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Ensuring Equitable Benefits: The Falealupo Covenant and the Isolation of Anti-Viral Drug Prostratin from a Samoan Medicinal Plant

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Abstract

Equitable sharing of benefits from pharmacological development of biodiversity has been the topic of much discussion, but few concrete examples of recent plant-derived pharmaceuticals exist. The discovery of prostratin as an anti-viral phorbol isolated from healer preparations of the rain forest tree *Homalanthus nutans* in Samoa illustrates the importance of careful liaison between western scientists and indigenous leaders. Development of prostratin as an anti-AIDS drug candidate was based on a carefully negotiated covenant between the chiefs and orators of Falealupo village and western researchers, with the concurrence of the Samoan Prime Minister and members of parliament. Since, like all drug candidates, potential commercial development of prostratin still remains uncertain, the case of prostratin indicates the importance of providing benefits to indigenous peoples in advance of royalty or license income. To date, over US\$ 480,000 have been supplied to Falealupo village for schools, medical clinics, water supplies, trails, an aerial rain forest canopy walkway, and an endowment for the rain forest based on the Falealupo Covenant. And, in August 2001 the AIDS Research Alliance (ARA) signed an agreement with the Prime Minister of Samoa guaranteeing a total of 20% of all ARA profits from the development of prostratin to be returned to Samoa.

Keywords: Prostratin, ethnobotany, equitable benefits, Falealupo covenant, Samoa.

Introduction

Ethnobotany and intellectual property rights

Ethnobotany, the study of the relationship of plants and people, has historically been a useful source for identifying

plants suitable for development as pharmaceuticals. Many important drugs in the western pharmacopoeia, including digitoxin, quinine, and vincristine have been discovered by studying the uses of plants as medicines within indigenous cultures. Of the 119 drugs still extracted from higher plants, 74% were discovered from ethnobotanical studies (Farnsworth, 1990; Laird, 1994). However, contrary to the popular myth of legions of botanists combing the jungles on the behalf of pharmaceutical firms, there is presently little commercial interest in the ethnobotanical approach to drug discovery (Balick & Cox, 1996). Gene therapy, combinatorial chemistry, molecular modeling, and so-call "rational drug design" are clearly the wave of the future; as a result, there are very few major pharmaceutical firms with any remaining interest in natural products, let alone ethnobotany, as a source of new pharmaceuticals. This lack of interest could rapidly change, however, if a major new pharmaceutical as important as vincristine were to be discovered from ethnobotanical sources. For this reason, it is important to develop workable models of sharing benefits of pharmaceutical discovery with indigenous peoples who play a role in the discovery and development of drugs from plants used for medicines, arrow poisons, ritual hallucinogens, toxins, fish poisons, and other traditional uses.

Most plant-derived drugs of the twentieth century were discovered during the colonial phase of world history, when the rights and aspirations of indigenous peoples were routinely overlooked (Cox, 1993; Cox & Elmqvist, 1997). As a result, indigenous peoples typically saw little return, or often even little acknowledgment, of the significant role they played in sharing their plants and traditional knowledge with investigators (Kloppenborg & Balick, 1996). The question faced by practicing ethnobotanists, particularly those who see themselves as advocates of indigenous peoples, is how

to best protect the intellectual property of the indigenous people with whom they work.

This question was particularly important in the years before the signing of the Convention on Biodiversity, where discussion and thought concerning protection of indigenous intellectual property rights was nascent, particularly for field botanists interested in discovering new lead compounds from plants. This paper briefly reviews the events surrounding the isolation of the anti-viral compound prostratin from a plant used by healers in Samoa. The Falealupo Covenant, an agreement between scientists and the village, which was endorsed by the Prime Minister and the Minister of Agriculture of Western Samoa, provided the basis for sharing of benefits from the drug discovery program with the village. Significantly, the Falealupo Covenant not only protected village interests in the event of any drug commercialization, but also guaranteed benefits to the village in advance of any drug royalties. And now, the AIDS Research Alliance which has licensed prostratin from the National Cancer Institute, has signed an agreement with the Prime Minister of Samoa to return 12.5% of ARA's net profits on prostratin to the government of Samoa, 6.7% to Falealupo village, and 0.4% to each of the families of two healers for a total return of 20%.

