Human schistosomiasis in the Senegal river basin: does wildlife matter?

Stefano Catalano
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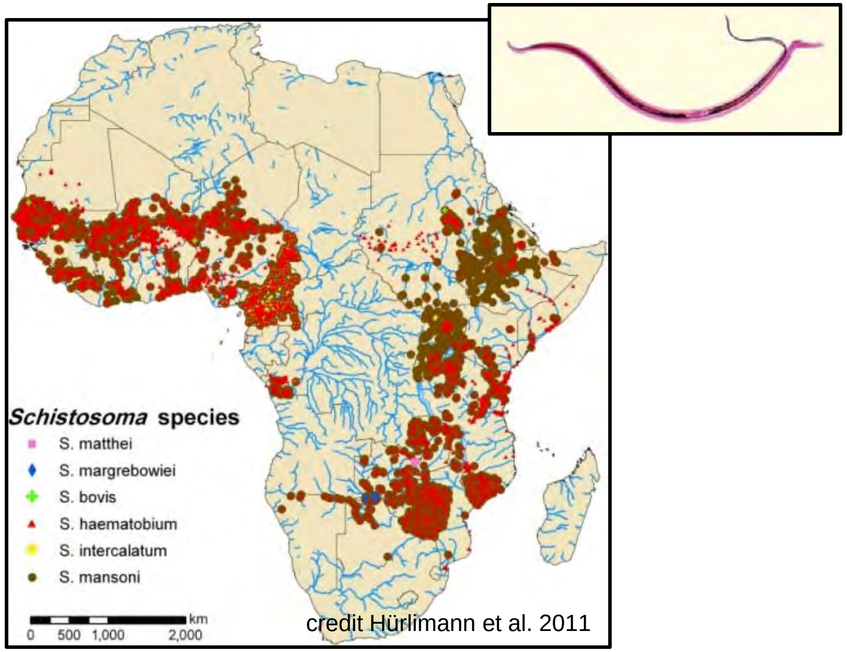
ZELS
Zoonoses & Emerging Livestock Systems
BBSRC
20 Years of Pioneering Great British Bioscience
[dstl]
UKaid from the British people
E·S·R·C Economic & Social Research Council
NERC Science of the Environment
MRC Medical Research Council
RVC Royal Veterinary College University of London
IRD Institut de Recherche pour le Développement
Université Gaston Berger Saint-Louis du Sénégal
L'humilité mon choix, l'excellence ma voie
Université de Thies
Natural History Museum
SCAN

Overview

Multi-host spectrum of *Schistosoma* species/hybrids in West Africa



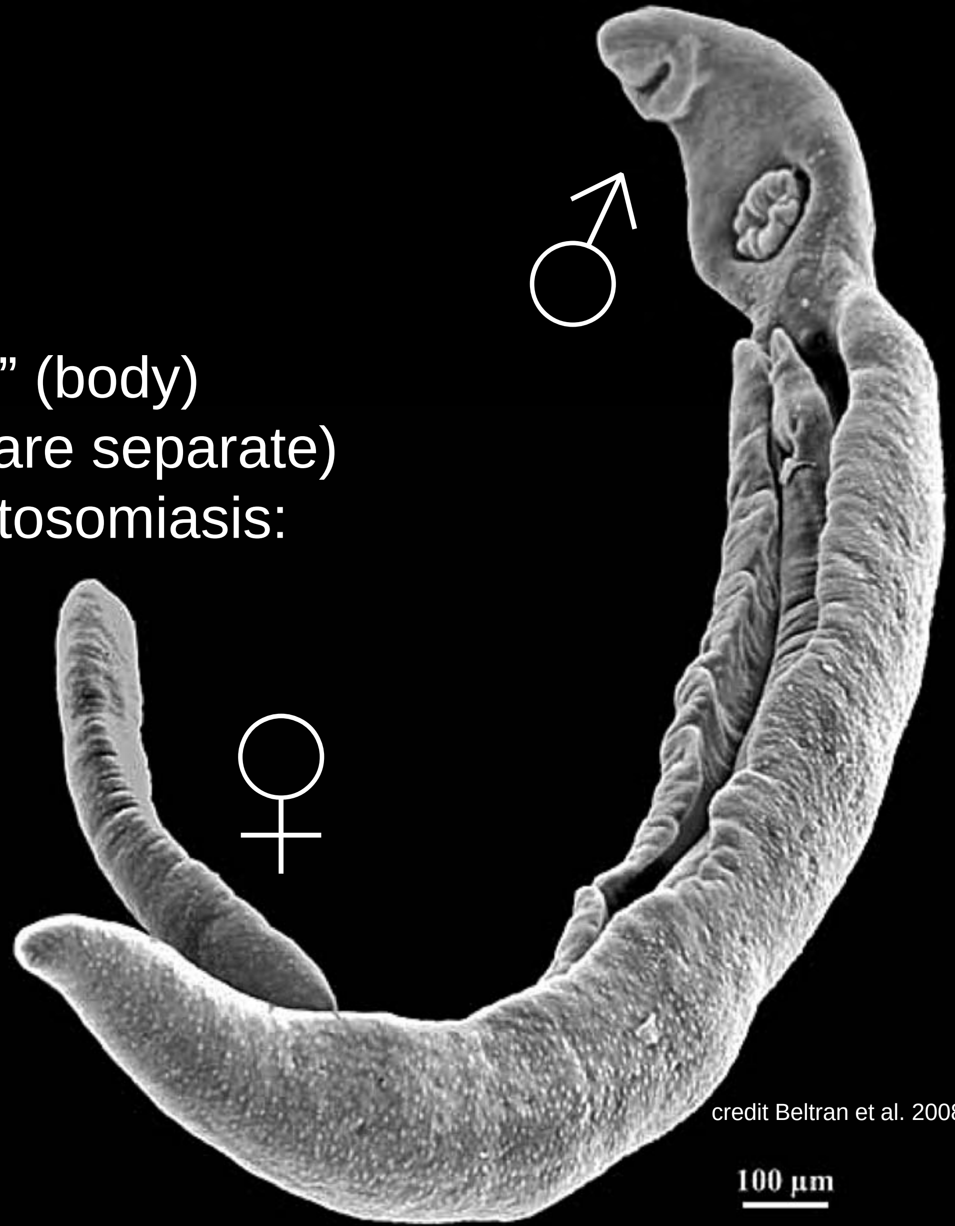
credit Hürlimann et al. 2011


credit E. Léger

Schistosoma

- or blood flukes -

- Greek origin “*schistos*” (split) and “*soma*” (body)
- Schistosomatidae are dioecious (sexes are separate)
- In Africa two main forms of human schistosomiasis:
  - Intestinal (*S. mansoni*)
  - Urogenital (*S. haematobium*)

