

Abstract

Vector bionomics and transmission intensities of malaria vectors on Bioko Island over 14 years of integrated vector control

Godwin Fuseini, Wonder Philip Phiri, Raul Nguema, Liberato Motobe, Carlos Cortes Falla, Christopher Schwabe, Guillermo Garcia.

Entomological surveillance has been an integral part of the Bioko Island Malaria Control Project (BIMCP) since the implementation of the project in 2004. Systematic vector surveillance over the years continued to inform and guide the vector control interventions in attaining remarkable outcomes. This study analyses the trend in the vector bionomics and transmission intensities of the local vectors since the inception of the BIMCP. The feeding and resting behaviors, as well as the compositions of the local vectors, were monitored using window traps, CDC light traps, and human landing catches. Trends in vector densities, sporozoite rates, and the entomological inoculation rates (EIR) were determined. Phenotypic resistance profile of the malaria vectors as well as target-site resistance and metabolic resistance patterns were also monitored. *An gambiae* s.s. (S and M forms) constituted 45% of the local vectors at baseline with *An funestus* 45% and *An melas* 10%. However after two years of IRS *An. funestus* s.l. was eliminated. In 2009, *An gambiae* s.s. S. was also eliminated and as of 2017, *An gambiae* s.s. M (*An. coluzzii*) (70%) and *An. melas* (30%) remained the main vectors on the Island. Biting rates have reduced from an average of 35 bites per person per night in 2009 to an average of 8 bites per person per night in 2017. Vectors biting behavior shifted to more of outdoor biting between 2004 and 2014. The EIR has dropped from 1,214 infective bites person per annum at baseline to 13 infective bites per person per annum in 2017. The frequency of *kdr-w* has increased to over 85% in the vector population in addition to the presence of P450s pyrethroid metabolizers. However, AChE mutations have not been detected. The planning, implementation, monitoring and evaluation of vector control interventions rely on the knowledge of the local vectors for effective programs. Changes in vector behaviors and transmission intensities are essential in directing vector control interventions and measuring the impacts of such interventions.

Malaria vectors bionomics and transmission intensities on Bioko Island over 14 years of integrated malaria control.

ASTMH 2018, Session 116
New Orleans, 31 October 2017

Godwin Fuseini

Medical Care Development International

The Bioko Island, Equatorial Guinea

- Bioko is the main Island of Equatorial Guinea of about 32km of the coast of Cameroon.
- A population of about 335,000 people
- Malaria situation pre-intervention, in 2004
 - *P. falciparum* prevalence in children 2-14 years in 2004 was 45%
 - Prevalence of moderate/severe anaemia (Hb< 8 g/dl) in children aged 1 to 5 years in 2004 was 15% (**Cook et al., 2018. Malar J**)
 - EIR of over 800 infective bites per person per annum (**Cano et al., 2004. J. Med. Entomol**)



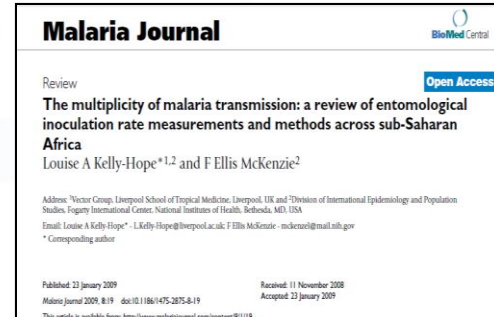
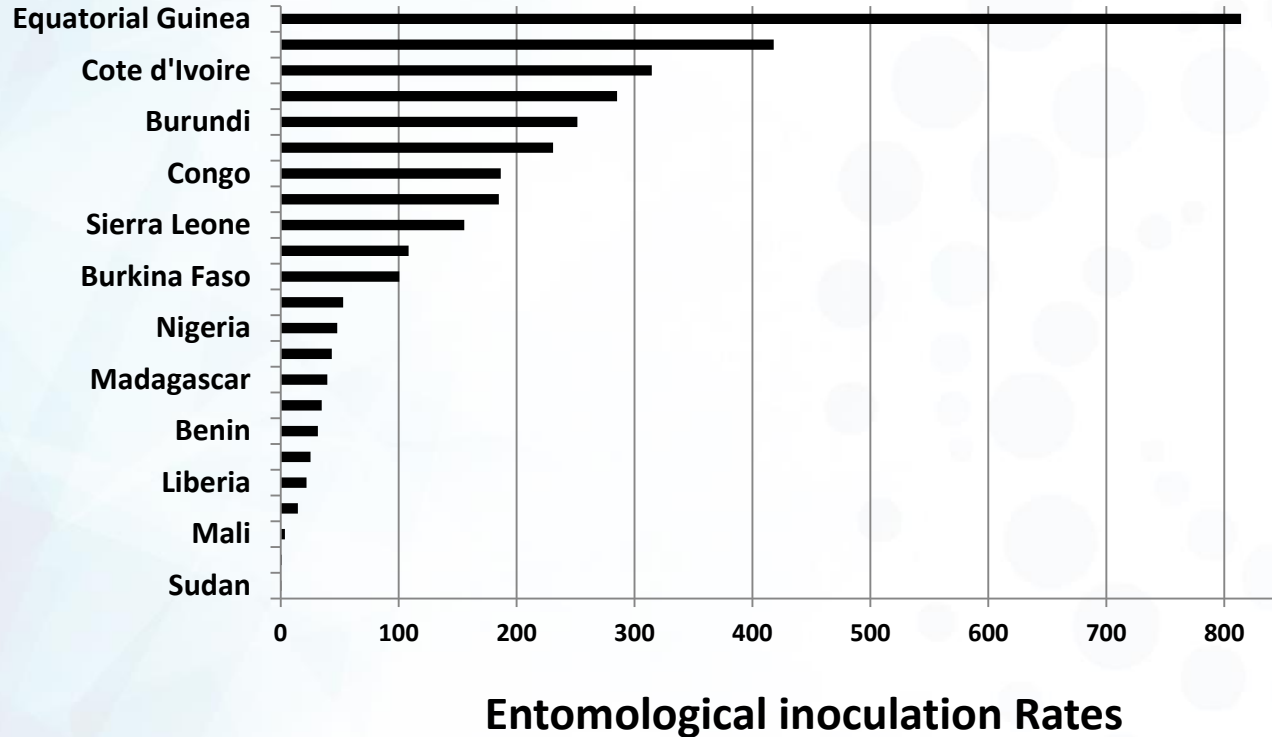
SAMPLING, DISTRIBUTION, DISPERSAL Malaria Vectors in the Bioko Island (Equatorial Guinea): Estimation of Vector Dynamics and Transmission Intensities

