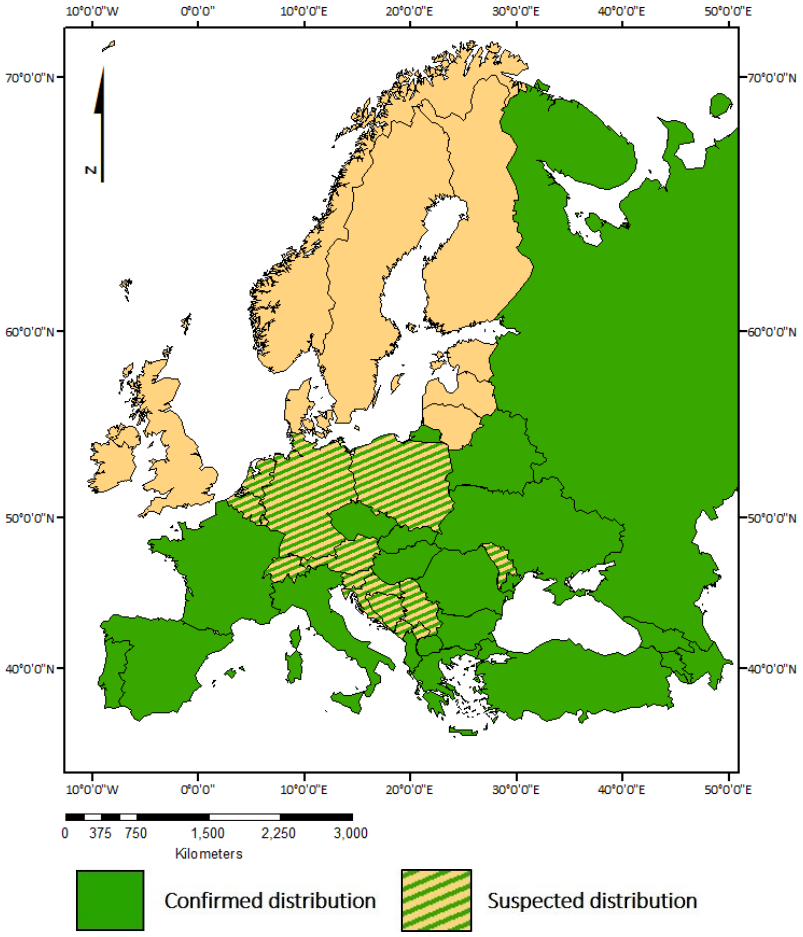
Bionomics:

Adult *Culex theileri* have been collected resting in vegetation and were attracted to human bait near sunset and to CDC traps set in secondary forests, and along edges of swamps and rivers. Larvae are reported from stagnant water (Forattini & Sallum, 1996).

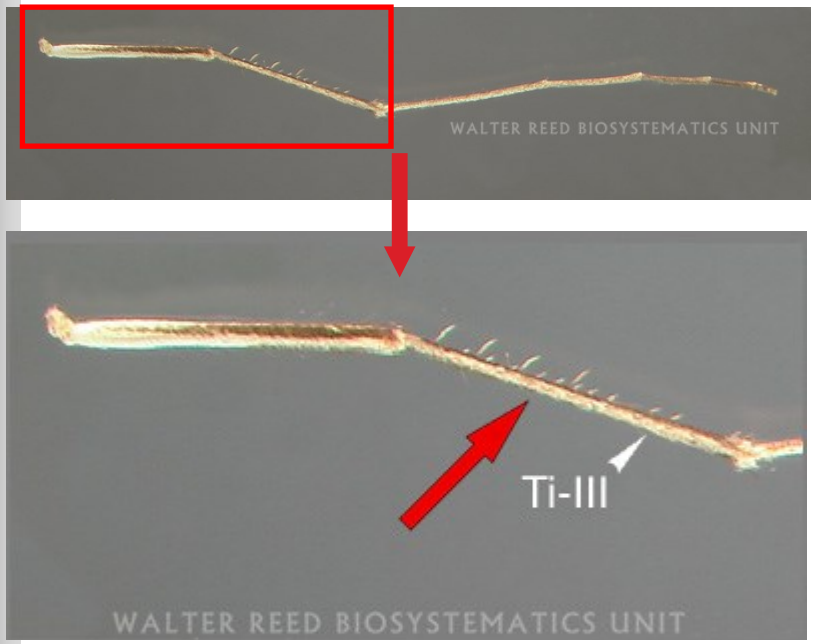
Medical Importance:

SINV, WEEV, WNV

Distribution:

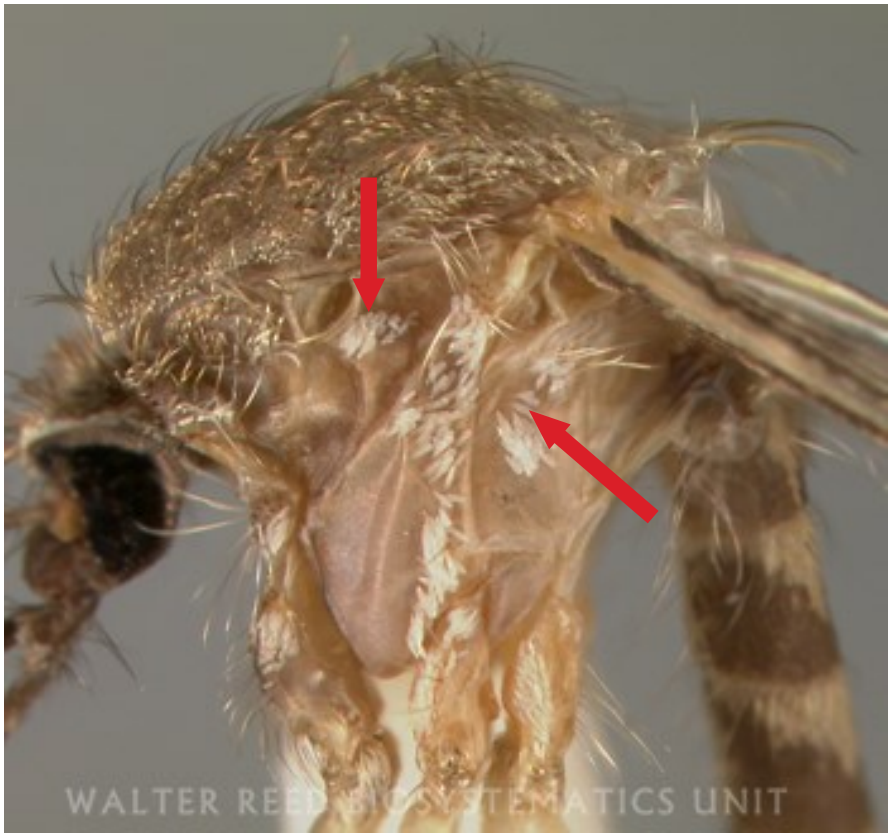


Culex (*Cux.*) *theileri* Theobald, 1903



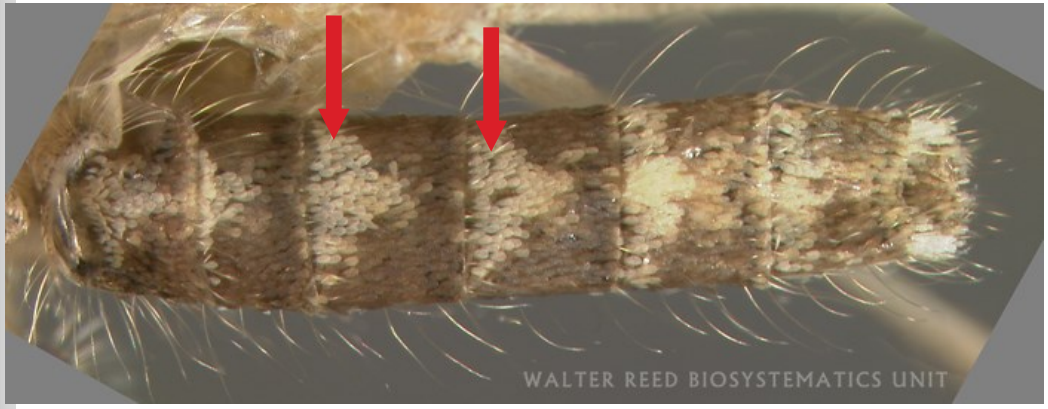
Tarsus (Lateral view):

All tibiae with anterior pale stripes



Thorax (Lateral view):

Post-spiracular scales present and one or more mesopimeral setae



Abdomen (Dorsal view):

