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Pharmacological Evaluation of Medicinal Plants from Western Samoa

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Abstract □ A total of 110 plant parts from 34 different species of medicinal and toxic plants was collected for pharmacological testing in or near the Lefaga District on the island of Upolu in Western Samoa. Voucher specimens of all species were also made. From the 110 plant parts, 211 different extracts were prepared and evaluated for antiviral, antibacterial, and anti-Ehrlich ascites tumor properties and for effects on blood pressure, heart rate, respiration, electrocardiogram, electroencephalogram, and gastric motility. Twelve extracts were effective *in vitro* as antibacterial agents and six inhibited Ehrlich ascites tumor growth in mice. Ninety-one extracts showed hypotensive properties, 31 for more than 30 min.

Keyphrases □ Medicinal plants—pharmacological evaluation of 34 species from Western Samoa □ Antiviral activity—34 plants from Western Samoa screened □ Antitumor activity—34 plants from Western Samoa screened □ Antibacterial activity—34 plants from Western Samoa screened □ Antihypertensive activity—34 plants from Western Samoa screened

As part of a broad program of ethnobotanical and pharmacological studies of medicinal plants and other biota from the Pacific basin, medicinal and poisonous plants of Western Samoa were collected for pharmacological and chemical evaluation. The ethnobotanical phase was centered in Lefaga District on the island of Upolu. The flora was studied intensively, and a large collection of herbarium specimens was obtained. Ethnobotanical data concerning the names, usage, and special significance of most of the woody and some of the herbaceous flora were gathered for native and introduced plants. This information, which included a large body of medicinal lore, was gathered from many people in Lefaga District. No prominent practitioner of native medicine was located in the District, so the data obtained on medicinal plants are not those of one outstanding individual but rather reflect that body of information widely known to many Samoans. Extensive botanical collections were also made in the interior of Savaii island and to a lesser extent at many coastal points on both islands. Whenever possible, ethnobotanical data were gathered at the same time from local people.

The 34 plants chosen for inclusion in the pharmacological studies are native or naturalized species, many of which also occur on adjacent island groups. Most are of therapeutic or toxicological interest to the Samoans today and many are noted in the literature concerning Samoa. Three plants, *Ochrosia oppositifolia*, *Barringtonia samoensis*, and *Terminalia samoensis*, were included because of their close botanical relationship to plants known for their physiological activity. Herbarium voucher specimens were made for all the plants studied[1]. The plant materials analyzed were air dried in Samoa in a large rack of screen trays heated gently by kerosene lanterns. The material was sealed in polyethylene for air shipment to Honolulu, Hawaii.

A direct evaluation under clinical conditions of the use of the plants by the local Samoans was not attempted. However, it was felt that the probability of physiological and chemotherapeutic effects might be greater with plants selected by the local people for medicinal use than with plants selected at random. Whether this is so remains a moot point. No checks were carried out for possible potentiation corresponding to use of several plants in a given local remedy.

Each plant part from Western Samoa was powdered and extracted with methylene chloride and then 60% ethanol. In this manner, the extraction method gave two extracts, the methylene chloride extract containing the relatively nonpolar constituents and the aqueous ethanolic extracts containing the more polar constituents. All extracts were examined for antiviral, antitumor, and antibacterial activity as well as for systemic effects in the rat.

[1] They are deposited at the B. P. Bishop Museum, Honolulu, Hawaii; U. S. National Herbarium, Washington, D. C.; Gray Herbarium, Cambridge, England; Royal Botanic Gardens, Kew, England; and at several other herbaria.

