Supplementary Material for:

Global invasion patterns and dynamics of disease vector mosquitoes

Authors:

Rebecca Pabst[1*], Carla A. Sousa[1], Franz Essl[2], Adrián García-Rodríguez[2], Daijun Liu[2], Bernd Lenzner[2], Anna Schertler[2], José Luís Zêzere[3], César Capinha[3*]

Affiliations:

[1] Global Health and Tropical Medicine, GHTM, LA-REAL, Institute of Hygiene and Tropical Medicine, IHMT, NOVA University Lisbon, Lisbon, Portugal.

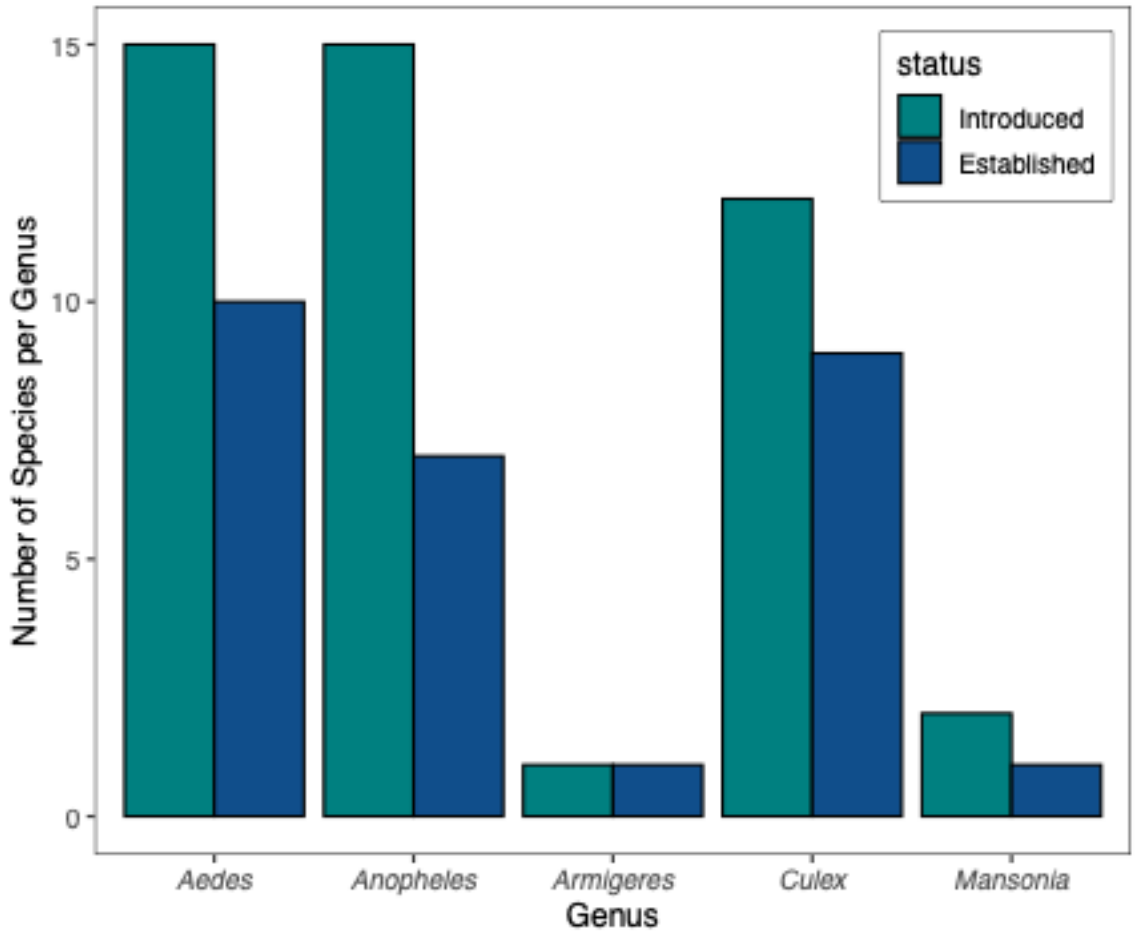
[2] Division of BioInvasions, Global Change and Macroecology, Department of Botany and Biodiversity Research, University Vienna, Rennweg 14, 1030 Vienna, Austria

[3] Centre of Geographical Studies, Institute of Geography and Spatial Planning, University of Lisbon, Lisboa, Portugal; Associate Laboratory TERRA, Lisboa, Portugal.

* *Corresponding authors*: pabst.rebecca@gmail.com; cesarcapinha@edu.ulisboa.pt

6 Figures

6 Tables



Supplementary Figure 1: Number of human disease-transmitting mosquito species introduced by humans outside their native range compared to the number of species that have become established. Values are shown for genera.

