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EDITORIAL

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This issue of the *Journal of Biogeography* is dedicated to Friedrich Wilhelm Heinrich Alexander von Humboldt, who was born 250 years ago, on 14 September 1769.

Alexander von Humboldt is often regarded as the "Father of Biogeography". Although the very concept that any discipline has a founder may be disputed, von Humboldt´s contributions are, without a doubt, enormous, integrative and global. His lucid writing was widely read, he built up a huge network of correspondents, he assisted many young researchers, and engaged the general public generating curiosity and enthusiasm about the natural world. By the end of his long life, he had stimulated a new kind of research, similar to what we now call biogeography. Maybe as important, he also encouraged, inspired and helped many young researchers, thus ensuring that there were many people exploring the questions that fascinated him, and many people with his inclusive and humanistic world-view.

Although he started his working life as a mining inspector, very early on in his career his attention turned to botany. It was during his groundbreaking work on the slopes of the Andes, however, that he developed his holistic view on nature. This view consisted of seeing nature as a living whole, in which biota, climate, topography and geology are all related and influence each other, a concept that is one of the basic principles of biogeography. Holistic thinking was not exclusive to Humboldt though, it was a development among natural philosophers that took place during the second half of the 18th century. Attention shifted from collecting species to fill museums and private collections, to making sense of the relation between species and their environment. Exponents of this movement included the philosopher Kant, natural scientists such as Willdenow and Forster, and the author and scientist Goethe, all friends of Humboldt. Similarly, in South America scientists like Caldas and Mutis were developing a similar vision of nature. And this concept of nature as an interconnected system was emerging in the community of naturalists. Humboldt's lasting scientific legacy is that he demonstrated that the perceived relation between species and environment was real, and he provided facts through extensive data collection and observation. He started this endeavour in Europe and extended it to South America, where his research culminated in his 'vision' of nature, summarized in the iconic *Naturgemälde* that formed part of the *Essay on the Geography of Plants* (1807), and still synthesizes the essence of biogeography today.

The Humboldtian holistic approach is still current and has gone through a revival in recent decades. At present, state-of-the-art geological, molecular, environmental and ecological data are available from ever more complete global databases and provide new insights into biogeography. Across the globe, the Humboldtian holistic approach to science has also led to a new and improved understanding of how biodiversity patterns in mountains and lowlands evolved through time under the influence of abiotic and biotic processes. Surely, these developments would have delighted Humboldt, as he was a great advocate for data collection, sharing and archiving. During Humboldt's lifetime the field of Earth Sciences was still developing. It is therefore only a logical step to take Humboldt's vision of holistic science into four dimensions and add the component time to his vision of the relation between species composition, across space and climatic zones.

The papers in this issue are in five groups: on Humboldt, on elevational and latitudinal gradients, on the impacts of geomophological diversity, on the impact of tectonism, and finally on the Anthropocene. The life and achievements of Alexander von Humboldt have been very well described by Andrea Wulf in "The invention of nature". This timely book played a key role in bringing the life and achievements of Alexander von Humboldt to prominence, and this wonderful book is reviewed by Norbert Sietze. Franziska Schrodt et al. add to this by focusing on the scientific contributions of Humboldt.

Since Alexander von Humboldt´s careful documentation of elevation belts, these have become a standard part of any montane biogeography. However, as Fattorini et al. argue, the terminology used is imprecise and oftentimes vague, and they make excellent suggestions of how the situation could be improved. Diversity changes along an elevation gradient have long been a research theme, and Vetaas et al. investigate diversity along an elevation gradient in the Himalayas (which Humboldt tried very hard to visit) showing that diversity is best predicted by the water-energy balance, which performed better than the net primary production (NPP) or the more individuals hypothesis (MiH). Elevational ranges are partially the result of factors external to the organisms, and partially to traits and adaptations of the organisms. Pintanel et al. explore how the thermal tolerance range of *Pristimantis* frogs changes in relation to elevation, and to open versus closed-habitats frogs, thermal tolerance and elevational gradients. Jiménez-Robles et al. explored the thermal tolerances of *Liolaemus* lizards in the Bolivian Andes, and showed the complex interaction between elevation and microhabitat in regulating available heat budgets. Latitudinal gradients are sometimes associated with elevation gradients, and many biogeographical variables may be linked to latitudinal gradients. However, Beerli et al. showed that for sphingid moths the overriding signal was continental distribution, apparently driven by food availability, rather than latitude.