J. CANO,¹ P. J. BEZCOSA,² J. ROCHE,¹ J. M. BUBIO,¹ E. MOYANO,² A. CUERRA-NEIRA,¹
H. BROCHERO,² M. MICO,¹ M. EDU,² AND A. BENITO²

J. Med. Entomol. 41(2): 178-181 (2004)

ABSTRACT The current study was performed on the Bioko Island (Equatorial Guinea) with the aim of establishing a rapid assessment technique for mapping malaria risk and measuring vector densities. Human bait collection, test traps, light traps, indoor resting collection, and window exit traps were used to collect *Anopheles gambiae* s.s. and *Anopheles funestus*, the two anopheline species involved in malaria transmission in this island. Capture data were used to compare differences in the behavior and vectorial capacity of *An. gambiae* s.s. and *An. funestus*. Differences in the two species of mosquitoes were found in relation to the season and trapping methods used. Entomological inoculation rates (EIR) for *Plasmodium falciparum* were calculated using a polymerase chain reaction (PCR) test with individual anopheline mosquitoes from human bait collections in two villages during the dry and rainy seasons. *P. falciparum* sporozoites were detected from both dissected heads/thorax and abdomens of both species.

Review of EIRs across 23 sub-Saharan Africa



The Bioko Island Malaria Control Project

The Bioko Island Malaria project

- Implemented since 2004 by Medical Care Development international (MCDI) in Partnership with MoHSW

Project funding (Public Private Partnership)

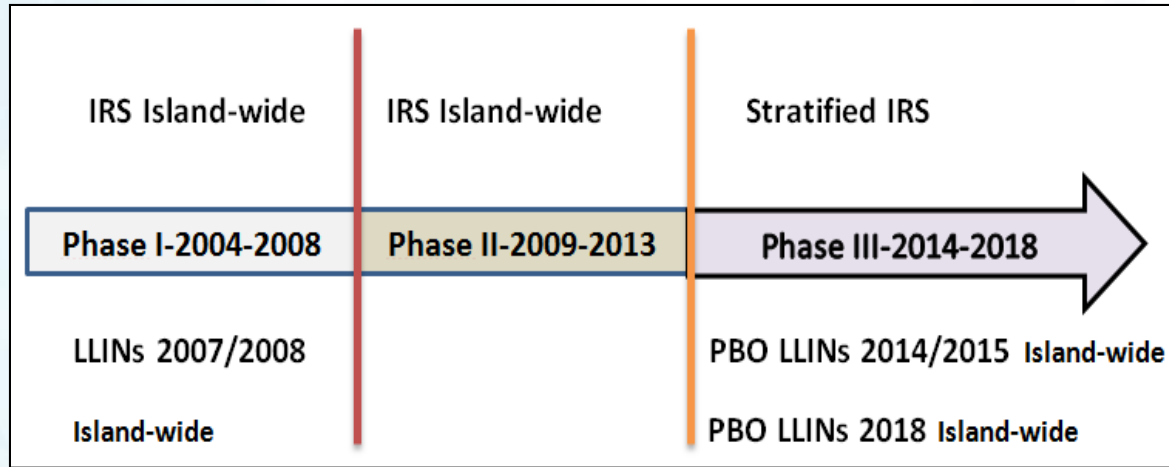
- Marathon Oil, Noble Energy, Atlantic Methanol, GEPetrol, SONAGAS, and the Government of Equatorial Guinea