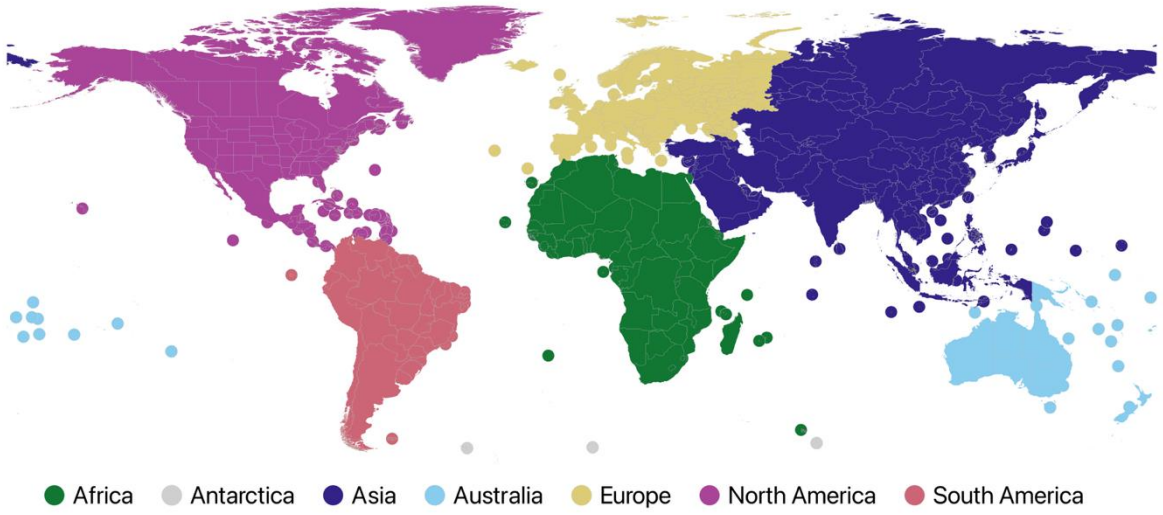
Supplementary Table 1: Number of regional introduction records and number of species of each genus for introduced species as well as introduced and established species.

Genus	Regional introduction records		Number of species	
	Introduced	Established	Introduced	Established
Aedes	469	409	15	10
Anopheles	33	17	15	7
Armigeres	1	1	1	1
Culex	192	184	12	9
Mansonia	2	1	2	1

Supplementary Table 2: Numbers of non-native mosquito species for donor and receiving continents.

Continent	All species			Species started spreading after 1900		
	Number of non-native species native from this continent (total: 45)	Number of species introduced to this continent	Number of species introduced to this continent from outside the continent*	Number of species originated from this continent (total: 38)	Number of species introduced to this continent	Number of species introduced to this continent from outside the continent*
Africa	8	8	3	2	2	1
Asia	12	15	2	10	11	-
Asia/Australia	5	-	-	5	-	-
Australia	3	18	9	4	14	4
Europe	1	13	11	1	11	9
Americas	4	-	-	4	-	-
North America	5	15	9	5	11	5
South America	-	5	4	-	1	-
Old World	4	-	-	4	-	-
uncertain	3	-	-	3	-	-

*Species of uncertain origin, along with species introduced to Asia from the Old World, and species originating from Asia and Australia introduced to one of these continents are not included in the count.



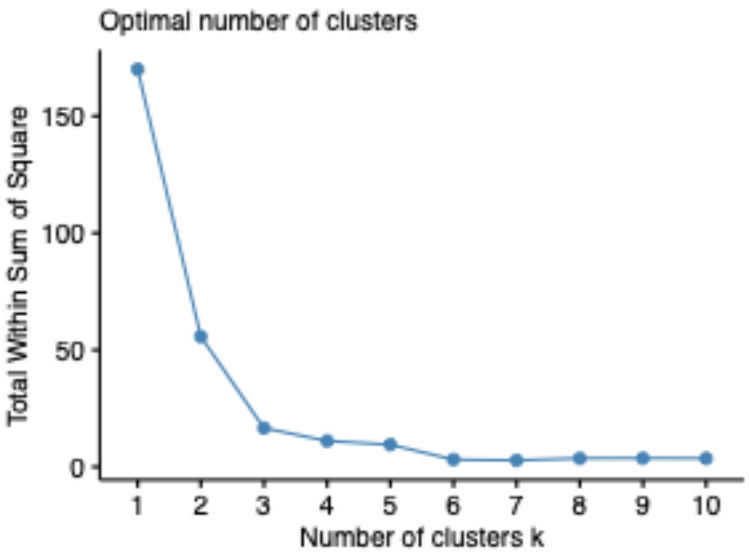
Supplementary Figure 2. Delineation of continents (colors) used for the analysis in this paper. Delineation follows the seven continent model[1]. The underlying world map data were obtained from GADM (https://gadm.org/), used under their academic-use license.

Supplementary Table 3. Number of regions non-native mosquito species were recorded after they were introduced to a continent. Number in () represent the total number of regions that belong to that continent. Colors represent the year of the first continental record. o 1495-1700 o 1700-1800 o 1800-1900 o 1900-2000 o 2000-2022

