ABSTRACT BOOK

I Conference for The Amazon We Want

Belém, Pará, Brazil
March 2023

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK
A GLOBAL INITIATIVE FOR THE UNITED NATIONS

THE AMAZON WE WANT
Science Panel for the Amazon

HOSTING

Science Panel for the Amazon (SPA).

Governo do Estado do Pará, Secretaria de Estado de Meio Ambiente e Sustentabilidade (SEMAS).

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ACKNOWLEDGEMENTS

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ABOUT THE SCIENCE PANEL FOR THE AMAZON (SPA)

The Science Panel for the Amazon (SPA) was established on September 23, 2019, at the United Nations in New York following a meeting with 46 leading scientists working in and on the Amazon. The SPA was inspired by the Leticia Pact for the Amazon, an agreement adopted by the governments of Amazonian countries on September 6, 2019, that highlights the importance of research, technology, and knowledge management to guide decision-making. The aim of the SPA is to advance scientific research on the Amazon, especially focused on sustainable development for the region. The panel was officially launched in July 2020, and since then it has obtained many achievements as the first high-level science initiative dedicated to the Amazon.

The SPA is currently comprised of more than 280 scientists—two-thirds of whom come from Amazonian countries—and is organized under the auspices of the Sustainable Development Solutions Network (SDSN), a global initiative of the United Nations. The Panel's leadership includes Professor Dr. Jeffrey Sachs, president of SDSN and convenor of the SPA; Dr. Carlos Nobre and Dr. Marielos Peña Claros, the Co-chairs; and Mrs. Emma Torres, the Strategic Coordinator. The SPA publications are of interest to a broad audience as they provide science-based recommendations for a healthy and sustainable Amazon.

INTRODUCTION

The Science Panel for the Amazon (SPA) and the government of the State of Pará jointly organized the I Conference for the Amazon We Want, with its public opening session on March 8, 2023, at the Maria Sylvia Nunes Theater in the Docas of Belém, Pará, Brazil.

The I Conference for the Amazon We Want aimed to foster dialogue among distinguished members from various sectors of Paraense and Amazonian society, including policymakers, academia, civil society members, the private and financial sectors, and representatives from the executive, legislative, and judicial bodies. The objective was to promote the advancement of science and sustainable development in the Amazon and to gather suggestions of priority themes and actions for the SPA to consider in the development of its Strategic Plan for the 2023-2025 period.

In the lobby of the Maria Sylvia Nunes theater, ongoing and completed scientific works by students from many Amazonian Universities were showcased as posters in the style of scientific conferences. These posters covered various topics, including biodiversity conservation and threats, the new socio-bioeconomy of healthy standing forests and flowing rivers, the crucial role of Indigenous Peoples and local communities in sustainable forest management, and many other relevant subjects. The poster exhibition served as part of the SPA's key strategy to engage Amazonian youth in science and conservation.

The conference was attended by 484 individuals in person and 50 individuals online and included the participation of notable national and state authorities. Engagement with these stakeholders helped advance the SPA's work to provide state-of-the-art, policy-relevant science and knowledge about the Amazon region.

Carlos A. Nobre
Marielos Peña-Claros
Co-Chairs of the Science Panel for the Amazon

EDITOR'S NOTE

The Abstract Book of the I Conference for the Amazon We Want presents 43 abstracts of scientific projects produced by students, professors, researchers, and Indigenous leaders dedicated to advancing scientific knowledge as a foundation for actions aimed at the conservation and pursuit of sustainable socio-economic and ecological solutions for the Amazon region.

The abstracts are organized into three distinct chapters.

Chapter 1 presents 14 abstracts covering scientific knowledge related to Amazon conservation. These abstracts encompass a range of topics, from predictive modeling of aquatic insect species distribution to conservation initiatives for species like the Amazonian manatee (*Trichechus inunguis* and *Trichechus manatus*), turtles (*Podocnemis* spp), and other species of Amazonian biodiversity. It is worth noting that some of these studies were conducted in areas of significant conservation importance within the Amazon, such as Jamanxim National Park and Saracá-Taquera National Forest. The abstracts underscore knowledge gaps that must be addressed and provide solutions to enhance understanding and integrate databases.

Chapter 2 presents 9 abstracts that explore threats to Amazonian biodiversity and ecosystems. These threats include land-use changes, zoonotic pathogens in Araguaia river dolphins (*Inia araguaiaensis*), the invasion of aquatic macrophytes (*Urochloa arrecta* and *Nymphaea caerulea*), contamination resulting from rudimentary gold mining methods in artisanal mines, and the population status of the *Isogomphodon oxyrhynchus* shark in the oceanic region at the mouth of the Amazon river. Deforestation, greenhouse gas emissions, and hydrometeorological risks are also addressed in the abstracts. Some describe field observations that identify negative interactions between native species and wastewater from domestic sewage discharged into rivers.

Chapter 3 presents 20 abstracts offering solutions for the sustainable development of the Amazon. These abstracts outline various projects being developed in the Amazon, primarily focusing on nature-based solutions. They cover a wide range of topics, from creating animal feed products using cassava and its derivatives to identifying microorganisms in native cocoa almonds from the floodplain islands of the lower Tocantins. Some abstracts also assess the conservation status of the surroundings of the Sororó Indigenous Territory in Pará, exploring the food culture of the Suruí-Aikewára ethnic group.

Other abstracts from Chapter 3 focus on bioproducts derived from cyanobacteria, fungi, and natural oils, as well as strategies for river and stream protection through environmental education. These sustainable development efforts also highlight native plants of the region, such as açaí (*Euterpe* spp), bacaba (*Oenocarpus bacaba*), brazil nut (*Bertholletia excelsa*), and cocoa (*Theobroma cacao*), as nature-based solutions to achieve the Sustainable Development Goals in the Amazon region.

We thank all the students and researchers from educational and research institutions who dedicated themselves to presenting their work at this conference. The knowledge in these 43 scientific abstracts reflects a deep collective commitment to the conservation of the Amazon. These initiatives bring hope for a resilient Amazon, underscoring the importance of continuous dedication to developing the Amazon that we all want.

Julia Arieira
Diego Oliveira Brandão
Members of the Technical-Scientific Secretariat
of the Science Panel for the Amazon

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CHAPTER ONE:
AMAZON CONSERVATION

THE IMPORTANCE OF SCIENTIFIC KNOWLEDGE FOR THE CONSERVATION OF THE AMAZON: PREDICTIVE MODELING OF DISTRIBUTION OF EPHEMEROPTERA SPECIES

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ABSTRACT

The Amazon has some areas unknown to science that are superimposed on anthropic activities that change the climate and threaten the environment and its biodiversity. Understanding the responses of species to climate change is one of the pertinent questions of today. Thus, it is fundamental to point out gaps in knowledge and conservation in the Amazon, predict the distribution of relevant species and bioindicators, and confirm theories quickly and efficiently in an effort to optimize financial resources and scarce labor in Brazil. We will be able to keep the Amazon mega-diverse in terms of flora and fauna and ecosystem services, aiming at a sustainable balance, efficient conservation, and restoration of important areas. Species Distribution Modeling (SDM) is one of the tools that predicts the distribution of species by combining their occurrence with predictive environmental variables and/or their characteristics, through algorithms that generate suitability models for their survival or permanence. In this work, we show the results of scientific advancements made through SDM. One result identified that only 5% of the Amazon was investigated for the study of Ephemeroptera, one of the orders of aquatic insects most used in the biomonitoring of aquatic ecosystems and an order that can be easily extrapolated to other orders. Another finding demonstrated that there are species with a restricted distribution located in unprotected areas, such as the Arc of Deforestation, making them threatened. This work also shows that there are more relevant areas for future scientific studies, with high potential richness and low sampling effort. Additional findings of this work include that smaller organisms of the order Ephemeroptera face less pressure from the effects of climate change because their dispersion is facilitated by the wind and larger organisms present a loss in their areas of suitability. Finally, smaller ephemerals showed greater niche breadth, suggesting that these species are habitat generalists, whereas larger species showed a restricted niche, suggesting that they are specialized habitat groups. Our study highlights the importance of intensifying studies of Ephemeroptera in the Brazilian Amazon and how climate change and anthropic impacts alter the distribution of species.

Keywords: Mayfly, Wallacean shortfalls, Aquatic ecosystems, Sampling effort.

MANATEE CONSERVATION: A GENETIC AND EVOLUTIONARY APPROACH IN THE AMAZON REGION

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ABSTRACT

Studies on the conservation of aquatic vertebrate biodiversity, specifically endangered species such as the Amazonian manatee (*Trichechus inunguis*) and the West Indian manatee (*Trichechus manatus*) and their genetic status, can help in the development of conservation plan management and recovery actions. Cytogenetics is essential for assessing the chromosomal stability of these species and can provide insight into the viability of hybrid manatees in nature. In addition, although there have been advances in genetic analysis with these species' genetic markers of neutral evolution, analyses by integrated biotechniques such as conservation genomics and cytogenomics can provide a clearer view of the similarities and differences between these two species, in addition to revealing how functional genes may be being impacted by population reduction. The advanced cytogenomic study of these aquatic vertebrates will be pivotal in the North region. By focusing on studying chromosomal painting and repetitive DNA in hybrids— which are likely involved in the structural and functional organization of the genome, acting in gene regulation, replication, and DNA repair—the possibility of these factors also strongly influencing the evolutionary process of their host emerged. The movement of these elements can promote structural changes that would lead to events such as chromosomal rearrangements, changes in gene regulation patterns, and the generation of genetic variability. All of these elements play a fundamental role in the evolution of genes and in the genomic structure of manatees, thus generating accurate biological information. It is expected that the data obtained can show an important genetic dimension of these aquatic vertebrate species, but this data is rarely used today in the conservation efforts of these species in the Amazon.

Keywords: Mammals, Sirenians, Biodiversity, Genetic approach.

AMAZON FISH CONSERVATION: CYTOGENOMIC ADVANCES

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ABSTRACT

Amazonian fish are recognized for their abundant richness and are considered an excellent model for studies focused on biodiversity and evolution. The neotropical region is home to many fish families, including *Loricariidae* and *Cichlidae*, and the Amazon contains a wide range of genera and species. Many of these fish are of great economic importance either for their consumption in subsistence fishing or for their commercial value as ornamental fish. Many of these species have been suffering from the harmful effects caused by anthropic actions in their habitats, such as predatory fishing, illegal trafficking, and the construction of hydroelectric power plants. Due to the great diversity of species, many species are lost before they can be studied. Cytogenetics has become an important tool for the study of fish species and genera and provides vital information about their evolution, speciation, and taxonomy. It also provides better measures of species identification and conservation. Several cytogenetic studies of fish seek to understand the macro and micro structural chromosome evolution, using classical (C- banding) and molecular (fluorescence in situ hybridization (FISH)) techniques to identify heterochromatin regions and sexual chromosomes, map repetitive sequences, and indicate the presence of chromosomal rearrangements, which contributes to a better understanding of Amazonian biodiversity.