Basal patches of creamy white scales

Culex (*Cux.*) *tritaeniorhynchus* Giles, 1901

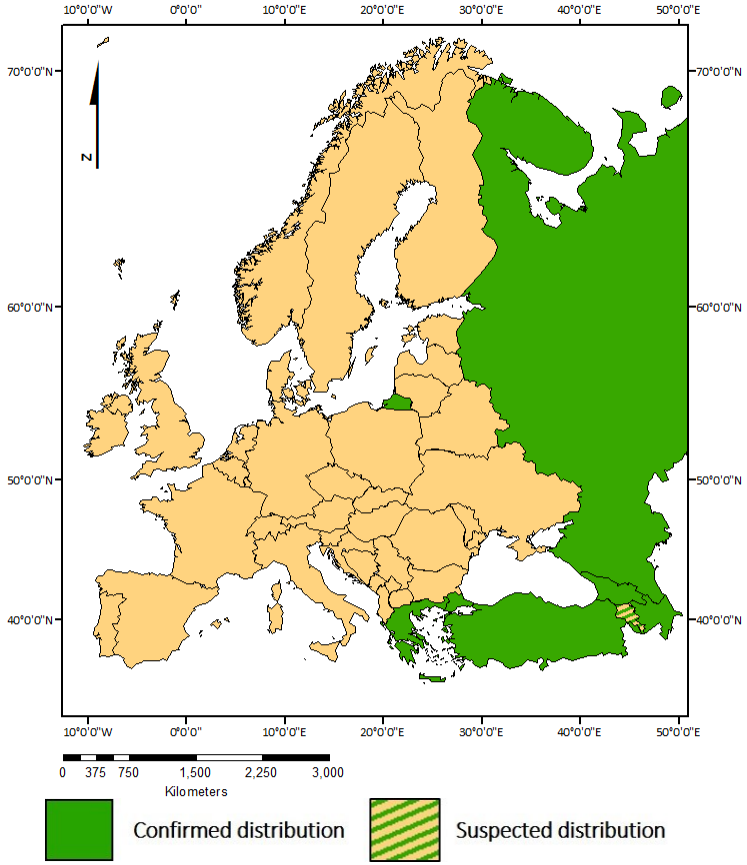
Bionomics:

Larvae of *Culex tritaeniorhynchus* are found in many temporary, semi-permanent and permanent ground water habitats that are sunlit and contain vegetation. Habitats include, but are not limited to, ground pools, streams, swamps, and low-salinity tidal marshes (Bram, 1967). Females primarily feed on cattle and pigs, but will opportunistically feed on humans (Bram, 1967).

Medical Importance:

EEV, GETV, JEV, SINV, TMUV, WNV

Distribution:



Culex (*Cux.*) *tritaeniorhynchus* Giles, 1901

Head (Lateral view):

Pale ring of proboscis extended proximally on ventral surface

Head (Dorsal view):

Erect scales on vertex all dark, dirty yellow to brown in middle

Culex (*Cux.*) *univittatus* Theobald, 1901

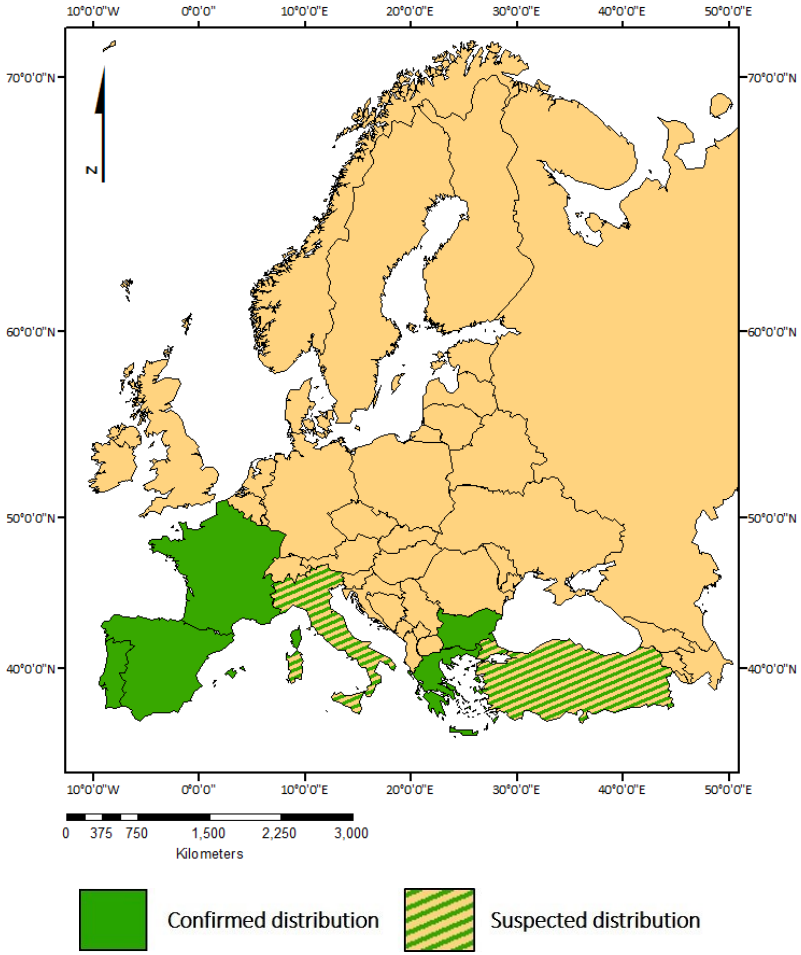
Bionomics:

Larvae of *Culex univittatus* are found in ground pools, marshy pools, barrow pits, stagnant drains and streams, canals and shallow wells. Females feed on birds and mammals other than humans (Sirivanakarn, 1976).

Medical Importance:

SINV, WEEV, WNV

Distribution:



Culex (*Cux.*) *univittatus* Theobald, 1901

Tarsus (Lateral view):

Midfemur with complete anterior pale stripe (Harbach, 1985)

Anopheles (*Ano.*) *maculipennis* complex

Species Names:

Anopheles (*Ano.*) *labranchiae* Falleroni, 1926

Anopheles (*Ano.*) *messeae* Falleroni, 1926

Anopheles (*Ano.*) *daciae* Linton, Nicolescu & Harbach 2004

Anopheles (*Ano.*) *atroparvus* van Thiel, 1927

Anopheles (*Ano.*) *sacharovi* Favre, 1903

Important Note:

Adults of this complex are indistinguishable by adult morphology alone. The photos provided here will aide users to identify specimens to the *maculipennis* complex, however molecular methods or egg comparisons are necessary to identify specimens to species level.

Bionomics:

***Anopheles* (*Ano.*) *sacharovi* Favre, 1903**

(Invasive species) In the Mediterranean area Anopheles sacharovi breeds typically in large brackish marshes though larvae can be found in a wide variety of habitats. (Bates, in Boyd 1949). Generally, larvae habitats are found to be sunlit with some floating or emergent vegetation (Becker et al. 2010). An. sacharovi is reported as highly anthropophilic, however has also been found feeding on other hosts including domesticated farm animals and pets (Hadjinicolaou and Betzios, 1973). An. sacharovi is considered a highly competent malaria vector in Europe (Alten et al. 2007, Becker et al. 2010).

Medical Importance: *Plasmodium vivax*, *Plasmodium falciparum*

***Anopheles* (*Ano.*) *labranchiae* Falleroni, 1926**

(Invasive species) Larvae of Anopheles labranchiae are found in clear, still and sunny habitats containing horizontal vegetation and algae. Habitats include large shallow spring flood pools, slow and stagnant streams, permanent swamps, marshes and rice fields. Females readily enter buildings to bite man and cattle (Aitken, 1953).

Medical Importance: *Plasmodium spp.*

Anopheles (*Ano.*) *maculipennis* complex

Bionomics:

Anopheles (*Ano.*) *messeae* Falleroni, 1926

This species rarely bites humans and is associated with malaria only in a few places where a rather dense human population lives in close association with large marshy areas (Bates, in Boyd 1949). Larvae of *An. messeae* have been collected in marshes with floating weeds and algae, drainage ditches and in clear water lakes in sand dunes (Takken, et al. 2002, Van der Torren, 1935).

Medical Importance: *Plasmodium spp.*

Anopheles (*Ano.*) *daciae* Linton, Nicolescu & Harbach, 2004

Anopheles daciae and *messeae* can only be differentiated on the basis of DNA or egg morphology (Nicolescu et al, 2004). Larvae of *messeae and daciae* are found in great inland river valleys and large marshes. Host preferences are yet to be fully defined, however blood-fed female *An*. *daciae* specimens collected in Southern England have been found positive for bird, deer, goat, horse, cow and human blood meals (Danabalan et al 2013).