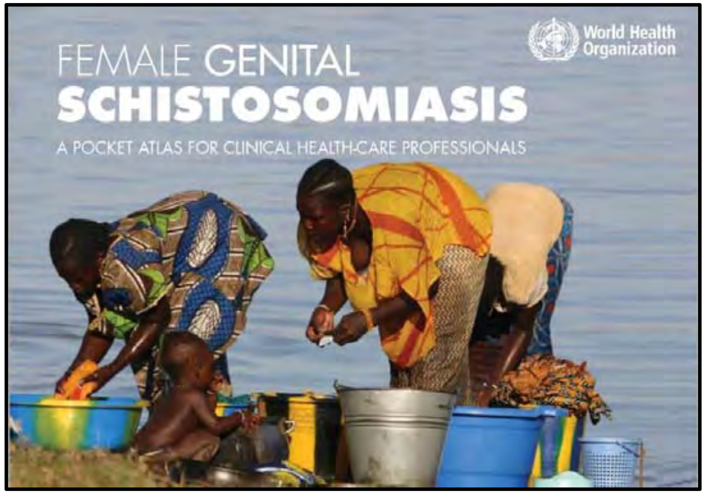


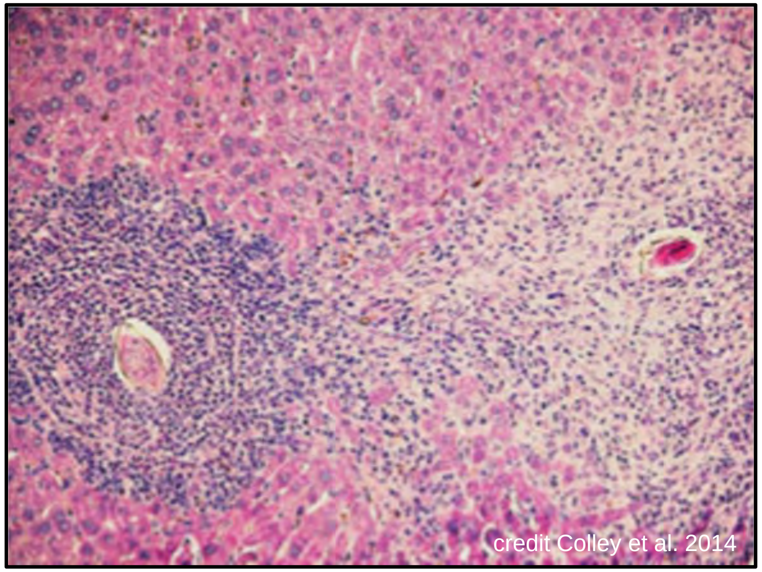
credit Beltran et al. 2008

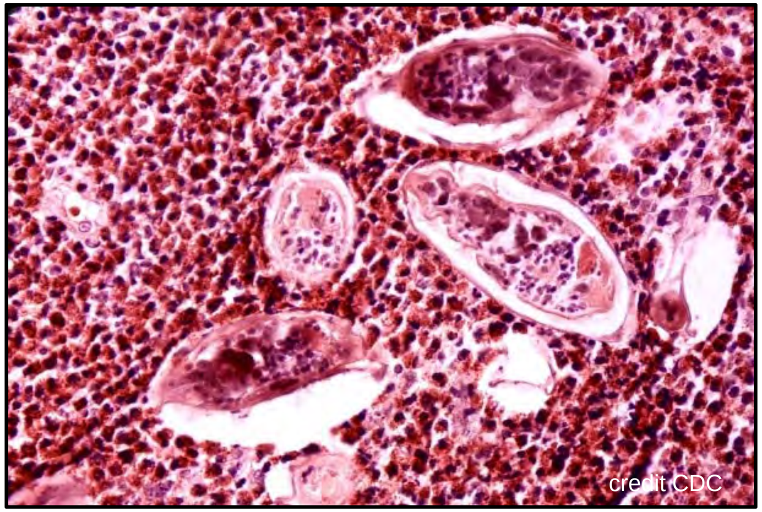

>240 million
human cases
credit GHIT Fund

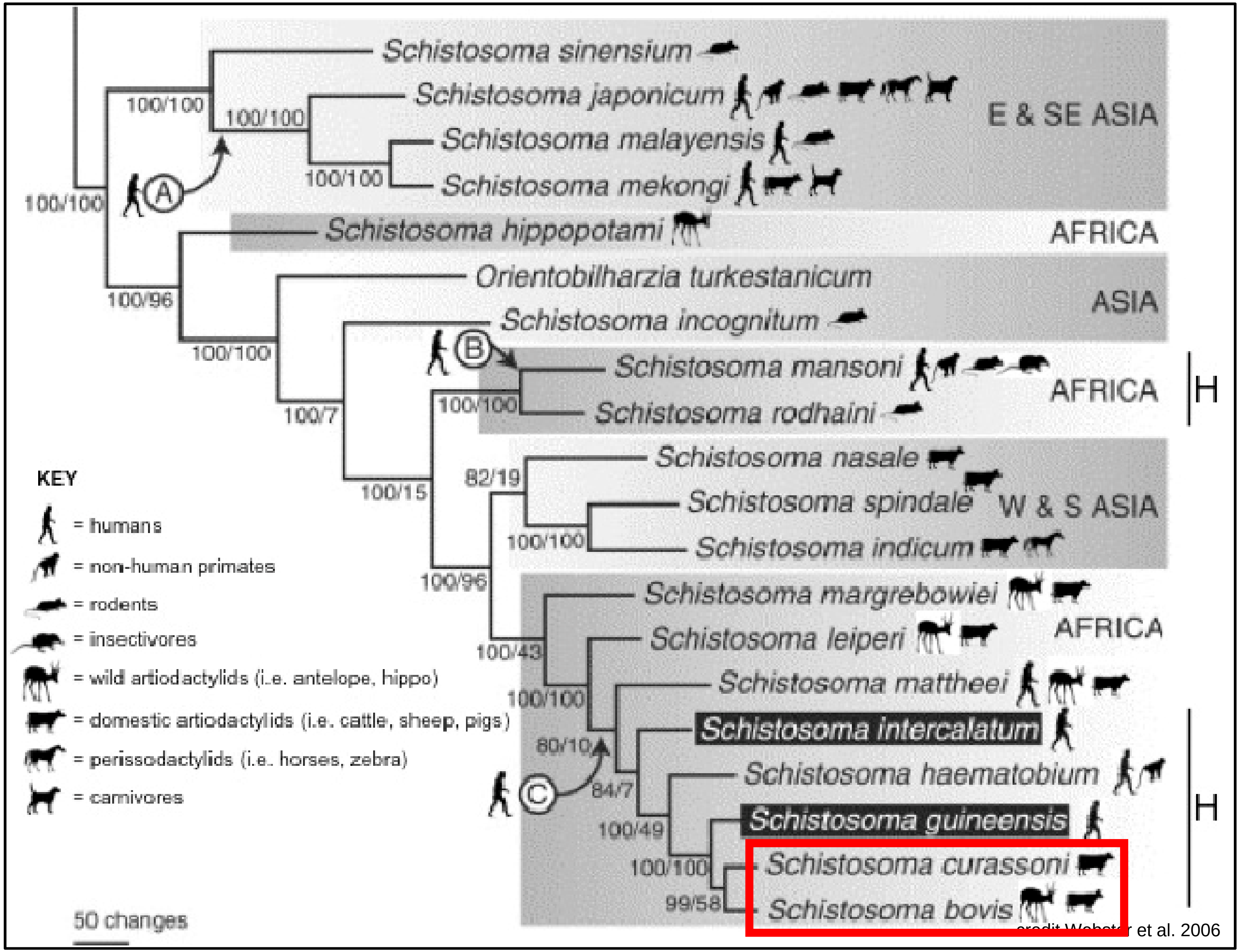
Pathology


credit The Carter Center

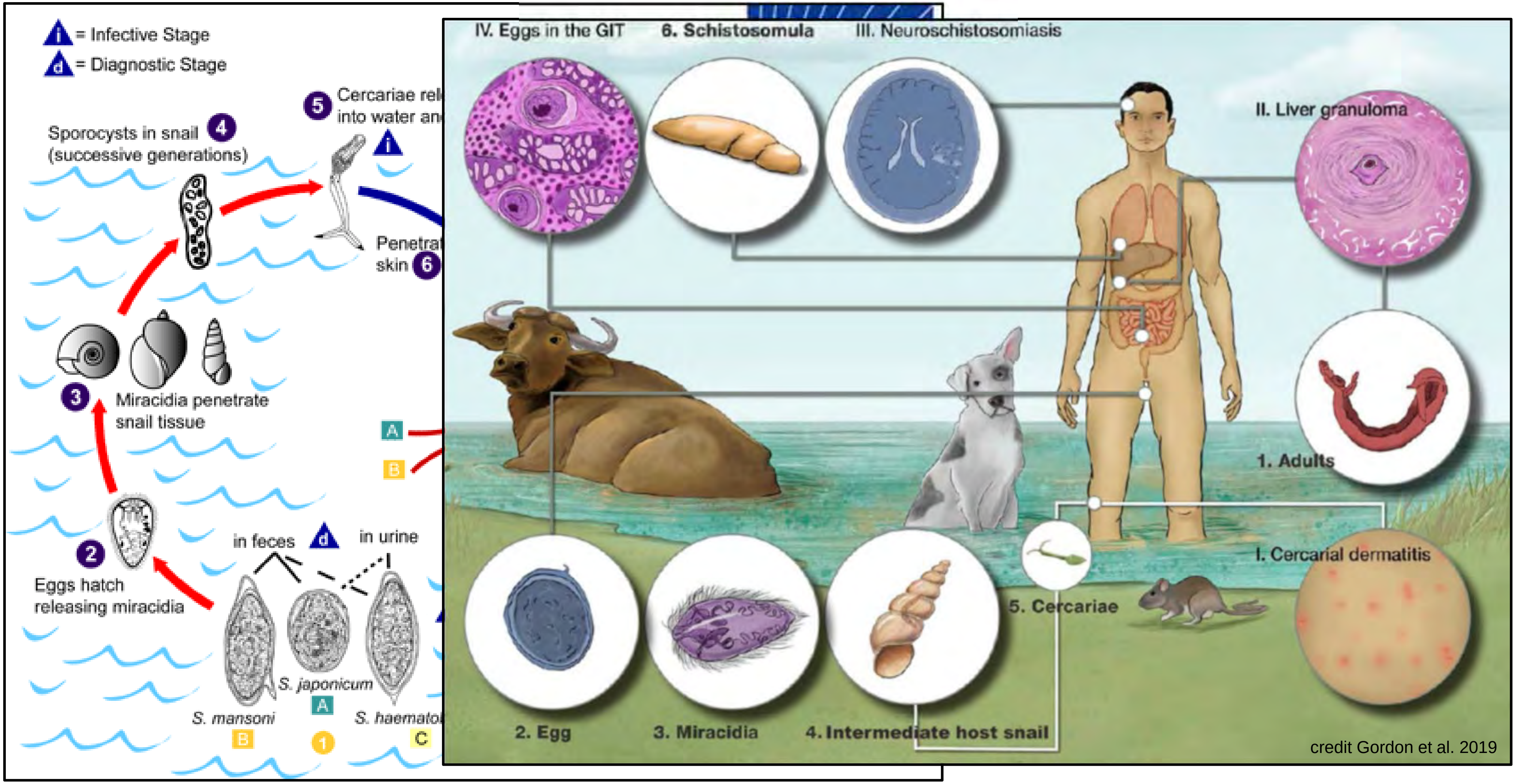


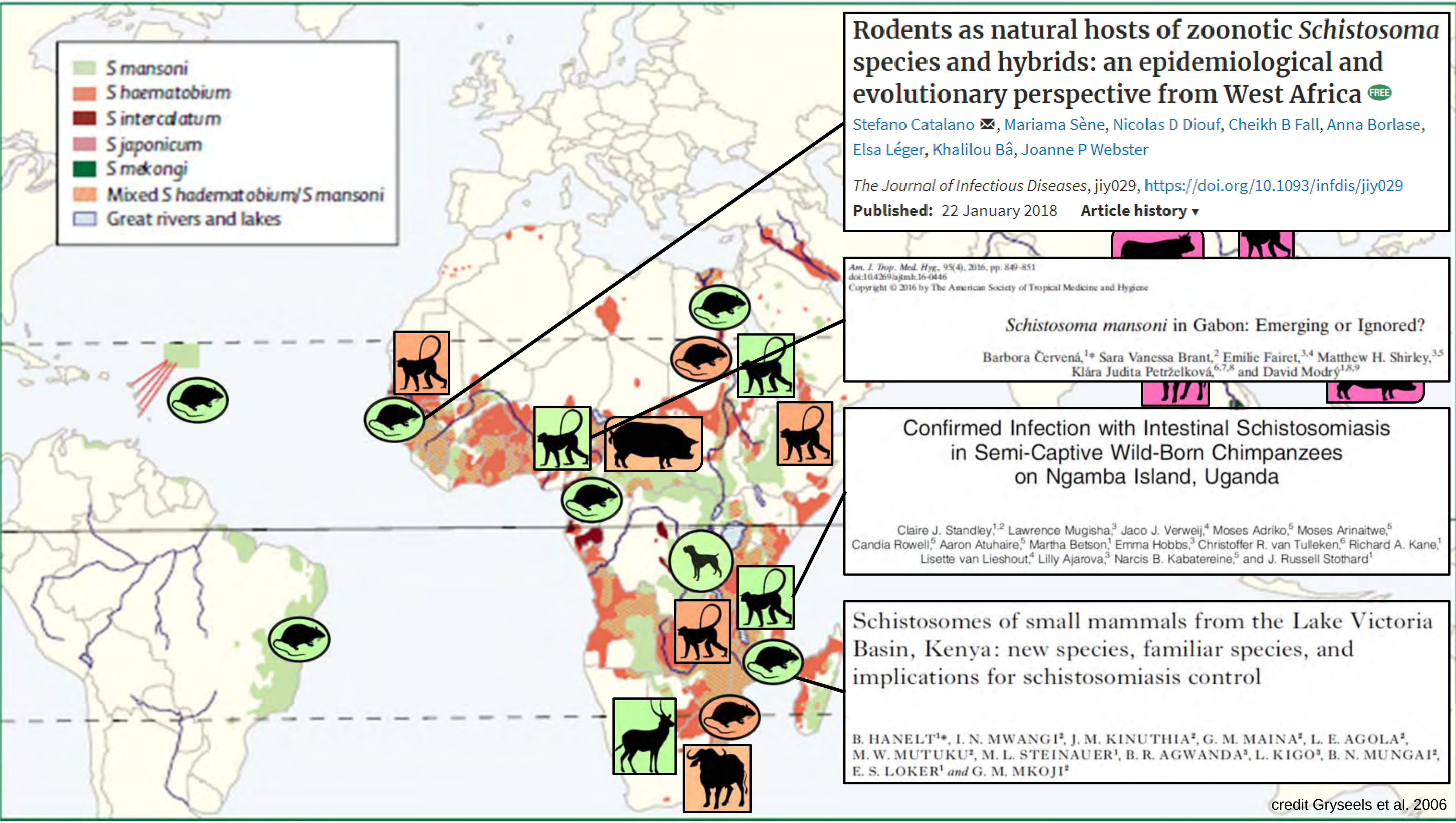

credit Colley et al. 2014


credit CDC


Schistosoma sinensium
Schistosoma japonicum
Schistosoma malayensis
Schistosoma mekongi
E & SE ASIA
Schistosoma hippopotami
AFRICA
Orientobilharzia turkestanicum
Schistosoma incognitum
ASIA
Schistosoma mansoni
Schistosoma rodhaini
AFRICA
H
Schistosoma nasale
Schistosoma spindale
Schistosoma indicum
W & S ASIA
Schistosoma margrebowiei
Schistosoma leiperi
AFRICA
Schistosoma mattheei
Schistosoma intercalatum
Schistosoma haematobium
Schistosoma guineensis
Schistosoma curassoni
Schistosoma bovis
H
100/100
100/100
100/100
100/100
100/100
100/96
100/100
100/7
100/100
100/15
82/19
100/100
100/96
100/43
100/100
80/10
84/7
100/49
100/100
99/58
A
B
C
KEY
= humans
= non-human primates
= rodents
= insectivores
= wild artiodactylids (i.e. antelope, hippo)
= domestic artiodactylids (i.e. cattle, sheep, pigs)
= perissodactylids (i.e. horses, zebra)
= carnivores
50 changes
et al. 2006

Life cycle


= Infective Stage
= Diagnostic Stage
Sporocysts in snail
(successive generations)
Cercariae rel
into water an
Penetrat
skin
Miracidia penetrate
snail tissue
Eggs hatch
releasing miracidia
in feces
in urine
S. japonicum
S. mansoni
S. haemato
IV. Eggs in the GIT
6. Schistosomula
III. Neuroschistosomiasis
II. Liver granuloma
1. Adults
I. Cercarial dermatitis
5. Cercariae
2. Egg
3. Miracidia
4. Intermediate host snail
credit Gordon et al. 2019


S mansoni
S haematobium
S intercalatum
S japonicum
S mekongi
Mixed S hadematobium/S mansoni
Great rivers and lakes
Rodents as natural hosts of zoonotic Schistosoma species and hybrids: an epidemiological and evolutionary perspective from West Africa
FREE
Stefano Catalano, Mariama Sène, Nicolas D Diouf, Cheikh B Fall, Anna Borlase, Elsa Léger, Khalilou Bâ, Joanne P Webster
The Journal of Infectious Diseases, jiy029, https://doi.org/10.1093/infdis/jiy029
Published: 22 January 2018 Article history ▾
Am. J. Trop. Med. Hyg., 95(4), 2016, pp. 849–851
doi:10.4269/ajtmh.16-0446
Copyright © 2016 by The American Society of Tropical Medicine and Hygiene
Schistosoma mansoni in Gabon: Emerging or Ignored?
Barbora Červená,1* Sara Vanessa Brant,2 Emilie Fairet,3,4 Matthew H. Shirley,3,5 Klára Judita Petrželková,6,7,8 and David Modrý1,8,9
Confirmed Infection with Intestinal Schistosomiasis in Semi-Captive Wild-Born Chimpanzees on Ngamba Island, Uganda
Claire J. Standley,1,2 Lawrence Mugisha,3 Jaco J. Verweij,4 Moses Adriko,5 Moses Arinaitwe,5 Candia Rowell,5 Aaron Atuhaire,5 Martha Betson,1 Emma Hobbs,3 Christoffer R. van Tulleken,6 Richard A. Kane,1 Lisette van Lieshout,4 Lilly Ajarova,3 Narcis B. Kabatereine,5 and J. Russell Stothard1
Schistosomes of small mammals from the Lake Victoria Basin, Kenya: new species, familiar species, and implications for schistosomiasis control
B. HANELT1*, I. N. MWANGI2, J. M. KINUTHIA2, G. M. MAINA2, L. E. AGOLA2, M. W. MUTUKU2, M. L. STEINAUER1, B. R. AGWANDA3, L. KIGO3, B. N. MUNGAI2, E. S. LOKER1 and G. M. MKOJI2
credit Gryseels et al. 2006

Schistosoma species hybridization

Parasitol Res
DOI 10.1007/s00436-015-4643-4

ORIGINAL PAPER

Outbreak of urogenital schistosomiasis in Corsica (France): an epidemiological case study

Jérôme Boissier, Sébastien Grech-Angelini, Bonnie L Webster, Jean-François Allienne, Tine Huyse, Santiago Mas-Coma, Eve Toulza, Hélène Barré-Cardi, David Rollinson, Julien Kincaid-Smith, Ana Oleaga, Richard Galinier, Joséphine Foata, Anne Rognon, Antoine Berry, Gabriel Mouahid, Rémy Henneron, Hélène Moné, Harold Noel, Guillaume Mitta

Summary

Background Schistosomiasis is a snail-borne parasitic disease endemic in several tropical and subtropical countries. However, in the summer of 2013, an unexpected outbreak of urogenital schistosomiasis occurred in Corsica, with more than 120 local people or tourists infected. We used a multidisciplinary approach to investigate the epidemiology of urogenital schistosomiasis in Corsica, aiming to elucidate the origin of the outbreak.

