Observations from an Expedition to Costa Rican Peatlands

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ABSTRACT

In July and August of 2023, we visited Costa Rica to examine some of the country's peatlands. The purpose of our trip was to collect peat samples from a variety of wetland habitats from the coast to the highlands for future analysis. We summarize our observations in this short essay.

RESUMEN

En julio y agosto de 2023, visitamos Costa Rica para examinar algunas de las turberas del país. El propósito de nuestro viaje fue recolectar muestras de turba de una variedad de hábitats de humedales desde la costa hasta las tierras altas para análisis futuros. Resumimos nuestras observaciones en este breve artículo.

INTRODUCTION

Across most of Central and South America, the spatial distribution of peatlands has been estimated using probability maps (e.g., Gumbricht et al. 2017, Melton et al. 2022). The large extent of these "potential peatlands" has increased their visibility on the global stage due to their roles in storing carbon, providing habitat for unique species, and mediating water flow (UNEP 2022). However, the difficulty to access these tropical ecosystems have made ground obser-

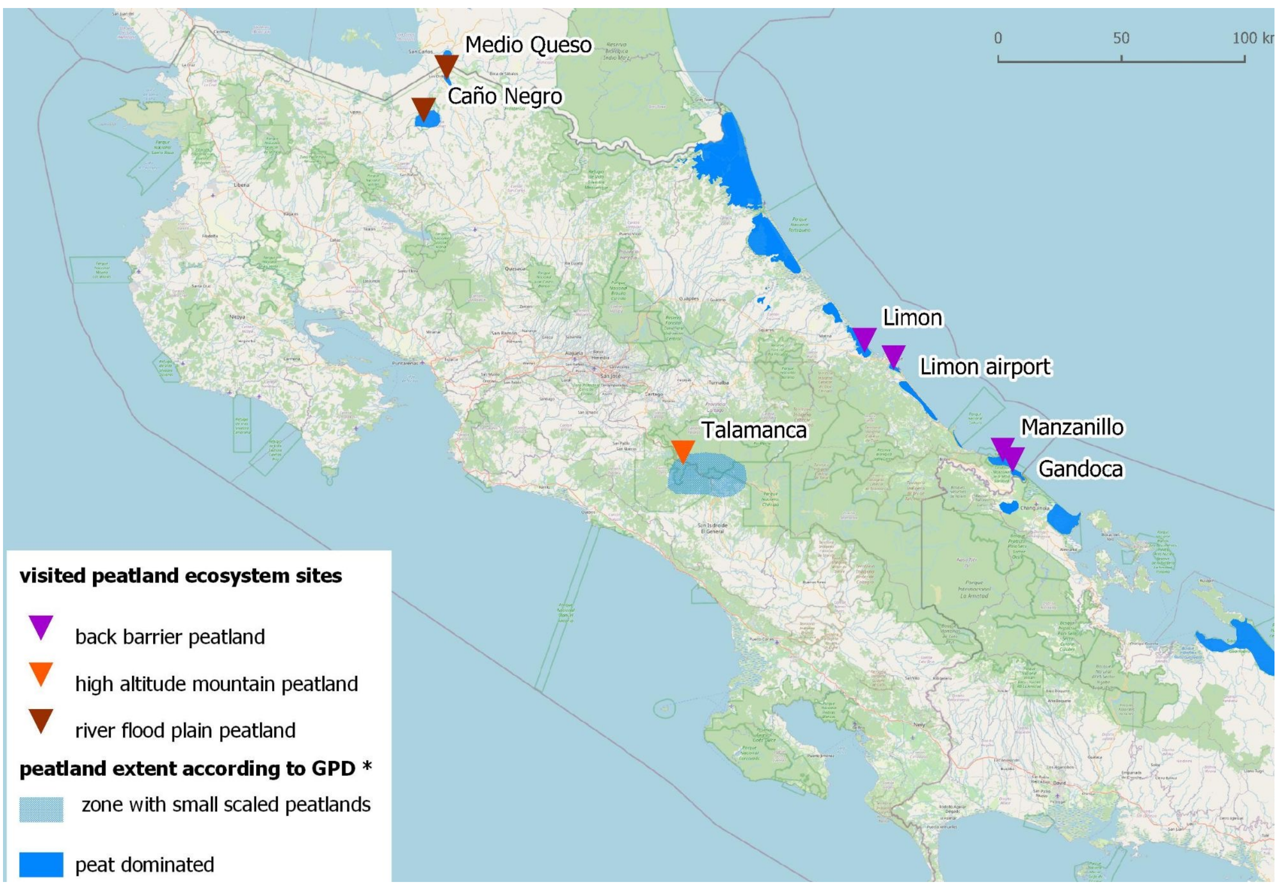

Figure 1. Map showing peatland areas that were visited during our 2023 field expedition across Costa Rica. The Global Peatland Database (GPD) can be viewed here: https://greifswaldmoor.de/global-peatland-database-en.html.

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Figure 2. Caño Negro (10°52’N 84°45’W), a National Wildlife Refuge and Wetland of International Importance (RAMSAR site #541), is home to seven types of wetlands, including (A) this palustrine wetland that serves as habitat for a great number of birds (including endangered ones), and (B) important populations of Caiman (*Caiman crocodilus*). (Photos by Patrick Campbell)

Figure 3. Medio Queso Wetland (11°02’N 84°41’W), a transboundary wetland complex between Costa Rica and Nicaragua, is a riverine peatland (A) characterized by major water level fluctuations throughout the year (>2 m); it is often burned for grazing. We retrieved peat cores (B) along a transect that traverses the western portion of this wetland complex. (Photos by Patrick Campbell and Julie Loisel, respectively)