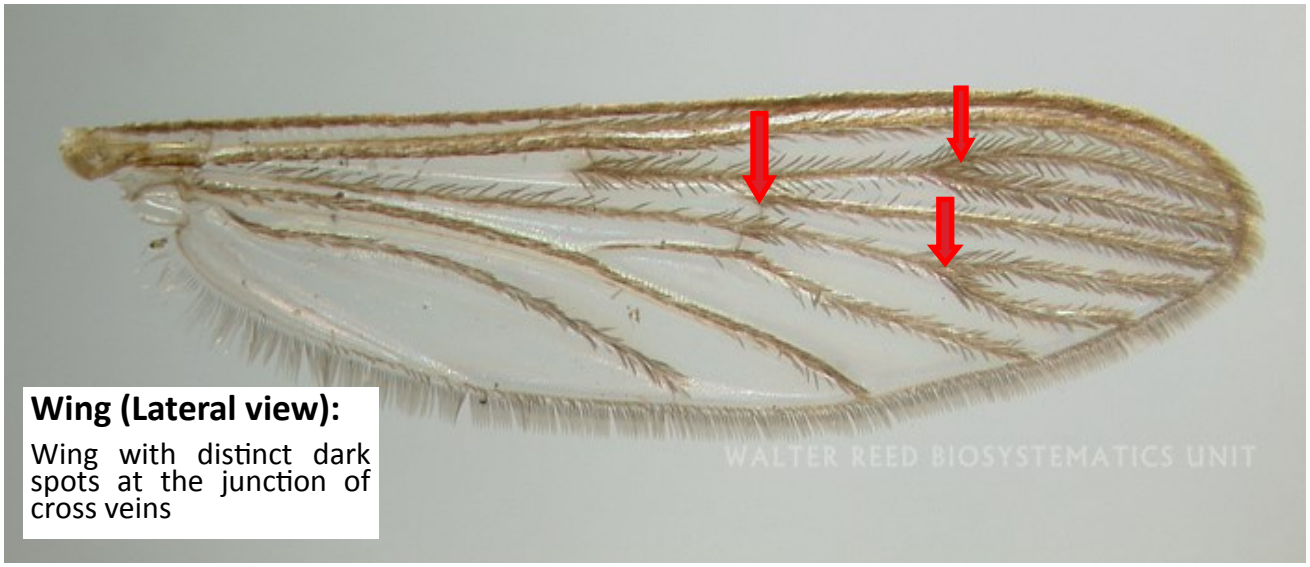
Medical Importance: *Plasmodium spp.*

Anopheles (*Ano.*) *atroparvus* van Thiel, 1927

The larvae of *Anopheles atroparvus* are found in brackish water along the coast from the southern Baltic to Spain and in inland salt springs and waters with high mineral content (Hackett and Missirroli, 1935; Bates, in Boyd 1949; Filipe, 1979).

Medical Importance: *Plasmodium spp.*

Anopheles (*Ano.*) *maculipennis* complex

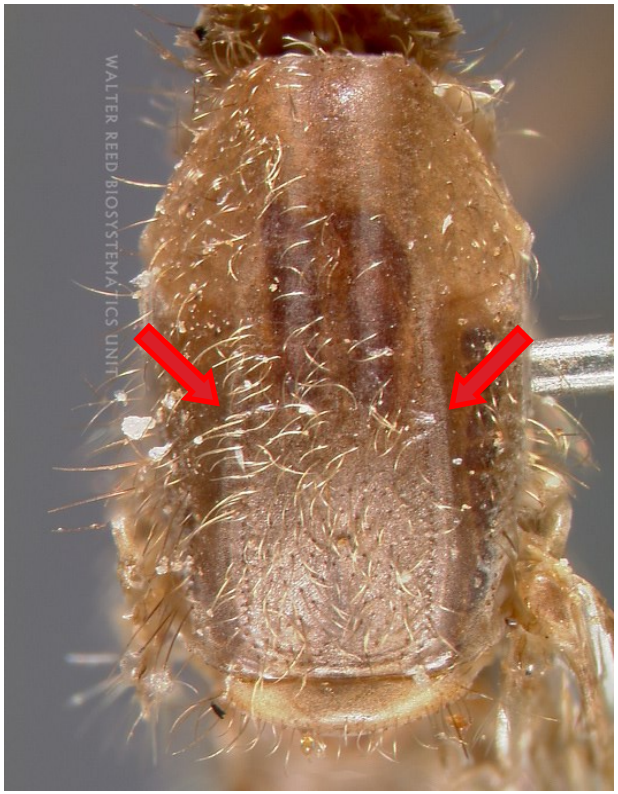


Wing (Lateral view):

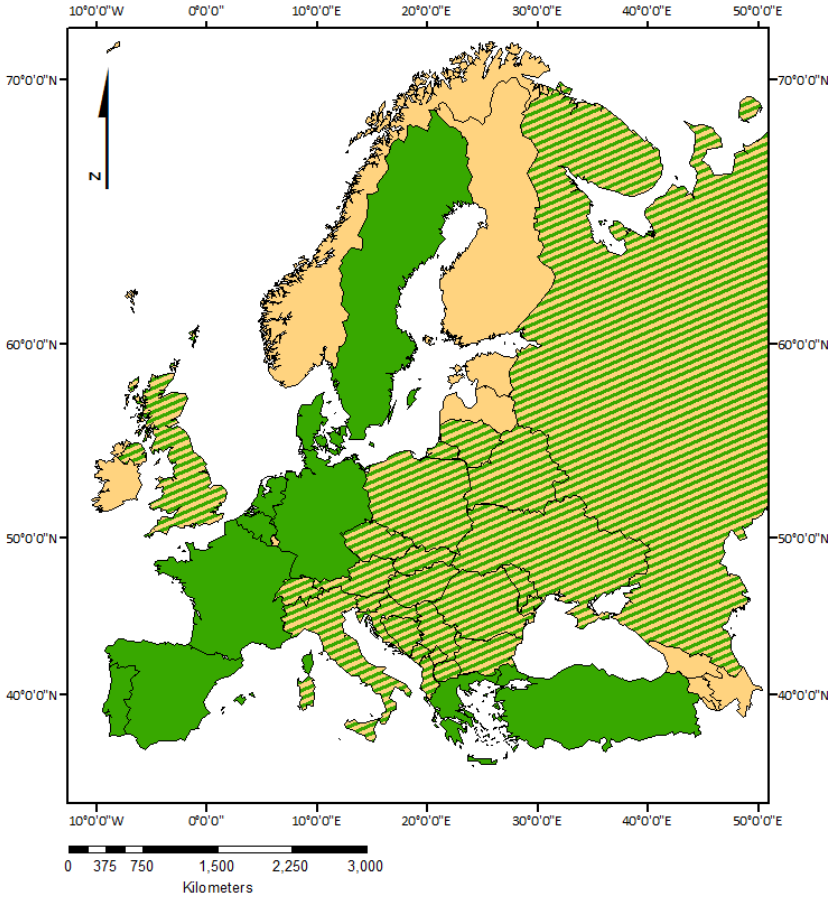
Wing with distinct dark spots at the junction of cross veins

Abdomen (Dorsal view):

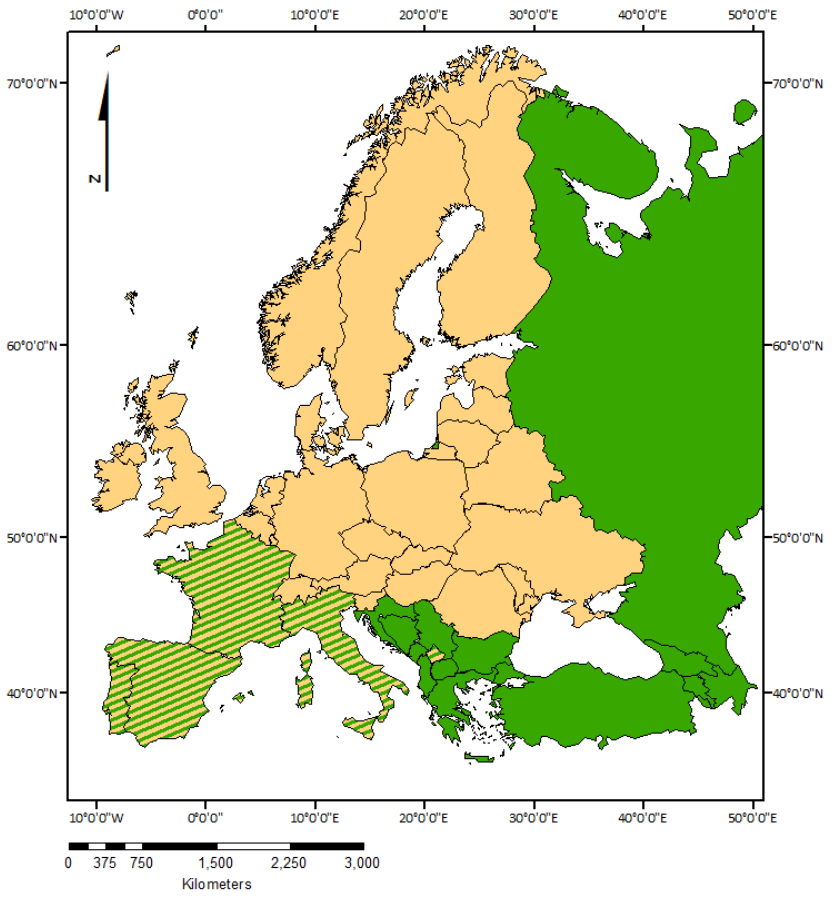
Scutum dark brown with broad pale longitudinal stripe



