

# CS IHU Octobre 2023

## Prof. Philippe PAROLA, MD, PhD,

University Hospital Institute *Méditerranée Infection*

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Director of VITROME (Vectors – Tropical and Mediterranean Infections) Research Unit

Aix-Marseille University (AMU) - Institut de Recherche pour le Développement (IRD)

French Military Health Service (SSA)

[www.vitrome.fr](http://www.vitrome.fr)

Chief of Acute Infectious Diseases Unit - Department of Infectious Diseases

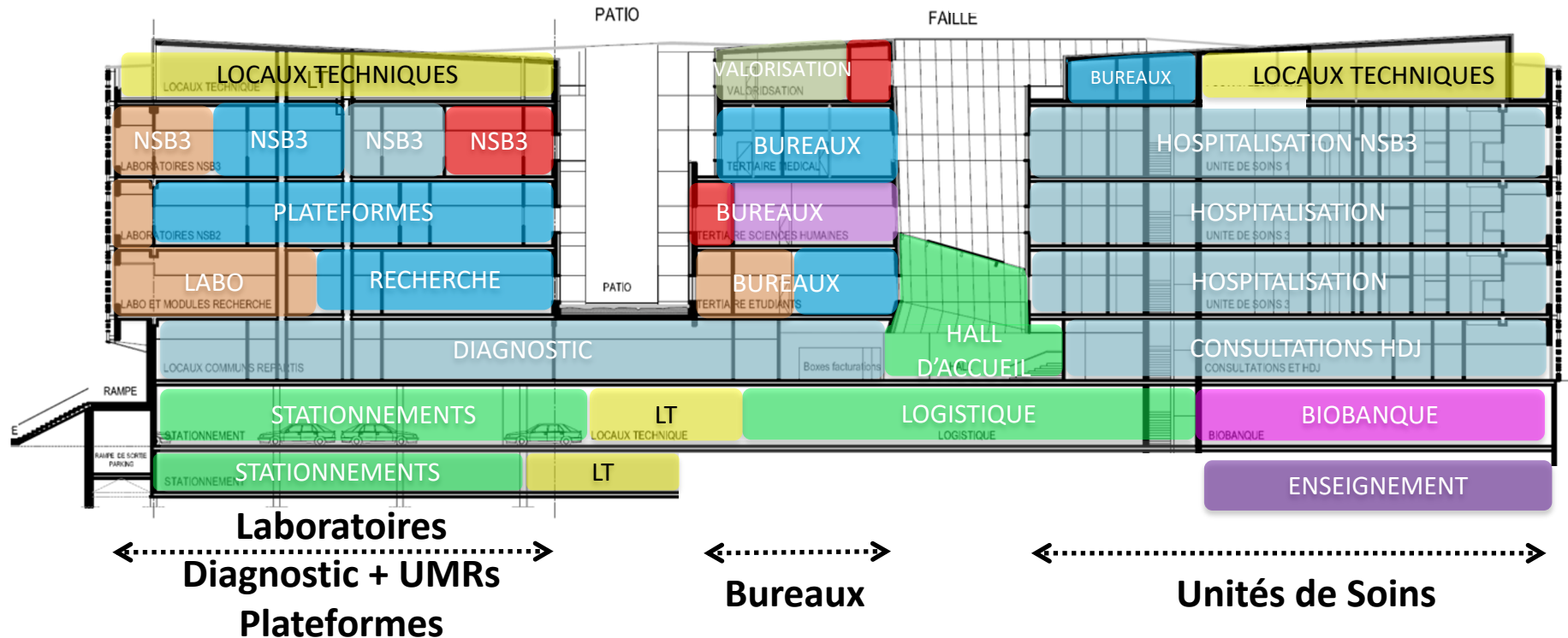
Assistance Publique – Hôpitaux de Marseille (AP-HM)

Médecin en chef (Col – OF5)

French Military Health Service



# VITROME UMR 257 IRD AMU SSA

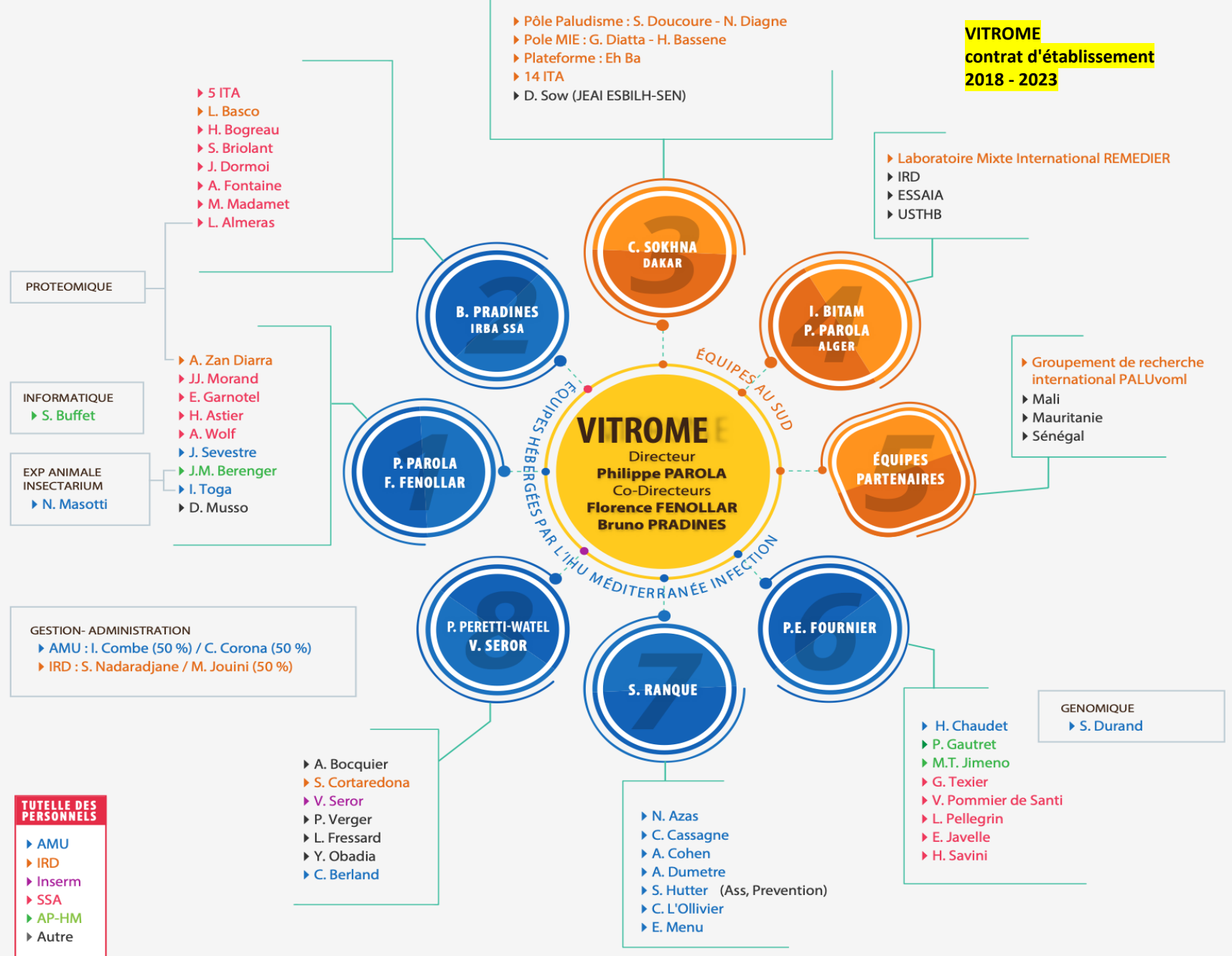




Une UMR d'envergure internationale.

**Les maladies vectorisées** et leurs arthropodes vecteurs, les **zoonoses**, et les maladies **parasitaires** notamment le **paludisme** sont au cœur d'une recherche basée sur l'observation et la technologie, bénéficiant des **équipements et plateformes** de la fondation IHU MI.

La **surveillance** des maladies infectieuses (allant de la surveillance épidémiologique à la surveillance **génomique**) ainsi qu'une approche en **sciences humaines et sociales** sont aussi développées.



Équipes des tutelles

Équipes partenaires

**VITROME**  
 contrat d'établissement  
 2018 - 2023

## L'UMR VITROME en prévisionnel au 1<sup>er</sup> janvier 2024 :

**81 personnels**

**40 Chercheurs (C : 19) ou Enseignants Chercheurs (EC : 21)**

**19 HDR,**

**41 ITA** dont 16 personnels affectés à l'équipe 3 de Dakar

**41 étudiants** dont 30 doctorants



MAJ isa  
sept  
2023

### Quatre Centres de références sont associés à VITROME :

- 1) le **Centre National de Référence (CNR)** pour les rickettsioses et les bartonelloses dirigé par le **Pr. PE Fournier**, <https://www.mediterranee-infection.com/diagnostic/les-centres-nationaux-de-reference-cnr/cnr-rickettsioses/>
- 2) le **CNR paludisme** dirigé par le **Dr. B. Pradines**, <https://www.mediterranee-infection.com/diagnostic/les-centres-nationaux-de-reference-cnr/cnr-paludisme/>
- 3) le **Centre Régional de Référence** pour les maladies vectorielles à tiques dirigé par le **Pr P. Parola** (<https://www.mediterranee-infection.com/diagnostic/les-centres-nationaux-de-reference-cnr/centre-de-reference-pour-la-prise-en-charge-des-maladies-vectorielles-a-tiques-de-la-region-sud-crmvt-sud/>)
- 4) CRA**tb** : **Centre Régional d'Antibiothérapie** créé en 2021 et dirigé par les **Pr. F Fenollar**

## LA VIE SCIENTIFIQUE DE VITROME



Organisée principalement dans le bâtiment de l'IHU Méditerranée Infection (IHU-MI) à Marseille (<https://www.mediterranee-infection.com>).

VISIO: Algérie – Dakar

Missions et Accueils

L'IHU-MI hébergeant également le pôle de maladies infectieuses (unités d'hospitalisations et soins) de l'AP-HM

16 HU: une recherche en maladies infectieuses et en microbiologie au cœur du soin.

SSA

Fondation IHU-MI : gratifications de doctorat d'université (appel d'offre annuel et gratification « Afrique ») ainsi que par un soutien au développement et au fonctionnement des plateformes technologiques.

## Statut des étudiants accueillis

VITROME au 20/09/2023	
Statut	Nombre
Doctorant	77
Master 2	54
Stage Doctoral	41
Master 1	22
Visiteur Scientifique	19
Post-Doctorant	11
BTS/Licence	10
Stagiaire Visiteur	6
DFGSM3 (AIR3)	2
Interne	2
Externe	1
<b>245</b>	

## Soutenances de thèses depuis la création de l'unité

Année	VITROME Soutenance de thèses
2018	9
2019	9
2020	10
2021	12
2022	11
2023	4
<b>Total</b>	<b>55</b>

Rappel : journées des thèses 23 et 24 novembre 2023

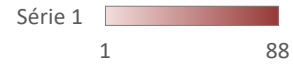
Pays	Nombre
France	88
Algérie	32
Sénégal	26
Vietnam	10
Gabon	9
Liban	9
Cameroun	8
Mauritanie	8
Maroc	7
Mali	7
Tunisie	5
Inde	4
Comorres	4
République Démocratique du Congo	3
Guinée	3
Italie	3
Brésil	3
Centre Afrique	2
Chine	2
Portugal	2
Turquie	1
Espagne	1
Rwanda	1
Haiti	1
Syrie	1
Vénézuela	1
Roumanie	1
Djibouti	1
Pays	1
Côte d'Ivoire	1
Niger	1

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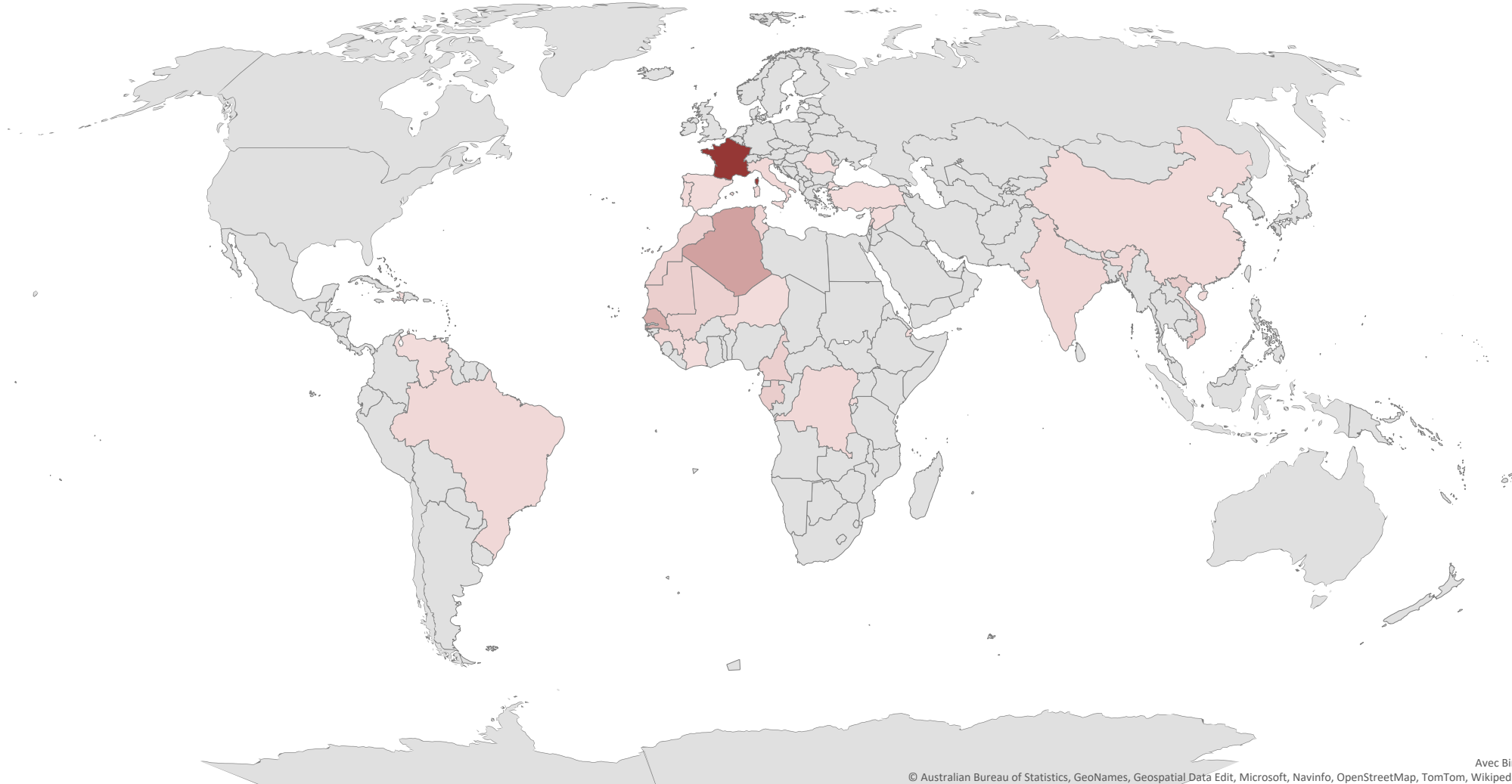


# BILAN ETUDIANTS 2018 - 2023

Etudiants VITROME : répartition par pays



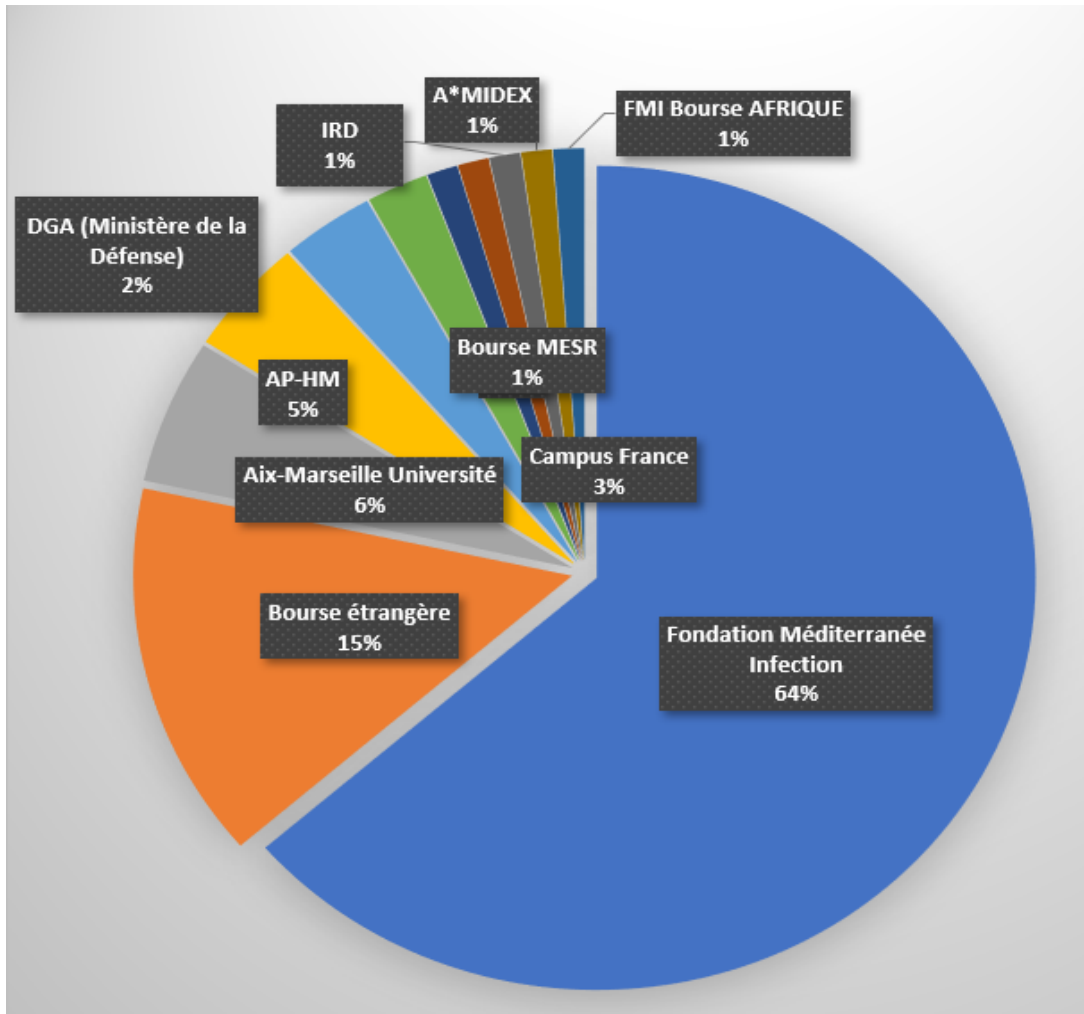
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2023



## Sources de financement des doctorants et post-doctorants de l'unité 2018-2023

Source de financement	
Fondation Méditerranée Infection	56
Bourse étrangère	13
Aix-Marseille Université	5
AP-HM	4
Campus France	3
DGA (Ministère de la Défense)	2
IRBA	1
Bourse MESR	1
IRD	1
A*MIDEX	1
FMI Bourse AFRIQUE	1
	<b>88</b>

## FMI est la source majeure de financement



# BUDGETS VITROME : AMU

Titre du contrat	Montant subvention HT (€)	Ouverture budget 2023	Montant engagé HT (€)	Solde	% Engagé	Commentaires	
AMU	CNR des Rickettsys	129 752,00 €	114 679,00 €	92 915,17 €	21 763,83 €	81%	
	Dotation AMU 2023	64 060,00 €	77 004,00 €	71 946,78 €	5 057,22 €	93,43%	
	Bonus AMU 2023	5 965,00 €					
	Aide ministerielle 2023	1 523,00 €					
	Rétrocession contrats de recherche 2023	5 456,00 €					
	Oligo CD 13	120 000,00 €	32 322,00 €	- €	32 322,00 €	0,00%	REPORT 31/12/2023 en attente de notif - mais il faut dépenser avant 31/12/2023
	Contrat Fungiplex (Ranque)	40 000,00 €	22 000,00 €	2 858,60 €	19 141,40 €	12,99%	REPORT DE CREDIT OK 2024
	Contrat Covjeco (Perreti)	234 333,00 €	19 818,00 €	12 500,00 €	7 318,00 €	63,07%	Se termine au 31/12/2023
	Contrat Break (Dumètre)	228 701,00 €	52 791,94 €	10 713,21 €	42 078,73 €	20,29%	Aurélien quitte l'unité au 1/01/2024 (son contrat part avec lui)
	<b>TOTAL</b>	<b>829 790,00 €</b>	<b>318 614,94 €</b>				

# BUDGETS VITROME : IRD

CREDITS IRD VITROME 16 OCTOBRE 2023					
Titre du contrat	montant Attribué HT (€)	Montant consommé HT (€)	Solde	% engagé	
<b>BUDGETS IRD</b>	<b>318 299,26</b>	<b>267 685,15</b>	<b>50 614,11</b>	<b>84%</b>	
IHU Accueil Vitrome	91 813,26	91 813,26	0,00	100%	
Fonctionnement IRD	121 486,00	89 124,00	32 362,00	73%	
Observatoires Dielmo Ndiop	50 000,00	49 312,00	688,00	99%	
Equipements Labo Dakar	0,00	0,00	0,00		
GDRI	15 000,00	12 547,34	2 452,66	84%	
LMI REMEDIER	40 000,00	24 888,55	15 111,45	62%	
<b>BUDGETS RESS EXTERNES</b>	<b>131 615,64</b>	<b>46 784,30</b>	<b>84 831,34</b>	<b>36%</b>	
MARS Amidex 2 - Jordi Landier	3 992,71	3 978,33	14,38	100%	Fin avril 2023
AREF - Amelé Wotodjo	948,28	948,28	0,00	100%	fin aout 2023
EDCTP - Bruno Senghor	9 788,76	9 788,76	0,00	100%	Fin sept 2023
VIH SOIGNANT ANRS - Luis Sagaon	11 259,17	8 141,01	3 118,16	72%	fin juin 2023- reporté au 31/12/23
AFRICAM PREZODE - AFD	55 506,00	4 247,36	51 258,64	8%	Fin 2025
Suite AREF - Amelé wotodjo	13 954,00	6 996,85	6 957,15	50%	fin Aout 2024
Cov 32 suite ANRS - Valérie Seror	36 166,72	12 683,71	23 483,01	35%	fin mars 2024
<b>TOTAL</b>	<b>449 914,90 €</b>	<b>314 469,45 €</b>	<b>135 445,45 €</b>	<b>70%</b>	



VITROME D-257	Nom du contrat	Type de contrat	responsable au sein de l'unité	porteur du projet	équipe	Dates du contrat (début, fin)	montant total K€
Contrats internationaux (hors Europe)							
	Africa Research Excellence Fund	SOUTIEN EXCELLENCE POST DOC	SOKHNA Cheikh	N	3	2021-2022	5
	INDIGO	EXPERTISE	SOKHNA Cheikh	O	3	2019-2022	63
	PRIX FIRST Min Rech Sénégalais	RECHERCHE	SOKHNA Cheikh	N	3	2018-2022	23
Contrats européens							
	EDCTP H2020	RECHERCHE	SOKHNA Cheikh	N	3	2020-2023	149
	EMERGEN	Consortium national	FOURNIER Pierre-Edouard	o	6; UMR MEPHI	2021-	2825
Contrats nationaux (ANR, PHRC, FUI, INCA, etc.)							
	FUNGIPLEX	ANR	RANQUE Stéphane	N	7	2021-2024	45
	ISIS	AMIDEX	CHAUDET Hervé	N	6	2022	
	COVJECO	IReSEP	PERETTI-WATEL Patrick	O	8	2021-2023	245
	MSProfileR	DGA	ALMERAS Lionel	O	2	2022-2024	60
	PLASMODRUG	ANR	AZAS Nadine	N	7	2018-2023	448
	NBC-2-B-2121	DGA	BRIOLANT Sébastien	O	2	2021-2024	160
	PRC 2015PPRC 14	DGA	BRIOLANT Sébastien	O	2	2017-2022	104
	ANR STRIP	ANR	DUMETRE Aurélien	O	7	2017 - 2022	557
	CRMVT Sud	DGS-DGOS Appel	PAROLA Philippe, SEVESTRE Jacques	O	1	2020-	300/an
	CNR Paludisme	Santé publique France - Centres Nationaux de Références	PRADINES Bruno	O	2	2017-	436/an
	CNR Rick, Cox, Barto	Santé publique France - Centres Nationaux de Références	FOURNIER Pierre-Edouard	O	6	2015-	125/an
	NBC-2-B-2120	DGA	PRADINES Bruno	O	2	2021-2024	280
	CO3ELSER-1	ANR	SEROR Valérie	O	8 ; 3	2020-2022	137
	CO3ELSER-2	ANR	SEROR Valérie	O	8 ; 3	2022-2024	105
	GDRI-Sud PALUvom	Groupe de Recherche sur le Paludisme non falciparum en Afrique de l'Ouest. ANRS	SOKHNA Cheikh	O	3	2021-2025	15
	UNISAHÉL	AFD	SOKHNA Cheikh	N	3	2018-2022	42
	MARS Hybride Invasion	AmiDEX - AMU	SOKHNA Cheikh	N	3	2020-2022	39
	AMBASS	RECHERCHE	SOKHNA Cheikh	N	3	2017-2022	157
	VIH SOIGNANT	RECHERCHE	SOKHNA Cheikh	N	3	2019-2022	44
Contrats financés par des associations caritatives et des fondations (ARC, FMR, FRM, etc.)							
Contrats avec les collectivités territoriales							
	CORONA-IHU-VITROME-B	CG13	FOURNIER Pierre Edouard	O	6	2022	110

# CHIFFRES CLÉS VITROME 2018 -2023



MAJ isa  
sept  
2023

190

MOY  
PUBLICATIONS/AN

42 %

PUBLICATIONS DANS  
LES JOURNAUX DE  
CATEGORIES A+B

97

DOCTORANTS  
ACCUEILLIS

55

THESES SOUTENUES

**SIGAPS APHM  
sur 504 HU:**

**Les 6 1<sup>er</sup> sont  
« IHU »**

**Dont VITROME  
1, 4, 19**

⇒	PAROLA	Philippe	9527
	DRANCOURT	Michel	9115
	ROLAIN	Jean Marc	9062
⇒	FOURNIER	Pierre-Edouard	7956
	DE LAMBALLERIE	Xavier	8039
	LEONE	Marc	6412
	LA-SCOLA	Bernard	6609
	PAPAZIAN	Laurent	5712
	BROUQUI	Philippe	6184
	HABIB	Gilbert	5861
	COLSON	Philippe	5600
	AUQUIER	Pascal	5453
	BRANGER	Dominique	5412
	BARLESI	Fabrice	5036
	BOYER	Laurent	5223
	CHARREL	Remi	5208
	BARTOLOMEI	Fabrice	5000
	GROB	Jean-Jacques	4632
	DIGNAT	Françoise	4521
	REGIS	Jean	4424
⇒	FENOLLAR	Florence	4328
	TAIEB	David	4308
	THOMAS	Pascal	3952
	ALESSI	Marie-Christine	4047
	MEGE	Jean-Louis	3989
	LAGIER	Jean-Christophe	3946
	MORANGE	Pierre	3702
	GUEDJ	Eric	3685
	BONELLO	Laurent	3535

## Production scientifique totale et par année

Periode : 2018 - 2023	
Année	Nombre
2018	281
2019	297
2020	301
2021	313
2022	281
2023	119
<b>Total</b>	<b>1592</b>

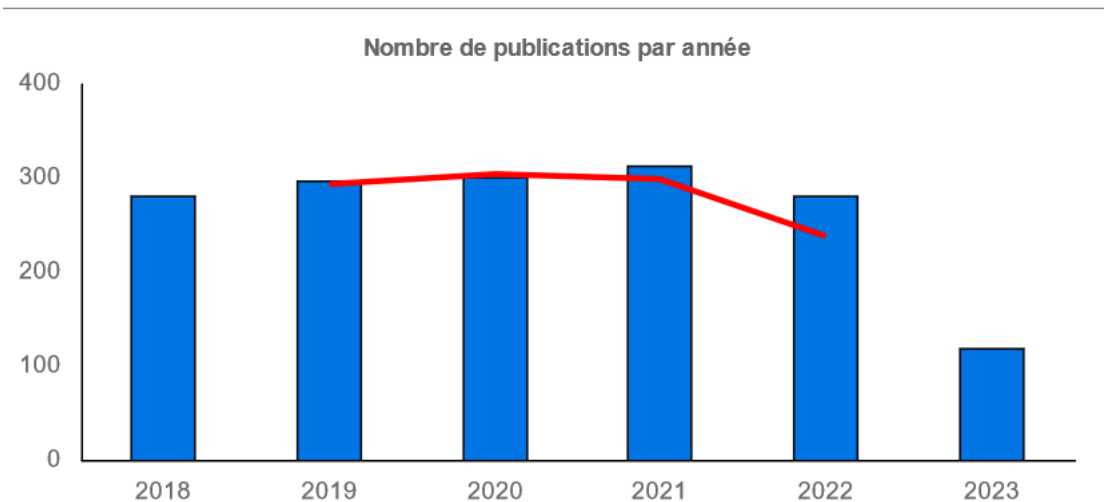
Année	Nb WOS	Nb Incites	CNCI moyen	CNCI [0-1]	CNCI [1-2]	CNCI [2-4]	CNCI >4	Top 1%	Top 5%	Top 10%	Hi Ci
2018	238	238	1.26	141	59	27	11	2	15	29	2
2019	257	257	1.06	171	56	24	6	3	11	22	1
2020	296	295	2.81	208	36	27	24	8	34	51	8
2021	308	307	1.66	195	54	31	27	8	29	52	7
2022	254	225	1.34	157	33	17	18	6	18	28	5
2023	100	80	1.00	66	0	3	11	0	1	1	0
<b>Total</b>	<b>1453</b>	<b>1402</b>	<b>1.63</b>	<b>938</b>	<b>238</b>	<b>129</b>	<b>97</b>	<b>27</b>	<b>108</b>	<b>183</b>	<b>23</b>

**CNCI : Category Normalized Citation Impact** - Indice de citation normalisé - Tient compte de l'année de publication, du champ disciplinaire et du type de documents. **Un CNCI de 2 indique que les publications sont en moyenne 2 fois plus cités que la moyenne mondiale.**

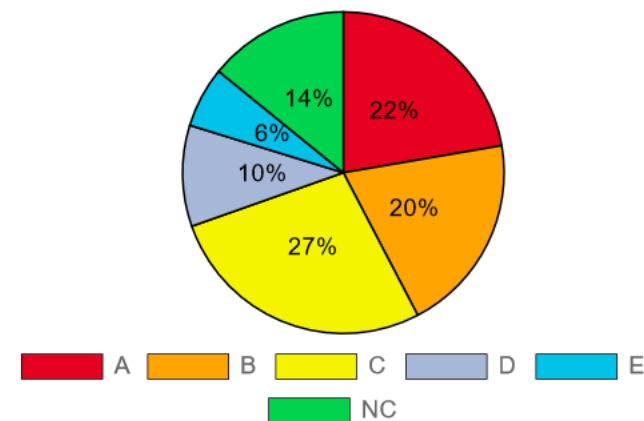
MAJ isa sept 2023

Les CNCI, Top 1%, Top 5% et Top 10% sont basés sur la classification WOS, les Hi Ci sur ESI.

## Qualité de la production



Répartition par catégorie





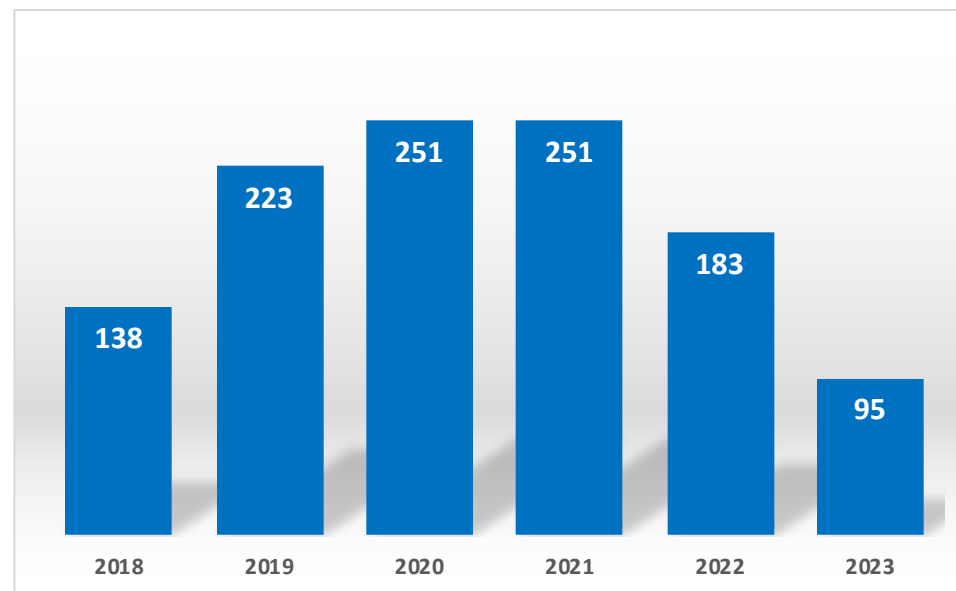
**Catégories A+B = 42 % sur 6 ans**



AD=((VITROME OR IRD257 OR IRD 257 OR MD 4 OR MD4 OR Vecteur\* Infect\*Trop\*Medit\*) SAME MARSEILLE)

Quick Filters

-  Highly Cited Papers 19
-  Review Article 130
-  Open Access 963



Evolution de la production scientifique par année

Moy : 190 publications par an

## Publications

1,162

Total

From 1637 to 2023

## Citing Articles

15,184 [Analyze](#)

Total

14,590 [Analyze](#)

Without self-citations



## Times Cited

18,495

Total

16,874

Without self-citations



50

H-Index

15.92

Average per item





RAPPORT D'ÉVALUATION DE L'UNITÉ  
VITROME - Vecteurs – Infections Tropicales et  
Méditerranéennes

SOUS TUTELLE DES ÉTABLISSEMENTS ET  
ORGANISMES :

Aix-Marseille université – AMU

Institut de recherche pour le développement –  
IRD

Ministère des armées

# HCERES - 7 décembre 2022

# UMR D-257 VITROME

## Rapport très positif

## Production Scientifique

## Gouvernance

## INTEGRITE scientifique



# UMR D-257 VITROME

- Une recherche *technology driven* et *observation driven* > recherche *hypothesis driven*
- Une recherche en nid > recherche en réseau (sauf surveillance)
- Sud +++ et Collaborations internationales  
thématiques – outils IRD – Grants - Etudiants +++

*Microbiologie du 21<sup>e</sup> siècle en Afrique*

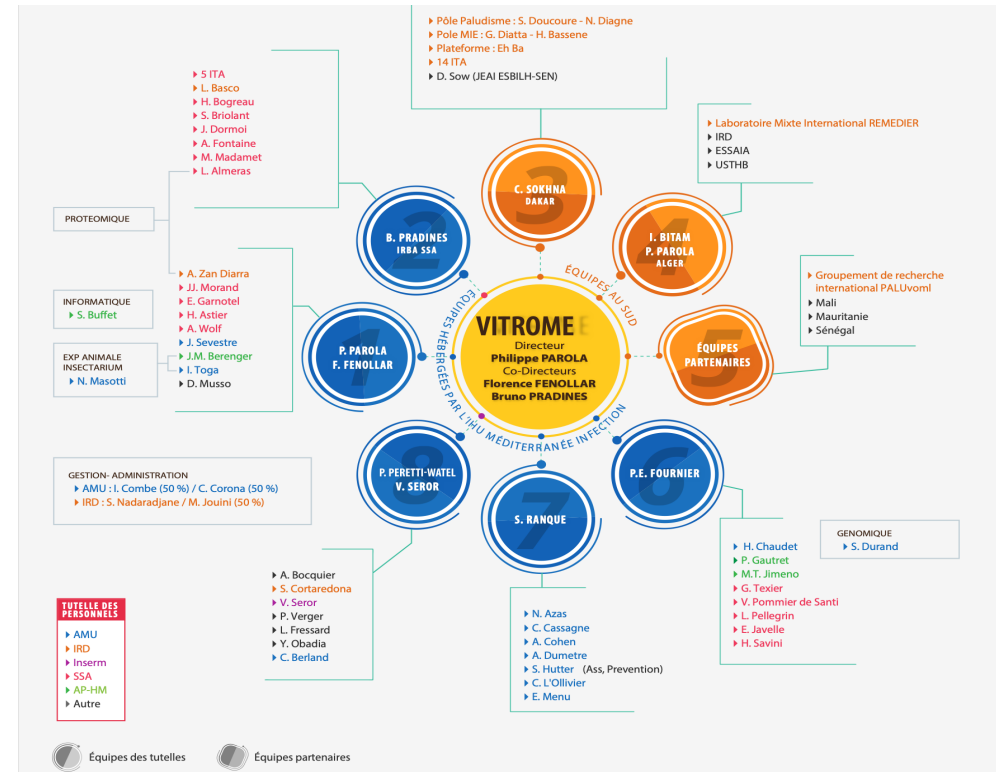
*Médecine et Santé Tropicales* 2019 ; 29 : 340-342

Vers la microbiologie du 21<sup>e</sup> siècle en Afrique

*Towards 21st century microbiology in Africa*

Parola Philippe<sup>1,2</sup>, Raoult Didier<sup>1,3</sup>

- Chercheurs: « temps partiels » et « temps plein »
- Interactions et Co publications : entre équipes et Nord/Sud
- Congrès:
  - Peu d'étudiants (Covid mais stratégie étudiants et sénior)
  - Peu de Seniors sauf invités et réunions stratégiques
  - Mais Libre sur grants
- Recherche clinique plutôt mono centrique et / ou observationnelle sauf CNR
- Vulgarisation et Communication: MOOC – Chaine youtube IHU
- Grants



# Equipe 1

Medical Entomology Zoonoses & Microbiology  
at the University Hospital Institute *Mediterranee*  
*Infection*

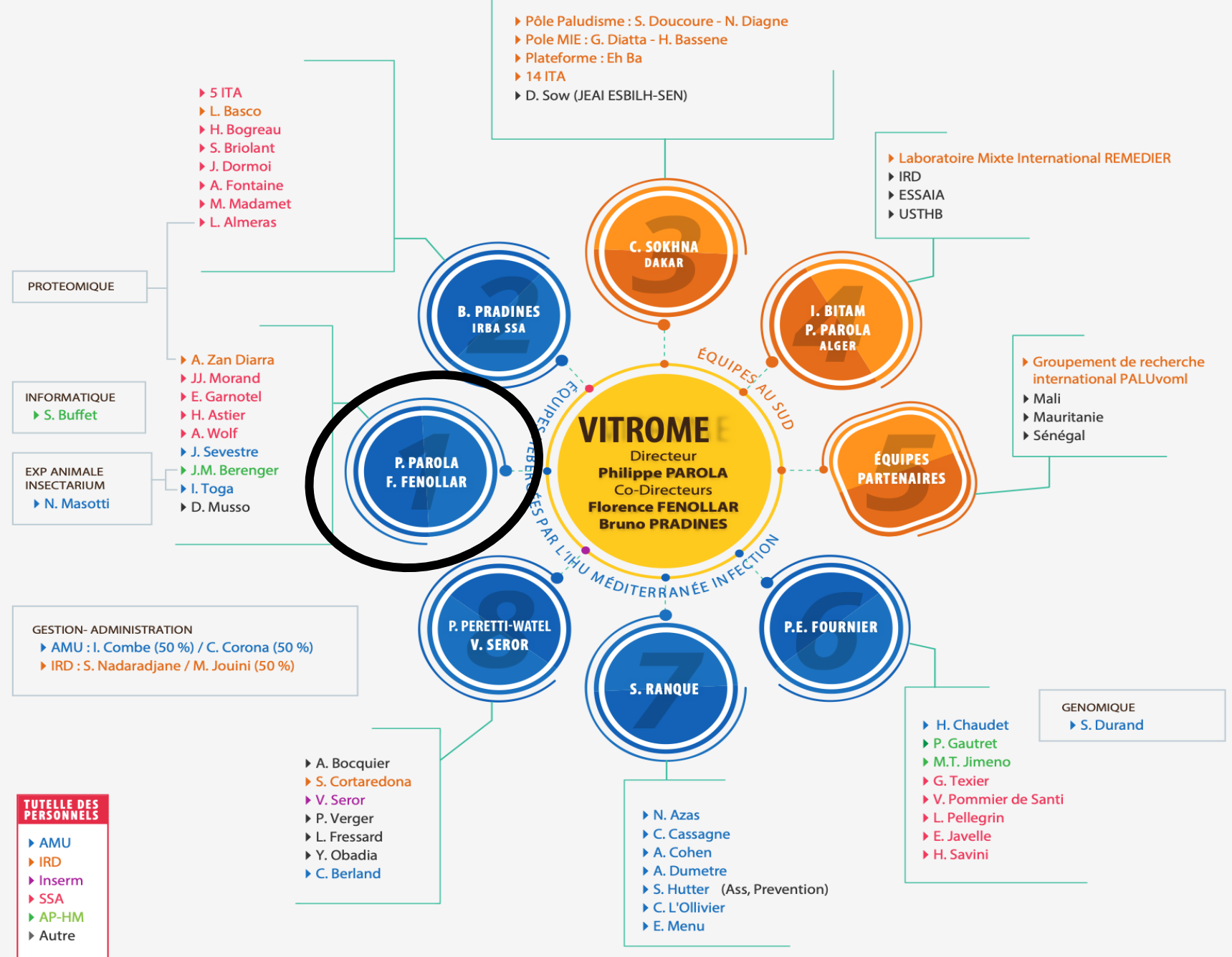


Faculté des sciences  
médicales et paramédicales  
Aix-Marseille Université

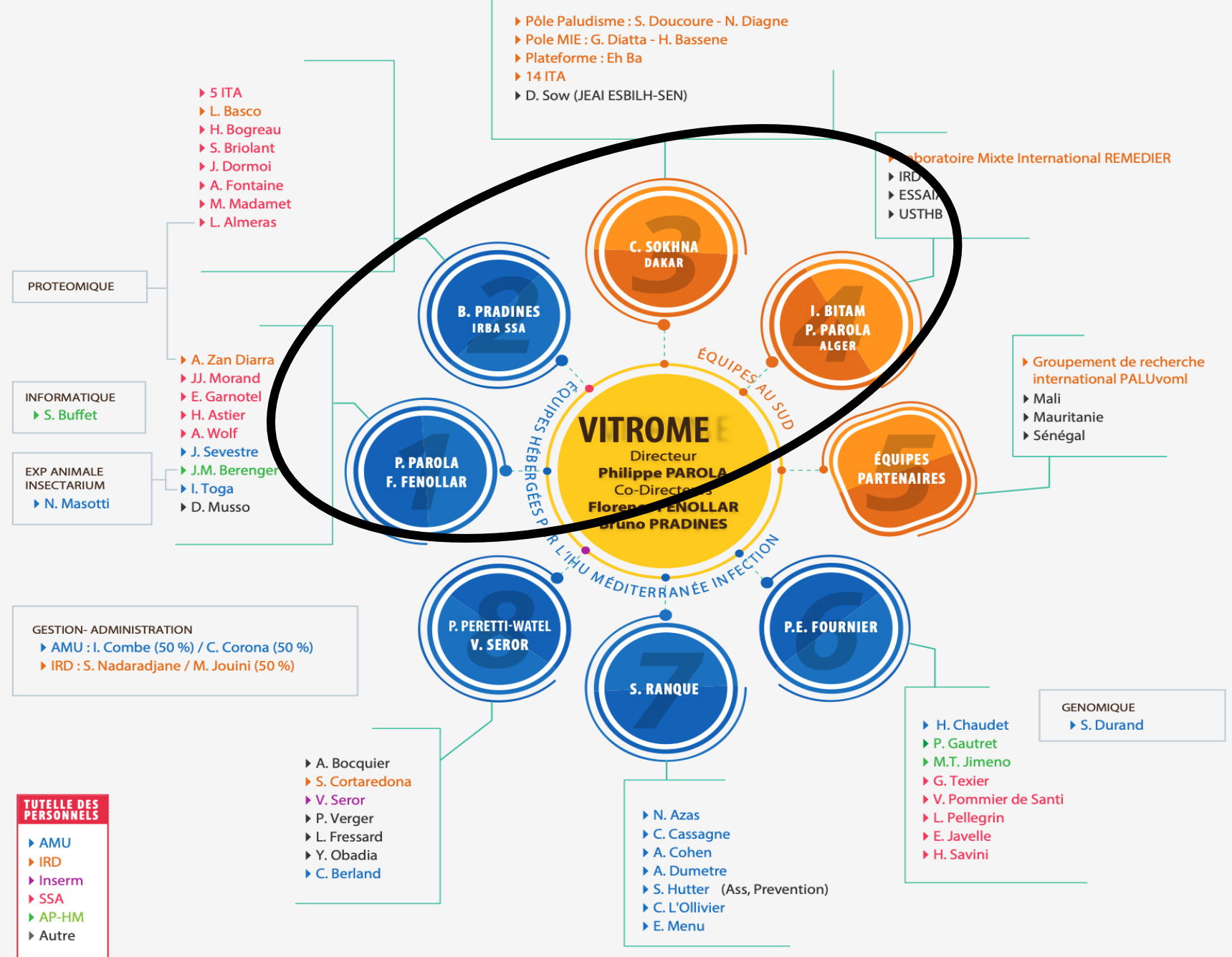


Hôpitaux Universitaires  
de Marseille | ap·hm

# One Health



# One Health



# Arthropod Platform: BSL2 / BSL3 lab

## TICKS

*Rhipicephalus sanguineus* 2018

*A. variegatum* infected with *R. africae* 2020

*D. marginatus* 2010

*Hyalomma marginatum rufipes* 2012



Jean-Michel Berenger

## LICE

*Pediculus humanus corporis* 1999

Attempts of Artificial membrane feeding system

**FLEAS** *Ct. Felis* 2011

## BUGS

*Cimex lectularius* 2013

*Triatoma infestans* 2014

*Rhodnius prolixus* 2014

*Platyeris biguttatus* 2016



Adama Zan Diarra

## MOSQUITOES

*Aedes albopictus* & *Anopheles coluzzii* S/M 2013



## OTHER

*Periplaneta americana* (blattes) 2013

.....



Noelle Masotti





# Medical Entomology at IHU

## SOME REPRESENTATIVE WORKS

**CONTRIBUTION TO THE REPERTOIRE OF THE MICROORGANISMS IN ARTHROPODS**

**THE USE OF MALDI TOF FOR THE IDENTIFICATION OF ARTHROPODS, THEIR BLOOD MEAL,  
AND THE ASSOCIATED MICROORGANISMS**

**EXPERIMENTAL MODELS**

**ECOLOGICAL STUDIES**

**ENTOMOLOGICAL SURVEYS AROUND CASES AND ON SPECIFIC POPULATIONS**

**EXPERTISE ET COMMUNICATION**

*Clinical Infectious Diseases*

**SUPPLEMENT ARTICLE**



### Medical Entomology: A Reemerging Field of Research to Better Understand Vector-Borne Infectious Diseases

Maureen Laroche,<sup>1</sup> Jean-Michel Bérenger,<sup>1</sup> Pascal Delaunay,<sup>2</sup> Remi Charrel,<sup>3</sup> Bruno Pradines,<sup>1,4,5</sup> Franck Berger,<sup>6</sup> Stéphane Ranque,<sup>1</sup>  
Idir Bitam,<sup>7</sup> Bernard Davoust,<sup>1</sup> Didier Raoult,<sup>1</sup> and Philippe Parola<sup>1</sup>

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

# Comparative Immunology, Microbiology and Infectious Diseases

journal homepage: [www.elsevier.com/locate/cimid](https://www.elsevier.com/locate/cimid)

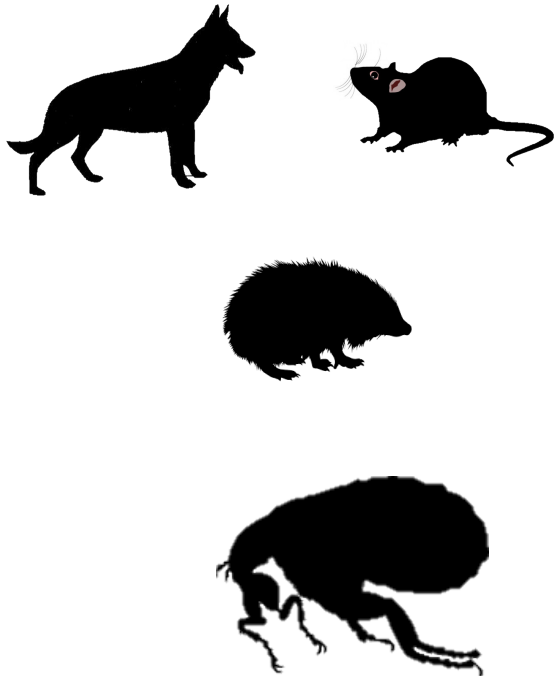
## New records of bacteria in different species of fleas from France and Spain

Antonio Zurita<sup>a</sup>, Linda Benkacimi<sup>b,c</sup>, Khalid El Karkouri<sup>b,c</sup>, Cristina Cutillas<sup>a</sup>,  
Philippe Parola<sup>b,c</sup>, Maureen Laroche<sup>b,c,\*</sup>

Table 3

Percentage of microorganism-positive fleas detected by PCR (qPCR and standard PCR).

