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ACCOMPLISHMENT REPORT

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Procurement of Plant Samples From  
Mexico & U.S. For Anticancer Screening

Plant explorations were undertaken in Mexico and U.S. for the National Cancer Institute's Anticancer Screening Program. The primary objective was to procure a diversity of small samples (1¼ to 1½ kilograms dried) with emphasis on genera, species and selected medicinal plants new to the program. Travel in Mexico was conducted during February and March 1979 and from March to May 1980. A preliminary accomplishment report was sent in reference to travel conducted in 1979. This report focuses on samples procured from desert areas, where I have concentrated my travel during the past three years.

Table 1 lists the species collected from our deserts (U.S. & Mexico) since 1978. Plant samples are grouped under three major headings: "RT" (root), "PL/PX" (entire plant or entire plant without root), and "OT" (other). Other plant parts include "SB" (stem bark), "WST" (woody-stem), "TW" (twig), "LF" (leaf), "FL" (flower) and "FR" (fruit). Under each heading of plant parts are extracts: "CHCL<sub>3</sub>" (Chloroform), "AQ/ETOH" (Aqueous/Ethanol), "AQ & ETOH" (Aqueous & Ethanol), and "ALC/CHL<sub>3</sub>" (Chloroform/Ethanol). These extract abbreviations represent various extraction methods that have been routinely employed during the past 20 years. The CHCL<sub>3</sub> extract represents the current procedure (see M. Suffness & J. Douros "Drugs of Plant Origin", Methods in Cancer Research 16:83, 1979). Thus, all species listed have at least one sample indicated (by State abbreviation) under the CHCL<sub>3</sub> column; about half of the species also were once extracted according to other procedures used in the past. States from where samples were obtained are indicated by three letter abbreviations for Mexico and two letter ones for the U.S. Since many of the species collected in the U.S. occur also in Mexico, these were included in the table.

The following is an example of how to read Table 1. Under Acanthaceae, Beloperone californica is listed with "BCN" indicated under the "CHCL<sub>3</sub>" column of "RT" heading. This means that a sample of root was collected from Baja California Norte and since no other states are indicated under the root heading, this was the first time a root sample of Beloperone californica was collected for anticancer screening. In fact more than 95% of all root samples were new to the program. On the other hand, a PX sample (entire plant without root) was obtained from "CA" (California) and this was not a new plant part since PX samples have been previously screened from "SON" (Sonora) and "AZ" (Arizona).

REVIEW OF ANTICANCER SCREENING OF PLANTS FROM THE DESERT REGIONS OF THE U.S. & MEXICO

DuWayne Statz and Francis Coon in Cancer Treatment Reports, Volume 60(8): 999-105 (1976) summarize extraction methods that have been used in the NCI screen. From 1960 to 1964, the University of Arizona collected and extracted samples from the arid regions of Mexico and U.S., primarily in Arizona and Sonora. Figure 2 in Statz & Coon shows a procedure developed by Jack Cole (AQ & ALC/CHL extracts). A battery of experimental tumors were employed: Adenocarcinoma 755 ('CA'), Sarcoma 180 ('SA'), Melanotic Melanoma ('MM'), Lewis Lung Carcinoma ('LL-old'), Lymphoid Leukemia ('LE'), Solid Friend Virus Leukemia ('FV'), Adenocarcinoma of the Duodenum ('D1'), Walker 256 ('WA'), and KB (Eagle).

About 1,043 species were extracted from fresh pl/px samples and 375 species from dried pl/px samples. Extracts were tested against various combinations of the tumors cited above, but SA, LE and KB were most frequently employed. Activity was found more often in fresh px samples (1.9% to 2.6%) than dried ones (0.8% to 1.6%) and mostly in aqueous extracts (1.6% to 2.6%) compared to ethanol/chloroform extracts (0.8% to 1.9%). Activity was seen in many of the tumor systems but there appeared to be selectivity for KB activity in fresh samples, 28 active KB extracts in fresh samples as opposed to only one in dried samples.

Active agents later isolated include phytosterols, peptides, tannins, cucurbitacins and sesquiterpenes. From J. Hartwell (1976), the peptide Cesalin, from Caesalpinia gilliesii, appears as the most significant compound isolated from this methodology.

Although the University of Arizona was a major supplier and extractor of samples from our desert regions, USDA botanists, notably Drs. Gentry and Barclay, also contributed. USDA samples were usually dried before extracted at Wisconsin Alumni Research Foundation (WARF). From 1961 to 1964, the WARF procedure, adopted from Morris Kupchan, also involved preparation of two extracts for each sample, Aqueous (AQ) and Ethanol (ETOH). About 10% of the samples screened against WA and KB showed activity and it was later discovered that most of the activity was due to WA being highly sensitive to tannins in aqueous extracts.

Comparing different screening methodologies with samples obtained from similar floristic regions is interesting. At Arizona, the absence of KB activity in dried samples could be partially correlated with insensitivity to cytotoxic lignans that were detected at other laboratories, especially in the Cupressaceae ( ex. Juniperus spp.). Tannins were often responsible for activity found in species of Pinus but at Arizona they reported a sterol. Activity due to peptides was only reported by Arizona workers. On the other hand, cucurbitacins (in Cucurbitaceae) and sesquiterpene lactones (in Asteraceae) were found as a result of screening at both WARF and Arizona. The differences are not based on conclusive studies but do point to a need for adjustments in the screen as feedback is received from chemical isolation of active agents. Such adjustments are part of an evolutionary screening process to improve detection of chemical agents most likely to be useful in cancer chemotherapy.

