

DNA Barcodes 2015  
Guelph, Canada, August 21st, 2015

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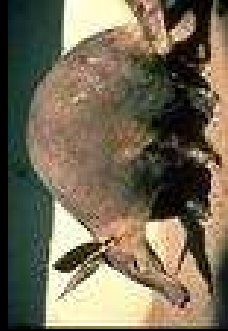
# The Brazilian Barcode of Life (BrBOL) initiative and its potential to aid in biodiversity conservation

Eduardo Eizirik

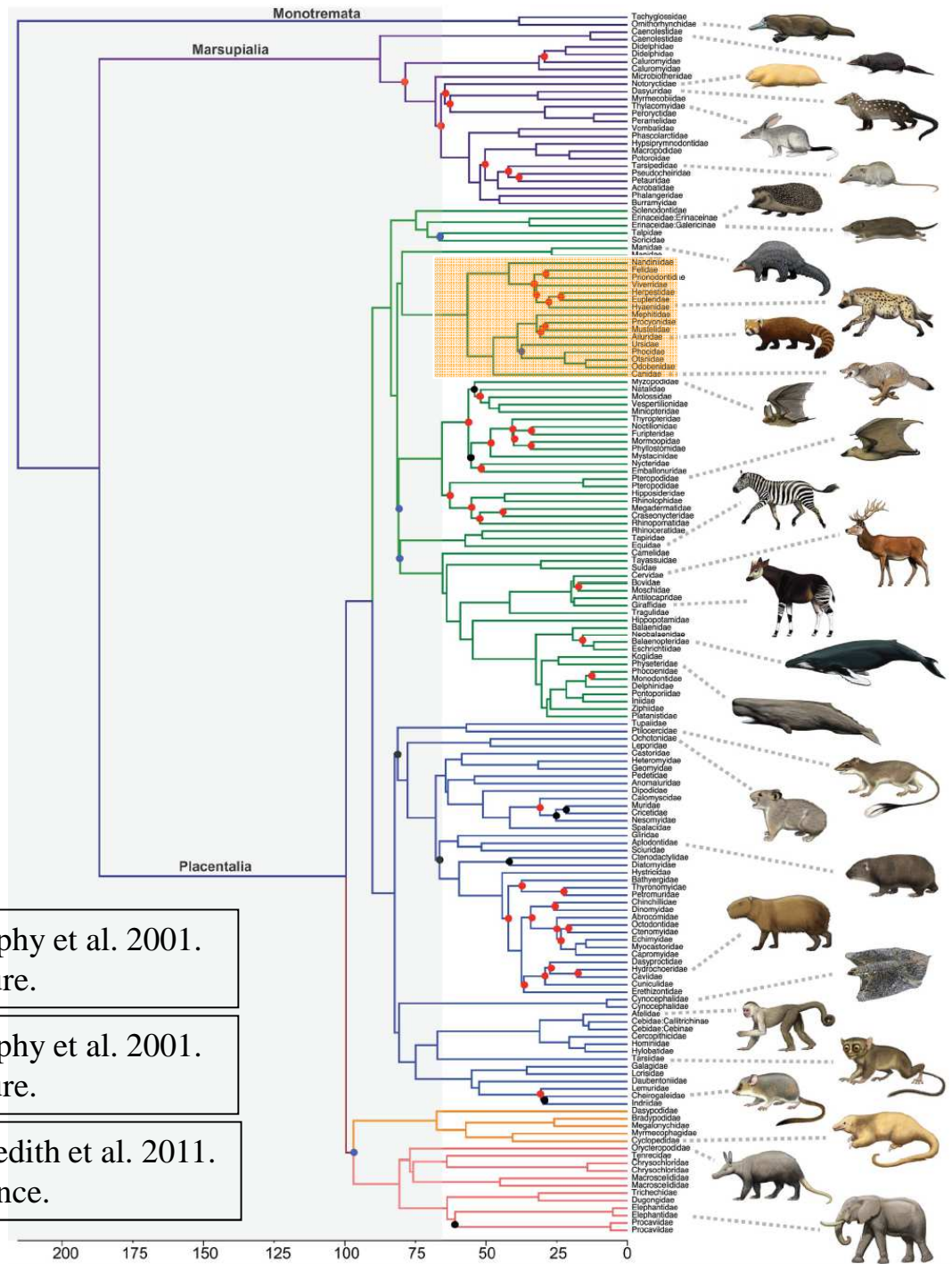
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Faculdade de Biociências, PUCRS, Brazil  
Instituto Pró-Carnívoros, Brazil









Murphy et al. 2001.  
Nature.

Murphy et al. 2001.  
Nature.

Meredith et al. 2011.  
Science.

## order Carnivora







(c) Associação Procarnívoros - Todos os direitos reservados



Phylogeny, phylogeography, population genetics,  
molecular ecology, genomics

## order Carnivora



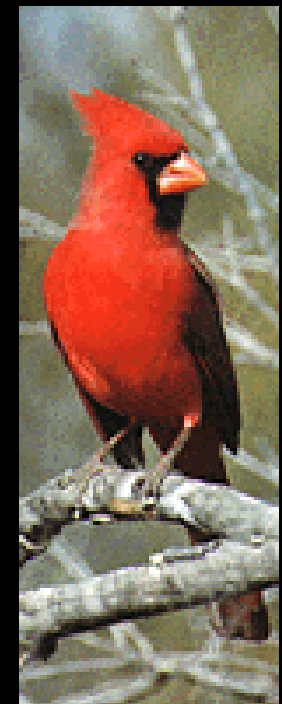
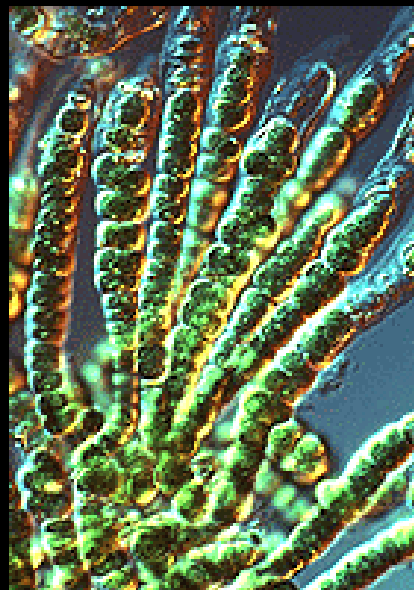
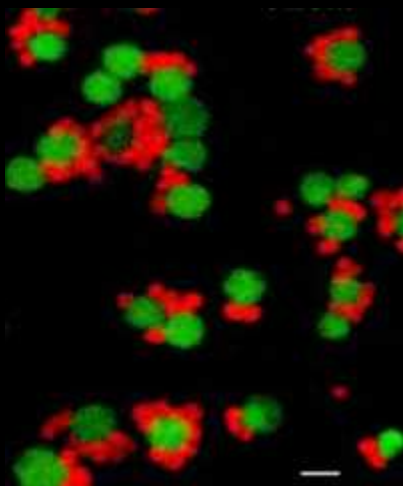
# THE JAGUAR GENOME PROJECT

- Brazilian-led initiative (PUCRS, FIOCRUZ-MG, ESALQ/USP) + Sorocaba zoo and several collaborators (USA, Russia, Spain, Portugal, Ireland)
- Full sequence of the jaguar genome (84x).
- De novo assembly, de novo annotation, comparative analyses.
- Transcriptomes from multiple tissues.
- Population genomics
  - Exome sequencing for >100 wild jaguars from different regions.
  - Population structure and history, scans for selection.





# BIODIVERSITY



# Applications of DNA Barcoding in Biodiversity Conservation

1. Gathering data on components of native biodiversity;
  - 1.1. Baseline data (*e.g.* community composition and dynamics, geographic distribution, trophic interactions).
  - 1.2. Monitoring of biodiversity in impacted areas.
2. Gathering data on threats to native biotas.
  - *e.g.* invasive species, pathogens, wildlife trafficking.
3. Helping to enforce actions aimed at curbing threats to biodiversity.
  - *e.g.* wildlife forensic analyses.