Table I—Pharmacological Testing

Family	Species	Plant Part[a], Solvent[b]	T/C Columbia SK Virus[c]	30-Day Survivors EA[d]	Rat Arterial Pressure[e]	Microbiology[f]
Anonaceae	*Canaga odorata* (Lam.) Hook, F. & Thomp.	BK–M	2.0, 92	—	neg.	neg.
		BK–E	2.0, 100	neg., tox.	sl. hypo.	neg.
		LV–M	2.0, 100	—	neg.	neg.
		LV–E	112	neg., tox.	v. hypo. act. i.p.	neg.
		RT–M	2.0, 138	neg., tox.	neg.	neg.
		RT–E	111	—	—	neg.
		ST–M	2.0, 112	—	hypo. neg. i.p.	neg.
		ST–E	133	1.5, neg., tox.	neg.	neg.
Apocynaceae	*Cerbera manghas* L.	FR+S–M	118	neg.	neg.	—
		FR+S–E	0.3, 100	0.5, neg., tox.	neg.	neg.
		LV–M	0.3, 100	0.5, neg.	neg.	neg.
		LV–E	0.2, 111	0.3, neg., tox.	v. hypo., neg. i.p.	neg.
		RT–CL	0.3, 100	neg.	neg.	—
		RT–E	0.6, 94	0.7, neg., tox.	sl. hypo.	—
		ST–CL	100	—	sl. hypo.	—
		ST–E	89	neg.	hypo., neg. i.p.	neg.
	Ochrosia oppositifolia (Lam.) K. Schum.	LV–M	2.0, 133	neg.	neg.	neg.
		LV–E	2.0, 88	neg.	v. hypo.	neg.
Araceae	*Amorphophallus campanulatus* (Roxb.) Bl. in Decaisne	LV+BL–M	111	—	neg.	neg.
		LV+BL–E	0.5, 67	neg.	v. hypo., act. i.p.	neg.
		PT–M	111	—	neg.	act. strep.
		RT+CRM–M	1.5, 89	—	neg.	neg.
		RT+CRM–E	100	—	sl. hypo.	neg.
	Raphidophora reineckei Engler	LV–M	2.0, 123	—	neg.	neg.
		LV–E	2.0, 100	1.5, neg.	v. hypo., act. i.p. act. oral, non-α-block.	neg.
		ST–M	2.0, 78	—	neg.	neg.
		ST–E	2.0, 154	neg.	sl. hypo.	neg.
Asclepiadaceae	*Hoya australis* R. Br.	ST+LV+RT–CL	100	—	neg.	neg.
