



**Massive introgressions of *Toxoplasma gondii*
domestic alleles in the Americas coincide with
the recent introduction of the domestic cat.**

Lokman GALAL,

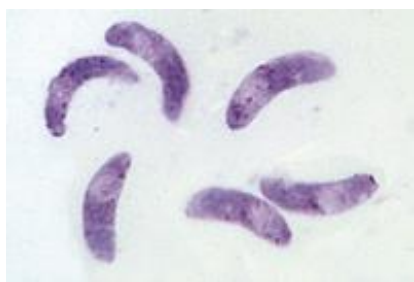
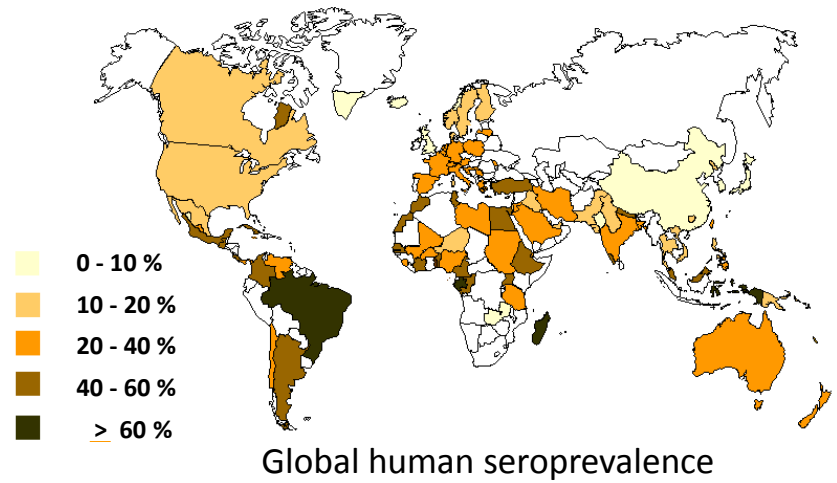
Frédéric Ariey, Meriadeg LE GOUIL, Marie-Laure DARDÉ,
Azra HAMIDOVIĆ, Franck LETOURNEUR, Franck PRUGNOLLE and Aurélien MERCIER

Journées Rongeurs 2021

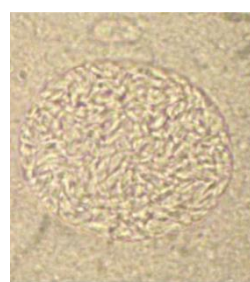


Intracellular zoonotic protozoan

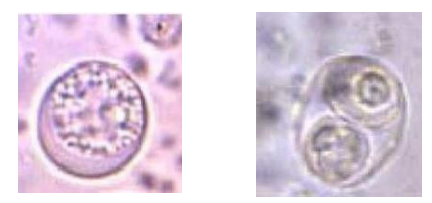
- ❑ Phylum: Apicomplexa
- ❑ Sub-class: Coccidia
- ❑ Hosts: All warm-blooded species



Tachyzoites (acute form)



Bradyzoites in tissue-cyst (chronic form)



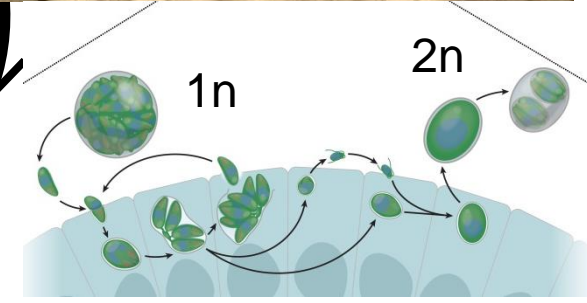
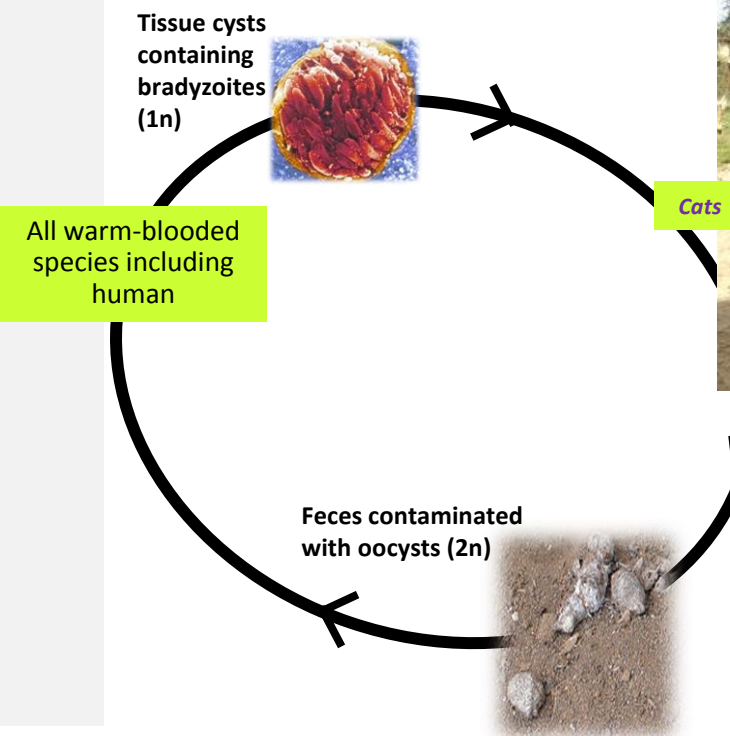
Unsporulated and sporulated oocysts (environmental form)

Introduction: *Toxoplasma gondii* life cycle in the domestic environment

Intermediate hosts



Final hosts



Introduction: Clinical forms of toxoplasmosis in human

About 85% of asymptomatic cases except in:

- Immuno-suppressed patients (HIV, transplants)
- congenital transmission



Dubey and Beattie, 1988
Hydrocephalus

Association to several mental disorders: schizophrenia, autism,...

