UNIVERSITE CHEIKH ANTA DIOP DE DAKAR
FACULTE DES SCIENCES ET TECHNIQUES
DEPARTEMENT DE BIOLOGIE ANIMALE

Laboratoire d'Ecologie Vectorielle et Parasitaire

INSECTICIDE RESISTANCE IN *An. arabiensis* POPULATIONS FROM DAKAR AND ITS SUBURBS: ROLE OF TARGET SITE AND METABOLIC RESISTANCE MECHANISMS

GUEYE O.K. [1], DIA A.K.[1*], NIANG E.A.[1,2], DIEDHIOU S.M.[1,2], KONATE A.[1], SY M.D.[1], SAMB B. [1], DIOP A. [3], KONATE L[1], FAYE O[1].

[1] Laboratoire d'Ecologie Vectorielle et Parasitaire, Universite Cheikh Anta Diop de Dakar, Senegal
[2] Institut de Recherche pour le Developpement, UMR 198 URMITE, Dakar, Senegal
[3] Abt Associates, Senegal

* Corresponding author: DIA Abdoulaye Kane
E-mail: milakd1@hotmail.com / Phone: +221 77 262 04 47

ASTMH,
67th Annual Meeting 2018
New Orleans, USA

❑ INTRODUCTION

Urban malaria is an increasing concern in most of the Sub-Saharan Africa countries. In Dakar, the capital city of Senegal, the malaria epidemiology has been complexified by recurrent flooding since 2005. The main vector control measure for malaria prevention in Dakar is the community use of Long-Lasting Insecticide Treated Nets (LLINs) (**PNLP, 2016**) . However the increasing of insecticide resistance reported in this area need to be better understood for suitable resistance management.

This study reports the situation of insecticide resistance and underlying mechanisms in *An. arabiensis* populations from Dakar and its suburbs.

❑ METHODS

➢ Study area, sampling and rearing mosquito larvae

The study was conducted during three successive years 2013, 2014 and 2015 in ten sites of Dakar (2013 & 2014) and its suburbs (Pikine and Guediawaye) in 2015 (Fig. 1 and table 1).

Anopheles larvae and pupae were collected from natural breeding sites within and around the study sites and reared in insectary as described in the MR4 manual for mosquitoes rearing **(MR4, 2014**).

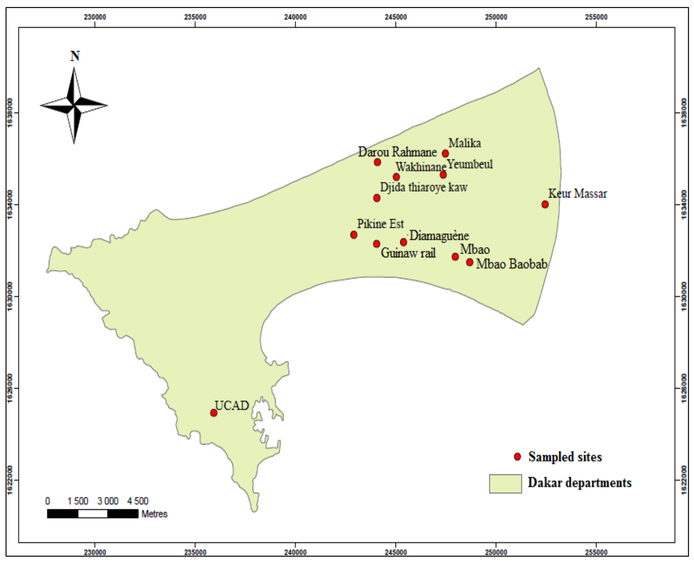

Figure 1 : Sampled sites

Table 1: Study sites in Dakar's health districts

Administrative departments	Health districts	Sampled sites
Dakar	Dakar centre	UCAD
Pikine	Mbao	Mbao
		Mbao Baobab
		Diamaguène
	Pikine	Pikine Est
		Djidah Thiaroye Kaw
	Keur Massar	Keur Massar
		Malika
		Yeumbeul
Guediawaye	Guediawaye	Wakhinane

➢ Insecticide susceptibility tests

WHO test kits for adult mosquitoes (**WHO, 2013**) was used in 2013 and 2014 while, for the 2015 both the WHO standard test and the CDC Bottle test were used (**WHO, 2013, Brogdon & McAllister, 1998**).

➢ Detection of metabolic resistance mechanisms

To assess the presence of the metabolic resistance mechanisms, 3-5 days old of non-blood-fed *An. gambiae* s.l. adult females were pre-exposed to the piperonyl butoxide (PBO) or ethacrynic acid (EA) prior to be exposed to insecticides (**Brogdon & McAllister, 1998**).

➢ Species identification, kdr molecular genotyping and data analysis

Genomic DNA was extracted from individual mosquitoes as described by CTAB method and the member of the *An. gambiae* complex were identified as describe by **Wilkins *et al.* (2006)**. The kdr mutations molecular genotyping was performed as describe in **Huynh *et al.* (2007)**. All statistical analyses were performed using R soft- ware (version 3.3.2) **(R Core Team, 2016)**

❑ RESULTS

➢ Species identification and Susceptibility to insecticide

✓ Molecular identification revealed the exclusive presence of A*n. arabiensis* in all the study areas and sites.

