

# Saving the ethnopharmacological heritage of Samoa

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Early European visitors to Samoa tended to denigrate the authenticity and efficacy of Samoan herbal medicine, yet bioassays indicate pharmacological activity in over 86% of Samoan medicinal plants. Novel anti-inflammatory compounds have been isolated from *Alphitonia zzyphoides* and *Erythrina variegata*, and the anti-HIV compound prostratin has been isolated from *Homalanthus nutans*. Unfortunately, both Samoan ethnopharmacology and Samoan rain forests are threatened. In order to prevent logging, funds were raised to build a needed village school in exchange for a village covenant to protect the 30 000 acre Falealupo forest. Subsequently, four additional rainforest reserves have been established. Hopefully such conservation measures can save the ethnopharmacological knowledge of Samoa.

Sa le talitonu tagata papalagi i le aoga o vai Samoa. Ae ua faamaonia nei su'esu'ega faasaianisi i le malolosi o 86% o la'au e fai ai vai Samoa. Ua maua ai vaila'au fou e aoga mo le fofoina o fula mai le toi (*Alphitonia zzyphoides*) ma le gatae Samoa (*Erythrina variegata*) atoa ma le vaila'au prostratin mai le mamala (*Homalanthus nutans*), e foliga lava lea vai e aoga i le fofoina o le AIDS. E faafetaui lelei ai nei aoga faasaianisi ma le faiva o fofo Samoa. Ae peta'i, e i ai le popolega olea le toe maua ai le faiga o vai Samoa atoa ma le vao matua. Ina ia faasao ai le vao, sa i ai se sa'iliega o tupe e faia le faleaoga i Falealupo ina ia osia se feaiga ma le nuu e puipuia ana vao tele. Ua toe faia foi isi faasaoina fou e fa. O le faamoemoe o nei faasaoina o le puipuiga lava lea o la'au ma le poto o fofo Samoa e fai ai vai.

**Key words:** Samoa, ethnopharmacology, prostratin, conservation, ethnobotany.

## Introduction

The Polynesians demonstrated masterful use of indigenous plant resources in the construction of ocean-going vessels (Banack and Cox, 1987), food preservation technologies (Cox, 1980a,b), the use of ichthyotoxic compounds (Cox, 1979), natural sweeteners (Cox, 1982), and the use of kava, but not hallucinogens (see Cox, 1981) to promote social tranquility (Cox and O'Rourke, 1987).

From a Polynesian perspective, however, the greatest indigenous achievements in the exploitation of island plants was the development of ethnopharmacology. Yet many Europeans have taken a skeptical view of Samoan ethnopharmacology (I use the term 'European' to include peoples derived from Europe such as Americans, Australians and New Zealanders). In this essay I discuss (1) the origins of European denigration of Samoan ethnopharmacology, (2) the possible efficacy of Samoan ethnopharmacology, and (3) possible strategies for preserving Samoan ethnopharmacology.

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## Methodology

Journals of early missionaries and visitors to Samoa were studied to document early European attitudes toward Samoan ethnopharmacology. Extant Samoan herbal medicine was studied from 1984 to 1992. Seven populations were chosen for study, including two traditional villages (Fa'ala and Falealupo tai on Savaii), two non-traditional villages near Apia (Pesega and Aleisa, on the island of Upolu), and three expatriate populations (Auckland, New Zealand; Honolulu, Hawaii; Laie, Hawaii).

In each population traditional healers were interviewed directly in the Samoan language. Interviews were documented with notebooks, portable computers, tape recorders, and video recorders. In remote villages electronic gear was driven by solar panels. Voucher specimens of all plants identified by healers as medicinal are deposited in the Brigham Young University Herbaria (BRY) and the Gray Herbarium of Harvard University (GH). Fresh plant collections for pharmacological testing were preserved in 70% EtOH in 1-liter aluminum bottles filled, then extracted in a rotary evaporator, lyophilized, and stored in a -20°C freezer until pharmacological analysis. Extracts were

screened at the Institutionen för Farmakognosi, University of Uppsala, Sweden for gross pharmacological activity (details appear in Cox et al., 1989); at the National Cancer Institute in Bethesda, MD for in vitro anti-HIV-1 activity (details appear in Gustafson et al., 1992) and at the Schering Research Institute in Bloomfield, NJ for inhibition of phospholipase A<sub>2</sub>.

