

## Native American Contributions to Science, Engineering, and Medicine

Contrary to the popularized “Cowboys-and-Injuns” misconception of the original American as a primitive and hostile savage, the Native American peoples have rich traditions which include numerous contributions to science, engineering, and medicine. In this article (1) we discuss briefly some examples of those contributions and enunciate the need for interdisciplinary research.

### **Native American Contributions**

The Native American peoples had and still have specialists—men and women with highly developed skills and extensive, intimate knowledge about the movement of the heavenly bodies, the chemical qualities of plants, and the medicinal applications of animal and botanical matter. These specialists sometimes have their own professional jargon, and their secrets are often closely guarded, partially to protect their professional status, and partially because it is simply not practical in any society to invest complex and specialized knowledge in all its members. The application of their knowledge has often been surrounded—as it is in our society—with ritual whose impact is psychological and whose interpretation is religious. In fact, one of the problems the contemporary scientist has in studying the knowledge and practices of the original Americans is the difficulty, for those who are unfamiliar with the total traditions of the original Americans, in separating religious belief from science and empirical knowledge. This is a distinction the Native Americans themselves have not usually made, and one many laymen have difficulty making in relation to contemporary science, as well.

One would not argue that the traditional Native American cultures were or are science-based cultures, nor that the people living in them understood the scientific basis for their daily practices, any more than the average U.S. farmer understands the process by which fertilizer increases yields or the reasons why hybridization can combat disease. The impressive knowledge of the Native American peoples about a wide variety of natural phenomena is not,

however, accidental, nor has its acquisition been haphazard. It is based on generations of systematic inquiry. It is the accumulation and transmittal of repeated observations, experiments, and conclusions. Some of the elements of the scientific method were inherent in their processes. Native Americans have understood, beyond the obvious, many of the relationships among different types of substances. With respect to plant taxonomy, for instance, some native Latin Americans knew the pharmacological uses of what is now known to be vitamin C, and they knew that it could be found in certain barks, other leafy plants, and mosses that are totally different from each other in outward appearances and specific environments in which they grow. Repeated use of the plants led to the development of a chemo-taxonomy. The Native Americans had recognized, quite accurately, the similarity of substance—which can now be verified by gas chromatography.

Traditional Native Americans, more so than more recent Old World settlers in this hemisphere, possess detailed knowledge regarding the habits, habitats, ecological communities, microdistributions, seasonal

In January 1975, the Council and Board of the AAAS passed the following resolution:

“*Be It Resolved* that the Council of the Association (a) formally recognize the contributions made by Native Americans\* in their own traditions of inquiry to the various fields of science, engineering, and medicine, and (b) encourage and support the development and growth of natural and social science programs in which traditional Native American approaches and contributions to science, engineering, and medicine are the subject of serious study and research.”

\*The term “Native American” refers to the descendants of the aboriginal inhabitants of the Americas, often referred to as American Indians.

variations, and recent history of the plant and animal species of their countries. Those few anthropologists and naturalists who have collaborated with traditional Native American specialists in field studies in botany, zoology, and soil science testify as to the value for natural science of this traditional knowledge, much of which is practical or applied, but a significant amount of which also is intellectual—that is, cultivated and valued for its own sake. Raven, Berlin, and Breedlove, in their recent definitive work, *Principles of Tzeltal Plant Classification*, provide a rationale of the plant world as the Mayas saw it (2). The Tzeltal taxonomy, say the authors, who have spent 10 years of research on the subject, is just as valid (even more so for that geographical area and the purposes for which it is put) as our own, which had its origin in European folk taxonomy based on comparable principles.