Keywords: Fish, Amazonian Ichthyofauna, Biodiversity, molecular cytogenetics.

CONSERVATION OF AMAZONIAN TURTLES: CYTOGENOMIC ADVANCES

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ABSTRACT

Repetitive DNAs are made up of similar sequences, classified in eukaryotic genomes into coding and non-coding. These highly repetitive sequences can be arranged in blocks or dispersed throughout the genome. Among the repetitive DNAs, the multigenic family of histones stands out. Histone genes contain sequences responsible for encoding 5 types of proteins—H1, H2A, H2B, H3, and H4—which are involved in important cellular roles such as transcription regulation, formation of heterochromatin, and DNA repair. These sequences can be mapped in the karyotypes of eukaryotic organisms and, through the analysis of their distribution patterns and behavior, corroborate evolutionary studies and feedback regulation for genome functionality. In this context, the present work aims to study the genomic dynamics of chelonians through the physical mapping of histone sequences H2A, H2B, and H4 in the karyotype of *Podocnemis unifilis* (PUN) and *Podocnemis expansa* (PEX) through fluorescence in situ hybridization (FISH). FISHs were performed following protocols found in the literature. Signals were detected with avidin-CY3, and chromosomes were counterstained with DAPI with Vectashield Antifade Mounting Medium and analyzed in a Zeiss epifluorescence microscope equipped with capture software. It was possible to observe that both species have a conserved diploid number (2n=28), with variation in the fundamental number (NF), with PEX displaying NF=50, while PUN has NF=46. The FISHs showed clusters of H2A located in the centromeric region of the pairs 1, 2, 3, 4, 5, 6, 7, 8, and 11 in PUN and pairs 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, and 14 in PEX. Histone H2B sequences are also clustered in the centromeric regions at pairs 1, 2, 3, 4, 5, 6, and 7 in PUN and pairs 1, 2, 6, 10, 11, and 12 in PEX. H4 histone sequences were observed mainly in clusters in the centromeric region of pairs 1, 2, 3, 6, 8, and 10 in PUN, with multiple clusters in pairs 4 and 5, while in PEX, clusters were detected in pairs 1, 2, 3, 4, 5, 7, 8, and 9.

Keywords: Chelonians, Repetitive sequences, Multigene.

REDUCING BIODIVERSITY GAPS IN THE STATE OF PARÁ

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ABSTRACT

Knowing and understanding what structures and maintains the high diversity of species in highly threatened tropical regions, such as the Amazon, is of fundamental importance. Tropical forests, when preserved, are valuable for maintaining ecosystem services. Therefore, understanding the distribution and structure of local biodiversity allows for incorporating measures that consider sustainable development in territorial management decision-making. In light of this, this proposal evaluates the biodiversity of aquatic insects, macrophytes, and fish in 83 streams with the following objectives: (i) reducing gaps in taxonomic knowledge and the distribution of fish, aquatic insects, and macrophytes; (ii) assessing the environmental, spatial, and biogeographic factors that influence the distribution of these organisms; (iii) describing potential new species; (iv) identifying endemic species and their distribution areas; and (v) estimating vulnerability to anthropogenic impacts. The study is being conducted in the municipalities of Altamira, Santarém, and Oriximiná, which represent significant gaps in the biological knowledge of the state of Pará. Biological collections were made within and outside the boundaries of the Amazon National Park and Jamanxim National Park, as well as in the Saracá- Taquera National Forest. So far, fish, macrophytes, and aquatic insects (Ephemeroptera, Plecoptera, and Trichoptera (EPT); Hemiptera; and Odonata) have been sampled in 83 streams, with 49 within conservation units and 34 in the surrounding areas. This information has been added to data from 347 other streams, creating a database that currently includes 430 streams in the Brazilian Amazon. For the EPT group, 6,345 individuals distributed across 63 genera have been identified. Of this total, 39 genera belong to Ephemeroptera, 3 to Plecoptera, and 21 to Trichoptera, with the genus Amazonatolica representing a new record for Trichoptera in Pará. In addition, a possible new record is the macrophyte species Heteranthera zosterifolia (under review). Other studies are ongoing, including the effects of deforestation on aquatic biodiversity; the effects of environmental selection and the dispersal of aquatic insect metacommunities in different ecoregions of the Amazon; the structure of distribution patterns of aquatic insect metacommunities from both taxonomic and functional perspectives; the effect of land use on the functional characteristics of EPT assembly in the Eastern Amazon; and the application of more predictive biotic indices of community structure and functioning (functional groups) to demonstrate environmental changes in the Amazon.

Keywords: Biodiversity, Aquatic insects, Macrophytes, Fish, Amazon.

DISTRIBUTION OF SAPROPHAGOUS FLIES (DIPTERA: CALLIPHORIDAE, MESEMBRINELLIDAE, AND SARCOPHAGIDAE) IN THE BRAZILIAN AMAZON: WHERE IS SAMPLING MISSING?

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ABSTRACT

The Amazon has great biodiversity and environmental complexity, and it often undergoes environmental changes. Saprophagous flies are sensitive to conservation and maintenance of the environment, recycling nutrients and reducing exposure to decaying waste. In the Brazilian Amazon, there are knowledge gaps about these species and potential ways to promote their conservation. To maintain the dynamics of the Amazon's ecosystem, it is important to identify the consequences of anthropic changes on its diversity, making it essential to determine the gaps in knowledge of its fauna. We compiled occurrence records of Calliphoridae, Mesembrinellidae, and Sarcophagidae from the Brazilian Amazon obtained from a literature review, an authors' database, a partnership with other research groups (MPEG, UFAC, and INPA), and digital platforms (GBIF, SpeciesLink, and Sibbr). We compiled 92,149 occurrence records from 324 sampled locations in the Brazilian Amazon. We detected that the distribution of records has taxonomic, spatial, and temporal bias. Only Calliphoridae represents 82% (n=75,194) of the database, followed by 10% (n=9,478) of Mesembrinellidae and 8% (n=7,477) of Sarcophagidae. The highest number of records was observed in Amazonas (n=67,207), Pará (n=15,706), and Amapá (n=6,361). The largest knowledge gaps were in Tocantins (n=1) and Roraima (n=61). We also identified that the largest gap of studied places is also in Tocantins (n=1). The records date from the past 100 years, with more than 75% of the data between 1999 and 2009. Thus, we show distribution patterns and knowledge gaps of three families of saprophagous flies collected over the past 100 years in the Brazilian Amazon. We emphasize that great efforts are still needed to overcome the challenges related to research biases and to improve our knowledge about biodiversity, especially in more remote and difficult-to-access areas that have much potential for conservation. We also hope to increase our database, making it more consolidated and contributing to the reduction of gaps, as well as pointing out the priorities and paths that can be followed in the coming years.

Keywords: Amazon rainforest, Knowledge gaps, Calliphorids, Mesembrinellids, Sarcophagids.

DOWNDRAFTS AND SURFACE OZONE INCREASES ABOVE THE AMAZON REGION

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ABSTRACT

Approximately two-thirds of the global precipitation that occurs in tropical regions is mainly caused by deep convection and is associated with Mesoscale Convective Systems (MCS). MCS occurs in all regions of Brazil. These are clusters of storms that self-organize into systems that move for several hours, causing heavy rain, strong winds, and, often, hail. In tropical regions, especially in the Amazon, deep convection events are closely related to the occurrence of updrafts and downdrafts. The downdrafts, or strong downward air movements, originate at high levels and are composed of a layer of cold, dense air that spreads over the ground as a “cold pool,” causing a change in wind direction near the ground. Downdrafts are the link between deep convection and the sources and sinks of trace gasses such as ozone (O_3). The presence of strong convective activities in the Amazon region and their downdrafts generally produce changes in O_3 close to the surface. Data collected during the GoAmazon experiment, carried out between 2014 and 2015 in the city of Manacapurú-AM, in central Amazonia, was analyzed. Of the 73 episodes of downdrafts analyzed, it was observed that approximately 50% of them presented a superficial increase in O_3. However, the other 50% were not related to increases in O_3. In some cases, there was even a reduction in O_3. Through reanalysis data Era5, it was found that during the occurrence of downdrafts, the origin of the increase or decrease of O_3 close to the surface was associated with the concentration of O_3 in the air parcels located in the middle and upper troposphere.

Keywords: Amazon, Convection, Ozone.

EFFECTS OF RIVER BREEZE ON GAS TRANSPORT IN THE CENTRAL AMAZON

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ABSTRACT

River breezes occur regularly along the Amazon River, but little is known about their effects on air pollution. During the first week of August 2014, river breeze events were observed for two days on the banks of the Rio Negro, in the Central Amazon. The WRF- Chem model was used to analyze this period to understand the formation mechanism and the influence of the river breeze on the transport of pollutants, such as ozone (O3) and carbon monoxide (CO). We show that the river breeze occurred due to a reduction in easterly winds associated with the cooling of the air temperature over the Rio Negro. The river breeze inhibited the transport of pollutants to the east, increasing their concentrations in some areas due to recirculation of these gasses on the riverbank where the breeze was associated. The strongest breeze occurred in a forest region that maintained the highest concentrations of CO and O_3 on the east bank of the Negro River. In the urban region, the breeze was less intense and had a shorter duration, but it still managed to maintain higher concentrations of CO and O_3 in the western region of the city of Manaus. Manaus is a predominantly residential region, meaning that the population of this region lives in an environment more polluted during the occurrence of breezes.

Keywords: Amazonia, River breezes, Gas transport, Recirculation zones.