## Results and Discussion

### *European ethnocentrism and the denigration of Samoan ethnopharmacology*

The efficacy and authenticity of Samoan ethnopharmacology has been questioned from the time of first European contact. Analysis of the accounts of early missionaries have led some to conclude that Samoan herbal medicine developed after European contact (Macpherson, 1985). However, since Samoa was one of the first areas settled in Polynesia, with pottery shards reliably carbon-dated as early as 940 B.C. (Davidson, 1979), it is unlikely that no medicinal plants were used in Samoa prior to European contact. I suggest that the absence of missionary comment on Samoan ethnopharmacology does not necessarily evidence lack of a precontact herbal medicine tradition since missionary accounts are largely silent on many aspects of plant uses that would capture the attention of a botanically adept observer. For example, the use of plants as fish poisons (Cox, 1979) and in food-preservation technologies (Cox, 1980a,b) received little mention in the journals of missionaries. However, missionary accounts did denigrate the medical acumen of Samoans (Williams, 1838; Turner, 1861, 1884; Stair, 1897). For example, missionary George Turner wrote:

The Samoans in their heathenism seldom had recourse to any internal remedy except an emetic, which they used after eating a poisonous fish. Sometimes juices from the bush were tried; at other times the patient drank on at water until it was rejected; and, on some occasions, mud, and even the most unmentionable filth, was mixed up and taken as an emetic draught. Latterly, as their intercourse with Tongans, Fijians, Tahitians, and Sandwich islanders increased, they made additions to their *pharmacopoeia* of juices from the bush.

(Turner, 1884, pp. 139–140)

I suggest that the early European missionaries were predisposed to either ignore or denigrate Samoan ethnopharmacology because (1) a developed system of ethnopharmacology ran counter to their view of Samoans as unenlightened heathen, (2)

spiritualism and witchcraft had a greater saliency to the Christian vocation of missionaries, and (3) traditional herbalism competed with sale of arsenic, mercury, and other European 'medicinal' compounds to the Samoans (Cox, 1991).

It is difficult to reconcile the view that Samoan herbalism was derived subsequent to European contact from other Polynesian islands, such as Tonga (Turner, 1884; Stair, 1897,) with the fact that early European visitors to other islands (including Tonga) argued that those herbal traditions were not indigenous either (Martin, 1817). As in most indigenous oral tradition, the antecedents to Samoan ethnopharmacology are not completely clear, but the abundance of indigenous plants and the relative paucity of European introductions in their ethnopharmacopoeia indicate that Samoan ethnopharmacology existed long before European contact. Certainly the Samoan healers themselves believe they are continuing a pre-European tradition (Cox, 1991). Furthermore, early botanically adept observers including Powell (1868), Reinecke (1898) and Kramer (1903) recorded lists of Samoan medicinal plants that other, less botanically adept observers, missed.

But it is clear that early European observers questioned the efficacy and rationality of Samoan ethnopharmacology. Even the confidence of the Samoan people in their ethnopharmacology was eroded by contact with Western culture. As early as 1895, Reinecke wrote that 'The trust of the Samoans in their medical science continuously disappears in favor of the viewpoint of the medical representatives' (Reinecke 1895, p. 22). Yet despite European pressure, many Samoans persisted in their faith in Samoan ethnopharmacology. In 1923 the Lieutenant Commander of the U.S. Navy Medical Corps in Pago Pago wrote:

A majority of the Samoans believe that their own crude drugs and harsh medical treatment are more efficacious than the purer manufactured drugs supplied to them through the Medical Department.

(Hunt, 1923, pp. 147–148)

Yet Hunt (1923, p. 150) also reported that many of the European residents, including missionaries, frequently resorted to the Samoan doctors. The report of the American Samoa Department of Health for 1933 (Stephenson, 1934) had an extensive discussion of Samoan herbalism. Christophersens's floristic works (1935, 1938) also mentioned the medicinal uses of Samoan plants. A government health manual admitted that Samoan

herbalism was an indigenous practice (Crosby and Brown, 1937).

More recent reporting on Samoan ethnopharmacology has been decidedly uneven. A physician in Samoa wrote of Samoan 'bush medicine' but did not mention the use of medicinal plants (Williams, 1952), while a more recent hospital study documented an extensive ethnopharmacopoeia (McCuddin, 1974). Recent botanists have also recorded many medicinal plants (Uhe, 1974; Whistler, 1984), yet several recent works (Meleisea, 1979; Forsyth, 1983; Macpherson, 1985; Gerding, 1986; Macpherson and Macpherson, 1990) relegate to plants a relatively minor role in Samoan healing.

#### *Efficacy of the Samoan ethnopharmacopoeia*

*Previous studies.* A study of possible pharmacological activity of Samoan medicinal plants was produced in 1973 (Norton et al., 1973). The team was unable to locate a healer but collected 34 plant species based on 'a body of information widely known to many Samoans'. Methylene chloride extracts of dried plants were tested for antiviral, antibacterial, and a variety of other possible pharmacological effects. A majority produced significant hypotensive effects in rats, 38% showed antibacterial activity, and 15% showed antiviral activity.

*Extant Samoan ethnopharmacology.* A description of Samoan ethnopharmacology appears elsewhere (Cox, 1990b; Cox, 1991). To summarize, except for a group of basic remedies known to nearly all Samoans, the practice of Samoan herbalism is carried on by a subspeciality of healer called *taulasea*. Samoan *taulasea* are almost always women who learned their craft from their mothers or other female relative. There are very few remaining Samoan herbalists. Those who can be found are very old and seldom have apprentices who are learning their knowledge.

