USAID
FROM THE AMERICAN PEOPLE

PRESIDENT'S MALARIA INITIATIVE

The PMI AIRS Project
Indoor Residual Spraying Task Order Six

THE DEMOCRATIC REPUBLIC OF CONGO ENTOMOLOGICAL MONITORING

2017 FINAL REPORT
NOVEMBER 01, 2016 – OCTOBER 31, 2017

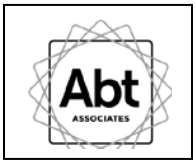
SUBMITTED APRIL 3, 2018

Recommended Citation: The President's Malaria Initiative (PMI)/Africa Indoor Residual Spraying (AIRS) Project. April 2018. Democratic Republic of the Congo 2017 Entomological Monitoring Report. Bethesda, MD. PMI AIRS Project Indoor Residual Spraying (IRS 2) Task Order Six, Abt Associates Inc.

Contract No. and Task order: GHN-I-00-09-00013-00 & AID- OAA-TO-14-00035

Submitted to: United States Agency for International Development/PMI

Prepared by: Abt Associates Inc.



Abt Associates Inc. | 4550 Montgomery Avenue | Suite 800 North

| Bethesda, Maryland 20814 | T. 301.347.5000 | F. 301.913.9061

ACRONYMS

AIRS	Africa Indoor Residual Spraying Project
CDC	Centers for Disease Control and Prevention
DRC	Democratic Republic of Congo
DPS	Provincial Health Division / Division Provinciale de la Santé
ELISA	Enzyme-linked Immunosorbent Assay
HBR	Human Biting Rate
HLC	Human Landing Catch
INRB	National Institute of Bio-medical Research/Institut National de Recherche Biomédicale
IRS	Indoor Residual Spraying
LLIN	Long Lasting Insecticide-treated nets
NMCP	National Malaria Control Program
PCR	Polymerase Chain Reaction
PMI	President's Malaria Initiative
PSC	Pyrethrum Spray Collection
UND	University of Notre Dame
USAID	United States Agency for International Development
WHO	World Health Organization

Contents

EXECUTIVE SUMMARY

The President's Malaria Initiative (PMI) Africa Indoor Residual Spraying (AIRS) Project conducted pyrethrum spray catch (PSC) and human landing catch (HLC) activities in the Democratic Republic of Congo (DRC) in 11 sentinel sites in 2017. The project conducted PSC and HLC during three periods: January to February, March to April, and May to June in nine sentinel sites. Of the 11 sites, four are new locations conducting trapping activities for the first time. The project monitored malaria vector dynamics and behavior monthly from January to December 2017 in two sites, Kapolowe and Lodja. *Anopheles gambiae* s.l. was present in all 11 sites, but were collected in higher numbers in Kabondo, Kalemie, Karawa, Pawa, and Lodja. The project captured another major malaria vector, *An. funestus* s.l., at higher densities in Katana, Mikalayi, Kabondo, and Kimpese.

The project completed insecticide susceptibility bioassays using *Anopheles gambiae* s.l. for permethrin, deltamethrin, and alpha-cypermethrin in 11 sites, with intensity tests in 10 sites. The team documented resistance to permethrin at all sites, to deltamethrin in four sites, and to alpha-cypermethrin in two sites. Resistance intensity to permethrin was high in all sites. Resistance intensity to deltamethrin was generally lower, with 98-100% mortality at 10 times the diagnostic concentration in five sentinel sites.

The project conducted Centers for Disease Control and Prevention (CDC) bottle bioassays in March, June, and July to determine the intensity of resistance in the Kinshasa suburbs in the wake of the 2016 mass long-lasting insecticide-treated net (LLIN) distribution campaign. In all Kinshasa municipalities, *An. gambiae* s.l. were susceptible to 5X and 10X the diagnostic concentration of deltamethrin. In contrast, there were survivors to permethrin at 2X, 5X, and 10X the diagnostic concentration. There did not appear to be any clear

differences between 2016 and 2017 resistance intensity, with no clear increase in resistance intensity as a result of LLIN distribution.

The University of Notre Dame (UND) has sequenced a sub-sample of *An. paludis* as part of a wider effort to determine malaria risk after recording high biting rates in some sites. Of the *An. paludis* samples tested from Kapolowe, the majority were molecularly identified as being *coustani*-like species (*An. cf coustani* 1 & 2) with the sequences corresponding to those previously reported from Zambia. The team conducted HLC in Kenge in the Kwango Province to collect specimens of *An. paludis*, which Karch and Mouchet identified in 1992 as a malaria vector in this region [1].

As part of the capacity building component, the team, in collaboration with the National Malaria Control Program (NMCP), conducted a group training for three supervisors from each of the 11 sites in Kinshasa from July 17 to July 22, 2017.

1. INTRODUCTION

Morbidity and mortality due to malaria remain a serious public health problem in the Democratic Republic of Congo (DRC) despite sustained malaria control strategies. According to the 2013/14 Demographic and Health Survey (DHS), from a total of 7,250 dried blood spots tested from children sampled across all 26 Provincial Health Divisions/ Divisions Provinciales de la Santé (DPS), Rapid diagnostic tests produced a 30.9% positive rate for *P. falciparum* using while polymerase chain reaction (PCR) produced a 34.1% rate. Current malaria control strategies in DRCrely heavily on core vector control interventions, especially the use of long lasting insecticide nets (LLINs). WHO estimates that between 2014 and 2016, approximately 61 million LLINs were distributed, with 77% of the population having access to an LLIN according to modelling studies (WHO, 2016). Between 2010 and 2014, LLINs aided by therapeutic treatments contributed to a 10% reduction of malaria morbidity and a 37% reduction in deaths for children under five years old (PSN, 2016-2020). However, more recent data indicated a trend showing an estimated increase of 500,000 malaria cases between 2015 and 2016 (WHO, 2016), which may in part be due to improvements in the reporting system and increased utilization of health services.

LLIN mass distribution campaigns are organized with the support of donors, including the President's Malaria Initiative (PMI), and occur throughout many DRC regions. The NMCP has planned LLIN distributions every three years since 2007, with mass distribution campaigns taking place annually in different provinces. In 2017, mass distribution campaigns were conducted with Yorkool®, Duranet® and Dawaplus 2.0®. In addition to mass distributions, Permanet 2.0® and Duranet® are distributed to pregnant women during antenatal care visits and to children under one year of age at health clinics. Abt

Associates conducts entomological monitoring and surveillance through PMI's Africa Indoor Residual Spraying (AIRS) Project in the DRC to help evaluate the impact of LLIN use on malaria vectors (vector density, seasonal distribution, behavior, species composition, and insecticide susceptibility). This report covers the entomological activities Abt undertook in 11 sites (Kingasani, Kalemie, Katana, Mikalayi, Lodja, Kapolowe, Kabondo, Pawa, Karawa, Inongo, and Kimpese) during year three of the task order (TO6) contract.

2. PROJECT OBJECTIVES

The goal of entomological activities in the DRC is to build capacity in generating data on malaria vectors and to develop tools to control them. The objectives are to:

1. Continue to conduct high-quality entomological monitoring activities with minimum technical assistance from outside the DRC.

2. Expand support for monitoring species composition, seasonality, behavior, and infectivity of malaria vectors in 11 sentinel sites (previously seven) in 11 provinces: Kinshasa, Kasai, Sankuru, Tshopo, Haut-Uele, Sud Kivu, Haut Katanga, Tanganyika, Kongo Central, Mai-Ndombe, and Sud Ubangi.

3. Determine the susceptibility level of the main vector of malaria, *Anopheles gambiae* s.l., to three insecticides (permethrin, deltamethrin and alpha-cypermethrin) recommended by the World Health Organization (WHO) Pesticide Evaluation Scheme for LLINs in the 11 sentinel sites. We also will determine the intensity of insecticide resistance to permethrin and deltamethrin using the CDC bottle assay in seven sites.

4. Continue to support the evaluation of *Anopheles paludis* as a malaria vector in Kapolowe (Haut Katanga) and Lodja (Sankuru). This includes close collaboration with the UND for sequencing mosquito samples to determine

whether *An. paludis* is a species complex with some species being more important malaria vectors.

5. Determine the impact of insecticide resistance on mosquito survival following exposure to LLINs using WHO cone bioassays for permethrin and deltamethrin LLINs with both insectary-reared susceptible and wild resistant *An. gambiae* s.l. mosquitoes.

6. Provide technical and material assistance to the NMCP in the development of its indoor residual spraying (IRS) strategy and national resistance monitoring plan.

7. Hire an AIRS medical entomologist who will provide daily support to the National Institute of Bio-medical Research/Institut National de Recherche Biomédicale (INRB) team on all technical and administrative matters.

8. Continue to build entomological capacity by strengthening laboratory quality assurance through collaboration with the UND and conducting training in mosquito identification with support from the new medical entomologist.

3. METHODOLOGY

3.1. Study Area

The project undertook entomological monitoring activities in 11 sentinel sites (Kingasani, Kalemie, Katana, Mikalayi, Lodja, Kabondo, Kapolowe, Pawa, Karawa, Inongo and Kimpese) in the DRC (Figure 1 and Table 1) in 2017.

Figure 1 : 2017 Sentinel Sites for Entomological Activity

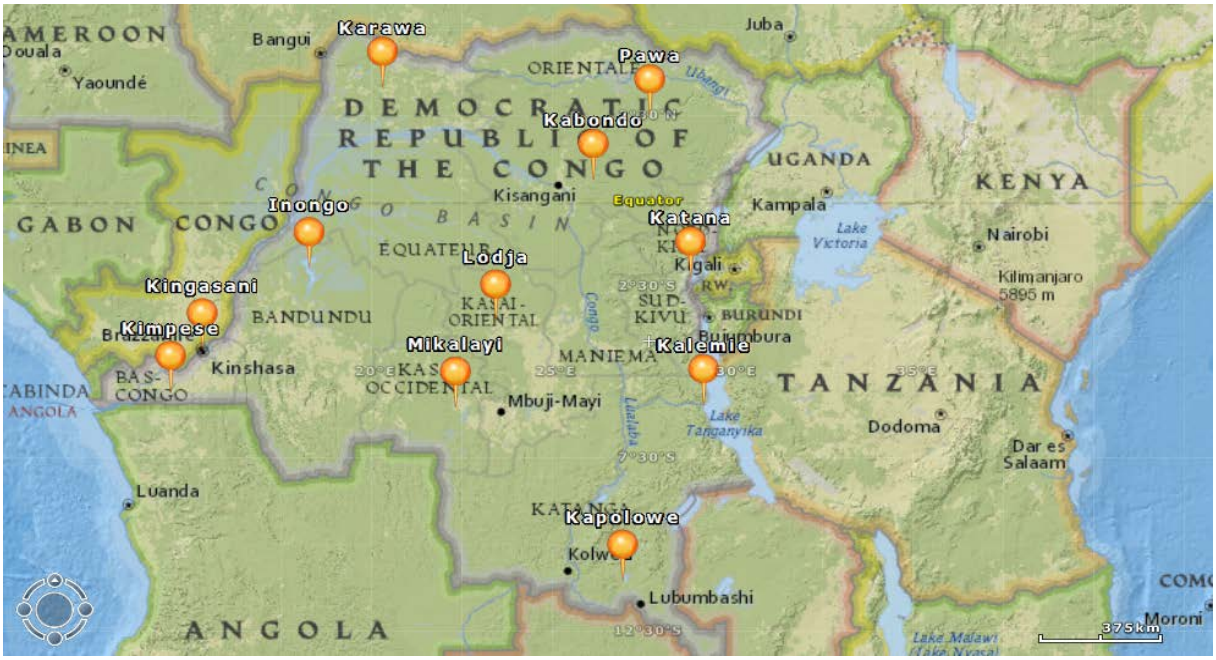


Table 1: 2017 sentinel sites for entomological surveillance

Old Province	New Province	Sentinel Site	Year added
Kinshasa	Kinshasa	Kingasani	2014
Kasai Occidental	Kasai	Mikalayi	2014
Kasai Oriental	Sankuru	Lodja	2013
Orientale	Tshopo	Kabondo	2013
Orientale	Haut-Uele	Pawa	2017
Sud Kivu	Sud Kivu	Katana	2015
Katanga	Haut Katanga	Kapolowe	2013
Katanga	Tanganyika	Kalemie	2015

Bas-Congo	Kongo Central	Kimpese	2017
Bandundu	Mai-Ndombe	Inongo	2017
Equateur	Sud Ubangi	Karawa	2017

INRB staff based in Kinshasa traveled to each site in 2017 to provide technical support. Sampling periods were January-March, April-June, and July-September in 9 of 11 sites. Vector sampling frequency in Kapolowe and Lodja was conducted monthly to determine seasonal vector dynamics.

In Lodja, monthly sampling was conducted in the following sites:

Cotonnière: altitude 414m, **S** 03° 32' 369", **E** 023° 34' 981" (Jan, May, June, July, Aug, Sept, Oct, Nov, Dec).

Diengenga: altitude, 494m, **S** 03° 26' 613", **E** 023° 36' 301" (February)

Asami (Edingo): altitude 453m, **S** 03° 30' 948", **E** 023° 35' 716" (March)

Shapembe: altitude 461m, **S** 03° 32' 092", **E** 023° 37' 617" (April)

In Kapolowe, monthly mosquito sampling was conducted in several locations within Kapolowe Mission.

Kapolowe Mission: altitude 1145 m, **S** 10° 56' 655", **E** O26° 57' 014"

3.2. Insecticide Susceptibility and Resistance Intensity Monitoring

Collections of *Anopheles gambiae* s.l. larvae were performed in all 11 sentinel sites using larval dippers and sieves. The larvae were reared in a field insectary and the emergent adults were raised to two to five days old for insecticide resistance tests. Insecticide resistance status was assessed using the WHO cylinder test using diagnostic concentrations of deltamethrin (0.05%), permethrin (0.75%), and alpha-cypermethrin (0.05%). At least 100 *An. gambiae* s.l. were exposed to each insecticide in replicates of 25. The project monitored knock-down every 10 minutes for 60 minutes. The tested mosquitoes were then transferred to a clean paper cup, provided with cotton wool soaked in sugar solution, and mortality was scored 24 hours after exposure.

The project determined the intensity of insecticide resistance to deltamethrin and permethrin using the CDC bottle assay for the first time in seven sentinel sites. Four replicates of 20 *An. gambiae* s.l. were exposed to each concentration of one, two, five, and 10 times the diagnostic dose. Following CDC protocols, the team recorded mortality at the diagnostic time of 30 minutes.

3.3. Human Biting Rate

Human Landing Catch (HLC)

The project used the HLC method to assess mosquito biting times and feeding behavior and to monitor species composition and sporozoite rates. Two teams collected adult mosquitoes during four consecutive nights (in two different houses each night), with one person indoors and the other outdoors in each selected house. Four collectors worked at each house, with each person working a six-hour shift (one person from 18:00 to midnight and the other from midnight to 06:00 indoors and outdoors). The human biting rate (HBR) was calculated for each sampling period based on eight person nights of collection.

3.4. Indoor resting densities

Pyrethrum Spray Catch (PSC)

The project used PSC to estimate the indoor resting density of mosquito species. Indoor PSC was used in ten houses/bedrooms at each sentinel site. The PSCs were carried out between 06:00 and 10:00. All occupants were asked to move water, food, or anything that insecticide could harm out of the house before spraying. The project sprayed a commercial aerosol (Baygon, SC Johnson, South Africa) containing the pyrethroids imiprothrin, prallethrin, tetramethrin, and synergist piperonyl butoxide (PBO) in each room; white sheets were lined on floors and other surfaces to collect mosquitoes. All mosquitoes were collected from the white sheets 15 minutes after spraying.