SAMPLING EFFORT AND INFORMATION GAPS FOR DRAGONFLIES (ODONATA) IN THE AMAZON

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ABSTRACT

The Amazon has some of the world's greatest species diversity and has been heavily impacted by human activities. The order Odonata presents a high potential for monitoring human impacts on forest ecosystems. Understanding more about their basic biology is important for predicting possible scenarios in the Amazon. Therefore, our objectives were: (i) to quantify the spatial and temporal sampling coverage of inventories in the Amazon region and (ii) to create a database of dragonflies occurring in the Brazilian Amazon. We compiled occurrence records of odonate species for the Neotropical region and subsequently applied a protocol to exclude records with potential errors. We conducted an active search for information on behavior, thermoregulation, geographic distribution, and habitats/habits of both stages in the scientific literature (books and articles) available in the databases Web of Science and Google Scholar. We constructed and provided a functional matrix with information extracted from eight major functional groups which, together, totalled 68 traits for 218 species. We checked 419 papers, 22 morphological traits of about 2,500 adult odonate species, and over 40,000 classified geographic records. Additionally, the distribution of Odonata records in the Neotropical region is spatially concentrated in certain regions. Of the total 1,057 cells, only 448 contained significant records. Furthermore, research in the Amazon region increased over time, with a significant change in the 2000s, specifically in the last decade. We attribute these results to the increase in universities and research centers. However, we emphasize that there are still considerable gaps in large forest remnants in the region. We believe that the data deficiency in these locations is related to low accessibility and financial limitations. We also point out an alarming lack of information regarding Amazonian dragonflies, especially regarding thermoregulation and larval habits, which severely limits research on the order and its relationship to the preservation of the Amazon forest.

Keywords: Data quality, Spatial bias, Database, Functional, Trait.

LARGE TREES OF THE AMAZON: RELATIONSHIPS BETWEEN CARBON STOCKS, SPECIES RICHNESS, AND TIMBER STOCKS

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ABSTRACT

Large trees in tropical forests are important for carbon stock and climate regulation. Using forest inventory data (DBH≥50 cm) from 10 logging sites in the Amazon, this study sought to evaluate the following: a) the minimum area for biomass sampling, b) the relationship between species richness and carbon stocks, and c) the minimum area suitable for biomass sampling. The relationship between species richness and carbon and wood stocks was evaluated using linear regression analysis. To evaluate the minimum sampling area, we created virtual plots ranging from 1 ha to 150 ha and calculated the coefficient of variation (CV%) of the average biomass per hectare (Mg ha- 1). The results indicated that the minimum area suitable for sampling large-tree biomass was 30 ha (CV<10%). Species richness was positively associated with biomass (r^2=0.53; $p<0.01$) and wood stocks (r^2=0.30; $p<0.01$). Our results indicate that species richness can be a good predictor of carbon and wood stocks in the Amazonian forest.

Keywords: Tropical forests, Biomass sampling, Species richness, Carbon stocks, Amazon region.

IMAGES IN RED: HYPERSPECTRAL IMAGES IN NEAR-INFRARED (HSI-NIR) AS A TOOL FOR BIODIVERSITY STUDIES IN THE AMAZON

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ABSTRACT

Hyperspectral imaging cameras have wide applications in several areas of science, including remote monitoring, detection, and quantification of bioactive molecules in medicines and foods, among others. The images resulting from these cameras are called hyperspectral images. They are a particular type of image in which a continuous spectrum is measured (in units of wavelengths or wavenumbers) for each of its pixels. These images layer to form a cube, the “hypercube,” where each pixel represents a spectral measurement from one or more hundreds of channels of the camera sensor, with each channel responsible for detecting a region of the electromagnetic spectrum. A hyperspectral image is a visual representation of an object as a function of a particular region of the electromagnetic radiation spectrum. When these technologies operate in the near-infrared range (between 750 and 2500 nm), the radiation is strong enough to change the molecular vibrational energy state. This allows for qualitative and quantitative information to be obtained in the form of a spectrum from the unique interaction between different molecules and near-infrared radiation. Therefore, it is possible to characterize samples from the spectral profiles of chemical compounds present in the samples, and how the compounds are distributed. With this technology’s advantages and potential applications, insects can be imaged to find unique spectral profiles of each species and/or different hierarchical ranks. With chemometric and multivariate statistical tools, it is possible to generate classification and predictive models of different categories—in this case, species. Thus, this work aims to use near-infrared hyperspectral imaging technology to trace the spectral profiles of the metabolites present in the cuticles of Amazonian insects to generate classification models capable of rapidly identifying them. The target insects of this work belong to the orders Orthoptera (grasshoppers, crickets, and katydids) and Hemiptera (true bugs, cicadas, and aphids). With the images, a calibrated hyperspectral database is being created to ensure rapid identification of the studied insects.

Keywords: Integrative taxonomy, Chemotaxonomy, Metabolomics, Chemometrics.

EVALUATION OF *CYP$_{85}$A$_2$*, *BZR1* AND *CAD1* GENES IN CADMIUM ATTENUATION IN SEEDLINGS OF THE SPECIES Schizolobium parahyba var. Amazonicum (Huber ex Ducke) Barneby (PARICÁ) IN DIFFERENT CONCENTRATIONS OF 24-EPIBRASSINOLIDE

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ABSTRACT

The Amazonian species Paricá (*Schizolobium parahyba* var. *Amazonicum* (Huber ex Ducke) Barneby), native to the Amazon, demonstrates bioaccumulation characteristics related to cadmium (Cd) ions. However, the lack of understanding of the gene regulation in interactions between Cd and phytoregulatory mechanisms, which act in different parts of the plant, such as leaves and roots, represents a challenge in understanding gene regulation's role and relevance in ecology, specifically in the rehabilitation of degraded areas. Therefore, the present work seeks to examine the expression of the *CYP85A2* and *BZR1* genes, precursors of endogenous 24-EBL, in the production of chelating proteins by the *CAD1* gene, under different concentrations of CdCl2 and 24-EBL. The study took place in an air-conditioned growth room, following a completely randomized experimental design (DIC) in a 4x3 factorial scheme, totaling 60 experimental units containing 15 seeds per replication and 4 CdCl2 treatments (0, 50, 100, and 150 µM); the other three treatments consisted of different doses of 24-epibrassinolide (0, 20, and 40 nM). For gene expression, 50 mg of tissue was selected from each part of the seedlings (leaflet and root), and the remainder of the tissue was used to quantify photosynthetic pigments. Then, total RNA was extracted, quantified, and purified in the laboratory for molecular diagnosis of the *CYP85A2*, *BZR1*, and *CAD1* genes through real-time PCR. The data were subjected to ANOVA analysis of variance ($p<0.05$), and the differences between treatments were analyzed using the Tukey test ($p<0.05$). The relative expression levels of the *CYP85A2*, *BZR1*, and *CAD1* genes were significantly ($p<0.05$), statistically higher in the aerial part with the 50 µM CdCl2 treatments at different doses of 24-EBL (0, 20, and 40 nM), in comparison to the root system. The spectrophotometry results of photosynthetic pigments showed an excellent percentage at doses of 50 µM CdCl2 in 24-EBL (0, 20, and 40 nM), but at high doses of CdCl2 (100 and 150 µM) there is a great influence of 20 and 40 nM of 24-EBPL on leaflets. Biometric variables contribute to an increase in the aerial part and a reduction in roots due to the harmful effect of CdCl2 on the substrate.

Keywords: Phytoremediation, Molecular biology, 24-epiBL, Bioregulation.

TO WHAT DEGREE ARE THE BIOLOGICAL COMMUNITIES OF AMAZON STREAMS HETEROGENEOUS?

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ABSTRACT

The Amazon basin has continental proportions—covering about 7,500,000 km2—but most of its watercourses consist of small streams. These streams harbor a rich fauna of diverse groups of organisms, including fish, plants, and invertebrates. The objective of this work was to verify how different (heterogeneous) the biological communities of Amazonian streams are at different spatial scales. For this, we used the fauna of aquatic insects (orders Ephemeroptera, Plecoptera, and Trichoptera, or EPT) as a model group. We sampled streams from different regions of the Brazilian Amazon (41 streams in total, in four regions). In each stream, we carried out a standardized sampling, collecting 20 sample units. To analyze the data, we used the additive partitioning of beta diversity (Greek symbol "β"), which is the name given to the variation in species composition between different locations. Thus, we consider a hierarchical experimental design covering the following spatial scales: variation between sample units (β1), variation between streams (β2), and variation between regions (β3) of the Amazon. The highest value of beta diversity was observed between regions (β3 contributed with 37.50% of the total richness of the study), followed by beta diversity between streams (β2 corresponded to 29.64% of the total richness) and by beta diversity between sampling units (β1 corresponded to 25.18% of the total richness). The observed diversity patterns suggest that factors such as habitat diversity within streams, environmental variation between streams, and even spatial and biogeographical factors, such as geographic distance between regions, may be contributing to the increase in aquatic insect biodiversity in Amazonian streams. Our results indicate the importance of targeting strategies aimed at multiple spatial levels, considering the variation in diversity that occurs within streams, between streams, and, above all, between different regions in the Amazon.

Keywords: Beta diversity, Aquatic insects, Biodiversity conservation.

‘SYNBIAM’: SYNTHESIS OF AMAZONIAN BIODIVERSITY

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ABSTRACT

The Amazon plays a crucial role in international strategies to mitigate the global climate and biodiversity crises. Its ecosystems are among the world’s most biodiverse, and it benefits the environment at different spatial scales. However, multiple anthropogenic and climatic disturbances are threatening Amazonian biodiversity and ecosystems. Our ability to conduct synthesis research aimed at understanding the patterns and drivers of Amazonian biodiversity—and to transpose results from the scientific frontier to applications in society—is limited by several challenges. Most biodiversity databases (global and national) focus on terrestrial flora and vertebrate fauna. Most also only include species occurrence data, and/or do not have technological tools that integrate and standardize data from different sources and studies. In addition, most studies of Amazonian biodiversity focus on specific taxa and/or regions, without integrating aquatic and terrestrial ecosystems and/or assessing the ecological impacts of multiple disturbances. The INCT-SinBiAm will establish a transdisciplinary and inter-institutional network of synthesis research on Amazonian terrestrial and aquatic biodiversity, enabling the continuity of efforts initiated through the Synergize Project funded by Sinbiose/CNPq. SinBiAm will produce highly relevant outcomes for decision-making and will strengthen associated laboratories inside and outside the large urban centers of the North Region in Brazil. Through the compilation, organization, and synthesis of previously collected data—as well as different educational and scientific dissemination actions—SinBiAm (1) will bring scientific and technological advances; (2) will guide future research, practices, and public policies; and (3) will provide training for the future generations of decision-makers, educators, and scientists from, and working in, the Amazon.

Keywords: Biodiversity, Research synthesis, Aquatic and terrestrial ecosystems, Collaborative networks, Databases.

