

Distribution chart for Euro-Mediterranean mosquitoes (western Palaearctic region)

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Abstract: The knowledge of the mosquito distribution in the Western Palaearctic region has significantly improved in recent decades. We here synthesise published records in an updated distribution chart. The western Palaearctic region is divided into 5 areas and 75 geographical units, the latter mainly considered on a country basis or on a geographical basis (e.g. islands). The total number of species accounts for 145. The status of each species for a defined geographic unit is given according to five categories: 'Present native', 'Present introduced', 'Uncertain for presence or absence', 'Absent extinct' and 'Absent never observed'. Relevant references are given per country in the annex.

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Introduction

The international projects MediLabSecure¹ and VectorNet² promote mosquito surveillance activities, including training and capacity building in EU Member States and Mediterranean riparian countries.

The MediLabSecure project aims to consolidate a laboratory network for surveillance and training on viruses that are pathogenic to humans and/or animals. It includes countries of the Mediterranean and Black Sea regions that have common sea borders and, as a result, share common public health issues and threats. Within the framework of this project, the medical entomology group produced MosKeyTool version 2³, a freely available interactive identification key for mosquito species (larvae and females) distributed in the Euro-Mediterranean-Middle East region. It provides the current knowledge for the identification of the 131 mosquito species encountered in the area and can be used by experts as well as non-expert entomologists.

VectorNet is a "European network for sharing data on the geographic distribution of arthropod vectors, transmitting human and animal disease agents" launched by the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA). The network of medical entomologists and public health professionals, already established during the former VBORNET project (2009-2013), was extended to include veterinary entomologists and veterinarians working in the field of vectors and/or vector-borne diseases in Europe and countries surrounding the Mediterranean Basin (2014-2018).

As a result and a step in the capacity building process for the territories these projects focus on, we here provide an updated distribution chart of the Euro-Mediterranean mosquito species.

Materials and Methods

A previous chart for European mosquitoes (Snow & Ramsdale, 1999) served as a basis and was supplemented by data published since 1999 and by including additional countries and additional taxa. Taxa are considered as valid species or subspecies according to the Systematic Catalog of Culicidae (Gaffigan et al., 2017). In addition, the Mosquito Taxonomic Inventory⁴ and the Catalogue of Palaearctic Diptera (Minař, 1990) were taken into consideration.

Distribution data have been extracted from scientific articles and grey literature collected by reference tracking and/or thanks to expert sharing. Authors' opinions were not considered except in excluding four papers that provide strongly implausible identifications which discredit the whole paper (Benmalek et al., 2018; Dahchar et al., 2017; Houmani et al., 2017; Möhlmann et al., 2017). The literature search focussed on the distribution of mosquito species with special emphasis on fauna checklists and references since 1999 (or earlier ones not listed in Snow & Ramsdale, 1999). Data searches were performed for all countries and territories belonging to the western Palaearctic region, i.e. Europe including its outermost regions of the eastern Atlantic Ocean, up to the Ural Mountains in the east; Northern Africa up to Central Sahara in the south; Near East countries belonging to the western Palaearctic region. Geographical units are considered on a country basis (e.g. Algeria, Finland, Malta, Switzerland) or on a geographical basis (e.g. Corsica, Crimean Peninsula, Cyprus,

¹ <http://www.medilabsecure.com>

² <https://ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/vector-net>

³ <http://medilabsecure.com/moskeytool.html>

⁴ <http://mosquito-taxonomic-inventory.info>

Madeira, Russian southern districts). The total number of units reaches 75 (Table 1 and Figure 1). The resulting list of references from which distribution data have been extracted is

presented thereafter by country or territory of the western Palaearctic region. The distribution maps per species may be observed on MosKeyTool version 2.1.

Table 1: List of the 75 geographical units of the western Palaearctic region, ordered according to five areas as in the charts (Tables 2-5), with codes given in Figure 1.

Area	Unit	ISO alpha-3 code	Other code	Remark	
Western and Central Europe	Albania	ALB			
	Austria	AUS			
	Belgium	BEL			
	Bosnia & Herzegovina	BIH			
	Bulgaria	BGR			
	Croatia	HRV			
	Cyprus Island	CYP			
	Czech Republic	CZE			
	Denmark	DNK			Faroe Islands excluded
	Faroe Islands	FRO			
	France (continental)	FRA			Corsica excluded
	Corsica			COR	
	Germany	DEU			
	Greece	GRC			Aegean islands included, Crete excluded
	Crete			CRE	
	Hungary	HUN			
	Ireland (Republic of)	IRL			Northern Ireland excluded
	Italy (continental)	ITA			Sardinia and Sicily excluded
	Sardinia			SAR	
	Sicily			SIC	
	Kosovo			KOS	
	Liechtenstein	LIE			
	Luxembourg	LUX			
	Former Yugoslav Republic of Macedonia	MKD			
	Malta	MLT			
	Montenegro	MNE			
	Netherlands	NLD			
	Poland	POL			
	Portugal (continental)	PRT			Madeira and Azores excluded
	Azores			AZO	
	Madeira			MAA	
	Romania	ROU			
	Slovakia	SVK			
	Slovenia	SVN			
	Serbia	SRB			
	Spain (continental)	ESP			Balearic and Canary islands excluded
	Balearic Islands			BAL	
	Canary Islands			CAA	
	Switzerland	CHE			
	Turkey (Thrace Region)			TUR-TH	Anatolia excluded
	United Kingdom	GBR			Shetland excluded; Channel, Man and Orkney islands and Northern Ireland included

