Privatizing Spanish research
1292

Aging and protein methylation
1299

LETTERS

edited by Jennifer Sills

The Age of Man: A Father Figure

IN HIS NEWS & ANALYSIS STORY "ARCHAEOLOGISTS SAY THE 'Anthropocene' is here—but it began long ago" (19 April, p. 261), M. Balter reports that the "Age of Man," characterized by detrimental environmental changes caused by human activities, may have begun thousands of years ago. This hypothesis was proposed more than a century ago by Alfred Russel Wallace (1823–1913), one of the greatest evolutionary biologists of the 19th century (*1*). Wallace is well known as the codiscoverer of the Darwinian principle of natural selection and as the founder of biogeography (*2*).

Alfred Russel Wallace

As Wallace was interested in many subjects, including anthropology, psychology, politics, and economics (*1*), he was well qualified to evaluate the impact of humans on natural habitats from an evolutionary perspective. In 1898, he described "[t]he plunder of the earth," with reference to the "struggle for wealth" by irresponsible humans (*3*). Wallace lamented the "reckless destruction of stored-up products of nature … not equaled in amount during the whole preceding period of human history" and the "clearing of the (tropical) forests … to make coffee plantations." He concluded that "[t]he devastation caused by the great despots of the Middle Ages and of antiquity … has thus been reproduced in our times" (*3*).

In 1910, Wallace described the era of human environmental destructiveness, which started with the systematic use of fire and the possession of weapons for hunting (*4*). He also argued that "the extinction of so many large Mammalia (at the end of the Pleistocene) is actually due to man's agency" (*4*). Hence, Wallace is the spiritual father of the "overkill hypothesis"—i.e., the idea that extensive hunting by early humans may have caused megafaunal extinctions, which led to zoologically devastated ecosystems (*4*).

The year 2013 marks the centenary of Wallace's death. It should be acknowledged that this "unselfish man in the shadow of Darwin" (*1*, *2*) was the first scientist who outlined, in his popular books (*3*, *4*), what we today (unofficially) call the Anthropocene.

U. KUTSCHERA

Institute of Biology, University of Kassel, D-34132 Kassel, Germany. E-mail: kut@uni-kassel.de

References

1. E. B. Poulton, *Nature* **92**, 347 (1913).
2. U. Kutschera, *Nature* **453**, 27 (2008).
3. A. R. Wallace, *The Wonderful Century* (Swan Sonnenschein, London, 1898).
4. A. R. Wallace, *The World of Life* (Chapman & Hall, London, 1910).

The Age of Man: Outpacing Evolution

IN THE NEWS & ANALYSIS STORY "Archaeologists say the 'Anthropocene' is here—but it began long ago" (M. Balter, 19 April, p. 261), Bruce Smith explains that the term "Anthropocene" was originally proposed as "a strategy for getting the public to appreciate the extent to which humans were destroying the world." In this case, one might define the beginning of the Anthropocene as the point in time at which humans begin altering the environment more quickly than biodiversity and ecosystems evolve and adapt to those changes. According to this definition, the era began long after the beginning of agriculture and even later than the beginning of the Industrial Revolution in 1750 CE. We propose that the Anthropocene began in the United States in the 1930s and spread globally during the green revolution from the 1950s to the 1970s.

During this time period, the human appropriation of net primary production increased markedly (*1*), and the quantity of materials mobilized, either directly or indirectly, by humans (anthropogenic flows) began to exceed the corresponding flows of resources unaffected by humans (geogenic flows). Recent abrupt changes, such as the green revolution and China's rapid industrialization, differ substantially from the pace of previous changes, such as agricultural practices, which evolved over centuries and thus allowed species and species interactions to coevolve. The systems resulting from those gradual changes maintained an equilibrium that benefits conservation, sustainable production, and cultural ecosystem services. To protect future human civilizations from the effects of the Anthropocene, we should work to decelerate change to gain time for evolution (*2*) and prevent breakdowns in ecosystem services (*3*).

JOSEF SETTELE* AND JOACHIM H. SPANGENBERG

Helmholtz Centre for Environmental Research–UFZ, 06120 Halle, Germany and iDiv, German Centre for Integrative Biodiversity Research, 04103 Leipzig, Germany.

