DIVERSITY AND CONSERVATION OF BRAZILIAN AMPHIBIANS

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What are amphibians?

They are vertebrates of the

CLASS AMPHIBIA

Order Gymnophiona (Apoda)

Caecilians

Order Caudata (Urodela)

Salamanders, newts, axolotls

Order Anura

Frogs, treefrogs, toads

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Order Anura (6345 species)

Frogs, treefrogs, toads

The Class Amphibia is a group in decline in the world by the human activities.

The main causes of the declines and extinctions of species are:

1) Habitat destruction

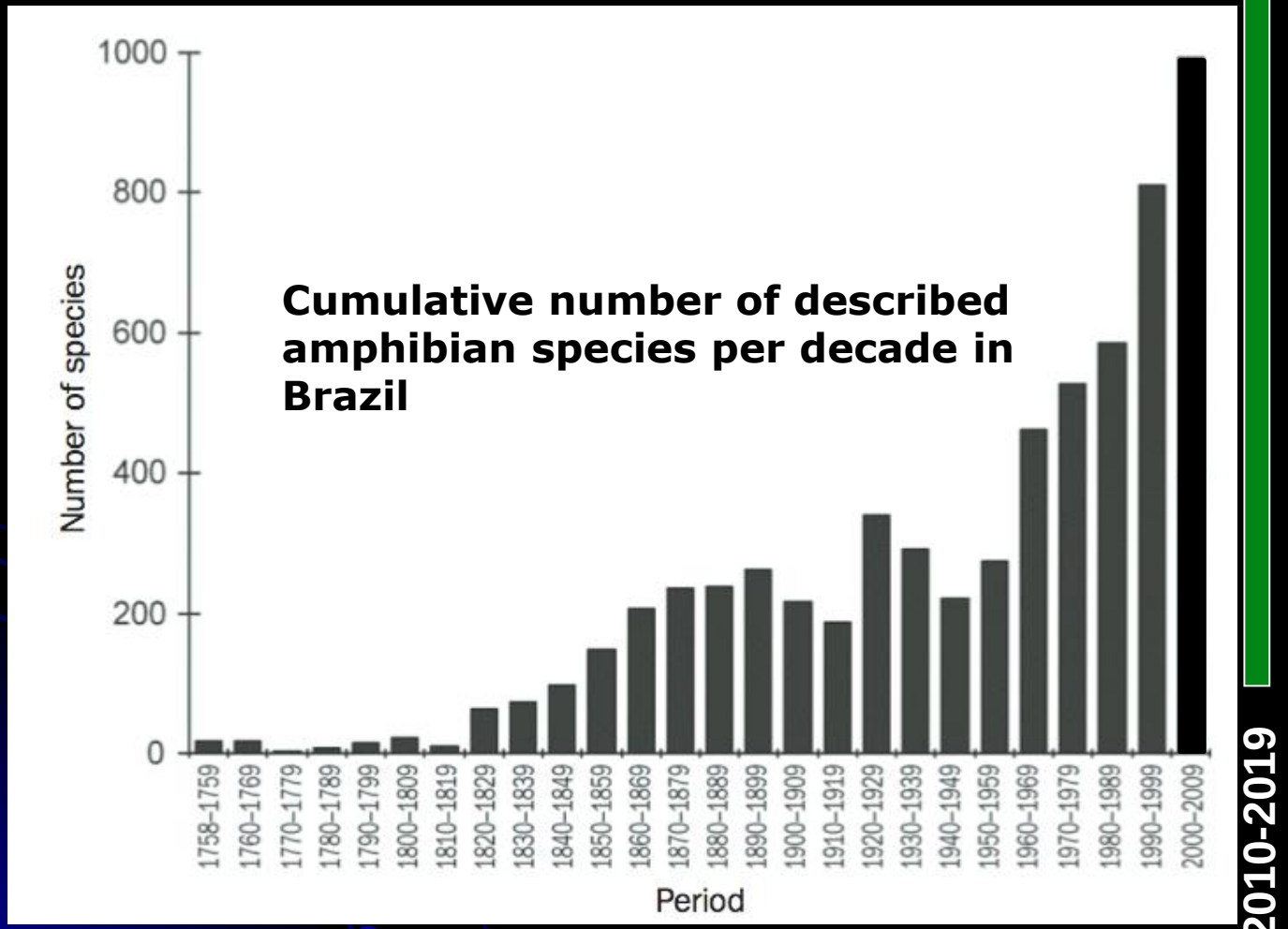
2) Man induced climatic changes

3) Man induced diseases

4) Uncontrolled hunting
(for food or pet trading)

There are 1010 known species of amphibians in Brazil

How many more might there be ?



