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COMMENTARY

A place for natural history in the 21st century

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Natural history, which has been defined in different ways (Schmidly, 2005) but at its core involves observing and understanding organisms in their natural environments (Travis, 2020), in many ways once provided a foundation for the study of biodiversity. The scientific literature is now replete with studies highlighting the causes, severity, and urgency of the global extinction crisis (Ceballos et al., 2015; Janzen, 1994; Jaureguiberry et al., 2022). Increasingly, biodiversity loss is linked to both land-use change (Foley et al., 2005) and climate change (Bellard et al., 2012), and there are calls for policy makers to address these multiple crises in an integrated and comprehensive manner (Pereira et al., 2024; Pettorelli et al., 2021). In parallel to these developments in the scientific literature, in the popular media there is abundant evidence of people feeling disconnected to nature and anxiety over the alarming state of the environment (Ojala et al., 2021). Academics have even given these feelings various names: nature deficit disorder, eco-anxiety, climate change worry, and ecological grief (Louv, 2008; Ojala et al., 2021). Indeed, the success of books in the popular press like "Green Sketching" (Foxon, 2022) and "Slow Birding" (Strassmann, 2022) is a testament to attempts to reestablish connections with nature in an increasingly digital world. Natural history may thus help uncover important aspects of species' biology that are essential components of biodiversity and also has the potential to inspire biologists and non-biologists alike (Tewksbury et al., 2014).

Recording observations about the natural world has been a part of human experience since people first took pigments to the walls of caves tens of thousands of years ago. Records became more formalized as explorers such as Oviedo made extensive botanical collections on overseas voyages (Villamil-Montero & Ming, 2016). Observations from these and other expeditions such as those of José Celestino Mutis, Alexander Von Humboldt, Charles Darwin, and Alfred Russell Wallace later became the foundation for fields including ecology, biogeography, evolution, and meteorology (Funk, 2018). I contend that while many fields of scientific enquiry developed from early natural history observations, few continue to be so intimately tied to natural history as the place-based sciences of tropical field ecology and biology (Raby, 2017).

Throughout the 20th and 21st centuries, natural history has been deemphasized in universities and academic journals (Barrows et al., 2016; Bartholomew, 1986; Schmidly, 2005) in parallel with the increasing focus on prediction and mathematical, theoretical, and molecular approaches to biology. This is unfortunate, as natural history provides a foundation for understanding how organisms interact with each other and the environment—information not easily gleaned from DNA sequences and 'omics approaches (see Greene, 2005 for a thought-provoking discussion of apparent distinctions between empiricists and theoretical biologists vis-à-vis their approaches to natural history and education). Simply put, it is very hard to interpret big data in ecology in meaningful ways if you do not know anything about who the organisms are and what they do in the environment.

Moreover, new tools and technological advances are bringing innovative ways to observe nature (Hartig et al., 2024), and many of these methods are noninvasive and unobtrusive. For example, passive acoustic monitoring coupled with data analysis pipelines now provides ways to collect community-level data for multiple vocalizing taxa including birds, insects, and frogs without introducing "observer bias", that is, altered animal behavior due to the presence of humans (Deichmann et al., 2018; LeBien et al., 2020). Similar to soundscape ecology, camera trapping can provide visual observations of animal presence and behavior (Delisle et al., 2021). Trail cameras or camera traps are now relatively reasonably priced and widely available, and online repositories of images are increasingly available. Environmental DNA metabarcoding (eDNA) is another new technology that is proving useful in detecting community-level presences of animals

in aquatic and terrestrial environments and may assist in monitoring biodiversity (Polanco F. et al., 2021). In addition to these methods that are usually applied or used by researchers, citizen or community science is helping to develop global, geospatial databases of observations including organismal presences and ecological processes such as phenology (Bison et al., 2019; Dickinson et al., 2010). This nonexclusive list of emerging new tools highlights the discrepancy between our growing ability to make natural history observations in novel ways, at the same time that outlets to publish such observations have decreased over the 20th and 21st centuries.