CHAPTER TWO:

THREATS TO AMAZONIAN BIODIVERSITY AND ECOSYSTEMS

LAND USE CHANGES IN THE AMAZON AND THEIR IMPACTS ON CARBON STOCK AND GREENHOUSE GAS EMISSIONS

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ABSTRACT

Brazil stands out among the biggest emitters of greenhouse gasses, which are often associated with land use change. Among the main gasses emitted into the atmosphere, nitrous oxide (N2O) has a high warming potential, accelerating climate change. In light of this, it is essential to use agricultural practices that increase the absorption of carbon (C) by the soil. Thus, the objective of this work was to estimate the carbon stock in different land uses and their N2O emissions, when subjected to temperature rise. Two experiments were conducted. In the first, a set of four soil samples was collected at each of three land uses (forest, pasture [black pepper], and agriculture) at each of eight depths (0–5, 5–10, 10– 20, 20–30, 30–40, 40–60, 60–80, and 80–100 cm deep). Using the samples, the organic carbon content of the soil was evaluated. In the second experiment, soil samples (0–20 cm) were collected. Soil incubation was carried out in a completely randomized 3x4 design, with three land use systems (forest, pasture, and agriculture) and four incubation temperatures (25, 30, 35, and 40 °C). From this, the soil N2O emissions were determined. The concentration of C was lower in the agriculture system ($p<0.05$), regardless of the evaluated depth. The pasture soil had lower C concentration than the forest only in the superficial layers (0–20 cm). N2O emissions were dependent on land use and temperature. A quadratic effect of emissions on pasture soils was observed, increasing up to the temperature of 35°C, with a drop occurring at 40°C. In agricultural soils, a linear effect was observed, where emissions were higher at 25°C and lower at 40°C. Comparing between systems, agricultural soil emitted more N2O than other soils, regardless of temperature. Agricultural soils store less C and emit more N2O into the atmosphere, while pasture and forest soils show proportional relationships.

Keywords: Agriculture, Arc of deforestation in the Amazon, Forest, Nitrous oxide, Livestock.

PHYSIOLOGICAL PARAMETERS AND RISK ANALYSIS FOR ZOONOTIC PATHOGENS IN ARAGUAIA RIVER DOLPHINS (*Inia araguaiaensis*) UNDER ENVIRONMENTAL IMPACTS IN THE CONTEXT OF ONE HEALTH

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ABSTRACT

The Araguaia river dolphin (*Inia araguaiaensis*) is an endemic Brazilian aquatic mammal, described in 2014, present in the Araguaia-Tocantins Basin. The genus Inia has a history of approximation and interaction with humans throughout the Amazon, which may trigger the risk of transmission of zoonotic agents. This study is being conducted in two towns in the Lower Tocantins River, Mocajuba and Cametá, where there is a history of interactions between humans/tourists and river dolphins dating back approximately 30 years. The animals come into contact with untreated wastewater from domestic sewage, which is drained into the river, as well as direct contact with tourists who caress and feed the dolphins. The objective of this study is to assess the health status of these animals, through hematological, biochemical, ultrasound, and hormonal analyses, in addition to the occurrence of pathogens with zoonotic potential (enteric viruses, Salmonella spp. *Staphylococcus aureus*, Leptospira spp., Cryptosporidium spp., and Toxoplasma gondii) in animals and wastewater and propose public policies aimed at implementing biosecurity measures for tourists and residents. Additionally, phenotypic and genotypic analyses will be performed to determine the presence of super-resistant bacteria to antimicrobials in bacterial isolates from dolphins and wastewater. So far, two pilot expeditions have been carried out, totaling 14 days of sampling effort, to collect biological material of dolphins' breaths and blows. These samples will undergo the extraction of cortisol and DHEAS. A total of 70 blow samples from 12 individuals—five adult females, two juvenile females, one adult male, two juvenile males, and two male calves— were collected. The first tests for the hormone extraction protocol were already conducted in order to verify the most efficient approach. The other matrices and analyses will be collected in the first semester of 2023. This proposal has a scientific and social impact, and, based on the results, it is intended to estimate the association of microorganisms present in wastewater with those detected in target animals.

Keywords: Araguaia river dolphin, One health, Hpa axis, Single health.

AUTOMATED MAPPING OF FOREST LOSS FROM 1988 TO 2023

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ABSTRACT

Forest loss, especially in the Amazon region, is one of the main environmental problems the world currently faces. With increasing demand for agricultural, logging, and mining products, forest degradation has been both accelerated and disorderly, generating significant impacts on biodiversity, biogeochemical cycles, climate, and the quality of life of local communities. To combat this problem, it is necessary to adopt effective control and monitoring measures that allow for the identification of the main deforestation hotspots and the evaluation of the effectiveness of enforcement and protection actions. In this sense, the creation of an automated and consistent monitoring system can be an essential tool for observing the evolution of this loss and implementing more efficient public policies in forest management. This system should encompass various types of forest removal, from logging to conversion for agricultural activities, and use advanced remote sensing and data processing technologies to generate accurate and updated information about deforestation. With an integrated and participatory approach, it is possible to build a monitoring model that involves civil society, environmental organizations, companies, and governments, ensuring more sustainable and responsible forest management.

Keywords: Mapping, Forest loss, Time series, Google Earth Engine.

HYDROMETEOROLOGICAL RISK IN THE COASTAL ZONE OF PARÁ: ENVIRONMENTAL DYNAMICS AND LAND OCCUPATION IN VIGIA DE NAZARÉ-PA, BRAZIL

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ABSTRACT

The town of Vigia de Nazaré, in the northeast of Pará, Brazil, is located in the coastal zone of Pará and sits on the lower levels of the regional terraces. The coastal zone is part of the continental estuarine sector, a coast protected from the action of sea waves and coastal drift. In this context, the city experienced new stages in its socio-spatial formation as the Amazon urbanized, culminating in the problem analyzed here: The annexation of fluviomarine plains—showing aspects of environmental degradation and hydro-morphodynamic alterations—into urban spaces, where several families, most of whom experience social vulnerability, settled. The objective of this work was to understand the occupation process in the city of Vigia, mainly in the floodplain area, as well as the seasonal dynamics of hydrometeorological phenomena. For the analysis, a bibliographic survey was carried out on hydro-morphodynamic aspects of the continental estuarine sector of the coastal zone of Pará (ZCP). An exploratory statistical analysis and quantile analyses of precipitation data, the tide forecast, the history of land occupation from 1988 to 2020, and the definition of the fluvial-marine plain were also conducted; the latter two analyses were performed using images from a high- resolution satellite and aerial footage from a drone, respectively. The results showed considerable accumulated annual precipitation for the region—above 300 mm on average—with a well-defined rainy season lasting from January to May; the macrotidal environment compounds these results, with the semidiurnal tide reaching 4.4 meters in the rainy season. In 2022, 60 records of tides equal or above 4.2 meters were verified, a level of local concern when coinciding with rain. The recent occupation, from 1970-1980, took place mostly in the morphological level of lower altimetry and intense environmental dynamics, the fluviomarine plain. The results show that risk is evident and socially constructed by these processes and that it is also the result of political and institutional negligence. This is yet another study that exposes the context of risks experienced in urban centers in the coastal zone of Pará and expresses the need for actions to over-mitigate and adapt to hydrometeorological risks.

Keywords: Hydrometeorological risk, Floodplain, Tide, Inundation, Risk construction.

BIOLOGICAL INVASION IMPACTS BIODIVERSITY: THE CASE OF AQUATIC MACROPHYTES

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ABSTRACT

Alien species are organisms that are brought to a new place, one in which they are not native. In this territory, they have no predators, no competitors, and no difficulty establishing themselves. However, not every alien species is considered invasive; only those that are able to spread quickly and easily upon arrival in a new ecosystem—to the point of threatening native species, modifying habitats, and affecting biodiversity—achieve the status of invasive alien species. These species are a threat to global biodiversity. Globalization has allowed various species to cross continents via ships and airplanes, and humans have played a clear role in facilitating the introduction of invasive species. This exchange comes at a cost, including the spread of disease, the loss of ecosystem services (e.g., drinking water), and the loss of biodiversity, in particular. It is estimated that just aquatic invasions alone have cost the global economy about $345 billion. With the conversion of forests into land use areas, several alien species have already established themselves in the Amazon, which is worrisome. In this study, we highlight the invasive macrophytes *Urochloa arrecta* and *Nymphaea caeruleax*, which inhabit aquatic environments. These plants can physically alter the habitat around them, such as through competing with and excluding native species, which results in a great loss of species diversity in these habitats. This results in the loss of fauna associated with aquatic plants, such as insects and fish, and the proliferation of species that can increase risks to human life. *Urochloa arrecta* is worth mentioning; it was first recorded in the state of Pará in 2017, but in biodiversity studies performed by UFPA, we observed that it is already present in several streams in the region. Its ability to quickly become well-established is worrisome. Thus, we want, through scientific research and public policies, to publicize the presence and promote the monitoring and control of the organisms that are invading our biome, so we can uphold global biodiversity and ecosystem maintenance.

Keywords: Alien species, Monitoring, Management, Amazon.

EFFECT OF ANTHROPIC ACTIVITIES ON AMAZON BIODIVERSITY

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ABSTRACT

Multiple anthropic activities, including burning, grazing, logging, mining, and agriculture, among others, without proper management, result in the modification of aquatic and terrestrial ecosystems' physical characteristics, a loss of biodiversity, and the reduction of ecosystem services. These isolated or joint activities, on small or large scales, contribute to the disorderly deforestation of the landscape. The accumulated rate of deforestation in the Brazilian Legal Amazon between 1988 and 2020 is approximately 41,341.325 km^2. The state of Pará accounts for approximately 38% of this total (15,766,700 km^2) and continues to show the highest rates of forest loss among the states of the Brazilian Legal Amazon. In the past 20 years, deforestation, both in the Legal Amazon and in the state of Pará, was highest between the years 2001 and 2003. With this change in the landscape, aquatic species such as insects, fish, and macrophytes are under constant threat of extinction and replacement by species more tolerant to environmental changes. Scientific results show that the richness, abundance, and composition of aquatic and terrestrial species have been decreasing with the increased deforestation caused by human activity. However, aquatic ecosystems are still studied less than terrestrial systems. Thus, we want to equip an Amazon for the future that undergoes fewer environmental changes affecting aquatic and terrestrial ecosystems; narrow knowledge gaps about aquatic biodiversity and its ecosystem services; implement a temporal monitoring program for aquatic biodiversity in the Amazon; highlight the importance of including the state of aquatic biodiversity in studies of environmental impacts and in the implementation of monitoring programs by medium and large enterprises; and establish actions for sustainable city development and resource use. The data obtained from these efforts will be essential for identifying directive actions to restore the landscape.

Keywords: Deforestation, Aquatic species, Amazon.