	Anaplasmataceae	<i>Rickettsia</i> sp.	<i>R. typhi</i>	<i>C. burnetti</i>	<i>Mycobacterium</i> spp.	<i>Borrelia</i> spp.	<i>Bartonella</i> spp.	<i>Leishmania</i> spp.
<i>C. felis</i>	32/53( <i>Wolbachia</i> spp.) (60.4 %)	15/53 ( <i>R. felis</i> ) (28.3 %)	–	–	1/53 (2.0 %)	–	–	–
<i>P. irritans</i>	22/23( <i>Wolbachia</i> spp.) (95.7 %)	–	–	–	1/23 (4.3 %)	–	2/23 ( <i>Bartonella</i> spp.) (8.7 %)	–
<i>S. t. tripectinata</i>	–	–	–	–	–	–	2/22( <i>B. henselae</i> ) (9.1 %); 3/22 ( <i>B. quintana</i> ) (13.6 %)	–
<i>N. fasciatus</i>	–	–	–	–	–	–	3/22 ( <i>B. elizabethae</i> ) (13.6 %)	–
<i>A. erinacei</i>	10/18( <i>Wolbachia</i> spp.) (55.5 %)	6/18 ( <i>R. felis</i> ) (33.3 %)	1/18 (5.5 %)	–	1/18 (5.5 %)	–	3/23 ( <i>B. henselae</i> ) (13.0 %); 1/23( <i>B. elizabethae</i> ) (4.3 %)	–
<i>L. taschenbergi</i>	–	–	–	–	–	–	3/23 ( <i>Bartonella</i> spp.) (13.0 %)	–
<i>Ct. b. boisseaorum</i>	10/60( <i>Wolbachia</i> spp.) (16.7 %)	1/60 ( <i>R. felis</i> ) (1.6 %)	–	–	–	–	4/60 ( <i>B. taylorii</i> ) (6.6 %); 4/60 ( <i>B. elizabethae</i> ) (6.6 %)	–
<i>Ct. a. allani</i>	–	–	–	–	–	–	2/60 ( <i>Bartonella</i> spp.) (3.3 %)	–
							1/60 ( <i>B. doshiae</i> ) (1.6 %)	–
							4/60 ( <i>B. taylorii</i> ) (6.6%); 1/60 ( <i>B. elizabethae</i> ) (1.6%)	–
							4/60 ( <i>B. taylorii</i> ) (6.6 %); 1/60 ( <i>Bartonella</i> spp.) (1.6%)	–





RESEARCH ARTICLE

# Tick-borne relapsing fever Borreliosis, a major public health problem overlooked in Senegal

El Hadji Ibrahima Ndiaye<sup>1,2</sup>, Fatou Samba Diouf<sup>3</sup>, Mady Ndiaye<sup>4</sup>, Hubert Bassene<sup>1,3</sup>,  
Didier Raoult<sup>2,5</sup>, Cheikh Sokhna<sup>1,3</sup>, Philippe Parola<sup>1,2</sup>, Georges Diatta<sup>1,3\*</sup>

**1** Aix Marseille Univ, IRD, APHM, SSA, VITROME, Marseille, France, **2** IHU Méditerranée Infection, Marseille, France, **3** VITROME, Campus International IRD-UCAD Hann, Dakar, Senegal, **4** Laboratoire d'Entomologie, Bactériologie, Rickettsiologie, Virologie, Département de Biologie Animale, Faculté des Sciences et Techniques, Université Cheikh Anta Diop de Dakar, Dakar, Senegal, **5** Aix Marseille Univ, IRD, APHM, MEPHI, Marseille, France

\* [georges.diatta@ird.fr](mailto:georges.diatta@ird.fr)



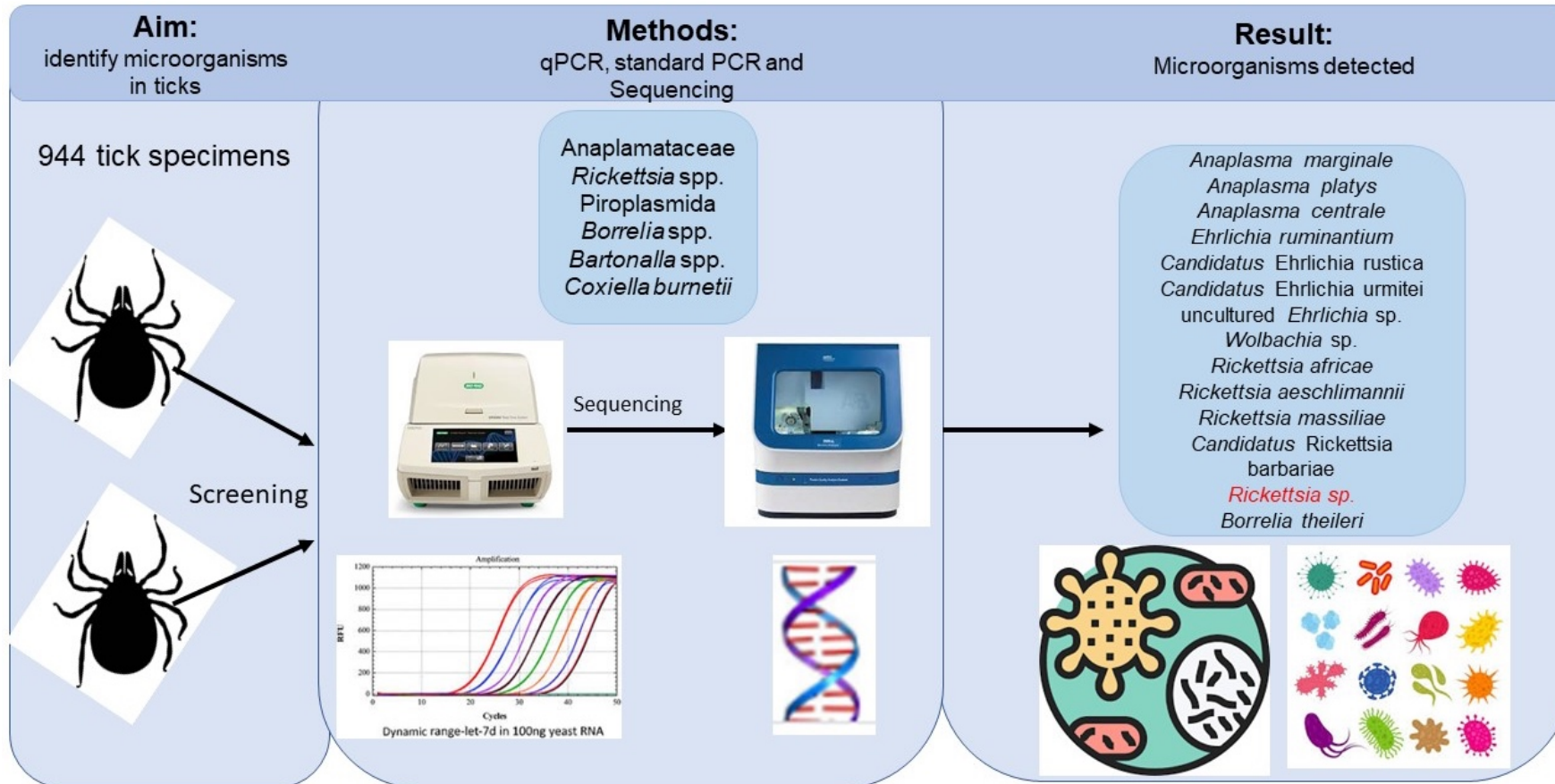




Article

# Detection of Tick-Borne Pathogens in Ticks from Cattle in Western Highlands of Cameroon

Yannick Ngnindji-Youdje <sup>1,2,3</sup>, Adama Zan Diarra <sup>1,2</sup>, Michel Lontsi-Demano <sup>3</sup>, Timoléon Tchuinkam <sup>3</sup> and Philippe Parola <sup>1,2,\*</sup>



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*Clinical Infectious Diseases*

SUPPLEMENT ARTICLE

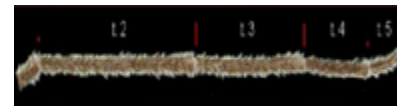
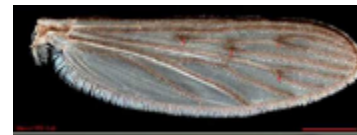
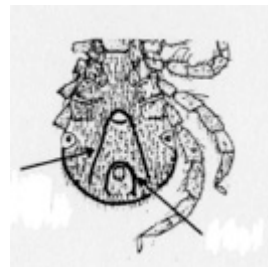
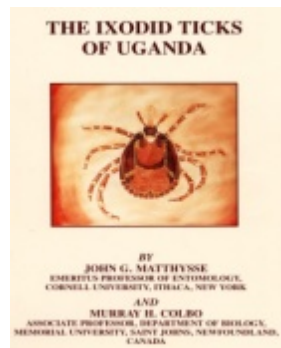


## Medical Entomology: A Reemerging Field of Research to Better Understand Vector-Borne Infectious Diseases

Maureen Laroche,<sup>1</sup> Jean-Michel Bérenger,<sup>1</sup> Pascal Delaunay,<sup>2</sup> Remi Charrel,<sup>3</sup> Bruno Pradines,<sup>1,4,5</sup> Franck Berger,<sup>6</sup> Stéphane Ranque,<sup>1</sup> Idir Bitam,<sup>7</sup> Bernard Davoust,<sup>1</sup> Didier Raoult,<sup>1</sup> and Philippe Parola<sup>1</sup>

# Morphological identification

## Tools / identification keys



## Limitations :

- Damaged specimens
- Immature stages
- Entomological knowledge



## Not suitable to distinct:

- species from the same complex (sibling species).
- bridged species (hybrids)
- ...

# Molecular identification



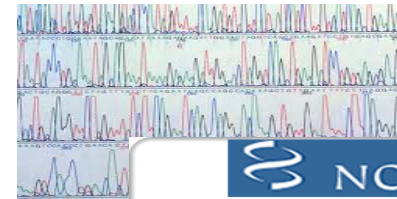
DNA  
extraction →



PCR →  
(28S, 18S, ITS1/2,  
12S, 16S, COI,...)



Sequencing  
&  
analysis ↓



## Limitations :

- Time consuming



- Relatively expensive



- Risk of contamination



- Difficulty for interpretation  
of new species  
(lack of sequences in Genbank)



## Gene choice:

-12S rDNA for ticks (Beati & Keirans, 2001)

-ITS2 for mosquitoes (Mario A. Zapata et al 2007)

-18S rDNA on fleas (F.whiting et al 2001)

# MALDI-TOF MS

## Background

- Since mid 1990's, MALDI-TOF MS apparatus and software progresses useful for bacteria identification (Cain, 1994; Holland, 1996)
- **MALDI-TOF profiling** revolutionize microbial identification (range analysis 2-20 kDa)
- **Principle:** Comparison of intact protein profiles using MALDI-TOF
- **Advantages:** rapid, simple, economic & accurate.

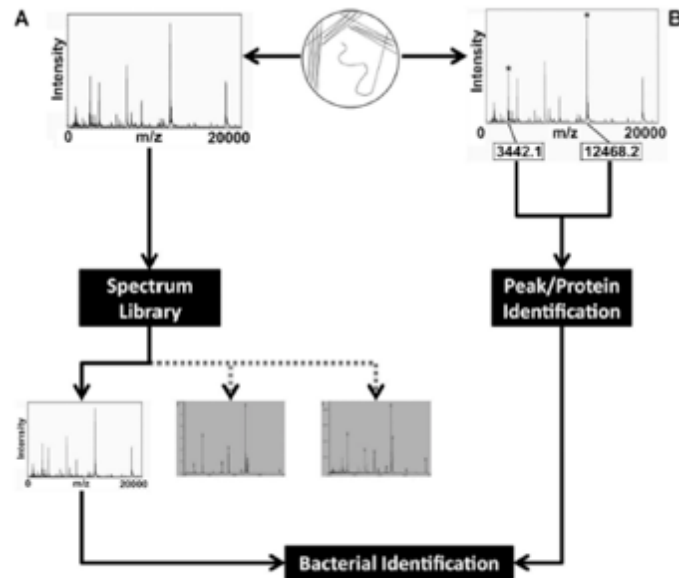


FIGURE 1. Overview of library-based (A) and bioinformatics-enabled (B) approaches to profiling bacteria using MALDI-MS.



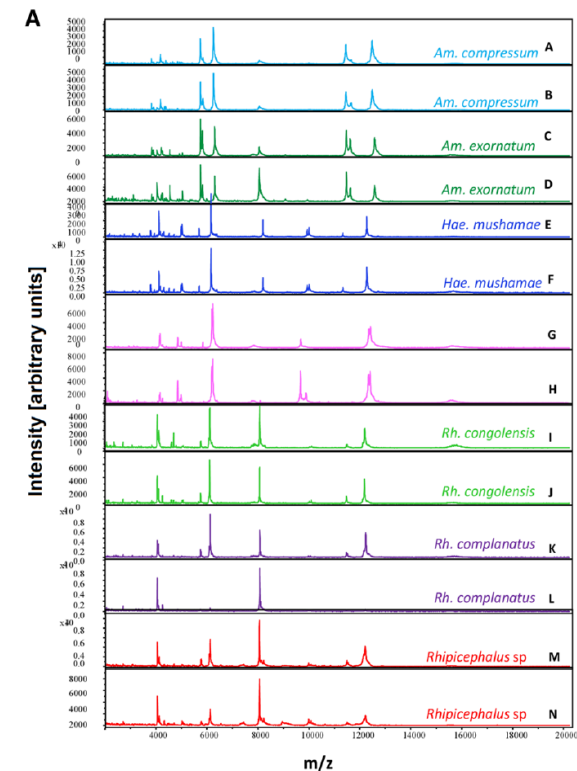
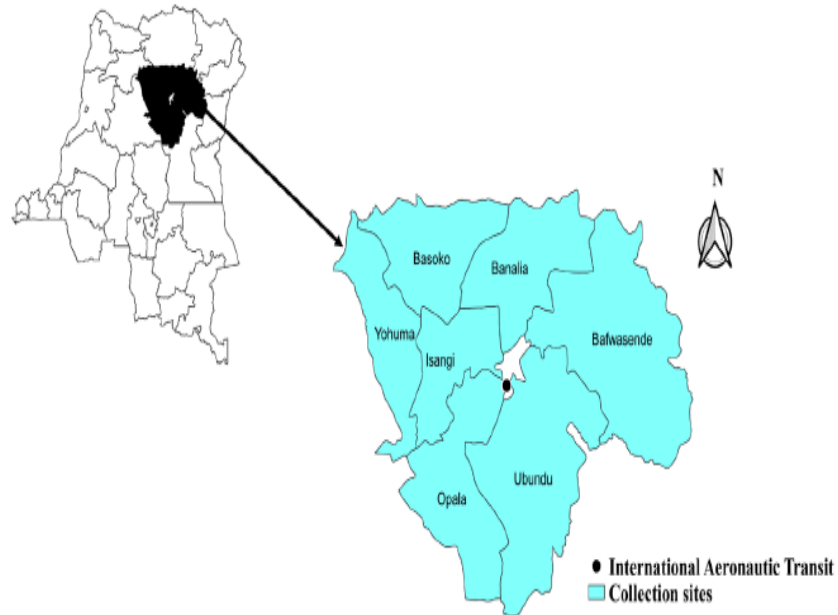




# Using MALDI-TOF mass spectrometry to identify ticks collected on domestic and wild animals from the Democratic Republic of the Congo

Steve Ngoy<sup>1</sup> · Adama Zan Diarra<sup>2,3</sup> · Anne Laudisoit<sup>4</sup> · Guy-Crispin Gembu<sup>1,5</sup> · Erik Verheyen<sup>6,7</sup> · Onésime Mubenga<sup>1,8</sup> · Sylvestre Gambalemoke Mbalitini<sup>1,5</sup> · Pascal Baelo<sup>1</sup> · Maureen Laroche<sup>2,3</sup> · Philippe Parola<sup>2,3</sup>

Received: 25 January 2021 / Accepted: 22 May 2021  
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RESEARCH ARTICLE

# Morphological, molecular and MALDI-TOF MS identification of ticks and tick-associated pathogens in Vietnam

Ly Na Huynh<sup>1,2,3</sup>, Adama Zan Diarra<sup>1,2</sup>, Quang Luan Pham<sup>3</sup>, Nhiem Le-Viet<sup>4</sup>, Jean-Michel Berenger<sup>1,2</sup>, Van Hoang Ho<sup>3</sup>, Xuan Quang Nguyen<sup>3</sup>, Philippe Parola<sup>1,2\*</sup>



A



B



C



D



E



F



G



H



**Fig. 2** Morphologically tick species identified were stored in 90% v/v ethanol since 2010, which could not be identified by molecular biology. *Amblyomma varanensis* [♀: **A**, **B**]; *Amblyomma* sp. [♀: **C**, **D**]; *Dermacentor auratus* [♂: **E**, **F**]; *Dermacentor compactus* [♂: **G**, **H**].




RESEARCH

Open Access



# MALDI-TOF mass spectrometry identification of mosquitoes collected in Vietnam

Ly Na Huynh<sup>1,2,3</sup>, Adama Zan Diarra<sup>1,2</sup>, Hong Sang Nguyen<sup>3</sup>, Long Bien Tran<sup>3</sup>, Van Nguyen Do<sup>3</sup>, Tran Duc Anh Ly<sup>1,2</sup>, Van Hoang Ho<sup>3</sup>, Xuan Quang Nguyen<sup>3</sup> and Philippe Parola<sup>1,2\*</sup> 



Human-Landing catch



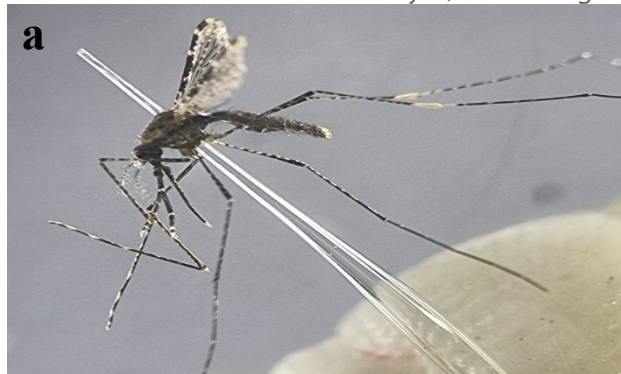
Animal-bait net trap



CDC light trap



BG-sentinel trap



Photographs of three mosquito species are known to be major malaria vectors in Vietnam: (a) *Anopheles dirus*; (b) *Anopheles minimus*; (c) *Anopheles epiroticus*

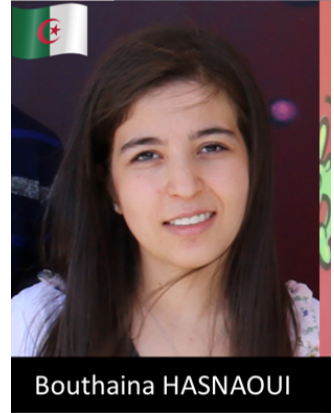


Photographs of mosquito species are known to be main dengue, Zika, and JE vectors in Vietnam: (d) *Aedes aegypti*; (e) *Aedes albopictus*; (f) *Culex quinquefasciatus*

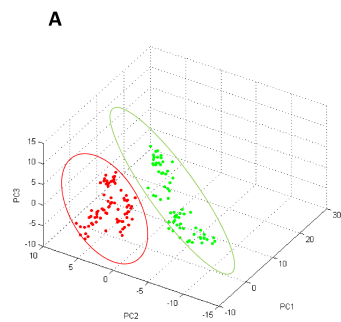


## OPEN Use of the proteomic tool MALDI-TOF MS in termite identification

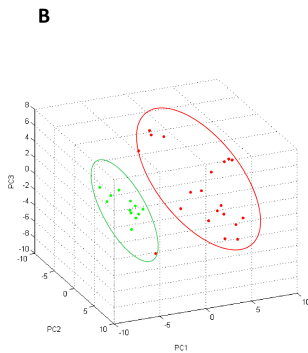
Bouthaina Hasnaoui<sup>1,2</sup>, Adama Zan Diarra<sup>1,2</sup>, Jean-Michel Berenger<sup>1,2</sup>, Hacène Medkour<sup>2,3</sup>, Ahmed Benakhla<sup>4</sup>, Oleg Mediannikov<sup>2,3</sup> & Philippe Parola<sup>1,2</sup>✉



Bouthaina HASNAOUI

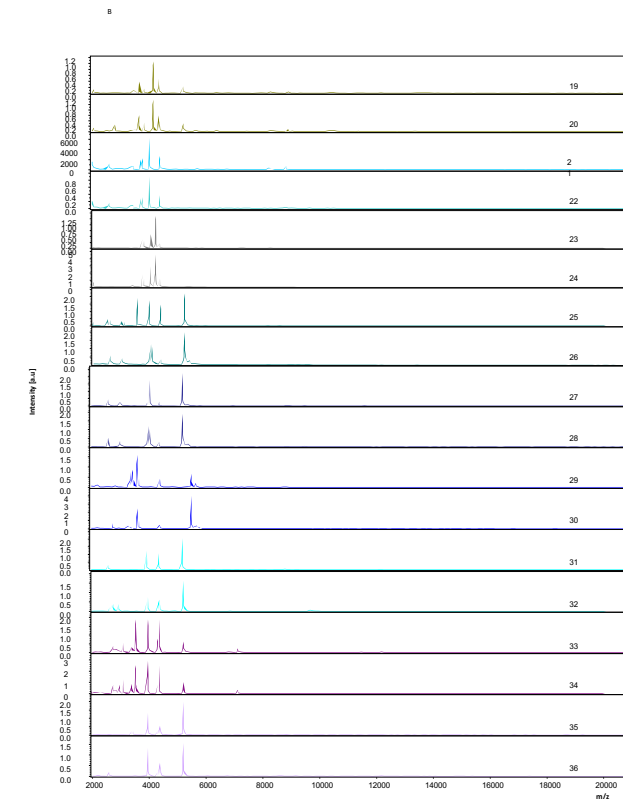
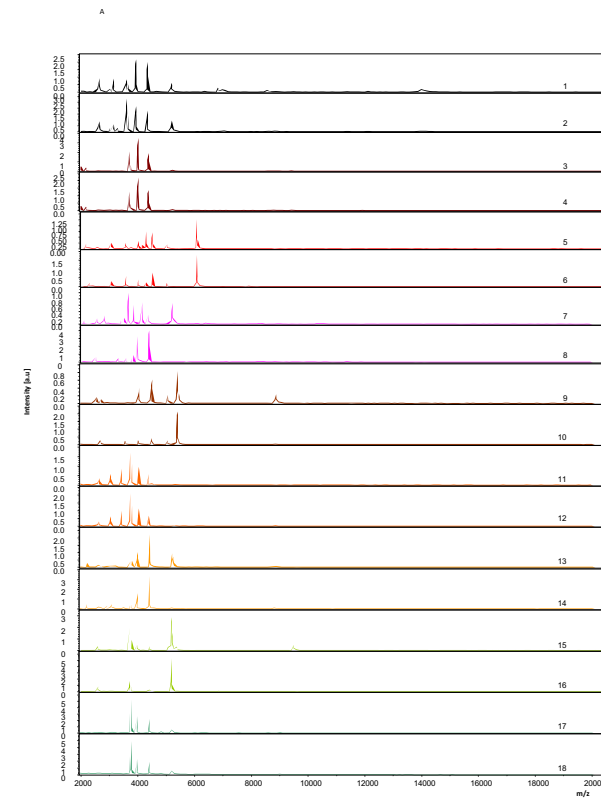


*Reticulitermes lucifugus*



*Kalotermes flavicollis*

- Sterile caste
- Reproductive caste







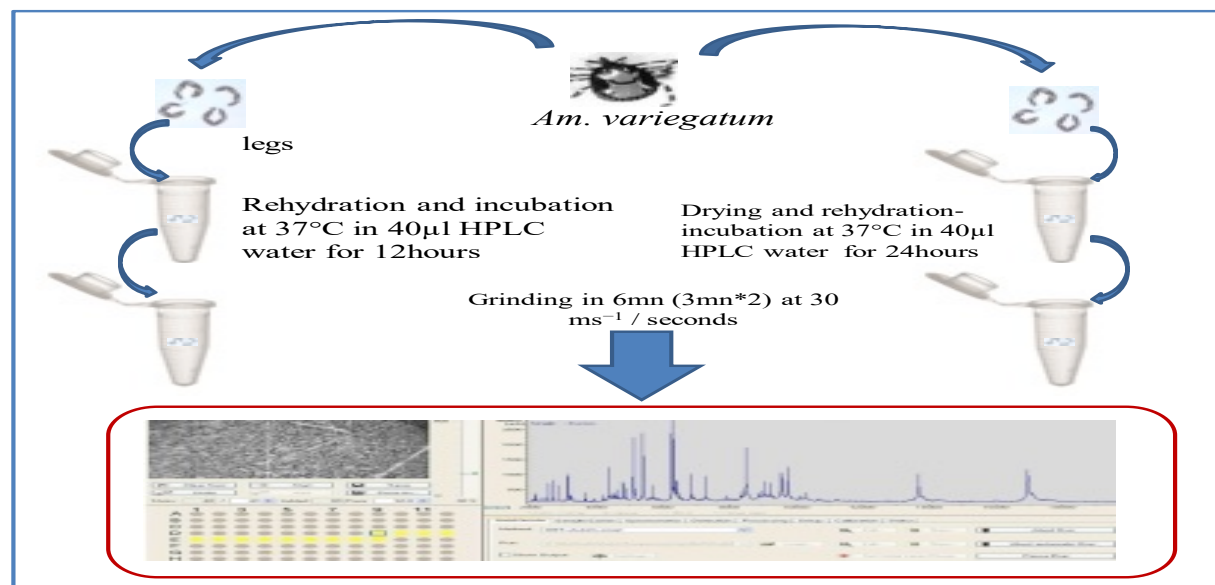
## Identification of ticks from an old collection by MALDI-TOF MS

Saidou Ahamada M'madi <sup>a,b</sup>, Adama Zan Diarra <sup>a,b</sup>, Lionel Almeras <sup>a,b,c</sup>, Philippe Parola <sup>a,b,\*</sup>

<sup>a</sup> Aix Marseille Univ, IRD, SSA, AP-HM, VITROME, Marseille, France

<sup>b</sup> IHU-Méditerranée Infection, Marseille, France

<sup>c</sup> Unité Parasitologie et Entomologie, Département Microbiologie et Maladies Infectieuses, Institut de Recherche Biomédicale des Armées, Marseille, France



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Journal of Medical Entomology, XX(X), 2022, 1–14

<https://doi.org/10.1093/jme/tjac019>

Research



Vector-Borne Diseases, Surveillance, Prevention

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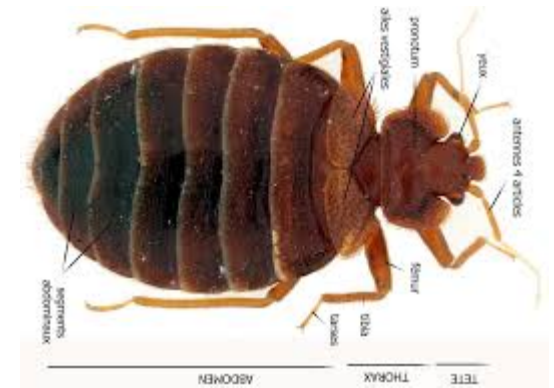
## Morphological, Molecular and MALDI-TOF MS Identification of Bedbugs and Associated *Wolbachia* Species in Rural Senegal

El Hadji Ibrahima Ndiaye,<sup>1,2,3</sup> Georges Diatta,<sup>3</sup> Adama Zan Diarra,<sup>1,2,Ⓞ</sup>  
Jean Michel Berenger,<sup>1,2</sup> Hubert Bassene,<sup>3</sup> Oleg Mediannikov,<sup>1,2</sup> Charles Bouganali,<sup>3</sup>  
Cheikh Sokhna,<sup>2,3</sup> and Philippe Parola<sup>1,2,4</sup>

<sup>1</sup>Aix Marseille Univ, IRD, APHM, SSA, VITROME, Marseille, France, <sup>2</sup>IHU Méditerranée Infection, Marseille, France, <sup>3</sup>VITROME, Campus International IRD-UCAD Hann, Dakar, Senegal, and <sup>4</sup>Corresponding author, e-mail: [philippe.parola@univ-amu.fr](mailto:philippe.parola@univ-amu.fr)

Subject Editor: Michael Rust

Received 3 November 2021; Editorial decision 23 January 2022





# Identification of Lice Stored in Alcohol Using MALDI-TOF MS

Hanene Benyahia,<sup>1,2</sup> Basma Ouarti,<sup>1,2</sup> Adama Zan Diarra,<sup>1,2,6</sup> Mehdi Boucheikhchoukh,<sup>3,6</sup> Mohamed Nadir Meguini,<sup>4</sup> Makhlouf Behidji,<sup>4</sup> Ahmed Benakhla,<sup>3</sup> Philippe Parola,<sup>1,2</sup> and Lionel Almeras<sup>1,2,5,6</sup>

<sup>1</sup>Aix Marseille Univ, IRD, SSA, AP-HM, VITROME, Marseille, France, <sup>2</sup>IHU-Méditerranée Infection, Marseille, France, <sup>3</sup>Department of Veterinary Sciences, Chadli Bendjedid University, El-Tarf, 36000, Algeria, <sup>4</sup>Institute of Veterinary and Agronomic Sciences, Mohamed Cherif Messaadia University, Souk-Ahras, Algeria, <sup>5</sup>Unité Parasitologie et Entomologie, Département Microbiologie et Maladies Infectieuses, Institut de Recherche Biomédicale des Armées, 19-21 Boulevard Jean Moulin, 13005 Marseille, France, <sup>6</sup>Corresponding author, e-mail: [almeras.lionel@gmail.com](mailto:almeras.lionel@gmail.com)

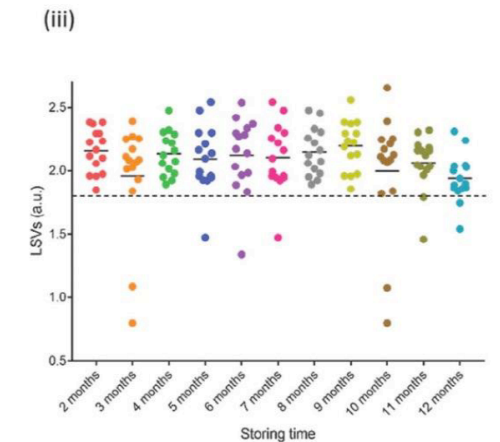
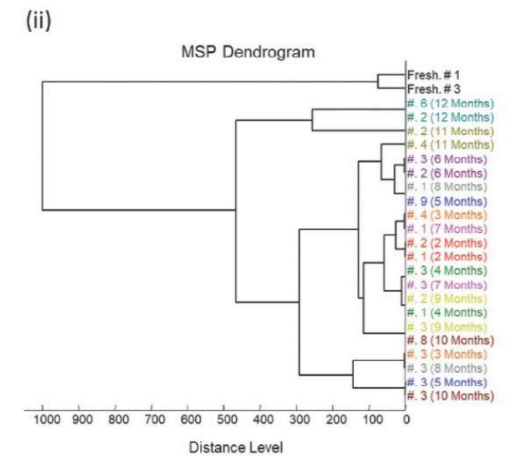
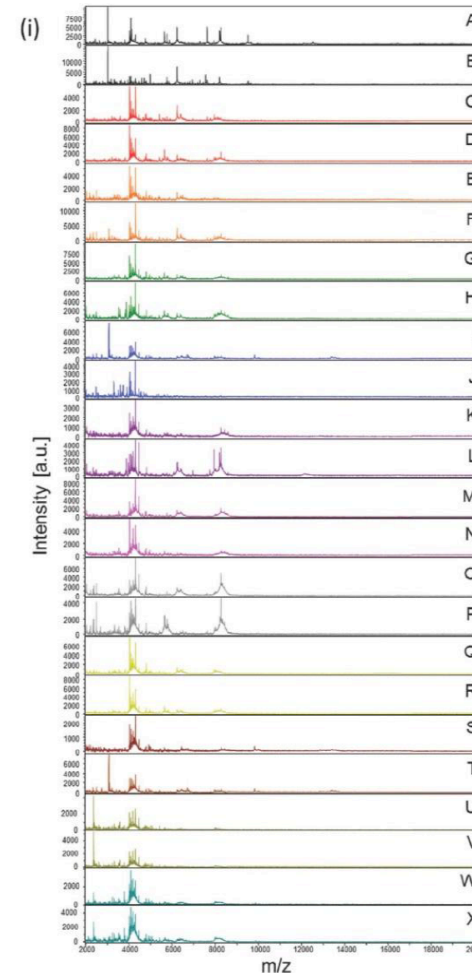
Subject Editor: David Severson

Received 16 July 2020; Editorial decision 27 October 2020

## Abstract

Lice pose major public and veterinary health problems with economic consequences. Their identification is essential and requires the development of an innovative strategy. MALDI-TOF MS has recently been proposed as a quick, inexpensive, and accurate tool for the identification of arthropods. Alcohol is one of the most frequently used storage methods and makes it possible to store samples for long periods at room temperature. Several recent studies have reported that alcohol alters protein profiles resulting from MS analysis. After preliminary studies on frozen lice, the purpose of this research was to evaluate the influence of alcohol preservation on the accuracy of lice identification by MALDI-TOF MS. To this end, lice stored in alcohol for variable periods were submitted for MS analysis and sample preparation protocols were optimized. The reproducibility and specificity of the MS spectra obtained on both these arthropod families allowed us to implement the reference MS spectra database (DB) with protein profiles of seven lice species stored in alcohol. Blind tests revealed a correct identification of 93.9% of *Pediculus humanus corporis* (Linnaeus, 1758) and 98.4% of the other lice species collected in the field. This study demonstrated that MALDI-TOF MS could be successfully used for the identification of lice stored in alcohol for different lengths of time.

**Key words:** lice, MALDI-TOF MS, storage method, identification

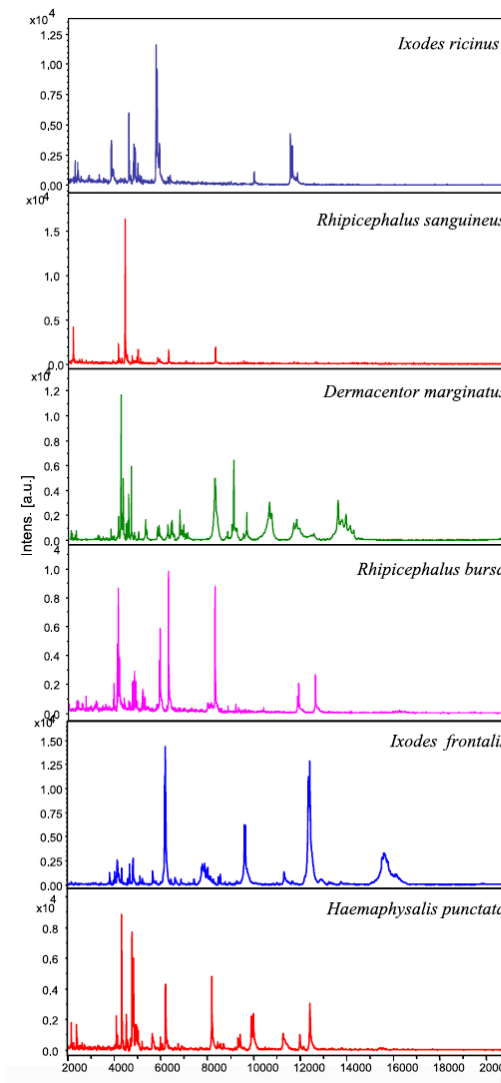
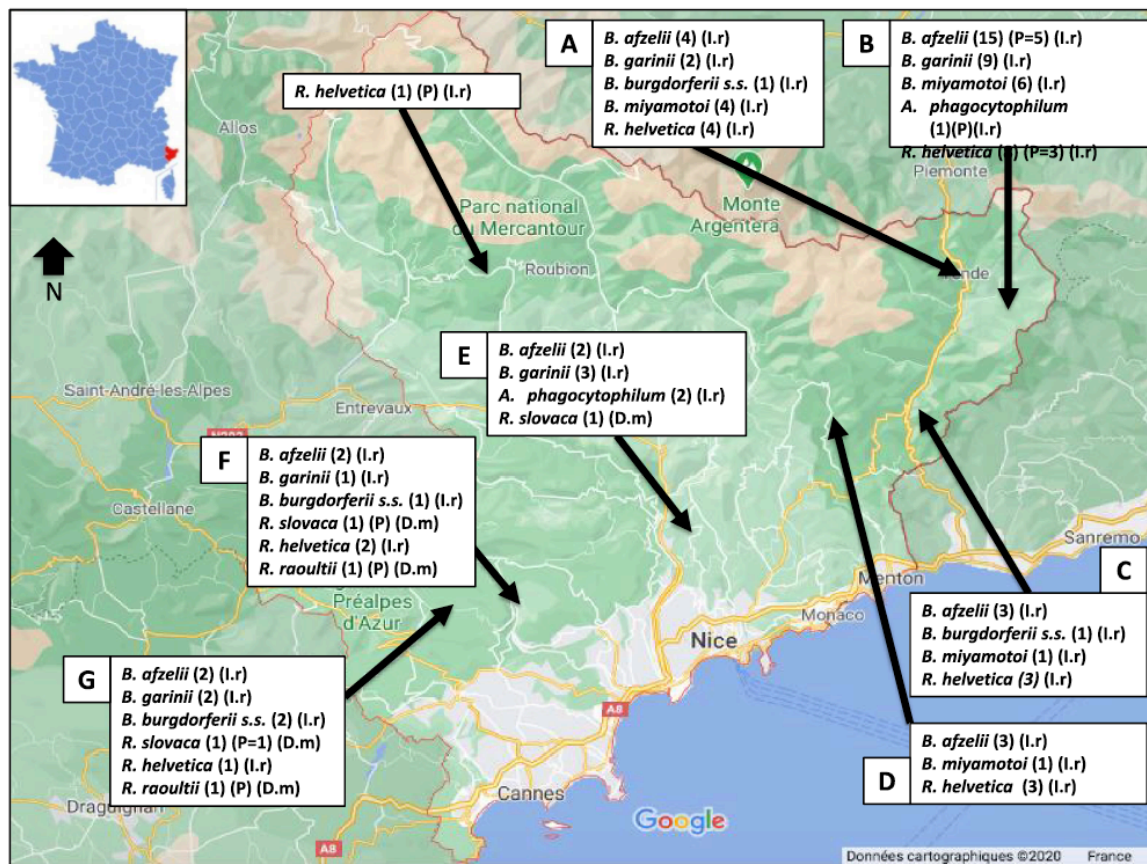






## Detection of emerging tick-borne disease agents in the Alpes-Maritimes region, southeastern France

Jacques Sevestre<sup>a,b,c</sup>, Adama Zan Diarra<sup>b,c</sup>, Halilou Almou Oumarou<sup>a</sup>, Jacques Durant<sup>d</sup>, Pascal Delaunay<sup>a,e,1</sup>, Philippe Parola<sup>b,c,1,\*</sup>



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*Clinical Infectious Diseases* 2017

SUPPLEMENT ARTICLE



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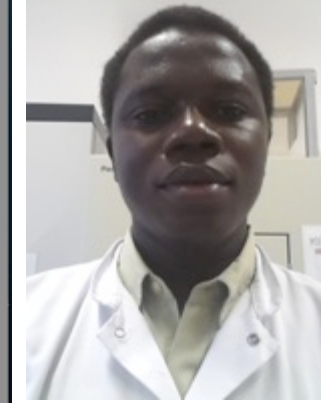
Maureen Laroche,<sup>1</sup> Jean-Michel Bérenger,<sup>1</sup> Pascal Delaunay,<sup>2</sup> Remi Charrel,<sup>3</sup> Bruno Pradines,<sup>1,4,5</sup> Franck Berger,<sup>6</sup> Stéphane Ranque,<sup>1</sup>  
Idir Bitam,<sup>7</sup> Bernard Davoust,<sup>1</sup> Didier Raoult,<sup>1</sup> and Philippe Parola<sup>1</sup>

# Transmission potential of *Rickettsia felis* infection by *Anopheles gambiae* mosquitoes

Constantin Dieme<sup>a,b,1</sup>, Yassina Bechah<sup>a,1</sup>, Cristina Socolovschi<sup>a</sup>, Gilles Audoly<sup>a</sup>, Jean-Michel Berenger<sup>a</sup>, Ousmane Faye<sup>b</sup>, Didier Raoult<sup>a</sup>, and Philippe Parola<sup>a,2</sup>

<sup>a</sup>Faculté de Médecine, Aix Marseille Université, Unité de Recherche sur les Maladies Infectieuses Tropicales et Emergentes, UM63, CNRS 7278, IRD 198, INSERM 1095, 13385 Marseille Cedex 5, France; and <sup>b</sup>Laboratoire d'Ecologie Vectorielle et Parasitaire, Université Cheikh Anta Diop de Dakar, BP 5005 Dakar, Senegal

Edited by Carolina Barillas-Mury, National Institutes of Health, Bethesda, MD, and approved May 1, 2015 (received for review July 21, 2014)



Acquisition and persistence of *R. felis* in mosquitoes : detection of the bacteria up to day 15 post-infection.

*R. felis* detected in mosquito feces up to day 14.

Highest levels of *R. felis* detected in mosquitoes by qPCR at day 16, suggesting that the bacterium is viable and capable of replication within mosquitoes.

*R. felis* visualized by IF in salivary glands, in and around the gut and in the ovaries, although no vertical transmission was observed.

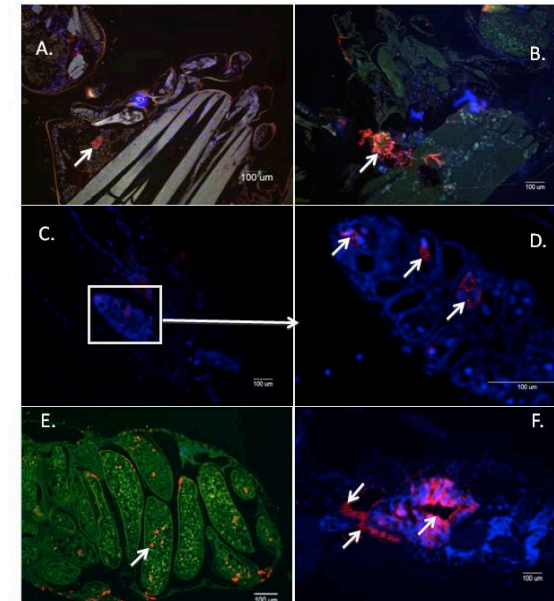
*R. felis* also found in the cotton used for sucrose feeding after the mosquitoes were fed infected blood (= in saliva)

Mosquitoes were also able to transmit *R. felis* to healthy mice by biting.

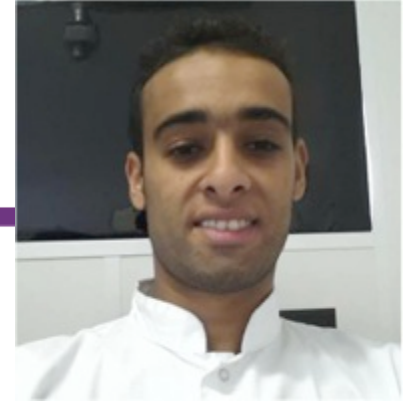
Collectively, these results suggest that *An. gambiae* is a competent vector of *R. felis*.

PNAS 2015

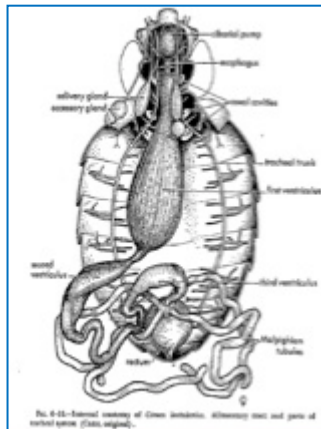
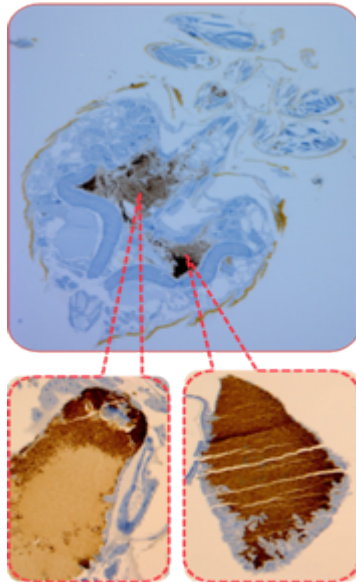
Constantin Dieme,  
Senegal







Hamza Leumli  
Algeria



RESEARCH ARTICLE

# Competence of *Cimex lectularius* Bed Bugs for the Transmission of *Bartonella quintana*, the Agent of Trench Fever

Hamza Leumli<sup>1,2</sup>, Idir Bitam<sup>2,3,4</sup>, Jean Michel Berenger<sup>1</sup>, Hubert Lepidi<sup>1</sup>, Jean Marc Rolain<sup>1</sup>, Lionel Almeras<sup>1</sup>, Didier Raoult<sup>1</sup>, Philippe Parola<sup>1\*</sup>

1 Aix Marseille Université, Unité de Recherche en Maladies Infectieuses et Tropicales Emergentes (URMITE), UM63, CNRS 7278, IRD 198 (Dakar), Inserm 1095, World Health Organization (WHO) Collaborative Center for Rickettsioses and Other Arthropod-Borne Bacterial Diseases, Marseille, France, 2 Ecole Nationale Supérieure Vétérinaire d'Alger, Alger, Algérie, 3 Université de Boumerdes, Laboratoire VALCORE, Faculté des Sciences, Boumerdes, Algérie, 4 Université de Bab Ezzouar, Laboratoire d'Ecologie et Environnement, Alger, Algérie

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*Clinical Infectious Diseases*

SUPPLEMENT ARTICLE



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Idir Bitam,<sup>7</sup> Bernard Davoust,<sup>1</sup> Didier Raoult,<sup>1</sup> and Philippe Parola<sup>1</sup>

RESEARCH

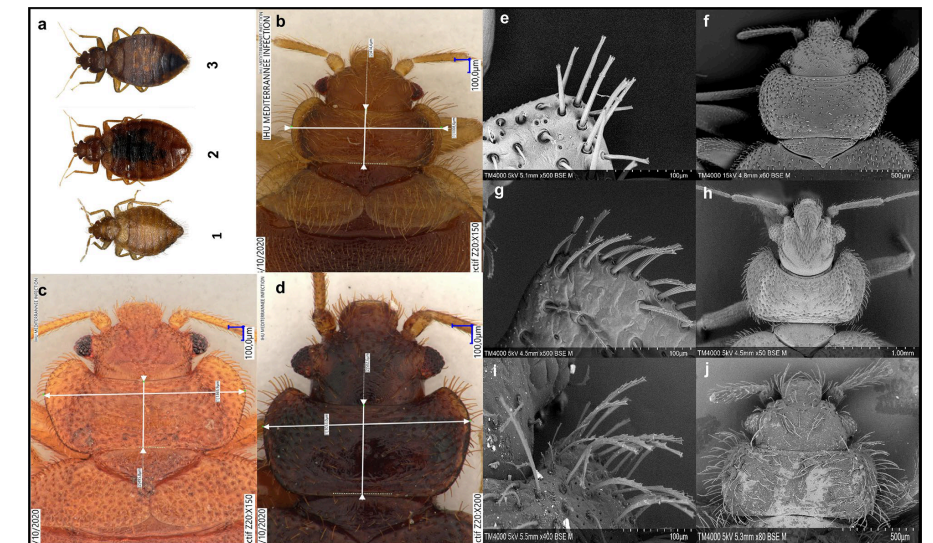
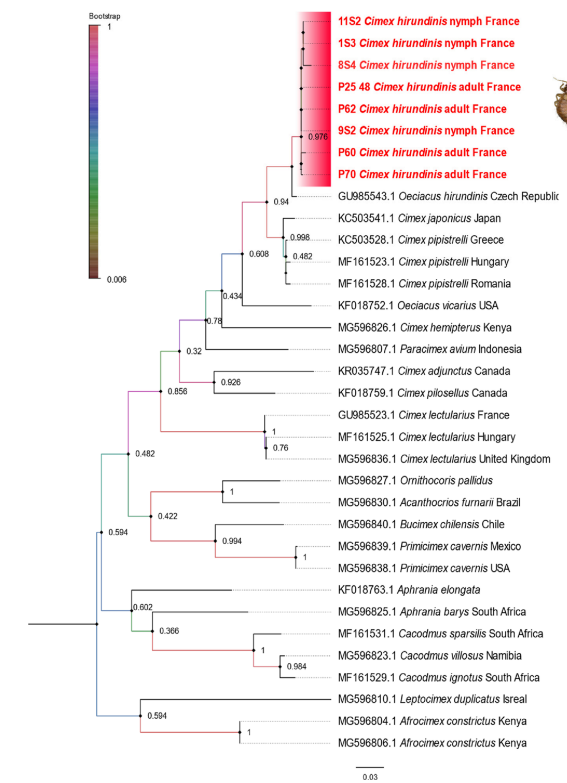
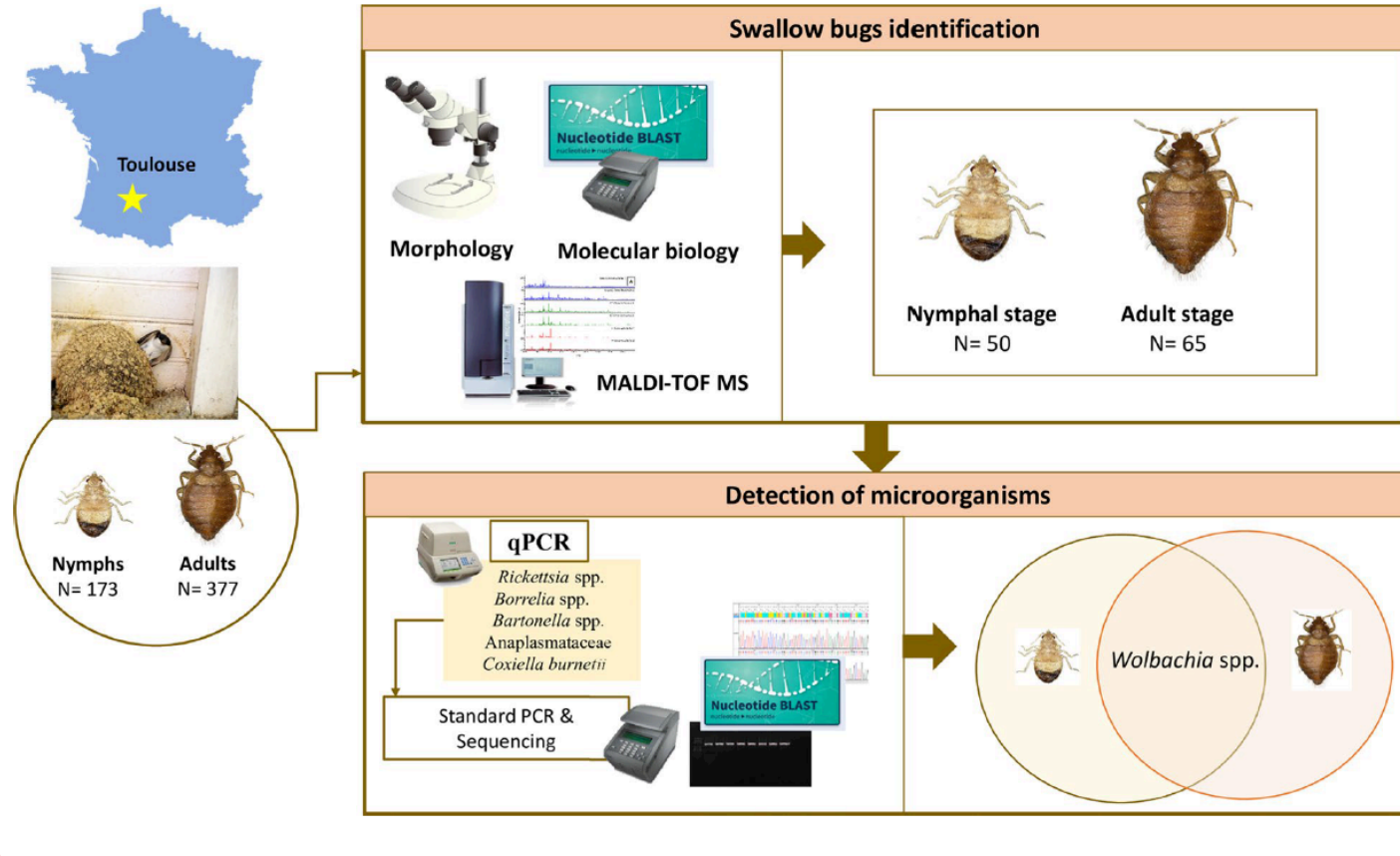
Open Access

# Molecular and MALDI-TOF MS identification of swallow bugs *Cimex hirundinis* (Heteroptera: Cimicidae) and endosymbionts in France

Fatima Zohra Hamlili<sup>1,2</sup>, Jean-Michel Bérenger<sup>1,2</sup>, Adama Zan Diarra<sup>1,2</sup> and Philippe Parola<sup>1,2\*</sup>



## Graphical Abstract





# ENTOMOLOGICAL SURVEYS AROUND CASES AND ON SPECIFIC POPULATIONS

## Preventing and Controlling Emerging and Reemerging Transmissible Diseases in the Homeless



Figure. An intervention in a homeless shelter in Marseilles for infectious diseases survey.



OPEN **Survey of bed bug infestations in homeless shelters in southern France**

Check for updates

Bouthaina Hasnaoui<sup>1,2</sup>, Jean Michel Bérenger<sup>1,2</sup>, Pascal Delaunay<sup>1,3</sup>, Adama Zan Diarra<sup>1,2</sup>, El Hadji Ibrahima Ndiaye<sup>1,2</sup>, Saidou Ahamada M'madi<sup>1,2</sup>, Noelle Masotti<sup>1</sup>, Jacques Sevestre<sup>1,2</sup> & Philippe Parola<sup>1,2,4</sup>

Bed bug has become a major public health pest worldwide. Infestation may result in numerous negative health effects. Homeless shelters are one of the most habitats that can be infested with bed bugs, a few studies have focused on bed bug infestations in these settings. We conducted a survey of infestations of bed bugs in a homeless shelter in southern France, using an innovative seven-level scale (0–6) to assess the degree of infestation, MALDI TOF-MS to identify bed bugs, and a biomolecular tool to detect bacteria. Bed bug infestations were documented in 13% (9/68) of investigated rooms. A total of 184 bed bugs were collected and morphologically identified as *Cimex lectularius*. MALDI TOF-MS analysis allowed us to obtain high-quality MS spectra for all 184 specimens, to correctly identify all specimens, and included 178/184 (97%) Log Score Values higher than 1.8. Among the bacteria tested, *Wolbachia* sp. DNA was found in 149/184 (81%) of the bed bugs, and one sample was positive for *Coxiella burnetii*, the agent of Q fever. Our study is the first of its kind that offers new perspectives for increasing public awareness of the conditions in homeless shelters.



which has 300 homeless rooms. Only 70 rooms are permanent for the vulnerable homeless, with the rest of the rooms reserved for the homeless for a period of 15 days.

Investigation at a shelter for homeless people (St jean de Dieu foundation Marseille)



# Medical Entomology at IHU

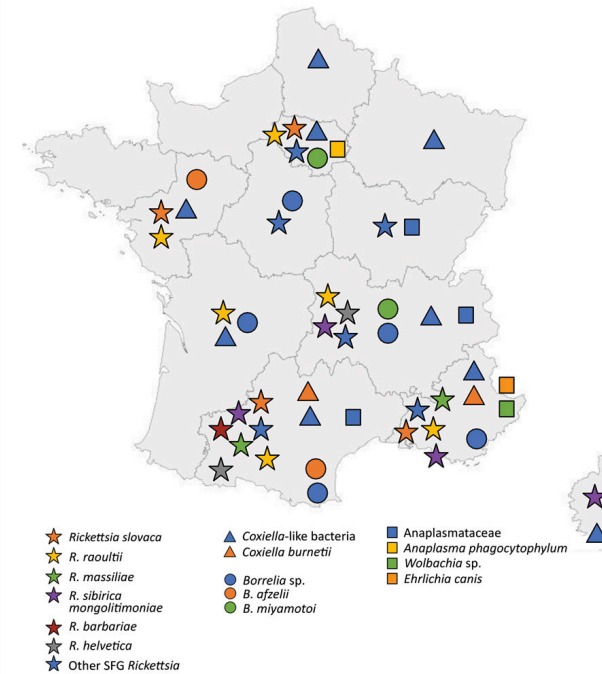
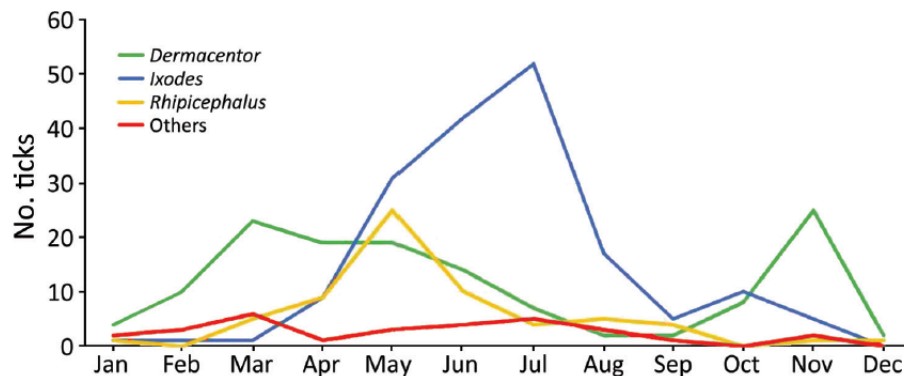
## SOME REPRESENTATIVE WORKS

### Bacterial Agents Detected in 418 Ticks Removed from Humans during 2014–2021, France

Marie Jumpertz, Jacques Sevestre, Léa Luciani, Linda Houhamdi, Pierre-Edouard Fournier, Philippe Parola

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 29, No. 4, April 2023

**Figure 1.** Tick seasonality in study of bacterial agents detected in 418 ticks removed from humans during 2014–2021, France. Overall prevalence of *Dermacentor*, *Ixodes*, *Rhipicephalus*, and other tick species in metropolitan France (n = 387), which includes Corsica, during January–December is indicated. The ticks were among those sent to the Institut Hospitalo-Universitaire Méditerranée Infection in Marseille, France, and identified by using matrix-assisted laser desorption/ionization time-of-flight mass spectrometry or sequencing PCR products.



