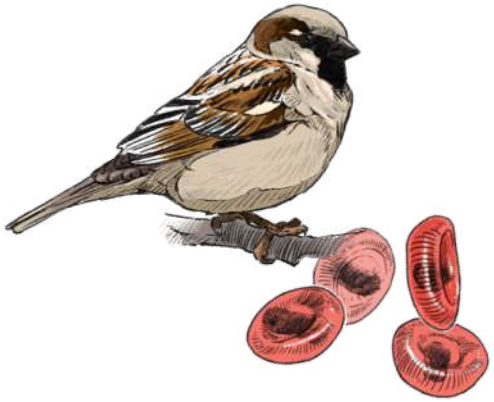
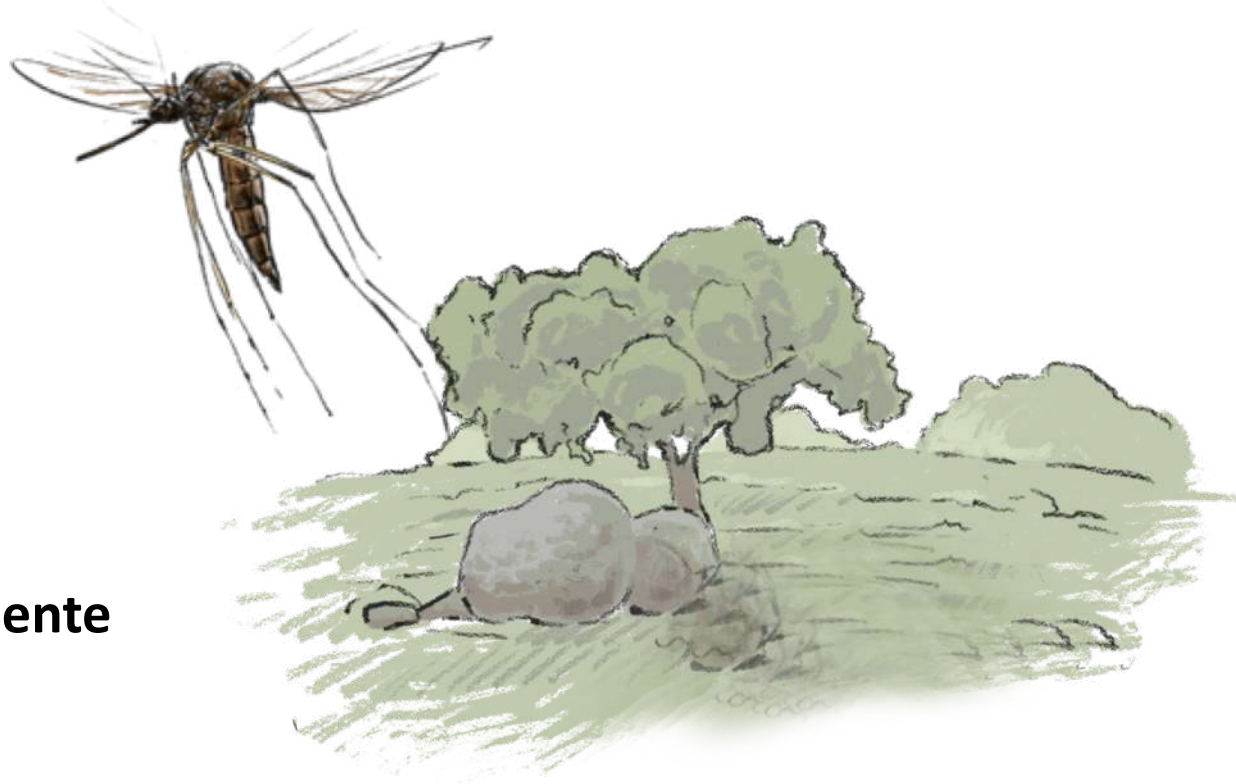
Integrating mosquito´s information on the epidemiology of vector-borne pathogens





Josué Martínez-de la Puente

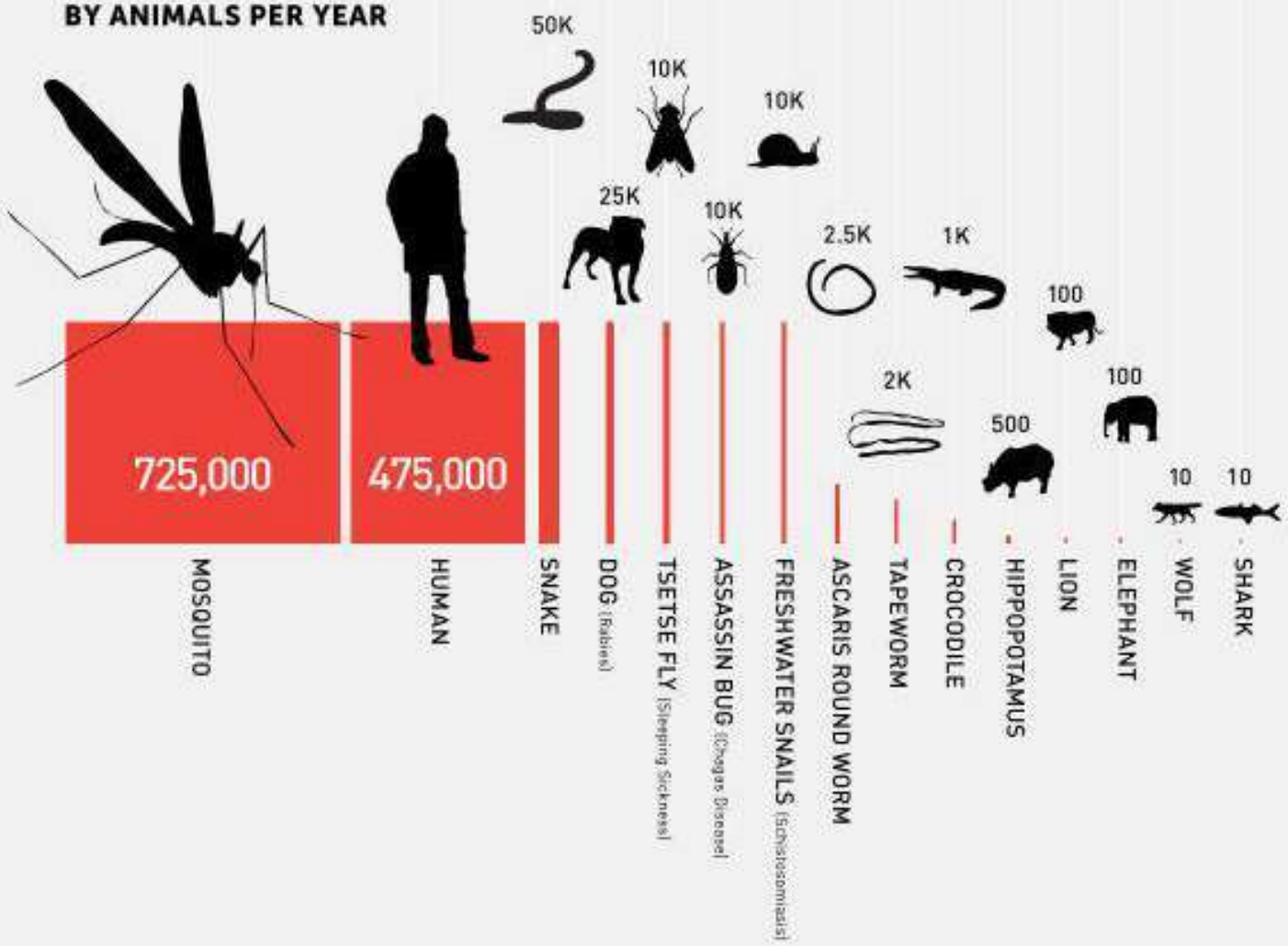
UNIVERSIDAD DE GRANADA

ciberesp isciii

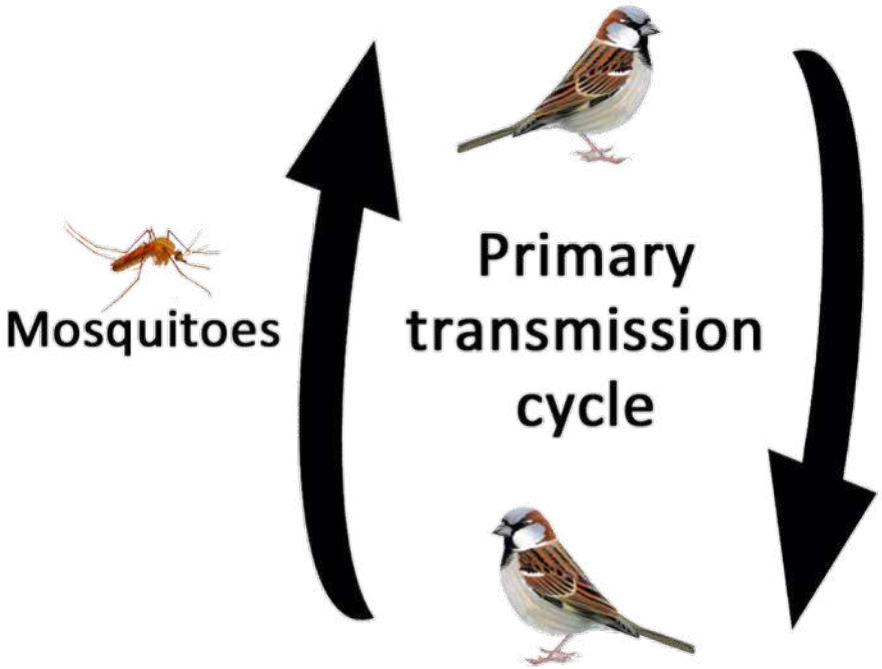
WORLD'S DEADLIEST ANIMALS

NUMBER OF PEOPLE KILLED BY ANIMALS PER YEAR

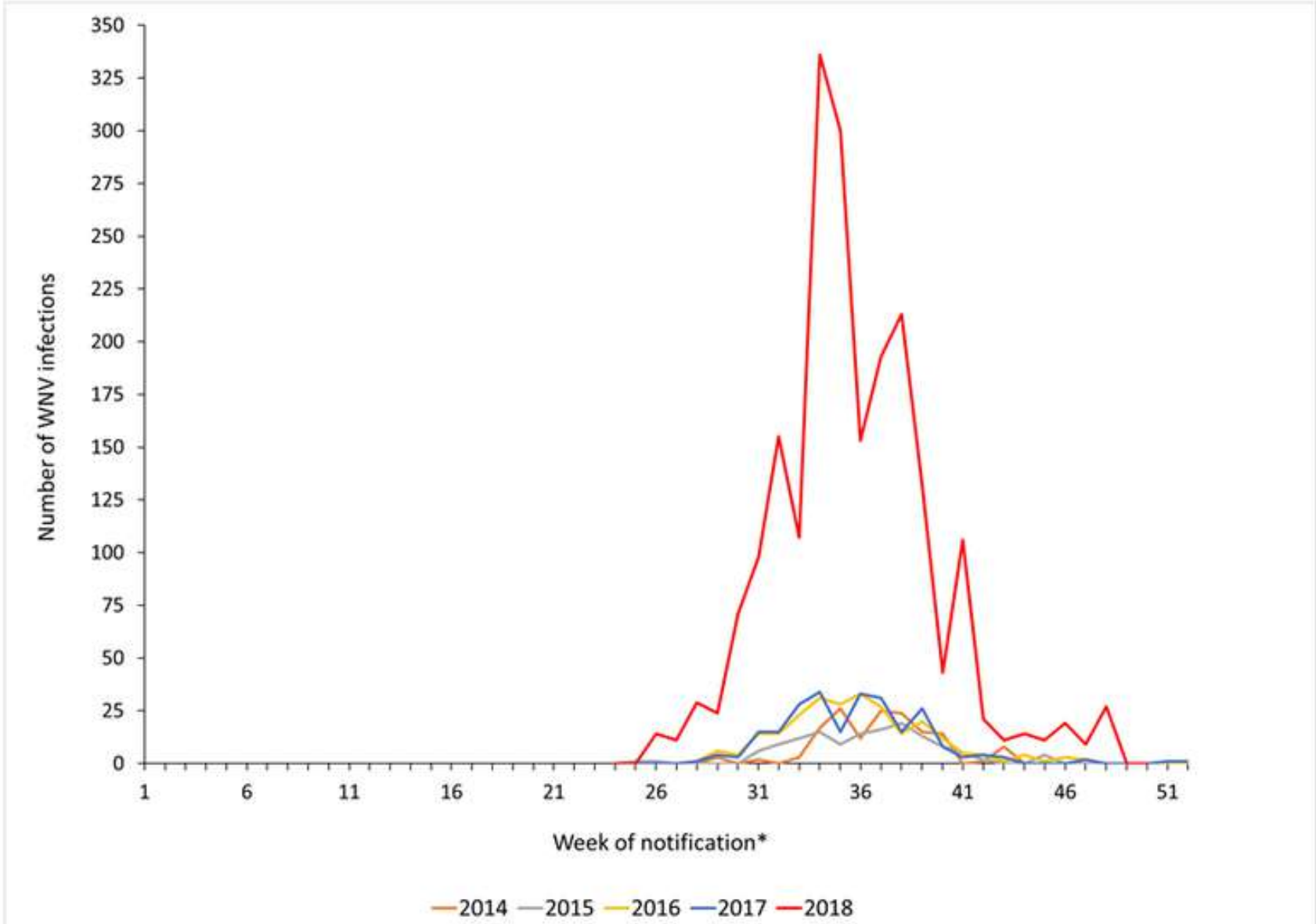
MOSQUITOWEEK
on gatesnotes.com



West Nile virus is a mosquito borne-*Flavivirus* circulating between birds and mosquitoes

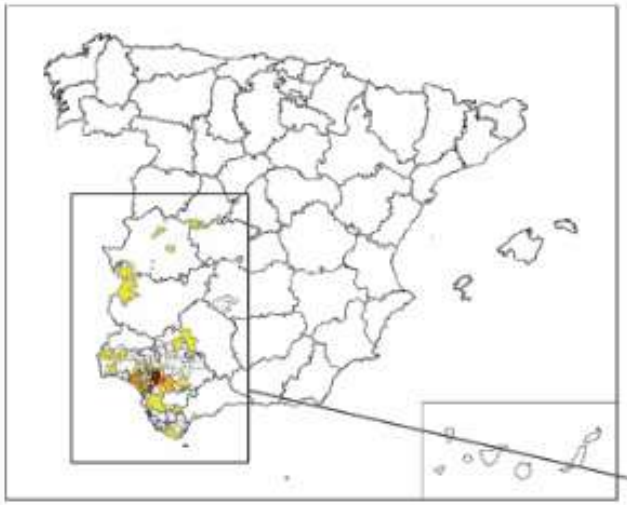


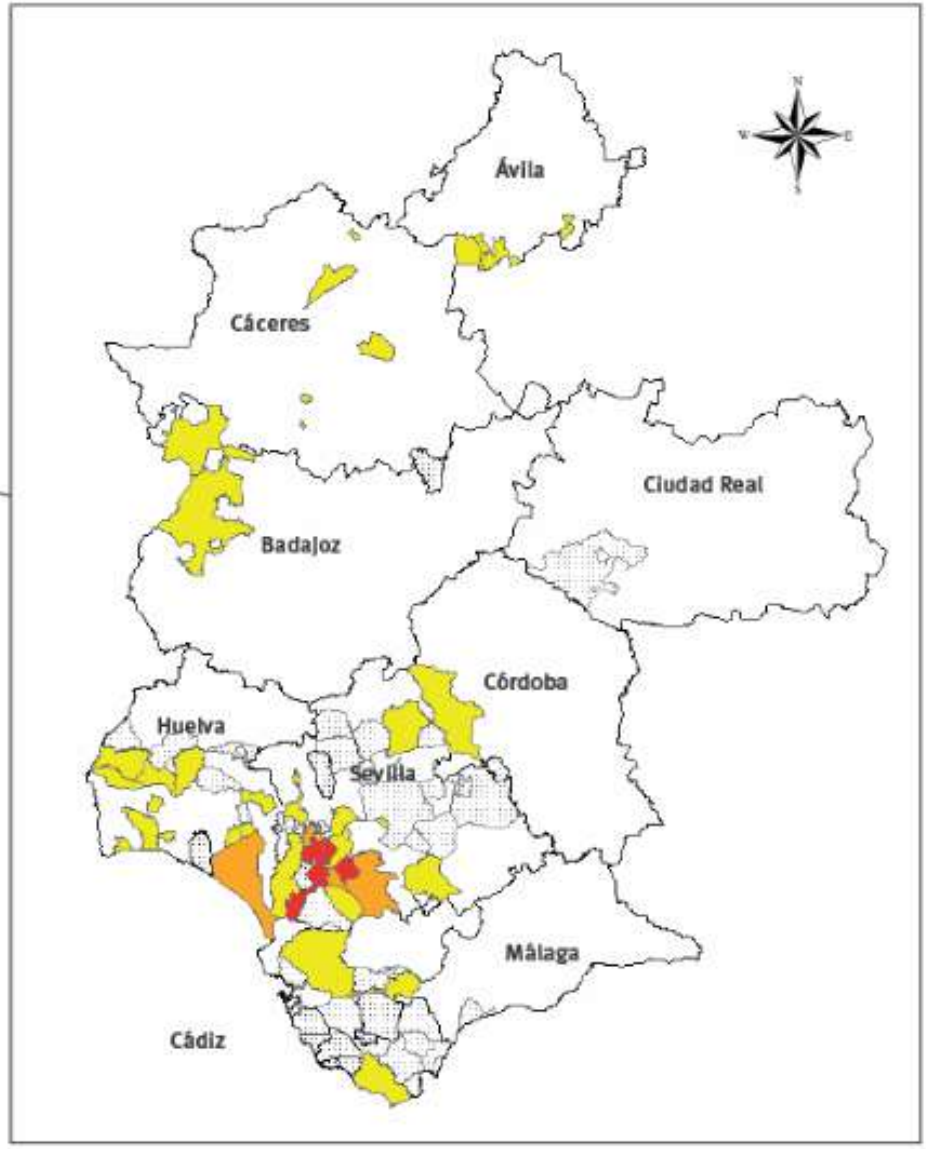
Number of WNV infections in EU/EEA and EU enlargement countries by epidemiological week of notification*, 2014-2018.



