Response from Soleri and colleagues

Authors: SOLERI, DANIELA, CLEVELAND, DAVID A., and CUEVAS, FLAVIO ARAGÓN

Source: BioScience, 56(9) : 709-710

Published By: American Institute of Biological Sciences

URL: https://doi.org/10.1641/0006-3568(2006)56[709:RFSAC]2.0.CO;2

PUBLISHER
Richard T. O'Grady

EDITOR IN CHIEF
Timothy M. Beardsley

SENIOR EDITOR
Donna Daniels Verdier

PRODUCTION MANAGER / ART DIRECTOR
Herman Marshall

PUBLICATIONS ASSISTANT
Jennifer A. Williams

Editors: Eye on Education: Susan Musante (educationoffice@aibs.org); Feature articles: Cathy Lundmark (features@aibs.org); Washington Watch: Robert E. Gropp (publicpolicy@aibs.org).

Editorial Associate: Barbara J. Orton.

Editorial Board: Agriculture: Sonny Ramaswamy; Animal Behavior: Janice Moore; Animal Development: Paula Mabee; Botany: Gregory J. Anderson; Cell Biology: Randy Wayne; Ecology: Scott Collins, Daniel Simberloff; Ecotoxicology: Judith S. Weis; Education: Gordon E. Uno; Environmental Policy: Gordon Brown, J. Michael Scott; Evolutionary Biology: James Mallet; Genetics and Evolution: Martin Tracey; History and Philosophy: Richard M. Burian; Invertebrate Biology: Kirk Fitzhugh; Landscape Ecology: Monica Turner; Microbiology: Edna S. Kaneshiro; Molecular Biology: David Hillis; Molecular Evolution and Genomics: David Rand; Neurobiology: Cole Gilbert; Plant Development: Cynthia S. Jones; Policy Forum: Eric A. Fischer; Population Biology: Ben Pierce; Professional Biologist: Jean Wyld; Sensing and Computation: Geoffrey M. Henebry; Statistics: E. Barry Moser; Vertebrate Biology: Harvey B. Lillywhite.

Editorial Correspondence: 1444 I Street, NW, Suite 200, Washington, DC 20005; telephone: 202-628-1500; fax: 202-628-1509; e-mail: bioscience@aibs.org. Instructions for preparing a manuscript for *BioScience* can be found at *www.aibs.org/bioscience/resources/Info_for_contribs.pdf.*

Advertising: For information on both display and line classified advertisements and deadlines, contact John Rasanen, American Geological Institute; telephone: 703-379-2480, ext. 224; fax: 703-379-7563; e-mail: jrasanen@aibs.org.

BioScience (ISSN 0006-3568) is published monthly by the American Institute of Biological Sciences. To subscribe, call 1-800-992-2427, ext. 29. Individual membership: sustaining, $90/yr; individual, $70/yr; family, $90/yr (includes $36 for *BioScience*); emeritus, $50/yr; K–12 teacher/administrator, $45/yr (includes $22 for *BioScience*); graduate and postdoctoral students, $40/yr (includes $21 for *BioScience*); undergraduate and K–12 students, $20/yr (includes $15 for *BioScience*); lifetime, $1400 (one-time fee). Institutional subscriptions: domestic, $280/yr; foreign, $336/yr. Single copies: $14 plus shipping and handling for up to 20 copies; volume discounts available for more than 20 (call 1-800-992-2427, ext. 29). Subscription renewal month is shown in the four-digit year–month code in the upper right corner of the mailing label.

 Periodical postage paid at Washington, DC, and additional mailing offices.

POSTMASTER: Send address changes to *BioScience* Circulation, AIBS, 1313 Dolley Madison Blvd., Suite 402, McLean, VA 22101. Printed in USA.

BioScience

Organisms from Molecules to the Environment

American Institute of Biological Sciences

Where to Find Allies?

Good news from the conservation front is rare, so the article that starts on p. 723 of this issue of *BioScience,* by L. J. Gorenflo and Katrina Brandon, is worth a careful look. The researchers examined priority "gap" locations around the world that had previously been identified as lying outside existing protected areas but harboring species vulnerable to extinction; these locations occur disproportionately in the tropics, on islands, and in mountains. Gorenflo and Brandon analyzed the priority gap locations, at high spatial resolution, in terms of their human population density, land use or land cover, and suitability for agriculture. The surprise, and the good news, is that in many priority gap locations, these human factors—which the authors see as crucial ones—are conducive to conservation. These locations had contiguous tracts of more than 10,000 hectares of conservation-compatible habitat, sparse human population, and poor suitability for agriculture. Most of the gap locations did not feature high levels of threat caused by humans.