# **Brazil**

**Area:** 8,515,767 km<sup>2</sup>

**Population:** 190,732,694

## **Megadiverse country**

- Estimated to harbor ~1.8 mi spp.  
(10-17% of the world's total)  
[Lewinsohn & Prado 2005]

- Known fauna:  
~9k vertebrates (711 mammals,  
1,900 birds, 732 non-avian  
reptiles, 973 amphibians, 3,133  
continental fish, 1,376 marine  
fish)



Map: wikipedia.org



## Brazil: newly recognized mammal species [2013-2014]



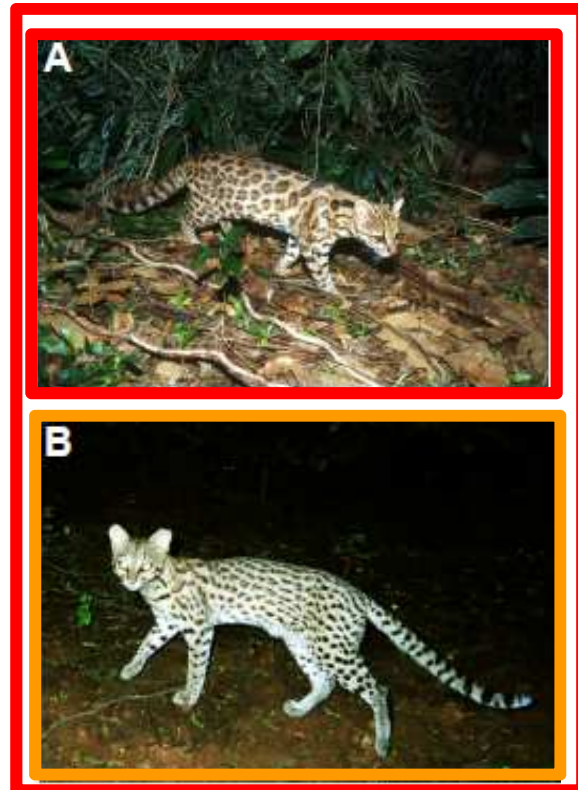
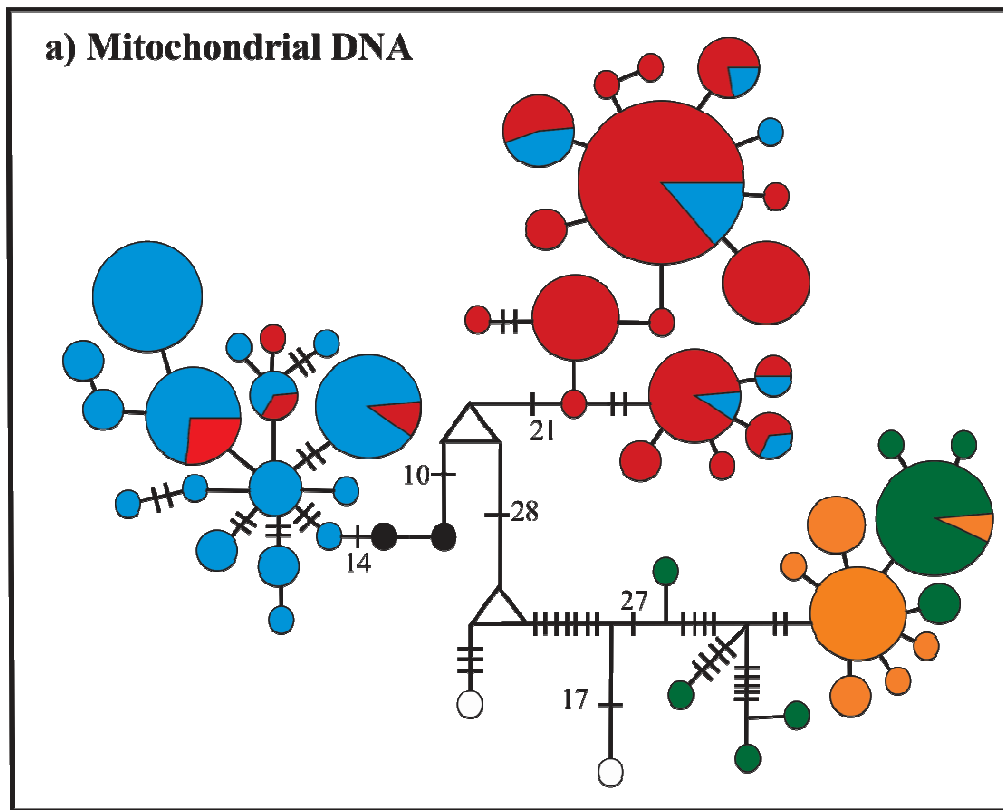
*Tapirus kabomani*



*Inia araguaiensis*

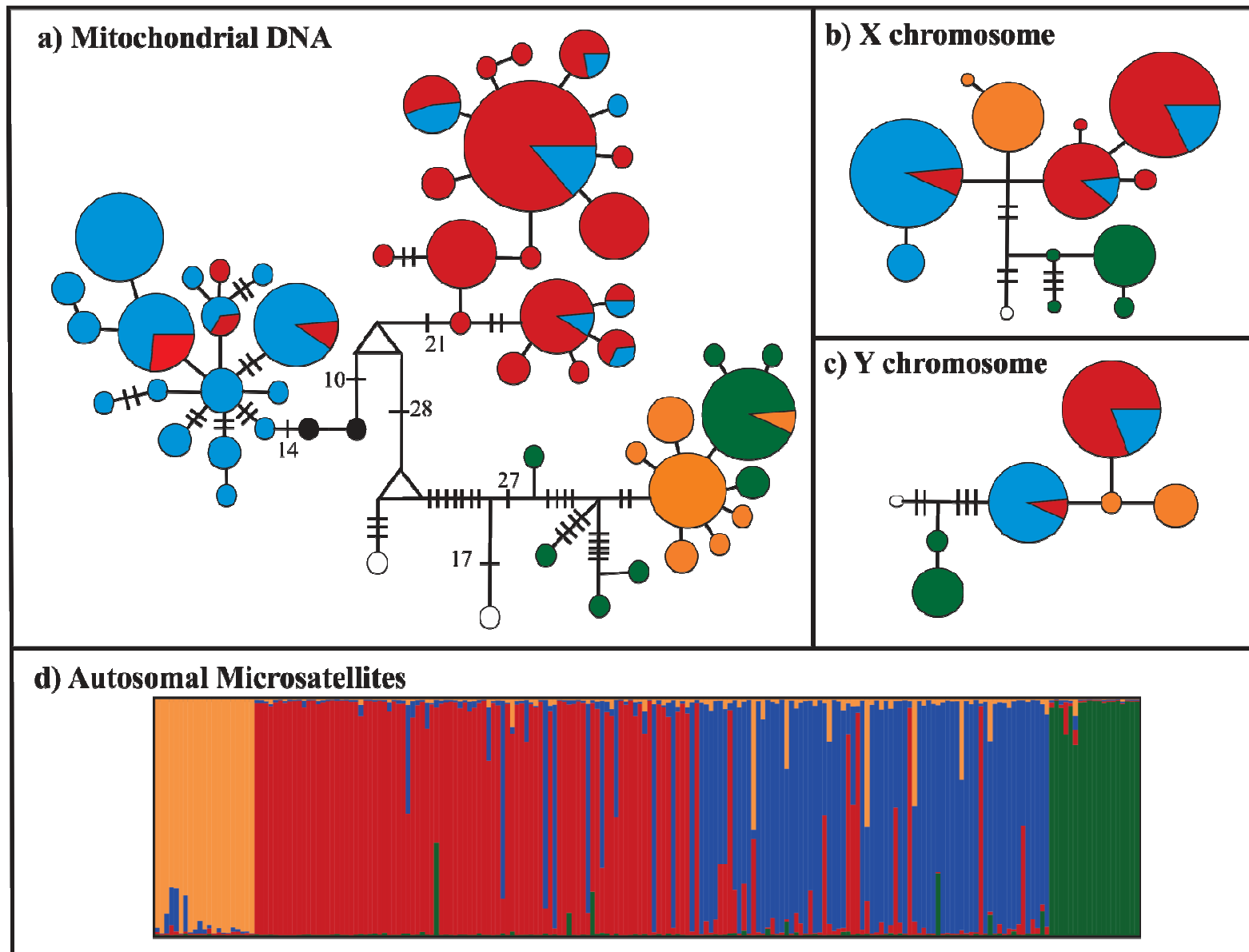


*Leopardus guttulus*



Trigo *et al.* 2013. Curr. Biol.





Trigo *et al.* 2013. Curr. Biol.

Implications for DNA barcoding

Going back to a broader perspective...

## **Brazilian Biomes**

- High biodiversity.
- High endemism.  
(*e.g.* 50% of Atlantic forest amphibians are endemic)
- High rate of habitat destruction.

