Celebrating Alexander von Humboldt's 250 th anniversary: Exploring bio- and geodiversity in the Andes (IBS Quito 2019)

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Editorial

Celebrating Alexander von Humboldt's 250th anniversary: Exploring bio- and geodiversity in the Andes (IBS Quito 2019)

Executive Summary. Alexander von Humboldt conducted his best-known work on the slopes of the Ecuadorian Andes. He did this by applying his own characteristic brand of multidisciplinary scientific approach. This consisted of thorough data collection while synthesizing and visualizing the data in innovative formats. Also important for his scientific success in South America was his collaborative network that helped him to identify specimens and formulate his transformative scientific thoughts. It is no surprise that Humboldt was captivated by Ecuador, as it is one of the most biodiverse places in the world, and this astounding diversity was formed in an intricate, dynamic geological and climatological setting. As of yet, this biodiversity is far from being fully documented and the processes that generated it are still poorly understood. The IBS meeting in Quito[1] and the Second Latin American Congress of Biogeography will form the perfect platform to both commemorate Humboldt while addressing current and unresolved matters concerning the biodiversity of Ecuador and South America at large.

Keywords: Alexander von Humboldt, geology, climate, biodiversity, Ecuador

Why an IBS meeting in Quito?

The fourteenth of September 2019 marks the 250th birth anniversary of Alexander von Humboldt, an occasion for celebration as Humboldt is one of the founding fathers of biogeography. Humboldt was a Prussian geologist and botanist who travelled extensively in the Americas. He arrived in South America in 1799 together with the French botanist Aimé Bonpland. The pair first visited Venezuela, followed by Cuba, Colombia and Ecuador (all united under the name Viceroyalty of New Granada, except for Cuba which was the General Captaincy of Cuba), and finally Peru (Fig. 1).

In 1803, they continued their journey to Mexico (Viceroyalty of New Spain) and the United States, and returned to Europe in 1804. Humboldt's expedition across northern South America became legendary, and the subsequent travel and scientific reports, and public speeches, made him world famous. He inspired many scientists and naturalists, including Charles Darwin, Henry David Thoreau, John Muir, George Perkins Marsh, and Ernst Haeckel (Wulf 2015). Much of this fame came from his engaging writing style and public lectures but also from his new and holistic view on science and nature (Wulf 2015, Schrodt et al. 2019, Keppel and Kreft 2019).

Humboldt and Bonpland did their most famous work on the slopes of the Chimborazo and the Antisana volcanoes in the Andes of Ecuador (Figs. 2 and 3). Here, in their usual thorough style, the explorers avidly collected plants and measured all that could be measured. This ranged from the blueness of the sky to earth magnetism, as well as air pressure, temperature, and humidity among many other parameters. What made the achievement so special was that Humboldt combined thorough observation with extensive, multidisciplinary data recording (Buttimer 2001, Keppel and Kreft 2019), which allowed him to demonstrate that plants are distributed according to climatic and altitudinal gradients. This view was epitomized in the book *Essai sur la géographie des plantes* (1807), which constitutes the foundation for plant geography (Nicolson 1987, Jackson 2009). The most famous illustration in this book is the *Naturgemälde* (1807) (Fig. 4), a very appealing synthetic graphic that still inspires us today and shows the plant composition along the altitudinal gradient of the Chimborazo and Antisana, with all the physical measurements in the flanks of the figure.

Humboldt's scientific alliances in South America

During his visit to South America, Humboldt established an extensive network of fellow-minded scientists, authors, humanists, and politicians with whom he had important collaborations (Wulf 2015). Two of Humboldt's most important scientific allies were José Celestino Mutis, head of the Royal Botanical Expedition who was sent to New Granada by the Spanish King Carlos III, and Francisco José de Caldas, a self-made

[1] The interim meeting of the International Biogeographic Society (IBS) will be held from 5–9 August 2019 in Quito, Ecuador. The venue is the prestigious Universidad de San Francisco de Quito, and the event will be co-hosted by IKIAM, Universidad Regional Amazónica (Tena, Napo). About 300 biogeographers from around the globe are expected to meet and, in keeping with Humboldt's spirit, interact and explore the links between geo- and biodiversity, while seeking new frontiers in the realm of biogeography.

Figure 1. Humboldt's journey across northern South America (reproduced with permission of Terra Carta).

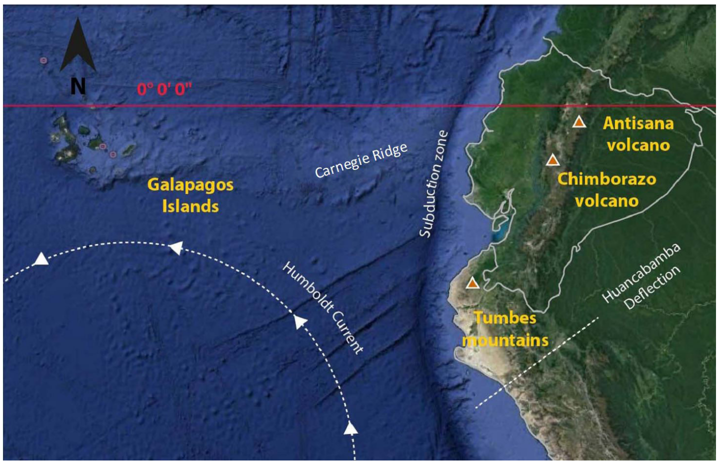

Figure 2. Ecuador and the Galapagos, with locations cited in the text.

