DartFrog – The evolution and maintenance of ecotypism in a changing world: the case of the poison dart frog *Dendrobates tinctorius*

PI: Mathieu CHOUTEAU – LEEISA, Cayenne, French Guiana
Charles PERRIER – CEFE, Montpellier, France

Abstract: The proposed project aims to strengthen our understanding of the processes driving patterns of adaptive diversity in the Amazonian poison dart frogs and to develop relevant tools for its conservation in French Guiana. First, the proposed genomic analyses will allow us to characterise the genetic diversity and infer the demographic parameters of *Dendrobates tinctorius* cotypic populations. Second, coupling genomic and colour-pattern analyses, we will investigate the genetic mechanisms behind the evolution and maintenance of colour patterns present among the strikingly diverse ecotypes. This will enable testing whether recent contact between ecotypes in some populations resulted in gene flow and the alteration of ancestral colour patterns. Third, experiments in the *Plateforme d'Étude Expérimentale Amazonienne* (PLEEA) will allow assessing the extent of mate choice and of genetic reproductive barriers between ecotypes, ultimately enhancing the mechanisms underlying the diversification and maintenance of the spectacular ecotypism in this species. Overall, the project DARTFROG has the potential to advance our understanding of the genomic diversity within populations of an emblematic and threatened species of the Amazon. Via discussions between researchers and conservation officer in French Guiana, we will propose guidelines and genetic tools for improving the conservation of this species.

DeepRoot – Into the deep: exploring root distribution and function in tropical forests

PI: Claire FORTUNEL – AMAP, Montpellier, France
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Abstract: While the hidden part of plants, roots are essential components of plant ecological strategies and are often assumed to be the missing piece to better understand ecosystem functioning in response to soil and climate gradients. However, there is very little information on root biomass and trait distribution with depth in tropical forests. It thus remains unclear how deep roots can contribute to tropical forest functioning, hampering predictions of the future of these ecosystems with ongoing climate change that forecast increasing frequency and intensity of drought events in tropical regions. To tackle this knowledge gap, we propose to sample roots down to 10 m in an undisturbed tropical forest, located at Paracou in French Guiana. We will quantify variation in biomass and traits of fine and coarse roots with depth and associated soil characteristics. We will then leverage this data in a forest dynamics model to better understand how deep roots contribute to ecosystem functioning, and evaluate their potential to improve model predictions. This project will significantly increase the data available so far on root distributions and traits in tropical forests and has the potential of considerably improving our understanding of tropical forest functioning.

GeoLaw – GIS modelling of spatial tensions for biodiversity conservation in the Brazilian Amazonia

PI: Luly FISCHER – LC2S, Schoelcher, Martinique
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Abstract: The implementation of biodiversity conservation policies in the Brazilian Amazonia has not always dealt with diverse and conflictual stakeholders with bottom-up conservation strategies. Historically, the environmental and the development agendas decided at the national level had as result biodiversity loss, associated with human rights violations of local populations. Scientific productions related to land use planning in Brazil suggests that the absence of coordinated geographic references to a global territorial planning in the Brazilian federation results in spatial tensions that negatively affect biodiversity conservation politics. The main objective of this project is to analyze the interactions between "society" and "ecosystem" to promote a joint management considering the context of socio-ecological systems (SES). The researchers will test the hypothesis of "politics of deregulation" using the spatial superposition cases and the aggregation of different geographic products for land use planning in the State of Pará in Brazil. The approach privileges the interdisciplinary relations Law and Geomatics. The basis of the methodology is in the transversal analysis of the two fields of study using legal, geomatics and geostatistical interpretation techniques. The research program has four tasks. First, the researchers will organize charts with the occupation rules for the different existent land use categories in the State of Pará. Secondly, we will identify the superposition zones and geographical aggregations. Thirdly, we will conceive the metrology of geographical uncertainties using geomatics, their location and attributes. Lastly, we will employ geographical modelization of spatial tensions concerning biodiversity conservation in the State of Pará.