In 1964, WARF adopted a single solvent extraction method as the routine procedure (AQ/ETOH). Sometime later, tannins and phytosterols were removed in the extraction process before screening against WA, KB and LE. From 1964 to 1969 about 570 species from the desert regions were screened by the University of Arizona and probably a similar number were collected by Drs. Barclay, Gentry and Perdue for extraction at WARF. The University of Arizona had changed their extraction procedure to that of WARF and in both screening laboratories just under 2% of the pl/px samples were showing activity. Some high-interesting compounds were later isolated: Holacanthone from Castela emoryi, Colubrinol from Colubrina texensis and Bouvardin from Bouvardia ternifolia. Several other species have shown high-interest activity: Aristolochia taliscana stem-leaf and Thevetia ovata twig-leaf, but more plant material is needed to complete the isolation and identification work. Both plants occur in Mexico, outside the desert region, and we would like permission to procure large samples (weighing 70 to 140 kilograms) for completion of the chemical isolation and pre-clinical evaluation studies. It is interesting to note that species of Castela, Bouvardia, Aristolochia and Thevetia are reportedly used in folk medicine for treating dysentery, cancer and other ailments.

In 1969, PS (P388 Leukemia) replaced LE, and WA was dropped. About 200 species from the deserts of California (collected by R. Spjut) and 100 from northern Mexico (collected by L. Spetzman) were screened against PS (and also KB). The most significant activity was found in Hunnemannia fumariaefolia (Papaveraceae) and this is currently of high interest to NCI. Hunnemannia is common in the highlands of Coahuilla and we would like permission to collect a 140 kilogram sample.

Soon after the introduction of the PS tumor to the screen, our laboratory began a major procurement effort on targeted plant families, known as FOSI for Families of Special Interest (see Barclay & Perdue, 1976). As pointed out by Suffness & Douros (1979), this effort led to isolation of many similar compounds but occasionally a new structural type with good activity was discovered. Stemmadenia palmeri (Apocynaceae), from Mexico, appears to be one of those exceptions and we wish to collect an additional 70 kilograms of stembark to complete the isolation work.

The extraction procedure was changed again in 1975 based on a '500 experiment' (see Statz & Coon, 1976) with further modification as described in Suffness and Douros (1979).

Instead of continuing to collect samples in random manner, I began to explore a more selective approach in 1977. A totally selective approach would drastically cut the rate of samples procured for preliminary screening as well as raise procurement costs for each sample. However, it is possible to increase the number of new genera and medicinal samples without increasing field costs and causing a reduction in procurement of small samples. Geographical distributions of woody plant genera that have never been tested were plotted on maps. Of several thousand medicinal species reviewed in Train et al. (1957), Standley (1920-1926) Chestnut (1902), Coville (1897) and also Hartwell (1967-1971), only 70 were selected. Geographical areas with concentrations of new genera and medicinal plants then became the target areas for random sampling: Baja California, limestone floras bordering the States of Nevada and California, also in western Texas, northern Coahuilla and Chihuahua.

In addition to using medicinal folklore as a tool, (cf. Spjut, 1976) I have researched relationships between anticancer activity and vegetation types. The most significant data are with herbs and root of shrubs and trees. With PS and KB tumors, the incidence of anticancer activity clearly increased with increasingly drier vegetation types. The root datum was particularly interesting because it seemed to go in hand with folk uses of plants; in arid regions the root was often the part selected in medicine. Moreover, when screening data were compared with medicinal plants on a plant part basis, it was discovered that root had been rarely collected for anticancer screening (evident in Table 1).

NCI, in conjunction with other scientists in our laboratory, also had been reviewing the random approach to plant procurement. To increase novelty it was decided that we should eliminate genera where numerous species had already been tested or compounds had already been isolated. For example, the genus Acacia has numerous species and numerous species have been screened producing nothing so far of any significance. Maytenus gave us maytansine, now in the second phase of clinical evaluation, but collecting more samples of Maytenus species will not likely lead to new discoveries. Genera with one hundred or more extracts tested and species with six or more tested were criteria used to reduce duplication, in addition to genera like Maytenus where known anticancer compounds have been determined. Approximately 350 genera and several thousands of species are now considered SLOP or Species Low on Priority. Actually, the 350 genera accounts for more than 67,000 species no longer of interest to us, or, about  $\frac{1}{4}$  of the world flora.

My field strategy planned for Baja California (and elsewhere) had to be amended to meet the new SLOP guidelines which became formulated in January 1979. Exceptions were made for root samples based on my research described earlier.

#### SCREENING RESULTS

Samples collected from Baja California and southern U.S. during 1979 have completed screening against KB and PS, but 1980 samples are still being tested. Table 2 lists those species that confirmed against either KB or PS. Unfortunately, activity was not significant enough to warrant further studies, except possibly in Castela, Bursera and Jatropha where we already can predict the kinds of compounds most likely to be isolated.

A new experimental tumor 'ASK' (a brain tumor) is under evaluation for replacing KB. Activity in KB has been correlated more often with cytotoxicity than with anticancer activity. For example in Spjut (1976) it was suggested that anticancer activity was correlated with poisonous plants. It can be demonstrated that most activity in poisonous plants will be with the KB tumor system and in most cases this will have no relationship to in vivo activity (PS).