There is now a subgroup of biochemical taxonomists composed of taxonomists and agronomists engaged in research on Latin American plants known to the Native Americans. Those Native Americans, in their own long experience, have accurately screened plants into categories that turn out to be related to their chemical makeup and the corresponding effects. Natural product chemists working in latex, sterols, and so forth, acknowledge their debt to the taxonomical knowledge of Native Americans with whom they have worked. Schultes and Hofman, in their recent work on hallucinogens, acknowledge dependence on the taxonomies developed by Native Americans (3). A colleague of Schultes’ work, Andrew Weil, notes their indebtedness to Native American collectors whose taxonomies made their own collection easier, in that they greatly shortened the necessary analysis because the Native Americans had already classified the materials (4).

In the fields of agronomy and food production, Native Americans also have made valuable contributions. One-third of the world’s most important economic plants are of Native American origin. Of the 13 major food plant staples, the Native Americans of North and South America domesticated and cultivated six: maize, common brown beans, peanuts, potatoes, sweet potatoes, and cassava. We are all especially indebted to them for the development of maize, the most important grain in the Western Hemisphere and the third most important grain in the world—and for the

development of some 300 races of this grain. Commercial corn production in the United States today is based on individual lines or varieties from one of these races. The parent wild plant, teosinte, which requires a relatively short span of daylight and can be grown only near the equator, was adapted by the Native Americans through persistent hybridization and selection over centuries. As a result of these efforts, the Native Americans could grow varieties suitable for environments as diverse as the Gulf of St. Lawrence, desert Chile, and the southwestern United States, where prehistoric Pueblo Indians developed drought-resistant races, some of which are still grown by the Hopi.

The distinguished geneticist George Beadle, who has done extensive work on the origins of maize, describes these efforts as "tremendous accomplishments." Beadle discusses the process by which the Native Americans are believed to have developed various races of maize (5). Continual observation and experimentation over centuries is analogous to the application of the scientific method in current agricultural research.

The processing of corn has an equally complex history. Katz, Hediger, and Valeroy, an interdisciplinary team from dentistry and anthropology, have discovered that many Mesoamericans used alkali processing techniques that increased the quality and quantity of otherwise unavailable nutrients such as essential amino acids and niacin (6). These techniques ensured the survival of some Native American groups, and their lack may have caused the decline of others.

There is considerable current interest among social and natural scientists in Native American traditions of medicine, especially regarding the knowledge and use of drugs. All of the pre-Columbian Americans had complex medical practices that combined a knowledge of drugs with physical and psychological treatments. These traditions have been studied by both anthropologists and natural scientists. Virgil J. Vogel, in his *American Indian Medicine*, while cautioning on the necessity of separating the ritual from the rational in the Native American's use of the term "medicine," cites hundreds of pharmacological contributions, and suggests scores of areas deserving of further inquiry (7). Native Americans made wide use of anesthetics and narcotics, cathartics, emetics and febrifuges, as well as psychotherapy and drugless therapies like cupping, sucking, and enemas. Among the better known drugs of Native American origin are quinine, curare, and ipecac. Their skill in treating bone injuries has been widely praised by both early and modern writers. Less well

## McElroy Awarded Honorary Degree

William D. McElroy, president-elect of AAAS, was awarded the degree of Doctor of Science, *honoris causa*, from the University of Notre Dame on 18 May 1975. McElroy is currently chancellor of the University of California at San Diego. The citation read in part: "... a man whose research elucidated the mechanisms whereby living organisms produce light ... and who is now faced with a more intriguing chiaroscuro landscape, that place where science and public policy meet. ... As president-elect of the American Association for the Advancement of Science, he brings to the task skills which encompass the trivium of contemporary higher education—the search for new knowledge, the transmission of known knowledge, and the application of all we know in the service of man."

known is the surgical prowess of some groups, including their ability to perform trephination. Most tribes practiced some kind of population control, and oral contraceptives were discovered and used centuries ago in some tribes. The Shoshone of Nevada, for instance, used *Lithospermum* ("stoneseed"), which, when used in varying concentrations and periods of time, could effect varying durations of sterility in the female. *Lithospermum* was among a number of Native American drugs studied in our own more recent search for oral contraceptives (8).