*Author for correspondence. E-mail: josef.settele@ufz.de

References

1. K.-H. Erb *et al.*, *Science* **338**, 1419 (2012).
2. J. Settele, E. Kühn, *Science* **325**, 41 (2009).
3. K. L. Heong, in *Planthoppers: New threats to the sustainability of intensive rice production systems in Asia*, K. L. Heong, B. Hardy, Eds. (International Rice Research Institute, Los Banos, Philippines, 2009), pp. 221–232.

CREDIT: WIKIMEDIA COMMONS

Shale-Gas Plans Threaten China's Water Resources

THE IMPACT OF SHALE-GAS DEVELOPMENT ON American water quality has received wide attention ("Impact of shale gas development on regional water quality," R. D. Vidic *et al.*, Review, 17 May, p. 826), but potential impacts of China's accelerating shale-gas exploration on the nation's water crisis have been largely ignored.

China has the world's largest shale-gas reserves, at 36 trillion m^3 (*1*). The country has an ambitious plan to produce 6.5 billion m^3 of shale gas by 2015 (*2*). Thirteen provinces have been selected as priority areas. However, seven of these provinces are already plagued by water shortages, with less than 2000 m^3 available per person, less than one-quarter of the world average. Four of the thirteen provinces are in Southwest China, and two of those have recently experienced severe half-year droughts (*3*). Shale-gas extraction will compete for limited water resources with agricultural, industrial, and domestic sectors. Hydraulic fracturing (fracking), the most widely used extraction method in China, consumes large volumes of water mixed with a range of additives. Due to complex geological conditions, Chinese shale-gas wells each consume 10,000 to 24,000 m^3 of water (*4*, *5*). The target gas production of 1.5 billion m^3 in Sichuan will require 171 million m^3 of water, equal to 10.5% of the province's domestic water demand (*6*).

Some 10 to 90% of fracking fluids are returned to the surface (*7*). Inadequate treatment introduces heavy metals, acids, pesticides, and other hazardous materials to soil and aquatic environments (*8*). This will exacerbate China's polluted water environment (*9*, *10*).

Exploitation of China's shale-gas reserves offers opportunities to satisfy the nation's growing energy demands and reduce carbon emissions, but careful management and legislation will be required to avoid shortages and pollution of already stretched water resources.

HONG YANG,[1]* ROGER J. FLOWER,[2] JULIAN R. THOMPSON[2]

[1]Geography and Environment, University of Southampton, Highfield, Southampton SO17 1BJ, UK. [2]Environmental Change Research Centre/Wetland Research Unit, UCL Department of Geography, University College London, London WC1E 6BT, UK.

*To whom correspondence should be addressed. E-mail: hongyanghy@gmail.com

CORRECTIONS AND CLARIFICATIONS

News Focus: "The numbers game" by M. Hvistendahl (31 May, p. 1037). The total for the grant given by the National Natural Science Foundation of China to the China Health and Retirement Longitudinal Study was incorrect. It should have been $813,000, not $813 million. The HTML and PDF versions online have been corrected.

Table of Contents: (17 May, p. 781). On page 783, the teaser for the Report by A. S. Gardner *et al.* was incorrect. The correct teaser is "The contribution of glaciers to sea level rise is nearly as much as that of the Greenland and Antarctic Ice Sheets combined." The HTML and PDF versions online have been corrected.

News Focus: "How big a role should neonicotinoids play in food security?" by E. Stokstad (10 May, p. 675). The credit for the chart was incomplete. The chart was adapted from: L. Maxim, J. van der Sluijs, in "Late lessons from early warnings: Science, precaution, innovation," European Environment Agency, Ed. (European Environment Agency, Report No. 1/2013, Copenhagen, 2013), ch. 16, p. 417. The HTML and PDF versions online have been corrected.

News & Analysis: "More high-tech visas, more STEM education funds" by D. Malakoff and J. Mervis (26 April, p. 415). The accompanying picture was mislabeled. The students in the Bridge 2 Engineering program at Saddleback College were visiting Terra Universal Inc. to learn about equipment used in critical environment applications. The label has been corrected in the HTML and PDF versions online.