Integrated malaria control approach

- Vector control, Case management and SBCC
- Capacity training and M&E
- Malaria Vaccine trial Initiative



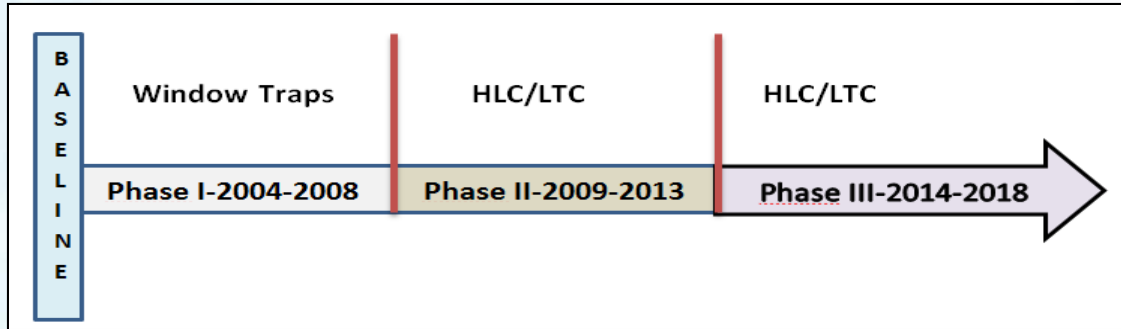
Bioko Island vector control Interventions



- Continuous distribution of LLINs at ANC and primary schools
- Larval Source Management
 - 2014-present: Targeted larviciding with *Bti* in priority areas.



Bioko Island Entomological monitoring

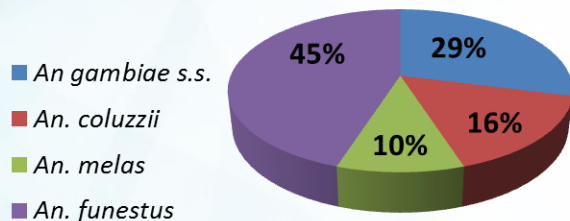


- Baseline HLC/WET (Cano et al., 2004/BIMCP)
 - Species composition
 - Feeding behavior/HBI
 - Vector densities
 - Sporozoite rates
 - EIR
 - Insecticide resistance monitoring



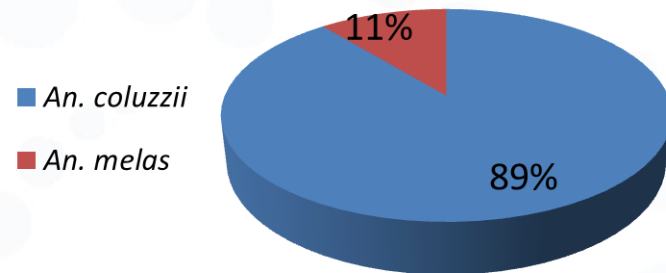
Composition of vector species

Species at baseline (2003)



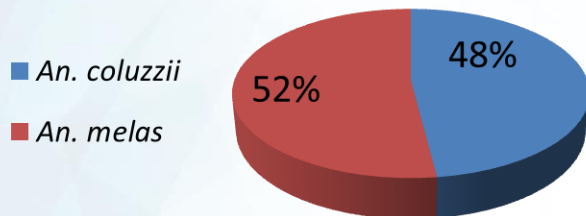
2 rounds IRS

Species in phase I (2006)



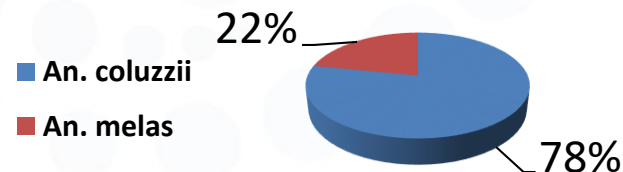
Window traps

Species in phase II (2009)



