ESSAY ON SCIENCE AND SOCIETY

Will Tribal Knowledge Survive the Millennium?

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As we begin a new millennium and contemplate how our current understandings might be evaluated in 1000 years, it may be useful to look backward. What pieces of knowledge do we treasure that come from 1000 years ago? Accounts from the end of the last millennium herald innovations like the metal plow but were imbued with folk knowledge from an era when trolls, fairies, and personifications of the elements, such as Jack Frost, were thought to play important roles in determining the course of human life.

A bit broader glance at the past might unearth the mathematical work of Leonardo Pisano Fibonacci who introduced Western culture to the concept of zero, a decimal positional system of numerals far different from the Roman numerals then in use, and the beginnings of linear algebra. Fibonacci's work underlies nearly all modern engineering calculations, stock market transactions, and computer manipulations. Credit for these innovations, however, does not belong to the west: Fibonacci spent his youth in Northern Africa and learned his arithmetic from Indian and Arabian merchants. Is it possible that knowledge systems outside of our current Western canon may be esteemed 1000 years from now?

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When I first met Epenesa Mauigoa, she seemed unremarkable—a diminutive 73-year-old who tended her infirm husband in their modest *fale* or hut on the outskirts of Apia, Western Samoa. True, some of the plants growing in her garden were unusual, but I did not expect anything extraordinary during my first interview. "Do you know anything about herbal medicine?" I asked respectfully. "I know a little," Epenesa quietly replied. Then for the next 3 hours, as I rapidly typed on my laptop computer, Epenesa related the most detailed account of Samoan herbal medicine that I have ever recorded. By the end of our sessions several weeks later, Epenesa had taught me the details of 121 different herbal remedies she carefully mixed from 90 different species of flowering plants and ferns. The 37th remedy Epenesa told me caught my attention: Epenesa claimed to be able to treat *fiva samasama*, a term used to describe hepatitis. "*E fasi ogala'au o le mamala moni*," she said in her quiet, but dignified Samoan: "Take the stem wood of the true *mamala* tree [which botanists call *Homalanthus nutans*]. Boil it, and pour off the water. The person who is ill should drink it twice a day."

Other healers confirmed Epenesa Mauigoa's report. Soon a team at the U.S. National Cancer Institute found healer preparations of *Homalanthus* to be active against a very different virus—human immunodeficiency virus–type 1—and discovered an antiviral drug called prostratin.* The U.S. government has guaranteed that half of all royalty income from prostratin will go back to the people of Samoa, which is one of the first formal legal recognitions of indigenous intellectual property rights. Unfortunately, despite its promise, prostratin still languishes as one of several interesting lead compounds that have not been picked up by pharmaceutical firms for clinical testing. However, the significance is clear: an indigenous claim of efficacy of a plant used in traditional medicine had been corroborated by a laboratory finding.

Ethnobotany is the study of the uses of plants by indigenous people. When I began my ethnobotanical research on Samoan medicine in the mid-1980s, some colleagues warned that my interest in traditional plant lore might blight an otherwise promising scientific career in evolutionary ecology. In our modern era, when science has largely superseded superstition in explaining the causes of disease, the nature of meteorological events, and the sources of astronomical phenomena, why should ethnobotanists, anthropologists, and linguists struggle to record folk knowledge in remote parts of the world?

On one point there is agreement: traditional knowledge systems are rapidly fading away. Linguist Michael Krauss suggests that half of the 6000 or so languages spoken at the beginning of the 20th century have now vanished, along with the cultures they once kept alive. Of those languages that remain, 80% are spoken only by small groups of elders.†

Consider, for example, the Gosiutes, an Amerindian tribe of several hundred people clustered in two small reservations in Utah and Nevada. Fluent speakers of the language number fewer than 20. When those last 20 Gosiute speakers die, their language and much of their culture will disappear forever. Why, on the cusp of a new millennium, should we care?

Among the 20 are elders whose experience as little children is extraordinary: they were raised as hunter-gatherers in the high

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*K. R. Gustafson *et al.*, *J. Med. Chem.* **35**, 1978 (1992).
†M. Krauss, *Language* **68**, 1 (1992).
‡N. R. Farnsworth, *Ciba Found. Symp.* **185**, 42–51 (1994); F. Grifo, D. Newman, A. S. Fairfield, B. Bhattacharya, J. T. Grupenhoff, in *Biodiversity and Human Health*, F. Grifo and J. Rosenthal, Eds. (Island Press, Washington, DC, 1997), pp. 131–163.
§J. Duke, in *New Crops*, J. Janick and J. E. Simon, Eds. (Wiley, New York, 1993).

deserts of the Great Basin. The desert life they described from their childhoods is not, however, one of deprivation. They were taught to demarcate seasons by the flowering times of different plant species. By tracking a diverse palette of edible roots and tubers, a desert habitat that might otherwise appear foreboding was transformed for them into a moveable feast. Unlike agricultural peoples dependent on a few crops, the Gosiutes could rely on many plant and insect species for nourishment. Gosiute children, though, have scant interest in learning this wisdom. As one aged Gosiute matriarch sadly told me, her grandchildren would rather watch television than listen to stories of a now-forgotten way of life. Whether the cause is considered to be the touted superiority of Western technology, the introduction of foreign money and goods, or the siren call of a new culture to young people, few indigenous societies have been able to withstand the onslaught of Western culture.