	Shetland		SHE	
Eastern Europe	Belarus	BLR		
	Moldova	MDA		
	Russia Central		RUS-CN	Central federal district
	Russia Volga		RUS-VO	Volga federal district
	Russia southern districts		RUS-SD	South and North Caucasus federal districts
	Ukraine	UKR		Crimean Peninsula excluded
	Crimean Peninsula		CRP	
Northern Europe	Estonia	EST		
	Finland	FIN		Åland included
	Iceland	ISL		
	Latvia	LVA		
	Lithuania	LTU		
	Norway	NOR		
	Svalbard		SVA	Jan Mayen included
	Russia Kaliningrad		RUS-KA	Kaliningrad Oblast
	Russia north-western		RUS-NW	North-western federal district
	Sweden	SWE		
Caucasus and Middle-East	Armenia	ARM		
	Azerbaijan	AZE		
	Georgia	GEO		
	Iraq	IRQ		
	Israel	ISR		
	Jordan	JOR		
	Kuwait	KWT		
	Lebanon	LBN		
	Palestine	PSE		Palestinian territories
	Syria	SYR		Syrian Arab Republic
	Turkey (Anatolia)		TUR-AN	Thrace Region excluded
North Africa	Algeria	DZA		
	Egypt	EGY		
	Libya	LYB		
	Morocco	MAR		Occidental Sahara excluded
	Tunisia	TUN		

Results & Discussion

Mosquito distribution data are given in Tables 2 to 5. The organisation of the species list matches the Systematic Catalog of Culicidae (Gaffigan et al., 2017). For the tribe Aedini, it also meets the systematic classification suggested by Wilkerson et al. (2015) and Wilkerson & Linton (2015) as for the subgenus *Rusticooidus*.

Five categories of distribution status are applied irrespective of abundance:

- 1) Present and autochthonous, including when spreading to neighbouring regions, labelled 'native' and highlighted by grey cells;
- 2) Present but exotic to the western Palaearctic, because introduced and then established (e.g. *Ae. albopictus* in Spain), labelled as 'introd' and highlighted by red cells;

3) Uncertain for presence or absence, labelled as 'uncertain' and highlighted by blue cells; Uncertain for presence means (i) with only a single or few records and impossible to verify, or (ii) introduced out of its natural distribution area and without confirmation of establishment (e.g. *Ae. albopictus* in Belgium, Czech Republic, Slovakia, United Kingdom); Uncertain for absence means previously present and probably extinct today;

4) Absent and extinct (previously present and certainly extinct today; e.g. *Ae. aegypti* in France), labelled as 'extinct' and highlighted by white cells;

5) Absent and/or never observed, shown by empty cells.