Samoan ethnomedicine differs significantly from Western medicine in its descriptions of disease etiology (Cox, 1990b). As a result many Samoan diseases are not directly translatable into Western terminology. When a healer diagnoses a disease requiring a herbal treatment, she will immediately begin to collect the necessary plant materials, since only fresh plants are used. Most Samoan remedies are formulated from angiosperms. Formulation techniques are specific as to the plant part used. Most remedies are water infusions, some are oil infusions, and a few are ignited and inhaled. Many remedies, including those for

internal ailments, are applied externally. Most treatments are prepared as multi-species combinations.

Listed in Table 1 are 81 ethnotaxa comprising 75 plant species identified by healers as having pharmacological activity. I have listed only those species which were identified in my interviews with healers as having medicinal properties. Thus Table 1 represents only a subset of the total Samoan ethnopharmacopoeia. Complete descriptions, formulations, uses and pharmacological activities of these species will appear elsewhere. Indicated on Table 1 for each species is a determination of whether or not the plant is wild, a feral escape from cultivation, or cultivated, and the general type of disease (in Western terms) for which each plant is used.

An analysis of Table 1 reveals some interesting patterns. Although cultivated plants are used in Samoan herbal medicine, most Samoan medicinal plants are gathered from the wild, a pattern common throughout Polynesia (Zepernick, 1972). Of the 75 species listed in Table 1, 41 (55%) are indigenous to Samoa, and 4 (5%) are endemic. Wild gathered species predominate in Samoan ethnopharmacology: 50 of the species (67%) are wild or feral species. This predominance of wild species indicates that Samoan ethnopharmacology is indeed an indigenous tradition, and highlights the importance of rain forest conservation in the preservation of Samoan ethnopharmacology.

#### *Broad pharmacological screens of the Samoan ethnopharmacopoeia*

Freeze-dried extracts of 74 Samoan medicinal plant species were screened using broad in vitro and in vivo bioassays for pharmacological activity at the University of Uppsala (Cox et al., 1989). The in vivo Hippocratic screen employed Sandberg's method (Malone and Robichaud, 1962; Sandberg, 1967), testing the ability of the extract to effect the behavior of mice after intraperitoneal or intravenous injection; 41% of the extracts showed significant activity. The in vitro test measured the ability of the extract to contract or inhibit contraction of an electrically stimulated guinea-pig ileum (Livingston, 1970); 86% of the plant extracts showed significant activity. A total of 19% of the extracts showed activity by both standards. Subsequent screening for anti-inflammatory activity was conducted by Lars Bohlin's group in Uppsala, testing the inhibition of prostaglandin formation from arachidonic acid in vitro by 57 different plant extracts. The specific results will appear elsewhere,