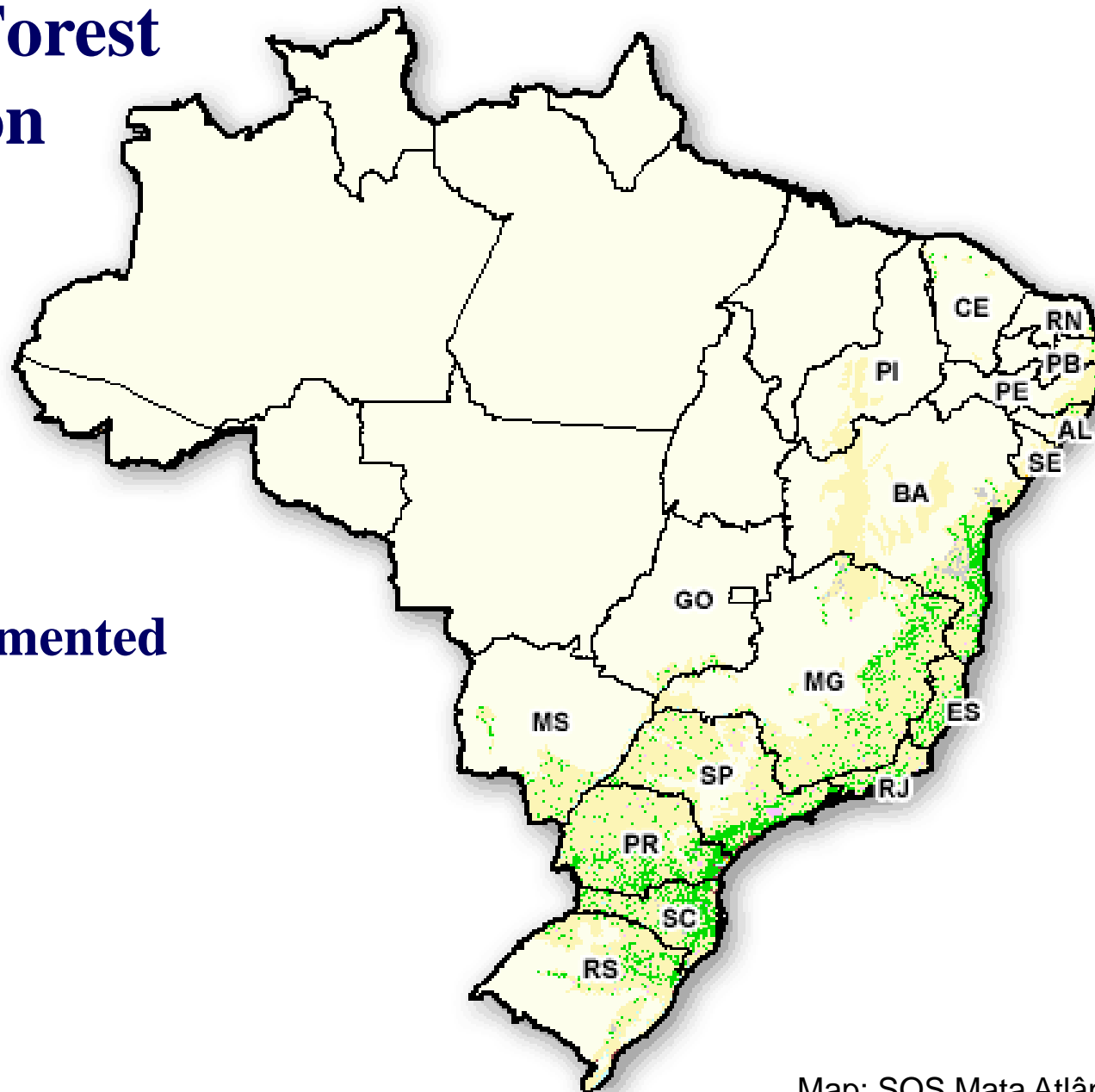


Map: <http://meioambiente.culturamix.com/>



# Atlantic Forest destruction

~10% left  
- Highly fragmented



Map: SOS Mata Atlântica

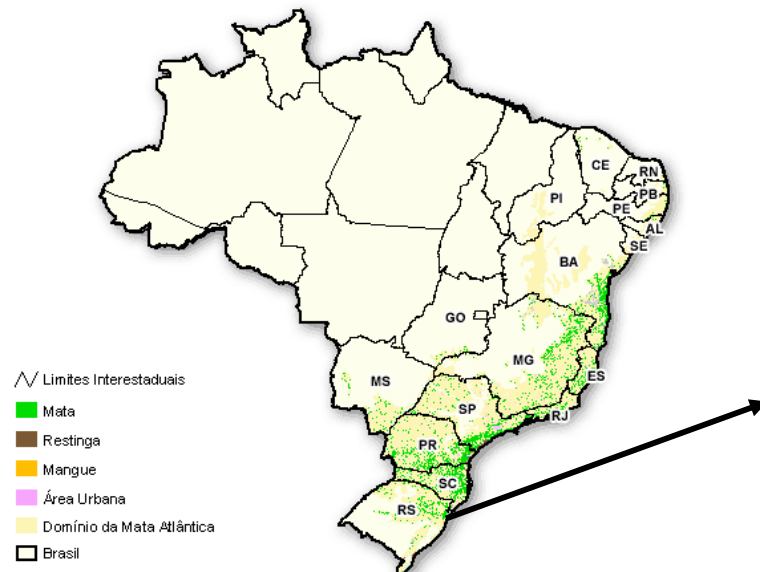
# Meta-barcoding of Atlantic Forest bromeliad tank waters



*Aechmea gamosepala*



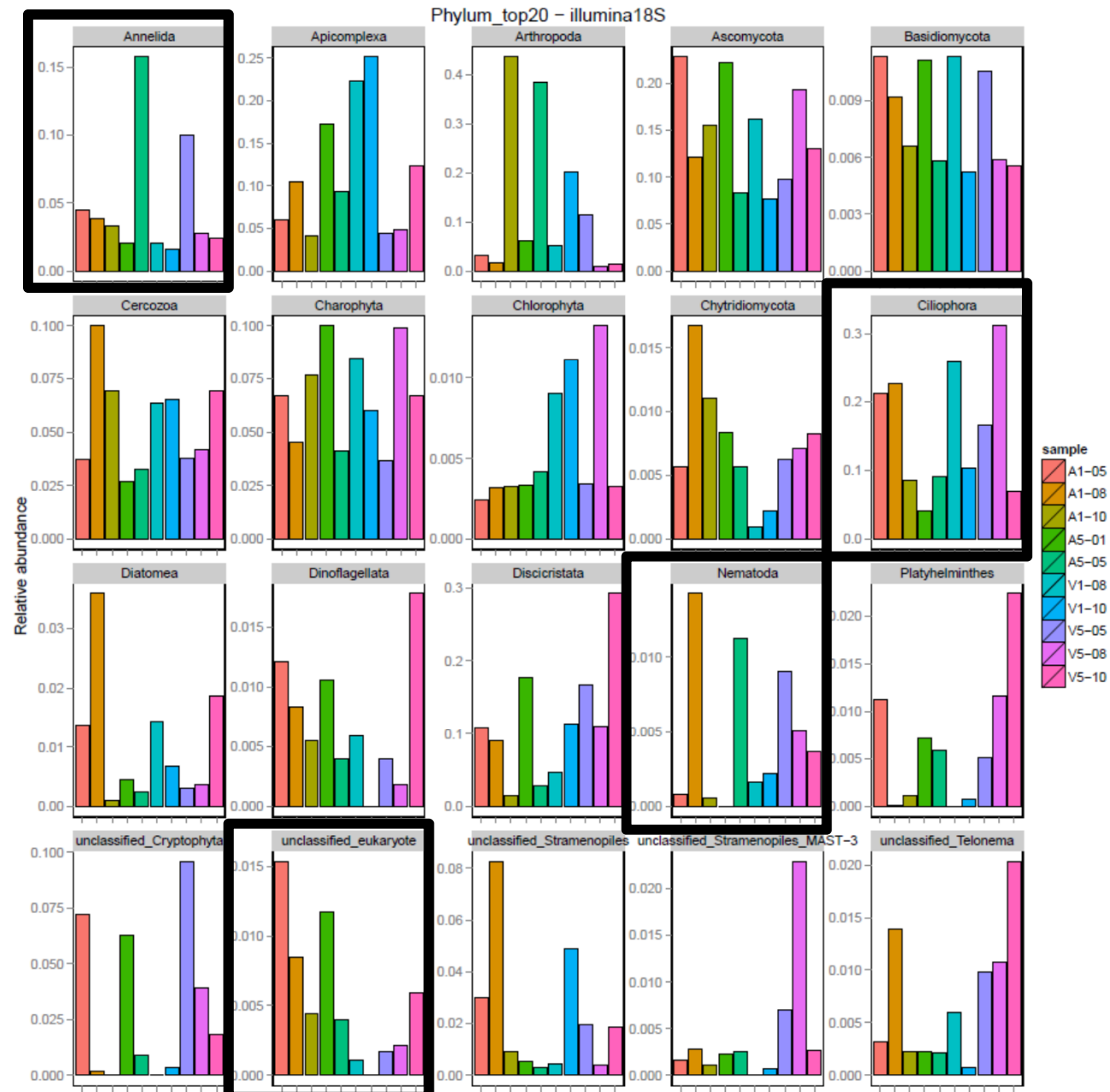
*Vriesea platynema*



CPCN Pró-Mata, PUCRS, Brazil



# Meta-barcoding of Atlantic Forest bromeliad tank waters



# The effort towards Large-scale DNA barcoding of Brazilian biodiversity

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Initial Proposal (2005):