* Week of notification to national authorities or if missing, week of notification to ECDC.

Local circulation of WNV in Spain: cases in horses





Area with 1–2 affected horses in 2016

Area with 3–4 affected horses in 2016

Area with more than 4 affected horses in 2016

Cases of WNV infection in horses in 2010–2015

Including cases in humans

Eurosurveillance Europe's journal on infectious disease surveillance, epidemiology, prevention and control

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Surveillance and outbreak report

Open Access

West Nile virus outbreak in humans and epidemiological surveillance, west Andalusia, Spain, 2016

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Nuria López-Ruiz[1,2], María del Carmen Montaño-Remacha[1], Enric Durán-Pla[1], Mercedes Pérez-Ruiz[3,4,5], Jose María Navarro-Marí[3,4,5], Celia Salamanca-Rivera[6], Blanca Miranda[7], Salvador Oyonarte-Gómez[7], Josefa Ruiz-Fernández[8]

View Affiliations

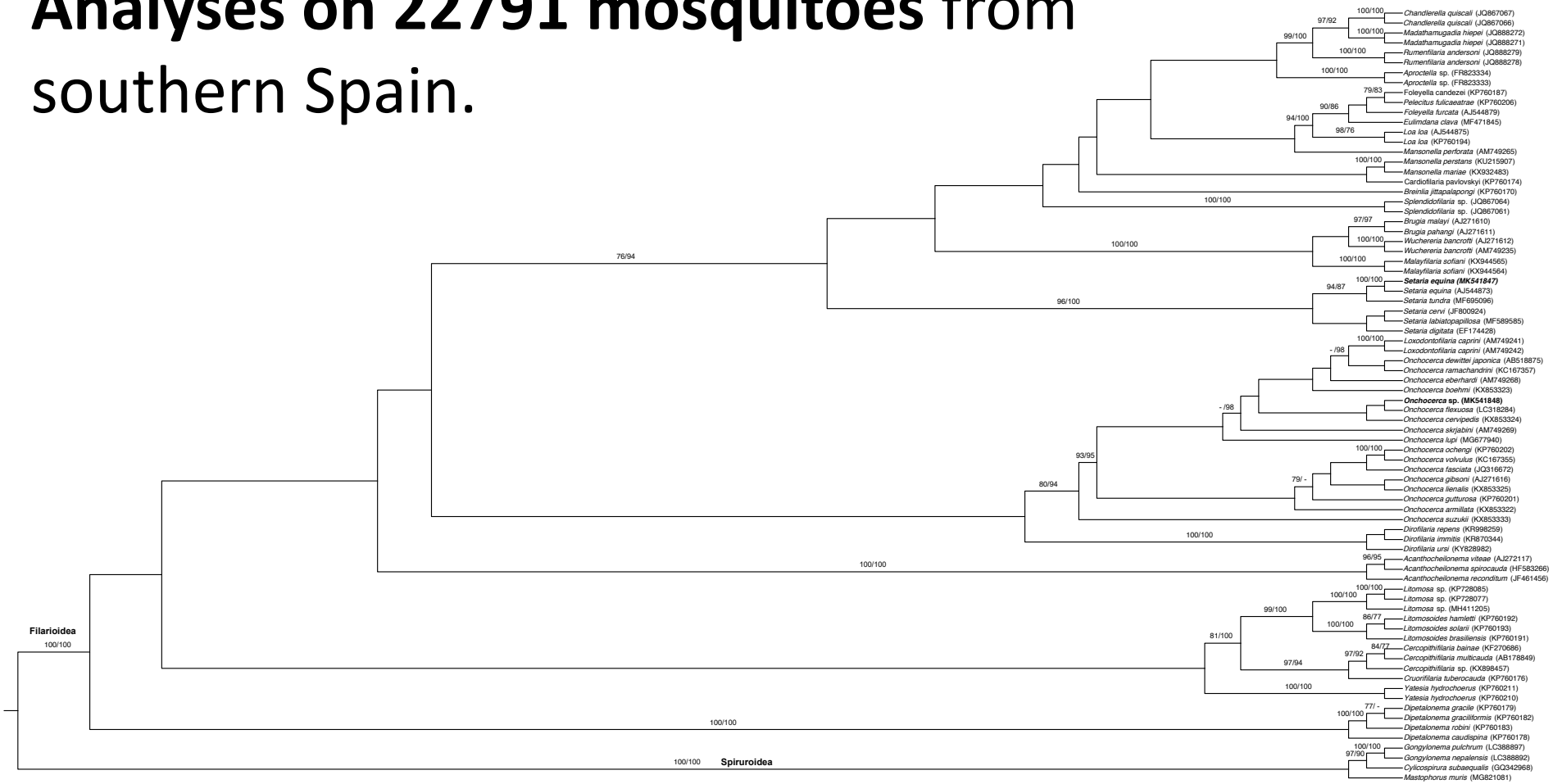
Molecular xenomonitoring: identification of WNV in mosquitoes

Number of pools and female mosquitoes from each species tested in Spain, based on published studies (see text).

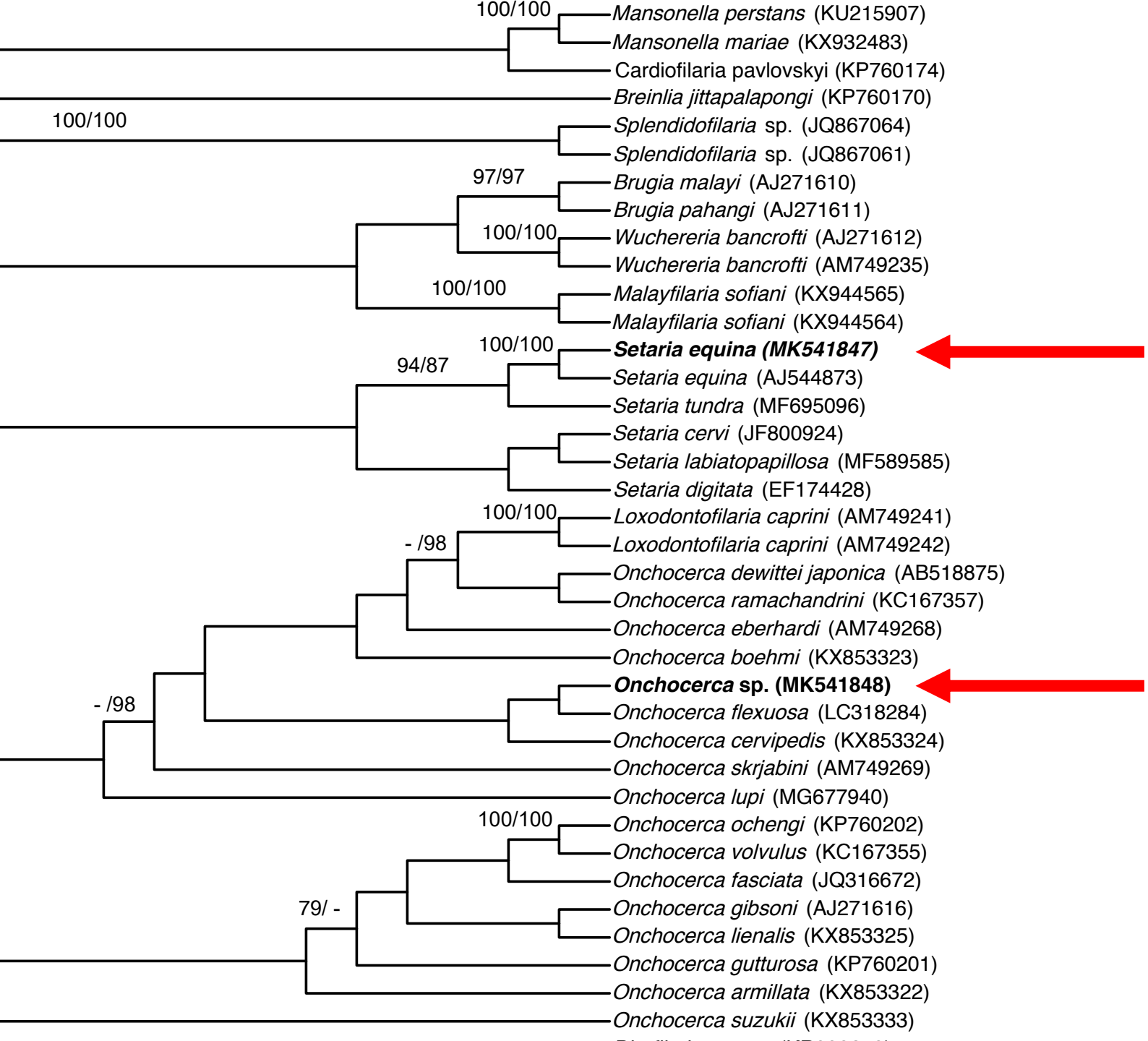
Mosquito species	Pools	Mosquitoes	WNV + pools	USUV + pools
Aedes albopictus	28	62	-	-
Aedes vexans	42	433	-	-
Anopheles algeriensis	59	241	-	-
Anopheles atroparvus	644	6,520	-	-
Anopheles claviger	2	2	-	-
Anopheles hyrcanus	1	1	-	-
Anopheles maculipennis	1	236	-	-
Anopheles plumbeus	5	12	-	-
Anopheles sp.	9	89	-	-
Coquillettidia richiardii	62	147	-	-
Culex modestus	1,181	21,426	-	-
Culex perexiguus	527	7,366	7	1
Culex pipiens	3,763	55,469	1	1
Culex sp.	69	551	-	-
Culex theileri	1,413	37,512	-	-
Culiseta annulata	114	212	-	-
Culiseta longiareolata	340	851	-	-
Culiseta subochrea	17	691	-	-
Culiseta sp.	4	4	-	-

Engler et al. 2013. Int J Environ Res Public Health 10:4869–95.

Evidence of local circulation of other zoonitic mosquito-borne pathogens: Analyses on 22791 mosquitoes from southern Spain.



Martínez-de la Puente *et al.* 2019. Transboundary and Emerging Diseases


100/100
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Mansonella mariae (KX932483)
Cardiofilaria pavlovskyi (KP760174)
Breinlia jittapalapongi (KP760170)
100/100
Splendidofilaria sp. (JQ867064)
Splendidofilaria sp. (JQ867061)
97/97
Brugia malayi (AJ271610)
Brugia pahangi (AJ271611)
100/100
Wuchereria bancrofti (AJ271612)
Wuchereria bancrofti (AM749235)
100/100
Malayfilaria sofiani (KX944565)
Malayfilaria sofiani (KX944564)
100/100
Setaria equina (MK541847)
94/87
Setaria equina (AJ544873)
Setaria tundra (MF695096)
Setaria cervi (JF800924)
Setaria labiatopapillosa (MF589585)
Setaria digitata (EF174428)
100/100
Loxodontofilaria caprini (AM749241)
- /98
Loxodontofilaria caprini (AM749242)
Onchocerca dewittei japonica (AB518875)
Onchocerca ramachandrini (KC167357)
Onchocerca eberhardi (AM749268)
Onchocerca boehmi (KX853323)
Onchocerca sp. (MK541848)
- /98
Onchocerca flexuosa (LC318284)
Onchocerca cervipedis (KX853324)
Onchocerca skrjabini (AM749269)
Onchocerca lupi (MG677940)
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Onchocerca ochengi (KP760202)
Onchocerca volvulus (KC167355)
Onchocerca fasciata (JQ316672)
79/ -
Onchocerca gibsoni (AJ271616)
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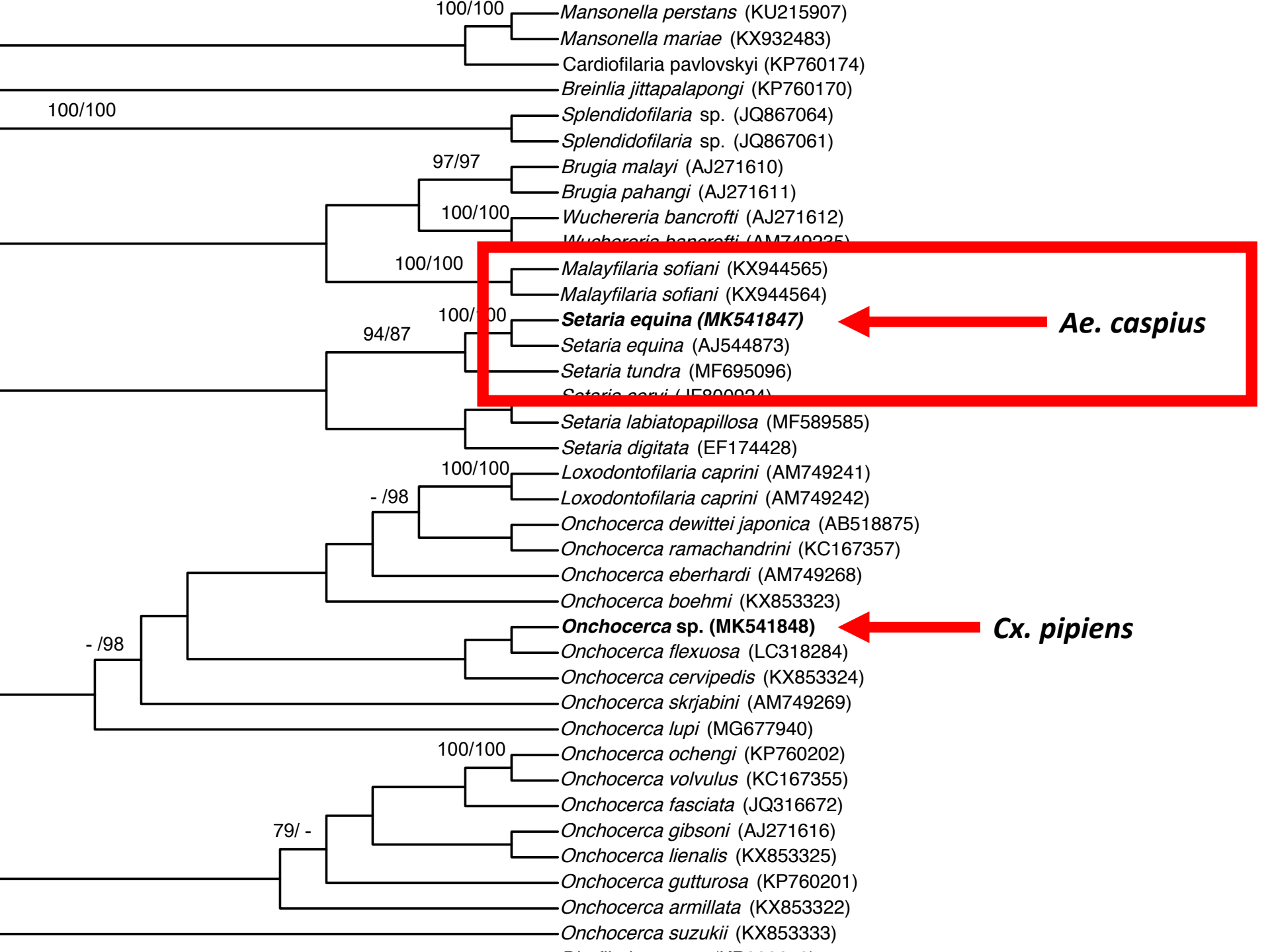
Onchocerca gutturosa (KP760201)
Onchocerca armillata (KX853322)
Onchocerca suzukii (KX853333)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Onchocerca gutturosa (KP760201)
Onchocerca armillata (KX853322)
Onchocerca suzukii (KX853333)
Ae. caspius
Cx. pipiens