Currently geomorphological diversity impacts biodiversity, this is illustrated by Tukiainen et al. who explored the relationship between landform diversity and geodiversity in Finland, and were able to reveal a complex pattern of alpha and beta diversity, in response to different types of landforms. Toivanen et al. similarly show a significant positive relationship between catchment geodiversity, and the diversity of aquatic macrophytes in Finnish freshwater systems. Such high geodiversity can also be found in relictual old mountains, such as the Brazilian Campo Rupestre. Colli-Silva et al. show that the Campo Rupestre is very rich in endemic species, and that this diversity is best summarized as two biogeographical regions. Puzzling is the huge biodiversity of the flat, equatorial, Amazon basin, where the apparent geodiversity is low. However, Tuomisto et al. show that a major factor correlated with the biodiversity is the diversity of soil types in the basin. This accounts for more plant diversity change than climate variation does. If modern geodiversity leaves a signal of biodiversity, then it follows that past geological or geomorphological diversity should also leave a signature of increased biodiversity. Bernal et al. document the curious occurrence of plant species typical of the coast many thousands of kilometres inland in South America, and interpret these as relicts of past oceanic transgressions. It can be difficult to infer what past environments were like, and Oksanen et al. use mammal dental traits to postdict palaeoclimates. Huang et al. summarize the importance of an integrated analysis of geomorphological and palaeoclimatic changes to understand the evolution of biodiversity, and show with an example of Anatolia and mammals how this could be done. Geodiverse areas such as mountains can also act as sources for less geodiverse areas, as illustrated by Hagen et al. for the relatively depauperate Arctic flora, which they argue was derived the Miocene–Pliocene alpine zones in the Asian mountains. Could it be that Humboldt foresaw these patterns, and that was the reason why he visited the Altai? Pleistocene climate fluctuations, when combined with a complex montane environment, can generate a remarkable complex geodiversity pattern. Flantua et al. refer to this rapid (in geological time) expansion and contraction of habitats as a flickering connectivity, and illustrate how this would have impacted range expansion and fragmentation in the Andes. A curious case of geodiversity stimulating biodiversity is for the western Ecuadorian pitvipers, where Salazar-Valenzuela suggests that migration along river valleys allowed colonization and subsequent diversification between montane and coastal lineages.

The question of how lineage distributions and diversification rates are impacted by tectonic events post-dates Humboldt, but he would surely have been fascinated. In this issue are three very different approaches. Parenti mapped the distribution patterns of teleost fish in the western Pacific, showing the breaks in the ranges, centres of endemism and where differentiation had occurred, thus documenting the patterns that resulted from these processes. Rolland and Condamine explore the impact of palaeotemperatures and continental fragmentation on amphibian diversification rates, and show that continental fragmentation resulted in early allopatric diversification, and palaeotemperature is positively related to diversification rates. Finally, Onstein et al. explore the impact of the evolution of large fruits in the Annonaceae on the frequency of long-distance dispersal (between tropical continents), and find that large fruits are associated with an increased dispersal rate, thus showing how intrinsic traits can modulate the effects inter-continental fragmentation.

Benito et al. explored a theme that worried Humboldt: the evidence of anthropogenic change and destruction, and how this could impact the ecosystems and habitats, by comparing the modern diatom records from Andean lakes, with those older than 150 years. Surprisingly, there is little evidence of change!

We collected here a set of papers that illustrate what we have learnt since Humboldt, a set of papers we think Humboldt would have loved to receive as a 250th birthday present, and would have read with fascination and pleasure.

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