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DO SCIENTIFIC COLLECTING AND CONSERVATION CONFLICT?

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***Abstract.*—With the acceleration of species descriptions and declines, we risk potential conflict between conservation and scientific collecting of specimens. Scientific collecting may typically have minor influences on species viability, but scientific collectors are accountable to the public and influence public perception of scientists. Although inappropriate collecting incidents seem rare, and are probably due to naïveté, some scientific collectors may not always behave responsibly. Scientific collections are extremely important to understanding biodiversity, and we owe the public our diligence and responsible conduct. I propose an initial, hypothetical sampling scheme that could structure prudent sampling in a way that may minimize risk to threatened species or populations. I call for a concerted effort among herpetological societies, as an exemplar, to work with permit agencies to adopt, implement, and enforce an improved sampling scheme. Using this rationale in permits may reduce public questioning of the integrity of scientific collecting.**

Key Words.—ethics; public trust; responsible; scientific collecting guidelines; vouchers

INTRODUCTION

Under most conditions, scientific collecting and conservation efforts are synergistic and productive, but there may be circumstances when collecting and conservation conflict. A recent Perspective published by Minteer et al. (2014) indicated that there are times when scientific researchers should refrain from collecting due to uncertain risks of compromising or extirpating a population, or of pushing species closer to extinction; Minteer et al. cite examples from within the past two decades. Scientists (Rocha et al. 2014; Greenfieldboyce, N. 2014. Is collecting animals for science a noble mission or a threat? Available from http://www.npr.org/2014/ 06/18/318307574/is-collecting-animals-for-science-a-noble-mission-or-a-threat [Accessed 18 June 2014]) criticized the arguments by Minteer et al., but there should be some common ground. The main argument by Minteer et al. (2014) was that scientific researchers should be cautious, and perhaps refrain from scientific collecting, when they rediscover a believed extinct species or when they do not know the status of the populations or species.

The conflict between scientific collecting and conservation may mount as rates of species descriptions increase (currently about 6,000 per year; Mora et al. 2011), and as species extinctions escalate in the Anthropocene (hundreds to thousands of extinctions per year; Barnovsky et al. 2011; Pimm et al. 2014; Ceballos et al. 2015; McCallum 2015; Urban 2015, and others). This potential for conflict is exacerbated because, while most described species are common and widespread (Pimm et al. 2014), making them easy to study, most new descriptions will be on species that have restricted ranges, small numbers, and a higher vulnerability to human impacts (Pimm et al. 2014; Urban 2015). Poorly described taxa have underestimated extinction rates and many species will go extinct before being described (Pimm et al. 2014).

As someone who has worked in museums, with collections, and in the field (e.g., collections and field work synergistically: Hofmeyr et al. 2005; Daniels et al. 2007 and 2010; field work: Henen 1997; Henen et al. 1998 and 2013), I will briefly review the merits of collection-based research, some potential issues with scientific collecting, and the need for responsible scientific practices (including collecting). I propose a simple sampling scheme that may reduce conflict between conservation and collecting and discuss enforcement of responsible practices. I also call for a concerted effort among herpetological societies, as an exemplar, to work with permit agencies to adopt, implement, and enforce an improved sampling scheme.

MERIT OF COLLECTION-BASED RESEARCH

There are many significant findings and established uses for secure, properly curated scientific collections (Suarez and Tsutsui 2004; Rocha et al. 2014). However, not all biodiversity research is based on scientific collections, and, unfortunately, there are cases in which researchers may not collect responsibly. The ease and efficiency of access to specimens and affiliated information (e.g., dates, location, habitat, behavior or social grouping) in collections can facilitate a wide range of studies (Colbert 1966; Gaffney 1972; Trauth et al. 1994; Sterli and Joyce 2007; Siegel et al. 2012; and others). Collections can address how biodiversity is impacted by humans, including effects of pollutants (e.g., Ganther et al. 1972; Pain et al. 2005; see Suarez and Tsutsui 2004) and climate change (e.g., Graham et al. 2004; McCallum et al. 2009; Tingley et al. 2009;

Gardner et al. 2011). Likewise, chytridomycosis impacts on amphibians were advanced with powerful historical sampling from collections (Cheng et al. 2011).