**Figure 2.** Geographic origin of ticks and identification of tickborne bacteria in study of bacterial agents detected in 418 ticks removed from humans during 2014–2021, France. Symbols indicate tick species and tickborne bacteria identified from locations in metropolitan France, including Corsica. Ticks were sent to the Institut Hospitalo-Universitaire Méditerranée Infection in Marseille, France, and identified by using matrix-assisted laser desorption ionization time-of-flight mass spectrometry. Bacteria carried by the ticks were isolated and identified by PCR or serologic methods at the institute. Of the ticks evaluated, 387 were from metropolitan France; 3 from Guadeloupe, a territory of France in the West Indies; and 28 from other countries.

# Medical Entomology at IHU

## SOME REPRESENTATIVE WORKS

CONTRIBUTION TO THE REPERTOIRE OF THE MICROORGANISMS IN ARTHROPODS

THE USE OF MALDI TOF FOR THE IDENTIFICATION OF ARTHROPODS, THEIR BLOOD MEAL,  
AND THE ASSOCIATED MICROORGANISMS

EXPERIMENTAL MODELS

ECOLOGICAL STUDIES

ENTOMOLOGICAL SURVEYS AROUND CASES AND ON SPECIFIC POPULATIONS

**EXPERTISE ET COMMUNICATION**

*Clinical Infectious Diseases*

SUPPLEMENT ARTICLE



### Medical Entomology: A Reemerging Field of Research to Better Understand Vector-Borne Infectious Diseases




Maureen Laroche,<sup>1</sup> Jean-Michel Bérenger,<sup>1</sup> Pascal Delaunay,<sup>2</sup> Remi Charrel,<sup>3</sup> Bruno Pradines,<sup>1,4,5</sup> Franck Berger,<sup>6</sup> Stéphane Ranque,<sup>1</sup>  
Idir Bitam,<sup>7</sup> Bernard Davoust,<sup>1</sup> Didier Raoult,<sup>1</sup> and Philippe Parola<sup>1</sup>



Review

For reprint orders, please contact: [reprints@futuremedicine.com](mailto:reprints@futuremedicine.com)

# Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry: an emerging tool for studying the vectors of human infectious diseases

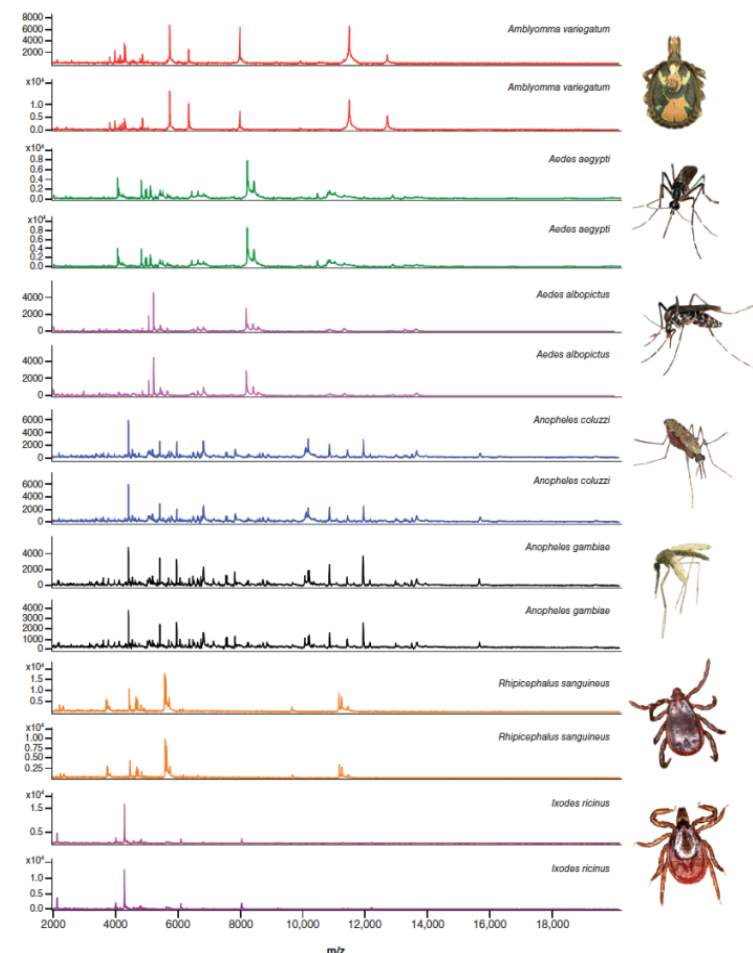
Jacques Sevestre<sup>1,2</sup> , Adama Z Diarra<sup>1,2</sup>, Maureen Laroche<sup>1</sup> , Lionel Almeras<sup>1,2,3</sup>  & Philippe Parola<sup>\*</sup>,<sup>1,2</sup>

<sup>1</sup>IHU Méditerranée Infection, 19-21 Boulevard Jean Moulin, 13005, Marseille, France

<sup>2</sup>Aix Marseille Univ, IRD, AP-HM, SSA, VITROME, Marseille, France

<sup>3</sup>Département Microbiologie et Maladies Infectieuses, Unité Parasitologie et Entomologie, Institut de Recherche Biomédicale des Armées, 19-21 Boulevard Jean Moulin, 13005, Marseille, France

\*Author for correspondence: Tel.: +33 (0)413 732 401; [philippe.parola@univ-amu.fr](mailto:philippe.parola@univ-amu.fr)





CLINICAL PRACTICE

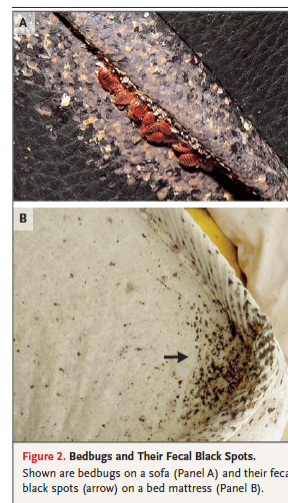
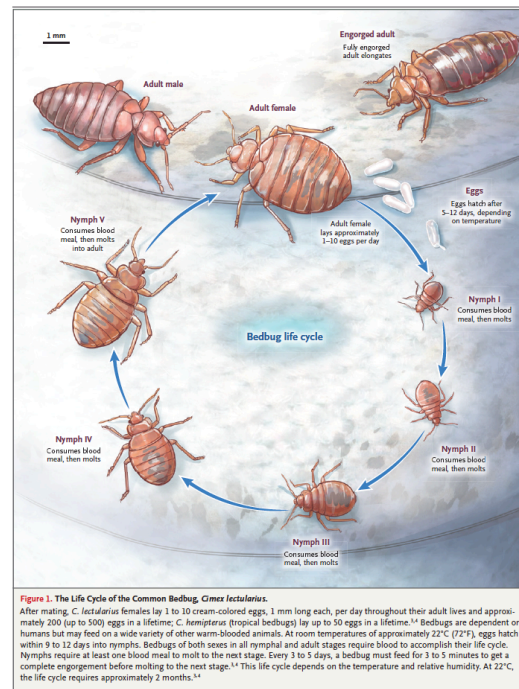
Caren G. Solomon, M.D., M.P.H., Editor

# Bedbugs

Philippe Parola, M.D., Ph.D., and Arezki Izri, M.D., Ph.D.

*This Journal feature begins with a case vignette highlighting a common clinical problem. Evidence supporting various strategies is then presented, followed by a review of formal guidelines, when they exist. The article ends with the authors' clinical recommendations.*

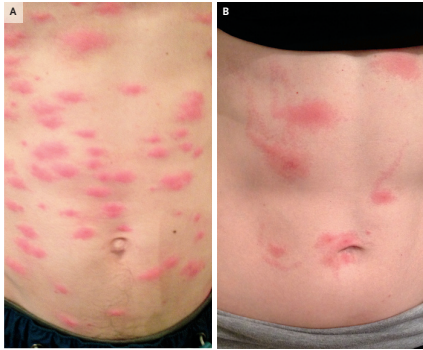
A 35-year-old man presented to the clinic with pruritic maculopapular skin lesions on his neck, left arm, and trunk; no other abnormalities were noted. He described having had a similar rash a few months earlier for which he did not seek treatment and reported that his wife had similar skin lesions on her arms and neck. They had just returned to their house in Marseille, France, after traveling out of the country for 3 months. How should his case be evaluated and managed?



**Figure 2. Bedbugs and Their Fecal Black Spots.**  
Shown are bedbugs on a sofa (Panel A) and their fecal black spots (arrow) on a bed mattress (Panel B).



Pyemotes ventricosus Dermatitis



Jean-Michel Berenger  
Philippe Parola, M.D., Ph.D.  
Aix-Marseille University  
Marseille, France  
philippe.parola@univ-amu.fr

A 30-YEAR-OLD MAN AND A 30-YEAR-OLD WOMAN PRESENTED TO THE INFECTIOUS DISEASE CLINIC WITH A 3-DAY HISTORY OF ITCHY SKIN LESIONS. THEY REPORTED NO HISTORY OF OUTDOOR ACTIVITIES. ON PHYSICAL EXAMINATION, THE MAN HAD PRURITIC PAPAULES ACROSS HIS TRUNK AND ABDOMEN (PANEL A). ON THE WOMAN'S ABDOMEN, THERE WERE SEVERAL ERYTHEMATOUS MACULES, SOME OF WHICH HAD CENTRAL DOTS AND SERPIGINOUS TRACTS EMANATING FROM THEM THAT GAVE THE APPEARANCE OF A COMET (PANEL B). OWING TO CONCERN ABOUT A HOUSEHOLD INFESTATION, THE COUPLE'S FURNITURE WAS EXAMINED. COMMON FURNITURE BEETLES — ALSO KNOWN AS ANOBIDUM PUNCTURATUM, A TYPE OF WOOD-BORING BEETLE — WERE IDENTIFIED. WITH THE KNOWLEDGE THAT COMMON FURNITURE BEETLES CAN BE PARASITIZED BY THE MICROSCOPIC MITE PYEMOTES VENTRICOSUS, ALSO KNOWN AS THE EUROPEAN STRAW ITCH MITE, A CLINICAL DIAGNOSIS OF P. VENTRICOSUS DERMATITIS WAS MADE. IN THIS CONDITION, SKIN LESIONS DEVELOP WITHIN 24 HOURS AFTER THE RECEIPT OF PAINLESS MITE BITES AND MAY MANIFEST WITH A COMET SHAPE, AS WAS SEEN IN THIS CASE. THE COUPLE'S INFESTED FURNITURE WAS REMOVED. TREATMENT WITH TOPICAL GLUCOCORTICOIDS AND ANTIHISTAMINES WAS GIVEN, AND THE SKIN LESIONS RESOLVED IN 8 DAYS.

DOI: 10.1056/NEJMcic2213963  
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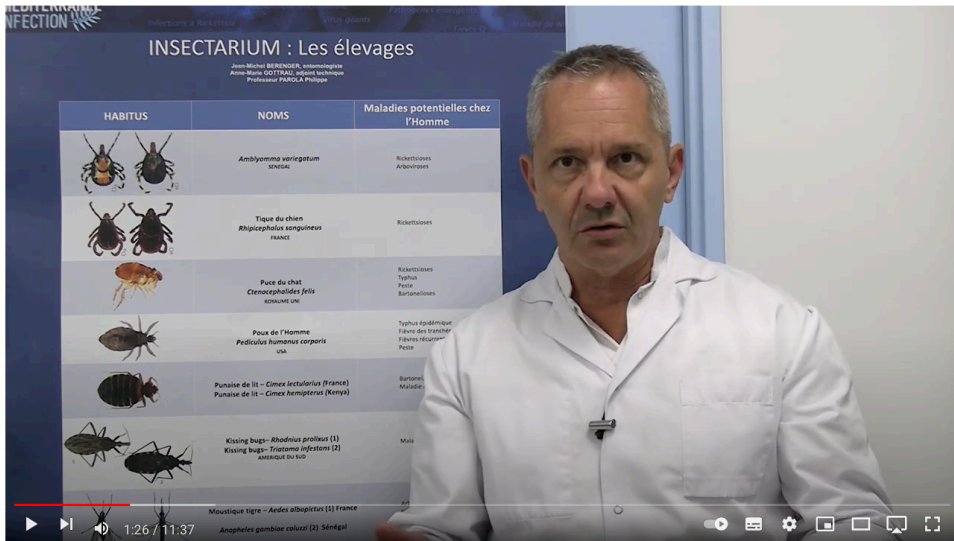


Chaine YOUTUBE IHU:  
<https://www.youtube.com/watch?v=dSrWon6QibQ>

Pyemotes... Des piqueurs méconnus

112 vues • 30 sept. 2022

J'AIME JE N'AIME PAS PARTAGER ENREGISTRER ...



## Insectarium

<https://www.youtube.com/watch?v=ejyWjzoZgec>

MALDITOF L ALMERAS :

<https://www.youtube.com/watch?v=AEyXhZIOIQo>

TIQUES ET LYME :

<https://www.youtube.com/watch?v=C0pmc2Eq-Zc>

SENEGAL :

<https://www.youtube.com/watch?v=VGwdKc4BgOk>

JM BERENGER : Entomologiste

<https://www.youtube.com/watch?v=BcT3cD5jm7I>

# Chaine YOUTUBE IHU: Entomologie

Tout

Source : IHU Méditerranée-Infection >



Le dossier du mois

PLATEFORME INSECTARIUM

Partie 2

7:22

Plateforme insectarium :

détection par MAI DI-

IHU Méditerranée-Infec...

2,5 k vues • il y a 1 mois



Le dossier du mois

PLATEFORME INSECTARIUM

Partie 3 - Ép.1

9:00

Plateforme insectarium :

Tique et Maladie de

IHU Méditerranée-Infec...

4,2 k vues • il y a 1 mois



Le dossier du mois

PLATEFORME INSECTARIUM

Partie 4

8:04

Plateforme insectarium :

Qu'est ce qu'un

IHU Méditerranée-Infec...

3,1 k vues • il y a 4...





Philippe PAROLA



Jean-Michel BÉRENGER

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Fatou Kiné FALL



Fatima Z. HAMLILI



Noelle MASOTTI



Adama Z. DIARRA



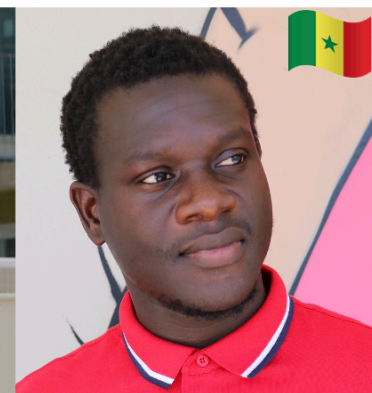
Linda BENKACIMI



Ly Na HUYNH



Jacques SEVESTRE



El Hadji I. NDIAYE



Bouthaina HASNAOUI



Saidou AHAMADA



Hanene BENYAHIA



Yannick NGNINDJI



Roland BAMOU



# Arbovirologie (Polynésie – Guyane – Expertise)

REVIEW ARTICLE

## Zika Virus Infection — After the Pandemic

Didier Musso, M.D., Albert I. Ko, M.D., and David Baud, M.D., Ph.D.

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**Article**   **Figures/Media**   **Metrics**

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[75 References](#)   [233 Citing Articles](#)   [Letters](#)

**Z** IKA VIRUS (ZIKV) WAS DISCOVERED IN AFRICA IN 1947 AND WAS FIRST DETECTED IN Asia in 1966, yet its potential effect on public health was not recognized until the virus caused outbreaks in the Pacific from 2007 to 2015 and began spreading throughout the Americas in 2015.<sup>1,2</sup> The ability of ZIKV to cause congenital defects in fetuses and infants, as exemplified by the microcephaly epidemic in Brazil, is an unprecedented feature in a mosquito-borne viral infection.<sup>2-4</sup> Although transmission of ZIKV has declined in the Americas, outbreaks and infection clusters continue to occur in some regions, such as India and Southeast Asia, where there are large populations of women of childbearing age who are susceptible to the virus.<sup>5</sup> We review the body of information that was acquired during the pandemic and discuss the epidemiologic trends, current knowledge about the transmission and natural history of ZIKV infection and its sequelae, and the principles of diagnosis and clinical management.

October 10, 2019  
N Engl J Med 2019; 381:1444-1457  
DOI: 10.1056/NEJMra1808246

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**Editors**

Dan L. Longo, M.D., Editor

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**Related Articles**

**CORRESPONDENCE** JAN 9, 2020  
Zika Virus Infection — After the Pandemic

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**NEJM**  
**CareerCenter**

## Travel Medicine and Infectious Disease

Volume 35, May–June 2020, 101614

Zika, dengue, chikungunya and yellow fever infections in Europe? – Winter is over, warm days are coming - So hedge your bets

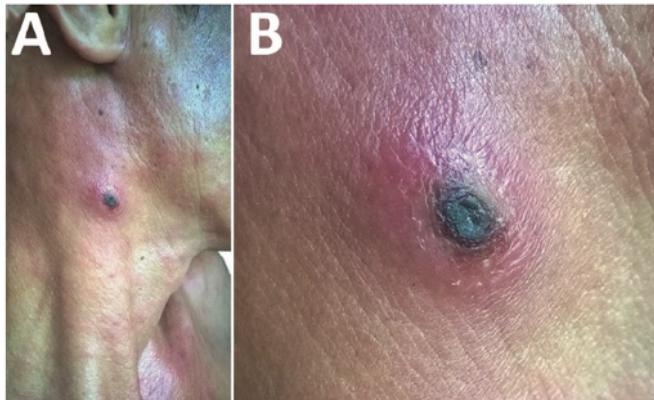
Philippe Parola , Didier Musso 



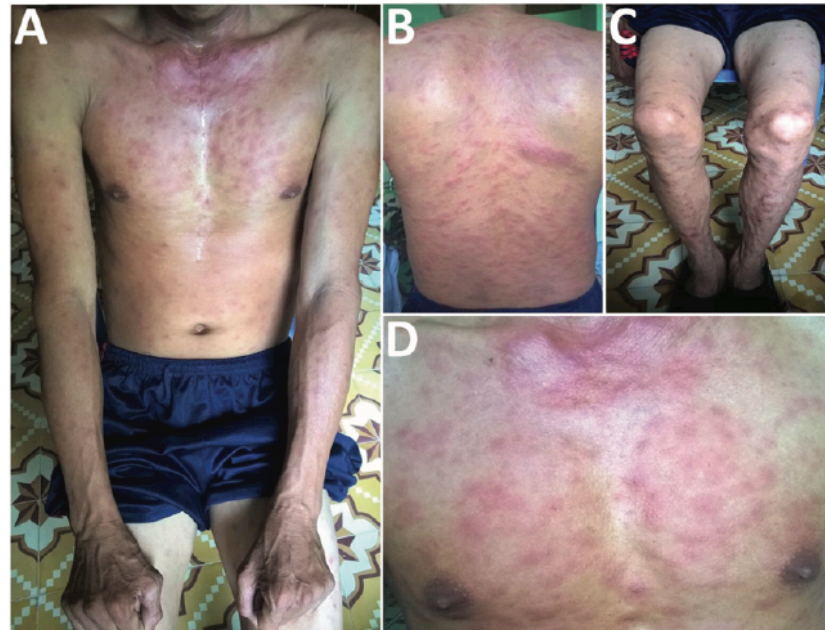
## Dual-Genotype *Orientia tsutsugamushi* Infection in Patient with Rash and Eschar, Vietnam, 2016

Nhiem Le-Viet, Duc-Tuan Phan,  
Nho Le-Viet, Sinh Trinh, Muoi To,  
Didier Raoult, Philippe Parola

We report a dual-genotype *Orientia tsutsugamushi* infection in Vietnam in 2016. The patient had fever, rash, and an eschar. The Kawasaki genotype was identified in the eschar specimen and Karp genotype in the whole blood specimen. The genotype co-infection rate for scrub typhus is unknown and should be further evaluated.



**Figure 1.** Eschar on right anterior neck of patient with dual genotype *Orientia tsutsugamushi* infection, Vietnam. A) Eschar location; B) enlarged view.

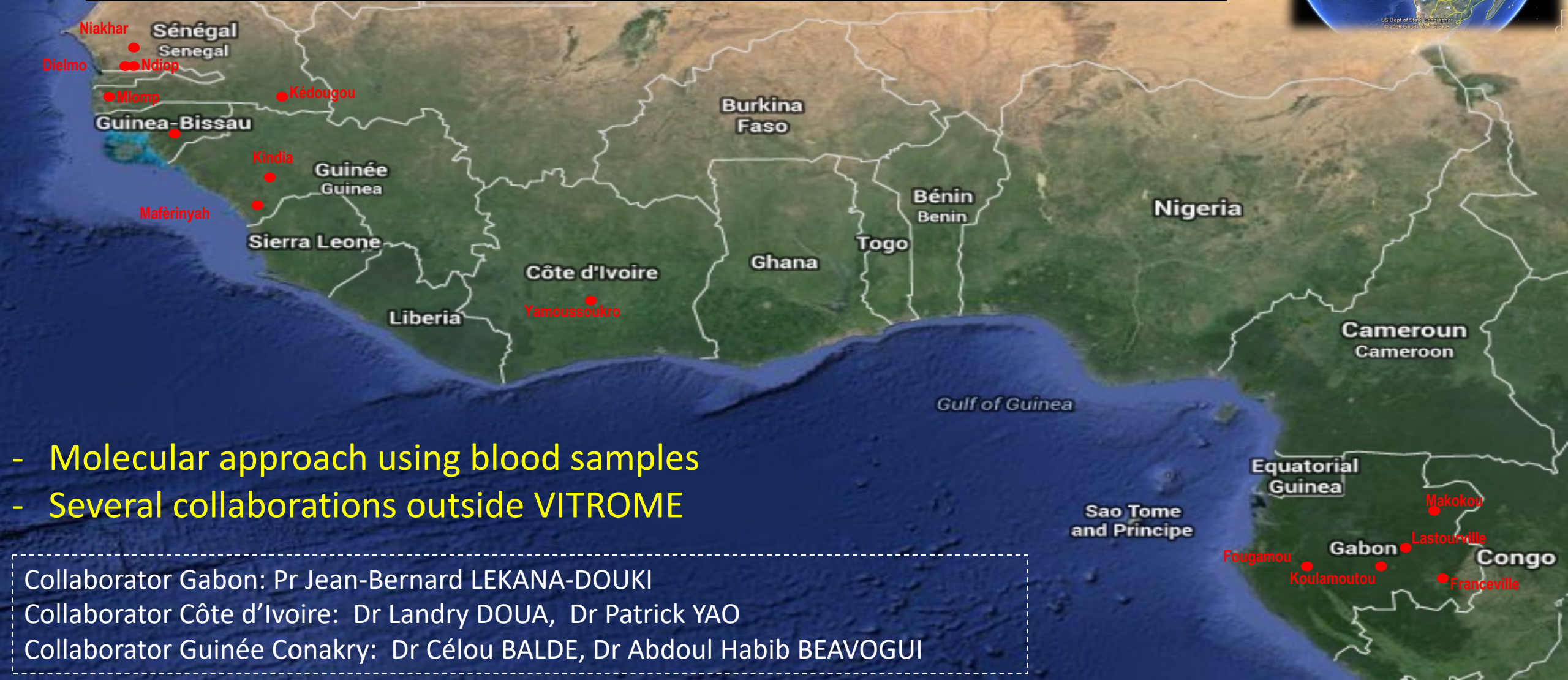


**Figure 2.** Rash on patient with dual-genotype *Orientia tsutsugamushi* infection, Vietnam. A) Trunk and arms; B) back; C) legs; D) chest.



# Etiology of fevers Sub-Saharan Africa, vectorized and zoonotic diseases – strategy

→ Then, SARS-CoV-2 and other respiratory viruses



- Molecular approach using blood samples
- Several collaborations outside VITROME

Collaborator Gabon: Pr Jean-Bernard LEKANA-DOUKI  
Collaborator Côte d'Ivoire: Dr Landry DOUA, Dr Patrick YAO  
Collaborator Guinée Conakry: Dr Célou BALDE, Dr Abdoul Habib BEAVOGUI



# Screening and Whole Genome Sequencing of SARS-CoV-2 Circulating During the First Three Waves of the COVID-19 Pandemic in Libreville and the Haut-Ogooué Province in Gabon

Sonia Etenna Lekana-Douki<sup>1†</sup>, Nadine N'dilimabaka<sup>1,2†</sup>, Anthony Levasseur<sup>3,4</sup>, Philippe Colson<sup>3,4</sup>, Julia Cyrielle Andeko<sup>1</sup>, Ornella Zong Minko<sup>1</sup>, Octavie Banga Mve-Ella<sup>1</sup>, Pierre-Edouard Fournier<sup>3,5</sup>, Christian Devaux<sup>3,4,6</sup>, Bertrand Mve Ondo<sup>7</sup>, Falone Larissa Akombi<sup>7</sup>, Laurianne Yacka Mouele Bolo<sup>7</sup>, Audrey Michel Ngonga Dikongo<sup>1</sup>, Abdoulaye Diané<sup>1</sup>, Arsène Mabika Mabika<sup>1</sup>, Jenny Francine Mathouet<sup>1</sup>, Cresh Dzembo<sup>1</sup>, Nick Chenis Atiga<sup>1</sup>, Anicet Mouity Matoumba<sup>1</sup>, Nal Kennedy Ndjangangoye<sup>1</sup>, Ludivine Brécharde<sup>3</sup>, Marielle Bedotto-Buffer<sup>3</sup>, Joa Braïthe Mangombi Pambou<sup>1</sup>, Marisca Kandet Yattara<sup>8</sup>, Elvire Anita Mbongo Nkama<sup>9</sup>, Armel Mintsa Ndong<sup>10</sup>, Ayola Akim Adegnika<sup>11,12</sup>, Didier Raoult<sup>3,4</sup>, Florence Fenollar<sup>3,5</sup> and Jean-Bernard Lekana-Douki<sup>1,13</sup>

<sup>1</sup> Centre Interdisciplinaire de Recherches Médicales de Franceville (CIRMF), Franceville, Gabon, <sup>2</sup> Département de Biologie, Faculté des Sciences, Université des Sciences et Techniques de Masuku, Franceville, Gabon, <sup>3</sup> IHU-Méditerranée Infection, Marseille, France, <sup>4</sup> Aix Marseille Univ, IRD, AP-HM, MEPIH, Marseille, France, <sup>5</sup> Aix Marseille Univ, IRD, AP-HM, SSA, VITROME, Marseille, France, <sup>6</sup> Centre National de la Recherche Scientifique (CNRS), Marseille, France, <sup>7</sup> Unité Mixte de Recherche CIRMF-SSM, Libreville, Gabon, <sup>8</sup> Hôpital d'Instructions des Armées Akanda, Akanda, Gabon, <sup>9</sup> Hôpital d'Instructions des Armées Omar Bongo Ondimba, Libreville, Gabon, <sup>10</sup> Laboratoire National de Santé Publique, Libreville, Gabon, <sup>11</sup> Centre de Recherches Médicales de Lambaréné (CERMEL), Lambaréné, Gabon, <sup>12</sup> Institute of Tropical Medicine, University of Tübingen and German Center for Infectious Research (DZIF), Tübingen, Germany, <sup>13</sup> Département de Parasitologie-Myologie Médecine Tropicale, Faculté de Médecine, Université des Sciences de la Santé, Libreville, Gabon



Pr Jean-Bernard  
Lekana

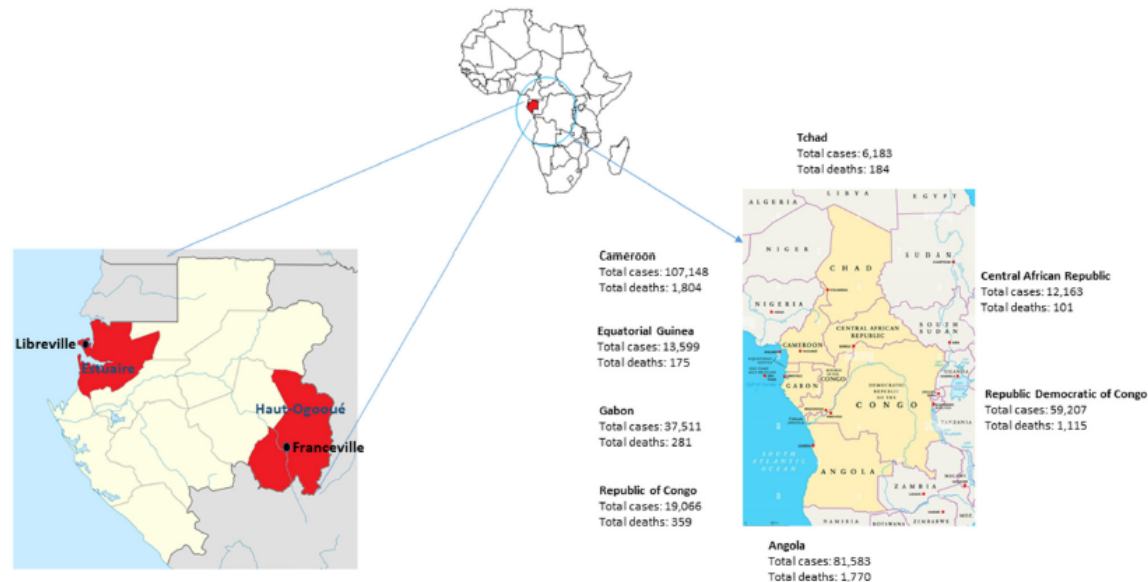


FIGURE 1 | Map of Gabon and its neighboring countries in Central Africa. Number of COVID-19 cases and deaths in December 2021.

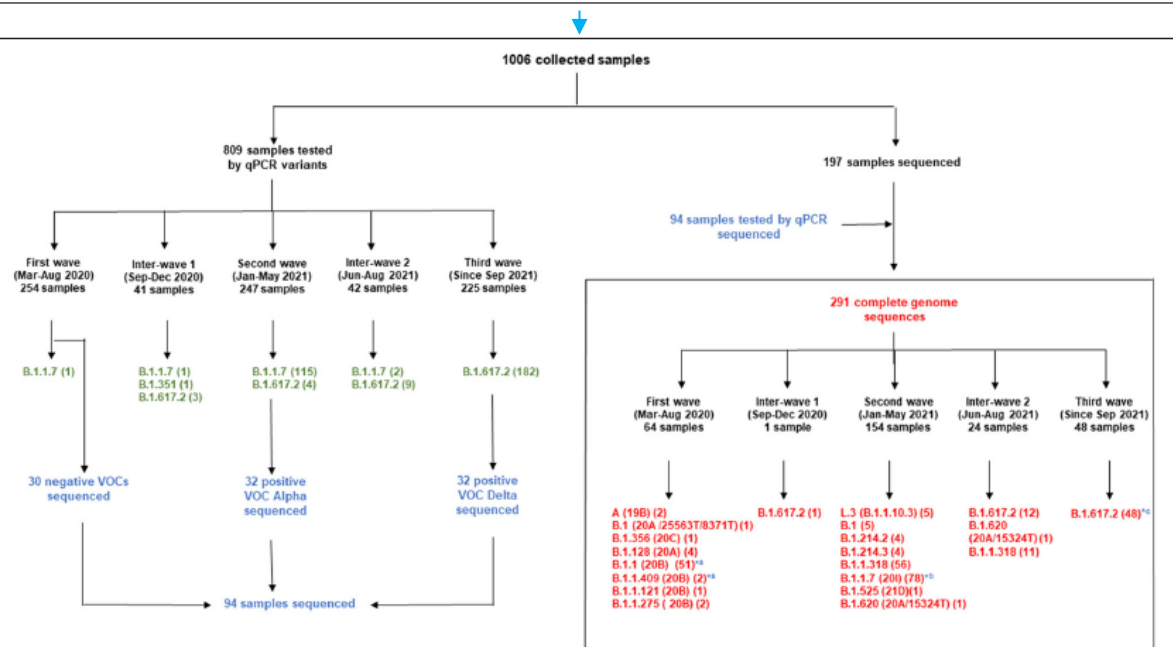


FIGURE 4 | Distribution of samples screened by qPCR during the different waves and whole genome sequencing. qPCR results are in green; Samples first tested by qPCR and sequenced are in blue; Complete genome sequences are in red. <sup>a</sup>, genomes from samples tested by qPCR and sequenced; <sup>b</sup>, first wave; <sup>c</sup>, third wave.

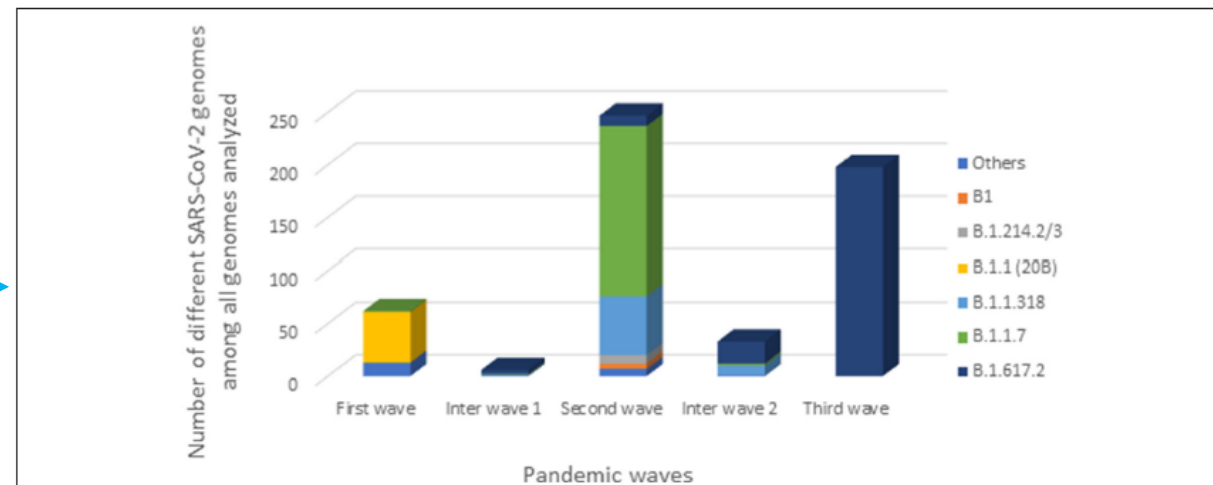
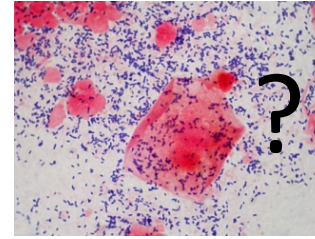


FIGURE 5 | Distribution of SARS-CoV-2 strains during the three Gabonese pandemic waves. "Others" represented the others genomes we found: lineage A, B.1.356, B.1.128, B.1.1.409, B.1.1.121, B.1.1.275, L.3, B.1.620, B.1.525.

# Women's health

## Bacterial vaginosis

- Impact?
- Diagnosis?



→ **Molecular quantification of *Gardnerella vaginalis* and *Atopobium vaginae* loads to predict bacterial vaginosis**

Clin Infect Dis. 2008;47:33-43.

→ **Molecular diagnosis of bacterial vaginosis: impact on IVF outcome**

Eur J Clin Microbiol Infect Dis. 2013;32:535-41.

→ **High *Atopobium vaginae* and *Gardnerella vaginalis* vaginal loads are associated with preterm birth**

Clin Infect Dis. 2015;60:860-7.

Pr Florence Bretelle



Since 2007

Specialized in premature birth  
Recurrent miscarriages

**Gyneco-obstetrician collaborators (AP-HM)**

Pr Blandine Courbière



Since 2012

Specialized in medically assisted procreation  
*In vitro* fertilization failures



# Characterization of the human microbiota

## Vaginal and endometrial microbiota



### Characterization of the vaginal microbiota

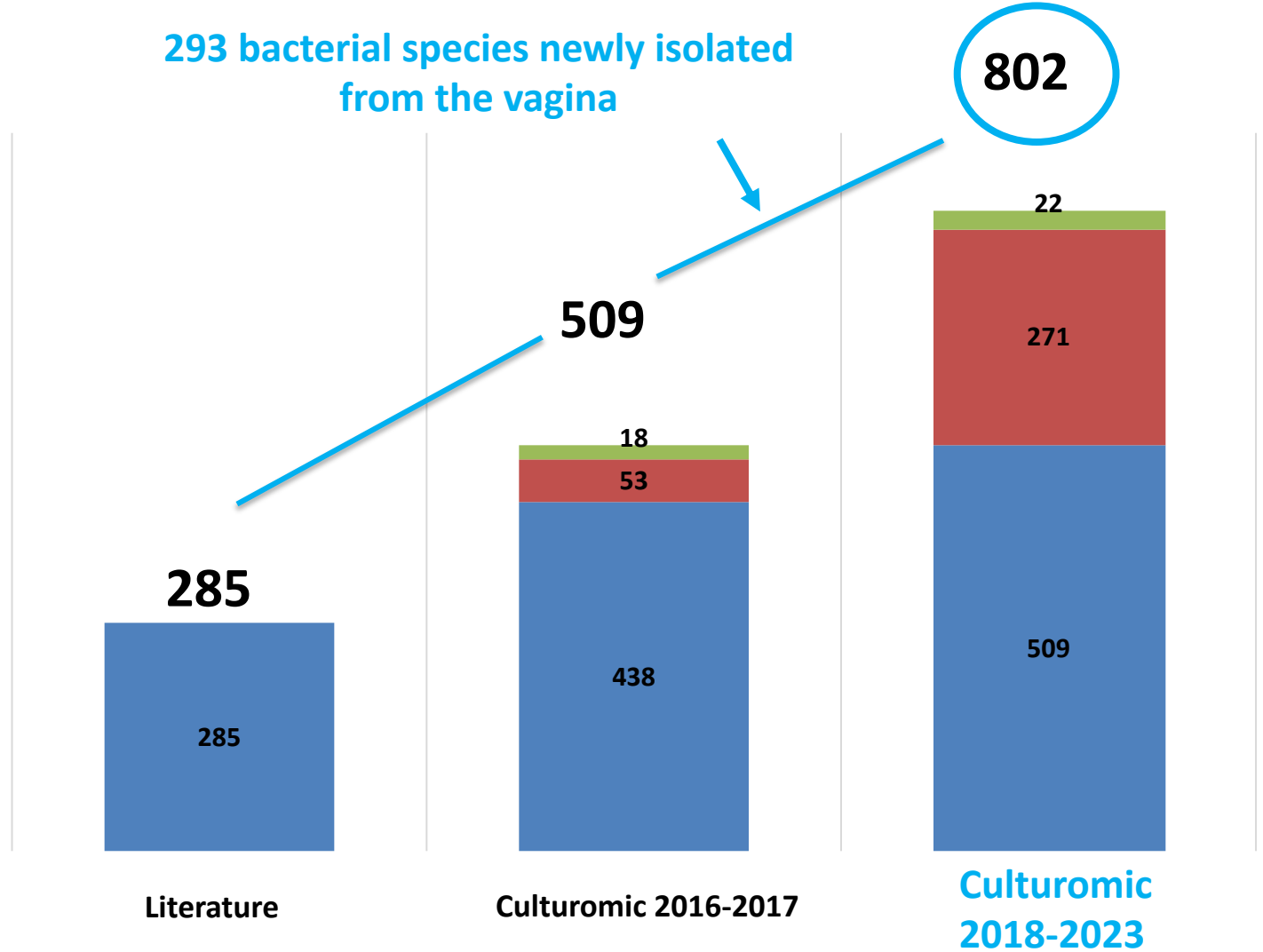
- Asymptomatic women
- Patients with bacterial vaginosis
- France and Senegal
- More recently:
- Premature delivery
- Failed assisted reproduction
- Recurrent miscarriage

### Characterization of the endometrial microbiota

- Failed assisted reproduction
- Recurrent miscarriage
- Successful assisted reproduction



■ Microorganismes identified by culture ■ First isolation in human vagina ■ New species

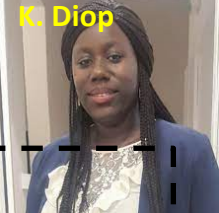






L. Abou Chacra

C. Lo

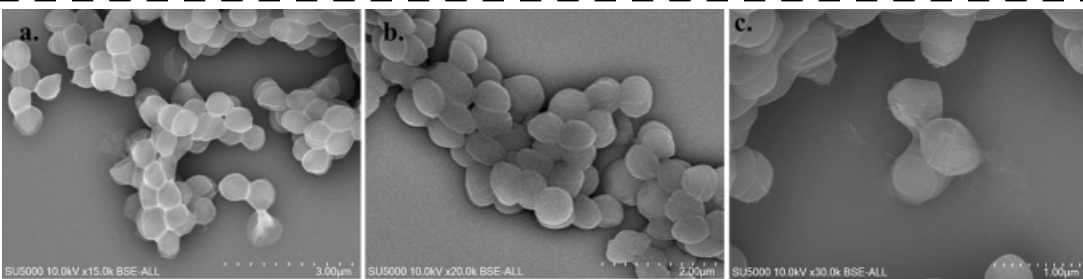


K. Diop

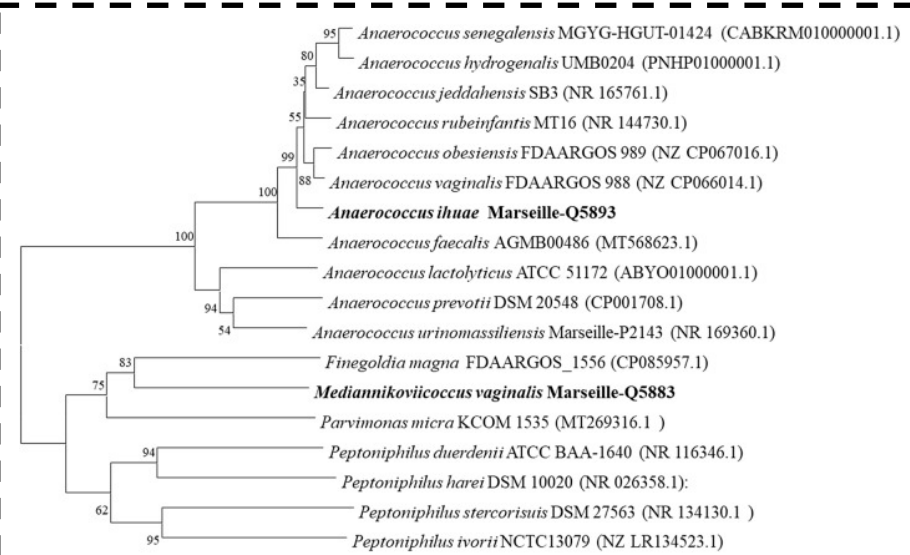
# Description of new bacterial species

## → Taxonomo-genomic strategy

- Collaboration (Team 6, VITROME)
- 70 new bacterial species described and published, including vaginal and endometrial microbiota

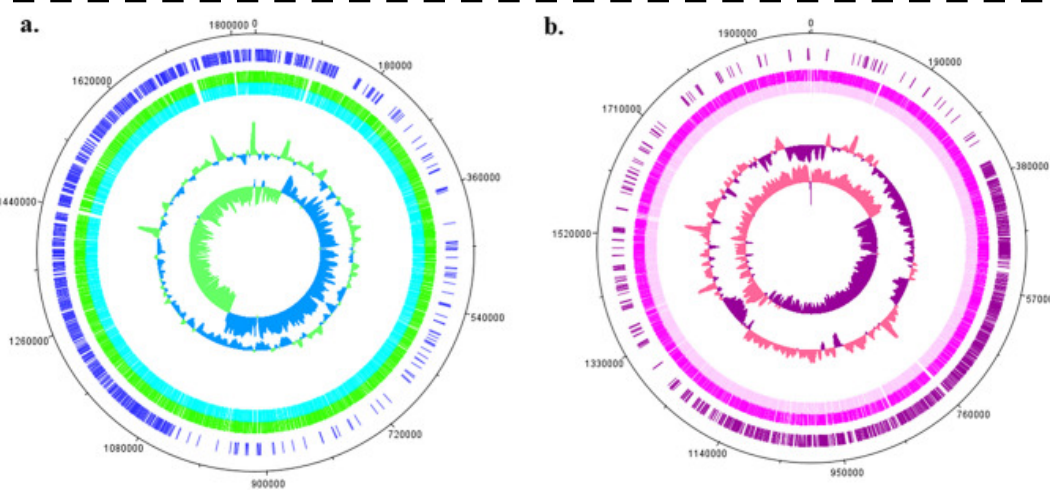


Scanning electron microscopy of *Mediannikoviiococcus vaginalis* gen. nov. sp. nov. strain Marseille-Q5883 (a, b and c)



Phylogenetic tree based on 16S rRNA deduced from sequence comparison of *A. ihuae* Marseille-Q5893 and *M. vaginalis* Marseille-Q5883 (bold) and closely related species

- New species isolated from vaginal and endometrial microbiota described in 2022-23**
- Anaerococcus ihuae*
  - Peptoniphilus genitalis*
  - Mobiluncus massiliensis*
  - Porphyromonas vaginalis*
  - Mediannikoviiococcus vaginalis*
  - Cellulomonas endometrii*



Circular graphical map of the genomes of *Anaerococcus ihuae* sp. nov. strain Marseille-Q5893 and *Mediannikoviiococcus vaginalis* gen. nov. sp. nov. strain Marseille-Q5883



# Effectiveness and costs of molecular screening and treatment for bacterial vaginosis to prevent preterm birth

The AuTop Randomized Clinical Trial

*JAMA Pediatr.* 2023;177(9):894-902.

**Bretelle F**, Loubière S, Desbriere R, Loundou A, Blanc J, Heckenroth H, Schmitz T, Benachi A, Haddad B, Mauviel F, Danoy X, Mares P, Chenni N, Ménard JP, Cocallemen JF, Slim N, Sénat MV, Chauleur C, Bohec C, Kayem G, Trastour C, Bongain A, Rozenberg P, Serazin V, **Fenollar F**

**3,438 nulliparous women**

Screen and treat of bacterial vaginosis was significantly more effective than usual care

**61 of 1671 (3.6%)**

versus

**105 of 1767 (5.9%)**

(RR, 0.62; 95% CI, 0.45-0.84; *P* for interaction = .003)

A nonsignificantly lower total cost

3632.4 € versus 3715.9 €

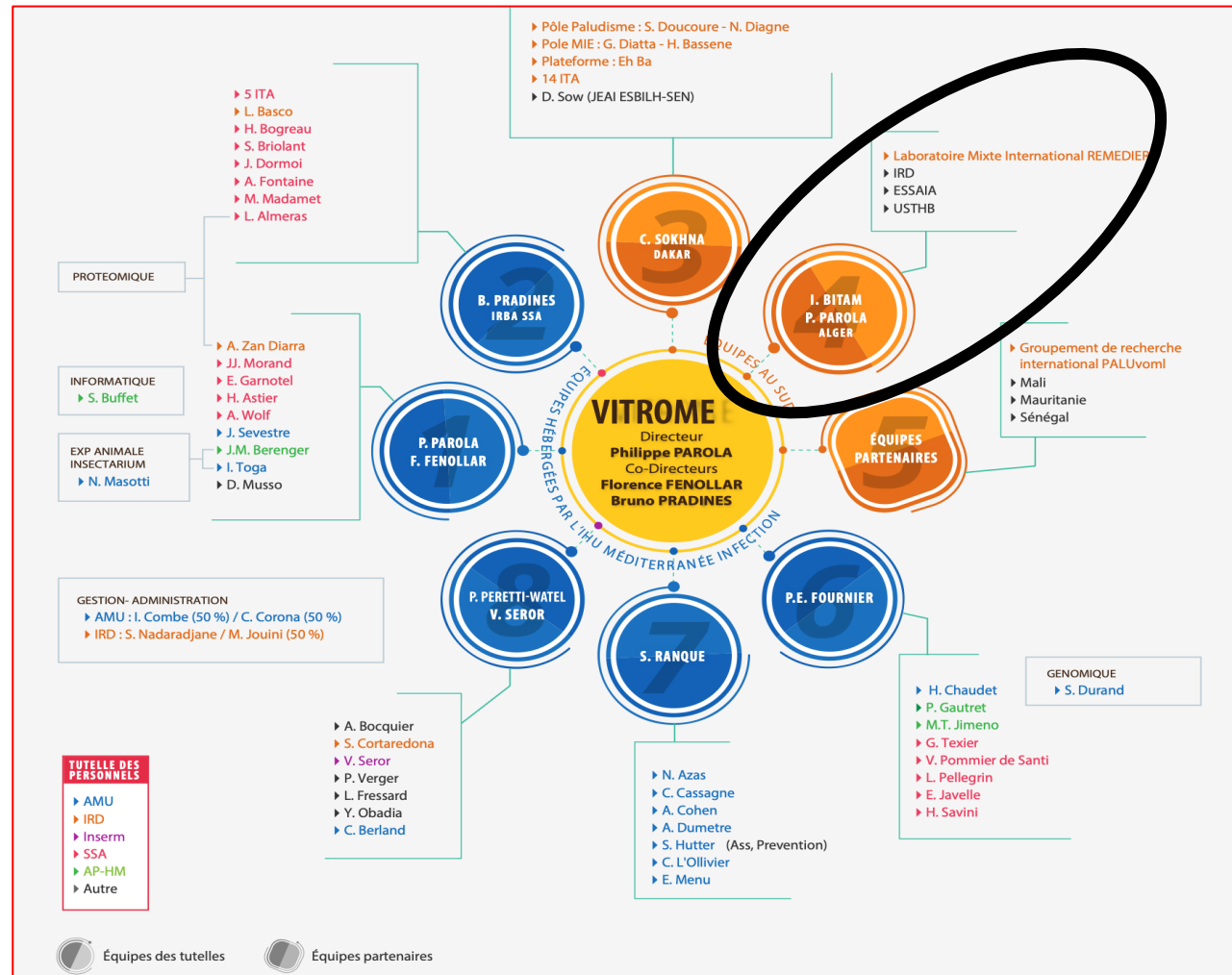
**PHRC National (PHRC-22-0168) AUTOP 2**

Screen-and-treat strategy for vaginal flora abnormalities by multiplex molecular biology using POC technology in pregnant women at high risk of preterm birth: A Multicentre, Randomized Study → 1,513,450 €

# Bilan Equipe 4: LMI REMEDIER

REcherche Méditerranéenne en Entomologie et Dans les Infections Emergentes et Réemergentes

Prof. Idir Bitam, HDR Alger





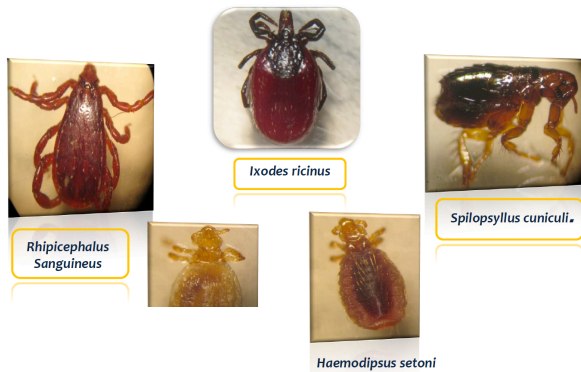
Evolution d'un partenariat ancien  
académique,  
scientifique  
à travers notamment

une JEAI IRD

un partenariat d'équipes entre l'UMR IRD-AMU  
VITROME,

et l'équipe de recherche *Parasites et vecteurs en  
Algérie*, d'Idir Bitam Professeur à l'Ecole  
Supérieure en Science de l'Aliment et des  
Industries Agroalimentaire (ESSAIA) à Alger.

En 2015, un accord de partenariat entre l'IRD et  
l'Universités des Université des Sciences et de la  
Technologie Houarie Boumedienne (USTHB)  
mettait en perspective la création de LMI en  
Algérie.



✓ LABORATORY AND FIELDS

✓ ENTOMOLOGICAL SURVEYS

✓ To contribute to the knowledge of arthropods Fauna in Algeria

✓ To study Phlebovirus and other Arbovirus in Algeria

✓ To complete the Repertory of the pathogens agents in arthropods in Algeria

✓ Surveillance and food security in Algeria (OGM-Traces de porcs...)



# MALDI TOF and arthropods

> Pol J Microbiol 9 mars 2018;67(1):67-72. doi : 10.5604/01.3001.0011.6145.