Female *Anopheles* mosquitoes were classified according to abdominal status (unfed, fed, half-gravid, or gravid). Each mosquito was labeled for subsequent analysis at INRB for sibling species identification using PCR and other lab-based analysis.

3.5. Testing the effect of resistance on LLIN-induced mortality using cone bioassays

Pyrethroid nets containing permethrin, deltamethrin, and alphacypermethrin were collected from Inongo in the province of Mai-Ndombe. Net age was estimated based on the timing of previous distribution campaigns in the region. Four of each of the following LLINs were collected from the community:

1- Permethrin LLIN (Olyset®): 5 years old
2- Deltamethrin LLIN (Yorkool®): 1 year old
3- Alpha-cypermethrin LLIN (Duranet®): 6 months old

Four nets of each brand were tested using WHO cone bioassays. Each net was tested with five cones, with one cone placed on each of the four sides at different heights, and one in the center of the roof. Bioassays were conducted with both insectary reared susceptible *An. gambiae* Kisumu and wild pyrethroid resistant *An. gambiae* s.l from Kingasani (Kinshasa) to determine the impact of resistance on survival following exposure to LLINs.

The efficacy of the used nets was compared with new nets of each brand obtained from Centre de Recherche Entomologique de Cotonou (CREC), Benin in October 2017, with mortality compared with the WHO bio-efficacy threshold.

3.6. Impact of mass distribution of LLINs on the intensity of insecticide resistance in Kinshasa

The objective of this study was to determine if selection pressure due to mass distribution of LLINs affects insecticide resistance intensity in Kinshasa. Insecticide resistance intensity in *Anopheles gambiae* s.l. was monitored in four

sites (Bu, Kingasani, Kinkole, and Kimpoko) within Kinshasa before the start of the 2016 mass LLIN distribution campaign. Resistance was monitored using the intensity assay (bottle bioassays using 1, 2, 5, and 10 times the diagnostic dose of permethrin and deltamethrin). Insecticide resistance intensity was also monitored in Kasangulu, a control area 40km from Kinshasa where there was no plan for mass distribution of LLINs (the last distribution in Kasangulu was in 2014). Intensity assays were conducted in 2017 in March, June, and October.

4. RESULTS

4.1. Vector Susceptibility to Insecticides

Maps of resistance for permethrin, deltamethrin, and alpha-cypermethrin are shown in Figure 2. Detailed results and comparison with 2016 data are shown in Table 2. There was no mortality for control bioassays conducted with oil-treated blank papers in 2017 (Table 2).

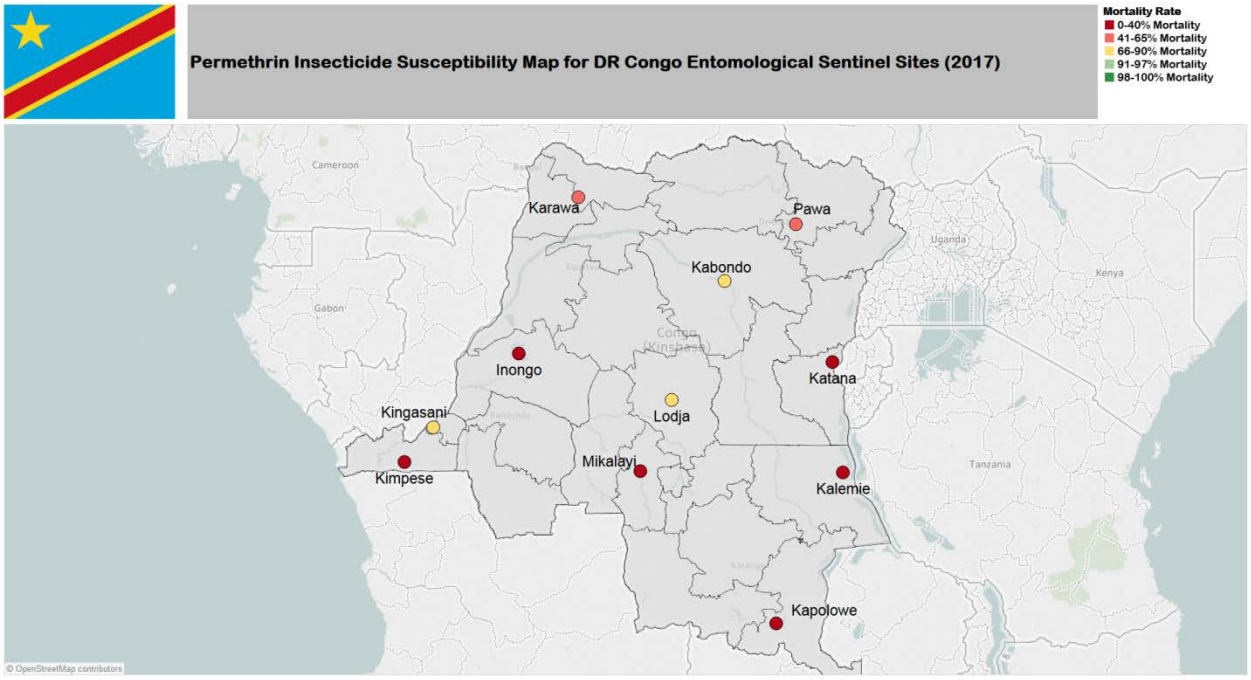
Permethrin resistance was widespread in DRC. The team recorded it at all 11 sentinel sites at moderate or high frequency (Figure 2). In Katana and Kapolowe, the frequency of permethrin resistance increased, with 38% (95% CI: 29-48) and 9% (95% CI: 5-16) mortality in 2017, compared with 100% at both sites in 2016 (Table 2); however, for Kapolowe it should be noted that resistance to permethrin was previously recorded in 2015.

The project observed deltamethrin resistance in four sites (Kimpese, Karawa, Pawa, and Kalemie) and detected possible resistance in five sites (Kingasani, Mikalayi, Kabondo, Kapolowe, and Lodja). The *An. gambiae* s.l. populations from Inongo and Katana were susceptible to deltamethrin 0.05%.

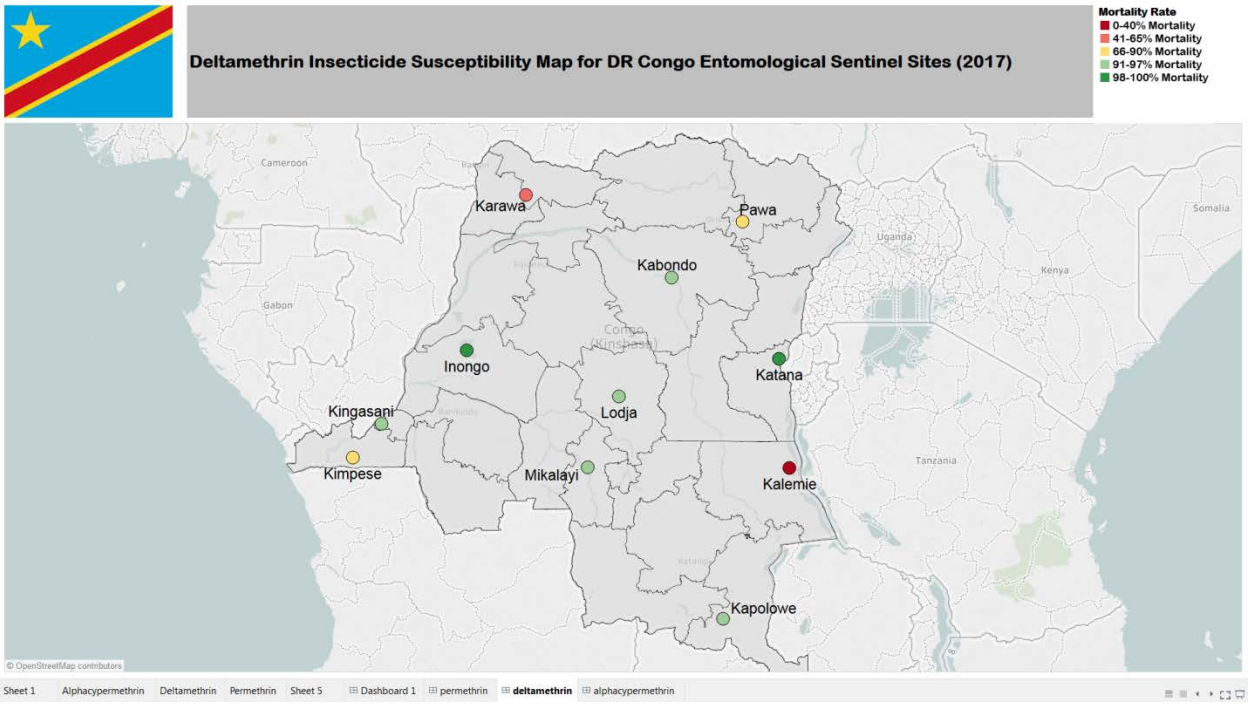
Populations of *An. gambiae* s.l. were fully susceptible to alpha-cypermethrin (0.05%) in all sites except Kingasani and Kalemie, where the project detected resistance. There was also possible resistance in Karawa.

Figure 2 : Insecticide WHO susceptibility maps for a) permethrin (0.75%), b) deltamethrin (0.05%), c) alpha-cypermethrin (0.05%)

A) PERMETHRIN (0.75%)



B) **DELTAMETHRIN (0.05%)**



C) ALPHA-CYPERMETHRIN (0.05%)

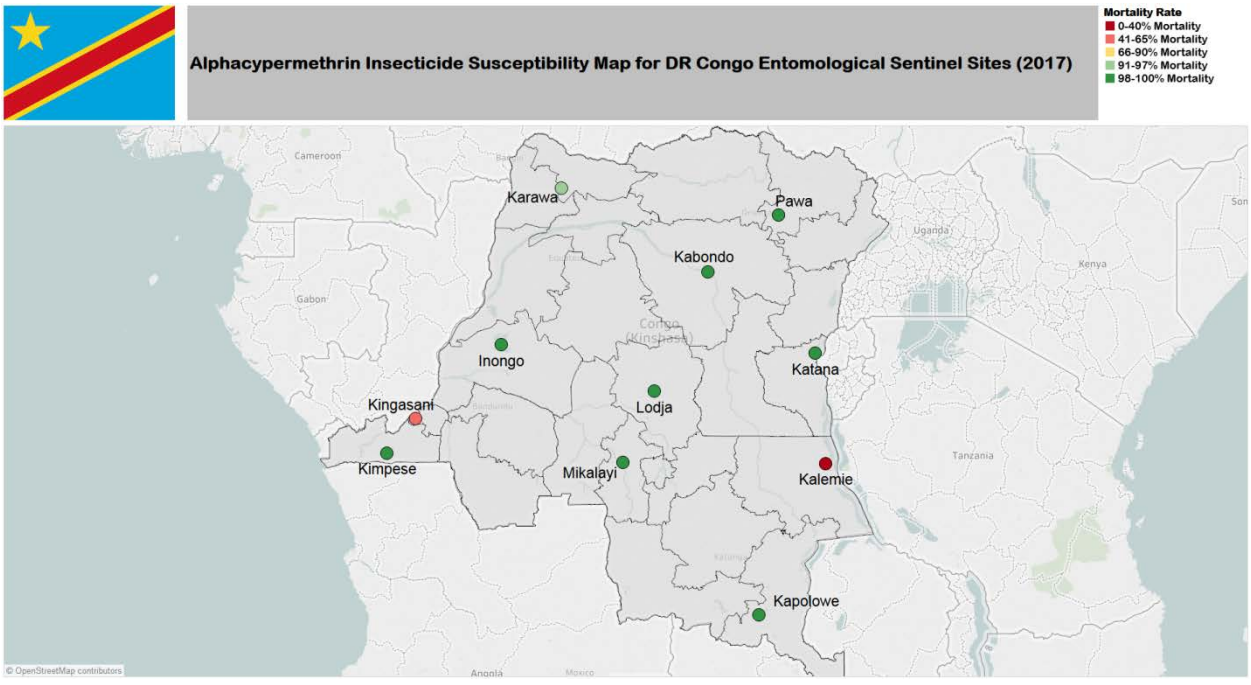


Table 2. Insecticide susceptibility status of *An. gambiae* s.s. exposed to WHO diagnostic doses of deltamethrin, permethrin, and alpha-cypermethrin in 2017

Sentinel Sites	Insecticides	2017 Nbr Exposed (control)	2017 Nbr Exposed (test)	2017 24hrs % Mortality (95% CI)	2016 24hrs % Mortality (95% CI)
Kingasani	Deltamethrin 0.05%	50	100	**93** (86 – 97)	**100**
	Permethrin 0.75%	50	100	**86** (78 – 91)	**21** (13 – 29)
	Alpha-cypermethrin 0.05%	50	100	**55** (45 – 64)	Not tested
Mikalayi	Deltamethrin 0.05%	50	100	**92** (85 – 96)	**88** (82 - 94)
	Permethrin 0.75%	50	100	**26** (18 – 35)	**36** (27 - 45)
	Alpha-cypermethrin 0.05%	50	100	**100**	Not tested
Kabondo	Deltamethrin 0.05%	50	100	**95** (89 – 98)	**76** (68 – 84)
	Permethrin 0.75%	50	100	**88** (80 – 93)	**12** (6 – 18)
	Alpha-cypermethrin 0.05%	50	100	**99** (95 – 100)	Not tested
Kapolowe	Deltamethrin 0.05%	50	100	**97** (92 – 99)	**100**
	Permethrin 0.75%	50	100	**9** (5 – 16)	**100**
	Alpha-cypermethrin 0.05%	50	100	**99** (95 – 100)	Not tested
Kimpese	Deltamethrin 0.05%	50	100	**76** (67 – 83)	Not tested
	Permethrin 0.75%	50	100	**17** (11 – 26)	Not tested
	Alpha-cypermethrin 0.05%	50	100	**100**	Not tested

Karawa	Deltamethrin 0.05%	50	100	**61** (51 – 70)	Not tested
	Permethrin 0.75%	50	100	**56** (46 – 65)	Not tested
	Alpha-cypermethrin 0.05%	50	100	**93** (86 – 97)	Not tested
Pawa	Deltamethrin 0.05%	50	100	**83** (74 – 89)	Not tested
	Permethrin 0.75%	50	100	**64** (54 – 73)	Not tested
	Alpha-cypermethrin 0.05%	40	80	**99** (93 – 100)	Not tested
Inongo	Deltamethrin 0.05%	50	100	**100**	Not tested
	Permethrin 0.75%	50	100	**22** (15 – 31)	Not tested
	Alpha-cypermethrin 0.05%	50	100	**99** (95 – 100)	Not tested
Kalemie	Deltamethrin 0.05%	50	100	**24** (17 – 33)	**100**
	Permethrin 0.75%	50	100	**3** (1 – 8)	**40** (30 – 50)
	Alpha-cypermethrin 0.05%	50	100	**14** (9 – 22)	Not tested
Katana	Deltamethrin 0.05%	50	100	**100**	**100**
	Permethrin 0.75%	50	100	**38** (29 – 48)	**100**
	Alpha-cypermethrin 0.05%	50	100	**100**	Not tested
Lodja	Deltamethrin 0.05%	50	100	**95** (89 – 98)	**100**
	Permethrin 0.75%	50	100	**69** (59 – 77)	**69** (60 – 78)
	Alpha-cypermethrin 0.05%	50	100	**100**	Not tested

Notes: **(S)** = susceptibility **(R)** = resistance **(PR)** = possible resistance

Resistance intensity data for permethrin and deltamethrin for seven sentinel sites are summarized in Tables 3 and 4. In all seven sites, A*n. gambiae* s.l. were highly resistant to permethrin, with relatively low mortality even at 10 times the diagnostic concentration.

