

Supplement 1: Spatio-temporal dynamics of *Plasmodium falciparum* transmission within a spatial unit on the Colombian Pacific Coast

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ABSTRACT

This supplement includes information describing the context of our findings. Detailed information by origin, time, and other variables is presented in Tables [S1 1-S1 4](#). Figure [S1 1](#) shows cases for the Pacific Coast of Colombia, and the Guapi municipality (data from SIVIGILA, the official public health surveillance system). Figure [S1 2](#) shows allele frequencies for loci associated with drug resistance. Map [S1 3](#) shows the spatial distribution of parasite subpopulations in the area of study. Map [S1 4](#) represent the suggested malaria transmission unit.

Figures

	MALARIA CASES (<i>P.falciparum</i>) DIAGNOSED IN GUAPI				
	2014	2015	2016	2017	TOTAL
GUAPI URBAN (Neighborhood)					
<i>20 de Julio</i>	1 (0.3)	0	0	0	1
<i>Batallón</i>	1 (0.3)	0	0	0	1
<i>Bellavista</i>	2 (0.5)	0	9 (2.4%)	7 (1.9)	18
<i>Canaan</i>	0	0	0	0	0
<i>El Carmen</i>	0	1 (0.3)	1 (0.3)	9 (2.4%)	11
<i>Fortaleza</i>	5 (1.3)	1 (0.3)	1 (0.3)	0	7
<i>Jardín</i>	0	0	2 (0.5)	1 (0.3)	3
<i>Las Flores</i>	2 (0.5)	0	0	0	2
<i>Olimpico</i>	0	3 (0.8)	1 (0.3)	4 (1.1)	8
<i>San Martín</i>	0	0	1 (0.3)	0	1
<i>Santa Mónica</i>	8 (2.2)	7 (1.9)	2 (0.5)	0	17
<i>Venecia</i>	0	0	1 (0.3)	0	1
Total urban cases	19 (70.4)	12 (37.5)	18 (9.7)	21 (16.5)	70 (18.8)
GUAPI RURAL					
Bagrero, Nariño	1 (3.7)	3 (9.4)	6 (3.2)	0	10
Bella Vista, Chanzará, Nariño	0	0	1 (0.5)	0	1
Bocas de Satinga, Nariño	0	1 (3.1)	0	0	1
Buena Vista, Timbiquí, Cauca	1 (3.7)	0	0	0	1
Calle Honda, Guapi	0	4 (12.5)	0	0	4
Carmelo, Guapi, Cauca	0	0	18 (9.7)	51 (13.7)	69
Chamón, Guapi, Cauca	0	0	5 (2.7)	1 (0.3)	6
Chanzará, Nariño	1 (3.7)	3 (9.4)	9 (4.8)	3 (0.8)	16
Chico Perez, Nariño	1 (3.7)	2 (6.3)	9 (4.8)	2 (0.5)	14
Comer, Guapi, Cauca	0	0	0	1 (0.3)	1
Cuerval, Timbiquí	0	0	1 (0.5)	0	1
El Charco, Nariño	0	1 (3.1)	2	0	3
Iscuandé, Nariño	1 (3.7)	0	0	0	1
Juanico, Guapi, Cauca	0	0	1 (0.5)	1 (0.3)	2
Las Parcelas, Guapi, Cauca	0	0	0	1 (0.3)	1
Las Peñas, Chanzará, Nariño	0	0	1 (0.5)	1 (0.3)	2
Las Varas, Guapi, Cauca	0	0	0	1 (0.3)	1
Limones, Guapi, Cauca	1 (3.7)	0	77	12 (3.23)	90
Loro, Juajui, Guapi, Cauca	0	0	3	1 (0.3)	4
Madrid, Iscuandé, Nariño	0	0	1 (0.5)	0	1
Patía, Nariño	1 (3.7)	0	0	2 (0.5)	3
Playa Chacón, Timbiquí, Cauca	0	1 (3.1)	2	0	3
Quiroga, Guapi, Cauca	0	0	25	7 (1.9)	32
San José de Guare, Guapi, Cauca	0	1 (3.1)	0	19 (5.1)	20
San Miguel del Mar, Timbiquí, Cauca	0	0	1 (0.5)	0	1
San Pedro, Nariño	0	0	1 (0.5)	0	1
Santa Rosa, Guapi, Cauca	0	0	1 (0.5)	1 (0.3)	2
Satinga, Nariño	0	0	0	2 (0.5)	2
Temuey, Guapi, Cauca	1 (3.7)	0	1 (0.5)	0	2
Timbiquí, Cauca	0	0	1 (0.5)	0	1
Tierra Firme, Iscuandé, Nariño	0	2 (6.3)	0	0	2
Vuelta Larga, Guapi, Cauca	0	0	1 (0.5)	0	1
Mining area,, Venezuela	0	2 (6.3)	1 (0.5)	0	3
Total rural cases	8 (29.6)	20 (62.5)	168 (90.3)	106 (83.5)	302 (81.2)
Total cases	27 (100)	32 (100)	186 (100)	127 (100)	372 (100)