TABLE 1

## SAMOAN MEDICINAL PLANTS

Samoa name	Latin name and Cox voucher number	Status	Parts	Use
A'atasi	<i>Rorippa sarmentosa</i> (Forst f ex DC) Macbr. 1038	Feral	leaves	Analgesic, emetic, antifungal
'Ago	<i>Curcuma longa</i> L. 1058	Feral	rhizomes	Fevers, rashes, internal distress
Aloalo	<i>Premna obtusifolia</i> R.Br. 813	Wild	leaves	Inflammation
			stem	Inflammation
Aloalo tai	<i>Clerodendrum inerme</i> L. Gaertn. 1009	Wild	leaves	Inflammation
Aloalo vao	<i>Mussaenda raiateensis</i> J.W.Moore	Wild	stem	Inflammation
			leaves	Inflammation
Aoa	<i>Ficus obliqua</i> Forst.f. 988	Wild	roots	Inflammation
Ateate	<i>Wedelia biflora</i> (L.) D.C. 1013	Wild	leaves	Inflammation
			stem	Internal distress, anti-fungal
Aute Samoa	<i>Hibiscus rosa-sinensis</i> L. 1048	Cult.	stem	Inflammation
'Ava'	<i>Piper methysticum</i> Forst.f. 1056	Cult.	rhizomes	Internal distress, inflammation
'Ava'ava'a'itu	<i>Piper</i> sp., <i>Macropiper</i> sp. 830	Wild	stem	Inflammation
			leaves	Inflammation
'Ava pui	<i>Zingiber zerumbet</i> (L.) J.E.Smith 1026	Wild	nodes	Inflammation
Fa'amoegalo	<i>Cymbopogon citratus</i> DC 968	Cult.	stems	Anti-bacterial, anti-fungal
Fa'i	<i>Musa paradisiaca</i> L. 1020	Cult.	roots	Inflammation and Hallucinations
	Ethnovariety Fa'i pata	Cult.	meristems	Wounds
Fasa	<i>Pandanus tectorius</i> Parkinson 874	Wild	roots	Internal distress
Fau	<i>Hibiscus tiliaceus</i> L. 984	Wild	bark	Appendicitis
			root sap	Eye injuries
Fetau	<i>Calophyllum inophyllum</i> L. 822	Wild	leaves	Inflammation
Filimoto	<i>Flacourtia rukam</i> Zoll.et Mor. 990	Wild	bark	Inflammation
Fisoa	<i>Colubrina asiatica</i> L. 985	Wild	leaves	Maternity complications
Fu'afu'a	<i>Kleinhovia hospitata</i> L. 847	Feral	bark?	Inflammation
Fuefue moa	<i>Ipomoea pes-caprae</i> (L.) R. Br. 981	Wild	leaves	Inflammation
Fuefuesina	<i>Vigna marina</i> (Burm.) Merr. 1007	Wild	leaves	Inflammation, maternity complications
Fue manogi	<i>Piper graeffei</i> Warb. 808	Wild	leaves	Inflammation
			stems	Internal distress
			bark	Appendicitis and stomach pain
Fueselela	<i>Hoya australis</i> R.Br. 1001	Wild	leaves	Inflammation, cardiotoxic
Fue vai	<i>Mucuna gigantea</i> (Willd.) DC. 1017	Wild	stem	Analgesic
Gatae samoa	<i>Erythrina variegata</i> L. 969	Cult.	bark	Inflammation, anti-viral
Ifi	<i>Inocarpus fagifer</i> (Park) Fosberg 1030	Feral	meristems	Inflammation
			roots	Internal distress
			bark	Appendicitis & stomach pain
	Ethnovar. Ifi lanu moana 1042		bark	Antibacterial
	Ethnovar. Ifi lanu mumu 1043		bark	Internal illness
Kuava	<i>Psidium guajava</i> L. 972	Cult.	leaves	Diarrhea
La'au fai lafa	<i>Cassia alata</i> L. 998	Cult.	leaves	Ringworm
La'au sauga	<i>Ocimum sanctum</i> L. 1032	Cult.	leaves	Anti-bacterial
Lama	<i>Aleurites moluccana</i> (L.) Willd. 855	Feral	leaves	Anti-fungal
Lau auta	<i>Phymatosorus scolopendria</i> (Burm.) Pichi Serm. 982	Wild	rhizomes	Inflammation, chills, analgesic
			leaves	Inflammation, internal distress
Lau fala	<i>Pandanus</i> sp. 292	Cult.	roots	Inflammation, internal distress
Lau fala ula	<i>Pandanus</i> sp.	Cult.	roots	Internal distress
Lau pata	<i>Macaranga harveyana</i> Muell. Arg. 1037	Wild	stem	Internal distress.
			roots	Wound healing, antibacterial
Lau talotalo	<i>Crinum asiatica</i> L. 10757	Cult.	leaves	Inflammation
Lau tamafalu	<i>Micromelum minutum</i> (Forster f.) Seemann 829	Wild	bark	Antifungal, antibacterial
			leaves	Antibacterial, analgesic
Lau ti	<i>Cordyline terminalis</i> (L.) Kunth 967	Feral	leaves	Inflammation
Ma'anunu	<i>Tarena sambucina</i> (Forst.f.) Durand 1019	Wild	bark	Inflammation, internal distress
Magele	<i>Trema cannabina</i> Lour. 1028	Wild	root	Eye infections
Mago	<i>Magnifera indica</i> L. 965	Cult.	bark	Internal distress, inflammation
Mamala	<i>Homalanthus nutans</i> (Muell. Arg.) Pax 842	Wild	bark	Tonic
			leaves	Inflammation, internal distress
			stems	Anti-viral
			roots	Internal distress, analgesic

TABLE 1 (continued)