Species	Number of introduced regions per continent						SUM
	Africa (60)	Asia (126)	Australia (32)	Europe (115)	North America (105)	South America (42)	
Ae. aegy	8	41	17	15	71	40	192
Ae. albo	28	17	13	36	59	36	189
Ae. atro				4	4		8
Ae. camp			1				1
Ae. japo			1	18	43		62
Ae. mcin				1			1
Ae. noto			1		1		2
Ae. poly			1				1
Ae. scut			1				1
Ae. togo					2		2
Ae. tris				1	1		2
Ae. unil		1					1
Ae. vexa		1	1		1		3
Ae. vigi			2				2
Ae. vitt					2		2
An. albi					2		2
An. arab	4					2	6
An. banc			1				1
An. barb		1					1
An. cous	2						2
An. cruc				1			1
An. darl						1	1
An. fune	2						2
An. gamb	2						2
An. lito		1					1
An. macu			1				1
An. phar				1			1
An. punc					1		1
An. step	8	1					9
An. subp		1		1			2
Ar. suba		1					1
Cx. annu			1				1
Cx. ante				1			1
Cx. bita			1				1
Cx. coro					1		1
Cx. fusc		1					1
Cx. geli			5				5
Cx. mode				1			1
Cx. pipi		11	6		46		63
Cx. quin	3	8	22		60	18	111
Cx. siti		1	1				2
Cx. tars					2		2
Cx. trit		1	1	1			3
Ma. titi				1			1
Ma. unif		1					1

Supplementary Table 4. Description and sources of the socio-economic, geographic and environmental variables that were considered as predictors used in the models to estimate the residuals and the models to explain the residuals.

Variable	Description	Source
Socioeconomic variables		
Gross domestic product (GDP) per capita (log transformed)	5-year average between 2017 and 2021	Worldbank (databank.worldbank.org)[2]
Total trade openness (log transformed)	5-year average between 2017 and 2021, average of import and export in US$ at current prices in millions	UNCTAD dataset (United Nation Conference on Trade and Development)[3]
Colonial impact	Occupation time by the eight European colonial powers: British, Dutch, Spanish, Portuguese, Belgian, French, German, and Italian. Number of European colonial powers that occupied the country.	Lenzner et al. 2022[4] and Lenzner (unpublished)
Human population (log transformed)	5-year average between 2017 and 2021, total number of individuals per country	Worldbank (databank.worldbank.org)[2]
Sampling bias	the average between a country's proactive and reactive capacity towards invasive alien species	Early et al. 2016[5]
Geographic variables		
Insularity	1 = island; 0 = mainland	No specific source
Latitude of centroid	absolute value of decimal degree	Calculated in QGIS
Area (log transformed)	size of the region/country in km2	Calculated in QGIS
Environmental variables		
Average annual temperature	The average annual temperature from 1970 to 2000 in °C, resolution 30 Arcsec	worldclim[6]
Average annual precipitation	The average annual total precipitation from 1970 to 2000 in millimeters, resolution 30 Arcsec	worldclim[6]
Landcover (log transformed)	Copernicus Global Land Service: Land Cover 100m; percentage of wetlands/rivers and agricultural land	Copernicus[7]