However, contributions in these research areas have also been advanced by field studies of free-ranging animals (e.g., Henny and Meeker 1981; Gibbons 1990; Grant and Grant 2002; Fitch 2006; Lovich et al. 2014; and others). Health and disease disciplines benefit from non-lethal, field-based studies on live, free-ranging animals to identify and monitor status of disease sign, vectors, etiology, incidence, and impacts on populations and species (Lips 2011), even of threatened species (e.g., U.S. Fish and Wildlife Service 1990; Brown et al. 1994; Christopher et al. 1999, 2003). As with collections (Rocha et al. 2014), field studies of live animals can provide growth and generation time data (e.g., Nagy 1983; Medica et al. 2012) that are necessary for International Union for the Conservation of Nature (IUCN) Red List Assessments. For example, we used field studies of growth, scute ring counts, and reproductive maturity in Red List Assessments of sub-Saharan chelonians (e.g., Margaretha Hofmeyr and Ernst Baard, unpubl. report). Additionally, not all species descriptions require a voucher specimen (Marshall and Evenhuis 2015), although secured vouchers provide long-term reference material that can be studied repeatedly, used to verify holotype traits, and studied for additional traits.

POTENTIAL ISSUES WITH COLLECTING

The illegal trade of wildlife and wildlife products exceeds $30 billion USD annually and affects many vulnerable species (Wyler, L.S., and P.A. Sheikh. 2008. International Illegal Trade in Wildlife: Threats and US Policy. Congressional Research Service, The Library of Congress: Washington, D.C., USA. Available from http://oai.dtic.mil/oai/ [Accessed 10 March 2013]; EUROPOL. 2011. EU Organised Crime Assessment. Europol Analysis and Knowledge Unit, The Hague, Netherlands. Available from http://www.europol.europa.eu/content/publication/octa-2011-eu-organised-crime-threat-assesment-1465 [Accessed 7 February 2016]; Henen et al. 2013). Yet, the arguments that poaching, habitat loss, invasive species, and other threats play a much larger role in population declines and extinctions (e.g., Rocha et al. 2014) do not absolve researchers from performing responsibly (see Shamoo and Resnik 2015). Unfortunately, not everyone adheres fully to recommended guidelines, either intentionally or through naiveté, and research misconduct occurs (Wager and Williams 2011; Shamoo and Resnik 2015). Although most of the documented misconduct is associated with human or biomedical research (Fang et al. 2012), likely due in part to tighter monitoring and controls imposed by institutions, governmental organizations, and granting agencies for human research, misconduct still happens in wildlife and biodiversity research. As a biologist for more than 20 y, I have experienced or known of modern violations of regulations and ethics and my experience is not unusual. For example, as an Associate Editor for the African Journal of Herpetology, I had authors withdraw their manuscripts from consideration when I enforced journal policy of documenting their permits in the Acknowledgments because the authors did not have permits.

Are collections more important than conserving diversity in the wild? Because 86% of species remain unknown, Rocha et al. (2014) claim that an important goal of collecting is, in part, to document through carefully planned collections this unknown biodiversity. This goal may be admirable, but does this goal imply 14% of species are already documented in secure, carefully planned collections, that we must increase our museums and collections by 600% (= 86/14), and that museum collections are the best way to document this diversity? Researchers and collection managers have long realized that funding for, and appreciation of, collections was not and may never again be sustained at rates of the past (Suarez and Tsutsui 2004), jeopardizing the long-term viability of these carefully planned collections. Additionally, this goal does not include the need and means to characterize, document, and curate other types of diversity that is gained from field studies on live animals.

Collections and vouchers have been critical for describing species and other phylogenetic diversity (e.g., Glaw and Vences 2006, among others), but non-lethal sampling (e.g., blood sampling for herptile DNA; e.g., Daniels et al. 2007, 2010), advances in species identification from vocalizations (Brandes et al. 2006; Acevedo et al. 2009; Depraetere et al. 2011), and habitat modeling (Gebremedhin et al. 2009; see review by Schwartz 2009) significantly reduce the number of animals to be collected, sampled invasively, or handled for scientific or conservation purposes. We may need these types of methods and new algorithms (e.g., Ratnasingham and Hebert 2013) to help quantify the risks of biodiversity loss (Myers et al. 2000; Pimm et al. 2014), prioritize conservation action, and determine the best approaches to species and biodiversity description.