Anopheles (Ano.) maculipennis complex



***Anopheles* (*Ano.*) *atroparvus* van Thiel, 1927**

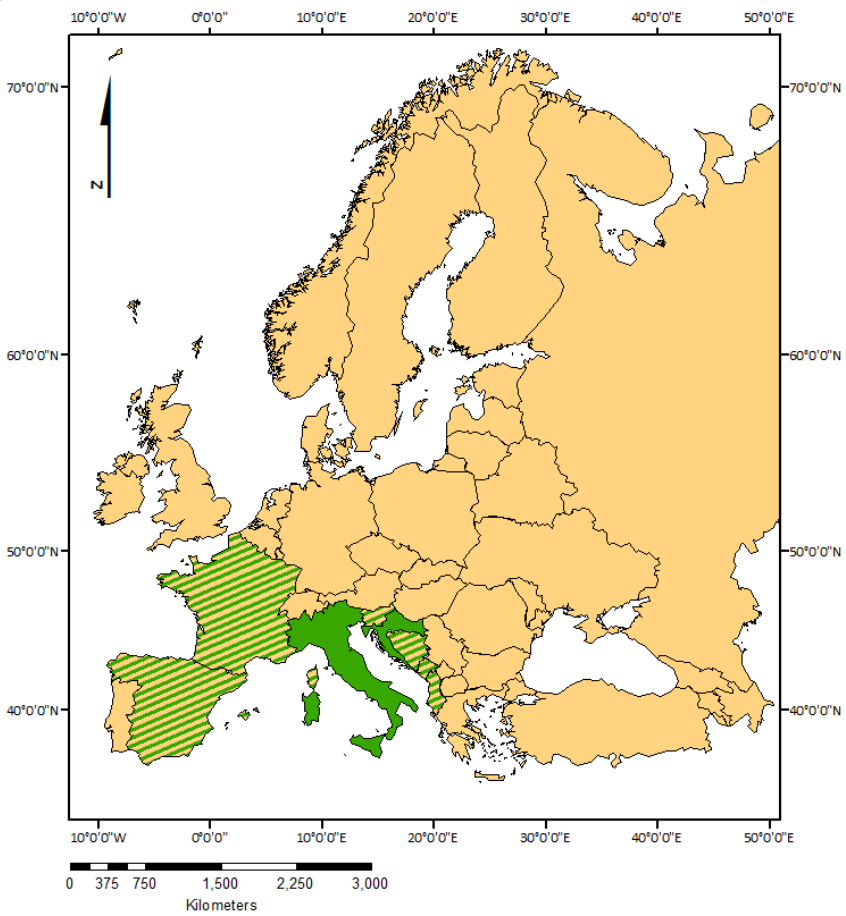


***Anopheles* (*Ano.*) *sacharovi* Favre, 1903**

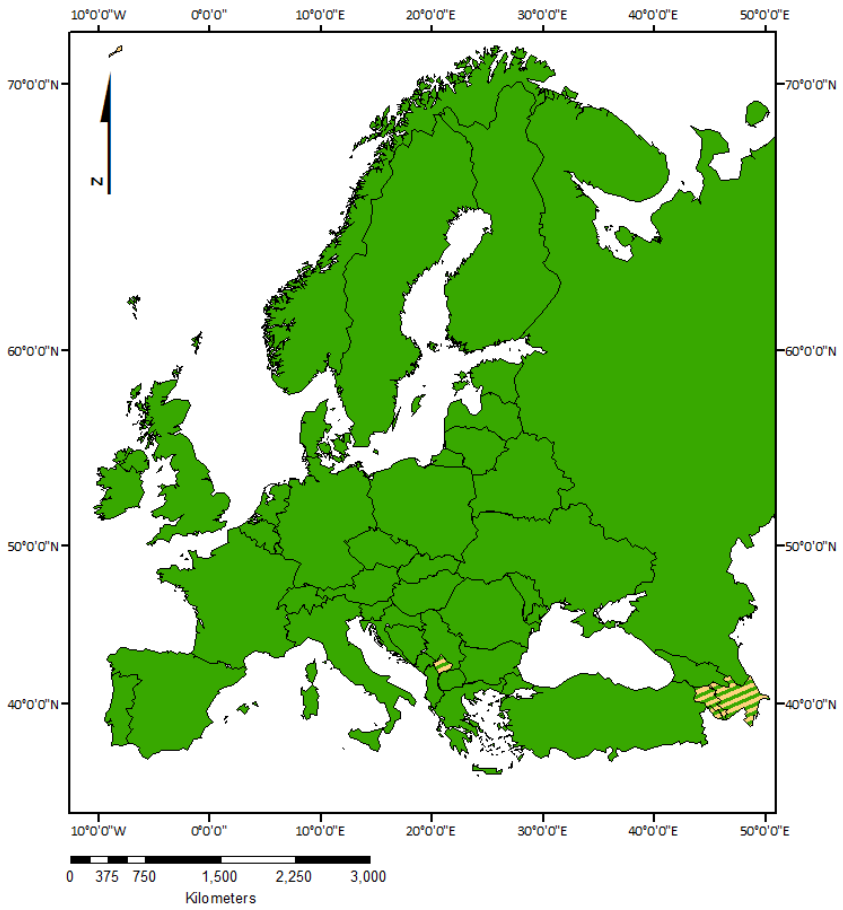
Confirmed distribution

Suspected distribution

Anopheles (Ano.) maculipennis complex



***Anopheles* (*Ano.*) *labranchiae* Falleroni, 1926**



***Anopheles* (*Ano.*) *messeae* Falleroni, 1926 /**

***Anopheles* (*Ano.*) *daciae* Linton, Nicolescu & Harbach 2004**

Confirmed distribution

Suspected distribution

Aedes (*Hul.*) *japonicus* (Theobald, 1901)

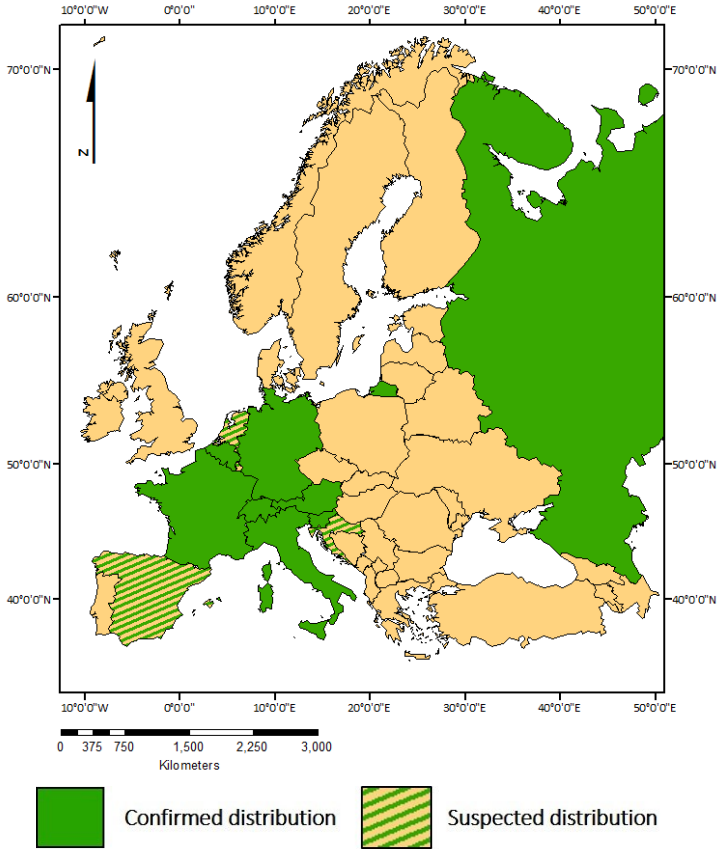
Bionomics: Invasive species

Larvae of *Aedes japonicus* occur in a wide variety of natural and artificial containers, usually preferring shaded places and water containing rich organic matter. Rock holes appear to be the most favored immature habitat for this subspecies. They are found from early spring to early autumn in Central Japan. Adults live in forested areas and are day biters, but do not readily bite humans (Miyagi, 1972). They overwinter as eggs in northeastern Japan and as larvae in southwestern Japan (Kamimura, 1976b).