Yet, clearly, it is in the interests of Western societies to help protect indigenous cultures. By 1994, pharmacologist Norman Farnsworth had identified over 119 plant-derived substances that are used globally as drugs.[‡] Many of the prescription drugs sold in the United States contain molecules derived from, or modeled after, naturally occurring molecules in plants,[§] and many of these (including reserpine, digitalis, and vincristine) come from plants used in traditional medicine.

Once, ethnobotany was the major source of new pharmaceuticals. In the 20th century, however, antibiotics derived from soil cultures, and advances in molecular pharmacology led to a precipitous decline in the importance of pharmacognosy and ethnobotany in drug discovery programs. The pendulum is slowly swinging back, however. Interest in natural product research has been rekindled by discoveries of novel molecules from marine organisms (such as bryostatin) and potent new chemotherapeutic agents from plants (such as taxol). Research has been facilitated by new rapid-throughput bioassays, in which robotic arms and computer-controlled cameras test exceedingly small quantities of plant samples for the presence of compounds active against a multiplicity of disease targets. It is possible to accomplish in a few minutes what once took months to analyze in the lab. Even with new technology, it appears that one of the best sources for finding plant species to test is still the healer's pouch, because such plants have been often been tested by generations of indigenous people.

Issues other than merely scientific ones can complicate ethnobotanical drug discovery programs, however. Soon after the discovery of prostratin, loggers arrived in Falealupo and began to clear-cut the rain forest where I first collected *H. nutans*. Required by the government to pay for a new school, the village had no recourse but to accept the logger's offer of $1.83 per acre for their 30,000 acre rain forest. Fortunately, with the courageous leadership of village chiefs and assistance from outside donors, funds were raised to pay for the school and to protect the forest.

Too often, though, forests disappear without any notice. Currently, 12.5% of all plant species are threatened with immediate extinction. Most botanists regard this estimate by the International Union for the Conservation of Nature (IUCN) as conservative, because it considers only species known to science: numerous undiscovered species pass from the world unrecorded and unmourned.

Samoan healer Pela Lilo and her apprentice Fa'asaina Lamositele treating a patient with rain forest plants on Savai'i Island, Western Samoa.

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The extinction crisis is so acute that, within my short career, the conservation stance of the academic community has changed from detached solipsism to widespread activism. No longer can the problem be ignored. In Hawaii (where I write these words) fully one-half of the indigenous flora are threatened with immediate extinction. If, as some argue, the current loss of biodiversity might be misinterpreted by future observers as the aftermath of an asteroid strike, then the impact crater might be sought in the vicinity of the Hawaiian archipelago. Here at the National Tropical Botanical Garden, I have joined a team of young energetic botanists who rappel down cliffs, dangle from helicopters, and face nearly any challenge to collect seeds from endangered Hawaiian plant species (89 at last count) that have fewer than 20 known representatives remaining alive. The other 174 endangered plant species are separated from extinction by fewer than 100 known survivors. Unfortunately, Hawaii is not unique among oceanic islands in its devastating loss of native species. Yet only a single conservation organization, Seacology (in Berkeley, California), is solely focused on island preservation.

In our endeavor to discover new medicines from the diverse life around us, we enter the next millennium with significant advances, but also significant challenges. At this moment, when we have never been better poised technologically to evaluate natural products, the plant species themselves are disappearing. Similarly, ease of air travel, better linguistic sophistication on the part of investigators (an increasing number of whom are citizens of developing countries), and renewed respect for the intellectual property rights and dignity of indigenous peoples have positioned ethnobotany for significant advances as never before. College courses and international conferences in ethnobotany are multiplying throughout the world, yet at this crescendo of enthusiasm, an increasing number of aged healers are dying, with their knowledge left unrecorded.

Is there hope? The 1992 Convention on Biological Diversity, which for the first time established international protocols for protection and sharing of national biological resources, specifically addresses issues of traditional knowledge. It binds the signatory nations to three laudatory goals: (i) to respect, preserve, and maintain traditional knowledge; (ii) to promote wide application of traditional knowledge, and (iii) to encourage equitable sharing of benefits from traditional knowledge. This international advocacy of indigenous rights is mirrored by advancement of indigenous causes in Western media. Indigenous peoples are no longer feared as the savages once portrayed by Hollywood, indigenous religious concepts are no longer reviled as pagan, and indigenous healers—once denigrated as witch doctors—are no longer ridiculed.

Equally important, conservation biology is now seen as a science in its own right, and advocates for plant conservation are no longer dismissed as dilettantes. To me it seems that conservation science, politics, and advocacy of indigenous issues are moving in the right direction. The question for the new millennium is whether these advances will occur fast enough to overtake the current rates of plant extinction and indigenous culture loss. Will tribal knowledge survive this millennium? Is it doesn't, the world will be far poorer for its loss.