Ethnomedical research in Samoa

Samoa is an archipelago in the Southwest Pacific Ocean with nine occupied islands. It remained unknown to Europeans until 1722 when it was sighted by Dutch navigator Jacob Roggeveen. In 1768, Louis-Antoine de Bougainville encountered the Samoan people in their canoes near the island of Ta'u. He mistook their full-body tattoos for body paint: "These islanders appear to be of middle size, but active and nimble. They paint their breast and their thighs, almost down to the knee, of a dark blue." (Bougainville, 1772, p. 281). Although Bougainville's crew was treated kindly by the Samoans, the second European voyage to reach Samoa, that of Jean-Francois de Galaup La Perouse on the *Astrolabe*, ended in disaster. On December 11, 1787, 11 French seamen and an uncounted number of Samoans died due to a cultural misunderstanding and the resultant conflict at Asu bay on the island of Tutuila (La Perouse, 1807). Because of this, Samoans gained an undeserved reputation as a ferocious people, and were assiduously avoided by European voyages for the next four decades. This avoidance was a blessing to the Samoans, however, because it allowed them to largely escape the deprivations of black birders, whalers, and sandal wood traders of that era. Thus, when the remarkably progressive and enlightened Christian missionary John Williams made landfall in Savaii in 1830, he encountered a relatively intact Polynesian culture.

Although many useful observations of Samoan traditional medicine were made by subsequent explorers, some of the best observations on plant medicines were made by early Christian missionaries (Crawford, 1977; Cox, 1991), particularly the English missionary Thomas Powell (1868).

His pioneering work was followed by botanically adept researchers from Germany, including Reinecke (1895) and Kramer (1903). In the twentieth century, officials with the U.S. Navy, health care workers, and interested scientists commented on the use of medicinal plants (Hunt, 1923; Stephenson, 1934; Norton et al., 1973; McCuddin, 1974) as did some professional botanists (Christopherson, 1935; Setchell, 1924; Uhe, 1974). Subsequent to 1980, former Peace Corps volunteer and ethnobotanist Arthur Whistler (1984, 1992, 1996) published several works on Samoan medicinal plants.

Broad pharmacological screens of the Samoan medicinal plants indicated significant bioactivity (Norton et al., 1973; Cox et al., 1989). Based on this finding, several Samoan medicinal plants were subjected to specific bioassays, with bioassay-guided fractionation yielding several novel activities and structures (Dunstan et al., 1994; Dunstan et al., 1997; Li et al., 1994; Perera et al., 1993). However, the most interesting of these structures was prostratin, isolated from *Homalanthus nutans* by a team at the U.S. National Cancer Institute (Gustaffson et al., 1992).

The isolation of prostratin from a Samoan medicinal plant

When Richard Evans Schultes, the famed Harvard ethnobotanist, learned of the fluency in Samoan I had gained living in remote islands of the archipelago for two years, he encouraged me to supplement my doctoral studies of the breeding systems of rain forest plants with some ethnobotanical work. Although I had published several studies on Samoan ethnobotany in the 1970s and early 1980s, I deliberately avoided studying Samoan herbal medicine because of the extraordinary commitment of time and effort that would be required; like physicians in the west, Samoan healers seemed to use a unique vocabulary and a detailed conceptual system to discuss disease causation and etiology. They also practiced medicine in a manner thoroughly alien to western ways. Clearly, a short study, of the type that I published before on Samoan fermentation pits or fish poisons, would be inadequate – an intensive multi-year research commitment would be required.

Two personal events dramatically altered my willingness to investigate Samoan medicine: my mother died an agonizing death from breast cancer, and I received unsolicited multi-year funding from the National Science Foundation for a research project of my choice. After my mother died, I took my family to the remote village of Falealupo in Savaii, Western Samoa, to study Samoan herbal medicine with the hope of finding something that could aid in the fight against breast cancer (Cox, 1997a). My first introduction to the village was a kava ceremony with the village chiefs where I explained the purpose of my research, and asked their permission to study with the village healers and to collect their medicinal plants for laboratory analysis. I also told them that there was slight chance that a discovery could result in a com-

mercial interest, and pledged to do my best to ensure a return to the village from any such discovery. The village chiefs unanimously agreed to grant me permission to conduct the research and to assist me in any way that they could. As I wrote in my memoir of that year:

“One plant that caught my interest was a small rainforest tree that the Samoans call “*mamala*” – (*Homalanthus nutans*) which sometimes grows up to five meters tall, but most often it is much smaller. It grows along the edge of the rain forest and has beautiful spade-shaped leaves that have a slight whitish sheen on the bottom. One of the more striking features of the leaves are the long slender petioles that attach them to the stem. Each leaf seems to hang suspended in air by a tiny thread. Although the *Homalanthus* tree is lovely, my interest in it was not primarily aesthetic but medicinal. Several healers, including Epenesa Mauigoa, Pela Lilo, and Seumantufa’s wife Lemau, told me that water infusions of *Homalanthus* are used to treat yellow fever and intestinal complaints . . .