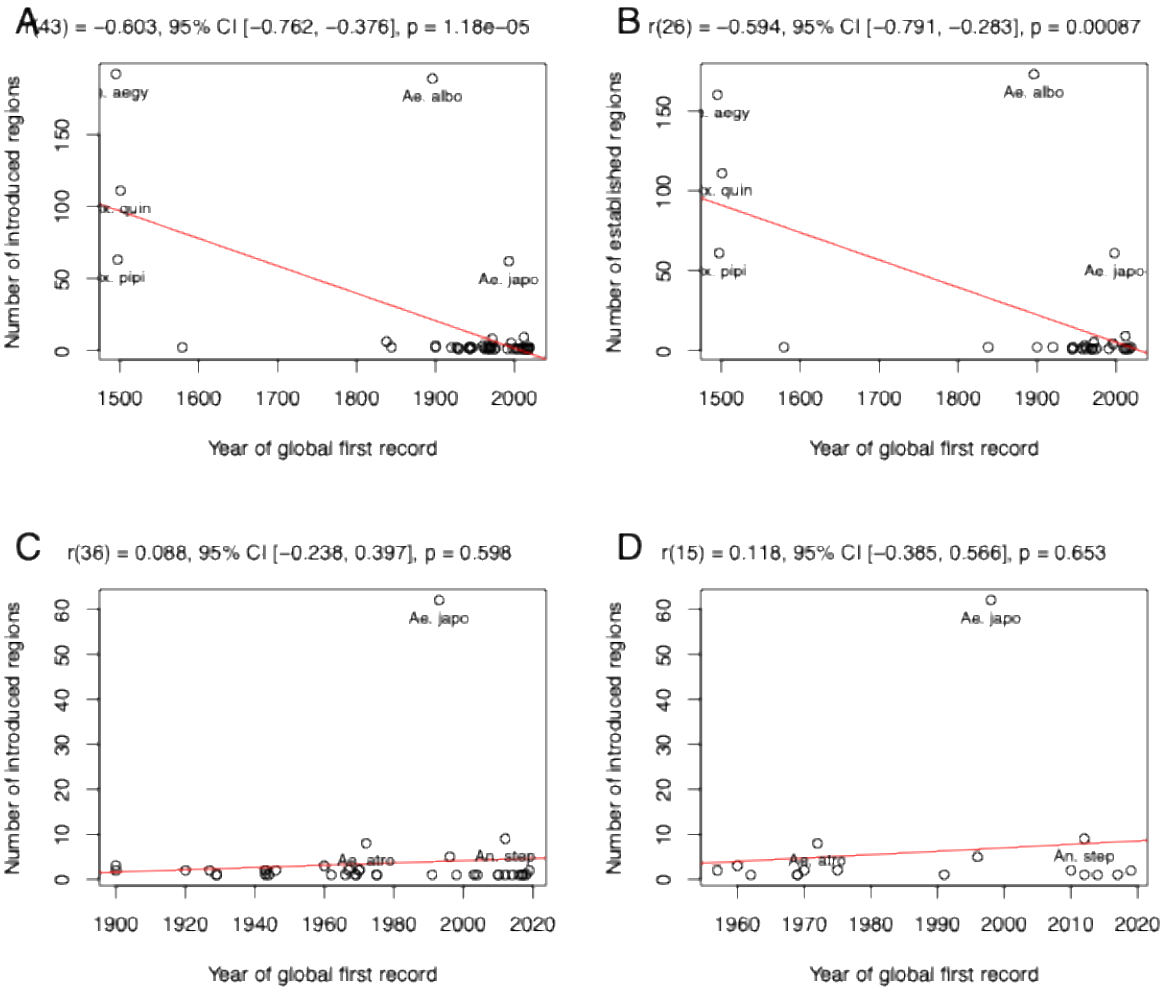


Supplementary Figure 3. Elbow method to identify optimum number of clusters to group mosquitoes represented in the PCA (Figure 3).

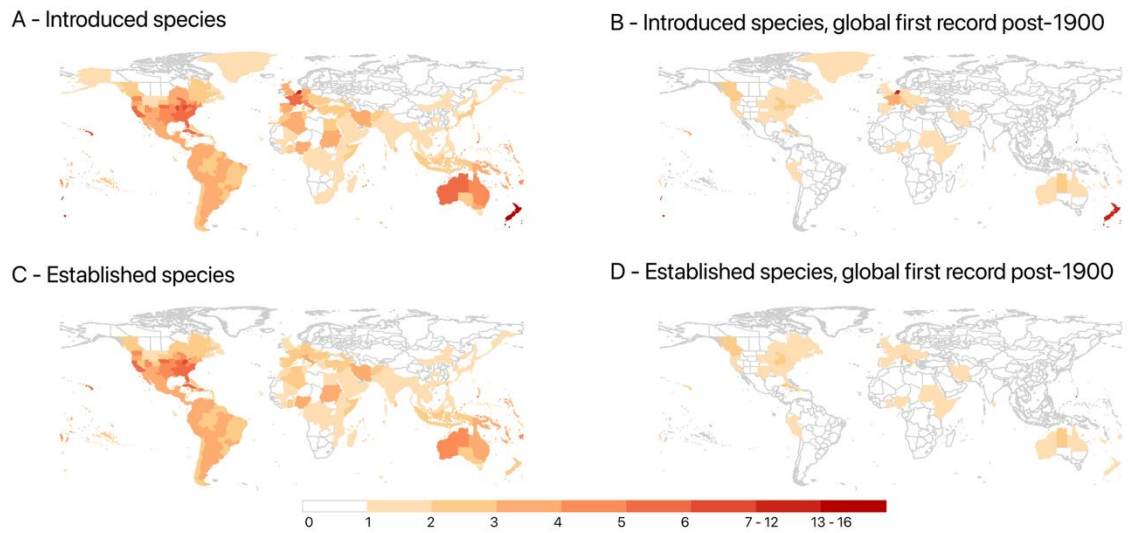
Supplementary Table 5. List of species names, descriptors, and abbreviations used in the manuscript, along with information on whether each species was introduced or also established beyond its native range. Includes the assignment of native ranges for non-native species to continents and relevant data sources.

Species	Author	Native Continent	Native continents if unclear	Abbreviation	Established outside their native range
Aedes (Aedimorphus) vexans	Meigen, 1830	Asia/Australia[8]	NA	*Ae. vexa*	yes
Aedes (Fredwardsius) vittatus	Bigot, 1861	Old World[8,9]	Africa/Asia-Trop/Europe	*Ae. vitt*	yes
Aedes (Georgecraigius) atropalpus	Coquillett, 1902	North America[10]	NA	*Ae. atro*	yes
Aedes (Hulecoeteomyia) japonicus japonicus	Theobald, 1901	Asia[10,11]	NA	*Ae. japo*	yes
Aedes (Ochlerotatus) camptorhynchus	Thomson, 1869	Australia[12]	NA	*Ae. camp*	no
Aedes (Ochlerotatus) mcintoshi	Huang, 1985	Africa[8]	NA	*Ae. mcin*	no
Aedes (Ochlerotatus) vigilax	Skuse, 1889	Asia/Australia[8]	NA	*Ae. vigi*	yes
Aedes (Protomacleaya) triseriatus	Say, 1823	North America[13]	NA	*Ae. tris*	no
Aedes (Rampamyia) notoscriptus	Skuse, 1889	Australia[8]	NA	*Ae. noto*	yes
Aedes (Stegomyia) aegypti aegypti	Linnaeus, 1762	Africa[14]	NA	*Ae. aegy*	yes
Aedes (Stegomyia) albopictus	Skuse, 1895	Asia[10]	NA	*Ae. albo*	yes
Aedes (Stegomyia) polynesiensis	Marks, 1951	Australia[8]	NA	*Ae. poly*	no
Aedes (Stegomyia) scutellaris	Walker, 1859	Asia/Australia[8]	NA	*Ae. scut*	no
Aedes (Stegomyia) unilineatus	Theobald, 1906	Old World[8]	Africa/Asia	*Ae. unil*	yes
Aedes (Tanakaius) togoi	Theobald, 1907	Asia[8]	NA	*Ae. togo*	yes
Anopheles (Anopheles) bancroftii	Giles, 1902	Asia/Australia[8,15]	NA	*An. banc*	yes
Anopheles (Anopheles) barbirostris	van der Wulp, 1884	Asia[8,16,17]	NA	*An. barb*	no
Anopheles (Anopheles) coustani	Laveran, 1900	Africa[8]	NA	*An. cous*	no
Anopheles (Anopheles) crucians	Wiedemann, 1828	North America[8]	NA	*An. cruc*	no
Anopheles (Anopheles) maculipennis	Meigen, 1818	Europe[8,18]	NA	*An. macu*	no
Anopheles (Anopheles) punctipennis	Say, 1823	North America[8,19]	NA	*An. punc*	no
Anopheles (Cellia) arabiensis	Patton, 1905	Africa[8,17]	NA	*An. arab*	yes
Anopheles (Cellia) funestus	Giles, 1900	Africa[8,17]	NA	*An. fune*	no
Anopheles (Cellia) gambiae s.s.	Giles, 1902	Africa[8,17]	NA	*An. gamb*	yes
Anopheles (Cellia) litoralis	King, 1932	Asia[8]	NA	*An. lito*	no
Anopheles (Cellia) pharoensis	Theobald, 1901	Africa[8,17]	NA	*An. phar*	no
Anopheles (Cellia) stephensi	Liston, 1901	Asia[20,21]	NA	*An. step*	yes