A number of 1980 collections from Baja California are now being evaluated against ASK and there are a surprisingly high number of active species. Table 3 shows those species which have confirmed against ASK. To learn more about this activity, but more important to increase our chances of finding new drugs, we would like to obtain 70 kilogram samples of those species marked by an asterisk. It is interesting that anticancer activity in this new tumor is showing up in families where little activity has been seen before.

OTHER PROJECTS

Following my visit to Baja California during the spring of 1979, 18 species of the Bryophyta (mosses & liverworts) were collected from northern California and activity in one species of moss (Claopodium) looks very promising. This led to more extensive collecting trips in 1980 in the U.S. for samples of mosses, liverworts and lichens. Screening results of several hundred lower plant samples are not expected before December 1981. Because of promising activity in Claopodium and that few mosses, liverworts and lichens have been tested in the program, we wish to procure some of these from southern Mexico sometime in the fall of 1982, or perhaps as early as May 1982. There are no floras covering lower plants of Mexico but we will try to put together some kind of list of taxa most likely to be sampled in amounts of 1½ to 1½ kilograms. Additionally, we would like to continue collecting new and seldom screened genera of higher plants and a separate list of these taxa will be provided.

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TABLE 1

	RT			PL/PX			OT					
	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC/CHL	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC/CHL	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC/CHL
<b>ACANTHACEAE</b>												
<u>Beleporone californica</u> Benth.	BCN				CA	SON CA		AZ				
<u>Berginia virgata</u> Harv. ex Benth. & Hook. var. <u>glanduliferum</u> Leonard & Morton	BCS				BCS							
<u>Carlowrightia californica</u> Brandegee					BCS							
<u>Justicia insolita</u> Brandegee	BCS				BCS							
<u>Ruellia californica</u> (Rose) I.M. Johnst.	BCS				BCS			SON				
<u>Ruellia peninsularis</u> (Rose) I.M. Johnst.	BCS				BCS							
<b>ACHATOCARPACEAE</b>												
<u>Phaulothamnus spinescens</u> Gray	BCS				BCS						BCS(wst)	
<b>AGAVACEAE</b>												
<u>Nolina bigelovii</u> (Torr.) Wats.											CA(fr)	CA(fr)
<u>Yucca brevifolia</u> Engelm. var. <u>jaegeriana</u> Mckelvey											CA(sb) NV(fr)	
<b>AIZOACEAE</b>												
<u>Mesembryanthemum crystallinum</u> L.					BCN	CHILE						
<b>AMARANTHACEAE</b>												
<u>Celosia floribunda</u> Gray	BCS				BCS							
<u>Dicraurus alternifolius</u> (S. Wats.) Uline & Bray	BCS				BCS							
<u>Froelichia interrupta</u> (L.) Moq.					BCS	PUE						
<u>Tidestromia lanuginosa</u> (Nutt.) Standl. var. <u>lanuginosa</u> var. <u>carnosa</u>					TX TX CA			AZ				
<u>Tidestromia oblongifolia</u> (Wats.) Standl. CA					CA	CA						
<b>ANACARDIACEAE</b>												
<u>Cyrtocarpa edulis</u> (Brandegee) Standl.	BCS				BCS	FL					BCS(sb)	
<u>Pachycormus discolor</u> (Benth.) Coville	BCN				BCN						BCS(sb)	
<u>Rhus integrifolia</u> (Nutt.) Benth. & Hook. f. ex Rothrock	BCN					CA CA					CA(1f)	
<u>Rhus ovata</u> Wats.					CA	UT AZ NM						AZ(fr) CA(
<u>Rhus trilobata</u> Nutt. ex T. & G.					CA							
<b>APIACEAE</b>												
<u>Angelica scabrida</u> Clokey & Mathias	NV											
<u>Lomatium dissectum</u> (Nutt.) Math. & Const. var. <u>multifidum</u> Math. & Const.	NV					NV	AZ					
<u>Osmorhiza occidentalis</u> (Nutt.) Torr.	NV	UT				NV	UT					
<b>APOCYNACEAE</b>												
<u>Amsonia brevifolia</u> Gray	CA					CA						
<u>Amsonia tomentosa</u> Torr. & Frem.	CA					AZ						
<u>Vallesia glabra</u> (Cav.) Link.	BCS				BCS	PUE						
<b>ASCLEPIADACEAE</b>												
<u>Sarcostemma hirtellum</u> (Gray) Holm.						AZ	CA					

AZ - Arizona  
 CA - California  
 CO - Colorado  
 HA - Hawaii  
 MO - Montana  
 NM - New Mexico  
 NV - Nevada  
 PR - Puerto Rico  
 TX - Texas  
 UT - Utah

BCN - Baja California Norte  
 BCS - Baja California Sur  
 COA - Coahuilla  
 GUE - Guerrero  
 MEX - Mexico  
 MIC - Michoacan  
 NUE - Nuevo Leon  
 OAX - Oaxaca  
 PUE - Puebla  
 SIN - Sinaloa  
 SON - Sonora

OT - Other  
 PL - Whole Plant  
 PX - Whole Plant without Root  
 RT - Root

AQ - Aqueous  
 ALC/CHL - Chloroform/Ethanol  
 CHCL<sub>3</sub> - Chloroform  
 ETOH - Ethanol

Br. Hon. - British Honduras

----- Collected From Many Places &  
 Extensively Screened

wst - woody-stem fl - flower  
 sb - stembark fr - fruit  
 tw - twig  
 lf - leaf

