Mosquito & pathogens

Diptera

Molte famiglie di interesse sanitario

- *Culicidae* (mosquitoes)
- *Muscidae* (flies)
- *Sarcophagidae e Calliphoridae* (blowflies)
- *Tabanidae* (horseflies)
- *Simuliidae* (black flies)

Inoltre i generi

- *Culicoides* (biting midges)
- *Phlebotomus* (sandflies)

Mosquito , family *Culicidae*

- Mosquitoes are dipterans of the Nematocera suborder, all placed within the Culicidae family.
- About 3200 species and subspecies of mosquitoes are recognized, divided into 42 genera.
- The medically more relevant species in Europe belong to the genera Anopheles, Culex, and Aedes.
- Evidence for the ability of the *Wuchereria bancrofti* worm (the agent of human lymphatic filariasis) to develop in mosquitoes was provided in 1877, while in 1898, the *Anopheles* mosquitoes was demonstrated to transmit malaria plasmodia to humans, and in 1900, *Aedes aegypti* was confirmed to transmit yellow fever

Mosquito , family *Culicidae*

- The definition of the composition of the mosquito fauna in a particular area is not always simple, because of the presence of sibling species grouped in complex, morphologically indistinguishable or hardly distinguishable.
- This is particularly true for the Anopheles mosquito: among the 460 species within the genus, 70 are known to transmit malaria and about 40 are important vectors. Several malaria vectors are grouped in closely related species that are morphologically similar but differ in biology, and hence in their capacity to transmit malaria.

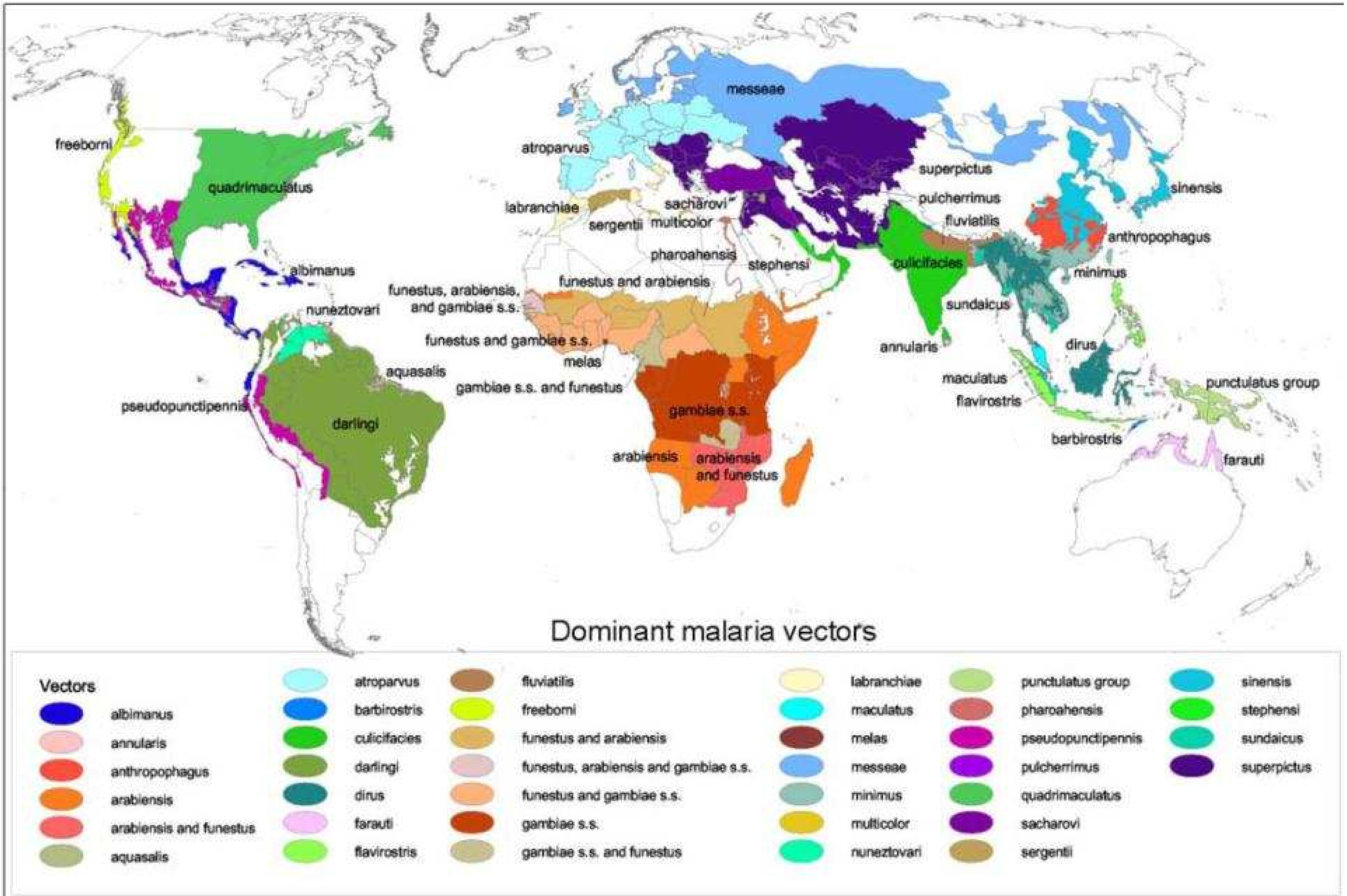


Figure 1 from Anthony Kiszewski, Andrew Mellinger, Andrew Spielman, Pia Malaney, Sonia Erlich Sachs, and Jeffrey Sachs. A Global Index Representing The Stability of Malaria Transmission. Am J Trop Med Hyg 2004 70:486–498.

European mosquitoes

CULICIDAE

ANOPHELINAE

Anopheles

(Anopheles)

- An. algeriensis
- An. atroparvus
- An. beklemishevi
- An. claviger
- An. hyrcanus
- An. labranchiae
- An. maculipennis s.s.
- An. marteri
- An. melanoon
- An. messeae
- An. petragnani
- An. plumbeus
- An. sacharovi
- An. subalpinus

(Cellia)

- An. cinereus
- An. multicolor
- An. sergentii sergentii
- An. superpictus

CULICINAE

Aedini

Aedes

(Aedes)

- Ae. cinereus
- Ae. esoensis rossicus
- Ae. geminus

(Aedimorphus)

- Ae. vexans vexans

(Stegomyia)

- Ae. aegypti
- Ae. albopictus
- Ae. cretinus

(Fredwardsius)

- Ae. vittatus

Ochlerotatus

(Ochlerotatus)

- Oc. annulipes
- Oc. atropalpus
- Oc. behningi
- Oc. berlandi
- Oc. cantans
- Oc. caspius caspius
- Oc. cataphylla
- Oc. coluzzii
- Oc. communis
- Oc. cyprius
- Oc. detritus
- Oc. diantaeus
- Oc. dorsalis
- Oc. euedes
- Oc. excrucians
- Oc. flavescens
- Oc. hexodontus hexodontus
- Oc. hungaricus
- Oc. impiger impiger
- Oc. intrudens
- Oc. leucomelas
- Oc. mariae
- Oc. nigrinus
- Oc. nigripes
- Oc. pionips
- Oc. pulcritarsis pulcritarsis
- Oc. pullatus
- Oc. punctodes
- Oc. punctor
- Oc. riparius
- Oc. sticticus
- Oc. subdiversus
- Oc. surcoufi
- Oc. zammitii

(Finlaya)

- Oc. eatoni
- Oc. echinus
- Oc. geniculatus
- Oc. gilcolladoi
- Oc. japonicus japonicus

(Rusticoidus)

- Oc. lepidonotus
- Oc. quasirusticus
- Oc. refiki
- Oc. rusticus

Culicini

Culex

(Barraudius)

- Cx. modestus
- Cx. pusillus

(Culex)

- Cx. brumpti
- Cx. laticinctus
- Cx. mimeticus
- Cx. perexiguus
- Cx. pipiens
- Cx. theileri
- Cx. torrentium
- Cx. tritaeniorhynchus
- Cx. vishnui

(Maillotia)

- Cx. deserticola
- Cx. hortensis hortensis
- Cx. hortensis maderensis

(Neoculex)

- Cx. impudicus
- Cx. martinii
- Cx. territans

Culisetini

Culiseta

(Allotheobaldia)

- Cs. longiareolata

(Culicella)

- Cs. fumipennis
- Cs. litorea
- Cs. morsitans
- Cs. ochroptera

(Culiseta)

- Cs. alaskaensis alaskaensis
- Cs. annulata
- Cs. bergrothi
- Cs. glaphyroptera
- Cs. subochrea

Mansoniini

Coquillettidia

(Coquillettidia)

- Cq. buxtoni
- Cq. richiardii

Orthopodomyini

Orthopodomyia

(Orthopodomyia)

- Or. pulcripalpis

Uranotaeniini

Uranotaenia

(Pseudoficalbia)

- Ur. unguiculata unguiculata

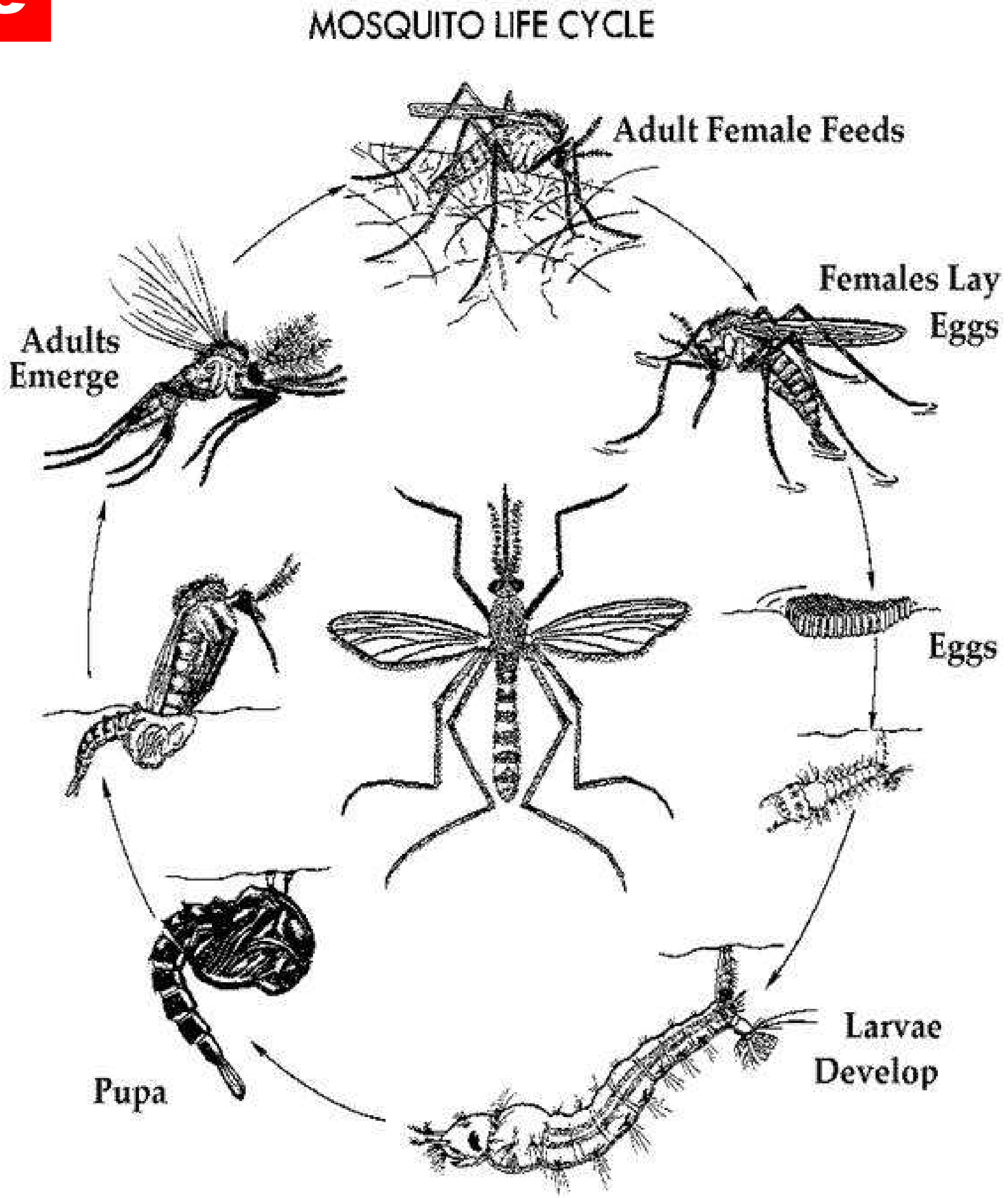
European vector of viruses

Aedes albopictus	CHIKV DEN YF vector WN lab
Aedes aegypti	CHIKV DEN YF vector WN lab
Aedes cinereus	SIN vector TAH in nature
Aedes vexans	TAH vector, Lednice WN nat
Aedes vittatus	YF vector Africa
Anopheles atroparvus	WN in nature
Anopheles claviger	TAH vector, BATAI in nature
Anopheles plumbeus	WN lab
Anopheles maculipennis	BATAI
Coquilletidia richiardii	BATAI, Lednice WN in nature
Culiseta annulata	TAH in nature
Culiseta longiareolata	WN lab
Culiseta morsitans	Sin nature
Culex mimeticus	WN in nature
Culex modestus	WN TAH vector, SIN LED nat
Culex perexiguus	WN SIN vector (medioriente)
Culex pipiens	WN SIN vector, TAH lab, BATAI in nature
Culex theileri	WN SIN in nature Africa

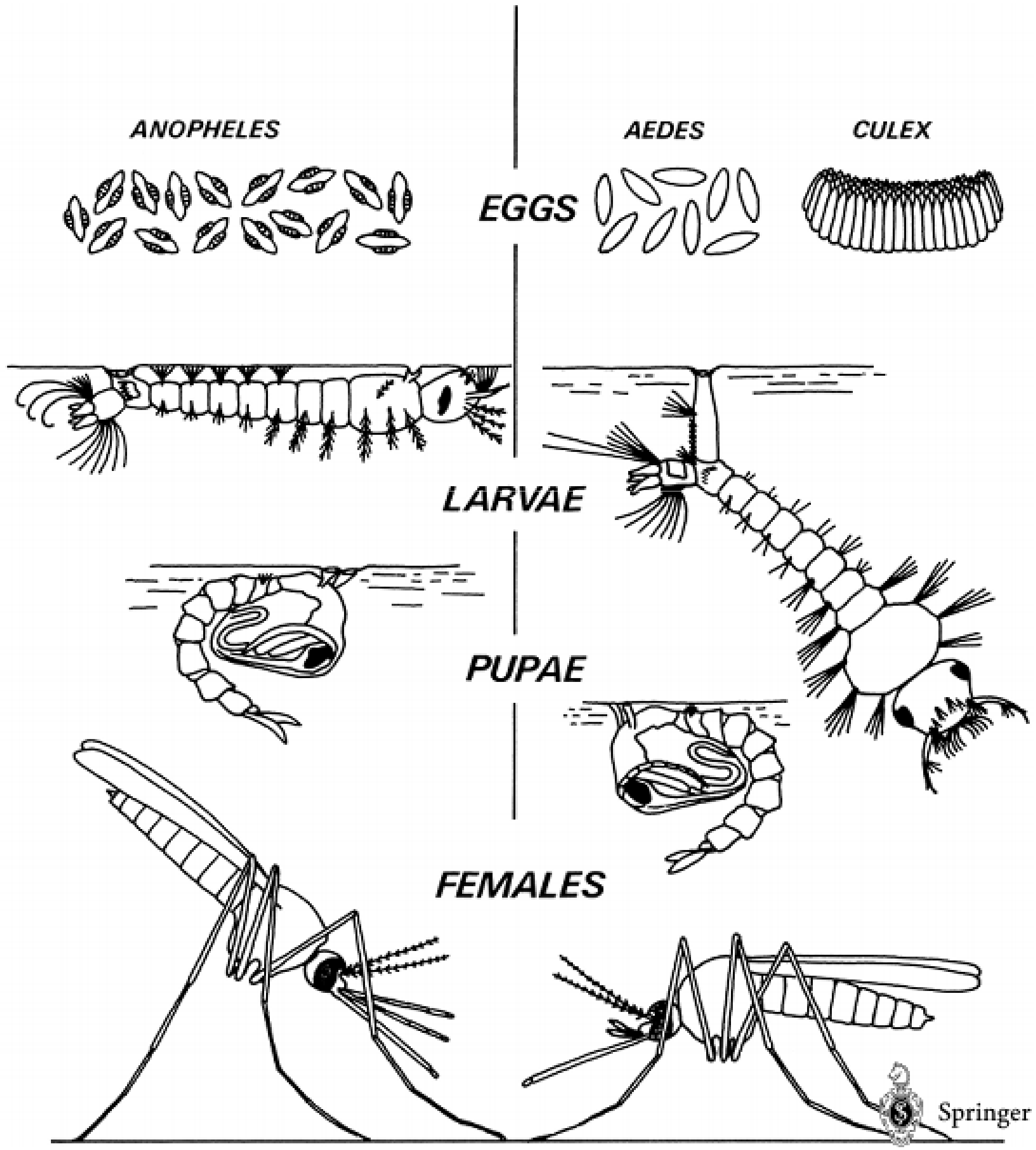
Culex torrentium	SIN vector
Culex tritaenorhynchus	WN in nature Asia, SIN nat Arabia
Culex vishnui	WN in nature Asia
Ochlerutatus annulipes	TAH nat
Ochlerutatus atropalpus	WN lab
Ochlerutatus caspius	TAH vector,WN in nature
Ochlerutatus communis	BATAI Inkoo in nature, TAH lab
Ochlerutatus cantans	TAH WN in nature
Ochlerutatus dorsalis	TAH in nature
Ochlerutatus excrucians	BATAI TAH WN in nature
Ochlerutatus flavescens	TAH lab
Ochlerutatus geniculatus	YF WN lab
Ochlerutatus hexodontus	INKOO in nat
Ochlerutatus japonicus	JE vector, WN lab e in nature
Ochlerutatus punctor	INKOO in nat TAH WN lab
Ochlerutatus sticticus	INKOO tah in nat

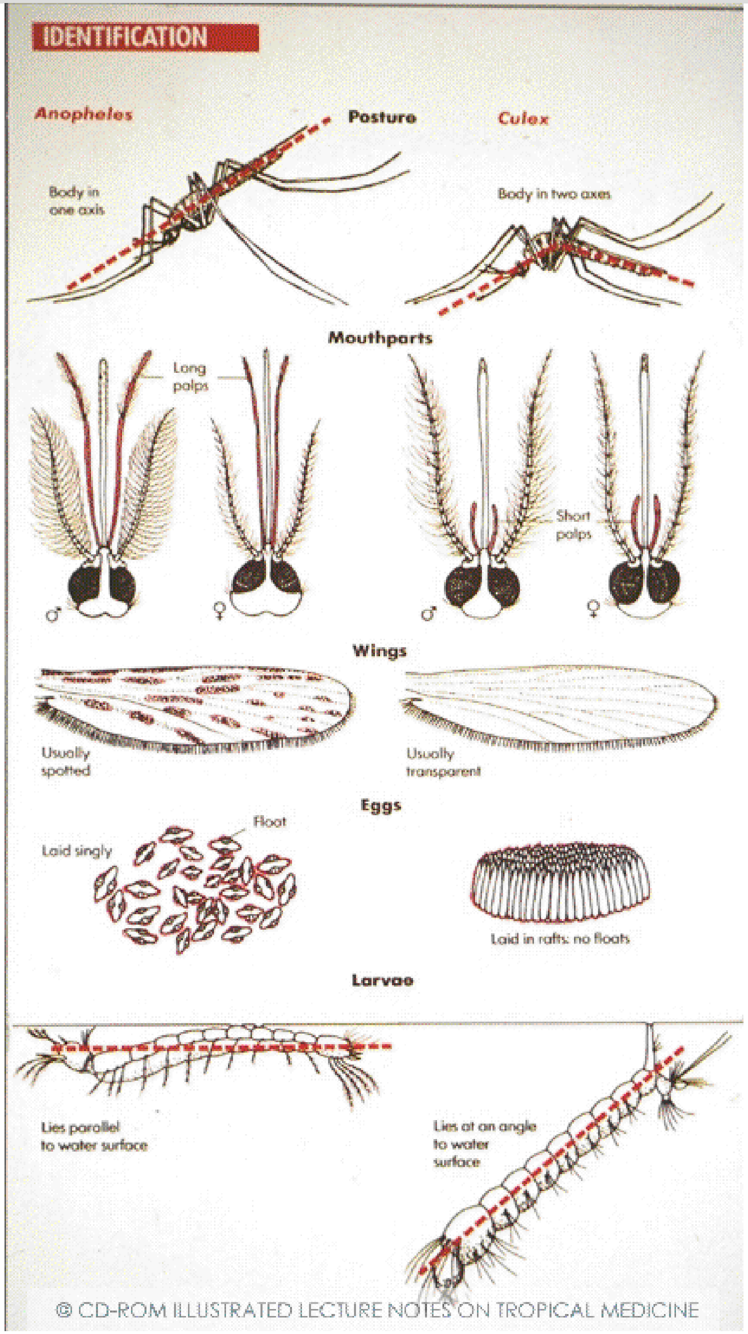
Modified frfom Schaffner F, 2001

Life cycle


MOSQUITO LIFE CYCLE
Adult Female Feeds
Females Lay Eggs
Eggs
Larvae Develop
Pupa
Adults Emerge

Genera characteristic





Bionomics

- These insects have great adaptability to different environments. Since the immature stages are aquatic, they are linked to fresh or brackish water.
- Depending on the species, mosquitoes are capable of breeding in a wide variety of aquatic environments: man-made containers of variable dimensions (e.g., used cans, plastic containers, flowerpot saucers, etc.), manholes, cesspits, catch basins, snow-melt ponds, tree holes, leaf axils, ditches, flooded basements, flooded meadows, fountains, marshes, peat bogs, ponds, rice fields, river banks, springs, wells, and marshes.
- Mosquito larvae usually do not occur in running or open waters; they prefer edges that provide shelter and minimal running water.

Development time

- Larvae feed on detritus, algae, and aquatic micro-organisms, and after three molts, they become pupae.
- The larval duration is variable, depending primarily on temperature and food sources, and, in good conditions, it could last 7–10 days.
- The larvae can also survive as an overwintering stage
- The duration of the pupae, a stage unable to feed, can last from 2–3 days up to a week.
- Total development time, from egg to adult, can last 10 days for certain *Culex* and *Aedes* mosquitoes, while *Anopheles* species have longest development time, and *Mansonia* and *Coquillettidia* show protracted life cycle.

Overwintering

- Some mosquitoes overwinter as adults (such as *Anopheles* and *Culex* species); this provides a possible way of overwintering for pathogens, through the infected female. In other species (*Aedes* genus), the eggs are the stage that survive the unfavorable season; the production of diapausing eggs can allow the overwintering of pathogens through vertical transmission.

Nutrition

- Adult mosquitoes feed on sugary liquids (e.g., nectar, damaged fruits, vegetative tissues and honey dew); only the females need a blood meal to mature their eggs. These insects can deposit hundreds of eggs per oviposition.

Gonotrophic cycle

- The time between the blood meal and the maturation of the eggs ranges from 2–3 days in hot conditions to up to 1–2 weeks at lower temperatures this interval is known as **gonotrophic cycle**, a mosquito may have different gonotrophic cycles during her life.

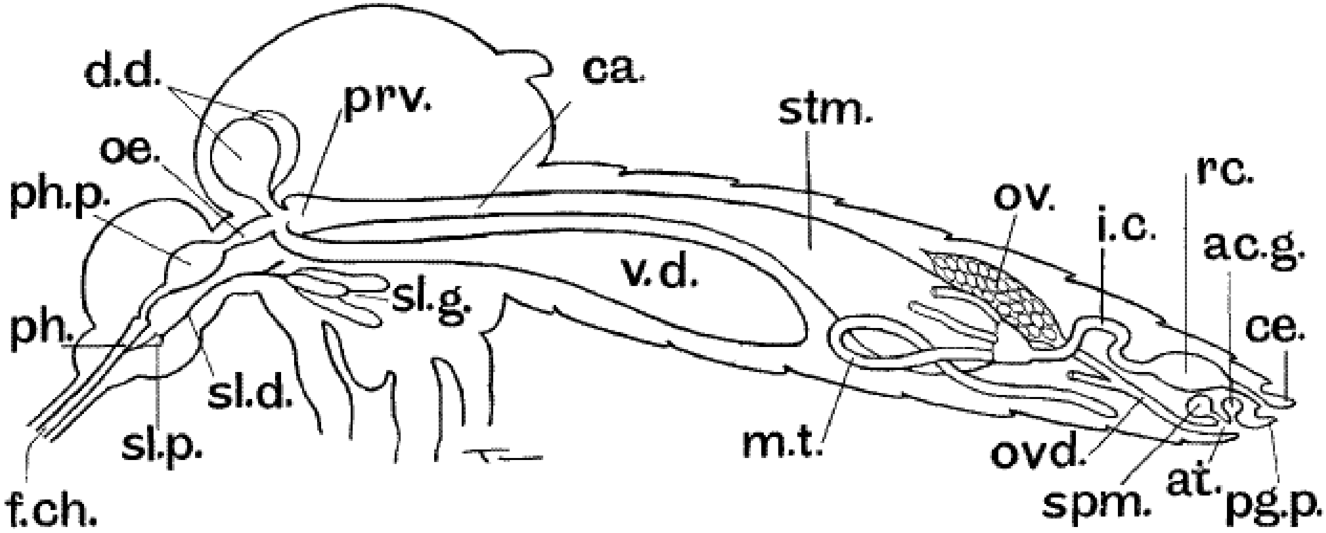


FIG. 56.—Diagram showing certain internal organs of a female mosquito.

ac.g., accessory gland; *at.*, atrium; *ca.*, cardia; *ce.*, cercus; *d.d.*, dorsal diverticula; *f.ch.*, food channel; *i.c.*, ileum-colon; *m.t.*, Malpighian tube (one of five); *oe.*, oesophagus; *ov.*, ovary; *ovd.*, oviduct; *ph.*, pharynx; *ph.p.*, pharyngeal pump; *pg.p.*, postgenital plate; *prv.*, proventriculus; *rc.*, rectum; *sl.d.*, salivary duct; *sl.g.*, salivary glands; *sl.p.*, salivary pump; *spm.*, spermatheca; *stm.*, stomach; *v.d.*, ventral diverticulum.