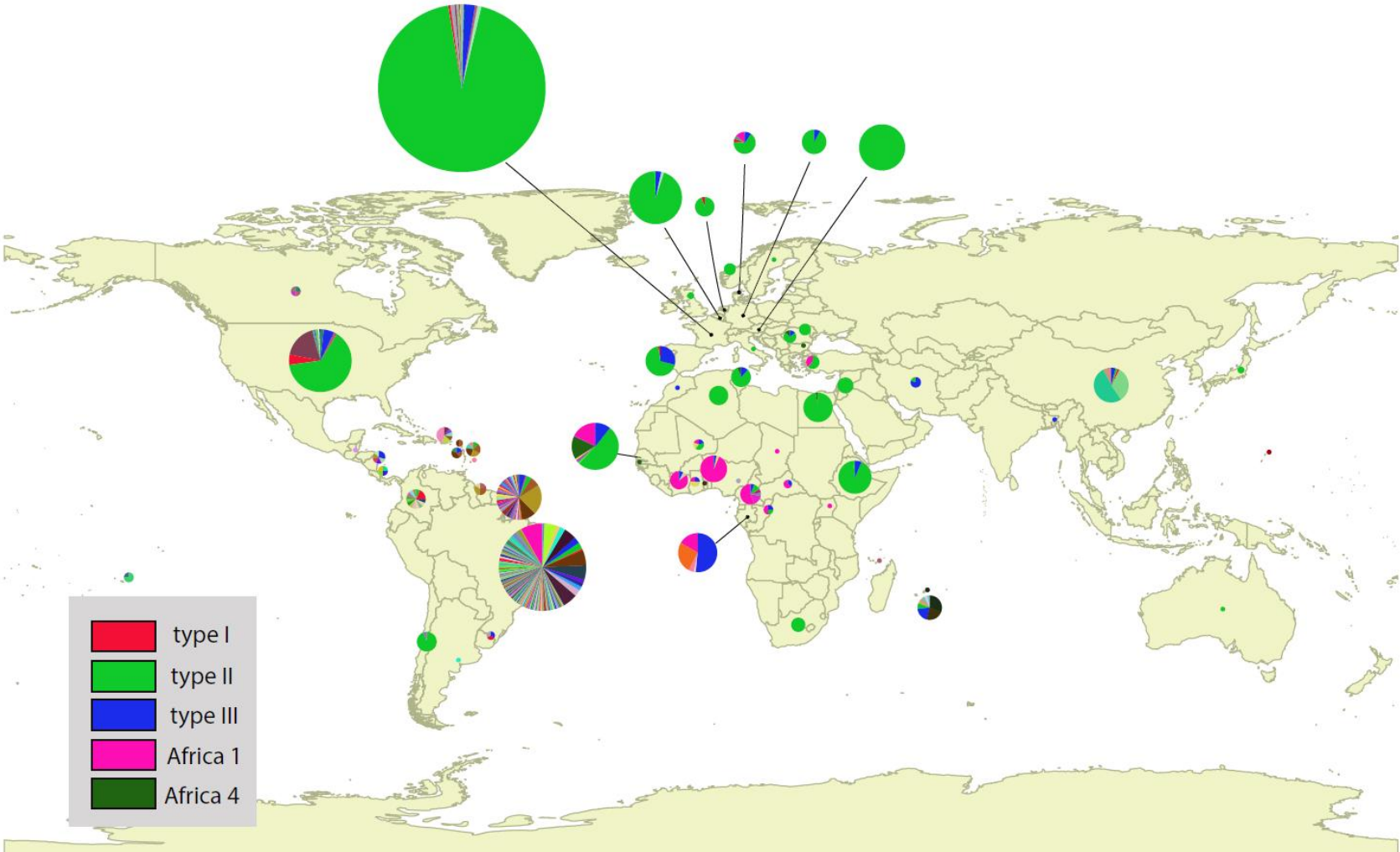
Public health problem in South America

- High prevalence of ocular toxoplasmosis in southern Brazil, northern Argentina and central Colombia
- Acute toxoplasmosis in immunocompetent / link to wild strains of Guyanese forest



Shobab et al., 2013
Arrow: retinochoroidal lesion

Introduction



Unpublished data

Global *T. gondii* genotypic diversity - analysis of 15 microsatellite markers

Revisit *T. gondii* evolutionary history

❑ Estimate *T. gondii* mutation rate



❑ Describe the most common *T. gondii* lineages

- Timing of emergence and intercontinental spread
- Phylogenetic positioning relative to other strains