MultiMyco – Multiscale determinants of arbuscular mycorrhizal fungal communities

PI: Francis Q. BREARLEY – Manchester Metropolitan University, UK
Mélanie ROY – EDB, Toulouse, France

Abstract: Arbuscular mycorrhizal fungi (AMF) are keystone organisms, particularly in Neotropical forests, where they form symbiotic associations with the majority of tree species. Different taxa of AMF can have differential effects on plant performance but multiple factors influence the diversity and composition of AMF taxa at a given location, and these factors will vary depending upon the scale at which they are studied. Using a single tree species (*Dicorynia guianensis*; Angélique), we will unravel the relative importance of biotic and abiotic factors on AMF communities within and across locations in French Guiana. We will use cutting-edge molecular techniques that will lead to a key novel contribution of our work to assess community genetic effects on AMF taxa *i.e.* how does the host tree genetic diversity influence AMF community composition. Our project will involve three complementary institutions with major expertise in the ecology of below-ground fungal communities, including in French Guiana, and will contribute to three of LabEx CEBA's work packages.

NSC-Focus – Non-structural carbohydrates and tree functional groups in the context of forest succession

PI: Alexia STOKES - AMAP, Montpellier, France

Abstract: Plants can be classified into functional groups depending on their ecological roles. Life history and functional trait analyses can be used in the definition of groups, and help us understand how species persist in their habitat, withstand a variety of climatic conditions and use and manage environmental resources. In trees, how resources are allocated and stocked internally will significantly affect growth, regeneration, defence and recovery mechanisms. Therefore, resource management in trees should be a major factor influencing their ecological role and niche occupation in a community, but no explicit hypothesis has yet been formulated linking resource supply and stocks with functional group construction in a mixed tropical forest. Resources are available following photosynthesis, and are supplied to tree

organs in the form of non-structural carbohydrates (NSC). NSC differs between species and organs, but apart from seasonal differences, no unifying hypothesis has been put forward explaining why NSC levels differ for the same organ among species. In sapwood, NSC, are stored in ray and axial parenchyma cells (RAP). An individual may need to rapidly mobilise NSC for drought recovery, wound repair, resprouting and fast growth. Certain species might need to mobilise NSC quickly to colonise newly available space after a disturbance. Conversely, late successional species can require large quantities of NSC for defence against natural enemies to maintain their position in the canopy. Also, taller tree species with a high axial parenchyma (AP) tissue fraction have wider vessels, with most of the AP packed around vessels, to help maintain hydraulic conductivity. In tropical species, highly diverse patterns of RAP and vessel size can be found, and we hypothesize that these patterns reflect species successional stage. Work in French Guiana provides an excellent opportunity to investigate diverse relationships and will enable us to test the relationship between resource supply and stocks, and functional grouping of species. We will examine anatomical wood traits, including RAP volume and vessel size and density on 50 tree species at Paracou, Guiana. NSC will be measured in leaves (supply) and sapwood (stocks). We expect that NSC stocks are correlated with RAP volume and that specific relationships occur with vessel traits. Links between supply, stock and traits should help our mechanistic understanding of how trees manage resources with regard to their ecological strategy in a context of forest succession.

NurseHab – Characterisation of near-shore habitats as nurseries for fish and shrimp commuities

PI: Morgana TAGLIAROLO – LEEISA, Cayenne, French Guiana

Abstract: The value and ecological significance of near-shore coastal waters is recognised and addressed worldwide for their provision of nursery grounds for juvenile fish and invertebrates. These habitats are however under threat from anthropogenic activities and global changes. The availability of optimal nursery zones is considered a limiting factor for recruitment and, consequently, for adult stocks. Very little is known about the nursery role of the different near-shore habitats for fish and invertebrates in French Guiana. With this project, we would like to assess the nursery role of various near-shore habitats by investigating the spatial and seasonal variability of environmental conditions and pollution. The proposed study tackles this aim through an integrated, multidisciplinary approach in order to determine the habitat preference as well as community assemblage and the effect of anthropogenic pressure on juveniles. Results will provide insightful information on habitat preference, associated communities composition and inshore/offshore stock recruitment dynamics. This new knowledge will provide the key elements for the development of a more efficient ecosystem-based-management approach, allowing not only the improvement of fish and shrimps conservation, but also of their habitat.