Host preference

- Regarding the host preference, mosquitoes can be more generalists or bait preferentially a particular group of animals, such as mammals or birds.
- Some species have a strict preference for one species only, such as the yellow fever mosquito (*Ae. aegypti*) which is an anthropophilic mosquito.
- The host preference is an important mosquito characteristic that strongly influences the vector capacity of the species.

Flying distance lifespan

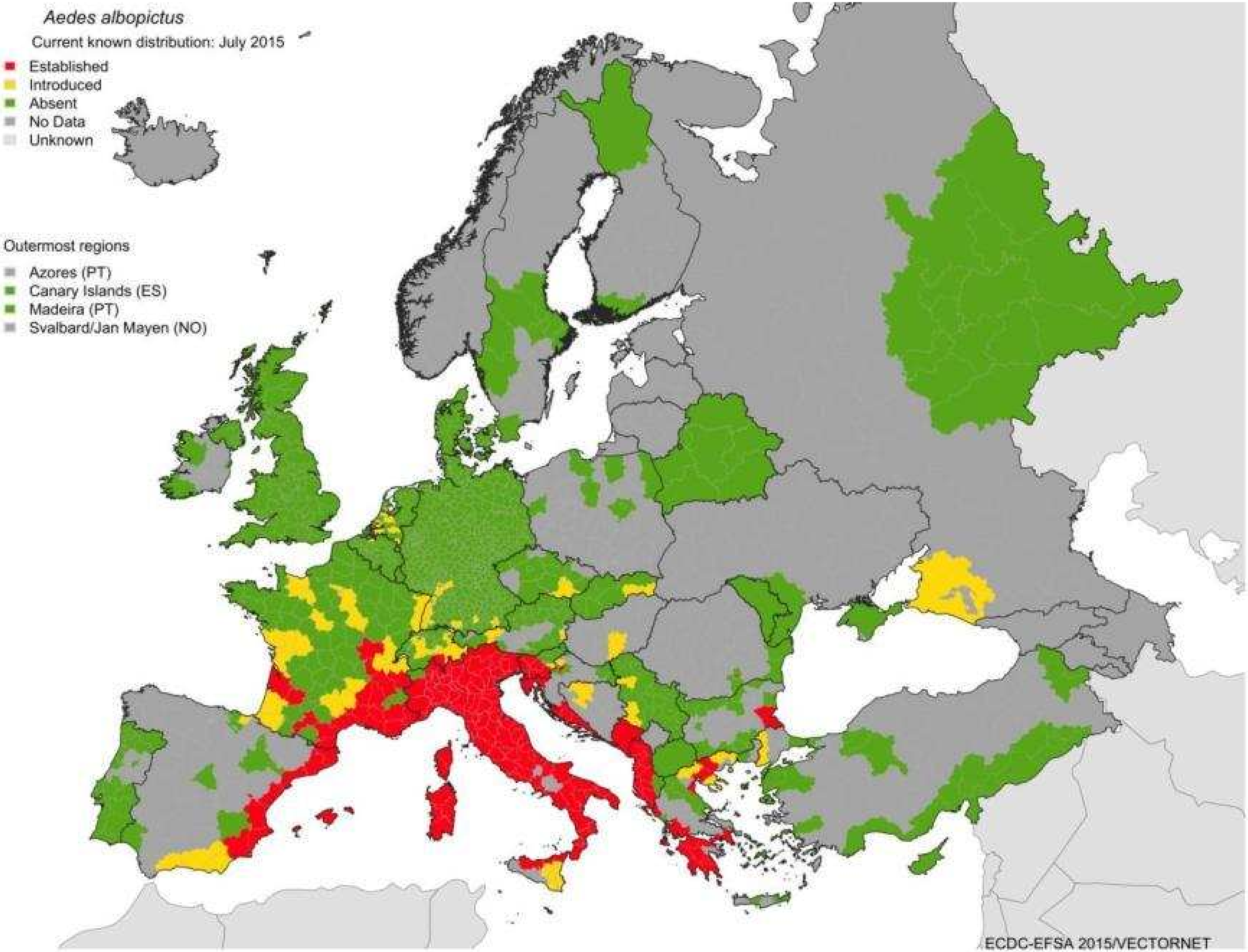
- Some mosquito species do not fly away from their larval breeding sites (hundreds of meters for *Aedes albopictus* and *Ae. aegypti*), while other species may travel over great distances, such as *Culex* mosquitoes, which can fly about 2 km away from its breeding sites, and even greater distances, especially if carried by the wind (distances over 20 km are reported for *Aedes vexans*).
- Adult females live 1–2 weeks in the tropics, but in temperate countries they may live 1–2 months.

Invasive species

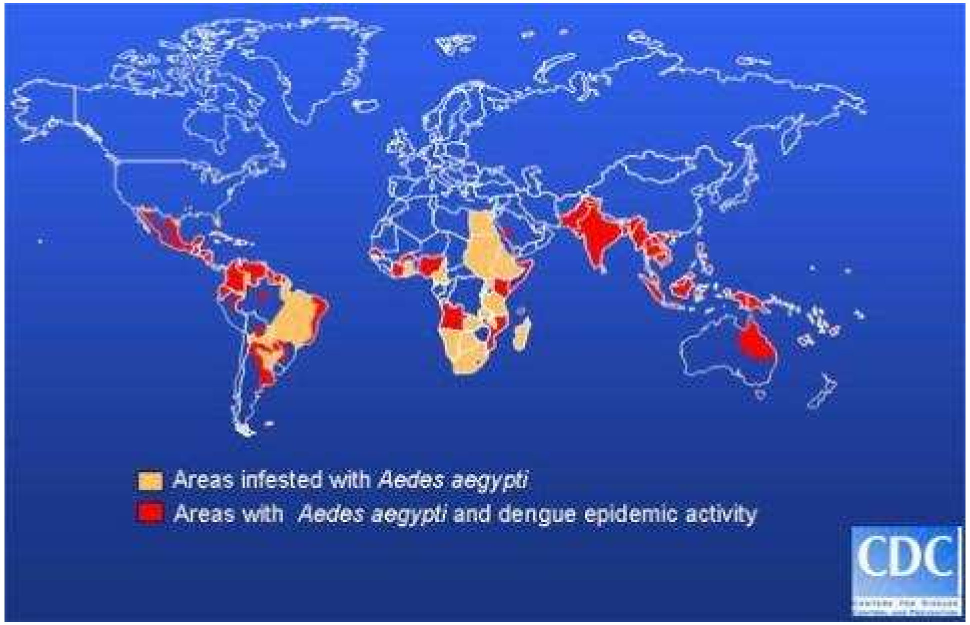
- Mosquitoes can be transported for long distances by cars, trains, ships, and airplanes. If these specimens are infected, then the pathogen could travel with the mosquito. Eggs or immature stages of mosquitoes could be also transported with commercial products. Several invasive species within the *Aedes* genus (e.g., *Ae. albopictus*, *Ae. japonicas*, *Ae. atropalpus*, *Ae. koreicus*, *Ae. triseriatus*, and *Ae. aegypti*) are transported primarily by humans, and have been increasingly reported in Europe since 1990.

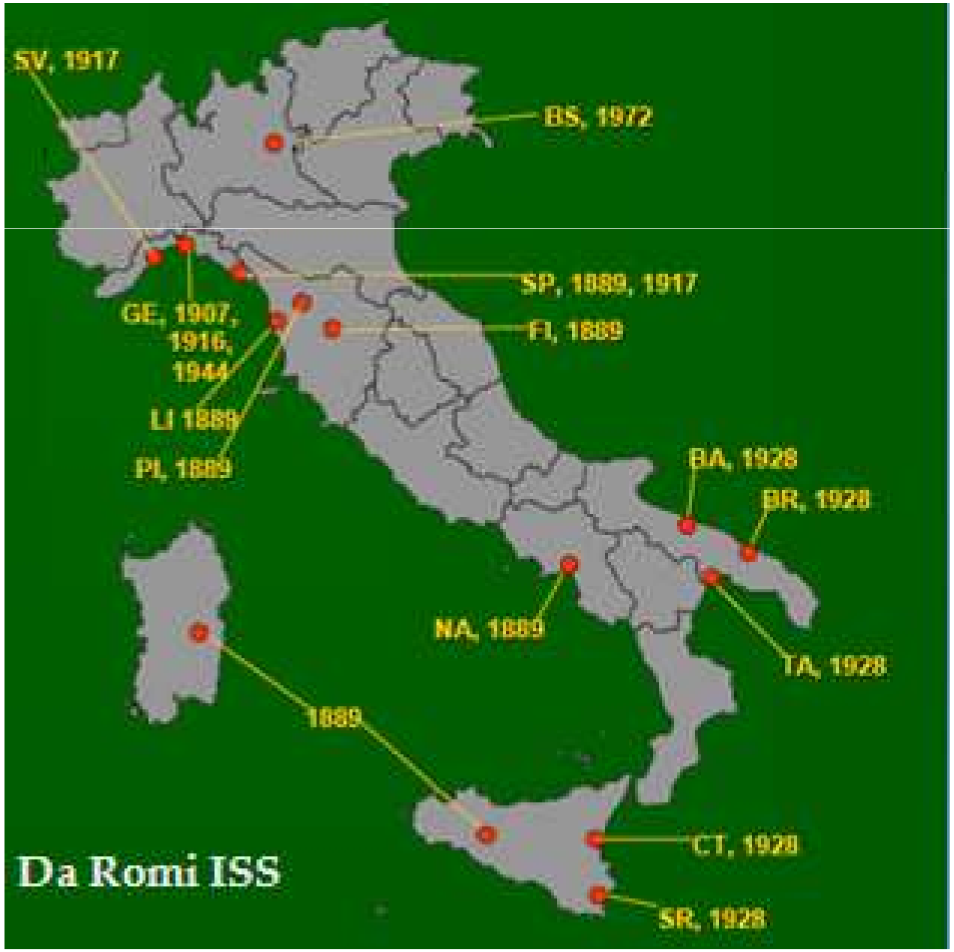
Invasive species

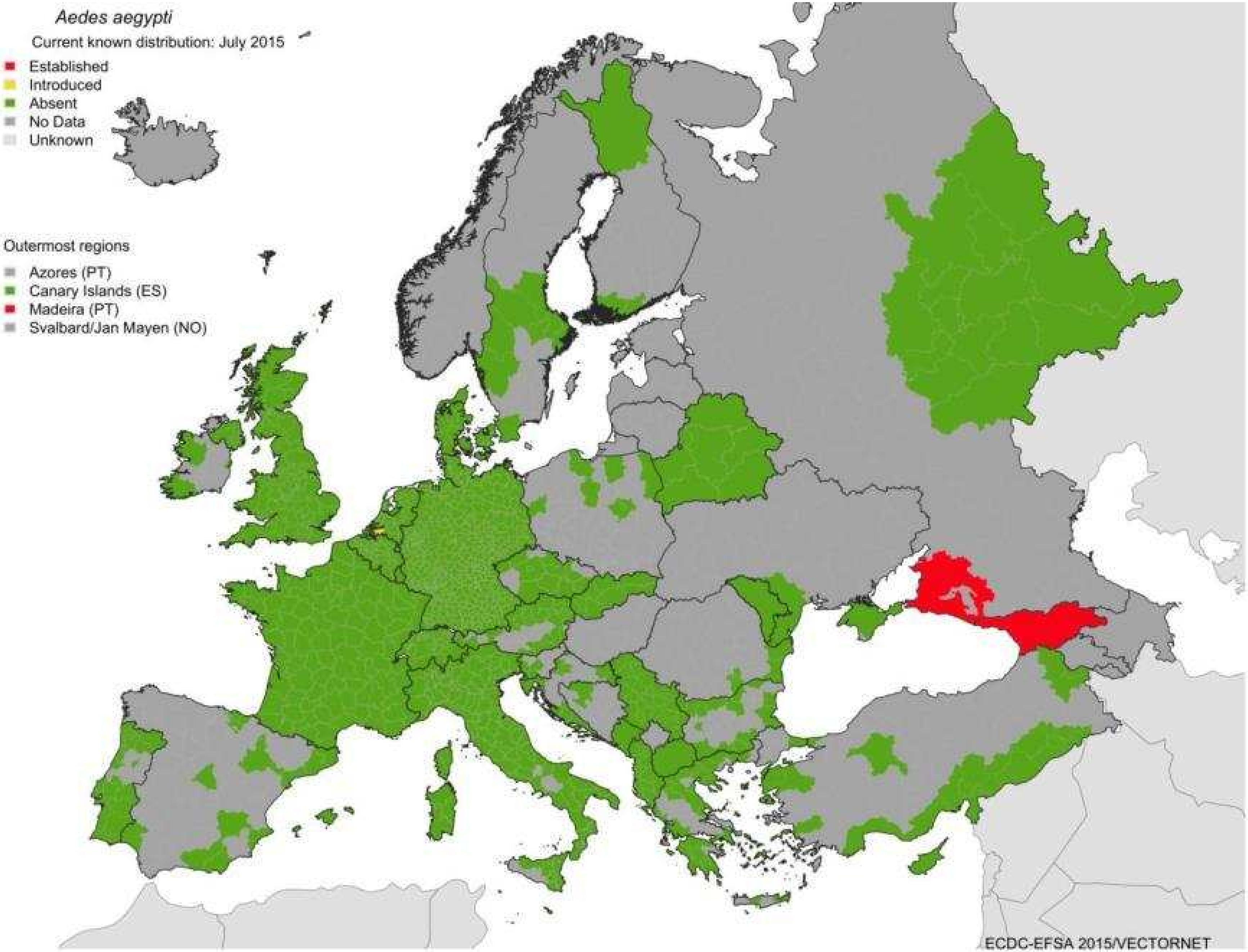
- The more impressive case is the tiger mosquito (*Ae. albopictus*), whose eggs were transported in used tires, a good breeding site for this mosquito, and traded worldwide, likely arising from infested deposits in Japan. Tiger mosquito eggs were also transported with ornamental plants as lucky bamboos.
- Today, this species is diffused throughout several counties outside its native area (Asia) and is expanding its home range to Europe and North and South America. That this species could have such expansion and be so often regarded with indifference by people and authorities is surprising, given that *Ae. albopictus* is a competent vector of several arboviruses.[6, 7, 17, 21]


Aedes albopictus
Current known distribution: July 2015
Established
Introduced
Absent
No Data
Unknown
Outermost regions
Azores (PT)
Canary Islands (ES)
Madeira (PT)
Svalbard/Jan Mayen (NO)
ECDC-EFSA 2015/VECTORNET

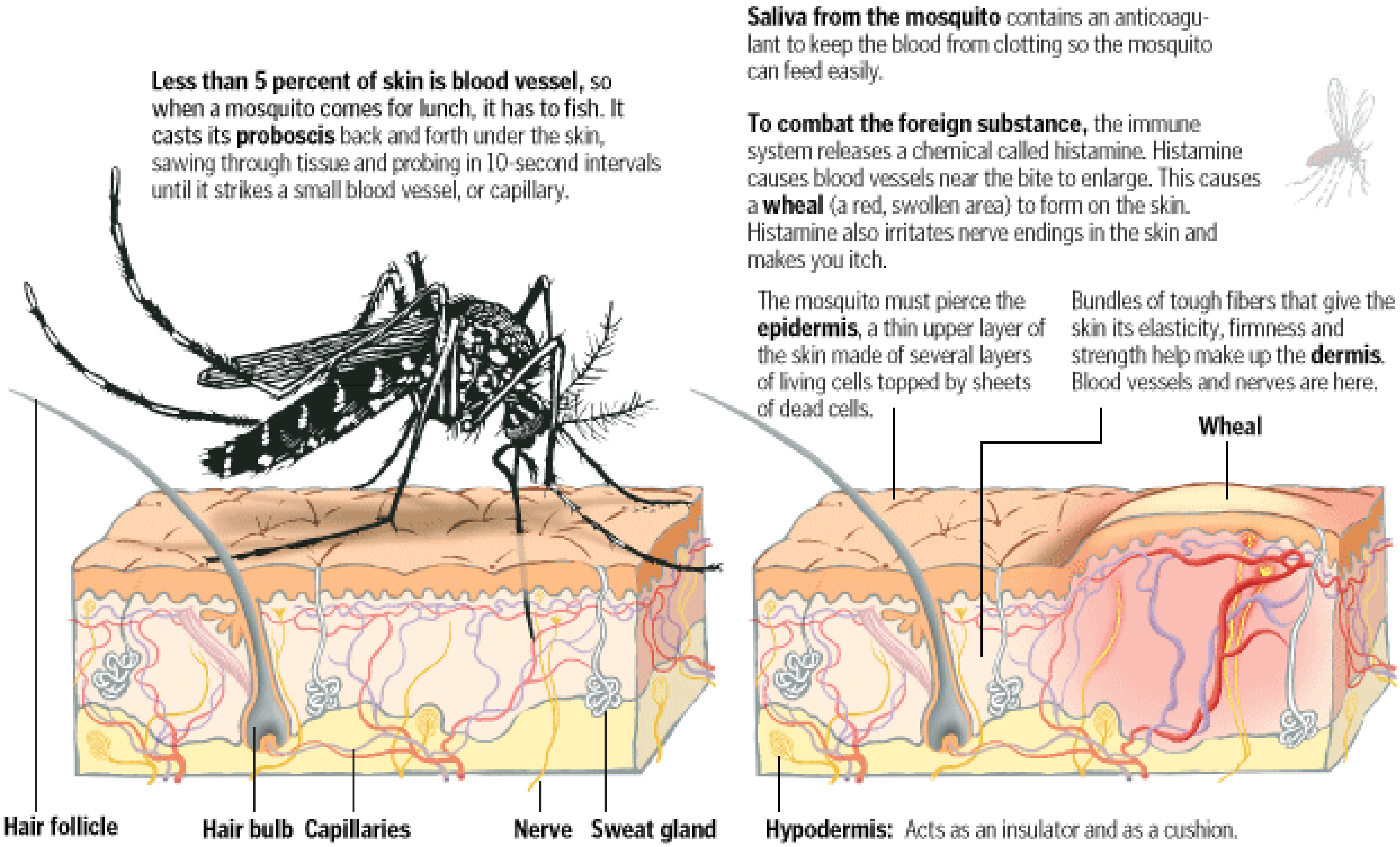
Aedes aegypti






Aedes aegypti
Current known distribution: July 2015
Established
Introduced
Absent
No Data
Unknown
Outermost regions
Azores (PT)
Canary Islands (ES)
Madeira (PT)
Svalbard/Jan Mayen (NO)
ECDC-EFSA 2015/VECTORNET

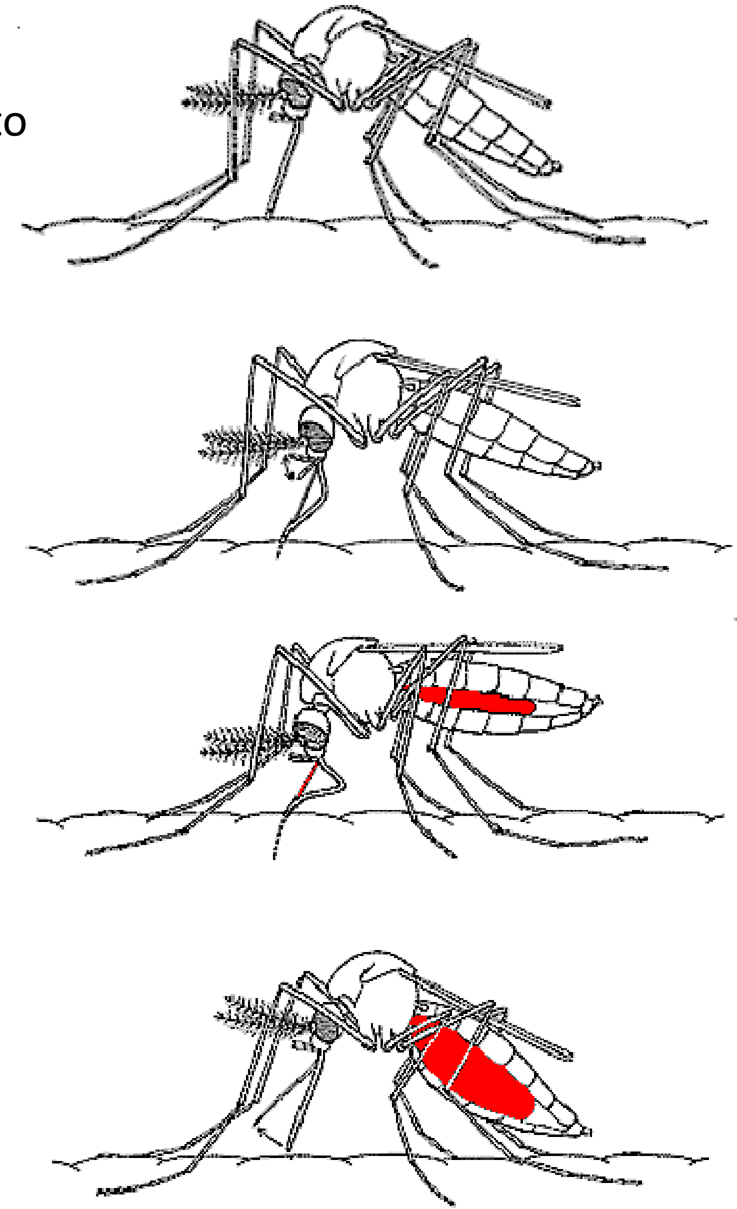
Bites

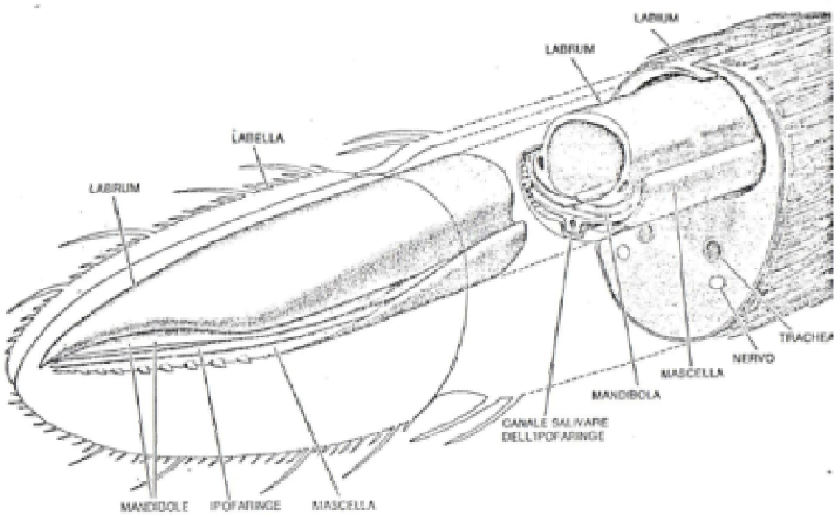


SOURCE: National Institute of Allergy and Infectious Diseases | GRAPHIC: By Brenna Maloney and Patterson Clark, The Washington Post - May 01, 2007

Bites

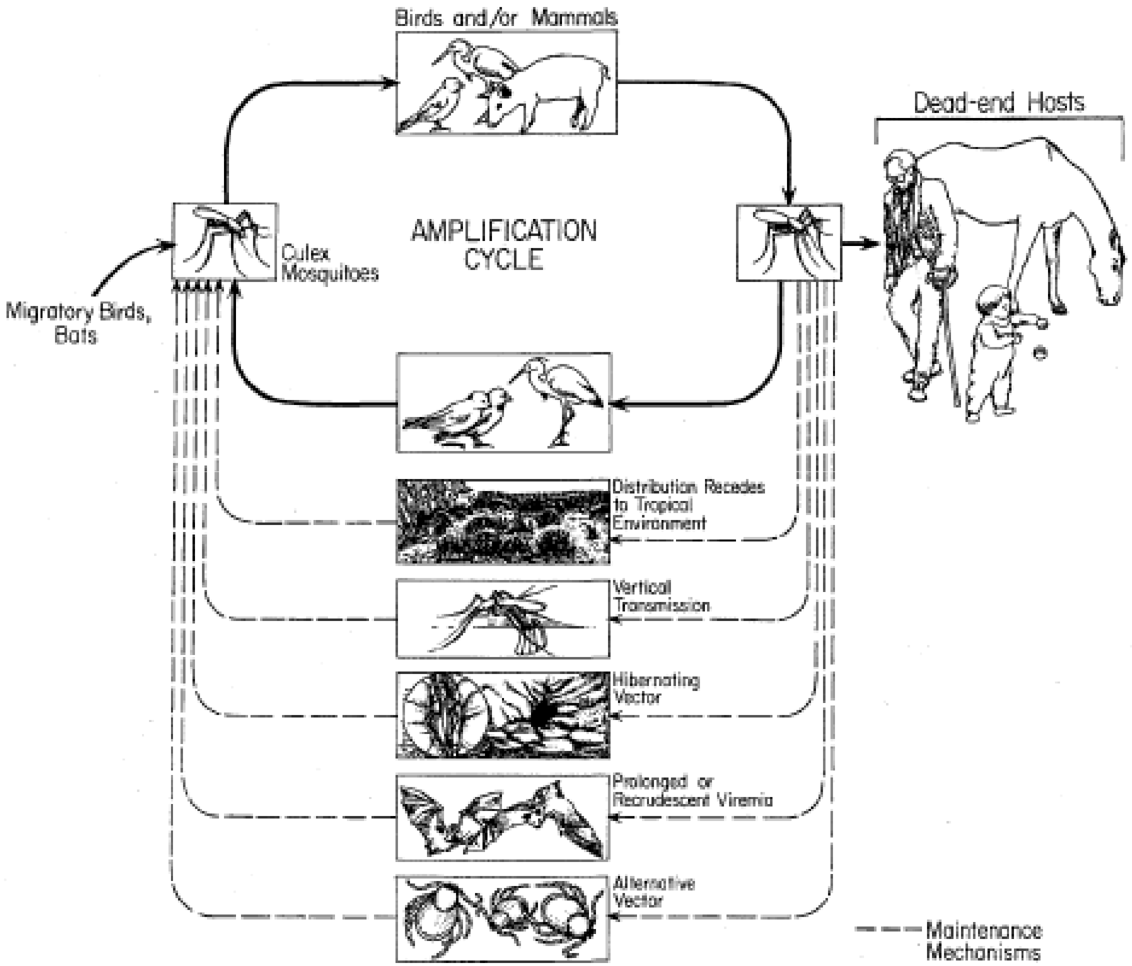
- Vector-borne diseases (VBD) are illnesses transmitted between an infected person, or animal (reservoir host), to another person, or animal, by another living organism (vector).
- Mosquitoes are the best-known disease vectors. Unlike mechanical transmission, VBD transmission involves the biological transmission of the pathogen, and its reproduction, or development, in the vector before transmission to the next vertebrate host.