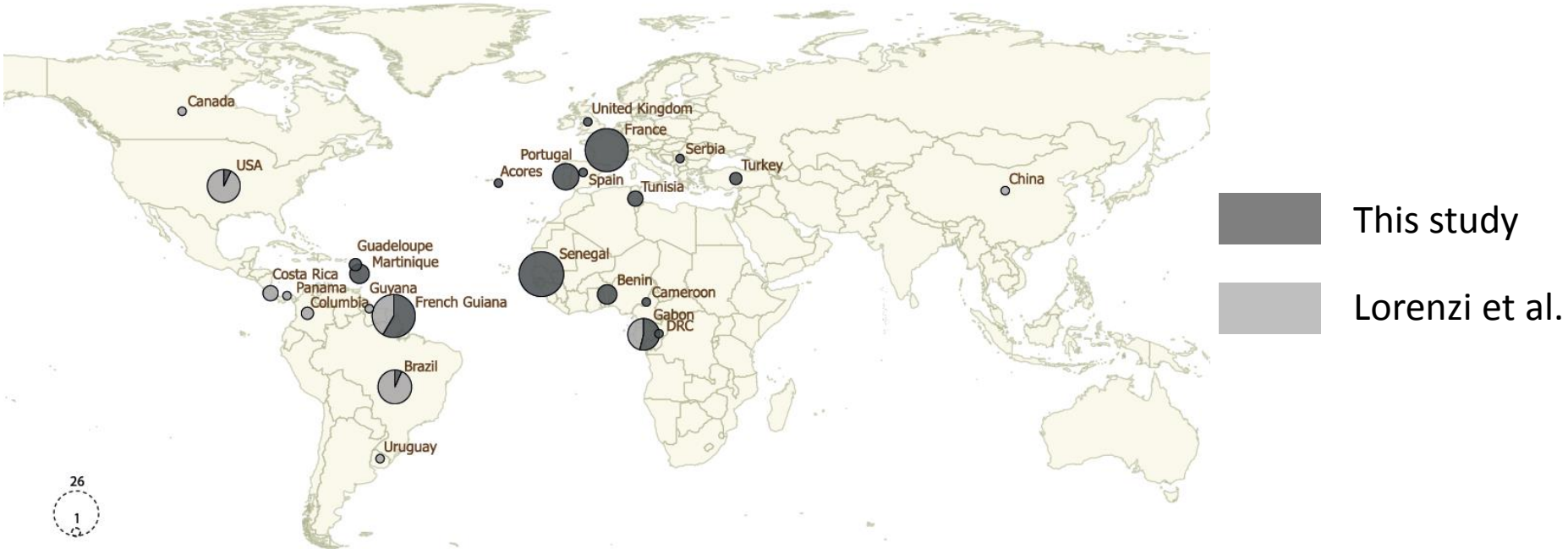
❑ Identify genomic regions under selection for adaptation to domesticity