Beginning of the Brazilian DNA barcoding network

- Large-scale inventory of Brazilian biodiversity
  - Multi-center project designed in 2005 to boost taxonomic research in Brazil using the DNA barcode concept as a catalyst to integrate field collections, museum-based biodiversity research, genome center networks and bioinformatics advances.
  - 6 museums, 14 Centers of Molecular Biodiversity, ~300 people
-



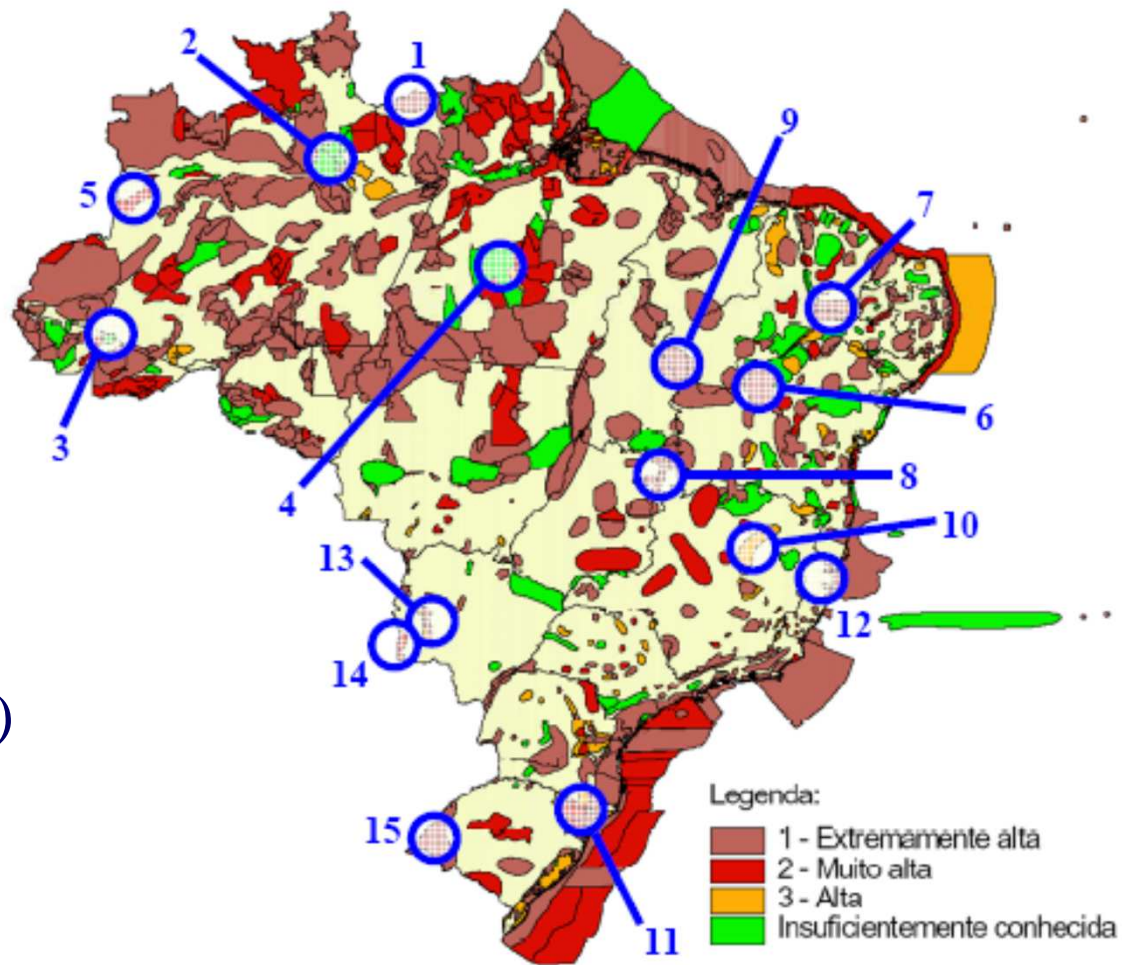
# Large-scale inventorying of Brazilian biodiversity (2005)

## Sampling strategy

15 sites:

-10,000 samples/site:

- fish
- amphibians
- reptiles (incl. birds)
- mammals
- spiders
- Leguminosae



# 2010 – BrBOL launched



The screenshot shows the BrBOL website homepage. At the top, there's a navigation bar with links: HOME, PROJECTS, NEWS, BOLD MIRROR, BOLD SYSTEM, CONTACT US, and LOGIN. Below this is a banner featuring the BrBOL logo and five images of diverse organisms: a green frog, a small fish, a coral, a larger fish, and a yellow parrot. The main content area is titled "BrBOL - Brazilian Barcode of Life" and includes a "User login" section on the left with fields for Username and Password, and a "Log in" button. Below the login section, there's a "Who are we?" section with a barcode graphic and text describing the project as a Brazilian consortium for molecular identification of biodiversity. Further down, there's a "What is DNA barcoding?" section with a DNA helix graphic and a quote about using DNA sequences for species identification. On the left sidebar, there's a "BrazilianBOL" section with a brief description and a "We follow" section with a link to a blog post. The URL "http://www.brbol.org/" is visible in the browser's address bar.

http://www.brbol.org/

BrBOL - Brazilian Barcode of Life

HOME PROJECTS NEWS BOLD MIRROR BOLD SYSTEM CONTACT US LOGIN

User login

Username: \*

Password: \*

Log in

Create new account  
Request new password

BrBOL  
BrazilianBOL

iBOLproject: Scientists use DNA barcodes to track 'staggering diversity' of world's oceans. [summitcountyvoice.com/2011/11/07/news/dnabarcoding](http://summitcountyvoice.com/2011/11/07/news/dnabarcoding)  
17 days ago · reply · retweet · favorite

BrazilianBOL Brazilian Barcode of Life - This project is a Brazilian consortium of molecular identification of biodiversity.  
83 days ago · reply · retweet · favorite

twitter Join the conversation

We follow

dnabarcodes2011 Our latest 'In Adelaide' blog post is up - find out the #Adelaide Institutions which are not to be missed

BrBOL - Brazilian Barcode of Life

Português

WHO ARE WE?

This project is a Brazilian consortium of molecular identification of biodiversity. Different categories will be characterized by barcode including: sea organisms, aquatic arthropods, terrestrial invertebrates, plants, fungi, parasites/vectors tropical diseases, fishes, amphibians, reptiles, birds and mammals from different Brazilian reference scientific collections.

More than thirteen institutions are involved in species collection, sequencing the barcodes, processing local data and integrate them to BOLD (Barcode of Life Data System). BOLD is a bioinformatics platform for storage, analysis, management and publication of DNA barcoding records from organisms (Ratnasingham and Hebert, 2007).

WHAT IS DNA BARCODING?

"That DNA sequence can be used to identify different species, in the same way a supermarket scanner uses the familiar black stripes of the UPC (Universal Product Code) barcode to identify your purchases."

[+]READ MORE

www.brbol.org

**Phase 1:**  
**~US\$ 3,000,000**  
**2010-2014**



>100 participating groups

~500 people involved

- All major Brazilian museums and natural history collections.

- Bioinformatics center

- Biomedical institution

- Agricultural research agency



The two largest museums did not have molecular biology laboratories.

- Implemented in both via funding from the BrBOL network.



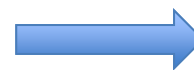




## PROJECTS

The Brazilian Barcode of Life Consortium has 11 projects:

PROJECT ID	PROJECT NAME	GROUP LEADER	DESCRIPTION
PJ 01	Bioinformatics Platform	Guilherme Corrêa de Oliveira	<a href="#">Read more</a>
PJ 02	Brazilian Initiative for Molecular Identification of Marine Organisms	Mariana Cabral de Oliveira	<a href="#">Read more</a>
PJ 03	Brazilian DNA Barcoding Initiative for Aquatic Arthropod	Fabio de Oliveira Roque	<a href="#">Read more</a>
PJ 04	Vouchers Management and Institutional Capacity to Generate DNA Barcodes	Paulo Andreas Buckup	<a href="#">Read more</a>
PJ 05	Molecular Identification of Biodiversity of Terrestrial Invertebrates	Ana Maria Lima de Azeredo Espin	<a href="#">Read more</a>
PJ 06	Molecular Identification of Brazilian Plants	Vânia Cristina Rennó Azevedo	<a href="#">Read more</a>
PJ 07	Molecular Identification of Brazilian Fungi	Aristóteles Góes Neto	<a href="#">Read more</a>
PJ 08	Molecular Identification of Brazilian Parasites and Vectors	Fernando Araujo Monteiro	<a href="#">Read more</a>
PJ 09	DNA Barcoding of Brazilian Ichthyofauna	Jorge Ivan Rebelo Porto	<a href="#">Read more</a>
PJ 10	DNA Barcoding of Tetrapoda: Amphibians, Reptiles, Birds and Mammals	Eduardo Eizirik	<a href="#">Read more</a>
PJ 11	BrBOL – Brazilian Network for Molecular Identification of Biodiversity	Claudio de Oliveira	<a href="#">Read more</a>