Supplemental Table S1 1. Origin and number of malaria cases diagnosed at the public malaria post during the study period (2014-2017). In parenthesis percentages per total number of cases per year.

Sampling (N)	April 2015 Santa Mónica	October 2015. Santa Mónica	April 2016. Santa Mónica	October 2016. Santa Mónica	December 2015. El Cuerval	May 2017. El Cuerval
Female (%)	110/226 (48.7)	127/250 (50.8)	152/298 (51)	89/188 (47.3)	152/298 (51)	89/188 (47.3)
Ethnicity (%)						
Afro-Colombian	222 (98.2)	248 (99.2)	290 (97.3)	188 (100)	290 (97.3)	188 (100)
Mixed	2 (0.9)	2 (0.8)	8 (2.7)	0	8 (2.7)	0
White	2 (0.9)	0	0	0	0	0
Age (years)	3 a 94	3 a 94	3 a 93	2 a 74	3 a 93	2 a 74
Time of Residence (years)	0.1-40	0.1-45	0.2-9	0.1-9	0.2-9	0.1-9
Health System (%)						
Contributive-based healthcare	24 (11)	17 (6.9)	27 (9.2)	8 (4.37)	27 (9.2)	8 (4.37)
Subsidised Healthcare	176 (80.7)	202 (82.5)	246 (84)	148 (80.9)	246 (84)	148 (80.9)
Bound to healthcare system + other + unknown	0	2 (0.8)	4 (1.4)	6 (3.3)	4 (1.4)	6 (3.3)
No Health card	18 (8.3)	23 (9.4)	15 (5.1)	21 (11.5)	15 (5.1)	21 (11.5)
Other	0	1 (0.4)	0	0	0	0
Not known	0	0	1 (0.3)	0	1 (0.3)	0
Occupation (%)						
Student	118 (53.9)	120 (48.0)	121 (40.7)	76 (40.9)	121 (40.7)	76 (40.9)
Housewife	23 (10.5)	42 (16.8)	51 (17.2)	30 (16.1)	51 (17.2)	30 (16.1)
Fisherman	5 (2.3)	6 (2.40)	10 (3.4)	42 (22.6)	10 (3.4)	42 (22.6)
Other	73 (33.3)	82 (29.2)	115 (38.7)	38 (20.4)	115 (38.7)	38 (20.4)

Supplemental Table S1 2. Socio-demographic data relating to asymptomatic individuals identified in Santa Mónica, Guapi and El Cuerval (Timbiquí municipality).