(Köhler *et al.* 2005, *BioScience*)

In Brazil any survey in a place that was not studied before results in several new species, recognized by morphology or vocalizations.

Although my laboratory is not exclusively dedicated to taxonomy, at this moment we are describing approximately 25 new amphibian species. This is a common situation in the different research groups in Brazil.

We need to know the species to protect them

A way to accelerate the discover of new species: DNA barcode

We are DNA barcoding amphibians from Brazil and neighbouring countries (use of the cytochrome oxidase subunit I – COI – a mitochondrial gene)

We are building the amphibian DNA barcode reference library for Brazil (as part of the Cold Code Project)

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NEWS AND VIEWS

OPINION

Cold Code: the global initiative to DNA barcode amphibians and nonavian reptiles

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Abstract

DNA barcoding facilitates the identification of species and the estimation of biodiversity by using nucleotide sequences, usually from the mitochondrial genome. Most studies accomplish this task by using the gene encoding cytochrome oxidase subunit I (*COI*; Entrez *COX1*). Within this barcoding framework, many taxonomic initiatives exist, such as those specializing in fishes, birds, mammals, and fungi. Other efforts center on regions, such as the Arctic, or on other topics, such as health. DNA barcoding initiatives exist for all groups of vertebrates except for amphibians and nonavian reptiles. We announce the formation of Cold Code, the international initiative to DNA barcode all species of these 'cold-blooded' vertebrates. The project has a Steering Committee, Coordinators, and a home page. To facilitate Cold Code, the Kunming Institute of Zoology, Chinese Academy of Sciences will sequence *COI* for the first 10 specimens of a species at no cost to the steward of the tissues.

DNA barcoding amphibians from Brazil and neighboring countries

4500 individuals with barcodes (3860 in BOLD)

~ 2650 specimens

~ 1850 specimens

FAPESP **– FAPESP project**

COLD CODE
DNA BARCODING AMPHIBIANS & REPTILES

KUNMING INSTITUTE OF ZOOLOGY, CAS

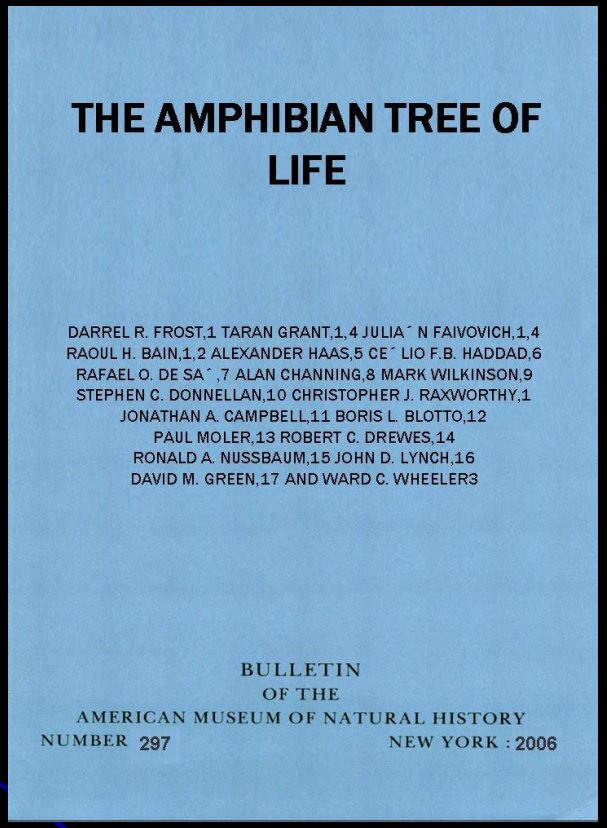
Cold Code Project - China

BrBOL
Brazilian Barcode of Life

– CNPq
(Brazilian Science Foundation)

PREVIOUS CONCLUSION: Being very conservative (considering 10% of DNA divergence) we would have ~20% of new species, mainly cryptic species detected by DNA barcoding. We are underestimating the amphibian diversity in Brazil if using just phenotype, putting several species at extinction risk.