Part 2: population structure

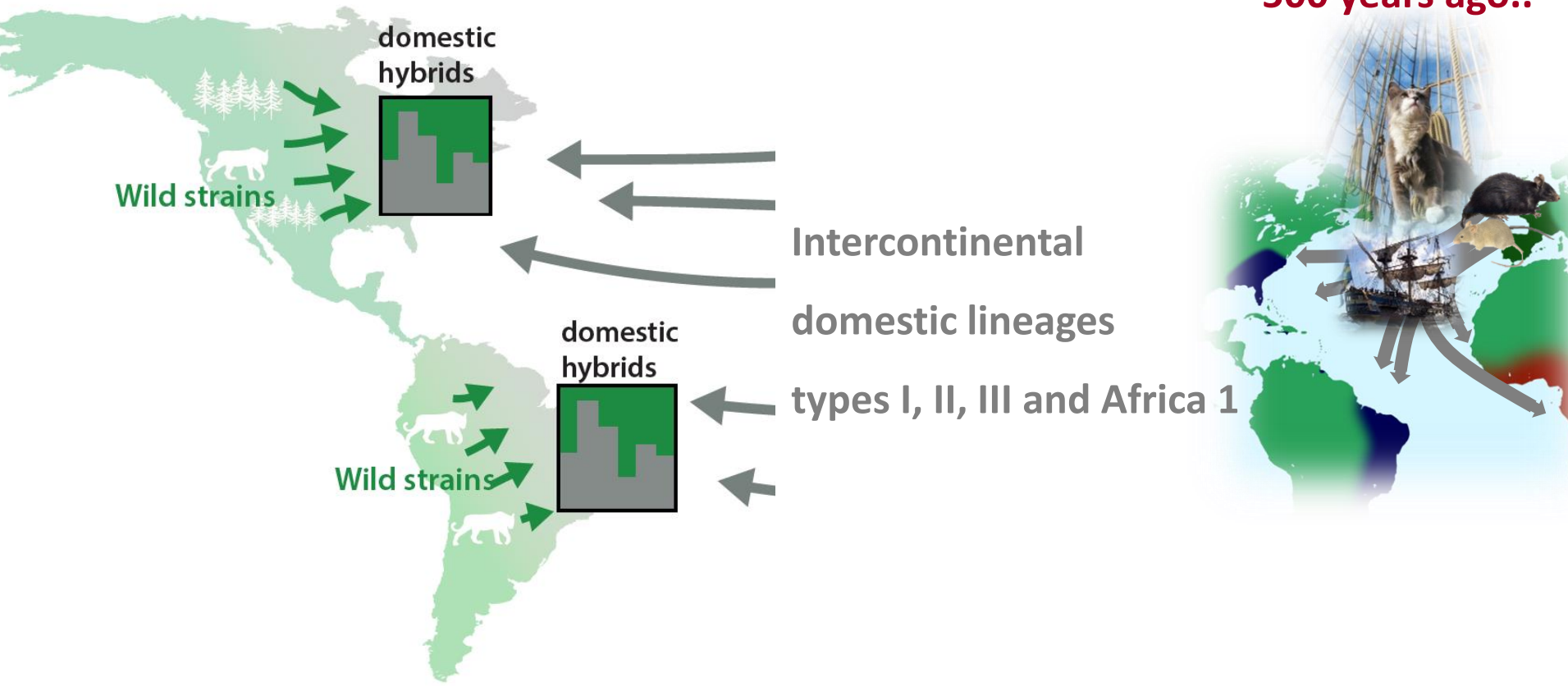
Sample size: 164 genomes

- 59 genomes from Lorenzi et al., 2016 *Nature Communications* (NCBI)
- 105 new genomes (mean depth of 21X) - Biological Resource Centre BRC *Toxoplasma*



Alignment & Variant calling: BWA – Samtools – Picard – Freebayes
156 genomes & 1,262,582 SNP-dataset

Part 2: emergence of New World domestic populations



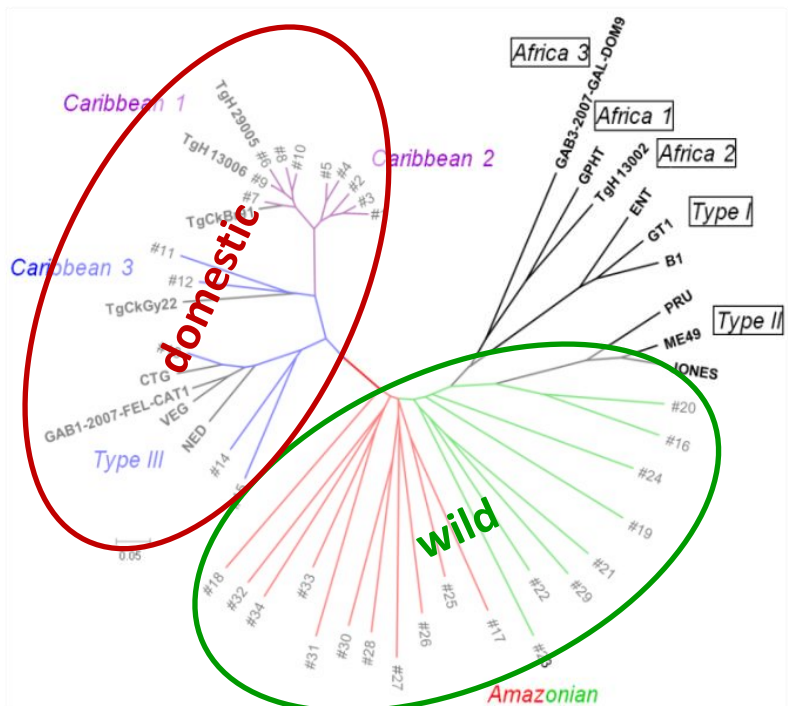
Domestic hybrids in North and South America...

...random hybridizations or selection of certain traits?

Part 3: Adaptation of *Toxoplasma gondii* to the domestic environment

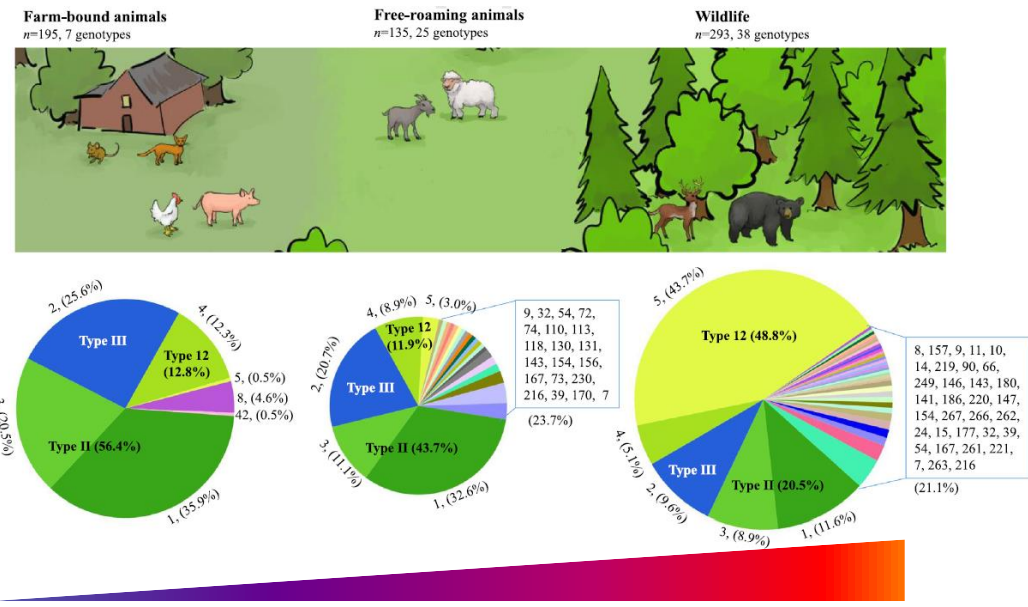
Different *T. gondii* populations between domestic and wild environment