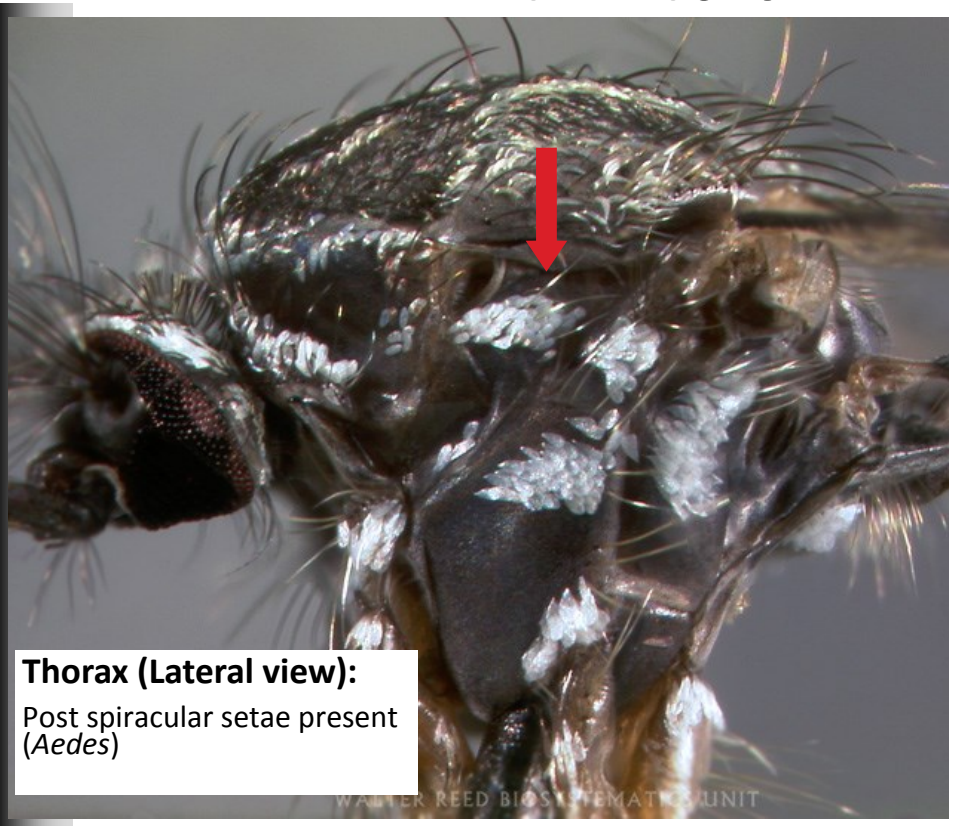
Medical Importance:

CHIKV, CVV, DENV, EEEV, JEV, LVC, ORUV, RVFV, SLEV, WEEV, WNV

Distribution:

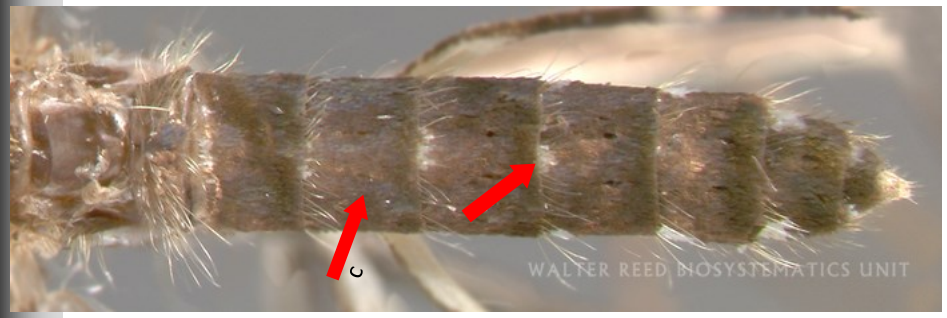


Aedes (*Hul.*) *japonicus* (Theobald, 1901)



Thorax (Lateral view):

Post spiracular setae present (*Aedes*)



Abdomen (Dorsal view):

Mostly dark scales; no pale bands; some pale spots

Thorax (Dorsal view):

Scutum with yellow stripes

Aedes (*Hul.*) *koreicus* (Edwards, 1917)

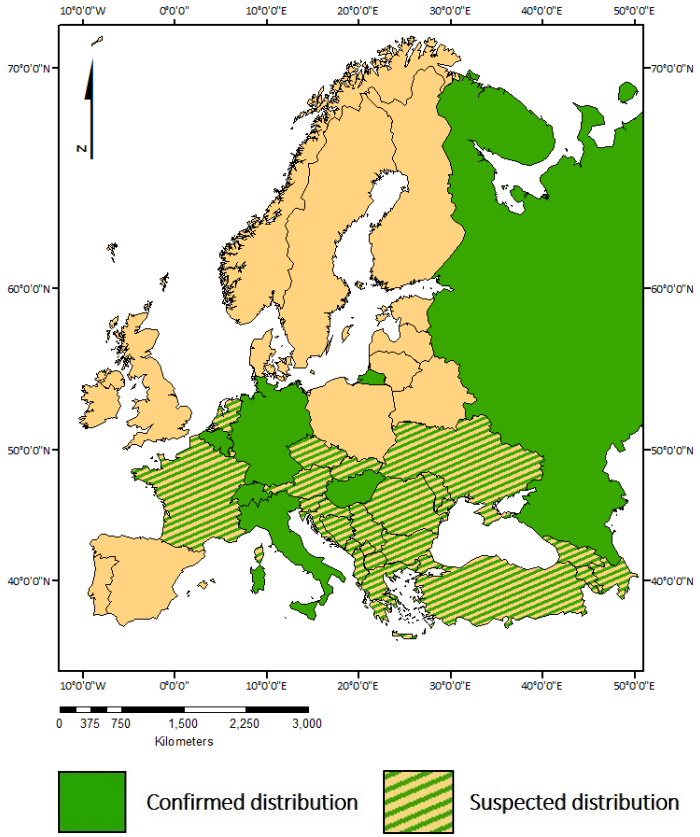
Bionomics: Invasive species

Larvae of *Aedes koreicus* have been collected in artificial containers, tree holes and rock pools (Feng, 1938) and (Ho, 1931). In the Republic of Korea, *Aedes koreicus* is known to bite both humans and farm animals and primarily feeds during the daytime (Kim, 2003) and (Tanaka, 1979). Eggs can overwinter and hatch in the spring making it easier for this invasive species to establish populations within Europe (Capelli, 2011) .

Medical Importance:

JEV

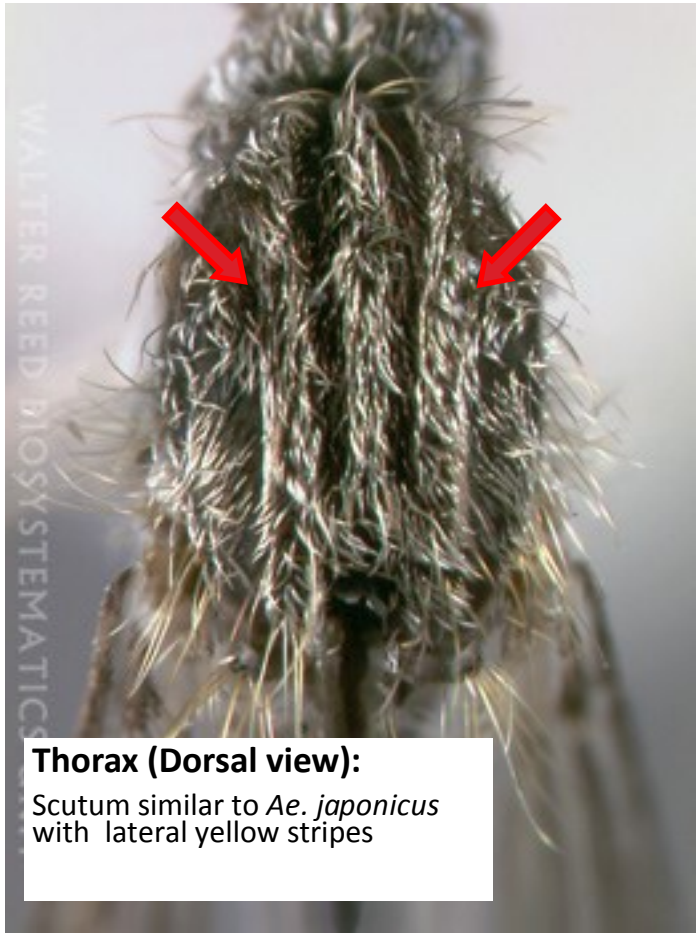
Distribution:



Aedes (*Hul.*) *koreicus* (Edwards, 1917)

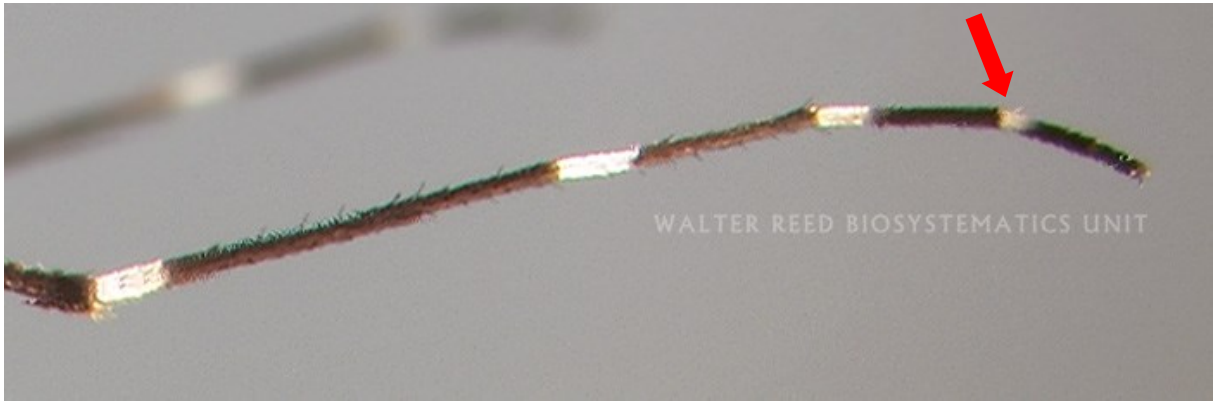
Thorax (Lateral view):

Post spiracular setae present (*Aedes*)



Thorax (Dorsal view):

Scutum similar to *Ae. japonicus* with lateral yellow stripes



Hind tarsus (Lateral view):

Complete basal band on Hindtarsomere 4

Aedes (*Grg.*) *atropalpus* (Coquillett , 1902)

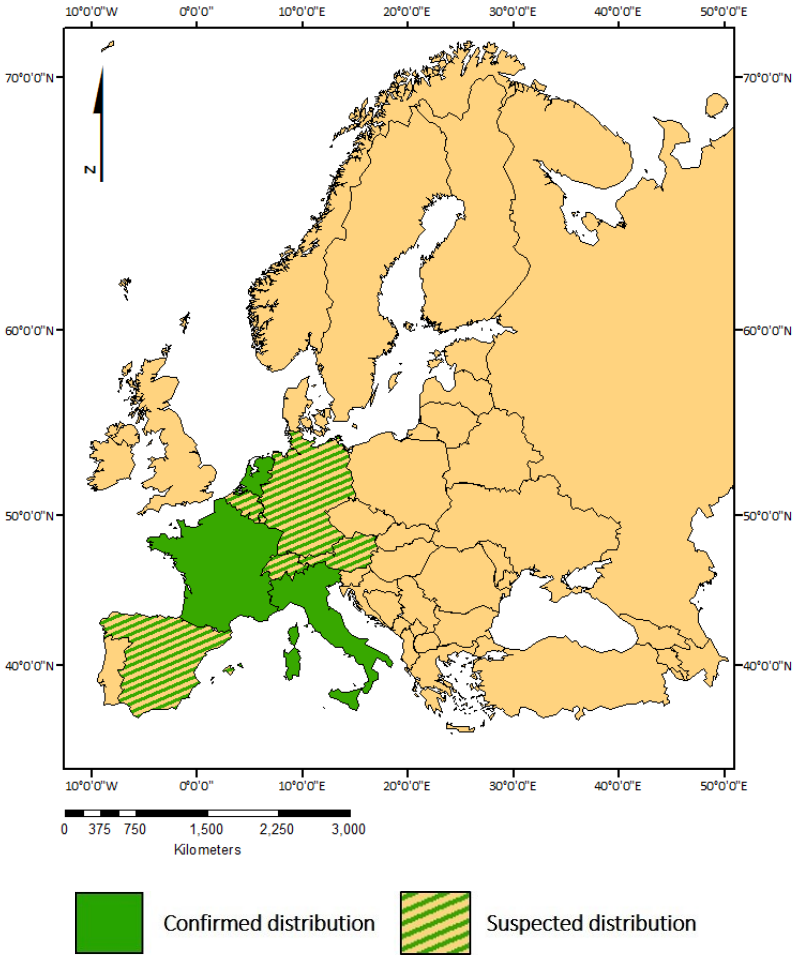
Bionomics: Invasive species

The larvae of *Aedes atropalpus* may be found throughout the summer in overflow pools in rockholes along mountain streams, and occasionally in rain-filled rockholes well removed from the stream. The females of *Aedes atropalpus* are persistent biters and are frequently found near rocky streams (Carpenter and LaCasse, 1955).

Medical Importance:

JEV, EEEV, WNV, WEEV, SLEV

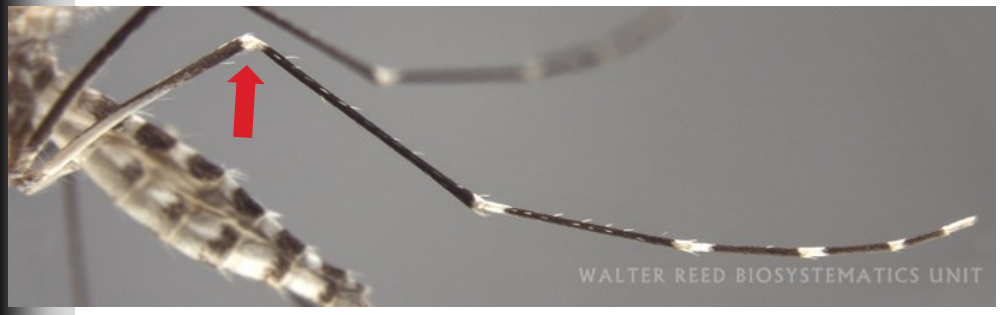
Distribution:



Aedes (*Grg.*) *atropalpus* (Coquillett, 1902)

Thorax (Lateral view):

Post spiracular setae present (*Aedes*)



Hind tarsus (Lateral view):

Inter-articular pale bands

Abdomen (Dorsal view):

Scutum: Two lateral lines of clear scales, similar to "lyre" shape found on *Ae. aegypti*

Aedes (*Stg.*) *aegypti* (Linnaeus, 1762)

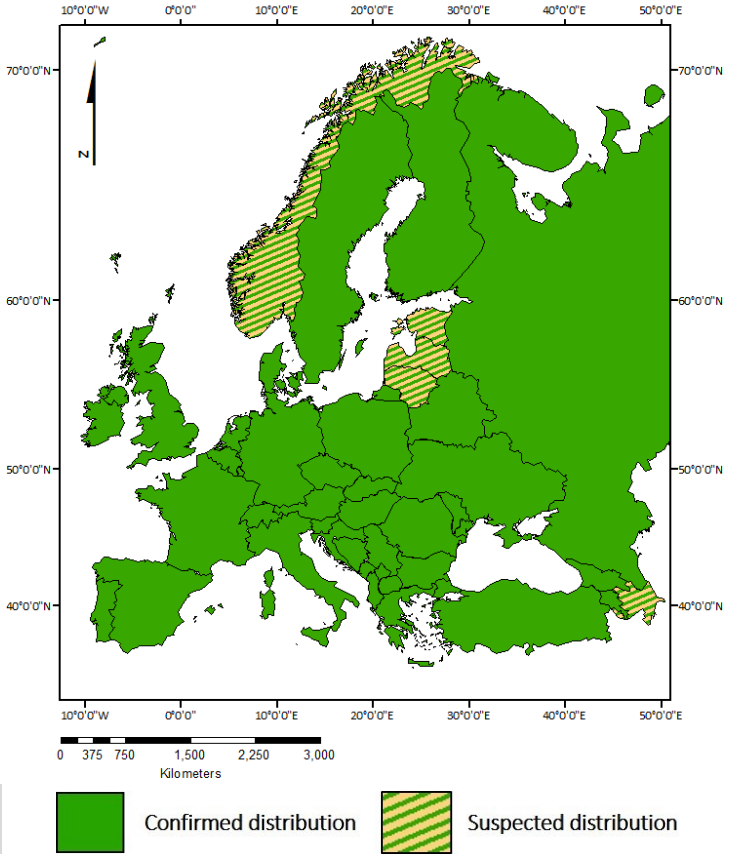
Bionomics: Invasive species

Aedes aegypti will use any and all natural and artificial containers as oviposition sites and are found in and around buildings in close association with man. Away from urban areas the species tends to favor pools in river beds, tree stumps, tree holes and natural containers. Water at the breeding site is most commonly clean, with a small amount of organic material present. Females are primarily day biters and readily enter buildings to feed. They are less active at night (Christophers, 1960), (Rey, 2007).