Resistance intensity to deltamethrin was generally lower than to permethrin, with 98-100% mortality at 10 times the diagnostic concetration in five of seven sentinel sites. However, the proportion of survivors at two times the diagnostic concentration of deltamethrin was generally high, with mean mortality of 63% across all sites. The data contradict the findings of WHO susceptibility tests, which showed full susceptibility to deltamethrin in two sites, possible resistance in five sites and resistance to deltamethrin only in Kimpese, Karawa, Pawa and Kalemie.

Full susceptibility was recorded in WHO tests in Inongo and Katana. Conversely, 24% survivors were recorded in Inongo at two times the diagnostic concentration and 20% survivors at five times in Katana.

Table 3: Resistance intensity of *An. gambiae* s.l. to ×1, ×2, ×5, ×10 the diagnostic concentration of permethrin

Sentinel Site	Total Number tested per dose	% Mortality (95% CI) Permethrin concentration x1	x2	x5	x10
Kabondo	100	1 (0-5)	4 (2-10)	23 (16-32)	43 (34-53)
Kalemie	80	0 (0-5)	3 (1-9)	14 (8-23)	40 (30-51)
Katana	100	8 (4-15)	18 (12-27)	36 (27-46)	80 (71-87)
Kingasani	100	0 (0-4)	1 (0-5)	15 (9-23)	38 (29-48)
Mikalayi	80	9 (4-17)	11 (6-20)	18 (11-27)	25 (17-35)

Inongo	78	10 (5-19)	5 (2-12)	15 (9-25)	16 (10-26)
Kapolowe	100	0 (0-4)	0 (0-4)	10 (6-17)	68 (58-76)
Overall	**638**	**4 (2-6)**	**6 (4-8)**	**19 (16-22)**	**46 (42-50)**

*NB. In each test, 25 *An. gambiae* s.l. were in an untreated control. Mortality was zero in all.

Table 4: Resistance intensity of *An. gambiae* s.l. to ×1, ×2, ×5, ×10 the diagnostic concentration of deltamethrin

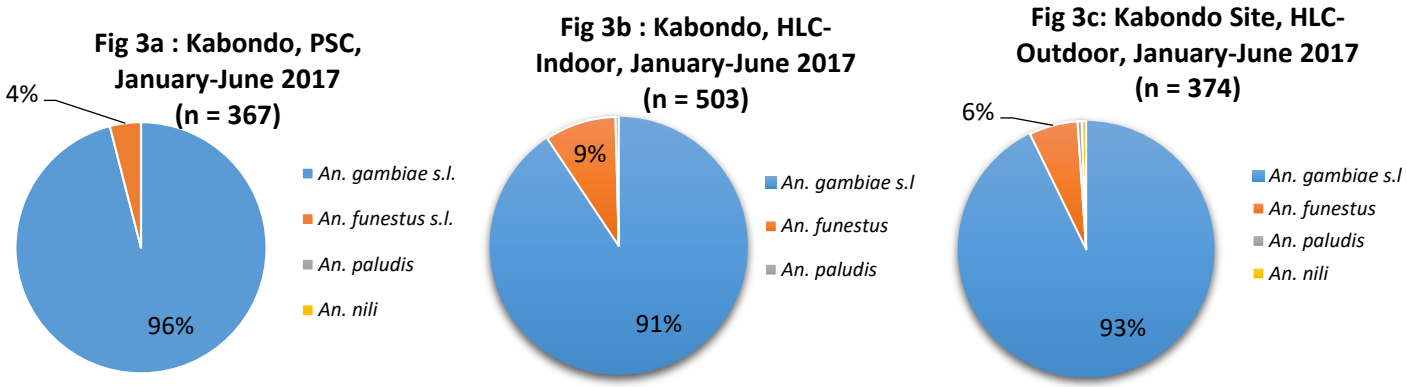
Sentinel Site	Total number tested per dose	% Mortality (95% CI) Deltamethrin concentration x1	x2	x5	x10
Kabondo	100	41 (32-51)	87 (79-92)	98 (93-99)	100 (96-100)
Kalemie	80	18 (11-27)	30 (21-41)	84 (74-90)	99 (93-100)
Katana	100	21 (14-30)	55 (45-64)	80 (71-87)	98 (93-99)
Kingasani	100	44 (35-54)	85 (77-91)	100 (96-100)	100 (96-100)
Mikalayi	80	75 (65-83)	78 (67-85)	85 (76-91)	96 (90-99)
Inongo	80	66 (55-76)	76 (66-84)	100 (95-100)	99 (93-100)
Kapolowe	100	24 (17-33)	32 (24-42)	61 (51-70)	80 (71-87)
Overall	**640**	**40 (36-44)**	**63 (60-67)**	**87 (84-89)**	**96 (94-97)**

*NB. In each test, 25 *An. gambiae* s.l. were tested in an untreated control. Mortality was zero in all.

4.2. Vector Species Composition

4.2.1. Tshopo Province, Kabondo Site (January – June 2017)

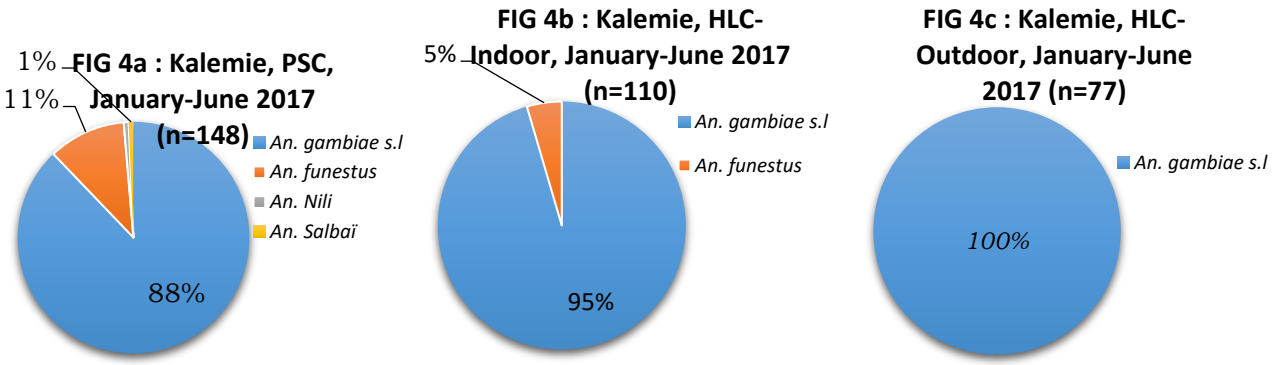
Figure 3: Morphological *Anopheles* species composition captured by PSC and HLC indoors and outdoors in Kabondo



In Kabondo, *An. gambiae* s.l. was the most common species caught by HLC and PSC throughout the year.

4.2.2. Tanganyika Province, Kalemie Site (January - June 2017)

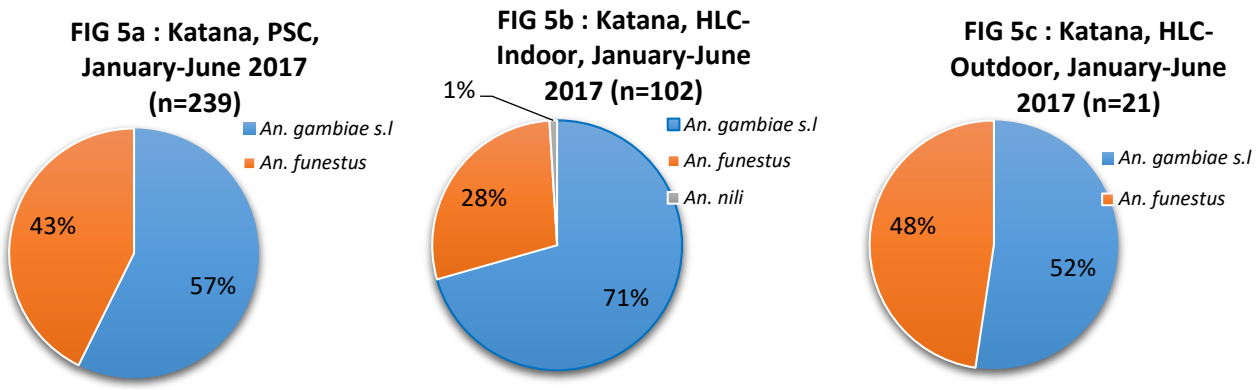
Figure 4: Distribution of *Anopheles* captured by PSC and HLC indoors and outdoors in Kalemie



An. gambiae s.l. was the predominant species caught in Kalemie through PSC and HLC.

4.2.3. Sud Kivu Province, Katana Site (January- June 2017)

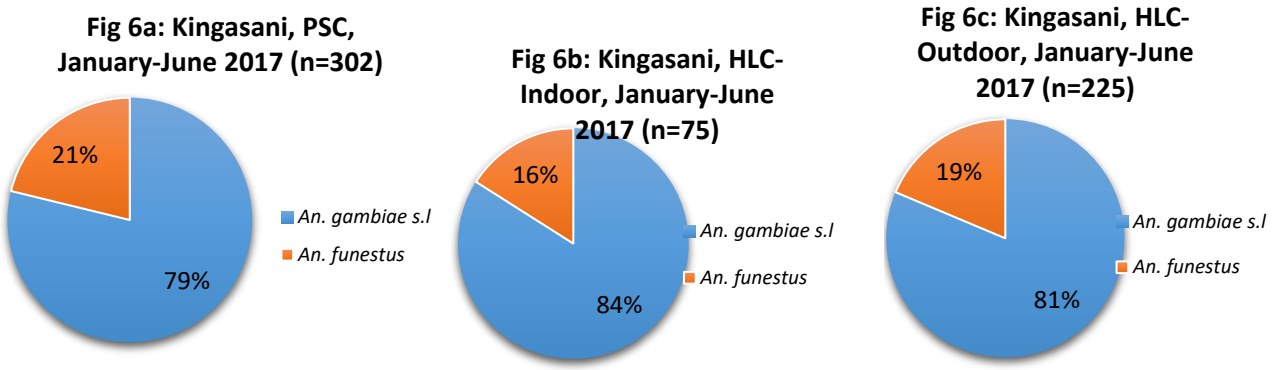
Figure 5: Distribution of *Anopheles* captured by PSC and HLC indoors and outdoors in Katana



In Katana, *An. gambiae* s.l. and *An. funestus* s.l. were caught in similar proportions by PSC and HLC outdoors.

4.2.4. Kinshasa Province, Kingasani Site (January- June 2017)

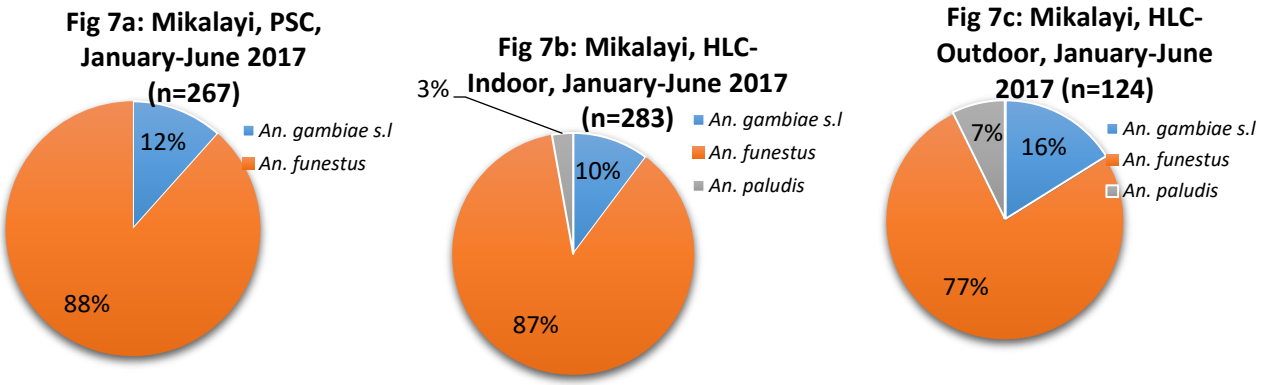
Figure 6: Distribution of *Anopheles* captured by PSC and HLC indoors and outdoors in Kingasani



In Kingasani, *An. gambiae* s.l. was the predominant species followed by approximately 15-20% *An. funestus* s.l. collected by PSC and HLC.

4.2.5. Kasai Province, Mikalayi Site (January- June 2017)

Figure 7: Distribution of *Anopheles* Captured by PSC and HLC indoors and outdoors In Mikalayi

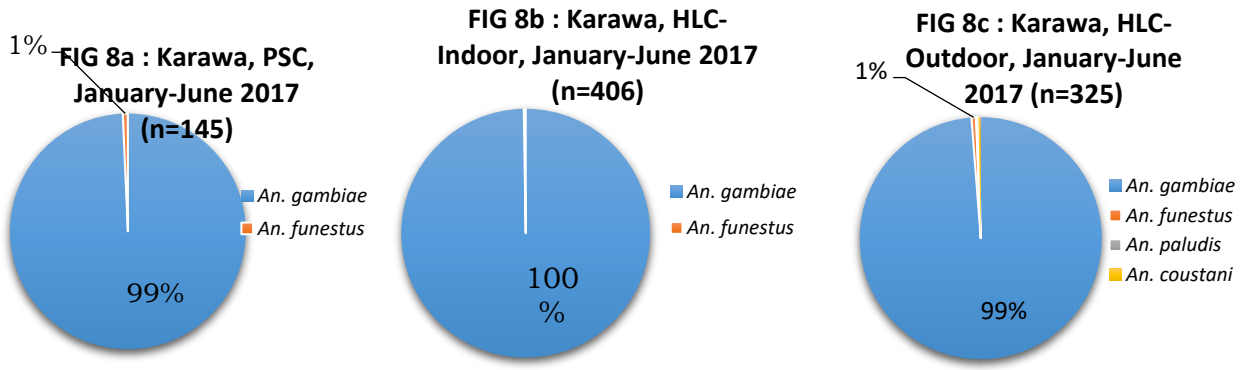


In Mikalayi, *An. funestus* s.l. was the predominant species collected by PSC and HLC both indoors and outdoors.