Anopheles (Cellia) subpictus	Grassi, 1899	Asia[22]	NA	*An. subp*	yes
Anopheles (Nyssorhynchus) albimanus	Wiedemann, 1821	Americas[8]	NA	*An. albi*	yes
Anopheles (Nyssorhynchus) darlingi	Root, 1926	Americas[17,23]	NA	*An. darl*	yes
Armigeres (Armigeres) subalbatus	Coquillett, 1898	Asia[8]	NA	*Ar. suba*	yes
Culex (Barraudius) modestus	Ficalbi, 1890	Old World[24]	Africa/Asia/Europe	*Cx. mode*	yes
Culex (Culex) annulirostris	Skuse, 1889	Asia/Australia[8]	NA	*Cx. annu*	no
Culex (Culex) antennatus	Becker, 1903	Asia[8]	NA	*Cx. ante*	no
Culex (Culex) coronator	Dyar & Knab, 1906	Americas[8,25]	NA	*Cx. coro*	yes
Culex (Culex) fuscocephala	Theobald, 1907	Asia[8]	NA	*Cx. fusc*	yes
Culex (Culex) gelidus	Theobald, 1901	Asia[8,26]	NA	*Cx. geli*	yes
Culex (Culex) pipiens s.s.	Linnaeus, 1758	Africa[27]	NA	*Cx. pipi*	yes
Culex (Culex) quinquefasciatus	Say, 1823	Asia[27,28]	NA	*Cx. quin*	yes
Culex (Culex) sitiens	Wiedemann, 1828	unknown[8]	Africa/Asia-Trop/Australia	*Cx. siti*	yes
Culex (Culex) tarsalis	Coquillett, 1896	North America[8]	NA	*Cx. tars*	yes
Culex (Culex) tritaeniorhynchus	Giles, 1901	Old World[8,29]	Africa/Asia	*Cx. trit*	yes
Culex (Oculeomyia) bitaeniorhynchus	Giles, 1901	unknown[30]	Africa/Asia/Australia	*Cx. bita*	no
Mansonia (Mansonia) titillans	Walker, 1848	Americas[8]	NA	*Ma. titi*	no
Mansonia (Mansonioides) uniformis	Theobald, 1901	unknown[17]	Africa/Asia-Trop/Australia	*Ma. unif*	yes



Supplementary Figure 4. Results of two-sided Pearson correlation tests between the year of global first record and the number of invaded regions. Panels show: (A) all introduced species, (B) all introduced and established species, (C) introduced species with a first global record after 1900, and (D) introduced species with a first global record after 1950. Reported statistics include the correlation coefficient (r), degrees of freedom (df, in brackets), 95% confidence intervals (CI), and exact p-values (p).



Supplementary Figure 5. Regional level richness of introduced non-native species. Maps represent introduced species richness (A), introduced species with first global record post-1900 (B), established species richness (C), and established species with first global record post-1900 (D). The underlying world map data were obtained from GADM (https://gadm.org/), used under their academic-use license.

Supplementary Table 6. Summary of Generalized Linear Mixed Models (GLMMs) evaluating the effects of socio-economic and environmental predictors on the number of introduced and established mosquito vector species. Four models are presented: (1) introductions of all species, (2) introductions of species first recorded post-1900, (3) establishments of all species, and (4) establishments of species first recorded post-1900. All predictor variables were log-transformed and standardized prior to analysis. Continent was included as a random intercept to account for regional clustering. For each predictor, the table reports the estimated effect size (β), 95% confidence interval (CI), Wald z-statistic, and associated p-value. Significance codes: *p < 0.001, p < 0.01, p < 0.05, .p < 0.1.