Traveling to the Falealupo forest, I found a small *Homalanthus* tree and cut some of the larger branches off with my machete. Placing the chopped branches in a coconut leaf basket, I returned to our little hut. There I macerated the bark and stem wood as the healers had shown me, packed the scrapings in an aluminum Sigg bottle, and filled the bottle with 75% ethanol. Taking a solvent-proof marking pen, I wrote on the outside of the bottle a legend: “#842 *Homalanthus acuminatus*, stemwood.”

I then turned on my solar-powered laptop computer and made the following entry in my collection log:

Flora of Samoa
Island of Upolu
Homalanthus acuminatus (Muell. Arg.) Pax
small tree 3 m. tall
08-02-1985
native name: *mamala*
native use: medicine- bark used for incontinency.
leaves and bark used for yellow fever.
Paul Alan Cox # 842

At that time I could find no collaborators to assist me in analyzing my collection of Samoan medicinal plants for efficacy. However, in January of 1986 I received a letter from Gordon Cragg of the National Cancer Institute (NCI) offering to collaborate with me in screening the plants for anti-cancer activity.

My research in Falealupo continued over the next several years, until a logging firm began destroying the forest in 1988. Village chiefs explained that they were required by the national government to build a school, but lacking any significant resources for construction, they were forced to accept an offer from the logging company that they had long resisted. Struck by both the starkness of the devastation wrought by the logging, and by the considerable unhappiness of the villagers with the situation, I pledged to raise the

funds necessary to pay for the school. Successfully raising the US\$ 85,000 necessary to both build the school and discharge the debt the village had already incurred to the logging company, I met in the fall of 1988 and early in 1989 with the villagers to negotiate a written covenant to protect the rain forest and to formalize our previous understandings of equitable sharing of benefits from any discovery of a new drug from village plants. In the Falealupo Covenant (Appendix I), which was signed by every village chief in a kava ceremony attended by the entire village, the chiefs and orators of Falealupo agreed to allow me to continue studies of Samoan medicines as long as these efforts did not damage the forest. There was also a proviso that if, “The efforts of Koki [Paul Cox] in finding new drugs from the plants of Falealupo are successful, he will return to the village 33% of the income received.” In return for this covenant, the villagers received US\$ 85,000 for the school and the logging debt.

Unfortunately, the samples I had previously sent to the NCI showed no activity against cancer, even though many showed activity in broad Hippocratic and guinea pig ileum screens conducted at the University of Uppsala by my colleague Lars Bohlin and his collaborators (Cox et al., 1989). Soon though, I received a request from the National Cancer Institute: could the samples be screened for anti-viral activity using an HIV-1 screen? That screening showed potent cytoprotective activity of sample #842, *Homalanthus nutans*, and chemical work by the NCI team resulted in the isolation of prostratin from the wood of the tree as well as from healer potions provided to me by Pela Lilo and Mariana Lilo in Falealupo. Prostratin was a type of phorbol – a class of compounds notorious for tumor promotion. Its structure had previously been characterized by workers in Australia who isolated it from plants unrelated to *Homalanthus nutans*, but which had been implicated there in livestock poisoning. Because prostratin was structurally very close to a known tumor promoter, NCI considered stopping the research, but I argued that the contemporary ethnobotanical profile and the long history of use by the Samoan people indicated that it was not acutely toxic as were other phorbol esters. Based on these arguments, the NIH team continued *in vivo* studies with mice, and discovered that while prostratin activates protein kinase C, it does not promote tumors (Gustafson et al., 1992). Further field studies with Andrew Sorensen of the University of California, San Francisco medical school showed the disease “*fiva samasama*” (which I originally translated as “yellow fever” in my collection notes) was in fact hepatitis, raising the possibility that prostratin may serve to protect healthy cells from a range of viral pathogens.