Figure 3. Antisana (left) and Chimborazo (right), the volcanoes that Humboldt famously researched during his journey in South America. Credits: Esteban Suárez.

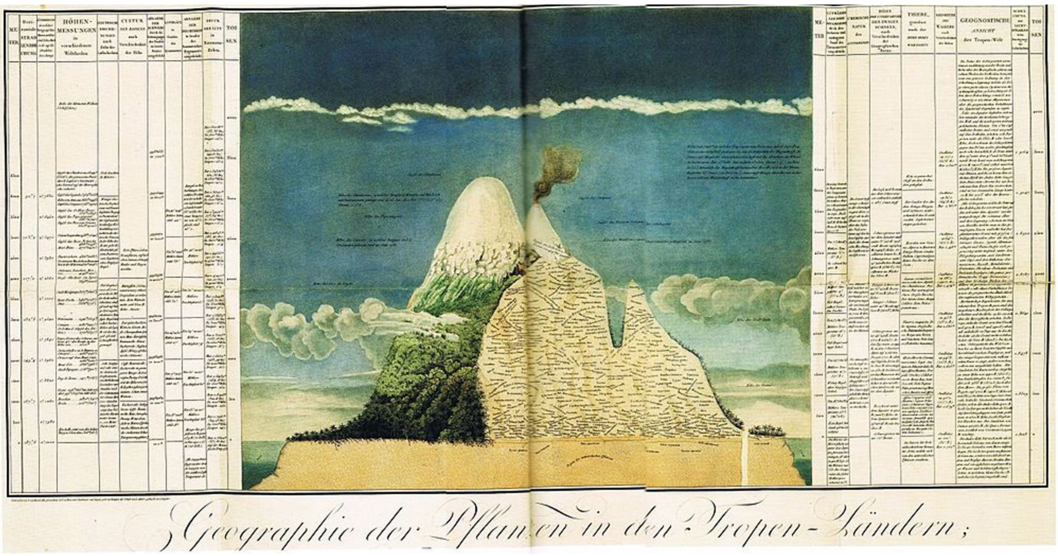

Figure 4. Alexander von Humboldt, Geographie der Pflanzen in den Tropen (Source: Wikimedia Commons)

scientist originally from Popayan, Colombia, who had become a keen observer of geography, astronomy, botany, and physical phenomena (Appel 1994). Mutis invited Humboldt to take part in botanical expeditions and taught him the local plant species. He also let him use herbarium specimens and drawings from his expeditions, and they communicated extensively. Caldas already had a well-developed model of his own concerning the interrelated nature of biological and climatic processes, and he impressed Humboldt with his geographical, astronomical, and meteorological knowledge (Appel 1994). Both men strongly influenced Humboldt's thought and data collection process, and they are now seen as instrumental in enabling him to realize his classic work (Wulf 2015, Gómez Gutiérrez 2018).

What attracted Humboldt to northern South America?

It is no surprise that the Andes and the Amazon region captivated Humboldt's attention as together they form a crucible of biodiversity. Moreover, Ecuador forms a cornerstone in this region in terms of geo- and biodiversity. It is situated at a geological crossroad, which is well reflected in the topography, soil, climate, and species heterogeneity (Fig. 5).

The Andes of Ecuador is part of the Northern Andes, which is limited to the south by a complex geological structure called the Huancabamba Deflection (Riel et al. 2014; Fig. 2). This deflection extends in SW-NE direction and represents the division between the Central Andes (Peru, Bolivia, northern Chile and Argentina) and the Northern Andes (Ecuador and Colombia). The Northern Andes record complex non-steady state mountain building together with other unique geological processes, such as the collision and accretion of oceanic terranes (tectonic plate fragments) along the Pacific subduction zone (Ramos, 2009). There are also conspicuous differences between the Andes of Colombia and Ecuador, mainly related to the collision of the Carnegie Ridge in the Pacific plate against the southern margin of Ecuador (Gutscher et al. 1999). Together, these processes influenced marine bathymetry, oceanic currents, and the terrestrial landscape. The effects of geology and climate are, for instance, reflected in the presence of the Humboldt Coastal Current and the endemic biota in the Tumbes Mountains (Calvez et al. 2017, Hazzi et al. 2018; Fig. 2).