TABLE 1 (CONTINUED)

	RT			PL/PX			OT					
	CHCL <sub>2</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL	CHCL <sub>2</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL	CHCL <sub>2</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL
ASTERACEAE												
<u>Acamptopappus sphaerocephalus</u> (Harv. & Gray)												
Gray var. <u>hirtellus</u> Blake	CA				CA							
<u>Acamptopappus shockleyi</u> Gray					NV							
<u>Anaurea brandegeana</u> (Rose) Rydb.					BCS							
<u>Amphipappus fremontii</u> T. & G.	CA				CA							
<u>Ambrosia bryantii</u> Payne	BCN				BCN							
<u>Ambrosia dumosa</u> (Gray) Payne	CA				CA	CA						
<u>Ambrosia illicifolia</u> (Gray) Payne	CA				CA	CA						
<u>Artemisia spinescens</u> D.C. Eat.	CA				CA		CA*					
<u>Aster spinosus</u> Benth.					BCS	COA						
<u>Beckhamia sarothroides</u> Gray	CA					AZ, CA	AZ	AZ				
<u>Bebbia atriplicifolia</u> (Gray) Greene					BCS							
<u>Bebbia juncea</u> (Benth.) Greene	CA					AZ		AZ				
<u>Brickellia californica</u> (T. & G.) Gray					CA	(AZ, CA, MEX)		AZ				
<u>Brickellia incana</u> Gray	CA				CA							
<u>Brickellia microphylla</u> (Nutt.) Gray					CA							
<u>Chaenactis carphoclinia</u> Gray					CA	CA						
<u>Chaenactis fremontii</u> Gray					CA	CA						
<u>Chaenactis lacera</u> Greene					BCS							
<u>Chaenactis stevioides</u> H. & A.					NV	AZ	CA*					
<u>Chaetadelphe wheeleri</u> Gray					NV							
<u>Chrysothamnus nauscosus</u> (Pall.) Britt.	NV					CA	CA					
ssp. <u>mohavensis</u> (Greene) Hall. & Clem.												
<u>Chrysothamnus paniculatus</u> (Gray) Hall	CA				CA	CA						
<u>Chrysothamnus teretifolius</u> (Dur. & Hilg.) Hall	CA											
<u>Cirsium nidulum</u> (Jones) Petr.					CA							
<u>Coreocarpus parthenoides</u> Benth.					BCS							
<u>Coreopsis calliopsida</u> (DC.) Gray					CA							
<u>Coulterella capitata</u> Vasey & Rose	BCS				BCS							
<u>Dicoria canescens</u> T. & G.	CA				CA	CA, AZ						
<u>Dyssodia acerosa</u> DC.			AZ		TX	AZ		AZ				
<u>Dyssodia anthemidifolia</u> Benth.					BCS							
<u>Dyssodia cooperi</u> A. Gray					CA							
<u>Dyssodia pentachaeta</u> (DC.) Rob. ssp. <u>pentachaeta</u>					NV			AZ				
var. <u>blenidium</u> (DC) Strother												
<u>Dyssodia porophylloides</u> Gray					CA	CA, AZ		AZ				
<u>Eastwoodii elegans</u> Bdg.	CA				CA							
<u>Encelia farinosa</u> Gray ex Torr.						CA		AZ			CA(fl-fr)	
<u>Encelia frutescens</u> Gray	CA		AZ			(UT, AZ, CA)		AZ				
<u>Encelia palmeri</u> Vasey & Rose	BCS				BCS							
<u>Encelia venetorum</u> Brandegee	BCN				BCN						BCN(wst)	
<u>Enceliopsis argophylla</u> (DC. Eat.) A. Nels.	NV				NV							
<u>Flourensia cernua</u> DC.			AZ		TX			AZ				
<u>Glyptopleura marginata</u> D.C. Eat.					NV							
<u>Gnaphalium wrightii</u> Gray	BCN		AZ		BCN			AZ				
<u>Gochmatia arborecens</u> Brandegee					BCS						BCS(sb)	
<u>Gutierrezia dracunculoides</u> DC.					TX							
<u>Gutierrezia microcephala</u> (DC.) Gray					CA			AZ				
<u>Gutierrezia sarothrae</u> (Fursh) Britt. & Rusby					NV	TX		AZ				
<u>Haplopappus arenarius</u> Benth.					BCS							
<u>Haplopappus brickelliioides</u> Blake	CA				CA							
<u>Haplopappus cooperi</u> (Gray) Hall	CA				CA							
<u>Haplopappus cuneatus</u> Gray	CA				CA	CA	CA*					
<u>Haplopappus linearifolius</u> DC.	CA				CA	CA, AZ	CA					
<u>Haplopappus venetus</u> (H.B.K.) Blake					BCN							
ssp. <u>furfuraceus</u> (Greene) Hall												
<u>Hecastocleis shockleyi</u> Gray	NV				NV							
<u>Hofmeisteria fasciculata</u> (Benth.) Walp.												
var. <u>pubescens</u> (Wats.) Robinson					BCS							
var. <u>xantii</u> Gray					BCS							
<u>Lepidospartum squamatum</u> (Gray) Gray												
var. <u>squamatum</u>					CA						CA(wst)	
var. <u>palmeri</u> (Gray) Wheeler	CA					CA						
<u>Leucelene ericoides</u> (Torr.) Greene					CA, AZ							
<u>Malacothrix glabrata</u> Gray					NV		CA*	AZ				
<u>Nicolletia trifida</u> Rydb.					BCS							
<u>Oxytenia acerosa</u> Nutt.					CA							
<u>Palafoxia linearis</u> Cav. var. <u>linearis</u>					BCS							
<u>Parthenium incanum</u> H.B.K.			AZ		TX	AZ		AZ				
<u>Pectis papposa</u> Harv. & Gray					TX	CA						
<u>Perityle aurea</u> Rose					BCS							
<u>Petroradia discoidea</u> L.G. Anderson	NV				NV							
<u>Pleurocoronis laphamioides</u> (Rose) King & Robins.												
var. <u>pauciseta</u> (Johnst.) King					BCS							
<u>Pluchea sericea</u> (Nutt.) Cov.	CA		AZ			CA		AZ				
<u>Porophyllum gracile</u> Benth.					BCS	CA, AZ		AZ				
<u>Psathyrotes annua</u> (Nutt.) Gray					CA							
<u>Psathyrotes ramosissima</u> Gray					CA	CA, AZ						
<u>Psilotrophe cooperi</u> (Gray) Greene					NV	AZ		AZ				
<u>Seheció longilobus</u> Benth.					TX	NUE		AZ				
<u>Stephanomeria exigua</u> Nutt. var. <u>pentachaeta</u>					NV							
(DC. Eat.) Hall												
<u>Stephanomeria pauciflora</u> (Torr.) Nutt.					CA		CA	AZ				
<u>Tetradymia axillaris</u> A. Nels.	NV				NV	UT						
<u>Tetradymia canescens</u> DC.					NV	UT		AZ				
<u>Tetradymia spinosa</u> H. & A.					NV		CA*					
<u>Tetradymia stenolepis</u> Greene	CA				NV	CA						

