ESTABLISHING ETHNOBOTANICAL CONSERVATION PRIORITIES: A CASE STUDY OF THE KALLAWAYA PHARMACOPOEIA

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ABSTRACT

The Kallawaya herbalists of Bolivia follow a healing tradition over a millennium old. Twenty-eight plants of the indigenous pharmacopoeia have been documented in both 16th and 17th century historical literature and contemporary ethnobotanical research. This continuity has bio-cultural implications representing not only useful medicinal plants but also traditional cultural knowledge. These plants and their antiquity of use represent the cultural heritage of the Kallawaya and should be considered along with the biodiversity priorities of local conservation programs. The rapid loss of biological diversity and local knowledge is putting modern ethnobotany at the risk of becoming decadent, before becoming a discipline. Analysis of indigenous pharmacopoeias can be an effective means of determining bio-cultural importance and establishing ethnobotanical conservation priorities. The following case study discusses a selected group of plants that have ethnomedical importance and also various economic uses. The utilization of these plants over time represents their bio-cultural importance and priority for conservation and sustainability efforts.

KEY WORDS: Bolivia, Conservation, Ethnobotany, Kallawaya, Pharmacopoeia

RESUMEN

Los herboristas Kallawaya de Bolivia siguen una tradición de curación de más de un milenio. Se han documentado veintiocho plantas de la farmacopea indígena en la literatura histórica de los siglos XVI y XVII y de la investigación etnobotánica contemporánea. Esta continuidad tiene implicaciones bio-culturales que representan no sólo plantas medicinales útiles sino también conocimiento cultural tradicional. Estas plantas y su antigüedad de uso representan la herencia cultural de los Kallawaya y debe ser considerada en los programas de conservación junto con las prioridades de biodiversidad. La pérdida rápida de diversidad biológica y conocimiento local está poniendo a la etnobotánica moderna en el riesgo de hacerse decadente antes de llegar a ser una disciplina. El análisis de las farmaconpeas indígenas puede ser un método efectivo de determinar la importancia bio-cultural y establecer las prioridades de conservación etnobotánicas. El siguiente caso de estudio discute un grupo selecto de plantas que tienen importancia ethnomédica junto con usos económicos variados. La utilización de estas plantas a lo largo del tiempo representa su importancia bio-cultural y los esfuerzos para la conservación y uso sostenido.

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INTRODUCTION

The Kallawaya herbalists of Bolivia are renowned throughout Argentina, Bolivia, Chile and Peru (Bastien 1987) (Fig. 1). Living at altitudes of 2700–4300m and frequently traveling to communities in varied ecological zones, the Kallawaya have not only established a continuity in Andean folk medicine, they have also had the opportunity to greatly augment their pharmacopoeia along the way (Bastien 1983; Abdel-Malek et al. 1996; Janni & Bastien n.d.). They follow a medical tradition from the Tihuanaco (400–1145), Mollo (1145–1453), Inca (1438–1532), Spanish (1532–1825), and Bolivian Republic (1825–present) periods (Oblitas-Poblete 1969; Bastien 1982, 1983, 1987; Abdel-Malek et al. 1996). The Kallawaya utilize nearly 900 plants (Girault 1987) of the 2000 medicinal plants reported in all of Bolivia (De Lucca & Zalles-Asin 1992). In contemporary times a syndicate of herbalists known as the Society for Bolivian Traditional Medicine (SOBOMETRA) has been responsible for preserving and disseminating Kallawaya herbal knowledge, while the Servicio Integrado en Salud (SIENS) clinics in La Paz utilize both physicians and Kallawaya herbalists to provide integrated ethnomedical and biomedical treatment (Abdel-Malek et al. 1996).

Compiled from a survey of historical and ethnobotanical literature are 28 plants that have been present in the health and healing practices of the Kallawaya since pre-Columbian times. This indigenous cultural knowledge extends deep into Kallawaya ethnohistory and offers compelling reasons for the conservation of bio-cultural diversity. By targeting plants in indigenous pharmacopoeias for conservation priority we not only help sustain traditional cultural knowledge and biological diversity, but also the ethnomedical practices of the community. Focusing ethnobotanical research on community level priorities helps target plants of cultural importance that frequently go unnoticed by global conservation programs that are, "...the action of outsiders who are culturally and politically detached from the threatened environments and who identify species for conservation through western economic models" (Etkin 1998). Discussion of the conservation priorities of ethnobotanical research has been unjustifiably rare (Alcorn 1995; Benz et al. 1996; Etkin 1998; Eisner & Beiring 1994; Laird et al. 1997; Posey & Balée 1989) and deserves further attention and investigation.