Considering the importance of the three human factors individually in the priority gap locations suggests that human presence is a hindrance to conservation in coastal areas worldwide and on several islands, such as Hispaniola, Jamaica, Sri Lanka, and Puerto Rico. It also suggests that agricultural potential could hinder conservation efforts in parts of the Andes, central Mexico, and parts of Brazil and Africa.

Such a global outlook might seem to have little to do with real, on-the-ground conservation decisions, which are usually political compromises between stakeholders with different agendas. True, the lack of global data prevented Gorenflo and Brandon from considering many human factors (such as form of governance) that are important in determining whether a protected area is established. Nonetheless, some global trends in human behavior suggest that the sort of extended gap analysis Gorenflo and Brandon describe could help in conservation decisionmaking.

Governments are not the only players able to conserve biodiversity. Globalization means that corporations have the power to take meaningful steps to protect the environment, and many are increasingly anxious to protect the public image of their brands. No matter that this is largely enlightened self-interest: The results can be significant. As a consequence of pressure from investors, customers, and employees, some major companies are now taking voluntary steps to reduce their environmental impacts. Thanks to the Web, worldwide communication is both convenient and immediate, and companies large and small are learning that there is such a thing as bad publicity, including publicity about poor environmental performance.

Activists have long sought to persuade companies to demonstrate their corporate good citizenship in environmental affairs. Detailed knowledge of sites worldwide that are promising prospects for conservation might well help, by suggesting how companies can burnish their brand images with conservation dollars. Further study of human factors in priority conservation sites might also suggest which companies can be persuaded to help prevent extinctions. Conservationists stand ready to accept allies wherever they find them.

TIMOTHY M. BEARDSLEY
Editor in Chief

American Institute of Biological Sciences

Dedicated to advancing biological research and education for the welfare of society.