Model 1 - Introduced species					
Predictor	Estimate	95% CI	z value	p-value	
Intercept	2.282	[2.261, 2.303]	211.17	< 0.001	***
Island	0.06	[0.005, 0.115]	2.15	0.031	*
Empire Richness	0.012	[-0.009, 0.032]	1.11	0.268	
Avg. Temp (scaled)	0.011	[-0.013, 0.034]	0.91	0.364	
log(GDP per cap)	0.023	[0.002, 0.043]	2.16	0.03	*
log(Precip + 1	0.006	[-0.014, 0.025]	0.55	0.584	
log(Population)	0.033	[0.009, 0.058]	2.67	0.008	**
log(Wetland %)	-0.009	[-0.028, 0.009]	-0.99	0.324	
log(Agriculture %)	0.006	[-0.016, 0.028]	0.52	0.606	
Model 2 - Introduced species, spreading after 1900					
Predictor	Estimate	95% CI	z value	p-value	
Intercept	2.295	[2.28, 2.311]	293.55	< 0.001	***
Island	0.021	[-0.019, 0.06]	1.02	0.307	

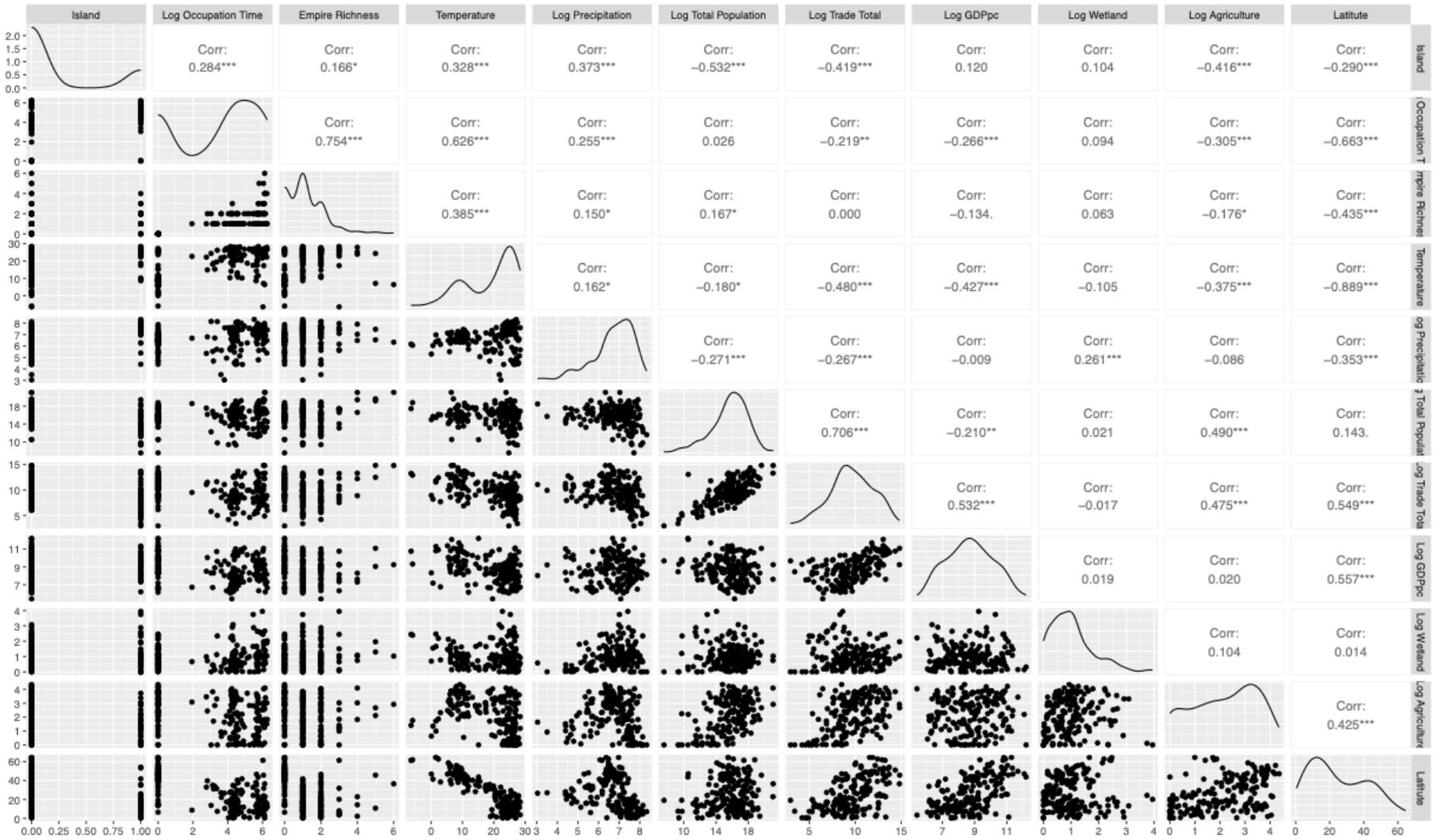
Empire Richness	0.012	[-0.003, 0.027]	1.59	0.112	
Avg. Temp (scaled)	-0.002	[-0.019, 0.015]	-0.22	0.828	
log(GDP per cap)	0.006	[-0.009, 0.021]	0.84	0.402	
log(Precip + 1	-0.001	[-0.015, 0.014]	-0.09	0.928	
log(Population)	0.004	[-0.013, 0.022]	0.48	0.634	
log(Wetland %)	-0.002	[-0.016, 0.011]	-0.36	0.721	
log(Agriculture %)	0.006	[-0.01, 0.022]	0.72	0.474	