Example of results of this intensive search for the comprehension of the diversity of amphibians



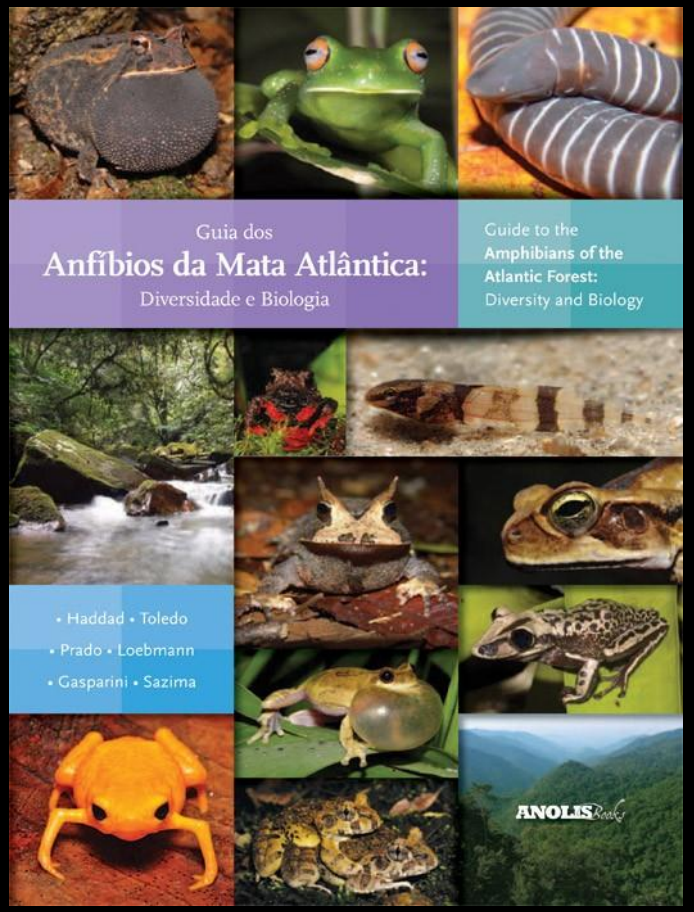
This monographic and seminal study changed the classification of the amphibians around the world. Descriptions of several genera, families and suprafamilial groups.

Web of science = 936 times cited

Google Scholar = 1407 times cited

Examples of results of this intensive search for the comprehension of the diversity of amphibians

A sound guide for the identification of anurans from the Atlantic forest in Brazil. It is widely used by scientists and general public, including people that practices yoga.



One of the largest guides of amphibians in the world. Photos of more than 450 species. Targets a wide audience, since scientists to nature lovers.

Reproductive Modes in Frogs and Their Unexpected Diversity in the Atlantic Forest of Brazil

CÉLIO F. B. HADDAD AND CYNTHIA P. A. PRADO

Amphibians, and especially the anurans (frogs and toads), exhibit a greater diversity of reproductive modes than other tetrapod vertebrates. Twenty-nine reproductive modes have been recognized for the anurans; we propose 10 more, elevating by more than 34% the number of reproductive modes known for anurans worldwide. These newly recognized reproductive modes for the frogs elevate by almost 48% the number of anuran reproductive modes known for the Neotropics. The highly complex topography of the Atlantic forest, breaking up the biome into many small microhabitats, and the high humidity, which reduces desiccation risks, have enabled the evolution of reproductive specializations such as eggs or tadpoles that develop out of water. Nearly 90% of the Atlantic forest has been cleared, and because several anurans are endemic to this region or have specialized reproductive modes dependent on the forest, this partly explains the generalized population declines and large numbers of species that have disappeared in the last few decades.

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Behavioural defences of anurans: an overview

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Among vertebrates, defensive behaviours have been reviewed for fishes, salamanders, reptiles, birds, and mammals, but not yet for anuran amphibians. Although several defensive strategies have been reported for anurans, with a few exceptions these reports are limited in scope and scattered in the literature. This fact may be due to the lack of a comprehensive review on the defensive strategies of anurans, which could offer a basis for further studies and insights on the basic mechanisms that underlie these strategies, and thus lead to theoretical assumptions of their efficacy and evolution. Here we review the present knowledge on defensive behavioural tactics employed by anurans, add new data on already reported behaviours, describe new behaviours, and speculate about their origins. A total of 30 defensive behaviours (some with a few sub-categories) are here recognised. The terminology already adopted is here organised and some neologies are proposed. Some of the behaviours here treated seem to have an independent origin, whereas others could have evolved from pre-existent physiological and behavioural features. The role of predators in the evolution of defensive behaviours is still scarcely touched upon and this overview adds data to explore this and other evolutionary unsolved questions.