NEW SENTINEL SITES FOR 2017 (KARAWA, INONGO, KIMPESE, PAWA)

4.2.6. Sud Ubangi Province, Karawa Site (January- June 2017)

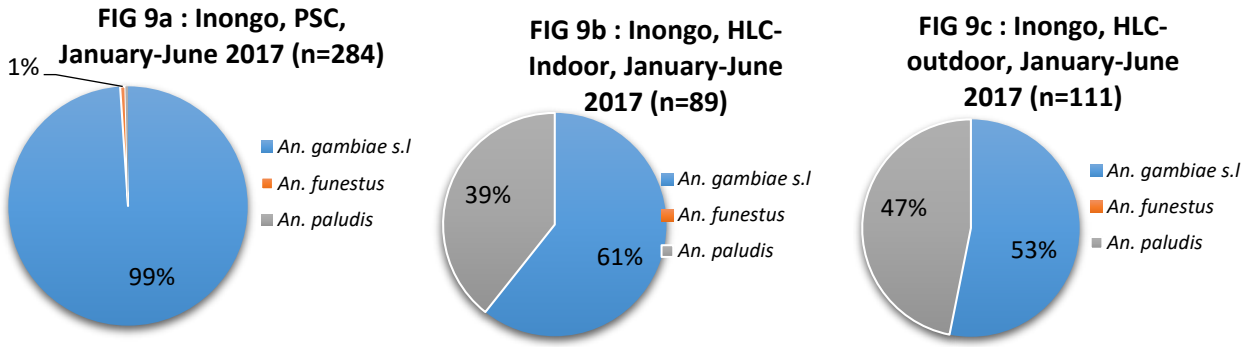
Figure 8: Distribution of *Anopheles* Captured by PSC and HLC indoors and outdoors in Karawa



In Karawa, *An. gambiae* s.l. accounted for 99% of *Anopheles* caught by PSC and HLC both indoors and outdoors.

4.2.7. Mai-Ndombe Province, Inongo Site (January- June 2017)

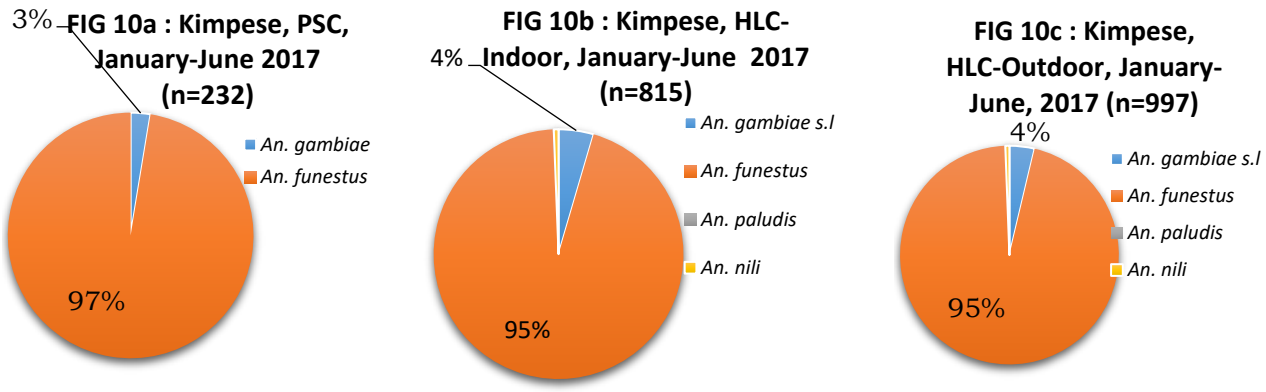
Figure 9: Distribution of *Anopheles* Captured by PSC and HLC indoors and outdoors in Inongo



In Inongo, 99% of *Anopheles* PSC collected resting indoors were *An. gambiae* s.l. For HLC indoors and outdoors, around 40% were *An. paludis*. This suggests *An. paludis* rest predominantly outdoors, even after indoor biting.

4.2.8. Kongo Central Province, Kimpese Site (January-June 2017)

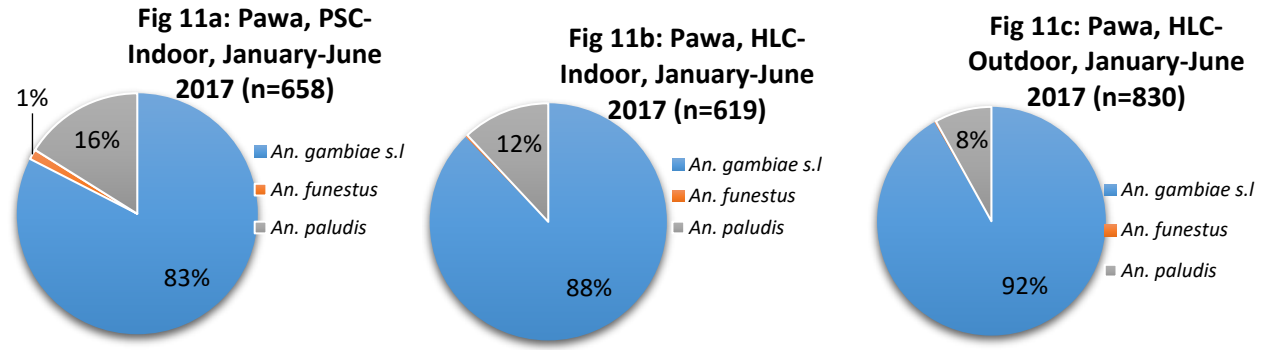
Figure 10: Distribution of *Anopheles* Captured by PSC and HLC Indoors and Outdoors in Kimpese



In Kimpese, *An. funestus* s.l. was the most abundant species collected by HLC and PSC.

4.2.9. Haut-Uele Province, Pawa Site (January- June 2017)

Figure 11: Distribution of *Anopheles* Captured by PSC and HLC indoors and outdoors in Pawa



In Pawa, *An. gambiae* s.l. were most abundant (83%-92%) followed *An. paludis* (8%-16%). The project collected *An. paludis* mostly during the dry season (May-June) (see Annex). Unlike in Inongo, the team captured *An. paludis* resting indoors.

4.3. Human Biting rate of Malaria Vectors Indoors and Outdoors Collected by HLC

Table 5: Indoor mean HBR of malaria vectors (January-June 2017)

Sentinel site and species	INDOORS			OUTDOORS		
	Nbr mosquitoes	Nbr of person-nights	HBR/night	Nbr mosquitoes	Nbr person-nights	HBR/night
Kabondo						
An. gambiae s.l.	456	24	**19**	347	24	**14**
An. funestus s.l.	45	24	**2**	23	24	**1**
Kalemie						
An. gambiae s.l.	105	24	**4**	75	24	**3**
An. funestus s.l.	5	24	**0**	0	24	**0**
Katana						
An. gambiae s.l.	72	24	**3**	11	24	**0**
An. funestus s.l.	29	24	**1**	10	24	**0**
Kingasani						
An. gambiae s.l.	63	24	**3**	183	24	**8**
An. funestus s.l.	12	24	**1**	42	24	**2**
Mikalayi						
An. gambiae s.l.	29	24	**1**	20	24	**1**
An. funestus s.l.	246	24	**10**	95	24	**4**
Karawa						
An. gambiae s.l.	405	24	**17**	321	24	**13**
An. funestus s.l.	1	24	**0**	2	24	**0**
Inongo						
An. gambiae s.l.	54	24	**2**	59	24	**2**
Kimpese						
An. gambiae s.l.	37	24	**2**	37	24	**2**
An. funestus s.l.	772	24	**32**	953	24	**40**
Pawa						
An. gambiae s.l.	543	24	**23**	761	24	**32**
An. funestus s.l.	2	24	**0**	2	24	**0**

The mean indoor human biting rate of *An. gambiae* s.l. in 2017 varied between one bite per person per night in Mikalayi and up to 23 bites per person per night in Pawa. The outdoor human biting rate of *An. gambiae* s.l. in 2017

varied between zero bites per person per night in Katana and up to 32 bites per person per night in Pawa. In general, there was significant outdoor biting potential, with outdoor biting rates similar to indoor biting rates for both *An. gambiae* s.l. and *An. funestus* s.l.

The biting rate of *An. funestus* s.l. was substantial in two sites, with an indoor biting rate of 10 in Mikalayi and 32 bites per person per night in Kimpese. Statistical comparison of biting rates should not be made between regions due to the relatively small number of houses sampled and differences in sampling timing.

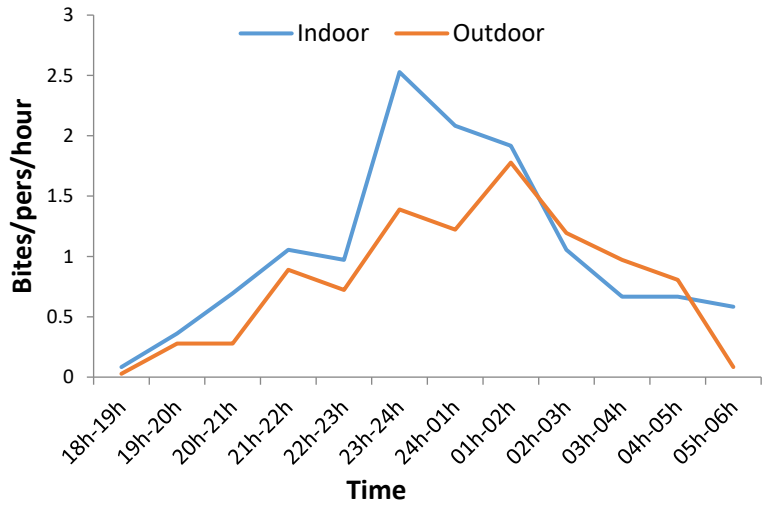
4.4. Biting Times of Malaria Vectors Indoors and Outdoors

Biting trends are presented only for locations where the total number caught per species by HLC was >200 between January and June 2017. In general, indoor biting by *An. gambiae* s.l. and *An. funestus* s.l. was primarily late at night, between 22:00 and 05:00, and mirrored outdoor biting trends. In Kimpese and Pawa, there was substantial biting occurring between 5:00am and 6:00am; thus, longer monitoring may be useful to determine whether morning biting occurs.

4.4.1. Tshopo Province, Kabondo Site (January – June 2017)

Figure 12: Mean nightly biting activity of *An. gambiae* s.l. at Kabondo site (January – June 2017), N=456 Indoors, N=347 Outdoors.

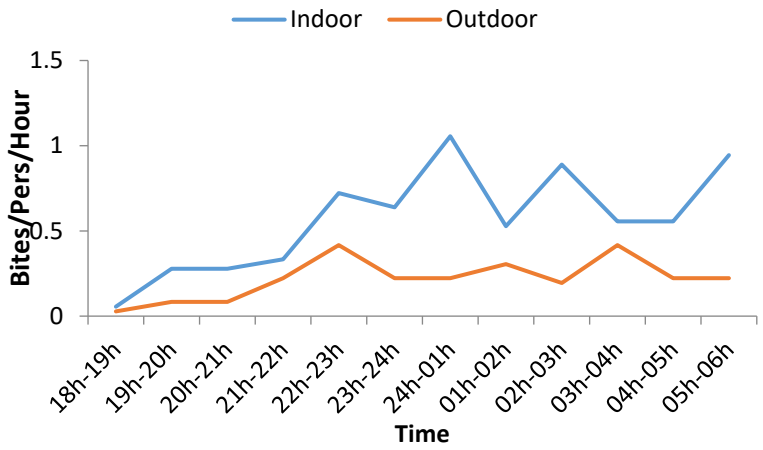
(n refers to total *An. gambiae* collected over the trapping period)



4.4.2. Kasai Province, Mikalayi Site (January – June 2017)

Figure 13: Biting ativity of *An. funestus* s.l. at Mikalayi site (January – June 2017), N=246 Indoors, N=95 Outdoors

(n refers to total *An. gambiae* collected over the trapping period)

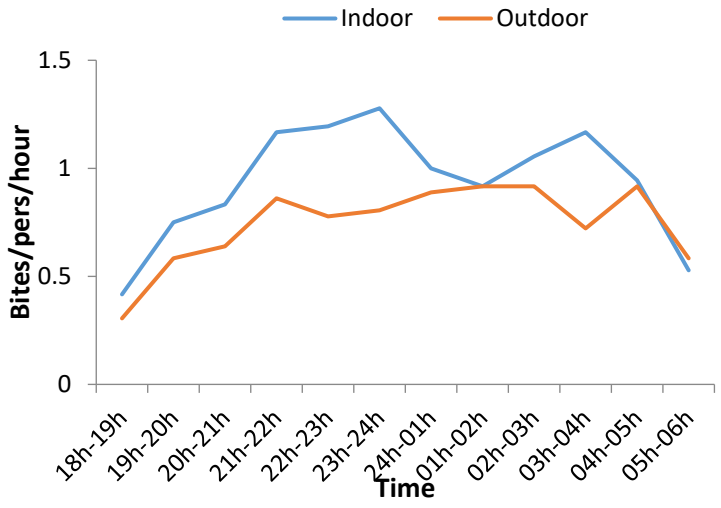


NEW SENTINEL SITES FOR 2017 (KARAWA, KIMPESE, PAWA)

4.4.3. Sud Ubangi Province, Karawa Site (January- June 2017)

Figure 14: Biting activity of *An. gambiae* s.l. at Karawa site (January – June 2017), N=405 Indoors, N=321 Outdoors

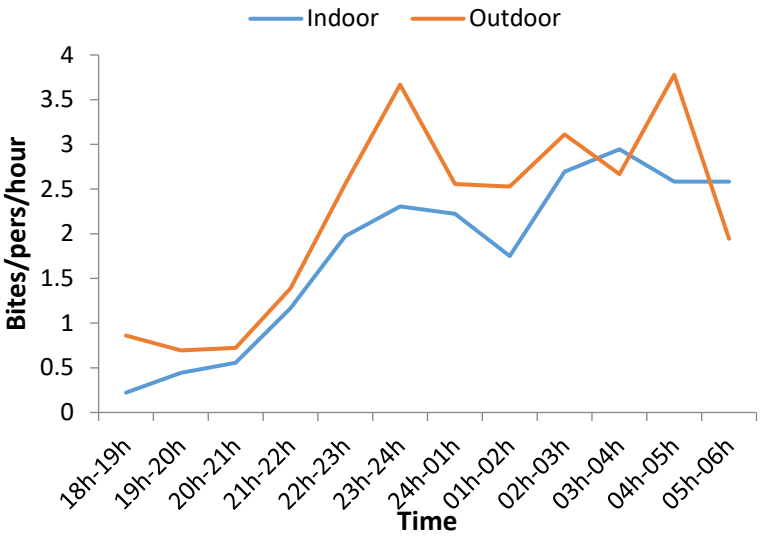
(n refers to total *An. gambiae* collected over the trapping period)



4.4.4. Kongo Central Province, Kimpese Site (January- June 2017)

Figure 15: Biting activity of *An. funestus* s.l. at Kimpese site (January – June 2017) N=772 Indoors, N=953 Outdoors

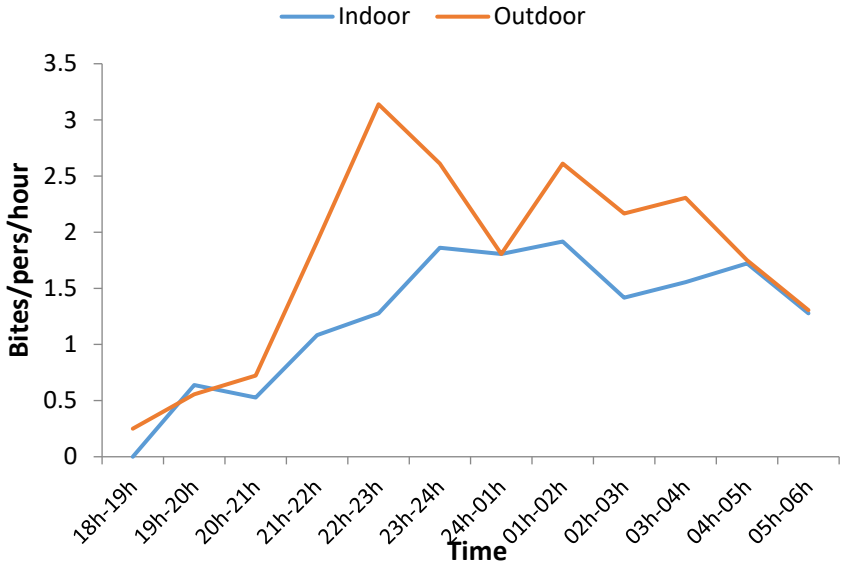
(n refers to total *An. gambiae* collected over the trapping period)



4.4.5. Haut-Uele Province, Pawa Site (January- June 2017)

Figure 16: Biting activity of *An. gambiae* s.l. at Pawa site (January – June 2017) N=543 Indoors, N=761 Outdoors

(n refers to total *An. gambiae* collected over the trapping period)



4.5. Monthly Monitoring of Malaria Vectors in Lodja and Kapolowe (January – December 2017)

4.5.1. Biting rate

In Kapolowe, *An. funestus* s.l. was the most abundant malaria vector, with particularly high biting rates at >100 bites per person per night in March and consistently above 20 bites throughout the year.