Genus	species	Subgenus	Authority	BEL	DNK	FRO	FRA	COR	DEU	IRL	LIE	LUX	NLD	PRT	AZO	MAA	ESP	BAL	CAA	CHE	GBR	SHE	Total geographical units:19					
				Belgium	Denmark	Faroe Islands	France (continental)	Corsica	Germany	Ireland	Liechtenstein	Luxembourg	Netherlands	Portugal	Azores	Madeira	Spain (continental)	Balearic Islands	Canary Islands	Switzerland	United Kingdom	Shetland	native	introd	uncertain	extinct	absent	
Culex	arbieeni	Maillotia	Salem, 1938														native		native					2	0	0	0	17
Culex	brumpti	Culex	Gaillard, 1931				native																	1	0	0	0	18
Culex	deserticola	Maillotia	Kirkpatrick, 1925														native							1	0	0	0	18
Culex	europaeus	Neoculex	da Cunha Ramos, Ribeiro & Harrison, 2003											native			native							2	0	0	0	17
Culex	hortensis s.l.	Maillotia	Ficalbi, 1889	native			native	native	native		native					native	native	native	native	native				11	0	0	0	8
Culex	impudicus	Neoculex	Ficalbi, 1890				native	native									native							4	0	0	0	15
Culex	laticinctus	Culex	Edwards, 1913														native	native	native					4	0	0	0	15
Culex	martinii	Neoculex	Medschid, 1930				native	native	native												native			4	0	0	0	15
Culex	mimeticus	Culex	Noè, 1899				native	native	native					native			native							4	0	0	0	15
Culex	modestus	Barraudius	Ficalbi, 1890		native		native	native	native				native	native			native				native	native		9	0	0	0	10
Culex	peregrinus	Culex	Theobald, 1903											native			native							2	0	0	0	17
Culex	pipiens	Culex	Linnaeus, 1758	native	native		native	native	native	native	native	native	native	native	native	native	native	native	native	native	native	native		17	0	0	0	2
Culex	territans	Neoculex	Walker, 1856	native	native		native	native	native		native	native	native	native			native				native	native		12	0	0	0	7
Culex	theileri	Culex	Theobald, 1903				native	native								native	native		native	uncertain				6	0	1	0	12
Culex	torrentium	Culex	Martini, 1925	native	native		native	native	native	native	native	native	native	native			native			native	native	native		14	0	0	0	5
Culex	univittatus	Culex	Theobald, 1901											native			native							2	0	0	0	17
Culiseta	alaskaensis s.l.	Culiseta	(Ludlow, 1906)				native		native	native				native							native	native		6	0	0	0	13
Culiseta	annulata	Culiseta	(Schrank, 1776)	native	native		native	native	native	native			native	native	native		native	native			native	native		13	0	0	0	6
Culiseta	atlantica	Culiseta	(Edwards, 1932)													native								1	0	0	0	18
Culiseta	bergrothi	Culiseta	(Edwards, 1921)		native																			1	0	0	0	18
Culiseta	fumipennis	Culicella	(Stephens, 1825)	native	native		native	native	native				native	native			native				native	native		10	0	0	0	9
Culiseta	glaphyroptera	Culiseta	(Schiner, 1864)				native	native	native												uncertain			2	0	1	0	16
Culiseta	litorea	Culicella	(Shute, 1928)				native	native		native				native			native					native		6	0	0	0	13
Culiseta	longiareolata	Allotheobaldia	(Macquart, 1838)				native	native	native					native		native	native	native	native	native	native	uncertain		9	0	1	0	9
Culiseta	morsitans	Culicella	(Theobald, 1901)	native	native		native	native	native	native			native				native				native	native		10	0	0	0	9
Culiseta	ochroptera	Culicella	(Peus, 1935)						native				native											2	0	0	0	17
Culiseta	subochrea	Culiseta	(Edwards, 1921)	native	native		native	native	native	native			native	native			native					native		10	0	0	0	9
Coquillettidia	buxtoni	Coquillettidia	(Edwards, 1923)				native	native	native							native	native				native			6	0	0	0	13
Coquillettidia	richiardi	Coquillettidia	(Ficalbi, 1889)	native	native		native	native	native	native			native	native	native		native				native	native		12	0	0	0	7
Orthopodomyia	pulcralpalpis	-	(Rondani, 1872)	native			native									native	native				uncertain	native		6	0	1	0	12
Uranotaenia	unguiculata	Pseudoficalbia	Edwards, 1913				native	native	native					native			native							5	0	0	0	14

species	complex	Total	taxa		32	35	0	61	48	54	20	9	16	39	44	5	9	65	17	11	41	37	1
			native	species																			
			31	34		0		60	47	53	19	8	15	38	43	4	9	64	16	11	40	36	1
			29	35	0	58	45	49	20	8	15	36	42	4	8	59	13	10	33	34	1		
			2	0	0	2	1	4	0	1	1	1	0	0	1	1	1	0	3	0	0		
			1	0	0	0	1	1	0	0	0	1	1	0	0	3	0	1	5	3	0		
			0	0	0	1	1	0	0	0	0	1	1	1	0	2	3	0	0	0	0		
			32	35	0	61	48	54	20	9	16	39	44	5	9	65	17	11	41	37	1		

native	present, autochthonous
introd	present, introduced and established (e.g. <i>Ae. albopictus</i> in Spain)
uncertain	uncertain for presence or absence; for instance with single or few records impossible to verify, or introduced without confirmation of establishment (e.g. <i>Ae. albopictus</i> in UK), or previously present and probably extinct today
extinct	absent extinct (previously present and certainly extinct today; e.g. <i>Ae. aegypti</i> in France)
	absent, never observed, or only few sporadic records out of its natural distribution area