Example of work that deal with conservation of the amphibian diversity

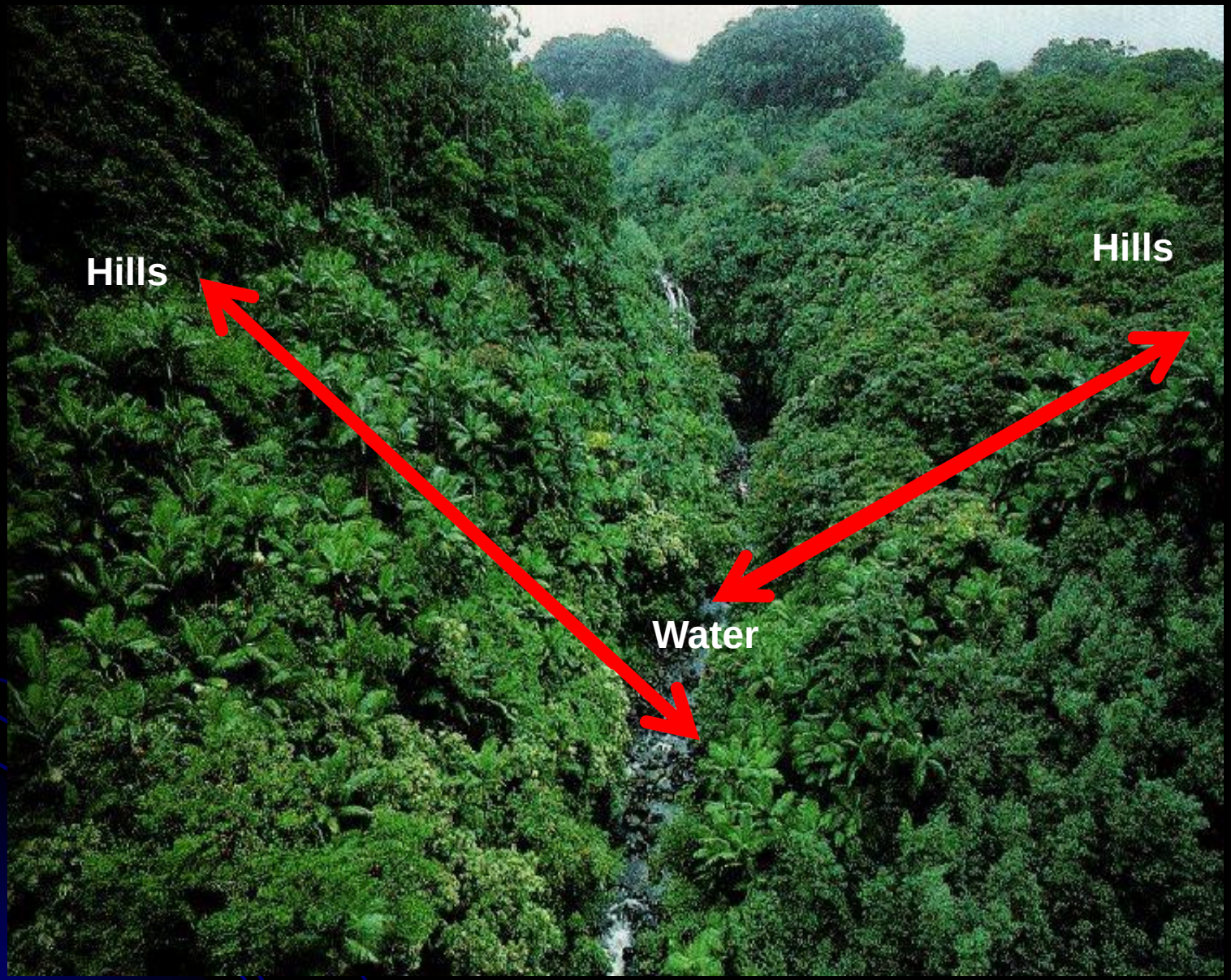
Habitat Split and the Global Decline of Amphibians

Carlos Guilherme Becker,[1,2] Carlos Roberto Fonseca,[2]* Célio Fernando Baptista Haddad,[3] Rômulo Fernandes Batista,[4] Paulo Inácio Prado[5]

The worldwide decline in amphibians has been attributed to several causes, especially habitat loss and disease. We identified a further factor, namely "habitat split"—defined as human-induced disconnection between habitats used by different life history stages of a species—which forces forest-associated amphibians with aquatic larvae to make risky breeding migrations between suitable aquatic and terrestrial habitats. In the Brazilian Atlantic Forest, we found that habitat split negatively affects the richness of species with aquatic larvae but not the richness of species with terrestrial development (the latter can complete their life cycle inside forest remnants). This mechanism helps to explain why species with aquatic larvae have the highest incidence of population decline. These findings reinforce the need for the conservation and restoration of riparian vegetation.

www.sciencemag.org SCIENCE VOL 318 14 DECEMBER 2007

Demonstration of a new human-induced process that generates amphibian decline around the world. In fact this process explains the decline of any organism with biphasic life-cycle.