		ST+LV+RT–E	89	—	hypo.	neg.
Barringtoniaceae	*Barringtonia asiatica* (L.) Kurz	BK–M	0.3, 100	1.3, neg., tox.	neg.	neg.
		BK–E	0.2, 124	—	v. hypo., v. tox.	—
		LV–M	128	neg., tox.	neg.	neg.
		LV–E	128	neg.	hypo.	—
	Barringtonia samoensis A. Gray	BK–M	2.0, 280[g]	—	neg.	neg.
		BK–E	352[g]	0.5, neg., v. tox.	sl. hypo.	neg.
		LV–M	100	—	neg.	neg.
		LV–E	100	—	sl. hypo.	neg.
		RT–M	2.0, 145	—	neg.	neg.
		RT–E	0.25, 150	0.5, neg.	fatal (1 ml./kg.)	neg.
		SD–M	2.0, 200[g]	—	neg.	neg.
		SD–E	—	0.4, neg., tox.	—	—
		ST–M	2.0, 280[g]	—	neg.	neg.
		ST–E	2.0, 320[g]	60% surv.[h]	hypo.	neg.
Combretaceae	*Terminalia samoensis* Rech.	BK–M	111	—	neg.	neg.
		BK–E	0.25, 111	0.2, neg., tox.	v. hypo., act. i.p., non-α-block., non-histaminergic	neg.
		LV–E	0.25, 111	0.13, 100% tox.	v. hypo., inact. i.p., act. oral.	act. shig.
		PT–M	—	—	—	—
		PT–E	1.5, 89	—	neg.	neg.
		RT–M	0.5, 111	—	neg.	neg.
		RT–E	0.5, 100	0.13, neg., tox.	v. hypo., inact. i.p., inact. oral	act. staph., strep.
Compositate	*Micania micrantha* H.B.K.	ST+RT+LV–M	—	0.50, neg.	neg.	neg.
		ST+RT+LV–E	88	neg.	sl. hypo., tox.	neg.
	Wedelia biflora (L.) DC.	FR–M	—	—	neg.	—
		LV–M	111	—	neg.	neg.
		LV–E	107	2.0, neg.	sl. hypo.	neg.
		RT–M	2.0, 73	—	neg.	neg.
		RT–E	0.25, 133	—	neg.	neg.
		ST–E	1.5, 78	2.0, neg.	sl. hypo.	neg.
Dioscoreaceae	*Dioscorea bulbifera* L.	TBR–Cl	106	neg.	neg.	—
		TBR–E	106	neg.	neg.	Act. F61, F284, F808, F1224, H37Ra, P27