PEPINO – Historical genomics of long-term people-palm interactions in the Neotropics

PI: Louise BROUSSEAU – DIADE, Montpellier, France
Guillaume ODONNE – LEEISA, Cayenne, French Guiana

Abstract: Recent discoveries suggest that humans have more intensively transformed Amazonia than previously thought, and that the contemporary biodiversity of Amazonian rainforests contains legacies of pre-Colombian societies. The present-day distribution of genomic diversity of hyperdominant food crops in Amazonian forest landscapes -and their underlying biogeographic history- are thus expected to result from complex interactions between natural and human-mediated evolutionary processes. However, the degree to which pre-Columbian human societies affected the contemporary distribution of functional genomic diversity in Amazonian food crops is largely unknown. The goal of this project is to evaluate how long-term

interactions between people and a hyperdominant food-producing palm (*Oenocarpus bataua* Mart.) acted together with natural evolutionary processes to create the present-day distribution of functional genomic diversity across Amazonia through a continental-scale biogeographic study. We will analyze retrospectively the effects of global (land use and climate) changes on population evolution and evaluate the resilience of populations after anthropogenic disturbance in ancient agro-ecosystems of Amazonia. Analyzing the simultaneous effects of natural and human-mediated pressures is of major interest, because these two processes are ongoing and are likely to intensify in the current context of global change.
We will address the following question: How have natural (gene flow, demography, climate adaptation) and human-mediated (dissemination, selection, resultant inbreeding) evolutionary processes interacted together to create the present-day distribution of genomic diversity of *O. bataua* across Amazonia? This question will be tackled through an original sampling design (combining sites close to ancient villages with archaeological evidence of strong human activity and sites with no nearby evidence of pre-Colombian occupation) and modern evolutionary genomics (setting-up a genome-wide capture experiment to sequence the coding regions of thousands of candidate genes for adaptation and domestication). The originality of this project lies in: (1) the integration of past anthropogenic-disturbance knowledge to understand the biogeographic history of a hyperdominant food-producing palm across Amazonia; (2) the use of a custom capture kit composed of 20'000 molecular probes to target the exons of thousands of candidate genes for adaptation and domestication; (3) the development of innovative analytic procedures, including specific bioinformatics pipelines and custom Bayesian models of evolutionary genomics.
This project is fully in line with the general objectives and tasks of the LabEx CEBA 'biodiscovery', 'history of biodiversity', 'ecological genetics & genomics of adaptation', 'modelling biodiversity in space and time' and 'services of biodiversity'. It will reinforce collaborations within the scientific network of LabEx CEBA (through collaborations with UMSR LEEISA, UMRs AMAP & BioGeCo, France), and promote the emergence of international collaborations within an interdisciplinary scientific network composed of geneticists, bioinformaticists, (ethno)botanists, plant physiologists and archaeologists (through collaborations with UMRs DIADE, AGAP and IPME in France, the Instituto Nacional de Pesquisas da Amazônia, Federal University of Western Pará and Instituto de Desenvolvimento Sustentável Mamirauá in Brazil, and the University of California Berkeley in USA). This project will also benefit from already-funded research programs (*LongTime*, *NeoPalmOmix*/*PalmOmix*, respectively) and would promote synergies between LabEx CEBA and complementary initiatives (*e.g.*, LMI 'BIOINCA').