Lancet Infect Dis 2016; 16: 971–79
Published Online May 16, 2016
http://dx.doi.org/10.1016/

Introgressed Animal Schistosomes *Schistosoma curassoni* and *S. bovis* Naturally Infecting Humans

Elsa Léger, Amadou Garba, Amina A. Hamidou, Bonnie L. Webster, Tom Pennance, David Rollinson, Joanne P. Webster

Author affiliations: Royal Veterinary College, University of London, London, UK (E. Léger, T. Pennance, J.P. Webster); RISEAL Niger, Niamey, Niger (A. Garba, A.A. Hamidou); Natural History Museum, London (B.L. Webster, D. Rollinson)

DOI: http://dx.doi.org/10.3201/eid2212.160644

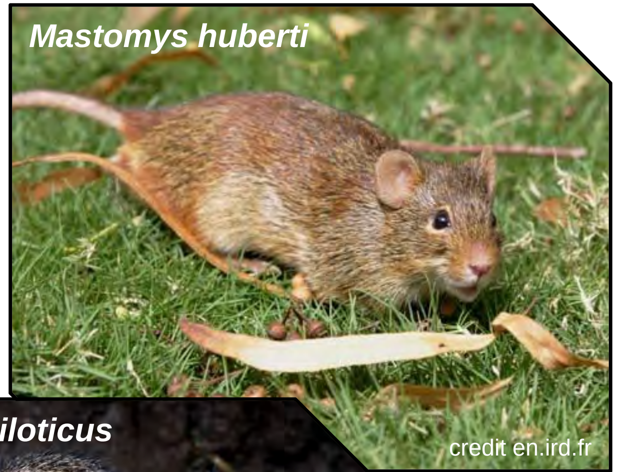
To the Editor: Schistosomiasis, a disease caused by nfection with parasitic worms (schistosomes), is a neglected tropical disease across many parts of the world. Numbers of infected livestock are unknown, but >250 million persons are infected; the greatest number of cases are in sub-Saharan Africa (*1*). Schistosome eggs are excreted through urine or feces, depending on the species, and hatch into miracidia upon contact with freshwater. Larvae are transmitted to the mammalian host indirectly hrough a molluscan intermediate host. Goals to eliminate schistosomiasis by 2020 in select countries in Africa have

Anthropogenic changes driving *Schistosoma* spp. hybridization?


credit E. Léger

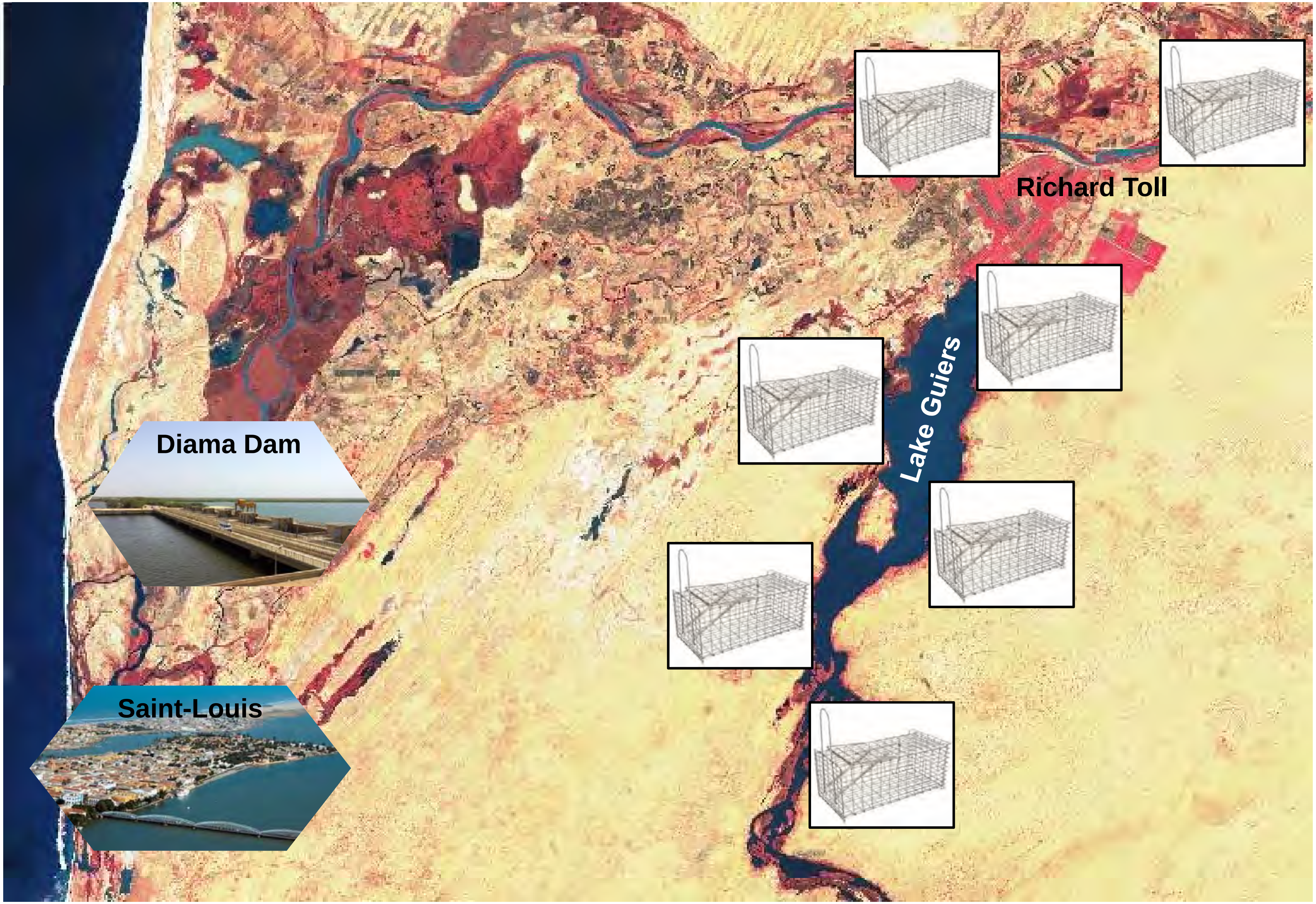

Study objectives
Multi-host spectrum of schistosomes and role of humans, livestock, wild rodents, and snails in the evolution of hybrids in West Africa
•
Hypothesis of rodents as reservoirs of zoonotic *Schistosoma* species and hybrids in endemic regions of Senegal
credit E. Léger

Methods



77 out of 1387 (5.5%) *A. niloticus*
39 out of 861 (4.5%) *M. huberti*
Duplantier and Sène (2000), Journal of Helminthology.

Methods



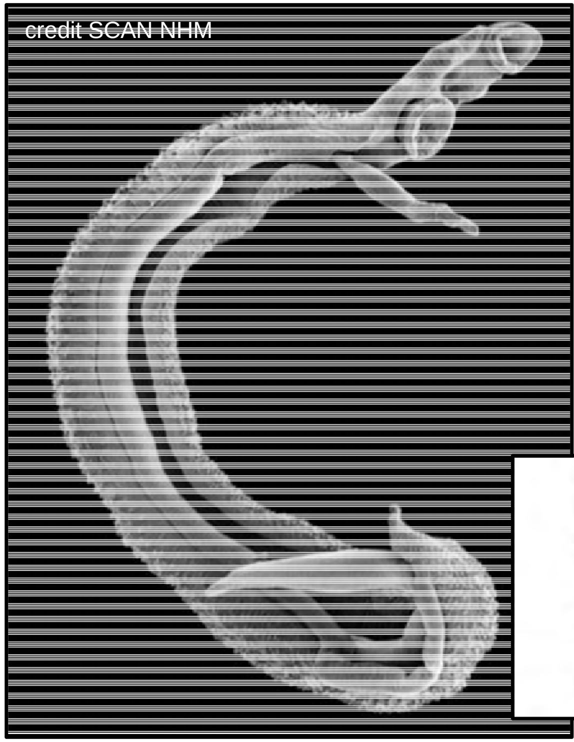
Methods

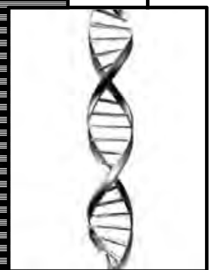
For each individual

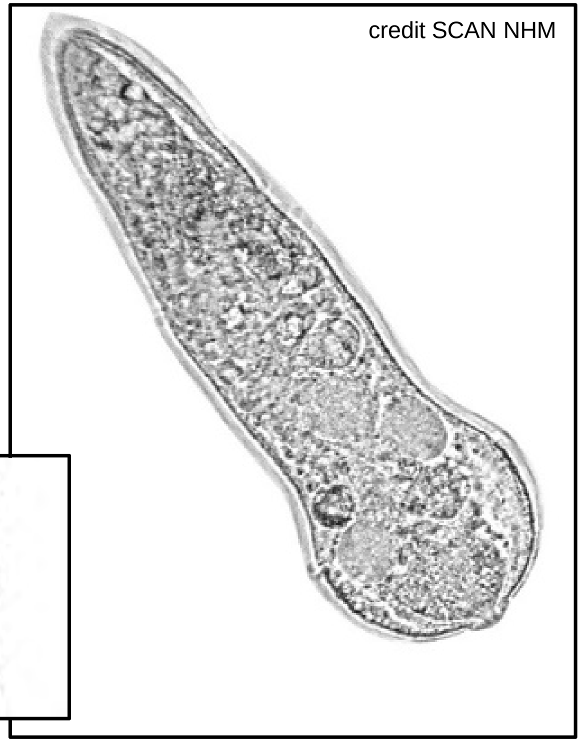
- GPS coordinates
- Habitat
- Capture date
- Species
- Gender
- Anatomical measurements

Specimens

- Plasma (stored at -20°C)
- Brain and heart in RNAlater®
- Kidneys in 90% ethanol
- Blood smears
- Faeces in 10% formalin
- Parasitological analysis of:
  cardiovascular system
  respiratory system
  digestive system
  liver
  urogenital system

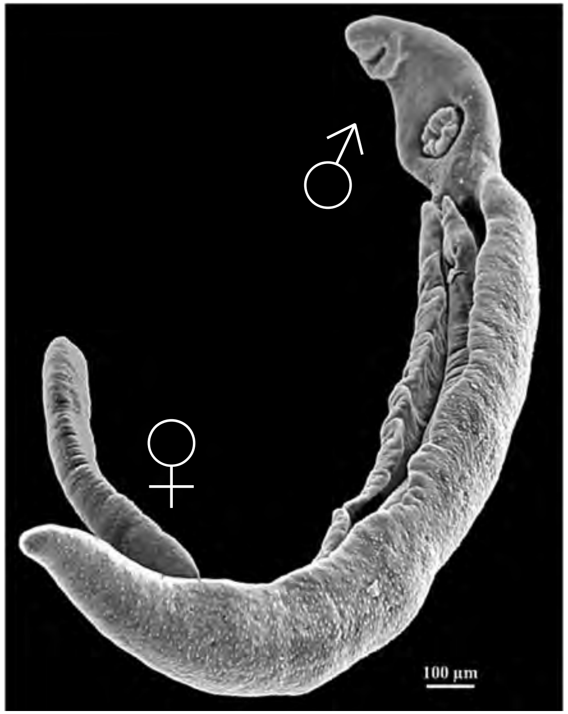


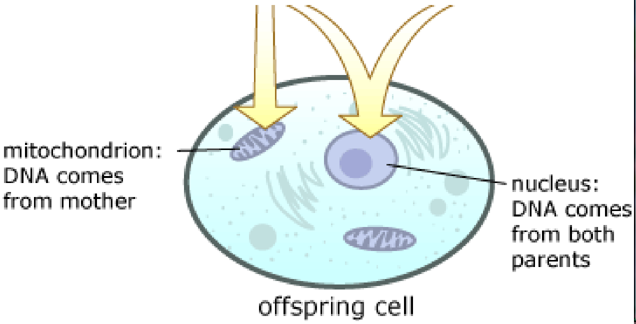


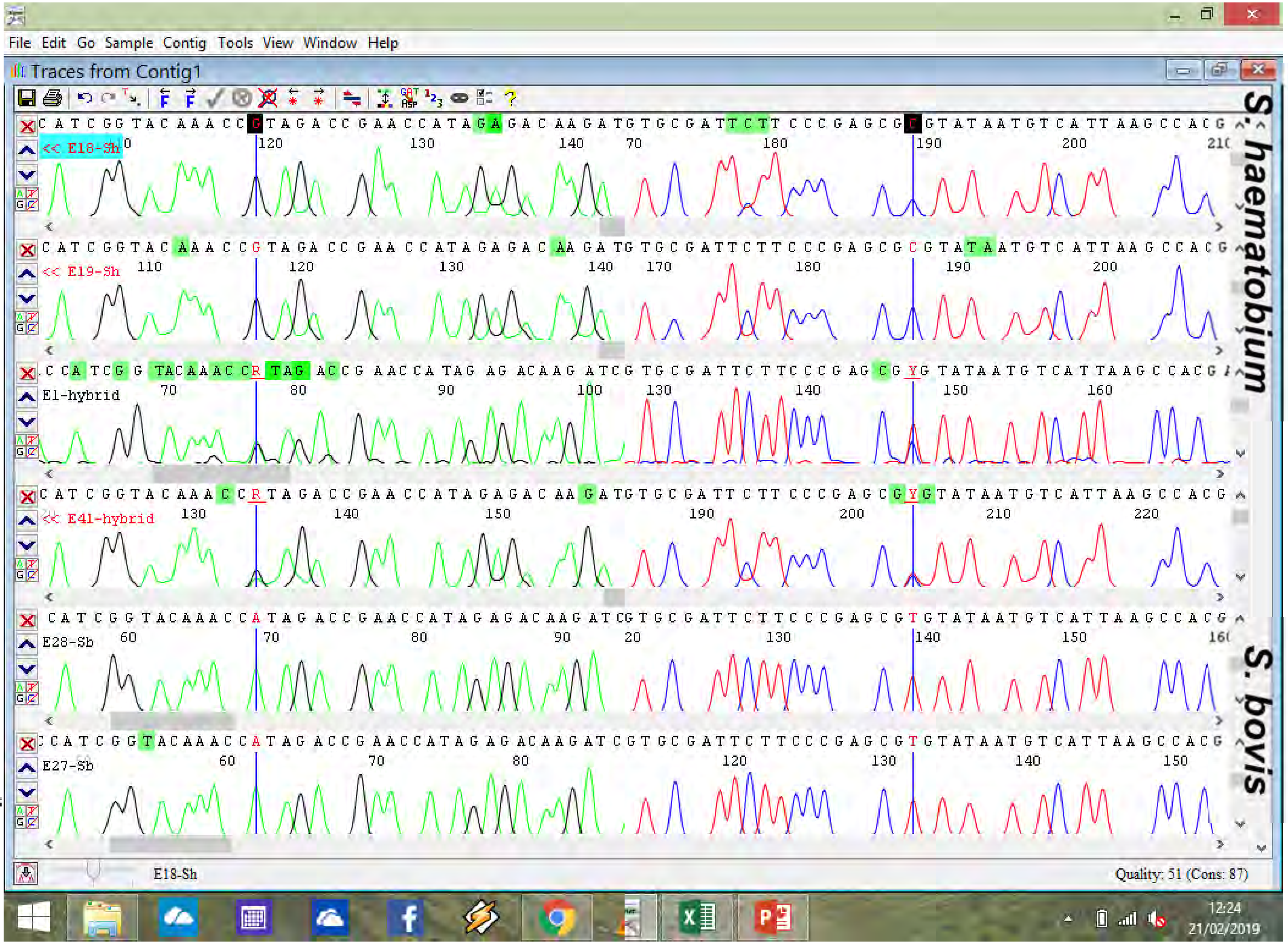


mtDNA *cox1* + rDNA ITS region

Methods


♂
♀
100 µm


mitochondrion: DNA comes from mother
nucleus: DNA comes from both parents
offspring cell


File Edit Go Sample Contig Tools View Window Help
Traces from Contig1
<< E18-Sh
<< E19-Sh
E1-hybrid
<< E41-hybrid
E28-Sb
E27-Sb
S. haematobium
S. bovis
E18-Sh
Quality: 51 (Cons: 87)
12:24
21/02/2019

Results

4,150 active traps
671 small mammals

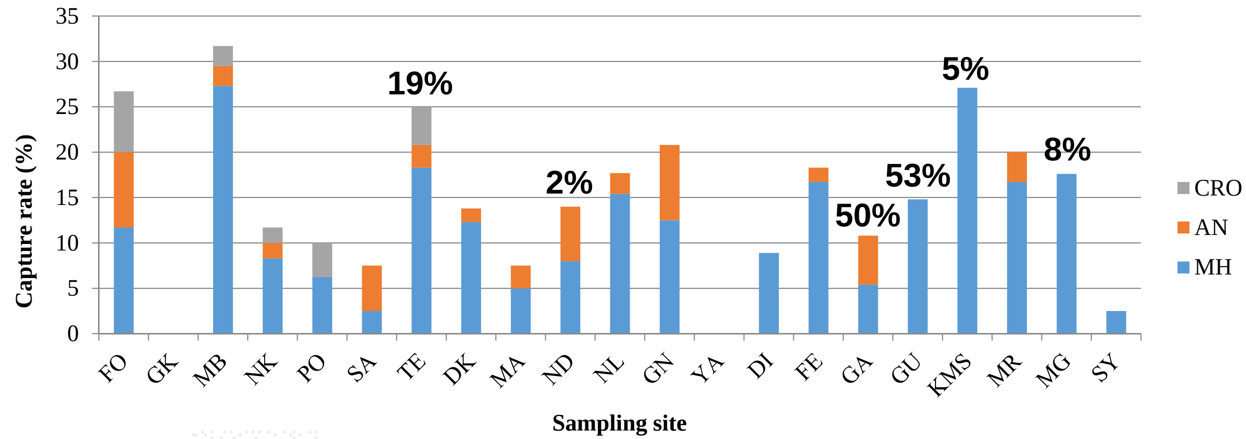
- 367 mice *Mastomys huberti*
- 257 rats *Arvicanthis niloticus*
- 41 shrews *Crocidura* sp.
- 6 gerbils *Taterillus* sp.