### **Barcoding Tetrapoda:**

4 sub-groups

Amphibians (C. Haddad)

Reptiles (H. Zaher)

Birds (C. Miyaki)

Mammals (E. Eizirik)

# DNA barcoding of Brazilian tetrapods (2010-2014)

25 participating  
institutions

> 100 people involved

## Participating labs

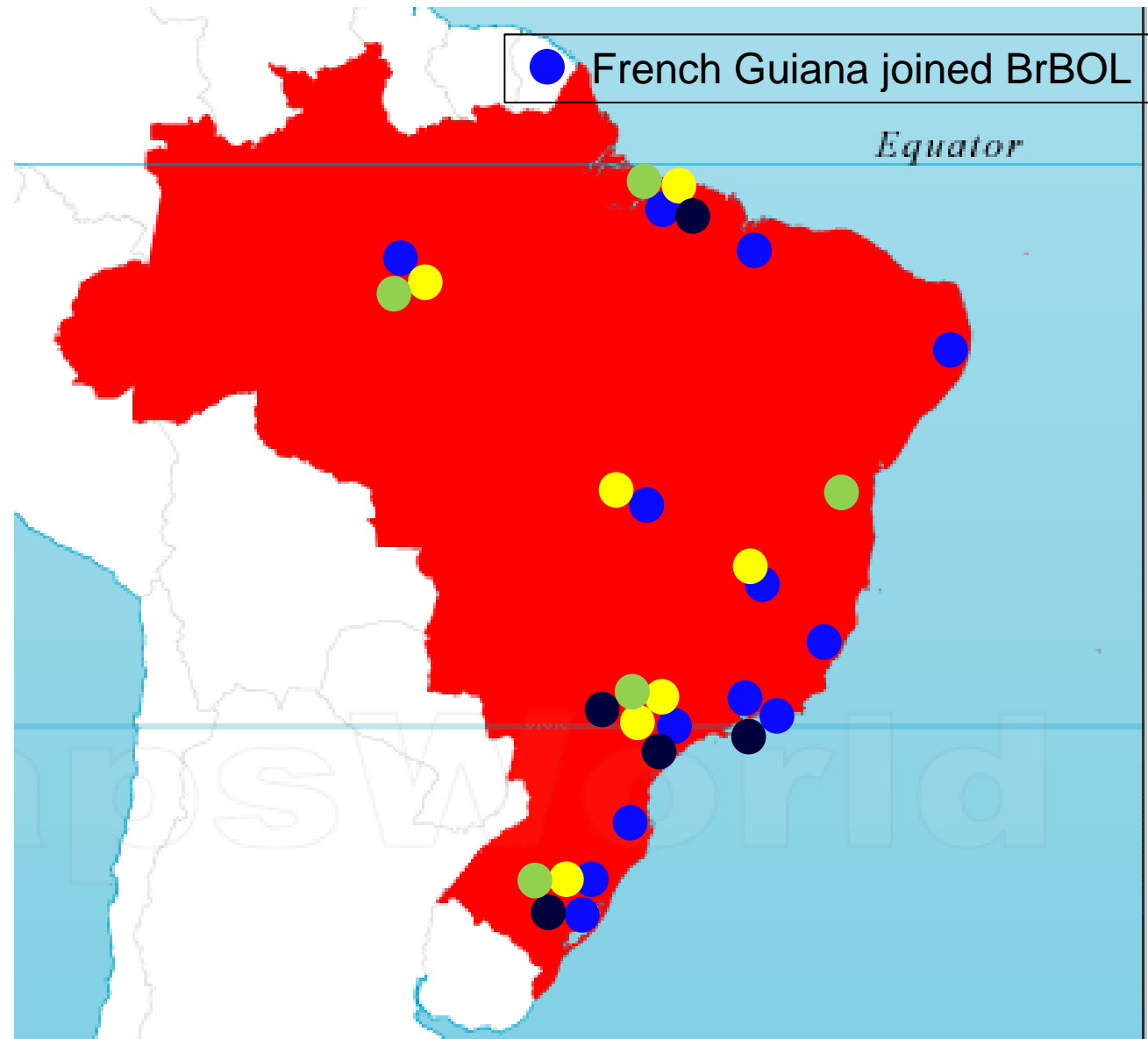
Mammals

Birds

Non-avian reptiles

Amphibians

4 Major Natural  
history collections in  
Brazil



# DNA barcoding of Brazilian tetrapods

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## Results: DNA Barcode (COI) library construction (2010-2015)

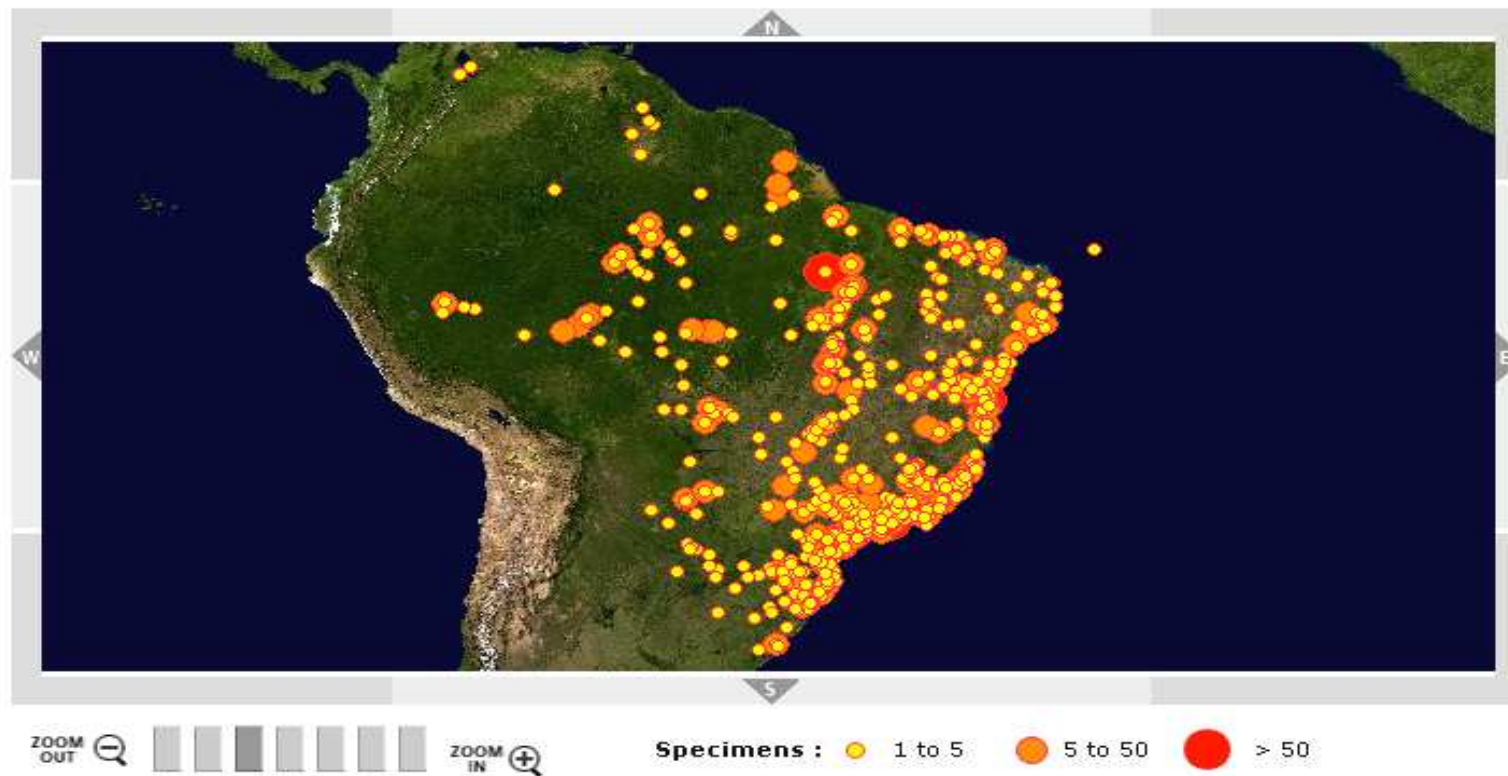
Group	Barcoded Individuals	Barcoded Species
Amphibians	5,100	450
Non-avian reptiles	2,608	816
Birds	3,508	1,253
Mammals	2,122	344
<b>Total</b>	<b>13,338</b>	<b>2,863</b>



# Geographic distribution of amphibian barcodes – BrBOL (M. Lyra, C. Haddad)

**BOLD**SYSTEMS

Total 5100 ind – 4750 in BOLD (~450 species)