French Guiana, South America



Mercier et al., 2011
Infection, Genetics and Evolution

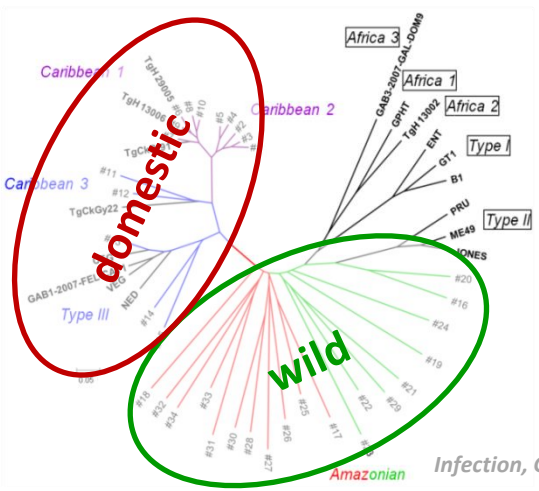
North America



Jiang et al., 2018
International journal for Parasitology

Part 3: Adaptation of *Toxoplasma gondii* to the domestic environment

Domestic and wild cats excrete different *T. gondii* strains...



Toxoplasma gondii population structure in French Guiana

Mercier et al., 2011
Infection, Genetics and Evolution

Domestic



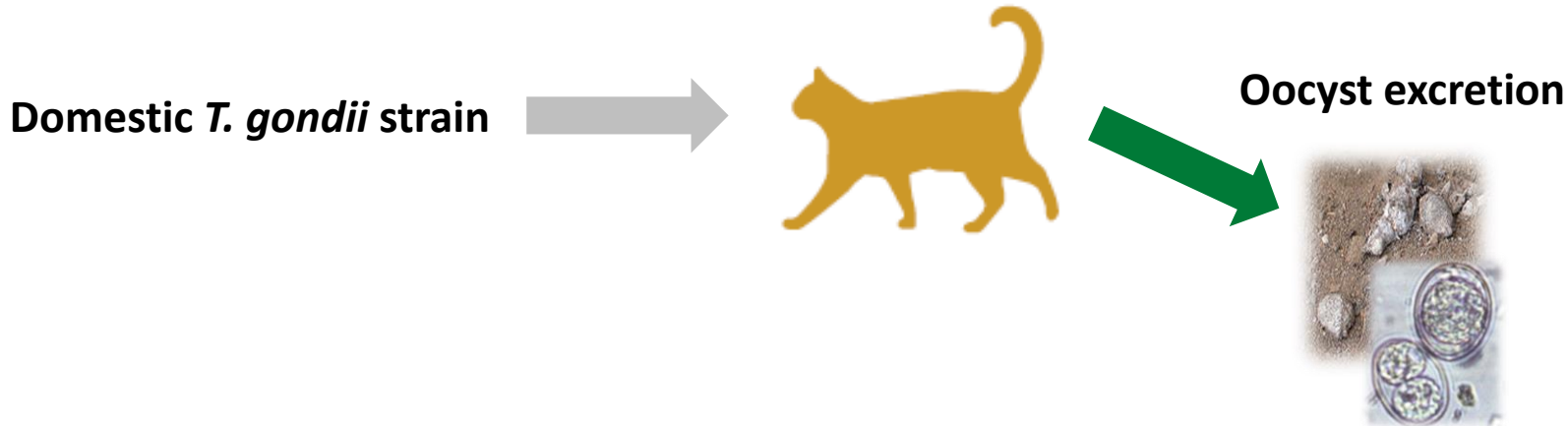
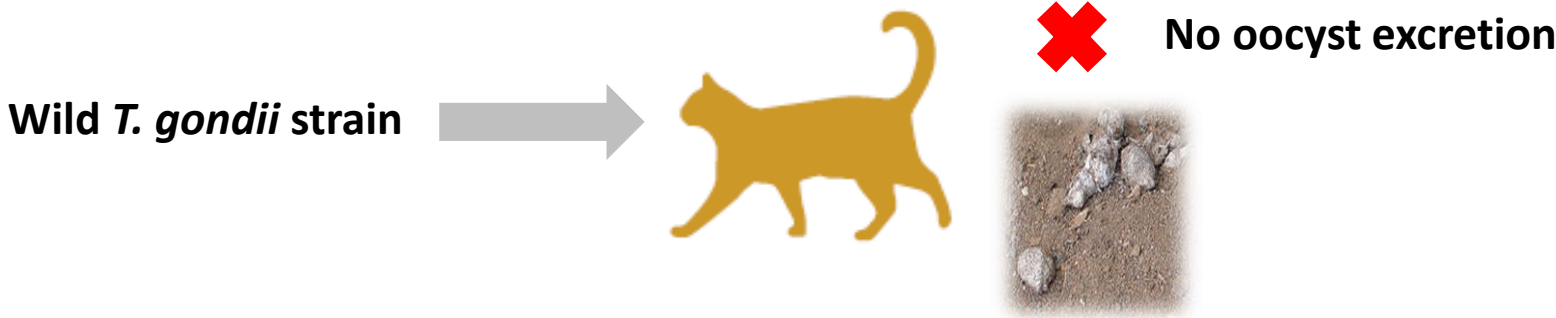
Wild