USE OF INDICATORS TO ASSESS THE RESIDUAL EFFECTS OF WATER AND NUTRIENT MANIPULATION IN A TROPICAL FOREST

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ABSTRACT

Shifting agriculture contributes to the supply of local businesses in the Amazon and guarantees the subsistence and income of small producers. However, the activity also contributes to the emission of greenhouse gasses due to the use of fire to clean the area and the consequent interruption of biogeochemical cycles. Shifting agriculture intensifies the expansion of secondary forests, which currently corresponds to 280 million hectares worldwide. Therefore, understanding the factors that affect the dynamics of these ecosystems is essential for establishing conservation and restoration strategies, especially in the Amazon. The project "Manipulation of Water and Nutrients in Secondary Forests in the Eastern Amazon," for example, found effects of irrigation on decomposition rates and the impairment of nutrient removal via litter for root biomass after eight years of water and nutrient management (1999-2007). However, little is known about the possible long-term effects of resource management. Thus, more than a decade after the project's conclusion, we sought to answer the question: Are the residual effects of the manipulation of water and nutrients still perceptible on the floristic composition and plant structure 12 years after the end of an experiment on the manipulation of water and nutrients? Our objective was to evaluate, through indicators, the residual effects of the manipulation of water and nutrients in a secondary tropical forest. We compared the density of species and individuals, plotted a rarefaction curve, and performed a non-metric multidimensional scale (nMDS) analysis. Species density ranged from 212.50 ± 92.42 sp ha^{-1} to 275.00 ± 88.98 sp ha^{-1} for REM and IRR, respectively. The density of individuals ranged from 531.25 ± 159.92 ind. ha^{-1} to 712.50 ± 510.51 ind. ha^{-1} for REM and CTL, respectively. However, for both cases, the ANOVA ($p>0.05$) showed that there was no statistical difference between treatments. The nMDS showed the similarity between the treatments. Thus, the results indicated the absence of residual effects, demonstrating the resilience capacity of the ecosystem and the optimization of resources in tropical forests.

Keywords: Secondary forest, Forest structure, Shifting agriculture.

CONTAMINATION BY RARE EARTH ELEMENTS IN GOLD MINING AREAS IN THE EASTERN AMAZON

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ABSTRACT

Gold (Au) is exploited using rudimentary methods in several artisanal mines in the Amazon; these rudimentary methods generate residues that can harm the ecosystem and public health, also known as pollution by rare earth elements (REEs). The objectives were to determine the concentrations and risks of REEs in areas altered by artisanal Au mining in the southeast and northeast of the Amazon. The areas in the southeast of the region referred to the zone of influence of the Serra Pelada artisanal mine, located in the municipality of Curionópolis, in the state of Pará, and included agricultural, urban, mining, and native forest areas. In the northeast Amazon, the areas corresponded to artisanal Au mines in Cachoeira do Piriá, in the state of Pará, where miners use methods such as underground exploration, reprocessing by cyanidation, and surface colluvial mining. Samples were collected and subjected to chemical and granulometric characterization. The concentrations of REEs were quantified by inductively coupled plasma mass spectrometry. In general, the properties showed marked differences between non-anthropic areas and altered areas, which had lower levels of organic matter and less acidity. Most REEs had higher concentrations in anthropized areas when compared to reference areas. The most alarming contamination factors were observed for lanthanum (La) and yttrium (Y) in agricultural areas in Serra Pelada, and for cerium (Ce), europium (Eu), La, neodymium (Nd), praseodymium (Pr), samarium (Sm), and scandium (Sc) in the underground and cyanidation mining areas in Cachoeira do Piriá. The highest enrichment factors were observed for Y in Serra Pelada, ranging from 18.2 to 44.4, and for Ce, La, Nd, Pr, and Sc in Cachoeira do Piriá, ranging from 5.5 to
20. The ecological risks from individual exposure to REEs were low in all areas studied, but simultaneous exposure was associated with risks ranging from moderate (167.3) to high (365.7) in Cachoeira do Piriá. Health risks for adults and children have not been detected. The results indicate that mitigation measures must be implemented to protect the environment from the impacts of REEs in altered areas.

Keywords: Serra Pelada, Cachoeira do Piriá, Emerging pollutants, Pollution indices, Ecological risks.

MOLECULAR ASSESSMENT OF THE TAXONOMIC AND POPULATION STATUS OF A CRITICALLY ENDANGERED FISHERY RESOURCE: *Isogomphodon oxyrhynchus* (Valenciennes, 1839)

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ABSTRACT

On the north coast of Brazil, few studies cover the fishing activity of elasmobranchs. The lack of studies contributes to the decline of these animals; shark populations already have a low productivity when compared to teleosts due to different life strategies, resulting in low sustainability in their fishing and consequently generating possible economic collapse. The duck shark (*Isogomphodon oxyrhynchus*, Muller and Henle, 1839) is a memorable example of this overexploitation. Among the studies involving the genus *Isogomphodon*, very few directly address phylogenetic and population relationships. *I. oxyrhynchus* is a species of elasmobranch endemic to the Amazon coast. Not only does it have one of the smallest areas of occurrence among sharks, but its stock also suffered a great population decline in recent years due to fishing activities. This species was removed from the genus *Carcharhinus* due to its peculiar characteristics, including a long, triangular, and narrow dorsoventral snout and very small eyes. However, the other characteristics of this species are of a typical member of *Carcharhinus*, including the absence of spiracles, presence of a precaudal groove, a second dorsal fin that is much smaller than the first, and viviparity. The aim of this study will be to evaluate the phylogenetic relationships of the monotypic genus *Isogomphodon* with the other genera of the *Carcharhinidae* family through nuclear (RAG 1 - 1110 bp) and mitochondrial (12S-16s, Citb, ND2, and ND4 - 3315 bp) fragments. In addition to determining its population status through molecular evaluation of the species, this work aims to analyze issues such as genetic variability and distribution area, among others, in order to generate information about the genus' real status in relation to fishing exploitation.

Keywords: North Coast, Fishing resources, Endemic species, overfishing.

CHAPTER THREE:

SOLUTIONS FOR THE SUSTAINABLE DEVELOPMENT OF THE AMAZON

DEVELOPMENT OF PRODUCTS FOR ANIMAL FEED FROM CASSAVA AND ITS DERIVATIVES

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ABSTRACT

Cassava is one of the crops that meets all criteria for sustainability. Due to its economic importance, it can contribute to the social development of local producers and other supply chains. Cassava processing generates some byproducts, including cassava peel. Instead of being a pollutant discarded in the environment, cassava peel can become a value-added product. This study aimed to develop products for animal feed using byproducts from the cultivation and processing of cassava and evaluate the productive and economic impacts of its use on rural properties, contributing to sustainable development in the Amazon. A trial was carried out to evaluate fresh cassava peel compared to cassava peel silage. The progress of technology development was evaluated using the Technology Readiness Level (TRL) scale. A good fermentation profile of cassava peel silage was observed, and it was found that ensiling is effective at preserving the chemical composition of this byproduct, especially the non-fibrous carbohydrate content. Currently, the technology is already at level 9 on the TRL scale. It was possible to develop a product that can partially or completely replace corn in ruminant diets using the cassava peel byproduct. Further research aimed at creating other products can contribute to improving cassava uses and animal production chains, both of which can have positive impacts on local communities and ecosystems.

Keywords: Amazon, Byproducts, Cassava peel, Silage, Sustainability.

IDENTIFICATION OF MICROORGANISMS IN NATIVE COCOA BEANS (THEOBROMA CACAO) FROM THE FLOODPLAIN ISLANDS OF THE BAIXO TOCANTINS REGION DURING THE FERMENTATION PROCESS

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ABSTRACT

The eastern Amazon, in the state of Pará, has the largest diversity and variety of cacao in the world. To produce quality chocolate, it is very important to have quality beans for the primary processing stage, which includes the harvesting, breaking, fermentation, and drying of the cacao beans (before they become chocolate). In the primary processing stage, fermentation is the most important step for obtaining a quality chocolate with the desired flavor and color, according to the literature. Fermentation occurs due to microorganisms already present in the cacao beans from instruments used in earlier stages, including the cacao beans' general environment, the equipment used to break the fruit, and the box used for fermentation. These microorganisms are divided into yeasts, lactic acid bacteria, and acetic acid bacteria. Each one has a function in the fermentation process, helping to create cocoa with better flavor. Yeasts are important because they generally initiate fermentation and help break down the pulp that covers the almonds, transforming the sugar into alcohol and initiating alcoholic fermentation, the first stage of the process. In the second stage, the yeast colonies decrease and acetic acid bacteria, which carry out the transformation of alcohol into acetic acid, increase. This stage is marked by a characteristic vinegar odor and an increase in temperature. Finally, there is an increase in the lactic acid bacteria colonies, which had been present since the beginning of fermentation, and the acetic acid bacteria colonies, which leave the pulp and enter the seed, thus fermenting the inside of the cotyledons and making it more acidic. The increase in temperature causes the death of the cacao embryo, one of the last stages of fermentation. At the conclusion of these processes, the beans gain the familiar dark color of chocolate beans. This study aims to isolate and identify—through morphology and molecular biology—the microorganisms present in the fermentation process. These microorganisms come from troughs on the island of Tauaré, one of the floodplain islands in the municipality of Mocajuba, state of Pará. Through this study, we seek to understand why the different types of microorganisms increase and decrease over the course of the fermentation process and in different fermentation troughs.

Keywords: Bioeconomy, Bacteria, Yeasts, Fermentation.

PRIMARY PROCESSING, PHYSICAL AND BIOCHEMICAL TRANSFORMATION OF NATIVE COCOA SEEDS (THEOBROMA CACAO) INTO COCOA BEANS AND CHOCOLATE: FLAVOR DEVELOPMENT

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ABSTRACT

The state of Pará has the greatest diversity and variety of cocoa in the world, with the potential to produce excellent chocolate. The native cacao tree grows along rivers and their tributaries; in these areas, there is the formation of *várzea* forests, which contribute to the maintenance of water resources and biodiversity. *Várzea* cocoa is related to global climate change, sustainable food production alternatives, new technological possibilities, and innovation. Chocolate is a product widely consumed around the world due to its exquisite taste. This flavor depends on a few controlled variables, including the genotype and the agroecological niche, and on two independent variables: the harvest and post- harvest operations. These operations entail (1) the transformation of cacao beans into cocoa beans, which involves pre-conditioning, fermentation, and drying of the cacao beans, and (2) the production of chocolate from cocoa beans. Thus, this research presents an overview of cocoa harvest and post-harvest operations, the variables and phenomena that influence and control the physical and biochemical transformation of seeds into cocoa beans, and their relationship with the formation of chocolate flavor. In addition, research perspectives are discussed in terms of the control and management of harvest and post-harvest (primary) practices, in order to obtain cocoa with differentiated and special characteristics, making it one of the best sustainable agricultural alternatives for family farming in the Amazon.