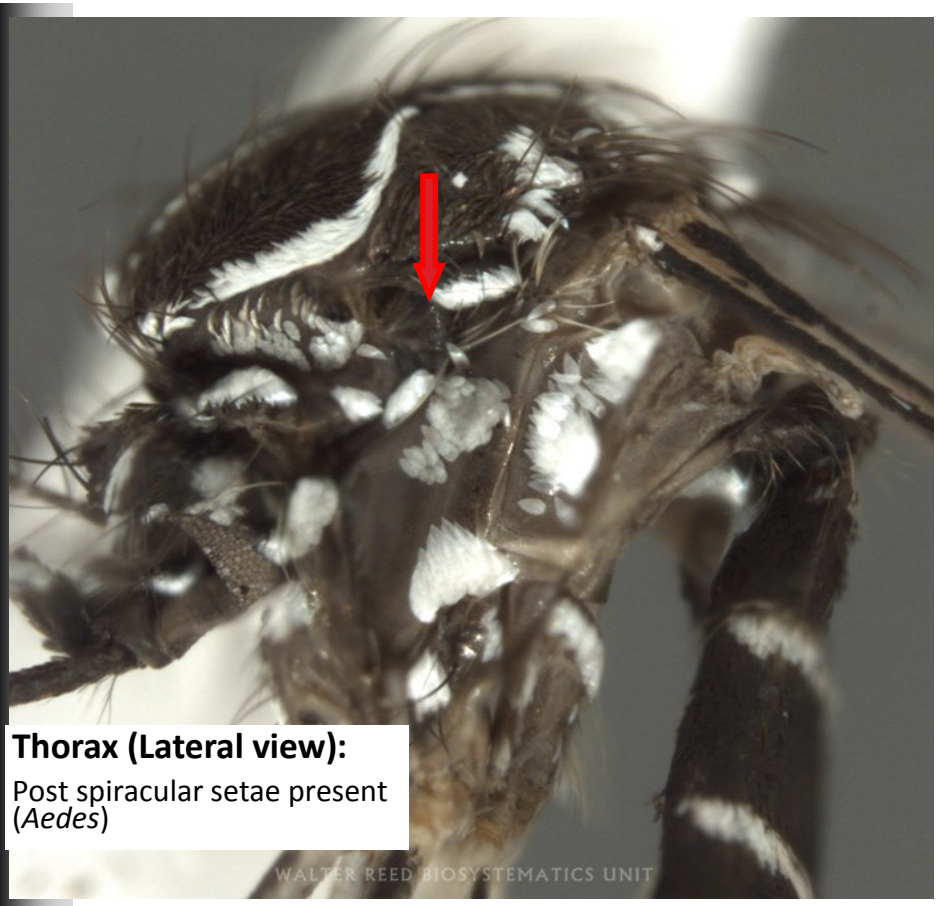
Medical Importance:

CHIKV, DENV, JEV, ORUV, RVFV, VEEV, YFV, ZIKV

Distribution:



Aedes (*Stg.*) *aegypti* (Linnaeus, 1762)

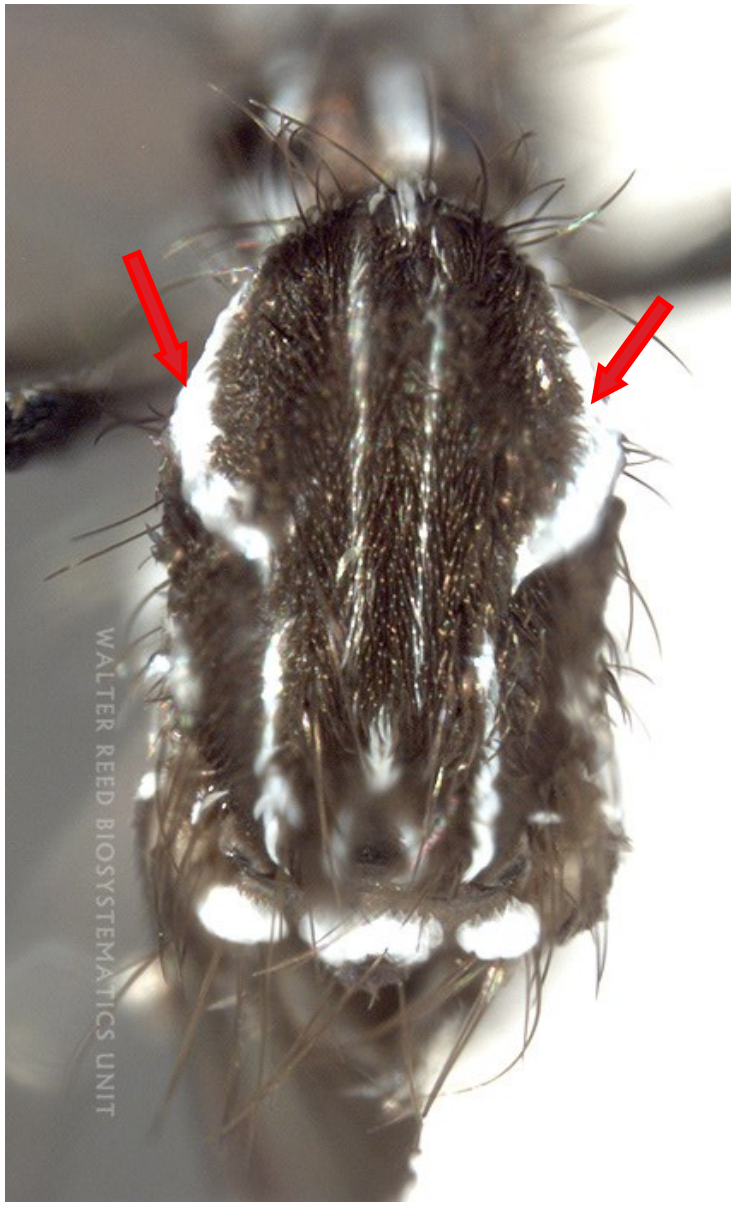


Thorax (Lateral view):

Post spiracular setae present (*Aedes*)

Hind tarsus (Lateral view):

Basal pale banding on hind tarsi



Thorax (Dorsal view):

Lyre-shaped pattern of silver or white scales on the scutum

Aedes (*Stg.*) *albopictus* (Skuse, 1895)