Genus	species	Subgenus	Authority	ALB	AUS	BIH	BGR	HRV	CZE	GRC	CRE	HUN	ITA	SAR	SIC	KOS	MKD	MLT	MNE	POL	ROU	SVK	SVN	SRB	TUR-TH	Total geographical units:22					
				Albania	Austria	Bosnia & Herzegovina	Bulgaria	Croatia	Czech Rep.	Greece	Crete	Hungary	Italy (continental)	Sardinia	Sicily	Kosovo	FYRO Macedonia	Malta	Montenegro	Poland	Romania	Slovakia	Slovenia	Serbia	Turkey (Thrace Region)	native	introd	uncertain	extinct	absent	
<i>Culex</i>	<i>hortensis</i> s.l.	<i>Mallotia</i>	Ficalbi, 1889	native	native	native	native		native	native		native	native	native	native	native	native	native	uncertain	native	native	native	native	native	native	native	19	0	1	0	2
<i>Culex</i>	<i>impudicus</i>	<i>Neoculex</i>	Ficalbi, 1890	native					native	native			native	native	native						uncertain				uncertain	5	0	2	0	15	
<i>Culex</i>	<i>laticinctus</i>	<i>Culex</i>	Edwards, 1913	native				native		native			native	native	native			native			native				uncertain	8	0	1	0	13	
<i>Culex</i>	<i>martinii</i>	<i>Neoculex</i>	Medtschid, 1930		native	uncertain		native	native	native		native	native								native	native			uncertain	8	0	2	0	10	
<i>Culex</i>	<i>mimeticus</i>	<i>Culex</i>	Noë, 1899	native			native			native		native	native	native	native	native	native		native		uncertain				uncertain	10	0	2	0	12	
<i>Culex</i>	<i>modestus</i>	<i>Barraudius</i>	Ficalbi, 1890	native	native			native	native	native		native	native						native	native	native	native	native	native	native	17	0	0	0	5	
<i>Culex</i>	<i>perexiguus</i>	<i>Culex</i>	Theobald, 1903	native			native			native			native	native	native		uncertain	native							native	7	0	1	0	14	
<i>Culex</i>	<i>pipiens</i>	<i>Culex</i>	Linnaeus, 1758	native	native	native	native	native	native	native		native	native								native	native	native	native	native	22	0	0	0	0	
<i>Culex</i>	<i>pusillus</i>	<i>Barraudius</i>	Macquart, 1850							native															uncertain	1	0	1	0	20	
<i>Culex</i>	<i>terrillans</i>	<i>Neoculex</i>	Walker, 1856	native	native			native	native	native	native	native	native						uncertain	native	native	native	native	native	native	16	0	1	0	5	
<i>Culex</i>	<i>thelleri</i>	<i>Culex</i>	Theobald, 1903	native			native			native		native	native	native	native				uncertain	native	native	native	native	native	native	11	0	1	0	10	
<i>Culex</i>	<i>torrentium</i>	<i>Culex</i>	Martini, 1925		native				native	native		native	native								native	native	native		native	9	0	1	0	12	
<i>Culex</i>	<i>tritaeniorhynchus</i>	<i>Culex</i>	Giles, 1901	native					native	native															native	3	0	0	0	19	
<i>Culiseta</i>	<i>alaskaensis</i> s.l.	<i>Culiseta</i>	(Ludlow, 1906)		native				native			native									native	native	native	native	native	7	0	0	0	15	
<i>Culiseta</i>	<i>annulata</i>	<i>Culiseta</i>	(Schrank, 1776)	native	native			native	native	native		native	native	native	native	native	native		native	native	native	native	native	native	native	19	0	0	0	3	
<i>Culiseta</i>	<i>fumipennis</i>	<i>Culicella</i>	(Stephens, 1825)	native			native	native	native			native	native	native			native				native	native			native	11	0	1	0	10	
<i>Culiseta</i>	<i>glaphyroptera</i>	<i>Culiseta</i>	(Schiner, 1864)		native	native	native	native	native	native											native	native	native			11	0	0	0	11	
<i>Culiseta</i>	<i>litorea</i>	<i>Culicella</i>	(Shute, 1928)	native									native	native	native											4	0	0	0	18	
<i>Culiseta</i>	<i>longiareolata</i>	<i>Allotheobaldia</i>	(Macquart, 1838)	native						native	native	native	native	native	native	native	native	native	native		native	native	native	native	native	17	0	0	0	5	
<i>Culiseta</i>	<i>morsitans</i>	<i>Culicella</i>	(Theobald, 1901)		native		native	native	native	native		native	native	native	native				uncertain	native	native	native	native	native	native	15	0	2	0	5	
<i>Culiseta</i>	<i>ochroptera</i>	<i>Culicella</i>	(Peus, 1935)									native	native								native	native	native			5	0	0	0	17	
<i>Culiseta</i>	<i>subochrea</i>	<i>Culiseta</i>	(Edwards, 1921)					native	native	native	native	native	native	native	native	native	native	native	native		native	native	native		native	12	0	1	0	9	
<i>Coquillettidia</i>	<i>buxtoni</i>	<i>Coquillettidia</i>	(Edwards, 1923)			native	native	native	native	native	native			native	native	native	native	native	native	native	native				native	11	0	0	0	11	
<i>Coquillettidia</i>	<i>richiardii</i>	<i>Coquillettidia</i>	(Ficalbi, 1889)	native	native		native	native	native	native		native	native	native	native	native	native	native	native	native	native	native	native	native	native	18	0	0	0	4	
<i>Orthopodomyia</i>	<i>pulcrispalis</i>	-	(Rondani, 1872)	native			native	native	native	native		native	native						uncertain	native	native	native			native	9	0	2	0	11	
<i>Uranotaenia</i>	<i>unguiculata</i>	<i>Pseudofalcibia</i>	Edwards, 1913		native		native	native	native	native		native	native	native	native	native	native	native	native	native	native	native	native	native	native	17	0	0	0	5	

native present, autochthonous
 introd present, introduced and established (e.g. *Ae. albopictus* in Spain)
 uncertain uncertain for presence or absence; for instance with single or few records impossible to verify, or introduced without confirmation of establishment (e.g. *Ae. albopictus* in UK), or previously present and probably extinct today
 extinct absent extinct (previously present and certainly extinct today; e.g. *Ae. aegypti* in France)
 absent, never observed, or only few sporadic records out of its natural distribution area