Samoa name	Latin name and Cox voucher number	Status	Parts	Use
Maota	<i>Dysoxylum maota</i> Reinecke 1015	Wild	bark	Tonic
Masame	<i>Glochidion ramiflorum</i> Forst. 992	Wild	leaves bark stems	Inflammation, anti-fungal, bacterial Internal distress, muscular aches Appendicitis, abdominal distress
Matalafi	<i>Psychotria insularum</i> A.Gray 989	Wild	leaves meristems stems roots	Inflammation, maternity complications, anti-bacterial Inflammation, anti-bacterial, eye injuries & sun blindness Internal illness, inflammation, anti-fungal Antiviral, antibacterial
Mautofu-	<i>Sida rhombifolia</i> L. 1041	Wild	leaves	Antibacterial
Moso'oi	<i>Cananga odorata</i> (Lam.) Hook.f.& Thoms. 975	Cult.	bark	Asthma
Milo	<i>Thespesia populnea</i> (L.) Sol. 1006	Wild	leaves	Internal illness
Namulega	<i>Vitex trifolia</i> L. 1053	Wild	leaves	Internal illness, inflammation
Nonu 'ai	<i>Syzygium samarangense</i> (Bl.) Merr. & Perry 995	Cult.	leaves	Coughs, asthma
Nonu fi'afi'a	<i>Syzygium malaccense</i> (L.) Merr. & Perry 841 leaf galls or swellings-mumu tuaula [E 13]	Cult.	leaf gall	Inflammation
Nonu togi	<i>Syzygium</i> sp. 991	Cult.	leaves roots	Inflammation Inflammation, yaws
O'a	<i>Bischofia javanica</i> Bl. 1027	Cult.	bark	Internal distress, appendicitis
Onoonotea	<i>Laportea</i> sp. 1051	Wild	leaves	Anti-bacterial,
Paogo-	<i>Pandanus tectorius</i> 1061	Wild	roots	Internal distress
Polo	<i>Capsicum frutescens</i> 859	Cult.	leaves fruits	Anti-bacterial, maternity complications Internal illness
Pua samoa	<i>Gardenia taitensis</i> D.C. 1008	Cult.	leaves	Inflammation
Pu'a	<i>Hernandia nymphaefolia</i> (Presl) Kub. 819	Wild	bark	Inflammation, Anti-viral
Seasea	<i>Syzygium corynocarpum</i> (Gray) Muell. 1050	Cult.	meristems	Inflammation
Seasea toto	<i>Syzygium</i> sp. 1018	Cult.	meristems roots	Inflammation Internal illness
Suni vao	<i>Phaleria acuminata</i> A. Gray 57	Wild	bark	Menstruation problems
Taipoipo	<i>Geniostoma samoense</i> Reinecke 288	Wild	bark stems	Internal distress Appendicitis, stomach pain
Talie	<i>Terminalia catappa</i> L. 1047	Wild	meristems bark	Inflammation Menstruation, maternal complications
Tipolo	<i>Citrus aurantifolia</i> Chris. 1046	Cult.	leaves	Inflammation
Ti vao	<i>Cordyline terminalis</i> (L.) Kunth 978	Feral	rhizomes	Internal distress
Togo	<i>Centella asiatica</i> (L.) Urb. 997	Wild	leaves	Inflammation, bacterial, eye infection, sunblindness
Togo vai	<i>Rhizophora mangle</i>	Wild	bark	Maternity complications
Toi	<i>Alphitonia zizyphoides</i> (Spreng.) A.Gray 987	Wild	bark	Tonic, internal distress
To'ito'i	<i>Scaevola taccada</i> (Gaertn.) Roxb. 1002	Wild	bark	Menstruation problems
Tutuna	<i>Rhapidophora graeffei</i> Engler 976	Wild	roots leaves	Inflammation, hallucinations Inflammation, hallucinations
Ufi	<i>Dioscorea alata</i> L. 1059	Cult.	leaves	Anti-fungal
Ulu ea-	<i>Artocarpus altilis</i> (Park) Fosberg ethnovar. 1044	Cult.	roots	Antiviral, antifungal
Ulu ma'afala	<i>Artocarpus altilis</i> (Park) Fosberg ethnovar. 1045	Cult.	roots	Diarrhea
Ulu maopo	<i>Artocarpus altilis</i> (Park) Fosberg ethnovar. 1036	Cult.	roots	Internal distress
Usi	<i>Euodia horiensis</i> Forst. 1039	Wild	stems	Inflammation, 'ghost sickness'
U'unu	<i>Sarcopygme</i> sp. 21	Wild	leaves stems	Inflammation Inflammation
Vavae	<i>Ceiba pentandra</i> (L.) Gaertner 970	Cult.	bark	Asthma
Vi	<i>Spondias dulcis</i> Parkinson 966	Cult.	leaves	Eye infections
Vi vao	<i>Physalis angulata</i> 1052	Wild	leaves	Antibacterial

but over 1/3 of the extracts showed 40% inhibition or more. Bioassay guided fractionation has yielded the active flavonoids (+)catechin 1,4'-MeO-(+)gallocatechin 2, and (+)gallocatechin 3, isolated from *Syzygium malaccense* (Myrtaceae) and *Atuna racemosa* (Chrysobalanaceae).

#### *Phospholipase A<sub>2</sub> inhibitors from the Samoan ethnopharmacopoeia*

A group headed by V.D. Hegde at the Schering-Plough Research Institute in Bloomfield, NJ screened extracts of *Erythrina variegata* (Leguminosae) for inhibition of phospholipase A<sub>2</sub>, an enzyme believed to play an important role in inflammation. Samoans recognize two varieties of *E. variegata*, 'gatae Samoa' and 'gatae palagi'. They use the bark of only one variety, 'gatae Samoa', to treat inflammation. Only 'gatae samoa' exhibits significant phospholipase A<sub>2</sub> inhibition. Using bioassay guided fractionation, three phospholipase A<sub>2</sub> inhibitors were isolated and identified. These include two flavonoids (4'-hydroxy-3',5'-diprenyl isoflavonone and 3,9-dihydroxy-2,10-diprenyl pterocarp-6a-ene) and a novel isoflavonone (4'-hydroxy-3'5',6 triprenyl isoflavonone). The complete results will appear elsewhere, but the isolation of these anti-inflammatory compounds and the confirmation of anti-inflammatory activity in only one ethnovariety of *Erythrina variegata* lends credibility to the healer's assertions.