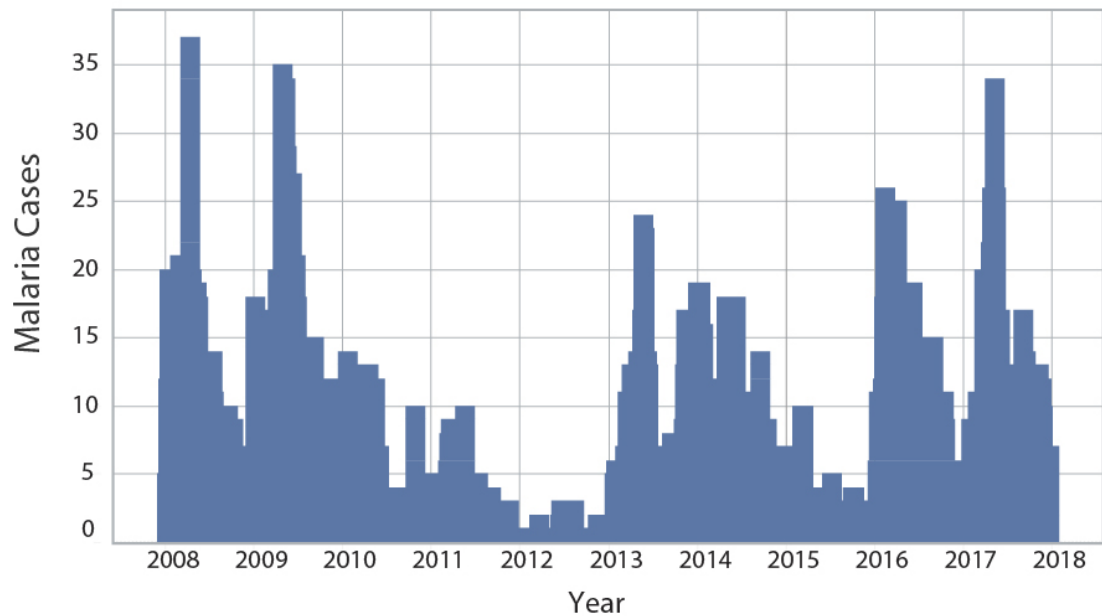
SAMPLE ID	LOCALITY	PF3D7_0831900	HRP2 (chr8) (PF3D7_0831800)	PF3D7_0831700	PF3D7_1372100	HRP3 (chr13)PF3D7_1372200	PF3D7_1372400
3D7		+	+	+	+	+	+
Dd2		-	-	-	+	+	+
HB3		+	+	+	-	-	-
GU013	Unknown, Guapi, Cauca	+	+	+	ND	-	+
GU025	Sta.Mónica, Guapi, Cauca	+	+	+	-	-	+
GU031	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU035	Sta.Mónica, Guapi, Guapi, Cauca	+	+	+	-	-	+
GU036	Fortaleza, Guapi, Guapi, Cauca	+	+	+	-	-	+
GU037	Unknown, Guapi, Cauca	+	+	+	+	+	+
GU040	Temuey, Guapi, Cauca	+	+	+	-	-	-
GU043	Patía, Nariño	+	+	+	-	-	+
GU053	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU058	Sta.Mónica, Guapi, Guapi, Cauca	+	+	+	-	-	+
GU059	Unknown, Guapi, Cauca	+	+	+	-	-	-
GU062	Sta.Mónica, Guapi, Guapi, Cauca	+	+	+	-	-	-
GU063	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU064	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU066	Chanzará, Nariño	+	+	+	-	-	+
GU067	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU069	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU072	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU073	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU074	Unknown, Guapi, Cauca	+	+	+	-	-	+
GU077	Bagrero, Nariño	+	+	+	-	-	-
GU081	Unknown, Guapi, Cauca	+	+	+	-	-	-
GU082	Bocas de Satinga, Nariño	+	-	+	-	-	-
GU083	Unknown, Guapi, Cauca	+	+	+	+	-	-
GU089	Unknown, Guapi, Cauca	+	+	+	-	+	+
CU009	Cuerval, Timbiquí, Cauca	+	-	+	-	-	-
CU010	Cuerval, Timbiquí, Cauca	+	+	+	-	-	+
CU011	Cuerval, Timbiquí, Cauca	+	+	+	-	-	+
GU037	Unknown, Guapi, Cauca	+	+	+	+	-	+
GU050	Zona Minera, Venezuela	+	+	+	-	-	-

Supplemental Table S1 3. Deletions of the *Pfhrp2*, *Pfhrp3* and flanking genes in *P.falciparum* samples diagnosed at the Guapi Malaria Post.