The peak biting rates for *An. gambiae* s.l. were between January and March (the rainy season). For *An. funestus* s.l., the biting peak was later, between March and May, with biting continuing at relatively high rates throughout the dry season (Figures 17).

In Lodja, *An. gambiae* s.l. was the primary malaria vector collected, with three apparent biting peaks in January, May, and October (Figure 18). *An. paludis* biting was predominantly outdoors and peaked in September with 40 bites per person per night (Figure 18).

Figure 17: Monthly indoor (left) and outdoor (right) biting rate of *Anopheles* species in Kapolowe (Haut Katanga) from HLC collections (8 houses per month)

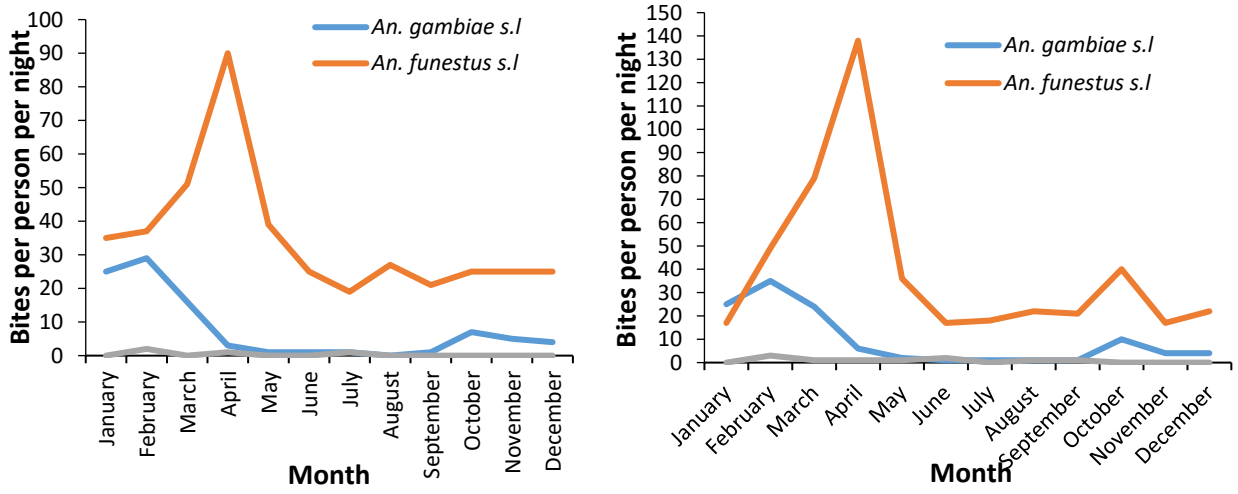
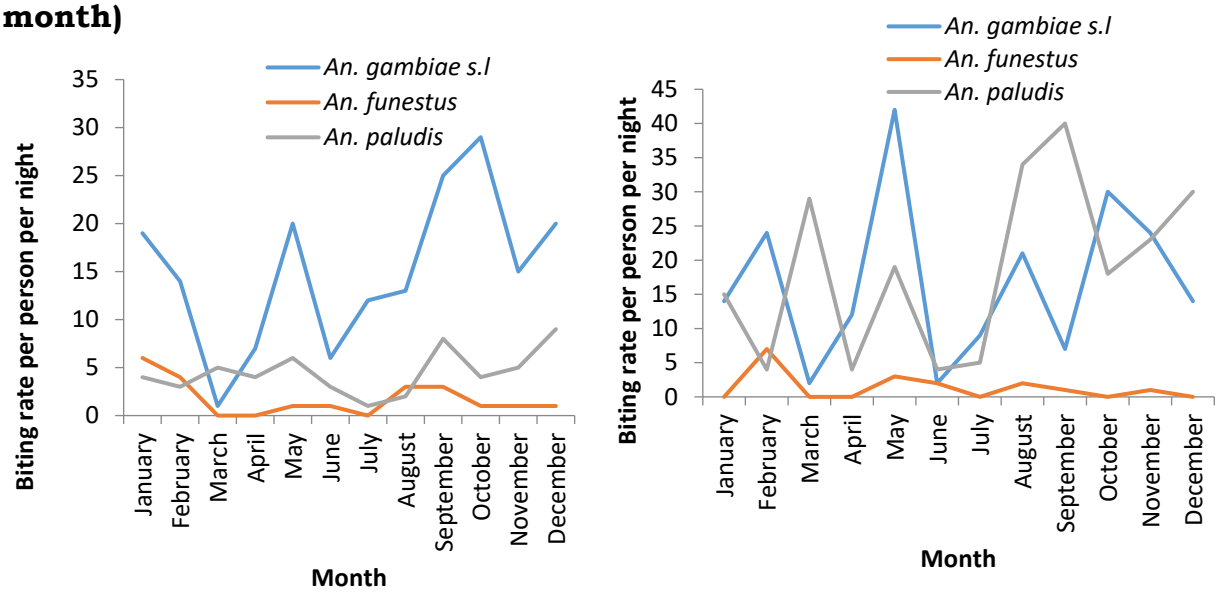


Figure 18: Monthly indoor (left) and outdoor (right) biting rate of *Anopheles* species in Lodja (Sankuru) from HLC collections (8 houses per month)



4.5.2. Biting Times of Anopheles Species Indoors and Outdoors

In Kapolowe, the mean hourly biting rates of *An. gambiae* s.l. and *An. funestus* s.l. were fairly constant throughout the night both indoors and outdoors (Figure 19). This is in keeping with trends from 2016.

In Lodja, *An. gambiae* s.l. biting trends were mirrored indoors and outdoors, with a gradual increase in biting rates until the peak at 1:00, followed by a gradual decrease until dawn (Figure 20).

Figure 19: Nocturnal biting times of *An. gambiae* s.l. and *An. funestus* s.l. indoors and outdoors in Kapolowe (Haut Katanga).

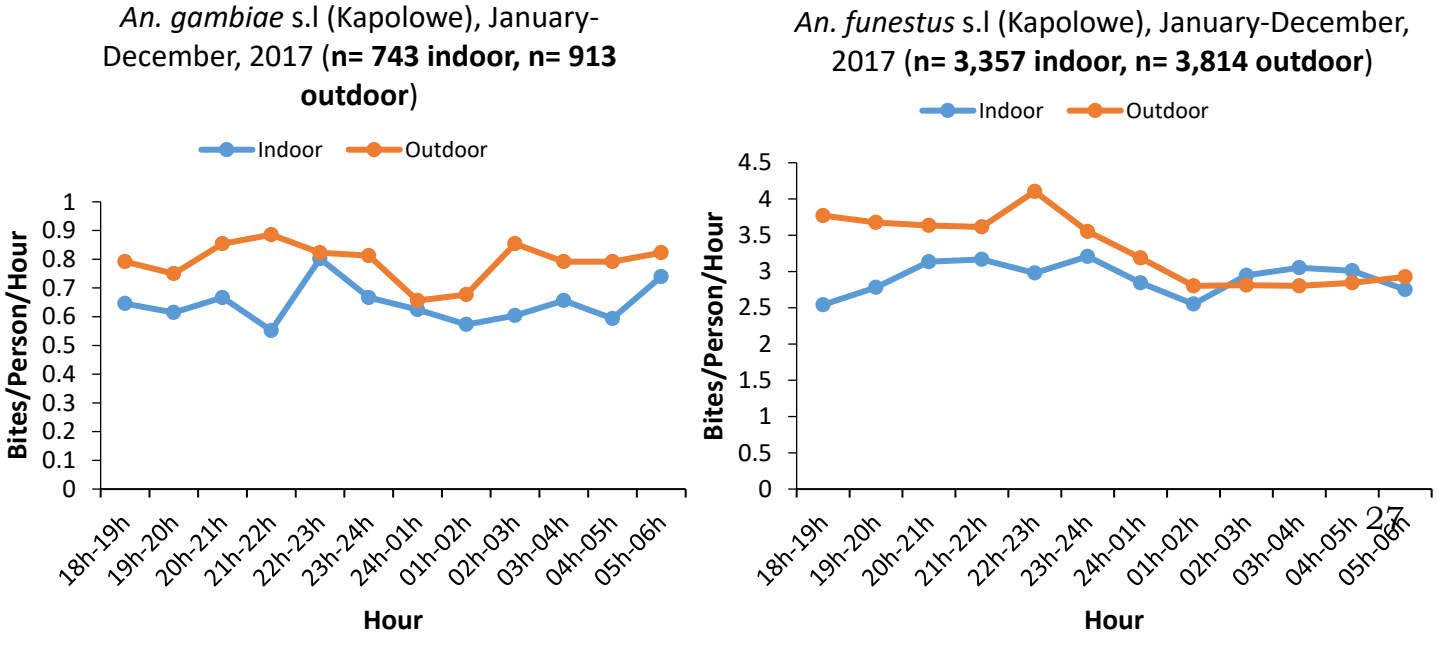


Figure 20: Nocturnal biting times of *An. gambiae* s.l. and *An. funestus* s.l. indoors and outdoors in Lodja (Sankuru)

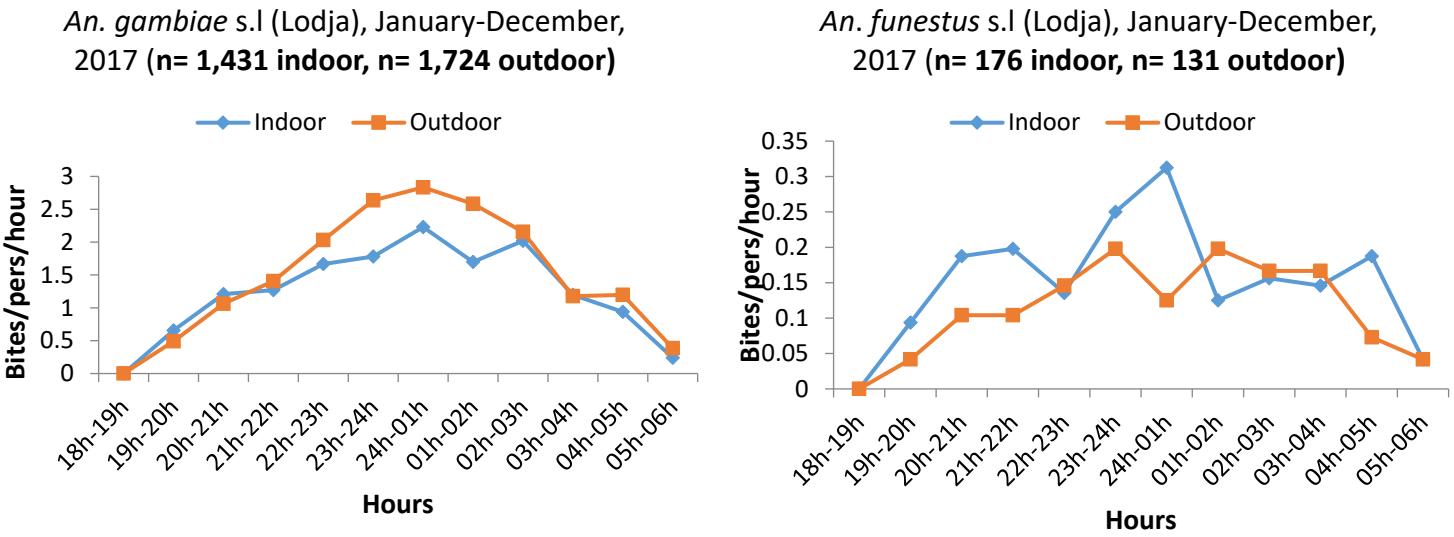
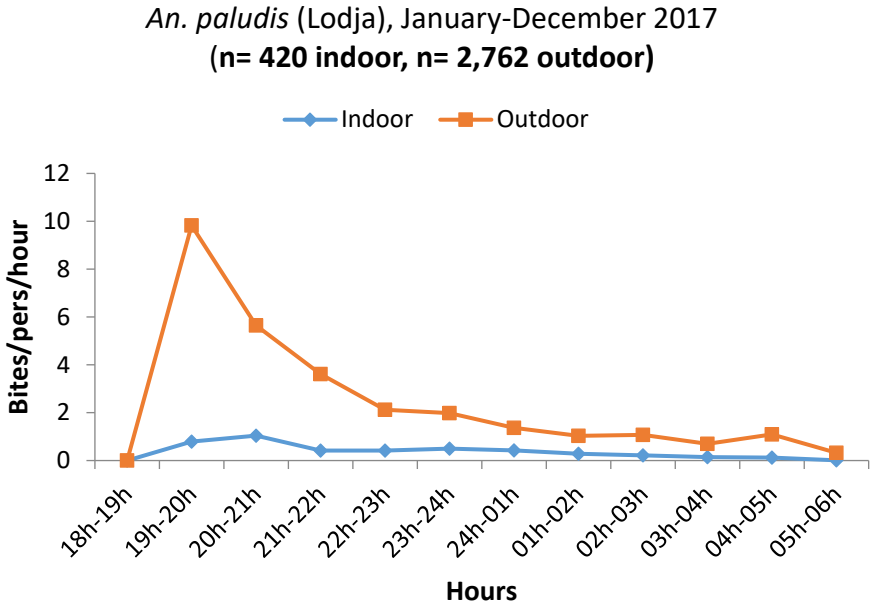


Figure 21: Nocturnal biting times of *An. paludis* indoors and outdoors in Lodja (Sankuru)



4.6. Impact of Resistance on Survival Following Exposure to LLINs

Table 6: Bio-efficacy of used permethrin, deltamethrin, and alpha-cypermethrin LLINs against laboratory susceptible Kisumu and wild resistant *An. gambiae* s.l. population from Kingasani

Net tested	Kisumu		Wild	
	Number tested	%Mortality (CI)	Number tested	%Mortality (CI)
Permethrin LLIN				
Olyset® used (≈5 yrs old)	80	35 (25-46)	100	23 (16-32)
Olyset® new	29	55 (36-72)	25	28 (14-48)
Deltamethrin LLIN				
Yorkool® used (≈1 yr old)	76	33 (23-44)	100	16 (10-24)
Yorkool® new	27	74 (55-87)	25	44 (27-63)
Alpha-cypermethrin LLIN				
Duranet® used (≈6 mths old)	95	100 (96-100)	100	47 (38-57)
Duranet® new	28	100 (88-100)	25	100 (87-100)

0% mortality rate was observed in control with untreated net against both susceptible and resistant *An. gambiae* s.l.