Protection of Samoan intellectual property

Prior to announcement of these research results, I met with the entire village of Falealupo to explain these developments and to assure them that their benefits, as agreed to in the Falealupo Covenant, were secure. I also personally met with

the Samoan Prime Minister Tofilau Eti, the Samoan Minister of Agriculture Solia Papu Va'ai, the leader of the opposition party of the Samoan parliament, Tuiatua Tamasese Tupuola Efi, and a variety of other members of parliament to notify them of the findings and of NCI's commitment to both honor the Falealupo Covenant and to require any licensee of the technology to travel to Samoa to negotiate a fair and equitable return of any proceeds with the Samoan Government. This latter provision is in accordance with standard NCI policy (Cragg et al., 1994). In addition, my employer, Brigham Young University, agreed to honor the Falealupo Covenant, and to return 33% of any royalty shares they received to the village. These assurances will cover any funds accrued from the use patent on anti-viral uses of prostratin which was issued to the National Cancer Institute in 1996.

In addition, my colleagues and I, through the Seacology Foundation (www.seacology.org), provided significant benefits to Falealupo village prior to any commercialization of prostratin. These included US\$ 2500 to build water tanks in the seaward part of the village; US\$ 85,000 to build the Falealupo school as promised in the Falealupo covenant; US\$ 75,000 to rebuild the school and a clinic after hurricane Ofa; US\$ 10,000 in emergency relief supplies after Hurricane Ofa; US\$ 65,000 to rebuild the school after hurricane Val; US\$ 10,000 to build water tanks in the inland part of the village; US\$ 15,000 to build trails, signs, and printed tickets in the Falealupo Rain Forest Preserve; US\$ 75,000 to build the Falealupo Rain Forest Walkway (from which the village retains all of the proceeds of admission charges); US\$ 15,000 in annual engineering maintenance of the walkway; US\$ 12,000 for the construction of an environmental center, a video player, videos, books, and t-shirts for sale by the villagers (with all proceeds retained by the village); a US\$ 3,500 personal contribution to the village retirement scheme for villager elders; and US\$ 112,500, which represents the entire amount of my Goldman environmental prize (plus corporate matches). This money serves as an endowment on the Falealupo Rain Forest reserve from which the village receives an annual dividend check each year in perpetuity. All of this is in addition to direct payments and assistance to the healers' families. Thus, over US\$ 480,000 have been made to Falealupo village in direct payments before any funds whatsoever have been received from the development of prostratin, whose commercial prospects at this point are still uncertain.

Although the magnitude of these advance payments is well known both to the Falealupo villagers and the highest levels of the Samoan government (with full-page photographs of the Falealupo aerial walkway having appeared in *National Geographic Traveler* and *Conde Nast Traveler* and descriptions of the aerial walkway, rain forest reserve, and Falealupo Covenant appearing in most tourist guides to Samoa; although news of the Goldman Environmental Prize and my allocation of it to the village received international press attention; although the dedication of the Falealupo aerial rainforest walkway was attended by the

Prime Minister, 11 cabinet members, and broadcast via radio throughout Samoa; although the actual signing of the covenant was broadcast as part of an international television documentary; and although descriptions of the benefit sharing plan were published in internationally circulated journals including TIME magazine, there has still been some confusion regarding the distribution of benefits to the village. Yet in the London Guardian of Dec. 21, 2000, Keith Perry wrote "There is no record of the American scientists having sought any prior agreement with the Samoan government, local communities, or healers for the collection and use of the plant and the associated knowledge." Better information on the Falealupo Covenant, and its support by the healers, village, and the government needs to be made to a broader audience.

Discussion

Although the isolation of prostratin from a Samoan medicinal plant as well as the development of the Falealupo Covenant occurred well in advance of the formulation of the Convention on Biodiversity (also known as the Rio Treaties), it is useful to use the light of that treaty to illuminate the pre-Rio efforts made to ensure equitable sharing of benefits with the Samoan people from prostratin. The Convention on Biodiversity, signed in 1992, had as its primary objectives the conservation of biological diversity, the sustainable use of that diversity, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. In the Convention, the signatory nations claimed biodiversity as part of national sovereignty. The convention was therefore primarily directed towards use of genetic resources, and did not have as its primary focus indigenous intellectual property rights. However, in article 8(j) of the convention, the signatory nations did briefly consider issues concerning indigenous peoples, and agreed to 1) respect, preserve, and maintain traditional knowledge, 2) promote wide application of traditional knowledge, and 3) encourage equitable sharing of benefits from traditional knowledge. No specific mechanisms, however, were articulated for the equitable sharing of benefits resulting from indigenous intellectual properties, nor was there any mention of the traditional institutions (such as village councils, chiefs and orators, elders, etc.) that often play crucial roles within indigenous societies.