Setaria equina: a vector-borne parasite potentially affecting human populations

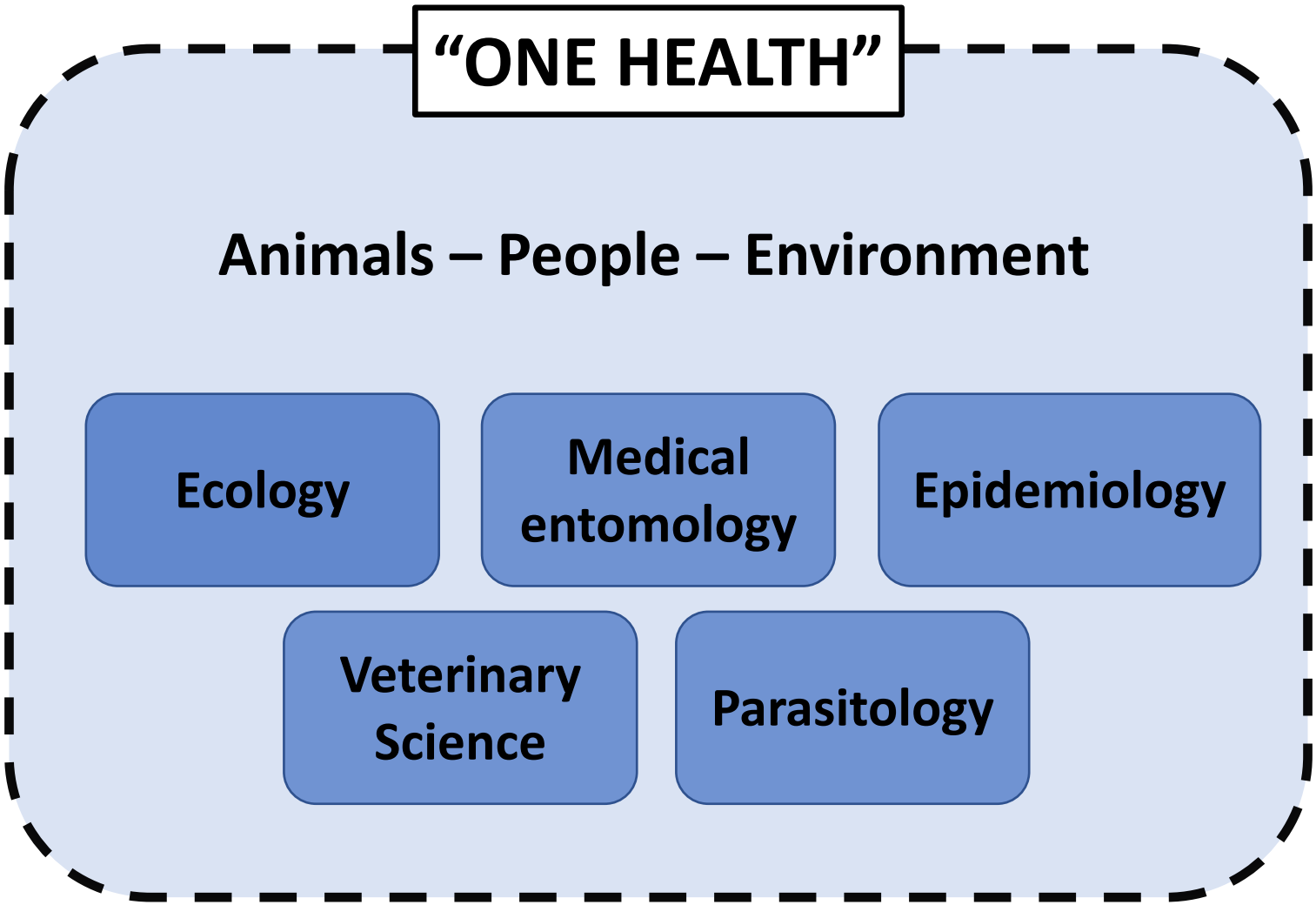
ELSEVIER

Parasitology International

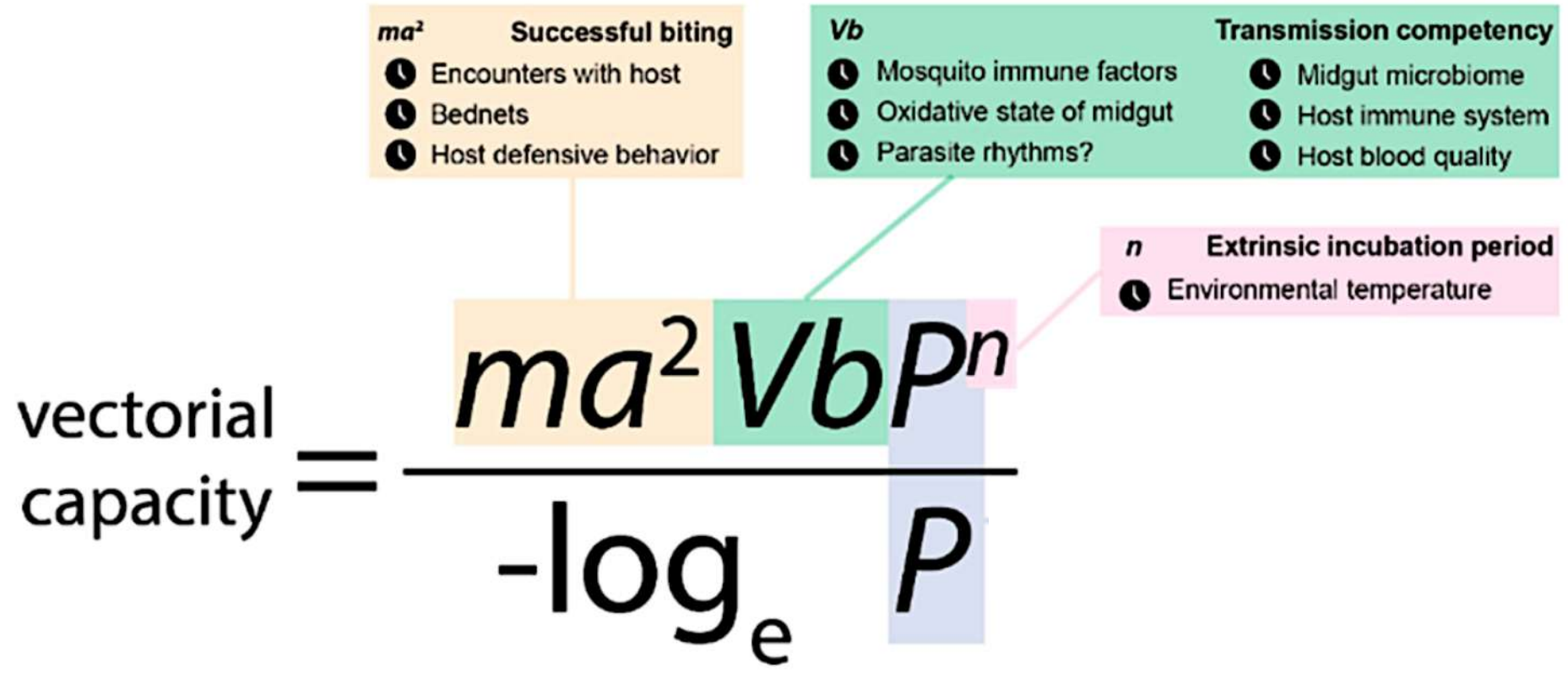
Volume 66, Issue 1, February 2017, Pages 930-932

Subconjunctival setariasis due to *Setaria equina* infection; a case report and a literature review

Reza Nabie [a], Adel Spotin [b, c] ✉, Soheila Rouhani [d]


"ONE HEALTH"
Animals – People – Environment
Ecology
Medical entomology
Epidemiology
Veterinary Science
Parasitology

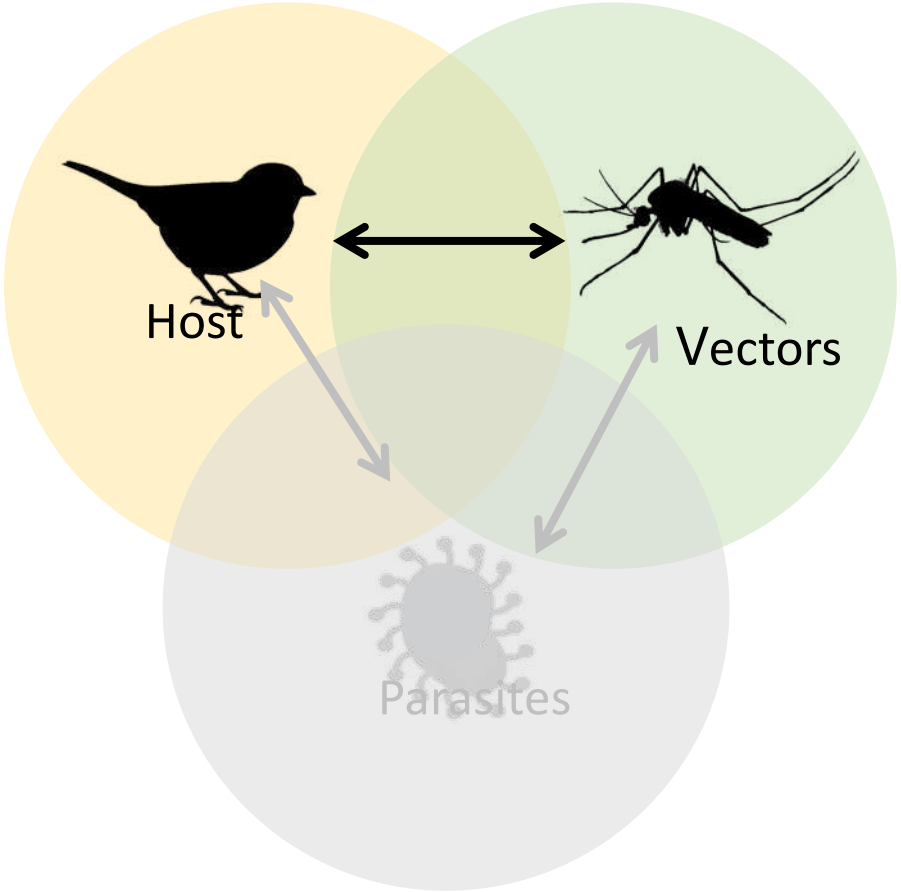
Factors including **biting behaviour** and **parasite development** may **impact** the ability of mosquitoes to transmit avian malaria parasites



Adapted from **Rund et al. 2016.** ***Insects* 7*:* 14.**

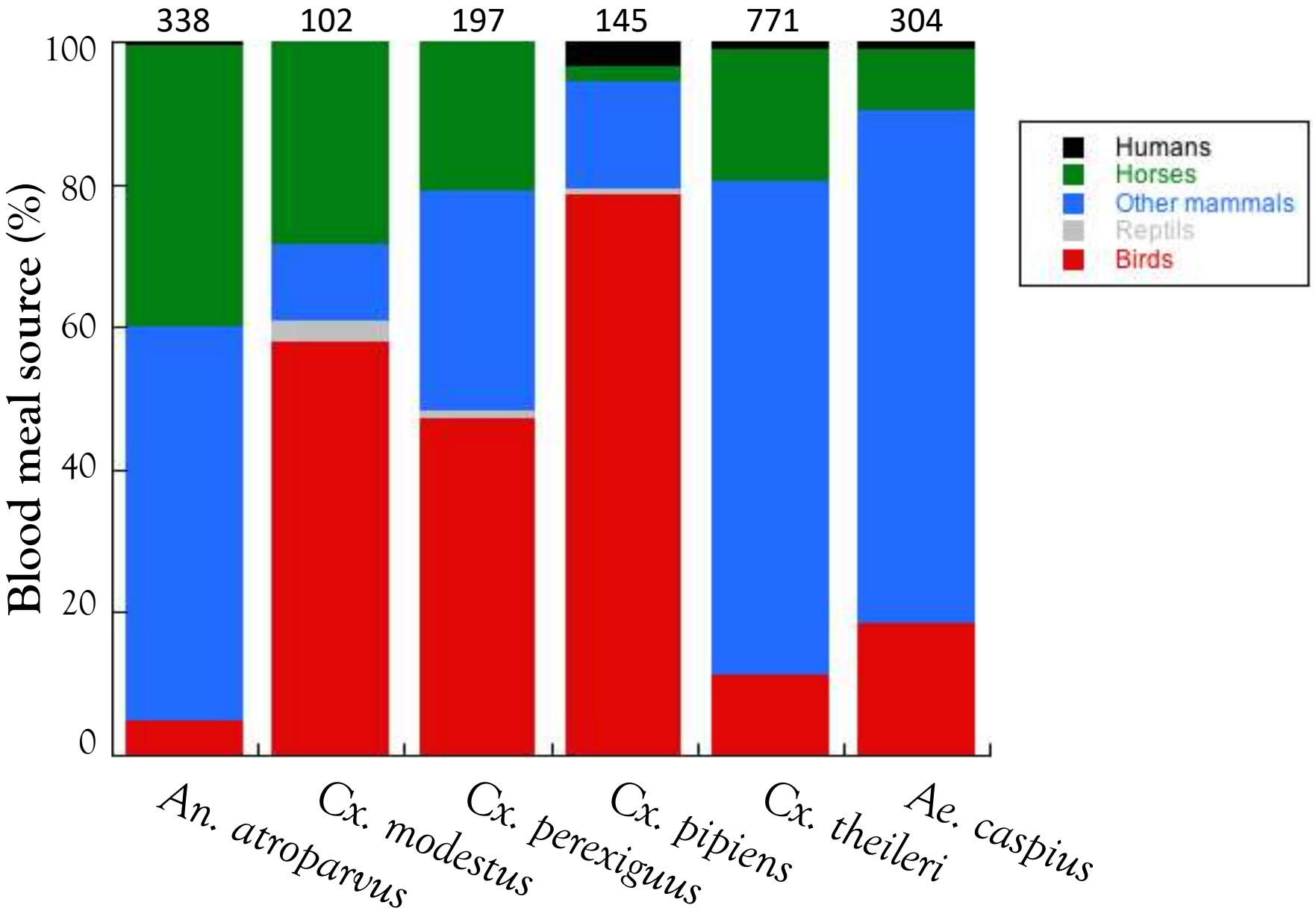
Studies on the different parameters affecting the vector compence of mosquitoes:

The role of host-vector interactions

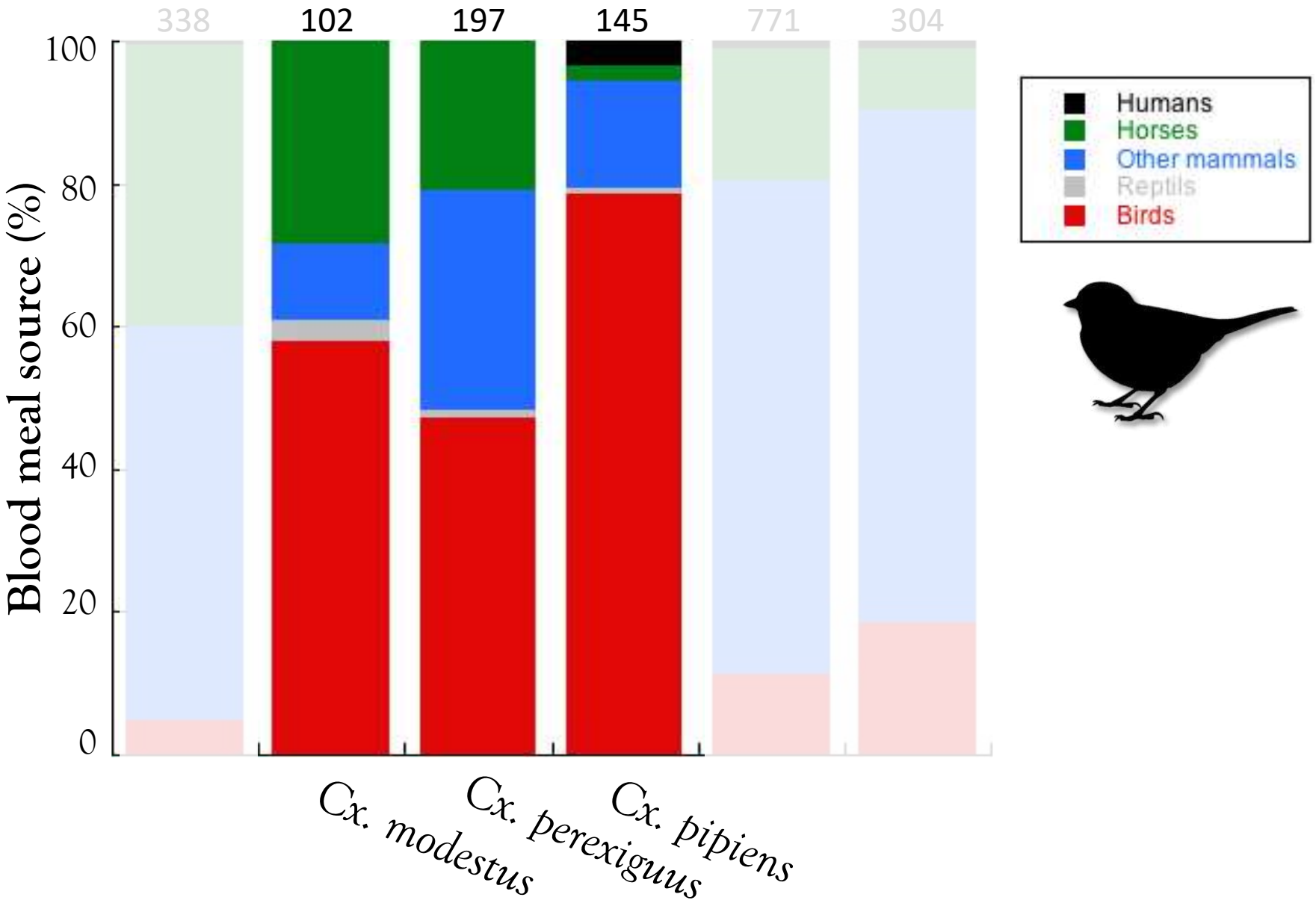


Amplify a 758 bp fragment of the mitochondrial COI gene

Alcaide *et al.* 2009. *Plos One*



Martínez-de la Puente et al. (2018) eLS. John Wiley & Sons, Ltd: Chichester


338
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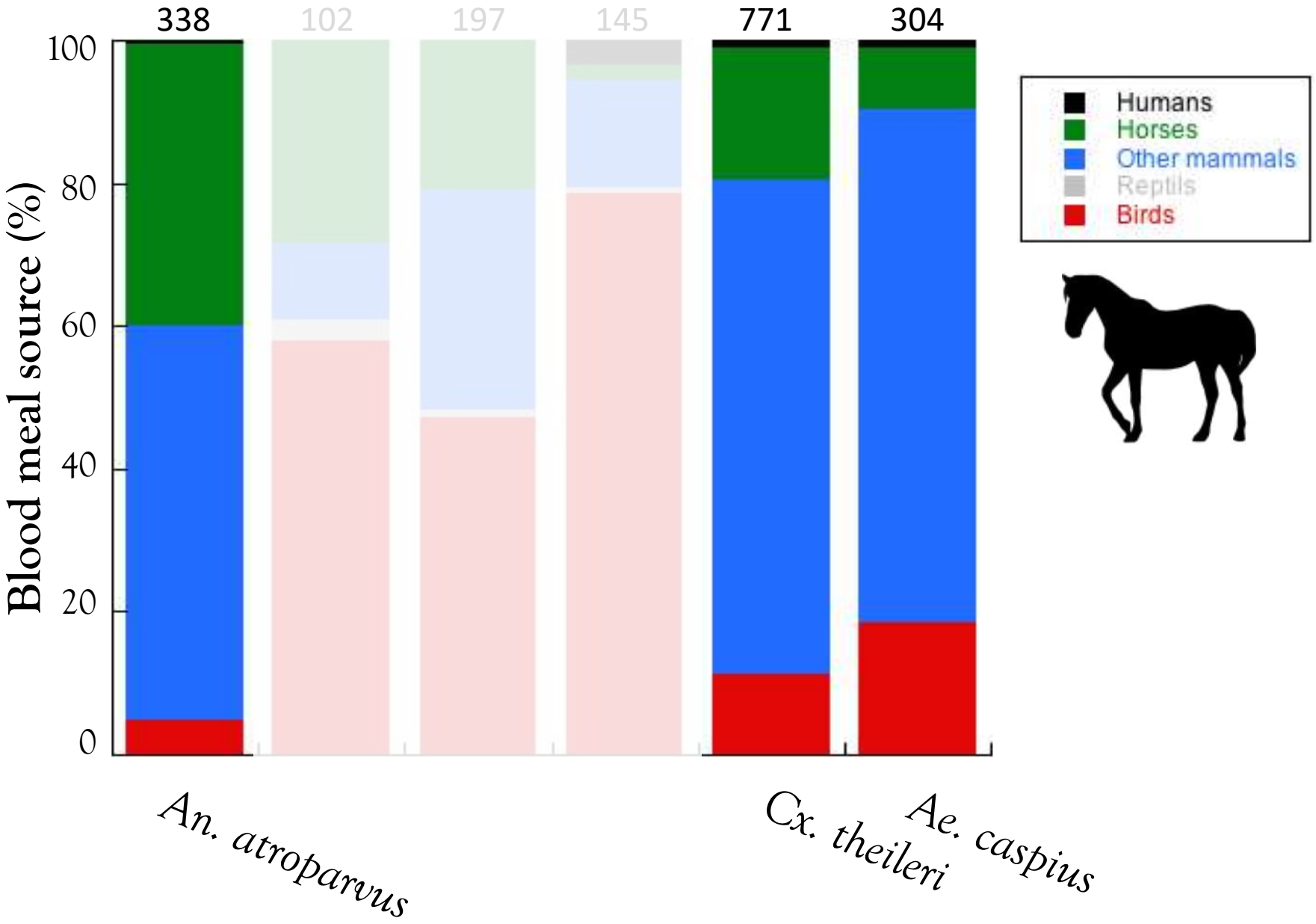
197
145
771
304
100
80
60
40
20
0
Blood meal source (%)
Humans
Horses
Other mammals
Reptils
Birds
Cx. modestus
Cx. perexiguus
Cx. pipiens


338
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Blood meal source (%)
Humans
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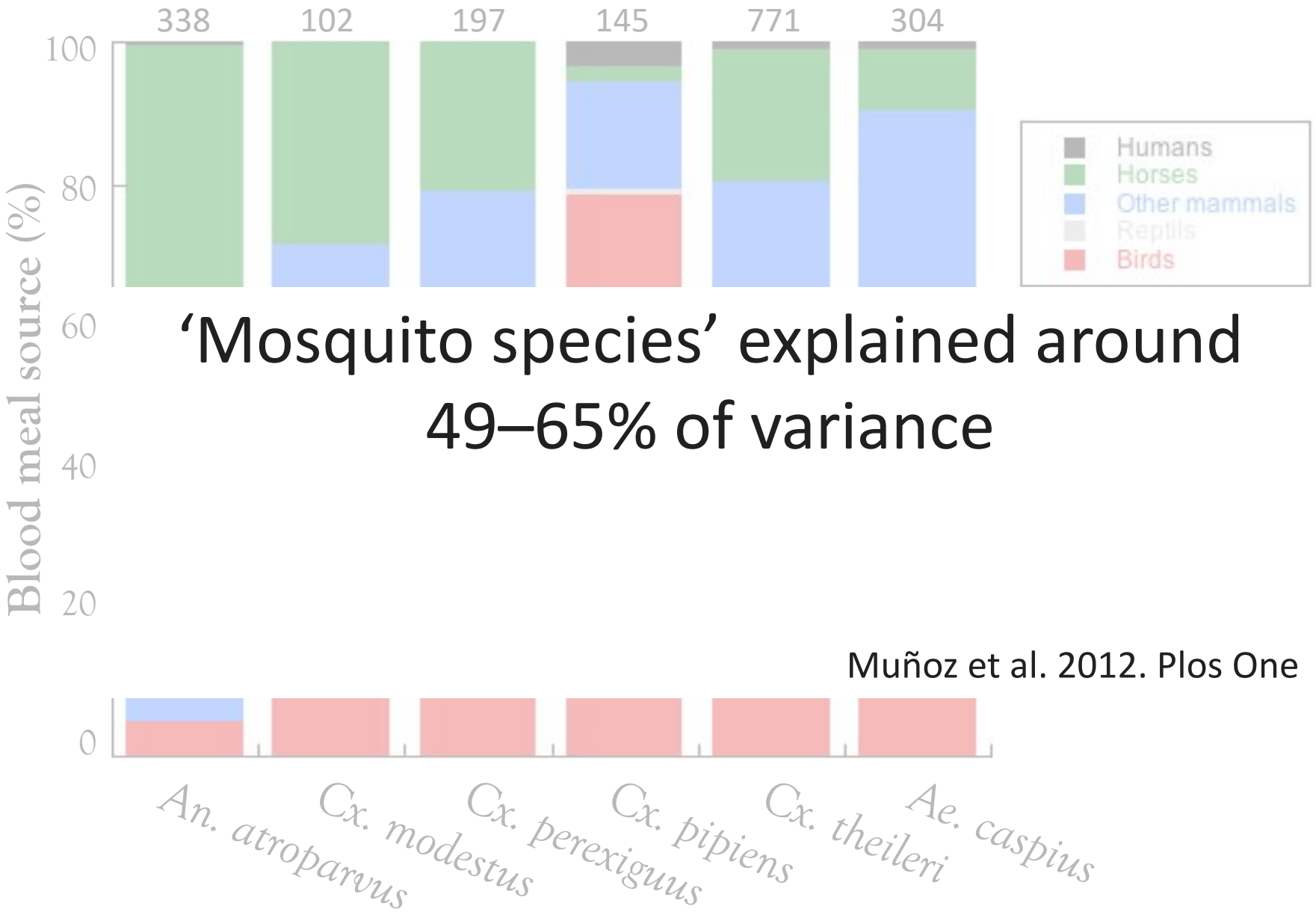
An. atroparvus
Cx. theileri
Ae. caspius

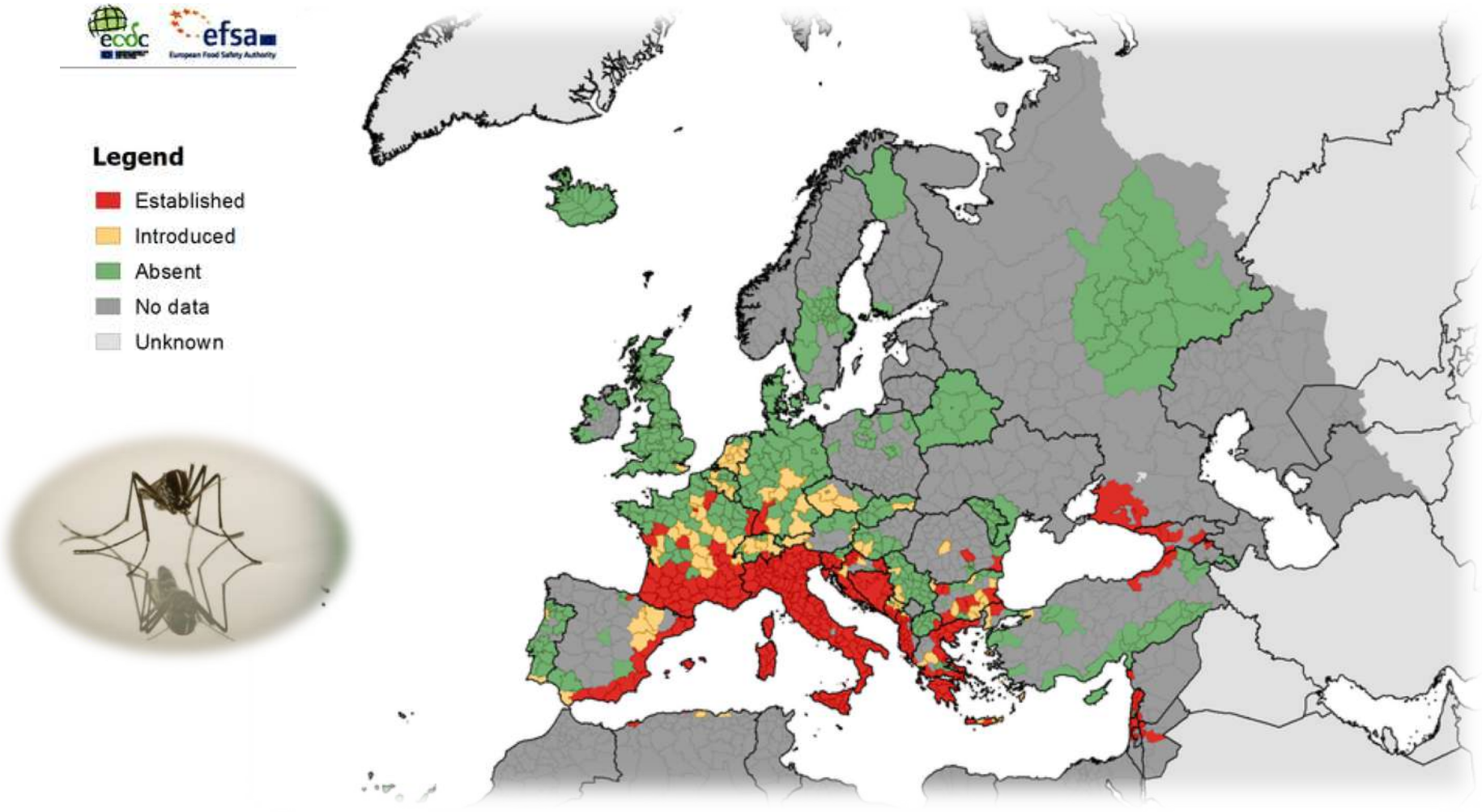


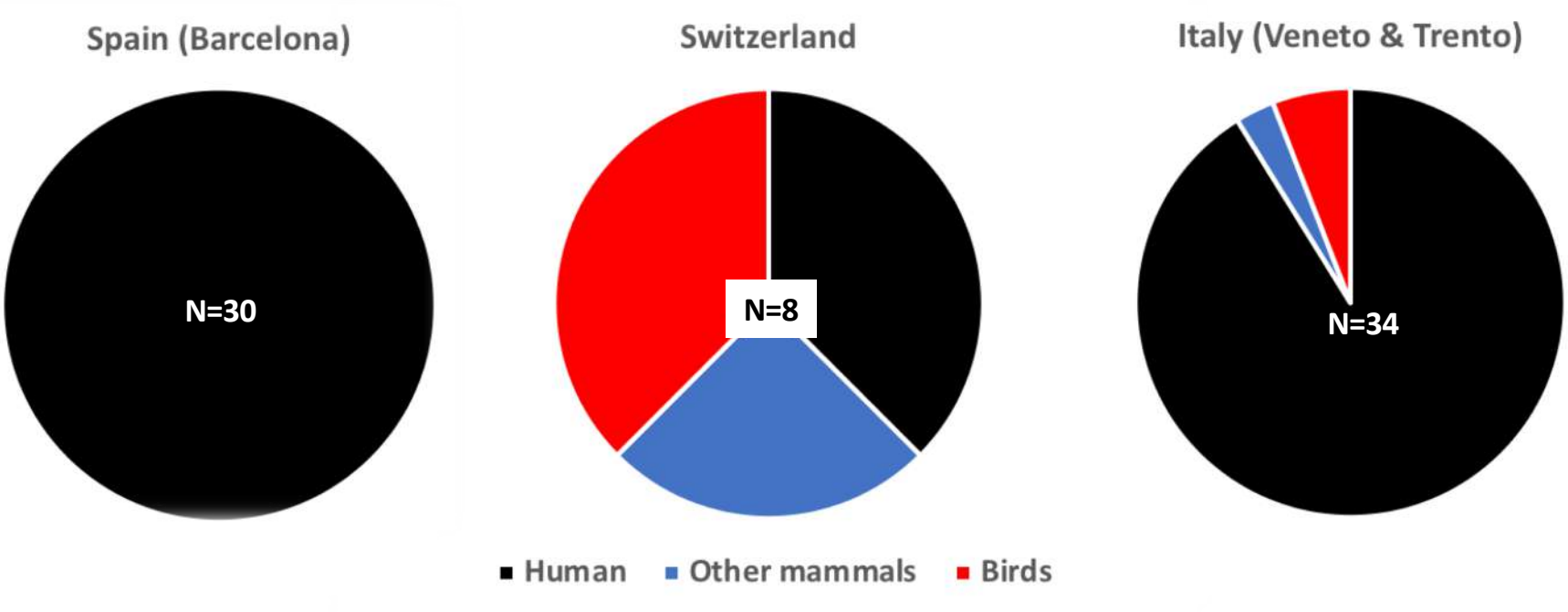
‘Mosquito species’ explained around 49–65% of variance

Muñoz et al. 2012. Plos One

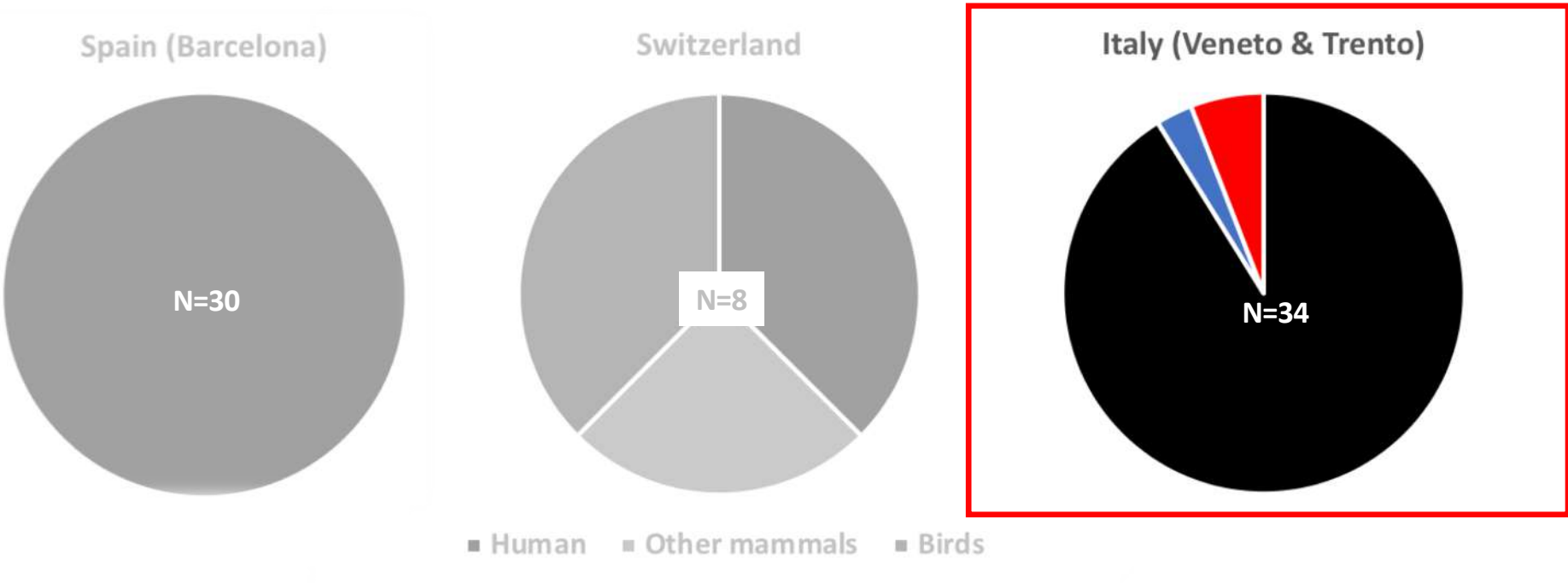
Martínez-de la Puente et al. (2018) eLS. John Wiley & Sons, Ltd: Chichester

The invasive mosquitoes may affect the epidemiological scenarios in Europe: **the case of *Aedes albopictus***