## MALDI-TOF MS Détection de Bactéries Endophytes Associées à la Grande Ortie (Urtica dioica L.), Cultivée en Algérie

Souhaila Toubal<sup>1</sup>, Ouahiba Bouchenak<sup>1</sup>, Djillali El Haddad<sup>1</sup>, Karima Yahiaoui<sup>1</sup>, Sarah Boumaza<sup>1</sup>, Karim Arabe<sup>1</sup>



Veterinary Parasitology: Regional Studies and Reports  
Volume 31, juin 2022, 100735



Article original

## Identification des moustiques vecteurs algériens capturés sur le terrain par MALDI-TOF MS

Zakaria Abdellahoum<sup>a</sup>, Amira Nabbak<sup>b</sup>, Ismail Lafri<sup>c</sup>, Amel Kaced<sup>b</sup>, Mustapha Mounir Bouhenna<sup>b</sup>, Khaldoun Bachari<sup>a</sup>, Ali Bourmégour<sup>d</sup>, Rym agrée<sup>d</sup>, Rima Hind Boudchicha<sup>e</sup>, Mustapha Adnane Smadi<sup>d,f</sup>, Max Maurin<sup>g</sup>, Idir Bitam<sup>h</sup>



Comparative Immunology, Microbiology and Infectious Diseases  
Volume 57, April 2018, Pages 39-49



## MALDI-TOF MS identification of ticks of domestic and wild animals in Algeria and molecular detection of associated microorganisms

Mehdi Boucheikhchoukh<sup>a</sup>, Maureen Laroche<sup>b</sup>, Atef Aouadi<sup>c</sup>, Loubna Dib<sup>d</sup>, Ahmed Benakla<sup>e</sup>, Didier Raoult<sup>f</sup>, Philippe Parola<sup>g</sup>

microorganisms



## MALDI-TOF MS Identification of Dromedary Camel Ticks and Detection of Associated Microorganisms, Southern Algeria

Fatima Zohra Hamili<sup>1,2</sup>, Maureen Laroche<sup>1,2</sup>, Adama Zan Diarra<sup>1,2</sup>, Ismail Lafri<sup>3,4</sup>, Brahim Gassen<sup>5</sup>, Boubakr Boutefra<sup>6</sup>, Bernard Davoust<sup>1,7</sup>, Idir Bitam<sup>8,9</sup> and Philippe Parola<sup>1,3,4</sup>

<sup>1</sup> IHU Méditerranée Infection, 19-21 Boulevard Jean Moulin, 13005 Marseille, France  
<sup>2</sup> Aix-Marseille Univ., IRD, AP-HM, IHU, INSERM, UMR1103, 13005 Marseille, France  
<sup>3</sup> Laboratoire des Phlébotomologie, LIPHE, 16, Rue Pasteur, Algérie, Institut des Sciences Vétérinaires, Université de Biskra, Biskra (DSD), Algérie  
<sup>4</sup> Laboratoire Mésa Interdisciplinaire BÉNEDEX, VÉTICOME, IRD, 13005 Marseille, France  
<sup>5</sup> Etablissement Public, Hôpitalier de Tanoussert, Tanoussert 11000, Algeria  
<sup>6</sup> Inspection Vétérinaire, Département des Services Agricoles, Tanoussert 11000, Algeria  
<sup>7</sup> Aix-Marseille Univ., IRD, AP-HM, MIEPHE, 13005 Marseille, France  
<sup>8</sup> Ecole Supérieure des Sciences de l'Aliment et des Industries Alimentaires, Alger 16000, Algeria

> JMed Entomol.15 mai 2021;58(3):1126-1133. doi : 10.1093/jme/tjaa266.

## Identification des poux stockés dans l'alcool à l'aide de MALDI-TOF MS

Hanène Benyahia<sup>1,2</sup>, Basma Ouarti<sup>1,2</sup>, Adama Zan Diarra<sup>1,2</sup>, Mehdi Boucheikhchoukh<sup>3</sup>, Mohamed Nadir Meguini<sup>4</sup>, Makhlouf Behidji<sup>4</sup>, Ahmed Benakla<sup>3</sup>, Philippe Parola<sup>1,2</sup>, Lionel Almería<sup>1,2,5</sup>



Collaboration + formation d'étudiants avec l'Equipe 1  
Transfert de technologie et Installation Maldi toff en Algérie



## LMI ALGERIAN TEAM LEADER



**Idir BITAM, PhD, HDR, 50 y.o.**

**82 indexed publications by 2018-2022 - H Index : 28, Citations : 3556 (5 ANS)**

« *Jeunes Équipes Associées à l'IRD* » (JEAI) program MALBAVECT (2010-2013),

2014, : main partner of the REMEDIER (for REsearch for MEDiterranean Infections that are Emerging or Reemerging) program granted by the A\*MIDEX (n° ANR-11-IDEX-0001-02) funded by the Investissements d'Avenir French Government.

2014, Director of the doctoral school “ecology of vector systems” at Université de Boumerdes

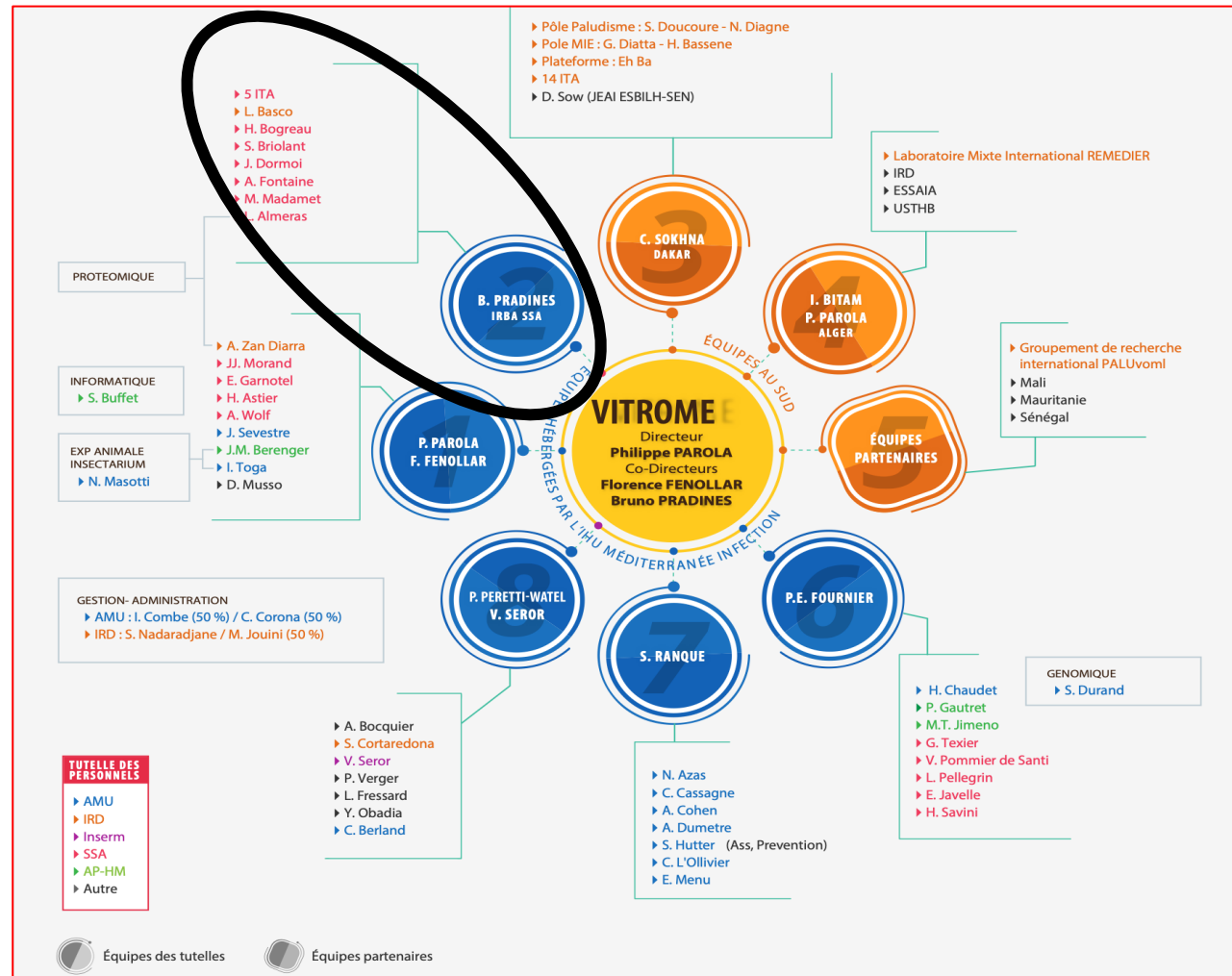
Invited Associate Professor at Aix-Marseille University in 2015 and 2016.

2016: Agreement of creation of a new laboratory at ESSAIA CRVAIIOP: Veilles des pathologies infectieuses et contrôle de la sécurité alimentaire

2021: LMI-REMIER (CRAP – CRAPC – USTHB – ESSAIA)

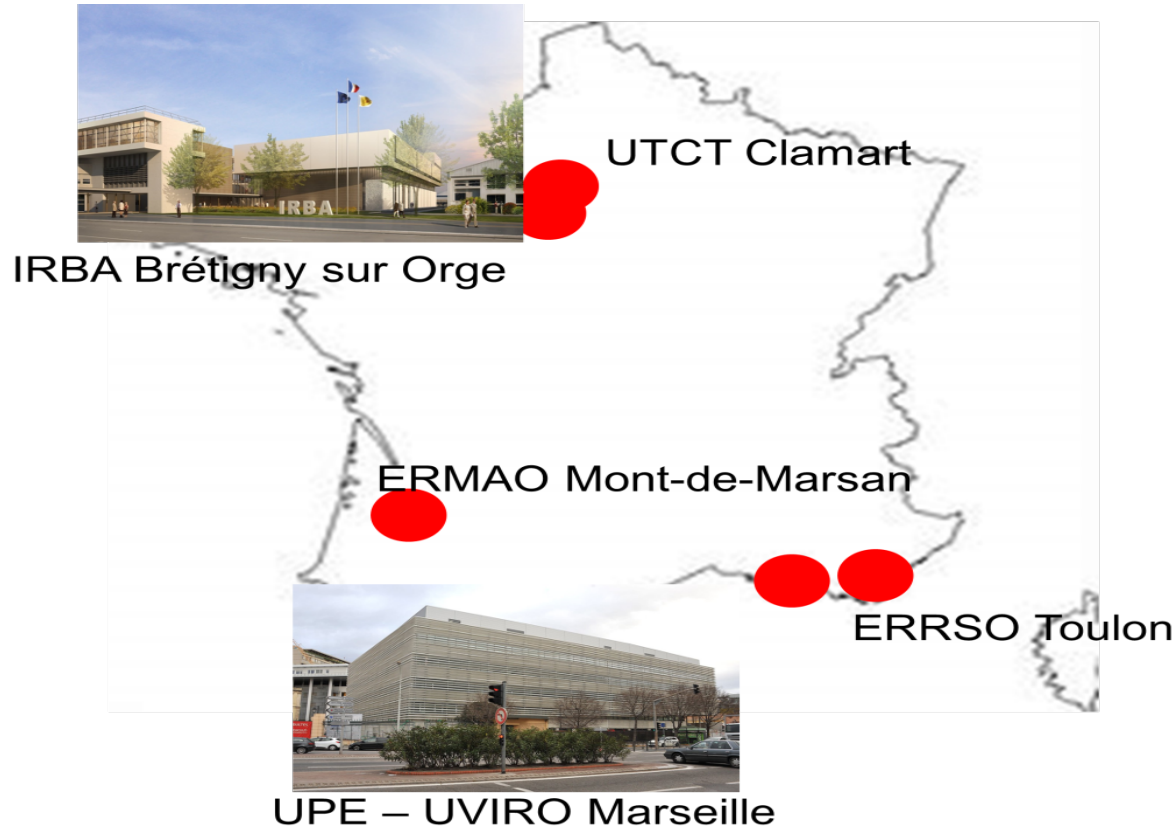
2023: Directeur Adjoint centre de recherche Agro-Pastorale Tjelfa (53 Chercheurs / ingénieurs)

# Equipe 2 Unité parasitologie et entomologie (UPE)



# Unité parasitologie et entomologie (UPE)

Participation à mission de soutien des Forces et au maintien de la capacité opérationnelle du combattant



## Missions duales de l'UPE

- au profit des armées
- au profit de la santé publique (Santé publique France, Haute autorité de santé, Ministère des solidarités et de la santé, Ministère de l'Europe et des Affaires étrangères, Ministères de la santé de pays Africains, OMS)

## Activités

- expertise
- recherche
- formation

# Composition

Service de santé des armées (8,8 ETP)  
Unité parasitologie et entomologie (IRBA)



1 pharmacien, PhD, HDR  
2 médecins, PhD  
1 ingénieur de recherche, PhD  
1 chercheur PhD, HDR  
3 chercheurs PhD  
5 techniciens

Institut de recherche pour le développement

1 médecin, PhD, DR, HDR



Service de santé des armées



1 doctorant (soutenance 2024)

1 doctorant (FMI)

1 doctorant (salarié Djibouti)

2 doctorants (FMI)

1 doctorant (Bourse Gouvernement Français)

1 doctorant (Université Picardie)





# Budget 2018-2023 = 4338 k€

ANR 2024-2026 = 20 k€

2024-2025 = 94 k€

Fond Européen développement  
7%

ARS  
0,4%

2 projets  
284 k€

DGA  
35%

7 projets = 1401 k€

Armées = 1484 k€

2 projets = 2540 k€

Santé publique France  
55%

AID  
1,5%

IRD  
0,5%

DFRI  
0,6%



Centre National de Référence du Paludisme

2023-2027 = 1811 k€



# Publications et Thématiques 2018-2023 = 158 publications

**Equipe Paludisme et Vecteurs**

**Surveillance épidémiologique** des accès palustres et du niveau de **résistance** aux antipaludiques (paludisme d'importation en France, Mayotte, Afrique)

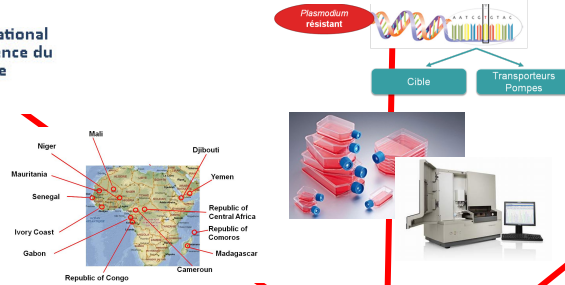
**31 publications**



Centre National de Référence du Paludisme

Identification et développement de **marqueurs moléculaires prédictifs de résistance** aux antipaludiques

**10 publications**



Identification et développement de **nouveaux antipaludiques**

**15 publications**



Développement et évaluation de nouvelles méthodes de **diagnostic** du paludisme

**9 publications**



**Interactions homme-moustique et entomologie**

**41 publications**

➤ Développement d'outils sérologiques

**4 publications**

➤ Développement d'outils d'identification

**17 publications**



➤ Evaluation entomologique et résistance

**10 publications**

➤ Compétence vectorielle et génome

**9 publications**

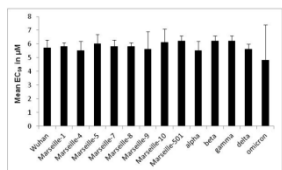


**12 publications**

**Autres**

**19 publications**

**Surveillance des maladies à vecteurs** dans les zones de positionnement des militaires



**SARS-CoV-2**

**20 publications**

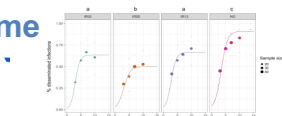
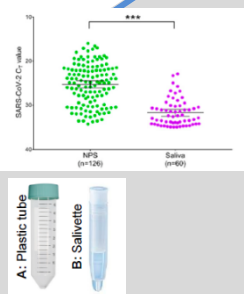
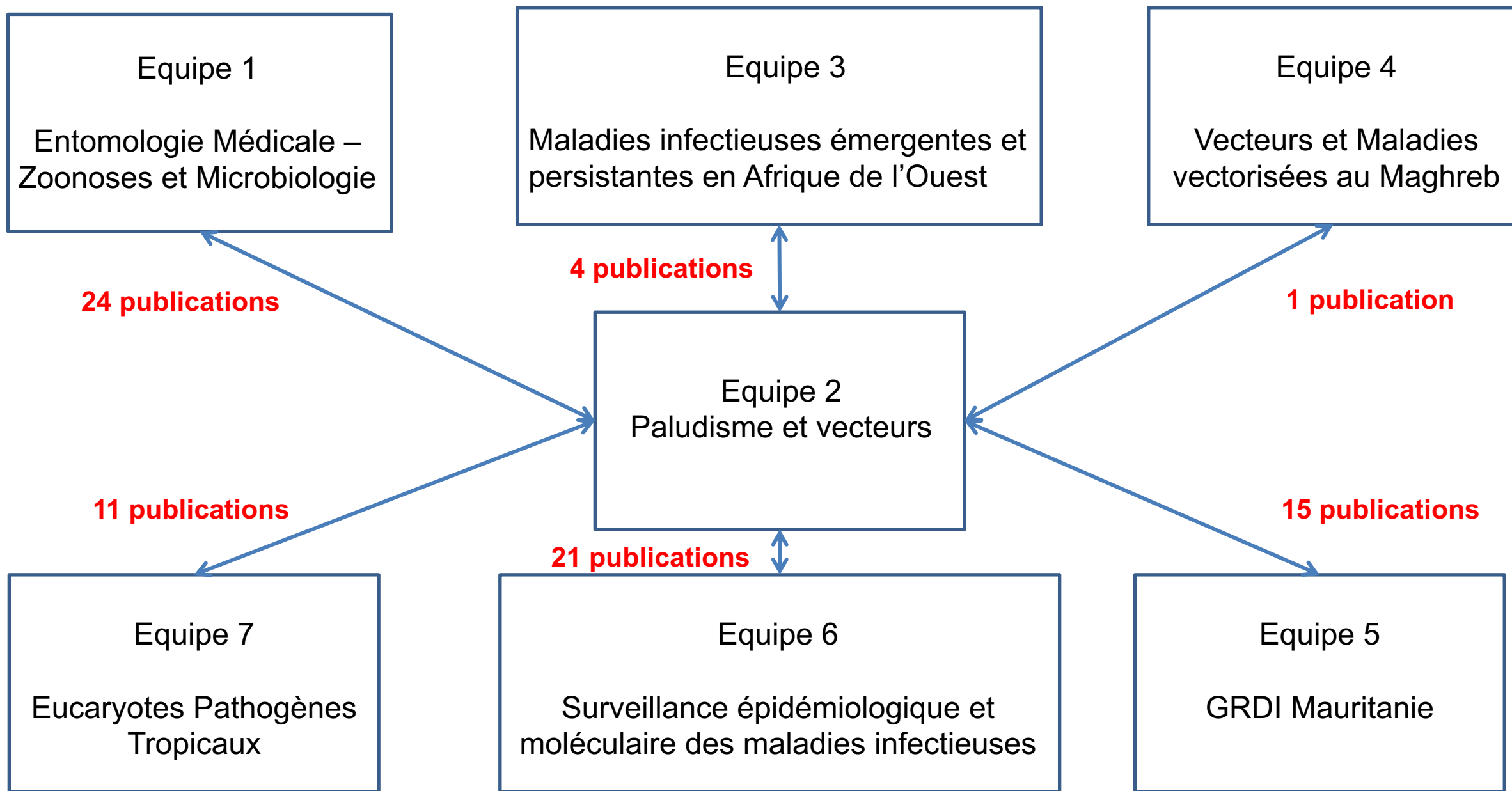


FIGURE 1. Cumulative proportion of mosquitoes with viral dissemination from the infected mosquito over time for each mosquito from the original infection.

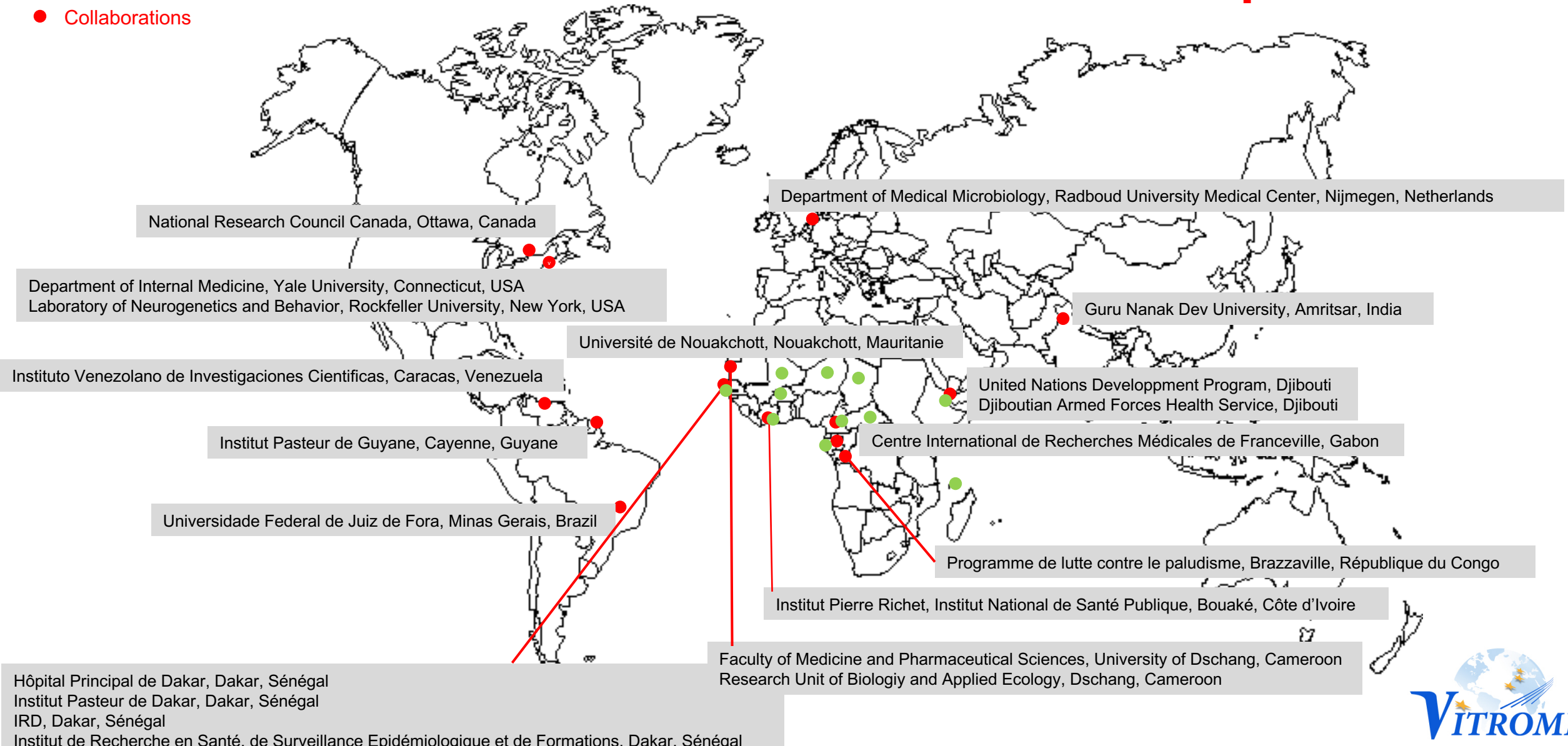
# Publications et collaborations VITROME = 62 publications, 76 collaborations



# Collaborations internationales 2018-2023

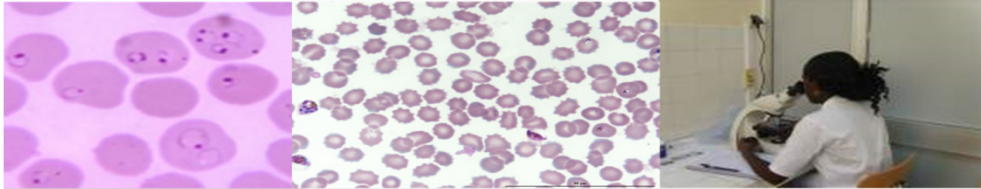
44% des publications

- Expertises
- Collaborations



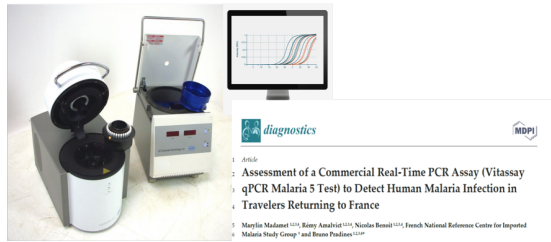
# Diagnostique

## Microscopie



Intelligence artificielle  
Automatisation en lecture numérique

## Biologie moléculaire



Extraction ADN parasitaire à partir

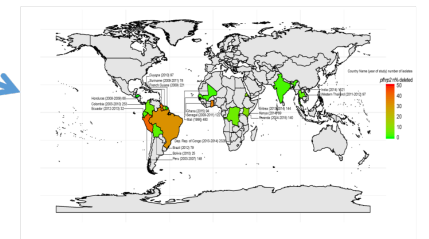


Séquençage du génome entier

## Tests de diagnostic rapide



Parasites n'exprimant plus la protéine HRP2 (reconnue par TDR)





# Surveillance de la résistance aux antipaludiques

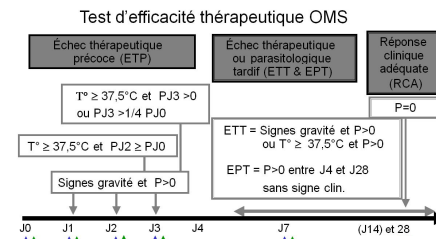
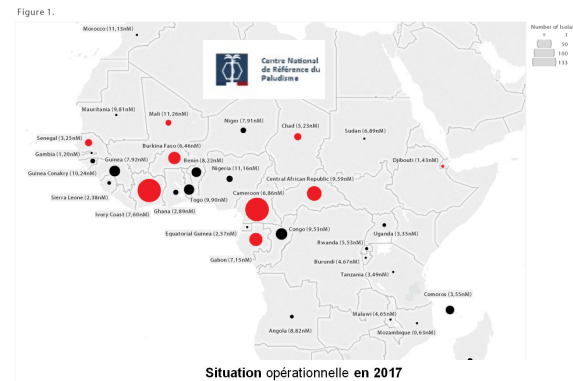
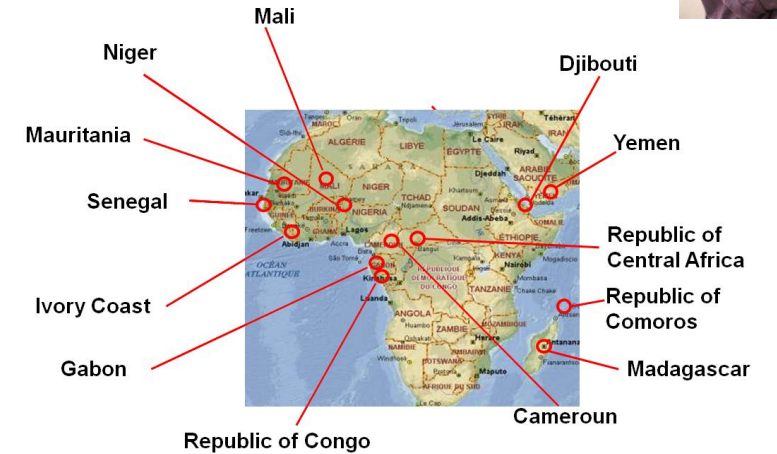


Centre National de Référence du Paludisme

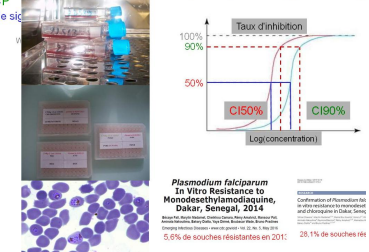
**Paludisme d'importation**  
**> 500 isolats / an à Equipe 2**  
**2000 isolats / an à BCL**

**CNR = leader en terme d'analyses réalisées au niveau international**

## Paludisme autochtone



## Test ex vivo (antipaludogramme)



OPEN ACCESS Freely available online

## Surveillance of Travellers: An Additional Tool for Tracking Antimalarial Drug Resistance in Endemic Countries

Myriam Gharbi<sup>1,2,3,4,\*</sup>, Jennifer A. Flegg<sup>3,5</sup>, Bruno Pradines<sup>6,7,8</sup>, Ako Berenger<sup>9</sup>, Magatte Ndiaye<sup>10</sup>, Abdoulaye A. Djimdé<sup>11</sup>, Cally Roper<sup>12</sup>, Véronique Hubert<sup>13</sup>, Eric Kendjo<sup>14</sup>, Meera Venkatesan<sup>3,15</sup>, Philippe Brasseur<sup>16</sup>, Oumar Gaye<sup>10</sup>, André T. Offianan<sup>9</sup>, Louis Penali<sup>9</sup>, Jacques Le Bras<sup>1,2,3,13</sup>, Philippe J. Guérin<sup>3,4,5,17</sup>, Members of the French National Reference Center for Imported Malaria Study

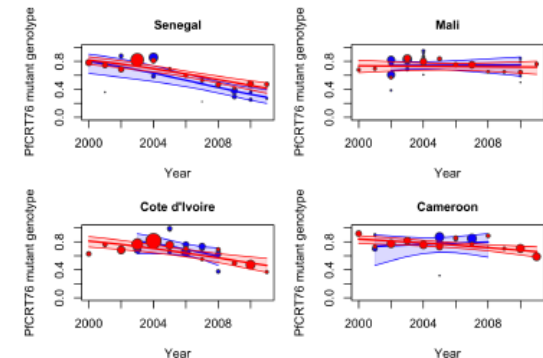
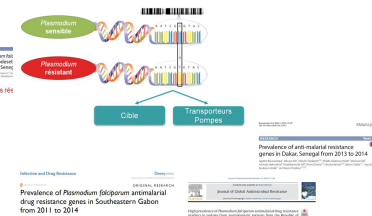


Figure 2. Observed data, fitted model (by logistic regression) and 95% confidence interval (shaded area) for the prevalence of the *PI-CR76* mutant isolates from 2000 to 2011 for travellers (red) and field studies (blue) for A-Senegal, B-Mali, C-Côte d'Ivoire and D-Cameroon. Each data point represents the prevalence of resistant isolates per year for travellers' data and per study for field studies, where the size of the circle is proportional to the number of isolates in the sample.

**CNR = Intérêt dual (importation et autochtone)**

**CNR = Intérêt dual (civil et militaire)**



# Identification et développement de nouveaux antipaludiques

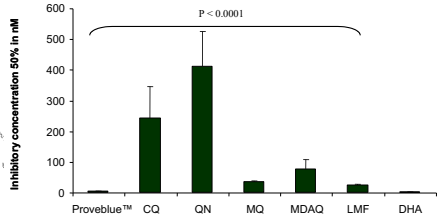
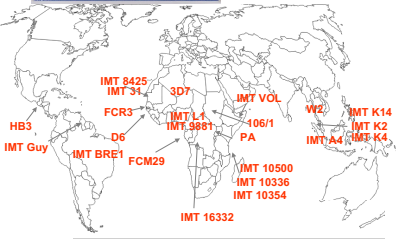


ANTHROBIOLOGICAL AGENTS AND CHEMOTHERAPY, May 2011, p. 2472-2474  
 0066-4804/11/\$12.00 doi:10.1128/AAC.10466-10  
 Copyright © 2011, American Society for Microbiology. All Rights Reserved.

Vol. 55, No. 5

## In Vitro Activity of Proveblue (Methylene Blue) on *Plasmodium falciparum* Strains Resistant to Standard Antimalarial Drugs<sup>1</sup>

Aurélien Pascual,<sup>1</sup> Maud Henry,<sup>1</sup> Sébastien Briolant,<sup>1</sup> Serge Charras,<sup>1</sup> Eric Baret,<sup>1</sup> Rémy Amalvict,<sup>1</sup> Emilie Huyghe des Etages,<sup>2</sup> Michel Feraud,<sup>2</sup> Christophe Rogier,<sup>2</sup> and Bruno Pradines<sup>1\*</sup>



International Journal of Antimicrobial Agents  
 Contents lists available at ScienceDirect  
 ELSEVIER  
 journal homepage: www.elsevier.com/locate/ijantmicag

## Ex vivo activity of Proveblue, a methylene blue, against field isolates of *Plasmodium falciparum* in Dakar, Senegal from 2013–2015

Bécaye Fall<sup>1</sup>, Marilyn Madamet<sup>1,2,3</sup>, Silman Diawara<sup>2</sup>, Sébastien Briolant<sup>1,2,3</sup>, Khalifa Ababacar Wade<sup>4</sup>, Gora Lo<sup>1,2</sup>, Aminata Nakoulima<sup>1</sup>, Mansour Fall<sup>4</sup>, Raymond Bercion<sup>1</sup>, Mame Bou Kounta<sup>4</sup>, Rémy Amalvict<sup>1,2,3</sup>, Nicolas Benoit<sup>1,2,3</sup>, Mamadou Wague Gueye<sup>4</sup>, Bakary Diatta<sup>1,2,3</sup>, Boubacar Wade<sup>1,2</sup>, Bruno Pradines<sup>1,2,3,4\*</sup>

Journal of Antimicrobial Chemotherapy  
 J Antimicrob Chemother 2020; 75: 2141-2148  
 doi:10.1093/jac/dkz174 Advance Access publication 14 May 2020

## Baseline and multinormal distribution of ex vivo susceptibilities of *Plasmodium falciparum* to methylene blue in Africa, 2013–18

Mathieu Gendrot<sup>1,2,3</sup>, Marilyn Madamet<sup>1,2,3</sup>, Joel Mosnier<sup>1,2,3</sup>, Isabelle Fonta<sup>1,2,3,4</sup>, Rémy Amalvict<sup>1,2,3</sup>, Nicolas Benoit<sup>1,2,3</sup>, Sébastien Briolant<sup>1,2,3</sup> and Bruno Pradines<sup>1,2,3,4\*</sup> on behalf of the French National Reference Centre for Imported Malaria Study Group

Table 1. Statistical analysis of the 609 methylene blue EC<sub>50</sub> values by year

Year	No. of EC <sub>50</sub> values	EC <sub>50</sub> (nM)			
		mean	minimum	maximum	95% CI
2013	24	8.34	0.5	3982	5.10–11.58
2014	88	8.62	0.69	8720	5.41–11.83
2015	113	4.79	0.16	3245	3.62–5.96
2016	104	8.61	0.5	7465	6.08–11.14
2017	105	9.39	0.49	5340	6.16–10.62
2018	175	6.81	0.17	6731	4.96–8.66
Total	609	7.17	0.16	8720	6.21–8.13



## Efficacy of Proveblue (Methylene Blue) in an Experimental Cerebral Malaria Murine Model

Jérôme Dormoi,<sup>1,2,3</sup> Sébastien Briolant,<sup>1,2,3,4</sup> Cai



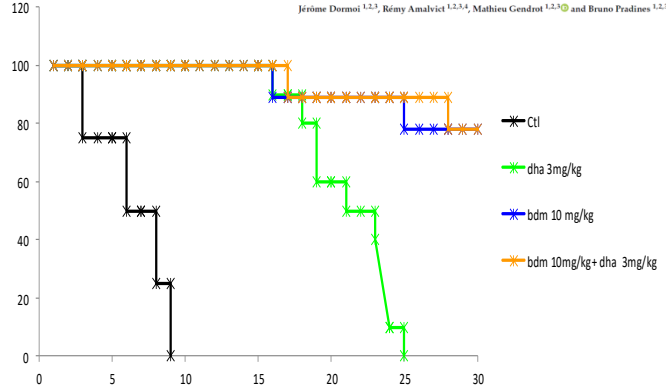
### Dose Responses of Proveblue Methylene Blue in an Experimental Murine Cerebral Malaria Model

Jérôme Dormoi, B



### Methylene Blue-Based Combination Therapy with Amodiaquine Prevents Severe Malaria in an Experimental Rodent Model

Jérôme Dormoi<sup>1,2,3</sup>, Rémy Amalvict<sup>1,2,3,4</sup>, Mathieu Gendrot<sup>1,2,3,4</sup> and Bruno Pradines<sup>1,2,3,4,5</sup>

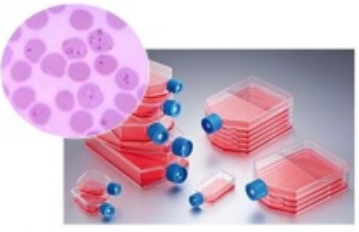


Courbe de survie (Kaplan-Meier) de souris C57Bl6/N infectées à J0 par *P. berghei* ANKA et traitées par Proveblue pendant 10 mg/kg +/- dihydroartémésinine



## Absence of Association between Methylene Blue Reduced Susceptibility and Polymorphisms in 12 Genes Involved in Antimalarial Drug Resistance in African *Plasmodium falciparum*

Mathieu Gendrot<sup>1,2,3,4</sup>, Océane Delandre<sup>1,2,3</sup>, Marie Gladys Robert<sup>1,2,3</sup>, Francis Tsombeng Foguim<sup>1,2,3</sup>, Nicolas Benoit<sup>1,2,3,4</sup>, Rémy Amalvict<sup>1,2,3,4</sup>, Isabelle Fonta<sup>1,2,3,4</sup>, Joel Mosnier<sup>1,2,3,4</sup>, Marilyn Madamet<sup>1,2,3</sup>, Bruno Pradines<sup>1,2,3,4,5</sup> and on behalf of the French National Reference Centre for Imported Malaria Study G



Souche sensible de *P. falciparum*



Génomique  
 Transcriptomique  
 Protéomique  
 Métabolomique

Mutagenèse dirigée

Evaluation in vitro, in vivo

Identification de marqueurs potentiels de la résistance



# Développement de nouveaux outils de capture

Article | OPEN

Excretion of dengue virus RNA by *Aedes aegypti* allows non-destructive monitoring of viral dissemination in individual mosquitoes

Albin Fontaine<sup>1</sup>, Davy Jiolle, Isabelle Moltini-Conclois, Sebastian Lequime & Louis Lambrechts<sup>2</sup>

Scientific Reports 6, Article number: 24885

Received: 10 February 2016

Detection of Chikungunya Virus Circulation Using Sugar-Baited Traps during a Major Outbreak in French Guiana

Romain Girod<sup>1\*</sup>, Amandine Guidez<sup>1</sup>, Romuald Carinci<sup>1</sup>, Jean Issaly<sup>1</sup>, Pascal Gaborit<sup>1</sup>, Emma Ferrero<sup>1</sup>, Vanessa Ardillon<sup>2</sup>, Albin Fontaine<sup>3,4,5</sup>, Isabelle Dusfour<sup>1</sup>, Sébastien Briolant<sup>1,6,7</sup>

Received: 17 March 2022 | Revised: 2 September 2022 | Accepted: 16 September 2022

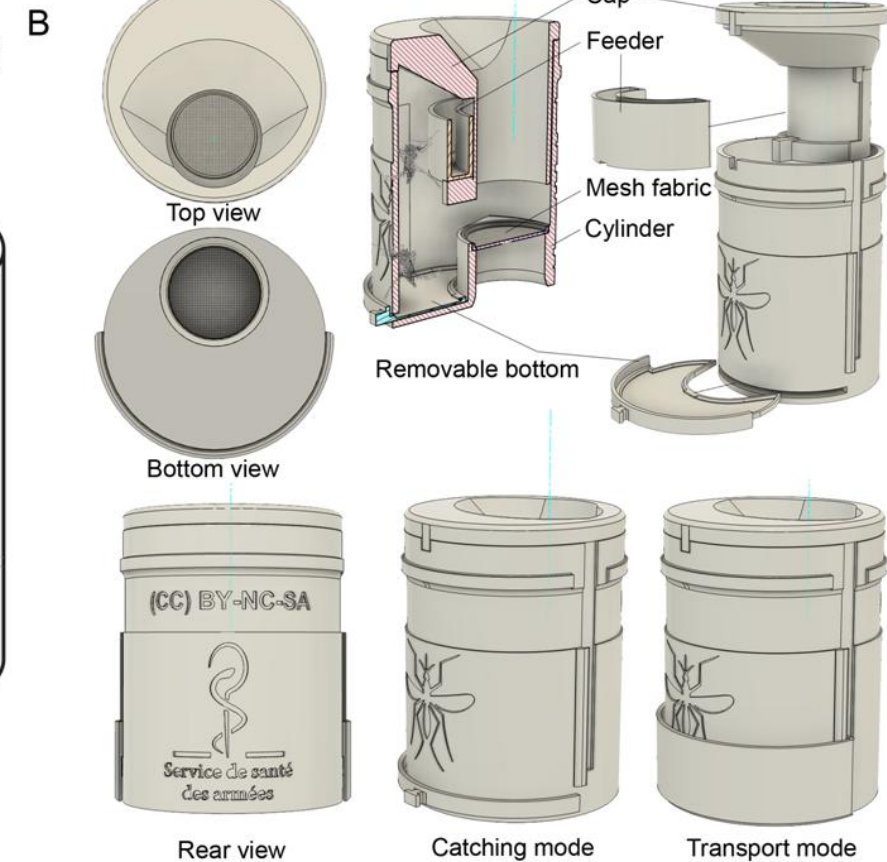
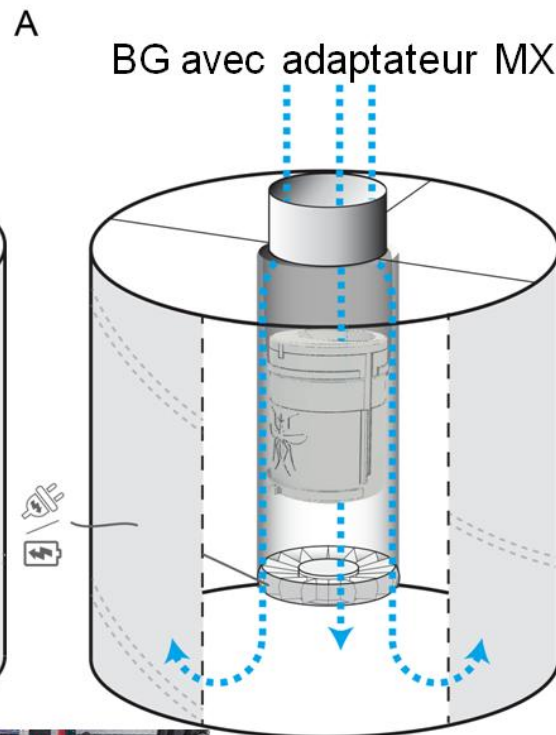
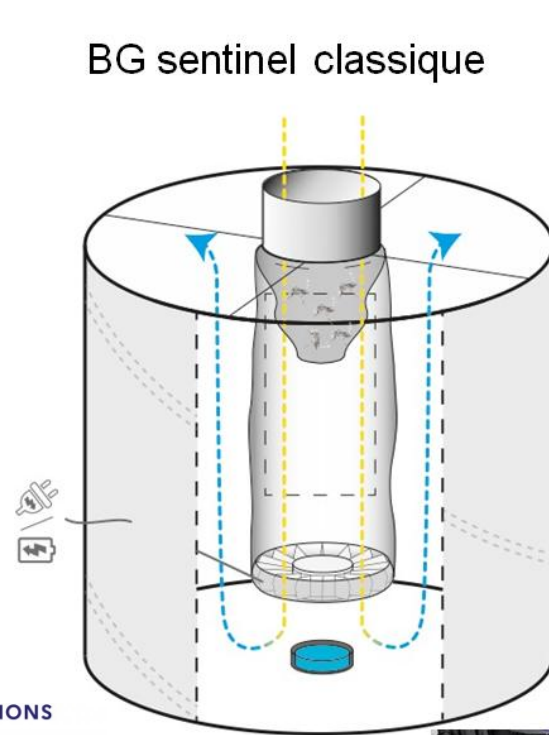
DOI: 10.1111/1755-0998.13716

RESOURCE ARTICLE

MOLECULAR ECOLOGY  
RESOURCES WILEY

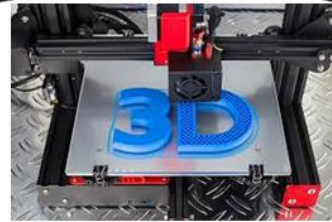
Analysis of trapped mosquito excreta as a noninvasive method to reveal biodiversity and arbovirus circulation

Grégory L'Ambert<sup>1</sup> | Mathieu Gendrot<sup>2,3,4</sup> | Sébastien Briolant<sup>2,3,4</sup> | Agnès Nguyen<sup>5</sup> | Sylvain Pages<sup>1</sup> | Laurent Bosio<sup>6,7</sup> | Vincent Palomo<sup>6,7</sup> | Nicolas Gomez<sup>2,3,4</sup> | Nicolas Benoit<sup>2,3,4</sup> | Hélène Savini<sup>3,8</sup> | Bruno Pradines<sup>2,3,4,9</sup> | Guillaume André Durand<sup>6,7</sup> | Isabelle Leparac-Goffart<sup>6,7</sup> | Gilda Grand<sup>6,7</sup> | Albin Fontaine<sup>2,3,4</sup>



EXPOSITION D'INNOVATIONS

Mercredi 12 octobre 2022





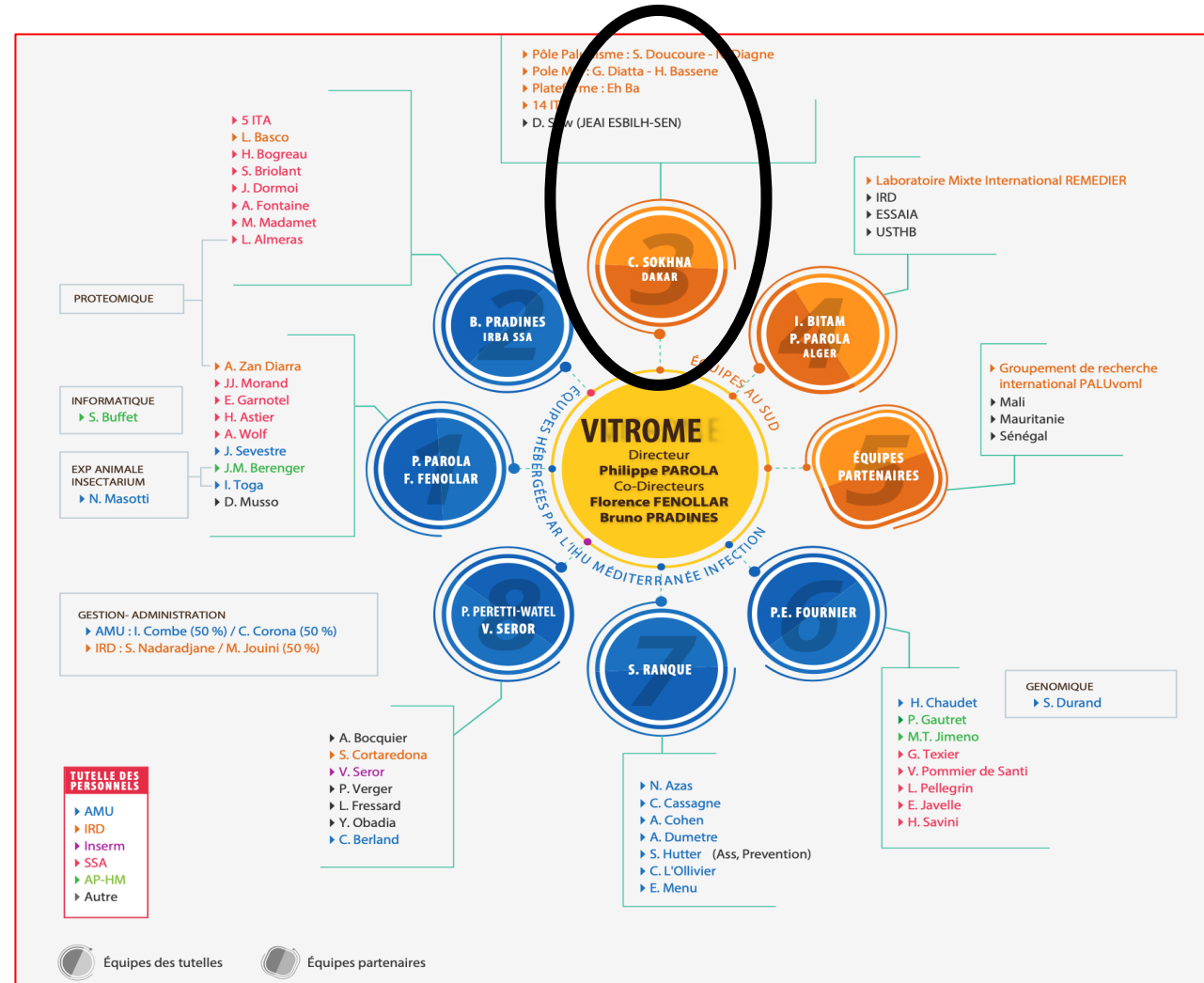


Merci pour votre attention



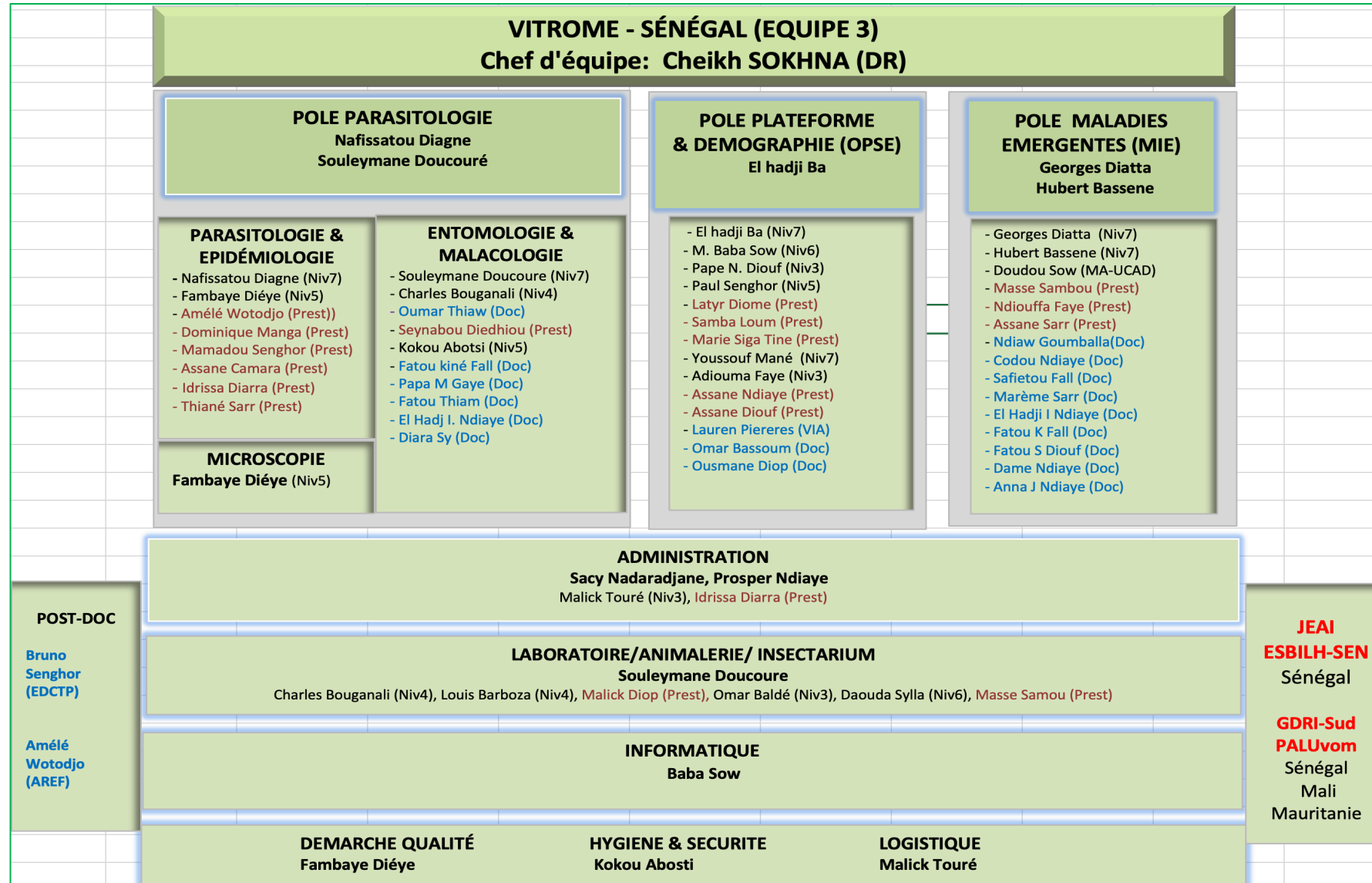
# Equipe 3 VITROME-SENEGAL

Maladies persistantes et émergentes en Afrique de l'ouest  
 Cheikh SOKHNA, PhD, HDR, DR IRD, Chef d'équipe





# Organigramme



Personnel statutaire IRD

Personnel contractuel

Doctorants et Postdoctorants

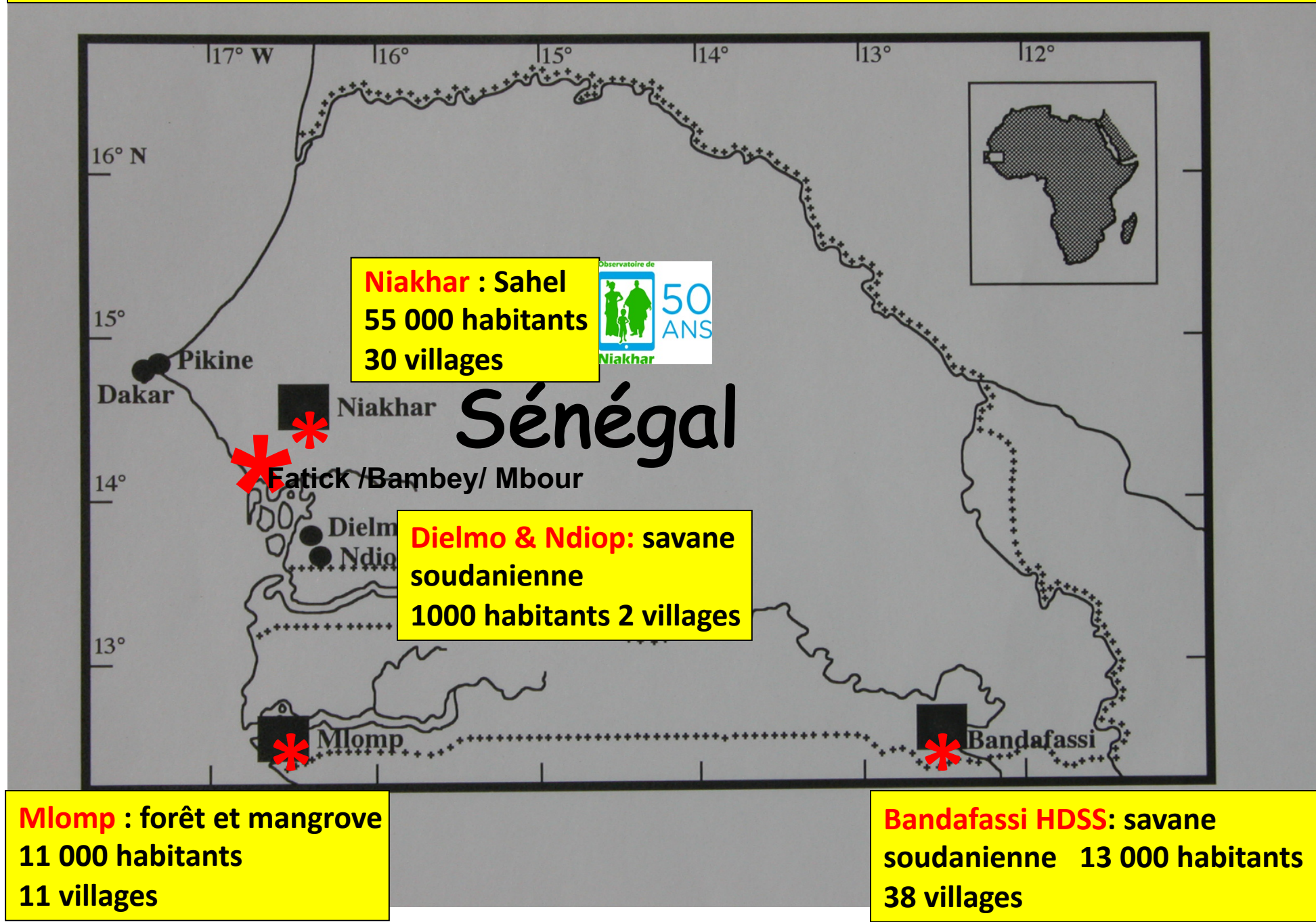
## Contrats de recherche 2018 - 2023

- **Projet Hépatite B (Ambass): financement ANRS, 158 527 €**
- **Projet Hépatite B (NéoVac): financement TOTAL, 98 820 €**
- **Projet Brucellose: financement DFID-UK, 78 724 €**
- **Projet Poux: financement ARTHROBAC PHARMA, 45 037 €**
- **Projet UniSSahel: financement AFD, 85 046 €**
- **Projet Diarrhée: financement Noventure (Espagne), 63 118 €**
- **Projet FIRST: financement MESRI du Sénégal, 23 000 €**
- **JEAI-IRD ESBILH-SEN (50 000 €) et GDRI-PALUvom: financement IRD (60 000 €)**
- **Grant EDCTP (147 000 €) et CEA AGIR sur la bilharziose (23 000 €)**
- **Projet Paludisme MARS: financement AMIDEX, 30 000 €**
- **Projet ECOVACSEN-HPV: financement ANR, 471 517 €**
- **Projet DIACOV-SEN, financement Fonds Crise IRD, 20 000 €**
- **Projet COV3ELSER, financement ANRS (phases 1 et 2), 86 543 €**
- **Projet Soignants, financement ANRS, 41 888 €**

## Activités en étroite relation avec nos partenaires.....

- Paludisme (projet Dielmo/Ndiop) en partenariat avec **le PNLP, IPD, UCAD, MoH**
- Borréliose à tique avec **l'équipe 1,**
- Entomologie avec **l'équipe 1,**
- Causes de fièvre à partir des POCs avec **l'équipe 1 et l'UMR MEPHI,**
- Schistosomoses avec **UCAD, UGB, IRESSEF et équipe 7,**
- Grand Magal de Touba avec **les équipes 6, 8 et RM Diourbel**
- Epidémiologie des Mansonelloses et autres filarioses au Sénégal avec **MEPHI**
- **GDRI-Sud PALUvom avec 11 équipes de recherche (Sénégal, Mali, Mauritanie)**
- Causes des avortements, Microbiote(s) et Malnutrition avec **l'UMR MEPHI,**
- Vaccination (ECOVACSEN-HPV) avec **l'équipe 8,**
- Covid-19, Conditions de vie, Comportements au Sénégal avec **l'équipe 8.**
- **GDRI-Sud DySAM avec MEPHI (Sénégal, Niger et Mali)**

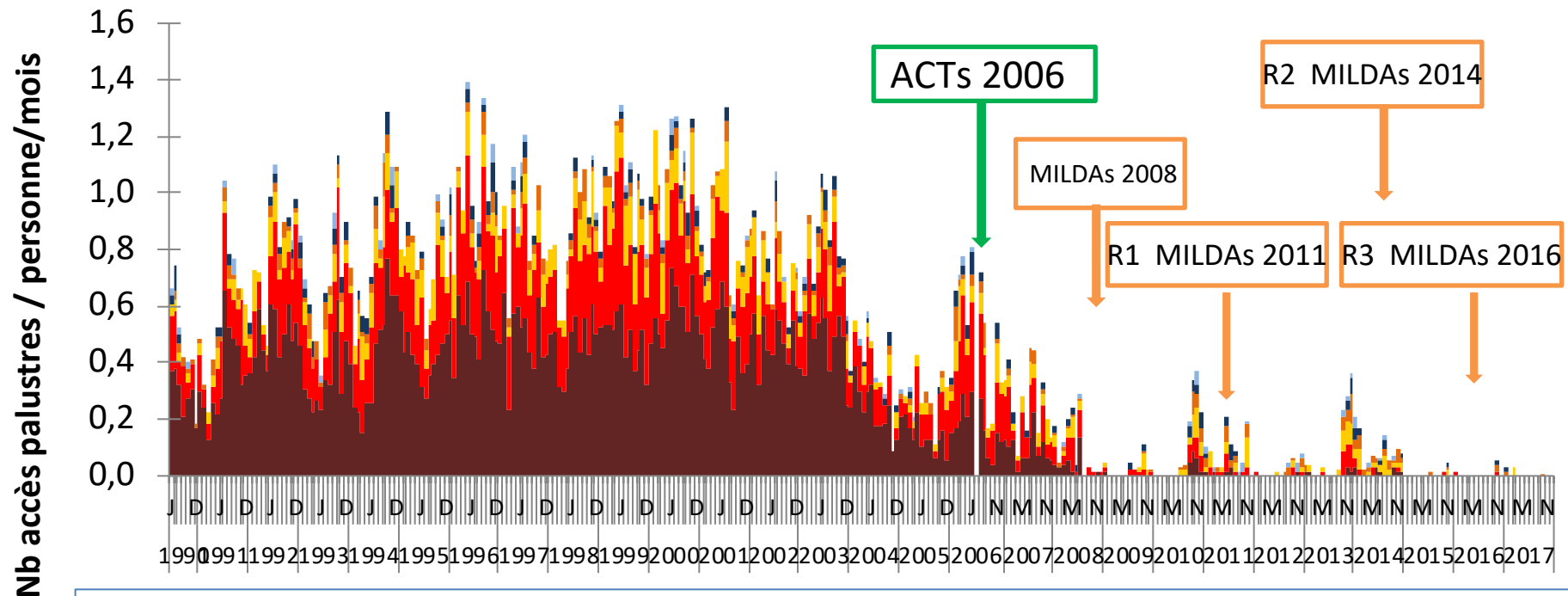
# Observatoire de Population, Santé et Environnement au Sénégal





# Poids du paludisme à Dielmo

■ 0-4 ans ■ 5- 9 ans ■ 10-14 ans ■ 15-29 ans ■ 30-44 ans ■ 45 ans et +



Plus de **600 accès** palustres par an dans les années 1990  
Durant les 3 dernières années (2015-2017): la moyenne du nombre  
d'accès palustres enregistrés a été **de 5 accès par an**

Entre 2000 et 2015, **la synergie nouveaux médicaments et moustiquaires imprégnée** a diminué la morbidité palustre d'un facteur **98** chez les enfants et d'un facteur **12** chez les adultes.