French Guiana

... wild felids are the reservoirs of the ancestral *T. gondii* populations

Part 3: Adaptation of *Toxoplasma gondii* to the domestic environment

French Guiana, South America



Khan et al., 2014 *Plos Neglected Tropical Diseases*

...divergent chr01a (whole chromosome: 1.8 megabases) between domestic and wild strains

Part 3: Adaptation of *Toxoplasma gondii* to the domestic environment

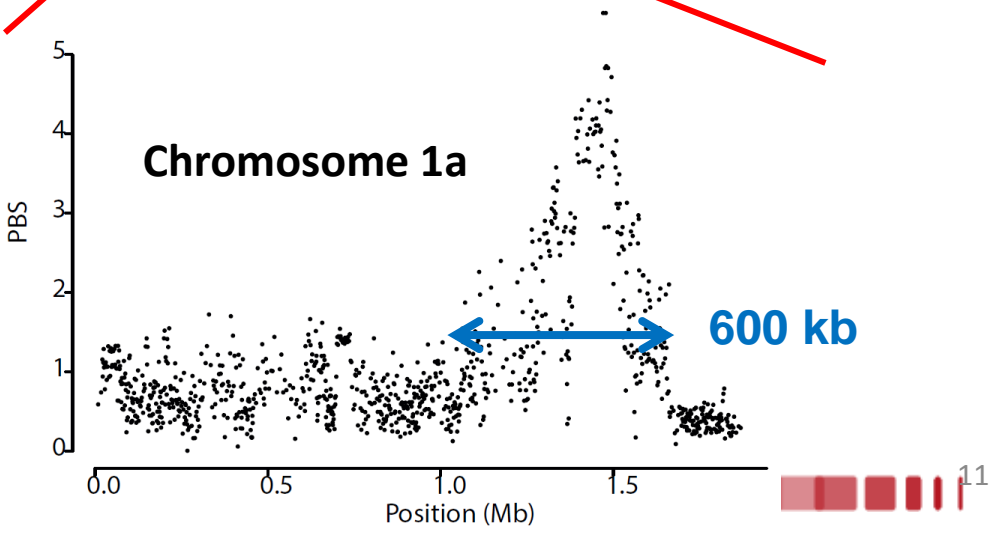
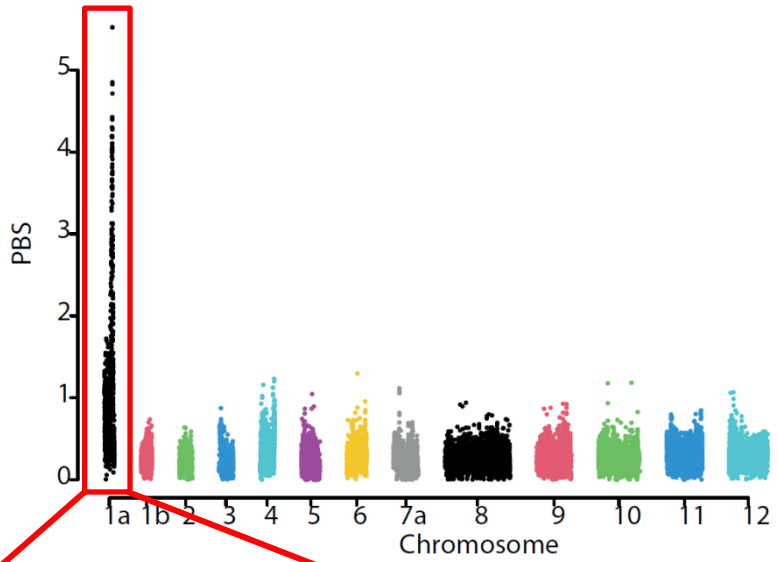
divergence-based selection scan

population branch statistic (PBS)

PBScan

Clone-censored dataset (n=71)