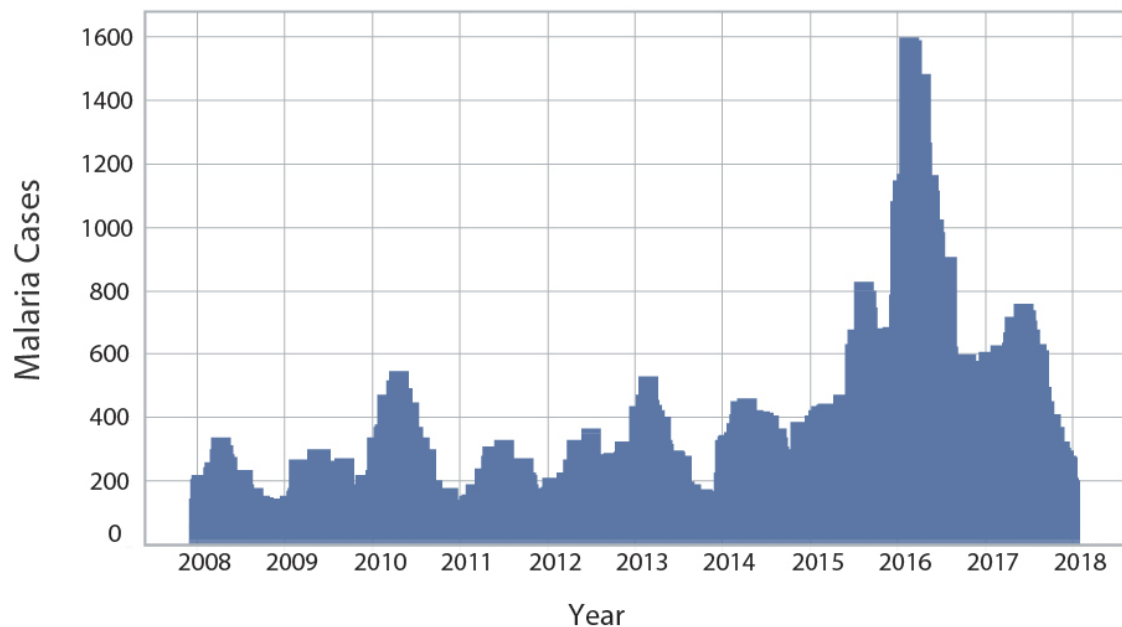
<i>PfKelch13 (Propeller domain)</i>		
Primer name	PCR	Sequence (5' - 3')
K13_PCR_forward	First PCR	CGGAGTGACCAAATCTGGGA
K13_PCR_reverse		GGGAATCTGGTGGTAACAGC
K13_N1_forward	Nested 1	GCCAAGCTGCCATTCATTTG
K13_N1_reverse		GCCTTGTTGAAAGAAGCAGA
K13_N2_forward	Nested 2	CGCCAGCATTGTTGACTAAT
K13_N2_reverse		GCGGAAGTAGTAGCGAGAAT
<i>Pfdhfr</i>		
Primer name	PCR	Sequence (5' - 3')
M1_Outer_forward	First PCR	TTT ATG ATG GAA CAA GTC TGC
M7_Outer_reverse		CTA GTA TAT ACA TCG CTA ACA
M3b_Inner_forward	Nested	TGA TGG AAC AAG TCT GCG ACG
M9_Inner_reverse		CTG GAA AAA ATA CAT CAC ATT
<i>Pfdhps</i>		
Primer name	PCR	Sequence (5' - 3')
N1_Outer_forward	First PCR	GATTCTTTTTTCAGATGGAGG
N2_Outer_reverse		TTCCTCATGTAATTCATCTGA
R2_Inner_forward	Nested	AACCTAAACGTGCTGTTCAA
R_Inner_reverse		AATTGTGTGATTTGTCCACAA
<i>Pfcrt</i>		
Primer name	PCR	Sequence (5' - 3')
CRTP1 forward	First PCR	CCGTTAATAATAAATACACGCAG
CRTP2 reverse		CGGATGTTACAAAATATAGTTACC
CRTD1 forward	Nested	TGTGCTCATGTGTTTAACTT
CRTD2 reverse		CAAAACTATAGTTACCAATTTTG

Supplemental Table S1 4. Primer sequence.