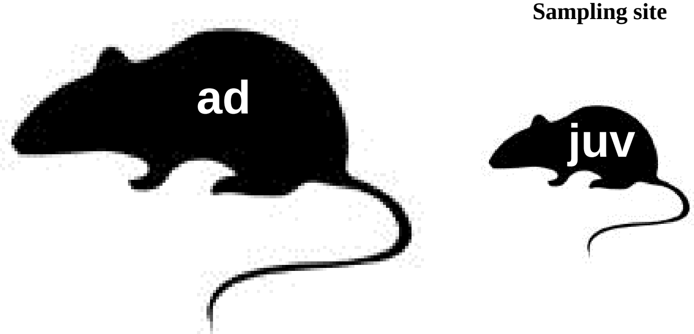
23 *S. mansoni* (5, 2-64)
1 *S. haematobium/S. bovis* (1)
6.3%

5 *S. bovis* (6, 1-44)
1 *S. mansoni* (4)
2.3%

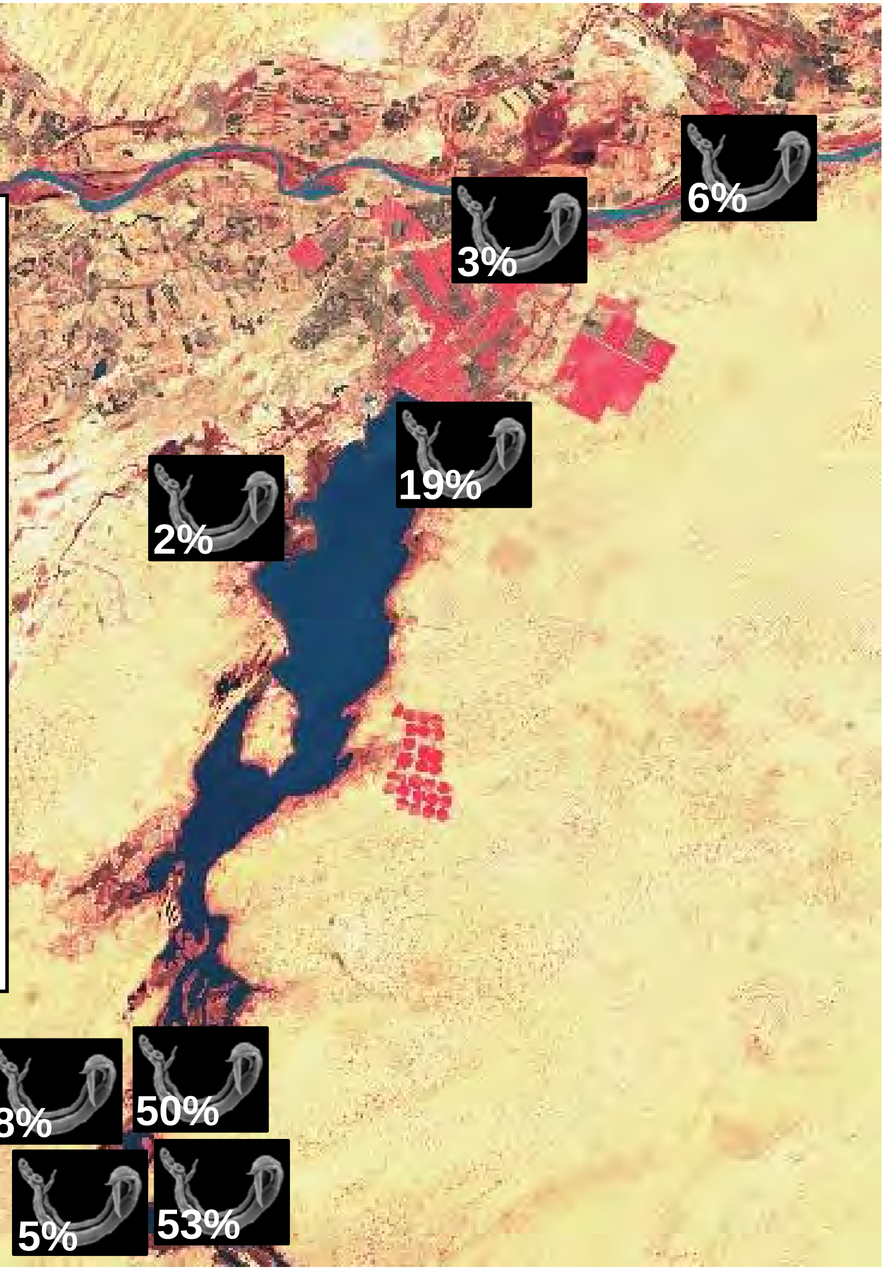
Village	Host	Prevalence
Gueo	*M. huberti*	52.6% (10/19)
Ganket	*M. huberti*	50.0% (2/4)
Temey	*M. huberti*	18.6% (8/43)
Merina Guewel	*M. huberti*	8.3% (1/12)
Djidiery	*A. niloticus*	5.8% (4/69)
Keur Momar Sarr	*M. huberti*	5.3% (1/19)
Richard Toll	*A. niloticus*	2.7% (2/73)
Nder	*M. huberti*	1.7% (1/60)

Results

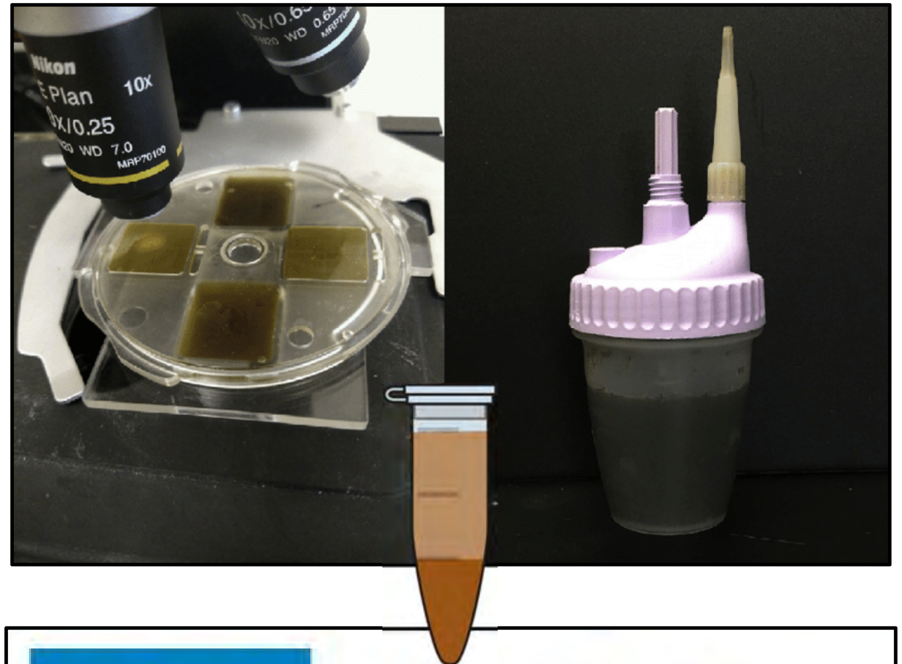




$P = 0.028$



Results



National Centre
for the Replacement
Refinement & Reduction
of Animals in Research

RESEARCH — Open Access

A cross-sectional study on schistosomiasis and soil-transmitted helminths in Mbita district, western Kenya using different

OPEN ACCESS Freely available online — PLOS | NEGLECTED TROPICAL DISEASES

Diagnostic Accuracy and Cost-Effectiveness of Alternative Methods for Detection of Soil-Transmitted Helminths in a Post-Treatment Setting in Western Kenya

OPEN ACCESS Freely available online — PLOS | NEGLECTED TROPICAL DISEASES

Mini-FLOTAC, an Innovative Direct Diagnostic Technique for Intestinal Parasitic Infections: Experience from the Field

Contents lists available at ScienceDirect

Acta Tropica

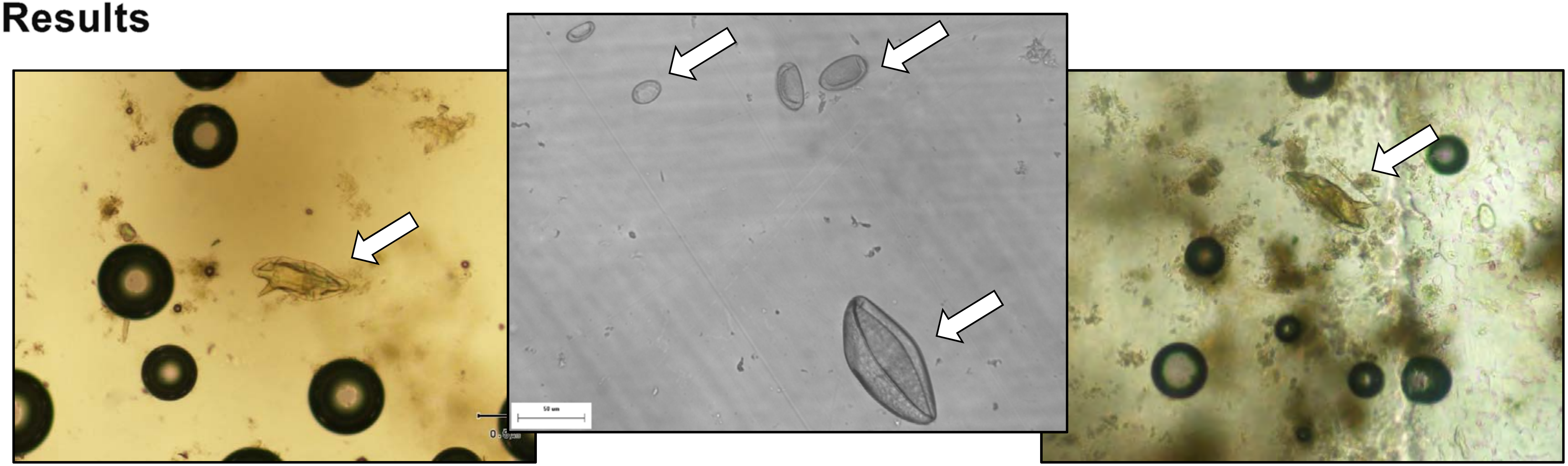
journal homepage: www.elsevier.com/locate/actatropica

ELSEVIER

Comparison of sensitivity and faecal egg counts of Mini-FLOTAC using fixed stool samples and Kato-Katz technique for the diagnosis of *Schistosoma mansoni* and soil-transmitted helminths

Jean T. Coulibaly[a,b,c,d,*], Mamadou Ouattara[a], Sören L. Becker[c,d,e], Nathan C. Lo[f], Jennifer Keiser[c,d], Eliézer K. N'Goran[a,b], Davide Ianniello[g], Laura Rinaldi[g], Giuseppe Cringoli[g], Jürg Utzinger[c,d]

Results



Parasite	*M. huberti* necropsy (n = 89) adult worm counts	*M. huberti* Mini-FLOTAC (n = 89) eggs per gram of faeces	Infection prevalence Infection intensity
***Plagiorchis* sp.**	87.6% 18; 1-61	85.4% 4,300; 25-134,900	*P* = 0.83 *P* = 0.19
Schistosoma mansoni	23.6% 8; 2-64	23.6% 262; 15-1,237	*P* = 1.00 *P* = 0.058
Echinostoma caproni	16.9% 2; 1-34	20.2% 232; 18-52,275	*P* = 0.85 *P* = 0.053
Anchitrema* cf. *sanguineum	3.4% 9; 1-24	1.1% 750	NA