Genus	species	Subgenus	Authority	Eastern Europe								Northern Europe								Total geographical units: 17					
				BLR	MDA	RUS-CN	RUS-VO	RUS-SD	UKR	CRP	EST	FIN	ISL	KAL	LVA	LTU	NOR	RUS-NW	SVA	SWE	native	introd	uncertain	extinct	absent
				Belarus	Moldova	Russia Central	Russia Volga	Russia Southern districts	Ukraine	Crimean Peninsula	Estonia	Finland	Iceland	Kaliningrad Oblast	Latvia	Lithuania	Norway	Russia Northwestern	Svalbard	Sweden					
<i>Culex</i>	<i>hortensis</i> s.l.	<i>Maillotia</i>	Ficalbi, 1889					native		native										2	0	0	0	15	
<i>Culex</i>	<i>martinii</i>	<i>Neoculex</i>	Medschid, 1930							native										1	0	0	0	16	
<i>Culex</i>	<i>mimeticus</i>	<i>Culex</i>	Noè, 1899					native		native										2	0	0	0	15	
<i>Culex</i>	<i>modestus</i>	<i>Barraudius</i>	Ficalbi, 1890																	9	0	0	0	8	
<i>Culex</i>	<i>pipiens</i>	<i>Culex</i>	Linnaeus, 1758	native	native	native	native	native	native	native	native		native	native	native	native	native	native	native	15	0	0	0	2	
<i>Culex</i>	<i>territans</i>	<i>Neoculex</i>	Walker, 1856	native	native	native	native	native		native	native	native			native	native	native	native	native	12	0	0	0	5	
<i>Culex</i>	<i>theileri</i>	<i>Culex</i>	Theobald, 1903		native			native												3	0	0	0	14	
<i>Culex</i>	<i>torrentium</i>	<i>Culex</i>	Martini, 1925	native	native	native	native	native		native	native	native			native	native	native	native	native	12	0	0	0	5	
<i>Culiseta</i>	<i>alaskaensis</i> s.l.	<i>Culiseta</i>	(Ludlow, 1906)	native	native	native	native		native	native	native	native		native	native	native	native	native	native	14	0	0	0	3	
<i>Culiseta</i>	<i>annulata</i>	<i>Culiseta</i>	(Schrank, 1776)	native	native	native	native	native	native	native	native	native			native	native	native	native	native	14	0	0	0	3	
<i>Culiseta</i>	<i>bergrothi</i>	<i>Culiseta</i>	(Edwards, 1921)			native	native									native	native	native	native	6	0	0	0	11	
<i>Culiseta</i>	<i>fumpennis</i>	<i>Culicella</i>	(Stephens, 1825)	native		native	native	native	native	uncertain	native					native	native	native	native	9	0	1	0	7	
<i>Culiseta</i>	<i>glaphyroptera</i>	<i>Culiseta</i>	(Schiner, 1864)						native											2	0	0	0	15	
<i>Culiseta</i>	<i>longiareolata</i>	<i>Allotheobaldia</i>	(Macquart, 1838)		native			native	native	native										4	0	0	0	13	
<i>Culiseta</i>	<i>morsitans</i>	<i>Culicella</i>	(Theobald, 1901)	native		native	native	native	native	native	native	native		native		native	native	native	native	13	0	0	0	4	
<i>Culiseta</i>	<i>ochroptera</i>	<i>Culicella</i>	(Peus, 1935)	native		native	native	native	native		native	native		native		native	native	native	native	10	0	0	0	7	
<i>Culiseta</i>	<i>subochrea</i>	<i>Culiseta</i>	(Edwards, 1921)				native	native				native				native				5	0	0	0	12	
<i>Coquillettidia</i>	<i>buxtoni</i>	<i>Coquillettidia</i>	(Edwards, 1923)		native				native											2	0	0	0	15	
<i>Coquillettidia</i>	<i>richiardii</i>	<i>Coquillettidia</i>	(Ficalbi, 1889)	native	native	native	native	native	native	native	native	native		native	native	native		native	native	14	0	0	0	3	
<i>Orthopodomyia</i>	<i>pulcripalpis</i>	-	(Rondani, 1872)					native	native	native										3	0	0	0	14	
<i>Uranotaenia</i>	<i>unguiculata</i>	<i>Pseudoficalbia</i>	Edwards, 1913		native			native	native	native										4	0	0	0	13	

species complex																							
Total				taxa	40	41	38	42	53	36	41	27	41	0	16	25	36	37	46	1	52		
				species	39	40	37	41	52	35	40	26	40	0	15	24	35	36	45	1	51		
				native	40	39	36	40	49	36	40	27	41	0	16	25	36	37	44	1	52		
				introd	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0		
				uncertain	0	2	2	2	1	0	1	0	0	0	0	0	0	0	2	0	0		
				extinct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Total taxa					40	41	38	42	53	36	41	27	41	0	16	25	36	37	46	1	52		