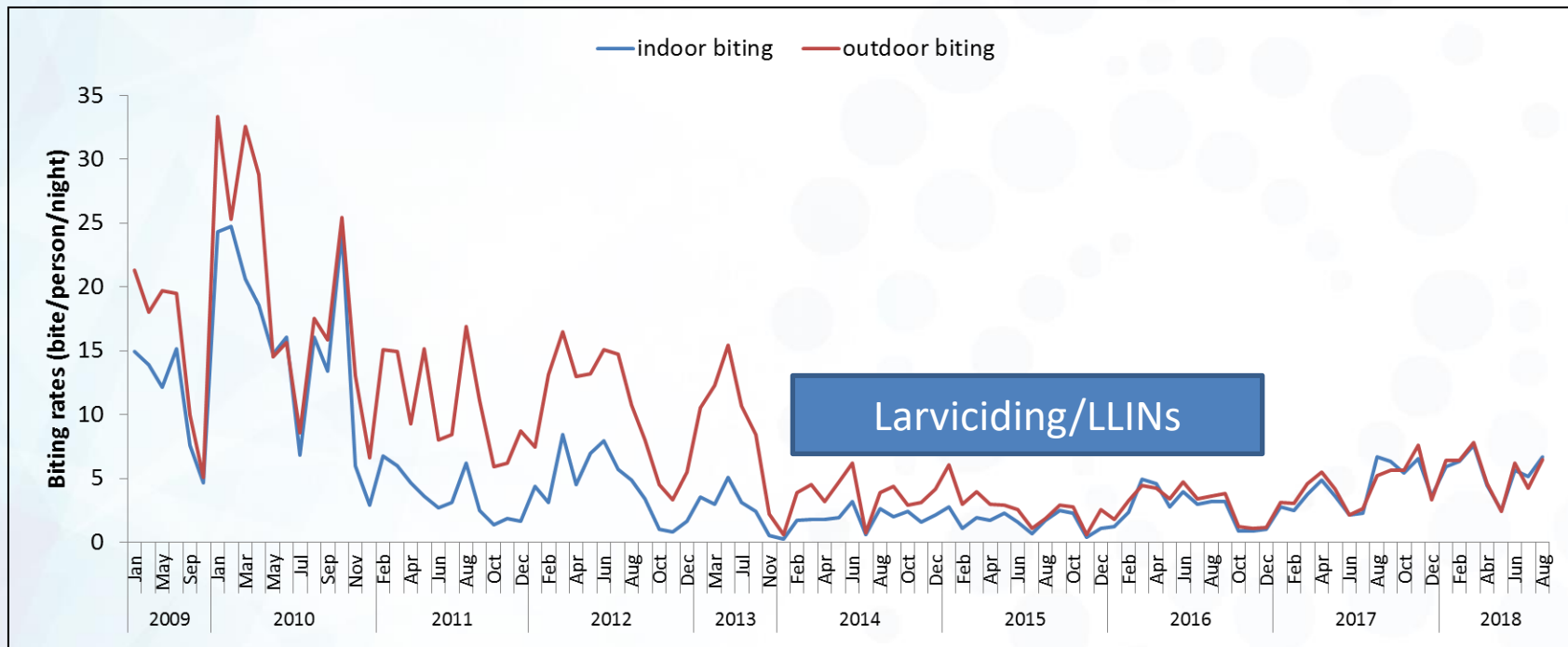
25 rounds IRS

Species phase III (2018),
n=2,959



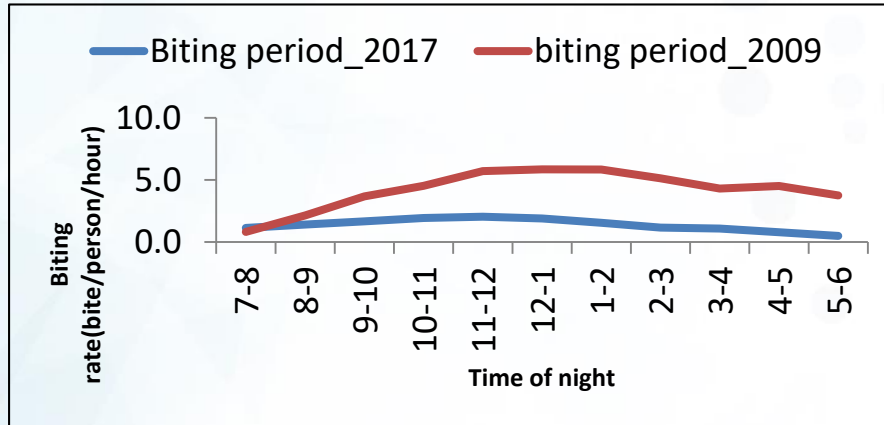
Human landing Catches

Biting rates (HLC)



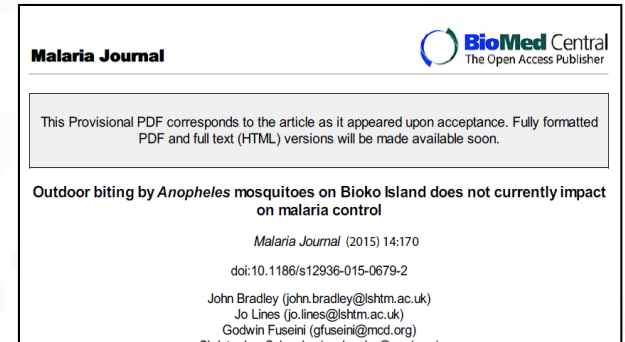
Blood meal analysis and biting period

- Blood meal analysis-2017
 - HBI-0.84. Dog-0.05. Chicken 0.03 and Mixed-0.08
 - Vectors are largely anthropophagic
- Biting rate still peaks at 11pm