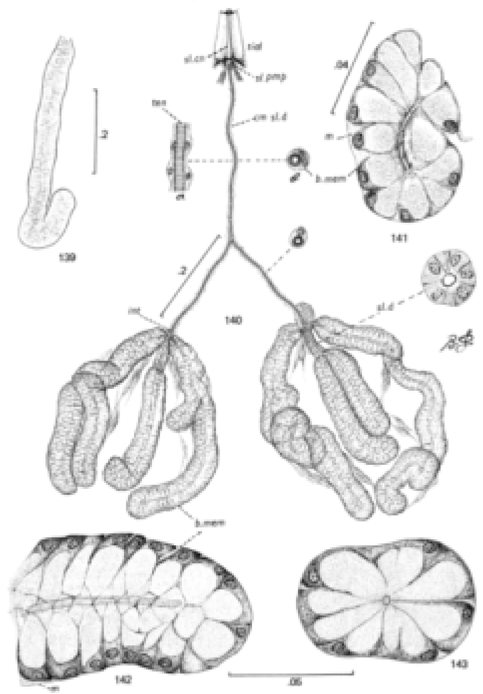
Other transmission rutes

- In addition to this mechanism, arboviruses can be transmitted by other routes, such as horizontal transmission during mating, trans-ovarian transmission, co-feeding transmission, and vertical transmission to the eggs during oviposition.

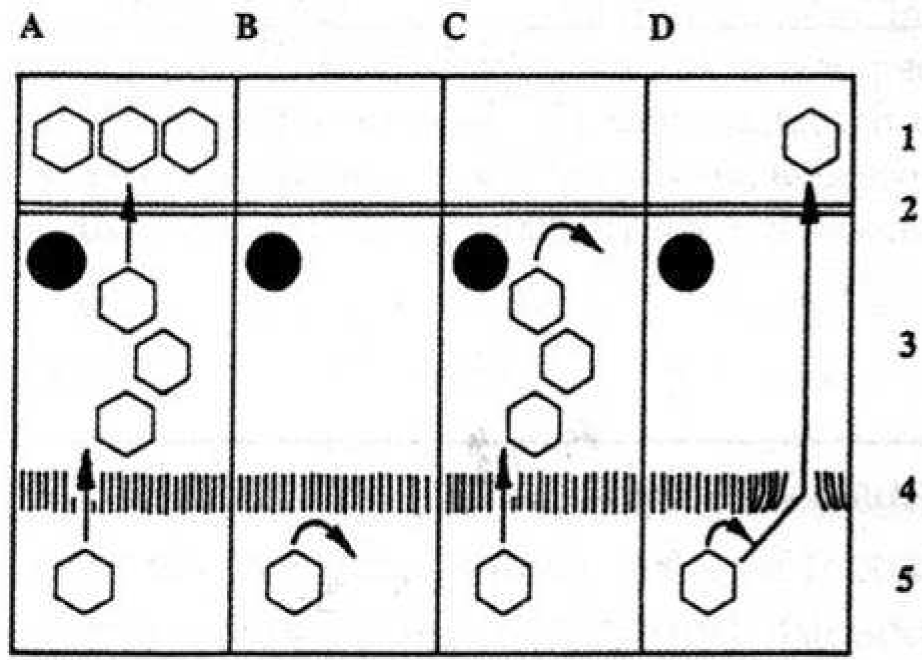


Saliva

•Mosquito saliva contains anticoagulants, antiplatelet, vasodilatory substance, antimicrobial agents, enzymes
•Saliva can alters the immune response favoring the pathogenicity of the virus
•Itching and swelling caused by the bite of a mosquito is due to allergic reaction to the saliva



Figs 139-143 Aedes aegypti, ♀. 139, salivary gland immediately after emergence of mosquito from pupa; 140, salivary glands of two-day-old mosquito, and longitudinal and transverse sections of common salivary canal; 141, section of middle gland showing intracellular duct and its supporting disc; 142, 143, longitudinal and transverse sections of lateral gland.



A = PERMISIVE
B = INFECTION BARRIER
C = DISSEMINATION BARRIER
D = LEAKY

MIDGUT	SALIVARY GLAND	OVARY
1 = Hemocoel	1 = Salivary duct	1 = Follicle
2 = Basement membrane	2 = Secretory surface	2 = Secretory surface
3 = Midgut epithelium	3 = Secretory cell	3 = Follicular epithelium
4 = Brush border	4 = Basement membrane	4 = Ovarian sheath
5 = Gut lumen	5 = Hemocoel	5 = Hemocoel

FIGURE 14.8 Barriers to biological transmission.

Vectorial competence

Vector competence refers to the intrinsic capability of a vector to transmit a pathogenic agent.

It results from a series of biological characteristics, such as the permissiveness of host barriers to penetration of the agent, since the pathogenic agents have to cross the gut and reach the salivary glands of the mosquito to be transmitted to another host. Every mosquito has a particular competence for a pathogen; sometimes distinct populations of the same mosquito have a different vector competence.

Vector capacity is the overall ability of a vector species in a given location and specific time to transmit a pathogen. It is influenced by factors such as vector population abundance, longevity, feeding behavior, and gonotrophic cycle lengths and numbers. The most competent vector in laboratory conditions is not always the principal vector in field conditions.

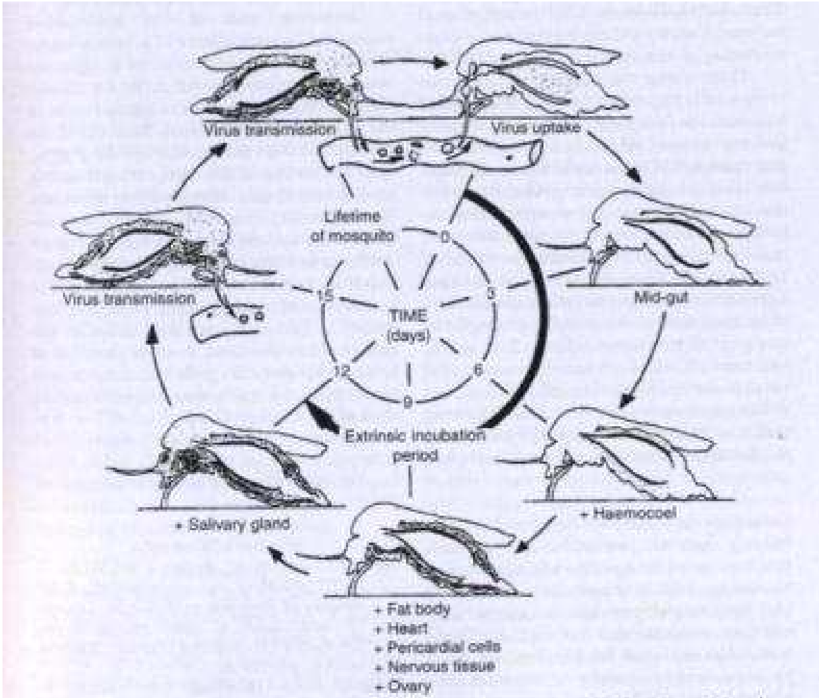


Fig. 1. The dissemination of La Crosse virus in *Ochlerotatus triseriatus* (modified from Beaty, B.J. and Marquardt, W.C. *The Biology of Disease Vectors*. University Press of Colorado, Niwot, 1996).

European vectors

The most relevant vector species of mosquito in Europe.

Species		Distribution	Pathogens transmitted in Europe
Aedes caspius		All Europe	Tahyna virus, *Dirofilaria* spp.
Aedes vexans		All Europe	Tahyna virus
Aedes albopictus		Signaled in 1991 in Italy, now established in Southern Europe	Dengue virus, Chikungunya virus
Aedes communis		Eastern Europe (rare in western Europe)	Inkoo virus, Sindbis virus
Culiseta morsitans		All Europe	Sindbis virus
Culex Pipiens Complex	*Cx. pipiens*	All Europe, more spread in Southern Europe	West Nile virus *Dirofilaria* spp.
	Cx. torrentium	All Europe, more spread in Northern-Central Europe	Sindbis virus
Anopheles Maculipenni Complex[a]	*An. labranchiae*	Southeastern Europe	*Plasmodium* spp.
	An. atroparvus	Mainly Continental Europe	
	An. sacharovi	Southern Europe (Mediterranean)	
	An. maculipennis s.l.		Batai virus

[a] *An. labranchiae, An. atroparvus, An. sacharovi, An. melanoon, An. subalpinus, An. messeae, An. maculipennis s.s., An. beklemishevi*.

Calzolari in press

Mosquito borne diseases

The more relevant MBDs worldwide, and relative DALYs estimation (in thousands).[23] DALYs (Disability-adjusted life years) are the sum of years of healthy life lost to premature death and years lived with disability. DALYs (Disability-adjusted life years) are the sum of years of healthy life lost to premature death and years lived with disability

	DALYs 2013
Malaria	65493.1
Lymphatic filariasis	2022.1
Dengue	1142.7
Yellow fever	30.7

Arboviruses transmitted by mosquitoes causing (or suspected to cause) disease in humans.
In italic virus of clinical importance [a]species reported in according to ICTV[80] serological criteria reported out of brackets
[Af]Africa, [Am]America, [Au]Australia, [As]Asia, [Eu]Europe, [p]primates as possible host, [h]human viremia suitable for vector transmission

Virus genus	Viruses name
Alphavirus	Babanki[Af], *Barmah Forest*[Au],*Chikungunya*[Af, As, Am, p, h], *Eastern equine encephalitis*[Am], Everglades[Am], *Igbo Ora*[Af], *Mayaro*[Am, p, h] , *O'nyon-nyong*[Af, p, h], *Ross River*[Au], *Semliki Forest*[Af As, p], *Sindbis*[Eu, Af, Au],Tonate[Am], *Venezuelan equine encephalomyelitis*[Am, h], *Western equine encephalitis*[Am]
Flavivirus	Banzi [Af], Bussuquara[Am, p], Cacipacore[Am], *Dengue* (4 serotypes)[As,Am, Af, p, h], Edge hill[Au], Ilheus[Am], *Japanese encephalitis*[As], Kedougou[Af], Kokobera[Au], Koutango[Af], *Murray Valley encephalitis* (Alfuy)[Au], *Rocio encephalitis*[Am], Sepik[Au], Sponsweni[Af], St. Louis encephalitis[Am], Usutu[Eu, Af], Wesselsbron[Af], *West Nile fever* (*Kunjin*)[Af, As, Am, Au, Eu], *Yellow fever*[Af, Am, p, h], *Zika*[Af, As, Au, p, h]
Orthobunyavirus[a]	Bunyawera [Bunyamwera[Af], Germiston[Af], Guaroa[Am], Batai (Calovo)[Eu, Af, As], Ilesha[Af], Tensaw[Am], Maguari[Am], Shokwe[Af], Fort Sherman[Am], Ngari[Af]], Bwaba [Bwamba[Af, p], Pongola[Af]], California encephalitis [Jamestown Canyon[Am], Inkoo[Eu], *La Crosse*[Am], *Tahyna*[Eu , As, Af], Snowshoe hare encephalitis[Eu, Am], Trivittatus[Am]], Caraparu [Apeu[Am], Caraparu[Am, p], Ossa[Am]], Catu[Am, p], Guama[Am, p], Madrid[Am], Marituba [Marituba[Am, p], Murutucu[Am], Nepuyo[Am], Restan[Am]], Nyando[Af], Oriboca [Oriboca[Am, p], Itaqui[Am]], Shuni[Am], Tacaiuma[Am, p], Ungrouped [Gan Gan[Au], Tataguine[Af], Tanga[Af], Bangui[Af]], Wyeomyia[Am]
Phlebovirus	*Rift Valley fever*[Af], Arumowot[Af]
Orbivirus	Lebombo[Af], Orungo[Af, p]
Seadornavirus	Banna[As]
Vesiculovirus	Piry[Am]

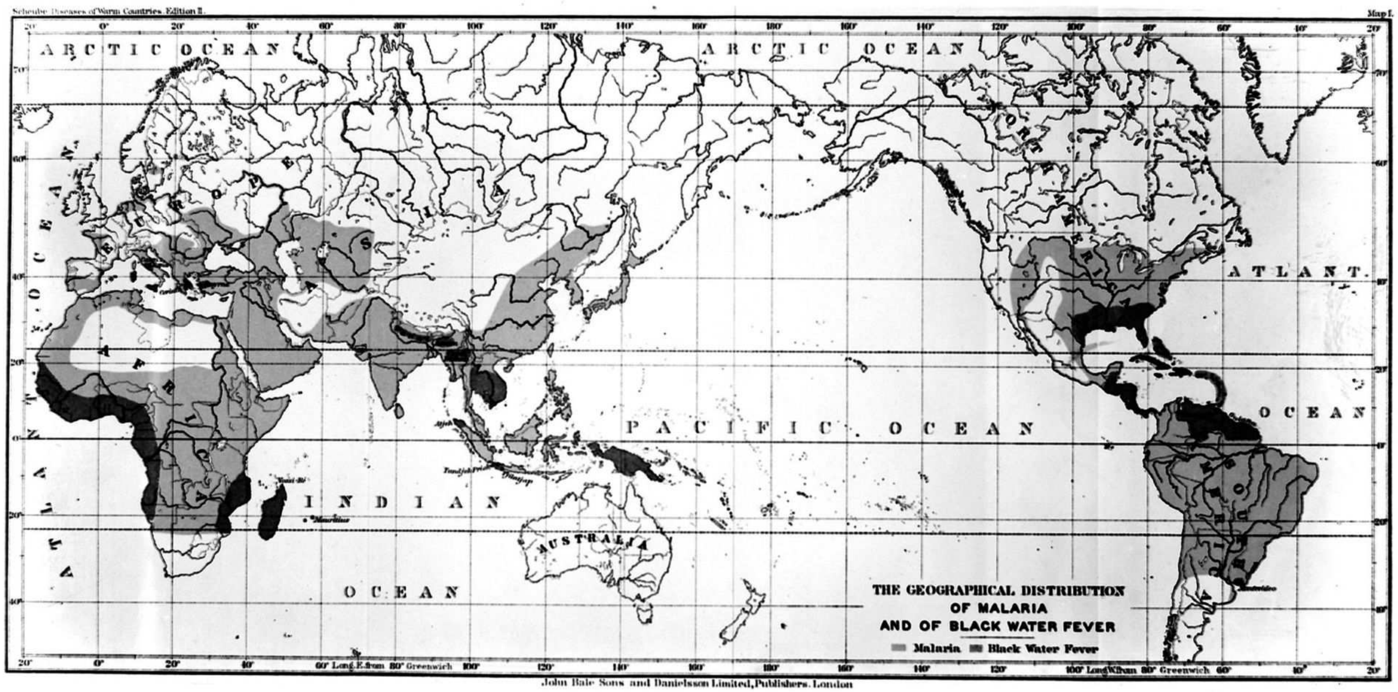
Calzolari in press

Europe was endemic for malaria, and this disease reached the northern limit of Central England, Southern Norway, Central Sweden and Finland, and Northern Russia, but the Mediterranean and Eastern Europe were the most exposed areas to the disease.

The final disappearance was probably due to the changed ecological conditions linked to elimination of larval breeding sites of *Anopheles* species, to the improvement in health systems, and ultimately to large-scale eradication campaigns.

Local populations of *Anopheles* mosquitoes can transmit plasmodia imported by travelers (as migrants, infected tourists, business travelers) and cause autochthonous malaria, malaria is the first imported disease in Europe.

Figure 14: A hut for agricultural workers in Tre Cancelli, in the immediate vicinity of Rome, close to Nettuno. Similar housing was observed in Corsica and Sardinia. The infection rate of the local inhabitants was high (Archives...1925)



The Diseases of warm countries

1903

Several sporadic cases were reported in Europe after the eradication of the disease; the most significant episode was recorded in Greece.

From 2009 to 2013, the Greek Health Authority reported 76 cases (7 in 2009, 4 in 2010, 42 in 2011, 20 in 2012, 3 in 2013) without a travel history in endemic countries.

Another localized episode of local transmission of malaria, with 18 cases, was recorded in Bulgaria in 1995–1996.

This is an impressive discovery, but due to today's European life habits and health system, the reintroduction of malaria seems to be low.

Deterioration of these parameters may raise this potential, but the importation of a number of plasmodia adequate to re-introduce the disease seems unlikely, episodes of local transmission shall be possible, and malaria surveillance should remain a priority.

PS the mosquito is not an Anopheles

The Telegraph

Home | Video | News | World | Sport | Finance | Comment | Culture | Travel | Life | Women | F

USA | Asia | China | Europe | Middle East | Australasia | Africa | South America | Central Asia

France | Francois Hollande | Germany | Angela Merkel | Russia | Vladimir Putin | Greece | Spai

HOME » NEWS » WORLD NEWS » EUROPE » GREECE

Malaria returns to crisis-torn Greece

Malaria has returned to Greece as financial cuts contribute to the re-emergence of a once extinct disease.

Email

T TRAVEL

PLAN WITH THE EXPERTS • BOOK WITH CONFIDENCE

Home | Hotels | Destinations | Cruise | USA | Family | Rail

HOME » TRAVEL » TRAVEL NEWS

Travellers to Greece given malaria warning

Travellers to Greece have been warned to take precautions against mosquito bites following six reported cases of malaria since June.

82 71 0 0 153 Email

Print this article

Travel News

Travel » News » World News » Oliver Smith »

Related Partners

Alphavirus

Virus		Vectors	Vertebrate Reservoir	Distribution
Barmah Forest	**BF**	*Ochlerotatus vigilax, O. camptorhynchus, Culex annulirostris*	Mammals (humans)	Australia
Chikungunya	**CHIK**	*Aedes aegypti*, *Ae. albopictus*, *Aedes* spp, *Mansonia africana*	Primates, humans	Africa, India, SE Asia
Eastern equine encephalitis	**EEE**	*Culiseta melanura, Coquilletidia perturbans*	Birds	North America
Western equine encephalitis	**WEE**	*Culex tarsalis, Ochlerotatus* spp	Birds, mammals (rabbits)	South and North America
Venezuelan equine encephalitis	**VEE**	*Culex pipiens, Culex* spp	Rodents, horses	South and North America
Mayaro (Uruma)	**MAY**	*Haemagogus janthinomys*	Primates, humans	South America
O'nyong nyong	**ONN**	*Anopheles funestus, A. gambiae*	Humans	Africa
Ross River	**RR**	*Ochlerotatus vigilax, O. camptorhynchus, Culex annulirostris*	Mammals (marsupials)	Australia, South Pacific
Sindbis (Ockelbo, Karelian fever, Pogosta)	**SIN**	*Culex* spp, *Culiseta* spp, *Aedes* spp	Birds	Europe, Africa, Australia, Midle Est

Flavivirus

Virus		Vectors	Vertebrate Reservoir	Distribution
Dengue	**DEN**	*Aedes aegypti*, *Ae. albopictus*, *Aedes* spp	Humans	Africa, Caribbean, South America, Asia
Murray Valley encephalitis	**MVE**	*Culex annulirostris*	Birds	Australia, New Guinea
Japanese encephalitis	**JE**	*Culex tritaeniorhynchus*, *Culex* spp	Birds, pigs	Asia
St Louis encephalitis	**SLE**	*Culex pipiens Culex nigripalpus Culex* spp	Birds	South and North America
Yellow fever	**YF**	*Aedes aegypti*, *Aedes africanus*, *Aedes* spp	Primates	Africa, South Central America
Ilheus	**ILH**	*Psorophora ferox*, *Psorophora* spp *Ochlerotatus* spp	Birds	South Central America
Kunjin	**KUN**	*Culex annulirostris*	Birds	Australia, New Guinea
Rocio	**ROC**	*Ochlerotatus scapularis*, *Psorophora fero x*	?	Brazil
Spondweni	**SPO**	*Mansonia africana, M uniformis*	?	South Africa
Usutu	**USUV**	*Culex* spp	Birds	Africa, Europe
Wesselsbron	**WSL**	*Aedes* spp	Birds, mammals	Africa del Sud
West Nile	**WN**	*Culex* spp	Birds	Worldwide
Zika	**ZIKV**	*Aedes africanus, Ae luteocephalus, Ae aegipty, Aedes* spp	Primates	Africa, SE Asia

Bunyavirus

Group	Virus		Vectors	Vertebrate Reservoir	Distribution
	Rift Valley	**RVF**	*Aedes* spp, *Ochlerotatus* spp, *Culex* spp, *Mansonia* spp, Culicoids, Simulids	Mammals (ovines, bovines)	Africa
California enchephalitis group	**LaCrosse enchephalitis**	**LAC**	*Ochlerotatus triseriatus*	Rodents	North America
	Inkoo		*Aedes* spp., *Ochlerotatus* spp	?	Europe
	Jamestown Canyon		*Aedes* spp., *Ochlerotatus* spp	Mammals	North America
	Tahyna	**TAH**	*Aedes vexans* , *Aedes* spp, *Ochlerotatus* spp	Rabbits	Europe
	Trivittatus		*Ochlerotatus* spp	?	North America
Simbu group	**Oropouche**	**ORO**	Culicoids *Culex quinquefasciatus*	Humanes	South and Central America
Bunyamwera group	**Batai**		*Anopheles* spp	Mammals	Europe
	Potosi		*Aedes* spp, *Anopheles* spp	Ungulates	North America
	Tensaw		*Anopheles crucians*	Mammals	North America

NOTA Le tabelle riportano solo alcuni degli Arbovirus più conosciuti e più pericolosi per la salute umana.

Arbovirus pericolosi

Genere	Virus	Vettori	Serbatoio	Distribuzione	Patologia umana
Bunyaviridae					
Bunyavirus	La Crosse	Zanzare	Roditori	USA	Encefalite
	California group (compresa LaCrosse)	Zanzare	Mammiferi	USA	Meningoencefalite
	Tahyna	Zanzare	Lagomorifi	Europa	Febbre, esantema
Phlebovirus	Toscana	Flebotomi		Area mediterranea	Febbre, talora meningoencefalite
	Febbre da pappataci (Napoli, Sicilia)	Flebotomi		Area mediterranea	Febbre dolori articolari
	Febbre della Valle del Rift	Zanzare, altri artropodi	Bestiame	Africa	Febbre emorragica
Flavivirudae					
Flavivirus	Febbre Gialla	Zanzare	Uomo, Primati	Africa, Centro/Sud America	Febbre emorragica, necrosi epatica, ittero
	Dengue	Zanzare	Uomo	Africa, Centro/Sud America	sindeome febbrile, esantema,febbre
	Encefalite st. Louis	Zanzare	Uccelli	America	Encefalite
	Encfalite giapponese	Zanzare	Uccelli, suini	Estremo oriente,India	Encefalite
	Murrey Valley	Zanzare	Uccelli	Australia	Encefalite
	West Nile	Zanzare	Uccelli	Ubiquitario	Encefalite
	Rocio	Zanzare	Uccelli	Brasile	Encefalite
Togaviridae					
Alphavirus	Encefalite equina dell'Ovest	Zanzare	Uccelli	America del Nord	Encefalite
	Encefalite equina dell'Venezuelana	Zanzare	Roditori, cavalli	America	Encefalite, sindrome febbrile
	Encefalite equina dell'Est	Zanzare	Uccelli	America	Encefalite
	Cikungunya	Zanzare	Primati, uomo	Africa India Sud-Est Asiatico	Febbre con esantema e artralgie
	Mayaro	Zanzare	Primati, uomo	Sud america, Trinidad	Febbre con esantema e artralgie
	Sindbis	Zanzare	Uccelli	Nord Europa Africa Asia	Febbre con esantema e artralgie
	Semliky Forest	Zanzare	Uccelli	Africa	Sindrome febbrile, encefalite
	O'nyong-nyong	Zanzare	Primati	Africa	Febbre con esantema e artralgie

Modificato da La Placa 2006

Cycles

FORESTAL

RURAL

URBAN

ANIMAL / MOSQUITO / MAN

MAN / MOSQUITO / MAN

(DEN YF CHIK)

The agent of mosquito-transmitted disease could circulate in a sylvatic cycle (or enzootic cycle) between the mosquito and wild reservoir hosts, which often act as amplification hosts, and rarely affect humans by the occasional spillover that occurs under certain conditions.

Human can be infected tangentially by "bridge" mosquitoes that occasionally bite humans but usually feed on other animals, such as birds in the case of WNV, SINV. Some arbovirus cycles involve domestic animals as amplifying hosts, exposing humans to the risk of infection (e.g., Venezuelan equine encephalitis, Japanese encephalitis and Rift Valley Fever).

The agent for which humans represent a potential amplification host could also trigger an epidemic cycle. These agents have high pathogenic potential and can be exported from one country to another via a sick person. Some of these are particularly dangerous because they can develop urban cycles upon reaching a densely populated area occupied by a competent vector that is adapted to feeding on humans.