Table I—(*Continued*)

Family	Species	Plant Part[a], Solvent[d]	T/C Columbia SK Virus[c]	30-Day Survivors EA[d]	Rat Arterial Pressure[e]	Microbiology[f]
Euphorbiaceae	*Bischofia javanica* Bl.	LV–M	2.0, 100	—	neg.	neg.
		LV–E	118	—	neg.	neg.
		RT–M	2.0, 128	—	neg.	neg.
		RT–E	0.3, 106	0.4, neg., tox.	fatal (1.0 ml./kg.)	neg.
		ST–M	2.0, 100	—	neg.	neg.
		ST–E	0.3, 118	neg.	fatal (0.5 ml./kg.)	neg.
	Homalanthus nutans (Forst.) Pax.	BK–M	2.0, 89	—	neg.	neg.
		BK–E	2.0, 92	neg., tox.	hypo.	neg.
		LV–M	2.0, 90	—	sl. hypo.	neg.
		LV–E	1.5, 90% tox.	0.5, neg.	sl. hypo.	neg.
		RT–M	2.0, 240[g]	—	neg.	neg.
		RT–E	2.0, 240[g]	—	sl. hypo.	neg.
		ST–M	2.0, 200[g]	—	sl. hypo.	neg.
		ST–E	2.0, 240[g]	0.5, neg.	neg.	neg.
	Macaranga stipulosa, Muell. Arg.	BK–M	112	—	sl. hypo.	neg.
		BK–E	0.2, 125	0.5, neg.	hypo.	neg.
		LV–M	2.0, 88	—	neg.	neg.
		LV–E	88	0.3, neg.	v. hypo., inact. i.p.,	neg.
		RT–M	125	—	neg.	neg.
		RT–E	88	neg.	hypo., inact. i.p.	neg.
		ST–M	67	—	neg.	neg.
		ST–E	0.3, 95	0.3, neg., v. tox.	hypo.	neg.
Flacourtiaceae	*Flacourtia rukam*, Zoll. & Morr.	BK–M	114	2.0, neg.	sl. hypo.	neg.
		BK–E	71	neg.	sl. hypo.	neg.
		FR–M	86	neg.	neg.	neg.
		FR–E	143	neg.	sl. hypo.	neg.
		LV–M	1.5, 112	neg.	neg.	neg.
		LV–E	100	neg.	v. hypo.	neg.
		ST–M	100	neg.	neg.	neg.
		ST–E	114	neg.	neg.	neg.
Guttiferae	*Calophyllum inophyllum* L.	BK–M	2.0, 67	—	—	—
		BK–E	—	—	—	—
		FR–M	2.0, 167	—	—	—
		FR–E	100	2.0, neg., tox.	fatal (1 ml./kg.)	neg.
		LV–M	—	—	neg.	—
		LV–E	107	2.0, neg.	v. hypo.	—
		RT–M	82	—	neg.	—
		RT–E	0.3, 118	—	v. hypo., inact. i.p., act. oral.	neg.
		ST–M	71	—	—	neg.
		ST–E	0.3, 78	—	v. hypo. (0.5 ml./kg.), act. i.p., act. oral, non-α block., non-histaminergic	—
Leguminosae	*Desmodium umbellatum* (L.) D.C.	LV–M	—	—	neg.	neg.
		LV–E	2.0, 143	0.5, neg.	sl. hypo.	neg.
	Erythrina fusca Lour.	BK–M	2.0, 107	—	neg.	act. strep.
		BK–E	150	2.0, neg.	v. hypo., inact. i.p.	neg.
		LV–M	2.0, 280[g]	—	neg.	neg.
		LV–E	2.0, 360[g]	neg.	neg.	neg.
		RT–M	2.0, 320[g]	—	neg.	neg.
		RT–E	240[g]	—	—	—
		ST–M	150	—	sl. hypo.	neg.
		ST–E	2.0, 360[g]	2.0, neg.	sl. hypo.	neg.
	Inocarus fagiferus (Parkins.) Fosb.	BK–M	2.0, 164	—	neg.	neg.
		BK–E	2.0, 127	—	sl. hypo.	neg.
		LV–M	1.5, 164	—	neg.	neg.
		LV–E	2.0, 94	2.0, neg.	v. hypo., inact. i.p.	neg.
		RT–M	2.0, 111	—	neg.	neg.
		RT–E	111	neg.	neg.	neg.
		SD–M	2.0, 127	—	neg.	neg.
		ST–M	2.0, 164	—	neg.	neg.
		ST–E	2.0, 182	—	neg.	neg.
		PER–M	100	—	neg.	neg.
		PER–E	0.3, 111	neg.	neg.	neg.
	Intsia bijuga (Colebr.) O. Ktze	BK–M	111	—	neg.	act. strep.
		LV–M	2.0, 107	—	neg.	neg.
		LV–E	2.0, 120	2.0, neg.	v. hypo., act. i.p., inact. oral	act. strep., P-27, P-39

