The bee and the turtle: a fable from Yasuní National Park

A chance observation of an interaction between two very different species while exploring the Ecuadorean Amazon reminds Olivier Dangles and Jérôme Casas of the importance of natural history observations in developing ecological theories.

Wandering through the forests and along the rivers of Yasuní National Park (YNP) in the Ecuadorian Amazon is probably every naturalist's dream. A few years ago, we made that dream a reality (Figure 1). As ecologists with a broad interest in many theoretical and applied aspects of this discipline, we wanted to go to YNP to find inspiration for new ideas about the structure and function of a variety of organisms and their interactions. For many taxa – especially insects and other arthropods, which constitute the main model organisms of our research – one can see more species in a day's walk in YNP than during a lifetime spent in temperate zones.

YNP has the highest density of tree, mammal, amphibian, and insect species ever recorded on the planet (Bass *et al.* 2010). The numbers are staggering. In an area equal to that of about 34 football fields (25 hectares), one can find over 1100 species of trees – more than in the whole of the US and Canada combined. Comparisons with similar plots in other tropical forests worldwide reveal that YNP has the highest density of tree diversity of any place on Earth. As for fauna, 185 amphibian and reptile species have been found in just a few hectares of the park, which also shelters half of all the mammal species that inhabit the Amazon Basin. As many as 35 000 insect species are estimated to exist within a 3-kilometer radius of a central point in YNP, which is about 40% of the total number of species described for all of North America (see Dangles *et al.* [2010] and references therein). YNP was therefore the perfect place to stumble onto exciting interactions, behaviors, and ecological mysteries. For us, as ecologists, it was a scientifically rejuvenating trip. One of us even took his teenage kids, who did not want to miss out on the chance to experience a real jungle firsthand.

Our journey began early on a chilly morning in Quito, the capital of Ecuador. A 30-minute flight took us over ice-capped volcanoes and pristine Andean jungles, and onwards to the small town of Coca, at the edge of the Amazon forest. The temperature was 20°C and the high humidity left our skin sticky to the touch. Our trip continued by canoe down the sediment-rich waters of the Napo River, the largest river in the Ecuadorian section of the Amazon Basin. From the entrance to YNP, we paddled up several blackwater creeks and reached the base camp of the Añangu indigenous community in the evening, accompanied by the rhythmic flashes of hundreds of fireflies.

Many YNP visitors take home treasured memories of seeing a rare harpy eagle in the dense canopy, a jaguar sitting on a river bank, or a giant otter fishing for piranha in the river. We had the privilege of seeing a family of the critically endangered giant otter (only a handful of which remain in the park), but our most memorable experience was, in fact, observing a bee (*Centris* sp) flying around a turtle (*Podocnemis unifilis*). *The Bee and the Turtle* may sound like a fable by Jean de La Fontaine, but the scene we were fortunate enough to witness and photograph appears to be the first documentation of tear-feeding behavior by solitary bees on river turtles (Figure 2).

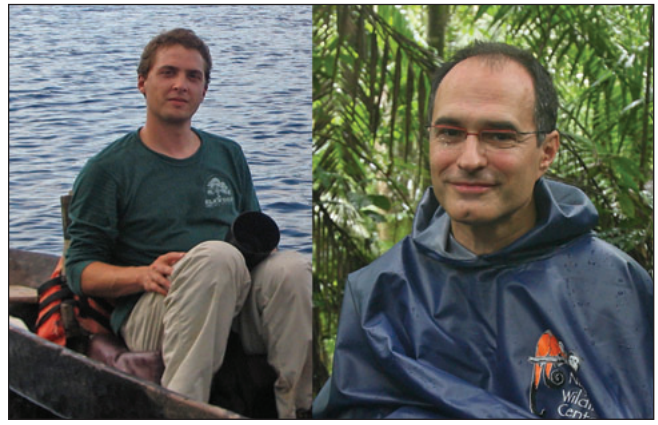

Figure 1. *The authors, Olivier Dangles (left) and Jérôme Casas (right), during their field trip in Yasuní National Park.*