Member Societies and Organizations

Academy of Natural Sciences
American Arachnological Society
American Association of Botanical Gardens and Arboreta
American Bryological and Lichenological Society
American Fern Society
American Fisheries Society
American Malacological Society
American Mosquito Control Association
American Museum of Natural History
American Ornithologists' Union
American Phytopathological Society
American Society for Gravitational and Space Biology
American Society for Photobiology
American Society of Agronomy
American Society of Ichthyologists and Herpetologists
American Society of Limnology and Oceanography
American Society of Mammalogists
American Society of Naturalists
American Society of Parasitologists
American Society of Plant Biologists
American Society of Plant Taxonomists
American Type Culture Collection
Animal Behavior Society
Arkansas State University Department of Biological Sciences
Association for Politics and the Life Sciences
Association for Tropical Biology and Conservation
Association of College and University Biology Educators
Association of Ecosystem Research Centers
Association of Southeastern Biologists
Bailey-Matthews Shell Museum
Bell Museum of Natural History
Berkeley Natural History Museums
Biological Sciences Curriculum Study
BioQUEST Curriculum Consortium
Bishop Museum
Botanical Research Institute of Texas
Botanical Society of America
Brooklyn Botanic Garden
Burke Museum of Natural History
Cactus and Succulent Society of America
California Academy of Sciences
Carnegie Museum of Natural History
Cell Stress Society International
The Centennial Museum
Charles R. Connor Natural History Museum
Chicago Botanic Garden
Cleveland Museum of Natural History
Coastal Education and Research Foundation
Cooper Ornithological Society
Cornell Center for the Environment
Cornell University Department of Plant Biology
Council of Science Editors
Crop Science Society of America
Dallas Museum of Natural History
Delaware Museum of Natural History
Denver Museum of Nature and Science
Ecological Society of America
Entomological Society of America
Entomological Society of Canada
Estuarine Research Federation
Field Museum
Florida Division of Plant Industry
Florida Marine Research Institute
Florida Museum of Natural History
Freshwater Mollusk Conservation Society
Georgia Museum of Natural History
Gulf Coast Research Laboratory
Harvard Museum of Comparative Zoology
The Helminthological Society of Washington
Herpetologists' League
Human Anatomy and Physiology Society
Hunt Institute for Botanical Documentation
Illinois Natural History Survey
Illinois State Museum
Instituto de Geología, UNAM
International Association for Bear Research and Management
International Association for Landscape Ecology, US Region
International Society for Ecological Modelling
International Society of Protistologists
Kansas (Central States) Entomological Society
Kansas University Natural History Museum and Biodiversity Institute
Long Term Ecological Research Network
Louisiana Museum of Natural Science
Miami University, W. S. Turrell Herbarium
Michigan State University Museum
Milwaukee Public Museum
Mississippi Museum of Natural Science
Missouri Botanical Garden
Monte L. Bean Museum of Life Sciences
Moore Laboratory of Zoology
Morton Arboretum
Museum of Southwestern Biology
Mycological Society of America
National Association of Biology Teachers
National Association of Marine Laboratories
National Evolutionary Synthesis Center
National Museum of Natural History
National Shellfisheries Association
National Tropical Botanical Garden
Natural Areas Association
Natural History Museum of Los Angeles County
Natural Science Collections Alliance
NatureServe
New Mexico Museum of Natural History and Science
New Mexico State University Department of Entomology, Plant Pathology, and Weed Science
New York Botanical Garden
New York State Museum
North American Benthological Society
North American Lake Management Society
North Carolina Botanical Garden
North Carolina Museum of Natural Science
North Carolina State University Insect Collection
Ohio State University Museum of Biological Diversity
Ohio University Department of Environmental and Plant Biology
Oklahoma State University, Office of the President
Organization for Tropical Studies
Organization of Biological Field Stations
The Orthopterists' Society
Paleontological Research Institution
Peabody Museum of Natural History
Phi Sigma Biological Sciences Honor Society
Phycological Society of America
Poultry Science Association
Purdue University Entomology Environmental Lab
R. M. Bohart Museum of Entomology
Radiation Research Society
Sam Noble Oklahoma Museum of Natural History
San Bernardino County Museum
San Diego Natural History Museum
Santa Barbara Museum of Natural History
Sarah P. Duke Gardens
Science Museum of Minnesota
Scripps Institution of Oceanography
Slater Museum of Natural History
Society for Conservation Biology
Society for Economic Botany
Society for In Vitro Biology
Society for Industrial Microbiology
Society for Integrative and Comparative Biology
Society for Mathematical Biology
Society for Northwestern Vertebrate Biology
Society for Range Management
Society for Sedimentary Geology
Society for the Study of Amphibians and Reptiles
Society for the Study of Evolution
Society of Environmental Toxicology and Chemistry
Society of Nematologists
Society of Systematic Biologists
Society of Wetland Scientists
Soil Science Society of America
Southern Appalachian Botanical Society
Southwestern Association of Naturalists
Sternberg Museum of Natural History
Texas A&M University Department of Entomology
Texas Memorial Museum
Texas Tech University Department of Biological Sciences
Torrey Botanical Society
University of Alaska Museum of the North
University of California–Santa Barbara Center for Biodiversity and Ecological Restoration
University of Connecticut Department of Ecology and Evolutionary Biology
University of Iowa Department of Geoscience
University of Michigan Genomic Diversity Laboratory
University of Nebraska State Museum
University of Wisconsin Zoology Museum
US Federation for Culture Collections
US Society for Ecological Economics
Utah Museum of Natural History
Virginia Institute of Marine Science
Virginia Museum of Natural History
Weed Science Society of America
Western Society of Naturalists
The Wildlife Society

Transgenic Maize in Mexico

In a recent article in *BioScience,* Soleri and colleagues (2006) cite our research and challenge our conclusions concerning the presence of transgenic maize in Oaxaca, Mexico (Ortiz-García et al. 2005a). As Soleri and colleagues stated, we concluded that the frequency of transgenic seeds was near zero, or extremely rare, and there was no current evidence for transgene introgression into maize landraces in the studied region of Sierra de Juárez, Oaxaca. However, Soleri and colleagues have misinterpreted or misunderstood many of our results, and we would like to clarify some points.