(*continued*)

Table I—(*Continued*)

Family	Species	Plant Part[a], Solvent[b]	T/C Columbia SK Virus[c]	30-Day Survivors EA[d]	Rat Arterial Pressure[e]	Microbiology[f]
Leguminosae	*Intsia bijuga* (Colebr.) O. Ktze	RT–M	2.0, 67	—	neg.	neg.
		RT–E	1.5, 89	—	neg.	neg.
		ST–M	80	—	neg.	act. staph., strep.
		ST–E	2.0, 100	2.0, neg.	sl. hypo.	neg.
Loganiaceae	*Fagraea berteriana* Benth.	FR+SD–CL	100	2.0, neg.	sl. hypo.	—
		FR+SD–E	111	neg., tox.	v. hypo., act. i.p.	neg.
		ST+RT+LV–CL	111	neg., tox.	neg.	neg.
		ST+RT+LV–E	89	neg.	v. hypo., act. i.p.	neg.
Malvaceae	*Sida rhombifolia* L.	WH.PL.–M	2.0, 89	—	neg.	neg.
		WH.PL.–E	2.0, 89	—	neg.	neg.
	Thespesia populnea (L.) Solander	BK–M	111	—	neg.	neg.
		BK–E	0.75, 118	—	fatal 0.5 ml./kg., neg. 0.1 ml./kg.	neg.
		FR–M	1.5, 106	—	neg.	neg.
		FR–E	106	neg.	neg.	neg.
		LV–M	1.5, 106	—	neg.	neg.
		LV–E	106	0.5 neg.	v. hypo., act. i.p., act. oral, non-α-block., nonhistaminergic	act. salm.
		RT–M	0.5, 106	—	neg.	neg.
		RT–E	0.5, 94	20% surv.[h], tox.	v. hypo., act. i.p., act. oral	neg.
		ST–M	1.5, 94	—	neg.	neg.
		ST–E	—	0.5, 40% surv.[h], tox.	v. hypo., inact. i.p.	neg.
Meliaceae	*Dysoxylum* aff. *Maota* Rein.	BK–M	105	—	neg.	neg.
		BK–E	2.0, 105	—	hypo.	neg.
		LV–M	105	—	neg.	neg.
		LV–E	2.0, 105	neg.	sl. hypo.	neg.
		RT–M	2.0, 70	—	sl. hypo.	neg.
		RT–E	90	—	hypo.	neg.
		ST–M	2.0, 105	—	neg.	neg.
		ST–E	0.5, 105	neg.	sl. hypo.	neg.
Moraceae	*Ficus obliqua* Forst. f.	AR RT BK–M	2.0, 123	—	neg.	neg.
		AR RT BK–E	123	neg., tox.	v. hypo., inact. i.p.	neg.
		AR RT WD–M	2.0, 92	—	neg.	neg.
		AR RT WD–E	1.5, 138	neg.	neg.	neg.
		UG RT–M	2.0, 123	—	neg.	neg.
		UG RT–E	—	0.5 neg., v. tox.	v. hypo., act. i.p., act. oral	neg.
Myrsinaceae	*Maesa samoana* Meg.	BK–M	182	—	neg.	neg.
		BK–E	100% tox.	0.5, 100% tox.	v. hypo., act. i.p.	neg.
		LV–M	125	—	neg.	neg.
		LV–E	133	100% tox.	hypo.	neg.
		RT–M	75	—	neg.	neg.
		RT–E	0.3, 100	—	fatal 1 ml./kg.	neg.
		ST–M	125	—	neg.	neg.
Rhamnaceae	*Colubrina asiatica* (L.) Brongn.	BK–M	70	—	neg.	neg.
		BK–E	0.75, 80	0.5 neg., tox.	hypo.	neg.
		LV–M	2.0, 118	—	neg.	neg.
		LV–E	0.75, 59	0.5 neg., v. tox.	v. hypo. 0.1 ml./kg., act. i.p.	neg.
		RT–M	1.5, 94	—	neg.	neg.
		RT–E	0.5, 80	0.5, 40% surv., tox.	hypo.	neg.
		ST–M	2.0, 80	—	sl, hypo.	neg.
		ST–E	0.50, 100	neg.	hypo.	neg.
Rubiaceae	*Psychotria insularum* A. Gray	LV–M	114	—	neg.	neg.
		LV–E	143	—	sl. hypo. 0.1 ml./kg., tox. 1 ml./kg.	neg.
		ST–M	0.3, 71	—	neg.	neg.
		ST–E	0.3, 100	—	hypo.	neg.
Sterculiaceae	*Kleinhovia hospita* L.	BK–M	2.0, 114	—	neg.	neg.
		BK–E	2.0, 143	—	v. hypo., inact. i.p., inact. oral	neg.
		FR–E	167	—	neg.	neg.
		LV–M	2.0, 78	—	hypo., inact. i.p.	neg.
		LV–E	2.0, 128	neg.	v. hypo. 0.1 ml./kg., inact. i.p., inact. oral	neg.
		RT–M	2.0, 128	—	neg.	neg.
		RT–E	2.0, 114	0.3, neg.	sl. hypo.	neg.