#### *Antiviral compounds from the Samoan ethnopharmacopoeia*

Samoan healers use water infusions of the macerated wood of *Homalanthus nutans* (Euphorbiaceae) as a tonic and to treat yellow fever. Extracts of *Homalanthus nutans* were screened by a team led by Michael Boyd at the National Cancer Institute (NCI) in Bethesda, MD for anti-HIV activity. In an in vitro tetrazolium-based assay to detect cytopathic effects of the AIDS virus HIV-1 (Gustafson et al., 1992), *Homalanthus* extracts exhibited potent activity. Bioassay guided fractionation resulted in the isolation of prostratin (12-deoxyphorbol 13-acetate). At non-cytotoxic concentrations prostratin was found to prevent HIV-1 reproduction in lymphocytic and monocytoid target cells. Prostratin also fully protected human cells from lytic effects of HIV-1. Since phorbols are known to be tumor-promoters (Evans, 1986), identification of the active anti-viral component of *Homalanthus nutans* as a phorbol raised some questions concerning the therapeutic potential of *Homalanthus* extracts. But in contrast

to many other phorbol derivatives, prostratin is reportedly not a tumor promoter (Zayed et al., 1984). Furthermore, Gustafson et al. (1992) found that prostratin does not induce hyperplasia in mice, yet stimulates protein kinase C. The NCI team concluded that prostratin 'represents a non-promoting activator of protein kinase C which strongly inhibits the killing of human host cells in vitro by HIV. By these criteria, prostratin is unique' (Gustafson et al., 1992, p. 1984).

It is possible that *Homalanthus nutans* contains other phorbols that have undesirable effects. However, since prostratin is a relatively polar phorbol ester, the water infusion techniques of the Samoan healers might serve to selectively extract prostratin from the other phorbols present; we are currently investigating this hypothesis. The isolation of prostratin from *H. nutans*, its extreme potency against HIV-1, and its unique nature as a non-promoting protein kinase C activator tends to corroborate the ethnopharmacological use of *H. nutans* against diseases of viral origin. Currently NCI considers prostratin as a potential candidate for drug development.

#### *Efforts to save the Samoan ethnopharmacopoeia*

Unlike much anthropology, which attempts to conceptualize human societies and social structures in Western terms, ethnobotany has as its ultimate goal a two-way flow of information and resources between indigenous and Western societies. The reason for this is quite simple: ethnobotanists do not view the indigenous people they work with as 'informants' but rather as colleagues.

One philosopher of science, Paul Feyerabend (1978), argues that current academic approaches to indigenous societies are intrinsically ethnocentric because they are focused on the *products* of these cultures, but refuse to seriously consider the indigenous intellectual *processes* responsible for the products:

They [western academics] examine them [indigenous cultures], they study them, they write about them, they 'interpret' them, they use them to bolster their own ideologies but they would never grant them a fundamental role in education, and they would never permit them to displace science from the central role it now assumes. This dogmatism is only rarely noticed, for nothing is now more popular than to praise primitive art, Chinese philosophy, Indian stories and so on. What is not seen, even by the concerned cultures and races themselves is that much of this so-called art was a science as well, it contained views of the world and rules for survival in it

(Feyerabend 1978, p. 177)

In this essay I have noted 6 new pharmacologically active compounds isolated from Samoan medicinal plants, with at least one considered to be an important new drug lead. Analysis of the pharmacological efficacy of the Samoan ethnopharmacopoeia has scarcely begun, and it is likely that further research will result in the discovery of more pharmacologically active compounds from Samoan medicinal plants.

Yet indigenous knowledge systems are rapidly disappearing under the onslaught of Western culture. The loss of these indigenous knowledge systems may yet prove to be one of the greatest tragedies of our age. By the time ethnobotanical studies emerge from the academic periphery to the mainstream it will likely be too late to salvage very much. Already the few ethnobotanists that exist are forced to travel to increasingly remote areas to locate healers, who frequently are aged and without any apparent intellectual heirs. Since in many indigenous societies ethnopharmacology is a specialist rather than a general tradition, the death of each healer results in an irreparable loss of generations of crucial knowledge. Hence one of the most important duties of an ethnobotanist is to document, in both western and indigenous languages, the indigenous knowledge system. It is in this spirit that ethnobotanists publish scientific articles with indigenous language abstracts; we wish to render our work easily accessible to our indigenous colleagues. My current work in process, "Samoan Ethnopharmacology — 'O le Faiga Vai Samoa", is an illustrated treatise written in both English and Samoan. Bo Landin of Scandinavia Films, Karlstad, Sweden has produced the first Samoan language feature film, "Nafanua — Fa'asoaina o le Vao Matua" (Nafanua — Saving the Samoan Rainforest), which was screened to villages throughout Western Samoa using a portable generator and 16 mm film projector and broadcast on T.V. throughout American Samoa. It is our hope that these efforts will affirm the dignity and significance of Samoan culture, particularly in the eyes of the younger generation.