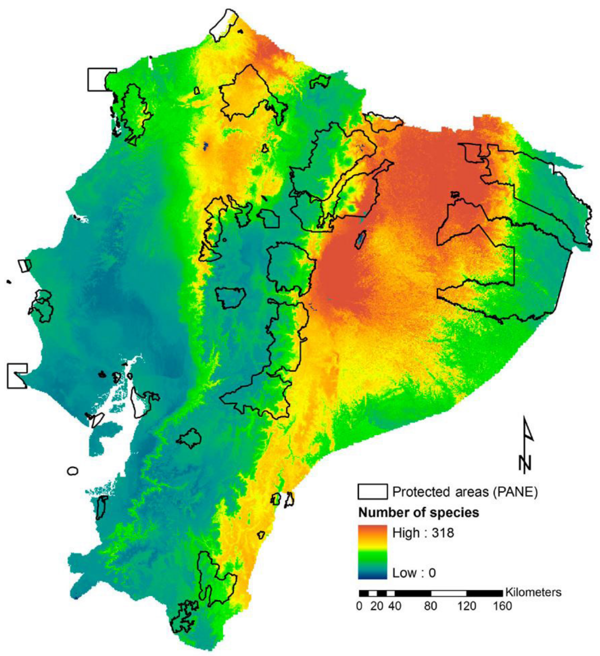

Figure 5. Biodiversity richness for continental Ecuador, based on the potential distributions of 809 species (amphibians, birds, mammals, and plants) (from Lessmann et al. 2014).

Humboldt, as geologist-turned-botanist, already appreciated that plant geography had to be seen in the light of geological and climatic history. At the time of his travels across South America, Darwin was yet to be born and the revolutionary *Principles of Geology* by Lyell (1830) had yet to be written; however, the notion of historical geology was getting off the ground. Even though at the time of his travels the field of Earth Sciences was still in its infancy, it was something that Humboldt already considered as a necessary — but yet incomprehensible— factor in plant distribution (Nicolson 1987).

Ecuadorian Biodiversity Today

Ecuadorian biodiversity is still not fully documented or understood. General richness patterns seem to be extensions of those seen in the surrounding biodiversity giants, Colombia and Peru, yet recent results indicate that local geodiversity and microclimates may be acting as biological lineage pumps at different geographic scales (e.g., Hutter et al. 2013, Polato et al. 2018, Sornoza-Molina et al. 2018, Guayasamin et al. 2019).

Currently, about 16% of Ecuadorian continental territory is included in public protected areas (Cuesta-Camacho et al. 2006) and a myriad of community and private conservation initiatives, but additional conservation efforts are still needed (Lessmann et al. 2014, 2016). Unfortunately, development tied to oil extraction, agriculture, cattle ranching, and expansions have devastated vast spans of the country's natural vegetation (Mosandl et al. 2008). More recently, gold and copper mining operations exceed the worst-case conservation scenarios for the future of Ecuadorian biodiversity (Roy et al. 2018). Whether scientists will be able to fully grasp the complexity of Ecuadorian biodiversity before it disappears is still to be seen.

It is noteworthy that the biological richness of continental Ecuador (Fig. 6) and its Galapagos Islands both have played a pivotal role in the development of the field of biogeography (Humboldt and Bonpland 1807; Darwin 1905; Lack 1947) and the theory of evolution (Darwin 1859), respectively. This further underlines the need for study and conservation of this natural wealth and its unique position as natural treasure and world heritage.

Is Humboldt still relevant to us today?

In recent decades, Humboldt's approach to science has undergone a revival. State-of-the-art geological, molecular, and ecological data are now available from

Figure 6. Icons of Ecuador's biological richness. A) *Ochthoeca fumicolor* (Brown-backed chat tyrant) on *Chuquiragua jussieui* plant; B) *Tremarctos ornatus* (Spectacled bear); C) *Tapirus pinchaque* (Andean tapir); D) *Vultur gryphus* (Andean condor). Photo credits: Esteban Suárez.

ever more complete global databases and provide new insights into biogeography (Funk 2018). Making sense of the relation between these data sources, however, requires an integrative approach (Schrodt et al. 2019, Keppel and Kreft 2019). Across the globe this brand of science has led to a new and improved understanding of the origins of biodiversity and how it evolved through time. These developments are entirely in line with Humboldt's approach, which comprised data collection, and international data sharing and archiving. Even now, Humboldt´s legacy is seen through biogeographic research, classes, books, scientific publications, as a referent and inspiration for researchers about his humanistic and inclusive, multifaceted work on natural sciences (Schrodt et al. 2019, Keppel and Kreft 2019).

The IBS interim meeting in Quito, Ecuador, comes as a superb opportunity to celebrate Humboldt´s achievements and influence in modern natural sciences. As such, it is a natural setting for the mingling of scientific minds in the fields of geology, ecology, evolution, and the influence of Humboldt in politics and social sciences. Additionally, for the first time, we've made it possible for the IBS meeting and the Latin American Congress of Biogeography to take place at the same place and time. This will be a unique opportunity to increase the interactions and collaborative projects among members of the IBS and the Latin American community. It is also a perfect occasion to place the Humboldtian, holistic perspective of nature in the face of global climate change and other environmental threats across the biodiversity hotspots of the world.

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