Amphibians that reproduce in water in a pristine forest perform up and down migrations.

Farmers cut the forests near the rivers forcing amphibians from the forest to live in forest fragments on the top of mountain. The amphibians are forced to abandon the fragments to search water bodies for the reproduction in the lower places that were cleared by the human activities. The amphibians die massively (by desiccation, opportunistic predators) during the migration process and year after year they suffer a fast decline and became extinct.

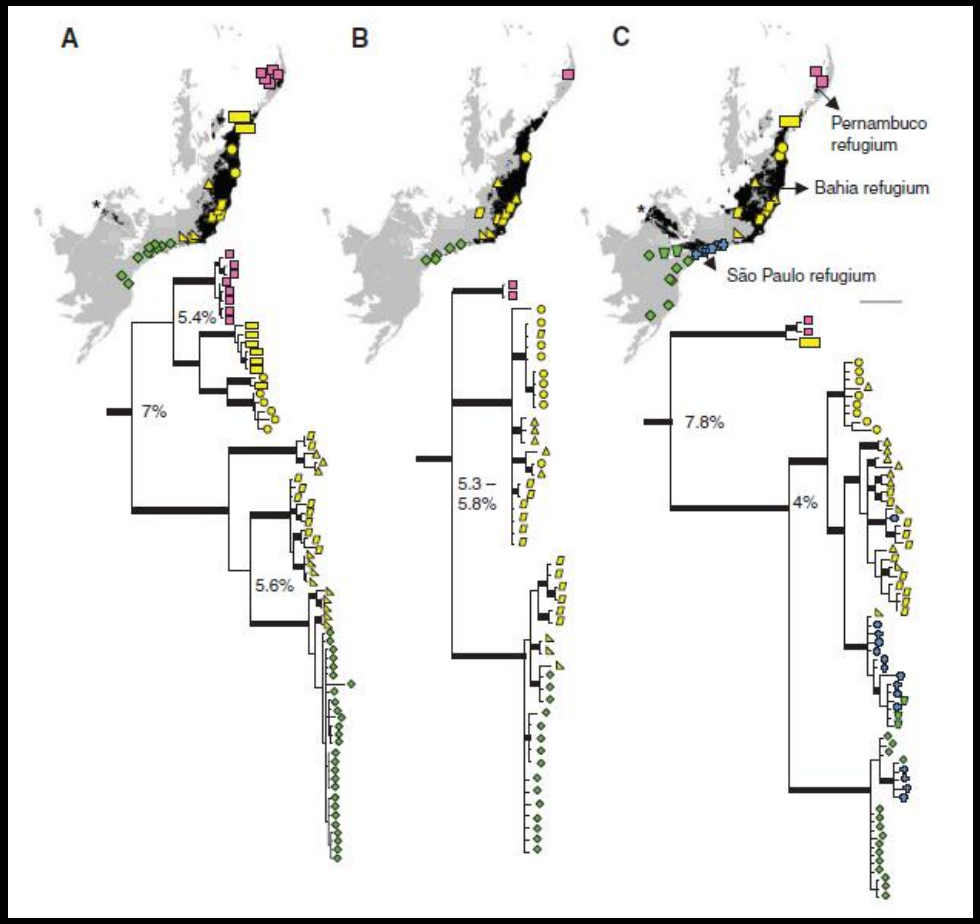
Another example of work on the conservation of the amphibian diversity

Stability Predicts Genetic Diversity in the Brazilian Atlantic Forest Hotspot

Ana Carolina Carnaval,[1]* Michael J. Hickerson,[2] Célio F. B. Haddad,[3]
Miguel T. Rodrigues,[4] Craig Moritz[1]