Keywords: Bioeconomy, Floodplain cocoa, Fermentation, Amazon Rainforest, Sustainability.

SORORÓ INDIGENOUS LAND (PARÁ, BRAZIL/AMAZONIA): STATUS OF CONSERVATION OF ITS SURROUNDINGS (1985-2020) AND BIODIVERSITY ASSOCIATED WITH THE FOOD CULTURE OF THE SURUÍ-AIKEWÁRA ETHNICITY

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ABSTRACT

Deforestation and fires have been one of the main threats to the conservation of biodiversity in the Amazon. Indigenous Lands (ILs) are the territories that most contribute to the maintenance of the socio-environmental and cultural heritage in the Legal Amazon. The objective of this research was to evaluate (1) the conservation status of the surroundings of the Sororó IL (Southeast Pará, Brazil) between the years 1985 and 2020 and (2) the biodiversity associated with the food culture of the Suruí-Aikewára ethnic group, which has adopted an ancestral practice of food preparation called "*moqueio*." The research involved a transdisciplinary research method—uniting knowledge and expertise—to investigate the sociobiogeodiversity of an Indigenous territory and its inhabitants' contributions to sustainable development in the Legal Amazon. The first stage of research consisted of processing Landsat satellite images from Google Earth Engine (GEE) using the random forest classification algorithm combined with the IBGE cartographic base. Five land use and cover classes were adopted: forest, secondary vegetation, hydrography, exposed soil, and mining. In addition, cartographic bases of the Sororó IL and an inventory of biological diversity associated with the food culture of the Suruí-Aikewara people were integrated, adopting ethical practices for procedures involving humans and traditional knowledge and based on the co-participation of Indigenous peoples as subjects of search. The results indicate that even with the continuous process of desertification—resulting from deforestation and the destruction of springs—faced in the past three decades around the Sororó IL, the Suruí-Aikewára people maintain traditional subsistence practices in their daily lives. These practices include *moqueio*, or roasting meat or fish on the *moquém*. It is a technique widely practiced in Brazil, originating among Indigenous populations that inhabited the coast and other areas of pre-European South America. In this way, the deforestation and fires that occur in the southeastern region of the state of Pará— in the region surrounding the Sororó Indigenous reserve, in particular—are threats that transcend the impact on the field of biogeodiversity; they become threats to the

maintenance of the sociocultural heritage of Indigenous peoples., that remains alive in the present day in the practices of the Suruí- Aikewara Indigenous Peoples. They make use of forest resources, including hunting, fishing, and, above all, wood resources, for the handmade production of the *moqueador*, which is exemplified here by the *moquém*. This research was nominated for the "Sororó Indigenous Lands" award, an Environmental, Social, and Governance (ESG) initiative, and recognized internationally in 2023 with the certification of the "Nobel Prize of Amazonia" ("United Earth Amazonia Award"), the new legacy of the Nobel family that is also known as the Green Nobel or Nobel Sustainability Prize and that is based on the same values as the Nobel Peace Prize.

Keywords: Suruí-Aikewara, Deforestation, Biodiversity, Moquem, ESG.

AMAZONIAN CYANOBACTERIAL BIOPRODUCTS AND THEIR POTENTIAL APPLICATIONS IN BIOREFINERIES

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ABSTRACT

Cyanobacteria have the potential to produce a broad range of compounds, which can be used or processed into biomaterials through biorefineries. These bacteria can be considered a renewable resource for producing biofuels, paints, bioplastics, fatty acids, proteins, and vitamins. They exhibit high productivity, low competition with food sources, and sustainable production, requiring only a minimal amount of arable land and little or no potable water. Thus, they are raw materials with high potential to drive the development of a bioeconomy.

Keywords: Cyanobacteria, Biorefineries, Bioproducts, Amazon.

BIOREFINERY AS A TRANSFORMATIVE TOOL FOR SOCIETY IN THE AMAZON

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ABSTRACT

Finding sustainable alternatives to petroleum—which is a source of several indispensable inputs for human life, including fuels, plastics, and fundamental chemical platforms—is essential. Studying vegetable oils, butters, and waste generated from various economic activities, such as fruit pulp and oleochemical industries, as renewable raw materials is one solution. This is crucial for establishing and/or strengthening several productive chains in the state of Pará. In the Amazon, there is significant quantity and diversity of mining and agro- industrial waste, which is comprised of lignocellulosic biomass. These waste materials can be studied for their potential role in biorefinery, which involves transforming them into valuable products such as adsorbents, (photo)catalysts, biofuels, bioplastics, and other chemical products that are of interest to various industrial sectors. The UFPA Catalysis and Oleochemistry Group, in collaboration with industries, cooperatives, and family farmer communities, has been researching bioproducts and various residues resulting from important economic activities in the Amazonian context, including lignocellulosic, fatty, and mineral waste. These waste materials could represent a promising alternative for creating a bioeconomic environment in various productive chains in Pará, promoting a technological revolution in our state. The goal is to generate higher value-added products from “waste” and create job and income opportunities for thousands of Pará residents.

Keywords: Biorefinery, Waste, Lignocellulose, Bioproducts, Bioeconomy.

STRATEGIES FOR PROTECTING THE RIVERS AND STREAMS OF THE AMAZON: ENVIRONMENTAL EDUCATION AND BIOTECHNOLOGY

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ABSTRACT

Socio-environmental issues have gained increasing attention from international players and have become a mandatory topic in the world economic agenda. For this reason, they are important variables for any initiative related to the Amazon region. Amazonian rivers and streams comprise an important part of the global environment, and their degradation impacts the entire environmental system, mangroves, and dryland areas, in addition to representing a health risk for riverside populations and local communities. Liquid effluent volumes of around 0.25 m^3 were determined for each kg of sample, reaching free cyanide contents of 62.5 mg/m^3. According to Brazilian legislation, for each liter of effluent discharged into water bodies, the maximum value allowed is 0.2 mg/L HCN (0.0002 mg/m^3). The use of bacteria *Bacillus pumilus*, *Bacillus subtilis*, *Pseudomonas pseudoalcaligenes*, and *Pseudomonas putida* has shown great potential in the bioremediation of cyanide in aquatic environments. Therefore, the microorganisms present in aquatic environments contaminated by effluents from the cassava process can provide biotechnological solutions for their recovery; they can also be applied as a biotechnological innovation for industries that require treatment of their effluents. The aim of this study is to evaluate the use of metaproteomics in cassava production effluents, their environmental impact, and methods of bioremediation. This technique is expected to be promising in understanding the distribution, abundance, and behavior of bacteria in natural environments, as well as their ecological role and their ability to adapt to environmental changes.

Keywords: Bacteria, Bioremediation, Effluents, Cassava, Metaproteomics.

THE SCIENCE AND TECHNOLOGY OF FOOD IN THE GENERATION OF BIODIVERSITY PRODUCTS AND INGREDIENTS: THE AMAZON WE WANT

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ABSTRACT

Raw materials from the Amazonian biodiversity are partially valued, generate waste, and compromise the environment and the income of local communities. With the conscious application of food science and technology, opportunities to use fully valued Amazonian raw materials are expanded. These opportunities are based on knowledge of the chemical composition, properties, and appropriate care for each material. Ingredients for different productive sectors can be obtained from fruit parts discarded in the production process. This work presents a bioeconomy scenario based on the full use of the raw materials bacuri, camu-camu, cupuaçu, soursop, guarana, and mangosteen. These materials serve as examples of opportunities for innovation for income generation and waste minimization by using technologies compatible with the capabilities of the producing communities.

Keywords: Food waste, Reuse, New ingredients, Innovation, Bioeconomy.

MAPPING BYPRODUCTS GENERATED BY THE BRAZILIAN AMAZON FOOD INDUSTRY

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ABSTRACT

The Brazilian Legal Amazon brings together nine Brazilian states to better plan socioeconomic development in the Amazon region. The Legal Amazon comprises about 61% of Brazilian territory, and it contains the main agricultural producers and exporters. Agro-industrial processing consists of generating products from raw materials. However, there is also the production of items that are commonly discarded or underutilized, such as waste and byproducts (residual biomass). Considering the environmental impact and the panorama of food insecurity in developing countries, valorization or a reduction in the generation of byproducts present an opportunity to overcome these issues. Nevertheless, there is no systematization of data in Brazil that qualitatively and quantitatively describes the byproducts generated by the food industry. Therefore, the aim of this research is to map the main food production chains to identify and estimate the byproducts generated by the agro-industry from vegetal biomass in the Legal Amazon. In general, the most abundant waste or byproduct was sugarcane bagasse (8.17 Mt), mainly due to the contribution of the state of Mato Grosso (6.13 Mt). Nonetheless, we observed a significant quantity and diversity of byproducts, especially in the state of Pará. The quantitatively most evident residual biomasses in this state were, in descending order, manipueira (1.15 Mt), wet cocoa pod (1.01 Mt), açai seed (1.046 Mt) and palm stalks (0.48 Mt), representing about 68% of the total production of residual biomass in the state. In addition, the total estimated production of all wastes and byproducts in the year 2018 for the state of Pará represents approximately 82.5% of the quantity of *in natura* banana produced throughout the country in the same year. Despite the expressive numbers, there is an ineffective use of byproducts, where a large portion of the waste produced is destined for underutilization as animal feed and organic fertilizer. The data provided will help governments take the initial step toward a sustainable agro-industry (food industry) in the Amazon and demand specific investments for key productive chains in the region.

Keywords: Food waste, Valorization, Circular economy.

VALORIZATION AND PROSPECTION OF AMAZONIAN FUNGI FOR FOOD BIOTECHNOLOGY

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ABSTRACT

The Amazon region, due to its biodiversity, presents several potential sources for the isolation of microorganisms of industrial interest. Among the various groups of microorganisms are yeasts and filamentous fungi, which have been the target of prospecting studies due to their efficiency in producing extracellular enzymes that show great potential for industrial applications. In this context, the enzyme market is stimulated to continuously search for new enzyme-producing microorganisms. In the investigation of these microorganisms, they appear as part of a natural microbiota on the fruits of typical Amazonian palm trees, such as bacaba (*Oenocarpus bacaba*). These trees may prove to be important sources of microorganisms that produce lipases (triacylglycerol-acyl hydrolases, EC 3.1.1.3). Lipases belong to the family of serine hydrolases, and their main function is to catalyze the total or partial hydrolysis of triacylglycerol, releasing diacylglycerol, monoacylglycerol, glycerol, and free fatty acids. Lipases can also catalyze synthetic reactions, such as esterification and interesterification (transesterification, alcoholysis, and acidolysis). Microbial lipases are characterized by high specificity and stability in their reactions, which give them an industrial prominence in multiple areas, including wastewater treatment, bioremediation, biofuels, food, cosmetics, flavoring, pharmaceuticals, and fine chemicals. In the food industry, lipases can be used to modify oils and fats and to change the sensory characteristics of foods, among other functions. In addition, they are used to obtain essential fatty acids, such as linoleic acid and α- linolenic acid. Thus, one of the lines of investigation of the Biotechnological Processes Laboratory/ITEC/UFPA research group is the prospection, isolation, selection, and identification of filamentous fungi-producing enzymes with lipolytic activities from bacaba fruits. Molecular biology, proteomics, and secretome tools will be used in optimized cultures. Immobilization studies of microbial lipases and application in the hydrolysis of Amazonian vegetable oils to obtain polyunsaturated fatty acids will also be a strategy to add value to Amazonian raw materials.