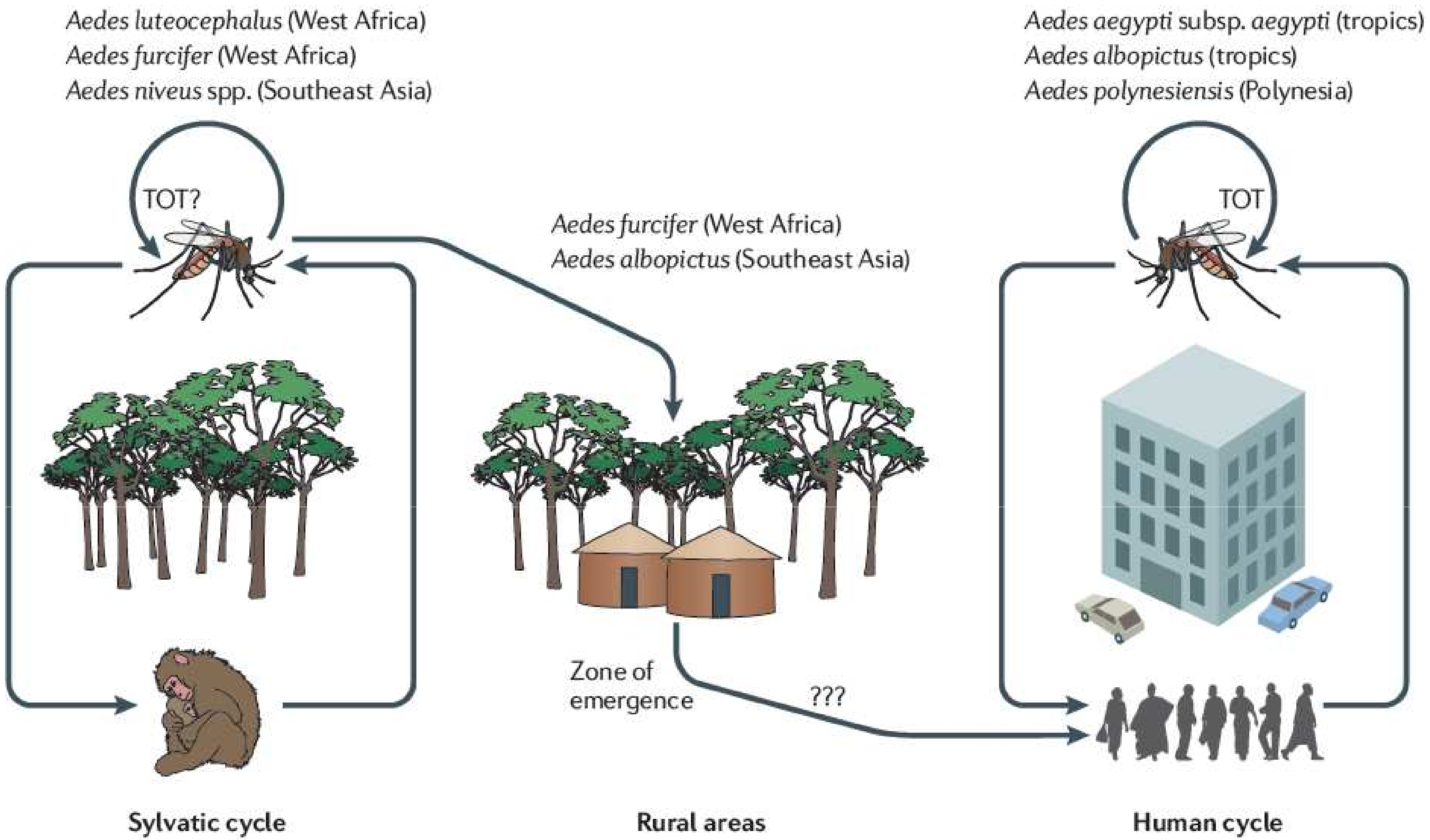


Figure 1 | **The transmission cycles of dengue virus.** The sylvatic origins of dengue virus, and the 'zone of emergence', where sylvatic cycles contact human populations in rural areas of West Africa and Southeast Asia. In addition, dengue virus can persist in mosquito populations by transovarial transmission (TOT), in which virus-infected mosquitoes transfer the virus to their eggs (this has been shown to occur in some species but not in all).

From Vasilakis et al 2011

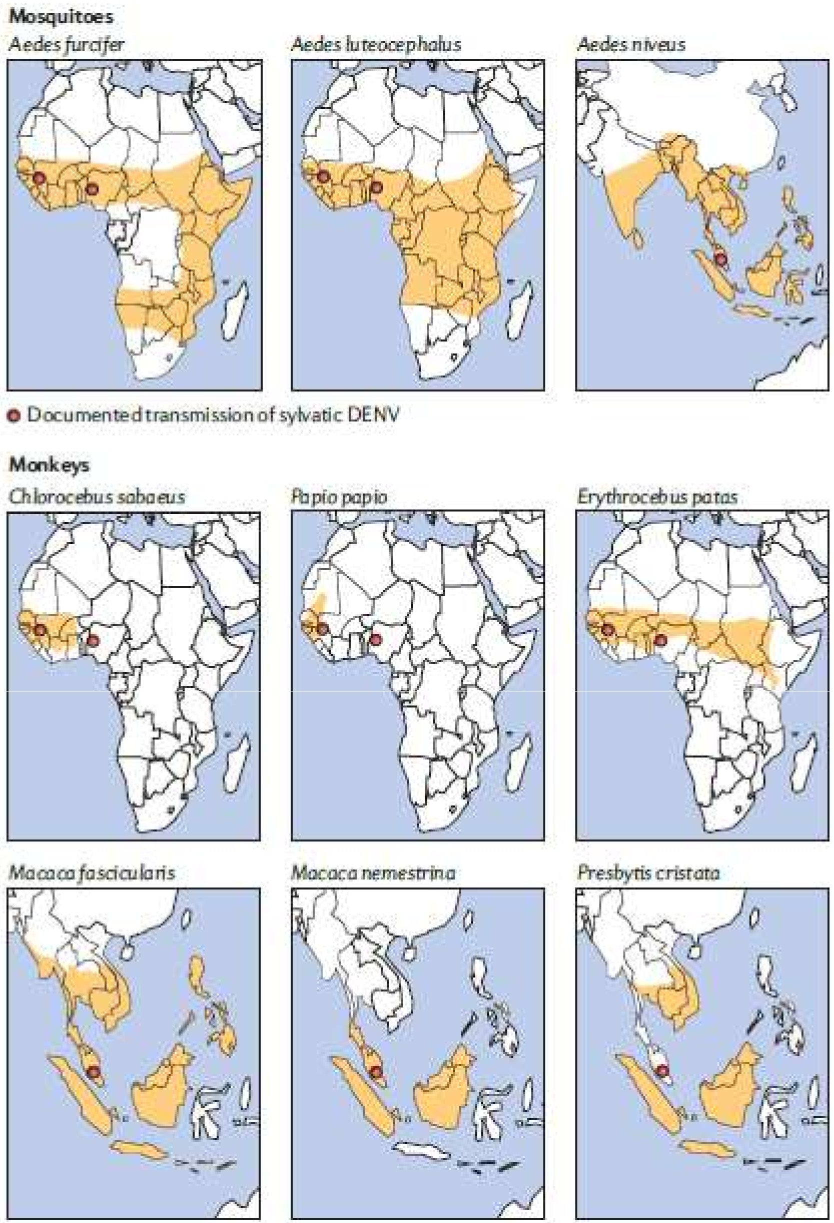
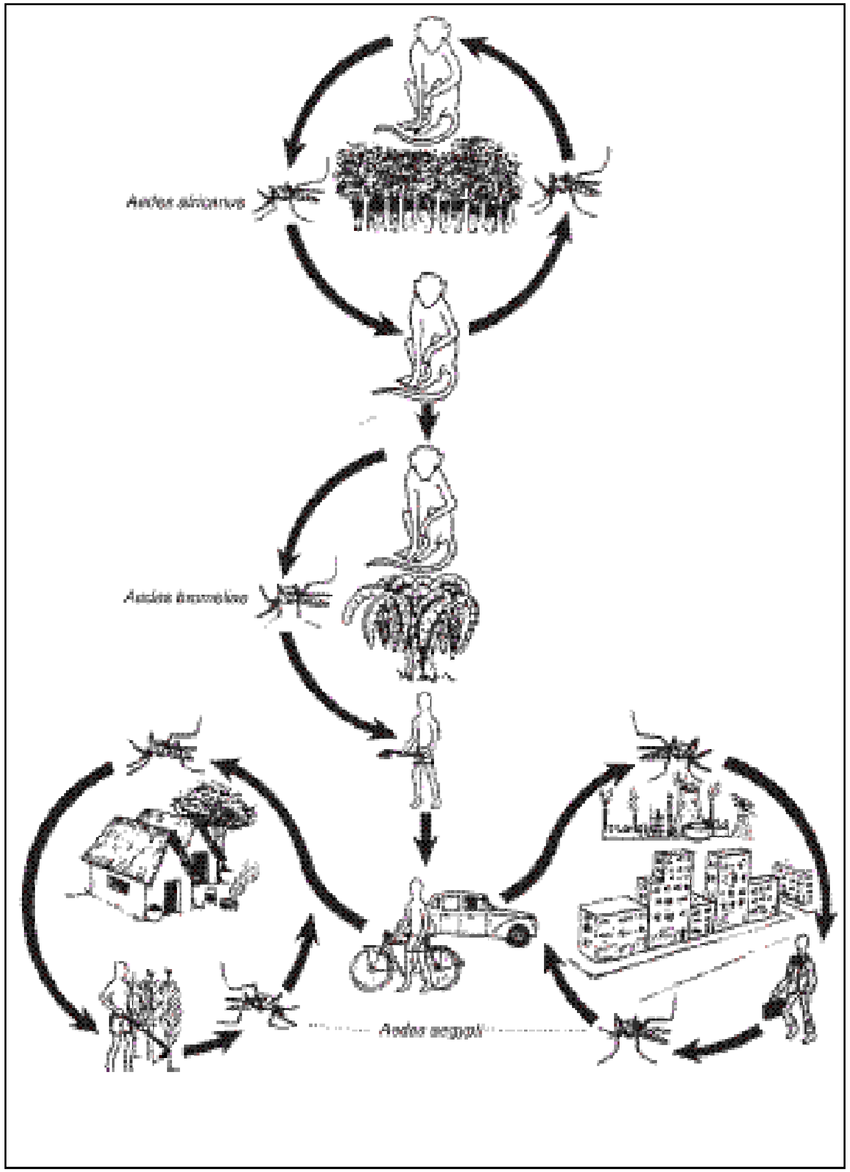


Figure 2 | **The geography of sylvatic dengue virus.** The geographic range of known and putative mosquito vectors and non-human primate hosts for the transmission cycles of sylvatic dengue virus in Africa and Southeast Asia. Although the range of the guinea baboon (*Papio papio*) is limited to West Africa, closely related species such as *Papio anubis*, *Papio ursinus* and *Papio cynocephalus* are found across the continent and could also be involved in dengue virus transmission.

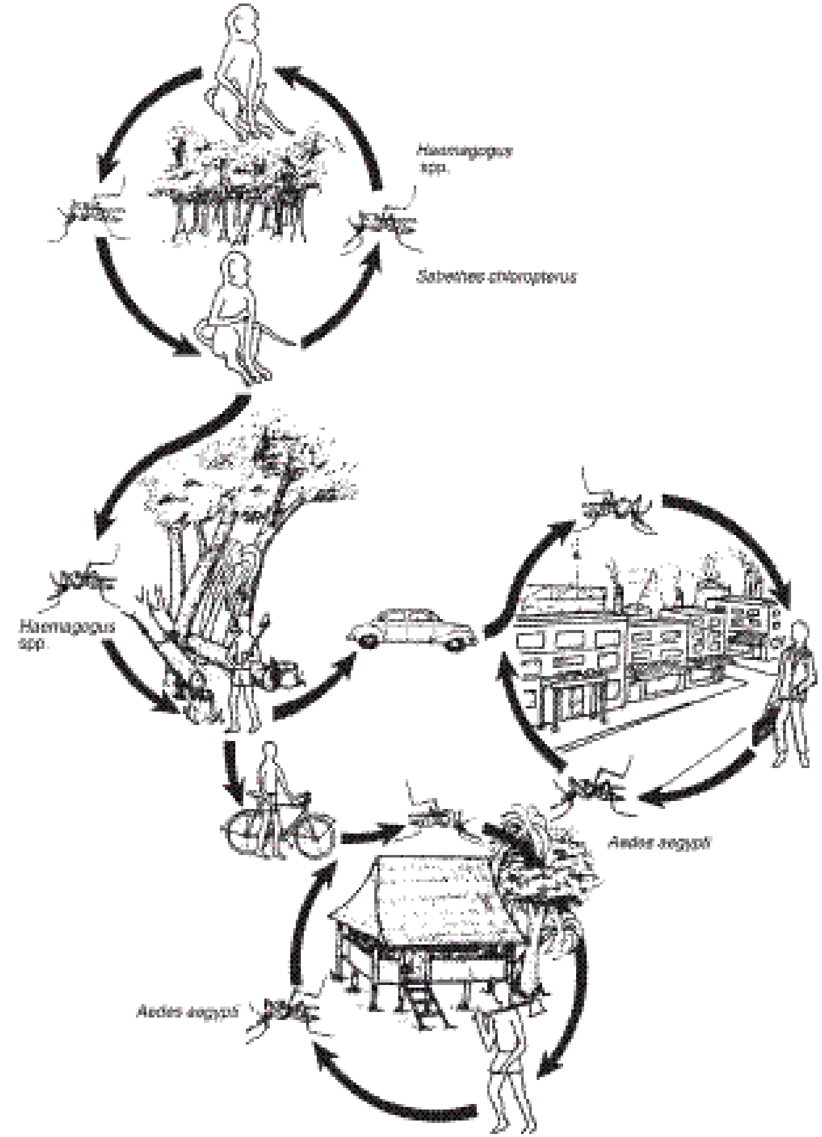
From Vasilakis et al 2011

Jungle, rural and urban transmission cycles of yellow fever

Africa



Central and South America



Urban risk

Arboviruses circulate among wild animals, and cause disease after spillover transmission to humans and/or domestic animals that are incidental or dead-end hosts. Viruses such as dengue (DENV) and chikungunya (CHIKV) that have lost the requirement for enzootic amplification now produce extensive epidemics. Many arboviruses that have evolved and diversified in the tropics have produced virulent and invasive strains that have caused major outbreaks at temperate latitudes.

Scott C. Weavera, , and William K. Reisenb Present and future arboviral threats Antiviral ResearchVolume 85, Issue 2, February 2010, Pages 328-345

Table 1
Characteristics of arboviruses with the risk of urbanization.

Virus	History of temporary urbanization[a]	History of permanent urbanization[a]	Human viremia suitable for vector transmission[b]	Experimental competence of urban vectors[b]	Mutations associated with urban emergence	References
DENV	Yes	Yes	Yes	Yes	No (except Asian strains of DENV-2; see Fig. 5)	Vasilakis and Weaver (2008)
CHIKV	Yes	Yes	Yes	Yes	E1 envelope glycoprotein mutation enhances *Ae. albopictus* infection	Schuffenecker et al. (2006), Tsetsarkin et al. (2007), Vazeille et al. (2007)
YFV	Yes	No	Yes	Yes	No	Monath (2001)
ZIKV	Yes	No	Yes (presumed based on Yap outbreak)	No (but isolation from *Ae. aegypti*)	No	Duffy et al. (2009), Marchette et al. (1969)
VEEV	No	No	Yes	Yes	No (although E2 envelope glycoprotein mutations enhance infection of epidemic vectors and equine amplification hosts)	Anishchenko et al. (2006), Brault et al. (2002a, 2004), Weaver et al. (2004)
MAYV	No	No	Unknown	Yes	No	Tesh et al. (1999), Aguilar and Weaver (unpublished)

[a] Urban transmission exceeding 5 years is considered permanent.
[b] *Aedes aegypti* and/or *Ae. albopictus*.

Da Weaver and Reisen 2010

CALIFORNIA VIRUSES SEROGROUP

TAHYNA, INKOO , SNOWSHOE HARE

LACROSSE, SAN ANGELO, JAMESTOWN CANYON

Tahyna

Aedes vexans, Ochlerotatus caspius, Culex spp

Lagomorphs, rodents, insectivores (hedgehogs)

Man, bats

Viremia especially in young lagomorphs (hare), hedgehogs, rodents, carnivores, pigs

Flu-like symptoms "Valtice fever" (fever, malaise, conjunctivitis, pharyngitis, nausea, anorexia, meningitis, non-lethal)

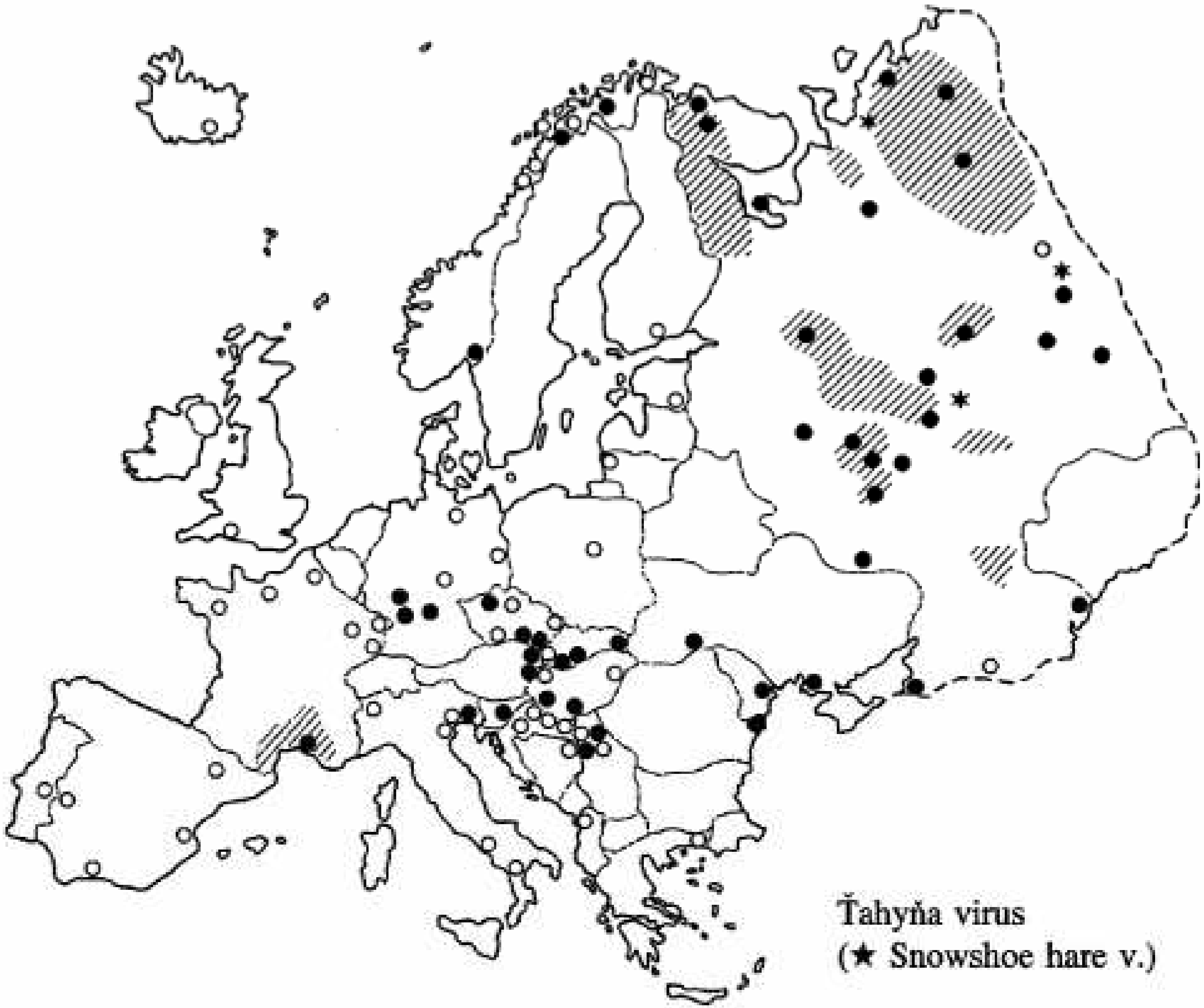


Fig. 3 Geographic distribution of moboviruses in Europe. Explanation: *black points*, the virus isolation; *white circles and hachures*, specific antibodies detected

Hubalek

2006

Fig. 4 Geographic distribution of moboviruses in Europe. Explanation: *black points*, the virus isolation; *white circles and hachures*, specific antibodies detected

Hubalek

2006

CHITTOOR

BUNYAMWERA GROUP

ILESHA – CHACHE VALLEY

Anopheles maculipennis Aedes vexans et al.;

pigs, man, birds

avian persistent infection

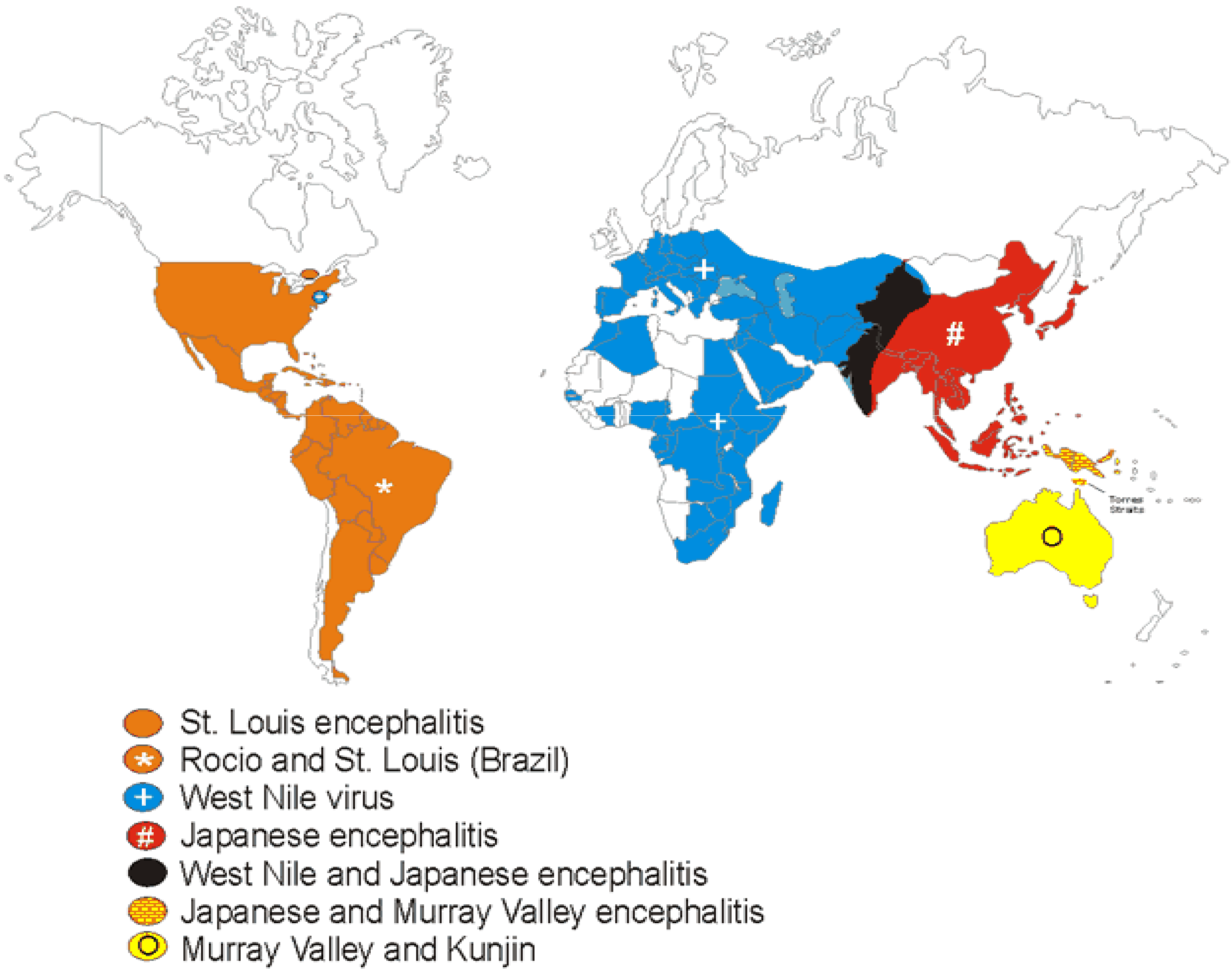
ABs in ruminants, horses, rodents, etc., humans are reported flu-like symptoms

Fig. 5 Geographic distribution of moboviruses in Europe. Explanation: *black points*, the virus isolation; *white circles and hachures*, specific antibodies detected

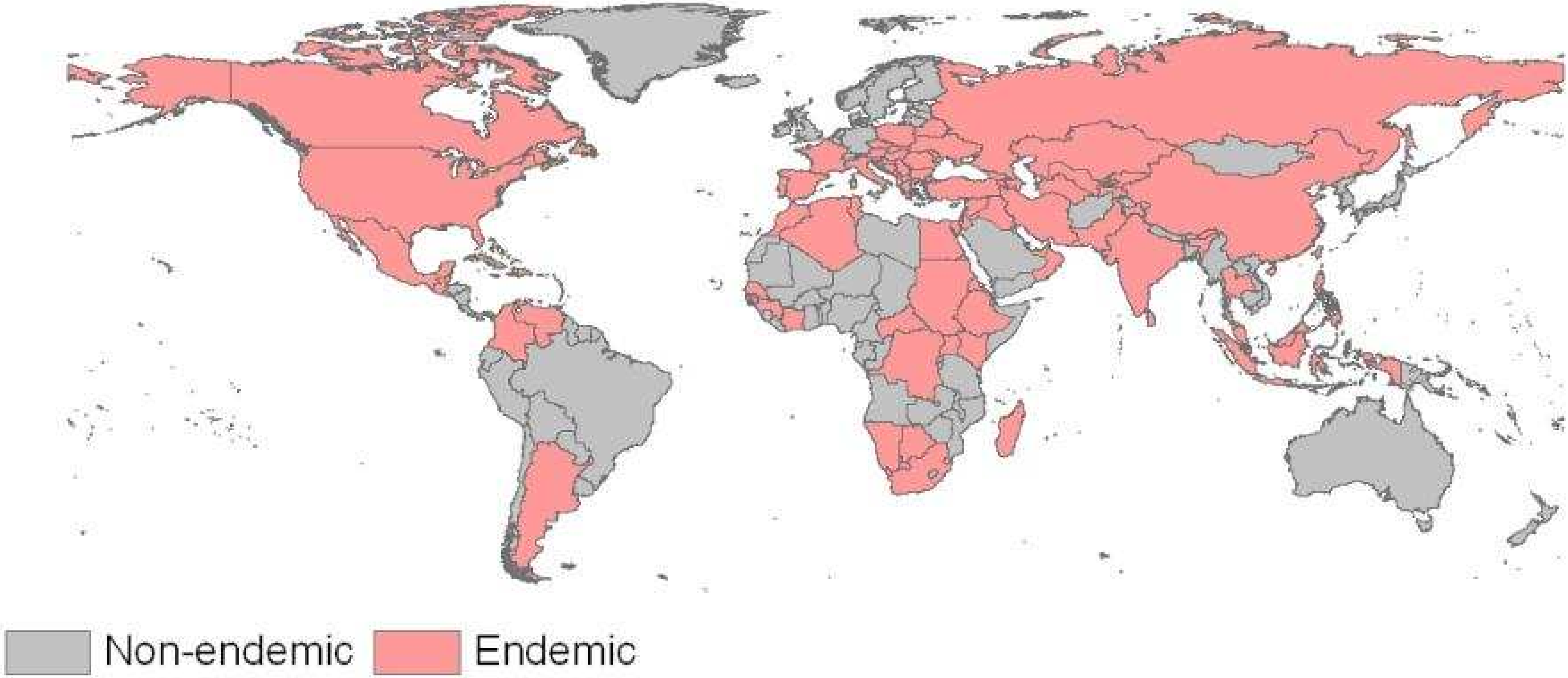
Hubalek

2006

The Geographic Distribution of the Japanese Encephalitis Serocomplex of the Family Flaviridae, 2000.