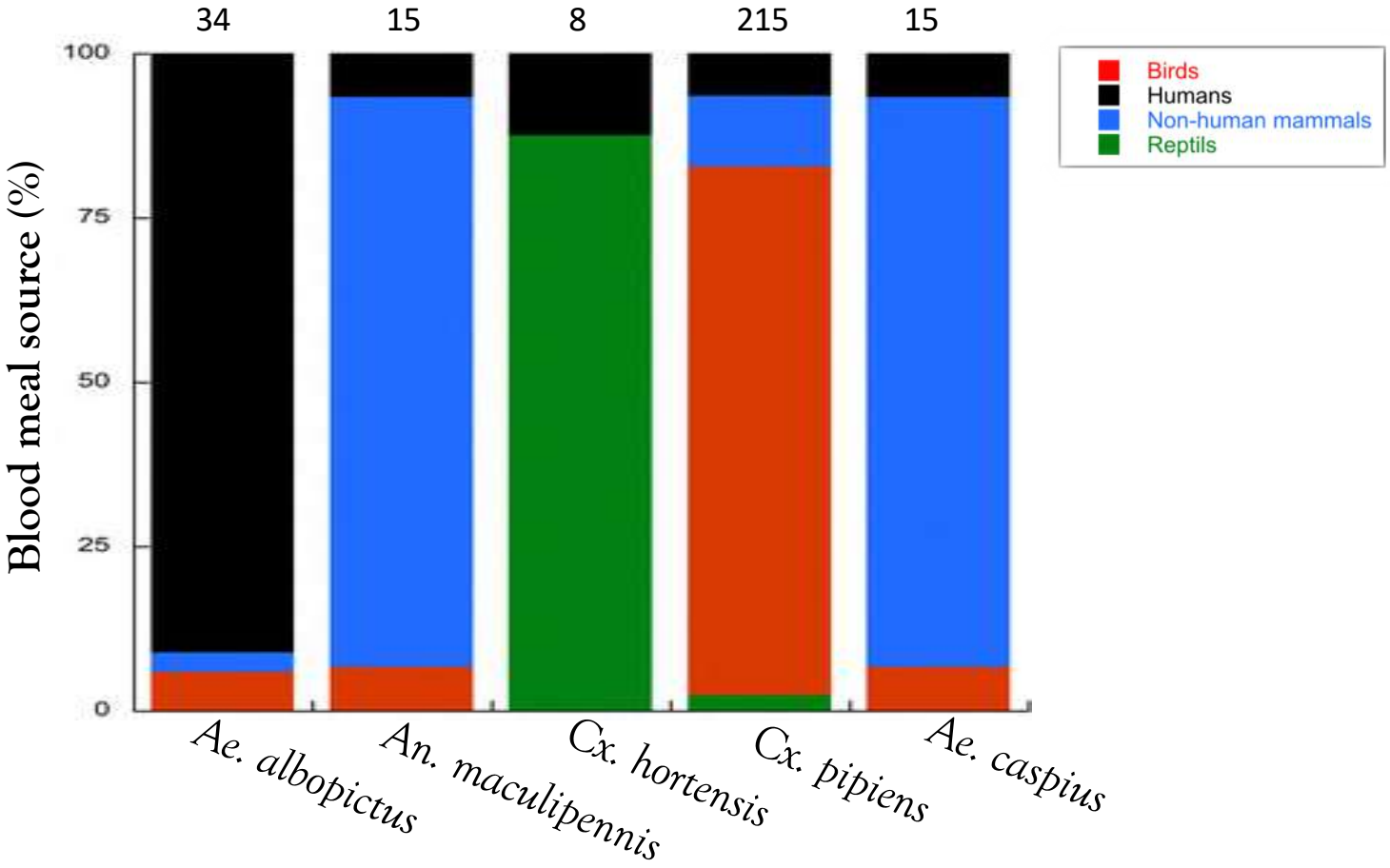




Muñoz J, […], Figuerola J. 2011. J Med Entomol; Suter, TT. The asian tiger mosquito *Aedes albopictus* in Switzerland : biology surveillance and control**. 2015. Doctoral Thesis, Univ of Basel; Martínez-de la Puente J, […], Figuerola J. 2015. Malaria J**



Muñoz J, […], Figuerola J. 2011. J Med Entomol; Suter, TT. The asian tiger mosquito *Aedes albopictus* in Switzerland : biology surveillance and control**. 2015. Doctoral Thesis, Univ of Basel;** **Martínez-de la Puente J, […], Figuerola J. 2015. Malaria J**

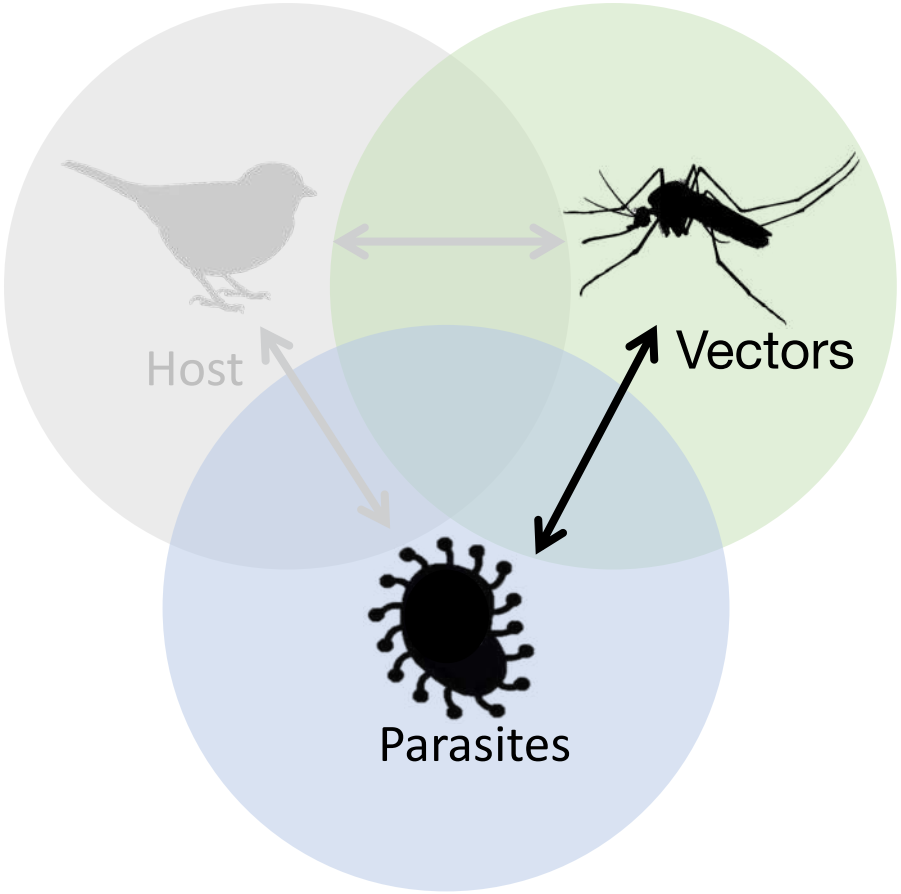


Martínez-de la Puente et al. 2015. Malaria J

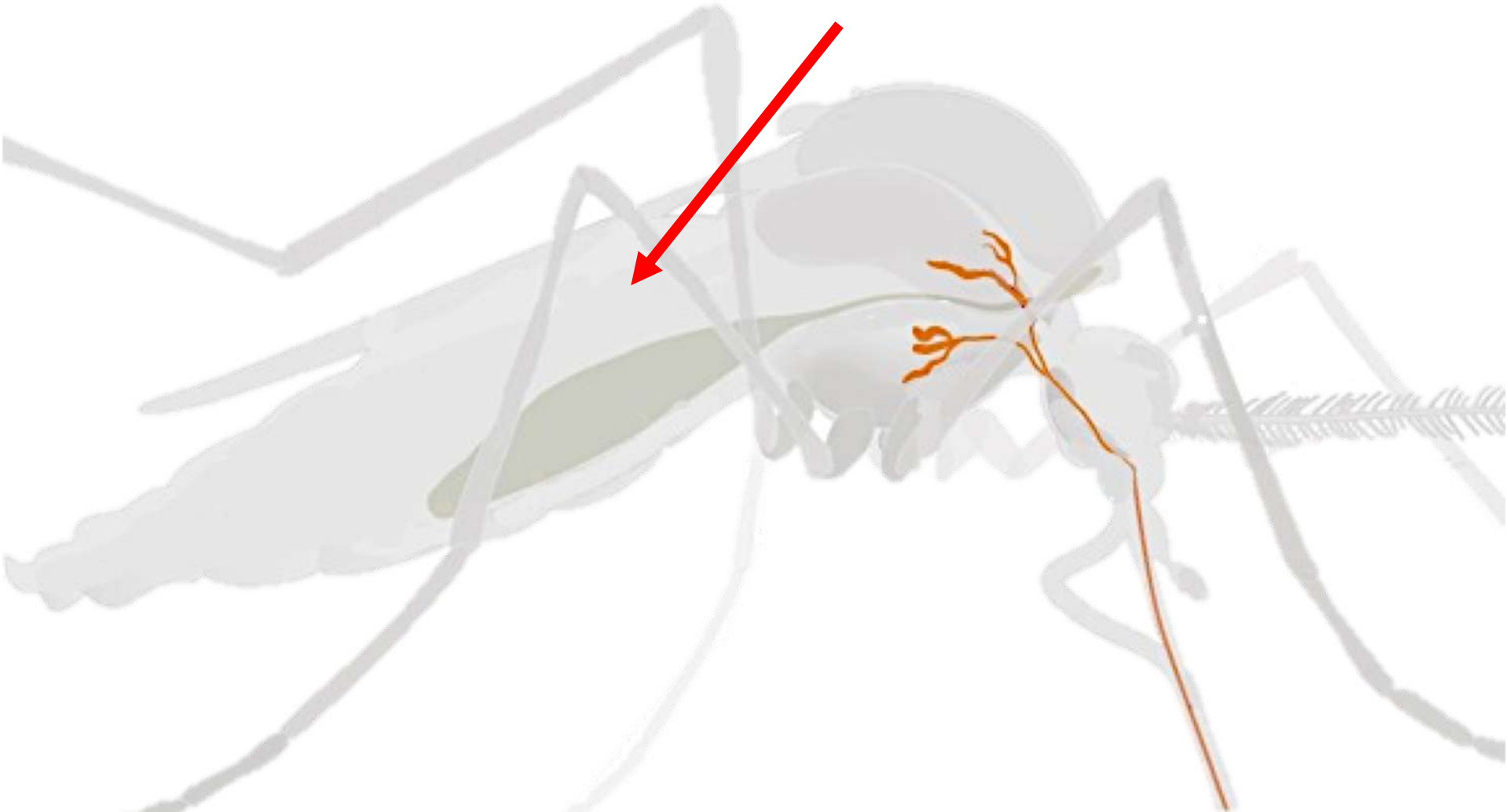
The feeding patterns of mosquitoes differs between species

Studies on the different parameters affecting the vector compence of mosquitoes:

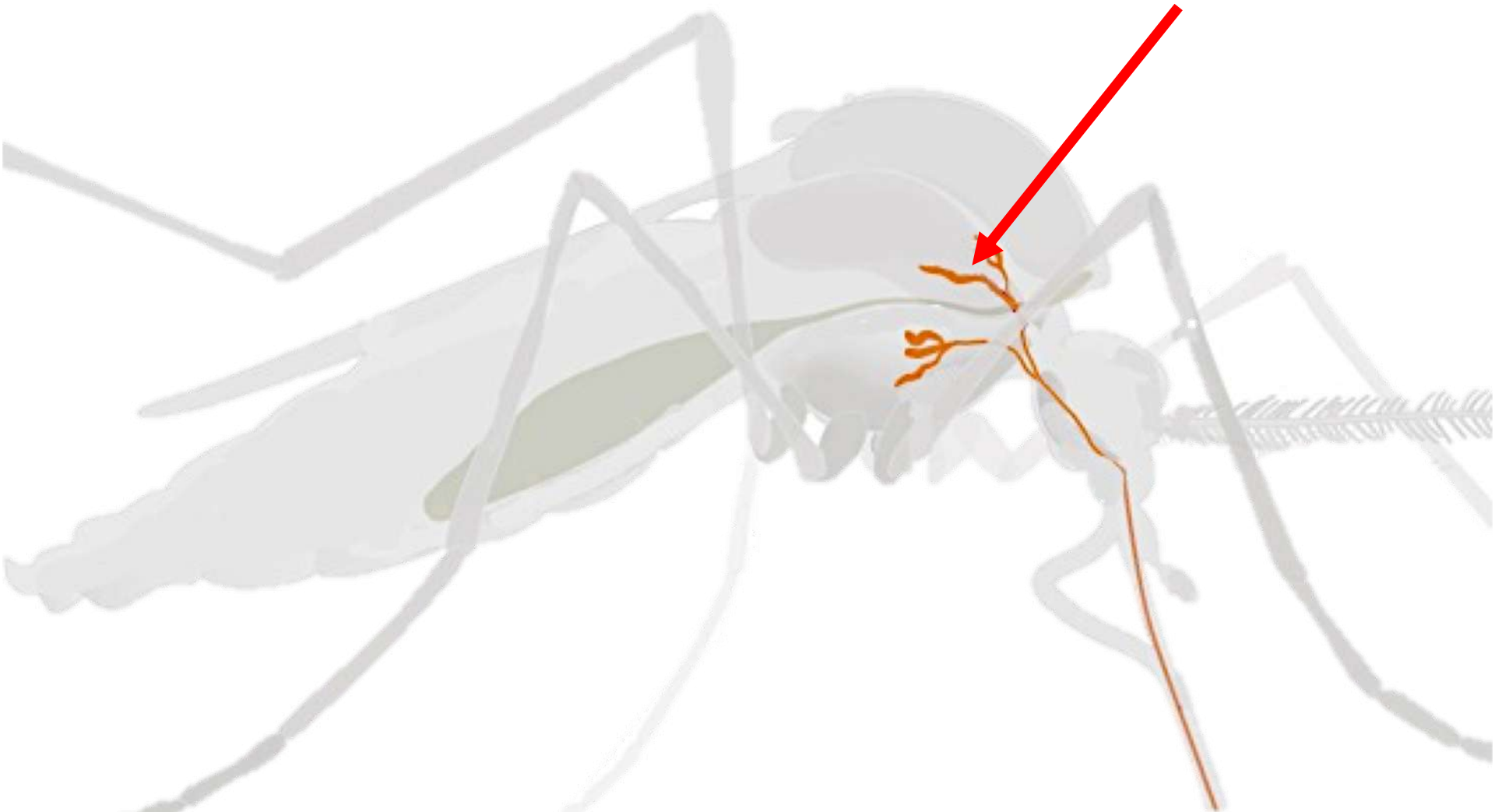
The role of vector-pathogen interactions

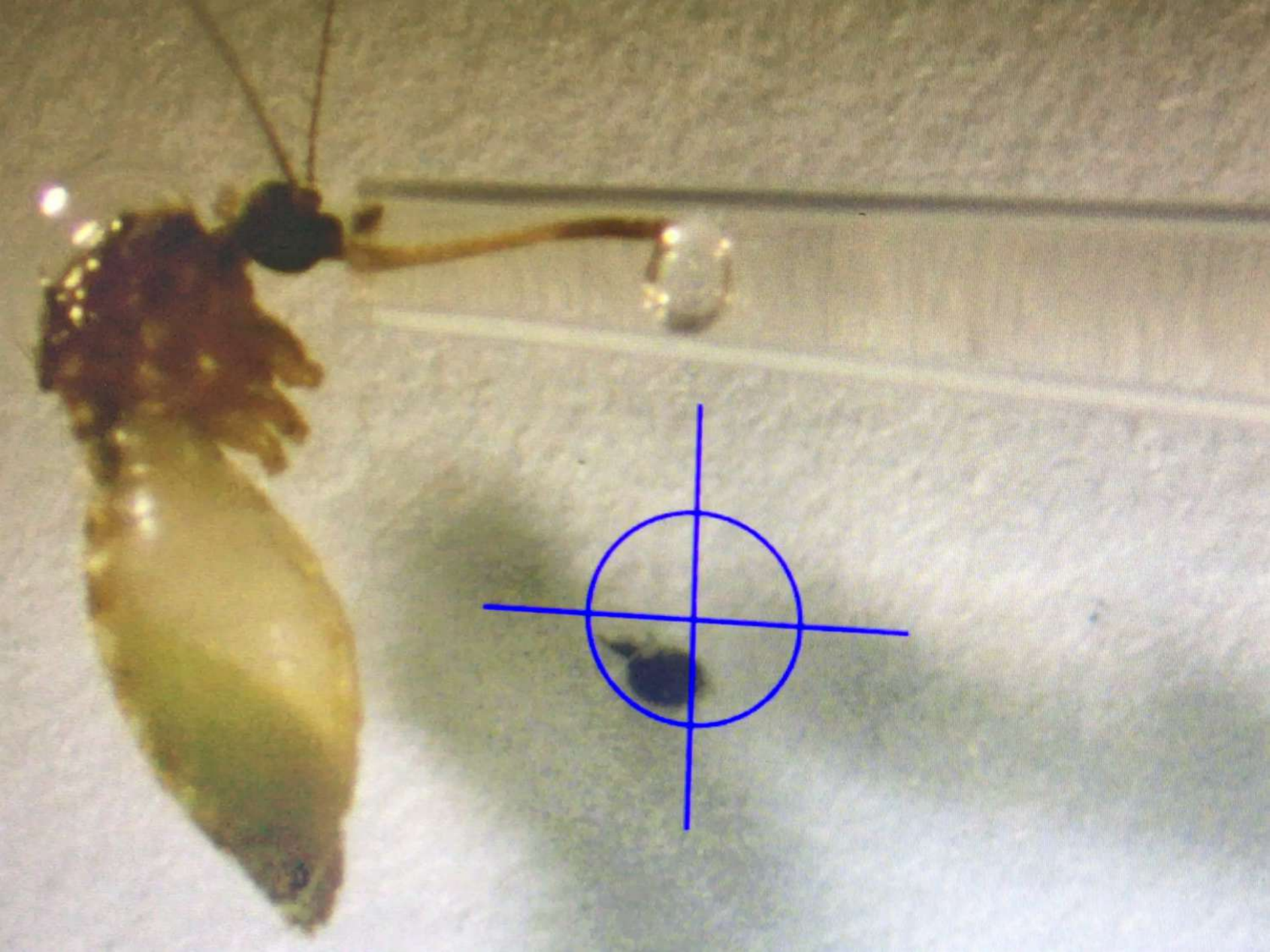


Infection rate:
detection of pathogens in the body of mosquitoes



Transmission rate:
detection of pathogens in the saliva of mosquitoes





PROTECT YOUR FAMILY AND COMMUNITY

HOW ZIKA SPREADS

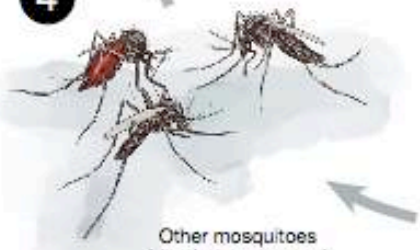
Accessible Version: https://www.cdc.gov/zika/transmission/index.html

Most people get Zika from a mosquito bite

1. A mosquito bites a person infected with Zika virus

2. The mosquito becomes infected

3. The infected mosquito bites a person and infects them with Zika



4. Other mosquitoes bite that person and become infected

5. More members of the community become infected when they are bitten by those infected mosquitoes

Other ways people get Zika

During pregnancy
A pregnant woman can pass Zika virus to her fetus during pregnancy. Zika infection during pregnancy can cause serious birth defects and is associated with other pregnancy problems.