vations challenging and, as a result, the 'true' location and extent of tropical peatlands still remain highly uncertain in many regions. For these reasons, it has become crucial to gain more knowledge of tropical peatlands distribution, processes, and properties. In July and August 2023, our team of ten students and five scientists ventured across Costa Rica to confirm the presence of peat soils and collect peat samples (Figure 1). With the support of several government officials and guides, we traveled to three regions where the potential for peat had been outlined in national probability maps (Villegas 2018; Peters and Tegetmeyer 2019). Those regions were also selected because they are important for land management purposes and represent common landscape features in Costa Rica and Central America, including high-altitude mountain, river floodplain, and coastal (back-barrier) zones (Cohen et al. 1995).

This study is also relevant to policy development in Costa Rica, which now includes commitments to its Nationally Determined Contributions (NDCs) related to increasing carbon sequestration and/or reducing greenhouse gas (GHG) emissions from terrestrial ecosystems. In addition, by 2030, improved schemes for Payments for Ecosystem Services (PES), which are expected to include soils and peatlands as priorities, should become more widely available and potentially very useful for continuing the wise management of Costa Rica's natural ecosystems. To achieve the aforementioned policy objectives, better knowledge on the distribution and status of national peatlands is key. The new knowledge that will come out of the selected regions and study sites is expected to provide benchmarks to the advancement of the country's NDCs and PES plans.

OUR EXPEDITION

From the coastline to the mountainous páramo, but also across inland lowlands and along rivers, we found peat. Our journey began in the northern portion of the country, in the province of Alajuela, near Lake Nicaragua. The study area is found in the "moist rain forest" zone and the landscape is characterized by large, groundwater-fed wetland complexes that include palustrine wetlands, marshes, riparian forests, and many others (SINAC 2018). We boated across the northern part of the seasonally flooded wetlands in Caño Negro National Wildlife Refuge, a Ramsar Wetland of International Importance. We were advised by the park rangers to visit a few shallow lagoons that were dominated by *Eleocharis equisetoides* and *Scleria microcarpa* (Figure 2A). To our own disbelief, we retrieved peat cores in excess of 200 cm in depth, directly from the boat platform, in waters about 50 cm deep. We also visited an adjacent site, the Medio Queso Wetland (Figure 3A), which is defined as a riparian peatland (Pérez-Castillo et al. 2023). The dominant plant type we encountered there was *Eleocharis interstincta*. This time, our team walked a transect from the valley edge towards the Medio Queso River and retrieved peat cores in excess of 300 cm in depth (Figure 3B). Note that