Table I—(*Continued*)

Family	Species	Plant Part[a], Solvent[b]	T/C Columbia SK Virus[c]	30-Day Survivors EA[d]	Rat Arterial Pressure[e]	Microbiology[f]
Sterculiaceae	*Kleinhovia hospita* L.	ST-M	2.0, 280[g]	—	neg.	neg.
		ST-E	2.0, 128	0.5, neg.	sl. hypo.	neg.
	Melochia aristata A. Gray	BK-M	0.3, 125	—	neg.	neg.
		BK-E	0.3, 125	0.5 neg., tox.	v. hypo., fatal 0.1 ml./kg.	neg.
		LV-M	63	—	neg.	neg.
		LV-E	100	0.3 neg., tox.	hypo., tox.	neg.
		RT-M	2.0, 95	—	neg.	neg.
		RT-E	—	0.3, 20% surv.[h], tox. (15)	—	—
		ST-M	2.0, 88	—	neg.	neg.
		ST-E	2.0, 182	0.5, 73% surv.[h], tox. (15)	hypo.	neg.
Verbenaceae	*Clerodendron inerme* (L.) Gaertn.	LV-M	2.0, 145	—	sl. hypo.	act. F1224
		LV-E	2.0, 145	neg.	sl. hypo.	act. staph., strep.
		RT-M	167	—	neg.	neg.
		RT-E	2.0, 120	—	neg.	neg.
		ST-M	2.0, 145	—	neg.	neg.
		ST-E	2.0, 182	neg.	sl. hypo.	neg.
	Premna taitensis Schauer in D.C.	BK-M	2.0, 100	—	neg.	neg.
		BK-E	2.0, 114	1.5 neg.	v. hypo. 0.1 ml./kg.	neg.
		LV-M	1.5, 120	—	sl. hypo.	neg.
		LV-E	2.0, 71	2.0 neg.	v. hypo., inact. i.p.	act. F61, F284, F808, F1224, H37Ra, P27, P39
		RT-M	2.0, 100	—	neg.	neg.
		RT-E	2.0, 100	1.5 neg.	hypo.	neg.
		ST-M	0.3, 164	—	neg.	neg.
		ST-E	2.0, 118	—	sl. hypo.	—

[a] AR RT BK = aerial root bark, AR RT WD = aerial root wood, BL = blades, BK = bark, CRM = corms, LV = leaves, PER = pericarp, PT = petioles, RT = roots, SD = seeds, ST = stems, TBR = tubers, UG RT = underground root, and WH PL = whole plant. [b] M = methylene chloride extract, Cl = chloroform extract, E = 60% aqueous ethanol extract after prior M or Cl extraction. [c] The T/C number is the fraction of treated deaths divided by the fraction of diseased control deaths times 100. The occasional preceding small number indicates the concentration factor as compared to the normal 0.1-ml. dose of full-strength extract. [d] EA = Ehrlich ascites tumor. neg. = no survivors 30 days after injection of 5×10^5 Ehrlich ascites tumor cells intraperitoneally, tox. = one or two out of five mice died of drug toxicity, v. tox. = three or four out of five mice died of drug toxicity, 100% tox. = five out of five mice died of drug toxicity, and (15) = 15 mice in group instead of the usual five. The number preceding the result is the concentration factor as compared to the normal 0.1-ml. dose of full-strength extract. [e] This is based on the intravenous injection of 1 ml./kg. of extract unless stated otherwise. act. i.p. = active using intraperitoneal injection at 10 times the effective intravenous dose, act. oral = active using stomach intubation of 20 times the effective intravenous dose, hypo. = reduces arterial blood pressure by >20% for 5–30 min., neg. = no appreciable effect on arterial blood pressure, neg. i.p. = no appreciable effect when administered at 10 times the effective intravenous dose, non-α-block. = normal pressor response seen when animal was challenged with 3 mcg./kg. epinephrine while blood pressure depressed from extract, non-histaminergic = action of hypotensive extract unchanged when given after pretreatment with 10 mg./kg. diphenhydramine, sl. hypo. = reduces arterial blood pressure >20% for <5 min., and v. hypo. = reduces arterial blood pressure by >20% for >30 min. [f] neg. = no inhibition of growth of bacteria compared to no drug standard, act. = obvious inhibition of growth of bacteria, strep. = *Streptococcus pyogenes*, staph. = *Staphylococcus aureus* (penicillin resistant), shig. = *Shigella flexneri*, F61 = *Mycobacterium avium*, F284 = *M. kansasii*, F808 = *M.* sp. (Battey type), F1224 = *Nocardia* sp., H37Ra = *M. tuberculosis*, P27 = *M.* sp. scotochromogen, and P39 = *M.* sp. (Battey type). [g] Controls only 5/20 died. [h] All nonascitic.