TABLE 1 (CONTINUED)

	RT			PL/PX			OT					
	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL
ASTERACEAE												
<i>Tricoptilium incisum</i> Gray					CA	CA						
<i>Trixis californica</i> Kell.					CA	CA		AZ				
<i>Viguiera deltoidea</i> Gray												
var. <i>deltoidea</i>												
var. <i>parishii</i> (Greene) Valley & Rose	BCS				BCS							
<i>Viguiera tomentosa</i> Gray	BCS				CA	CA						
<i>Zinnia acerosa</i> (DC.) A. Gray					TX							
BERBERIDACEAE												
<i>Berberis haematocarpa</i> Woot.					CA	SON		AZ	CA(wst)			
BORAGINACEAE												
<i>Amsinckia tessellata</i> Gray				CA								
<i>Bourreria sonora</i> S. Wats.	BCS				AZ	GA	CA*	AZ				BCS(wst)
<i>Cryptantha angelica</i> Johnston					BCS							
<i>Cryptantha angustifolia</i> (Torr.) Greene					BCS							
<i>Cryptantha confertiflora</i> (Greene) Payson	NV				CA	CA	CA*					
<i>Cryptantha costata</i> Brandege					NV	CA						
<i>Cryptantha maritima</i> (Greene) Greene					BCN							
var. <i>pilosa</i> I.M. Johnston					BCN							
<i>Cryptantha racemosa</i> (Wats.) Greene					CA							
<i>Cryptantha recurvata</i> (T. & G.) Greene					AZ							
<i>Cryptantha</i> sp. (SPJ-6001)					CA							
<i>Heliotropium torreyi</i> I.M. Johnston					TX							
<i>Pectocarya platycarpa</i> (M. & J.) M. & J.					AZ	AZ		AZ				
<i>Tequilia canescens</i> (DC.) A. Richardson					AZ			AZ				
<i>Tequilia cuspidata</i> (I.M. Johnston) A. Richardson					BCS							
<i>Tequilia gossypina</i> (Woot. & Standl.) A. Richards					TX							
<i>Tequilia greggii</i> (T. & G.) A. Richardson	TX				TX							
<i>Tequilia latior</i> (I.M. Johnston) A. Richardson					NV							
<i>Tequilia palmeri</i> (Gray) A. Richardson					CA			AZ				
<i>Tequilia plicata</i> (Torr.) A. Richardson					CA	CA		CA				
BRASSICACEAE												
<i>Alyssum desertorum</i> Stapf					NV							
<i>Descurainia pinnata</i> (Walt.) Britt. ssp. <i>glabra</i> (Woot. & Standl.) Detl.					CA							
<i>Lepidium fremontii</i> Wats.	CA				CA	CA	CA*					
<i>Lepidium virginicum</i> L. var. <i>pubescens</i> (Greene) Thell					CA							
<i>Lesquerella arizonica</i> Wats.					AZ							
<i>Lesquerella tenella</i> Nelson					CA							
<i>Nerisyrenia camporum</i>					TX							
<i>Physaria chambersii</i> Roll.					NV							
<i>Physaria newberryi</i> Gray					UT							
<i>Stanleya elata</i> Jones	NV				NV							
BROMELIACEAE												
<i>Tillandsia recurvata</i> L.					BCS	OAX COA		AZ				
BUDDLEJACEAE												
<i>Buddleja marrubifolia</i> Benth.					TX	COA						
<i>Buddleja utahensis</i> Cov.	NV				NV							
<i>Bursera cerasifolia</i> Brandege												
BURSERACEAE												
<i>Bursera cerasifolia</i> Brandege					BCS							
<i>Bursera epinnata</i> (Rose) Engler												BCS(sb)
<i>Bursera hindsiana</i> (Benth.) Engl.	BCS											
<i>Bursera microphylla</i> Gray	BCS				BCS	(PUE, MIC)		AZ				BCS(sb)
<i>Bursera</i> sp. (SPJ-5308)					BCS							
BUXACEAE												
<i>Simmondsia chinensis</i> (Link.) Schneider	BCS					AZ, CA		AZ				
CACTACEAE												
<i>Bergerocactus emoryi</i> (Engelm.) Britt. & Rose	BCN				BCN							
<i>Echinocactus horizontalis</i> Lem.					TX	NUE						
<i>Echinocereus enneacantha</i> Engelm. var. <i>stramineus</i> (Engelm.) L.	TX											
<i>Ferocactus acanthodes</i> (Lenaire) Britt. & Rose var. <i>lecontei</i> (Engelm.) Lindsay					NV							
<i>Lemaireocereus thurberi</i> (Engelm.) Britt. & Rose	BCS				BCS			SON				
<i>Machaerocereus gummosus</i> (Engelm.) Britt. & Rose	BCN											
<i>Opuntia echinocarpa</i> Engelm. & Bigel.	CA					(CA, AZ, BCN)						
<i>Opuntia ramosissima</i> Engelm.	CA					AZ, CA						
<i>Opuntia schottii</i> Engelm.					TX							
<i>Pachycereus pringlei</i> (S. Wats.) Britt. & Rose	BCS					SIN						BCS(wst)