Through sex
Zika virus can be passed through sex from a person who has Zika to his or her sex partners.

Through blood transfusion
Zika virus may be spread through blood transfusion.

264550-A

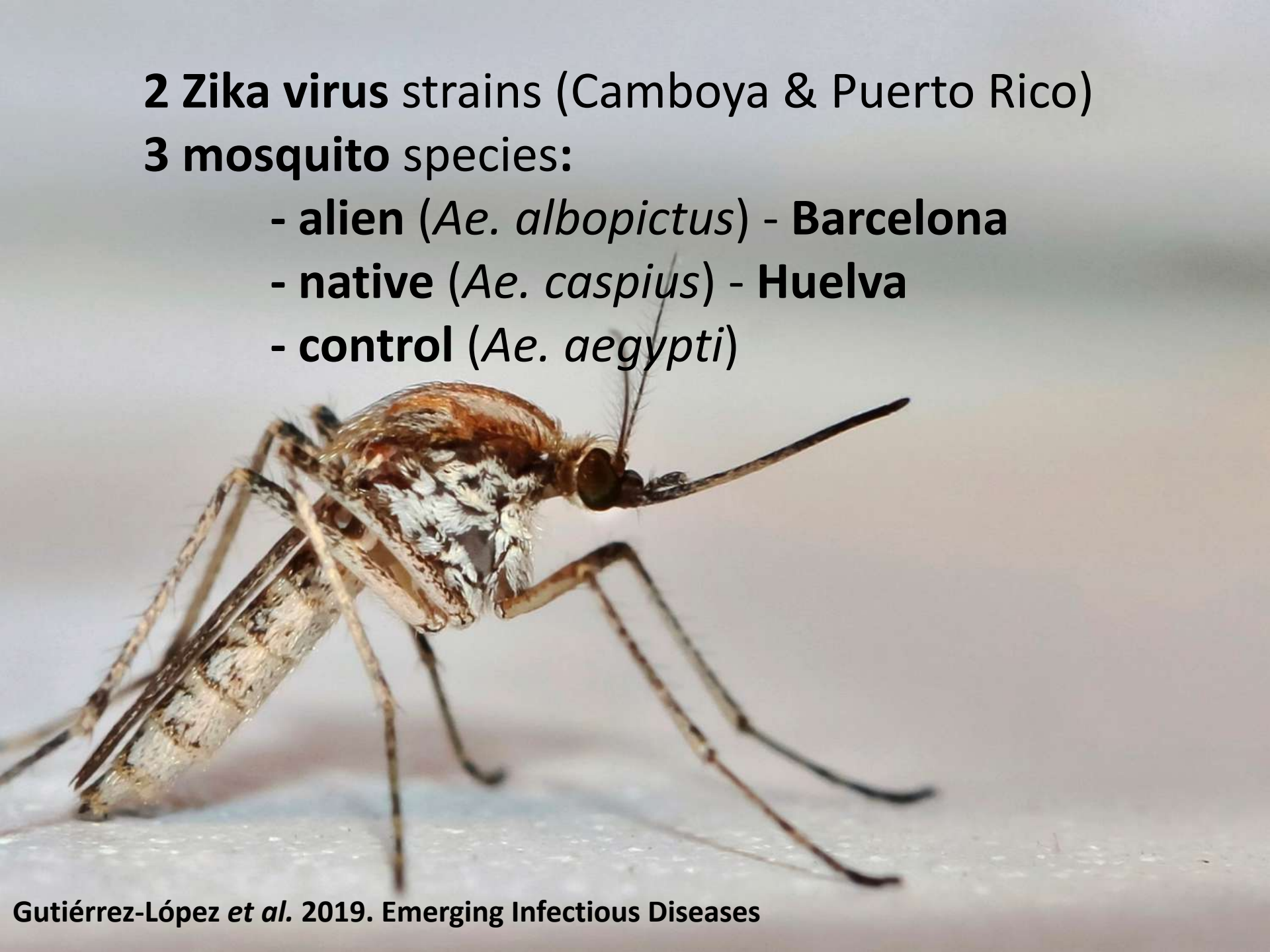
2 Zika virus strains (Camboya & Puerto Rico)

3 mosquito species**:**

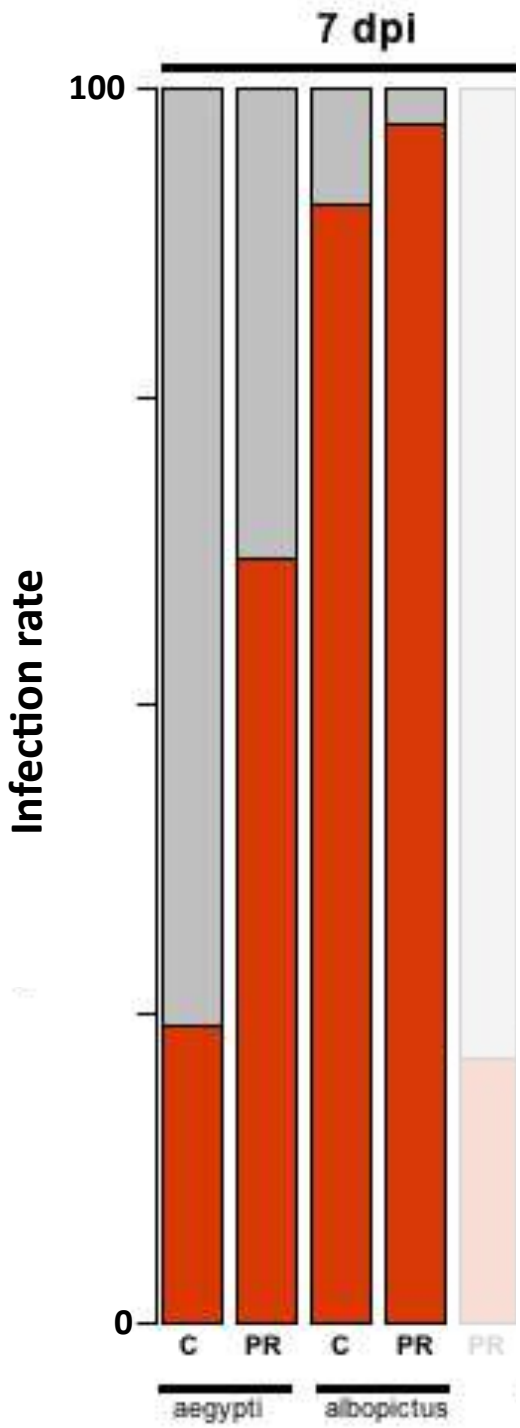
- alien (*Ae. albopictus*) - **Barcelona**

- native (*Ae. caspius*) - **Huelva**

- control (*Ae. aegypti*)



Gutiérrez-López *et al.* 2019. Emerging Infectious Diseases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Infection rate
C
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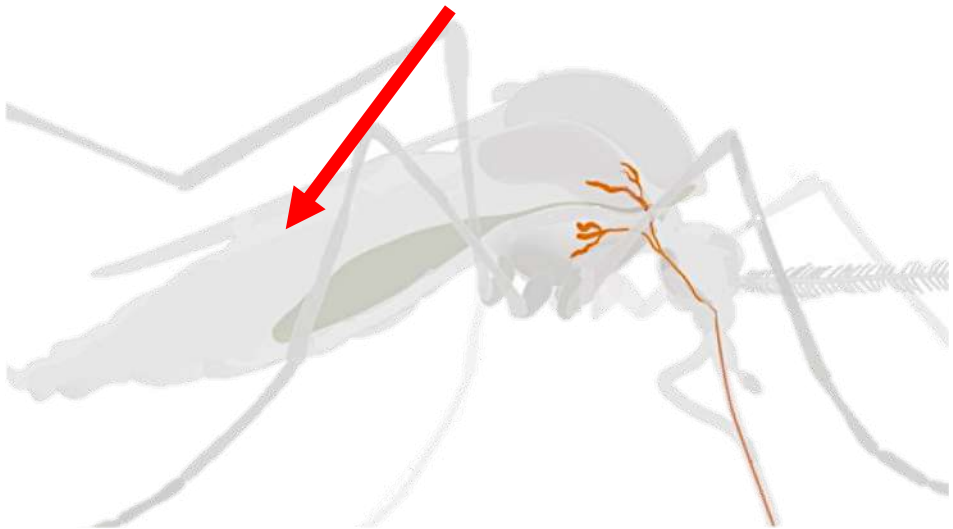
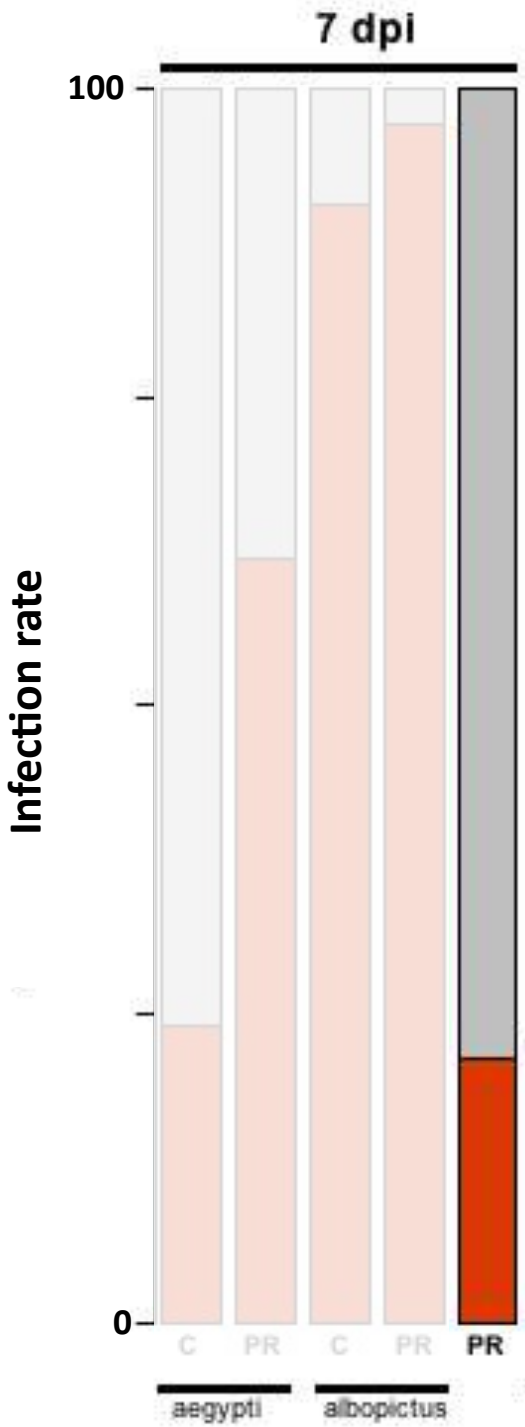
aegypti
albopictus

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Infection rate
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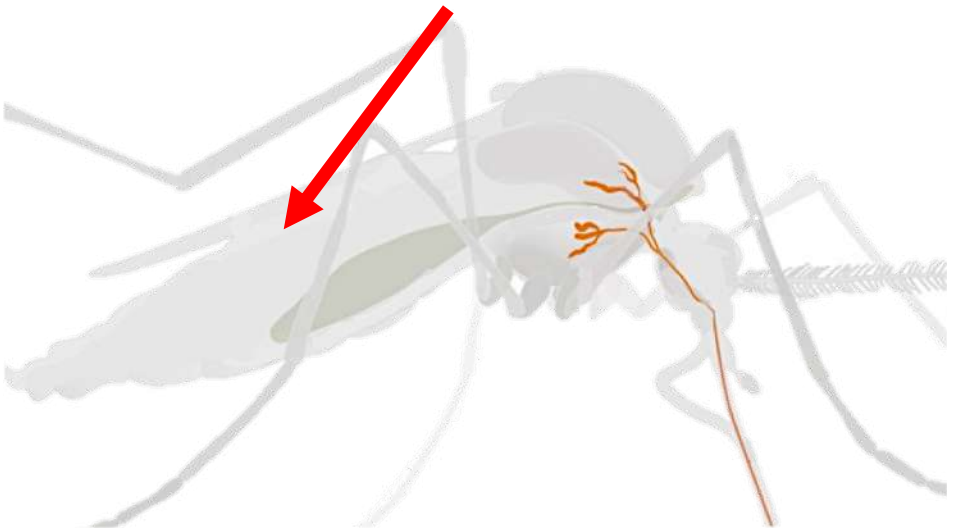