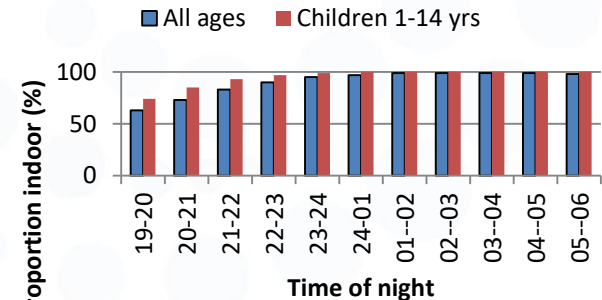


Impact of outdoor biting on malaria transmission

- Earlier study suggested vectors were endophilic (Molina et al., 1993 J Med Entomol)
- Between 2009 to 2014 changed in biting behavior
- Survey in 2013 indicated 95% of the population is indoor at 11pm, peak biting period of vectors
- The majority of resources should remain with control measures that target indoor



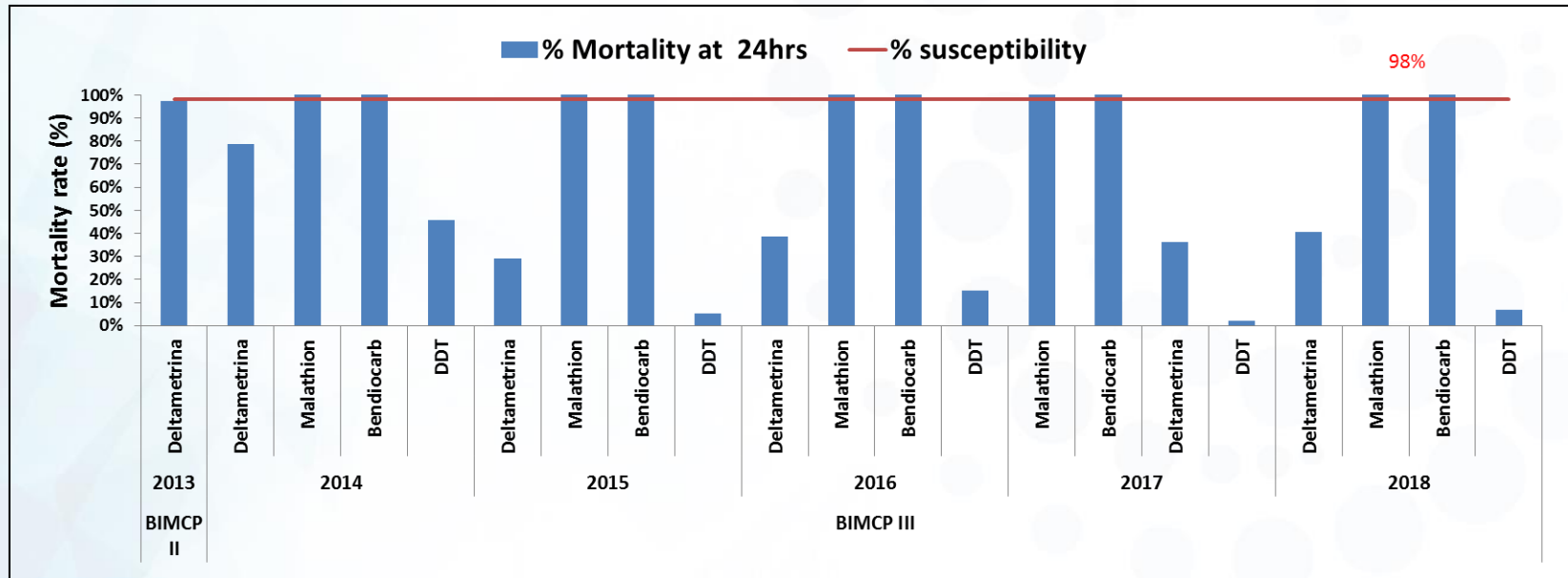
Respondents reporting being at different hours of night-2013



Insecticide resistance monitoring

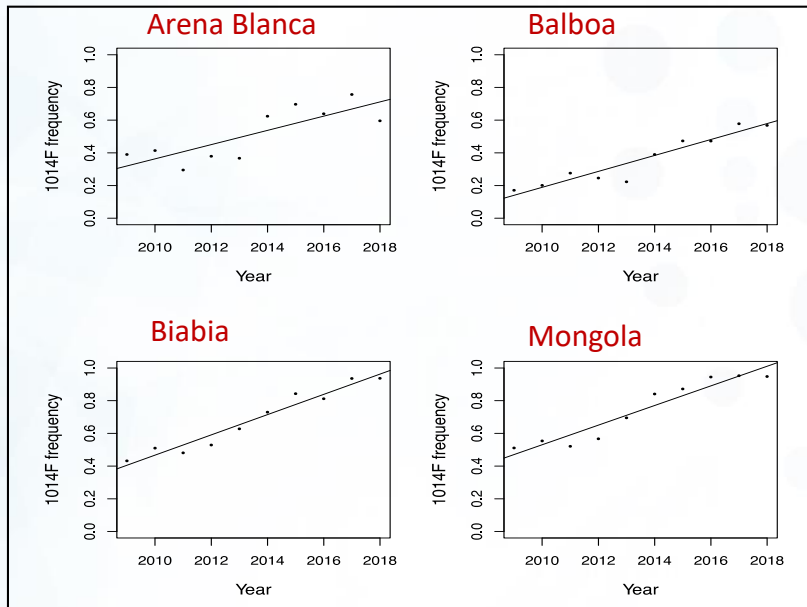
Bioassays using the WHO's standard susceptibility tests