Although I made careful efforts to coordinate my research findings both with the Samoan Prime Minister's office and the Ministry of Agriculture, prior to 1992 there did not exist within Samoa a Rio-type national clearinghouse for biodiversity exploration and development. There did, however, exist a body who claimed sovereignty over their own forest, plants, and resources, and who could demonstrate through genealogies and oral histories a continuous unbroken stewardship of those resources for over 1000 years. This body was none other than the Chiefs and Orators of Falealupo Village. In Samoan culture, every extended family has several chiefs and so is represented by multiple members of the village

chiefs' council. Falealupo, in particular, plays a large role in Samoan ethnohistory because it was there that the ancient goddess Nafanua first created a national government for all of Samoa. High Chief Auva'a, the four paramount orators Fuiono, Soifua, Taii, and Taofinuu, together with Silia Laie and the other high chiefs and orators regards themselves as personal representatives of Nafanua. Thus, when over 50 of these chiefs, after vigorous negotiations, entered into and signed a covenant for the sharing of the proceeds of any drug developed from their forests, I considered their words (which were affirmed by the Prime Minister) as binding.

Perhaps instead of dealing directly with the chiefs' council, I should have sought a NGO to serve as intermediary in the discussions. Indeed, Kloppenberg and Gonzales (1994) have suggested that "professional NGOs" (but not "grass-root NGOs") are the best guardians of indigenous intellectual property:

"But if indigenous peoples do wish to confront the admittedly abstract and longer-term implications of IPRs [intellectual property rights] they are unlikely to find the guidance they need from local/grass roots NGOs. Instead they will usually need to contact the professional NGOs at the national and international level . . ." (Kloppenber & Gonzales, 1994, p. 167)

My experience with the Falealupo villagers, however, suggests that the Chiefs and Orators are very comfortable with "abstract" concepts (Cox, 1995, 1997b) – in fact, the difficulties I have faced as a ethnobotanist revolve around trying to render extraordinarily "abstract" indigenous concepts into terms accessible to westerners. Additionally, based on our experience in Tafua with village conflict with an outside NGO (Cox & Elmqvist, 1997; Cox, 2000a), villagers are reluctant to deal with "outsiders" as intermediaries. It strikes me that whoever proffers assistance in developing appropriate agreements, ultimately it is the ethnobotanist whose personal integrity is on the line with the villagers. I found no reluctance at the NCI, or the ARA, or at my university, to honor the terms of the covenant I made with Falealupo. Also, the personal responsibilities that the villagers required me to assume as a condition of signing that covenant (Cox, 1997a) have animated much of my actions since that time.

How can the experience in Falealupo inform other arrangements with other indigenous peoples in other places? One solution to ensure equitable sharing of benefits with indigenous peoples is the imposition of Western concepts such as "terms of equitability", and western legal mechanisms to administer such "equity". Yet it strikes me that any solution, no matter how well intended, that is imposed on indigenous peoples could portend a new type of colonialism, merely substituting ethnocentricity and cultural imperialism for the economic and political colonialism of the 19th century. Furthermore, due to our current era of massive deforestation, mass biological extinction, and massive loss of traditional knowledge systems (Cox, 2000b, 2000c), the radical solution

proposed by some of "locking up" biodiversity in lesser developed nations will unfortunately serve only to guarantee that poor countries will lose their biodiversity before it is ever surveyed for possible benefit. If clear-cutting rain forests is an easier enterprise to obtain permission for than biodiversity surveys, logging will prevail. Also overlooked are the rights, if any, of the sick and afflicted throughout the world who hope daily for new treatments and cures (Cox, 2000d).

Instead, I suggest that solutions to indigenous intellectual rights should be freely and directly negotiated with the indigenous peoples in terms acceptable to them, with of course, the advice and consent of the national government. As a result, each solution, while incorporating some common features, will be unique. *Consent* of the indigenous people, *respect* for their culture, and *submission* to indigenous political control are features that should characterize all responsible agreements (Cox & Elmqvist, 1991; Cox, 1994).

In the case of prostratin in Samoa, research was performed with the explicit oral and written consent of the healers, the villagers, and the village chiefs (Cox, 1993, 1997a). The aims and intents of all research were carefully explained and consent was obtained before research began. The village authorities negotiated and signed an agreement concerning the disposition of any commercial proceeds. The NCI, Brigham Young University, and the AIDS Research Alliance (ARA) agreed to completely accept the terms of the Falealupo Covenant, and, where possible to exceed them: NCI has guaranteed that licensee would negotiate with the Samoan government for a fair share to be returned to Samoa; as a result the ARA reached an agreement to return 20% of ARA's profits to Samoa. Agreements for profits from extracting prostratin from the plants (should natural rather than synthetic prostratin be marketed) have also been encouraged. Yet, as of this writing, it is not known if prostratin will ever make it to market, and whether any royalty benefit will accrue to the villagers. To ensure some benefit to the villagers, private funds have been raised to build schools, clinics, water supplies, and an income-generating walkway; all these funds have been controlled and administered by the village chiefs (Cox & Elmqvist, 1991, 1997).

