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Surprise, Surprise...The Continued Value of Natural History in Contemporary Biology

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Abstract

Observation and natural history studies remain important to advancements in science. The value of technology in biological, ecological, and conservation science is indisputable. From molecular and biochemical methods to high-resolution micro- and macroimagery to global positioning technologies to high-performance computing and applications of artificial intelligence, the ways that we do science have significantly changed in scope and scale to the benefit of science, society, biodiversity and our wild places. Natural history approaches, broadly described, remain at the heart of scientific endeavor, where we must initiate investigations with observations using new technologies and pursue them through new analytical approaches by the application of new tools. I write not only to remind us of the importance of such approaches but also to advocate for the continued teaching of skills in observation, exploration and discovery that yield novel insights and perspectives.

Key words: Observation, biodiversity, discovery, field methods, fluorescence.

Resumen

Los estudios de historia natural y observacionales siguen siendo fundamentales para los avances en la ciencia. El valor de la tecnología en las ciencias biológicas, ecológicas y de conservación es indiscutible. Desde los métodos moleculares y bioquímicos hasta la obtención de imágenes micro y macro de alta resolución, las tecnologías de posicionamiento global, la computación de alto rendimiento y la aplicación de inteligencia artificial, han llevado a que las formas en que hacemos ciencia cambien significativamente en alcance y escala, en beneficio de la ciencia, la sociedad, la biodiversidad y nuestros espacios naturales. Los enfoques de historia natural, entendidos en un sentido amplio, siguen estando en el corazón del quehacer científico, donde debemos iniciar nuestras investigaciones con observaciones que utilicen nuevas tecnologías y desarrollarlas mediante nuevos enfoques analíticos aplicando herramientas innovadoras. Escribo esta editorial no solo para recordarnos la importancia de estos enfoques, sino también para abogar por la enseñanza continua de habilidades de observación, exploración y descubrimiento que generan nuevas ideas y perspectivas.

Palabras clave: Observación, biodiversidad, descubiertos, métodos de campo, fluorescencia.

Flying squirrels (*Glaucomys* sp.) fluoresce under ultraviolet light! I stared dumbfounded at the article found in the first issue of the *Journal of Mammalogy* for 2019 (Kohler et al. 2019) and I continued to review the pages almost in disbelief. Headlines that suggested flying squirrels 'glow in the dark' began to appear in natural history magazines, internet publications and newspapers around the world. I was flabbergasted. I had been studying squirrels since 1980 when I was an 18 year old undergraduate at Ohio State University in the USA looking for a study species that was found on or close to campus, since I did not have access to transportation to the field from this urban college campus. Never had I ever considered this to be possible. The retinal properties of squirrels had been well studied, characteristics of their lenses and the behavioral ecology and use of colors were well known (MacDonald 1992, Koprowski 1994, Van Hooser & Nelson 2006, Thorington et al. 2012). Everything that I knew told me that squirrels should not fluoresce under ultraviolet light, yet the paper in front of me demonstrated that they do! I was wrong yet again in life. At an earlier time in my life, I would have been frustrated or perhaps embarrassed to have been 'wrong' (although I had substantial experience being wrong in my life!). With age, I have become reasonable in expectations of myself and tend to take great joy in finding out that I am wrong in such instances. Being reminded of how little we know about even the most common of species is important. We can miss so much when we are not looking with the right tools and/or the proper perspective.

Whether one is working in the laboratory or field, we are surrounded by opportunities to explore and discover, but these opportunities are only capitalized upon if we are observing. The value of technology in biological, ecological and conservation science is indisputable. From molecular and biochemical methods to high-resolution micro- and macroimagery to global positioning technologies to high-performance computing and applications of artificial intelligence, the ways that we do science have significantly changed in scope and scale to the benefit of science, society, biodiversity and our wild places. Natural history approaches, broadly described, remain at the heart of scientific endeavor where we must initiate our investigations with observations using new technologies and pursue them through new analytical approaches by the application of new tools. Most of the advances in technology over the centuries provide new tools to observe in new ways... from lens-based scopes to molecular techniques to nuclear magnetic resonance technologies to satellite-based sensors. Coalescing such observations using an intellectual framework within science adds value to observation. Often, natural history is considered to be less than scientific as it can remain solely focused on a collection of observations; however, this would also be the case for sequencing genomes, cataloguing habitat types or counting colonies on a plate. I believe that an acceptable framework for natural history of a species or other biological systems incorporates the integration of current theory to provide additional value and context to natural history studies.

In the case of fluorescing flying squirrels, I had much of the pieces that provided context but had not made the important connections. I had always marveled at the interesting publication on the fluorescence of bones and urine of fox squirrels (*Sciurus niger*: Flyger & Levin 1971). Certainly, I knew that many bird species have the ability to see in the ultraviolet range and often appear significantly different in hue and pattern when viewed in ultraviolet light (Cronin & Bok 2016). Furthermore, I had led discussions on the response of birds and mammals to ultraviolet coronas along electric power lines (Tyler et al. 2014) and the use of ultraviolet cues in foraging in some mammals (Honkavaara et al. 2002). I had been teaching these for years in several of my courses on vertebrate behavior and biology. I enjoyed talking about how surprising such findings are and how we must step

out of our own world of sensory and scientific biases to learn more about the natural world around us. My surprise and the experience of being wrong are what remind me how important our experiences that document the natural history of a species, a habitat or an ecosystem can be. The importance of teaching and celebrating observation, how we document observations and how we can incorporate observations on natural history into critical information for the advancement of science and conservation are crucial.

In fact, the paper by Kohler et al. (2019) was the result of a fortuitous observation of one of the biologists involved who was out in their backyard one evening with an ultraviolet light when a new world flying squirrel glided through the beam to produce the remarkable colors that we now know are the result of fluorescence. What is the significance of that brief, quite literally less than a second, observation was not realized by a scientist broadly trained to appreciate the patterns of our natural world? The scientists then developed hypotheses and tested their ideas to assess how widespread the phenomenon was. As it turns out, the original novelty of the observation and efforts to provide context have led to additional studies that demonstrate that fluorescence is more common (Hughes et al. 2022, Sobral & Souza-Gudinhon 2022, Travouillon et al. 2023); however, the situation is not ubiquitous and clearly more complex in ways that suggest the importance of an evolutionary perspective (Newar et al. 2024). Natural history often permits us to literally and figuratively illuminate our natural world in new light. The value of natural history that provides context to observations must be cultivated, appreciated, and taught. A journal like *Mammalogy Notes* provides an important service to science in this way. As Albert Einstein once said, "It is entirely possible that behind the perception of our senses, worlds are hidden of which we are unaware," I wonder what he would have thought about fluorescent squirrels!

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