- Indication of vector-resistance from 2014 –present
 - Deltamethrin and DDT
- Vectors susceptible to carbamates and organophosphates



Target-site and metabolic resistance

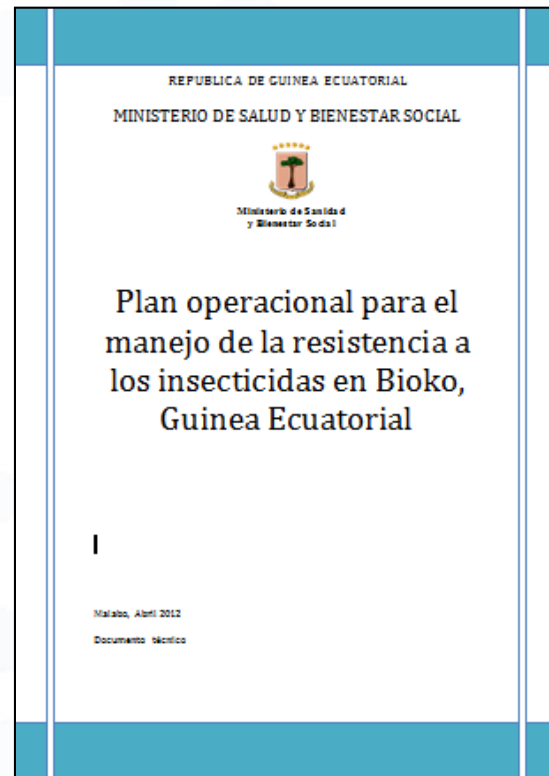
- Frequency of *kdr-w* (L1041F) allele has increased significantly over the last 9 years.
- Ace1 (G119S) mutation has not been detected
- Presence of metabolic resistance to pyrethroid



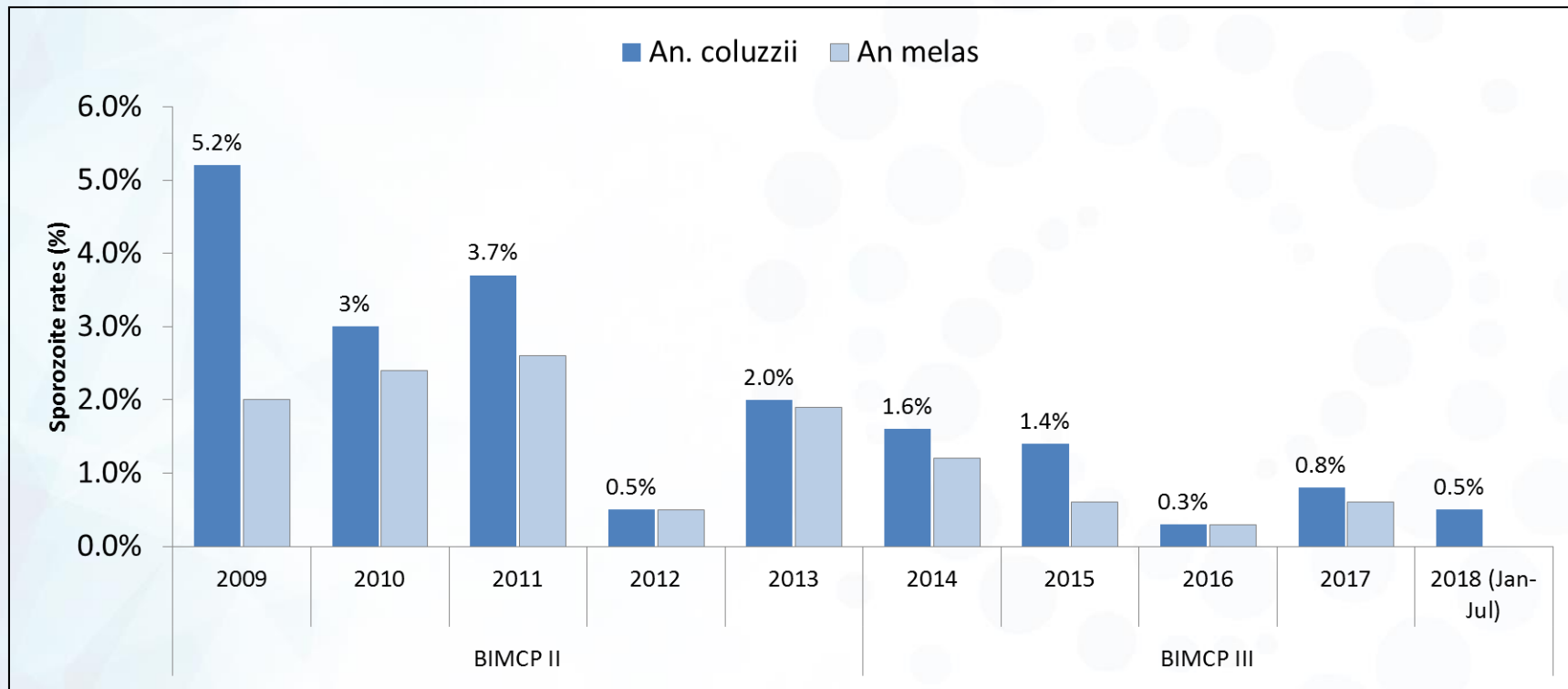
Operational Plan for insecticide resistance management on Bioko Island