- native present, autochthonous
- introd present, introduced and established (e.g. *Ae. albopictus* in Spain)
- uncertain uncertain for presence or absence; for instance with single or few records impossible to verify, or introduced without confirmation of establishment (e.g. *Ae. albopictus* in UK), or previously present and probably extinct today
- extinct absent extinct (previously present and certainly extinct today; e.g. *Ae. aegypti* in France)
- absent absent, never observed, or only few sporadic records out of its natural distribution area

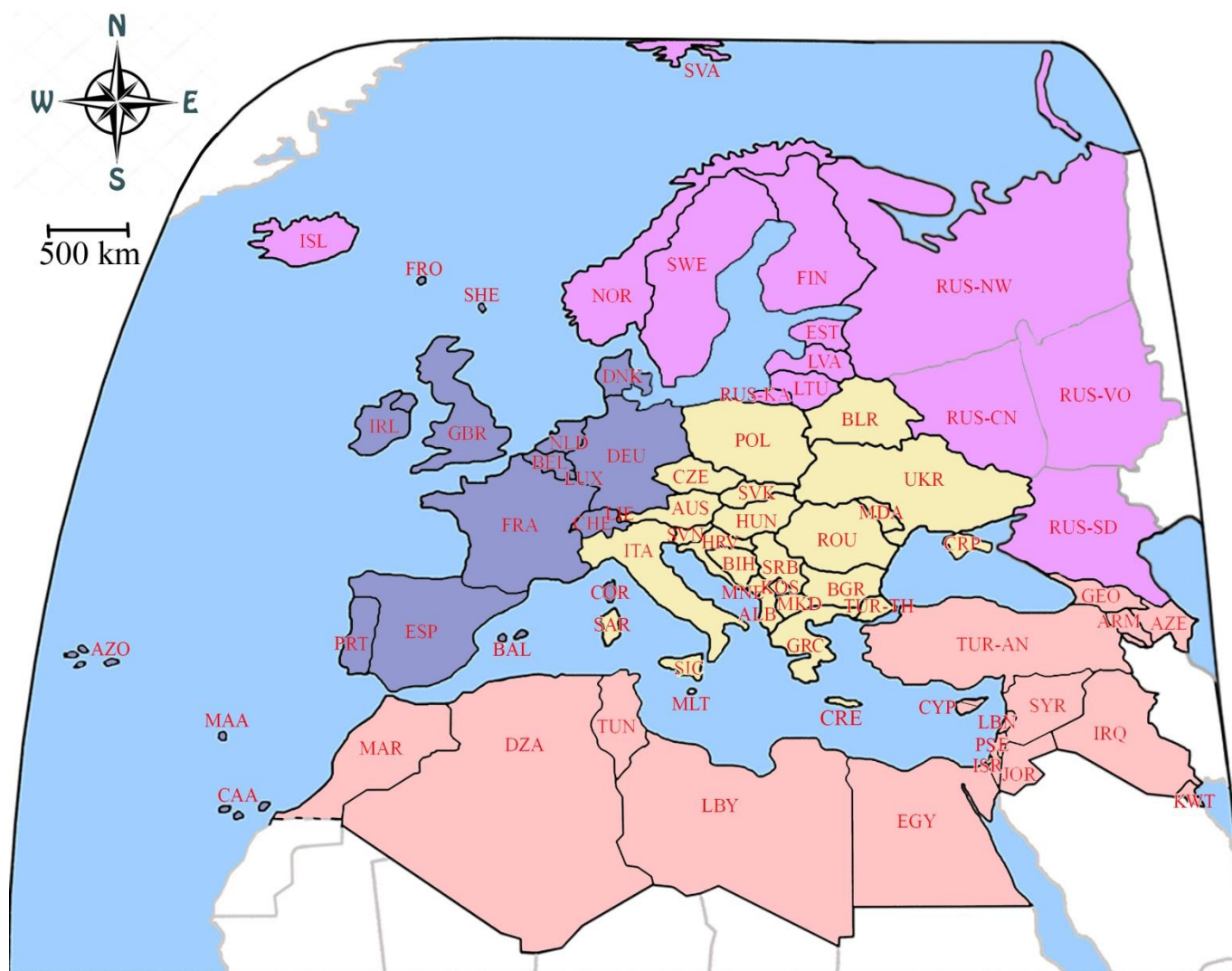


Figure 1: Map of the western Palearctic region, with abbreviations of the 75 geographical units considered in the chart (Tables 2-5).