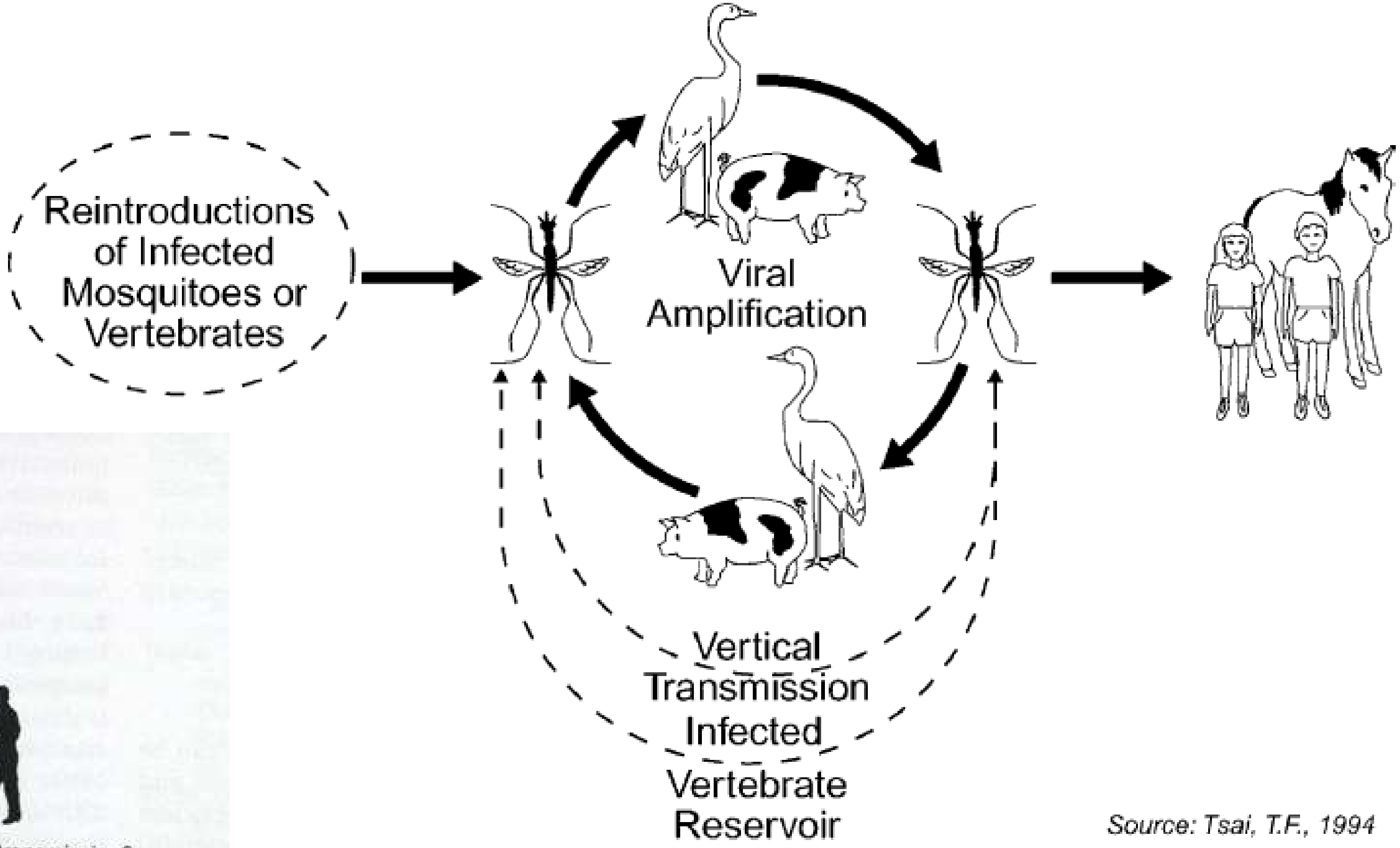


West Nile fever

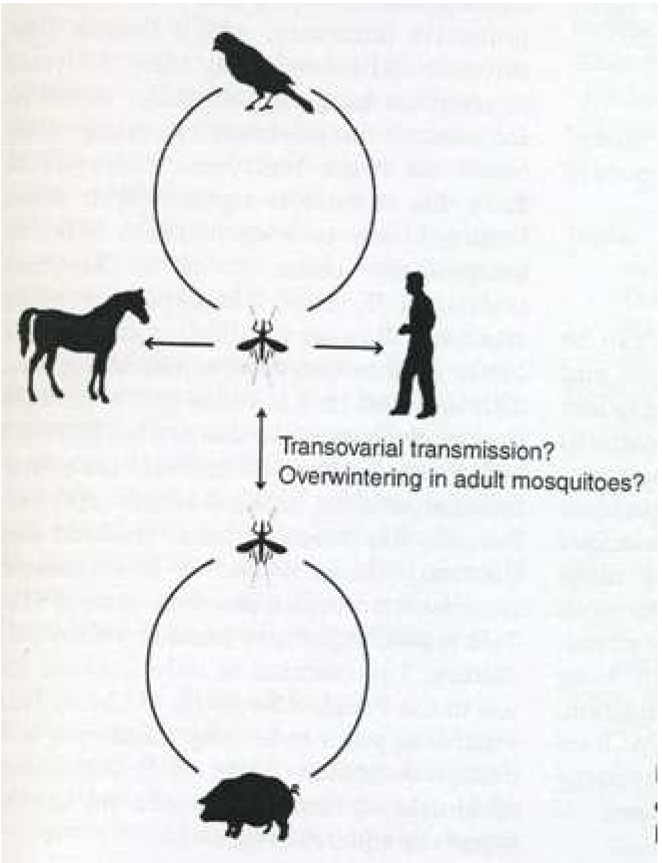


Citation: GIDEON (1994-2011) http://web.gideononline.com/web/epidemiology/. Los Angeles: GIDEON Informatics, Inc.

JE

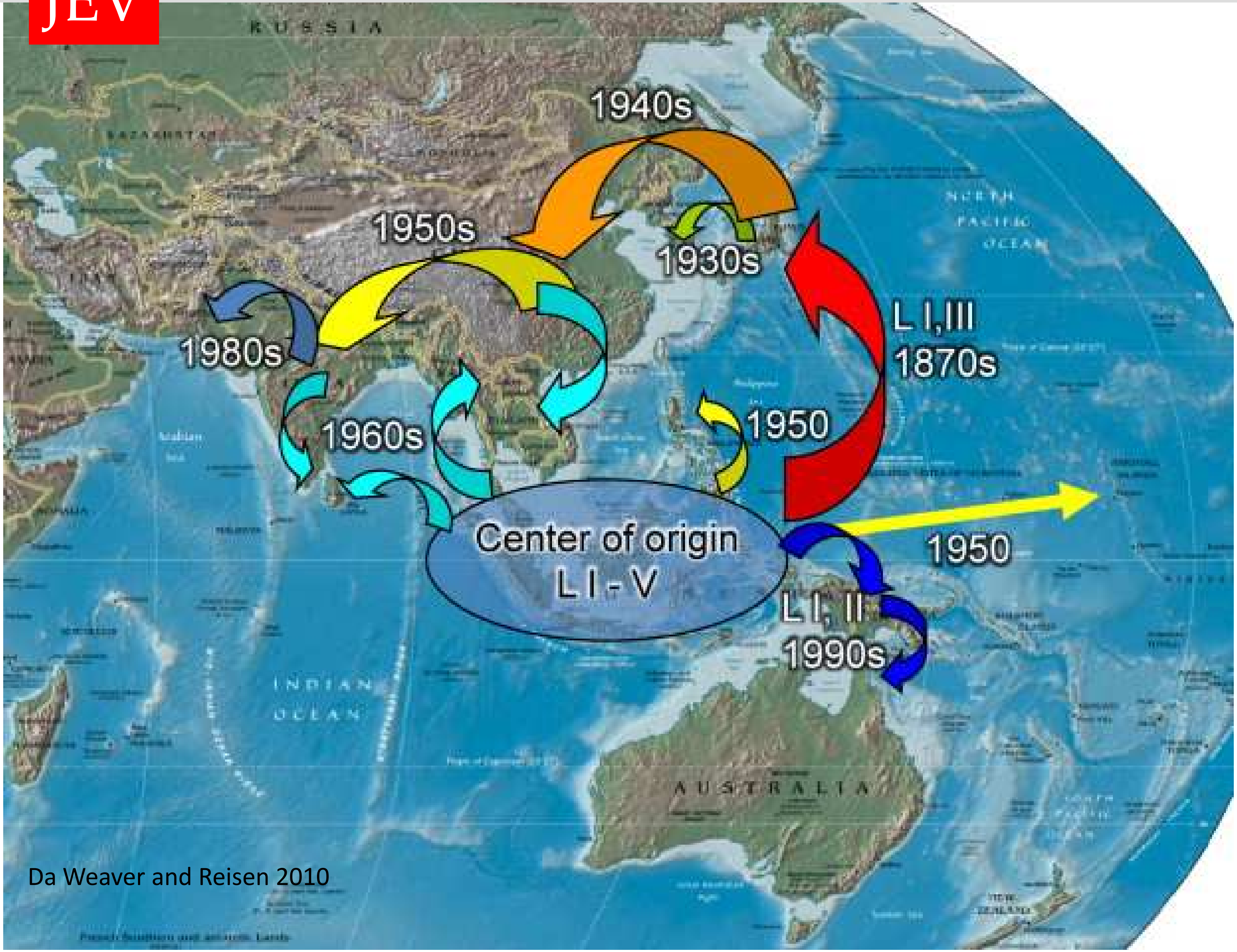


Source: Tsai, T.F., 1994



A. D. T. Barret

JEV



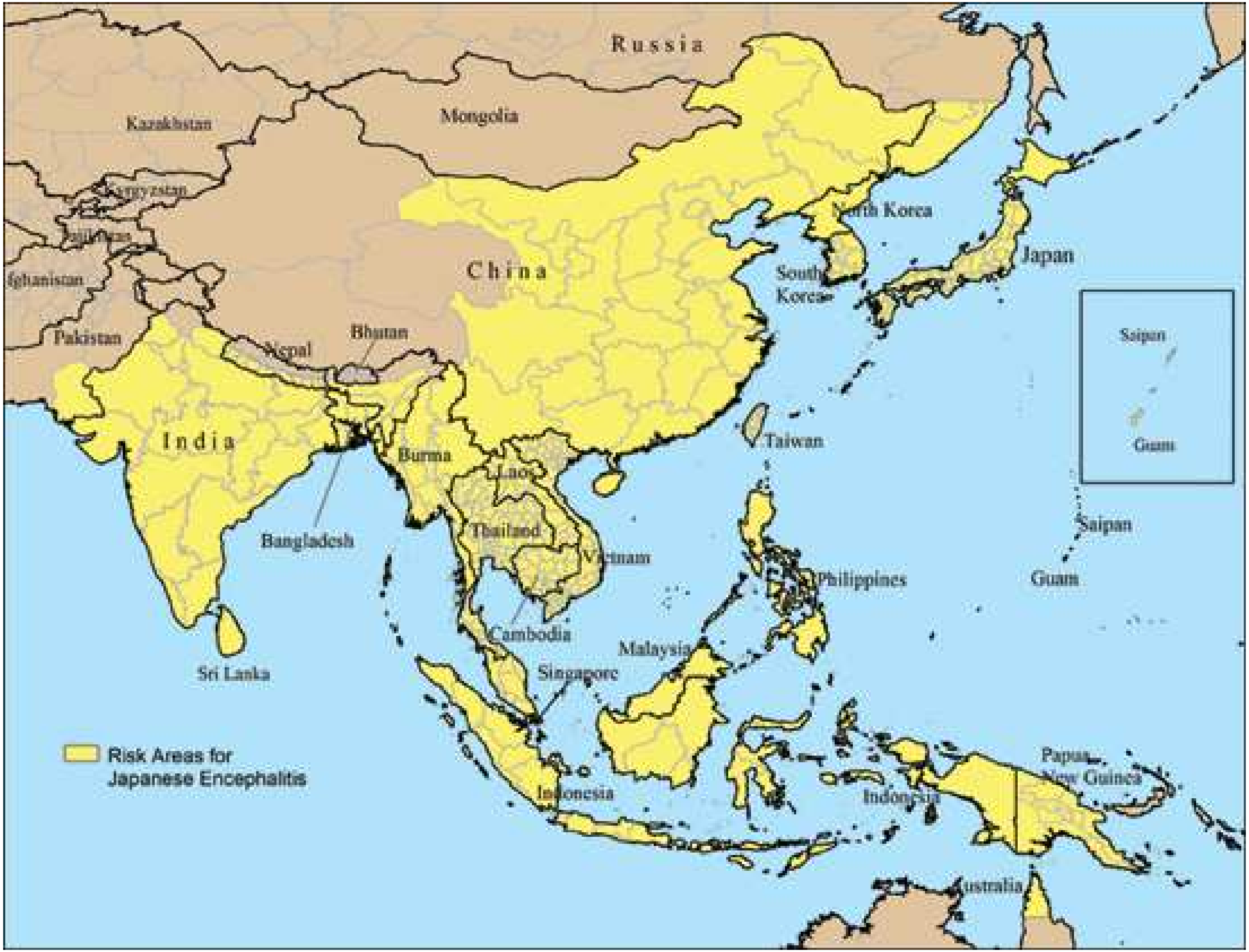
Da Weaver and Reisen 2010

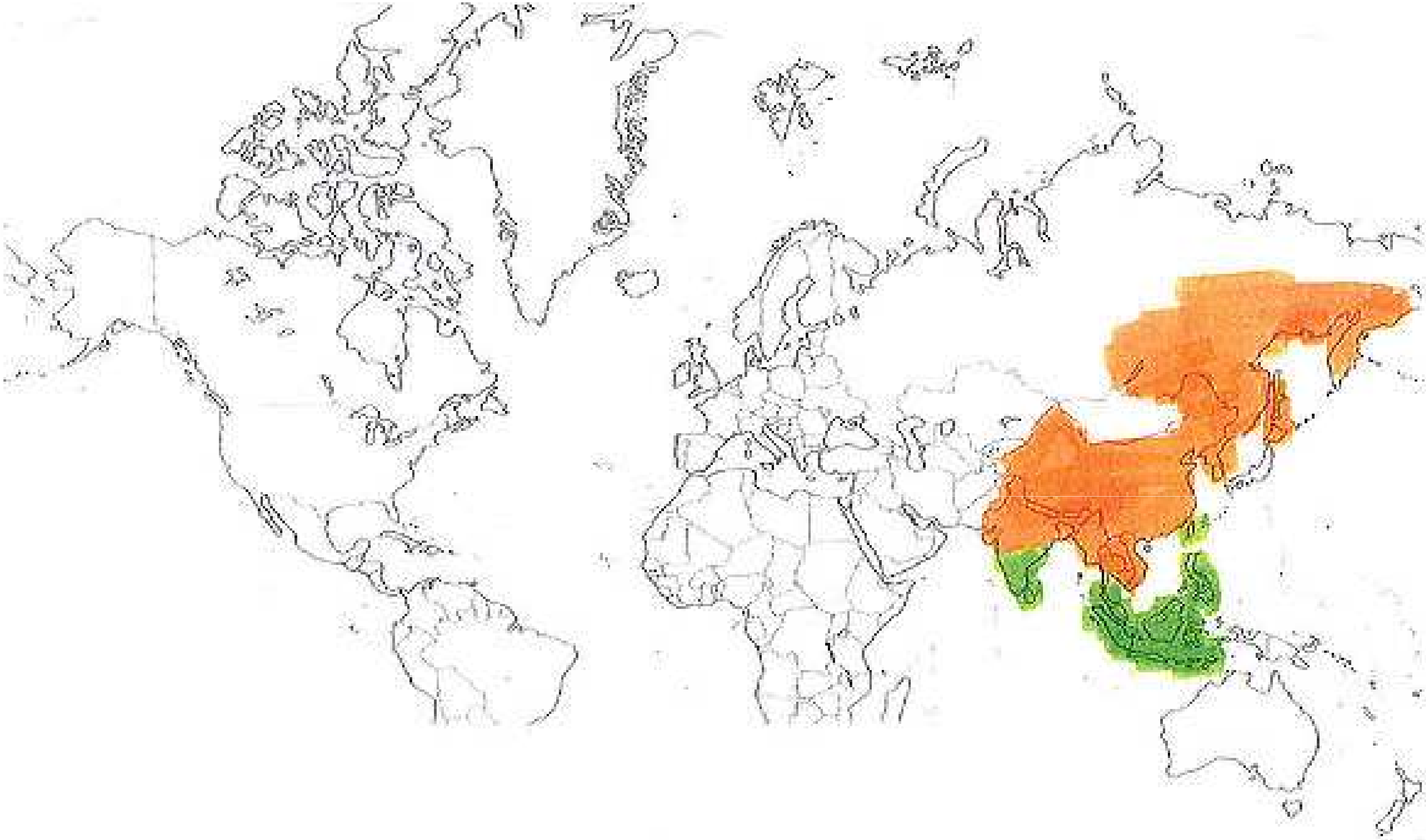
Japanese encephalitis, countries or areas at risk, 2008

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

World Health Organization


Russia
Kazakhstan
Mongolia
Kyrgyzstan
fghanistan
China
North Korea
South Korea
Japan
Pakistan
Nepal
Bhutan
Saipan
Guam
India
Burma
Laos
Taiwan
Bangladesh
Thailand
Vietnam
Saipan
Philippines
Guam
Cambodia
Malaysia
Sri Lanka
Singapore
Risk Areas for Japanese Encephalitis
Papua New Guinea
Indonesia
Indonesia
Australia

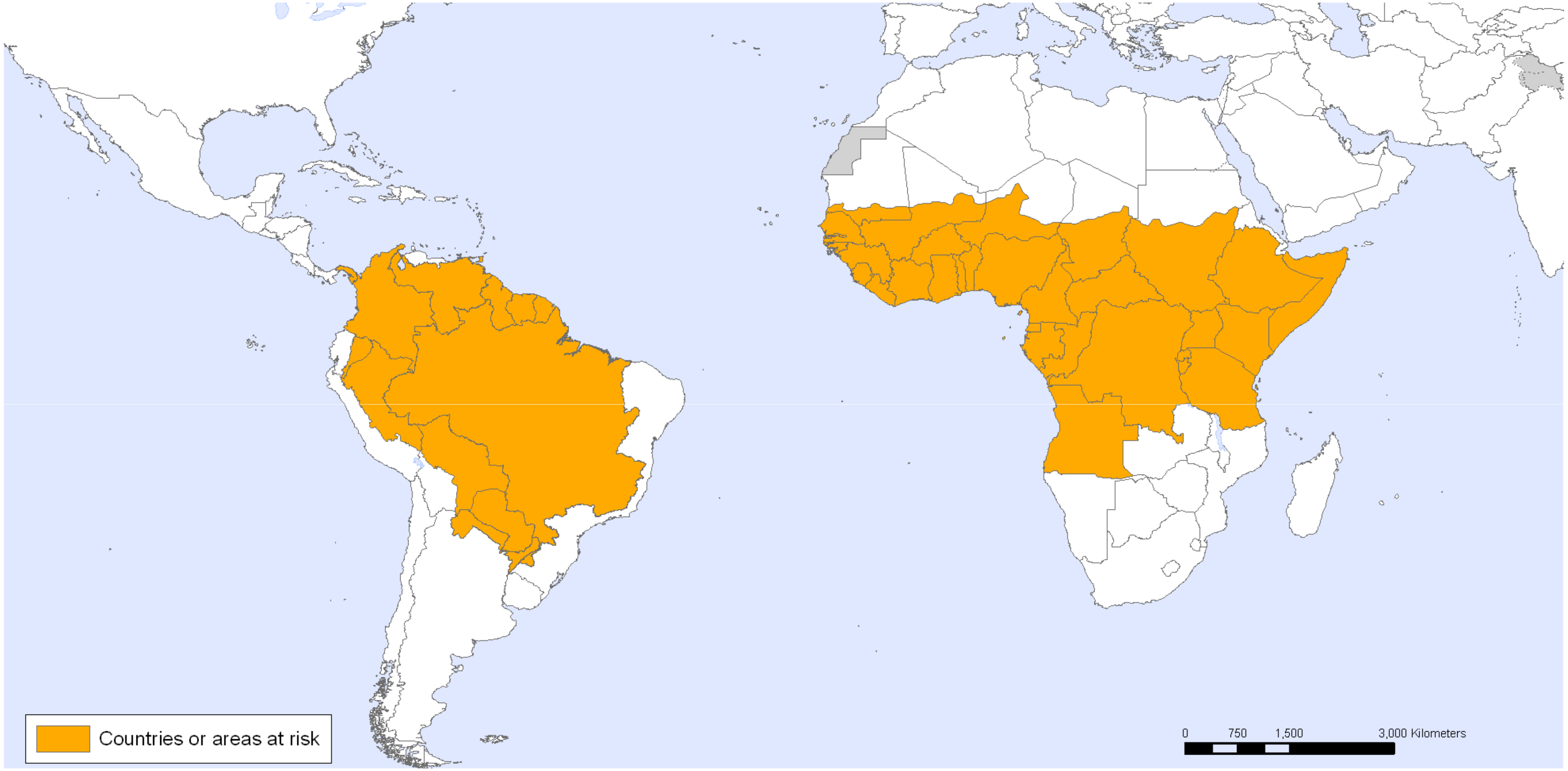


orange: temperate, mostly June thru September
green: tropical, endemic year-round, esp. rainy season

J. Japanese encephalitis

risk is highest in rural, agricultural areas with wet fields and swine

Yellow Fever, countries or areas at risk, 2008



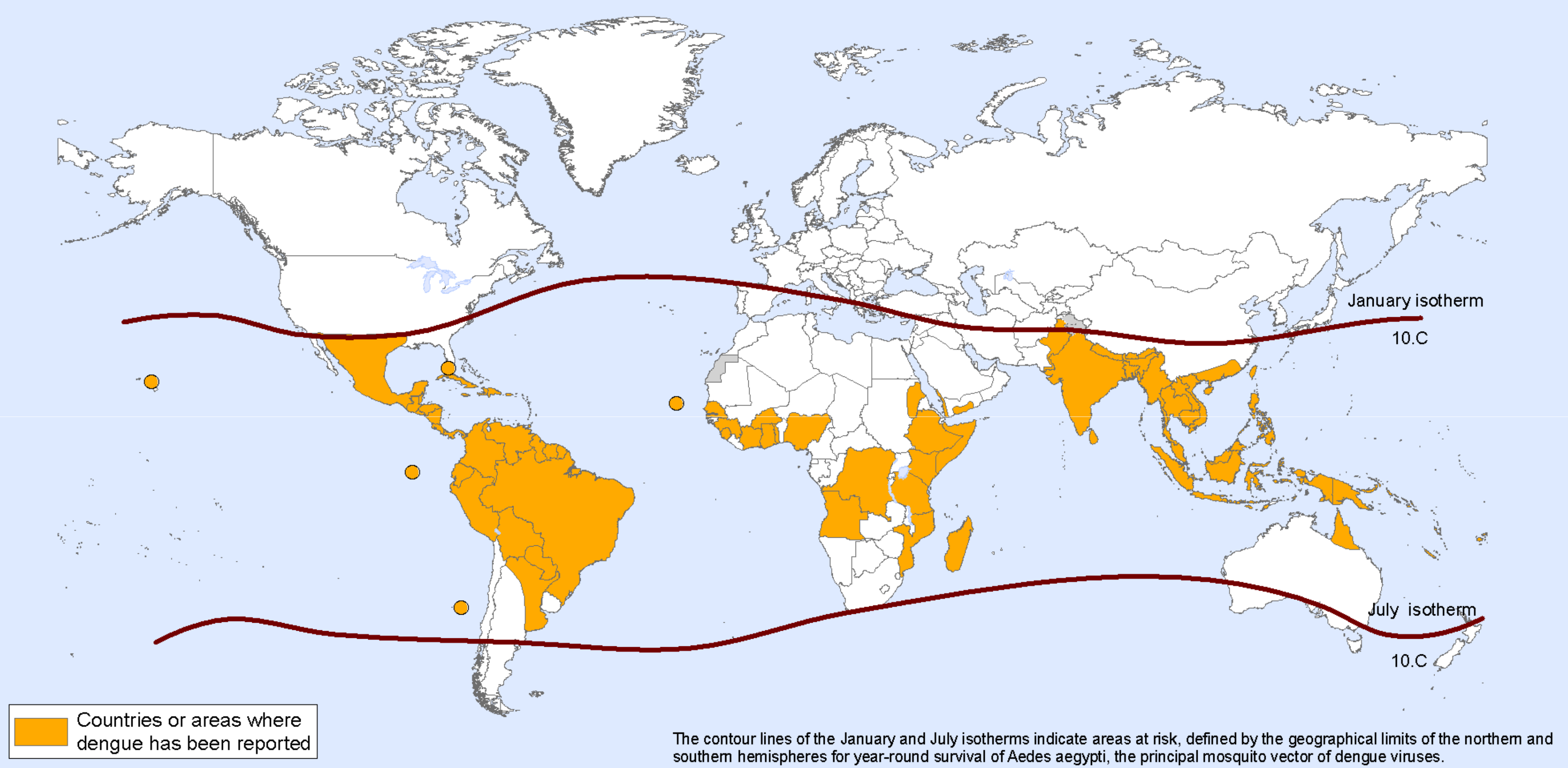
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization/CDC
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

World Health Organization

Febbre gialla 2008

Dengue, countries or areas at risk, 2009



The contour lines of the January and July isotherms indicate areas at risk, defined by the geographical limits of the northern and southern hemispheres for year-round survival of Aedes aegypti, the principal mosquito vector of dengue viruses.