SELF-REGULATION, RESPONSIBLE CONDUCT, AND TRUST

Scientists regulate the scientific discipline and define what is good practice (Shamoo and Resnik 2015), yet scientists are accountable to the public (Shamoo and Resnik 2015; and American Society of Ichthyologists and Herpetologists [ASIH] 2004. Use of Live Reptiles and Amphibians in Research. Available at http://www.asih. org/publications [Accessed 7 February

2016]). This self-regulation also applies to researchers who wish to collect specimens and who typically are the experts in their field and taxa. However, they request permits from agency personnel who usually are not experts with those taxa, and who may not be experts in the rigors of scientific analyses and conduct. So researchers have a burden for responsible conduct and must continually sustain their integrity for the good of science, conservation, and public trust. Still, researchers may frequently have a conflict of interest (see Shamoo and Resnik 2015); their publication success, curation success, and career may depend on their voucher specimens and collections. Regardless of the seemingly minor threat new collections may have towards species extinction, we need to establish essential, sensible, and ethical rules of collection for when our collecting could compromise a species or population; this will benefit everyone involved, including the researchers and those overseeing their work.

Shamoo and Resnik (2015) reviewed the intrinsic value of animals and listed five R's for responsible use of animals in research. Although most conflict (e.g., from the Animal Liberation Front) and controls (e.g., Institutional Animal Care and Use Committees [IACUC]) are associated with laboratory animals and experiments, the fundamentals still apply to the intrinsic value of wild animals as important sources of biodiversity (Shamoo and Resnik 2015). The five R's include Replacement (use a method that does not require an animal), Reduction (use a smaller sample size with more powerful analytic and statistical methods when possible), Refinement (adjust methods to minimize use of or harm to animals), Relevance (use animals if the research has scientific relevance), and Redundancy avoidance (repeat research only if necessary). While collections are valuable, new methods may reduce the need for vouchers and collections. Additionally, the use of innovative, non-destructive sampling (see above) can alleviate the harm that animals may endure and the need for some handling and sampling (Schwarz 2009).

Science relies on honesty and trust within the community and the support of science by society depends on scientific integrity and trust of scientists (Shamoo and Resnik 2015). This applies to collecting, degrees of manipulating live animals in the field (ASIH. 2004. *op. cit.*), humane treatment of subjects, reduction of animal numbers used, and protection of animals in research (Shamoo and Resnik 2015), including abiding by IACUC, society (e.g., ASIH 2004. *op. cit.*), and publisher rules. One question used to support collecting voucher specimens is 'how can we trust the research if we cannot verify data for the specimen?' Although there is validity to this argument (i.e., vouchers can support verification), much of the scientific enterprise is based on trust. From grant proposals to study design, sample collection, sample analyses and calculations, statistical analyses, and interpretations from those analyses, we grant a certain degree of trust to members of our scientific community. At some level there is some trust applied to all the manuscripts that we review for journals, and proposals we review for funding agencies. This trust does not eliminate the need for vouchers in many circumstances, but we may need to trust some research without vouchers (e.g., see Marshall and Evenhuis 2015), or verify such research as best possible with subsequent study.

To minimize the inadvertent or deliberate harm induced by collecting specimens, and sustain the public support of science, it is essential that we teach and enforce protocols to reduce collecting from small or poorly-known populations and species, and avoid collecting vouchers for new species or those previously believed to be extinct (Minteer et al. 2014) until we know the population and species are viable and sustainable. We should be careful to avoid rapid field decisions that may occur under stressful field or political situations. Clear guidelines and recommendations can help with these decisions, but matters of right and wrong depend on factors inherent in the situation (Shamoo and Resnik 2015) and researchers should weigh whether to collect based on the state of the species and populations that they sample. By using a more explicit rationale and scheme for collecting, we may reduce over-collecting (Norton et al. 1994; Puschendorf et al. 2005; Nishida 2006; Minteer et al. 2014), and be better able to justify collecting to the public (see Hill. 2015. Scientist Takes First-Ever Photo of Rare Bird, Then Kills It in the Name of Science. Available from http://www.takepart.com/article/2015/10/09/first-photo-bird-killed-science [Accessed 11 November 2015]; Filardi. 2015. Available from https://www.audubon.org/news/why-i-collected-moustached-kingfisher [Accessed 11 November 2015]).