To the cynic who considers ethnobotany to be, by definition, an intrinsically exploitative enterprise, no agreement or arrangement can ever be satisfactory. Nothing short of permanently stopping all ethnobotanical research activities can be sufficient. Yet, such critics seem strangely absent when villages with clear and pressing needs for schools for their children, water supplies, and for simple services taken for granted in developed countries seek outside assistance. Nor do such critics have a strong record of drug discovery, or any service at all, to the millions of Earth's inhabitants who are sick or afflicted. Fortunately, healers, village chiefs, and the leaders of the Samoan government, including the Prime Minister lack such cynicism. And yet, for the poor villagers (particularly those of Falealupo), the admittedly small ca. 1/2 million dollars in benefits provided in advance of any real profitability are seen as highly significant – as is the scien-

tific validation of their own traditional knowledge. And for this scientist, the very hope, however remote, of finding something useful to the millions who suffer with AIDS or other serious diseases, as well as the opportunity to join hands with the wonderful people of Falealupo village, has been its own reward. As Camus writes in *The Myth of Sisyphus*

“I leave Sisyphus at the base of the mountain. One always finds one’s burden again. . . . The struggle to the heights is enough to fill a man’s heart. One must imagine Sisyphus happy. (Camus, 1991).

References

- Balick MJ, Cox PA (1996): *Plants, People and Culture: The Science of Ethnobotany*. New York, Scientific American Library.
- Bougainville L (1772): *A Voyage Round the World*, Translated by J. R. Forster, London, J. Nourse.
- Camus A (1991): *The Myth of Sisyphus and Other Essays*, O’Brien J trans. New York, Random House, p. 123.
- Christopherson C (1935): Flowering plants of Samoa, *Bernice P Bishop Mus Bull* 128: 1–221.
- Cox PA (1990): Ethnopharmacology and the Search for New Drugs. In: Battersby A, Marsh J, eds., *Bioactive Molecules From Plants*, Ciba Symposium 154, Chichester (England), Wiley, pp. 40–47.
- Cox PA (1991): Polynesian Herbal Medicine. In: Cox PA, Banack SA, eds., *Islands, Plants, and Polynesians*. Portland, Dioscorides Press, pp. 147–169.
- Cox PA (1993): Saving the ethnopharmacological heritage of Samoa. *J Ethnopharmacol* 38: 181–188.
- Cox PA (1994): The Ethnobotanical Approach to Drug Discovery: Strengths and Limitations. In: Prance G, Marsh J, eds., *Ethnobotany and the Search For New Drugs*. Ciba Foundation Symposium 185: 25–41. London, Academic Press.
- Cox PA (1995): Shaman as scientist: indigenous knowledge systems in pharmacological research and conservation biology. In: Hostettmann K, Marston A, Maillard M, Hamburger M, eds., *Phytochemistry of Plants Used in Traditional Medicine*, Oxford, Clarendon Press, pp. 1–15.
- Cox PA (1997a): *Nafanua: Saving the Samoan Rainforest*. New York, W. H. Freeman.
- Cox PA (1997b): Indigenous peoples and conservation. In: Grifo F, Rosenthal J, eds., *Biodiversity and Human Health*, Washington, DC, Island Press, pp. 207–220.
