Taxonomic Bias in Conservation Research

TAXONOMIC BIAS IS PERVASIVE IN organismal research; i.e., research is not proportional to organisms' frequency in nature (*1–4*). Quantifying research bias is difficult, but a reasonable proxy measure is to evaluate subject organisms in the research literature (e.g., *1*, *4*). For example, in a review of over 32,000 entries from 1979 to 1998 in the Zoological Records database, researchers found that, although amphibian species outnumber mammalian species, the literature contained 10 times as many papers on mammals (*3*). We wondered if conservation research would show less taxonomic bias. After all, conservationists advocate a comprehensive, integrated approach to preservation of biodiversity, e.g., the famous Aldo Leopold statement that the first precaution of intelligent tinkering is to "keep every wheel and cog " (*5*, p. 190). Saving all these parts necessarily requires research on each of them.

To evaluate taxonomic bias in conservation research, we reviewed 15 years of issues (1987–2001) of the two leading conservation research journals: *Conservation Biology* (United States) and *Biological Conservation* (United Kingdom). We examined all reviews, contributed papers, and short notes from these journals. Overall, we analyzed and cataloged more than 2700 articles with a primary focus on one or more organismal groups. In general, we used IUCN (World Conservation Union) data for species numbers worldwide (*6*, *7*). Unfortunately, we found that taxonomic bias also pervades the conservation literature (see panel A of figure).

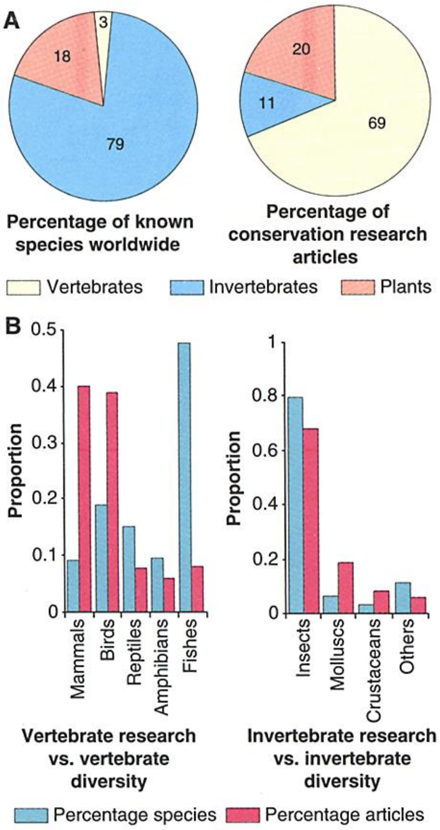
Plant research generally reflected plants' relative prevalence in nature (20% of papers versus 18% of species). But invertebrate research was highly underrepresented (11% of papers versus 79% of species), and vertebrate research was highly overrepresented (69% of papers versus just 3% of species). Among vertebrates (see panel B of figure), birds (39% of papers versus 19% of species) and mammals (40% of papers versus 9% of species) were substantially overrepresented. However, fish (8% of papers versus 48% of species), reptiles (8% of papers versus 15% of species), and amphibians (6% of papers versus 9% of species) were underrepresented.

We also found bias among invertebrates (see panel B of figure), but this bias was less profound. Molluscs (19% of papers versus 6% of species) and crustaceans (8% of papers versus 3% of species) were overrepresented, whereas insects (68% of papers versus 80% of species) and other invertebrates (6% of papers versus 11% of species) were underrepresented. And among insects, butterflies and moths (48% of papers versus 15% of species) were substantially overrepresented, whereas beetles (26% of papers versus 39% of species) and other insects (26% of papers versus 46% of species) were underrepresented.

The taxonomic bias we document in the conservation literature is even more severe than that in the taxonomic community's literature (*2*) or in the scientific literature in general (*4*). But this bias is not as severe as in the funding and research activities of the majority of conservation organizations (*8*), whose focus is almost wholly on birds and mammals.

Given the maturation of conservation biology as a discipline and the increasing attention to the issue of taxonomic bias, we hoped that such bias in conservation research would have decreased over time. However, we were disappointed to find that, with the exception of an increase in the proportion of articles on amphibians, taxonomic bias in the conservation literature has not improved over the past 15 years (*9*).