Archeologists and ethnohistorians, working largely without collaboration with specialists in other fields, have only recently begun to elucidate the knowledge of engineering, architecture, and city planning implied by the huge urban settlements and massive monumental structures of pre-Columbian Mesoamerica and the Andean region. The large-scale and highly specialized agricultural technologies which permitted these urban developments are also little understood, despite the lessons for food production they may offer the modern world. The engineering and architectural accomplishments of the North American aborigines were less impressive—and yet here, too, important technical skills of probable modern relevance are embedded in such fossils as the extensive irrigation canals of the Hohokam of prehistoric Arizona, and the Pueblo high-rises of Taos.

While the Native Americans did not duplicate many of the engineering and mechanical discoveries of the Old World, nevertheless highly sophisticated and complex technologies were developed in the working of materials such as stone and other building materials, ceramics, paints and colorings, and metallurgy.

Scientists now recognize the possible advantages of some of these ancient technologies and are examining them with renewed interest. At the University of Utah, for example, scholars are trying to synthesize the mineral colorings used by Native Americans for paintings, still visible today, made on exposed rock walls more than 2000 years ago in Utah, Wyoming, and Colorado. The adobe construction of the traditional Pueblo homes is a fine way of "air conditioning" structures against extremes of climate. The walls of sun-dried clay plastered over sun-dried brick and crib-roofing of beams covered with crisscrossed layers of peeled aspen and willow, were topped with 2 inches of mud and surfaced with desert clay. This method of building provides a more nearly constant temperature than any other kind of construction except possibly quarters located in deep caves. Use of these local natural materials and traditional construction techniques can lower a 120° day to 90° and make it possible to satisfactorily heat a home in freezing weather with minimum fuel (9).

These engineering accomplishments are of particularly great importance for science and the history of science in that they were entirely or nearly entirely independent of the Old World sequence of discoveries and thus provide the only really independent control cases we have.

In astronomy, the achievements of the pre-Columbian peoples of Southern Mexico and Central America are well known. The complex Mayan calendar, superior in its accuracy to 16th-century European knowledge, stands as ample evidence of that civilization's comprehension of the movement of the stars and their relation to the seasons. Less developed but still impressive was the calendrical knowledge of the Aztecs.

Much less is known of the astronomical knowledge of other Native American peoples. Astronomer John A. Eddy in his article, "Astronomical alignment of the Big Horn Medicine Wheel," suggests a fairly sophisticated understanding of the solstices and their relation to seasonal changes by prehistoric Native Americans on the Great Plains (10). A subsequent letter to *Science* suggests that the same Native Americans may have had the capability to predict eclipses (11).

The recitation of examples can go on

## New Deadline for Nominations for AAAS-Rosenstiel Award in Oceanographic Science

The deadline for submission of nominations for the \$5000 AAAS-Rosenstiel Award in Oceanographic Science, which the Association will administer for the first time this year, has been changed from 1 July to 1 September. As stated in the 2 May issue of *Science*, the 1975 award will honor outstanding work in the field of geology, physics, and chemistry of the seabed.

Nominations, including adequate justification (one or two pages) and a list of the nominee's relevant publications, should be sent to the Chairman of the Selection Panel, Dr. Joshua I. Tracey, U.S. Geological Survey National Center, MS 915, 12201 Sunrise Valley, Reston, Virginia 22092.

and on, for the tribes of the Americas are many and their traditional knowledge and experience richly varied. To all the fields of science, engineering and medicine, one or more of these groups has made discoveries of importance and applied their knowledge to the solution of practical problems of existence. Natural and social scientists are just beginning to appreciate the wealth of those traditions and to research and evaluate the Native Americans' contributions.