METHODS

Data on pre-Columbian (before European invasion) uses of medicinal plants were compiled by a survey of the historical literature (Anonimo 1703; Calancha 1638; Cobo 1891, 1892, 1893; Contreras & Valverde 1650; Jimeneza 1965; Monardes 1569; Oviedo 1535; Polo de Ondegardo 1585; Vega 1609; Yacovleff & Herrera 1935). Information on medicinal plants was often fragmentary and incomplete, but fourteen plants had two or more references. Information from modern ethnobotanical literature was considerably more substantial and was compiled to see what plants had persisted since pre-Columbian-era. Data on the Kallawaya pharmacopoeia were compiled by Bastien (1982, 1983, 1987), including information on therapeutic uses and non-medicinal or economic uses. The

Fig. 1 Geographical location of the Kallawaya Indians. (From Bastien 1987 with permission of University of Utah Press).

Kallawaya reportedly have an unwritten pharmacopoeia of over 900 medicinal plants. For the purpose of this study, the pharmacopoeia is limited to published information and follows the nomenclature therein (Bastien 1982, 1983, 1987).

Relative importance values were calculated for each plant using a normalized number of pharmacological properties (PH) and a normalized number of body systems (BS) treated. This approach follows the one used by Bennett and Prance (2000) for measuring the relative importance of plants in indigenous pharmacopoeias and is primarily a mea-

sure of the versatility of each plant in relation to the pharmacopoeia as a whole. For example, *Minthostachys andina* is used to treat 10 body systems, the most of any plant in the pre-Columbian pharmacopoeia. Therefore, it has a normalized BS value of 1 (10/10). *Erythroxylum coca* is used to treat six body systems, four less than *Minthostachys andina*. The BS value for *E. coca* is 0.6 (6/10). *Minthostachys andina* has seven pharmacological properties, again the most of any pre-Columbian plant in the Kallawaya pharmacopoeia. Thus its PH value is 1(7/7). The combined PH and BS values of *M. andina* equal 2.0, which is then divided by two and multiplied by 100 to calculate the relative importance of pre-Columbian *M. andina*, 100. This approach is useful for calculating the relative importance of a plant by taking into account the differences in number of pharmacological properties and body systems treated. For example, *E. coca* has five pharmacological properties and treats six body systems giving it a pre-Columbian relative importance of 65. *Nicotiana rustica* also has five pharmacological properties, but treats only five body systems, giving it a relative importance of 60. The relative importance scores for each plant reflect differences in versatility.

The relative importance of each pre-Columbian plant is then analyzed comparatively with its relative importance in contemporary times. By taking an average of pre-Columbian relative importance and contemporary relative importance we find the overall relative importance of each plant. For example, *E. coca* has a pre-Columbian relative importance of 65 and a contemporary relative importance of 70, thus having an overall relative importance of 68. By comparative analysis, those plants used in pre-Columbian times are recognized for their continuity. Seven plants, *Psoralea pubescens, Mutisa acuminata, Salvia haenkii, Verbena hispida, Peperomia anaequifolia, Gnaphalium quadichaudium, Ambrosia peruviana*, are included in this table because they were cited in the literature without specific pharmacological or therapeutic details other than being medicinal. There is no known pre-Columbian importance for these plants, but their contemporary relative importance is included. This comparative analysis is designed to show the changes in number of pharmacological properties and body systems treated between pre-Columbian and contemporary times. Medical terminology follows that of Dorland's Medical Dictionary (1980) and discussed in Bastien (1982, 1983, 1987).

