Letters to the Editor

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Conservation Policy in Coffee Landscapes

IN THEIR POLICY FORUM "CAFFEINE AND Conservation" (25 April, p. 587), T. G. O'Brien and M. F. Kinnaird outline how coffee-price crashes act against tropical wildlife conservation. They argue that reducing coffee production will improve prices and livelihoods for farmers and that by rejoining the International Coffee Organization, the United States could help stabilize coffee prices and aid development of sustainable solutions to the coffee crisis. Although we agree with this summary, we argue that sun-grown coffee is not sustainable and instead suggest that current coffee certification programs can address social and environmental problems.

Worker looking for mature coffee beans in Glenmore Estates, Java, Indonesia

CREDIT: DEAN CONGER/CORBIS

The authors attribute high deforestation rates in Lampung, Indonesia, to high *robusta* coffee prices, deriving causation from correlation and failing to consider other plausible alternatives. During the 1990s, Asian governments, supported by international development banks, promoted intensive sun-grown coffee, contributing to an overproduction crisis—and eventually a price collapse. Thus, deforestation may instead be driven by distorted incentives from government programs providing land access and resources to clear forests.

Decoupling conservation and agricultural production is unwise, given the interconnectedness of biological, social, and economic factors (*1*). One commonly held misconception suggests that intensifying production allows more land for conservation. Yet, intensification results not only in higher yields but can also increase overall production area (*1*). Additionally, agrochemical use associated with sun-grown coffee has broad environmental consequences (*2*). Although forests are critical to conservation, national parks are often too small to meet many conservation goals, and an approach that only removes coffee production from parks discounts conservation opportunities within agricultural areas. Shaded coffee agroecosystems provide habitat for biodiversity, frequently at levels comparable to natural forests (*2*, *3*). Shade trees also provide valuable ecological services, such as nitrogen fixation, protection from soil erosion, and alternative income (*3*).

Plans to intensify production assume coffee-price and job stability, yet prices of overproduced export crops are volatile. In general, green revolution intensification benefits consumers via lower prices, but farmers have experienced increased costs and reduced prices for crops (*1*). Price drops may result in worker layoffs on large farms or land conversion on small farms—contributing to forest clearing (*4*). In contrast, shaded coffee farms provide cash income from coffee, and farmers can harvest nontimber products (*5*) accounting for up to 25% of total revenues (*6*). This reduces vulnerability to market fluctuations and household dependence on outside products while increasing local commerce. Thus, product diversification can reduce household and community vulnerability to price fluctuations and the need to exploit nearby forests. Although national parks need additional resources, environmentally compatible and economically sustainable agricultural projects are also needed outside parks.

Promoting shade-grown coffee can lower production and, over time, could help alleviate effects of the coffee crisis while advancing conservation goals. Coffee is less productive under high-shade conditions but requires lower inputs. Shade certification can increase financial benefits to farmers, while maintaining habitat useful for conservation. If promoted outside parks, shade-grown coffee could also buffer against forest degradation. With development aid used to restore sun-grown to shade-grown coffee, coffee yields would decrease and economic viability for farmers would increase. In particular, small-scale farmers could benefit from shade and fair-trade certification programs guaranteeing prices sufficient to maintain a reasonable standard of living. An equitable income distribution could reduce both poverty and pressure on forests for subsistence crops.

Agricultural technologies rarely produce the win-win scenario envisioned by O'Brien and Kinnaird, and factors contributing to deforestation frequently derive from unintended consequences of agricultural technologies (*7*). Their analysis does not adequately support the recommendation of certifying sun-grown coffee production, nor does it make clear how this program might work. Instead, promoting intensive sun-grown coffee could negatively impact conservation efforts in areas where shade-grown coffee provides a critical refuge for biodiversity (*3*). Addressing the economic crisis in coffee is critical to reduce the poverty putting pressure on protected forests. Thus, by reducing overproduction problems and enhancing conservation of protected areas, encouraging certified shade coffee may help achieve both economic and conservation goals.