Citing their own work as evidence (Cleveland et al. 2005), Soleri and colleagues argue that our conclusions are "not scientifically justified." However, they fail to note that (a) their paper was part of an editor-reviewed roundtable discussion and not a peer-reviewed scientific analysis, and that (b) their criticisms were appropriately answered in a reply published together with their discussion paper (Ortiz-García et al. 2005b). Soleri and colleagues reiterate arguments that have already been addressed in our published reply, which was omitted from the citations in their *BioScience* article. In order not to wade again through a prolonged technical discussion, we would like to refer readers to their original paper and to our detailed rebuttal.

Despite Soleri and colleagues' conclusions, the results of our study are quite clear-cut: In 2000, Quist and Chapela (2001, 2002) sampled six maize ears in some plots near Ixtlán de Juárez in Oaxaca and found transgenic constructs in four of them. Then, when we sampled the same area in 2003 and 2004, we did not find a single transgenic construct among 153,746 seeds from more than 870 plants growing in 125 fields (Ortiz-García et al. 2005a). This, of course, is not proof that transgenes were completely absent from the area (as we clearly mention in our paper), but our results certainly imply that if transgenes were present in these plots, they persisted at frequencies that were, in all likelihood, far lower than they were in 2000. This absence of detectable transgenes is consistent with recent reports cited on the ETC Group Web page (*www.etcgroup.org/documents/ETCMaizeNRfinal.pdf*), and no peer-reviewed papers have appeared to either confirm or refute our findings.

To reiterate, at the scale and the resolution at which we did our analysis, transgenes that seemed to be common in traditional maize varieties in the year 2000 can no longer be regarded as common, and earlier assumptions that they had introgressed widely (e.g., Quist and Chapela 2001) have not been confirmed. We are now refining our sampling procedures for this region to gain even greater precision in our detection capacity by sampling fewer seeds from a larger number of maternal plants. However, this effort does not invalidate the results we have published so far. We hope that other research groups will publish related studies promptly to provide a better understanding of the generality of our findings from the Sierra de Juárez of Oaxaca.

SOL ORTIZ-GARCÍA
EXEQUIEL EZCURRA
BERND SCHOEL
FRANCISCA ACEVEDO
JORGE SOBERÓN
ALLISON A. SNOW

Sol Ortiz-García is the coordinator of the Biosafety Program at the Instituto Nacional de Ecología, SEMARNAT, in Mexico City, Mexico. Exequiel Ezcurra is director of the Biodiversity Research Center of the Californias and provost of the San Diego Natural History Museum, San Diego, CA 92101. Bernd Schoel is at Genetic ID North America, Inc., Fairfield, IA 52556. Francisca Acevedo is at the Comisión Nacional para el Conocimiento y Uso de la Biodiversidad en México, Mexico City, Mexico. Jorge Soberón is at the Biodiversity Institute, University of Kansas, Lawrence, KS, 66047. Allison A. Snow (e-mail: snow.1@osu.edu) is a professor in the Department of Evolution, Ecology, and Organismal Biology, Ohio State University, Columbus, OH 43210.

Letters to the Editor
BioScience
1444 I Street, NW, Suite 200
Washington, DC 20005
E-mail: bioscience@aibs.org
The staff of *BioScience* reserves the right to edit letters for clarity without notifying the author. Letters are published as space becomes available.

References cited

Cleveland DA, Soleri D, Aragón Cuevas F, Crossa J, Gepts P. 2005. Detecting (trans)gene flow to landraces in centers of crop origin: Lessons from the case of maize in Mexico. Environmental Biosafety Research 4: 197–208.

Ortiz-García S, Ezcurra E, Schoel B, Acevedo F, Soberón J, Snow AA. 2005a. Absence of detectable transgenes in local landraces of maize in Oaxaca, Mexico (2003–2004). Proceedings of the National Academy of Sciences 102: 12338–12343.

———. 2005b. Reply to Cleveland et al.'s "Detecting (trans)gene flow to landraces in centers of crop origin: Lessons from the case of maize in Mexico." Environmental Biosafety Research 4: 209–215.

Quist D, Chapela IH. 2001. Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico. Nature 414: 541–543.

———. 2002. Quist and Chapela reply. Nature 416: 602.