EXPERIMENTAL

Extraction—The dried plants received by air from Western Samoa were powdered in a Wiley mill. About 100–300 g. of the powdered sample was suspended in 5–10 times its weight of methylene chloride, the amount of solvent necessary to impart fluidity to the mixture. In a few cases, chloroform was used instead of methylene chloride. After standing for about 24 hr., the mixture was filtered and the marc was washed several times with additional chlorinated solvent. The combined filtrate was evaporated to dryness at room temperature, and the residue was mixed with approximately 300 ml. of 95% ethanol. This mixture was then evaporated at ≦50° to a volume (in milliliters) equal to one-tenth of the weight (in grams) of the original sample; it was then diluted with nine volumes of water to give a 10% ethanolic emulsion, called the "methylene chloride extract."

The marc was air dried at room temperature and then suspended in 5–10 times its weight of 60% ethanol, the amount of solvent necessary to impart fluidity to the mixture. After standing for 24 hr., the mixture was filtered and the marc was washed several times with additional 60% ethanol. The combined filtrates were evaporated at ≦50° to a volume equal (in milliliters) to the original weight (in grams) of the plant sample. The resulting extract was called the "aqueous ethanol extract."

All extracts were stored frozen and thawed just before use.

Columbia SK Virus—Five-week-old Swiss-Webster mice were inoculated intraperitoneally with Columbia SK virus (brain adapted) of LD_{70-90} titer (1). The infected controls were in groups of 20 and the treated mice were in groups of 10 for each drug. Two hours after the virus inoculation, 0.1 ml. of the extract was inoculated subcutaneously. All extracts were first checked for acute toxicity at 0.1 ml. If toxic at this level, dilutions were made to achieve the maximum nontoxic dose. This latter dose was injected subcutaneously for a total of 4 days (eight doses). The mice were observed for another 5 days after termination of the treatment. The T/C listed in Table I is the percent mortality of the treated mice divided by the percent mortality of the controls, multiplied by 100. When enough sample was available, experiments that gave T/C values below 75 were rerun for confirmation.

Ehrlich Ascites Tumor—Five-week-old Swiss-Webster mice were injected intraperitoneally with 5×10^5 Ehrlich ascites tumor cells. The experiments were carried out as previously reported (2). One-tenth milliliter of extract was checked for acute toxicity. If 0.1 ml. of extract was acutely toxic, dilutions of the extract were made to determine a maximum nontoxic dose. Intraperitoneal injections of the maximum nontoxic dose to groups of five mice were started 24 hr. after Ehrlich ascites tumor cell inoculation and were continued twice daily for 10 days. The mice were observed daily for 30 days after Ehrlich ascites tumor inoculation. Groups of 10 diseased controls always died by the 21st day, with a mean survival

time of about 17 days. A drug was considered active if there were any survivors at 30 days.

Systemic Effects—Wistar-derived (MW-3) male rats (300–500 g.) were anesthetized with sodium pentobarbital[2] (50 mg./kg.) and connected to an eight-channel polygraph[3]. The following parameters were recorded: electrocardiogram (lead I), electroencephalogram (parietal skin leads), heart rate (tachograph driven by the output of the electrocardiogram channel), arterial and intragastric pressures (liquid pressure transducers[4] connected by cannulas to a femoral artery, and the stomach, *via* the esophagus, respectively), respiration (low pressure air transducer[5] connected to the trachea by a cannula), and respiratory rate (tachograph driven by the output of the respiration channel). Sodium heparin[6] (10 mg./kg.), the extracts, and drugs were given intravenously through a cannula inserted into a femoral vein.