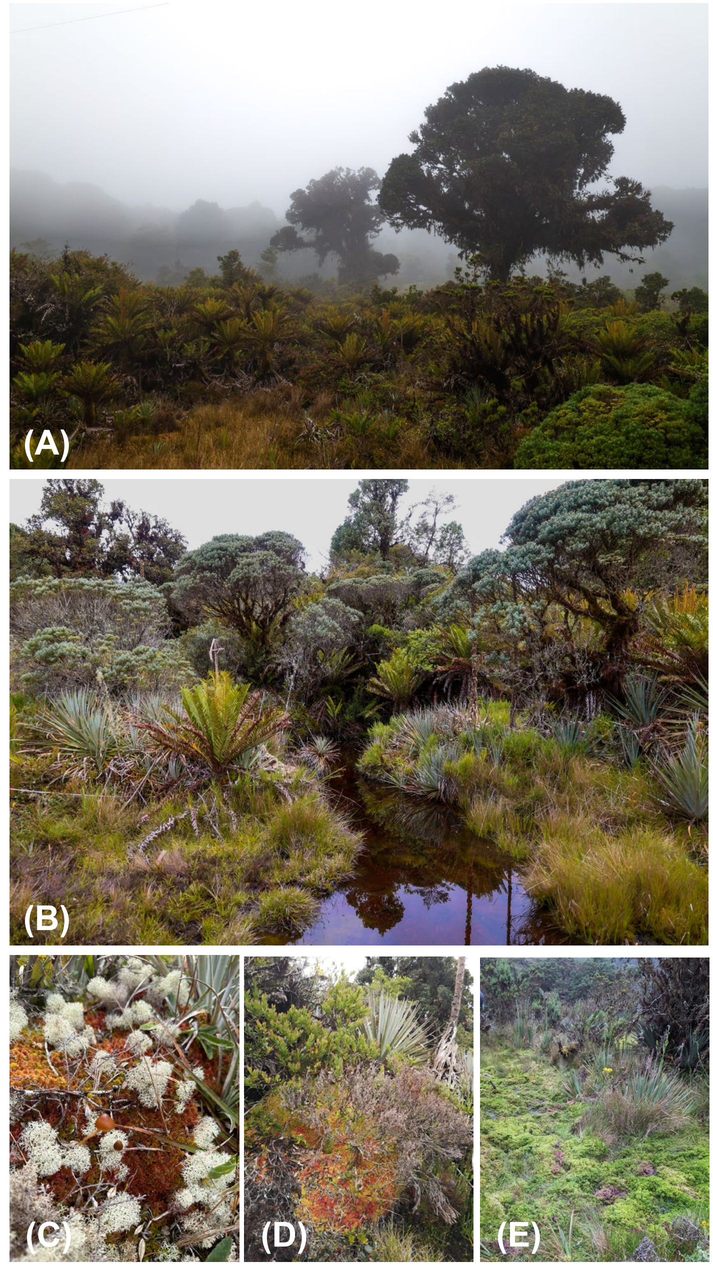

Figure 4. The mountain peat bogs in Costa Rica (9°39'N 83°51'W) are part of the "Turberas de Talamanca" (RAMSAR site #1286). A general view of Bog 68 (A) shows the layered vegetation communities, from the Sphagnum carpet and herbaceous understory to the tall ferns and sparse trees. This closer view of Bog 70 (B) shows surface water coming into the peatland near its lower edge. The behavior of Sphagnum spp. is worth noting. Here (C), it is interspersed with lichen in a similar fashion as in Arctic peatlands. There (D), it grows around the lower portions of shrubs. And lastly, we noted extensive carpets of Sphagnum section cuspidata (E) at Bog 70. (Photos by Patrick Campbell, Nataleigh Perez, Jan Peters, and Hannah Mitchell)

the age, history, and chemistry of these peat soils remain unknown so far, as laboratory analyses will be carried out over the next few years.