Research Articles: "A massive pulsar in a compact relativistic binary" by J. Antoniadis *et al.* (26 April, p. 448). The Web site in reference 33 should be wwwcascina.virgo.infn.it. The HTML and PDF versions online have been corrected.

Policy Forum: "Right-sizing stem-rust research" by P. G. Pardey *et al.* (12 April, p. 147). A misplaced insertion of the words "pests and" introduced an error. The correct sentence follows: "A $51.1 million annual R&D expenditure is equivalent to investing $0.23 per hectare of wheat in 2009; by comparison, U.S. wheat farmers spent $34.56 per hectare on seed in 2009." In addition, the last lines of the acknowledgment were dropped. It should read as follows: "Acknowledgments: The authors thank M. Carson, R. Singh, B. Steffenson, and Y. Chai for insights and C. Chan-Kang and M. Hallaway for research assistance. This paper was prepared for the HarvestChoice project with support from the BMGF, the University of Minnesota, and the Commonwealth Scientific and Industrial Research Organization (CSIRO)." The HTML and PDF versions online have been corrected.

References

1. U.S. Energy Information Administration, "World shale gas resources: An initial assessment of 14 regions outside the United States" (2011); www.eia.gov/analysis/studies/worldshalegas/pdf/fullreport.pdf.
2. China National Development and Reform Commission, China's shale gas development plan (2011–2015) (2012); www.sdpc.gov.cn/zcfb/zcfbtz/2012tz/t20120316_467518.htm.
3. Y. Wang, Y. Ke, X. Zhou, Q. Li, *Environ. Prot. Oil Gas Fields* **22**, 50 (2012).
4. Z. Wang, *Sino-Global Energy* **18**, 23 (2013).
5. D. Wang *et al.*, *Natural Gas Ind.* **33**, 8 (2013).
6. Y. Xia, *Sci. Technol. Rev.* **28**, 103 (2010).
7. T. Colborn, C. Kwiatkowski, K. Schultz, M. Bachran, *Hum. Ecol. Risk Asses.* **17**, 1039 (2011).
8. D. M. Kargbo, R. G. Wilhelm, D. J. Campbell, *Environ. Sci. Technol.* **44**, 5679 (2010).
9. J. Liu, J. Diamond, *Nature* **435**, 1179 (2005).
10. H. Yang, P. Xie, L. Ni, R. J. Flower, *Science* **337**, 410 (2012).

The Human Animal

IN HIS PERSPECTIVE "ANIMAL CONFORMISTS" (26 April, p. 437), F. B. M. de Waal asks "Do animals learn from each other in the same way as humans do?" Implying that humans occur in a category separate from animals may have unintended consequences.

First, the "humans and animals" paradigm undermines the unifying concept of all biology—evolution. Under this paradigm, it seems coincidental that a trait would occur in both humans and dogs, for example, despite their common ancestry.

Second, the loose use of "humans and animals" handicaps future learning. Research in science education has shown that students are prone to a number of misconceptions, which are often integrated into their cognitive framework early, making them remarkably difficult to correct (*1*).

Third, our future as a species hinges on a worldview that places humans deep within the context of ecology. We consider ourselves superior to other animals due to our sharp intellect, complex social structure, and domination of most ecosystems and natural resources. This feeling of separateness from the other members of our ecosystems hinders efforts to promote conservation and sustainability.

KIM QUILLIN

Department of Biological Sciences, Salisbury University, Salisbury, MD 21801, USA. E-mail: kxquillin@salisbury.edu

Reference

1. J. D. Coley, K. D. Tanner, *CBE Life Sci. Ed.* **11**, 209 (2012).

Letters to the Editor

Letters (~300 words) discuss material published in *Science* in the past 3 months or matters of general interest. Letters are not acknowledged upon receipt. Whether published in full or in part, Letters are subject to editing for clarity and space. Letters submitted, published, or posted elsewhere, in print or online, will be disqualified. To submit a Letter, go to www.submit2science.org.