- Cox PA (2000a): A tale of two villages: culture, conservation, and ecocolonialism in Samoa. In: Zerner, Charles, ed., *People, Plants, and Justice: The Politics of Nature Conservation*, New York, Columbia University Press, pp. 330–344.
- Cox PA (2000b): Will tribal knowledge survive the millennium? *Science* 287: 44.
- Cox PA (2000c): Endangered plants, vanishing cultures: Ethnobotany and conservation. In: Raven PH, Williams T, eds., *Nature and Human Society: The Quest for a Sustainable World. Proceedings of the 2nd National Forum on Biodiversity*, Washington, D.C. October 1997, Washington, DC, National Academy Press, pp. 435–442.
- Cox PA (2000d): Biodiversity and pharmacology. In: Levin, Simon A, ed., *Encyclopedia of Biodiversity*, San Diego, Academic Press, pp. 4: 523–536.
- Cox PA, Balick MJ (1994): The ethnobotanical approach to drug discovery. *Scientific American* 270(6): 82–87.
- Cox PA, Elmqvist T (1991): Indigenous control: An alternative strategy for the establishment of rainforest preserves. *Ambio* 20: 317–321.
- Cox PA, Elmqvist T (1997): Ecocolonialism and indigenous-controlled rainforest preserves in Samoa. *Ambio* 26: 84–89.
- Cox PA, Sperry LR, Tuominen M, Bohlin L (1989): Pharmacological activity of the Samoan ethnopharmacopoeia. *Econ Bot* 43: 487–497.
- Cragg GM, Boyd MR, Grever MR, Shepartz (1994): Policies for international collaboration and compensation in drug discovery and development at the United States National Cancer Institute, the NCI letter of collection. In: Greaves T, ed., *Intellectual Property Rights for Indigenous Peoples: A Source Book*, Oklahoma City, Oklahoma Society for Applied Anthropology, pp. 85–98.
- Crawford RJ (1977): Missionary Accounts of Fofu Mo’omo’o. *Journal of the Polynesian Society* 86: 531–534.
- Dunstan CA, Andersson J, Bohlin L, Cox PA, Gronvik K-O (1994): A plant extract which enhances the plating efficiency of lymphoid cell lines and enhances the survival of normal lymphoid cells *in vitro*. *Cytotechnology* 14: 27–38.
- Dunstan CA, Noreen Y, Serrano G, Cox PA, Perera P, Bohlin L (1997): Evaluation of some Samoan and Peruvian medicinal plants by prostaglandin biosynthesis and rat ear oedema assays. *Journal of Ethnopharmacology* 57: 35–56.
- Farnsworth N (1990): The role of ethnopharmacology in drug development. In: Battersby A, Marsh J, eds., *Bioactive Molecules From Plants, (Ciba Symposium 154)*, Chichester (England), Wiley. pp. 2–21.
- Gustafson KR, Cardellina JH, McMahan JB, Gulakowski RJ, Ishitoya J, Szallasi Z, Lewin NE, Blumberg PM, Weislow OS, Beutler JA, Buckheit RW, Cragg GM, Cox PA, Bader JP, Boyd MR (1992): A non-promoting phorbol from the Samoan medicinal plant *Homalanthus nutans* inhibits cell killing by HIV-1. *J Med Chem* 35: 1978–1986.
- Hunt D (1923) Samoan medicines and practices. *U.S. Naval Medical Bulletin* 19: 145–152.
- Kloppenborg JR, Balick MJ (1996): Property rights and genetic resources: a framework for analysis. In: Balick MJ, Elisabetsky E, Laird SA, eds., *Medicinal Resources of the Tropical Forest*, New York, Columbia University Press, pp. 174–190.
- Kloppenborg J, Gonzales T (1994): Between state and capital: NGOs as allies of indigenous peoples. In: Greaves T, ed., *Intellectual Property Rights for Indigenous Peoples: A Source Book*, Oklahoma City, Oklahoma Society for Applied Anthropology, pp. 163–178.