WHO susceptibility tests showed that wild *An. gambiae* s.l. from Kingasani were resistant to permethrin and alpha-cypermethrin, with possible resistance to deltamethrin.

All used and new permethrin and deltamethrin LLINs produced mortality rates inferior to the WHO bio-efficacy threshold of 80% mortality at 24h after exposure for both insectary and wild *An. gambiae* s.l. The biggest difference in mortality was for the used Duranet, with mortality at 47% for wild *An. gambiae* s.l. and 100% for *An. gambiae* Kisumu. This appears to indicate that alpha-cypermethrin resistance in Kingasani may affect used LLIN performance.

4.7. Intensity of Pyrethroid Resistance of *An. gambiae* s.l. in Kinshasa

Table 7: Summary of insecticide resistance intensity in Kasangulu and Kinshasa (2016 and 2017)

	Permethrin dose Resistance intensity classification					
	Year 2016			Year 2017 (March-October)		
Village	**Low[1]**	**Moderate[2]**	**High[3]**	**Low[1]**	**Moderate[2]**	**High[3]**
Control 40km outside Kinshasa						
Kasangulu			✓			✓
Kinshasa area						
Bu Village			✓			✓
Kimpoko			✓			✓
Kingasani			✓			✓
Kinkole			✓			✓

	Deltamethrin dose Resistance intensity classification					
	Year 2016			Year 2017 (March-October)		
Village	**Low[1]**	**Moderate[2]**	**High[3]**	**Low[1]**	**Moderate[2]**	**High[3]**
Control 40km outside Kinshasa						
Kasangulu		✓			✓	
Kinshasa area						
Bu Village			✓			✓
Kimpoko			✓		✓	
Kingasani		✓		✓		
Kinkole			✓		✓	

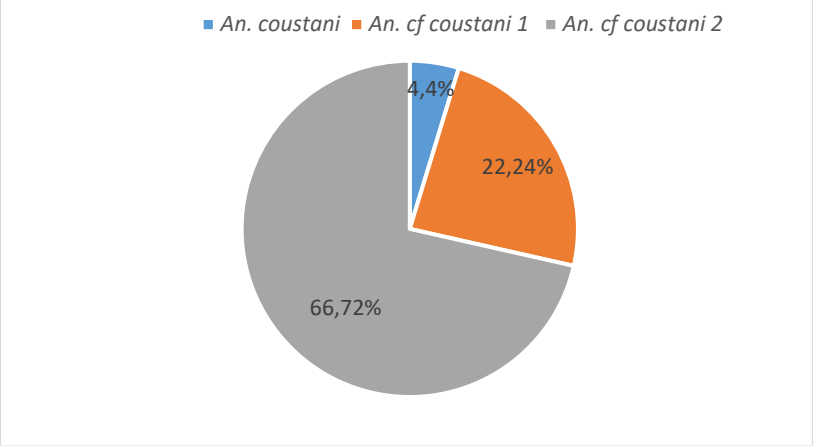
[1]Mortality of 98-100% at the 5x concentration; [2] Mortality of < 98% at 5x but in the range 98-100% and [3] Mortality < 98% at the 5x and 10x.

Permethrin resistance intensity was the same (high) before (2016) and after (2017) the mass LLIN distribution in Kinshasa suburbs. Deltamethrin resistance intensity was the same (moderate) in Kasangulu before (2016) and after (2017) the LLINs distribution. Observed deltamethrin resistance intensity in 2017 was less than that in 2016 in Kimpoko, Kingasani, and Kinkole. The detailed data are in Annex C.

5. *ANOPHELES PALUDIS*

University of Notre Dame received samples morphologically identified as *An. paludis* collected by HLC in 2015, predominantly from Kapolowe. The team dissected a subset of samples (head and thorax from abdomen), extracted DNA using cetyl trimethylammonium bromide, conducted internal transcribed spacer polymerase chain reaction, amplified samples, and conducted Sanger sequencing. Of the *An. paludis* samples tested from Kapolowe, the majority were molecularly identified as being *coustani*-like species (*An. cf coustani* 1 & 2) with the sequences corresponding to those reported from Zambia.

Figure 22. Molecular species composition in Kapolowe for mosquitoes morphologically identified as *An. paludis*.



Human landing catch was conducted in Kenge in the Kwango Province to research the presence of *An. paludis*, which was identified as a malaria vector in this region in 1992 (Karch et al). Just one female specimen was captured and identified as *An. paludis*. This specimen was sent to CDC/Atlanta for further analysis. *An. paludis* collected from all sites in 2017 will be sent to the University of Notre Dame for sequencing analysis.

6. TRAINING

In collaboration with the NMCP, the INRB conducted group training for three supervisors from each of the 11 sites in Kinshasa from July 17 to July 22. The objective was for field supervisors at all sites to be able to conduct insecticide susceptibility testing and morphological species identification in addition to PSC and HLC. The training consisted of theoretical instruction on mosquito morphological identification, mosquito sampling methods, rearing mosquitoes in the laboratory, labelling and conservation of mosquito samples, susceptibility, and CDC bottle resistance intensity testing. INRB conducted practical sessions in the field on HLC, PSC, and larvae collections and in the laboratory by performing WHO susceptibility tests and intensity tests according to standard operation procedures (SOPs) 001/01 and 001/03.

AIRS Entomologist Dr. Rodrigue Fiacre Agossa worked with the INRB team as a trainer. He focused his efforts on capacity building by developing a culture of using SOPs for all activities, improving supervisors' skills in mosquito identification, improving productivity of the insectary, troubleshooting field data, and working with the laboratory team.

7. ANNEX

ANNEX A. Schedule For Entomological Activities

Table 8. Schedule for entomological activities

Activity	Purpose	Timeline	Frequency	STATUS
Vector composition, behavior, and infectivity	To morphologically identify malaria vectors, determine vector composition and infectivity	January – March 2017 April - June 2017 July – Sept 2017	9 sites, 3 times	Vector Infectivity data collection ongoing. Morphological ID complete.
Seasonal vector dynamics, species composition, annual innoculation rate, biting times.	To gather more detailed annual information on malaria vector dynamics and behavior	November 2016 – October 2017	2 sites, every month	Completed
Vector behavior	To evaluate the indoor/outdoor resting/biting behavior of the vector in sentinel areas	January – March 2017 April - June 2017 July – Sept 2017	9 sites, 3 times per sites	Completed
Vector susceptibility	To determine vector susceptibility level to at least three insecticides recommended for LLINs	April 2017	11 sites, 1 time per site	Completed
Molecular assays	To identify the mosquito species, molecular forms of *An. gambiae* s.s. and mechanism of resistance (knockdown resistance)	March - December 2017	11 sites	Not yet completed. Scheduled for January to May 2018 Quality assurance training scheduled for May 2018.

Activity	Purpose	Timeline	Frequency	STATUS
Vector susceptibility	Determine intensity of insecticide resistance	July – Auguest 2017	7 sites	Completed
Enzyme-linked immunosorbent assay (ELISA) work	To determine the sporozoite rate and calculate the entomological inoculation rate	March – October 2017	11 sites	Completed for 9 sites. Not yet completed in Kapolowe and Lodja. Scheduled for January and February 2018
Evaluation of *Anopheles paludis* as malaria vector	Determine whether *An. paludis* is a vector of malaria in Kenge	March 2017	1 site, 1 time	Completed; however, only one *An. paludis* female was captured. It was sent to CDC for analysis

ANNEX B. Technical Support

Scientific support – short-term technical assistance in DRC from Richard Oxborough (AIRS). Technical, financial, and contractual support from Djenam Jacob (AIRS).	The technical team conducted a short-term technical assistance trip in May 2017. The technical team visited field sites in Kimpese where April - June 2017 activities took place. The technical team shared the objectives of the study with the local authorities and gave guidance to supervisors for mosquito species identification and susceptibility testing. The financial team explored the financial network.
Training	INRB and Dr. Agossa, in collaboration with the NMCP, conducted group training for three supervisors from each of the 11 sites in Kinshasa from July 17 to July 22 with financial support from Abt through PMI AIRS. The objective is for field supervisors at all sites to be able to conduct insecticide susceptibility testing and species identification in addition to PSC and HLC.

ANNEX C: Results

TSHOPO PROVINCE, KABONDO SITE (JANUARY – JUNE 2017)

Table 9: HBR of malaria vectors indoors and outdoors in the Kabondo site (January-February, March-April and May-June 2017)

Site		**KABONDO**				
Period		**January - June, 2017**				
Method		**HLC**				
Species	**Area**	**Variables**	**Jan/ Feb**	**Mar/ Apr**	**May/ June**	**Jan-June**
An. gambiae s.l.	Indoor	Total mosquitoes	152	143	161	456
		Nbr person-night	8	8	8	24
		HBR/night	**19**	**18**	**20**	**19**
	Outdoor	Total mosquitoes	107	150	90	347
		Nbr person-night	8	8	8	24
		HBR/night	**13**	**19**	**11**	**14**
An. funestus	Indoor	Total mosquitoes	29	11	5	45
		Nbr person-night	8	8	8	24
		HBR/night	**4**	**1**	**1**	**2**
	Outdoor	Total mosquitoes	11	7	5	23
		Nbr person	8	8	8	24
		HBR/night	**1**	**1**	**1**	**1**
An. paludis	Indoor	Total mosquitoes	0	0	2	2
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
	Outdoor	Total mosquitoes	0	2	0	2
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
An. nili	Outdoor	Total mosquitoes	1	1	0	2
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**

TANGANYIKA PROVINCE, KALEMIE SITE (JANUARY - JUNE 2017)

Table 10: HBR of malaria vectors indoors and outdoors in the Kalemie site (January-February, March-April and May-June 2017)

Site	**KALEMIE**					
Method	**HLC**					
Period	**January-June, 2017**					
Species	**Area**	**Variables**	**Jan/ Feb**	**Mar/ Apr**	**May/ June**	**Jan-June**
***An. gambiae* s.l.**	Indoor	Total mosquitoes	53	25	27	105
		Nbr person-night	8	8	8	24
		HBR/night	**7**	**3**	**3**	**4**
	Outdoor	Total mosquitoes	66	0	11	77
		Nbr person-night	8	8	8	24
		HBR/night	**8**	**0**	**1**	**3**
An. funestus	Indoor	Total mosquitoes	**0**	**1**	**4**	**5**
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**1**	**0**

SUD KIVU PROVINCE, KATANA SITE (JANUARY- JUNE 2017)

Table 11: HBR of malaria vectors indoors and outdoors in the Katana site (January-February, March-April and May-June 2017)

Site	**KATANA**					
Period	**January-June 2017**					
Method	**HLC**					
Species	**Area**	**Variables**	**Jan/**	**Mar/**	**May/**	**Jan-June**

			Feb	Apr	June	
An. gambiae s.l.	Indoor	Total mosquitoes	11	23	38	72
		Nbr person-night	8	8	8	24
		HBR/night	**1**	**3**	**5**	**3**
	Outdoor	Total mosquitoes	4	7	0	11
		Nbr person-night	8	8	8	24
		HBR/night	**1**	**1**	**0**	**0**
An. funestus	Indoor	Total mosquitoes	8	11	10	29
		Nbr person-night	8	8	8	24
		HBR/night	**1**	**1**	**1**	**1**
	Outdoor	Total mosquitoes	2	8	0	10
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**1**	**0**	**0**
An. nili	Indoor	Total mosquitoes	0	1	0	1
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**

KINSHASA PROVINCE, KINGASANI SITE (JANUARY- JUNE 2017)

Table 12: HBR of malaria vectors indoors and outdoors in the Kingasani site (January-February, March-April and May-June 2017)

Site	**KINGASANI**					
Period	**January – June 2017**					
Method	**HLC**					
Species	**Area**	**Variables**	**Jan/ Feb**	**Mar/ Apr**	**May/ June**	**Jan/June**
An. gambiae	Indoor	Total mosquitoes	21	21	21	63

		Nbr person-night	8	8	8	24
		HBR/night	**3**	**3**	**3**	**3**
	Outdoor	Total mosquitoes	84	62	37	183
		Nbr person-night	8	8	8	24
		HBR /night	**11**	**8**	**5**	**8**
An. funestus	Indoor	Total mosquitoes	1	2	9	12
		Nbr person-night	8	8	8	24
		HBR /night	**0**	**0**	**1**	**1**
	Outdoor	Total mosquitoes	1	22	19	42
		Nbr person-night	8	8	8	24
		HBR /night	**0**	**3**	**2**	**2**

KASAI PROVINCE, MIKALAYI SITE (JANUARY- JUNE 2017)

Table 13: HBR of malaria vectors indoors and outdoors in the Mikalayi site (January-February, March-April and May-June 2017)

Sites	**Mikalayi**					
Period	**January-June 2017**					
Species	**Area**	**Variables**	**Jan/ Feb**	**Mar/ Apr**	**May/ June**	**Jan/June**
An. gambiae s.l.	Indoor	Total mosquitoes	17	6	6	29
		Nbr person-night	8	8	8	24
		HBR/night	**2**	**1**	**1**	**1**
	Outdoor	Total mosquitoes	9	3	8	20
		Nbr person-night	8	8	8	24

		HBR/night	**1**	**0**	**1**	**1**
An. funestus	Indoor	Total mosquitoes	200	8	38	246
		Nbr person-night	8	8	8	24
		HBR/night	**25**	**1**	**5**	**10**
	Outdoor	Total mosquitoes	76	3	16	95
		Nbr person-night	8	8	8	24
		HBR/night	**10**	**0**	**2**	**4**
An. paludis	Indoor	Total mosquitoes	3	4	1	8
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**1**	**0**	**0**
	Outdoor	Total mosquitoes	3	3	3	9
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**

NEW SENTINEL SITES FOR 2017 (KARAWA, INONGO, KIMPESE, PAWA)

SUD UBANGI PROVINCE, KARAWA SITE (JANUARY- JUNE 2017)

Table 14: HBR of malaria vectors indoors and outdoors in the Karawa site (January-February, March-April and May-June 2017)

Site	Karawa					
Period	**January-June 2017**					
Method	**HLC**					
Species	**Area**	**Variable**	**Jan/ Feb**	**Mar/ Apr**	**May/ June**	**Jan-June**
An. gambiae s.l.	Indoor	Total mosquitoes	81	193	131	405
		Nbr person-night	8	8	8	24
		HBR/night	**10**	**24**	**16**	**17**
	Outdoor	Total mosquitoes	56	187	78	321
		Nbr person-night	8	8	8	24
		HBR/night	**7**	**23**	**10**	**13**
An. funestus	Indoor	Total mosquitoes	1	0	0	1
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
	Outdoor	Total mosquitoes	2	0	0	2
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
An. paludis	Indoor	Total mosquitoes	0	0	0	0
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
	Outdoor	Total mosquitoes	1	0	0	1
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
An. coustani	Indoor	*Total mosquitoes*	0	0	0	0
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
	Outdoor	Total mosquitoes	1	0	0	1
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**

MAI-NDOMBE PROVINCE, INONGO SITE (JANUARY- JUNE 2017)