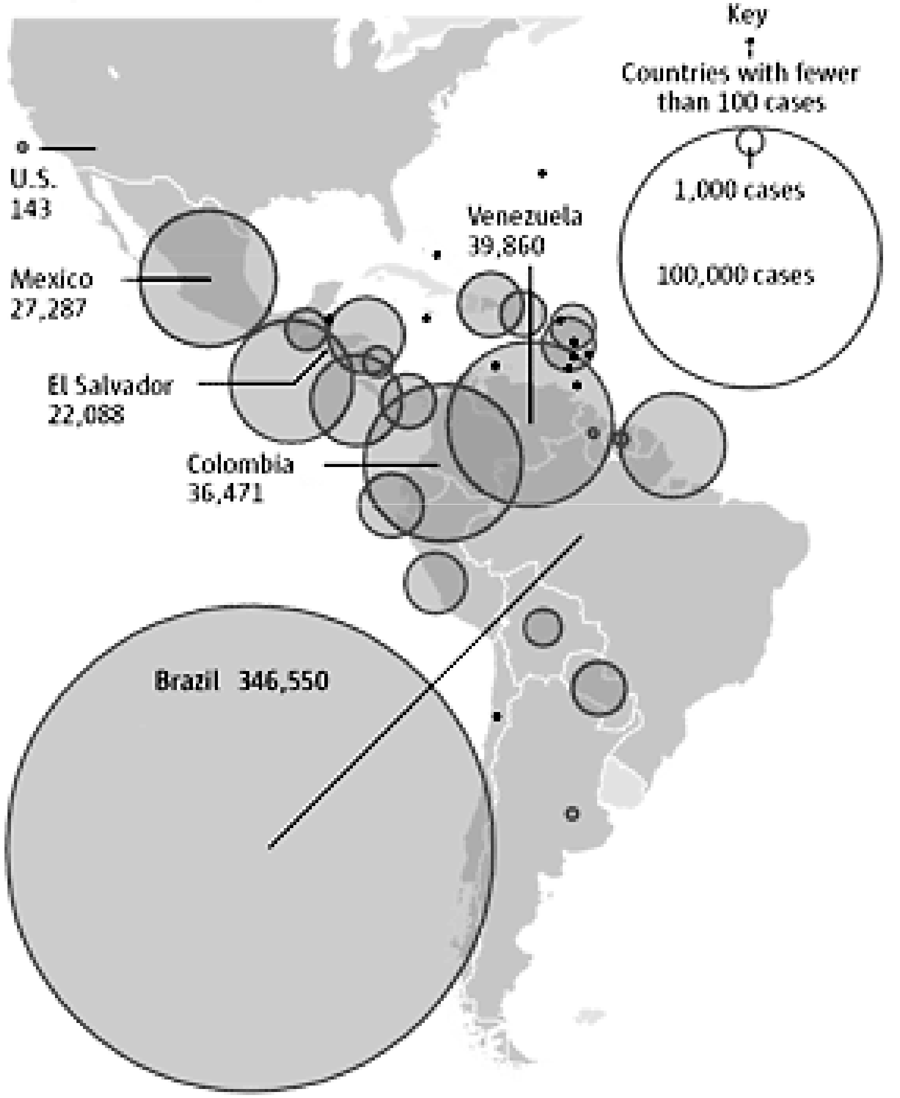
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

World Health Organization

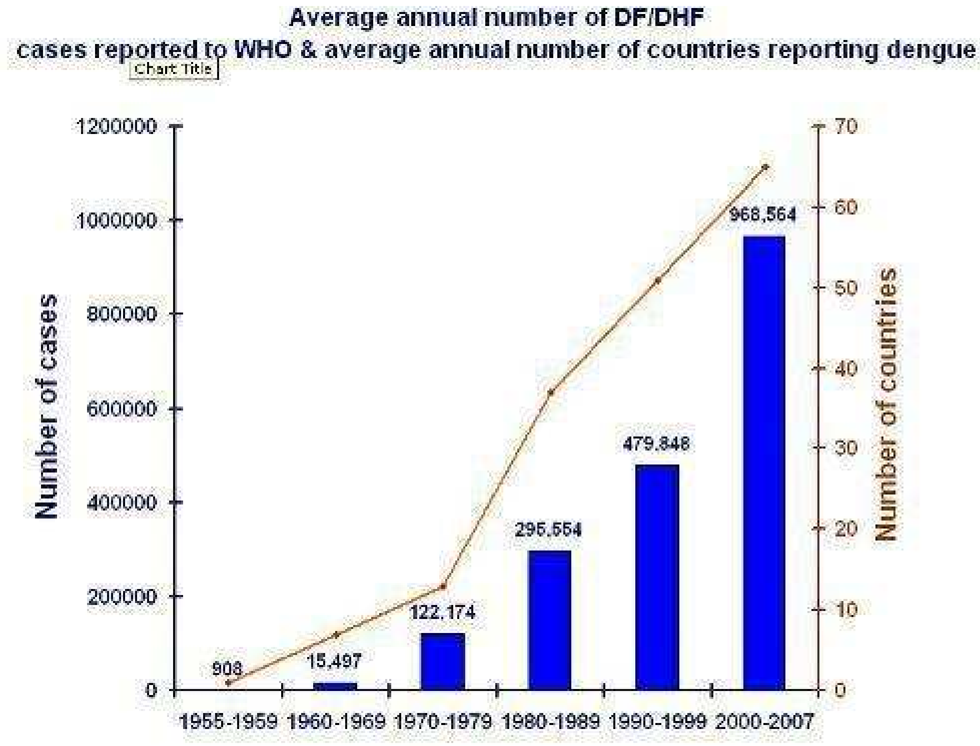
Outbreaks

In the Americas, cases of dengue fever have mostly appeared in South and Central America. Reported cases of dengue fever and dengue hemorrhagic fever in 2006:



Source: World Health Organization

LOS ANGELES TIMES



Europe experienced hemorrhagic fever outbreaks due mosquito-borne viruses in historical time beginning in eighteenth century.
Although the diagnosis of the pathogen causing histori outbreaks is difficult, at least 20 epidemics, recorded in Europe in the nineteenth century, were attributable to yellow fever, in the 1800, epidemics occurred in Cadiz, Seville, Gibraltar, with an estimated number of 51,000 victims.
Furthermore, epidemics ascribable to dengue were recorded in Europe from the second half of the eighteenth century until 1927-1928 in Greece, with an outbreak that caused more than 1000 deaths.

DENGUE FEVER

Serious Spread in Greece

ATHENS, Tuesday.

Eighty per cent. of the population of Athens and Piraeus is stricken with dengue fever, and the epidemic is now spreading to the provinces.

The Canberra Times
Thursday 30 August 1928, page 1

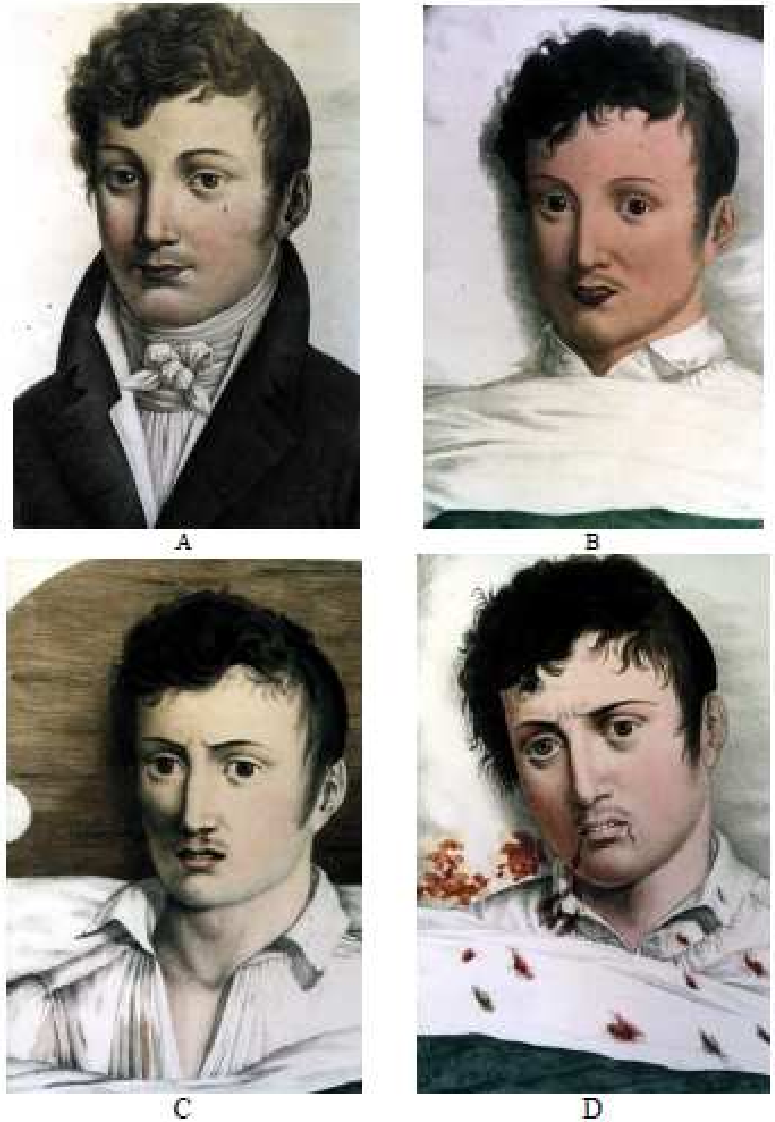
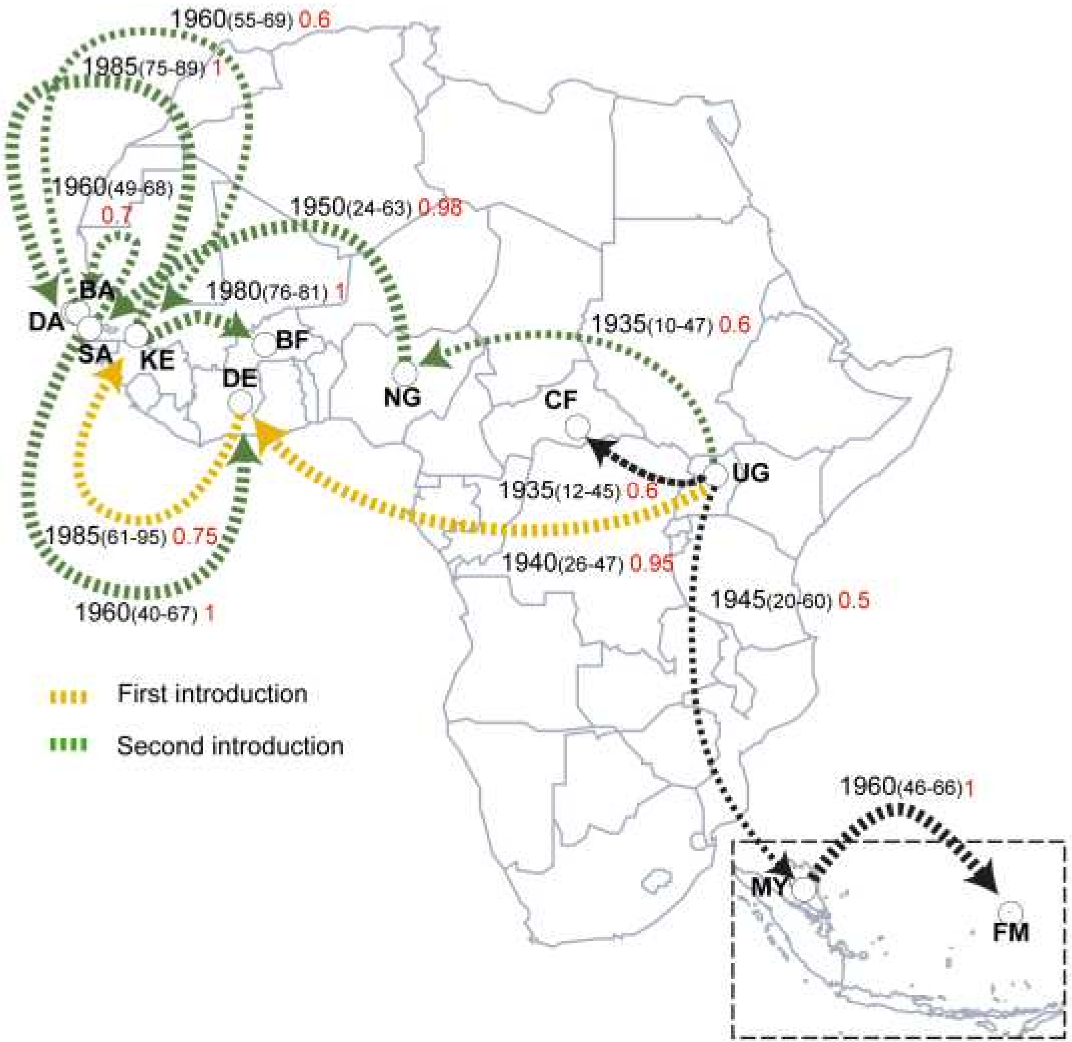


Figure 2: "death of a young noble man". These portraits represent the dramatic evolution of the face during the different steps of yellow fever during the Cadiz outbreak in 1820 (from Parizet, 1820).
A: Beginning of the fever; B: Erythematous period; C: Icteric period; D: Haemorrhagic and terminal period

MORILLON et al 2002

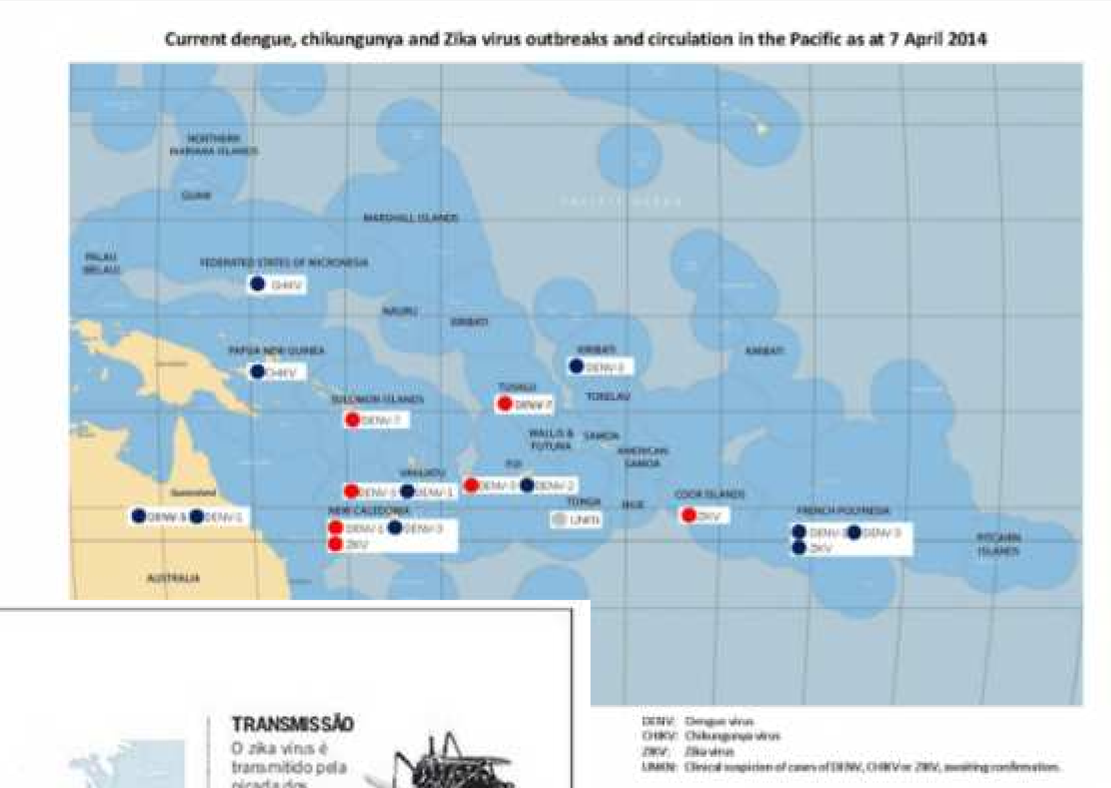
Zika virus

Zika fever is a mosquito-borne viral disease caused by Zika virus, consisting of mild fever, rash (mostly maculo-papular), headaches, arthralgia, myalgia, asthenia, and non-purulent conjunctivitis, occurring about three to twelve days after the mosquito vector bite. One out of four people may not develop symptoms, but in those who are affected the disease is usually mild with symptoms that can last between two and seven days. Its clinical manifestation is often similar to dengue, also a mosquito-borne illness (WHO site).

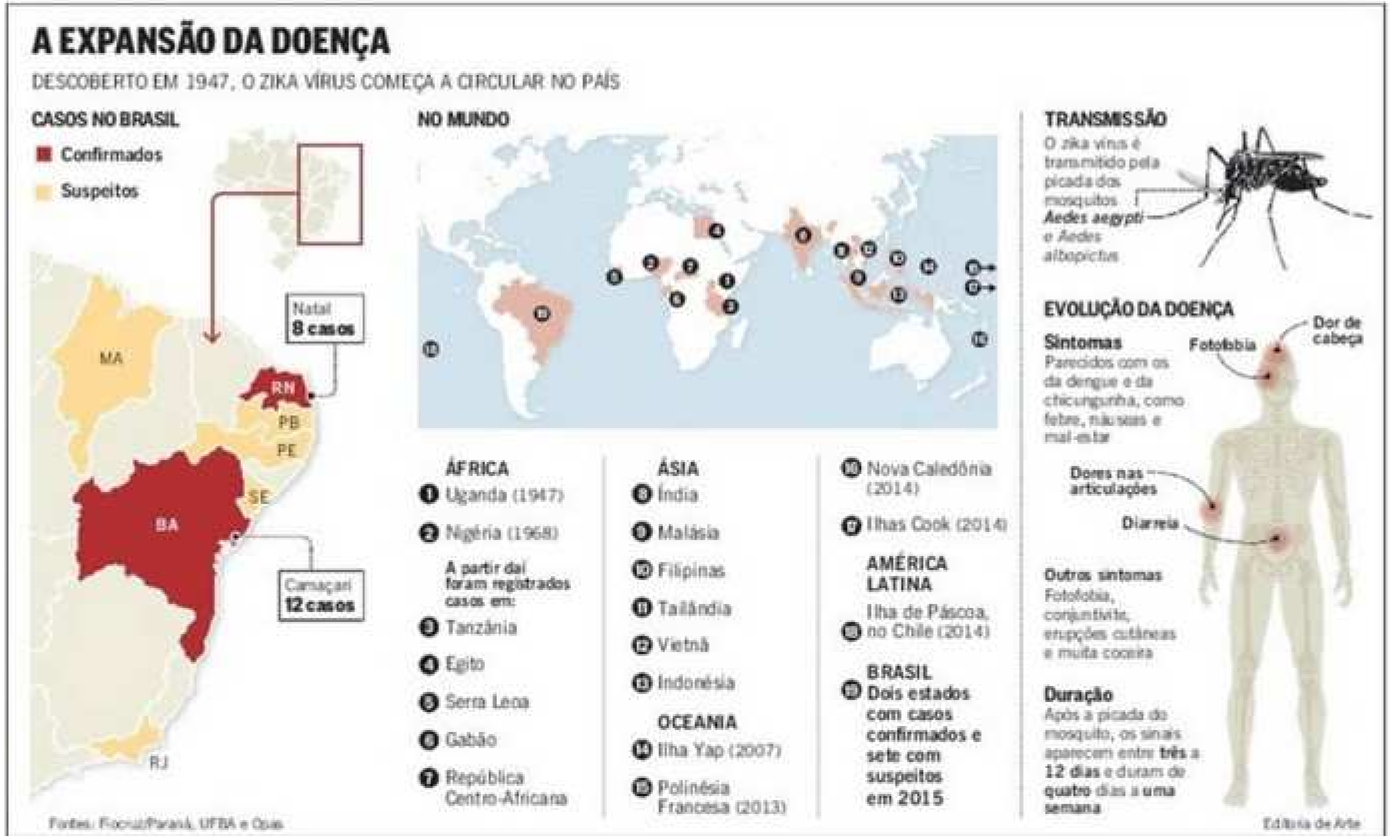


from Faye et al. 2014

Zika virus



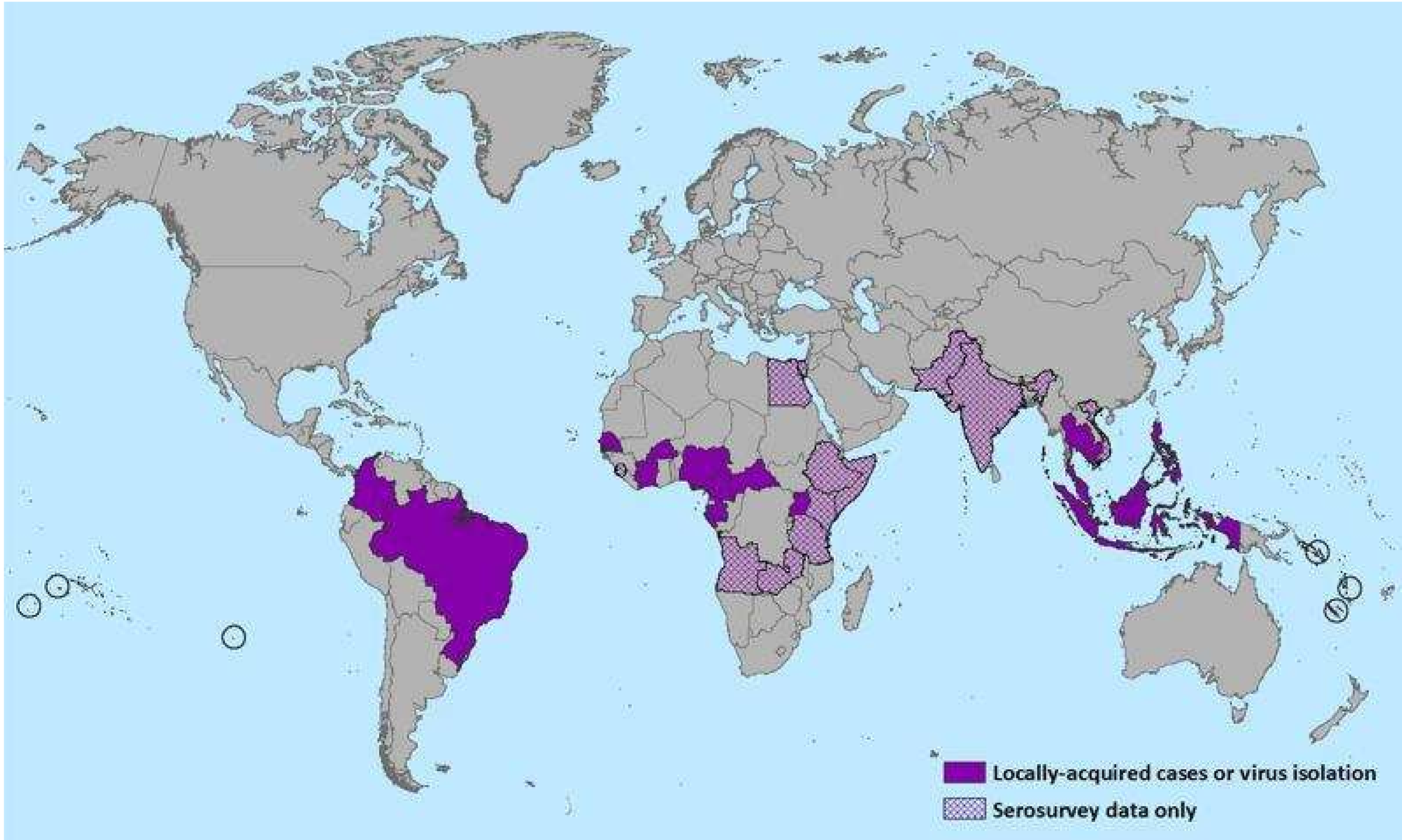
Current dengue, chikungunya and Zika virus outbreaks and circulation in the Pacific as at 7 April 2014
DENV: Dengue virus
CHIKV: Chikungunya virus
ZIKV: Zika virus
UNKN: Clinical suspicion of cases of DENV, CHIKV or ZIKV, awaiting confirmation.