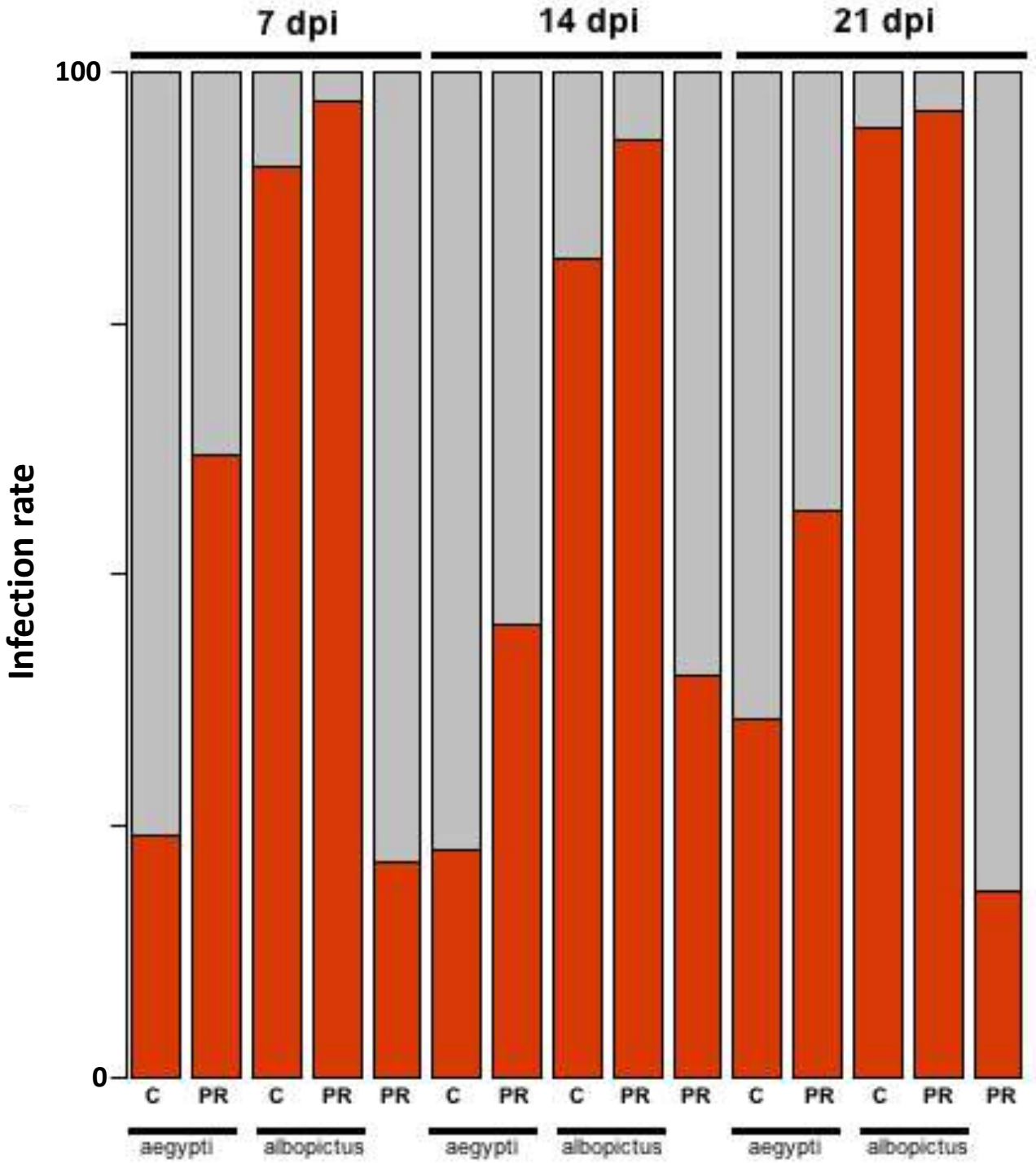
7 dpi
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Infection rate
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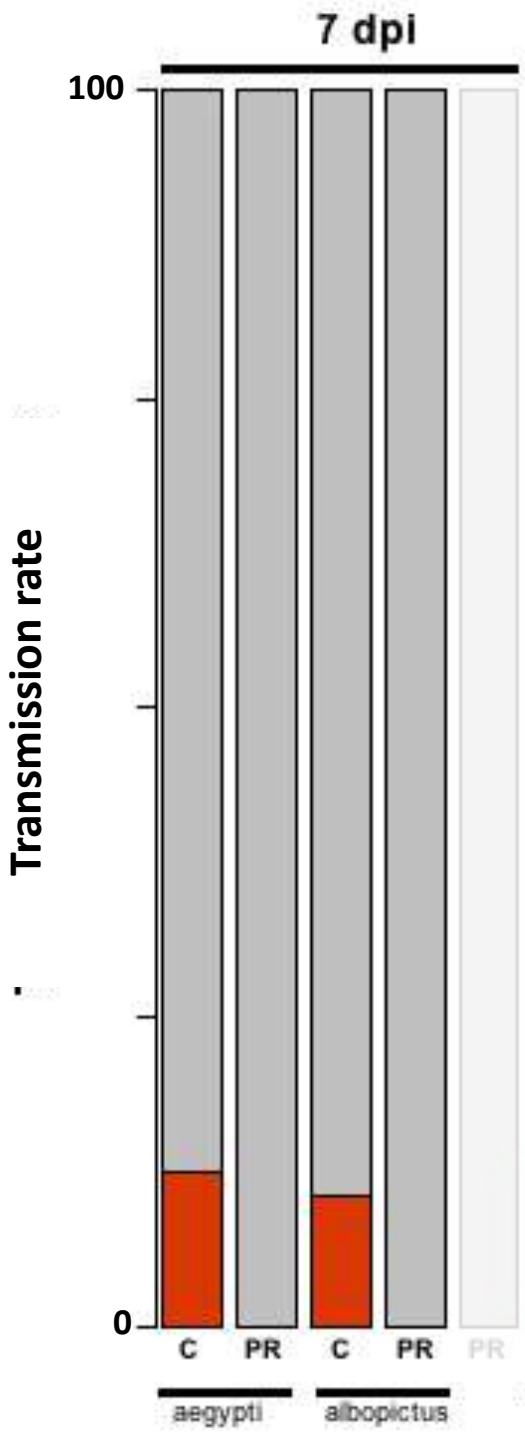
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Transmission rate
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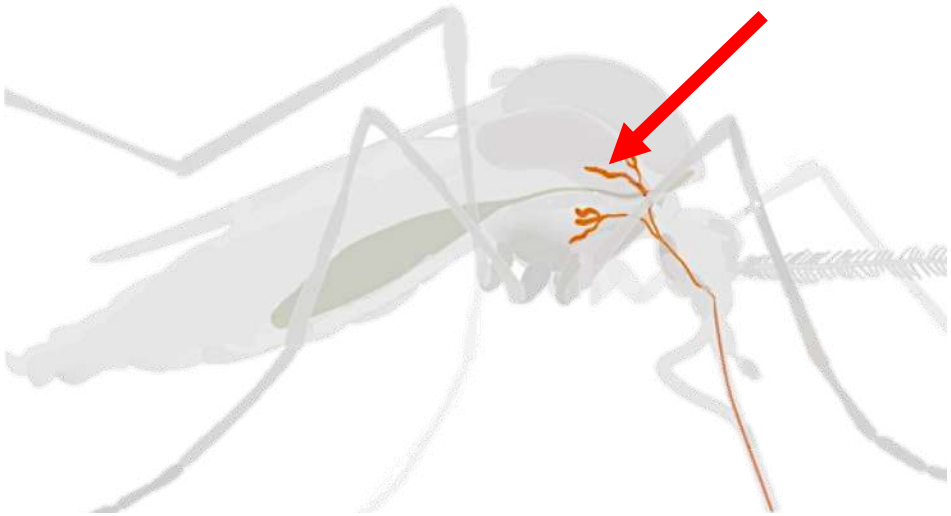
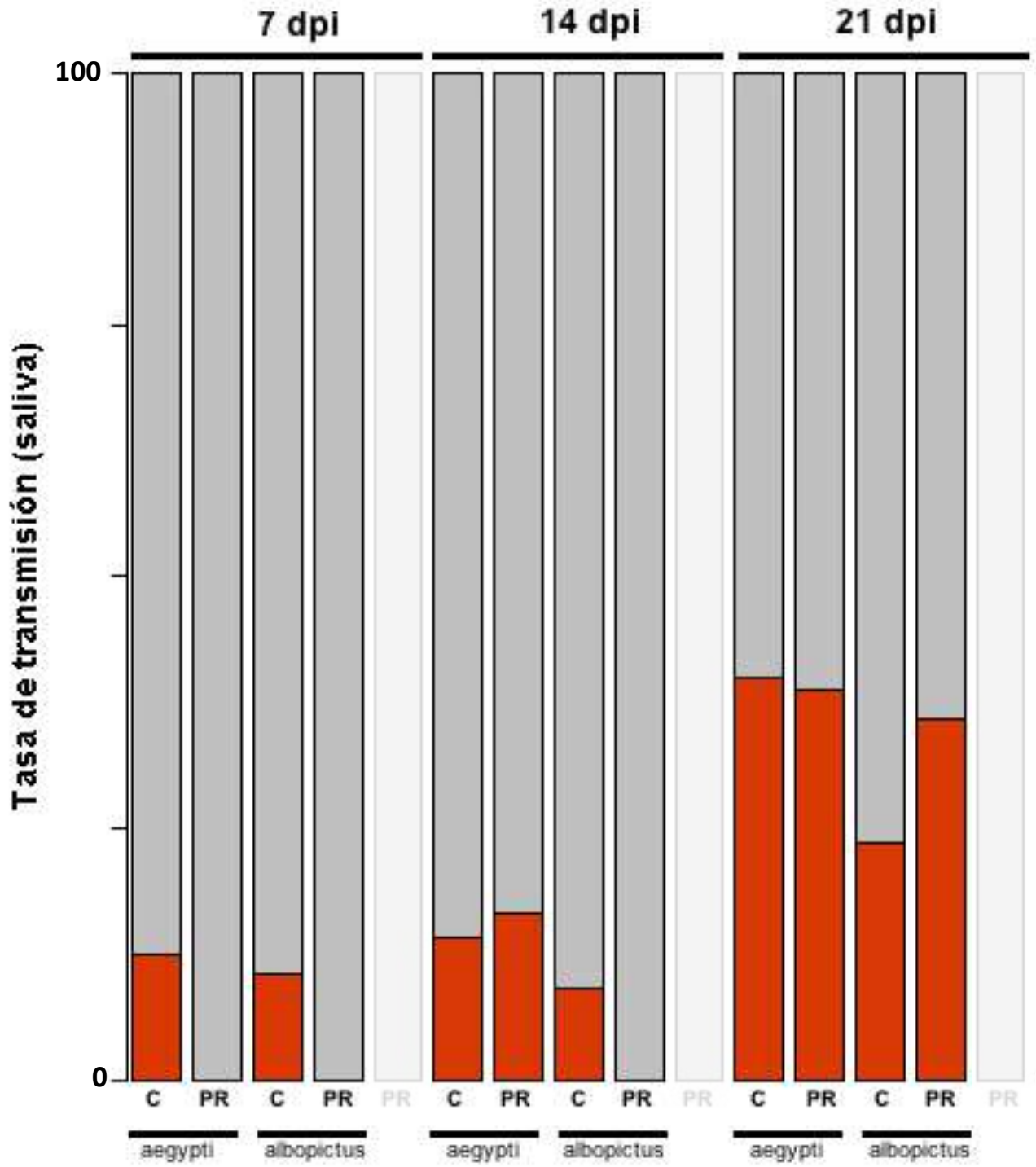
albopictus




7 dpi
14 dpi
21 dpi
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Tasa de transmisión (saliva)
C
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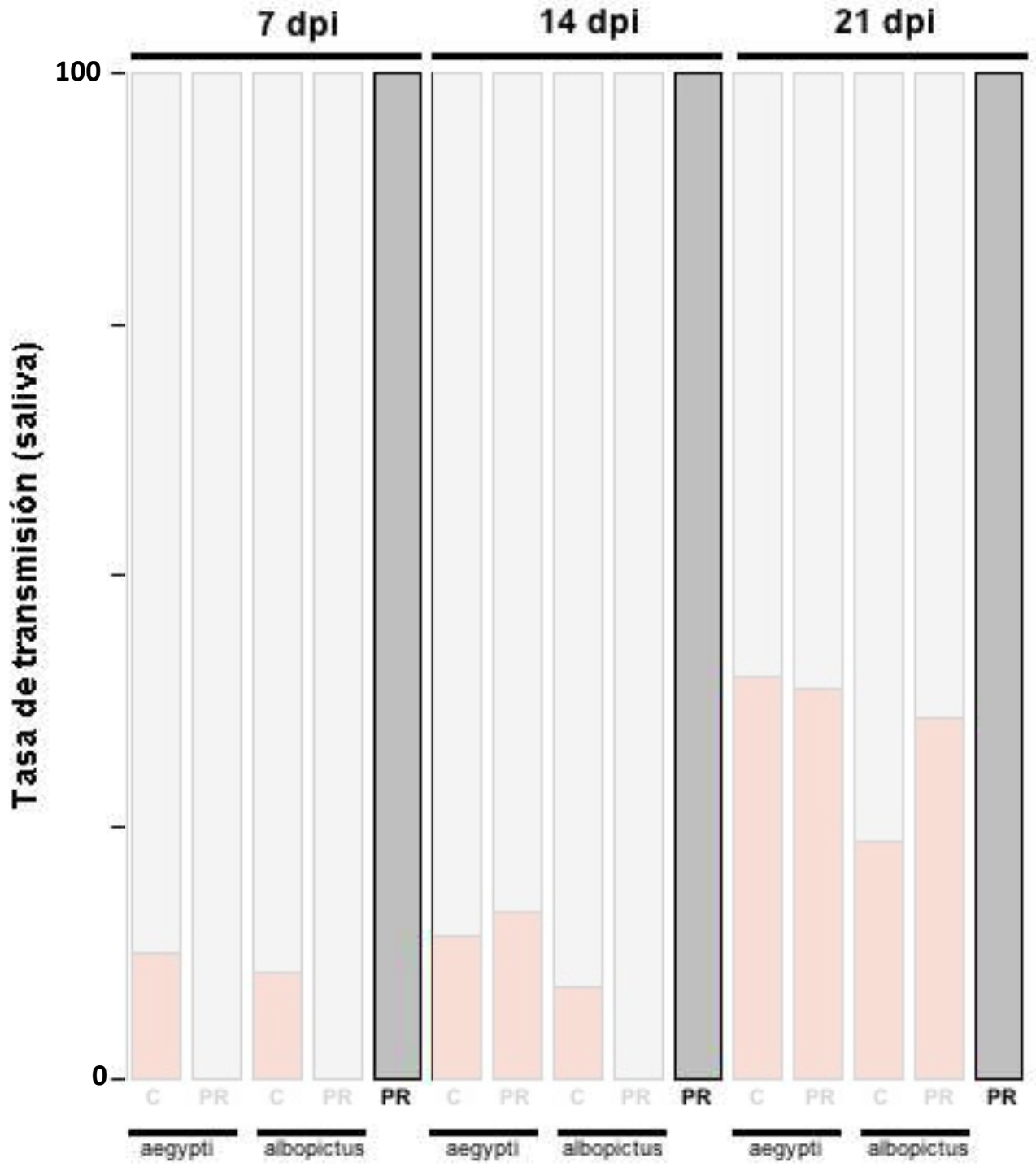
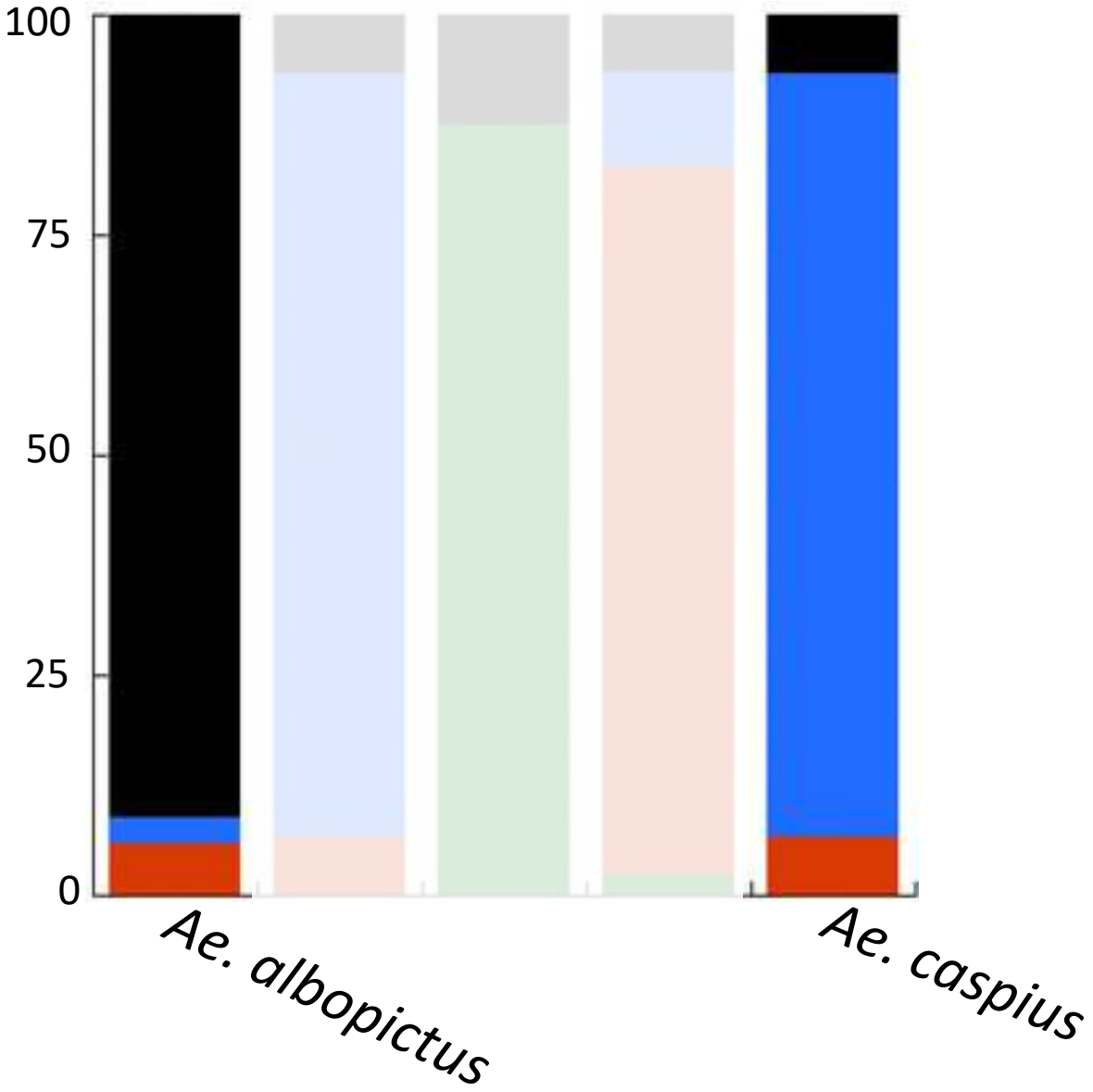
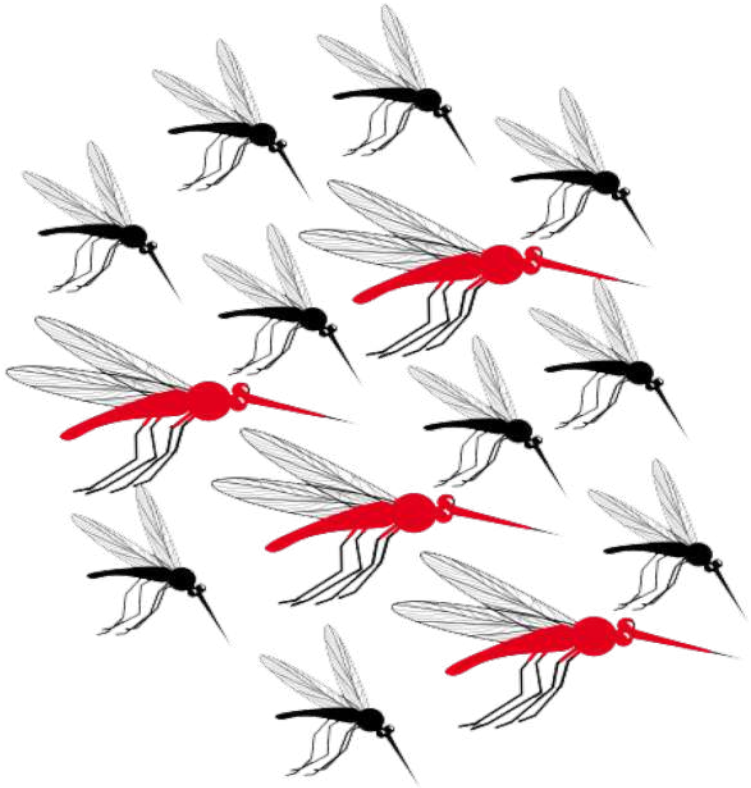
PR
PR
aegypti
albopictus
aegypti
albopictus
aegypti
albopictus