Recommendations for vector control

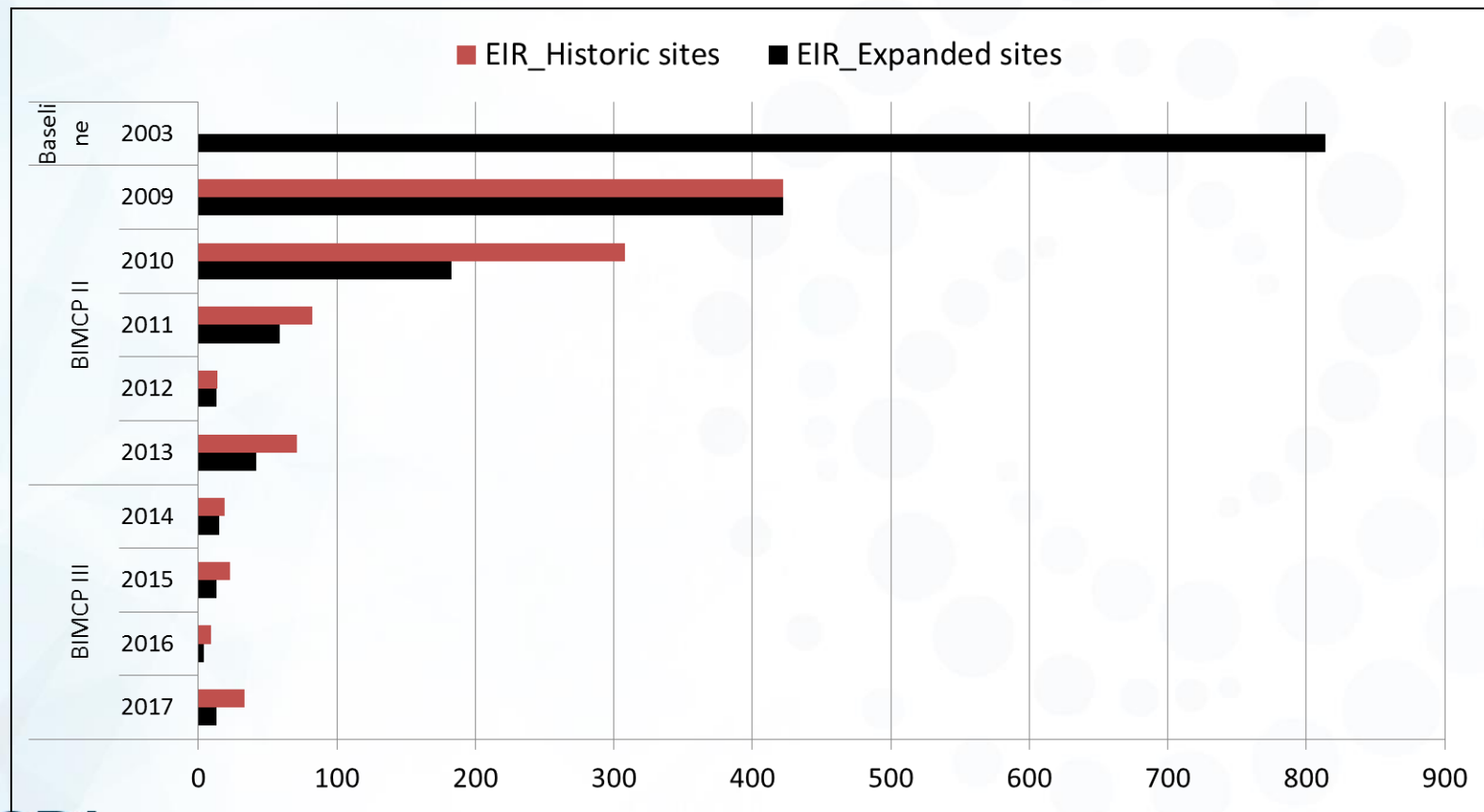
- Pyrethroid should no more be used for IRS
- Use of PBO LLINS.
- Use of carbamates and organophosphates. Currently using ACTELLIC 300CS
- Larviciding with non-pyrethroid insecticide
- Considering the use of neonicotinoid /pyrethroid formulations
- Routine insecticide resistance monitoring should be maintained