Table 15: HBR of malaria vectors indoors and outdoors in the Inongo site (January-February, March-April and May-June 2017)

Site		**INONGO**				
Period		**January - June, 2017**				
Method		**HLC**				
Species	**Area**	**Variables**	**Jan/ Feb**	**Mar/ Apr**	**May/ June**	**Total Jan-June**
An. gambiae s.l.	Indoor	Total mosquitoes	14	21	19	54
		Nbr person-night	8	8	8	24
		HBR/night	**2**	**3**	**2**	**2**
	Outdoor	Total mosquitoes	7	30	22	59
		Nbr person-night	8	8	8	24
		HBR/night	**1**	**4**	**3**	**2**
An. paludis	Indoor	Total mosquitoes	11	6	18	35
		Nbr person-night	8	8	8	24
		HBR/night	**1**	**1**	**2**	**1**
	Outdoor	Total mosquitoes	22	8	22	52
		Nbr person-night	8	8	8	24
		HBR/night	**3**	**1**	**3**	**2**

KONGO CENTRAL PROVINCE, KIMPESE SITE (JANUARY- JUNE 2017)

Table 16: HBR of malaria vectors indoors and outdoors in the Kimpese site (January-February, March-April and May-June 2017)

Site	**Kimpese**					
Period	**January-June, 2017**					
Method	**HLC**					
Species	**Area**	**Variable**	**Jan/ Feb**	**Mar/ Apr**	**May/ June**	**Jan-June**
An. gambiae s.l	Indoor	Total mosquitoes	3	23	11	37
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**3**	**1**	**2**
	Outdoor	Total mosquitoes	11	15	11	37
		Nbr person-night	8	8	8	24
		HBR/night	**1**	**2**	**1**	**2**
An. funestus	Indoor	Total mosquitoes	235	338	199	772
		Nbr person	8	8	8	24
		HBR/night	**29**	**42**	**25**	**32**
	Outdoor	Total mosquitoes	274	469	210	953
		Nbr person-night	8	8	8	24
		HBR/night	**34**	**59**	**26**	**40**
An. paludis	Indoor	Total mosquitoes	0	1	0	1
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
	Outdoor	Total mosquitoes	0	1	0	1
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
An. nili	Indoor	Total mosquitoes	0	0	5	5
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**1**	**0**
	Outdoor	Total mosquitoes	0	0	6	6
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**

HAUT-UELE PROVINCE, PAWA SITE (JANUARY- JUNE 2017)

Table 17: HBR of malaria vectors indoors and outdoors in the Pawa site (January-February, March-April and May-June 2017)

Sites	**PAWA**					
Period	**January-June 2017**					
Method	**HLC**					
Species	**Area**	Variable	**Jan/ Feb**	**Mar/ Apr**	**May/ June**	**Jan-June**
An. gambiae s.l.	Indoor	Total mosquitoes	456	87	0	543
		Nbr person-night	8	8	8	24
		HBR/night	**57**	**11**	**0**	**23**
	Outdoor	Total mosquitoes	699	62	0	761
		Nbr person-night	8	8	8	24
		HBR/night	**87**	**8**	**0**	**32**
An. funestus	Indoor	Total mosquitoes	2	0	0	2
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
	Outdoor	Total mosquitoes	2	0	0	2
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**0**	**0**
An. paludis	Indoor	Total mosquitoes	1	0	73	74
		Nbr person-night	8	8	8	24
		HBR/night	**0**	**0**	**9**	**3**
	Outdoor	Total mosquitoes	6	0	61	67
		Nbr person-night	8	8	8	24
		HBR/night	**1**	**0**	**8**	**3**

INTENSITY OF PYRETHROID RESISTANCE OF *AN. GAMBIAE* S.L IN KINSHASA

TABLE 18: Results of resistance intensity bottle bioassays for *An. gambiae* s.l. in Kinshasa and Kasangulu to deltamethrin and permethrin (March 2017).

Sites	Insecticide	Concentration	Control Exposed	Control Died	Nbr Exposed (test)	Observed 30 min Mortality	Observations
KINGASANI	Deltamethrin	1X	50	0	100	67	R
KINGASANI		2X	50	0	100	94	R
KINGASANI		5X	50	0	100	100	S
KINGASANI		10X	50	0	100	100	S
KINGASANI	Permethrin	1X	50	0	100	0	R
KINGASANI		2X	50	0	100	8	R
KINGASANI		5X	50	0	100	37	R
KINGASANI		10X	50	0	100	71	R
BU	Deltamethrin	1X	50	0	100	73	R
BU		2X	50	0	100	93	R
BU		5X	50	0	100	100	S
BU		10X	50	0	100	100	S
BU	Permethrin	1X	50	0	100	3	R
BU		2X	50	0	100	23	R
BU		5X	50	0	100	56	R
BU		10X	50	0	100	91	R
KINKOLE	Deltamethrin	1X	50	0	100	68	R
KINKOLE		2X	50	0	100	93	R
KINKOLE		5X	50	0	100	99	S
KINKOLE		10X	50	0	100	100	S
KINKOLE	Permethrin	1X	50	0	100	0	R
KINKOLE		2X	50	0	100	19	R
KINKOLE		5X	50	0	100	42	R
KINKOLE		10X	50	0	100	75	R
KIMPOKO	Deltamethrin	1X	50	0	100	54	R
KIMPOKO		2X	50	0	100	85	R
KIMPOKO		5X	50	0	100	100	S

KIMPOKO		10X	50	0	100	100	S
KIMPOKO	Permethrin	1X	50	0	100	1	R
KIMPOKO		2X	50	0	100	18	R
KIMPOKO		5X	50	0	100	62	R
KIMPOKO		10X	50	0	100	91	**R**
KASANGULU	Deltamethrin	1X	50	0	100	70	R
KASANGULU		2X	50	0	100	91	**R**
KASANGULU		5X	50	0	100	100	S
KASANGULU		10X	50	0	100	100	S
KASANGULU	Permethrin	1X	50	0	100	2	R
KASANGULU		2X	50	0	100	26	R
KASANGULU		5X	50	0	100	83	R
KASANGULU		10X	50	0	100	95	**R**

Kasangulu, located 40 km outside Kinshasa, is the control area

Table 19: Results of resistance intensity bottle bioassays for *An. gambiae* s.l. in Kinshasa and Kasangulu to deltamethrin and permethrin (June – July 2017).

Sites	Insecticide	Concentration	Control Exposed	Control Died	Nbr Exposed (test)	Observed 30 min Mortality	Observations
KINGASANI	Deltamethrin	1X	50	0	100	44	**R**
KINGASANI		2X	50	0	100	85	**R**
KINGASANI		5X	50	0	100	100	**S**
KINGASANI		10X	50	0	100	100	**S**
KINGASANI	Permethrin	1X	50	0	100	0	**R**
KINGASANI		2X	50	0	100	1	**R**
KINGASANI		5X	50	0	100	15	**R**
KINGASANI		10X	50	0	100	38	**R**
BU	Deltamethrin	1X	50	0	100	36	**R**
BU		2X	50	0	100	69	**R**
BU		5X	50	0	100	98	**S**
BU		10X	50	0	100	100	**S**
BU	Permethrin	1X	50	0	100	0	**R**

BU		2X	50	0	100	0	R
BU		5X	50	0	100	3	R
BU		10X	50	0	100	10	R
KINKOLE	Deltamethrin	1X	50	0	100	37	R
KINKOLE		2X	50	0	100	74	R
KINKOLE		5X	50	0	100	94	R
KINKOLE		10X	50	0	100	100	S
KINKOLE	Permethrin	1X	50	0	100	0	R
KINKOLE		2X	50	0	100	0	R
KINKOLE		5X	50	0	100	13	R
KINKOLE		10X	50	0	100	31	R
KIMPOKO	Deltamethrin	1X	50	0	100	44	R
KIMPOKO		2X	50	0	100	79	R
KIMPOKO		5X	50	0	100	91	R
KIMPOKO		10X	50	0	100	100	S
KIMPOKO	Permethrin	1X	50	0	100	0	R
KIMPOKO		2X	50	0	100	0	R
KIMPOKO		5X	50	0	100	9	R
KIMPOKO		10X	50	0	100	37	R
KASANGULU	Deltamethrin	1X	50	0	100	14	R
KASANGULU		2X	50	0	100	33	R
KASANGULU		5X	50	0	100	79	R
KASANGULU		10X	50	0	100	100	S
KASANGULU	Permethrin	1X	50	0	100	0	R
KASANGULU		2X	50	0	100	0	R
KASANGULU		5X	50	0	100	11	R
KASANGULU		10X	50	0	100	60	R

Kasangulu, located 40 km outside Kinshasa, is the control area

Table 20: Results of resistance intensity bottle bioassays for *An. gambiae* s.l. in Kinshasa and Kasangulu to deltamethrin and permethrin (October 2017).

Sites	Insecticide	Concentration	Control Exposed	Control Died	Nbr Exposed (test)	Observed 30 min Mortality	Observations
KINGASANI	Deltamethrin	1X	40	0	80	9	R
KINGASANI		2X	40	0	80	34	R
KINGASANI		5X	40	0	80	98	S
KINGASANI		10X	40	0	80	100	S
KINGASANI	Permethrin	1X	40	0	80	0	R
KINGASANI		2X	40	0	80	0	R
KINGASANI		5X	40	0	80	41	R
KINGASANI		10X	40	0	80	50	R
BU	Deltamethrin	1X	40	0	80	40	R
BU		2X	40	0	80	54	R
BU		5X	40	0	80	80	R
BU		10X	40	0	80	90	R
BU	Permethrin	1X	40	0	80	0	R
BU		2X	40	0	80	5	R
BU		5X	40	0	80	6	R
BU		10X	40	0	80	28	R
KINKOLE	Deltamethrin	1X	40	0	80	36	R
KINKOLE		2X	40	0	80	55	R
KINKOLE		5X	40	0	80	81	R
KINKOLE		10X	40	0	80	100	S
KINKOLE	Permethrin	1X	40	0	80	0	R
KINKOLE		2X	40	0	80	20	R
KINKOLE		5X	40	0	80	63	R
KINKOLE		10X	40	0	80	66	R
KIMPOKO	Deltamethrin	1X	40	0	80	16	R
KIMPOKO		2X	40	0	80	34	R
KIMPOKO		5X	40	0	80	94	R
KIMPOKO		10X	40	0	80	100	S

KIMPOKO	Permethrin	1X	40	0	80	0	R
KIMPOKO		2X	40	0	80	14	R
KIMPOKO		5X	40	0	80	50	R
KIMPOKO		10X	40	0	80	74	R
KASANGULU	Deltamethrin	1X	40	0	80	46	R
KASANGULU		2X	40	0	80	59	R
KASANGULU		5X	40	0	80	63	R
KASANGULU		10X	40	0	80	100	S
KASANGULU	Permethrin	1X	40	0	80	18	R
KASANGULU		2X	40	0	80	36	R
KASANGULU		5X	40	0	80	53	R
KASANGULU		10X	40	0	80	91	R

Kasangulu located in 40 Km outside Kinshasa is the control area

TSHOPO PROVINCE, KABONDO SITE (JANUARY – JUNE 2017)

Table 21: Distribution and abundance of mosquitoes collected in Kabondo by species and method (PSC and HLC) of collection

Site	**Kabondo**			
Period	**January – June, 2017**			
Species / Method	**PSC**	**HLC Indoors**	**HLC Outdoors**	**Total**
January – February, 2017				
An. gambiae s.l.	47(87%)	152 (84%)	107 (90%)	306 (86%)
An. funestus s.l.	7(13%)	29 (16%)	11 (09%)	47 (13%)
An. nili	0(0%)	0(0%)	1 (1%)	1 (0%)
Total 1	**54 (100%)**	**181 (100%)**	**119 (100%)**	**354 (100%)**
March-April 2017				
An. gambiae s.l.	81 (100%)	143 (93%)	150 (91%)	374 (93%)
An. funestus s.l.	0 (0%)	11 (7%)	7 (6%)	18 (5%)
An. paludis	0 (0%)	0 (0%)	2 (3%)	2 (1%)
An. nili	0 (0%)	0 (0%)	1 (1%)	1 (0%)
Total 2	**81 (100%)**	**154 (100%)**	**160 (100%)**	**395 (100%)**
May-June 2017				
An. gambiae s.l.	225 (97%)	161 (96%)	90 (95%)	476 (96%)
An. funestus s.l.	7 (3%)	5 (3%)	5 (5%)	17 (3%)
An. paludis	0 (0%)	2 (1%)	0 (0%)	2 (0%)

Total 3	**232 (100%)**	**168 (100%)**	**95 (100%)**	**495 (100%)**
All three Periods : January-June 2017				
An. gambiae s.l.	353 (96%)	456 (91%)	347 (93%)	1156 (93%)
An. funestus s.l.	14 (4%)	45 (9%)	23 (6%)	82 (7%)
An. paludis	0 (0%)	2 (0%)	2 (1%)	4 (0%)
An. nili	0 (0%)	0 (0%)	2(1%)	2 (0%)
General Total	**367 (100%)**	**503 (100%)**	**374 (100%)**	**1244 (100%)**

TANGANYIKA PROVINCE, KALEMIE SITE (JANUARY - JUNE 2017)

Table 22: Distribution and abundance of mosquitoes collected in Kalemie by species and method (PSC and HLC) of collection

Site	**KALEMIE**			
Period	**January-June, 2017**			
Species/Method	**PSC**	**HLC Indoors**	**HLC Outdoors**	**Total**
January – February 2017				
An. gambiae s.l.	28 (88%)	53 (100%)	66 (100%)	147 (97%)
An. funestus s.l.	4 (12%)	0 (0%)	0 (0%)	4 (3%)
Total 1	**32 (100%)**	**53 (100%)**	**66 (100%)**	**151 (100%)**
March-April 2017				
An. gambiae s.l.	69 (87%)	25 (96%)	0 (0%)	94 (90%)
An. funestus s.l.	9 (11%)	1 (4%)	0 (0%)	10 (10%)
An. nili	1 (1%)	0 (0%)	0(0%)	1 (1%)
	79 (100%)	**26 (100%)**	**0 (%)**	**105 (100%)**
May-June 2017				
An. gambiae s.l.	33 (89%)	27 (87%)	11 (100%)	71 (90%)
An. funestus s.l.	3 (8%)	4 (13%)	0 (0%)	7 (10%)
An. salbaii	1 (3%)	0 (0%)	0 (0%)	1(0%)
	37 (100%)	**31 (100%)**	**11 (100%)**	**79 (100%)**
All three Periods : January-June 2017				
An. gambiae s.l.	130 (88%)	105 (95%)	77 (100%)	312 (93%)
An. funestus s.l.	16 (11%)	5 (5%)	0 (0%)	21 (6%)
An. nili	1 (1%)	0 (0%)	0 (0%)	1 (0%)
An. salbaii	1 (1%)	0 (0%)	0 (0%)	1 (0%)
General Total	**148**	**110**	**77**	**335**

Table 23: Distribution and abundance of mosquitoes collected in Katana by species and method (PSC and HLC) of collection