7 dpi
14 dpi
21 dpi
100
0
Tasa de transmisión (saliva)
C
PR
C
PR
PR
C
PR
C
PR
PR
C
PR
C
PR
PR
aegypti
albopictus
aegypti
albopictus
aegypti
albopictus

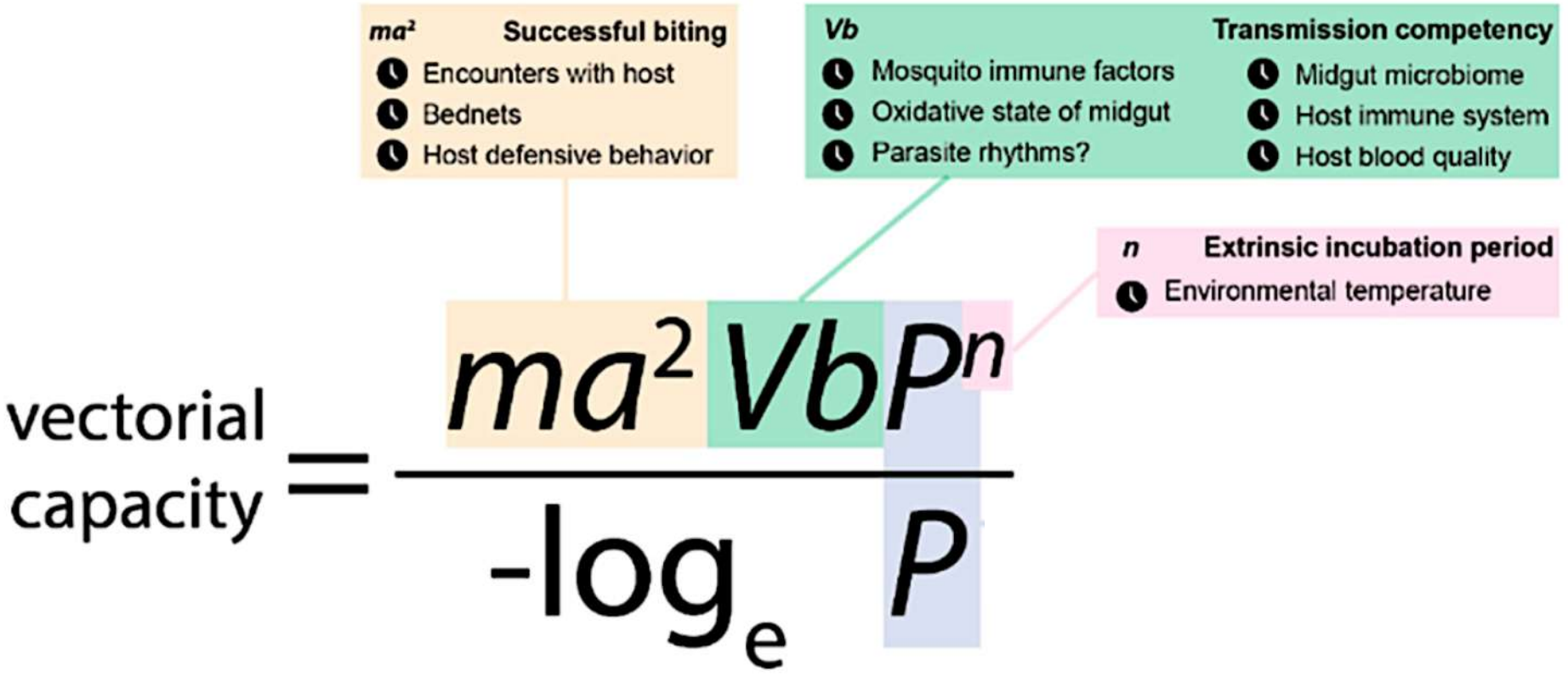
Although both species fed on humans, their ability to develop human-infecting pathogens significantly differs.



Vector competence (ability to transmit the virus) differs between mosquito species

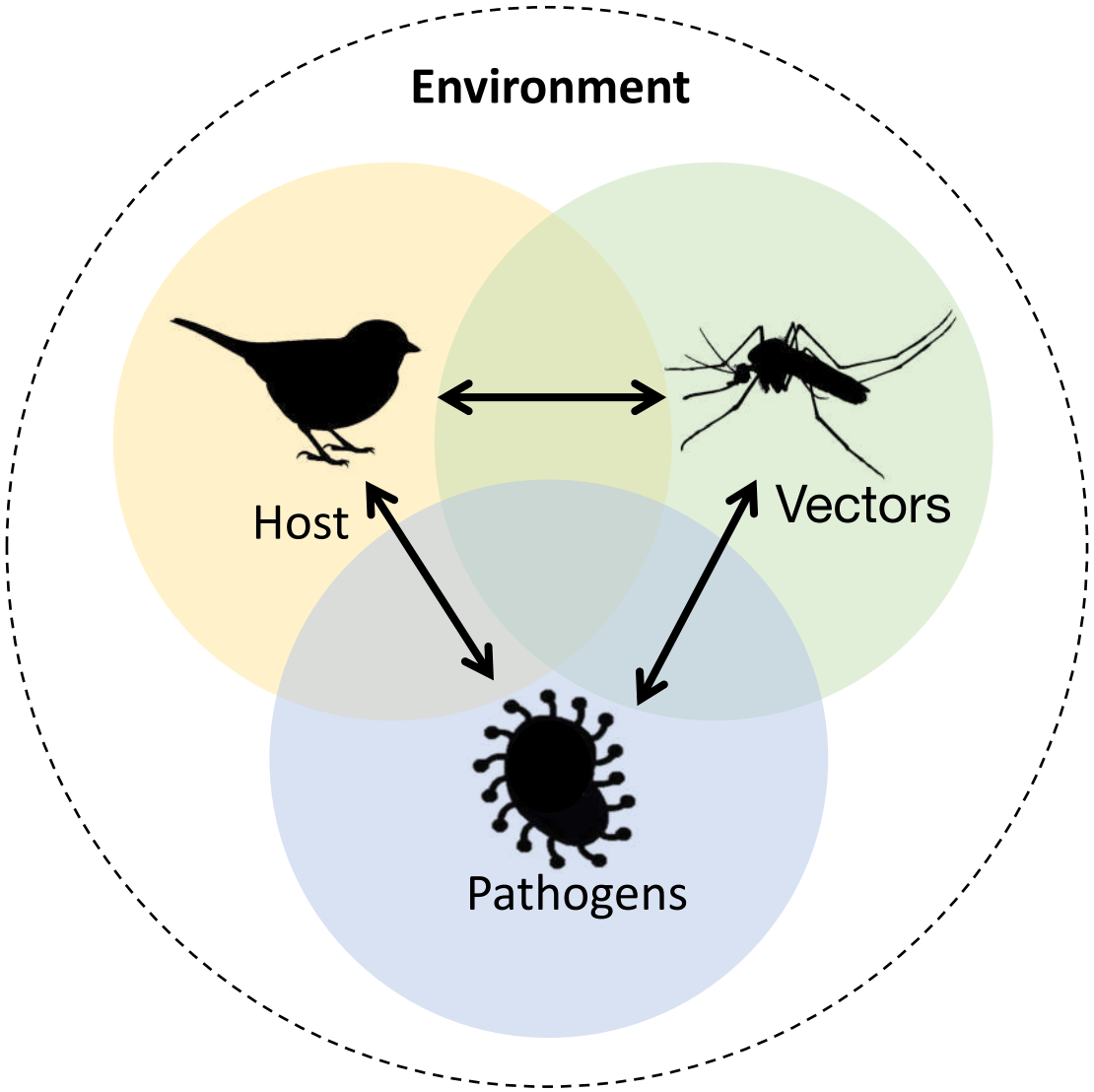


Contact rate and **vector competence are factors strongly affecting** the ability of mosquitoes to transmit mosquito-borne pathogens



Adapted from **Rund et al. 2016.** ***Insects* 7*:* 14.**

But it is essential to consider the **environmental factors affecting these interactions to integrate all of this information**

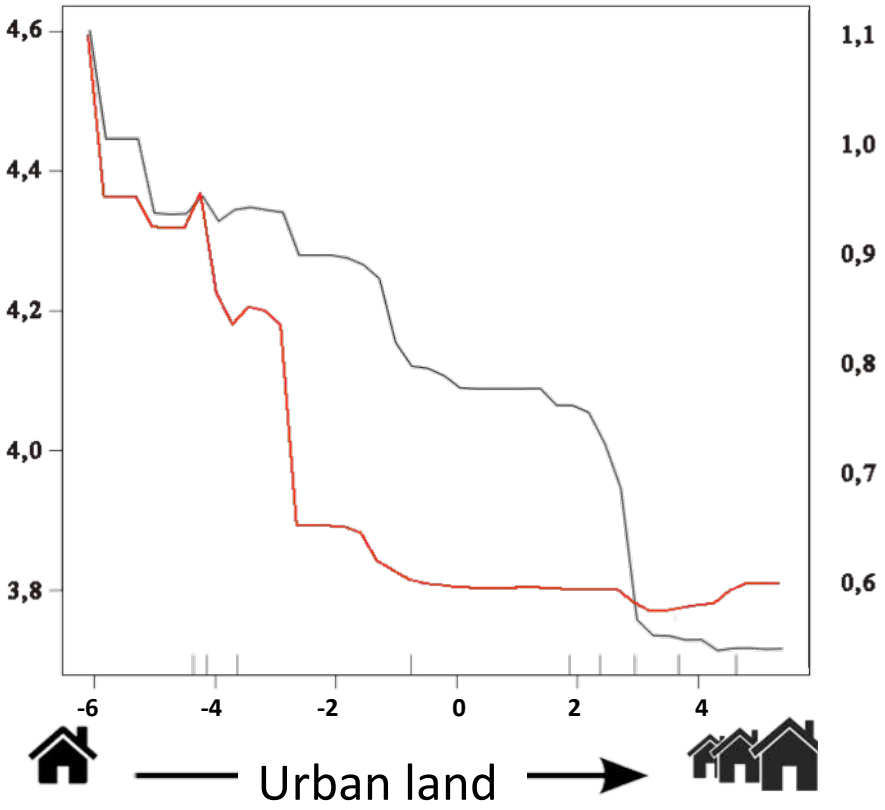


Mosquito species have different **environmental requirements**

Mosquito variable	Buffer	% Var. explained	Most important variables in model
Abundance	1000	45.35	(+) Wetlands, (−) Urban land, (−) Human density
Richness	250	32.06	(−) Urban land, (−) Human density, (−) Marshland
An. atroparvus	1000	41.25	(+) Summer NDVI, (+) Wetlands, (−) Urban land
Cx. modestus	100	19.07	(+) Wetlands, (−) Marshland, (+) Summer NDVI, (−) Winter NDVI
Cx. perexiguus	1000	26.59	(+) Summer NDVI, (+) Autumn NDVI, (−) Urban land
Cx. theileri	2000	45.55	(−) Urban land, (+) Wetlands, (+) Summer NDVI
Oc. caspius	500	45.76	(−) Marshland, (−) Urban land

The **urbanized area** negatively impact the **abundance of** mosquito **vectors**

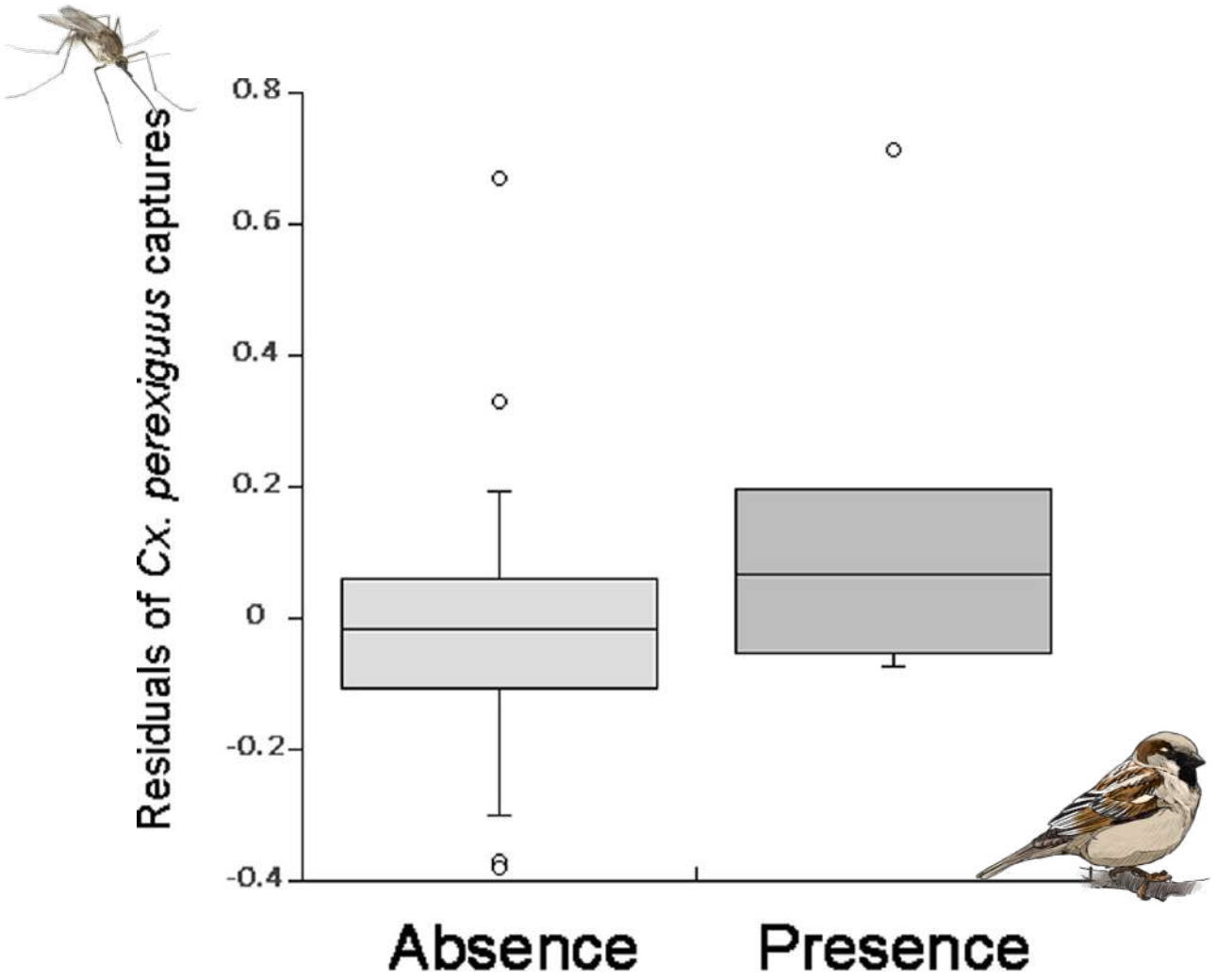
Mosquito abundance



Culex perexiguus

Ferraguti, Martínez-de la Puente *et al. 2016. Sci Rep*

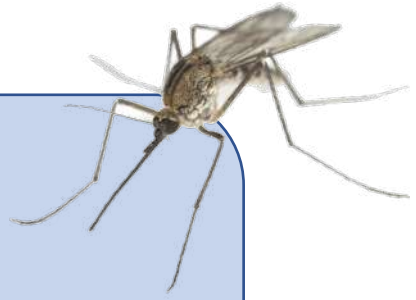
A higher number of *Cx perexiguus* were captured in areas with WNV seropositive sparrows than in areas with absence of positive birds



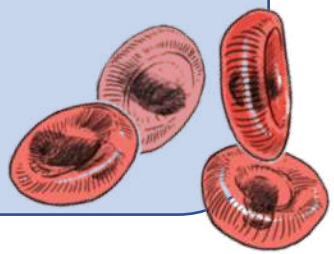
Martínez-de la Puente *et al. 2018. Sci Rep*

<u>In conclusion</u>, different **mosquito species** have different:

Feeding patterns



Vector competence



and environmental requirements, finally playing **different roles** in the **transmission** of **mosquito-borne pathogens**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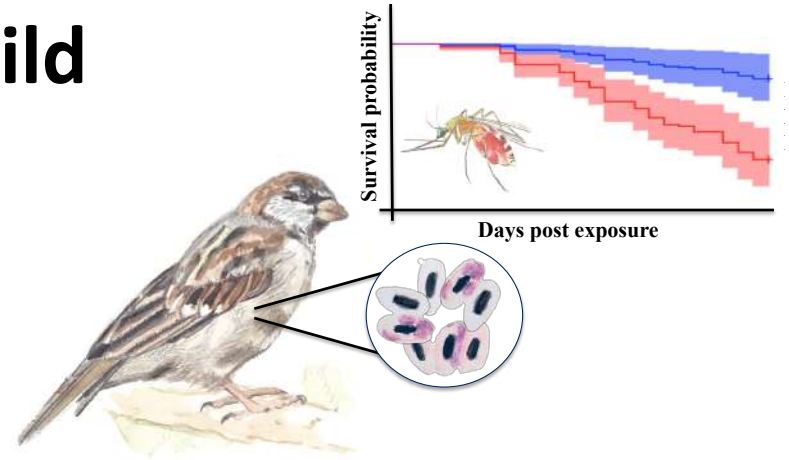
Mosquito related factors should be considered in studies on the **transmission** of mosquito-borne pathogens in the **wild**



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