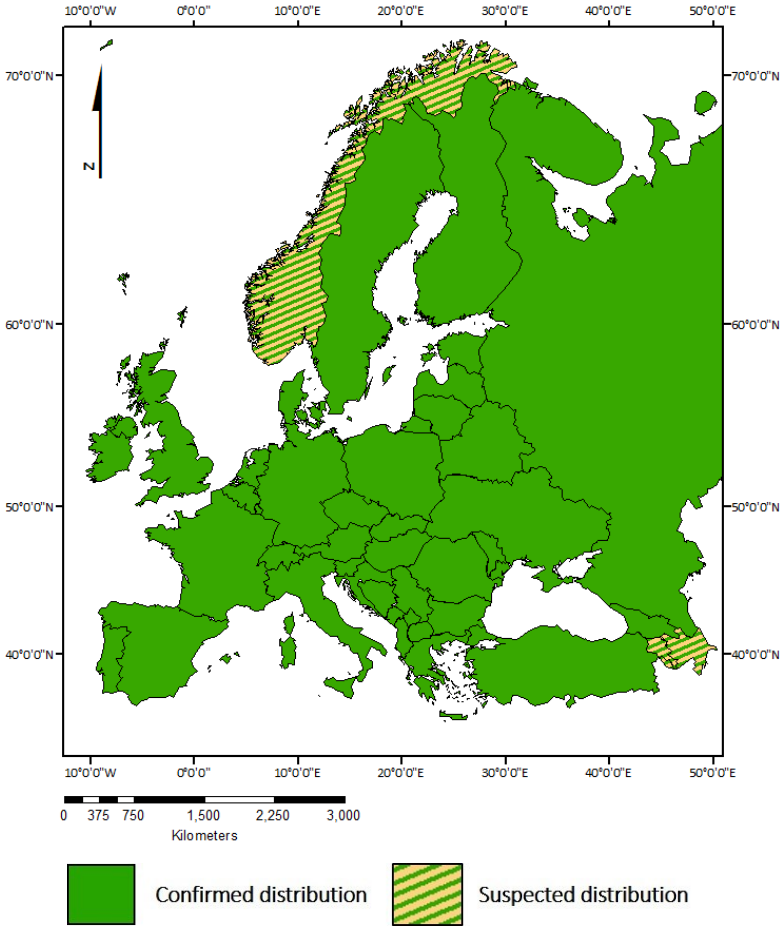
Bionomics: Invasive species

Immatures of *Aedes albopictus* are found in natural containers, including tree holes, bamboo stumps, coconut shells, rock holes, palm fronds, and leaf axils. They are also found in all varieties of artificial containers and will utilize indoor habitats. Females readily bite humans during the daytime (Huang, 1972).

Medical Importance:

CHIKV, CVV, DENV, JEV, YFV, USUV, ZIKV

Distribution:



Aedes (*Stg.*) *albopictus* (Skuse, 1895)

Thorax (Lateral view):
Post spiracular setae present (*Aedes*)

Hind tarsus (Lateral view):
Hind tarsi with basal bands

Thorax (Dorsal view):
Scutum with narrow median longitudinal white or silver stripe

Anopheles (*Cel.*) *multicolor* Cambouliu, 1902

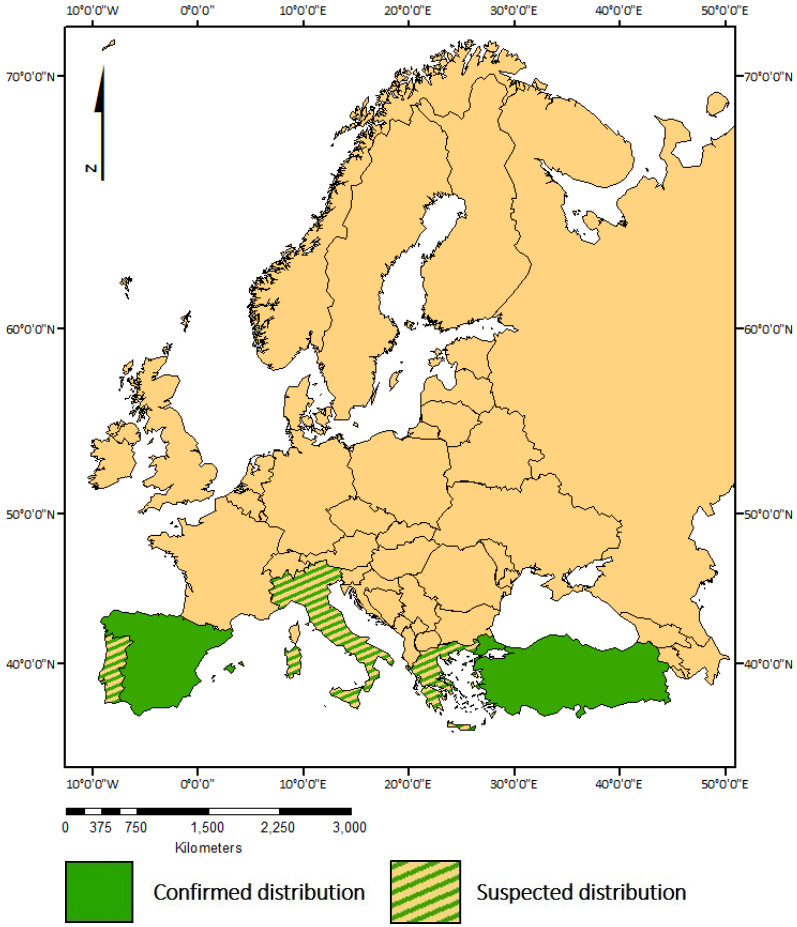
Bionomics: Invasive species

Anopheles multicolor is an inland and coastal breeder of semi-arid regions in pans, oases and collections of brackish water. Breeds in fresh water, cesspools and highly saline pools. Females readily enter houses and bite man (Gillies and de Meillon, 1968).

Medical Importance:

***Plasmodium* spp.**

Distribution:



Anopheles (Cel.) multicolor Cambouliu, 1902

Wing (Lateral view):
Pale scales on base of costa

Hind tarsus (Lateral view):
Hindtarsi number 5 completely dark

Scutum (Dorsal view):
Scutal fossa covered with pale scales

Vector/ Pathogen Checklist: EUCOM

Species Name	Viruses Associated with Mosquitoes of EUCOM										
	BATV	CHIKV	CVOV	INKV	LEDV	OCKV	SINV	TAHV	USUV	WNV	VIRUSES ISOLATED ELSEWHERE IN RANGE
Aedes (Aed.) cinereus **						X*		X		X	
Aedes (Aed.) rossicus **										X	RABV
Aedes (Adm.) vexans	X							X	X*	X	BAV, CHAOV, EEEV, LCV, POTV, SLEV, TVTV. WEEV
Aedes (Dah.) geniculatus											EEEV, WEEV, YFV
Aedes (Grg.) atropalpus										X	EEEV, JEV, SLEV, WEEV
Aedes (Hul.) japonicus										X	CHIKV, CVV, DENV, EEEV, JEV, LVC, ORUV, RVFV, SLEV, WEEV
Aedes (Hul.) koreicus											JEV*
Aedes (Och.) caspius								X		X	RVFV
*Aedes (Och.) communis/punctor***			X	X*			X*	X			
Aedes (Och.) excrucians **						X*		X			RVFV*
Aedes (Och.) sticticus **								X			
Aedes (Stg.) aegypti											CHIKV, DENV, JEV, ORUV, RVFV, VEEV, YFV, ZIKV
Aedes (Stg.) albopictus		X							X		CVV, DENV, JEV, YFV, ZIKV*
Anopheles (Ano.) claviger	X										RVFV
Anopheles (Ano.) maculipennis s.l.	X		X					X		X	RVFV, WEEV
Anopheles (Ano.) plumbeus										X*	
Coquillettidia (Coq.) richiardii **			X					X		X	
Culex (Bar.) modestus **					X			X		X	
Culex (Cul.) torrentium **						X*	X				
Culex (Cux.) perexiguus **										X	
Culex (Cux.) pipiens s.l.						X*	X	X	X	X	EEV, JEV, RVFV, WEEV
Culex (Cux.) theileri							X			X	WEEV
Culex (Cux.) tritaeniorhynchus							X			X	EEV, JEV, GETV, TMUV
Culex (Cux.) univittatus							X			X	WEEV
Culiseta (All.) longiareolata **										X	
Culiseta (Cuc.) morsitans **						X*	X				
Culiseta (Cus.) annulata **								X	X*		
Mansonia (Man.) uniformis **										X	

* indicates suspected vector; **species not included in this guide

Pathogen Codes and Names									
BATV	Batai virus	CVV	Cache Valley virus	JEV	Japanese encephalitus virus	RABV	Rabensburg virus	TVTV	Trivittatus virus
BAV	Banna Virus	DENV	Dengue vrus	LCV	La Crosse Virus	SINV	Sindbis virus	USUV	Usutu virus
CHAOV	Chaoyang vrus	EEEV	Eastern equine encephalitus virus	LEDV	Lednice virus	SLEV	St. Louis encephalitus virus	VEEV	Venezuelan equine encephalitus virus
CHIKV	Chikungunya vrus	GETV	Getah virus	OCKV	Ockelbo virus	TAHV	Tahyna virus	WEEV	Western equine encephalitus virus
CVOV	Calovo virus	INKV	Inkoo virus	RVFV	Rift Valley fever virus	TMUV	Tembusu virus	ZIKV	Zika virus

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For more information about these and other medically important arthropods visit wrbu.si.edu or contact us at wrbu-nmnh@si.edu

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Photos of mosquitoes were taken by Judith Stoffer and David Pecor, using specimens housed within the National Mosquito Collection. For more information about these or other images of mosquitoes, contact WRBU.