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References
1. R. E. Evenson, D. Gollen, *Science* **300**, 758 (2003).
2. I. Perfecto, R. A. Rice, R. Greenberg, M. E. Vander Voort, *Bioscience* **46**, S98 (1996).
3. J. Beer, R. Muschler, D. Kass, E. Somarriba, *Agrofor. Syst.* **38**, 139 (1997).
4. J. Vandermeer, I. Perfecto, *Breakfast of Biodiversity: The Truth About Rainforest Destruction* (Institute for Food and Development Policy, Oakland, CA, 1995).
5. K. M. Wilkinson, C. R. Elevitch, in *The Overstory Book: Cultivating Connections with Trees*, C. R. Elevitch, K. M. Wilkinson, Eds. (Permanent Agriculture Resources, Holualoa, HI, 2001), pp. 208–214.
6. E. Somarriba *et al.*, in *Agroforestry and Biodiversity: Conservation in Tropical Landscapes*, G. Schroth *et al.*, Eds. (Island Press, Washington, DC, in press).
7. A. Angelsen, D. Kiamowitz, Eds. *Agricultural Technologies and Tropical Deforestation* (CABI Publishing, New York, 2001).

Response

DIETSCH *ET AL.* AGREE WITH OUR GENERAL conclusions but argue that sun-grown coffee should not be promoted and that coffee certification programs should address social and environmental problems. They argue in favor

of conversion from sun- to shade-grown coffee. We believe that Dietsch *et al.* have generalized coffee conservation issues in Latin America to Asia, and this has resulted in confusion. Although we agree that shade-grown coffee is the most appropriate form of environmentally friendly coffee agriculture, the elevation, climate, and soil conditions are not appropriate in much of Sumatra. Shade-grown coffee is *arabica* coffee, which does not grow well at low elevations and is thus not a viable option for Asian farmers living on the borders of lowland rainforest. We have argued that promoting shade-grown coffee is insufficient to address conservation problems in Asia, that forest conversion for coffee should stop, and that coffee certification should recognize sun-grown coffee produced in a manner that is organic and brings fair trade by providing a higher price to the farmers who cease their deforestation practices.

Almost all coffee farms in Vietnam, Indonesia, or Papua New Guinea are small, generally under 3 ha. In Lampung Province, the average farmer plants just 1.9 ha, of which 0.9 is planted with coffee; the remainder is divided among rice, banana, coconuts, beans, peppers, corn, and nontimber forest products. Of these, only pepper is an export crop. The farmers already practice diversified agriculture, but coffee and pepper provide the bulk of their cash income.

We did consider the alternatives to coffee agriculture that might drive deforestation in Bukit Barisan Selatan National Park (BBSNP) (*1*), including small-scale logging, ENSO-related fires, other agriculture, and perverse incentives. We have completed an inspection of >100 locations in deforested areas, and 67% were planted with coffee. The scenario of distorted incentives that occurred in Vietnam did not occur around BBSNP. The World Bank has been very vocal in denying the accusation by OXFAM of involvement in coffee expansion in Vietnam, and Dietsch *et al.* should clarify the reference to "international development banks." We know of no international or national programs supporting land access (other than limited road construction), resources to clear forest, or coffee production in Lampung Province. Although Nestlés has a coffee processing plant in Lampung Province, they provide no support for coffee agriculture.

Dietsch *et al.* cite Evenson and Gollen (*2*) to support the view that intensification of agriculture results in increased use of fertilizer and pesticides and may increase land area under cultivation. Evenson and Gollen however, state that between 1981 and 2000, "The area under food crop cultivation remained flat overall, with declines in Latin America offsetting the continued expansion of agricultural lands in Sub-Saharan Africa and the Middle East–North Africa region." They argue that the use of new high-yielding varieties slowed the rate of growth in inputs such as fertilizer and irrigation. Falling coffee yields in Indonesia are attributed to poor access to quality seed stock and neglect of groves (*3*). These production problems can be improved without resorting to chemicals.