# DNA barcoding of Atlantic Forest amphibians (M. Lyra, C. Haddad)

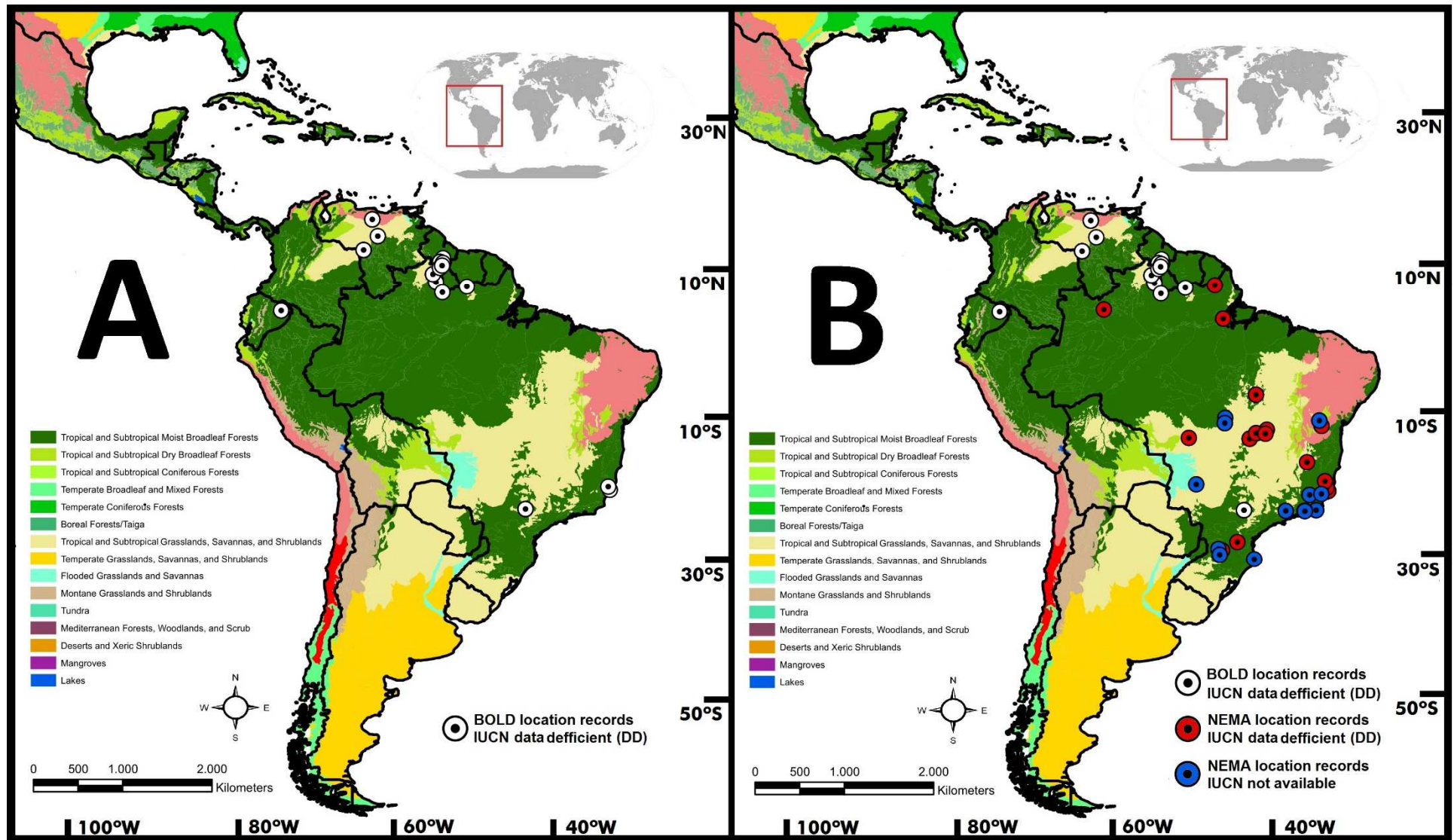
~3800 inds/vouchers

- 386 species  
(71% of the known  
species).