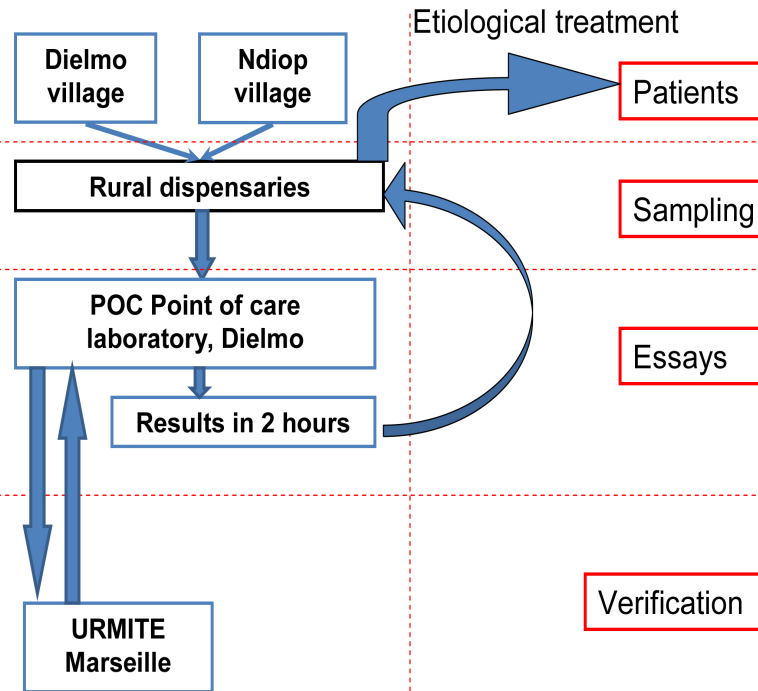
**Depuis 2018, zéro accès palustre autochtone et zéro anophèle infecté**

# Maladies fébriles à TDR palu négatif

## Inclusion des patients & diagnostic

### List of pathogens to test in POC:

- *Borrelia* spp., including *B. crocidurae*
- *Rickettsia* spp., including *R. felis*, *R. conorii*, and *R. africae*
- *Tropheryma whippelii*
- *Coxiella burnetii*
- *Bartonella* spp., including *B. quintana*
- *Leptospira* spp.
- Malaria (RDT)
- Dengue fever (RDT)
- Influenza A and B (RDT)



## Mini labo pour analyses médicales express

**E**n matière de santé, les délais d'action sont souvent décisifs. Un diagnostic biologique express, disponible en moins de deux heures, peut s'avérer vital pour le malade. L'IRD vient de développer en ce sens un mini laboratoire d'analyses médicales, adapté aux conditions des pays du Sud. Il permet d'identifier très vite les principales maladies infectieuses, à partir de simples prélèvements sanguins, salivaires ou urinaires. Ce dispositif, baptisé POC pour « petit laboratoire à proximité du malade », est déjà en service dans deux sites ruraux pilotes au Sénégal. Et il y fait ses preuves. « Grâce à cette nouvelle approche de l'analyse biologique, nous avons pu étiqueter une borréliose en quelques heures, et commencer immédiatement le traitement adapté, explique ainsi le biologiste Cheikh Sokhna, développeur de ce projet. Jusqu'ici, il fallait attendre quinze jours pour distinguer cette affection d'un paludisme, délai très préjudiciable à la santé du patient. » La vitesse d'obtention des résultats permet aussi, le cas échéant, d'isoler tout de suite un patient très contagieux pour protéger son entourage et de prendre les

précautions imposées par son état pour la sécurité des personnels de santé. Concrètement, le POC regroupe un appareillage de PCR<sup>1</sup> destiné à multiplier, interpréter et identifier l'ADN des pathogènes. Il se différencie en cela du laboratoire d'analyse conventionnel, dans lequel les échantillons doivent être observés au microscope par un personnel expérimenté - pour reconnaître d'éventuels parasites - ou bien mis en culture pendant des jours afin de tester la résistance des bactéries contenues aux différents antibiotiques. Plus simple et automatisé, ce nouveau système est opéré par un personnel après une formation courte et appropriée. Il tient aussi dans un petit local - 9 m<sup>2</sup> suffisent ! -, juste alimenté en eau courante et en électricité. La simplicité de d'installation et de mise en œuvre du POC pourrait changer le visage de la médecine rurale au Sud. ●

1. Polymerase chain reaction

### Contact

cheikh.sokhna@ird.fr  
UMR URMITE (IRD, CNRS, Inserm et Aix-Marseille Université).



Le mini labo POC tient dans une pièce de 9 m<sup>2</sup>, juste alimentée en eau et électricité.



Point Of Care  
(POC)  
Niakhar

# POC de Niakhar 2018 – 20 Octobre 2022

## Bactériémies et parasitémies

Année	2018	2019	2020	2021	2022
<b>TOTAL PRELEVEMENTS</b>	<b>532</b>	<b>689</b>	<b>1337</b>	<b>1767</b>	<b>966</b>
PALUDISME	1	7	12	11	10
R. FELIS	0	0	0	0	0
FIEVRE Q		0	0	0	0
BORRELIOSE	60	25	146	96	110
MALADIE DE WIPPLE	0	0	1	1	0
STAPHYLOCOCCUS AUREUS	2	15	46	52	9
BARTONELLOSE	0	0	0	0	0
STREPTOCOCCUS PNEUMONIAE	138	18	102	78	14
DIARRHEE FEBRILES	0	0	0	0	0
SALMONELLA	0	0	0	0	0

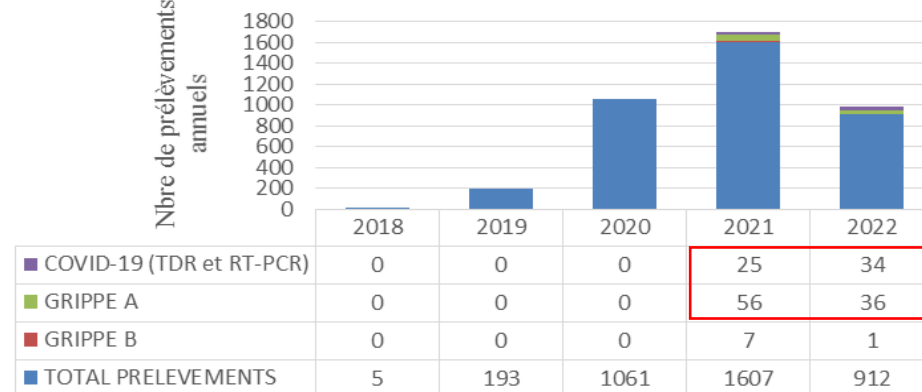
## Infections respiratoires

Année	2018	2019	2020	2021	2022
<b>TOTAL PRELEVEMENTS</b>	<b>5</b>	<b>193</b>	<b>1061</b>	<b>1607</b>	<b>912</b>
GRIPPE B	0	0	0	7	1
GRIPPE A	0	0	0	56	36
COVID-19 (TDR et RT-PCR)	0	0	0	25	34

Surveillance des bactéries et parasites responsable de fièvres : POC de Niakhar 2018- Octobre 2022



Surveillance des virus responsable d'infections respiratoires : POC de Niakhar 2018- Octobre 2022



**Génomomes des virus respiratoires testés dans des échantillons des POC par multiplex.  
Mettre en œuvre le séquençage de nouvelle génération (NGS) basé sur MinION/Oxford Nanopore Technologies des virus au niveau des POC**

**MULTIPLEX SYSTEMS**

**1. Quatre duplex PCR ciblant les micro-organismes ADN + actine :**

- Adenovirus / *S. aureus* => OK - Bocavirus / Actine => OK -  
*H. influenzae* / *S.pyogenes* => OK *S. pneumoniae* / *M. pneumoniae* => OK

**2. Trois PCR duplex ciblant les micro-organismes ARN :**

- **Rhinovirus / Metapneumovirus => OK** VRS /  
Paraechovirus => OK  
- **Enterovirus / Coronavirus OC43 => OK**

**3. Trois triplex PCR ARN ciblant les micro-organismes :**

- **Influenza A / Influenza B / SARS-CoV-2 => OK**  
- **Coronavirus HKU1 / Coronavirus 229E / Coronavirus NL63 => OK**  
- Parainfluenza 1 / Parainfluenza 2 / Parainfluenza 3

Séquençage Novaseq (Illumina) des virus et pour certaines d'entre eux, séquençage avec MinION (Oxford Nanopore) en parallèle



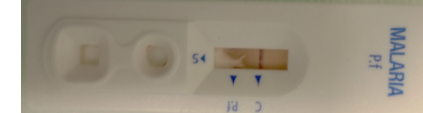


# Fièvre non palustre et cassettes TDR paludisme

## Bilan de la collecte des cassettes TDR *P.falciparum*

2020 Sanitary structures	Commune	Region	Geographic coordinates	Number de RDTs <i>P.falciparum</i>	quarterly collection 2019 - 2020			
					January - March	April - June	July - September	October - December
Ngayokhem	Ngayokhème	Nord Fatick	14°32' N / 16°26' W	521	33 39 40	28 24 59	45 15 135	66 37 N/A
Patar Sine	Patar	Nord Fatick	14°33' N / 16°22' W	310	15 10 10	15 16 6	16 63 46	55 55 X
Mbadatte	Patar	Nord Fatick	14°32' N / 16°21' W	50	En cours 2020	En cours 2020	X X 30	11 7 3
Ndiambour	Patar	Nord Fatick	14°33' N / 16°20' W	578	37 20 11	3 N/A 21	31 53 157	132 83 30
Ndoss diarraff	Niakhar	Nord Fatick	14°27' N / 16°21' W	921	106 90 65	59 N/A 46	51 94 211	114 46 40
Sagne	Niakhar	Nord Fatick	14°24' N / 16°24' W	256	En cours 2020	X 9 15	30 23 62	85 33 ---
Nema Nding	Samba Gueye	Sud Fatick	13°42'N - 16°24'W	254	27 16 25	8 24 15	16 18 40	34 14 15
Keur Moussa	Keur Moussa	Thies	14°46'N - 17°6'W	631	En cours 2020	En cours 2020	17 N/A 253	220 105 36
Nguérane Fass	Koungheul	Kaffrine	14°14'N - 14°50'W	685	En cours 2020	En cours 2020	X 96 155	322 112 X
Kathiotte	Kaffrine	Kaffrine	14°6'N - 14°33'W	214	En cours 2020	En cours 2020	X 38 32	105 25 13
Taouey	Richard Toll	Saint Louis	16°27'N - 15°41'W	310	En cours 2020	X X 3	25 40 242	Attendues
Gaya	Dagana	Saint Louis	16°15'N - 15°53'W	84	En cours 2020	En cours 2020	X 19 61	2 Attendues

qPCR *Borrelia crocidurae* sur TDR Palu Neg



Cas de borréliose dans les causes de fièvre non palustre au Sénégal

- ❖ 16,5 % (43/261) au mois de Juillet
- ❖ 11,4 % (51/446) au mois d'Août
- ❖ 3 % (30/987) au mois de Septembre

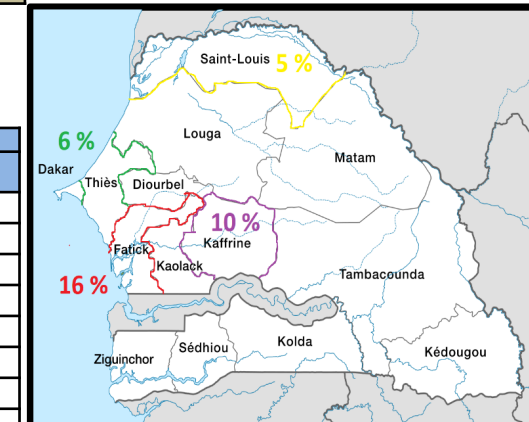
13%

Prévalence globale sur les trois mois

☐ 7,3 % (124/1694)

## Cas de borrélioses identifiés à partir de cassettes négatives RDTs *P.falciparum*

Sanitary structures	Commune	Collected RDTs <i>P.falciparum</i>	July		August		September		Total Positive (%)
			Tested	Positives (%)	Tested	Positives (%)	Tested	Positives (%)	
Ngayokhem	Ngayokhem	195	45	8 (17,8%)	15	2 (13,3%)	124	8 (6,5%)	18 (9,8%)
Patar	Patar	125	16	0 (0%)	63	6 (9,5%)	46	7 (15%)	13 (10,4%)
Ndiambour	Patar	237	31	5 (16,1%)	49	5 (10,2%)	80	3 (3,7%)	13 (8,1%)
Mbadatte	Patar	30		N/A		N/A	30	1 (3,3%)	1 (3,3%)
Ndoss diarraff	Niakhar	377	81	11 (13,5%)	85	11 (12,9%)	100	3 (3%)	25 (9,5%)
Sagne	Niakhar	115	30	13 (43,3%)	23	8 (34,8%)	62	1 (1,6%)	22 (19,1%)
Nema Nding	Samba Gueye	74	16	3 (18,75%)	18	3 (16,6%)	40	0 (0%)	6 (8,1%)
Keur Moussa	Keur Moussa	270	17	1 (5,9%)		N/A	162	2 (1,2%)	3 (1,7%)
koungheul	koungheul	251		N/A	96	3 (3,1%)	149	3 (2%)	6 (2,4%)
kaffrine	kaffrine	70		N/A	38	11 (28,9%)	32	0 (0%)	11 (15,7%)
Taouey	Richard Toll	307	25	2 (8%)	40	0 (0%)	101	0 (0%)	2 (1,2%)
Gaaya	Dagana	80		N/A	19	2 (10,5%)	61	2 (3,3%)	4 (5%)



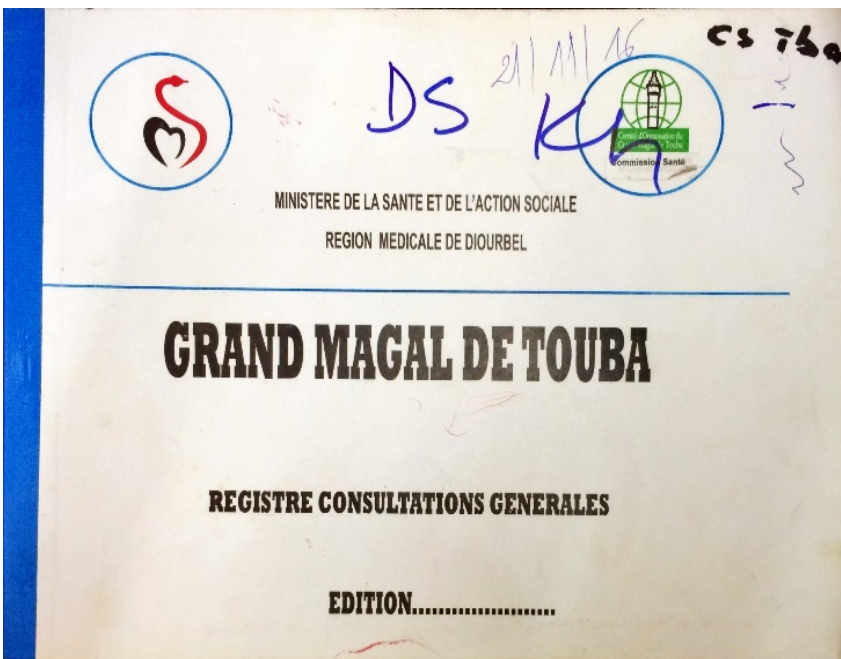
Prévalence des cas de TBRF dans les cassettes TDR *P.falciparum* négatifs au Sénégal

La borréliose à tiques est méconnue et assimilée au paludisme en Afrique



**Grand Magal de Touba,  
mobilité et mondialisation  
des maladies infectieuses**





**60% des motifs de consultation sont dus à des maladies infectieuses avec un taux élevé de fièvres, de paludisme confirmé, d'affections diarrhéiques et d'infections respiratoires.**

Travel Medicine and Infectious Disease xxx (2017) 1–5

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journal homepage: [www.elsevierhealth.com/journals/tmid](http://www.elsevierhealth.com/journals/tmid)

**Communicable and non-communicable disease risks at the Grand Magal of Touba: The largest mass gathering in Senegal**

Cheikh Sokhna<sup>a</sup>, Balla Mbacké Mboup<sup>b</sup>, Papa Gallo Sow<sup>c</sup>, Gaoussou Camara<sup>c</sup>, Mamadou Dieng<sup>b</sup>, Mbaké Sylla<sup>b</sup>, Lamine Gueye<sup>c</sup>, Doudou Sow<sup>a,d</sup>, Aldiouma Diallo<sup>a</sup>, Philippe Parola<sup>a</sup>, Didier Raoult<sup>a</sup>, Philippe Gautret<sup>a,\*</sup>

<sup>a</sup> URMITE, Aix Marseille Université, UM63, CNRS 7278, IRD 198, INSERM 1095, IHU-Méditerranée Infection, France  
<sup>b</sup> Région Médicale de Diourbel, Senegal  
<sup>c</sup> Université Alioune Diop de Bambey, Senegal  
<sup>d</sup> Université Cheikh Anta Diop de Dakar, Senegal

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**ABSTRACT**

**Background:** An estimated 4–5 million individuals gather each year in the holy city of Touba, Senegal during the Grand Magal religious pilgrimage. Pilgrims come from across Senegal and the surrounding countries, as well as from countries outside Africa. It is the largest mass gathering (MG) of the Mouride community and the largest Muslim religious MG in West Africa.

**Method:** A cross-sectional study was conducted on all patients who attended a public healthcare structure during the November 2015 Grand Magal.

**Result:** Data were collected on a total of 32,229 healthcare contacts. The most frequent reasons for consultation were trauma, followed by fatigue and heatstroke. Infectious diseases were also prevalent with, notably, a high rate of febrile systemic illnesses and malaria, diarrheal diseases, and respiratory tract infections. Such results are likely to be linked to overcrowding and climatic conditions, the relative lack of sanitary facilities, and limited medical resources available during the event.

**Conclusion:** The context of the Grand Magal MG is unique, given its location in a tropical developing country and its international component which may favor the globalization of locally endemic diseases. As such, it warrants investment in modern methods for public health surveillance and planning of the event.

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### Senegal's Grand Magal of Touba: Syndromic Surveillance during the 2016 Mass Gathering

Cheikh Sokhna,<sup>1,2,3\*</sup> Ndiaw Goumballa,<sup>2</sup> Van Thuan Hoang,<sup>1,3,4</sup> Balla M. Mboup,<sup>5</sup> Mamadou Dieng,<sup>5</sup> Ahmadou B. Sylla,<sup>5</sup> Aldiouma Diallo,<sup>2</sup> Didier Raoult,<sup>3,6</sup> Philippe Parola,<sup>1,3</sup> and Philippe Gautret<sup>1,3</sup>

<sup>1</sup>Aix Marseille University, IRD, AP-HM, SSA, VITROME, Marseille, France; <sup>2</sup>VITROME, Campus International IRD-UCAD de l'IRD, Dakar, Senegal; <sup>3</sup>IHU-Méditerranée Infection, Marseille, France; <sup>4</sup>Thai Binh University of Medicine and Pharmacy, Thai Binh, Viet Nam; <sup>5</sup>Région Médicale de Diourbel, Diourbel, Senegal; <sup>6</sup>Aix Marseille University, IRD, AP-HM, MEPHI, Marseille, France

**Abstract.** The Grand Magal of Touba (GMT) is an annual 1-day Muslim religious event that takes place in Touba in Senegal. The city of Touba swells from 800,000 to four million people during the GMT. All patients who attended one of the 154 dedicated medical care public healthcare structures of the medical region of Diourbel during the GMT were included in a cross-sectional survey from November 16 to November 21, 2016. Demographic, morbidity, and mortality data were collected on a daily basis using a standardized article form that allows data to be recorded in a free-text format. Data were obtained from a total of 20,850 healthcare encounters, and 30.9% patients were aged ≤ 15 years. The most frequent conditions were gastrointestinal and respiratory diseases. Most frequent gastrointestinal symptoms were abdominal and gastric pain, nausea and vomiting, and diarrhea, suggesting that most patients suffered gastroenteritis. The predominance of cough, rhinitis, influenza-like illness, and sore throat among patients with respiratory symptoms suggests that most patients suffered from upper respiratory tract infections. Other frequent symptoms were headaches and pain in various organs. Three percentage of patients were considered to have malaria, 29.8% of patients were prescribed antibiotics and 2.6% antimalarial drugs, and 1.5% of patients were hospitalized. Only one death was recorded. Preparedness of the medical infrastructure should target these syndromic features, in terms of diagnostic tools and specific treatments, including pediatric formulations. It is also essential to improve the quality and rapid availability of data to enable real-time analysis of medical events at the GMT and to implement a rapid response, if necessary.

# Laboratoire Point Of Care (POC) durant le Grand Magal de Touba



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15. Sokhna C *et al.*, (2020). Sénégal : comment gérer les risques sanitaires du plus grand rassemblement religieux en temps de Covid-19. *The Conversation France*, 01 octobre 2020, en ligne [4 p.]. ISSN 2431-2134.



# Bilharzioses et JEAI

Comprendre l'épidémiologie de la schistosomose urinaire dans des foyers temporaires

- Etudier la prévalence et l'intensité de l'infection
- Etudier les mollusques hôtes intermédiaires et leurs rôles épidémiologiques
- Déterminer l'impact du traitement annuel répété sur la transmission

## Projet EDCTP Bilharziose

Hybridation entre *Schistosoma haematobium* (humain) et *Schistosoma bovis* (animal) à Richard Toll au Sénégal.

## Projet de LMI en cours d'évaluation

# Mares et Marigots



Actualité 

## La JEAI ESBILH-SEN contribue à une plateforme de malacologie dans la lutte contre la bilharziose au Sénégal

La bilharziose ou schistosomiase est la deuxième endémie parasitaire mondiale derrière le paludisme. La maladie se manifeste par une infection intestinale ou urogénitale et est causée par des parasites du genre *Schistosoma* qui sont transmis à l'homme par des mollusques d'eau douce.

**D**urant plusieurs décennies, la chimiothérapie de masse à base de praziquantel (PZQ) n'a pas permis d'arriver aux résultats escomptés notamment une diminution drastique de la transmission pouvant aboutir à son élimination. A titre d'exemple, au Sénégal, la maladie a gagné du terrain à tel point qu'elle est devenue endémique à l'échelle du territoire à l'exception de la région de Dakar où des cas sporadiques sont signalés. Dans ce contexte, afin de limiter la transmission de la maladie, il est préconisée d'associer la lutte contre les mollusques hôtes intermédiaires des schistosomes à l'utilisation massive du PZQ.

Cependant, l'efficacité des stratégies de lutte anti-mollusque pourrait être réduite ou limitée par des préoccupations environnementales liées notamment à l'utilisation de molluscicides chimiques. A cela s'ajoute la mise en place d'aménagements hydro-agricoles qui contribuent à l'émergence de biotopes favorables au développement des mollusques ce qui peut constituer un frein à la durabilité de la lutte anti-mollusque. Ainsi donc, bien que son efficacité ne soit pas remise en cause, le contexte socio-environnemental

lié à la maladie incite à repenser la lutte anti-mollusque afin qu'elle soit plus adaptée aux réalités sociales des zones rurales endémiques. Cela passe nécessairement par une meilleure connaissance de la biologie des mollusques et de leurs interactions avec les parasites qu'ils transmettent, d'où la nécessité de développer des études expérimentales à cette fin. C'est ainsi nous avons décidé dans le cadre du programme JEAI ESBILH-SEN (Evaluer les stratégies de lutte contre la bilharziose au Sénégal) de mettre en place une plateforme expérimentale de malacologie afin de pouvoir étudier les traits de vie des mollusques et de développer des stratégies de lutte efficaces. Aujourd'hui, la plateforme installée au sein du laboratoire de VITROME héberge une dizaine d'espèces de mollusque dont 6 sont impliquées dans la transmission de la bilharziose au Sénégal, notamment *Biomphalaria pfeifferi*, *Bulinus truncatus*, *B. senegalensis*, *B. umbilicatus*, *B. truncatus*, *B. globosus*.

Nos travaux ont également montré que la qualité de l'eau utilisée pour l'élevage est déterminante pour le développement des mollusques qui ont une adaptation différentielle selon l'origine de l'eau. Ces connaissances sont déterminantes en vue de standardiser les protocoles expérimentaux portant sur l'étude de mollusques. Elles permettront aussi de mieux comprendre la dynamique et la distribution de populations de mollusque dans leur habitat naturel et ouvre la perspective de développer des stratégies de lutte mieux adaptées aux conditions socio-environnementales. Grâce à la plateforme,



Mesure de la taille des mollusques en élevage

férentes espèces de mollusque en utilisant le Maldit-Of qui présente l'avantage de pouvoir traiter plus de spécimens en moins de temps comparé à la biologie moléculaire. L'objectif à court terme est d'utiliser la technique du Maldit-Of pour diagnostiquer l'infestation chez l'homme et le mollusque.

En plus de servir de plateforme pour les équipes de la JEAI ESBILH-SEN, cette plateforme est destinée à accueillir d'autres équipes/projet au niveau local. Elle héberge depuis 2019 un projet EDCTP (European and Developing Countries Clinical Trials Partnership) portant sur l'évaluation de la capacité invasive de hybrides de schistosomes sous la pression de traitement au PZQ au Sénégal. La plateforme de malacologie est également ouverte aux équipes de recherche internationale afin de leur servir de laboratoire d'élevage de spécimens collectés sur le terrain mais aussi leur permettre de réaliser des expérimentations qu'il est difficile de faire à l'étranger (Europe/Amérique du nord) du fait des contraintes liées au transport international d'organismes vivants. ■



# Bilan : 2018 - 2022

**147** publications dont **78 en faisant intervenir au moins une autre équipe de VITROME**

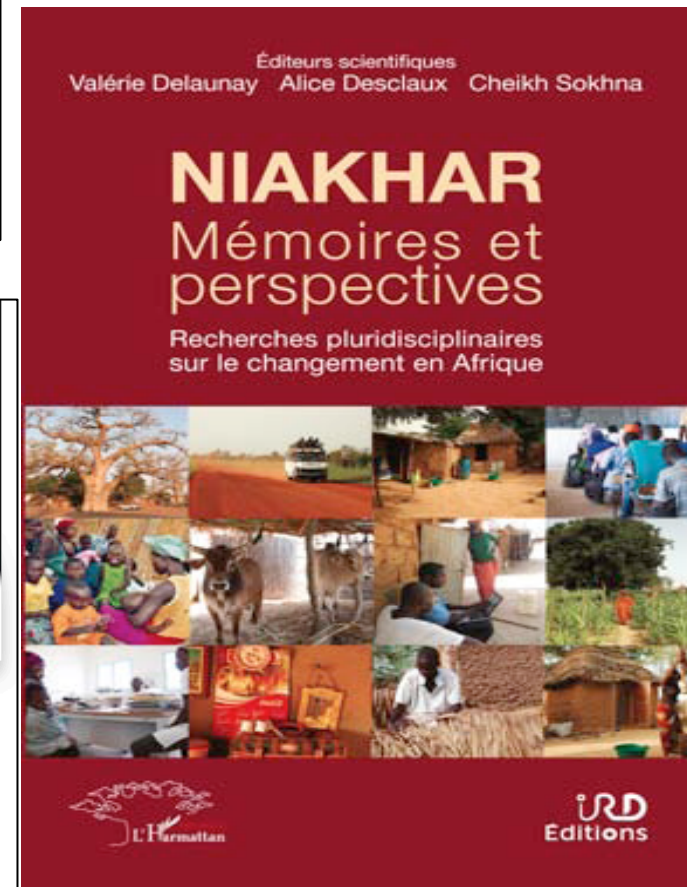


## Top 10 des chercheurs sénégalais selon ExpertScape

Par Frederic Atayodi Publié le 12 mai 2022 14:41 Dans : Actu Santé

Durant la décennie 2011-2021, le classement fait par Expertscape a recensé **les chercheurs sénégalais ayant fait des publications majeures** dans le domaine médical.

En tête de liste on retrouve le docteur Cheikh Sokhna Paludologue et Directeur de Recherche à l'IRD qui au cours de la dernière décennie a fait 109 publications. En 2021, Dr. Sokhna a publié quatre travaux de recherches dont l'une portant sur le COVID-19 et le grand Magal de Touba. Cette étude a été publiée dans **International Journal of Infectious Diseases**



Conseil scientifique IHU  
18-20 octobre 2023

## Equipe 6

Surveillance épidémiologique et moléculaire  
des maladies infectieuses  
Pierre-Edouard FOURNIER





# Equipe 6 : Surveillance épidémiologique et moléculaire des maladies infectieuses

Pierre-Edouard FOURNIER

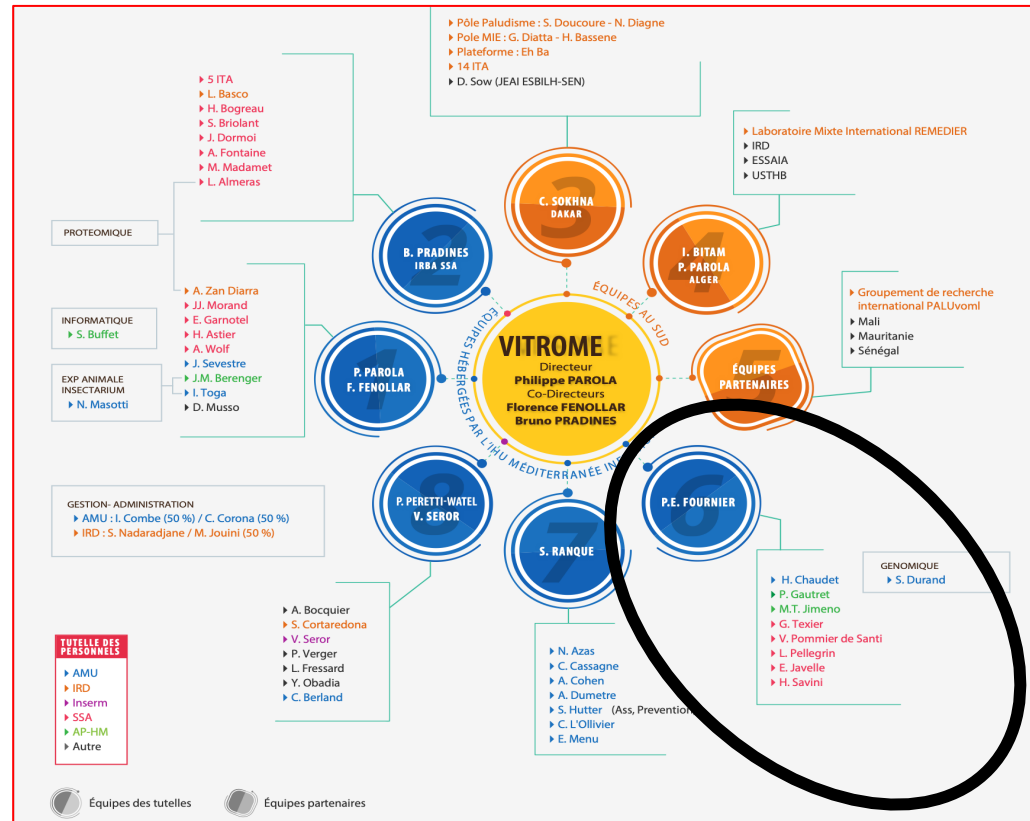


AMU-AP-HM: Hervé CHAUDET,  
Pierre-Edouard FOURNIER

AMU: Idir KACEL

AP-HM: Philippe GAUTRET,  
Marie-Thérèse JIMENO

SSA: Liliane PELLEGRIN,  
Vincent POMMIER DE SANTI,  
Hélène SAVINI, Gaetan TEXIER





# Etudiants

Master 2: Hélène MARTEL, Emilie RENUCCI (2018), Farah AZOUZI, Naomie CANARD, Mathis ROUZOUL, Marguerite VILLOTE (2019), Lea FUSTER, Marine MAKOA (2020), Philippe LAVRARD-MEYER (2021), Fama NDIME (2022), Feng WU, Martin GRAU (2023)



Thésards: Rita ABOU ABDALLAH, Awa DIOP (2018), Ganesh WARTHI (2019), Hussein ANANI, Diyoly AYONA, Pierre-Yves CORDIER, Thi Loi DAO, Tran Duc Anh LY (2020), Audrey GIRAUD-GATINEAU, Ndiaw GOUMBALLA, Van Thuan HOANG, Emilie JAVELLE, Lancei KABA, Luis KANGALE, Mudra KHARE, Ngoc Anh Tu NGUYEN, Rita ZGHEIB (2021), Malak ZOAITER (2022), Ali AKOUM, Emilie BUREL, David DELARBRE, Philippe LAVRARD-MEYER, Anna-Julienne NDIAYE, Coumba TOURE, Stéphanie WATIER GRILLOT (en cours)



Post-doc Raj SIN



## Financements obtenus (3100 k€)

- PRC SSA: SOAP: Plate-forme de simulation pour l'aide à la décision, la formation et l'entraînement en surveillance et veille sanitaire pour l'alerte précoce (55k€), FLORIMAC (35 k€), Spectra Def (55 k€), méthode alternative pour la recherche dans les aliments d'agents de toxi-infections alimentaires collectives au sein des armées françaises (116,5 k€), RAAID (Résistance d'*Anopheles* et d'*Aedes* aux Insecticides, 230 k€)

PHRC régional: SpectraSurv (250 k€)

Ministères de la Santé/MESRI: Consortium EMERGEN (2500 k€)

Commonwealth scientific and industrial research organisation: pangenic study of *Piscirickettsia salmonis*, 2018-2019 (90 k€)

Partenariat Hubert Curien franco-slovaque, 2018-2019: (10.6 k€)

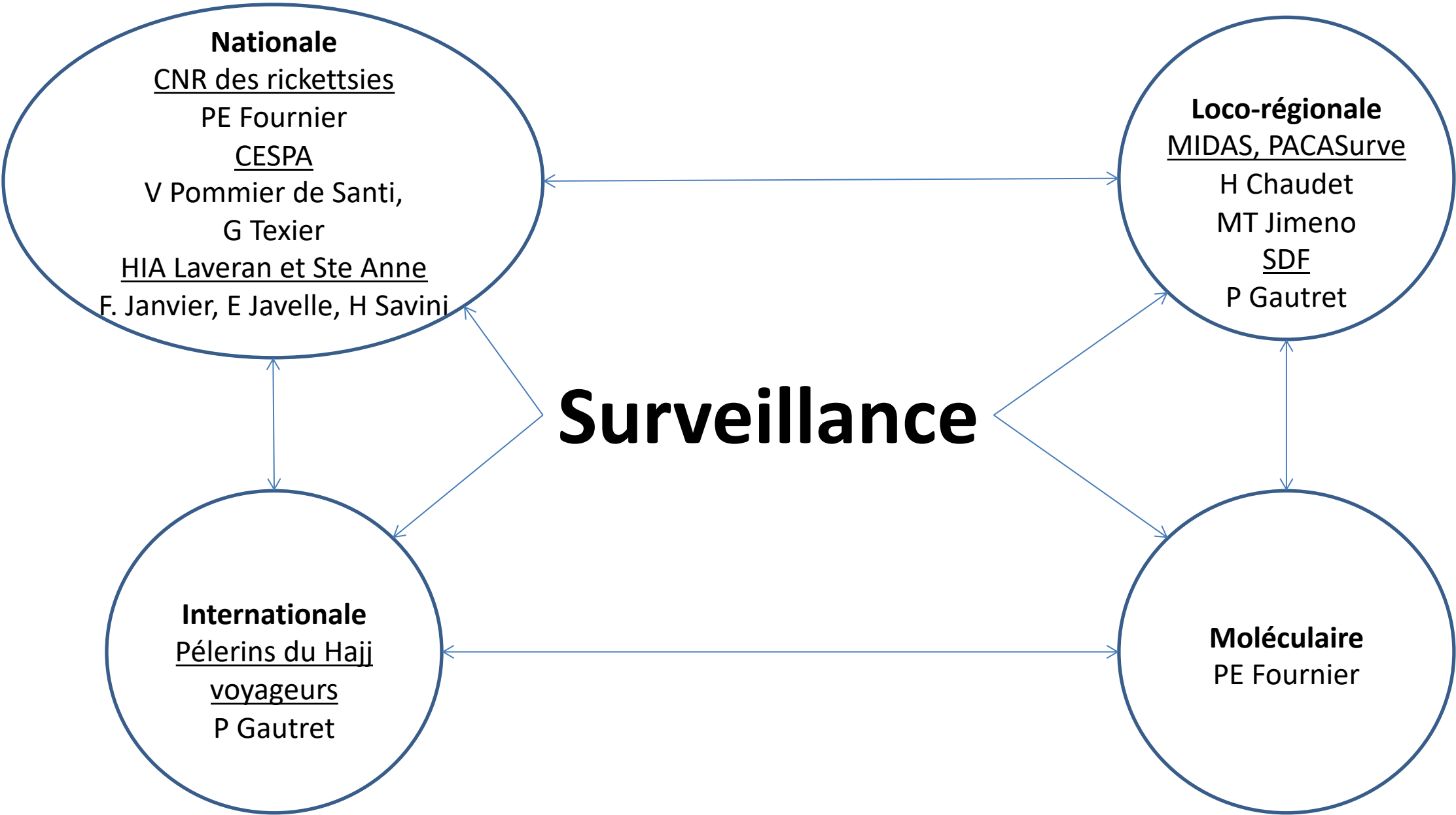
# Collaborations

Intra VITROME: équipes 1 (Parola-Fenollar) et 3 (Sokhna)

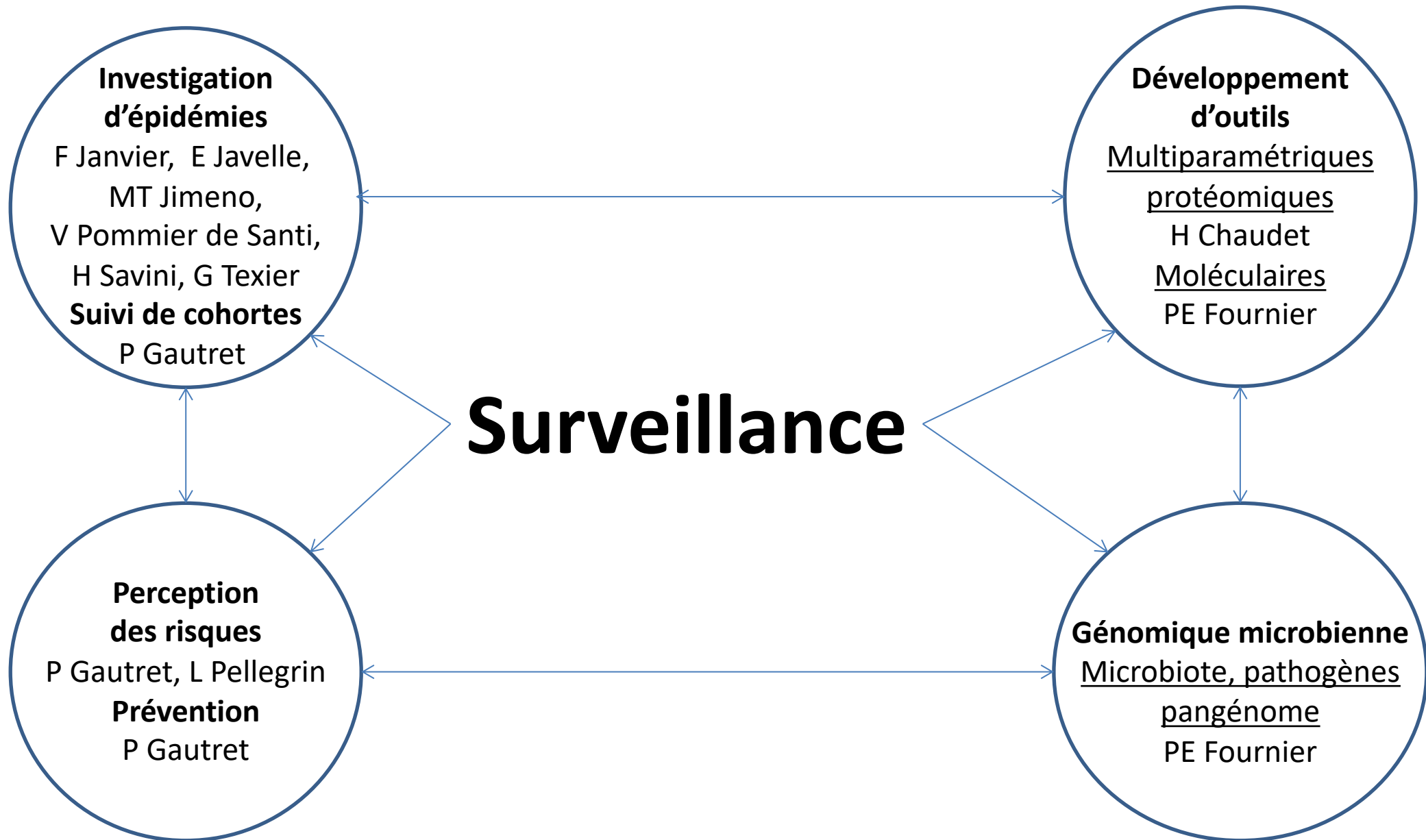
UMR MEPHI, SESSTIM

ANSES, CIRAD, EuroTravNet & Geosentinel, HCSP, INRAE EPIA,  
Institut Pasteur Paris & réseaux des Instituts Pasteur, IRD  
MIVEGEC, OMS (Initiative *An. stephensi*), OTAN, Sorbonne  
Université, Santé Publique France, US Army

Société Sud-Cosmétique







# Thématiques de recherche

- COVID-19

- Surveillance des populations (voyageurs internationaux et migrants , rassemblements de masse (Hajj, Grand Magal), SDF, militaires...)