HYPOTHETICAL SAMPLING SCHEME

As scientists, we typically pioneer studies where much is not known, including the viability of populations. If we are then permitted to venture forward, other permit criteria are prudent. Permit options could include collecting suspected new taxa based on encounter frequencies after meeting a threshold sample size for DNA samples, recordings, photographs, and individual measurements on live animals; such data can be used for grant proposals, publications, and arguing for habitat and species conservation. For example, after encountering 20 individuals of a suspected new taxon (see botanical guideline by Norton et al. 1994), scientists might collect every fifth, tenth, or twentieth individual encountered. The rate of scientific collecting might be influenced by the encounter rate relative to encounter rates of other species (e.g., 1:5, 1:10, or 1:20 ratios), and the number

of additional animals anticipated to be encountered. The sample size should not exceed that necessary to achieve analytical and statistical power for critical biological questions. Subsequent encounter rates may change within or among populations, so subsequent collecting rates should be adapted conservatively. Additional considerations may include whether to collect juveniles or gravid females, which may help sustain the population.

IMPLEMENTING AND ENFORCING RESPONSIBLE COLLECTING

Study design and sampling are prudent procedures most of us learn in graduate school before we are allowed to pursue research. The critical decisions and criteria are established before getting the permit and long before field work begins. Permit enforcement is another critical element to minimize violations. The IUCN has sound, inter-disciplinary scientific information, policy, and risk-assessed practices (Soorae 2013) for re-introducing animals to the wild. For the opposite practice, collecting from the wild, we can devise analogous, practical, and ethical guidelines.

Given the increasing risks of conflict between scientific collecting and conservation, decreased financial support, and what may be a decreasing trust of the public, it is prudent that we devise, implement and enforce improved collecting guidelines among our research societies and permit agencies. If our herpetological societies collaborate with each other and permit agencies, we can develop consistent guidelines that may also be adapted by researchers working with other taxa. The synergism of our collective efforts should help minimize conservation risks while also strengthening a good reputation with and support of the public.

We must also provide better education, implementation, and enforcement of permitting policies to enhance our scientific ethos, whether for collecting, handling, data analysis and interpretation, publishing, or providing peer review. Ethical conduct in research requires ethical leadership at individual, institutional, supervisory, national, and international levels (Shamoo and Resnik 2015). Mentorship, setting examples, and making responsible choices are necessary to prevent misconduct and promote integrity (Shamoo and Resnik 2015). Abiding by a rigorous permit with a logical sampling scheme to address potential new discoveries should help us minimize errors in collecting, and minimize conflict between scientific collecting and conservation.

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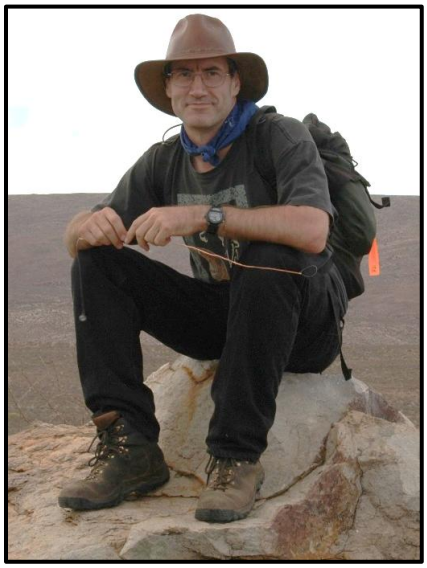

BRIAN T. HENEN received his Ph.D. for his ecophysiological study of reproductive effort in Agassiz's Desert Tortoises, *Gopherus agassizii*. Since then he has studied the biology of *G. agassizii* and other tortoise species, including endangered or critically endangered species. (Photographed by leFras N. Mouton).