TABLE 1 (CONTINUED)

	RT			PL/PX			OT					
	CHCL <sub>2</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL	CHCL <sub>2</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL	CHCL <sub>2</sub>	AQ/ ETOH	AQ & ETOH	AQ & AL/CHL
<b>CAPPARACEAE</b>												
<u>Atamisquca emarginata</u> Miers.				BCS								
<u>Cleomella obtusifolia</u> Torr. & Frem.							CA					
<u>Forcchammeria watsonii</u> Rose				BCS								BCS(sb) SON(1f)
<u>Isoneris arborea</u> Nutt.				(BCN, CA)			(BCN, CA)					
<u>Oxystylis lutea</u> Torr. & Frem.							CA					
<b>CAPRIFOLIACEAE</b>												
<u>Symphoricarpos longiflorus</u> Gray							CA					
<u>Symphoricarpos parishii</u> Rydb.							NV					
<b>CARYOPHYLLACEAE</b>												
<u>Scopulophila rixfordii</u> (Bdg.) M. & J.				CA			CA					
<b>CELASTRACEAE</b>												
<u>Forsellesia nevadensis</u> (Gray) Greene				NV			CA					
<u>Mortonia utahensis</u> (Gov.) A. Nels.				AZ								
<b>CHENOPODIACEAE</b>												
<u>Allenrolfea occidentalis</u> (Wats.) Kuntze							BCS	CA				BCS(wst)
<u>Arthrocnemum subterminale</u> (Parish) Standley				BCN			BCN					
<u>Atriplex barclayana</u> (Benth.) Dietr.							BCS					
ssp. <u>lurida</u> (Brandegee) Hall. & Clements												
<u>Atriplex canescens</u> (Pursh) Nutt. ssp. <u>linearis</u>				CA								
(Wats.) Hall. & Clements												
<u>Atriplex elegans</u> (Moq.) Dietr.							NV				AZ	
<u>Atriplex hymenelytra</u> (Torr.) Wats.				CA			CA					
<u>Atriplex julacea</u> S. Wats.				BCN			BCN					
<u>Eurotia lanata</u> (Pursh) Moq.							AZ	(UT, CA)			AZ	
<u>Gravia spinosa</u> (Hook.) Moq.				CA			CA	(UT, CA)				
<u>Nitrophila occidentalis</u> (Moq.) S. Wats.							CA					
<u>Sarcobatus vermiculatus</u> (Hook.) Torr.				CA			CA	(UT, CO) CA			AZ	
<u>Suaeda californica</u> Wats.				BCN			BCN	CA				
<u>Suaeda torreyana</u> Wats.				NV				(AZ, UT)			AZ	
<b>CNEORACEAE</b>												
<u>Cneoridium dumosum</u> (Nutt.) Hook. f.				CA			CA					
<u>Morremia aurea</u> (Kell.) O'Donell												
<b>CONVOLVULACEAE</b>												
<u>Morremia aurea</u> (Kell.) O'Donell				BCS			BCS					BCS(wst)
<b>CRASSULACEAE</b>												
<u>Dudleya albiflora</u> Rose				BCN			BCN					
<u>Dudleya attenuata</u> (S. Wats.) Moran							BCN					
<u>Dudleya ingens</u> Rose				BCN			BCN					
<u>Dudleya pulverulenta</u> (Nutt.) Britt. & Rose				BCN			BCN	CA				
<u>Dudleya saxosa</u> (Jones) Britt. & Rose							CA					
ssp. <u>alcoides</u> (Rose) Moran												
<b>CROSSOSOMATACEAE</b>												
<u>Grossosoma bigelovii</u> Wats.							CA			AZ		CA(1f-fr)
<b>EPHEDRACEAE</b>												
<u>Ephedra viridis</u> Cov.				CA			CA	(AZ, UT) CA*				
<b>ERICACEAE</b>												
<u>Arctostaphylos glauca</u> Lindl.							CA	(CA, MEX)				CA(wst)
<u>Arctostaphylos pungens</u> H.B.K.								OAX		AZ		NV(fr)OAX(wst)
<u>Ornithostaphylos oppositifolia</u> Small				BCN								AZ
<u>Xylococcus bicolor</u> Nutt.				CA			CA	CA				