In an attempt to "get back to the basics," in 2021 Biotropica inaugurated a new manuscript category called "Natural History Field Notes (NHFN)" (Powers et al., 2021), as other journals have done (Jenkins et al., 2022). Our goal was to provide a platform for biologically rich observations about species and their inter-connections withing the context of their environments, that is, observations that do not easily fit within the confines of a standard research paper. The instructions to authors of NHFN state that: "Submissions to NHFN must tell a compelling story that generates a novel hypothesis or that can be placed in a larger context of tropical ecology, biology, and evolution. While we recognize that these may be rare events and thus inferences may be based on a single event or handful of observations, the manuscript as a whole must be robust enough to be of broad interest to our international readership." (Powers et al., 2021). Now that Biotropica has published NHFN for 2 years, it is fair to ask: what have we learned from these contributions? In an attempt to answer this question, I reviewed all Field Notes published from March, 2021 to November, 2023 and extracted the focal taxa, methods, key findings and further hypotheses (Table 1).

Collectively, these papers address a remarkably diverse range of taxa and include marine, aquatic, and terrestrial habitats. The focal taxa include birds, frogs, fish, jaguars, ocelots, sengis, insects, bats, snakes, and trees. Researchers themselves were not spared as subjects of NHFN, as one paper reported evidence of an ocelot attacking people in a remote field station (Champagne et al., 2023). Four of the 17 papers used camera traps to document animal presence and behavior, while many relied on the "tried and true" methods of careful field observations. In other words, nobody should retire their binoculars just yet. Importantly, several of these papers grew out of rare, chance encounters, and speak to the ubiquity of cell phone cameras as a means to record these serendipitous sightings.

The topics that these papers engage are as diverse as the taxa and include community ecology, basic biology, behavior, and some amazing things that are difficult to categorize. They reveal many novel interactions among species, such as commensal African ground-foraging ant birds that follow ground-foraging sengi (Cordeiro et al., 2022) and cases that blur the lines between competition and predation, such as evidence of a jaguar killing an ocelot at a waterhole during a drought in a water-limited ecosystem (Perera-Romero et al., 2021). Papers that increase our knowledge of the basic biology of species include a study of a frugivorous fish that swallows seeds whole and then regurgitates them prior to careful chewing and digestion (Carvalho et al., 2021). Other surprising findings include a tree species with medicinal properties that apparently functions as a pharmacy for at least 10 species of mammals as diverse as bats, deer, and primates (Kaisin et al., 2022).

These field notes have not only enhanced scientists' knowledge of the natural world, they have also captured the popular imagination. Who knew that there were hawkmoths that keep predatory bats away by using sound to jam their sonar systems (Rubin, 2022) and snakes that avoid predation by cartwheeling away (Quah et al., 2023)? These papers made splashes on social media and traditional news outlets. For example, the NHFN on cartwheeling snakes was covered by 75 news organizations across the globe. This underscores the ability of natural history to move out of the "ivory tower" and connect people back to nature through a common sense of wonder. I argue that this is an essential step if we are to convince people that we all need to do more to ensure the future of biodiversity on this planet.

It is heartening but perhaps not surprising that there are still so many fascinating things that we do not yet know about the natural world, particularly in tropical latitudes, which harbor the bulk of the planet's biodiversity. Careful observations of the natural world are typically the starting point for the development of ecological theory and further hypothesis tests, and not the other way around. The papers highlighted in Table 1 suggest what makes a successful Natural History Field Note: a set of novel observations that links something specific from one locality to general phenomena that may occur elsewhere and suggests further research directions. For example, the observation in the Atlantic Forest of Brazil that many animal species use the same tree species prophylactically or therapeutically (Kaisin et al., 2022) may not be limited to this particular region, as recent reports of a Sumatran orangutan in Indonesia suggest self-medication with a plant species to treat a facial wound (Laumer et al., 2024). Collectively, these two studies beg the question of how many other tree species out there have been used as local pharmacies by animal communities. They also have applied significance as they imply a possible route for drug discovery.

Besides serving as fodder for future studies, there are other benefits that accompany making a space for natural history observations. Natural history was typically construed as a realm where explorers with names like "Squamish P. Wigglesworth III" read out reports of their travels to the adventurers' club. Promoting natural history, especially in the tropics, allows people living in those ecosystems to record their observations; for example, a group of high school students in Panama (along with a biologist coauthor) published their observations of mutualistic ants repairing damage to their *Cecropia* host plants (Wcislo et al., 2021). In summary, in this age of looming twin crises of biodiversity decline and climate change, our need for natural history is greater than ever before. I am proud that the journal *Biotropica* can play a role in promoting natural history observations by providing an outlet for such studies.

TABLE 1 Natural History Field Notes published in Biotropica from March, 2021 to November, 2023 in chronological order of publication.