Although taxonomic bias in conservation research is extensive, such bias is not necessarily insidious and, in some cases, could serve a reasonable end. Without public support, biodiversity protection efforts will likely fail. Public support for more charismatic species, such as eagles and pandas, could have trickle-down benefits for less charismatic species. However, it is difficult to imagine how we can save all the parts without knowing anything about the vast majority of those parts. Perhaps conservation funding agencies and organizations should more equitably allocate research monies across the taxonomic spectrum, and perhaps conservation journals should more equitably publish research on underrepresented taxa. But simply knowing that taxonomic bias exists in conservation



(A) Proportion of major organismal taxa in nature versus conservation literature. (B) Proportion of vertebrates and invertebrates in nature versus conservation literature.

PHOTO CREDITS: (BIRD) GERALD AND BUFF CORSI/CALIFORNIA ACADEMY OF SCIENCES; (BEETLE) LLOYD GLENN INGLES/CALIFORNIA ACADEMY OF SCIENCES; (CRAB) GERALD AND BUFF CORSI/CALIFORNIA ACADEMY OF SCIENCES research is a first step in determining what actions we should take to address this bias.

J. ALAN CLARK[1]* AND ROBERT M. MAY[2]
[1]Department of Zoology, University of Washington, Box 351800, Seattle, WA 98195–1800, USA.
[2]Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK.
*To whom correspondence should be addressed.
E-mail: alanc@u.washington.edu

References and Notes
1. R. May, *Science* **241**, 1449 (1988).
2. K. Gaston, R. May, *Nature* **356**, 281 (1992).
3. R. Shine, X. Bonnet, *Trends Ecol. Evol.* **15**, 221 (2000).
4. X. Bonnet *et al.*, *Trends Ecol. Evol.* **17**, 1 (2002).
5. A. Leopold, *A Sand County Almanac, and Sketches Here and There* (Oxford Univ. Press, New York, 1949).
6. C. Hilton-Taylor, *2000 IUCN Red List of Threatened Species* (IUCN, Gland, Switzerland, and Cambridge, UK, 2000).
7. For comparisons among insects, we used R. Arnett Jr., *American Insects* (CRC Press, Boca Raton, FL, ed. 2, 2000).
8. B. Czech *et al.*, *Conserv. Biol.* **12**, 1103 (1998).
9. See supplemental figure available on *Science Online* at www.sciencemag.org/cgi/content/full/297/5579/191/DC1.

Igniting Nanotubes with a Flash

THE ASTONISHING RESULTS OF P. M. AJAYAN *et al.* ("Nanotubes in a flash—ignition and reconstruction," Brevia, 26 April, p. 705) demonstrating ignition of carbon nanotubes after exposure to a photographic flash inspired us to make further explorations along the same lines. We found that similar effects can be obtained with other carbons that bear noble metal catalysts, for example, Pd on carbon.

We first reproduced both the photoacoustic effect and the ignition of single-walled carbon nanotubes. Exposing commercially available nanotubes (HiPco or as-prepared samples from Tubes@Rice) to a flash from an ordinary photoflash unit held 1 to 3 cm from the surface of the samples resulted in easily heard retorts. Sound intensity increased as the flash was moved closer to the samples. On very close approach (<1 cm), both nanotube samples ignited with a dull red glow. These two materials contain catalytic particles of iron or nickel/cobalt alloy, respectively, in addition to carbon. Other carbons (Norit-activated carbon and graphite powder) produced a weaker photoacoustic effect but did not ignite. However, several commercial Pd catalysts supported on carbon (Pd loadings of 5, 10, and 30 weight %) all produced marked photoacoustic effects and ignition. Simple physical mixtures of Pd powder, iron carbide powder, or copper powder with graphite or Norit produced photoacoustic effects but not ignition. Similarly, graphite powder that was sputter-coated with very small amounts of Pd did not ignite.

Our simple survey indicates that the photoacoustic effect and ignition are not peculiar to carbon nanotubes. The common features of materials that ignite are the combination of a well-dispersed metal catalyst in intimate contact with a high–surface area carbon. Although the mechanism of this ignition process is unclear, we hypothesize that it arises from photophysical effects associated with metal and carbon in chemical contact.

BRADLEY BOCKRATH,* J. KARL JOHNSON, DAVID S. SHOLL, BRET HOWARD, CHRISTOPHER MATRANGA, WEI SHI, DANIEL SORESCU
National Energy Technology Laboratory, Post Office Box 10940, Pittsburgh, PA 15236, USA.
*To whom correspondence should be addressed.
E-mail: bockrath@netl.doe.gov

Response

BOCKRATH *ET AL.* CONFIRM OUR EXPERIMENTAL observation about the photoignition of single-walled carbon nanotubes (SWNTs) but suggest that the catalytic particles present in the sample play a key role in the ignition process. Although this might be the case, the ignition process is far more complicated than that. Indeed, the lack of ob-