TABLE 1 (CONTINUED)

	RT			FL/FX			OT					
	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC/CHL	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC/CHL	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC
<b>HYDROPHYLLACEAE</b>												
<i>Eriodictyon angustifolium</i> Nutt.	CA				CA	MEX		AZ				
<i>Eriodictyon crassifolium</i> Benth.					CA						CA(wst, lf)	
<i>Eriodictyon sessilifolium</i> Greene	BCN				BCN						BCN(wst)	
<i>Eriodictyon trichocalyx</i> Heller												
ssp. <i>lanatum</i> (Brand) Munz	CA				CA							
<i>Nana hispidum</i> Gray												
var. <i>mentzellii</i> Brand					TX							
<i>Nana rothrockii</i> Gray					CA		CA					
<i>Phacelia crenulata</i> Torr.					CA	CA	CA	AZ				
<i>Phacelia ixodes</i> Kell.	BCN										BCN(lf)	
<i>Phacelia palmeri</i> Torr. ex Wats.	NV				NV							
<b>IRIDACEAE</b>												
<i>Iris missouriensis</i> Nutt.	NV					NM	CA	AZ				
						COA						
<b>JUNCEAE</b>												
<i>Juncus balticus</i> Willd.					NV	AZ						
<b>KOEBERLINIACEAE</b>												
<i>Koeberlinia spinosa</i> Zucc.						AZ		AZ			TX(wst)	
						NM						
<b>KRAMERIACEAE</b>												
<i>Krameria grayii</i> Rose & Painter	CA		AZ		CA	CA		AZ				
<i>Krameria parvifolia</i> Benth.												
var. <i>parvifolia</i>	BCS				BCS							
var. <i>glandulosa</i> (Rose & Painter) Macbr.					CA			AZ				
var. <i>imparata</i> Macbr.			AZ		CA	CA						
<b>LAMIACEAE</b>												
<i>Hedeoma pumilum</i> (Torr.) Brig.												
ssp. <i>californicum</i> Stewart						NV						
<i>Hyptis laniflora</i> Benth.						BCS						
<i>Salazaria mexicana</i> Torr.	CA						CA			AZ		
<i>Salvia dorrii</i> (Kell.) Abrams	CA, NV						CA					
<i>Salvia vaseyi</i> (Porter) Parish	CA						CA					
<b>LENNOACEAE</b>												
<i>Ammobroma sonora</i> Torr. ex Gray						CA	CA					
<b>LILIACEAE</b>												
<i>Hesperocallis undulata</i> Gray						CA	CA					
<b>LOASACEAE</b>												
<i>Cevallia sinuata</i> Lag.	TX	COA							TX	COA		AZ
<i>Eucnide aurea</i> (A. Gray) Thompson & Ernst									BCS			
<i>Eucnide cordata</i> Kell ex Curran	BCS								BCS	MEX		
<i>Eucnide urens</i> Parry									CA	NV, AZ		
<i>Mentzelia adhaerans</i> Benth.									BCS			
<i>Mentzelia lobata</i> (Rydb.)												
Thompson & Zavortink	NV								NV	AZ		AZ
<i>Petalonyx linearis</i> Greene									BCS	BCN		
<i>Petalonyx nitidus</i> S. Wats.	CA								CA			
<i>Petalonyx parryi</i> A. Gray	NV								NV			
<i>Petalonyx thurberi</i> A. Gray	CA									CA	CA	AZ
<b>LORANTHACEAE</b>												
<i>Phoradendron californicum</i> Nutt.												
var. <i>leucocarpum</i> Jepson									BCS			





TABLE 1 (CONTINUED)