Keywords: Filamentous fungi, *Oenocarpus bacaba*, Microbial lipase, Proteomics polyunsaturated fatty acids.

SOIL RECOVERY AND SUSTAINABLE PRODUCTION THROUGH SOIL REMINERALIZATION IN PARÁ

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ABSTRACT

Rockfill, qualified by the incorporation of ground rock and/or minerals into the soil, is a technology that can enable the granulometric recovery and sustainable fertilization of agricultural soils. The state of Pará presents enormous potential for growth in the application of this technology because it is considered the second- largest national producer of ore. The present challenge in the growth of this activity is the still-low investment in technology, as well as a lack of experimentation with different rock type formulations to enable continued fertility for soil recovery to enable sustainable and low-cost agricultural production. The objective of this work is to identify and test different rock potentials that meet the criteria of the rock technology for use as soil remineralizer for sustainable agriculture in Pará. The study area encompassed the largest agricultural production municipalities of Pará, represented by Acará, São Domingos do Capim, Viseu, Aurora do Pará, Santa Maria do Pará, Moju, Ipixuna do Pará, and Bragança. To evaluate the potentiality and availability of the rocks, maps were generated according to the data made available by CPRM and IBGE, with the help of the QGIS 2.8.1 program. The lithological analysis of the eight municipalities resulted in 20 different rocks with eight types of minerals, mostly composed of macronutrients (potassium, phosphorus, calcium, and magnesium) and micronutrients (iron and manganese). The use of rock powder for soil fertilization may become a new sustainable practice in Pará, with social and economic gains. The disclosure of this new technological route, through recommended agricultural experiments that prove the positive effect on soil using rock dust, will be of great value to Pará agriculture and the agricultural and business communities. Such practices will result in the expansion of investments in the sector, consequently increasing working capital and reducing costs in agricultural cultivation. From an environmental perspective, agricultural cultivation would become more sustainable; degraded areas would be reduced or recovered more quickly; and waste from mining companies would be reused.

Keywords: Stonework, Sustainability, Agricultural land.

THE AMAZON BIOME AS AN INEXHAUSTIBLE SOURCE OF HEALTH: MEDICINAL PLANTS AS A FOCUS FOR NEW PHARMACOLOGICAL DISCOVERIES

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ABSTRACT

Medicinal plants and their therapeutic capacity are the “treasure” of the Amazon and are present in traditional medicine, existing before modern medicine. This summary aims to compile the scientific studies of the Laboratory of Pharmacology of Inflammation and Behavior (LAFICO) and emphasize the importance of studies with Amazonian species in the discovery of possible pharmacological activities. LAFICO has several studies with botanical species that aim to identify pharmacological properties, including anti-inflammatory action, antinociceptive action, and therapeutic effects related to neurological functions. Among the botanical species and bioactive compounds studied at LAFICO, *Eupatorium ayapana* (White Japana), *Aniba canelilla* (Rosewood), *Petiveria alliacea* (Mucura), Propolis, Linalool, and *Varronia multispicata* (Maria-Black), among others, stand out. When properly studied, these materials allow for the creation of new herbal resources that can augment current pharmacological therapies. The importance of the Amazon for the development of these studies is of immeasurable value, as this biome presents both a communion of species that have already been tested and many unknown species with possible properties that may be the key to treating various diseases. In this way, the observation, incentive, and investment for the development of these studies open possibilities for more research to be carried out and for new therapeutic properties of Amazonian species to be recognized, which is essential to valuing the richness present in the expansive Amazon.

Keywords: Medicinal plants, Pharmacological activities, Therapies, Amazonian species.

THE AMAZON WE WANT IS... ONE WHERE COMPANIES CONTRIBUTE TO BIODIVERSITY RESEARCH

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ABSTRACT

The Amazon is known for sustaining the greatest biodiversity in the world; however, a portion of this biodiversity is being lost due to deforestation and land use changes, considered one of the main drivers of current global changes. Approximately 7.3 million hectares of the Amazon were deforested between August 2019 and July 2020. Deforestation in the Brazilian Amazon represents about 60% of total global deforestation. With this scenario, if the loss of biodiversity from these activities is not controlled, efforts for long-term sustainable development will not be effective. Many land use practices are considered essential for society as they provide services and products for human subsistence, such as food, water, and energy. As a result, the private sector plays a crucial role in balancing the production of inputs for modern society and environmental preservation. In this panel, we will present the main research products from the partnership between the Institute of Biological Sciences at UFPA and three large private companies in the Amazon, engaged in long-term agriculture, managed logging, and mining activities. What we will present here begins with the establishment of work plans that meet the mission and needs of the University, society, and partner companies. Regarding long-term agricultural activity, using oil palm production as an example, we partnered with Conservation International of Brazil and the company AGROPALMA. The partnership began in 2014 and the first scientific production took place in 2015, assessing the environmental effects on aquatic insects. The partnership continues to this day, with over 15 articles published in high-impact journals that address various biological groups (e.g., birds, stingless bees, amphibians, fish, odonates), habitat assessment, and the perception of traditional communities regarding oil palm cultivation. In terms of managed logging, our partnership was with CIKEL Brazil Verde Madeiras Ltda, and it began in 2015. We have produced six articles and at least four master's and doctoral theses. In the mining sector, our research falls under the BRC (Biodiversity Research Consortium) with Norsk HYDRO, with ongoing execution. So far, 22 articles have been produced, and at least seven theses are in development. It is worth noting that these previously presented works focused on land use as the main aim; however, we have published more than 30 manuscripts covering different land uses and biodiversity in these eight years of research in partnership with companies. The production of articles, in addition to increasing scientific knowledge about the impacts of land use on biodiversity, has at various times involved feedback with companies and society, with results presented to employees, used in annual company reports, and exhibited to the public. Thus, we highlight the importance of partnerships with the private sector for research development in the Amazon, always aiming to improve human well-being and conserve biodiversity.

Keywords: Biodiversity, Amazon, Private companies, Fish, Aquatic insects, Aquatic macrophytes.

ASSESSMENT OF FUNCTIONAL TRAJECTORIES AND THEIR IMPLICATIONS FOR THE RECOVERY OF SECONDARY FORESTS IN THE STATE OF PARÁ

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ABSTRACT

Secondary forests have the potential to mitigate the effects of climate change due to their high carbon sequestration capacity. They represent about 20% of the areas recovering in the Amazon and are the second-largest land use in the state of Pará. To study the ecological strategies of the species and the dynamics of functional recovery in these areas, we can use the morphological, physiological and phenological functional traits that reflect the adaptive efficiency of individuals in response to environmental conditions. Despite the extensive literature on vegetation dynamics in secondary forests in the tropics, there are several gaps in understanding the variation of functional traits between successional stages for the Amazon. Thus, our goal is to evaluate the spectrum of variation of foliar, wood, anatomical, and hydraulic functional traits, as well as their coordination and trade-offs in secondary forest areas in the state of Pará. In addition, we intend to evaluate the importance of edaphic factors and vegetation dynamics rates for the functional recovery of these areas. For this, the selected study area was the Bragantina Region, in the northeast of the state of Pará, using six plots (0.25 ha each) of secondary and mature forest areas with different abandonment ages. We selected the species that contribute to 80% of the above-ground biomass in each area. We collected a set of leaf, wood, anatomical, and hydraulic traits, namely specific leaf area, leaf dry matter content, wood density, vessel diameter, vessel area, lumen fraction, and conductivity loss potentials of 50% and 88%. We will use multivariate analysis of variance to evaluate the variation of traits between areas of different ages and linear models to evaluate trade-offs between functional traits. In this way, we expect to understand the trends in the variation of functional traits and how intense land use may be affecting the rates of functional recovery in secondary forests. Thus, using our conclusions from this proposal, it will be possible to provide forest recovery solutions focused on functional traits and assist decision-making policies at the regional and national levels for the socio-environmental development of and reduction of deforestation in the Amazon.

Keywords: Forest recovery, Environmental gradient, Ecological succession, Amazon.

EVALUATION OF NATURAL OILS AND BIOPRODUCTS WITH POTENTIAL FOR THE AMAZON BIOECONOMY

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ABSTRACT

The use of local biodiversity in the development of bioproducts is a novelty in scientific technology. Bioproducts can be used for innovations in and the sustainable use of renewable biological resources and are promising for the bioeconomy. In vitro analysis is a primordial initial step for advances in production. Based on its results, it can be said whether a bioproduct is cytotoxic, mutagenic, genotoxic, etc., depending on its cell viability. In this study, different bioproducts—such as polymeric biomembranes, used in tissue engineering; biocomposites, used in plastic bags; and polymeric biomembranes with incorporated Amazonian oils—were tested using the MTT assay, which evaluates the cell survival rate. The results verified that the polymeric biomembrane tested did not demonstrate cytotoxicity and had good adherence to cellular experiments, paving the ground for new testing potential. Therefore, the bioproducts are non- toxic and biocompatible.

Keywords: Amazonian oils, Bioeconomy, Biomembrana, Bioproducts.