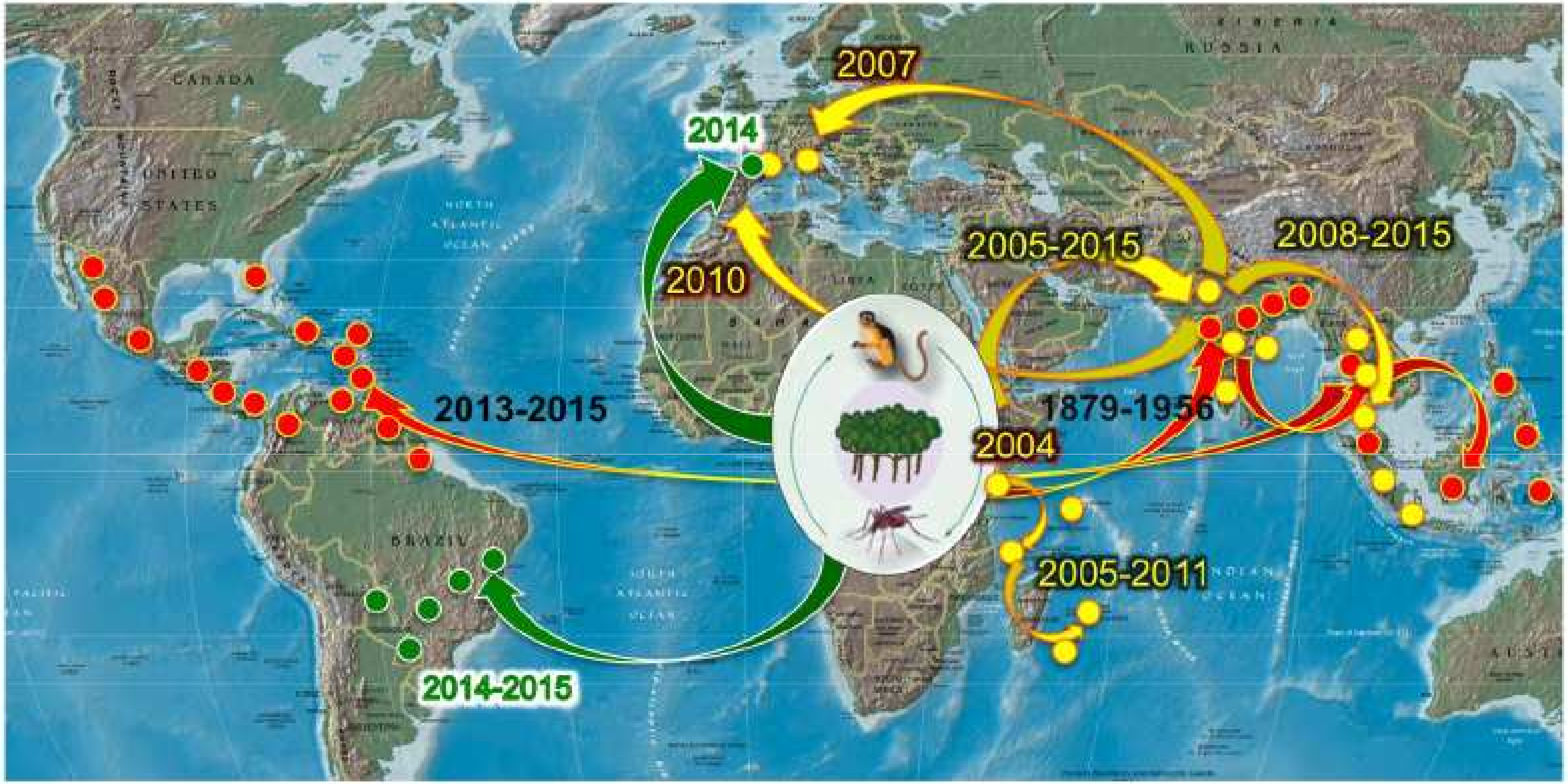
A EXPANSÃO DA DOENÇA
DESCOBERTO EM 1947, O ZIKA VÍRUS COMEÇA A CIRCULAR NO PAÍS
CASOS NO BRASIL
Confirmados
Suspeitos
MA
RN
PB
PE
SE
BA
RJ
Natal
8 casos
Camaçari
12 casos
Fontes: Fiocruz/Paraná, UFBA e Opas
NO MUNDO
ÁFRICA
1 Uganda (1947)
2 Nigéria (1968)
A partir daí foram registrados casos em:
3 Tanzânia
4 Egito
5 Serra Leoa
6 Gabão
7 República Centro-Africana
ÁSIA
8 Índia
9 Malásia
10 Filipinas
11 Tailândia
12 Vietnã
13 Indonésia
OCEANIA
14 Ilha Yap (2007)
15 Polinésia Francesa (2013)
16 Nova Caledônia (2014)
17 Ilhas Cook (2014)
AMÉRICA LATINA
18 Ilha de Páscoa, no Chile (2014)
BRASIL
19 Dois estados com casos confirmados e sete com suspeitos em 2015
TRANSMISSÃO
O zika vírus é transmitido pela picada dos mosquitos Aedes aegypti e Aedes albopictus
EVOLUÇÃO DA DOENÇA
Sintomas
Parecidos com os da dengue e da chicungunha, como febre, náuseas e mal-estar
Fotofobia
Dor de cabeça
Dores nas articulações
Diarreia
Outros sintomas
Fotofobia, conjuntivite, erupções cutâneas e muita coceira
Duração
Após a picada do mosquito, os sinais aparecem entre três a 12 dias e duram de quatro dias a uma semana
Editoria de Arte

Zika virus

Countries that have past or current evidence of Zika virus transmission (as of October 2015) CDC



CHIKV



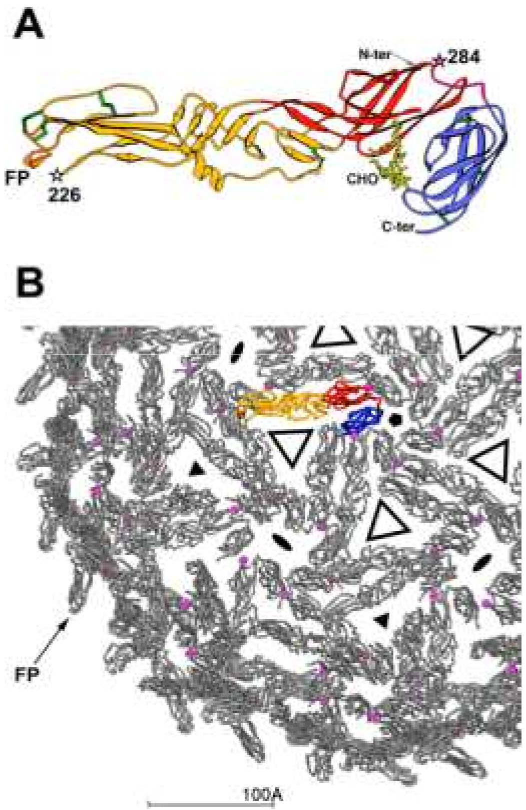
ECSA lineage, Asian lineage, Indian Ocean Lineage

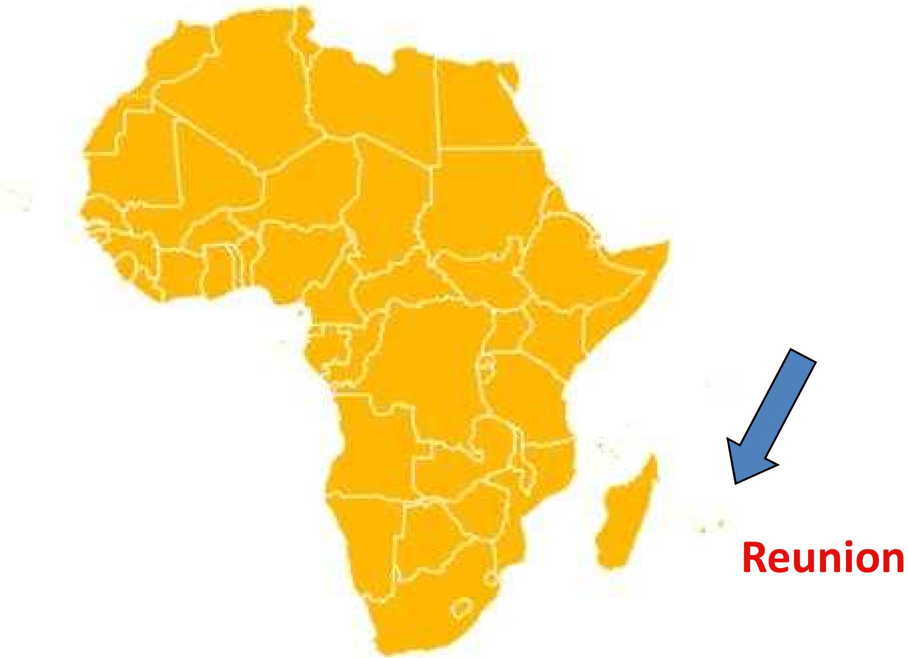
Fig. 3. Map showing the known historic spread of Chikungunya virus based on phylogenetic reconstructions (Lanciotti and Valadere, 2014; Volk et al., 2010; Tsetsarkin et al., 2014, 2011b), as well as recent introductions (http://www.ecdc.europa.eu/en/press/news/_layouts/forms/News_DispForm.aspx?List=8db7286c-fe2d-476c-9133-18f-f4cb1b568&ID=1096) Nunes et al. (2015). Green dots, arrows and years indicate the East/Central/South African (ECSA) lineage, Red dots, arrows and years indicate the Asian lineage, and yellow dots, arrows and years indicate the Indian Ocean lineage (IOL).

from Weaver and Forrester 2015

THE MUTATION

....coming from the Indian Ocean.....

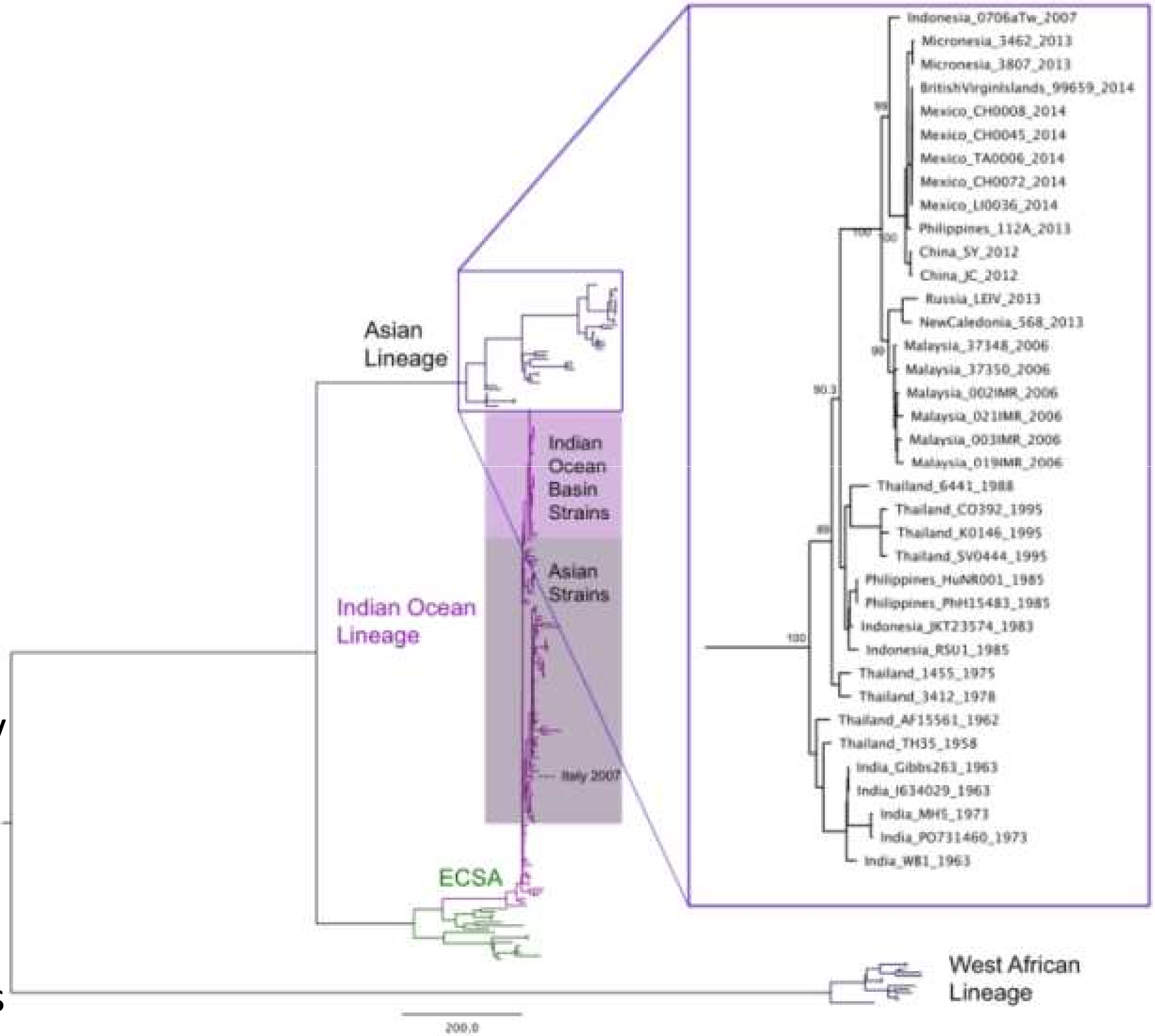




Schuffenecker I, Iteman I, Michault A, Murri S, et al. (2006)
Genome Microevolution of Chikungunya Viruses Causing the Indian Ocean Outbreak.
PLoS Med 3(7): e263. doi:10.1371/journal.pmed.0030263

CHIKV

The capacity of CHIKV to shift from *Ae. aegypti* to *Ae. albopictus* was already reported, and linked with a single amino acid mutation (from Alanine to Valine at position 226 of the envelope glycoprotein) recorded in strains which caused epidemics in Indian Ocean, Asia, and also in strain which caused the Italian outbreak. Other mutations of CHIKV, linked with enhanced capacity to be transmitted from *Ae. albopictus* were also recorded in Asian lineage. A similar phenomenon could be hypothesized for dengue virus (DENV).



Sindbis virus

OCKELBO, KERELIAN FEVER, POGOSTA

CULEX spp.

Many species of birds

Rodents and bats

Encephalitis in pigeons

Fever in humans (3-4 days), headache, muscle pain, polyarthritis, conjunctivitis, pharyngitis, rash.

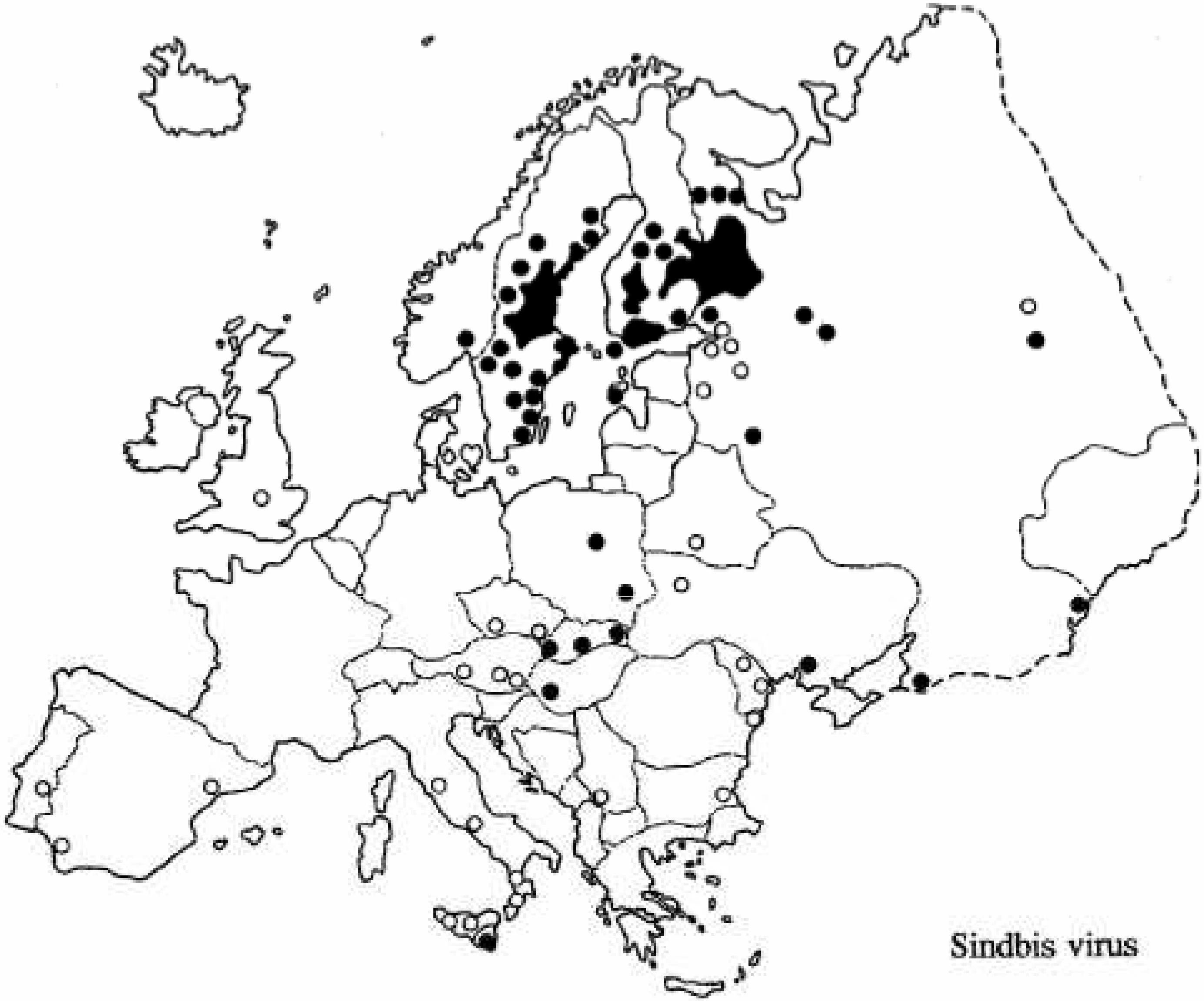


Fig. 1 Geographic distribution of moboviruses in Europe. Explanation: *black points*, the virus isolation; *white circles and hachures*, specific antibodies detected

Hubalek

2006

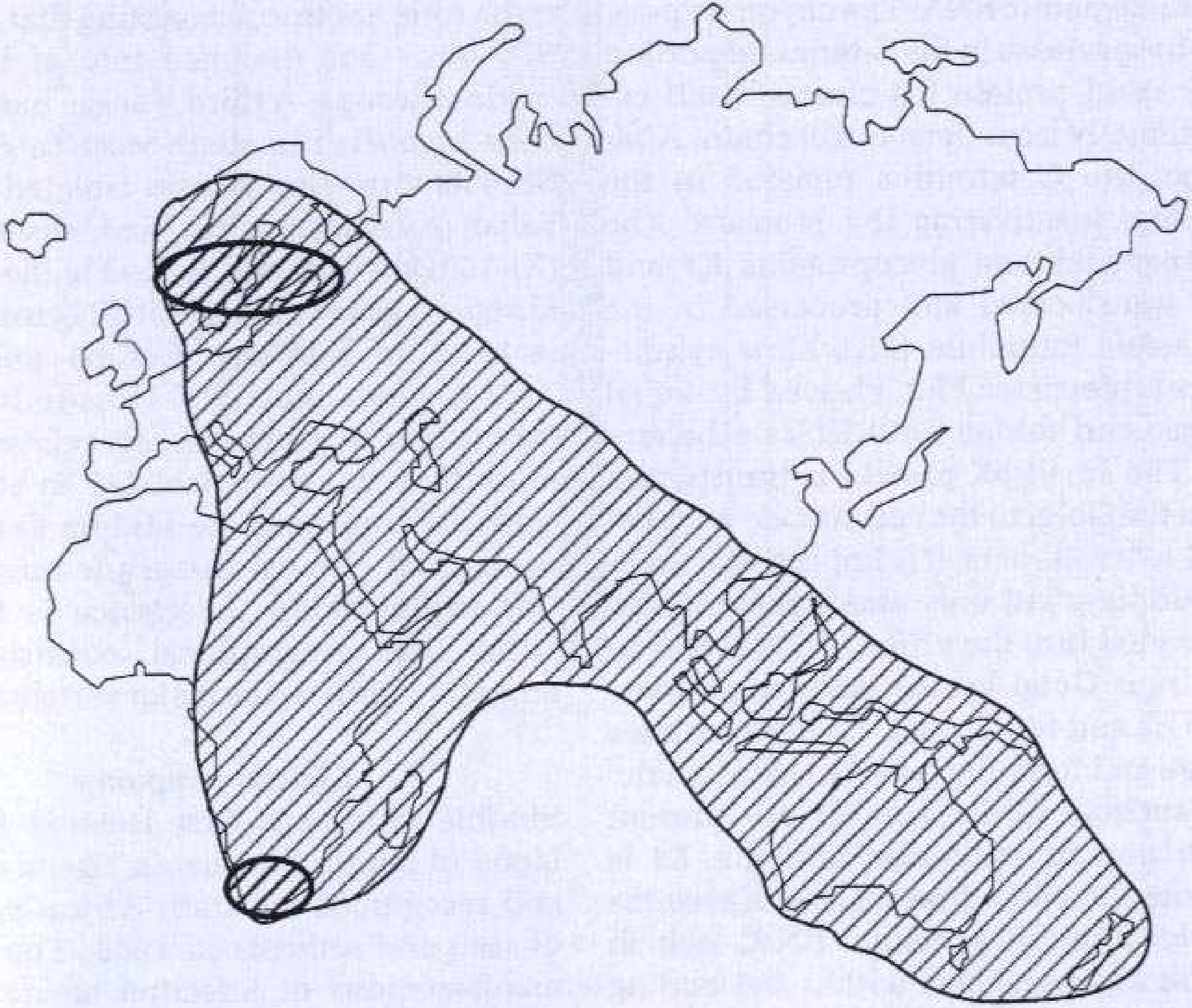


Fig. 1. Distribution of Sindbis virus. Darker encircled areas are regions where clinical disease occurs most often.

Arthriogenic alphaviruses

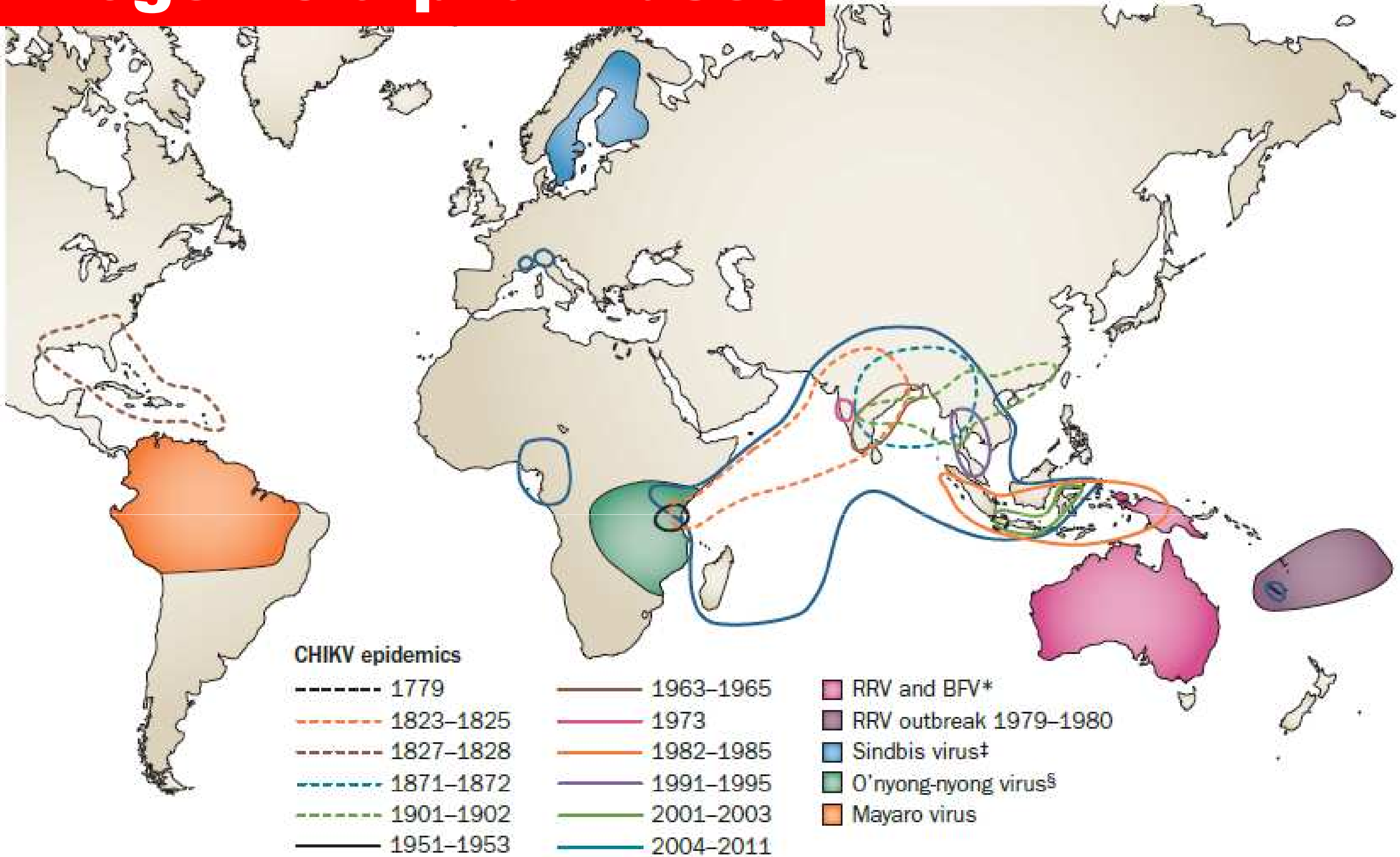
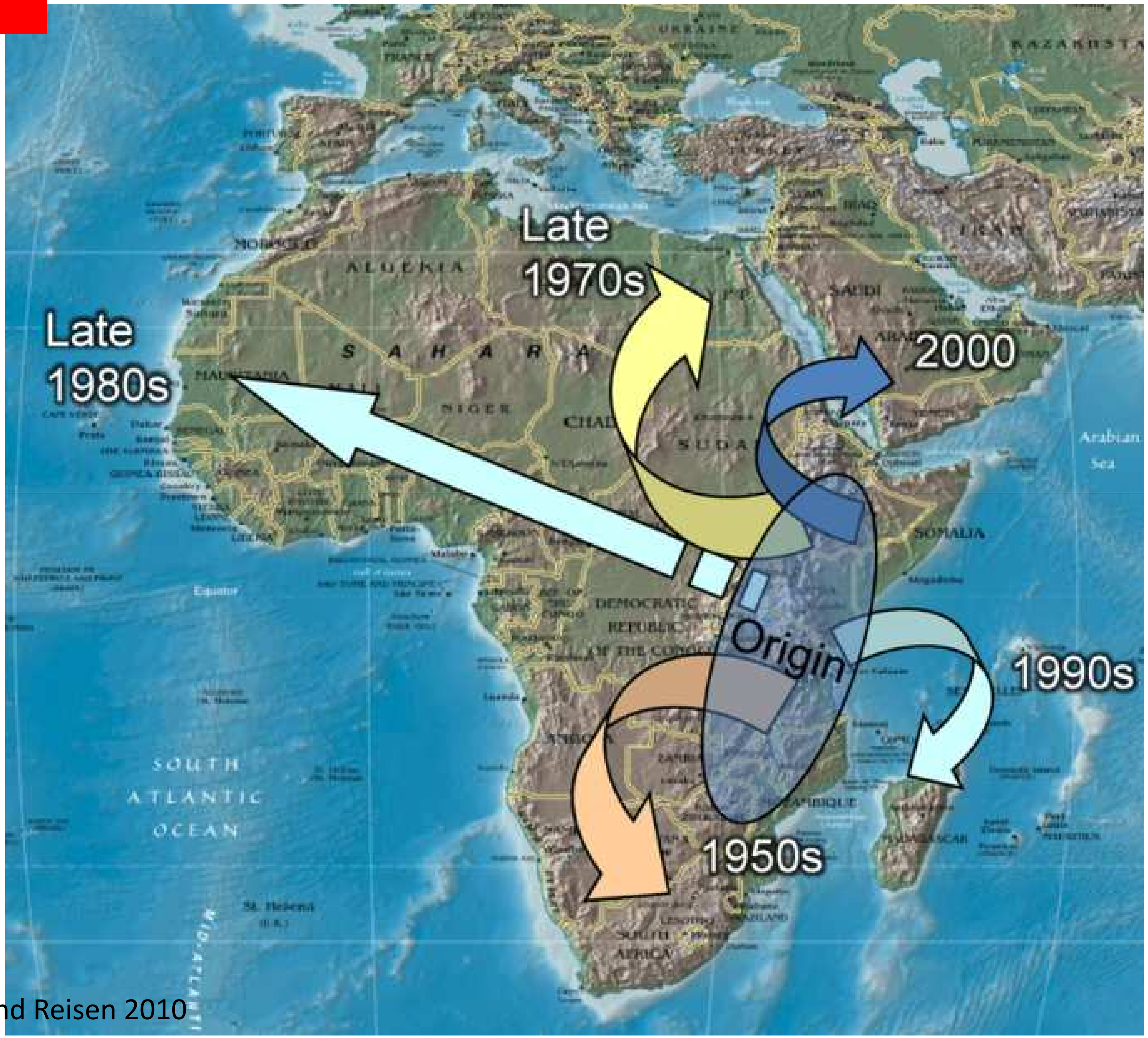


Figure 1 | Approximate geographical locations of diseases associated with arthritogenic alphaviruses. For CHIKV disease, locations of documented large outbreaks are shown;[3,4,7,9,26,112] epidemics prior to 1902 are shown in dashed lines and were initially classified as outbreaks of dengue, but were likely to have been due to CHIKV.[3] *Geographical locations of RRV and BFV diseases overlap, with BFV restricted to the Australian mainland.[17,74] ‡Main location of diseases caused by the Sindbis virus family.[22] §O'nyong-nyong virus disease outbreaks in 1959–1961 (East Africa), 1996–1997 (Uganda) and 2003 (West Africa).[30,104] Mayaro virus disease outbreak regions.[17,25,74] Abbreviations: BFV, Barmah Forest virus; CHIKV, chikungunya virus; RRV, Ross River virus.