- 59/63 genera

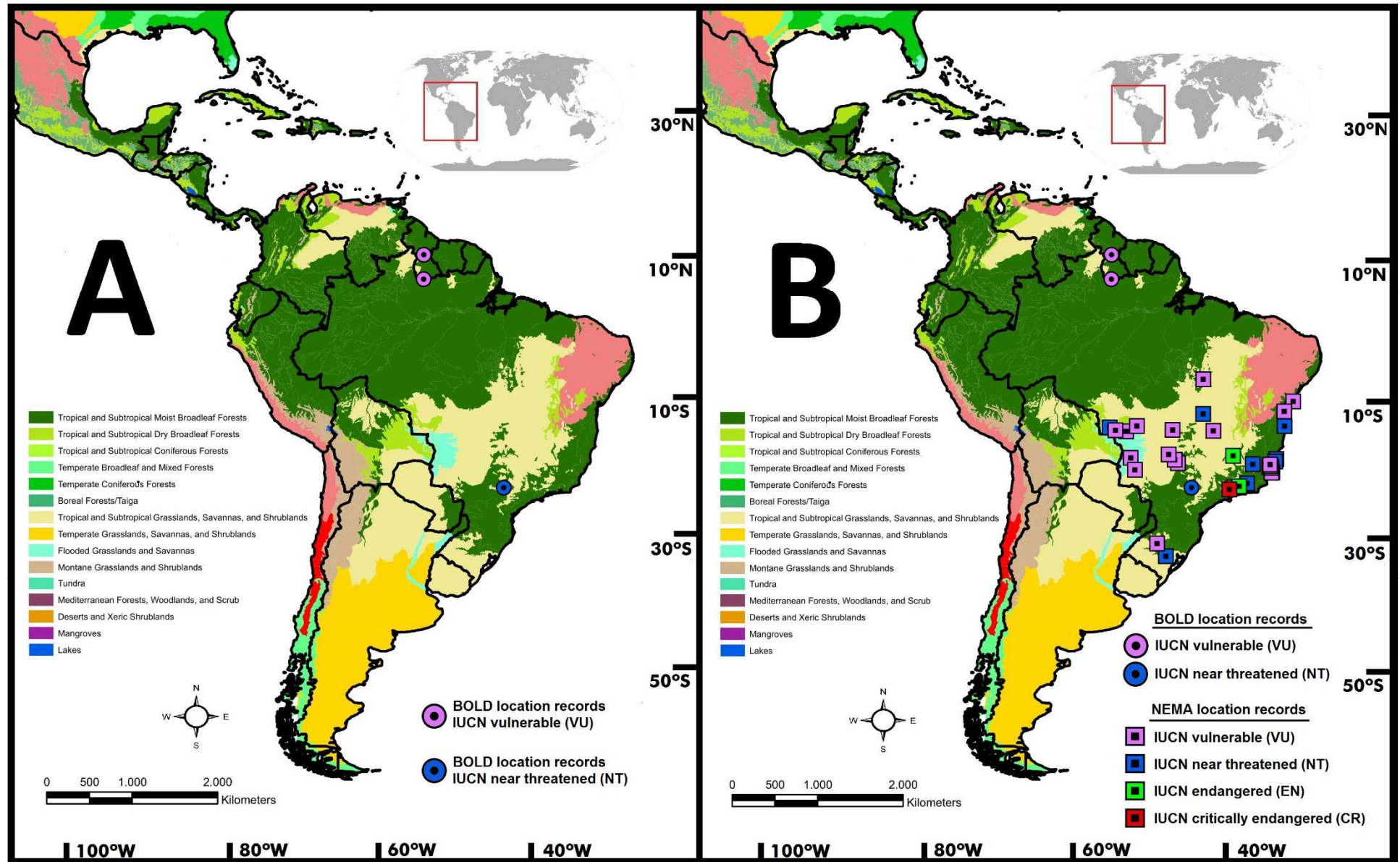


# Geographic distribution of mammal DNA barcodes



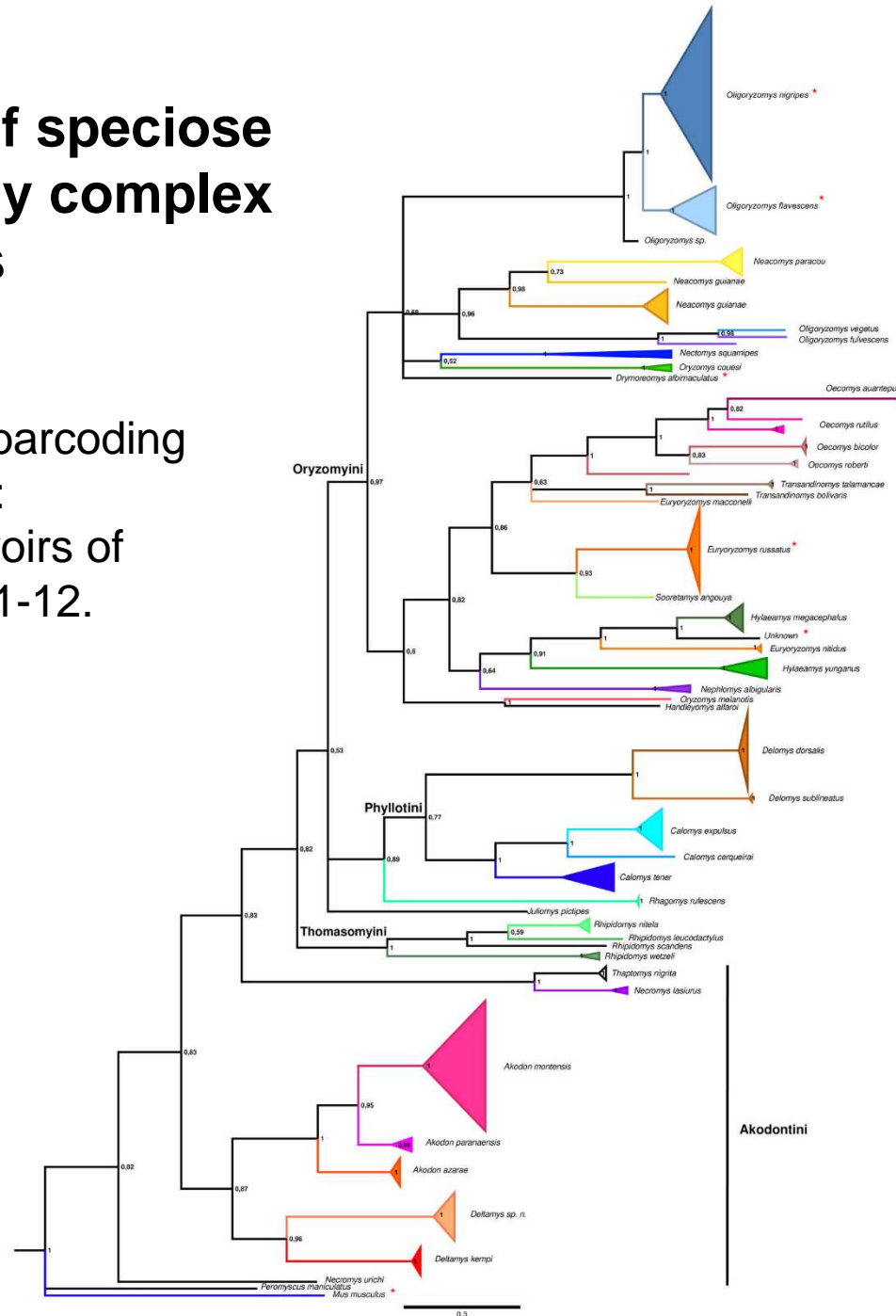


# Geographic distribution of mammal DNA barcodes

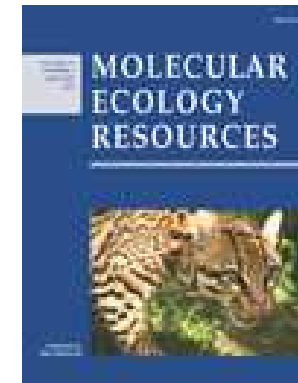
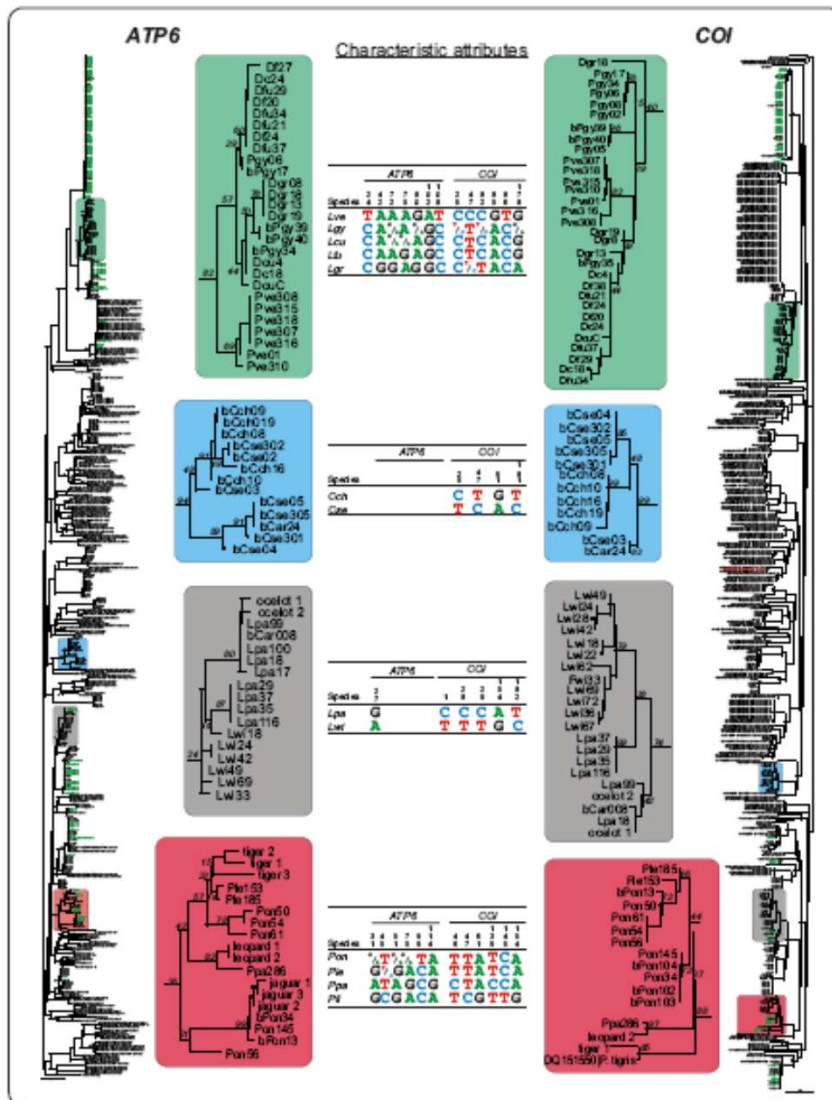


# DNA barcoding of speciose and taxonomically complex groups

Müller et al. 2013. DNA barcoding of sigmodontine rodents: identifying wildlife reservoirs of zoonoses. Plos One, 8: 1-12.



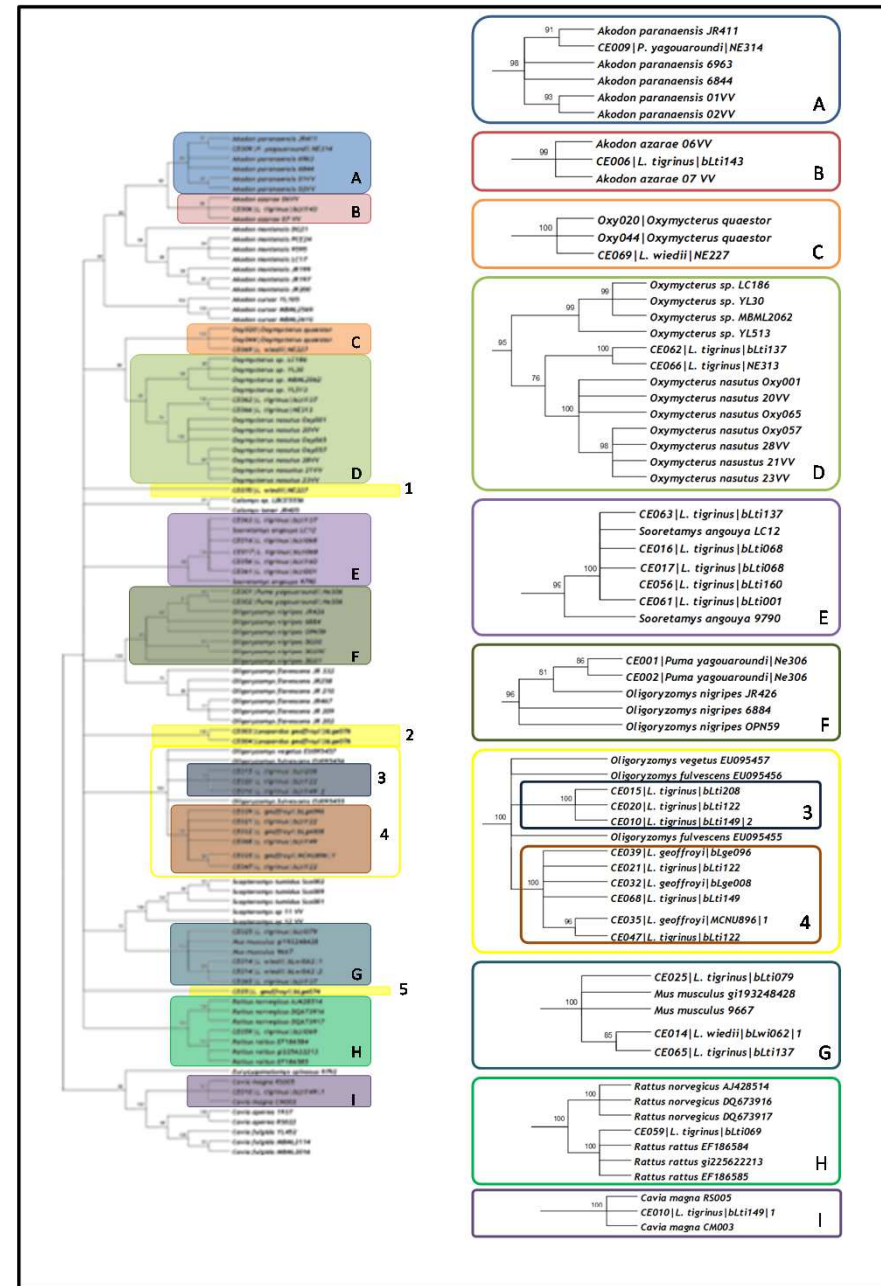
# Development of mini-barcodes for the identification of carnivores from fecal samples