Domestic **vs** wild



Part 3: Adaptation of *Toxoplasma gondii* to the domestic environment

Fixed “domestic” SNPs

Bcftools *--private*

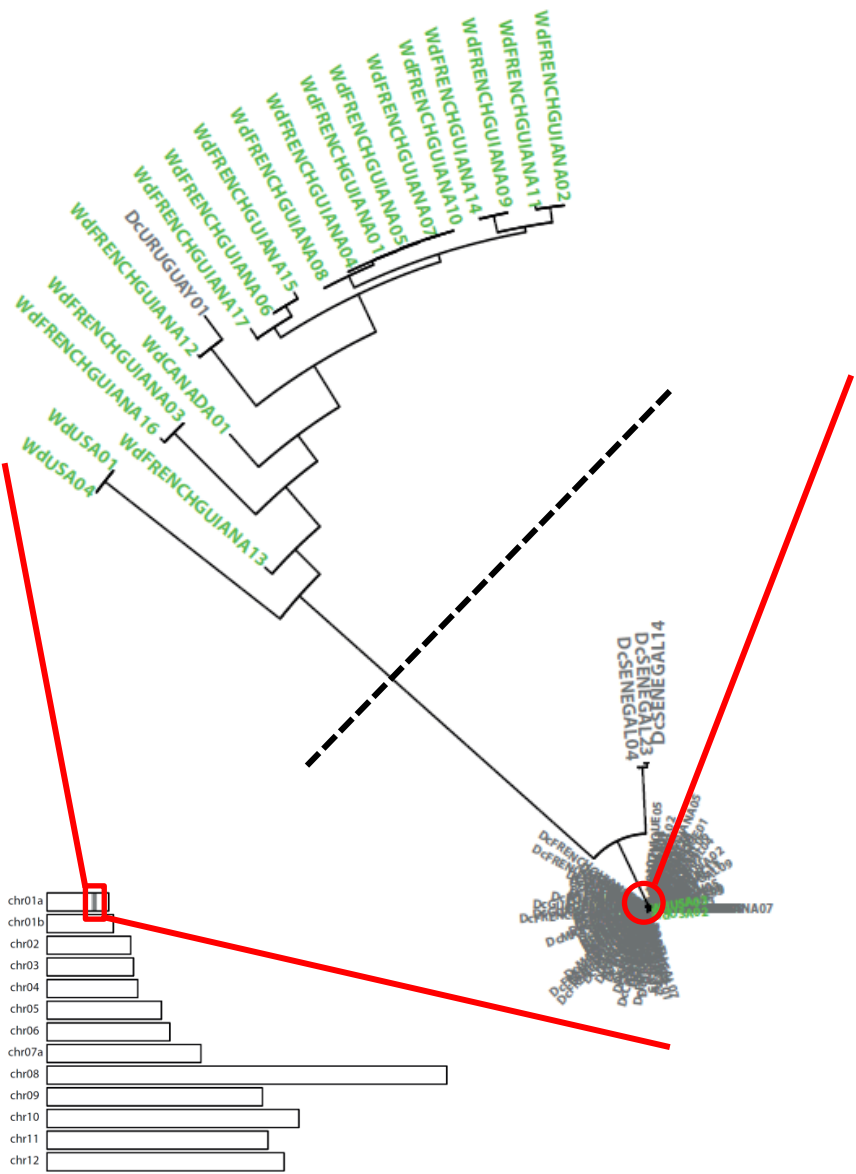
=> **310** SNPs



Part 3: Adaptation of *Toxoplasma gondii* to the domestic environment

Almost perfect dichotomy between domestic (grey) and wild (green) strains at this genomic region

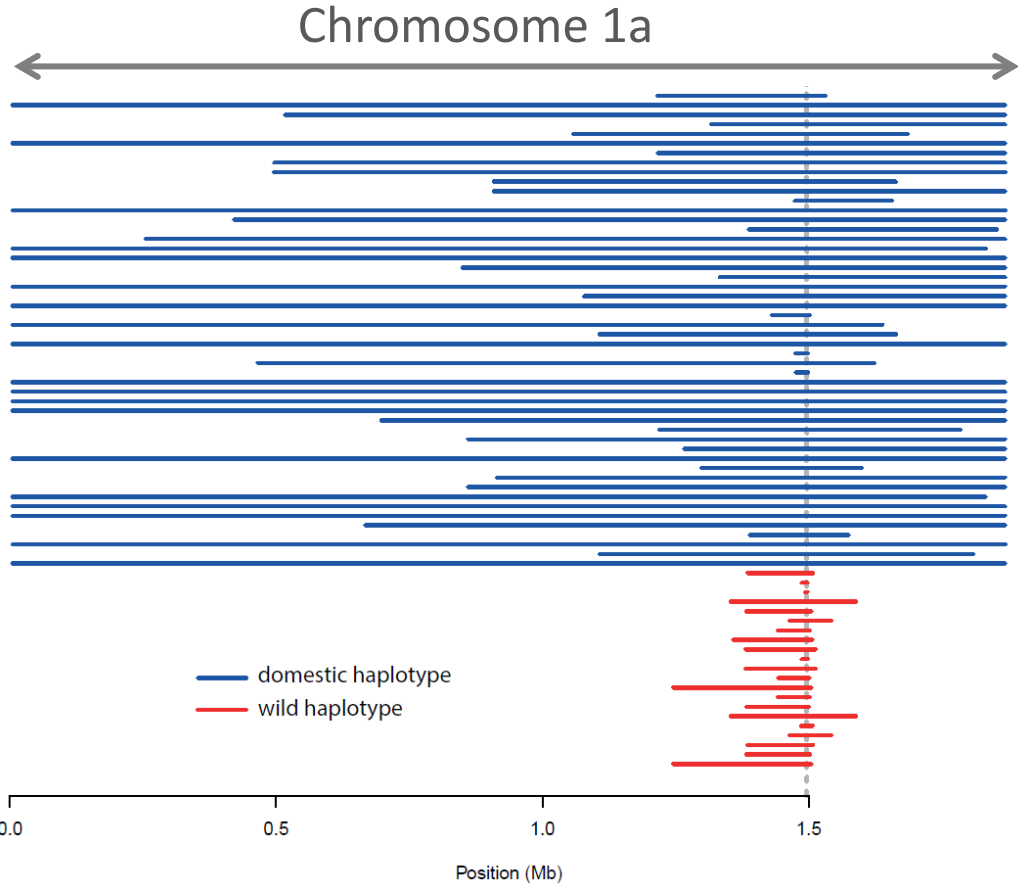
Single global domestic haplotype
=> Adaptation to domestic cats ?