Model 3 - Established species

Predictor	Estimate	95% CI	z value	p-value	
Intercept	2.293	[2.278, 2.308]	299.23	< 0.001	***
Island	0.026	[-0.013, 0.065]	1.32	0.187	
Empire Richness	0.011	[-0.004, 0.026]	1.48	0.138	
Avg. Temp (scaled)	0.007	[-0.01, 0.024]	0.82	0.411	
log(GDP per cap)	0.012	[-0.003, 0.027]	1.59	0.113	
log(Precip + 1	0.007	[-0.007, 0.021]	1.01	0.31	
log(Population)	0.019	[0.002, 0.037]	2.2	0.028	*
log(Wetland %)	-0.008	[-0.021, 0.005]	-1.2	0.231	
log(Agriculture %)	-0.002	[-0.018, 0.013]	-0.27	0.79	

Model 4 - Established species, spreading after 1900

Predictor	Estimate	95% CI	z value	p-value	
Intercept	2.301	[2.293, 2.309]	565.3	< 0.001	***
Island	0.003	[-0.017, 0.024]	0.3	0.759	
Empire Richness	0.007	[-0.001, 0.014]	1.7	0.094	.
Avg. Temp (scaled)	0.001	[-0.008, 0.009]	0.1	0.909	
log(GDP per cap)	0.004	[-0.004, 0.012]	1.1	0.29	
log(Precip + 1	0	[-0.007, 0.008]	0.1	0.931	
log(Population)	0	[-0.009, 0.01]	0.1	0.938	
log(Wetland %)	-0.006	[-0.013, 0.0]	-1.8	0.067	.
log(Agriculture %)	0.005	[-0.003, 0.013]	1.2	0.22	


Island
Log Occupation Time
Empire Richness
Temperature
Log Precipitation
Log Total Population
Log Trade Total
Log GDPpc
Log Wetland
Log Agriculture
Latitute
Corr: 0.284***
Corr: 0.166*
Corr: 0.328***
Corr: 0.373***
Corr: −0.532***
Corr: −0.419***
Corr: 0.120
Corr: 0.104
Corr: −0.416***
Corr: −0.290***
Corr: 0.754***
Corr: 0.626***
Corr: 0.255***
Corr: 0.026
Corr: −0.219**
Corr: −0.266***
Corr: 0.094
Corr: −0.305***
Corr: −0.663***
Corr: 0.385***
Corr: 0.150*
Corr: 0.167*
Corr: 0.000
Corr: −0.134.
Corr: 0.063
Corr: −0.176*
Corr: −0.435***
Corr: 0.162*
Corr: −0.180*
Corr: −0.480***
Corr: −0.427***
Corr: −0.105
Corr: −0.375***
Corr: −0.889***
Corr: −0.271***
Corr: −0.267***
Corr: −0.009
Corr: 0.261***
Corr: −0.086
Corr: −0.353***
Corr: 0.706***
Corr: −0.210**
Corr: 0.021
Corr: 0.490***
Corr: 0.143.
Corr: 0.532***
Corr: −0.017
Corr: 0.475***
Corr: 0.549***
Corr: 0.019
Corr: 0.020
Corr: 0.557***
Corr: 0.104
Corr: 0.014
Corr: 0.425***

Supplementary Figure 6. Correlation matrix for the predictors used in the models to test the drivers. Variable description:Log Occupation.timeframe: Time a country was colonized by European colonial powers log transformed; Empire.Richness: Number of colonial empires that occupied the country; Temperature: average yearly temperature between 1970 and 2000 in °C; Log GDPpc: average GDP per capita between 2017 and 2021; Log Precipitation: yearly average precipitation between 1970 and 2000 in mm log transformed; Log Total population: average total population between 2017 and 2021 log transformed; Log Trade Total: average between import and export of trade as total US$ between 2017 and 2021 log transformed; Log Wetland: percentage of the country's area covered by wetlands log transformed; Log Agriculture: percentage of the country's area covered by agriculture log transformed; Latitude: absolute latitude indicating only the magnitude of the distance from the Equator without specifying the direction (north or south)