✓ WHO susceptibility tests showed that *An. arabiensis* populations were susceptible only to organophosphate.

✓ CDC bottle tests showed resistance to DDT, Pyrethroid and Pirimiphos-methyl and susceptibility to Bendiocarb.

Table 2 : Mortality (%) after exposure of impregnated Pyrethroïd (PYR) or Organochlorine (OC) papers

Districts		Localities	OC		PYR				
			DDT	Diel-drin	Perme-thrin	Delta-methrin	Alphacyper-methrin	Cyflu-thrin	Lambda-cyhalothrin.
RS 2013	Guediawaye	Wakhinane	-	-	-	65 (100)	-	-	-
	Keur Massar	Keur Massar	4 (91)	-	-	-	-	-	-
	Mbao	Mbao Baobab	7 (95)	-	-	73 (94)	-	-	-
		Diamaguene	-	-	-	-	38 (98)	-	-
	Pikine	Pikine Est	-	14 (93)	39 (93)	-	-	-	-
DS 2014	Keur Massar	Yeumbeul	1 (85)	-	2 (102)	69 (97)	-	-	-
	Mbao	Mbao	3 (103)	-	0 (94)	46 (102)	-	-	-
RS 2015	Guediawaye	Darou Rahmane	0.98 (102)	31 (124)	3 (102)	47 (104)	42.59 (108)	31.69 (124)	17 (112)
	Pikine	Guinaw Rails	1 (113)	14 (103)	21.81 (110)	62 (110)	64. 22 (123)	25.04 (104)	23 (100)

Table 3 : Mortality (%) after exposure of impregnated Carbamate (CAR) or Organophosphate (OP) papers

Districts		Localities	CAR	OP		
			Bendiocarb	Pyrimiphos methyl	Malathion	Fenitrothion
RS 2013	Dakar centre	UCAD	2.99 (93)*	100 (87)*	-	-
	Keur Massar	Yeumbeul	98.81 (93)	-	-	-
		Keur Massar	-	-	100 (96)	-
		Malika	-	-	-	100 (101)
	Mbao	Mbao Baobab	88 (86)	100 (97)	-	-
DS 2014	Keur Massar	Yeumbeul	27.03 (74)	100 (86)	100 (99)	-
	Mbao	Mbao	0.96 (104)	-	-	-
		Mbao Baobab	-	-	94 (98)	-
		Djida Thiaroye Kaw	-	100 (91)	-	-
RS 2015	Guediawaye	Darou Rahmane	35.17 (107)	100 (103)	100 (102)	73.05 (106)
	Pikine	Guinaw Rails	62 (120)	100 (118)	95 (120)	100 (103)

RS= Rainy Season**; DS**= Dry Season
() Numbers between brackets indicate the total of specimens tested
* Corrected mortality

Table 4 : Mortality (%) after exposure of impregnated CDC botlles

Districts	Localities	OC	PYR		CAR	OP
		DDT	Permethrin	Deltamethrin	Bendiocarb	Pirimiphos-methyl
Guediawaye	Darou Rahmane	1.98 (101)	86.66 (105)	93.45 (107)	100 (96)	61.22 (98)
Pikine	Guinaw Rails	36.19 (105)	87.12 (101)	83.01 (106)	100 (106)	55.66 (106)

() Numbers between brackets indicate the total of specimens tested

➢ Resistance mechanisms

✓ Results indicate the involvement of metabolic resistance mechanisms via *GST* and *CYP450* detoxification genes families.

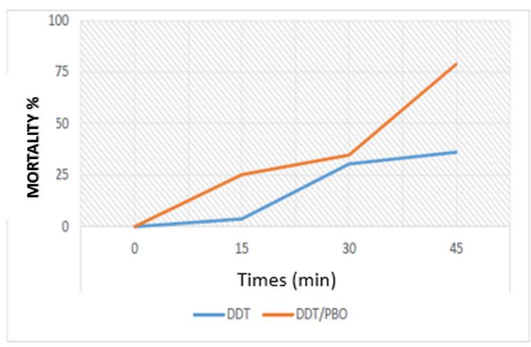

Figure 2 : Mortality rate of *An. arabiensis* with DDT before and after exposure to PBO in Pikine (2015)

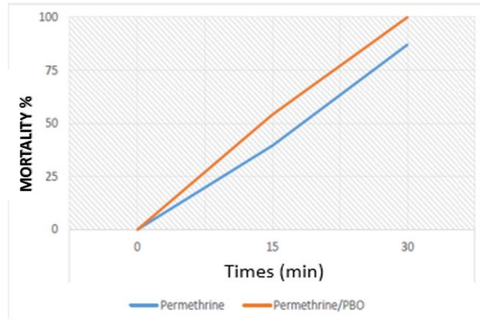

Figure 3 : Mortality rate of *An.arabiensis* with Permethrine before and after exposure to PBO in Pikine (2015) As all are An. arabiensis, you can directly correct for all figures.