Soleri D, Cleveland DA, Aragón Cuevas F. 2006. Transgenic crops and crop varietal diversity: The case of maize in Mexico. BioScience 56: 503–514.

Response from Soleri and colleagues

Ortiz-García and colleagues (2005a) agreed with us that variance effective population size ($N_{e(v)}$), not census population size (n), should be used to estimate transgene frequency (Vencovsky and Crossa 1999), and reanalyzed their data using $N_{e(v)}$ with two additional statistical tests. The first was based on the assumption that sampled maize populations had no significant structure, which is not valid (Cleveland et al. 2005). The second, Fisher's combined probability test, gave a minimum detection level for seeds in 2004 of approximately 1% (0.00775, $P < 0.05$) (Ortiz-García et al. 2005b), close to our estimate of approximately 1%–4% (0.00961–0.03586, $P < 0.05$) across individual locations, accounting for popula-

tion structure (Cleveland et al. 2005), and contrasted with their original estimate of 0.01%, P = 0.00003 (Ortiz-García et al. 2005a). Therefore, there is no evidence to refute our conclusion that "we still do not have any data to support the proposition that transgenes are not present at other localities, or at frequencies below 1–4% in the localities in the Ortiz-García et al. study" (Cleveland et al. 2005, p. 205).

Although Ortiz-García and colleagues assume that Quist and Chapela's study showed transgenes "common in traditional maize varieties," that study was based on a very small, nonrandom sample; the study showed only transgene presence and thus cannot be used to estimate changes in transgene frequency (Cleveland et al. 2005).

It is important to see the debate about transgene presence from unintended gene flow in a wider policy context: Commercialization of transgenic varieties, especially in centers of origin, may have difficult-to-predict effects—many irreversible—on landrace diversity and farmer well-being. Therefore, wide scientific discussion of research methodologies and results is critical.

DANIELA SOLERI
DAVID A. CLEVELAND
FLAVIO ARAGÓN CUEVAS
Daniela Soleri (e-mail: soleri@es.ucsb.edu) is an ethnoecologist in the Environmental Studies Program and Geography Department, and David A. Cleveland is a human ecologist in the Environmental Studies Program, at the University of California, Santa Barbara, CA 93106. Flavio Aragón Cuevas is a maize breeder and senior plant genetic resources specialist with the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias, Santo Domingo Barrio Bajo, Etla, Oaxaca, Mexico.
The authors thank José Crossa for comments on this letter.

References cited

Cleveland DA, Soleri D, Aragón Cuevas F, Crossa J, Gepts P. 2005. Detecting (trans)gene flow to landraces in centers of crop origin: Lessons from the case of maize in Mexico. Environmental Biosafety Research 4: 197–208.

Ortiz-García S, Ezcurra E, Schoel B, Acevedo F, Soberón J, Snow, AA. 2005a. Reply to Cleveland et al.'s "Detecting (trans)gene flow to landraces in centers of crop origin: Lessons from the case of maize in Mexico." Environmental Biosafety Research 4: 209–215.

———. 2005b. Absence of detectable transgenes in local landraces of maize in Oaxaca, Mexico (2003–2004). Proceedings of the National Academy of Sciences 102: 12338–12343.

Vencovsky R, Crossa J. 1999. Variance effective population size under mixed self and random mating with applications to genetic conservation of species. Crop Science 39: 1282–1294.

The Value of Barcoding

Kirk Fitzhugh (2006a, 2006b) has recently offered a novel critique of DNA barcoding based on his own carefully considered interpretation of species as "explanatory hypotheses." Though he is not alone in questioning a method that claims to identify species based on a single genetic locus (Lipscomb et al. 2003, Mallet and Willmott 2003, Wheeler 2005), I fear that Dr. Fitzhugh's particular philosophical interpretation of the problem may prove more than he intends.

According to that interpretation, since species as explanatory hypotheses are the products of abductive reasoning, they cannot be identified on the basis of DNA data alone without running afoul of Rudolf Carnap's requirement of total evidence, which holds that "for one to rationally believe a conclusion on the basis of some set of evidence, then all available relevant evidence must be taken into consideration" (Fitzhugh 2006a). But DNA barcoding is hardly unique in failing to meet this requirement. If barcoders cannot rationally defend species identifications based solely on DNA sequence because this ignores "other relevant properties in need of explanation" (presumably morphological, biochemical, behavioral, or other non-DNA properties), then surely morphological taxonomists are also irrational if their identifications fail to consider DNA sequences, which are similarly properties in need of explanation.