The debt of the research team to the indigenous healers should always be remembered during all phases of drug searches based on ethnopharmacological screens (Cox, 1990a). By the time that a drug search produces a new lead compound, it is sometimes easy to forget that the compound in the test tube was originally obtained through the willingness of traditional healers to collaborate. Thus steps must be taken from the inception of a project to protect indigenous intellectual property rights. This requires sensitivity in implementation

because it is as unethical to raise hopes of financial returns among indigenous people prematurely as it is to raise hopes of cures among sick people prematurely. In Samoa we have protected these rights by written patent agreements signed by representatives of involved institutions as well as openly negotiated agreements signed with villages. In the case of prostratin, both the National Cancer Institute and Brigham Young University have guaranteed to return to the Samoan people a significant portion of any royalties.

In unmonetized cultures, financial interests can be translated into conservation efforts to preserve and protect rain forest and other habitats valued by the healers. Together with a variety of American donors I raised funds sufficient to protect the 30 000 acre lowland rainforest of Falealupo from logging. The resultant rain forest reserve is completely owned, controlled, and managed by the village. Three additional indigenously controlled preserves have been established with funds from the Swedish Society for the Conservation of Nature (Cox and Elmquist, 1991), and a new non-profit foundation, Seacology, seeks to expand the establishment of indigenous controlled preserves throughout the islands of the South Pacific and Caribbean.

The task we face, to preserve the ethnopharmacological traditions of the world, is daunting. But we can make a meaningful attempt, if we can learn in time to jettison our ethnocentricity and reverse historical Western approaches to indigenous societies. If Western scientists approach indigenous people with an attitude of humility, generosity, and the desire to learn, both Western and indigenous societies can be benefitted.

## References

- Banack, S.A. and Cox, P.A. (1987) Ethnobotany of ocean-going canoes in Lau, Fiji. *Economic Botany* 41, 148-162.
- Christopherson, C. (1935) Flowering Plants of Samoa. *Bernice P. Bishop Museum Bulletin* 128, 1-221.
- Christopherson, C. (1938) Flowering plants of Samoa — II. *Bernice P. Bishop Museum Bulletin* 154, 1-77.
- Cox, P.A. (1979) Use of indigenous plants as fish poisons in Samoa. *Economic Botany* 33, 397-339.
- Cox, P.A. (1980a) Two Samoan technologies for breadfruit and banana preservation. *Economic Botany* 34, 181-185.
- Cox, P.A. (1980b) Masi and tanu 'eli: two Polynesian technologies for breadfruit and banana preservation. *Bulletin of the Pacific Tropical Botanical Garden* 4, 81-93.
- Cox, P.A. (1981) Use of an hallucinogenic mushroom, *Copelandia cyanescens*, in Samoa. *Journal of Ethnopharmacology* 4, 115-116.
- Cox, P.A. (1982) Cordyline ovens (umu ti) in Samoa. *Economic Botany* 36, 389-396.
- Cox, P.A. (1990a) Ethnopharmacology and the search for new drugs. In: A. Battersby and J. Marsh (Eds.), *Bioactive*