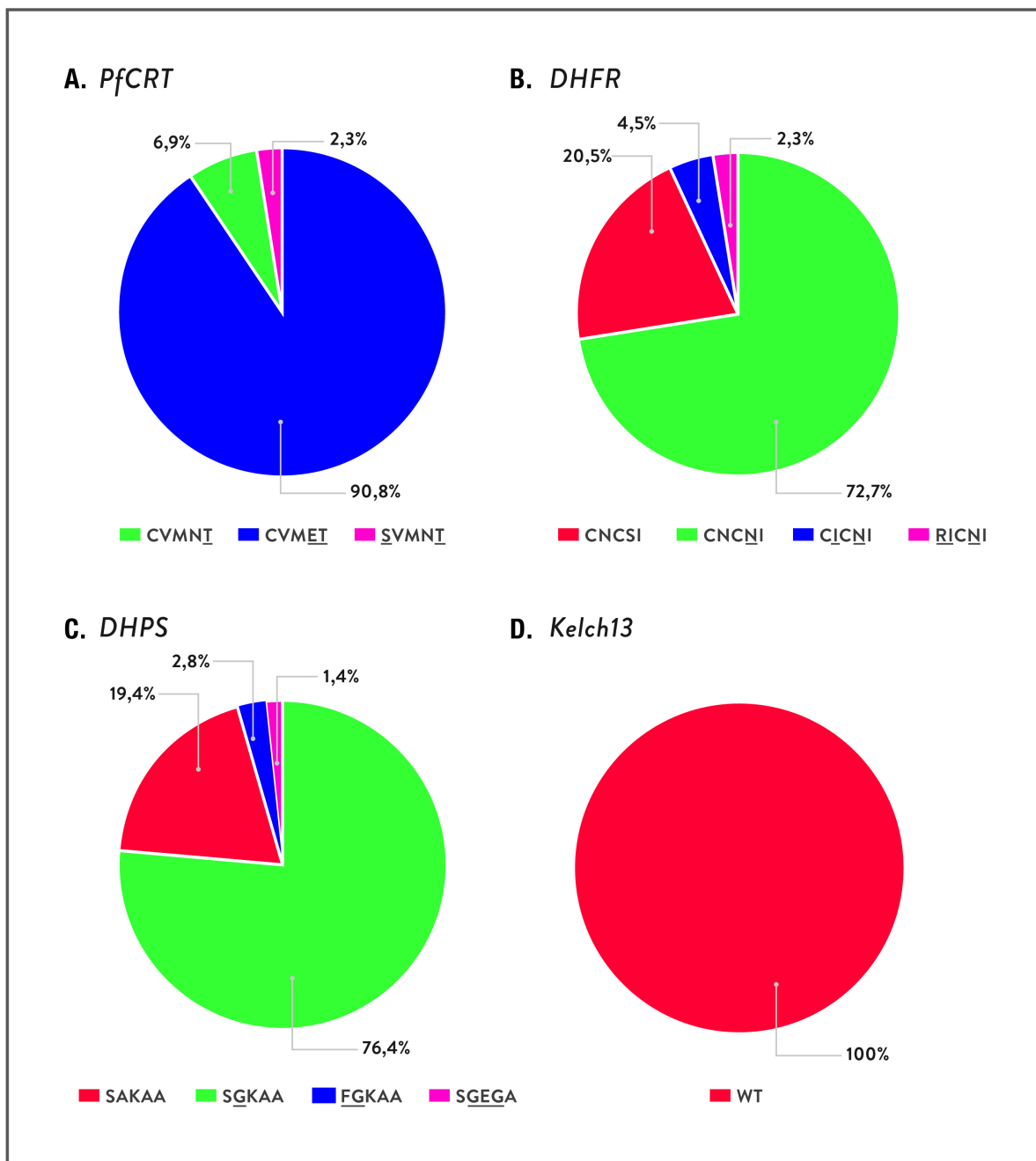
P.falciparum cases in Guapi



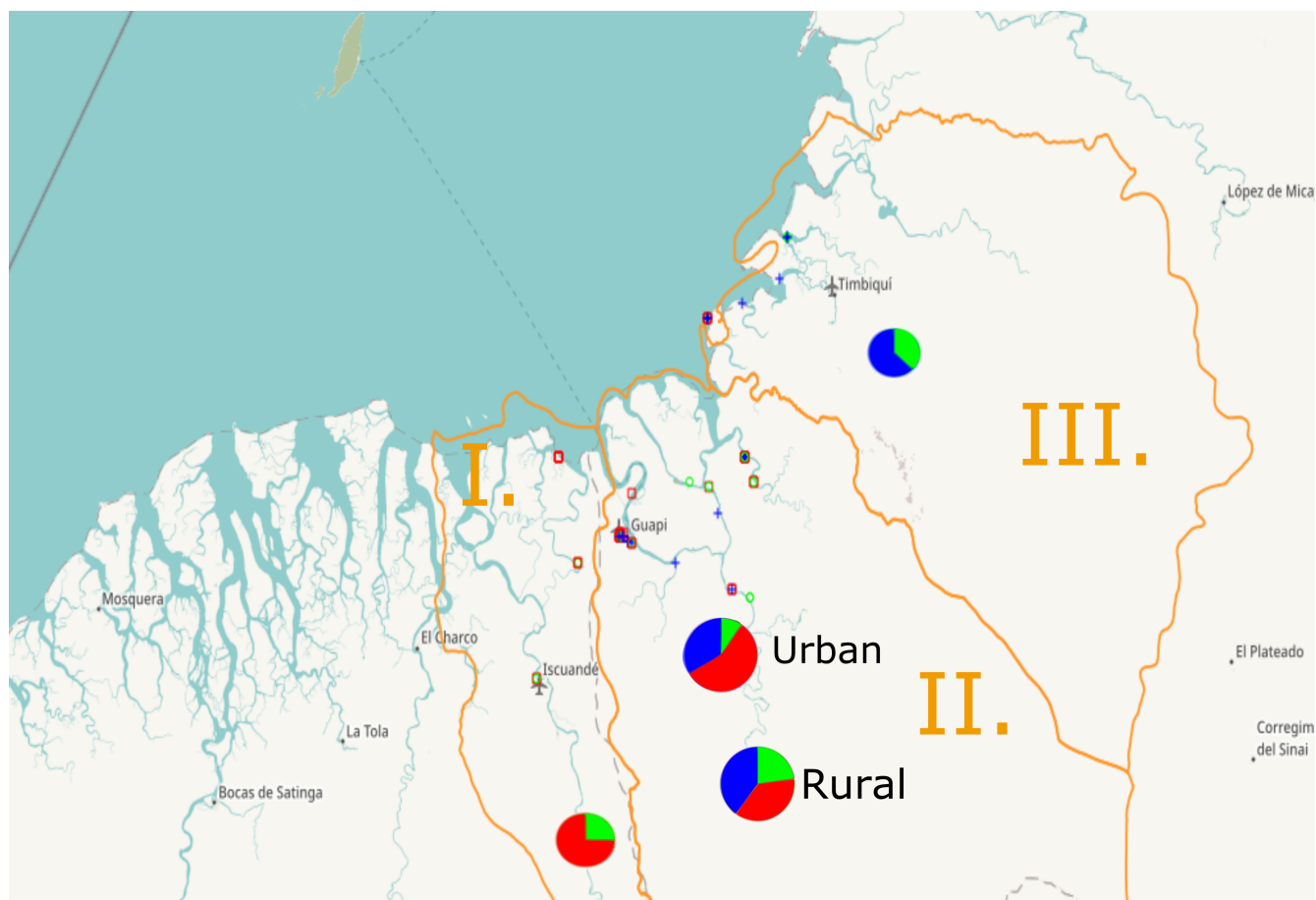
P.falciparum cases in the Pacific Coast



Supplemental Figure S1 1. Epidemic curves for Guapi and the Pacific Coast. Note that while infection by *P.falciparum* in the Pacific Coast have increased in intensity over the past 10 years, Guapi has experienced outbreaks of similar magnitudes over the same period.



Supplemental Figure S1 2. Allele frequencies for *PfCRT* (positions 72-76), *dhfr* (positions 50, 51, 59, 108, 164), *dhps* (positions 436, 437, 540, 581, 613) and *kelch13* (propeller domain) in samples diagnosed in Guapi, Cauca between 2014 and 2017. Mutant positions underlined



Supplemental Figure S1 3. Distribution of *P.falciparum* populations identified by STRUCTURE (Green: population A, Red: population B; Blue: population C). I, II and III indicate the Santa Bárbara de Icuandé, Guapi and Timbiquí municipalities respectively. Pie charts indicate the frequency of each population. II and III are connected by riverways. Note that cases may overlap. QGIS version 2.18 (<https://www.qgis.org>)¹. Source: OpenStreetMap², © OpenStreetMap contributors, under an Attribution-Share-Alike 2.0 Generic licence (<https://creativecommons.org/licenses/by-sa/2.0/>).



Supplemental Figure S1 4. Guapi Malaria Transmission Unit. Sites of origin of malaria cases diagnosed at the Public Malaria Post in Guapi between 2014-2017. Red circle indicates Malaria Transmission Unit (i.e. area of origin of 95% or more of the malaria cases)

References

1. QGIS Development team (2018). Quantum GIS Geographic Information System. Open Source Geospatial Foundation Project. <http://qgis.osgeo.org> .
2. OpenStreetMap contributors. Planet dump retrieved from <https://planet.osm.org> . <https://www.openstreetmap.org>, 2017.