- Etude du microbiote (humain, planaire)

- Mise au point d'outils (surveillance des infections, détection moléculaire, aide à la décision)

# COVID-19 in 16 West African Countries: An Assessment of the Epidemiology and Genetic Diversity of SARS-CoV-2 after Four Epidemic Waves

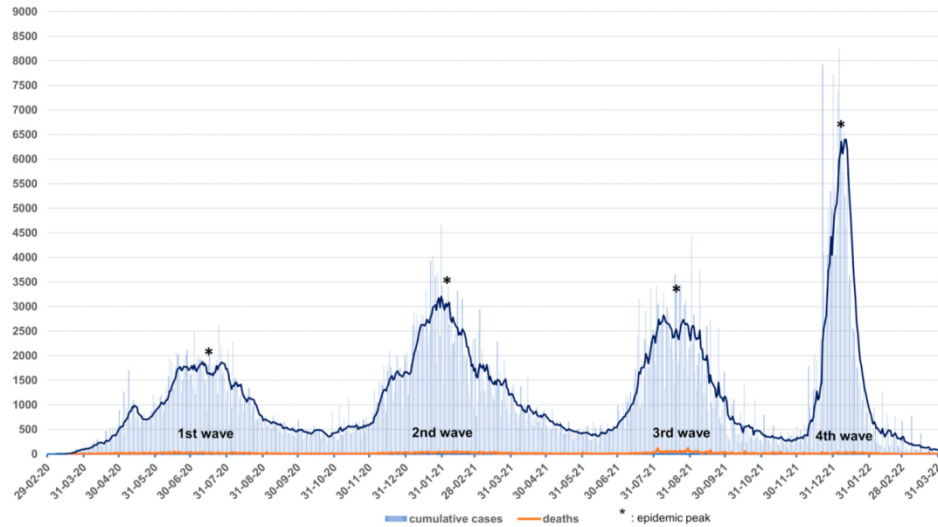
Anna Julienne Selbé Ndiaye,<sup>1,2</sup> Mamadou Beye,<sup>2</sup> Aissatou Sow,<sup>1</sup> Gora Lo,<sup>1</sup> Abdou Padane,<sup>1,2</sup> Cheikh Sokhna,<sup>2,3,4</sup> Coumba Touré Kane,<sup>1</sup> Philippe Colson,<sup>2,5</sup> Florence Fenollar,<sup>2,4</sup> Souleymane Mboup,<sup>1</sup> and Pierre-Edouard Fournier<sup>2,4\*</sup>

*Am. J. Trop. Med. Hyg.*, 109(4), 2023, pp. 861–873

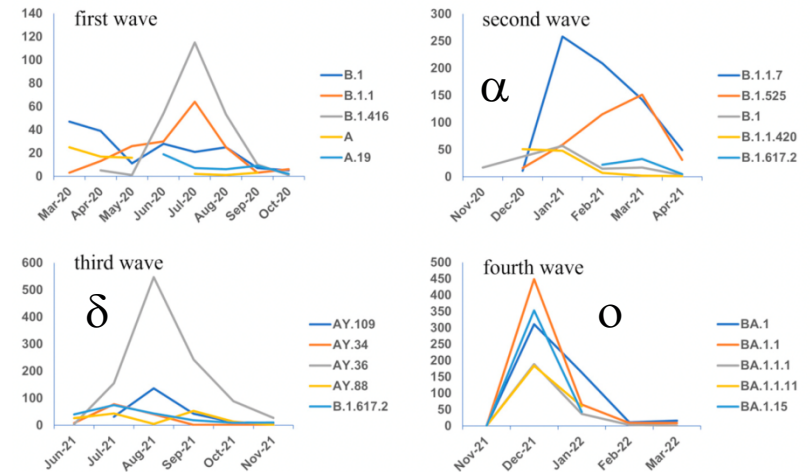
# COVID-19



- Revue de l'impact de la COVID-19 dans 16 pays d'Afrique de l'Ouest
- 4 vagues épidémiques de février 2020 à mars 2022



- Identification de 205 lignages de SARS-COV-2



# Genomic Epidemiology of SARS-CoV-2 in Urban Settings in Senegal

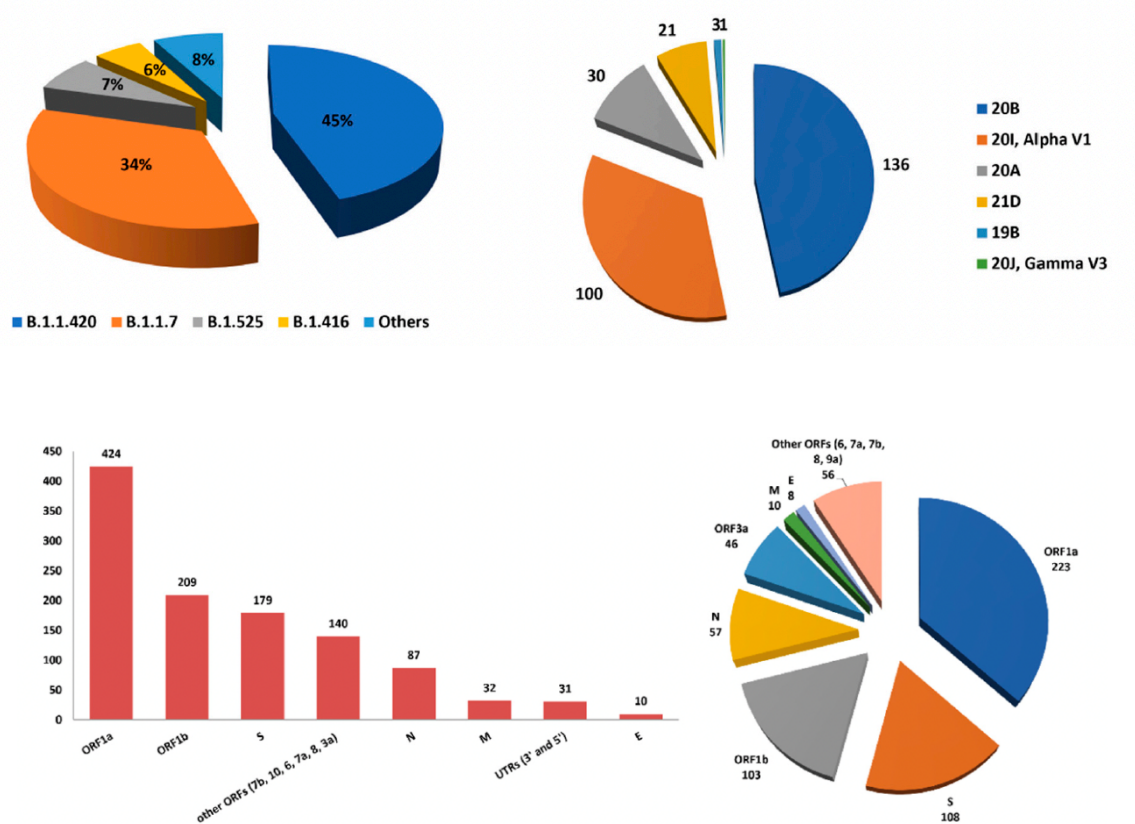
Anna Julienne Selbé Ndiaye <sup>1,2</sup>, Mamadou Beye <sup>2</sup>, Gora Lo <sup>1</sup>, Idir Kacel <sup>2</sup>, Aissatou Sow <sup>1</sup>, Nafissatou Leye <sup>1</sup>, Abdou Padane <sup>1</sup>, Aminata Mboup <sup>1</sup>, Halimatou Diop-Ndiaye <sup>3</sup>, Cheikh Sokhna <sup>2,4,5</sup>, Coumba Touré Kane <sup>1</sup>, Philippe Colson <sup>2,6</sup>, Florence Fenollar <sup>2,5</sup>, Souleymane Mboup <sup>1</sup> and Pierre-Edouard Fournier <sup>2,5,\*</sup>

*Viruses* 2023, 15, 1233. <https://doi.org/10.3390/v15061233>

# COVID-19



- 379 patients, 1<sup>ère</sup> et 2<sup>nde</sup> vagues
- Dakar et Thies
- 16 lignages
- Lignée majeure B.1.1.420 > alpha
- 1125 SNPs, plus grande densité dans ORF10





# Chikungunya Outbreak in Country with Multiple Vectorborne Diseases, Djibouti, 2019–2020

Emilie Javelle, Franck de Laval, Guillaume André Durand, Aissata Dia, Cécile Ficko, Aurore Bousquet, Deborah Delaune, Sébastien Briolant, Audrey Mérens, Constance Brossier, Hervé Pommier, Florian Gala, Alain Courtiol, Quentin Savreux, Sébastien Sicard, Jean-Philippe Sanchez, Francis Robin, Fabrice Simon, Xavier de Lamballerie, Gilda Grard, Isabelle Leparc-Goffart, Vincent Pommier de Santi

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 29, No. 4, April 2023

- Co-épidémie chikungunya et dengue touchant la communauté de Défense Française à Djibouti en 2019-2020
- 56 cas de dengue et 58 cas de Chikungunya
- Intervention du SSA : infectiologue, médecin de santé publique et biologiste :
  - Diagnostic et prise en charge des cas
  - Contrôle de l'épidémie
- Bonne sensibilité du buvard et du TDR Ag NS1 versus PCR

# Investigation d'épidémies

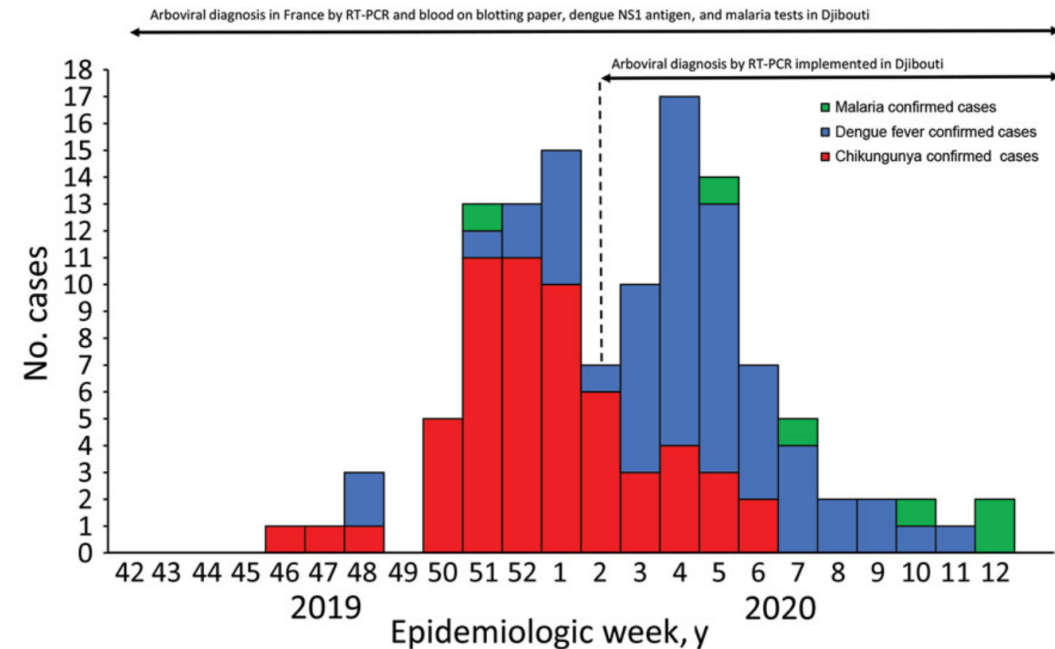


Figure 2. Vectorborne diseases among the French Defense Community in Djibouti: epidemic curve and availability of diagnostic tools, 2020 (chikungunya = 58, dengue = 56, and malaria = 6 cases). NS1, nonstructural protein 1; RT-PCR, reverse transcription PCR.

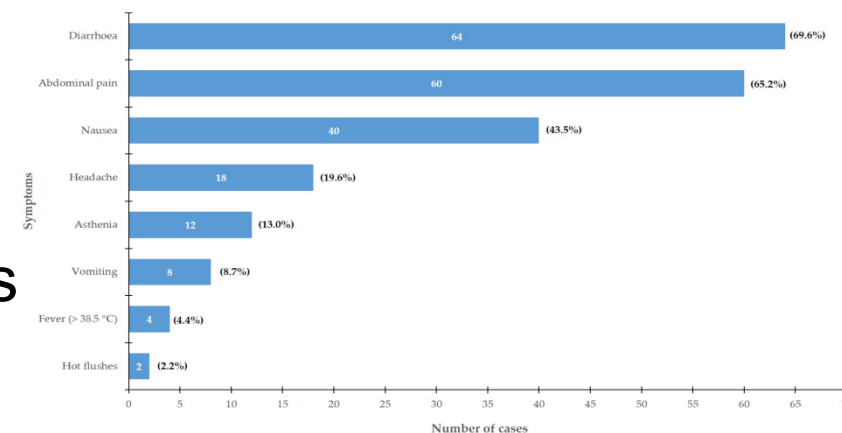
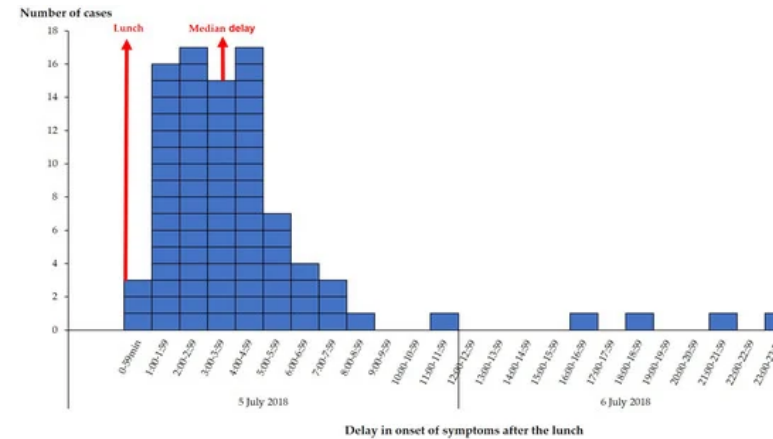
## From Foodborne Disease Outbreak (FBDO) to Investigation: The Plant Toxin Trap, Brittany, France, 2018

Stéphanie Watier-Grillot <sup>1,\*</sup>, Sébastien Larréché <sup>2,3</sup>, Christelle Mazuet <sup>4</sup>, Frédéric Baudouin <sup>5</sup>,  
Cécile Feraudet-Tarisse <sup>6</sup>, Lise Holterbach <sup>1</sup>, Aïssata Dia <sup>1</sup>, Christelle Tong <sup>1</sup>, Laure Bourget <sup>7</sup>, Sophie Hery <sup>8</sup>,  
Emmanuel Pottier <sup>9</sup>, Olivier Bouilland <sup>9</sup>, Marc Tanti <sup>1</sup>, Audrey Merens <sup>2,3</sup>, Stéphanie Simon <sup>6</sup>, Laure Diancourt <sup>4</sup>,  
Aurélié Chesnay <sup>7</sup> and Vincent Pommier de Santi <sup>1,10</sup>

*Toxins* 2023, 15, 457. <https://doi.org/10.3390/toxins15070457>

# Investigation d'épidémies

- 2018, 200 cas de gastroentérite (taux d'attaque 17%)
- Intoxication / phytohémagglutinine du haricot rouge
- Première description en France / 200 malades
- Investigations microbiologiques négatives
- Investigation épidémiologique
- Chili con carne aOR = 32,8 [13,8-77,8]
- Haricots mal cuits
- Manque d'outils de détection des toxines



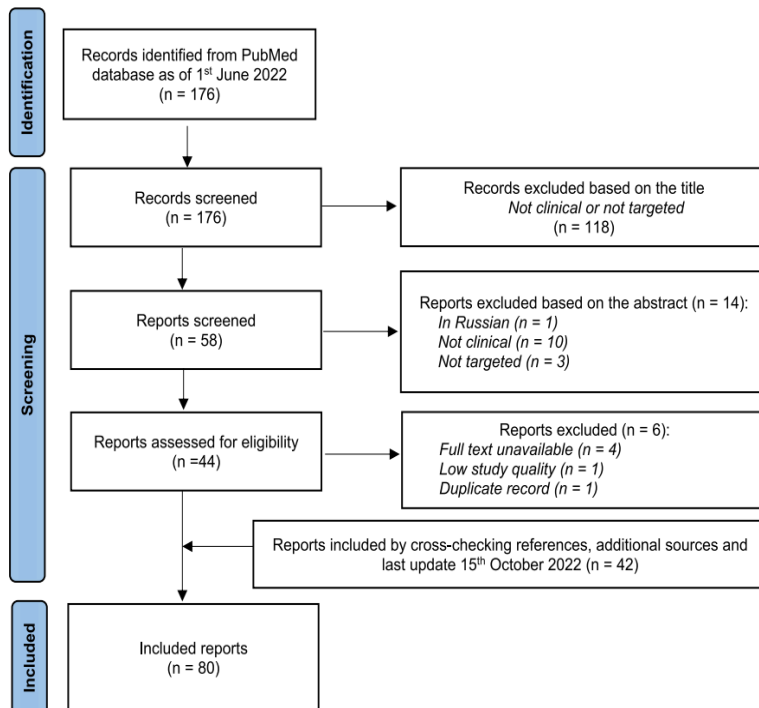
# Monkeypox clinical disease: Literature review and a tool proposal for the monitoring of cases and contacts

Emilie Javelle<sup>a,b,c,\*</sup>, Cécile Ficko<sup>d,e</sup>, Hélène Savini<sup>b,c</sup>, Marie Mura<sup>f,g</sup>, Olivier Ferraris<sup>f,h</sup>, Jean Nicolas Tournier<sup>e,f,g</sup>, Franck de Laval<sup>i,j</sup>

Travel Medicine and Infectious Disease 52 (2023) 102559

# Développement d'outils d'investigation des épidémies

- Revue de la littérature et mise au point d'un outil de suivi des cas et contacts
- Forme actuelle ≠ forme historique
- Contagiosité & symptômes longs (mois)
- Expression bénigne avec gestion essentiellement ambulatoire



**MONKEYPOX FOLLOW-UP: DAILY COLLECTION OF CLINICAL SIGNS**  
To be completed every day by the patient during 28 days

NAME: ..... DATE OF BIRTH: .....  
 FIRST NAME: ..... I AM A CONTACT CASE → DATE OF THE LAST AT-RISK CONTACT: .....  
 PHONE NUMBER: ..... I AM SYMPTOMATIC → DATE OF THE FIRST SYMPTOMS: .....  
 I AM VACCINATED AGAINST SMALLPOX → DATE: .....

Give this form to your doctor available by:  
 → Phone: .....  
 → Email: .....  
 The form will be implemented in your medical file. If you do not want this form to be analyzed for studies, check here:

\*0 is the minimum (no pain) and 10 is the maximum (worst pain ever)

Fill out the table below and the 2 figures to the right. Bring your form to the medical visits. Write your free comments and/or add photos following the sheet.

D = day	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	D28	
Write the dates D0, D7, D14, D21																								
Body weight																								
Temperature, indicate the value																								
Physical pain score from 0 to 10*																								
Anxiety or sadness from 0 to 10*																								
Skin lesions: indicate in the box: Total count of lesions →																								
AND The score(s) from 0 to 6 =>																								
Corresponding to the aspects of the lesions present that day: use the stages of lesions development depicted on the right; if different stages are observed, list all separated by a comma.																								
Each day, put an X in the box of the symptoms you have:																								
Swelling + locate on the figure 1																								
Itching																								
Genital lesion																								
Anal lesion																								
Oral lesion																								
Hair loss																								
Red eyes																								
Sensitivity to light																								
Visual disorders, vision loss																								
Sore throat																								
Difficulties when swallowing																								
Fatigue																								
Headache																								
Muscle aches																								
Joint aches																								
Backache																								
Cough																								
Difficulty breathing																								
Nausea or vomiting																								
Abdominal or anal pain																								
Difficulties in urinating																								
Inability to eat or drink																								
Bed-ridden																								
Bleeding (precise where)																								

Other symptoms, precise below and use the back of the sheet if necessary:

**1. Swelling or lumps under skin (lymph nodes)**

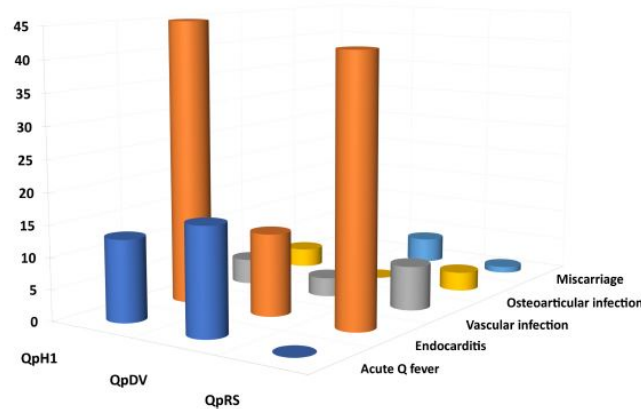
**2. Lesions on skin, scalp, mouth, genitalia**  
Color or hatch areas with lesions:

# Pangenomic analysis of *Coxiella burnetii* unveils new traits in genome architecture

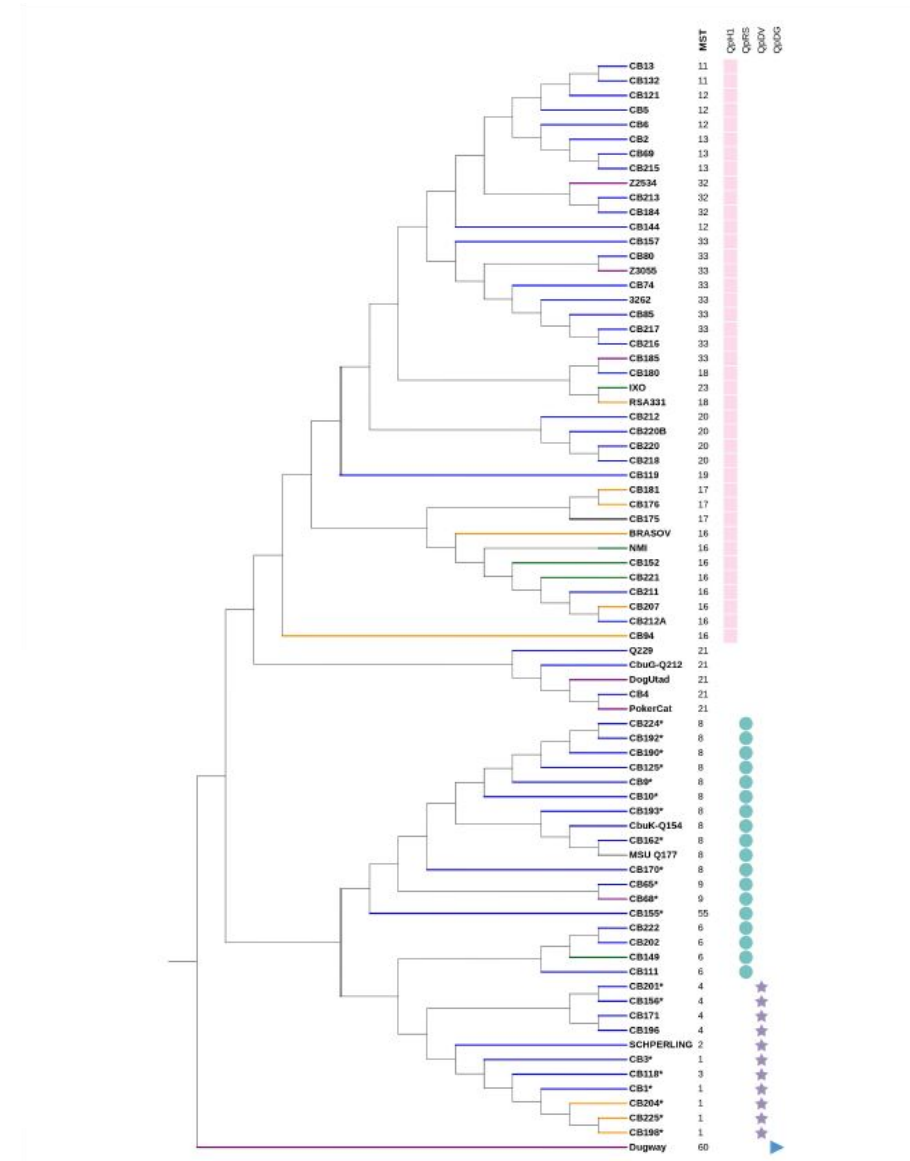
Rita Abou Abdallah<sup>1,2</sup>, Matthieu Million<sup>2,3</sup>, Jeremy Delerce<sup>2,3</sup>, Hussein Anani<sup>1,2</sup>, Awa Diop<sup>1,2</sup>, Aurelia Caputo<sup>2,3</sup>, Rita Zgheib<sup>1,2</sup>, Elodie Rousset<sup>4</sup>, Karim Sidi Boumedine<sup>4</sup>, Didier Raoult<sup>2,3</sup> and Pierre-Edouard Fournier<sup>1,2\*</sup>

Front. Microbiol. 13:1022356.  
doi: 10.3389/fmicb.2022.1022356

- 64 souches
- 22 génotypes
- 5 gènes acquis des *Chlamydiae*
- Pathogénicité plasmide-dépendante
- QpDV fièvre Q aigüe
- QpRS fièvre Q chronique
- QpH1 endocardite



# Génomique





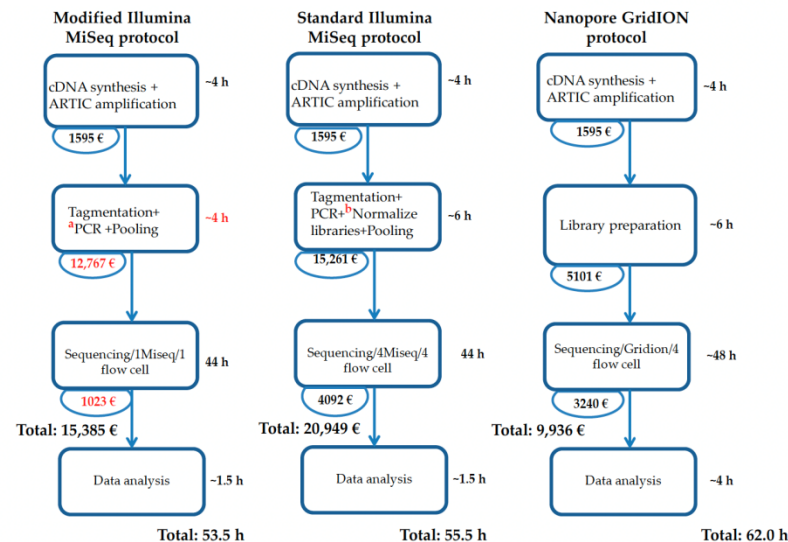
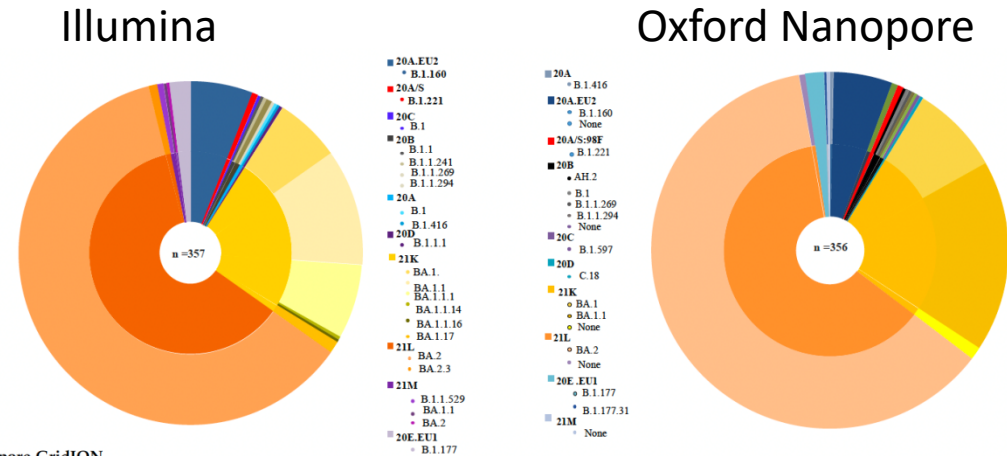
# Simultaneous SARS-CoV-2 Genome Sequencing of 384 Samples on an Illumina MiSeq Instrument through Protocol Optimization

Nasserdine Papa Mze <sup>1,2,\*</sup>, Mamadou Beye <sup>1,†</sup>, Idir Kacel <sup>1,†</sup>, Raphael Tola <sup>1</sup>, Leonardo Basco <sup>1,2</sup>, Hervé Bogreau <sup>1,2,3</sup>, Philippe Colson <sup>1,2</sup> and Pierre-Edouard Fournier <sup>1,2</sup>

Genes 2022, 13, 1648. <https://doi.org/10.3390/genes13091648>

# Développement d'outils de génomique

- Développement d'une méthode de séquençage génomique multiplexé
- 384 échantillons par flow cell
- 95% de séquences interprétables
- 53.5 vs 55.5 heures
- Economie de 4744 euros

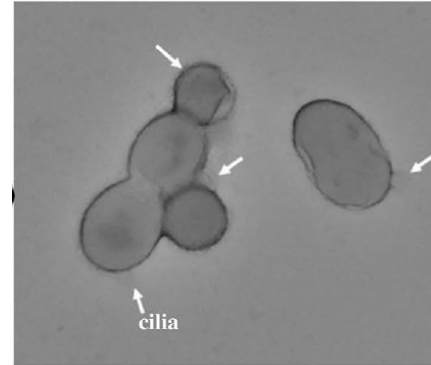


# Reclassification of eight *Akkermansia muciniphila* strains and description of *Akkermansia massiliensis* sp. nov. and *Candidatus Akkermansia timonensis*, isolated from human feces

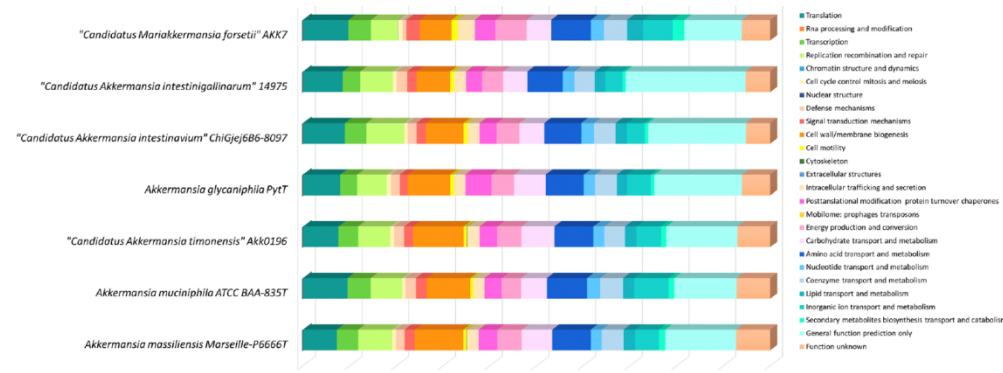
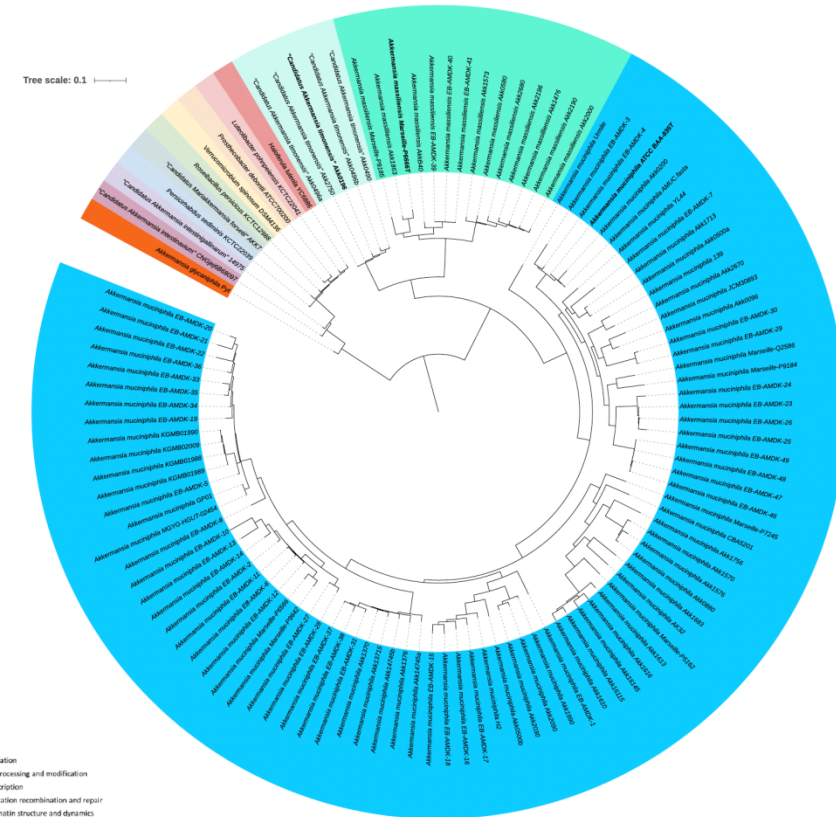
Sokhna Ndongo<sup>1,2,3</sup>, Nicholas Armstrong<sup>2,3</sup>, Didier Raoult<sup>1,2,4</sup> & Pierre-Edouard Fournier<sup>2,3,5</sup>

Scientific Reports | (2022) 12:21747

- 104 souches
- Caractérisation multi-modale
- 3 espèces
- *A. muciniphila*
- *A. massiliensis* sp. nov.
- « *A. timonensis* sp. nov. »



# Microbiote



# Production 2018-2023

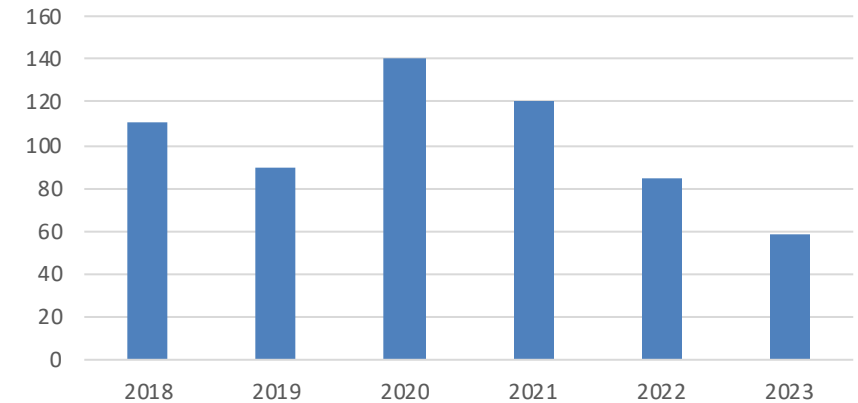
- Création d'une start-up: Technojouvence (2020)

  - 2 brevets

- Présentations YouTube: infections respiratoires, COVID-19 (tests antigéniques, vaccination, génomique), abcès cérébraux, Disease Health Surveillance level 1 Course, Le CESPAs fête ses 10 ans, NATO TV : could NATO fight diseases like Ebola using big data?

# Bibliométrie 2018-2023

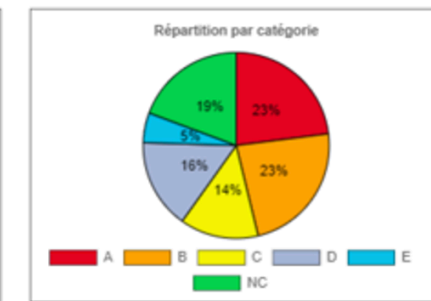
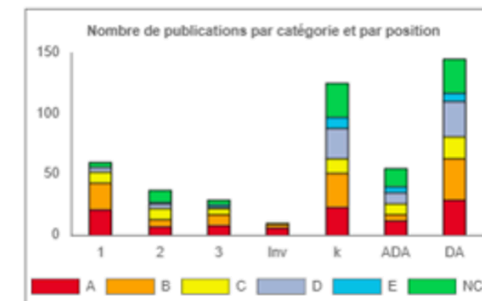
nombre de publications par année



- 461 articles en 2018-2021, 141 en 2022-2023
- 42,4 % des articles publiés dans des revues de rang A (106) ou B (107)

- 32831 citations, 5322 en 2023

- Un chercheur highly cited 2021: Philippe GAUTRET





*Infections au cours  
des grands rassemblements*



# The Magal project

P. Gautret

C. Sokhna

October 2023





# Grand Magal de Touba

→ **Mass gathering** : 4 to 5 million pilgrims coming from all Senegalese cities and beyond in and out of Africa (diaspora).

→ 18th of Safar, according to the Islamic calendar.

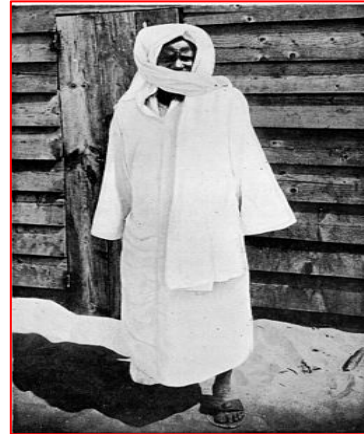
→ It celebrates the exile of Cheikh Ahmadou Bamba Mbacké, the founder of Mouridism.

→ **Rituals** last **one day**, but pilgrims usually **stay** in Touba for **several days**.

→ Activities: visit of the **central mosque** in Touba and the **mausoleum** of the Cheikh, **Recital of Quran and "Qasaid"**, visit of **Touba market** .

→ Housing: **family or spiritual guides (marabouts) homes**.

→ No hotels in Touba.





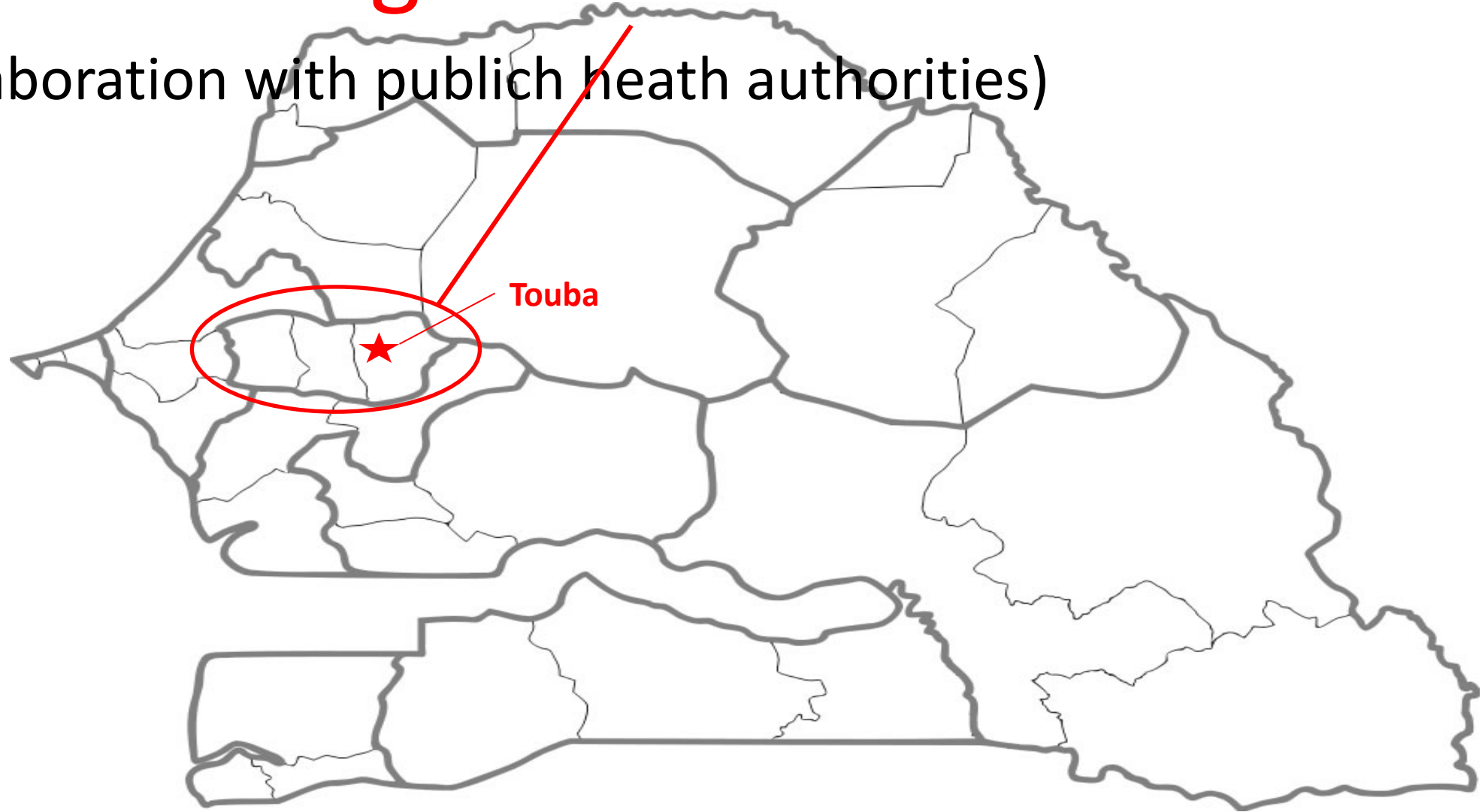
**High population density → risk for transmission of infectious diseases at the Magal as already demonstrated at the Hajj pilgrimage in Saudi Arabia ?**





- 1-Syndromic surveillance **Diourbel**  
**medical region**

(Collaboration with public health authorities)



# Magal 2015

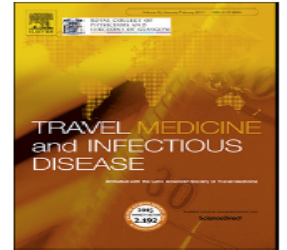
Travel Medicine and Infectious Disease 19 (2017) 56–60



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## Travel Medicine and Infectious Disease

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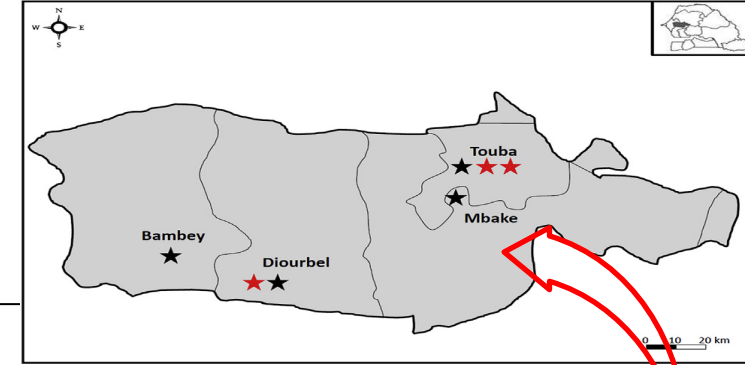


### Communicable and non-communicable disease risks at the *Grand Magal* of Touba: The largest mass gathering in Senegal



Cheikh Sokhna <sup>a</sup>, Balla Mbacké Mboup <sup>b</sup>, Papa Gallo Sow <sup>c</sup>, Gaoussou Camara <sup>c</sup>,  
Mamadou Dieng <sup>b</sup>, Mbaké Sylla <sup>b</sup>, Lamine Gueye <sup>c</sup>, Doudou Sow <sup>a, d</sup>, Aldiouma Diallo <sup>a</sup>,  
Philippe Parola <sup>a</sup>, Didier Raoult <sup>a</sup>, Philippe Gautret <sup>a, \*</sup>

# Estimated 4.16 Millions participants in 2015\*



**Table 1**

Medical infrastructures involved in the *Grand Magal* by districts in the medical region of Diourbel, 2015.

	District				Total
	Bambey	Diourbel	Mbacke	Touba	
Tertiary care hospitals <sup>a</sup>	—	1	—	2	3
Secondary care hospitals <sup>b</sup>	1	1	1	1	4
Primary healthcare centers <sup>c</sup>	23	23	21	27	94
Dispensaries (“cases de santé”) <sup>d</sup>	47	22	29	6	104
Advanced medical posts <sup>e</sup>	3	3	9	94	109
Private medical structures	3	13	2	33	51
Health squads <sup>f</sup>	1	2	1	1	5
Social rehabilitation centers	1	1	1	1	4

78 MD  
481 beds

<sup>a</sup> Bed capacity of 130 in Diourbel, 171 and 90 in Touba.

<sup>b</sup> Bed capacity of 23 in Diourbel, 30 in Mbacke, 27 in Touba and 10 in Bambey.

<sup>c</sup> Managed by nurses and midwives.

<sup>d</sup> Managed by volunteer community health agents reinforced by nurses and midwives during the *Grand Magal*.

<sup>e</sup> In charge of first aid treatment and referral to other medical structures.

<sup>f</sup> In charge of environmental hygiene including insecticide spraying.

\*Moubarack Lô (4,16 millions de Pèlerins enregistrés au Grand Magal de Touba 2015 (senego.com))

# Magal 2016

*Am. J. Trop. Med. Hyg.*, 102(2), 2020, pp. 476–482

doi:10.4269/ajtmh.19-0240

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## Senegal's Grand Magal of Touba: Syndromic Surveillance during the 2016 Mass Gathering

Cheikh Sokhna,<sup>1,2,3\*</sup> Ndiaw Goumballa,<sup>2</sup> Van Thuan Hoang,<sup>1,3,4</sup> Balla M. Mboup,<sup>5</sup> Mamadou Dieng,<sup>5</sup> Ahmadou B. Sylla,<sup>5</sup>  
Aldiouma Diallo,<sup>2</sup> Didier Raoult,<sup>3,6</sup> Philippe Parola,<sup>1,3</sup> and Philippe Gautret<sup>1,3</sup>



- **20,850 patients (5 days)**
- 98.5% outpatients
- **1.5% hospitalization**
- **1 death only**
- 1.0% transfer Dakar
- **29.8% antibiotics**

- **Median age: 26 years** (IQR 11-45 years, range 0-96 years)
- **31% individuals  $\leq 15$  years** and **11%  $\geq 60$  years**
- **56% patients were female**

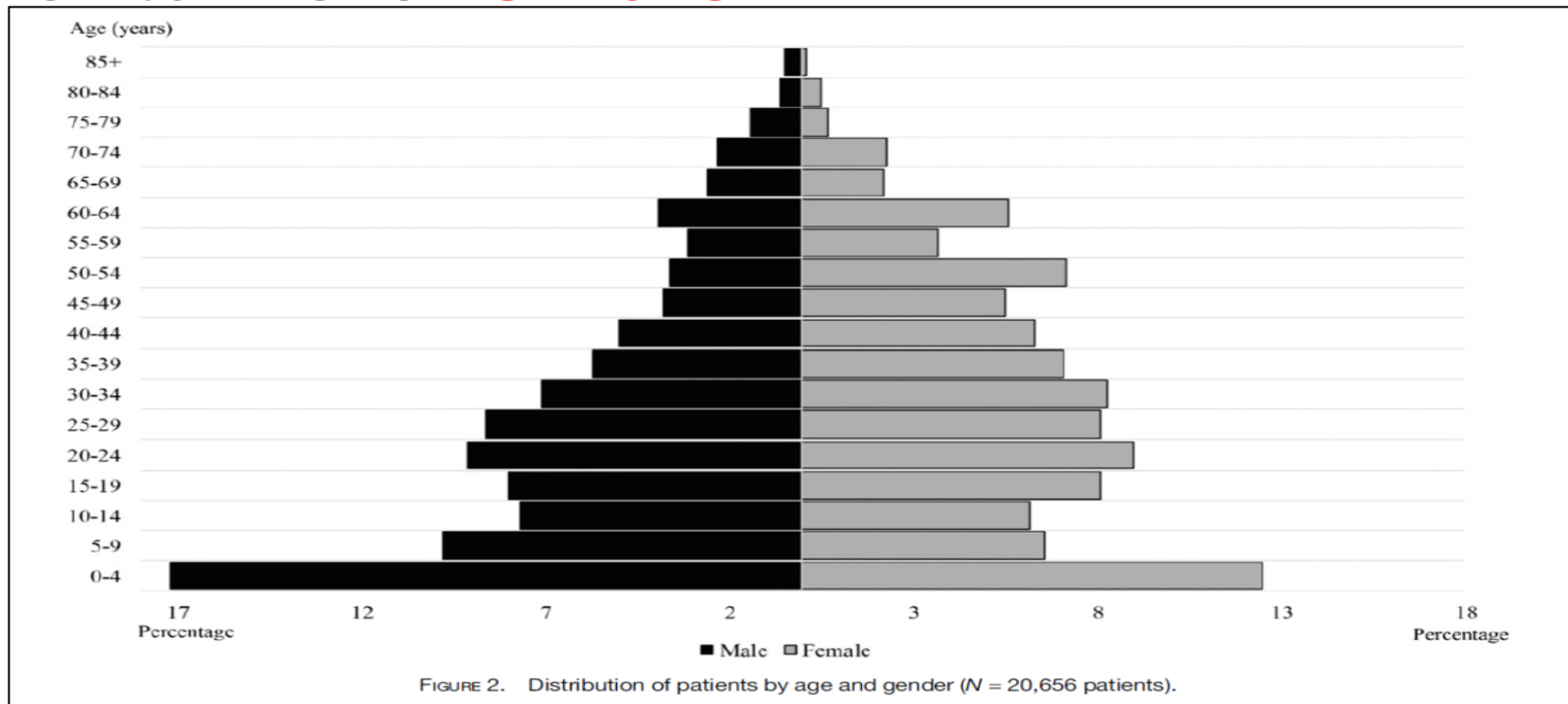


TABLE 1

Main symptoms presented by patients (N = 20,850)

Symptoms	Number of patients	Proportion of all patients (%)
Headache	5,913	28.4
Fever	3,593	17.2
Fatigue	3,277	15.7
Vertigo	1,476	7.1
High blood pressure	1,398	6.7
Diffuse pain	1,216	5.8
Arthralgia	567	2.7
Myalgia	566	2.7
Gastrointestinal symptoms	4,591	22.0
Abdominal pain	1,509	7.2
Vomiting or nausea	1,223	5.9
Epigastric pain	1,222	5.9
Diarhea	803	3.9
Constipation	340	1.6
Anorexia	288	1.4
Respiratory symptoms	3,563	17.1
Cough	3,126	15.0
Rhinitis	1,791	8.6
Influenza-like illness	446	2.1
Sore throat	194	0.9
Dyspnea	153	0.7
Skin infections	600	2.9
Wound	1,039	5.0
Dermatitis	454	2.2
Skin abscess	146	0.7
Dental pain	750	3.6
Trauma	1,578	7.6
Conjunctivitis	300	1.5
Heat stress	282	1.4
Urinary symptoms	227	1.1

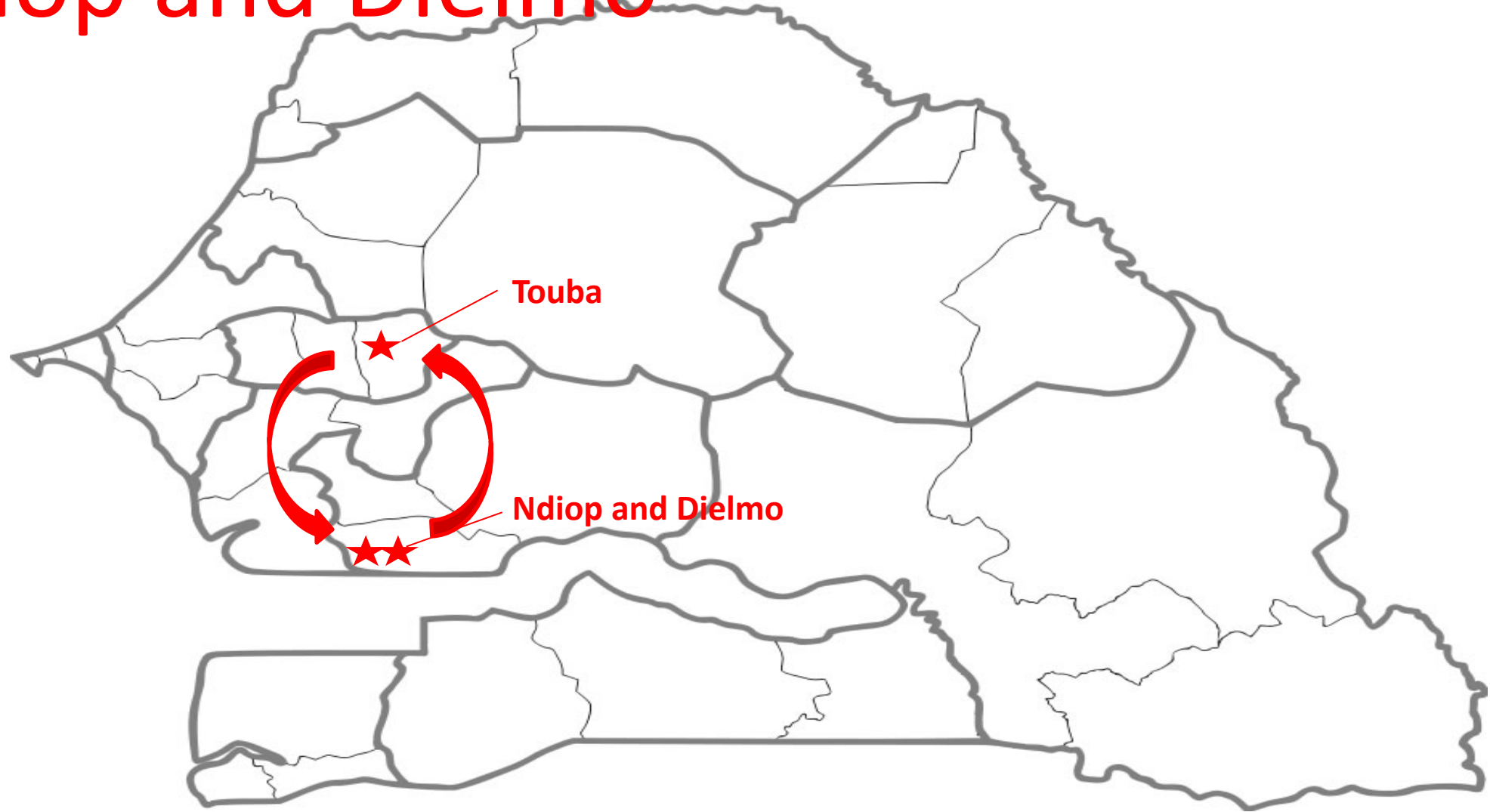
**Malaria**  
(*falciparum* RDT)  
(3% total)

**Gastroenteritis**

**URTI**

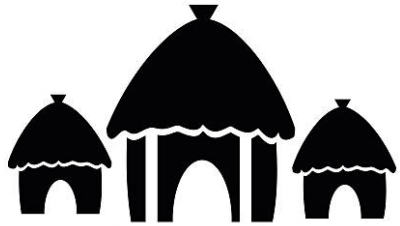
- 2-Prospective cohort studies

## Ndiop and Dielmo





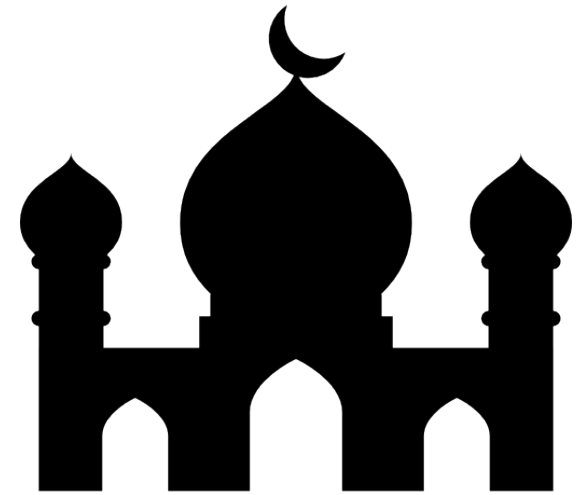
- Prospective cohort survey with standardized questionnaires + respiratory and stool systematic sampling **before** and **after** the Grand Magal (pilgrims versus **controls**)



Dielmo Ndiop



Touba





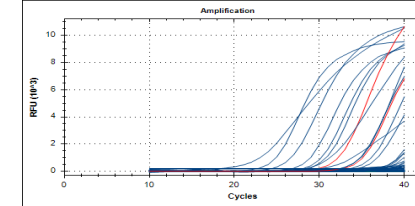
**Questionnaires:** demographics, chronic medical conditions, vaccination status and non-pharmaceutical preventive measures, symptoms, antibiotics...