Results

IJP: Parasites and Wildlife 8 (2019) 164–170

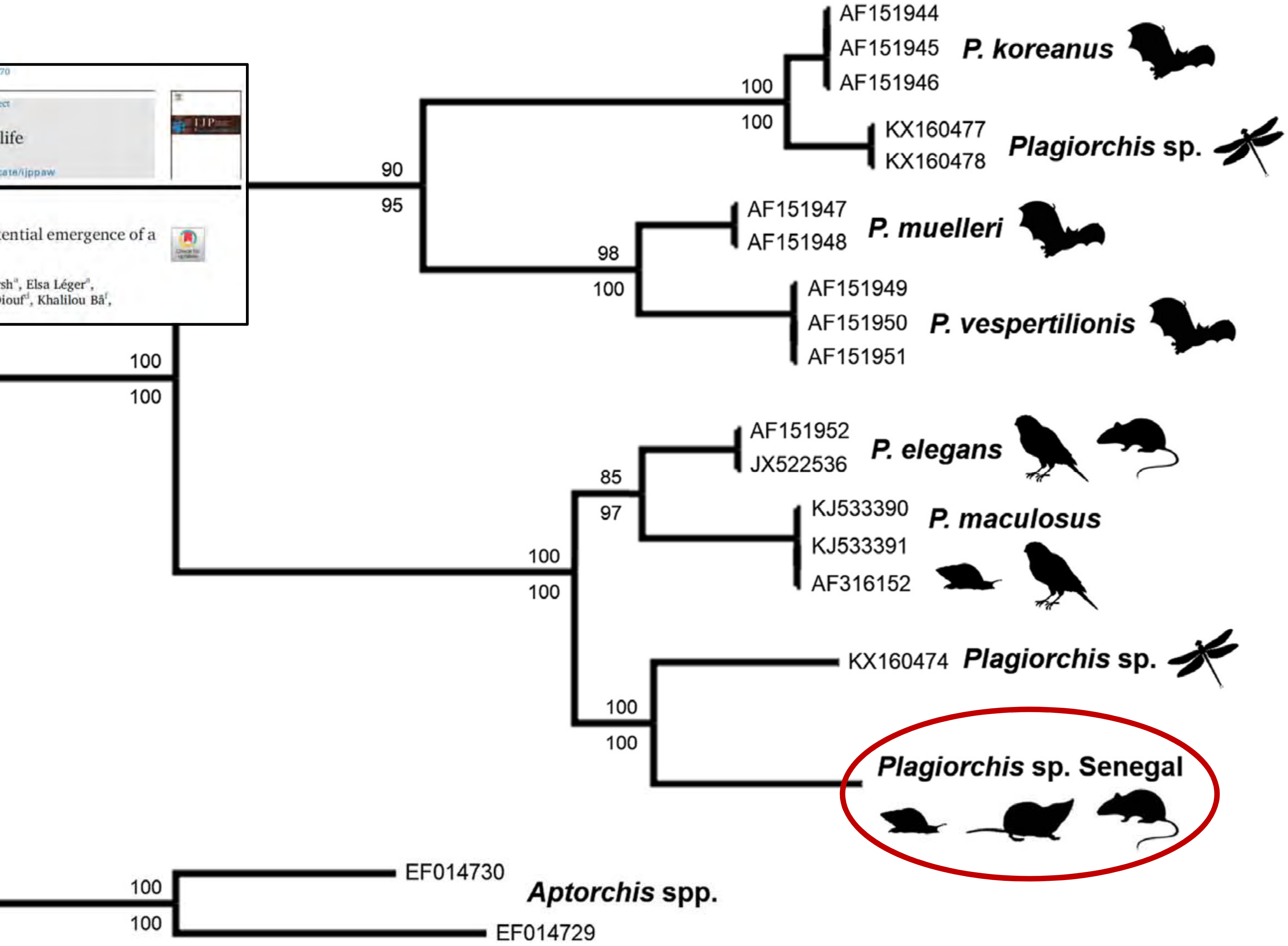
Contents lists available at ScienceDirect

IJP: Parasites and Wildlife

journal homepage: www.elsevier.com/locate/ijppaw

Plagiorchis sp. in small mammals of Senegal and the potential emergence of a zoonotic trematodiasis

Stefano Catalano[a,*], Steven A. Nadler[b], Cheikh B. Fall[c], Kirsty J. Marsh[a], Elsa Léger[a], Mariama Sène[d], Simon L. Priestnall[a], Chelsea L. Wood[e], Nicolas D. Diouf[d], Khalilou Bâ[f], Joanne P. Webster[a,g]



Plagiorchis spp. – Geographical distribution of human cases

J. Parasitol., 93(5), 2007, pp. 1225–1227

A Human Case of *Plagiorchis vespertilionis* (Digenea: Plagiorchiidae) Infection in the Republic of Korea

S.-M. Guk, J.-L. Kim, J.-H. Park, and J.-Y. Chai*, Department of Parasitology and Tropical Medicine, Seoul National University College of Medicine, and Institute of Endemic Diseases, Seoul National University Medical Research Center, Seoul 110-799, Korea; *To whom correspondence should be addressed. *e-mail: cjy@snu.ac.kr*

A Human Case of *Plagiorchis muris* (Tanabe, 1922: Digenea) Infection in the Republic of Korea: Freshwater Fish as a Possible Source of Infection

Sung-Jong Hong, Ho-Choon Woo, and Jong-Yil Chai*, Department of Parasitology, Gyeongsang National University College of Medicine, Chilam-dong, Chinju 660-280, Republic of Korea; and *Department of Parasitology, Seoul National University College of Medicine, Chongno-gu, Seoul 110-799, Republic of Korea

2017-5-18 A new intestinal fluke, Plagiorchis harinasutai n.sp. - PubMed - NCBI

PubMed ▾

Format: Abstract

Southeast Asian J Trop Med Public Health. 1989 Mar;20(1):101-7.

A new intestinal fluke, Plagiorchis harinasutai n.sp.

Radomyos P[1], Bunnag D, Harinasuta T.

Author information

Abstract
Dilution-sedimentation examination of stool specimens from four opisthorchiasis patients treated with praziquantel led to the discovery of six Plagiorchis worms. This is the first known report of plagiorchis infection in man in Thailand. The morphological features differed from those of previously described Plagiorchis species indicating that these worms belong to a new species.

Results

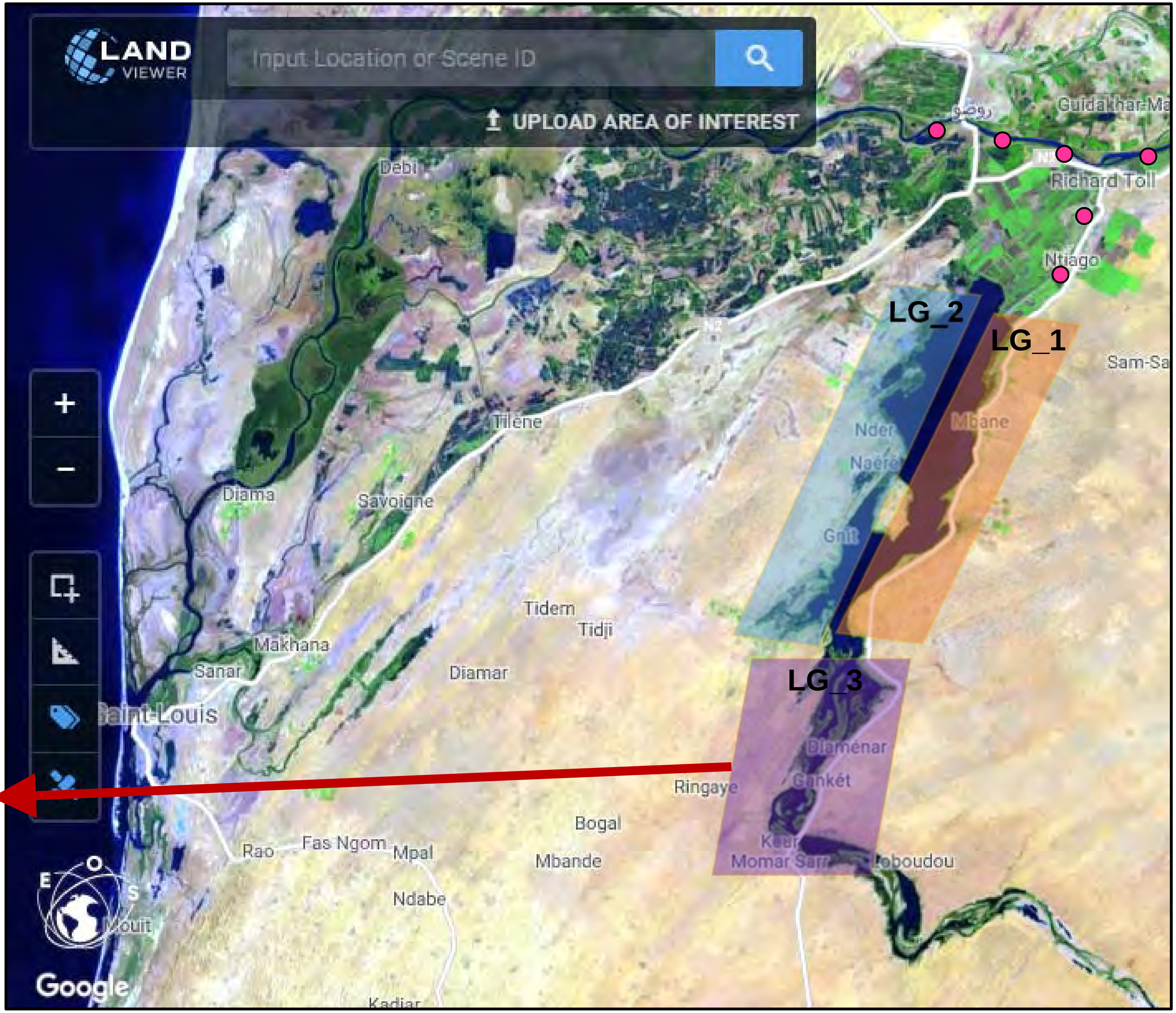
244 from Richard Toll

- 176 rats *A. niloticus* (0%)
- 43 mice *M. huberti* (0%)
- 19 shrews *Crocidura* spp. (0%)
- 6 gerbils *Taterillus* spp. (0%)

427 from Lake Guiers

- 324 mice *M. huberti* (58.6%)
- 81 rats *A. niloticus* (6.2%)
- 22 shrews *Crocidura* spp. (31.8%)

LG_3		
Host	**Liver**	**Intestine**
A. niloticus ad (n=7)	1/7 (14.3%) >61	0/7
M. huberti juv (n=25)	14/25 (56.0%) 42 (7->61)	6/25 (24.0%) 3.5 (1-8)
M. huberti ad (n=55)	49/55 (89.1%) >61 (1->61)	38/55 (69.1%) 9 (1->61)



Results

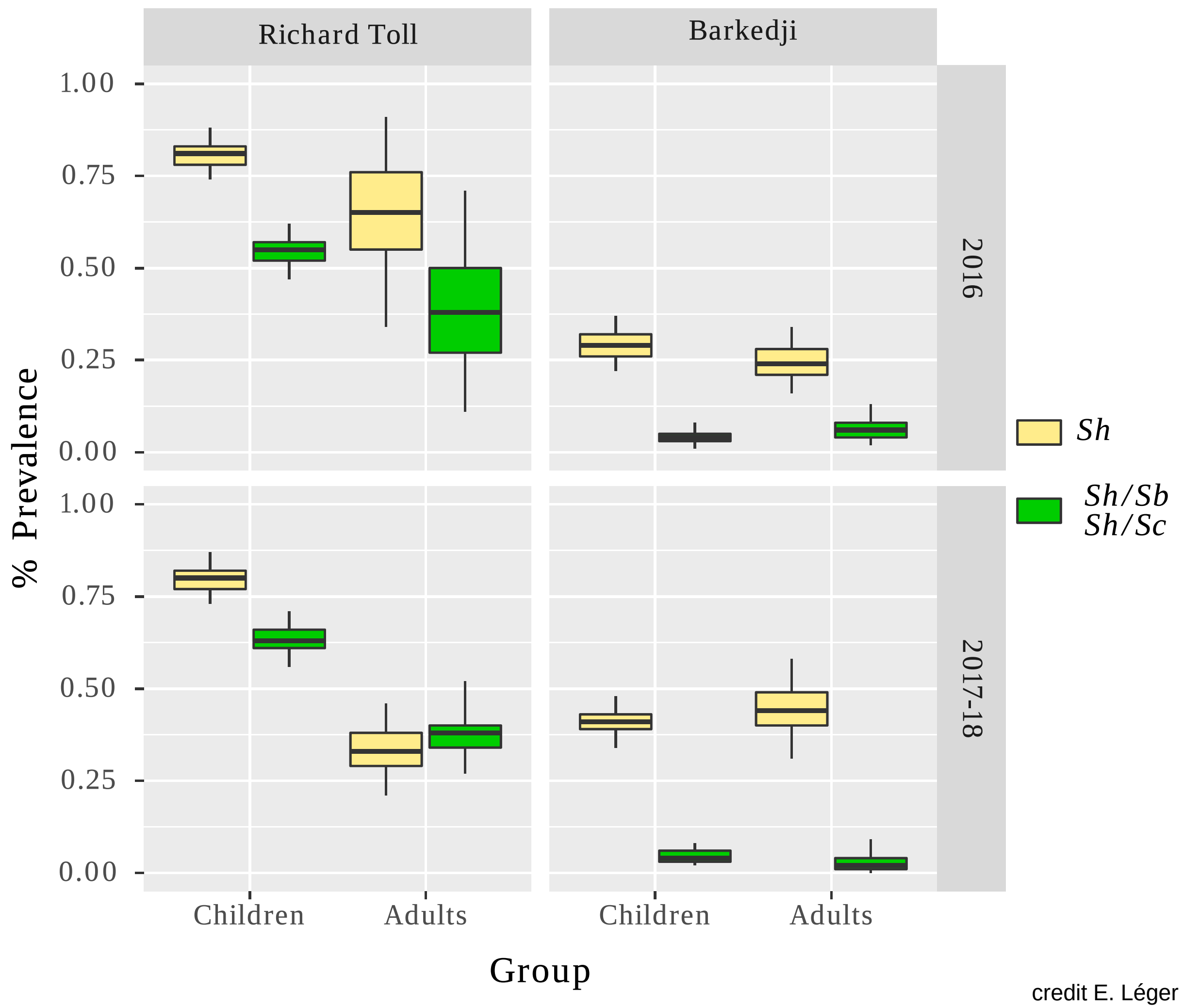
Schistosoma - Human data

Intestinal schistosomiasis
Kato-Katz
PCR 23 miracidia from 4 individuals

Richard Toll 2016-2017
13.3% (45/338) – 10.5% (35/333)
Barkedji 2016-2017
0% (0/314) – 0% (0/347)

Urogenital schistosomiasis
Urine filtration
PCR 2,582 miracidia from 472 individuals

Richard Toll 2016-2017
70.1% (277/395) – 64.1% (304/474)
Barkedji 2016-2017
22.7% (70/308) – 34.6% (141/408)