Ranking candidate genes (n=25)

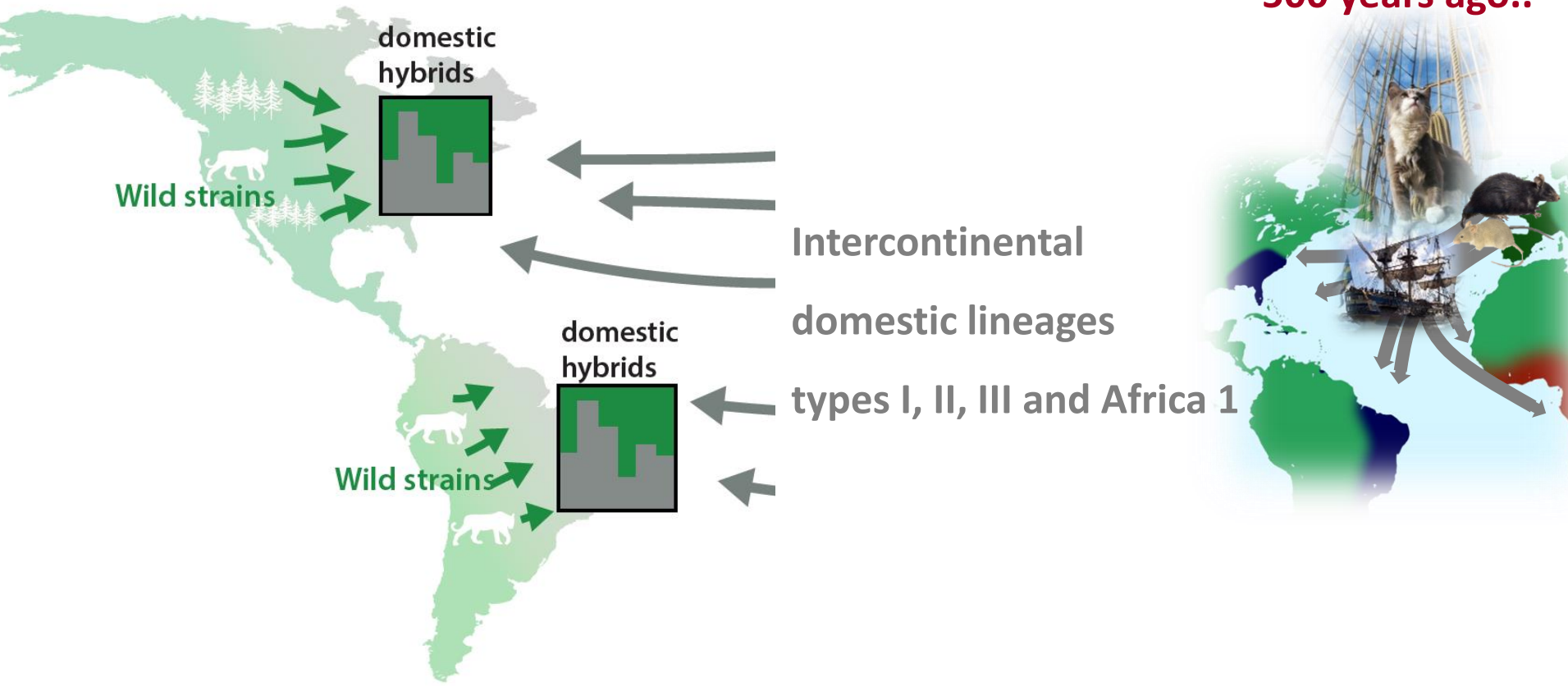
- Stage of expression
- Functional variants
- conservation

Part 3: Adaptation of *Toxoplasma gondii* to the domestic environment



Extended Linkage disequilibrium around domestic haplotypes relative to wild haplotypes
=> Positive selection of the domestic haplotype

Emergence of New World domestic populations



Domestic hybrids in North and South America...

...selection of a cat adaptation haplotype ?



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Thank you for you attention!

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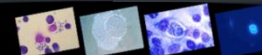
Meriadeg LE GOUIL



Lionel FORESTIER | Eden LEBRAULT



CRB Toxoplasma
BRC Toxoplasma



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