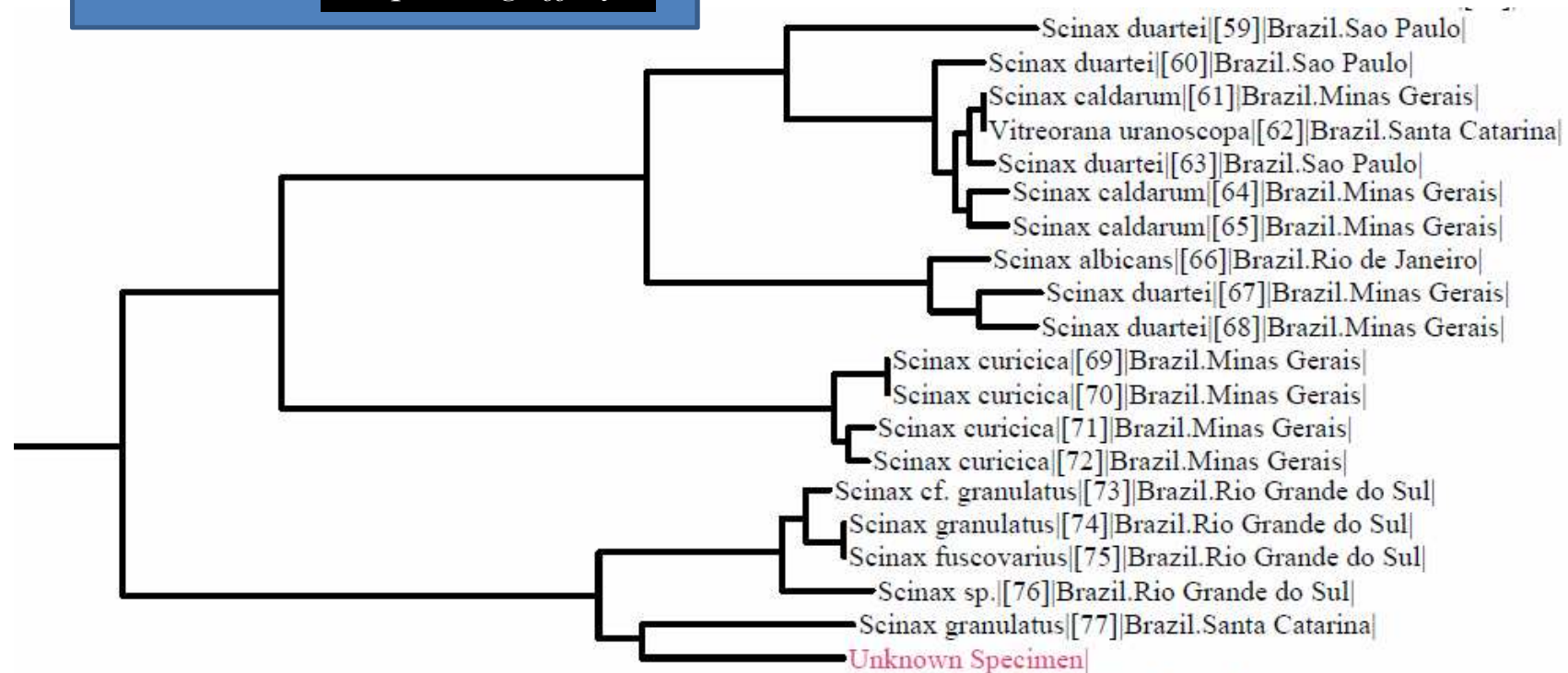
P. B. Chaves et al. 2012. Mol. Ecol. Res.



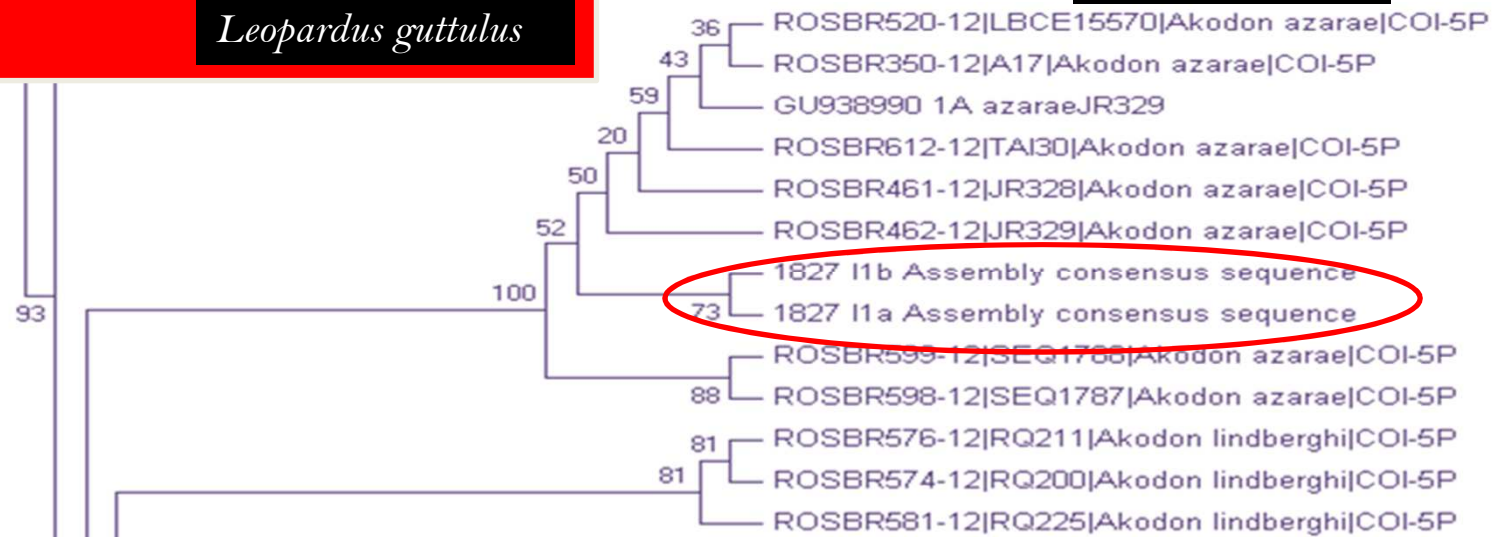
# Dietary analyses of wild cats using DNA barcodes of prey items



# Dietary analyses of wild cats using DNA barcodes of prey items



# Dietary analyses of wild cats using DNA barcodes of prey items





# Wildlife Forensics

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- Proof of concept studies by various university laboratories.
- DNA barcoding now routinely used by the Brazilian Federal Police.



Well-publicized case: Man arrested in 2003 with 58 eggs packed around his body. DNA barcoding used to identify the source species.

# Wildlife Forensics

## DNA Barcoding Identifies Illegal Parrot Trade

Priscila F. M. Gonçalves, Adriana R. Oliveira-Marques,  
Tania E. Matsumoto, and Cristina Y. Miyaki

*Journal of Heredity*, 2015, 560–564



# DNA barcoding in Brazil - Perspectives

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## Good news:

1. We got started and scratched the surface
2. An unprecedented community of biodiversity scientists has been assembled and integrated in Brazil.
3. There is capacity in the country to move forward.

## Challenges ahead:

1. Securing continuous, large-scale funding.
2. Improving governance and organizational structure.
3. Scaling up and speeding up to tackle the magnitude of the task and the pace of habitat loss in the country.



# Acknowledgments

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## BrBOL

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Paulo Buckup  
Ana Maria Espin  
Fernando Monteiro  
Jorge Porto

Hussam Zaher  
Célio Haddad  
Mariana Lyra  
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Yuri Leite  
Larissa Oliveira  
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Fernanda Valdez  
Cristine Trinca  
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Marina Favarini  
Tiago Ferraz  
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Paulo Chaves  
Flavia Tirelli  
Fernanda Michalski  
Anne Schmidt-Küntzel  
Maria Eduarda Appel

## Bromeliad meta-barcoding

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Renata Medina