PlastiPhys – Plasticity in physiological capacity and thermoregulatory behaviour as adaptive responses to climate change

PI: Donald B. MILES – Ohio University, USA & SETE, Moulis, France

Abstract: Climate change is rapidly modifying thermal and hydric conditions of global environments. These changes pose a pervasive threat to biological diversity through the reorganization of biological communities and extinction of species. A priority for biologists is to predict potential organismal responses to extreme environments generated by climate change. Three potential responses include: 1) distributional shifts involving species following their preferred thermal niche, 2) adaptation to new environmental conditions either through phenotypic plasticity or evolutionary adaptation, or 3) failure to adapt followed by population decline and extinction. Most current studies focus either on range shifts as estimated by species distributional models or phenological changes in life history traits. Ectothermic species in the tropics are assumed to be operating at their physiological limits. Hence, novel, altered thermal environments due to climate change may exceed the thermal safety margins of tropical species leading to population collapse. In addition, tropical species are may be exposed to increasing episodes of drought. Yet, physiological adaptations to water stress are understudied in tropical reptiles. Understanding how species can persist in fluctuating environments requires determining their ability to contend with both

rising temperatures and prolonged water stress. Moreover, it is desirable to have a marker identifying potential population collapse in stressed environments. We have four objectives in this project. First, to quantify the thermal heterogeneity across diverse tropical habitats. Second, to assess how plasticity in thermal physiology may buffer species from the deleterious effects of extreme environments. Third, identify how environmental stressors affect water balance, immunocompetence, parasite load, and the gut microbiome in lizard species that differ in habitat occupancy. Fourth, to use telomere length as a molecular tool for identifying populatoins at risk of decline, given that attrition of telomeres is accelerated by exposure to environmental stressors. Tropical species are predicted to be at a higher risk, because of their specialized thermal characteristics and limited exposure to water stress. Two predictions are that tropical species have narrower physiological tolerances and are less likely to exhibit plastic responses to environmental changes. Yet, recent studies have shown substantial plasticity in thermal traits. One of the themes of LabEx CEBA is to predict the ability of tropical systems to withstand environmental change. Because the environmental changes predicted to affect tropical ecosystems are novel and unlikely to have been experienced by the constituent species, determining the magnitude of thermal heterogeneity and potential biotic responses remains a challenge. Data on the physiological and behavioral plasticity is lacking for many lizard species in the tropics. The ability to tolerate new thermal environments is also likely to be affected by rising parasite loads as a consequence of increased levels of stress and lowered immune competence. Our project is designed to assess the vulnerability of tropical lizard communities to altered thermal niches.

RareTree – Eco-evolutionary implications of commonness vs. rarity in Amazonian tree congeners

PI: Myriam HEUERTZ – BIOGECO, Cestas, France

Abstract: RARETREE aims to address the eco-evolutionary implications of commonness vs. rarity in closely related tropical tree species belonging to the genus *Eschweilera*, Parvifolia clade (Lecythidaceae), “EP species” hereafter, using a replicated design between French Guiana and Amazonian Ecuador to uncover the mechanisms of coexistence and evolution of related common and rare tropical tree species across Amazonian regions, and to develop an emerging scientific collaboration between INRA, CIRAD, the University of Michigan and the Universidad San Francisco de Quito. 1. We will build the ecological niches occupied by EP species at local scale based on individual competition indices derived from forest inventories, and microenvironmental variables. 2. Based on targeted sequencing, we will estimate current and historical effective population sizes, *Ne*, to test the prediction that common species have large *Ne*, indicative of high adaptive potential, and to examine whether rare and common species are equally persistent through time. 3. We will estimate scenarios of genetic introgression between common and rare species, to test the prediction of high introgression rate in common species, increasing their *Ne*, and of lower introgression rates and lower *Ne* in rare species, due to a trade-off between reproductive assurance vs. avoidance of genetic assimilation. We will also assess if rare species preferentially introgress functional genetic variants, increasing their adaptability. We expect to discover whether current ecological niche breath associates with long time evolutionary processes, i.e. if niche breath associates with *Ne*. Extending the study of eco-evolutionary processes in tropical tree species complexes to a novel Amazonian region, Amazonian Ecuador, will offer opportunity for uncovering general mechanisms. We will organize a Lecythidaceae workshop at the 2nd Latin American Congress of Biogeography in August 2019 to foster scientific exchange and future collaboration, after which we will go on a field sampling mission to UNESCO Yasuní Biosphere Reserve and Tiputini Biological Station.