Site	KATANA			
Period	**January-June 2017**			
Species\Method	**PSC**	**HLC Indoor**	**HLC Outdoor**	**Total**
January-February 2017				
An. gambiae s.l	28 (30%)	11 (58%)	4 (67%)	43 (36%)
An. funestus s.l.	65 (70%)	8 (42%)	2 (33%)	75 (64%)
Total 1	**93 (100%)**	**19 (100%)**	**6 (100%)**	**118 (100%)**
March-April 2017				
An. gambiae s.l.	44 (68%)	23 (66%)	7 (47%)	74 (64%)
An. funestus s.l.	21 (32%)	11 (31%)	8 (53%)	40 (35%)
An. nili	0 (0%)	1 (3%)	0 (0%)	1 (1%)
Total 2	**65 (100%)**	**35 (100%)**	**15 (100%)**	**115 (100%)**
May-June 2017				
An. gambiae s.l.	65 (80%)	38 (79%)	0 (0%)	113 (80%)
An. funestus s.l.	16 (20%)	10 (21%)	0 (0%)	26 (20%)
Total 3	**81 (100%)**	**48 (100%)**	**0 (0%)**	**129 (100%)**
All three Periods : January-June 2017				
An. gambiae s.l.	137 (57%)	72 (71%)	11 (52%)	220 (61%)
An. funestus s.l.	102 (43%)	29 (28%)	10 (48%)	141 (39%)
An. nili	0 (0%)	1 (1%)	0 (0%)	1 (0%)
General Total	**239 (100%)**	**102 (100%)**	**21 (100%)**	**362 (100%)**

Table 24: Distribution and abundance of mosquitoes collected in Kingasani by species and method (PSC and HLC) of collection

Site	KINGASANI			
Period	**January-June 2017**			
Species /Method	**PSC**	**HLC Indoor**	**HLC Outdoor**	**Total**
January-February 2017				

An. gambiae s.l.	68 (99%)	21 (95%)	84 (99%)	173 (98%)
An. funestus s.l.	1 (1%)	1 (5%)	1 (1%)	3 (2%)
Total 1	**69 (100%)**	**22 (100%)**	**85 (100%)**	**176 (100%)**
March-April 2017				
An. gambiae s.l.	143 (89%)	21 (91%)	62 (74%)	226 (85%)
An. funestus s.l.	17 (11%)	2 (9%)	22 (26%)	41 (15%)
Total 2	**160 (100%)**	**23 (100%)**	**84 (100%)**	**267 (100%)**
May-June 2017				
An. gambiae s.l.	27 (37%)	21 (70%)	37 (66%)	85 (53%)
An. funestus s.l.	46 (63%)	9 (30%)	19 (34%)	74 (47%)
Total 3	**73 (100%)**	**30 (100%)**	**56 (100%)**	**159 (100%)**
All three Periods : January-June 2017				
An. gambiae s.l.	238 (79%)	63 (84%)	183 (81%)	484 (80%)
An. funestus s.l.	64 (21%)	12 (16%)	42 (19%)	118 (20%)
General Total	**302 (100%)**	**75 (100%)**	**225 (100%)**	**602 (100%)**

Table 25: Distribution and abundance of mosquitoes collected in Mikalayi by species and method (PSC and HLC) of collection

Site	**MIKALAYI**			
Period	**January-June, 2017**			
Species/Method	**PSC**	**HLC Indoor**	**HLC Outdoor**	**Total**
January-February 2017				
An. gambiae s.l.	8 (7%)	17 (8%)	9 (10%)	34 (8%)
An. funestus s.l.	106 (93%)	200 (91%)	76 (86%)	382 (91%)
An. paludis	0 (0%)	3 (1%)	3 (3%)	6 (1%)
Total 1	**114 (100%)**	**220 (100%)**	**88 (100%)**	**422 (100%)**
March-April 2017				

An. gambiae s.l.	3 (8%)	6 (33%)	3 (33%)	12 (19%)
An. funestus s.l.	33 (92%)	8 (44%)	3 (33%)	44 (70%)
An. paludis	0 (0%)	4 (22%)	3 (33%)	7 (11%)
Total 2	**36 (100%)**	**18 (100%)**	**9 (100%)**	**63 (100%)**
May-June 2017				
An. gambiae s.l.	20 (17%)	6 (13%)	8 (30%)	34 (18%)
An. funestus s.l.	97 (83%)	38 (84%)	16 (59%)	151 (80%)
An. paludis	0 (0%)	1 (2%)	3 (11%)	4 (2%)
Total 3	**117 (100%)**	**45 (100%)**	**27 (100%)**	**189 (100%)**
All Three Periods : January-June 2017				
An. gambiae s.l.	31 (12%)	29 (10%)	20 (16%)	80 (12%)
An. funestus s.l.	236 (88%)	246 (87%)	95 (77%)	577(86%)
An. paludis	0 (0%)	8 (3%)	9 (7%)	**17 (3%)**
General Total	**267 (100%)**	**283 (100%)**	**124 (100%)**	**674 (100%)**

Table 26: Distribution and abundance of mosquitoes collected in Karawa by species and method (PSC and HLC) of collection

Site	**Karawa**			
Period	**January-June 2017**			
Species/Method	**Indoor PSC**	**HLC Indoor**	**HLC Outdoor**	**Total**
January-February 2017				
An. gambiae s.l.	86 (99%)	81 (99%)	56 (93%)	223 (97%)
An. funestus s.l.	1 (1%)	1 (1%)	2 (3%)	4 (2%)
An. paludis	0	0	1 (2%)	1 (0%)
An. coustani	0	0	1 (2%)	1 (0%)
Total 1	**87 (100%)**	**82 (100%)**	**60 (100%)**	**229 (100%)**
March-April 2017				
An. gambiae s.l.	27 (100%)	193 (100%)	187(100%)	407 (100%)
Total 2	**27 (100%)**	**193 (100%)**	**187 (100%)**	**407 (100%)**
May-June 2017				
An. gambiae s.l.	31 (100%)	131 (100%)	78 (100%)	240 (100%)

Total 3	**31 (100%)**	**131 (100%)**	**78 (100%)**	**240 (100%)**
All three Periods : January-June 2017				
An. gambiae s.l.	144 (99%)	405 (99%)	321 (99%)	870(99%)
An. funestus s.l.	1 (1%)	1 (1%)	2 (1%)	4(1%)
An. paludis	0	0	1(0%)	1(0%)
An. coustani	0	0	1(0%)	1(0%)
General Total	**145**	**406**	**325**	**876**

Table 27: Distribution and abundance of mosquitoes collected in Inongo by species and method (PSC and HLC) of collection

Site	**INONGO**			
Period	**January - June, 2017**			
Species/Method	**PSC**	**HLC Indoors**	**HLC Outdoors**	**Total**
January-February 2017				
An. gambiae s.l.	28(100%)	14(56%)	7(24%)	49(60%)
An. paludis	0(0%)	11(44%)	22(76%)	33(40%)
Total 1	**28**(100%)	**25**(100%)	**29**(100%)	**82**(100%)
March-April 2017				
An. gambiae s.l.	65(97%)	21(78%)	30(79%)	116 (88%)
An. funestus s.l.	2 (3%)	0(0%)	0(0%)	2 (2%)
An. paludis	0(0%)	6(22%)	8(21%)	14 (11%)
Total 2	**67**(100%)	**27**(100%)	**38**(100%)	**132**(100%)
May-June 2017				
An. gambiae s.l.	188(99%)	19(51%)	22(50%)	229(85%)
An. paludis	1(1%)	18(49%)	22(50%)	41(15%)
Total 3	**189**(100%)	**37**(100%)	**44**(100%)	**270**(100%)
All three Periods : January-June 2017				
An. gambiae s.l.	281 (99%)	54(61%)	59(53%)	394(81%)
An. funestus s.l.	2 (1%)	0(0%)	0(0%)	2(0%)
An. paludis	1 (0%)	35(39%)	52(47%)	88(18%)
General Total	**284**(100%)	**89**(100%)	**111**(100%)	**484**(100%)

Table 28: Distribution and abundance of mosquitoes collected in Kimpese by species and method (PSC and HLC) of collection

Site	**KIMPESE**			
Period	**January-June, 2017**			
Species/Method	**PSC**	**HLC Indoor**	**HLC Outdoor**	**Total**
January-February 2017				
An. gambiae s.l.	2 (2%)	3 (1%)	11 (4%)	16 (2%)
An. funestus s.l.	129 (98%)	235 (99%)	274 (96%)	638 (98%)
Total 1	**131 (100%)**	**238 (100%)**	**285 (100%)**	**654 (100%)**
March-April 2017				
An. gambiae s.l.	3 (8%)	23 (6%)	15 (3%)	41 (5%)
An. funestus s.l.	37 (93%)	338 (93%)	469 (97%)	844 (95%)
An. paludis	0 (0%)	1 (0%)	1 (0%)	2 (0%)
Total 2	**40 (100%)**	**362 (100%)**	**485 (100%)**	**887 (100%)**
May-June 2017				
An. gambiae s.l.	1 (2%)	11 (5%)	11 (5%)	23 (5%)
An. funestus s.l.	59 (97%)	199 (93%)	210 (93%)	468 (93%)
An. nili	1 (1%)	5 (2%)	6 (3%)	12 (2%)
Total 3	**61 (100%)**	**215 (100%)**	**227**	**503**
All three Periods : January-June 2017				
An. gambiae s.l.	6 (3%)	37 (5%)	37 (4%)	80 (4%)
An. funestus s.l.	225 (97%)	772 (95%)	953 (96%)	1950 (95%)
An. paludis	0 (0%)	1 (0%)	1 (0%)	2 (0%)
An. nili	1(0%)	5 (1%)	6 (1%)	12 (1%)
General Total	**232**	**815**	**997**	**2044**

Table 29: Distribution and abundance of mosquitoes collected in Pawa by species and method (PSC and HLC) of collection

Site	PAWA			
Period	**January-June 2017**			
Species/Methods	**PSC**	**HLC Indoor**	**HLC Outdoor**	**Total**
January-February 2017				
An. gambiae s.l.	464 (99%)	456 (99%)	699 (99%)	1619 (99%)
An. funestus s.l.	3 (1%)	2 (0%)	2 (0%)	7 (0%)
An. paludis	0 (0%)	1 (0%)	6 (1%)	7 (0%)
Total 1	**467 (100%)**	**459 (100%)**	**707 (100%)**	**1633 (100%)**
March-April 2017				
An. gambiae s.l.	78 (95%)	87 (100%)	62 (100%)	227 (98%)
An. funestus s.l.	3 (4%)	0 (0%)	0 (0%)	3 (1%)
An. paludis	1 (1%)	0 (0%)	0 (0%)	1 (0%)
Total 2	**82 (100%)**	**87 (100%)**	**62 (100%)**	**231 (100%)**
May-June 2017				
An. gambiae s.l.	1 (1%)	0 (0%)	0 (0%)	1 (0%)
An. funestus s.l.	3 (3%)	0 (0%)	0 (0%)	3 (1%)
An. paludis	105 (96%)	73 (100%)	61 (100%)	239 (98%)
Total 3	**109 (100%)**	**73 (100%)**	**61 (100%)**	**243 (100%)**
All three Periods : January-June 2017				
An. gambiae s.l.	543 (83%)	543 (88%)	761 (92%)	1847 (88%)
An. funestus s.l.	9 (1%)	2 (0%)	2 (0%)	13 (1%)
An. paludis	106 (16%)	74 (12%)	67 (8%)	247 (12%)
General Total	**658 (100%)**	**619 (100%)**	**830 (100%)**	**2107 (100%)**

BLOOD DIGESTION STATE OF MALARIA VECTORS COLLECTED USING PSC

Table 30: Abdominal status of malaria vectors collected resting indoors through PSC (January-June 2017)

Sentinel site & species	Abdominal status				
	Unfed	Fed	Half gravid	Gravid	TOTAL
Kabondo					
An. gambiae s.l.	100 (28%)	140 (40%)	60 (17%)	53 (15%)	353
An. funestus s.l.	5 (36%)	6 (43%)	1 (7%)	2 (14%)	14
Kalemie					
An. gambiae s.l.	11 (8%)	111 (85%)	3 (2%)	5 (4%)	130
An. funestus s.l.	1 (6%)	14 (88%)	0	1 (6%)	16
Katana					
An. gambiae s.l.	103 (75%)	33 (24%)	1 (1%)	0	137
An. funestus s.l.	44 (43%)	53 (52%)	4 (4%)	1 (1%)	102
Kingasani					
An. gambiae s.l.	117 (49%)	81 (34%)	34 (14%)	6 (3%)	238
An. funestus s.l.	5 (8%)	53 (83%)	6 (9%)	0	64
Mikalayi					
An. gambiae s.l.	5 (16%)	25 (81%)	1 (3%)	0	31
An. funestus s.l.	56 (24%)	170 (72%)	8 (3%)	2 (1%)	236
Karawa					
An. gambiae s.l.	50 (35%)	66 (46%)	18 (13%)	10 (7%)	144
An. funestus s.l.	0	1 (50%)	1 (50%)	0	2
Inongo					
An. gambiae s.l.	8 (3%)	232 (83%)	7 (3%)	33 (12%)	280
An. funestus s.l.	1 (50%)	1 (50%)	0	0	2
Kimpese					
An. gambiae s.l.	2 (33%)	4 (67%)	0	0	6
An. funestus s.l.	78 (35%)	135 (60%)	8 (6%)	4 (2%)	225
Pawa					
An. gambiae s.l.	282 (52%)	162 (30%)	59 (11%)	40 (7%)	543
An. funestus s.l.	6 (67%)	3 (33%)	0	0	9

The abdominal status of malaria vectors collected by PSC between January and June 2017 is presented in Table 15. In all sites, the majority of *An. gambiae* s.l. and *An. funestus* s.l. collected by PSC were blood-fed (24-88%), with <18% being either half-gravid or gravid.

MONTHLY MONITORING OF ABDOMINAL STATUS FOR MALARIA VECTORS CAUGHT RESTING INDOORS BY PSC

In Kapolowe, the majority of captured *An. gambiae* s.l. and *An. funestus* s.l. were blood-fed (75%). In Lodja, the majority of *An. gambiae* s.l. and *An. funestus* s.l. captured by PSC indoors between January and December were either unfed (32%) or blood-fed (63%), with very few half-gravid (4%) or gravid (1%) females.

Table 31: Monthly indoor resting density of *Anopheles* species in Kapolowe (Haut Katanga) from PSC collections (10 houses per month).

Site	**Kapolowe**				
Species	**Unfed**	**Blood-fed**	**Half-Gravid**	**Gravid**	**Total PSC**
TOTAL January-December 2017					
An. gambiae s.l.	9 (8%)	73 (68%)	26 (24%)	0	108
An. funestus s.l.	52(12%)	324 (76%)	47 (11%)	1 (<1%)	424
Total	**61 (11%)**	**397 (75%)**	**73 (14%)**	**1 (<1%)**	**532**

Table 32: Monthly indoor resting density of *Anopheles* species in Lodja (Sankuru) from PSC collections (10 houses per month).

Site	**LODJA**				
Method **PSC**	**Blood feeding**				
Species	**Unfed**	**Fed**	**Half-gravid**	**Gravid**	**Total PSC**
TOTAL: January – December 2017					
An. gambiae s.l.	125 (33%)	235 (62%)	17 (4%)	3 (1%)	380
An. funestus s.l.	4 (18%)	17 (77%)	1 (5%)	0	22
An. paludis	1 (17%)	5 (83%)	0	0	6
General Total	**130 (32%)**	**257 (63%)**	**18 (4%)**	**3 (1%)**	**408**