In those cases where the extracts depressed the blood pressure, preliminary studies on the characteristics for the hypotensive action were begun. These consisted of testing the extract by other routes (oral and/or intraperitoneal) against the antihistamine diphenhydramine hydrochloride[7] (10 mg./kg.), challenging with epinephrine bitartrate[8] (3 mg./kg.), and boiling the extract for 5 min. prior to injection.

Inhibition of Bacterial Growth—The qualitative evaluation for antibacterial activity of the extracts was conducted using a modification of the small tube method of Catalfomo and Schultz (3). Cultures of mycobacteria and nocardia were maintained on Bushnell's poi agar, while all other bacteria were maintained on Bacto stock culture agar. The mycobacteria and nocardia were inoculated into Bacto dubos broth and allowed to grow for approximately 2 weeks at 37°. All other organisms were inoculated into BBL trypticase soy broth and incubated at 37° for approximatey 24 hr. These suspensions were used as the inocula for testing.

Each extract was centrifuged at approximately $30,000 \times g$ for 20 min. The supernate was then passed through a filter unit[9] equipped with a 0.45-μ filter[10] to obtain a sterile extract. Two drops of the sterile extract was added to 0.5 ml. of the desired melted medium at 45° in 17 × 60-mm. screw-capped vials. The vials were then allowed to cool in a slanted position. The mycobacteria and nocardia were grown in Bacto dubos agar, while all others were grown in BBL trypticase soy agar. After cooling, 1 drop of the liquid culture of the test bacterium was added to each vial. Aseptic technique was used throughout. The test vials were incubated at 37° for up to 2 weeks or until the control had grown. To determine growth, cultures were examined with a binocular dissecting microscope. All extracts that showed no growth were retested for confirmation of activity. In the retests, the pH of the extract was also adjusted to 7.0 to detect any effect of pH change. The organisms employed were: F21, *Mycobacterium smegmatis;* F47, *M. kansasii,* F61, *M. avium;* F284, *M. kansasii;* F808, *M.* sp., Battey type; F1224, *Nocardia* sp.; H37Ra, *M. tuberculosis;* P27, *M.* sp., scotochromogen; P39, *M.* sp., Battey type; R11, *M.* sp., from dairy; T3, *M.* sp., from patient; T122, *M.* sp., from bovine feces; OH9BA, *Escherichia coli,* pathogenic serotype; *Pseudomonas aeruginosa*[11]; *Salmonella typhimurium*[11], *Shigella flexneri*[11]; *Staphylococcus aureus,* penicillin resistant[11]; and *Streptococcus pyogenes*[11].

[2] Robinson.
[3] Grass model 7.
[4] Statham P23dc.
[5] Grass PT5A.
[6] City Chemical Corp.
[7] Tiffany Chemical Co.
[8] Winthrop Labs.
[9] Swinnex 13.
[10] Millipore HA.

RESULTS AND DISCUSSION

The results of the pharmacological tests are shown in Table I. None of the 211 extracts showed any significant inhibition of Columbia SK virus. However, 12 extracts showed inhibition of bacterial growth *in vitro* and six inhibited Ehrlich ascites tumor growth in mice. Ninety-one of the 211 extracts caused hypotensive effects; some were quite potent, lowering the blood pressure by as much as 70%, with the effects lasting for several hours. Four of the extracts produced a general systemic toxicity.

Because some species produced more than one active extract (probably because the active agent was present in more than one tissue of the plant), it is more meaningful to speak in terms of the number of species yielding active extracts. On this basis, 19 of the 34 species tested contained hypotensive substances worthy of further study (produced hypotension for more than 30 min.).

There were no clear cut correlations between local medicinal use and the pharmacological results reported here. A report of the ethnobotanical study will be made later.

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[11] Stock cultures on hand in the Tropical Medicine Department, University of Hawaii.