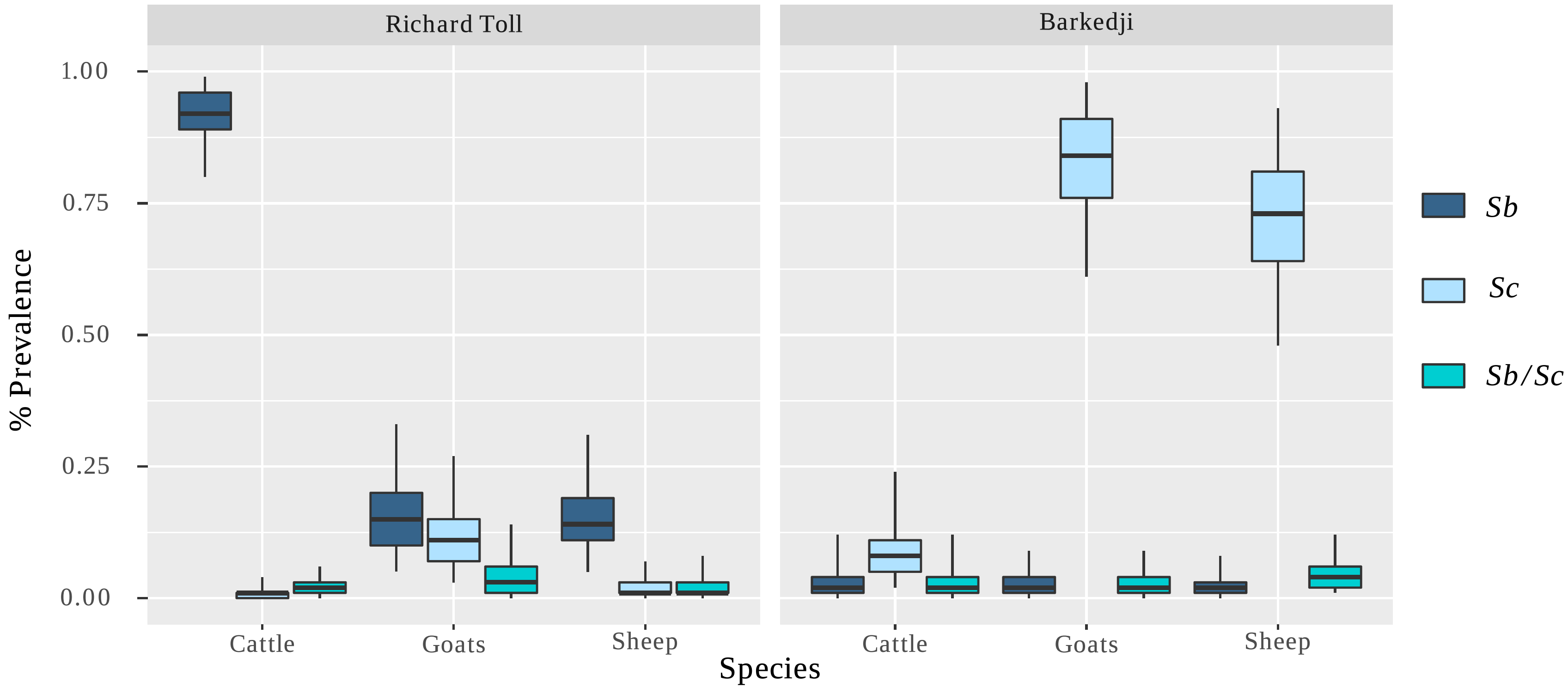


credit E. Léger

Results

Schistosoma - Livestock data

PCR 913 miracidia from 182 animals



94%

26%

16%

9%

86%

77%

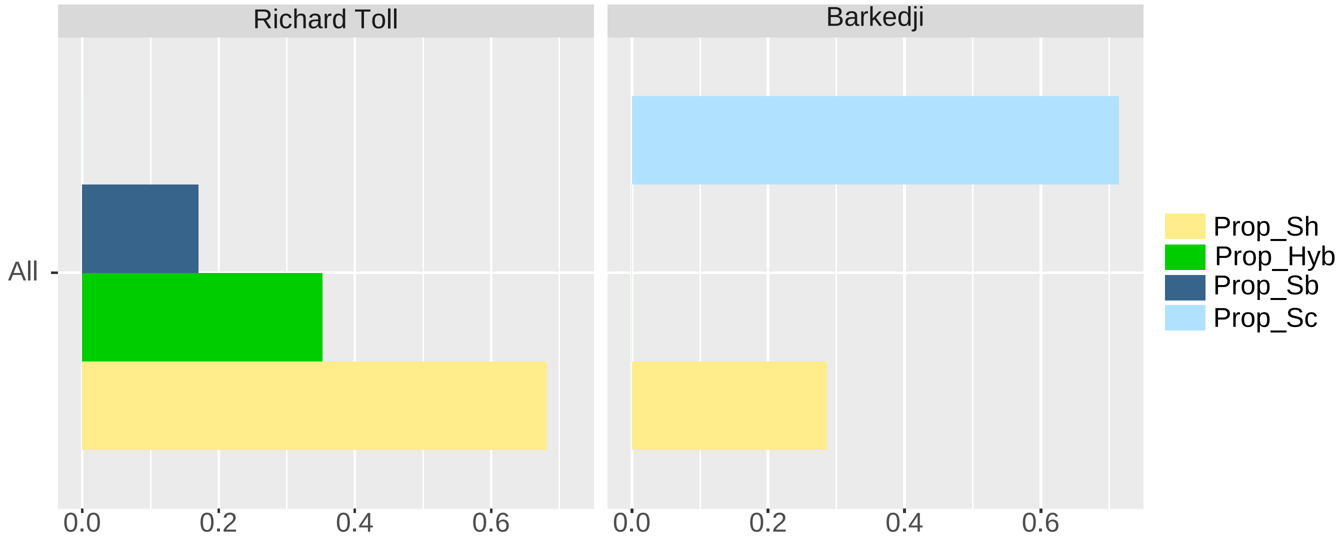
credit E. Léger

Results

Schistosoma - *Bulinus* snail data

Overall prevalence **3.71%** in Richard Toll and **0.49%** in Barkedji

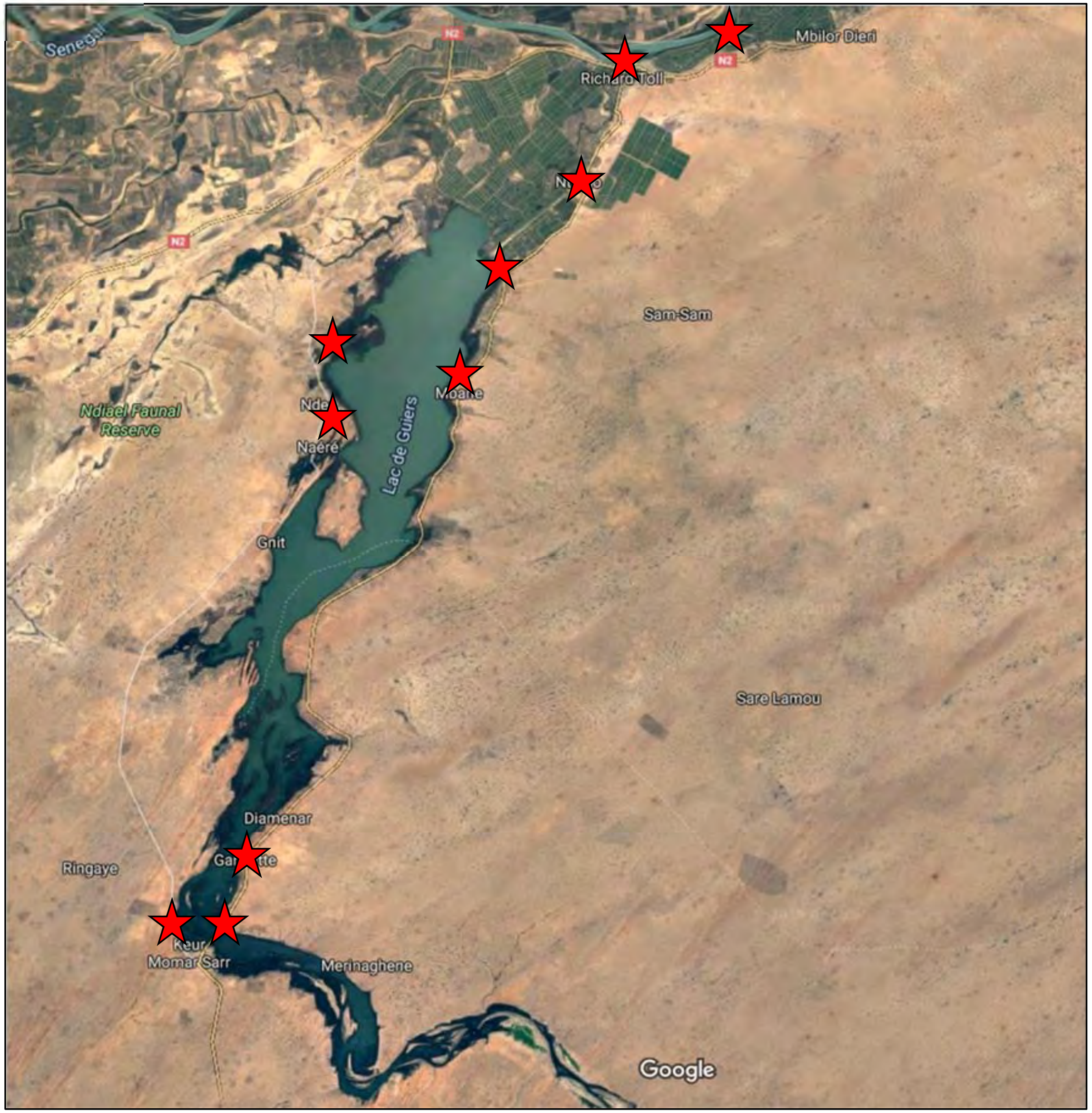
PCR 660 cercariae from 109 *Bulinus* snails



Proportion of snails infected with schistosome genotypes

credit E. Léger

Results



S. mansoni N = 43

ITS rDNA (914 bp)

mtDNA (3,933 bp)

26 *M. huberti*
3 *A. niloticus*
7 *H. sapiens*
7 *B. pfeifferi*

***S. haematobium* group N = 52**

ITS rDNA (928 bp)

mtDNA (1,773 bp)

***S. bovis* N = 22**

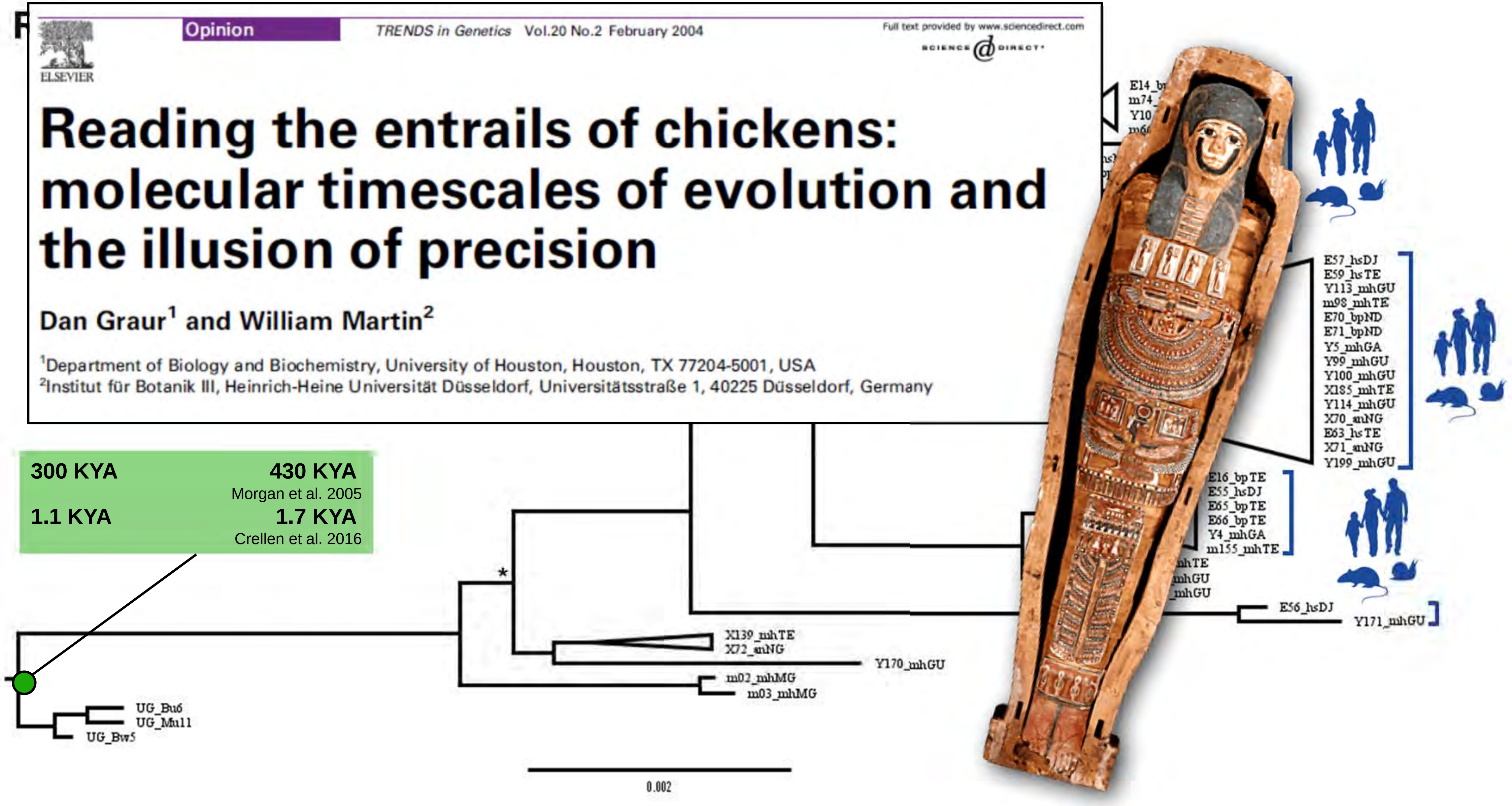
7 *A. niloticus*
7 cattle
3 sheep
1 goat
4 *Bulinus* spp.

***S. haematobium* N = 10**

6 *H. sapiens*
4 *Bulinus* spp.

***Sh/Sb* hybrids N = 20**

11 *H. sapiens*
1 *M. huberti*
8 *Bulinus* spp.