Thermo Scientific™  
KingFisher™ Flex  
purification systems



CFX96



## qPCR

Respiratory pathogens		Gastrointestinal pathogens	
Virus	Bacteria	Virus	Bacteria and parasites
IAV	<i>S. pneumoniae</i>	Adenovirus	EPEC
IBV	<i>S. aureus</i>	Astrovirus	EHEC
HRV	<i>M. catarrhalis</i>	Norovirus	EAEK
ADV	<i>H. influenzae</i>	Hepatitis A virus	Shigella/EIEC
HCov	<i>K. pneumoniae</i>	Hepatitis E virus	<i>C. jejuni</i>
VRS	<i>M. pneumoniae</i>		<i>G. Lamblia</i>
MPV	<i>B. pertusis</i>		<i>Salmonella sp.</i>
SARS-CoV2	<i>N. meningitidis</i>		<i>T. whipplei</i>
HPIV			<i>Cryptosporidium sp.</i>
			<i>E. histolytica</i>



# 533 pilgrims

# Magal 2017-2021



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## Travel Medicine and Infectious Disease

journal homepage: [www.elsevier.com/locate/tmaid](http://www.elsevier.com/locate/tmaid)



### Respiratory and gastrointestinal infections at the 2017 Grand Magal de Touba, Senegal: A prospective cohort survey

Van-Thuan Hoang<sup>a</sup>,  
Stéphane Ranque<sup>a</sup>,  
Vincent Pommier<sup>d</sup>

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<sup>b</sup> Thai Binh University of Medicine  
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## Travel Medicine and Infectious Disease

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Original article

### Respiratory infections among pilgrims at the Grand Magal of Touba: A comparative cohort study



Ndiaw Goumballa<sup>a,b,c</sup>,  
Papa Mouhamadou  
Philippe Gautret<sup>a,c,\*</sup>

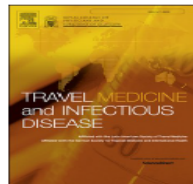
Travel Medicine and Infectious Disease 49 (2022) 102418



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## Travel Medicine and Infectious Disease

journal homepage: [www.elsevier.com/locate/tmaid](http://www.elsevier.com/locate/tmaid)



### Risk factors for symptoms of infection and the acquisition of pathogens among pilgrims at the Grand Magal of Touba, 2017–2021

Ndiaw Goumballa<sup>a,b,c</sup>, Van Thuan Hoang<sup>d</sup>, Fatou Samba Diouf<sup>b,c</sup>, Babacar Mbaye<sup>c</sup>,  
Philippe Parola<sup>a,c</sup>, Cheikh Sokhna<sup>a,b,c</sup>, Philippe Gautret<sup>a,c,\*</sup>



- Median age: 24 years (range 0-85 years)
- 29% individuals  $\leq 15$  years
- 51% patients were male
- Comorbidities: 9%
- Vaccination influenza <1%
- Vaccination IPD: 5%
- Vaccination MEN A: 100%
- Face mask: 41%;  $\leq 2019$ : 11%, 2020-2021: 70%
- Frequent hand washing: 55%;  $\leq 2019$ : 51%, 2020-2021: 58%
- Frequent use of Hand soap: 83%;  $\leq 2019$ : 74%, 2020-2021: 94%
- Frequent use of disposable tissues: 45%;  $\leq 2019$ : 41%, 2020-2021: 50%



- R symptoms: 55% overall [ 13% pre-Magal, 41% post-Magal] no significant difference between  $\leq 2019$  and 2020-2021
- GI symptoms: 13% overall [4% pre-Magal, 9% post-Magal]. Significant decrease of GI symptoms in 2020-2021 vs.  $\leq 2019$

**Table 1**  
Prevalence of clinical symptom and antibiotic intake.

Symptoms	2017 N = 110	2018 N = 101	2019 N = 93	sub-total (2017–2019) N = 304	2020 N = 106	2021 N = 125	Sub-Total (2020–2021) N = 231	P-value <sup>a</sup>	Total 2017–2021 N = 535
Respiratory symptoms <sup>a</sup>	46 (41.8)	49 (48.5)	70 (75.3)	165 (54.3)	60 (56.6)	68 (54.4)	128 (54.3)	0.79	293 (54.8)
Before Touba	12 (10.9)	11 (10.9)	14 (13.2)	37 (12.2)	18 (17.0)	17 (13.6)	35 (15.1)	0.31	72 (13.4)
After Touba	34 (30.9)	38 (37.6)	56 (60.2)	128 (42.1)	42 (39.6)	51 (40.8)	93 (40.3)	0.67	221 (41.3)
Cough <sup>a</sup>	28 (25.4)	38 (37.6)	46 (49.5)	112 (36.8)	38 (35.8)	47 (37.6)	85 (36.8)	0.99	197 (36.8)
Dyspnoea <sup>a</sup>	0 (0)	9 (8.9)	12 (12.9)	21 (6.9)	3 (2.8)	9 (7.2)	12 (5.2)	0.41	33 (6.2)
Sore throat <sup>a</sup>	11 (10.0)	17 (16.8)	21 (22.6)	49 (16.1)	11 (10.4)	10 (8.0)	21 (9.1)	0.02	70 (13.1)
Voice loss <sup>a</sup>	5 (4.5)	2 (2.0)	10 (10.7)	17 (5.6)	0 (0)	3 (2.4)	3 (1.3)	0.01	20 (3.7)
Rhinitis <sup>a</sup>	33 (30.0)	39 (38.6)	49 (52.7)	121 (39.8)	42 (39.6)	27 (21.6)	69 (29.9)	0.02	190 (35.5)
Fever <sup>a</sup>	11 (10.0)	5 (4.9)	33 (35.5)	49 (16.1)	23 (21.7)	9 (7.2)	32 (13.1)	0.03	81 (15.1)
Influenza like illness <sup>a</sup>	2 (1.8)	2 (2.0)	14 (15.0)	18 (5.9)	5 (4.7)	3 (2.4)	8 (3.5)	0.19	26 (4.8)
Use of antibiotics	3 (2.73)	2 (2.0)	2 (2.1)	7 (2.3)	0 (0)	1 (0.8)	1 (0.4)	0.08	8 (1.5)
Gastrointestinal symptoms <sup>a</sup>	16 (14.5)	9 (8.9)	27 (29.0)	52 (17.1)	6 (5.6)	13 (10.4)	19 (8.3)	0.003	71 (13.3)
Before Touba	4 (3.6)	1 (1.0)	13 (14.0)	18 (5.9)	2 (1.9)	2 (1.6)	4 (1.7)	0.02	22 (4.1)
After Touba	12 (10.9)	8 (7.9)	14 (15.1)	34 (11.2)	4 (3.8)	11 (8.8)	15 (6.5)	0.06	49 (9.1)
Diarrhoea <sup>a</sup>	5 (4.5)	4 (4.0)	8 (8.6)	17 (5.6)	1 (0.9)	6 (4.8)	7 (3.0)	0.16	27 (4.5)
Nausea <sup>a</sup>	1 (0.9)	1 (1.0)	5 (5.4)	7 (2.3)	1 (0.9)	0 (0)	1 (0.4)	0.08	8 (1.5)
Vomiting <sup>a</sup>	10 (9.1)	1 (1.0)	3 (3.2)	14 (4.6)	1 (0.9)	3 (2.4)	4 (1.7)	0.07	18 (3.4)
Stomach ache <sup>a</sup>	0 (0)	5 (4.9)	11 (11.8)	16 (5.3)	4 (3.8)	10 (8.0)	14 (6.1)	0.69	30 (5.6)
Fever <sup>a</sup>	0 (0)	1 (1.0)	5 (5.4)	6 (2.0)	2 (1.9)	0 (0)	2 (0.9)	0.30	8 (1.5)
Use of antibiotics	2 (1.8)	2 (2.0)	1 (1.1)	5 (1.6)	0 (0)	0 (0)	0 (0)	0.05	5 (0.9)

\*\*chi2 compare sub-total (2017–2019) versus (2020–2021).

<sup>a</sup> Overall (before and after Touba).

URTI

Gastroenteritis

# Magal 2019-2021

	Respiratory symptoms post-Magal	GI symptoms post-Magal
<b>PILGRIMS</b> (N=324)	<b>46%</b>	<b>9%</b>
<b>CONTROLS</b> (N=215)	<b>11%</b>	<b>1%</b>

- Acquisition of respiratory viruses 18% (rhinovirus 10%) and bacteria 45% (*H. influenzae* 19%, *S. pneumoniae* 14%...)
- Significant decrease in 2020-2021 vs.  $\leq 2019$

**Table 2**  
Acquisition rates of respiratory pathogens among pilgrims.

Pathogens	2017	2018	2019	Sub-total (2017–2019)	2020	2021	Sub-total (2020–2021)	P-value	Total (2017–2021)
	N = 108	N = 101	N = 93	N = 302	N = 106	N = 125	N = 231		N = 533
<b>Virus</b>									
At least one virus	35 (32.4)	16 (15.8)	26 (27.9)	77 (25.5)	15 (14.1)	5 (4.0)	20 (8.7)	<0.0001	97 (18.2)
Influenza A	0 (0)	1 (1.0)	0 (0)	1 (0.3)	4 (3.8)	4 (3.2)	8 (3.5)	0.005	9 (1.7)
Influenza B	1 (0.9)	0 (0)	0 (0)	1 (0.3)	2 (1.9)	0 (0)	2 (0.9)	0.41	3 (0.6)
Human rhinovirus	14 (13.0)	12 (11.9)	21 (22.6)	47 (15.6)	6 (5.7)	1 (0.8)	7 (3.3)	<0.0001	54 (10.1)
Respiratory syncytial virus	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.8)	1 (0.4)	0.25	1 (0.2)
Human coronaviruses	18 (16.7)	4 (4.0)	6 (6.5)	28 (9.3)	2 (1.9)	0 (0)	2 (0.9)	<0.0001	30 (5.6)
Adenovirus	8 (7.4)	0 (0)	1 (1.1)	9 (2.3)	0 (0)	0 (0)	0 (0)	0.008	9 (1.7)
SARS-CoV2	–	–	–	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)
<b>Bacteria</b>									
At least one bacteria	45 (41.6)	61 (60.4)	45 (48.4)	151 (50.0)	42 (69.6)	46 (36.8)	88 (38.1)	0.006	239 (44.8)
<i>S. pneumoniae</i>	4 (3.7)	12 (11.9)	16 (17.2)	32 (10.6)	22 (20.7)	21 (16.8)	43 (18.6)	0.008	75 (14.1)
<i>S. aureus</i>	15 (13.9)	23 (22.8)	12 (12.9)	50 (16.6)	4 (3.8)	9 (7.2)	13 (5.6)	<0.0001	63 (11.8)
<i>M. catarrhalis</i>	–	9 (8.9)	8 (8.6)	17 (8.8)	6 (5.7)	4 (3.2)	10 (4.3)	0.06	27 (5.1)
<i>H. influenzae</i>	29 (26.9)	16 (15.8)	15 (16.1)	60 (19.9)	17 (16.0)	24 (19.2)	41 (17.5)	0.53	101 (18.9)
<i>K. pneumoniae</i>	7 (6.5)	39 (38.6)	18 (19.2)	64 (21.2)	2 (1.9)	1 (0.8)	3 (1.3)	<0.0001	67 (12.6)
<i>M. pneumoniae</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)
<i>B. pertussis</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)

\*chi2 compare sub-total (2017–2020) versus (2020–2021).

- Acquisition of intestinal bacteria 32% (EAEC 19%, EPEC 11%...)
- Significant decrease in 2020-2021 vs. ≤ 2020

**Table 3**  
Acquisition rates of gastrointestinal pathogens among pilgrims.


Pathogens	2017 N = 45	2018 N = 53	2019 N = 93	Sub-total (2017–2019) N = 191	2020 N = 106	2021 N = 121	Sub-total (2020–2021) N = 227	P-value	Total (2017–2021) N = 418
<b>Virus</b>									
At least one virus	3 (6.7)	2 (3.8)	0 (0)	5 (2.6)	1 (0.9)	1 (0.8)	2 (0.9)	0.17	7 (1.7)
ADV	2 (4.4)	2 (3.4)	0 (0)	4 (2.1)	1 (0.9)	0 (0)	1 (0.4)	0.30	6 (1.4)
Norovirus	1 (2.2)	0 (0)	0 (0)	1 (0.5)	0 (0)	0 (0)	0 (0)	0.27	1 (0.2)
Astrovirus	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)
Rotavirus	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)
Hepatitis A virus	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)
Hepatitis E virus	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)
<b>Bacteria</b>									
At least one bacteria	25 (55.6)	33 (62.3)	25 (26.9)	83 (43.5)	24 (22.6)	28 (23.1)	52 (22.9)	<0.0001	135 (32.3)
Shigella/EIEC	2 (4.4)	5 (10.2)	4 (4.3)	14 (4.7)	3 (2.8)	6 (4.9)	9 (4.0)	0.39	20 (4.8)
EHEC	8 (17.8)	7 (14.2)	10 (10.7)	25 (13.1)	3 (2.8)	2 (1.6)	5 (2.2)	<0.0001	31 (7.4)
EPEC	15 (33.3)	14 (28.8)	6 (6.4)	39 (20.4)	1 (0.9)	4 (3.3)	5 (2.2)	<0.0001	44 (10.5)
EAEC	11 (24.4)	18 (36.7)	11 (11.8)	36 (18.7)	16 (15.1)	27 (22.3)	43 (18.9)	0.98	79 (18.9)
<i>T. whipplei</i>	0 (0)	1 (2.0)	0 (0)	1 (0.5)	3 (2.8)	0 (0)	3 (1.3)	0.40	4 (0.9)
<i>C. jejuni</i>	1 (2.2)	0 (0)	0 (0)	1 (0.5)	0 (0)	0 (0)	0 (0)	0.27	1 (0.2)
<b>Parasitic</b>									
At least one parasitic	1 (2.2)	0 (0)	1 (1.1)	2 (1.0)	6 (5.7)	4 (3.3)	10 (4.4)	0.04	12 (2.9)
<i>G. lamblia</i>	1 (2.2)	0 (0)	1 (1.1)	2 (1.0)	6 (5.7)	4 (3.3)	10 (4.4)	0.04	12 (2.9)
<i>E. histolytica</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)
<i>C. parvum hominis</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)

\*chi2 compare sub-total (2017–2019) versus (2020–2021).




- *N. meningitidis* acquisition = 0
- SARS-CoV-2 acquisition = 0

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Letter to the Editor

**Lack of *Neisseria meningitidis* among pilgrims during the 2017, 2018 and 2019 Grand Magal of Touba, Senegal**

N. Goumballa<sup>1,2,3</sup>, V.T. Hoang<sup>1,3,4</sup>, L. Perieres<sup>2</sup>, P. Parola<sup>1,3</sup>, C. Sokhna<sup>1,2,3</sup>, P. Gautret<sup>1,3</sup>

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**International Journal of Infectious Diseases**

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Perspective

**The Grand Magal of Touba was spared by the COVID-19 pandemic**

Cheikh Sokhna<sup>a,b,c,\*</sup>, Ndiaw Goumballa<sup>a,b,c</sup>, Van Thuan Hoang<sup>b,c,d</sup>, Hubert Bassene<sup>a,b</sup>, Philippe Parola<sup>b,c</sup>, Philippe Gautret<sup>b,c</sup>



# Risk factors for symptoms?

- Correlation between female gender and respiratory and GI symptoms
- Correlation between acquisition of respiratory viruses and *S. pneumoniae* and respiratory symptoms

**Table 5**  
Risk factors for respiratory and gastrointestinal symptoms (Multivariate analysis).

Variables	At least one respiratory symptom post-Magal	At least one gastrointestinal symptom post-Magal
2017–2019	REF	REF
2020–2021		0.45 [0.23–0.89] 0.02
Sex = male	0.55 [0.38–0.79] 0.001	0.39 [0.20–0.79] 0.009
Acquisition of at least one respiratory virus	2.20 [1.38–3.50] 0.001	
Acquisition of <i>S. pneumoniae</i>	2.76 [1.64–4.62] <0.0001	
Use of face mask <sup>a</sup>	0.54 [0.35–0.86] 0.009	

<sup>a</sup> Sometimes and often combined.

# Effect of preventive measures?

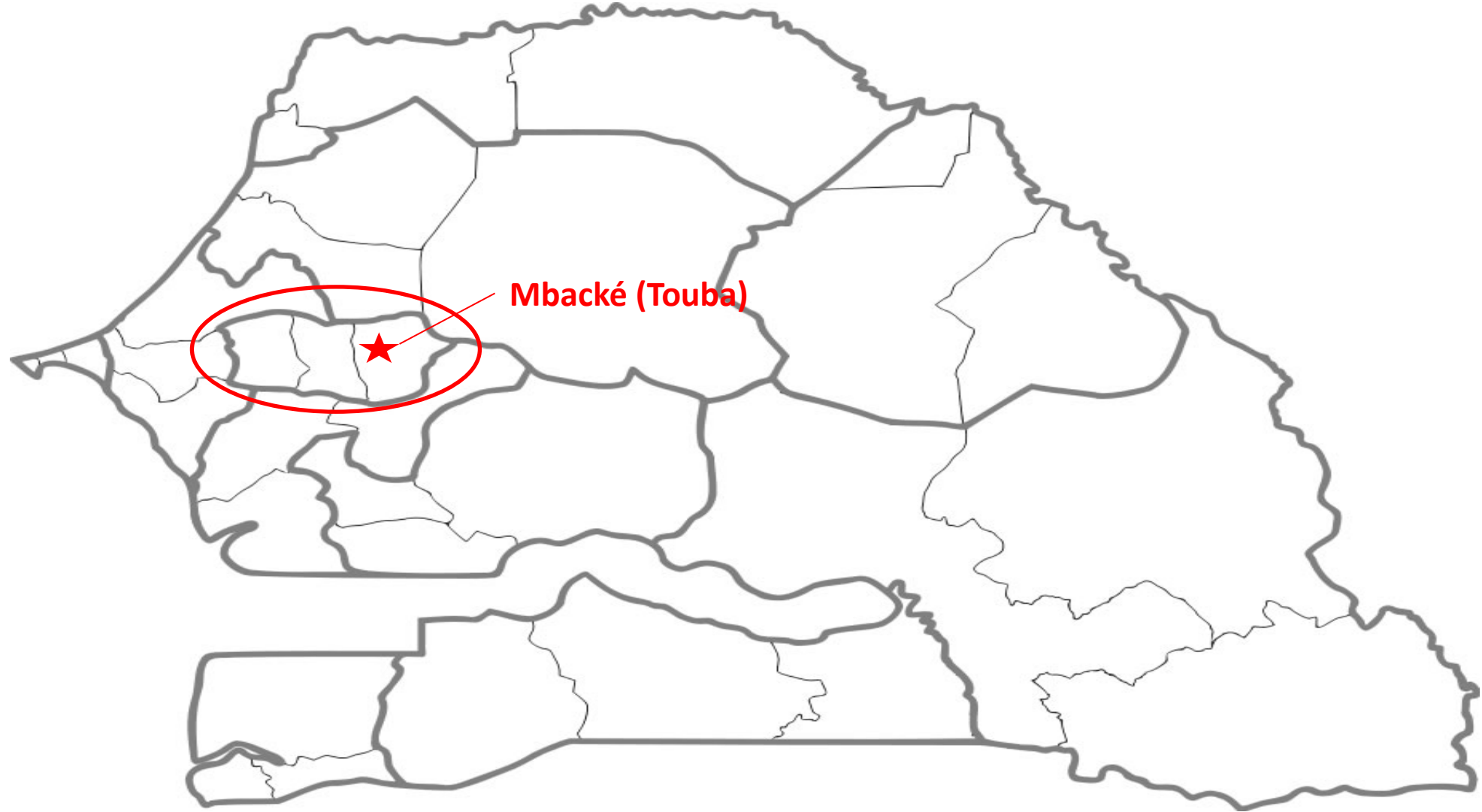
- Correlation between face mask use and lower prevalence of respiratory symptoms
- Correlation between hand soap use or disposable tissues use and lower acquisition rate of respiratory pathogens (rhinovirus, endemic CoVs and *M. catarrhalis*, respectively)

**Table 4**  
Risk factors for the acquisition of pathogens (multivariate analysis).

Variables	At least one virus	Human rhinovirus	Human coronavirus	<i>S. pneumoniae</i>	<i>S. aureus</i>	<i>K. pneumoniae</i>	<i>M. catarrhalis</i>	EPEC	EHEC
2017–2019	REF	REF	REF	REF	REF	REF	REF	REF	REF
2020–2021	0.36 [0.21–0.63] <0.0001	0.21 [0.09–0.49] <0.0001	0.08 [0.02–0.33] 0.001	1.93 [1.18–3.16] 0.009	0.28 [0.15–0.55] <0.0001	0.05 [0.01–0.16] <0.0001		0.09 [0.03–0.23] <0.0001	0.15 [0.06–0.40] <0.0001
0 to 15	REF	REF	REF	REF	REF	REF			
16 to 44			0.48 [0.26–0.90] 0.02		0.61 [0.39–0.94] 0.03				
Sex = Male		2.22 [1.2–4.09] 0.01					0.40 [0.17–0.92] 0.03		
Use of hand soap <sup>a</sup>	0.34 [0.20–0.57] <0.0001	0.42 [0.22–0.80] 0.008	0.43 [0.23–0.81] 0.009						
Use of disposable tissues <sup>a</sup>							0.34 [0.15–0.79] 0.01		

<sup>a</sup> Sometimes and often combined.

- Cross-sectional surveys **Mbacké**





**Secondary healthcare Hospital**  
**Outpatient department**  
**Emergency ward**  
**Inpatient department (30 beds)**

**Patients with**

**RTI**

**GII**

**FUO**

**Five day Magal period**

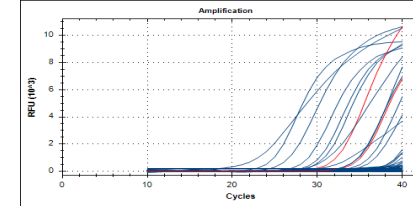




Thermo Scientific™  
KingFisher™ Flex  
purification systems



CFX96



**Questionnaires:** demographics, symptoms, antibiotics...

## qPCR

Respiratory pathogens		Gastrointestinal pathogens	
Virus	Bacteria	Virus	Bacteria and parasites
IAV	<i>S. pneumoniae</i>	Adenovirus	EPEC
IBV	<i>S. aureus</i>	Astrovirus	EHEC
HRV	<i>M. catarrhalis</i>	Norovirus	EAEC
ADV	<i>H. influenzae</i>	Hepatitis A virus	Shigella/EIEC
HCov	<i>K. pneumoniae</i>	Hepatitis E virus	<i>C. jejuni</i>
VRS	<i>M. pneumoniae</i>		<i>G. Lamblia</i>
			<i>Salmonella sp.</i>
MPV	<i>B. pertusis</i>		<i>T. whipplei</i>
SARS-CoV2	<i>N. meningitidis</i>		<i>Cryptosporidium</i>
HPIV			<i>E. histolytica</i>

## qPCR

### Blood pathogens

Dengue virus	<i>Rickettsia sp.</i>
<i>P. falciparum</i>	<i>Salmonella sp.</i>
<i>Borrelia sp.</i>	<i>S. pneumoniae</i>
<i>Bartonella sp.</i>	<i>S. aureus</i>
<i>C. burnetti</i>	<i>T. whipplei</i>

# 538 patients

# Magal 2018-2021

Travel Medicine and Infectious Disease 37 (2020) 101820

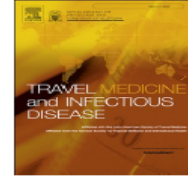


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Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

## Travel Medicine and Infectious Disease

journal homepage: [www.elsevier.com/locate/tmaid](http://www.elsevier.com/locate/tmaid)



**Pathogens associated with respiratory, gastrointestinal and febrile illness in patients consulting at Mbacke healthcare centre during the 2018 Grand Magal of Touba: A preliminary study**



ELSEVIER

journal homepage: [www.elsevier.com/locate/tmaid](http://www.elsevier.com/locate/tmaid)

Correspondence

**Lack of SARS-CoV-2 among Grand Magal de Touba pilgrims consulting for respiratory symptoms in October 2020**



ELSEVIER

## Travel Medicine and Infectious Disease

journal homepage: [www.elsevier.com/locate/tmaid](http://www.elsevier.com/locate/tmaid)

**High influenza A prevalence but no SARS-CoV-2 among 2021 Grand Magal pilgrims in Touba, Senegal**



ELSEVIER

## Travel Medicine and Infectious Disease

journal homepage: [www.elsevier.com/locate/tmaid](http://www.elsevier.com/locate/tmaid)

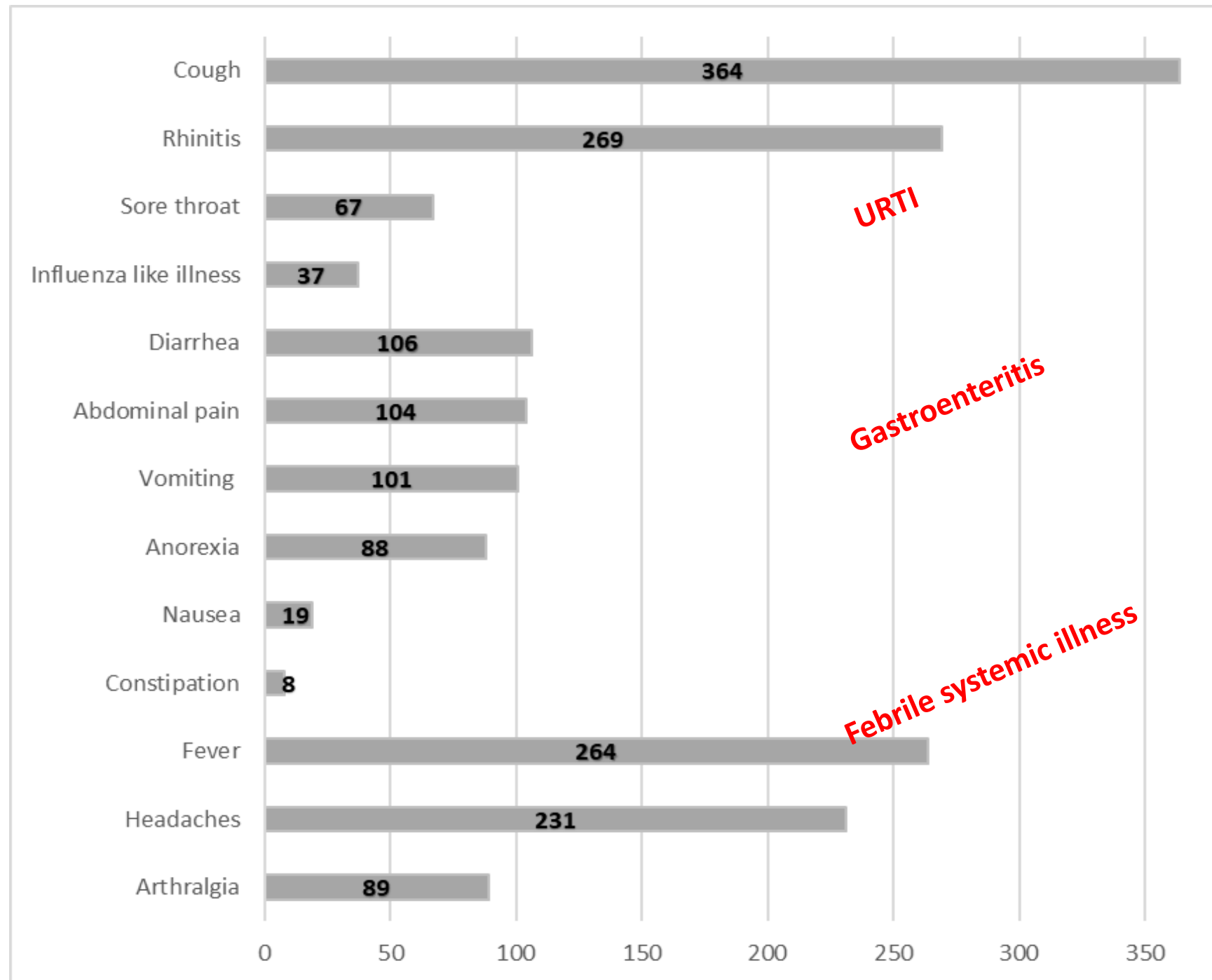
**PCR investigation of infections in patients consulting at a healthcare centre over a four-year period during the Grand Magal of Touba**



**Median age: 17 years** (IQR 2-27 years, range 0-91 years)

**57% individuals  $\leq 15$  years**

**54% patients were female**





- Respiratory pathogens:  
influenza +++, RSV, rhinoV, *H. influenzae*, *S. pneumoniae*, *M. catarrhalis*

**Table 1**

Prevalence of respiratory pathogens among 326 patients with respiratory samples available.

Pathogens	2018 N =	2019 N =	2020 N =	2021 N =	Total N =	P-value <sup>a</sup>
At least one pathogen	48 (92.3)	112 (100.0)	106 (97.2)	51 (96.2)	317 (97.2)	0.04
At least one virus	27 (51.9)	74 (66.1)	62 (56.9)	42 (79.2)	205 (62.8)	0.01
Influenza viruses	22 (42.3)	22 (19.6)	30 (27.5)	34 (64.2)	108 (33.1)	<0.0001
Influenza A virus	7 (13.5)	22 (19.6)	22 (20.2)	34 (64.2)	85 (26.1)	<0.0001
Influenza B virus	15 (28.8)	0 (0)	8 (7.3)	0 (0)	23 (7.0)	<0.0001
Respiratory syncytial virus	2 (3.8)	37 (33.0)	14 (12.8)	3 (5.7)	53 (16.2)	<0.0001
Human rhinovirus	3 (5.8)	18 (8.5)	6 (5.5)	4 (7.6)	27 (8.3)	0.03
Metapneumovirus	1 (1.9)	2 (0.9)	7 (6.4)	0 (0)	10 (3.1)	0.08
Adenovirus	0 (0)	5 (2.3)	3 (2.7)	0 (0)	8 (2.4)	0.20
Endemic coronaviruses	0 (0)	4 (1.9)	1 (0.9)	0 (0)	5 (1.5)	0.17
Human parainfluenza viruses	0 (0)	0 (0)	2 (1.8)	2 (3.8)	4 (1.2)	0.16
SARS-CoV2	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
At least one bacteria	46 (88.5)	109 (97.3)	105 (96.3)	37 (69.8)	297 (91.1)	<0.0001
<i>Haemophilus influenzae</i>	33 (63.5)	91 (42.9)	89 (81.6)	24 (45.3)	237 (72.7)	<0.0001
<i>Streptococcus pneumoniae</i>	24 (46.1)	53 (25.0)	66 (60.5)	24 (45.3)	167 (51.2)	0.12
<i>Moraxella catarrhalis</i>	19 (36.5)	52 (24.5)	59 (54.1)	20 (37.7)	150 (46.0)	0.10
<i>Staphylococcus aureus</i>	15 (28.8)	39 (18.4)	8 (7.3)	9 (17.0)	71 (21.8)	<0.001
<i>Klebsiella pneumoniae</i>	2 (3.8)	1 (0.5)	0 (0)	0 (0)	3 (0.9)	0.09
<i>Bordetella pertussis</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
<i>Mycoplasma pneumoniae</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
Co-infection virus-bacteria	25 (48.1)	71 (63.4)	61 (56.0)	27 (50.9)	184 (56.4)	0.22

<sup>a</sup> Chi2 compares prevalence of pathogen between years.

- GI pathogens, EAEC, Shigella/EIEC, EPEC

**Table 3**

Prevalence of gastrointestinal pathogens among 95 patients with rectal samples available.

Pathogens	2018 N = 23	2019 N = 54	2020 N = 15	2021 N = 3	Total N = 95	P- value <sup>a</sup>
At least one pathogen	14 (60.9)	41 (75.9)	11 (73.3)	1 (33.3)	67 (71.3)	0.40
At least one virus	2 (8.7)	5 (9.3)	1 (6.7)	0 (0)	8 (8.5)	0.95
Adenovirus	2 (8.7)	3 (5.6)	1 (6.7)	0 (0)	6 (6.3)	0.92
Rotavirus	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
Norovirus	0 (0)	2 (3.7)	0 (0)	0 (0)	2 (2.1)	0.49
Astrovirus	0 (0)	2 (3.7)	0 (0)	0 (0)	2 (2.1)	0.67
At least one bacteria	13 (59.1)	36 (66.7)	10 (66.7)	1 (33.3)	60 (63.1)	0.68
Enteroaggregative <i>Escherichia coli</i>	5 (21.7)	27 (50.0)	10 (66.7)	1 (33.3)	43 (45.3)	0.01
Shigella/ Enteroinvasive <i>Escherichia coli</i>	6 (26.1)	11 (20.4)	1 (6.7)	0 (0)	18 (18.9)	0.32
Enteropathogenic <i>Escherichia coli</i>	7 (30.4)	10 (18.5)	3 (20.0)	0 (0)	20 (21.1)	0.50
Enterohaemorrhagic <i>Escherichia coli</i>	0 (0)	4 (7.4)	0 (0)	0 (0)	4 (4.2)	0.23
<i>Tropheryma whipplei</i>	2 (8.7)	2 (3.7)	0 (0)	0 (0)	4 (4.2)	0.41
<i>Campylobacter jejuni</i>	0 (0)	4 (7.4)	1 (6.7)	0 (0)	5 (5.3)	0.41
<i>Salmonella</i> sp.	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
At least one parasite	4 (17.4)	8 (14.8)	2 (13.3)	0 (0)	14 (14.7)	0.93
<i>Giardia lamblia</i>	2 (8.7)	5 (9.3)	2 (13.3)	0 (0)	9 (9.5)	0.88
<i>Cryptosporidium</i> sp.	1 (4.3)	3 (5.6)	0 (0)	0 (0)	4 (4.2)	0.65
<i>Entamoeba histolytica</i>	1 (4.3)	1 (1.8)	0 (0)	0 (0)	2 (2.1)	0.65

<sup>a</sup> Chi<sup>2</sup> compares prevalence of pathogens between years.

- Blood pathogens: *P. falciparum*, dengue virus, *Borrelia* sp.

**Table 5**

Prevalence of blood pathogens in patients with blood samples available.

Pathogens	2018 N = 26	2019 N = 51	2020 N = 36	2021 N = 28	Total N = 141	P-value <sup>a</sup>
At least one pathogen	13 (50.0)	22 (43.1)	6 (16.7)	4 (14.3)	45 (31.9)	0.002
<i>Plasmodium falciparum</i>	5 (19.2)	18 (35.3)	4 (11.1)	3 (10.7)	30 (21.3)	0.02
Dengue virus	7 (26.9)	0 (0)	0 (0)	0 (0)	7 (5.0)	<0.0001
<i>Borrelia</i> sp.	1 (3.8)	4 (7.8)	2 (5.6)	1 (3.6)	8 (5.7)	0.83
<i>Bartonella</i> sp.	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
<i>Tropheryma whipplei</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
<i>Coxiella burnetii</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
<i>Salmonella</i> sp.	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
<i>Streptococcus pneumoniae</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
<i>Staphylococcus aureus</i>	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA
<i>Rickettsia</i> sp.	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	NA

<sup>a</sup> Chi<sup>2</sup> compares prevalence of pathogens between years.

**Update, 2023**



# Antibiotic resistance

- **Cohorts Ndiop/Dielmo (2018-2021)**
  - Rectal samples before and after the GMT
  - PCR resistance genes (CTM-X, SHV, TEM, OXA23, OXA48, NDM, KPC, VIM, Colistine R)
  - Culture

# 291 pilgrims

- **Resistance gene acquisition rates:**

- at least one: 36%

- CTX-MA: 21%

- CTX-MB: 4%

- SHV: 17%

- TEM: 8%

- OXA23: <1%

**Bêta-Lactamases**

- **Cultures**

- BLSE: post-GMT: 11%

- Mostly *E. coli*, resistant to amoxicillin and amoxicillin+clavulanic acid and sensitive to carbapenem


**Carbapenemases**

# COVID Magal 2022



Letter to the Editor

## Circulation of SARS-CoV-2 virus among pilgrims at the 2022 Grand Magal of Touba

Coumba Diouf, PhD<sup>1</sup>, Ihssane Ouaddane, PhD<sup>2,3</sup>, Ndiaw Goumballa, PhD<sup>1,3</sup>,  
Masse Sambou, PhD<sup>1</sup>, Hubert Bassène, PhD<sup>1</sup>, Mamadou Dieng, MD<sup>4</sup>,  
Philippe Gautret, MD<sup>2,3</sup> and Cheikh Sokhna , PhD<sup>1,2,3,\*</sup>

**Table 1.** Main characteristics of participants

Variable	Ndiop and Dielmo before the Grand Magal de Touba N = 99 (%)	Ndiop and Dielmo after the GMT N = 99 (%)	Mbackè N = 57 (%)
Mean age (years)	25.7	25.7	22.6
Male gender	42 (42.4)	42 (42.4)	24 (42.1)
Vaccination against COVID-19	10 (10.1)	10 (10.1)	5 (8.8)
Respiratory tract infection symptoms overall	10 (10.1)	45 (45.4)	57 (100.0)
Cough	6 (6.0)	30 (30.3)	57 (100.0)
Rhinitis	8 (8.0)	33 (33.3)	36 (63.1)
Fever	1 (1.0)	16 (16.1)	22 (57.9)
Positive SARS-CoV-2 PCR	1 (1.0)	7 <sup>a</sup> (7.1)	3 (5.3)

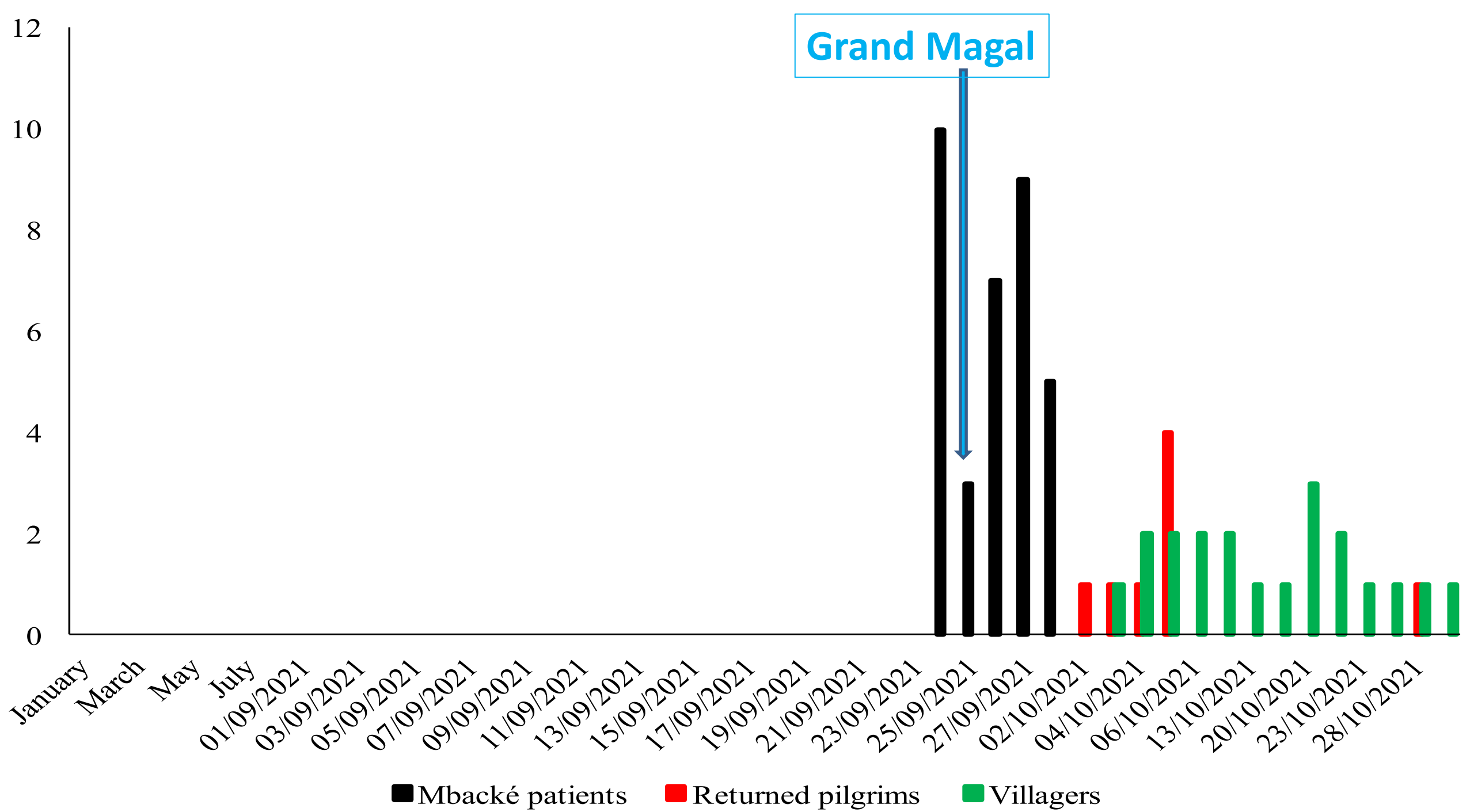
<sup>a</sup>All tested negative before the event.

# Influenza circulation during the 2021 Grand Magal

- **Screening for influenza (PCR)**
  - Ill pilgrims in Mbacké (RTI), 24-28 Sept
  - Ill patients in Ndiop/Dielmo (Fever), Jan-Dec
  - Cohorts of pilgrims from Ndiop/Dielmo before (14-18 Sept) and after the GMT(5-8 Oct)
- **Sequencing**

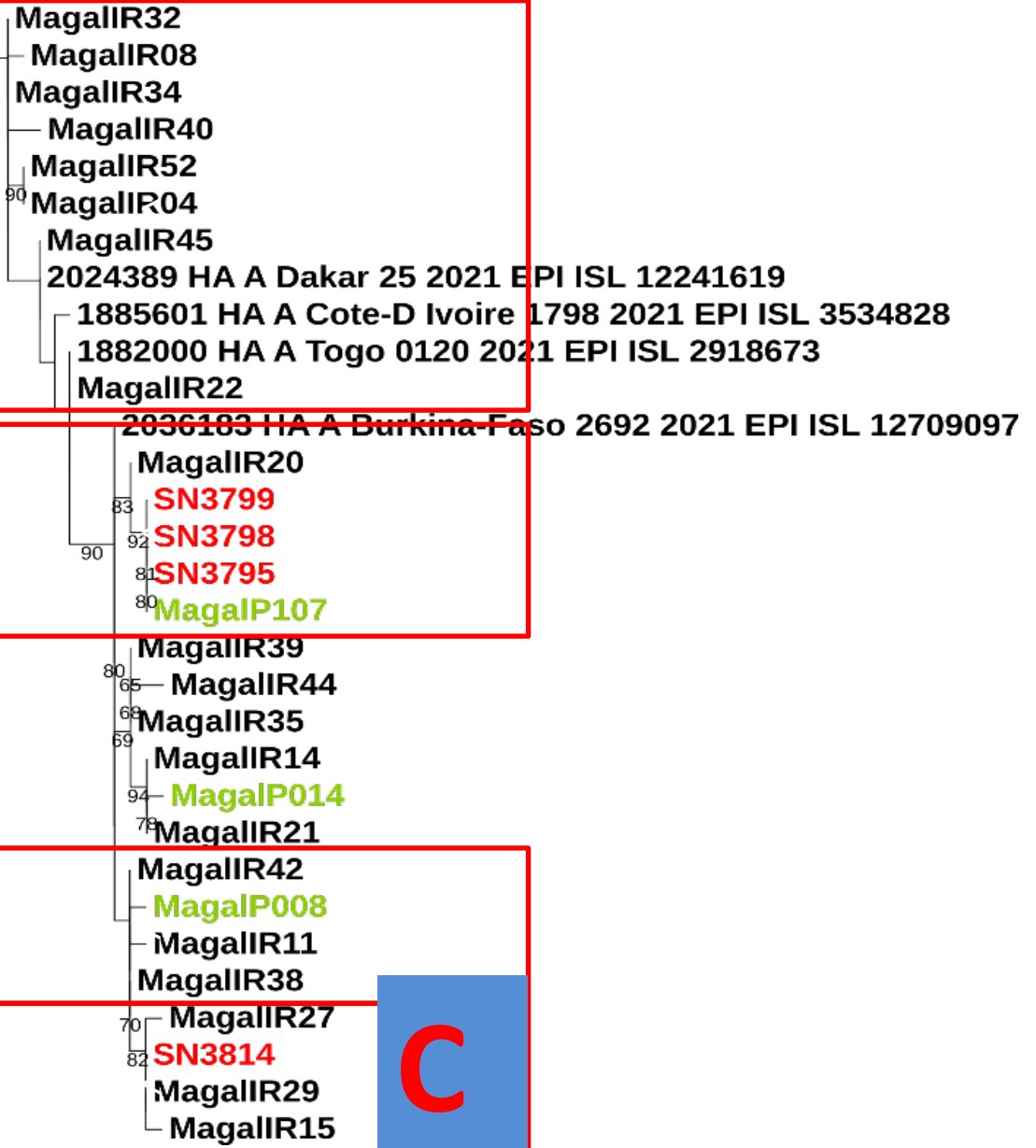


	<b>Mbacké</b>	<b>Ndiop/Dielmo</b>	<b>Cohort before</b>	<b>Cohort after</b>
N	53	374	129	129
PCR pos	34 (62%)	20 (5%)	0	8 (6%)
Sequence	20	4		3



Tree scale: 0.01

Segment4 A-California-07-2009 H1N1



A

D

B

C

4 clusters

**Mbacké patients (R)**

			R14	
			R15	
			R35	
R04			R38	
R20	R08	R11	R39	R44
R21	R27	R32	R40	R45
R22	R29	R34	R42	R52

**Returned pilgrims (P)**

**Villagers (SN)**

		P008	
		P014	
		SN3798	
P107	SN3795	SN3799	
			SN3814

24/09/2021

25/09/2021

26/09/2021

27/09/2021

28/09/2021

03/10/2021

04/10/2021

05/10/2021

14/10/2021

**Cluster A**

**Cluster B**

**Cluster C**

**Cluster D**



- **Inhabitants of Ndiop/Dielmo may have been infected with viral strains originating from the GMT and possibly imported by pilgrims who returned from the MG.**

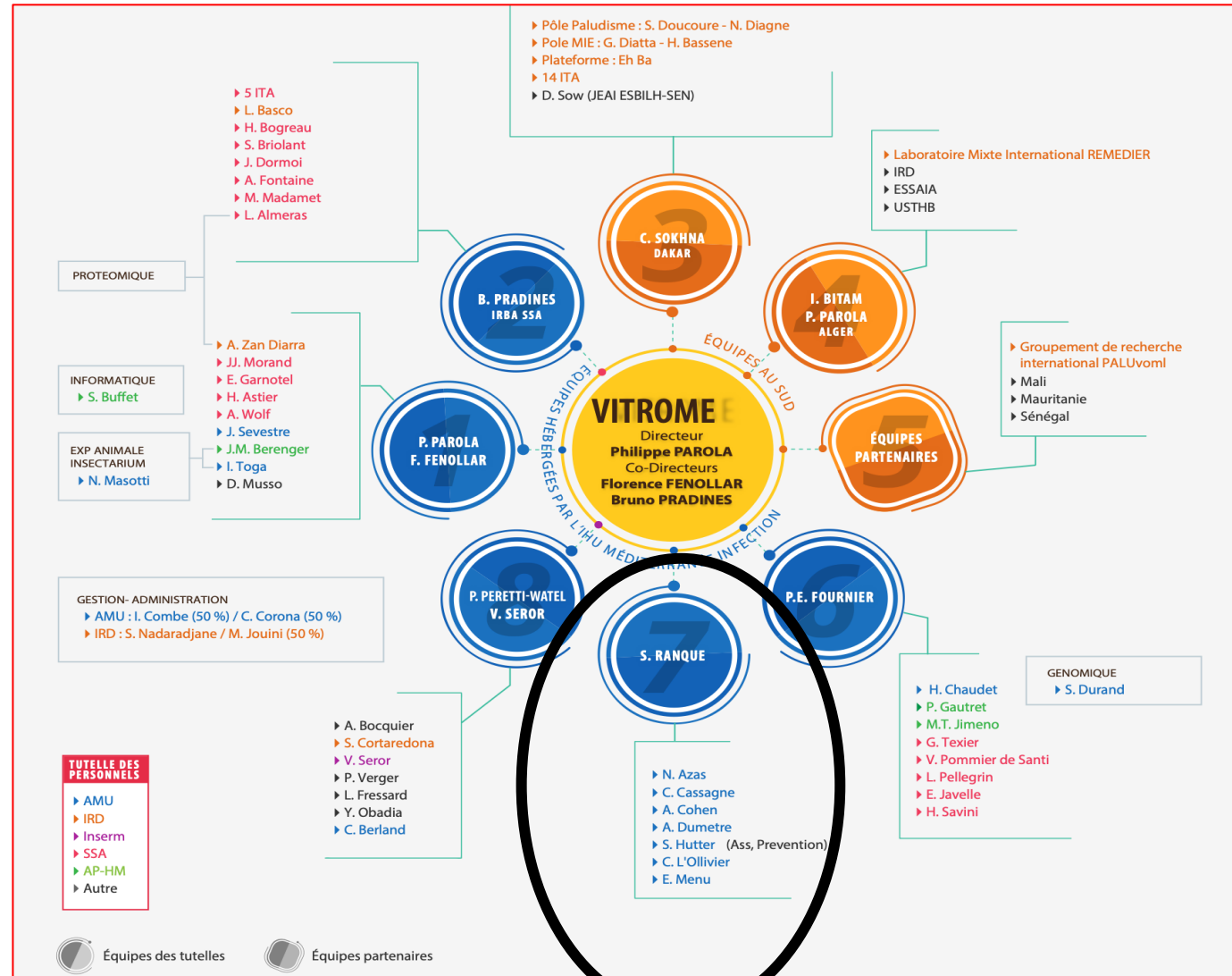


## PhD: I. Ouadanne and C. Diouf)

- **Circulation of endemic coronaviruses** (pilgrims => villages)
- Implementation of a **POC laboratory** in Mbacké, multiplex + sequencing (Minion)
- Analysis of malaria RDT (other pathogens)
- **Environmental sources** of infection (surfaces in Touba houses, buses, food and water, animals for sacrifice...)

# Equipe 7 Eucaryotes Tropicaux Pathogènes

## Stéphane Ranque



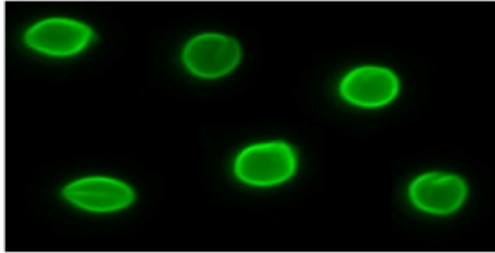


Master Biologie Santé – Maladies infectieuses et Microbiote  
2020 - 2021

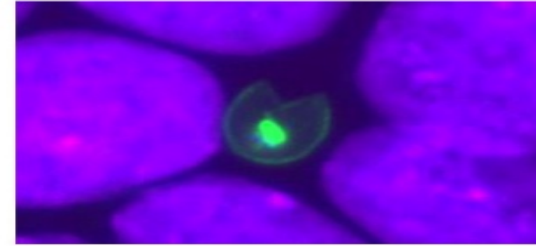


Nadine AZAS

## Development of an *in vitro* culture model of *Cryptosporidium parvum* on COLO-680N cells



HUTTER Sébastien



### Project

Development of a *Cryptosporidium parvum* *in vitro* culture model on COLO-680N cells :

- Complete *in vitro* the whole life cycle : asexual and sexual cycles
- Long term production of infectious oocysts
- Test the activity of molecules in local or national chemical libraries

### Perspectives

- Test **free-living amoebae - *Cryptosporidium parvum* interactions**
- Phalloidin labelling of the actin cytoskeleton : **specify intracellular localization of parasites** and intracellular parasites stages characterization with antibodies



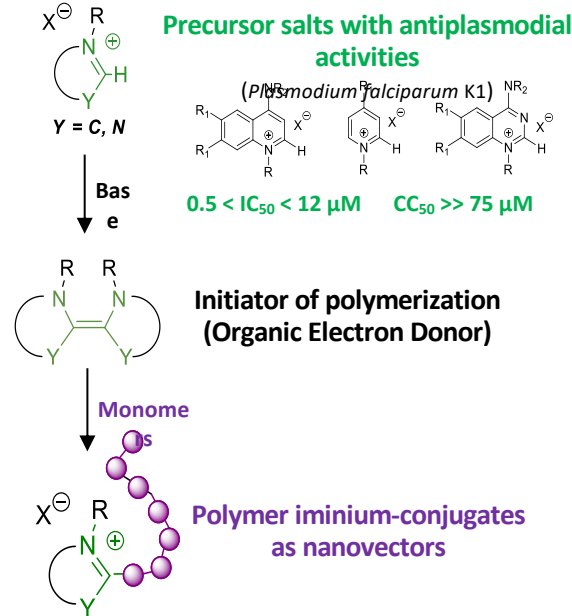
# Innovative synthesis of polymeric systems for the vectorization of new antiplasmodial iminium derivatives



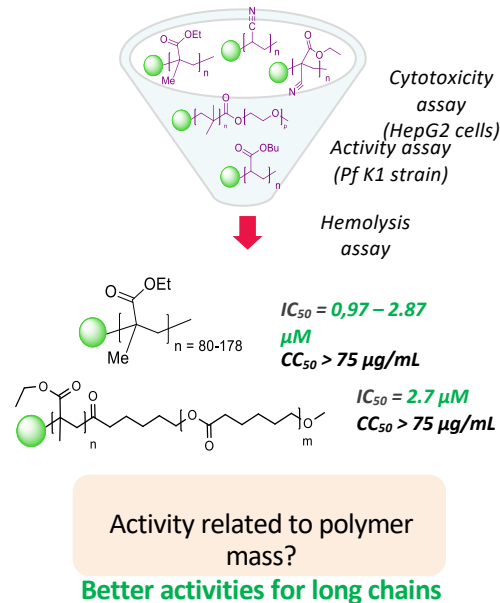
Nadine AZAS

New polymer carriers were developed for the vectorization of iminium antiplasmodial drugs. Our methodology uses the drug as polymerization initiator and allows an effective, flexible and inexpensive anchorage strategy.[1] The resulting iminium chain-end confers an *in vitro* antiplasmodial activity to the polymeric carrier, with higher activities observed for long polymer chains.