- Kramer A (1903): *Die Samoa-Inseln. II Band. Ethnographie*. Stuttgart, E. Nagele.
- Laird S (1994): Natural products and the commercialization of traditional knowledge. In Greaves T, ed., *Intellectual Property Rights for Indigenous Peoples: A Source Book*, Oklahoma City, Oklahoma Society for Applied Anthropology. pp. 147–162.
- La Perouse JFG (1807): A voyage around the world. translated from the french. 3rd edition. Lackington and Allen, London.
- Li D, Owen NL, Perera P, Andersson C, Bohlin L, Cox PA, Pugmire RJ, Mayne CL, Grant DM (1994): Structure elucidation of three triterpenoids saponins from *Alphitonia zizyphoides* using 2D NMR Techniques. *J Nat Prod* 57: 218–224.
- McCuddin CR (1974): *Samoan Medicinal Plants and Their Usage*. Pago Pago, Office of Comprehensive Health Planning, Department of Medical Services, Government of American Samoa.
- Norton TR, Bristol ML, Read GW, Bushnell OA, Kashiwagi M, Okinaga CM, Oda CS (1973): Pharmacological evaluation of medicinal plants from Western Samoa. *J Pharm Sci* 62: 1077–1082.
- Perera P, Andersson R, Bohlin L, Andersson C, Du L, Owen NL, Dunkel R, Mayne CL, Pugmire RJ, Grant DM, Cox PA (1993): Structure determination of a new saponin from the plant *Alphitonia zizyphoides* by NMR spectroscopy. *Magnetic Res Chem* 31: 472–480.
- Powell T (1868): On various Samoan plants and their vernacular names. *J Bot* 6: 278–285, 342–347, 355–370.
- Reinecke F (1895): *Über die Nutzpflanzen Samoas und ihre Verwendung. Ber der Schles Ges für vaterl Kult Breslau* 1–24.
- Setchell WA (1924): American Samoa: Part I. Vegetation of Tutuila Island, Part II. Ethnobotany of the Samoans. *Carnegie Institute of Washington*, 20: 1–224.
- Stephenson CS (1934): *Report of the Department of Public Health*. Pago Pago, Government of American Samoa.
- Uhe G (1974): Medicinal plants of Samoa. *Econ Bot* 28: 1–30.
- Whistler WA (1984): Annotated list of Samoan plant names. *Econ Bot* 28: 1–39.
- Whistler WA (1992): *Polynesian Herbal Medicine*. Lawai, Hawaii, National Tropical Botanical Garden.
- Whistler WA (1996): *Samoan Herbal Medicine*. Apia, Western Samoa: O Le Siosiomaga Society.

Appendix I: The Falealupo Covenant*

On this 9th day of February, 1989 we, the chiefs and orators of Falealupo, Savaii as the recognized authorities and leaders of Falealupo village, hereby affirm that we are legally and culturally empowered to represent Falealupo village in enter-

ing into a covenant with Mr. Rex Maughan, Mr. Ken Murdock, Dr. Paul Alan Cox, and other interested donors for the purpose of preserving forever the rainforests of the Falealupo peninsula.

Responsibility of the Donors

1. In consideration of the importance of the unique beauty and nature of the Falealupo rainforest, we, Rex Maughan, Ken Murdock, Paul Cox, and other donors covenant to assume the current debt for the construction of the school called “Falealupo Primary School” as carried on the books of the Development Bank of Western Samoa and the accounts of Samoa Timber Products. That debt has an approximate book value of \$ 77,000 WST to the Bank and \$ 31,000 to Samoa Forest Products.

2. We, the donors hereby affirm the perpetual sovereignty of Falealupo village over the Falealupo rainforest and renounce, any claim or title by ourselves or by our heirs to the rainforests or land of Falealupo village.

Responsibility of the Village

1. In consideration of the funds and goodwill freely given by the donors, we, the chiefs and orators of Falealupo covenant and promise to continue to preserve the rainforests of Falealupo for 50 years.

2. We, the chiefs and orators, further promise to preserve and protect the indigenous flora and fauna of the rainforest and specifically promise to stop any person who attempts to destroy or shoot these creatures, particularly the Samoan flying fox *Pteropus samoensis* and the White-necked flying fox *Pteropus tonganus*. However, the people of Falealupo are allowed to hunt pigeons during the appropriate season.

3. We, the chiefs and orators of Falealupo, covenant to allow in perpetuity Dr. Paul Alan Cox and his associates access to our rainforests for the purposes of scientific research including the search for Samoan medicines as long as these efforts do not damage the forest. If the efforts of Koki [Paul Cox] in finding new drugs from the plants of Falealupo are successful, he will return to the village 33% of the income received.

Understandings

1. The chiefs and donors agree that the village should continue to use the forest for cultural uses including collection of medicinal plants, selective harvesting of trees for kava bowls, canoes, and houses as long as (a) traditional techniques and tools are used, (b) the uses are limited and do not significantly alter the pristine character of the rain forests. The donors and chiefs further agree to allow traditional garden plots to be used along the edges of the disturbed forest as long as these gardens are for subsistence use and do not involve the clearing of primary forest.

*This is the English translation of the covenant; only the Samoan language version is considered by all parties to be authoritative.

2. The chiefs and donors agree that indigenous flora and fauna will be otherwise protected against harvesting and hunting although fishing and the hunting of feral pigs and other noxious non-indigenous animals will be allowed if such activities are designed to protect the forests.

3. The chiefs and donors agree that all terms of this

covenant shall be binding from the date of signature upon them and their heirs for 50 years.

4. The chiefs and donors agree that the donors may use any channel to forward the promised funds and thank the kindness of Brigham Young University for its good offices in these regards.