- Molecules From Plants*. Ciba Symposium 154, Wiley, Chichester, pp. 40-47.
- Cox, P.A. (1990b) Samoan Ethnopharmacology. In: H. Wagner and N.R. Farnsworth (Eds.), *Economic and Medicinal Plant Research. Vol. 4. Plants and Traditional Medicine*. Academic Press, London, pp. 123-139.
- Cox, P.A. (1991) Polynesian Herbal Medicine In: P.A. Cox and S.A. Banack (Eds.), *Islands, Plants, and Polynesians*. Dioscorides Press, Portland, pp. 147-169.
- Cox, P.A. and Elmquist, T. (1991) Indigenous control: An alternative strategy for the establishment of rainforest preserves. *Ambio* 20, 317-321.
- Cox, P.A. and O'Rourke, L. (1987). Kava (*Piper methysticum* Forst.) *Economic Botany* 41, 452-454.
- Cox, P.A., Sperry, L.R., Tuominen, M. and Bohlin, L. (1989) Pharmacological activity of the Samoan ethnopharmacopoeia. *Economic Botany* 43, 487-497.
- Crosby, P.T. and Brown, G.G. (1937) *A book of Health for Samoans*. U.S. Navy, Pago Pago.
- Davidson, J.M. (1979) Samoa and Tonga. In: J.D. Jennings (Ed.), *The Prehistory of Polynesia*. Harvard University Press, Cambridge, MA, pp. 82-109.
- Evans, F.J. (Ed.) (1986) *Naturally occurring Phorbol esters*. CRC Press, Boca Raton, FL.
- Feyerabend, P. (1978) *Science in a Free Society*. NLB Press, London.
- Forsyth, C. (1983) *Samoan art of healing: a description and classification of the current practice of the Taulasea and Fofo*. Ph.D. Dissertation, United States International University, San Diego.
- Gerding, H. (1986) *Medizin in Samoa seit Beginn der Kolonialisierung*. Arbeiten der Forschungsstelle des Instituts für Geschichte der Medizin der Universität zu Köln. Band 42, 1-118.
- Gustafson, K.R., Carellina, J.H., McMahon, J.B., Gulakowski, R.J., Ishitoya, J., Szallasi, Z., Lewin, N.E., Blumberg, P.M., Weislow, O.S., Beutler, J.A., Buckheit, R.W., Cragg, G.M., Cox, P.A., Bader, J.P. and Boyd, M.R. (1992) A non-promoting phorbol from the Samoan medicinal plant *Homalanthus nutans* inhibits cell killing by HIV-1. *Journal of Medicinal Chemistry* 35, 1978-1986.
- Hunt, D. (1923) Samoan medicines and practices. *U.S. Naval Medical Bulletin* 19, 145-152.
- Kirch, P.V. (1984) *The Evolution of the Polynesian Chiefdoms*. Cambridge University Press, Cambridge.
- Kramer, A. (1903) *Die Samoa-Inseln. II Band. Ethnographie*. Stuttgart, E. Nagele.
- Kramer, A. (1906) *Hawaii, Ostmikronesien und Samoa*. Verlag von Strecker & Schroder, Stuttgart.
- Livingstone, E. and Livingstone, S. (1970) *Pharmacological Experiments on Isolated Preparations*, 2nd Edn. University of Edinburgh Press, Edinburgh.
- Macpherson, C. (1985) Samoan medicine. In: C.D.F. Parsons (Ed.), *Healing practices in the South Pacific*. The Institute for Polynesian Studies, Laie, Hawaii, pp. 1-15.
- Macpherson, C. and Macpherson, L. (1990) *Samoan Medical Belief and Practice*. Auckland University Press, Auckland.
- Malone, M.H. and Robichaud, R.C. (1962) A Hippocratic screen for pure or crude drug materials. *Lloydia* 25, 3230-332.
- Martin, J. (1817) *An Account of the Natives of the Tongan Islands. . . Compiled and Arranged from the Extensive Communications of John Martin, M.D. Vol. II*. John Murray, London.
- McCuddin, C.R. (1974) *Samoan Medicinal Plants and their Usage*. Office of Comprehensive Health Planning, Department of Medical Services, Government of American Samoa, Pago Pago.
- Meleisea, P. (1979) *Daughters of Sina: A Study of Gender, Status, and Power in Western Samoa*. Ph.D. diss., Australian National University.
- Norton, T.R., Bristol, M.L., Read, G.W., Bushnell, O.A., Kashiwagi, M., Okinaga, C.M. and Oda, C.S. (1973) Pharmacological evaluation of medicinal plants from Western Samoa. *Journal of Pharmaceutical Sciences* 62, 1077-1082.
- Powell, T. (1868) On various Samoan plants and their venacular names. *Journal of Botany* 6, 278-285, 342-347, 355-370.
- Reinecke, F. (1895) Über die Nutzpflanzen Samoas und ihre Verwendung. *Jahresbericht der Schlesischen Gesellschaft für vaterländische Cultur, Breslau*, 1-24.
- Reinecke, F. (1898) Die Flora der Samoa-Inseln. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 25, 758-708.
- Sandberg, F. (1967) *Pharmacological Screening of Medicinal Plants*. Ceylon Government Printer, Colombo, Ceylon.
- Stair, J.B. (1897) *Old Samoa*. Religious Tract Society, London.
- Stephenson, C.S. (1934) *Report of the Department of Public Health*. Government of American Samoa, Pago Pago.
- Turner, G. (1861) *Nineteen years in Polynesia*. John Snow, London.
- Turner, G. (1884) *Samoa a Hundred Years Ago and Long Before*. Macmillan, London.
- Uhe, G. (1974) Medicinal plants of Samoa. *Economic Botany* 28, 1-30.
- Williams, B. (1952) They still believe in 'bush-medicine'. *Pacific Discovery* 5, 12-14 (Sept.-Oct.)
- Williams, J. (1838) *A Narrative of Missionary Enterprises in the South Sea Islands*. John Snow, London.
- Whistler, W.A. (1984) Annotated list of Samoan plant names. *Economic Botany* 38, 464-489.
- Zayed, S., Sorg, B. and Hecker, E. (1984) Structure activity relations of poly-functional diterpenes of the tagliane type. VI. Irritant and tumor-promoting activities of semisynthetic mono and diesters of 12-deosyphorbol. *Planta Medica* 34, 65-59.
- Zepernick, B. (1972) *Arzneipflanzen der Polynesier*. Verlag von Deitrich Reimer, Berlin.