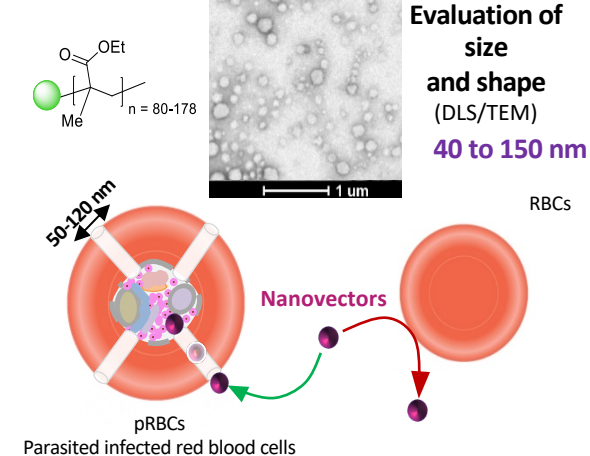
## Fast, moduable and inexpensive synthesis



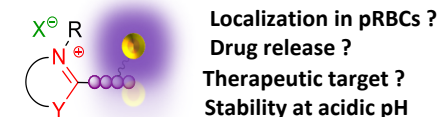
## In vitro selection of best candidates



## Observations



## Perspectives (ANR déposée)



Marion Casanova (PhD), et al., 2023,

Efficient Synthesis of Aminoquinolinium and Aminoquinazolinium

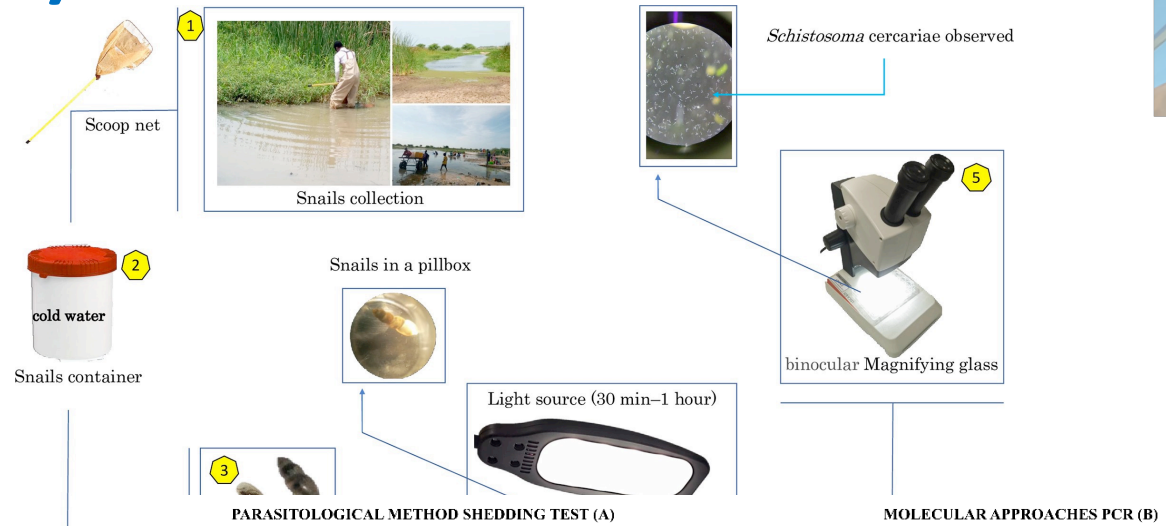
Salt Series: Amination or N-Alkylation First? *Synlett*, ST-2023-V0116-L

A how-to guide through the physico-chemistry and biology of polymeric drug delivery systems: Antimalarial vectors as study case, *Chemical Reviews*, submitted

# Trematode (schistosomiasis) intermediate hosts characterization



Papa M. GAYE



## Article *Bulinus senegalensis* and *Bulinus umbilicatus* Snail Infestations by the *Schistosoma haematobium* Group in Niakhar, Senegal

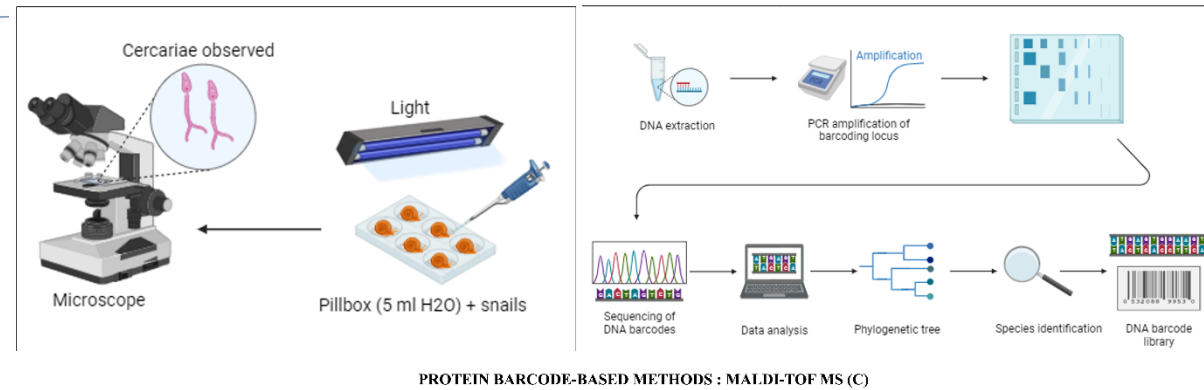
Papa Mouhamadou Gaye<sup>1,2,3,4</sup>, Souleymane Doucoure<sup>2</sup>, Bruno Senghor<sup>2</sup>, Babacar Faye<sup>5</sup>, Ndiaw Goumballa<sup>1,2,3</sup>, Mbacké Sembène<sup>4</sup>, Coralie L'Ollivier<sup>1,3</sup>, Philippe Parola<sup>1,3</sup>, Stéphane Ranque<sup>1,3</sup>, Doudou Sow<sup>2,5,6,\*</sup> and Cheikh Sokhna<sup>1,2,3</sup>

PLOS NEGLECTED TROPICAL DISEASES

RESEARCH ARTICLE

### Identification of *Bulinus forskalii* as a potential intermediate host of *Schistosoma haematobium* in Senegal

Papa Mouhamadou Gaye<sup>1,2,3,4</sup>, Souleymane Doucoure<sup>2</sup>, Doudou Sow<sup>5</sup>, Cheikh Sokhna<sup>2,3</sup>, Stéphane Ranque<sup>2,3,\*</sup>



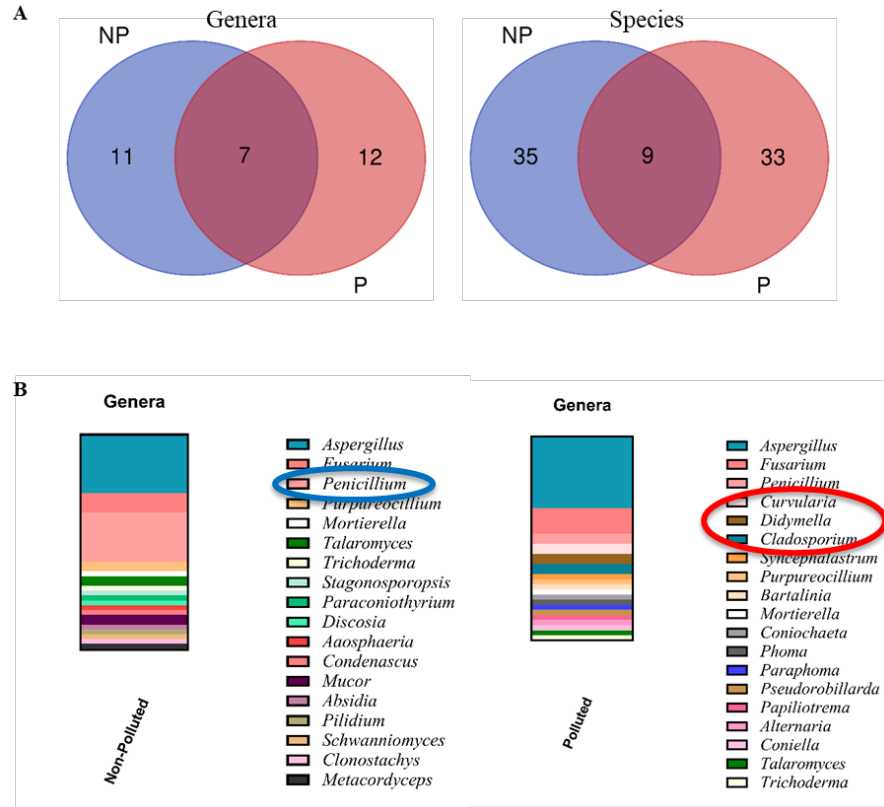
MALDI-TOF mass spectrometry traces the geographical origin of *Biomphalaria pfeifferi* and *Bulinus forskalii* involved in schistosomiasis transmission.

Papa M Gaye, El Hadj I Ndiaye, Souleymane Doucouré, Doudou Sow, Mapenda Gaye, Ndiaw Goumballa, Carole Cassagne, Coralie L'Ollivier, Oleg Mediannikov, Cheikh Sokhna, Stéphane Ranque

# Development of a novel approach involving Culturomics coupled to MALDI - TOF mass spectrometry for the characterization of soil fungal communities and comparison to metabarcoding analysis



Elias CHARBEL



UNRAVEL  
THE SOIL  
MYCOBIOME



COMBINING BOTH  
COMPLEMENTARY APPROACHES

- Metabarcoding → Wider picture on microbial communities residing in a given environment  
→ Tons of Unidentified OTUs
- Culturomics → More accurate identification and characterization of fungi (MALDI-TOF ms, Sanger Sequencing)  
→ Access to novel microorganisms, leading to the discovery of new species  
→ Potential for biotechnological applications (Bioremediation)  
→ Validation of metagenomics data

METABARCODING  
ITS

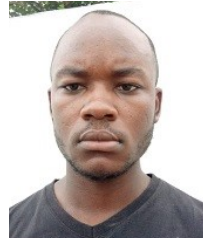
FUNGAL  
CULTUROMICS  
APPROACH

(A) Venn Diagrams representing the comparison between the different pollution profiles, NP (non-polluted) and P (HAP-polluted) of studied soil samples at the species and genera taxa. Constructed using “Bioinformatics & Evolutionary Genomics” - <https://bioinformatics.psb.ugent.be/webtools/Venn/>. (B) Bar plots representing the distribution of isolated fungi between fungal at the genera and family level, respectively, both in HAP-polluted and non-polluted soils.

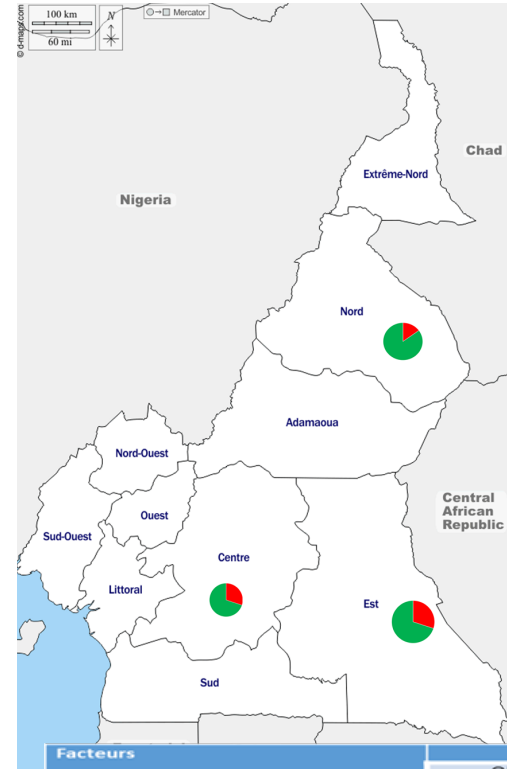
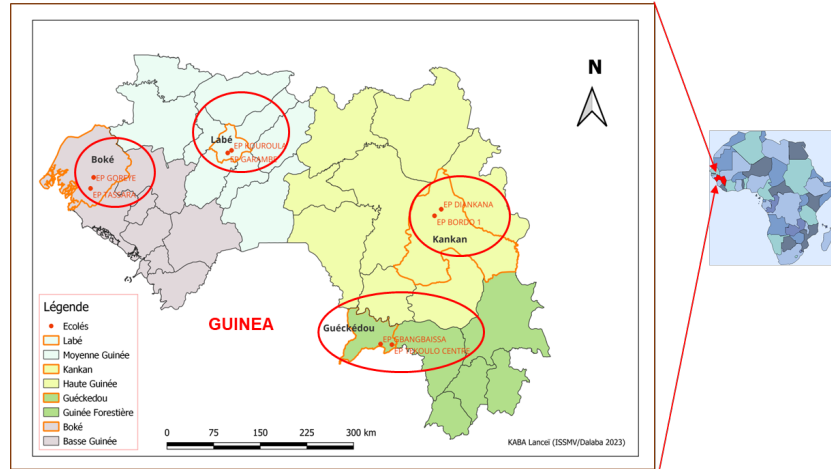


Elisabeth Y DIAWARA

# Dermatophytoses epidemiology among African school children



Armel AGOKENG



Variable	N	Total population	TCC+	TCC-	RR [IC95%]	p-value
Age	497	10.21 (2.96)	9.97 (2.81)	10.64 (3.17)	1.02 [0.98 – 1.06]	0.015
Male	497	261 (53%)	190 (73%)	71 (27%)	2.38 [1.64 – 3.47]	0.0001
Epidermophytie	497	21 (4%)	11 (52%)	10 (48%)	0.81 [0.54-1.23]	0.28
Pityriasis versicolor	497	45 (9%)	30 (67%)	15 (33%)	1.05 [0.84-1.31]	0.63
Scabies	497	20 (4%)	9 (45%)	11 (55%)	0.62 [0.36-1.06]	0.026
Pediculosis	497	33 (7%)	11 (33%)	22 (67%)	0.49 [0.30-0.80]	0.0001
<b>Contact with animals/ shaving/braiding/hairdressing at home/presence of cases in family</b>						
Contact with animals	497	428 (86%)	270 (63%)	158 (37%)	0.852 [0.776-0.940]	0.001
<b>Shaving</b>	497	230 (46%)	167 (73%)	63 (27%)	1.27 [1.11-1.45]	0.0004
<b>Traditional braiding</b>	497	231 (46%)	128 (55%)	103 (45%)	0.78 [0.68-0.90]	0.0005
<b>Hairdressing at home</b>	497	375	264 (70)	111 (30)	3.24 [2.13-4.94]	0.0001
<b>Presence of cases in the family circle</b>	497	140 (28%)	111 (79%)	29 (21%)	2.89 [1.83-4.58]	0.0001

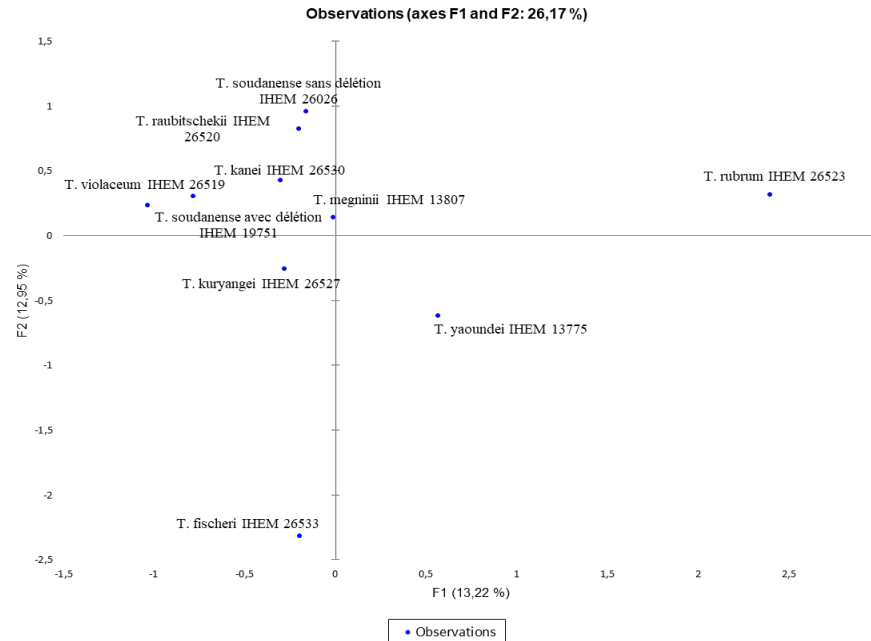
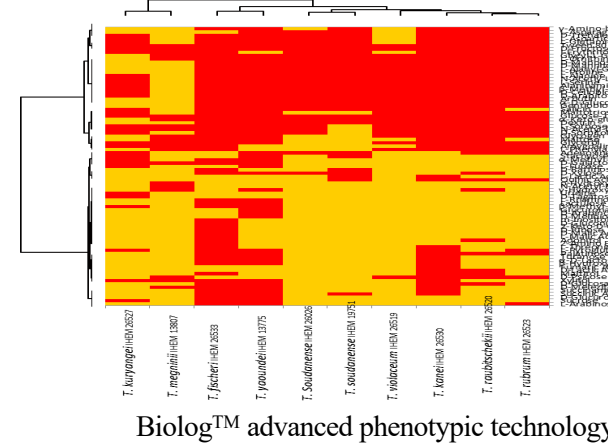
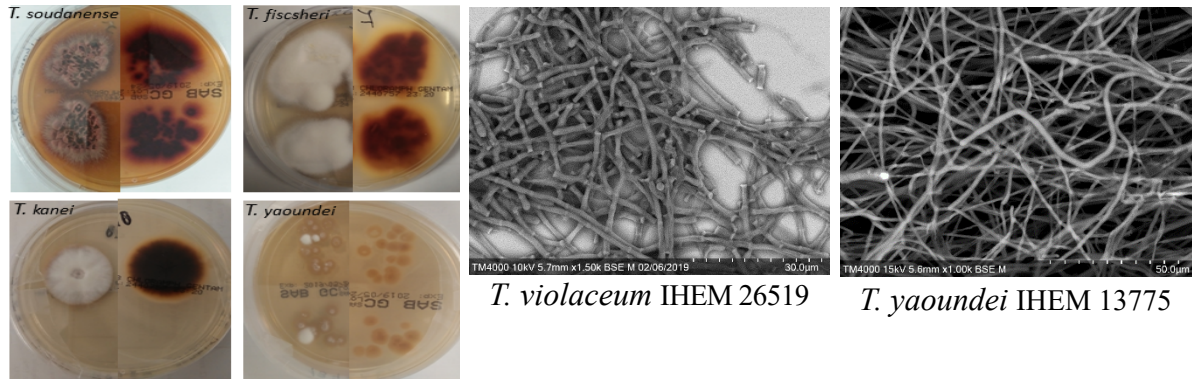
Facteurs	Univ			Multiv		
	OR	IC 95%	P. value	OR	IC 95%	P. value
Age	0.912	[0.836-0.995]	0.037	1.076	[0.852-1.358]	0.539
Sexe	2.752	[1.684-4.497]	<0.0001	-	-	-
Zone	1.520	[0.997-2.320]	0.052	1.456	[0.905-2.344]	0.122
Coiffure à domicile	0.509	[0.324-0.800]	0.003	0.405	[0.241-0.682]	0.001
Fréquente les salons de coiffure	0.932	[0.608-1.429]	0.748	-	-	-
Rasage habituel du crâne	0.459	[0.289-0.729]	0.001	0.782	[0.392-1.557]	0.484
Dors seul	1.797	[1-3.230]	0.050	2.238	[1.175-4.263]	0.014
Présence de teigne dans la fratrie	0.377	[0.241-0.589]	<0.0001	0.381	[0.233-0.623]	<0.0001
Présence d'animaux domestiques	0.784	[0.508-1.210]	0.272	0.831	[0.507-1.361]	0.461
Présence enclose proche de l'habitation	0.972	[0.640-1.478]	0.896	-	-	-
Dépôt ordure proche de l'habitation	0.809	[0.532-1.230]	0.322	1.140	[0.706-1.840]	0.592
Tréssage traditionnel cheveux	3.961	[1.606-9.773]	0.003	0.671	[0.067-6.714]	0.734



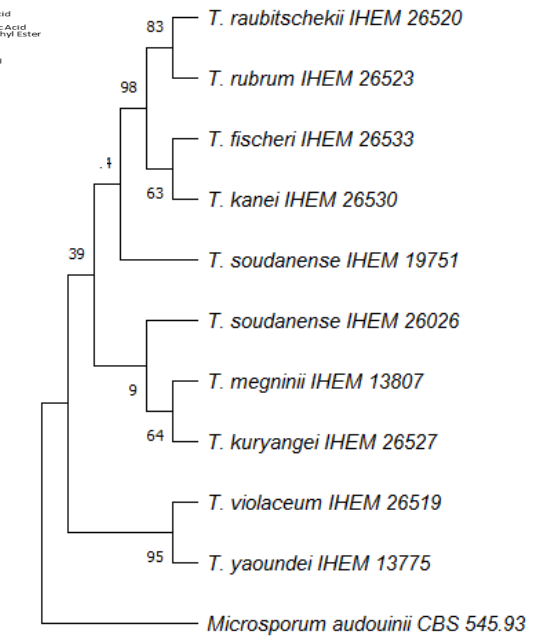
# A comprehensive characterization of the *Trichophyton rubrum* complex type strains



Jihane KABTANI



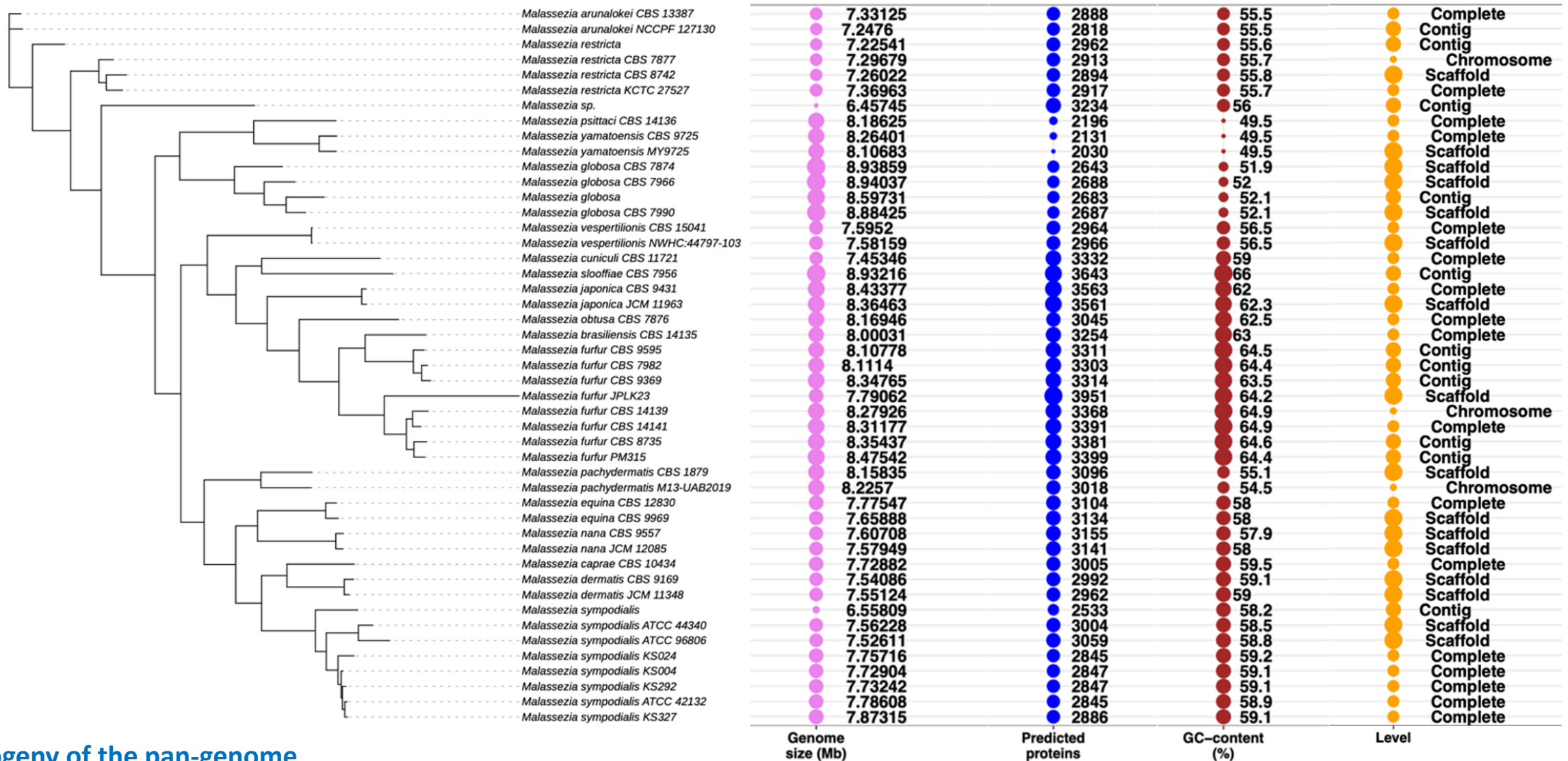
Scanning Electron Microscope Energy-Dispersive X-ray Spectroscopy (EDX)



# Genomic study of the *Malassezia* genus



Fatima BOULANOUAR



Phylogeny of the pan-genome

Tree based on absence and presence of gene families

# Malassezia spp. and fungal communities in HIV patients

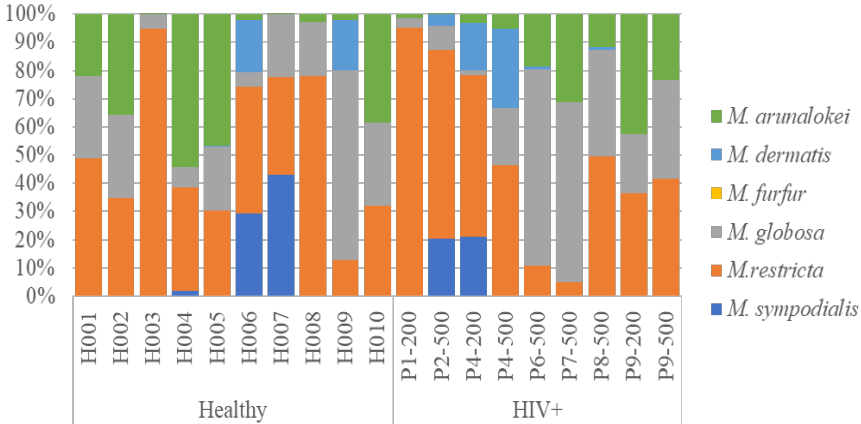
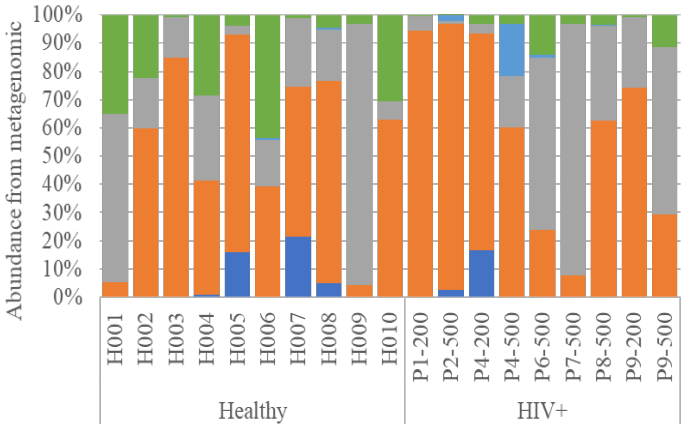
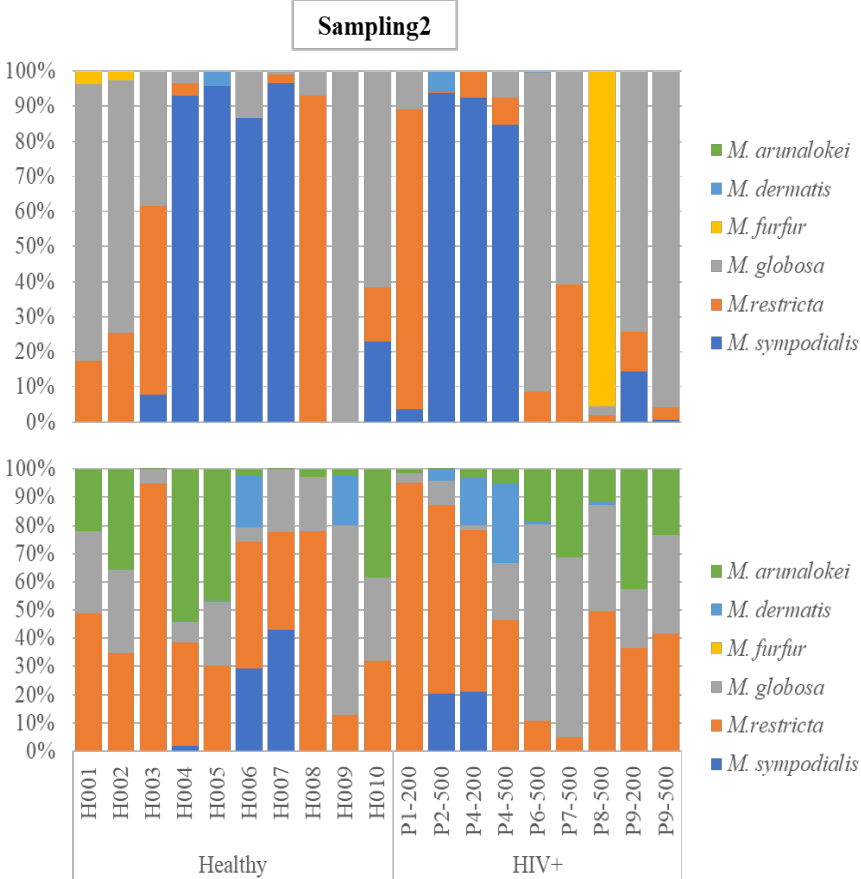
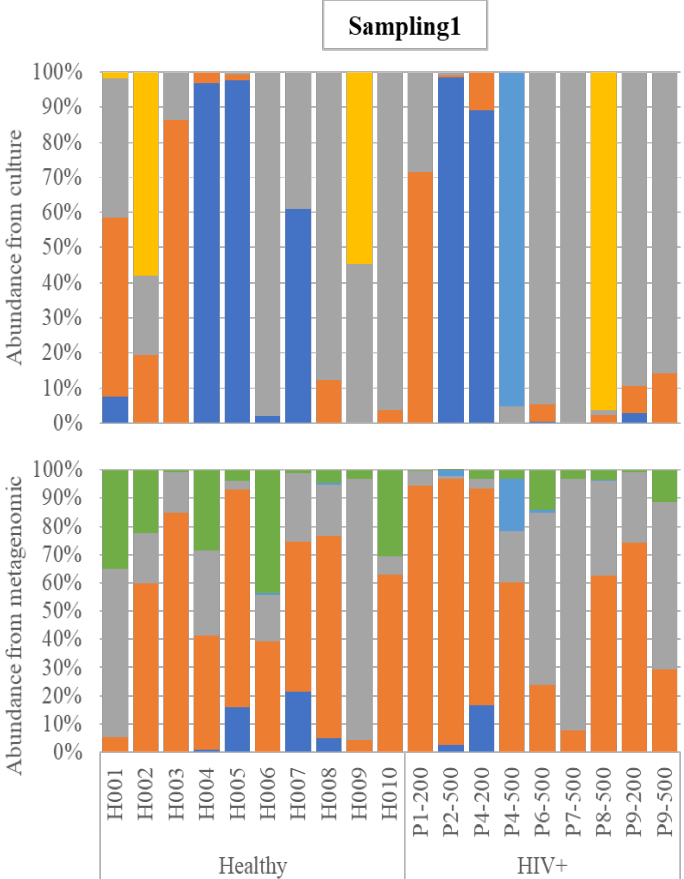
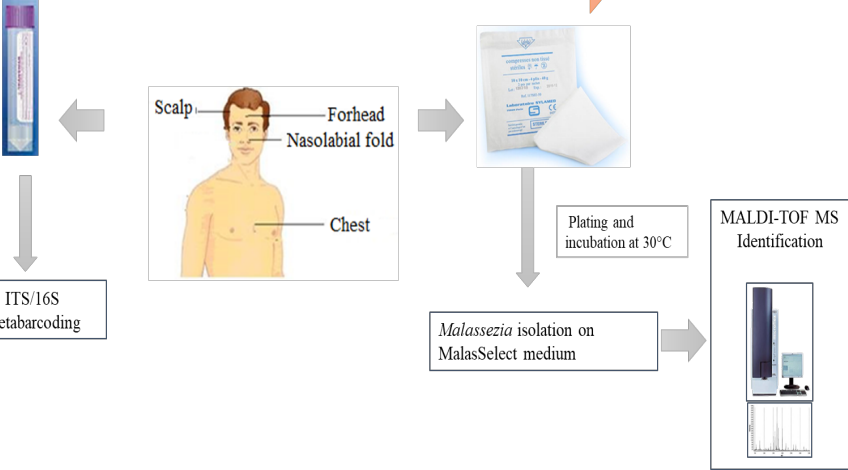


Abdourahim ABILLAH

CD4 T cell < 200/mm<sup>3</sup>  
HIV-infected patients

CD4 T cell > 500/mm<sup>3</sup>  
HIV-infected patients

Healthy subjects  
volunteers



# Repertoire of Clinical Fungi







Estelle MENU



*Review*

## A Repertoire of Clinical Non-Dermatophytes Moulds

Estelle Menu<sup>1,2,\*</sup>, Quentin Filori<sup>3</sup> , Jean-Charles Dufour<sup>3,4</sup> , Stéphane Ranque<sup>1,2</sup>  and Coralie L'Ollivier<sup>1,2</sup> 



*Review*

## A Repertoire of the less common clinical yeasts

**SUBMITTED**


Estelle Menu<sup>1,2,\*</sup>, Quentin Filori<sup>3</sup>, Jean-Charles Dufour<sup>3,4</sup>, Stéphane Ranque<sup>1,2</sup> and Coralie L'Ollivier<sup>1,2</sup>

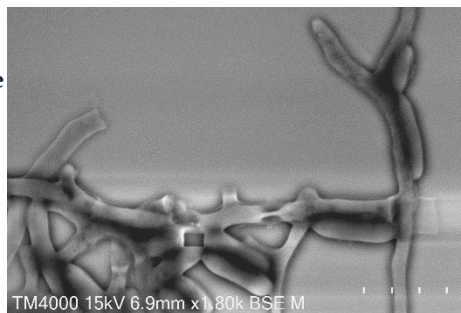


# Description of new fungal species based on the combined genotypic and phenotypic characters

Article

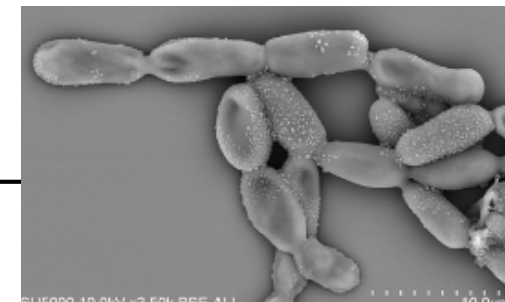
## *Coniochaeta massiliensis* sp. nov. Isolated from a Clinical Sample

Jihane Kabtani <sup>1</sup> , Muriel Militello <sup>1,2</sup> and Stéphane Ranque




Mycopathologia  
<https://doi.org/10.1007/s11046-023-00792-4>

ORIGINAL ARTICLE



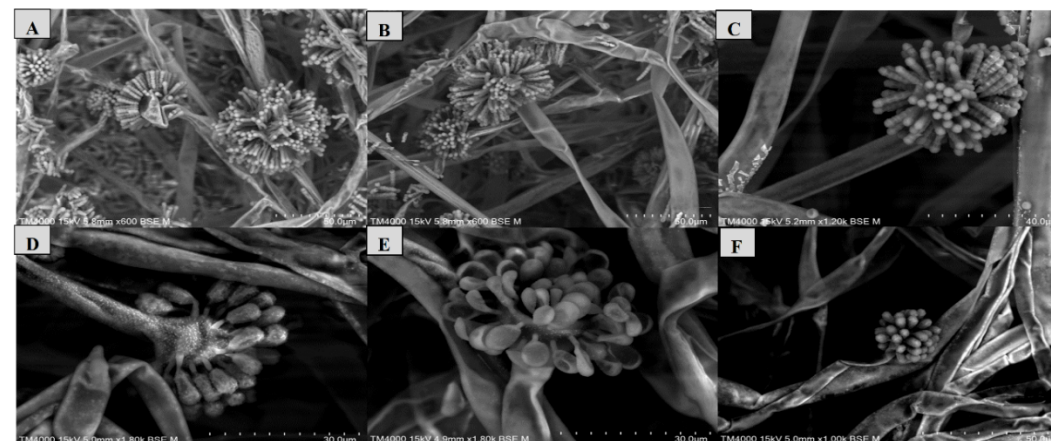
## *Candida massiliensis* sp. nov. Isolated from a Clinical Sample

Jihane Kabtani · Fatima Boulanouar · Muriel Militello · Carole Cassagne · Stéphane Ranque 



Article

## *Syncephalastrum massiliense* sp. nov. and *Syncephalastrum timoneanum* sp. nov., isolated from clinical samples

Kabtani J.<sup>1</sup>, Boulanouar F.<sup>1</sup>, Gaye P. M.<sup>1</sup>, Militello M.<sup>1,2</sup>, Ranque S.<sup>1,3</sup>

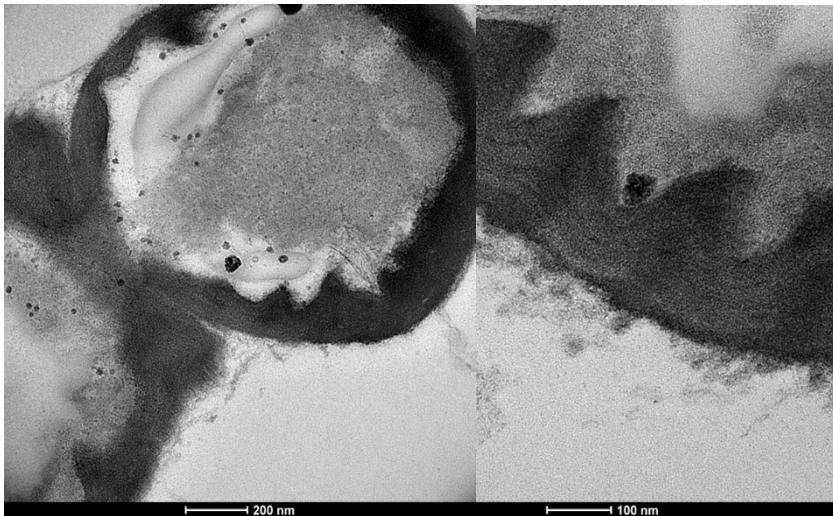


# Tracking Mycoviruses in Public RNAseq Datasets of *Malassezia*: Three Original Totiviruses Revealed

Fatima Boulanouar <sup>1,2,3</sup> , Stéphane Ranque <sup>1,3</sup>  and Anthony Levasseur <sup>1,2,3,4,\*</sup>

## Description of 3 new Totivirus mycoviruses:

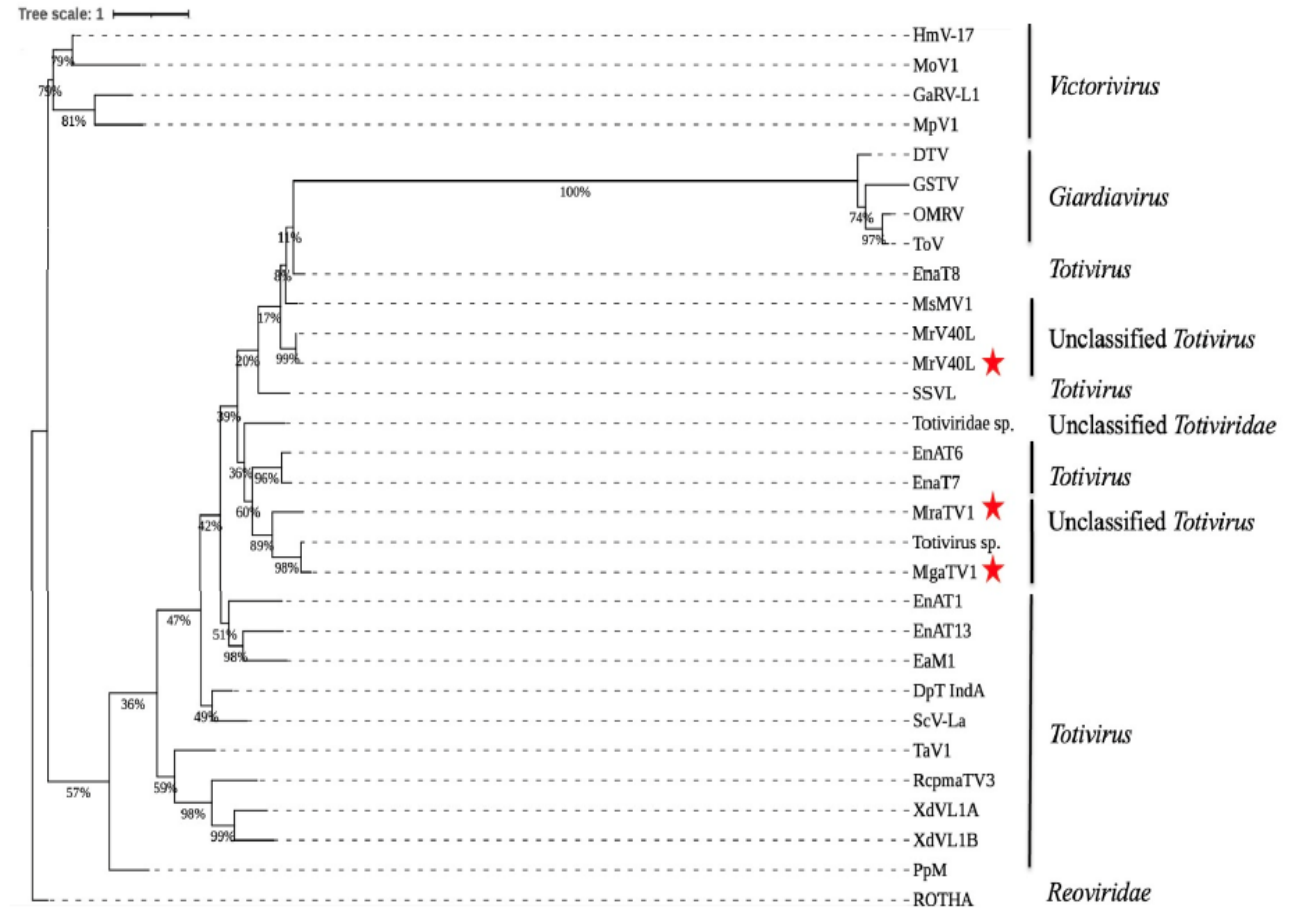
- *Malassezia globosa*-associated-totivirus 1 (MgaTV1)
- *Malassezia restricta*-associated-totivirus 1 (MraTV1)
- *Malassezia restricta*-associated-totivirus 2 (MraTV2)



Transmission electron microscopy image of isometric mycoviruses particles of ~40 nm diameter



Fatima BOULANOUAR



RNA-dependent RNA polymerase (RdRP)-based phylogenetic reconstruction of mycoviruses (Totivirus, Gardiavirus, Victorivirus, and unclassified Totivirus families)



Merci





# CS IHU Octobre 2023: Complément Conclusions et Perspectives





# Recherche transversale

RAPID COMMUNICATION

## Outbreak of pneumococcal pneumonia among shipyard workers in Marseille, France, January to February 2020

Nadim Cassir<sup>1,2,3</sup>, Laurence Pascal<sup>3,4</sup>, David Ferrieux<sup>1</sup>, Christiane Bruel<sup>5</sup>, Christophe Guervilly<sup>6,7</sup>, Stanislas Rebaudet<sup>8</sup>, Kostas Danis<sup>9</sup>, Lora Kopec<sup>1,2</sup>, Florence Fenollar<sup>1,10</sup>, Emmanuelle Varon<sup>11</sup>, Véronique Vig<sup>5</sup>, Jean-Luc Lasalle<sup>4</sup>, Lauriane Ramalli<sup>4</sup>, Pierre Michelet<sup>12</sup>, Jean-Christophe Lagier<sup>1,2</sup>, Nicolas Persico<sup>7,13</sup>, Philippe Brouqui<sup>1,2</sup>, Philippe Malfait<sup>4</sup>, Philippe Parola<sup>1,10</sup>

Travel Medicine and Infectious Disease 44 (2021) 102183

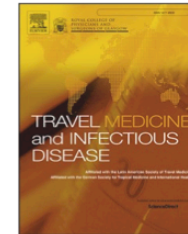


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Pneumococcal pneumonia among shipyard workers: Inside the features of disease onset

Nadim Cassir<sup>a,b,\*</sup>, Léa Luciani<sup>a</sup>, David Ferrieux<sup>a</sup>, Anthony Levasseur<sup>a,b</sup>,  
Pierre-Edouard Fournier<sup>a,c</sup>, Philippe Parola<sup>a,c</sup>



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EID Journal > Volume 28 > Number 12—December 2022 > Main Article

Volume 28, Number 12—December 2022

Research

## Observational Cohort Study of Evolving Epidemiologic, Clinical, and Virologic Features of Monkeypox in Southern France

Nadim Cassir✉, Florian Cardona, Hervé Tissot-Dupont, Christiane Bruel, Barbara Doudier, Salima Lahouel, Karim Bendamardji, Céline Boschi, Sarah Aherfi, Sophie Edouard, Jean-Christophe Lagier, Philippe Colson, Philippe Gautrel, Pierre-Edouard Fournier, Philippe Parola, Philippe Brouqui, Bernard La-Scola, and Matthieu Million

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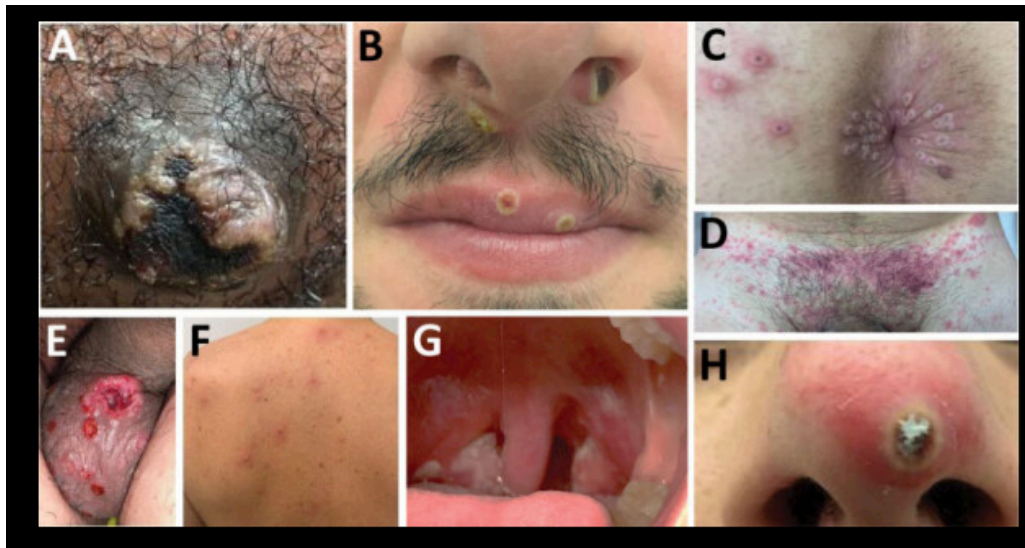
**MEDICAL VIROLOGY**

RESEARCH ARTICLE

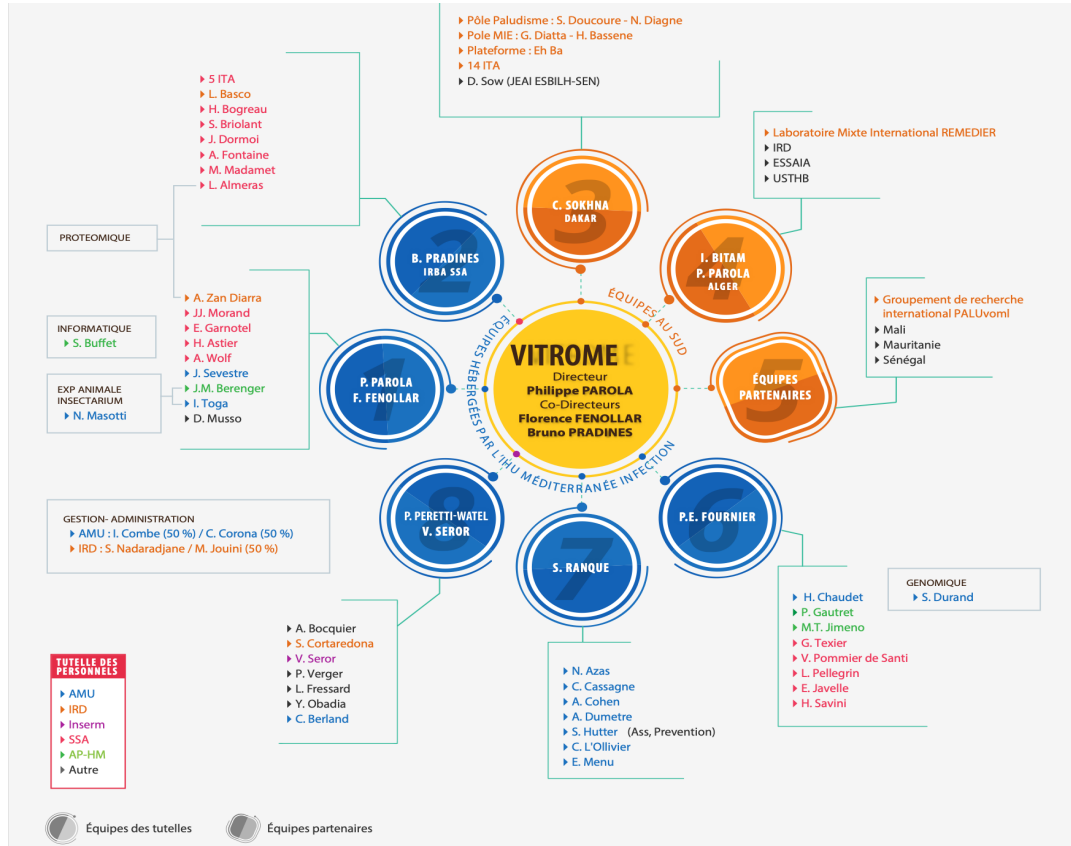
### Sequencing of monkeypox virus from infected patients reveals viral genomes with APOBEC3-like editing, gene inactivation, and bacterial agents of skin superinfection

Philippe Colson✉, Gwilherm Penant, Jeremy Delerce, Céline Boschi, Nathalie Wurtz, Marielle Bedotto, Stéphanie Branger ... [See all authors](#) ✓

First published: 21 June 2023 | <https://doi.org/10.1002/jmv.28799> | Citations: 1



# COVID



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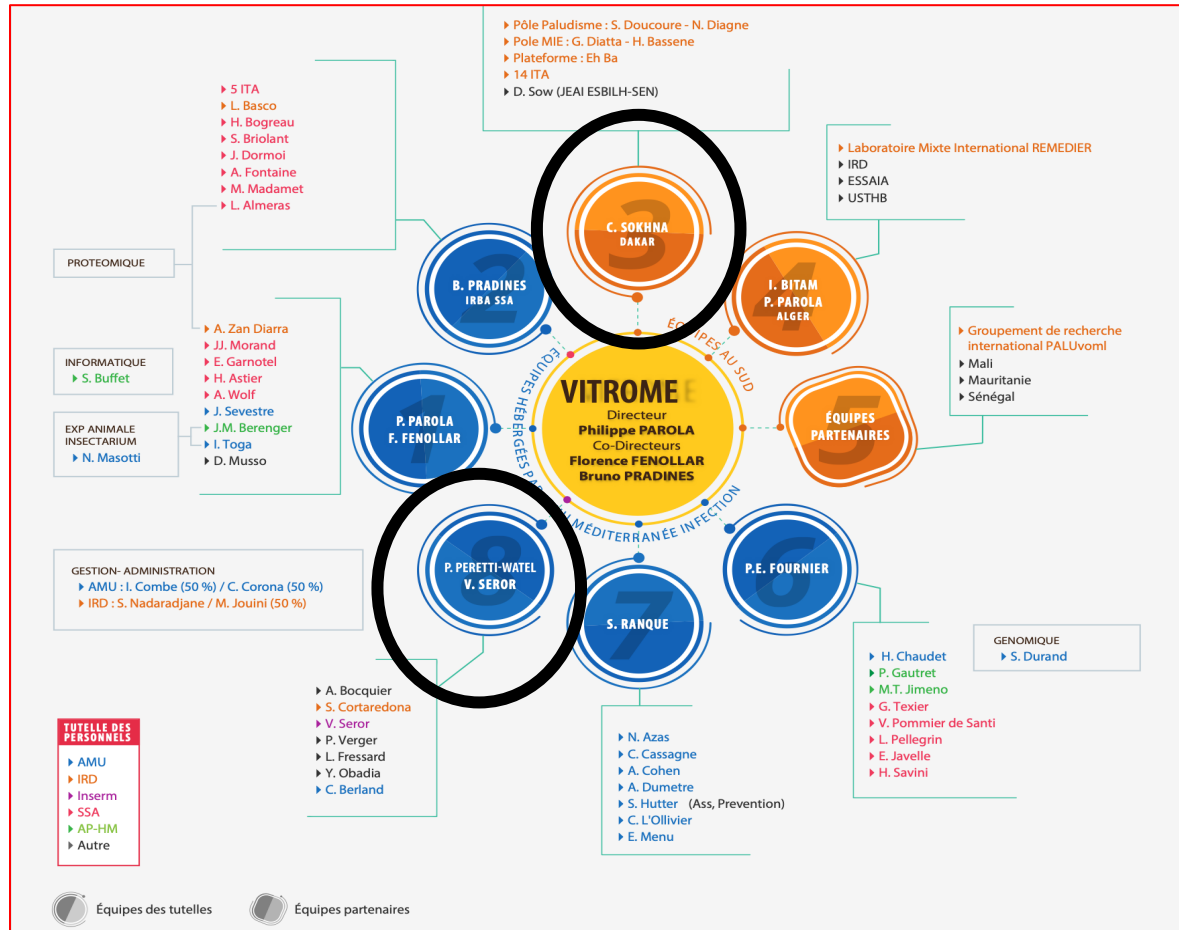
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SARS-CoV-2
- PUBLICATIONS & PRÉ-PRINTS**  
Retrouver les chiffres quotidiens du COVID-19 dans le monde et à Marseille et à l'IHU
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**DDREAM: Dilemmes, Décisions, Risques et Actes Médicaux**  
Patrick Peretti-Watel & Valérie Seror



**Vont se poursuivre:**

**CO3ELSER-2**, ANRS 2022-2024, 105 373 euros, coordonné par Valérie Seror et Cheikh Sokhna ;

**ECOVACSEN-HPV**, ANR 2021-2024, 472 000 euros, coordonné par Patrick Peretti-Watel ;