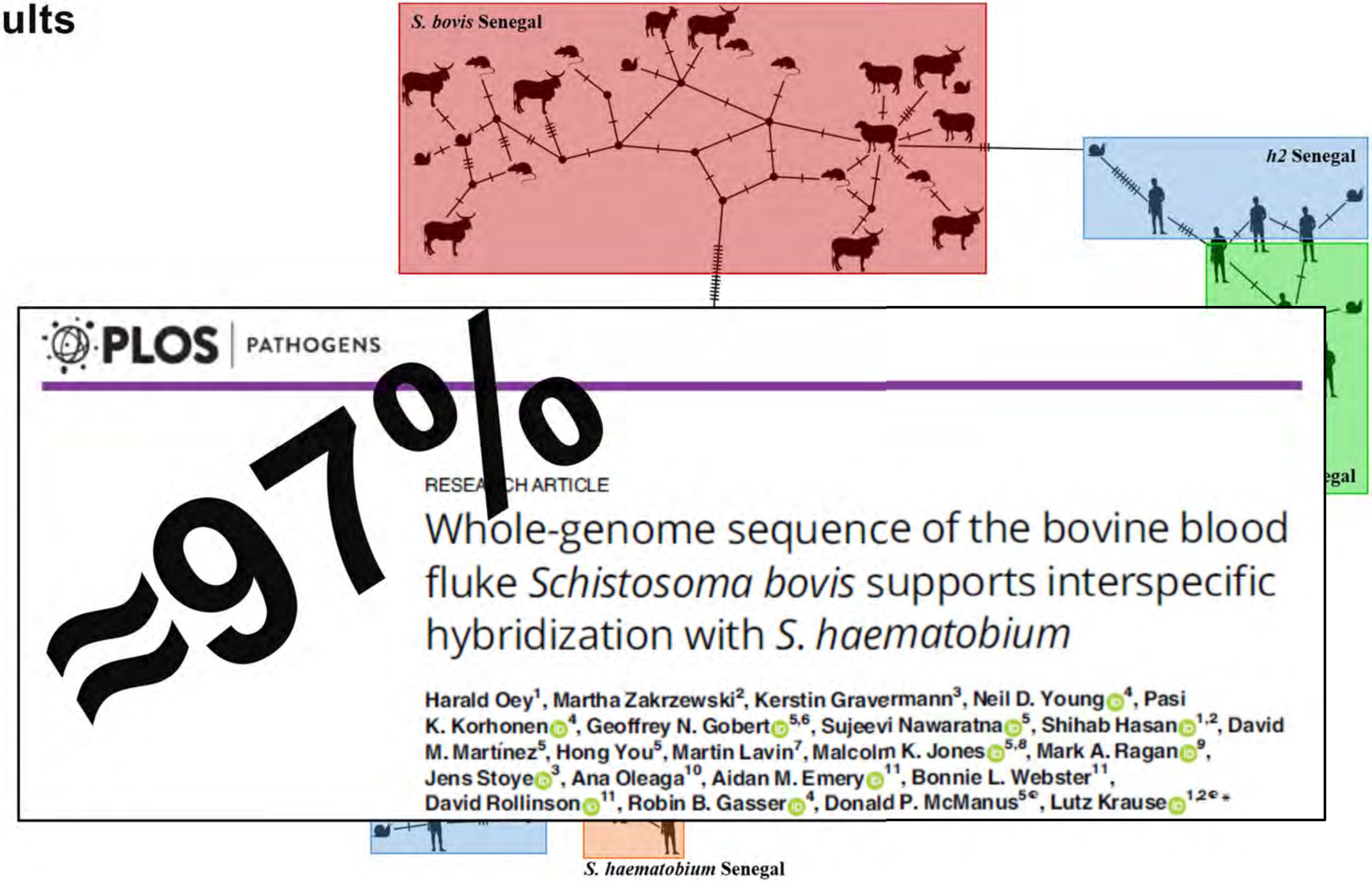
Opinion TRENDS in Genetics Vol.20 No.2 February 2004
Full text provided by www.sciencedirect.com
ELSEVIER

Reading the entrails of chickens: molecular timescales of evolution and the illusion of precision

Dan Graur[1] and William Martin[2]

[1]Department of Biology and Biochemistry, University of Houston, Houston, TX 77204-5001, USA
[2]Institut für Botanik III, Heinrich-Heine Universität Düsseldorf, Universitätsstraße 1, 40225 Düsseldorf, Germany

Results



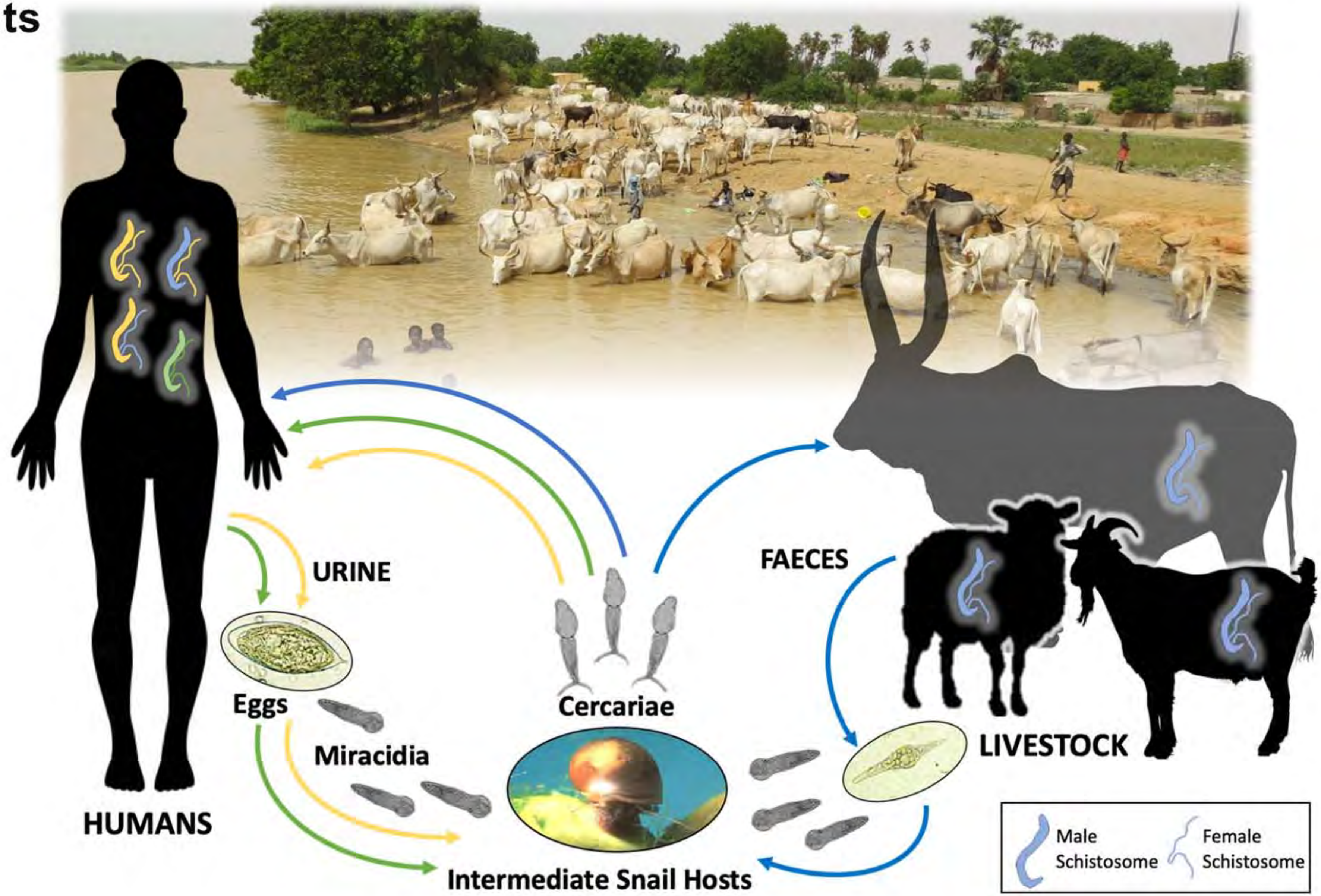
PLOS | PATHOGENS

RESEARCH ARTICLE

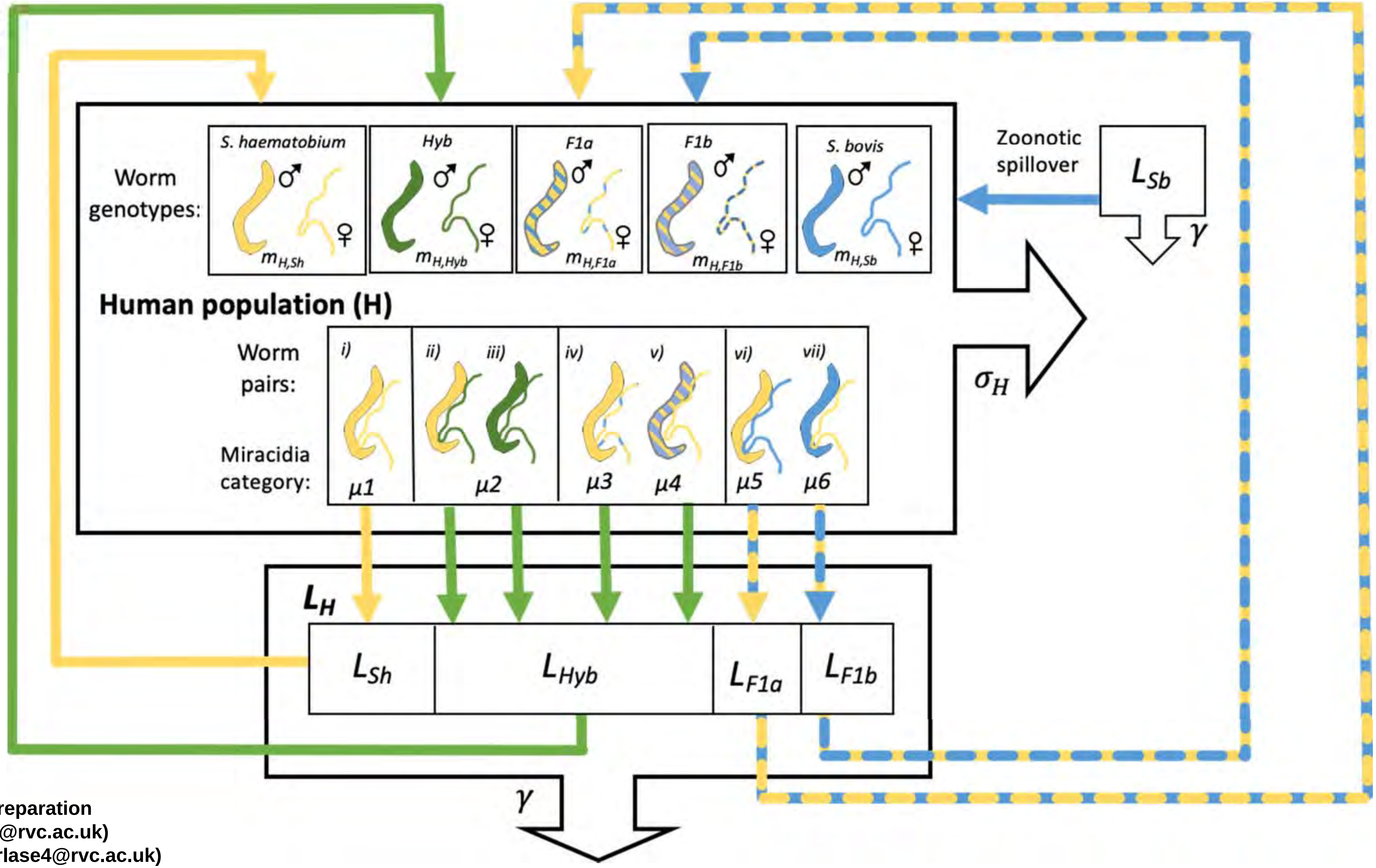
Whole-genome sequence of the bovine blood fluke *Schistosoma bovis* supports interspecific hybridization with *S. haematobium*

Harald Oey[1], Martha Zakrzewski[2], Kerstin Gravermann[3], Neil D. Young[4], Pasi K. Korhonen[4], Geoffrey N. Gobert[5,6], Sujeevi Nawaratna[5], Shihab Hasan[1,2], David M. Martínez[5], Hong You[5], Martin Lavin[7], Malcolm K. Jones[5,8], Mark A. Ragan[9], Jens Stoye[3], Ana Oleaga[10], Aidan M. Emery[11], Bonnie L. Webster[11], David Rollinson[11], Robin B. Gasser[4], Donald P. McManus[5e], Lutz Krause[1,2e*]

Results


URINE
Eggs
Miracidia
Cercariae
FAECES
LIVESTOCK
HUMANS
Intermediate Snail Hosts
Male Schistosome
Female Schistosome