Comments regarding the species list

The number of taxa accounts for 147 (including one complex of species, *Anopheles maculipennis* s.l., and one extinct species, *Aedes atropalpus*) in the western Palearctic region. In total, the number of species that are present in the region is 145. For a country/territory, only taxa with established populations are included, not those showing only sporadic

introductions, with the exception of the invasive species *Ac. aegypti*, *Ac. albopictus* and *Ac. japonicus* for which introduction without confirmation of establishment is given in the category 'uncertain' (see above).

Developments of the distribution charts from Snow & Ramsdale, 1999 to the present one are provided in Table 6.

Table 6: Changes of the distribution charts from Snow & Ramsdale (1999) to the present one.

Region	Snow & Ramsdale, 1999	Present paper
No. geographic units	43	75
No. mosquito species	96	145
No. references (text+annex)	5+272	41+331

- Genus *Anopheles*

- *Anopheles (Cellia) cinereus cinereus* Theobald, 1901 and *An. c. hispaniola* (Theobald, 1903) are very difficult if not impossible to separate morphologically and in the chart therefore considered together under the taxon *An. cinereus* s.l.; *An. c. hispaniola* is distributed mainly in the Mediterranean region and *An. c. cinereus* in tropical Africa.

- The *Anopheles (Cellia) gambiae* complex includes several major human malaria vectors and is mainly distributed in sub-Saharan Africa, but some populations have been reported from northern Africa. For instance *An. coluzzii* Coetzee and Wilkerson, 2013 was observed in Tinzaouatine, a village in Algeria near the Algeria-Mali border during a small malaria outbreak in 2007 (Boubidi et al., 2010) and *An. arabiensis* Patton, 1905 invaded Upper

- Egypt from Sudan twice during 1942 and 1950 resulting in 180,000 malaria deaths (Kenawy, 1990).
- The *Anopheles* (*Anopheles*) *maculipennis* complex is represented by nine species in the western Palaearctic region, of which eight belong to the *Maculipennis* Subgroup (*An. atroparvus*, *An. daciae*, *An. labranchiae*, *An. maculipennis*, *An. melanoon*, *An. messeae*, *An. persiensis* and *An. sacharovi*), and one to the *Quadrifasciatus* Subgroup (*An. beklemishevi*) (Nicolescu et al., 2004). All species are listed separately in the chart, but because many old records are not reliable to a single species, they are also grouped under the name *An. maculipennis* s.l.
 - The member of the *An. maculipennis* complex, *Anopheles* (*Anopheles*) *daciae* Linton, Nicolescu & Harbach, 2004 is included in the taxa list, despite growing scepticism regarding its taxonomic status (Kronefeld et al., 2014; Blažejová et al., 2017).
 - *Anopheles* (*Anopheles*) *subalpinus* Hackett & Lewis, 1935, formerly recognised as a separate species of the *An. maculipennis* complex is now considered as a synonym of *An. melanoon* (Linton et al., 2002). All records previously referred to as *An. subalpinus* were changed to *An. melanoon* in the chart.
 - *Anopheles* (*Anopheles*) *pseudopictus* Grassi, 1899 is now considered a synonym of *An. hyrcanus* (Moaoulis et al., 2018). Consequently, we list all previous *An. hyrcanus* and *An. pseudopictus* records from the western Palaearctic region under the name *An. hyrcanus* (Pallas, 1771).
- Genus *Aedes*
 - *Aedes* (*Georgecraigius*) *atropalpus* (Coquillett, 1902) has been introduced into Italy, France, and The Netherlands and was established for some years in Italy and The Netherlands but was later eliminated (Medlock et al., 2015). This taxon is included in the chart although the species is no longer considered as a member of the western Palaearctic fauna.
 - The complex *Aedes mariae* comprises three species: *Aedes* (*Acartomya*) *mariae* (Sergent & Sergent, 1903), *Ae.* (*Acy.*) *zammitii* (Theobald, 1903) and *Ae.* (*Acy.*) *phoeniciae* Coluzzi & Sabatini, 1968. The first species is distributed along coasts of the western Mediterranean, the second along coasts of the central Mediterranean, Adriatic and Aegean Seas, and the third along coasts of the eastern Mediterranean. The precise limits of these distributions in North Africa are not known. The species distribution was suggested to be contiguous but without overlap around the Mediterranean Sea (Coluzzi and Sabatini, 1968). The aquatic stages develop specifically in saline sea rock-pools. Because the three species are almost identical morphologically, old records may be considered with caution and new investigation might be performed based on recently developed molecular methods (Mastrantonio et al., 2015).
 - *Aedes* (*Protomacleaya*) *triseriatus* (Say, 1823), a North American mosquito species has only once been reported in France in 2004. The interception occurred in a batch of used tyres originating from the U.S. and no establishment was confirmed (Medlock et al., 2012). This taxon is consequently not included in the chart.
 - *Aedes* (*Hulecoeteomyia*) *japonicus* (Theobald, 1901) comprises four subspecies; to date, all populations reported from the western Palaearctic belong to *Ae. j. japonicus* and are listed as *Ae. japonicus* in the chart. This species was recorded in 2018 in Asturias, Spain (Eritja et al., In press).
 - *Aedes* (*Ochlerotatus*) *beklemishevi* Denisova, 1955 is now considered a synonym of *Ae.* (*Och.*) *euedes* Howard, Dyar & Knab, 1913 (Wood, 1977).
 - *Aedes* (*Ochlerotatus*) *caspicus hargreavesi* Edwards, 1920, which has been described from Italy, is here included in the taxon *Ae. caspius* (Pallas, 1771) because of the scarcity of available information.
 - *Aedes* (*Ochlerotatus*) *duplex* Martini, 1926 was described from two males collected in the European part of Russia. As no further record of any stage has since been made, these males are now considered aberrant specimens (Becker et al., 2010). Consequently, *Ae. duplex* is excluded from the chart.
 - Because *Aedes* (*Ochlerotatus*) *dzeta* Seguy, 1924 is still listed as a valid species in the Systematic Catalog of Culicidae (Gaffigan et al., 2017), we include this taxon in the chart although it was only ever recorded as a larva found in Morocco during the first half of the 20th century. Recent publications related to mosquitoes in Morocco do not mention this species (Trari et al., 2017).
 - The species *Aedes* (*Aedes*) *rossicus* Dolbeskin, Gorickaja & Mitrofanova, 1930 was previously considered a subspecies of *Ae.* (*Aed.*) *esoensis* Yamada, 1921 (Peus, 1972), but elevated to full species status by Becker et al., 2010. All records previously referred to as *Ae. e. rossicus* were changed to *Ae. rossicus*. *Aedes esoensis* is present in Russia, but not in its European part (Gutsevitch et al., 1971) and thus is not included in the chart.
 - *Aedes* (*Aedimorphus*) *vexans* (Meigen, 1830) is listed here as a single taxon, although the existence of cryptic taxonomic units related to *Ae. vexans* is suggested in northern Europe (Lilja et al., 2018), and the subspecies *Ae. v. arabiensis* (Patton, 1905) has been reported from the Arabian Peninsula.
 - Genus *Culex*
 - *Culex* (*Maillotia*) *hortensis hortensis* Ficalbi, 1889 is widespread in the western Palaearctic region although the subspecies *Cx. h. maderensis* Mattingly, 1955 is reported as endemic from Madeira, but suspected to occur also in the Canaries (Schaffner et al., 2001) and in Albania (Rogozi et al., 2012). The two taxa are considered together under the name *Cx. hortensis* s.l. in the list.
 - *Culex* (*Culex*) *univittatus* Theobald, 1901 has been confirmed to occur in the Iberian Peninsula (Mixão et al., 2016), demonstrating that *Culex* (*Culex*) *perexiguus* Theobald, 1903 is not the only species of the *Univittatus* subgroup occurring in Europe. Therefore records of *Cx. perexiguus* without detailed morphological examination or molecular identification may refer to *Cx. univittatus*.
 - *Culex* (*Culex*) *juppi* Dumas et al., 2016 has been suggested as a cryptic species belonging to the *Cx. pipiens* complex that is associated with the absence of *Wolbachia* infection. This taxon does not fulfil the mandated requirements for availability and is considered a *nomen nudum*. Thus, the taxon is not included in the chart.
 - The *Culex* (*Culex*) *pipiens* complex (sensu Sirivanakarn, 1976) in the Western Palaearctic region comprises two species. *Culex pipiens* L., 1758 is distributed over the whole region and *Cx. quinquefasciatus* Say, 1823, a tropical variant,