CITIES, GREEN AREAS, AND ADAPTATION TO CLIMATE CHANGE: A CONTRIBUTION TO THE URBAN ENVIRONMENTAL REGISTRY IN THE MUNICIPALITY OF BARCARENA, IN THE STATE OF PARÁ

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ABSTRACT

The primary research question is understanding how territorial development processes that restructured local spaces and induced forest loss took place in the municipality of Barcarena, in the state of Pará, which is occupied by a large mining industrial port project. To understand this dynamic, bibliographic and cartographic analysis were performed using photographic records from a descriptive character case study based on Vieira (2010), a documentary review, and literature and field observations. The research uses geotechnology techniques, due to the mapping and monitoring methodologies providing Earth's surface data. Thus, the study aims to analyze the land use and cover (UCT) in the years 2000, 2010, and 2020 using data provided by the MapBiomas platform (collection 7), collected in Google Earth Engine and processed in QGIS software, for area calculation, cartographic production, and statistical analysis. In addition, the study will develop the Vegetation Cover Index (ICV), the Vegetation Cover Index per Inhabitant (ICVH), the Green Area Systems, and the Climate Model. The preliminary results of the UCT indicate that the main changes in the study area over 20 years come from the significant reduction in forest formation (455,845 hectares) and the increase of pastures (376,309 ha), urbanized areas (93,120 ha), and mining areas (130,427 ha). Thus, the research indicates that forest formations reduce environmental vulnerabilities and should be considered a strategic instrument because they contribute positively to the environmental quality and quality of life. Green areas are aligned with the 2030 Agenda of the 17 Sustainable Development Goals (specifically, SDGs 11, 13, and 15), the New Urban Agenda, and the Decade of Ecosystem Restoration. Finally, from this study's recommendations, it aims to contribute to the Urban Environmental Registry (CAU) through cartographic representations presented to the managing body, as a subsidy to territorial and sustainable development to assist with the revision of the Master Plan.

Keywords: Territorial planning, Geoprocessing, Use and coverage, Green areas, Urban Environmental Registry.

BIOENERGETIC PROPERTIES AND A PRACTICAL OPENING TECHNOLOGY OF THE BRAZIL NUT

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ABSTRACT

Brazil nut is one of the main non-timber exports from the Amazon. Unfortunately, 85% of the harvested material is actually residue. The Amazon communities that harvest the nuts could benefit from finding an economic use. This work comprises three aims and stages: (i) to review current research and technologies for the sustainable potential of Brazil nut residues, (ii) to evaluate the energy potential of biomass and charcoal from both fresh and degraded Brazil nutshell (BNS) mesocarp, and (iii) to design and produce a device capable of removing the Brazil nuts from the fruit easily. Brazil nut residues are suitable for conversion into many bioproducts and biofuels. However, the current applied method—carbonization— leaves a lot of residues partially carbonized, which decreases BNS market value. This undesired result is mainly because the shape of residues harms carbonization. Because BNS has remarkable physical properties and strength, cutting them into a suitable shape for traditional carbonization is difficult. Therefore, a device has been designed for a quick, safe, and efficient cutting of the BNS for later carbonization without harming the edible nuts. The device is basically a modification of the Miter Saw Vonder Sev857, designed to hold and cut open Brazil nuts. The device was able to cut the shells into equal halves. Fresh BNS mesocarp samples presented a net calorific value of 4,797 kcal/kg and basic density of 1 g/cm^3, while degraded BNS mesocarp samples showed a net calorific value of 4,600 kcal/kg and basic density of 0.84 g/cm^3. Thermogravimetric analysis indicated that fresh and degraded BNS mesocarp samples are suitable for carbonization and have energy potential, but their thermal behavior differed. The charcoal produced at T=400°C from degraded BNS showed 43.2% of volatile matter, 3.5% of ash, and 53.3% of fixed carbon, while fresh samples showed 18.63% of volatile matter, 1.23% of ash, and 80.14% of fixed carbon. It was concluded that degradation in the forest floor decreases the bioenergy potential of Brazil nut shells, specifically by altering their chemistry.

Keywords: Higher calorific value, Bioenergy, Lignocellulose, Pyrolysis, Mechanics, Kinetics.

CACAO TERROIR FROM THE ISLANDS: HOW DO THE CHARACTERISTICS OF FLOODPLAIN SOILS IMPACT THE QUALITY OF CACAO BEANS?

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ABSTRACT

The exploitation of native cocoa (*Theobroma cacao* L.) in the Brazilian Amazon is an agro extractive activity that has been growing rapidly due to the appreciation and demand for the manufacturing of the so-called "wild chocolate." Native cacao trees grow naturally under the canopy of trees in floodplain and island areas. Thus, the purpose of this study was to characterize the physical, chemical, and microbiological properties of the soils of native cacao trees in the state of Pará, in northern Brazil, and to establish a soil quality index. Deformed and undisturbed soil samples were taken (depth 0-0.10 m) in Ilha de Tatuoca, Ilha do Combu, and Comunidade Pacajá, all in the state of Pará. Soils were characterized in terms of chemical properties (pH, organic carbon, P, K, Ca, Mg, Al, potential acidity, sum of bases, cation exchange capacity, and base saturation); physical properties (texture, water content, microporosity, macroporosity, total porosity, textural, residual, structural and total void ratio, effective textural and structural pore diameter, soil density, particle density, and aggregate stability); and microbiological properties (microbial biomass carbon, basal respiration, and microbial density). The biochemical characterization of the microorganisms was carried out (solubilization of phosphorus, production of siderophores, indole acetic acid 3 – AIA, catalase, content of easily extractable glomalin, and total glomalin), and the mass of roots was quantified. The high concentration of organic carbon contributed positively to the results of base sum, cation exchange capacity, and base saturation in soils. Base saturation was greater than 50% in the soils. The soils of the islands of Tatuoca, Combu, and Comunidade Pacajá have silty clay loam, silty loam, and loam texture classes, respectively. The minimum set of data—DMC formed from the analysis of principal components— PCA selected the variables, including pH in water, sum of bases, total porosity, soil density, microbial biomass carbon, and basal respiration as indicators of soil quality under native cacao trees. The soil quality indices were close to 1, indicating the good quality of these soils. Thirteen bacterial isolates produced a characteristic halo of P solubilization in NBRIP medium; 4 produced siderophores; 3 produced AIA; and 23 were positive for catalase. There was a positive correlation between easily extractable glomalin and the mass of aggregates <2 mm in diameter. Total glomalin interacted positively with phosphorus content. Root mass increased with increasing phosphorus content in the soil of Tatuoca Island. The high levels of soil quality linked to native areas are associated with low human intervention and high nutrient cycling. Soils with these characteristics have a high potential to produce cacao beans, the quality of which is linked to its place of origin.

Keywords: Native fruit trees, *Theobroma cacao* L., Soil quality, Microorganisms.

COLLECTION OF MICROORGANISMS WITH POTENTIAL FOR THE DEVELOPMENT OF AGROFORESTRY BIO INPUTS

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ABSTRACT

Soil microbial biodiversity plays a central role in maintaining the Amazon rainforest. In addition to nutrient cycling, microorganisms have pharmacological and nutritional potential, plant growth promoting agents, and pest insect biocontrollers. Global food production needs to be increased to meet the growing world population, but, at the same time, dependence on inorganic fertilizers and pesticides must be minimized. In order to achieve this objective, a research group from the Plant Protection Laboratory of UFRA has been prospecting microorganisms since 2006. These microorganisms were sourced from soils in forest areas—both anthropic and non-anthropic—and cultivated in perennial crops, such as palm trees, cacao, grasses, and forest species. The researchers isolated strains of fungi and bacteria that establish beneficial associations with plants and carry out biocontrol of pests (insects and diseases). The collection of microorganisms was named Maria de Lourdes Duarte Reis and is composed of 865 strains of bacteria, 85 Trichoderma, 10 Metarhizium, 10 Isaria, and 15 Beauveria. Of these, 10 strains of *Trichoderma asperellum* were identified as growth promoters in palm trees and native fruit and forest species. Among the strains of bacteria, the strains of the genus Bacillus stand out as growth promoters, inducers of tolerance to water deficiencies, and biocontrol agents for diseases in plants, such as palm trees, teak, eucalyptus, and cocoa. Among the entomopathogenic fungi, five strains of *Metarhizium anisopliae*, two strains of *Beauveria bassiana*, and two strains of *Purpureocillium lilacinum* stand out. These strains stand out for their efficiency in the management of caterpillars, borers, white flies, aphids, and mites. These results indicate that the bioprospecting of fungi and bacteria in Amazonian soils can unearth increased potential of microorganisms to contribute to biotechnological applications, including the development of bio inputs for sustainable agriculture.

Keywords: Biostimulants, Sustainable development, Plant production.

TRADITIONAL COMPLEMENTARY AND INTEGRATIVE MEDICINES THROUGH THE EYES OF SCIENCE: PHYTOTHERAPY AND AROMATHERAPY IN THE BRAZILIAN UNIFIED HEALTH SYSTEM AS PRACTICES FOR THE TRANSFORMATION OF THE AMAZON

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ABSTRACT

Traditional integrative and complementary medicines, such as phytotherapy and aromatherapy in the unified health system (Sistema Único de Saúde, or SUS), contribute to the restoration process in the Amazon. This work was developed from a brief correlational analysis of the messages of the "Executive Summary - 2021 Amazon Assessment Report of the Scientific Panel for the Amazon" and four themes related to the practice of phytotherapy and aromatherapy. Of the concepts presented, five messages from the executive summary present direct correlations with the themes of the discussion. Even if indirectly, all other messages have effects in this context. It was observed that there is an impact of these practices on the immaterial perspective in the preservation of cultural and economic capital. Amazonian socio-biodiversity is rich and should be valued to generate a collective identity that disseminates the beneficial effects of herbal resources, to also reach non-Amazonian territories. Phytotherapy and aromatherapy should be promoted through public policies—in addition to the use of new production technologies—to strengthen a bioeconomic model based on expanding the production chain, sustainably obtaining resources to process, and developing products with higher purchase values, such as herbal medicines and essential oils, including in SUS applications. This could preserve biodiversity and the national sovereignty of Amazonian populations over their natural resources. Finally, this initiative generates benefits for the community: the improvement of the agrobioeconomy increases the autonomy of local communities and allows them to deal with socioeconomic discrepancies, raise their quality of life, and expand access to lasting services, such as health and education.

Keywords: Traditional medicine, Integrative and complementary medicine, Phytotherapy, Aromatherapy, Amazon, Unified health system, Agrobioeconomics.

Suggested citation:

Nobre, C.A., Peña-Claros, M., Arieira, J., Brandão, D.O., Dias, B., Riveros, F.E.V., Lucas, I.L., Barredo, L., Nascimiento, N., Oz, E., Ribeiro, C., Williams, C., Siqueira, V.L., Topf, J., Arnal, G., Potter, L., Malacuso, A. (Eds.). Abstract Book: I Conference for The Amazon We Want, Belém, Pará, Brazil, March 8, 2023. (2024). Science Panel for the Amazon, United Nations Sustainable Development Solutions Network, New York, USA. Available from https://www.theamazonwewant.org/spa-reports/. DOI: 10.55161/DDHT3138

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