Biodiversity hotspots, representing regions with high species endemism and conservation threat, have been mapped globally. Yet, biodiversity distribution data from within hotspots are too sparse for effective conservation in the face of rapid environmental change. Using frogs as indicators, ecological niche models under paleoclimates, and simultaneous Bayesian analyses of multispecies molecular data, we compare alternative hypotheses of assemblage-scale response to late Quaternary climate change. This reveals a hotspot within the Brazilian Atlantic forest hotspot. We show that the southern Atlantic forest was climatically unstable relative to the central region, which served as a large climatic refugium for neotropical species in the late Pleistocene. This sets new priorities for conservation in Brazil and establishes a validated approach to biodiversity prediction in other understudied, species-rich regions.

www.sciencemag.org **SCIENCE** VOL 323 6 FEBRUARY 2009



Using phylogeographic analyses based on DNA sequences of amphibians and climatic modeling, it is possible to determine with better precision the quaternary refuges, that represent the areas with climatic stability over the geological time. This areas must be a priority in conservation because they are "factories of biodiversity".

Amphibians are predators of insects that may spread diseases or that are agricultural pests. Declines and extinctions of amphibians may imply that these insects will proliferate and we will have an increase in the incidence of some diseases and more problems in the agriculture.

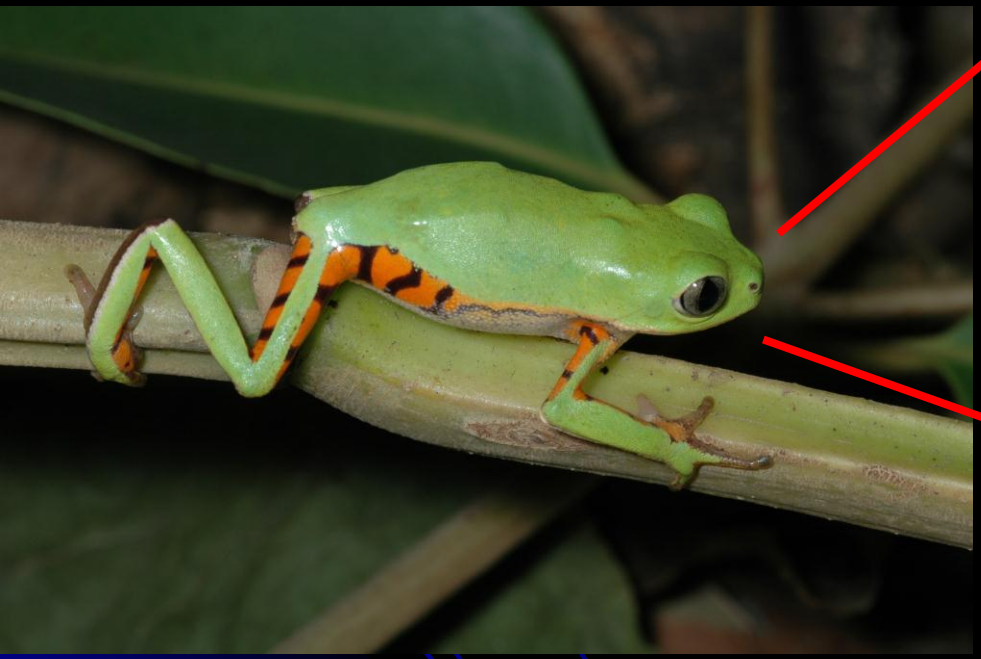
Hematophagous insects can cause diseases such as malaria, dengue, and Chagas disease.

Leafcutter ants and caterpillars cause damage to the agriculture.

The use of amphibians as medicine is a tradition among some Indian groups in the Amazon Basin. The sapo-kambô (*Phyllomedusa bicolor*) is used in the "vaccination process". The Indians say that the vaccination cures some diseases, like malaria. The first time I heard about vaccination I interpreted this as a popular believing, because the Indians described hallucinations, headache, and nausea as adverse reactions to the vaccination .

Photo by Marcio Martins

Besides the hallucinogens, there are other compounds in the skin of *Phyllomedusa* that kill protozoa like *Plasmodium* (that causes malaria) and *Trypanosoma* (that causes Chagas disease), and apparently are harmless to human cells.



Maybe I was wrong about the Indian vaccination. Probably they discovered a medicine that cures malaria.

We are still finding new species, like this *Phyllomedusa*, in huge cities, like São Paulo, in Brazil. Certainly this new species has chemical compounds in the skin that may be potentially useful for the development of drugs for disease treatment in humans. However, the conservation status of this new species is unknown and the species may be at risk.

Thank you

謝謝

P. Bernardo