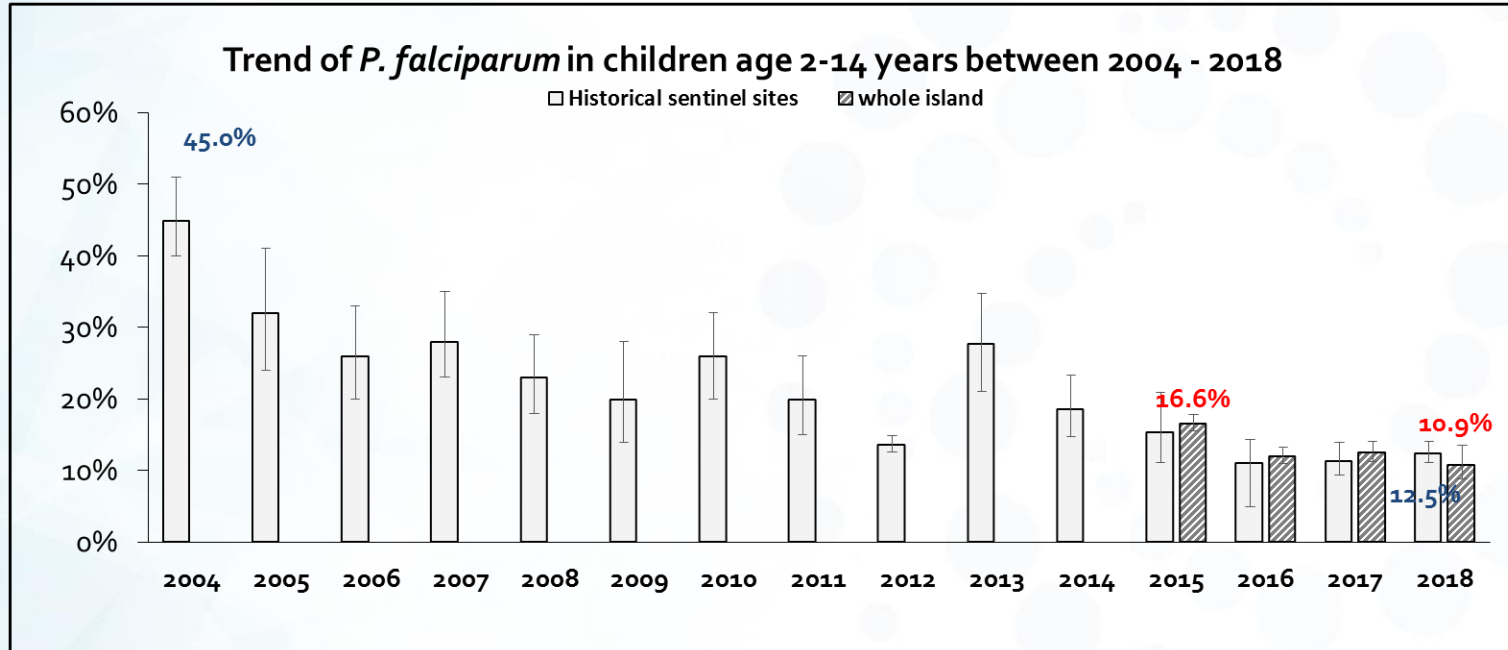
Sporozoite rates (HLC)



EIR Bioko Island



Bioko Island malaria parasite prevalence (2-14yrs)



Moderate to severe anaemia in children aged 1-5 years

- Reduced from 14.9 to 1.6%.

Infection importation: a key challenge

- Parasite prevalence on mainland (Bata) in 2015 46.7% vs 15.4% on the Island in 2015
- Four boat sailings per week and approximately ten flights per day between Malabo on Bioko and Bata on mainland Equatorial Guinea,
- Around 21,000 people arriving on Bioko every month from the mainland.
- Infection in arriving boat passengers was substantially higher than in those departing (70 vs 38%, $p = 0.017$).
- Phase IV aims at standard control and the introduction of malaria vaccine currently on trial



Conclusion

- Vector species composition has changed
 - *An funestus* and *An gambiae* s.s disappeared
- Biting behavior has changed but does not impact on malaria transmissions
- Vectors are still anthropophagic and bite largely at mid night
 - LLINs and IRS still effective
- Vectors developed resistance to 2 classes of insecticides
 - Operational plan to manage insecticide resistance in place
- Infection importation remains a challenge

Acknowledgements

Bioko Island Malaria Control Project implementers



Ministerio de Sanidad y Bienestar Social

Collaborators



Bioko Island Control Malaria Project Donors



Ministerio de
Mina,
Industria y
Energia