Dr. Fitzhugh is thus unfair to level his criticism specifically at DNA barcoding, as it should be aimed instead at any nonintegrative taxonomic method. More to the point, there has never been—nor will there ever be—a taxonomic hypothesis that did not exclude some available relevant evidence. Since any practicable taxonomic approach will inevitably fail the strict requirement laid out in Dr. Fitzhugh's critique, and as the scientific community is unlikely to classify all taxonomy as irrational, I submit instead that Carnap's principle is perhaps not the most satisfying way to assess the rationality of scientific thought.

In addition, I think it important to note that the validity of DNA barcoding does not rest entirely (and perhaps not even primarily) on its success in species identification. Many proposed applications of this technology focus instead on the identification of individuals to the species level. In these applications the identification of species is done quite independently, typically by traditional and integrative taxonomic methods; in fact, most applied barcoding assumes the validity of species identifications made by such methods. Such applications of DNA barcoding could prove enormously useful in a variety of contexts, despite the tendency of some to consider them scientifically uninteresting (e.g., Wheeler 2005, Will et al. 2005). Technically, as individuals are neither hypotheses nor explanatory constructs, Dr. Fitzhugh's philosophical objections do not apply to the adoption of barcoding as a means to identify them. Even if successful, then, his critique is not a wholesale indictment of DNA barcoding, and should not on its own forestall the pursuit of that technology.

JOHN DARLING
John Darling (e-mail: Darling.John@epamail.epa.gov) is a postdoctoral fellow in the National Exposure Research Laboratory at the US Environmental Protection Agency, Cincinnati, OH 45268. The views expressed in this letter are his own and do not necessarily reflect those of the US Environmental Protection Agency.

References cited

Fitzhugh K. 2006a. DNA barcoding: An instance of technology-driven science? BioScience 56: 462–463.

———. 2006b. The inferential basis of species hypotheses: The solution to defining the term "species." Marine Ecology 26: 155–165.

Lipscomb D, Platnick N, Wheeler Q. 2003. The intellectual content of taxonomy: A comment on DNA taxonomy. Trends in Ecology and Evolution 18: 65–66.

Mallet J, Willmott K. 2003. Taxonomy: Renaissance or Tower of Babel? Trends in Ecology and Evolution 18: 57–59.

Wheeler QD. 2005. Losing the plot: DNA "barcodes" and taxonomy. Cladistics 21: 405–407.

Will KW, Mishler BD, Wheeler QD. 2005. The perils of DNA barcoding and the need for integrative taxonomy. Systematic Biology 54: 844–851.

Response from Fitzhugh

I appreciate Dr. Darling's concerns regarding application of the requirement of total evidence (RTE). The difficulty, however, is that Dr. Darling has correctly characterized neither the RTE nor current systematic practice.

Rationality is always a matter of degree. The intent of the RTE is to ensure that as much as possible we base our conclusions on all available relevant evidence, for such conclusions are the most rational. Dr. Darling claims that all systematic reasoning fails to meet the RTE, and therefore is irrational. Such a claim is incorrect for the simple fact that if researchers know they are actively excluding evidence from consideration, then it is just as easy to correct that error in the name of rationality.

But more fundamentally, Dr. Darling's argument regarding systematic reasoning does not make it scientifically acceptable to engage in such practices as species "identification" by way of DNA barcoding. Scientists should not accept the positive promotion of greater irrationality—e.g., barcoding—in lieu of less irrationality, which can be attained through consideration of all evidence.

Finally, Dr. Darling states that DNA barcoding serves the purpose of identifying individuals to the species level. Such reasoning only applies if organisms are parts of more inclusive ontological individuals called "species." But if species represent explanatory hypotheses, then no organism is "identified as a species," and barcoding cannot then be justified by such a practice. The relation of individual to species name is one of observed effects to explanation, respectively, which cannot be accomplished by DNA barcoding alone.

KIRK FITZHUGH

Kirk Fitzhugh (e-mail: kfitzhug@nhm.org) is Curator of Polychaetes at the Natural History Museum of Los Angeles County, Los Angeles, CA 90007.