References

1. World map - Map identifying the world's continents. *Encyclopædia Britannica* https://www.britannica.com/science/continent (2024).
2. Worldbank. World Development Indicators. https://databank.worldbank.org (2024).
3. United Nations. UNCTAD dataset (United Nation Conference on Trade and Development). (2024).
4. Lenzner, B. *et al.* Naturalized alien floras still carry the legacy of European colonialism. *Nat Ecol Evol* **6**, 1723–1732 (2022).
5. Early, R. *et al.* Global threats from invasive alien species in the twenty-first century and national response capacities. *Nat Commun* **7**, 1–9 (2016).
6. Fick, S. E. & Hijmans, R. J. WorldClim 2: new 1km spatial resolution climate surfaces for global land areas. *International Journal of Climatology* **37**, 4302–4315 (2017).
7. Copernicus. Land Cover 2015-2019 (raster 100 m), global, annual - version 3. *European Commission Directorate-General Joint Research Centre* (2020).
8. Wilkerson, R. C., Linton, Y.-M. & Strickman, D. *Mosquitoes of the World*. (Johns Hopkins University Press, Baltimore, Maryland, 2021).
9. Díez-Fernández, A. *et al.* Aedes vittatus in Spain: current distribution, barcoding characterization and potential role as a vector of human diseases. *Parasites & Vectors* **11**, 297 (2018).
10. Medlock, J. M. *et al.* An entomological review of invasive mosquitoes in Europe. *Bull. Entomol. Res.* **105**, 637–663 (2015).
11. Tanaka, K., Mizusawa, K. & Saugstad, E. S. A Revision of the Adult and Larval Mosquitoes of Japan (Including the Ryukyu Archipelago and the Ogasawara Islands) and Korea (Diptera: Culicidae). *American Entomological Institute* **16**, 987 (1979).
12. Hearnden, M. N. A health risk assessment for the establishment of the exotic mosquitoes Aedes camptorhynchus and Culex australicus in Napier, New Zealand. *Wellington School of Medicine* (1999).
13. Medlock, J. M. *et al.* A Review of the Invasive Mosquitoes in Europe: Ecology, Public Health Risks, and Control Options. *Vector-Borne and Zoonotic Diseases* **12**, 435–447 (2012).
14. Powell, J. R., Gloria-Soria, A. & Kotsakiozi, P. Recent History of *Aedes aegypti* : Vector Genomics and Epidemiology Records. *BioScience* **68**, 854–860 (2018).
15. Beebe, N. W., Maung, J., van den Hurk, A. F., Ellis, J. T. & Cooper, R. D. Ribosomal DNA spacer genotypes of the Anopheles bancroftii group (Diptera: Culicidae) from Australia and Papua New Guinea. *Insect Molecular Biology* **10**, 407–413 (2001).

16. Taai, K. & Harbach, R. E. Systematics of the Anopheles barbirostris species complex (Diptera: Culicidae: Anophelinae) in Thailand. *Zoological Journal of the Linnean Society* **174**, 244–264 (2015).
17. White, G. Geographical distribution of arthropod-borne diseases and their principal vectors. *World Health Organization, Division of Vector Biology and Control, Geneva* 7–22 (1989).
18. Novikov, Y. M. & Vaulin, O. V. Expansion of Anopheles maculipennis s.s. (Diptera: Culicidae) to northeastern Europe and northwestern Asia: Causes and Consequences. *Parasites & Vectors* **7**, 389 (2014).
19. Furumizo, R. T., Warashina, W. R. & Savage, H. M. First collection of *Anopheles (Anopheles) punctipennis* (Say) on Oahu, Hawaii: Implications for the potential introduction of West Nile Virus. *moco* **21**, 225–226 (2005).
20. Faulde, M. K., Rueda, L. M. & Khaireh, B. A. First record of the Asian malaria vector *Anopheles stephensi* and its possible role in the resurgence of malaria in Djibouti, Horn of Africa. *Acta Tropica* **139**, 39–43 (2014).
21. Sinka, M. E. *et al.* A new malaria vector in Africa: Predicting the expansion range of Anopheles stephensi and identifying the urban populations at risk. *Proc. Natl. Acad. Sci. U. S. A.* **117**, 24900–24908 (2020).
22. Chandra, G., Bhattacharjee, I. & Chatterjee, S. A review on Anopheles subpictus Grassi—A biological vector. *Acta Tropica* **115**, 142–154 (2010).
23. Mirabello, L. & Conn, J. E. Molecular population genetics of the malaria vector Anopheles darlingi in Central and South America. *Heredity* **96**, 311–321 (2006).
24. Soto, A. & Delang, L. Culex modestus: the overlooked mosquito vector. *Parasites Vectors* **16**, 373 (2023).
25. Romero-Weaver, A., Reeves, L., Riles, M., Lee, Y. & Giordano, B. A Concise Guide to the Bionomics and Key Morphological Characteristics for Identifying Culex coronator (Dyar & Knab, 1906)-an Invasive Mosquito Species from the Neotropics 1 Neotropical Region (Nearctic Region) and Part of the United States [Global Invasive]. *EDIS* (2023) doi:10.32473/edis-IN1385-2022.
26. Sudeep, A. B. Culex gelidus: An emerging mosquito vector with potential to transmit multiple virus infections. *J. Vector Borne Dis.* **51**, 251–258 (2014).
27. Farajollahi, A., Fonseca, D. M., Kramer, L. D. & Marm Kilpatrick, A. "Bird biting" mosquitoes and human disease: A review of the role of Culex pipiens complex mosquitoes in epidemiology. *Infection, Genetics and Evolution* **11**, 1577–1585 (2011).
28. Fonseca, D., Meyer, J., Wilkerson, R. & Fleischer, R. Pathways of expansion and multiple introductions illustrated by large genetic differentiation among Worldwide populations of the Southern house mosquito. *The American journal of tropical medicine and hygiene* **74**, 284–9 (2006).
29. Alves, J., de Pina, A., Diallo, M. & Dia, I. First report of Culex (Culex) tritaeniorhynchus Giles, 1901 (Diptera: Culicidae) in the Cape Verde Islands. *Zoologia Caboverdiana* **5**, 14–19 (2014).
30. Sirivanakarn, S. The Forms of *Culex (Culex) bitaeniorhynchus* Giles in Southeast Asia. *Mosquito Systematics* **5**, 235–251 (1973).