Removing coffee production from parks is not the only approach we advocate; it is the minimum action required. In areas of Asia where coffee agriculture is expanding, alternatives are needed that protect parks, improve the matrix surrounding protected areas, and are appropriate for the local communities. Because converting to shade-grown coffee is an inappropriate solution for lowland areas of Southeast Asia, we believe that the greatest conservation benefits would be gained by actions that improve the value of sun-grown *robusta* coffee through organic and fair trade certification. Although we recognize that there are problems with the implementation of certification of sun- and shade-grown coffee (*4*), we believe that the carrot-and-stick approach of providing incentives to improve coffee agriculture, discouraging the purchase of coffee grown inside protected areas, and penalizing expansion through deforestation is worth pursuing. Otherwise, current efforts to unify the coffee certification process will offer only a neotropical solution.

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References and Notes
1. M. F. Kinnaird *et al.*, *Conserv. Biol.* **17**, 245 (2003).
2. R. E. Evenson, D. Gollen, *Science* **300**, 758 (2003).
3. C. Ritgers, N. S. Alam, Indonesia coffee update, USDA/FAS GAIN report #ID2002 (U.S. Department of Agriculture, Washington, DC, 2002).
4. J. H. Rapole, D. I. King, J. H. Vega Rivera, *Conserv. Biol.* **17**, 334 (2003).

Cellular Distribution of Nonionic Micelles

IN THEIR REPORT "MICELLAR NANOCONTAINERS distribute to defined cytoplasmic organelles" (25 April, p. 615), R. Savić *et al.* studied the intracellular distribution of endocytosed poly(caprolactone)$_{23}$-poly(ethylene oxide)$_{45}$ (PCL-PEO) micelles in PC12 cells where tetramethylrhodamine-5-carbonyl azide (TMRCA) was covalently linked to PCL (*1*). They demonstrate the appearance of the tagged TMRCA in various intracellular organelles. The observations reported are not indicative of the intracellular fate and distribution of the nonionic micelles, because the monomers are modified with a cationic marker. If micellar internalization is via endocytosis, although no evidence is presented, then micelles or TMRCA–PCL-PEO monomers must leave endosomes/lysosomes and appear in the cytoplasm prior to interaction with other organelles. In addition to the carboxyl group (p*Ka* 3.1), TMRCA contains a quaternary dimethylamino group (with a permanent positive charge), as well as a tertiary amine (p*Ka* 5.1). The latter group is likely to be protonated at the low pH encountered in late endosomes/lysosomes. Thus, TMRCA–PCL-PEO may act as a cationic surfactant that could destabilize the endosome/lysosome membrane or cause organelle rupture, a process similar to endosomal/lysosomal disruption by cationic lipids and poly(ethylenimine) (*2*, *3*). In cytoplasm, the tagged TMRCA presumably facilitates incorporation of the copolymer into various organelles. Although cytoplasmic pH is neutral, the permanent positively charged quaternary amine group may mediate copolymer interaction with mitochondrial outer membrane. This process may damage the negatively polarized membrane of mitochondria, leading to initiation of cell death by apoptosis. Interestingly, the data presented by Savić *et al.* in their fig. 4M demonstrate low cell viability in the presence of TMRCA-labeled micelles but not with TMRCA alone or unlabeled nonionic micelles, an observation that was not addressed. Furthermore, the unlabeled nonionic PCL-PEO micelles or their monomeric constituents are unlikely to escape endosomes/lysosomes. This statement is supported by previous work from the same group, where TMRCA was physically entrapped in these nonionic micelles (*1*, *4*). Therefore, nonionic PCL-PEO monomers are ineffective membrane-solubilizing agents. This may explain the lack of observed toxicity with unlabeled PCL-PEO micelles, because their ultimate destination is a lysosome. We believe that comparing the integrity of isolated lysosomes (e.g., by determining the free activity of *N*-acetyl-β-D-glucosaminide) using both unlabeled and TMRCA-labeled micelles (as well as monomers) at low pH is essential, an approach that has previously established lysosomal damage by poly(ethyleneimine) and cationic lipids (*2*, *3*). Similarly, experiments with isolated mitochondria may shed light on the possible mechanism of TMRCA–PCL-PEO–mediated cell death. Hence, we believe that the results of Savić *et al.* are indicative of the intracellular distribution of cationic surfactant molecules and have nothing to do with the fate of nonionic micelles, which was the aim of their work.