Suhrbier et al. 2012

RVF



Da Weaver and Reisen 2010

Autochthonous confirmed cases of exotic diseases reported in Europe

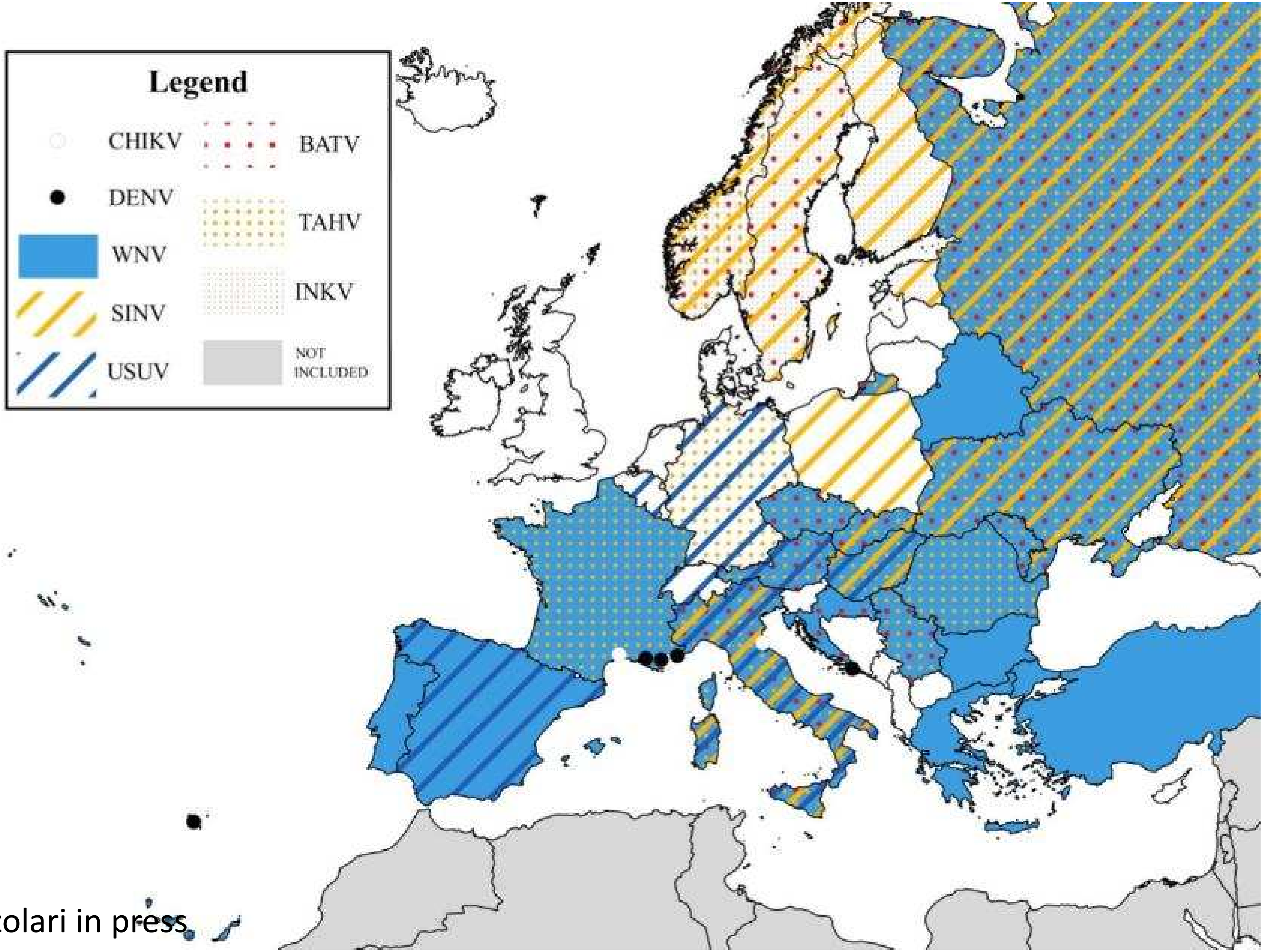
Disease	Location	Year	Human cases	Involved mosquto
Chikungunya	Castiglione, Emilia-Romagna, Italy	2007	205	*Aedes albopictus*
	Frejus, department of Var, France	2010	2	*Aedes albopictus*
	Montpellier, France	2014	12	*Aedes albopictus*
	Gandía, Spain	2015	1	*Aedes albopictus*
Dengue	Nice, France	2010	2	*Aedes albopictus*
	Peljesac peninsula, Croatia	2010	2	*Aedes albopictus*
	Funchal, Madeira, Portugal	2012-13	1080	*Aedes aegypti*
	Departement of Var, France	2014	2	*Aedes albopictus*
	Departement of Bouches du Rhône, France	2014	2	*Aedes albopictus*

Schmidt-Chanasit J, Haditsch M, Schoneberg I, et al.

Dengue virus infection in a traveller returning from Croatia to Germany.

Euro Surveill. 2010 Oct 7;15(40).

Arbovirus Europe



Calzolari in press

Drivers

- Population Growth

(Human Settlement, deforestation)

- Globalization

(tourism, business immigration, transport)

- Climate Changes

(rainfall, temperatures, extension of favorable season)

- Outdoor Activities

Hubalek 2006

Eco-epidemiological factors in the natural history of mosquito-borne viruses

Moboviruses and their circulation in natural foci can be influenced by great number of factors, affecting primarily their vectors—mosquitoes. For instance, major factors are land use and climate. Favorable ecological factors for moboviruses (not only those imported) are, in general:

1. Abundance of wild vertebrates and vectors
2. Intense summer precipitations, floods
3. Higher summer temperatures and drought
4. Appropriate habitats, e.g., humid building basements (Bucharest, Volgograd—WNV)
5. Contact transmission among wild birds (e.g., WNV)

Climate effects under global warming scenario on moboviruses may cause:

1. Higher virus replication rate in vector mosquitoes at elevated ambient temperature, with a shortened extrinsic incubation period (Lundström et al. 1990b)
2. Increased vector populations
3. Expanding range of vectors—northwards (e.g., *Culex modestus*)
4. But higher mortality rate of the vector population

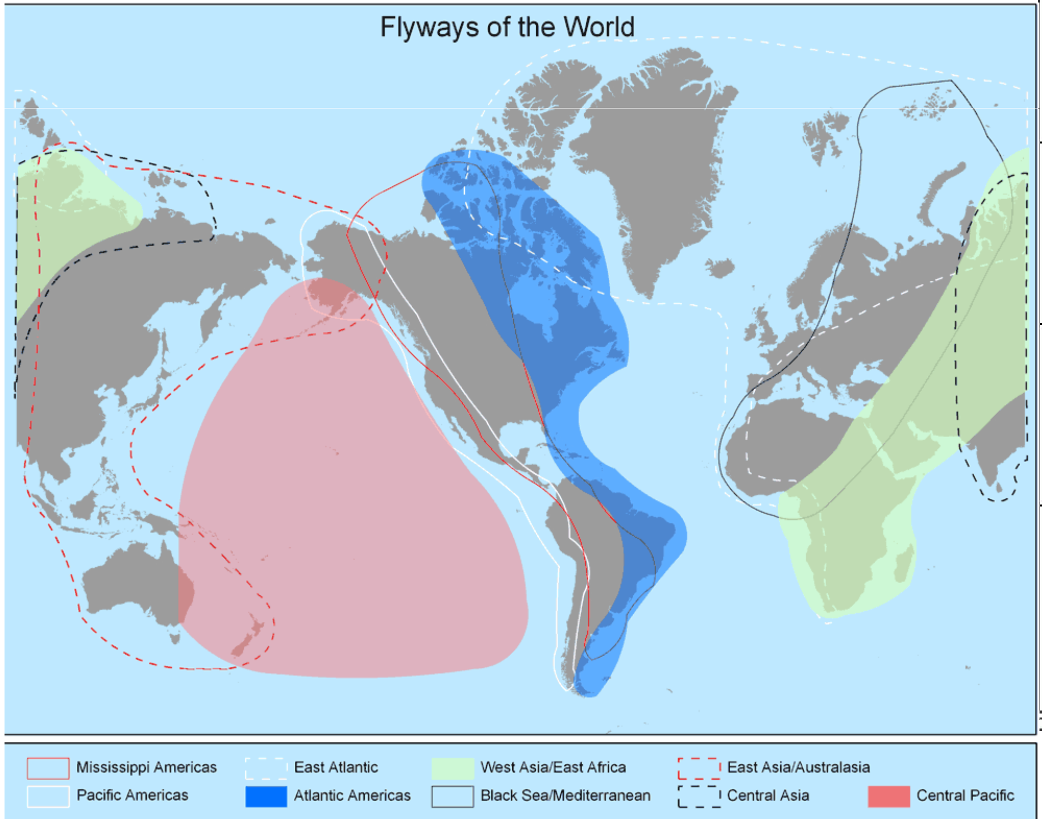
Epidemiological surveillance of mosquito-borne viruses

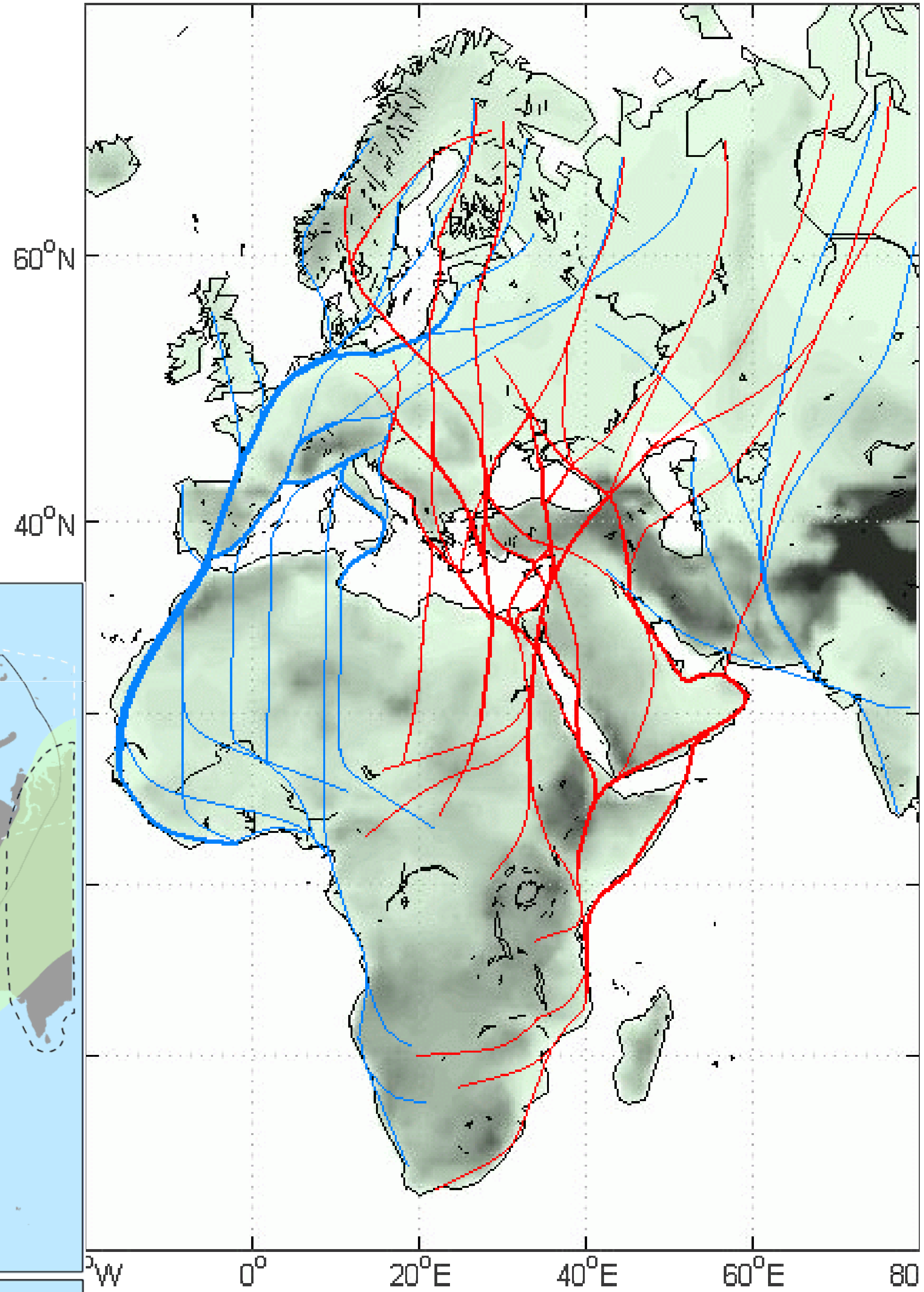
An approach combining *epidemiology* with *ecology*, consisting of:

1. Routine diagnosis of human disease
2. Reporting incidence of human disease
3. Increased awareness for imported mobovirus infections (Gubler 1996)
4. Monitoring animal disease (if it exists)
5. Monitoring mosquito vector populations
6. Testing mosquito vector infection rates
7. Domestic+wild vertebrate serosurveys
8. Monitoring ecological factors

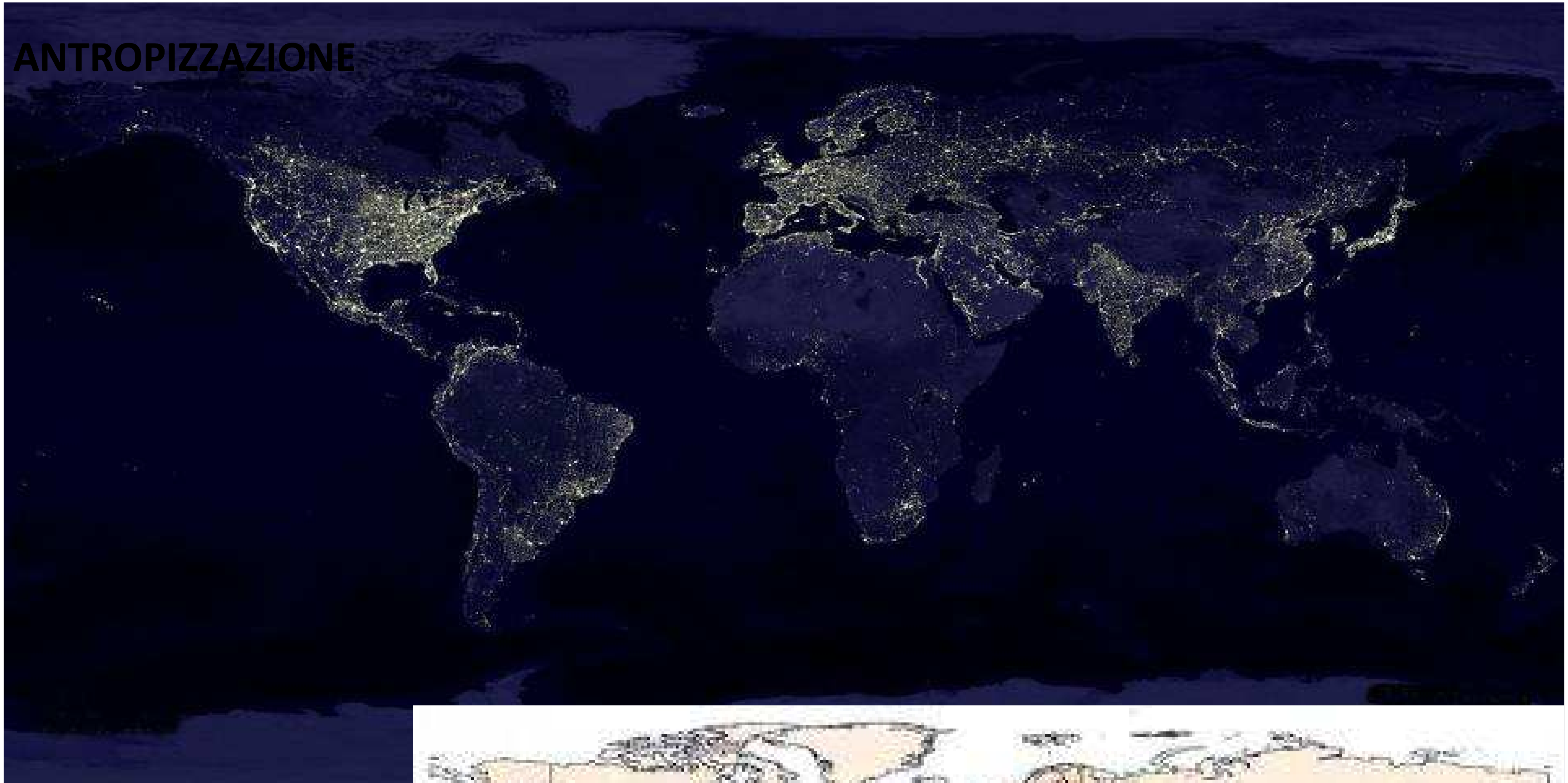
https://upload.wikimedia.org/wikipedia/commons/a/ac/World-airline-routemap-2009.png

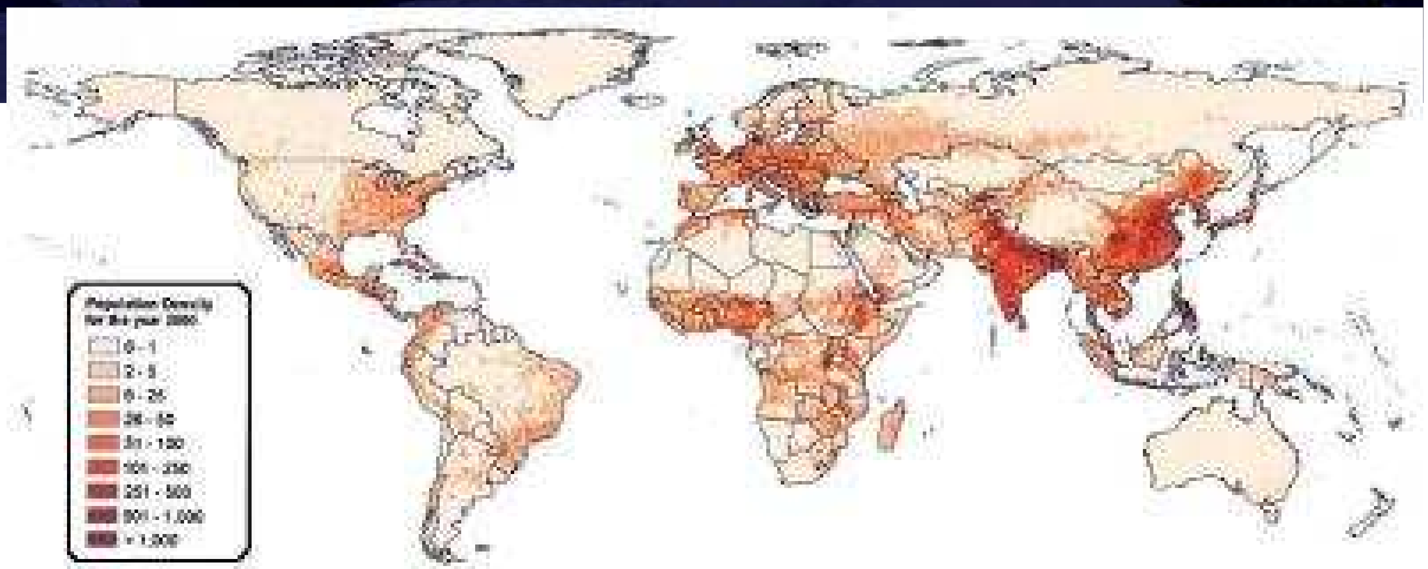
Sat immage


Flyways of the World
Mississippi Americas
Pacific Americas
East Atlantic
Atlantic Americas
West Asia/East Africa
Black Sea/Mediterranean
East Asia/Australasia
Central Asia
Central Pacific


60°N
40°N
W
0°
20°E
40°E
60°E
80

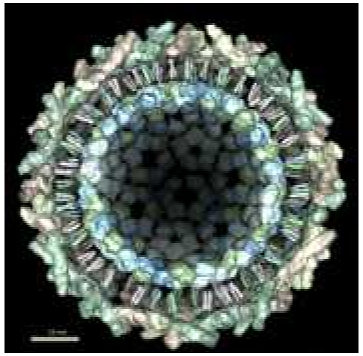
ANTROPIZZAZIONE





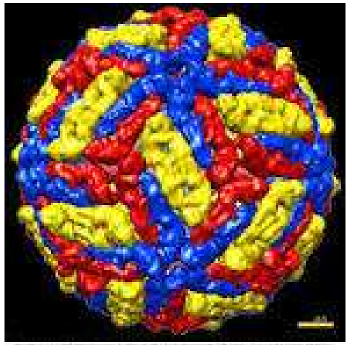

Some Challenges with Arboviral Disease Surveillance 1

- **Outbreaks widely dispersed by time and space – hard to maintain interest and resources**
- **Difficult to link ecological surveillance with subsequent human disease**
- **Time from detection to development of a huge outbreak is often very short**



Some Challenges with Arboviral Disease Surveillance 2

- Serological cross-reactivity
- Lack of laboratory resources
- Interaction of human and animal health professionals often lacking
- Asymptomatic disease



When?

- From 15 th June to 30 th November

Why a Surveillance of autochthonous fevers?

- no specific therapy…?!?
- to detect autochthonous cases of WNF, in order to obtain a more reliable picture of the disease transmission in the region.
- renal involvement

Murray K, Walker C, Herrington E, et al.
Persistent infection with West Nile virus years after initial infection.
J Infect Dis. 2010 Jan 1;201(1):2-4.

Why a Surveillance of imported fevers?

- to increase the detection rate of imported CHIKV and DENV cases in travellers from endemic areas, and to promptly identify potential autochthonous cases

- to detect DENV or CHIKV in *Ae. albopictus* vectors, in case of the report of a viremic human case of DENV or CHIKV

- immediate reference to tropical diseases Units…. in primis **to rule out malaria**

DEN/CHIK **Protocol**

- Fever >38° C in the last 7 days
- Stay in endemic countries in the last 15 days
- Absence of leucocytosis (WBC <10,000 µL)
- Absence of other obvious causes of fever

GPs
Emergencies

↓

- RAPID TEST (anti-CHIK IgM, anti-DENV IgM and NS1 DENV) positive

Tropical and Infectious Diseases Units

↓

- PCR DENV and CHIK positive
- Seroconversion or detection of increasing serum levels of specific IgM and IgG.

Regional Reference Laboratory

WNF **Protocol**

- Fever >38° C in the last 7 days
- Absence of other obvious causes of fever

GPs
Emergencies

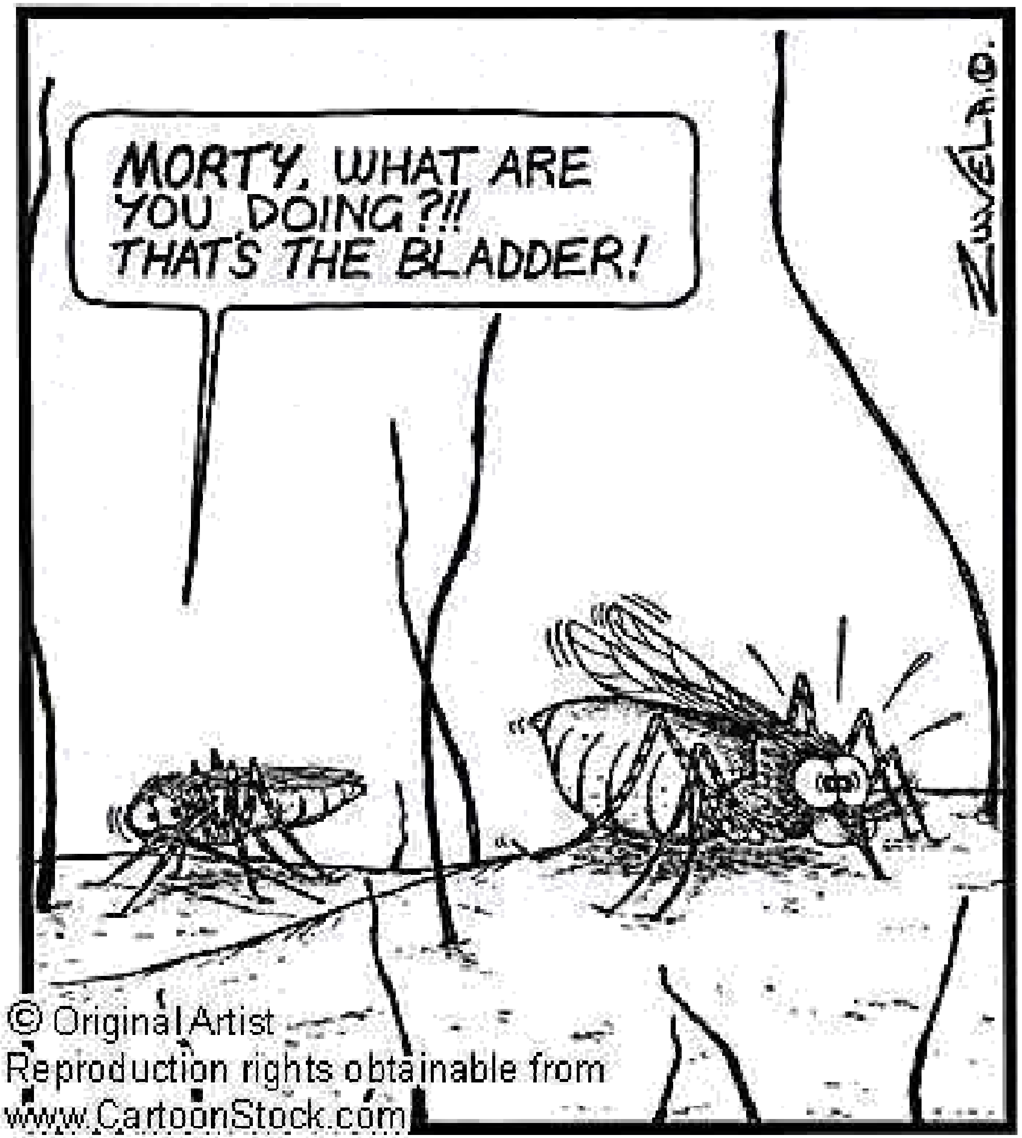
- Absence of leucocytosis (WBC <10,000 µL)

Tropical and Infectious Diseases Units

- PCR WNV
- Seroconversion or detection of increasing serum levels of specific IgM and IgG

Regional Reference Laboratory

Grazie per l’attenzione!



Morty, cosa stai facendo?!! Quella è la vescica