Focal taxon/taxa	Methods	Main finding and further hypotheses	Citation
Felids, a jaguar and an ocelot	Camera trap	This study provided some of the first photographic evidence of a jaguar killing an ocelot at a waterhole during a strong drought where water sources were restricted. Further hypotheses include testing whether the increasing frequency or severity of drought alters population dynamics and competitive dynamics of carnivores	(Perera-Romero et al., 2021)
Frugivorous fish (*Brycon*) and fruits of *Mabea fistulifera*	Direct observations and videos of fish in experimental aquaria	Fish swallowed entire seeds and later regurgitated and then carefully chewed them; temporal storage of seeds may be a strategy to optimize food intake. This previously undocumented behavior might switch this species from a seed disperser to a seed predator	(Carvalho et al., 2021)
White-lipped and collared peccaries	Camera trap	Two white-lipped peccaries killed and consumed two juvenile collared peccaries, the first report of heterospecific infanticide in ungulates	(Carrillo & Fuller, 2022)
Large waterbirds (woolly-necked storks) and raptors (dusky eagle-owls)	Visual surveys	Owls preferentially re-used vacated stork nests in near irrigation canals, suggesting a commensal relationship	(Sundar et al., 2022)
Cane toads with toxins and reptiles (snake and crocodile)	Direct observations during chance encounters	The snake and crocodile had different strategies for consuming toxic toads: the snake appears to have evolved immunity from venom while the crocodile avoided toxic tissues	(Oda et al., 2022)
Long-tongued hawkmoths and predatory bats	Experiments playing ultrasonic bat echolocation calls to moths and recording moth acoustic responses	Males of one of the three tested hawkmoth species respond to bat calls with dense ultrasound that is likely capable of jamming bat sonar	(Rubin, 2022)
Ten different mammal species and a tree species, *Myroxylon peruiferum*, (Fabaceae)	Camera trap	Diverse mammals (bats, deer, primates, tayra, etc.) rubbed their fur with resin from a species of tree known for wound-healing, anti-parasitic, and anti-inflammatory properties in apparent self-medication behavior. This suggests that medicinal use of plants by animals may be more widespread that currently acknowledged.	(Kaisin et al., 2022)
Seedlings of *Vataireopsis iglesiasii* (Fabaceae)	Repeated surveys in marked plots	Evidence of conspecific negative density dependence of a wind dispersed tree species	(Queenborough et al., 2022)
Sengis (elephant shrews) and birds	Direct observations and camera traps	Ground-foraging bird species followed three species of ground-foraging sengis, suggesting that commensal interactions may be common	(Cordeiro et al., 2022)
Marsh-dwelling songbirds from two different families	Direct observations of chance encounters	Nests were constructed stacked on top of conspecific or heterospecific nests	(Gadek et al., 2022)
Snake	Direct observations of chance encounter	The dwarf reed snake cartwheeled as an escape mechanism in one of the first documented reports of the mythical “hoop snake”	(Quah et al., 2023)
Bats	Direct measurement and observation of tagged bats	First observation of bat hibernation in South America	(Odon et al., 2023)
Myrmecophilous butterflies, treehopper insects, and host plants	Direct observation and chemical analyses	Treehopper chemical profiles resembled that of hosts plants, resulting in oviposition mistakes where the butterflies laid eggs directly on the treehoppers	(Lima et al., 2023)
Coexisting mangrove-coral ecosystems and fish	Visual surveys	Mangroves with coral had distinct, more species rich fish communities compared to mangroves lacking coral	(Wright et al., 2023)
Two species of frogs from the genus *Agalychnis*	Repeated, direct observations of marked egg clutches	Two syntopic frog species oviposited in slightly different microsites, contributing to different predation risks	(Griffis-Kyle et al., 2023)
Ocelot and humans	Direct experience	An unprovoked ocelot repeatedly attacked a group of researchers, tourists, and field station staff; this unusual behavior was attributed to disease or potential previous trauma with humans; this incident serves as a warning to researchers in close proximity to wildlife to be vaccinated and mindful of zoonotic diseases.	(Champagne et al., 2023)
Oak forests	Visual estimates of damage in permanent forest plots	Trees were damaged by an extreme snowfall event, but those that had previously had branches lopped by local people suffered less damage.	(Thadani, 2023)

(Continues)

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DATA AVAILABILITY STATEMENT

No data were used in this Commentary.

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