	RT				PL/FX				OT			
	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC/CHL	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC/CHL	CHCL <sub>3</sub>	AQ/ ETOH	AQ & ETOH	AQ & ALC/
<b>RUBIACEAE</b>												
<u>Randia megacarpa</u> Brandegee					BCS							
<u>Randia obcordata</u> S. Wats.					BCS		SON	SON			BCS(wst)	SON(fr)
<b>RUTACEAE</b>												
<u>Esenbeckia flava</u> Brandegee					BCS						BCS(sb)	
<u>Ptelea aptera</u> (Farry) Greene	BCN				BCN						BCN(wst)	
<b>SALICACEAE</b>												
<u>Salix laevigata</u> Bebb							CA				BCN(sb)	CA(sb)
<b>SAPINDACEAE</b>												
<u>Cardiospermum corindum</u> L.					BCS							
<b>SAPOTACEAE</b>												
<u>Bumelia occidentalis</u> Hemsl.					BCS				SON		BCS(sb)	
<u>Bumelia peninsularis</u> Brandegee					BCS						BCS(wst)	
<b>SAXIFRAGACEAE</b>												
<u>Fendlerella utahensis</u> (S. Wats.) Heller					NV							
<u>Ribes aureum</u> Pursh					CA		UT,NM					
<u>Ribes indecorum</u> Eastw.	BCN				BCN		CA					
<b>SCROPHULARIACEAE</b>												
<u>Antirrhinum cyathiferum</u> Benth.					BCS							
<u>Castilleja foliosa</u> Hook. & Arn.					CA							
<u>Castilleja aff. linariaefolia</u> Benth.	CA				CA		AZ					
<u>Castilleja linariaefolia</u> Benth.												
var. <u>omnipubescens</u> (Rennell) Clokey	NV				NV							
<u>Galvezia juncea</u> (Benth.) Ball												
var. <u>pubescens</u> (Brandegee) Johnst.	BCN				BCN							
<u>Keckia antirrhinoides</u> Straw	BCN				BCN		CA					
<u>Leucophyllum frutescens</u> (Berl.) I.M. Johnst.							TX			AZ		TX(wst)
<u>Leucophyllum minus</u> A. Gray							TX					
<u>Penstemon palmeri</u> S. Wats.							CA		UT			
							AZ					
<b>SELAGINELLACEAE</b>												
<u>Selaginella lepidophylla</u> (Hook. & Grev.) Spring							TX					
<b>SIMARUBACEAE</b>												
<u>Castela peninsularis</u> Rose					BCS							
<u>Castela polyandra</u> Moran & Folger	BCS											
<b>SOLANACEAE</b>												
<u>Lycium andersonii</u> A. Gray	CA			AZ			CA			AZ		
<u>Lycium brevipes</u> Benth.							BCS		CA		AZ,SON	
<u>Lycium fremontii</u> A. Gray	BCN				BCN		BCN		AZ		AZ	
<u>Lycium megacarpum</u> Wiggins							BCS					
<u>Lycium pallidum</u> Miers							UT		AZ		AZ	
<b>STERCULIACEAE</b>												
<u>Ayenia microphylla</u> A. Gray							TX					
<u>Fremontodendron californicum</u> (Torr.) Cov.							CA		CA*		CA(wst)	CA(fl)
<u>Hermannia palmeri</u> Rose							BCS					
<u>Melochia tomentosa</u> L.	BCS						-----					
<u>Waltheria indica</u> L.							BCS		-----			
<b>TURNERACEAE</b>												
<u>Turnera diffusa</u> Willd.					BCS		Br.Hon.		SON			SON(1f)
<b>VERBENACEAE</b>												
<u>Aloysia barbata</u> (Bradegee) Moldenkee					BCS							
<u>Verbena goodingii</u> Briq.					AZ		AZ			AZ		
<b>ZYGOPHYLLACEAE</b>												
<u>Fagonia barclayana</u> (Benth.) Rydb.					BCS							
<u>Fagonia pachyacantha</u> Rydb.					CA		CA					
<u>Fagonia palmeri</u> Vasey & Rose	BCS				BCS							



TABLE 2. LIST OF SPECIES WITH CONFIRMED ACTIVITY IN PS AND KB

	<u>Plant Part</u>	<u>Tumor</u>
<u>Acalypha californica</u> (Euphorbiaceae)	px	KB
<u>Baccharis sarothroides</u> (Asteraceae)	px	KB
<u>Bursera microphylla</u> (Burseraceae)	rt	KB
	sb	KB
	tw-1f (px)	KB
<u>Bursera</u> sp. (Burseraceae)	tw-1f (px)	KB
<u>Castela peninsularis</u> (Simaroubaceae)	px	KB
<u>Cercocarpus betuloides</u> (Rosaceae)	rt	KB
<u>Dicoria canescens</u> (Asteraceae)	rt	KB
<u>Eastwoodii elegans</u> (Asteraceae)	rt	KB
<u>Esenbeckia flava</u> (Rutaceae)	sb	KB
<u>Gochnatia arborescens</u> (Asteraceae)	sb	KB
<u>Gutierrezia sarothrae</u> (Asteraceae)	pl	KB
<u>Hermannia palmeri</u> (Sterculiaceae)	pl	KB
<u>Jatropha</u> cf. <u>cinerea</u> (Euphorbiaceae)	sb	PS
<u>Stillingia linearifolia</u> (Euphorbiaceae)	rt	PS
<u>Viguiera deltoidea</u> (Asteraceae)	rt	KB
<u>Xylonagra arborea</u> (Onagraceae)	tu	PS
<u>Zinnia acerosa</u> (Asteraceae)	pl	KB



TABLE 3. LIST OF CONFIRMED ACTIVE SPECIES IN ASK FROM BAJA CALIFORNIA

<u>Atamisquea emarginata</u> (Capparaceae)	rt
<u>Berginia virgata</u> var. <u>glandulifera</u> (Acanthaceae)	px
<u>Camissonia crassifolia</u> (Onagraceae)	pl
* <u>Dicraurus alternifolius</u> (Amaranthaceae)	*tw-lf
<u>Dyssodia anthemidifolia</u> (Asteraceae)	pl
* <u>Forchhammeria watsonii</u> (Capparaceae)	*rt
* <u>Hoffmansseggia intricata</u> (Fabaceae)	rt *px
<u>Krameria parvifolia</u> var. <u>parvifolia</u> (Krameriaceae)	px
* <u>Marina peninsularis</u> (Fabaceae)	*rt
<u>Merremia</u> sp. (probably <u>M. aurea</u> , Convolvulaceae)	px
* <u>Orobanche cooperi</u> (Orobanchaceae)	*px
* <u>Phaulothamnus spinescens</u> (Achatocarpaceae)	*rt
* <u>Sphaeralcea axillaris</u> (Malvaceae)	rt *px
<u>Stegnosperma halimifolium</u> (Stegnospermaceae)	rt
* <u>Thryallis angustifolia</u> (Malpighiaceae)	rt *tw-lf

\*Species and plant parts needed in 70 kilogram quantities for isolation of anticancer agents.