- was only present in the most eastern side of the region (Iraq and Kuwait) until 2014. In addition, the latter was recorded from various areas around the Mediterranean Sea, including Turkey (Günay et al., 2015) and also as *pipiens/quinquefasciatus*-hybrids on the Greek island Kos (Shaikovich & Vinogradova, 2014) and in Morocco (Shaikovich et al., 2016). However, the establishment of *Cx. quinquefasciatus* populations in the western Palaearctic has not been demonstrated yet. The two taxa *Cx. pipiens* biotype *pipiens* Linnaeus, 1758 and *Cx. pipiens* biotype *molestus* Forskål, 1775 are grouped together under the name *Cx. pipiens* in the chart.
- *Culex (Culex) thalassius* Theobald, 1903 has only been reported from Syria (Abdel-Malek, 1960) with the status "doubtful" (Harbach, 1988) and, thus, is not included in the chart.
 - Genus *Culiseta*
 - The two taxa *Culiseta (Culiseta) alaskaensis alaskaensis* (Ludlow, 1906) and *Cs. a. indica* Edwards, 1920 are considered together under the name *Cs. alaskaensis* s.l. in the list. The two subspecies differ in general body coloration: dark in *Cs. a. alaskaensis* and light in *Cs. a. indica*. *Culiseta a. alaskaensis* is generally reported from the western Palaearctic region while *Cs. a. indica* is reported from Caucasus and Russia (Becker et al., 2010).
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Annex:

References for mosquito distribution by country/territory of the western Palearctic region

Albania

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