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References

1. L. Luo, J. Tam, D. Maysinger, A. Eisenberg, *Bioconjug. Chem.* **13**, 1259 (2002).
2. R. Wattiaux, M. Jadot, M. T. Warnier-Pirotte, S. Wattiaux-De Coninck, *FEBS Lett.* **417**, 199 (1997).
3. A. R. Klemm, D. Young, J. B. Lloyd, *Biochem. Pharmacol.* **56**, 41 (1998).
4. D. Maysinger, O. Berezovska, R. Savić, P. L. Soo, A. Eisenberg, *Biochim. Biophys. Acta (Mol. Cell Res.)* **1539**, 205 (2001).

Response

SINGLE CHAINS CAN DESTABILIZE THE membranes, but it is highly unlikely that what we are looking at are only reassembled single chains. Thermodynamically, micelle solution is at equilibrium; however, the questions are where is the position of the equilibrium, and how fast is the equilibrium achieved? The concentration of unimers is equal to the critical micelle concentration (CMC). This low concentration of single chains can destabilize the membranes, thereby facilitating the endosomal escape of the whole micelles. The CMC of PCL_{21}-b-PEO_{45} was measured in the mixed solvent *N*,*N*-dimethylformamide (DMF)/water (*1*). In this mixed solvent system, in the range in which we performed the experiments, the PCL is in a noncrystalline state, and the micelle single chain equilibrium reflects the absence of crystalinity. Extrapolation of these data to zero water content gives a CMC of 1.2 mg/liter (0.28 μM). However, in water, PCL is crystalline, which depresses the CMC considerably, to the point that we were not able to measure it. CMCs of block copolymer micelles can be extremely low. For example, for the styrene-polyacrylic acid block copolymers, the values of CMC measured in the DMF/water system [with the styrene core above glass transition temperature (Tg) because it is swollen with DMF], when extrapolated to pure water, are in the range of 10^{-60} M (*2*). This extrapolated value is not measurable by any physical means and merely reflects the extremely unfavorable thermodynamics of the disassembly process.

The single chain exchange in the PEO-b-PLA micelle system, which is similar to ours, is unobservable below 40°C, which is close to the Tg of PLA (*3*). Below that temperature, the mobility of PLA chains in the core of the micelles is low. Because PCL-b-PEO micelles have a partly crystalline core in water, and the melting point of PCL is 60°C, the rate at which the single chains come out of the micelles is exceedingly slow. Therefore, because of the crystallinity of the core, CMC should be far lower than the extrapolated value of 0.28 μmol/liter, and also, because the kinetics are likely to be exceedingly slow, we believe that our conclusions regarding subcellular localization are tenable. We do not have quantitative data for either CMC in the presence of crystalinity (we could not measure that) or kinetics of single chain exchange, which we have not yet attempted to measure.