We spent more than an hour observing this unexpected interaction between the two species, first spotted by the restless teenagers. We watched the scene with the same wonder that characterized our first natural history discoveries as children, while at the same time our adult selves were trying to decipher this behavior in the context of ecological concepts, like optimal foraging and species coexistence. It was only once we were back at home with our books and computers that we learned that tear-feeding behavior is quite well documented. Sodium is an essential nutrient for the survival and reproduction of living organisms: it helps maintain blood volume, regulates the balance of water in cells, and keeps nerves functioning properly. Although plentiful in the oceans, this element is in short supply on land, particularly in plants, which is why many terrestrial herbivores crave salt. Many species of insects, including several types of butterflies and moths, frequently visit moist ground and the excrement and carcasses of animals to obtain the dissolved nutrients they contain. Some of these insects specialize in tear-feeding (ie feeding on placid animals like deer, crocodiles, and even sleeping birds) that cannot readily swat them away. Local scarcity of

important minerals in the soil may lead insects to use tears as an alternate potential source of sodium. We did not, however, find a single paper relating to tear-feeding behavior by bees on river turtles.

We talked a lot about the bee and the turtle during the rest of our journey through YNP, although our observation was likely not a scientific mystery if we assumed that the tear-feeding habits of butterflies and other insects might also apply to bees. However, the incident served to remind us of how important natural history observations have been in our approach to ecology throughout our careers. Indeed, most of our work has been firmly grounded in direct observations of nature, which have then been applied to a more standard scientific approach. Quantification, if not modeling, is a tool we often like to use, but generally at a later stage in our scientific method, not as a starting point. The rapidly vanishing role of natural history observations in modern ecological research has been a constant subject of concern among scientists. In a recent paper, Robert Ricklefs, the President of the American Society of Naturalists, stated: "Whereas the origins of ecology were firmly grounded in direct observation of nature, the emergence of strong theory in ecology appears to have changed our perspective on natural history, to the point that observation is often used to serve theory rather than test predictions and find inspiration for new ideas" (Ricklefs 2012). Ricklefs himself revived ideas presented almost 15 years earlier by the American biologist Douglas Futuyma who argued that scientists should put more energy into and emphasis on teaching students about the importance of learning about and being inspired by natural history (Futuyma 1998).

It seems to us that the unprecedented rates of global changes and biodiversity losses should impel all those involved in ecological research and teaching (from lecturers to journal editors to undergraduate students) toward placing greater value on field-based natural history observations. As the number of species vulnerable to global environmental change continues to rise, along with the Earth's temperature and widespread habitat disturbance, previously undocumented facts in the natural world will likely be observed (eg increasing forest damage by insect pests, modified times of bird migration). It also seems increasingly urgent to continue efforts to document the distribution of species, which in many cases relies on the observations made by skilled amateur naturalists, such as volunteer bird- and butterfly-watchers involved in national monitoring programs. While ecologists make ever-greater advances in modeling, in-the-field observation of species continues to be neglected.

Work within this context is being conducted in YNP by the Tropical Ecology Assessment and Monitoring network, led by the Smithsonian Tropical Research Institute, which monitors terrestrial vertebrate communities in YNP through annual, large-scale, camera-trap-based surveys. This georeferenced cataloguing of these flagship species provides evidence of their actual distribution and sets a baseline for future studies.

Figure 2. *A solitary bee* (Centris *sp) drinking the tears of a yellow-spotted river turtle* (Podocnemis unifilis).

Back to our bee and turtle – while some may contend that there is not much left to learn about such interactions, we argue that natural history phenomena like this are still a fruitful starting point of investigations. To what extent do bees depend on turtles for survival? Could bees switch to other tear providers if the endangered yellow-spotted river turtle disappeared from the park? What would be the consequences for wild orchids pollinated by the bees? As Bodemer and Ruggeri (2012) suggested, we should primarily investigate natural phenomena that we find intriguing. There is no reason to dismiss questions just because they do not fit into or lead to new ecological theories. Paying attention solely to mainstream theoretical frameworks is often dull and can result in so-called "Type III errors" – finding the right answers to the wrong questions.

What lessons can be learned from *The Bee and the Turtle* fable? Next time you go into the field, take your kids along; their enjoyment in the pursuit of unexpected encounters will provide a familiar echo of your own early experiences, reveal interesting questions waiting to be answered, and extend the precious gift of environmental education to the next generation.

Acknowledgements

We thank D Roubik for the identification of the solitary bee and N Bedrava for English editing.

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