### **The Need for Interdisciplinary Research**

So segregated are the professional lives of most social and natural scientists that they lack understanding of each other's work. Natural scientists' training provides them with little that prepares them to know about or even be aware that these "primitive" peoples possess sophisticated knowledge and skills. Our scientists in most cases are not even aware of how deeply embedded our own science is in cultural suppositions that are not universal (12). Social scientists, on the other hand, are often so poorly trained in the natural sciences that they are inadequately equipped to recognize the scientifically valuable experience of traditional societies, since they are usually ignorant of natural science and often in awe of it.

It is imperative that the present generation of natural and social scientists recognize the need for interdisciplinary research before it is too late. Peter Raven, Director of the Missouri Botanical Garden, is seriously concerned that it will soon be too late for scientists to make such studies. As Raven, Berlin, and Breedlove argue in their article on "The origins of taxonomy," we need to study the 10 million species of organisms in the world because 80 percent may well become extinct before they can be inventoried (13). Raven also points out that philosophical differences among tax-

onomies are important, are to be respected, and are useful to scientists in perfecting our own systems and analyses. Rapid worldwide social and cultural change is sweeping away many traditional ways. "As these cultures are lost, the world loses a diversity that can never be recovered. As their languages fall into disuse, we are losing the change to get a handle on this. This is a matter of major scientific concern," says Raven (14). The kind of effort that he, Berlin, and Breedlove have devoted to Highland Maya plant knowledge should be undertaken for all traditional communities where botanical and zoological knowledge is still intact.

—JANET W. BROWN

### **References**

1. This article is the culmination of investigations made by the author at the behest of the Committee on Opportunities in Science, which initiated the AAAS resolution on Native American Contributions to Science, Engineering and Medicine. The author is indebted for advice and assistance to Margaret Mead, William Sturtevant, Alfonso Ortiz, and Michael Dorris.
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7. V. J. Vogel, *American Indian Medicine* (Ballantine, New York, 1973).
8. ———, *ibid.*, p. 230. See also B. O. de Montellano, "Empirical Aztec medicine," *Science* **188**, 215 (1975), for a discussion of empirical research of Aztec doctors and an evaluation of the effectiveness of their medicinal herbs.
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11. T. H. Lewis, *ibid.* **187**, 14 (1975).
12. M. Mead, "Anthropologists, scientists and laity," in *The Sciences*, 7 (Nos. 6 and 7) (November-December 1967).
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14. P. H. Raven, personal communication.

## Notes from Other Offices

*Science and Society*: Dr. Dixon Long of the AAAS Committee on Science and Public Policy testified before the new Subcommittee on Domestic and International Planning and Analysis of the House Science and Technology Committee on observations regarding the reporting of federal R & D program expenditures and steps the subcommittee might take in the near future to carry out its responsibility for "special oversight" of the nonmilitary R & D budget. He was accompanied by Dr. John Logsdon, also of the AAAS committee, and Dr. Richard Scribner of the AAAS staff. Copies of the submitted statement are available on request.

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*Science Education*: Under a grant from the U.S. National Science Foundation the Education Office is working with ten school systems, having large minority group populations, to assist them in implementing the elementary school science program *Science—A Process Approach*. Representatives of the school systems will meet at AAAS from 7 to 18 July.

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*Opportunities in Science*: A "Comprehensive Annotated Bibliography of Science Education Projects for Minority Students, 1960-1975" will be produced by the Office of Opportunities in Science this year. Funded by the National Science Foundation, the project will collect and categorize natural science efforts at all levels to improve science education for minorities. Any information on such projects is welcome.

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*International Science*: A report and summary record of a Research Workshop on the relevance of satellite data for anthropological research will be available in July 1975 through the Office of International Science. The report stresses the importance of anthropologists making feasibility studies utilizing satellite data, the present state of the art in data interpretation, and possible future developments. A series of appendices includes bibliographic materials, examples of different kinds of imagery, how to gain access to satellite data, and several recommendations, including the desirability of a Technology Committee by the American Anthropological Association to evaluate and monitor technological developments in re-

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