The high-elevation peatlands (~ 2750 m.a.s.l.) found in the trans-continental Talamanca Mountains were nothing short of spectacular. We only had time to visit two sites (Bog 68 and Bog 70; Figure 4) along the road that crosses Los Quetzales and Tapantí National Parks. Those two sites

Figure 5. *Yolillal* (peat swamps) along the southern Caribbean coast of Costa Rica (9°35N 82°36'W - 10°02'N 83°08'W). Notably, we visited the Gandoca-Manzanillo National Wildlife Refuge, which is also a wetland of international importance given its habitat for nesting turtles and its high biodiversity, with some endangered and threatened species present (RAMSAR site #783). Many of the coastal sites we visited were only accessible by boat (A); the *Raphia* palms (B) combined with the muddy wet soils made these ecosystems difficult to access and challenging to navigate. (Photos by Patrick Campbell and Andrew Parsekian)

Figure 6. Red mangrove stands along the southern Caribbean coast of Costa Rica (9°35N 82°36'W): (A) - This mangrove forest is located along the Gandoca lagoon and is protected by local land owners, and (B) - Peat cores were collected in the mangrove forest and wells were installed to monitor water level fluctuations. (Photos by Patrick Campbell and Jan Peters)

are also designated as mountain wetlands of high importance by Ramsar, given their position in a large biological corridor and provision of habitat for endemic species. These small peatlands form a mosaic of flat and open vegetation with few bushes and trees (Figures 4A, 4B), within the otherwise steep and dense mountain cloud forest. Notable are the near-continuous *Sphagnum* mosses that carpet these ecosystems (Figure 4C-D), even enclosing shrubs, ferns, and small trees (Figure 4E). Since these peatlands had already been described in the literature (e.g., Jiménez 2016; Ricardo et al. 2022), the goal of our visit there was to collect surface vegetation and peat core samples, rather than to confirm the existence of peat. We collected over 100 cm of peat in depth, which is in line with previous studies.

The trip ended in the *yolillal* (swamp forests) and mangroves of the southern Caribbean coast, where peat was recently described by Peters and Tegetmeyer (2019). These two ecosystems are characterized by low vegetation diversity, with the swamp forests primarily composed of *Raphia taedigera* (palm; Figure 5A) while the mangroves were almost uniquely comprised by *Rhizophora mangle* (Figure 6A). Unlike the open wetlands that we encountered in the north and in the mountains, the coastal peat swamps were difficult to navigate, both in terms of orienting oneself under the darker closed canopy as well as walking through thick, but soft wet peat, while forging a path with machetes (Figure 5B). As for the mangroves, their formidable root systems made exploration on foot a slow (but fun!) process (Figure 6B). Here again, we consistently retrieved long peat cores in the 200- to 300-cm range. With that said, extensive ground truthing walks along the coastline around Gandoca could not confirm peat occurrence in many adjacent areas, even within dominant *Raphia taedigera* stands. The origin and process(es) behind peat initiation and maintenance over time thus remain unclear in this area, but may relate to the geomorphological history given the migrating dynamic of the streams that transect the land. Nevertheless, peat was confirmed in many sectors, including in "Laguna de Manzanillo", which is locally known as a forest swamp (Jiménez 2016). With the support of local park rangers, peat occurrence was confirmed in this sector, after a strenuous mission to the edge of the site. A 250-cm peat core was retrieved for further analysis. Peters and Tegetmeyer (2019) had described this site as a probable peatland complex, but it had not been confirmed until this summer.

FINAL REMARKS

Overall, the expedition was a success. Our team identified peatlands across the Costa Rican landscape, some of them never described as peatlands before in the literature (here's a link to our storytelling field book: https://patrick-campbell.exposure.co/back-waters-1). We also retrieved numerous samples that will help us quantify the amount of carbon stored in these soils in addition to understanding the paleoenvironmental history of these understudied ecosystems. This work also acts as initial input for the government of Costa Rica within the framework of compliance with its 2020 NDC goal. It is essential to build a baseline of technical information for peatlands to support decision-making and stop the degradation and loss of these ecosystems. The current NDC, in compliance with the Paris Agreement, commits Costa Rica to take actions aligned with a trajectory consistent with the global goal of limiting the increase in global average temperature to 1.5°C. At the same time, peatland protection will contribute to increasing the country's adaptive capacity, especially by buffering water and safeguarding coastal zones, protecting specific biodiversity, and reducing its vulnerability to climate change.

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