In our previous study (*4*), we utilized noncovalently bound DiI (Cell Tracker CM-DiI) in nonlabeled PCL-b-PEO micelles and asked if the micelle-incorporated DiI will be taken up by glia and neurons to the same extent or if the glial cells will internalize significantly larger amounts. The key issue here was the kinetics of rapidly diffusing DiI to the glia and neurons, as compared with micelle-incorporated DiI. The rate and the extent of the DiI that entered these cells were reduced by micelles. No experiments were done with fluorescent micelles at that time. Extrapolation of the data from the primary cultures and nonlabeled micelles with noncovalently incorporated DiI to the cell lines with covalently and noncovalently bound TMRCA is risky.

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References
1. C. Allen, thesis, McGill University, Montreal, Canada (1999).
2. L. Zhang, A. Eisenberg, *Polym. Adv. Tech.* **9**, 677 (1998).
3. Y. Yamamoto, K. Yasugi, A. Harada, Y. Nagasaki, K. Kataoka, *J. Controll. Release* **82**, 359 (2002).
4. D. Maysinger, O. Berezovska, R. Savić, P. L. Soo, A. Eisenberg, *Biochim. Biophys. Acta* **1539**, 205 (2001).

CORRECTIONS AND CLARIFICATIONS

Reports: "Multiple Ebola virus transmission events and rapid decline of central African wildlife" by E. M. Leroy *et al.* (16 Jan., p. 387). The GenBank accession number for the reference sequence used in this paper was omitted. It is AY058898 for the GP gene from the Booue outbreak in Gabon in 1997. The GenBank accession numbers for the additional sequences determined in this study are AY526098, AY526099, AY526100, AY526101, AY526102, AY526103, AY526104, and AY526105.

Special Issue on the Tragedy of the Commons: Viewpoint: "Tales from a troubled marriage: Science and law in environmental policy" by O. Houck (12 Dec., p. 1926). It should have been noted in the Viewpoint that the text was based on Houck's 2003 Robert C. Barnard Environmental Lecture, presented at the American Association for the Advancement of Science on 12 September 2003.

TECHNICAL COMMENT ABSTRACTS

COMMENT ON "Reactions at Interfaces as a Source of Sulfate Formation in Sea-Salt Particles" (I)

William C. Keene, Alexander A. P. Pszenny

Laskin *et al.* (Research Articles, 18 July 2003, p. 340) hypothesize that $OH + Cl^- \rightarrow OH^- + Cl$ sustains high pH and, thus, significant S(IV) oxidation in sea-salt aerosols. However, measurements indicate that acidification rates are greater and pHs lower than those inferred; consequently, S(VI) production was substantially overestimated.
Full text at www.sciencemag.org/cgi/content/full/303/5658/628b

COMMENT ON "Reactions at Interfaces as a Source of Sulfate Formation in Sea-Salt Particles" (II)

Rolf Sander, Paul J. Crutzen, Roland von Glasow

Laskin *et al.*, in a laboratory study of the surface reaction $OH + Cl^- \rightarrow OH^- + Cl$, concluded that it increases the sulfate production rate in tropospheric sea-salt particles. Their extrapolation to atmospheric conditions, however, neglected to include important gas-phase diffusion limitations. The proposed reaction is not important for regulating sea-salt aerosol pH and sulfate production in the marine troposphere.
Full text at www.sciencemag.org/cgi/content/full/303/5658/628c

RESPONSE TO COMMENTS ON "Reactions at Interfaces as a Source of Sulfate Formation in Sea-Salt Particles"

Alexander Laskin, Daniel J. Gaspar, Weihong Wang, Sherri W. Hunt, James P. Cowin, Steven D. Colson, Barbara J. Finlayson-Pitts

Our proposed mechanism that generates hydroxide ions in sea-salt particles is expected to modulate the rate of acidification of the particles during the day, not prevent them from eventually becoming acidic. Given the distribution of particle sizes and the strong likelihood of additional OH sources at the interface, the diffusion limitation for large salt particles may not prove to be as significant as proposed. Current literature indicates that the assumptions used in our first-order approximation are quite reasonable.
Full text at www.sciencemag.org/cgi/content/full/303/5658/628d