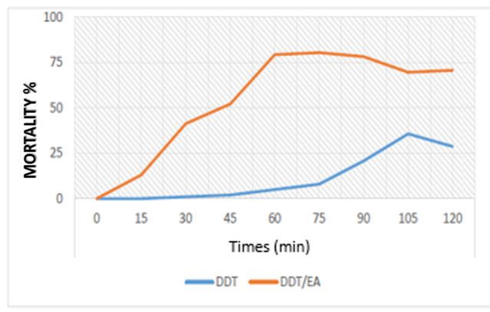

Figure 4 : Mortality rate of *An. arabiensis* with DDT before and after exposure to EA in Guediawaye (2015)

✓ The Kdr (L1014F and L1014S) mutations, conferring cross-resistance to DDT and pyrethroids, were identified either at homozygous or heterozygous resistant genotype varying between study sites. The homozygous L1014S resistant genotype was the most common genotype in all the surveyed with the highest frequency recorded in Mbao

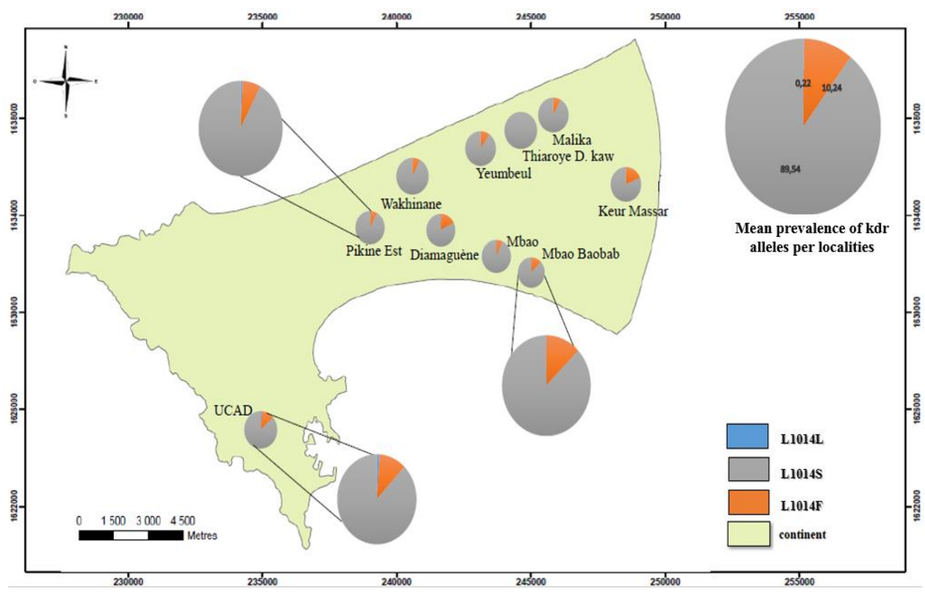

Figure 5: Geographical distribution of L1014L, L1014F and L1014S frequency in Dakar (2013 and 2014)

❑ DISCUSSIONS AND CONCLUSION

- ***An. Arabiensis***, main malaria vector in the Cap Vert Peninsula attributed this to the presence of permanent larval habitats formed by the so-called "Ceane" gardening pits which served as breeding site, especially during the dry season (**Diedhiou et al., 2016; Gadiaga et al., 2011**).
- **Resistance Organochlorine, Pyrethroïd, and Carbamate; susceptibility to Organophosphate** : Similar results were previously reported in the country including the study area (**Faye *et al*., 1991;1995; Thiaw, 2014**). This situation may be explained by an extensive use of insecticide for crops protection in the market gardening activities in the Niayes area (**Niang *et al.*, 2016 ; Cisse *et al*., 2006**).
- **Hight prevalence of L1014S (Kdr-e), and presence L1014F (Kdr-w) mutation** which confers a highest resistance level (**Soderlund & Knipple, 2003; Lynd *et al.*, 2010**). More investigations are necessary to assess the contribution of each mutations to the resistance level of *An. arabiensis*.
- **Metabolic resistance :** a proportion of mosquitoes did not harbor the kdr alleles while the populations were fully resistant, suggesting the existence of other resistance mechanisms. The restoration of susceptibility to pyrethroid and DDT after a pre-exposure of EA and PBO showed involvement of metabolic resistance mechanisms implying *GST* and *CYP450* detoxification genes families. More investigations are need.

REFERENCES

1. **PNLP, 2016**. *Ministère de la Sante et de L'Action Sociale, Senegal,*. Plan strategique national de lutte contre le paludisme au Senegal 2016-2020
2. **MR4,2014.**
3. **WHO 2013.** Malaria entomology and vector control: guide for participants
4. **Brogdon & McAllister, 1998.** Journal of the American Mosquito Control Association, 14(2), 159-164.
5. **Wilkins *et al.* 2006.** *Malaria journal*. 7:1–7
6. **Huynh *et al.* 2007.** In: Annual Meeting of the Society for the Study of Evolution. Christchurch, New Zealand.
7. **WHO,2012.** Global plan for insecticide resistance management in malaria vectors.