Results



Manuscript in preparation
E. Léger (eleger@rvc.ac.uk)
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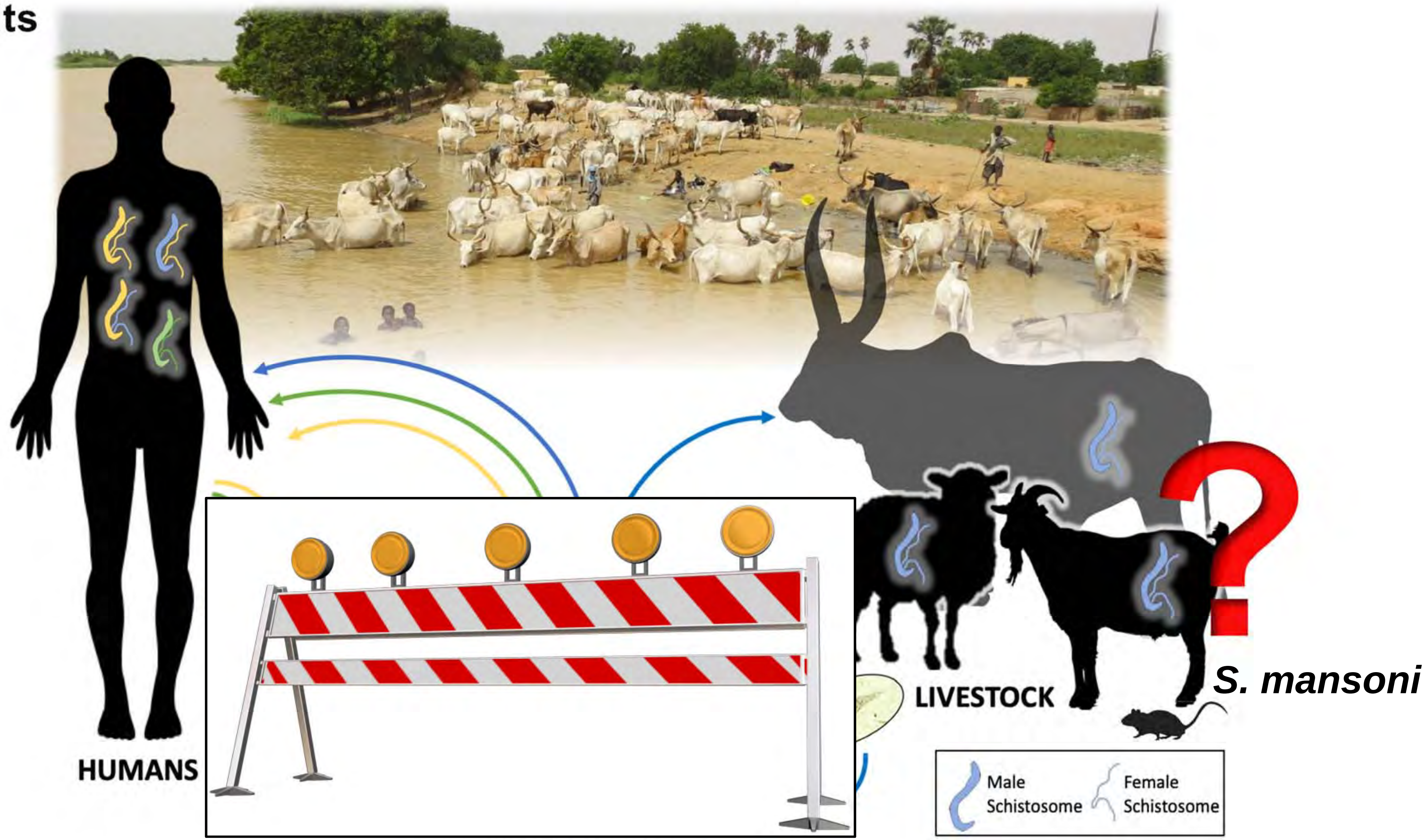
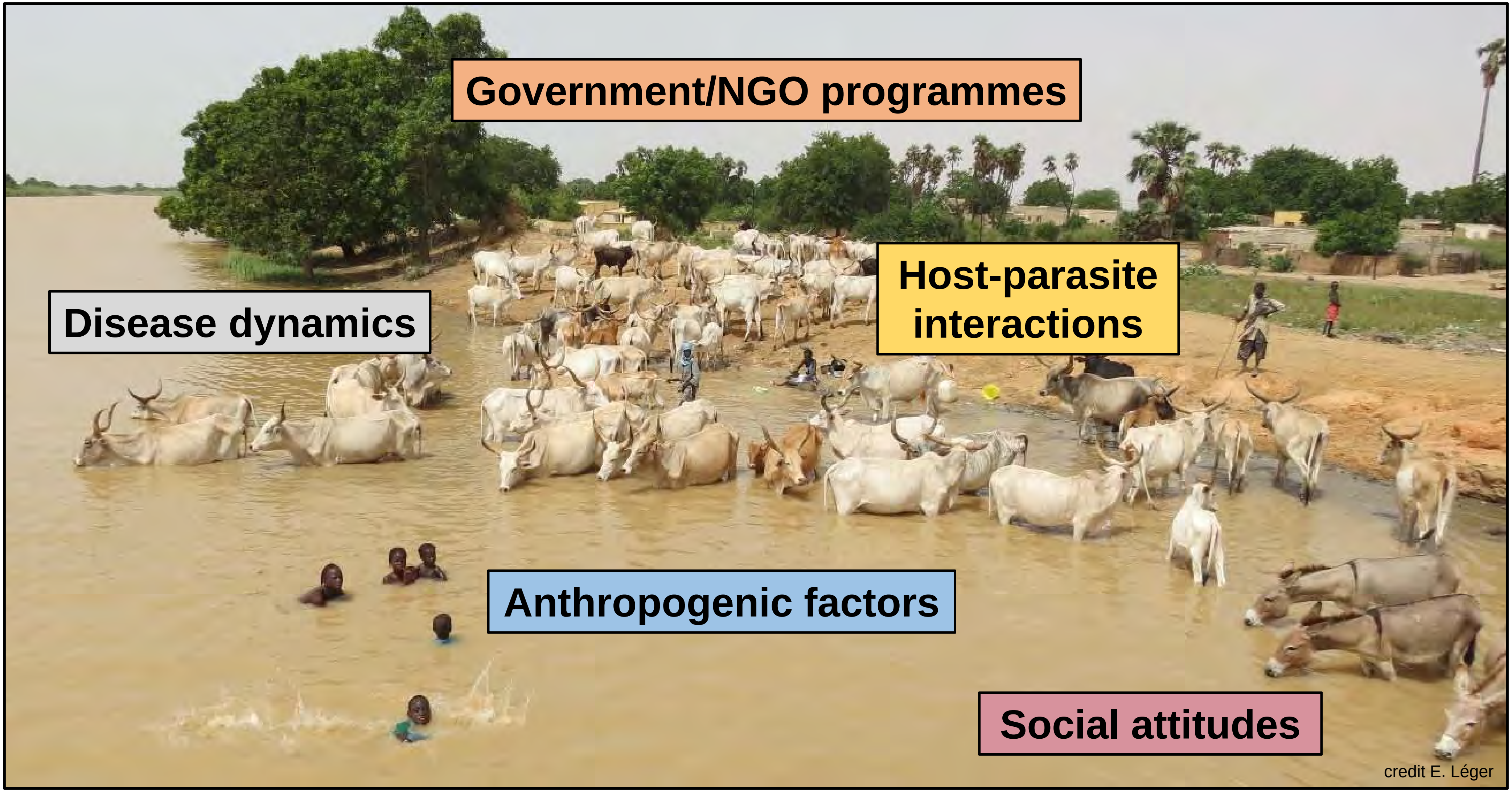
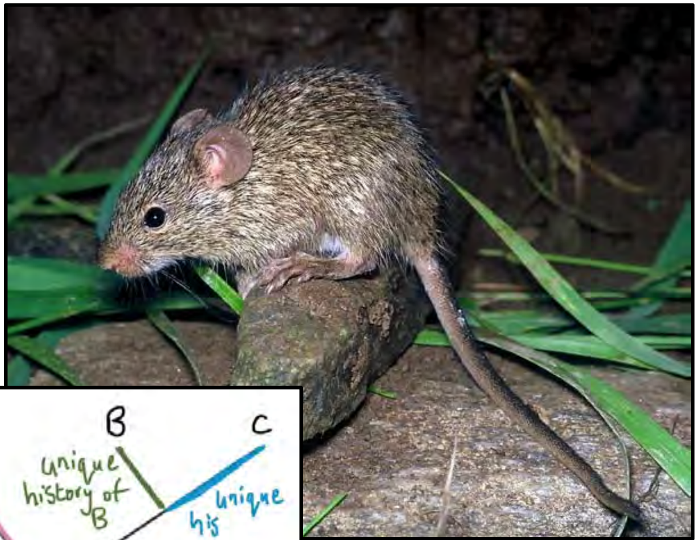
Results

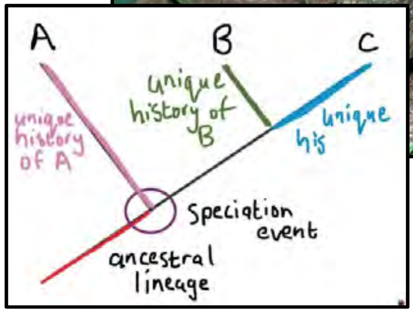

HUMANS
LIVESTOCK
S. mansoni
Male Schistosome
Female Schistosome

Significance

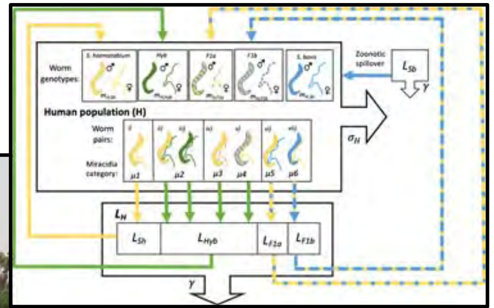


In a nutshell…





Zoonotic reservoir VS Accidental host in the transmission of schistosomiasis



Apparent multi-host spectrum of *Schistosoma* hybrids as a cover up

Future work?

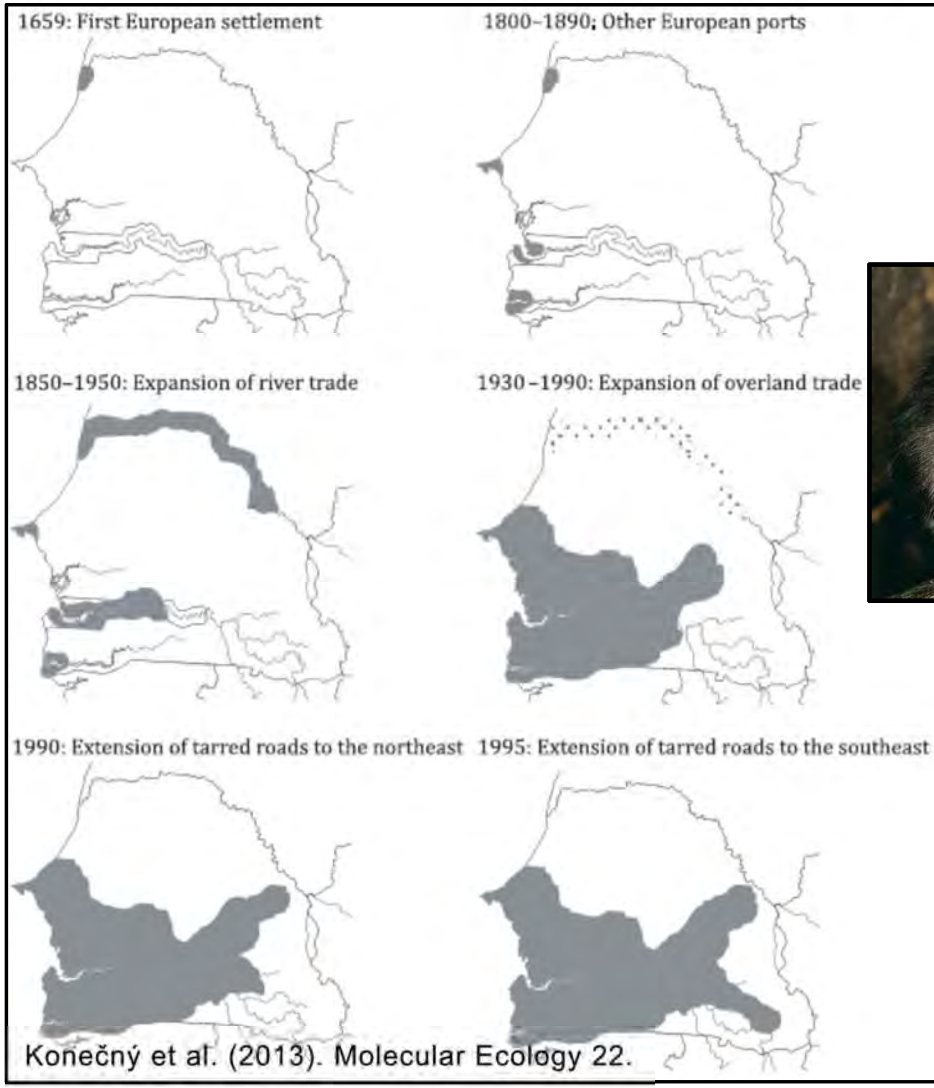


Fig. 1 Colonization of Senegal by the black rat, based on historical data. Gray areas represent the approximate distribution over time (see main text for dating and references). Note the disappearance of black rats along the Senegal River following the decrease in river-based trade after the 1930s (shaded area).

Konečný et al. (2013). Molecular Ecology 22.

Schwan et al. (2012). PloS NTDs 6.

Species	Total	Caught Inside	Caught Outside
Mastomys natalensis	430	414 (96%)	16 (4%)
Mastomys erythroleucus	80	5 (6%)	75 (94%)
Mastomys huberti	55	1 (2%)	54 (98%)
Crocidura olivieri	57	42 (74%)	15 (26%)
Praomys daltoni	50	30 (60%)	20 (40%)
Rattus rattus	29	28 (97%)	1 (3%)
Arvicanthis niloticus	16	1 (6%)	15 (94%)
Taterillus gracilis	7	0	7 (100%)
Acomys airensis	5	2 (40%)	3 (60%)
Mus musculoides	4	0	4 (100%)
Gerbillus campestris	1	0	1 (100%)
Crocidura viaria	6	0	6 (100%)
Crocidura fulvastra	3	0	3 (100%)
Crocidura sp.	1	1 (100%)	0
	744	**524 (70%)**	**220 (30%)**

doi:10.1371/journal.pntd.0001924.t003

Lucaccioni et al. (2016). PloS One 11.

Material and Methods

Study Area and Sampling

A total of 32 localities were prospected, based on previous knowledge on the black rat distribution [21] in Southeastern Senegal (Fig 1).

Rodent Data Collection

Small mammals were caught in single capture live traps between May 2012 and April 2015, indoors in 27 human settlements (villages or towns; hereafter referenced as localities), as *R. rattus* is strictly commensal (i.e. confined to human buildings) in Sahelo-Sudanian West Africa [21]. We used both Sherman folding box traps (8 × 9 × 23 cm; H.B. Sherman Traps, Inc., Tallahassee, Florida, USA) and wire-mesh live traps (8.5 × 8.5 × 26.5 cm; locally made). Typically

ZELS Zoonoses & Emerging Livestock Systems

BBSRC 20 Years of Pioneering Great British Bioscience

[dstl]

UKaid from the British people

E·S·R·C Economic & Social Research Council

NERC Science of the Environment

MRC Medical Research Council

RVC Royal Veterinary College University of London

IRD Institut de Recherche pour le Développement

Université Gaston Berger Saint-Louis du Sénégal

Université de Thiès — L'humilité mon choix, l'excellence ma voie

Natural History Museum

SCAN

Senegal:
Alassane Ndiaye
Cheikh Thiam
Boubacar Bâ
Cheikh Fall
Samba Diop
Mapaté Gaye
Abdoul Bâ
Khalilou Bâ
Nicolas Diouf
Mariama Sène

England:
Joanne Webster
Elsa Léger
Anna Borlase
Kirsty Marsh
Louise Vince
Sara Laskowski
Lucy Yasenev
Alice Morrell
Topaz Reid
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Muriel Rabone
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Aidan Emery
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