RESULTS

There are 28 plants in the Kallawaya pharmacopoeia cited in historical literature (Table 1). This is a small portion of the Kallawaya pharmacopoeia and information on these plants and others in the modern literature is considerably more comprehensive. These plants have a wide variety of therapeutic uses (19 in all) mainly as analgesics, diuretics, antiseptics, and expectorants (Table 2). Aside from medicinal uses there are 12 plants that overlap economically as aromatics, ornamentals, dyes, foods, intoxicants, etc (Table 3). *Minthostachys andina* recorded an overall relative importance of 80, the highest of all 28 pre-Columbian plants (Table 4). Three plants, *Erythroxylum coca, Urtica flabellate,* and *Nicotiana rustica*, scored in the sixties and only one plant, *Polypodium angustifolium*, scored

TABLE 1. Pre-Columbian medicinal plants of the Kallawaya pharmacopoeia.

Genus, species (Family)	Vernacular Name	References
Ambrosia peruviana Willd. (Asteraceae)	Malco	5, 9, 10
Azorella biloba Schlecht. (Apiaceae)	Yareta	3
Baccharis pentandii DC. (Asteraceae)	Chilca	3, 5
Calceolaria cuneiformis R&P. (Schrophulariaceae)	Ava Zapatilla	3
Calceolaria aff. *engleriana* (Schrophulariaceae)	Puru Puru	3
Chenopodium ambrosioides L. (Chenopodiaceae)	Paico Lombrio	5, 6, 8, 10
Cinchona calvisa Wedd. (Rubiaceae)	Quina Cascarilla	2, 3, 10
Datura sanguinea L. (Solanaceae)	Floripondio	2, 3
Equisetum bogotense HBK. (Equisetaceae)	Cola de Caballo	3
Erythroxylum coca Lam. (Erythroxylaceae)	Coca	3,6
Gentiana lutea L. (Gentianaceae)	Pencacuc	3
Gnaphalium quadichaudium DC. (Asteraceae)	Wira Wira	4
Minthostachys andina Benth. (Lamiaceae)	Muña	3, 10
Mutisa acuminata R&P. (Asteraceae)	Chinchircuma	10
Myroxylon balsamum L. (Fabaceae)	Quina Quina	3, 10
Nasturtium officinale R.Br. (Brassicaceae)	Berro	3, 9
Nicotiana rustica L. (Solanaceae)	Sayre	3, 6, 7, 8
Peperomia inaequalifolia R&P. (Piperaceae)	Conqona	3, 6
Plantago tomentosa Lam. (Plantaginaceae)	Llanten	3, 5, 10
Polypodium angustifolium SW. (Polypodiaceae)	Calaquala	3, 10
Polystichum aculeatum SW. (Polypodiaceae)	Helecho Macho	3, 10
Psoralea pubescens Pers. (Fabaceae)	Bilyea	1
Psittacanthus cuneifolius R&P. (Loranthaceae)	Suelda con Suelda	3
Salvia haenkii Benth. (Lamiaceae)	Savia Grande	3, 10
Senecio tephosiodes Turcz. (Asteraceae)	Mamanlipa	3
Solanum radicans L.f. (Solanaceae)	K'umasillo	3, 9
Urtica flabellate H.B.K. (Urticaceae)	Ortega	3, 10
Verbena hispida R&P. (Verbenaceae)	Verbena	3, 9

1. Anonimo 1703
2. Calancha 1638
3. Cobo 1891–93
4. Contreras and Valverde 1650
5. Jimenez de la Espada 1965
6. Vega 1609
7. Polo de Ondegardo 1585
8. Monardes 1569
9. Oviedo 1535
10. Yacovleff and Herrera 1935

in the fifties (Table 4). Twenty-three of the 28 pre-Columbian plants have a relative importance under 50. Seven plants, *Polypodium angustifolium, Plantago tomentosa, Cinchona calvisa, Gentiana lutea, Polystichum aculeatum, Psittachanthus cuneifolius,* and *Solanum radicans,* show an increase in pharmacological properties and body systems treated

TABLE 2. Therapeutic properties of Pre-Columbian medicinal plants in the Kallawaya pharmacopoeia. **A** = analgesic. **A1** = antiseptic. **A2** = astringent. **C** = cardiotonic. **D** = disinflammatory. **D1** = Diuretic. **D2** = diaphoretic. **D3** = demulcent. **E** = emetic. **E1** = expectorant. **F** = febrifuge. **R** = refrigerant. **R1** = resolvent. **S** = stomachic. **S1** = sudorific. **S2** = Stimulant. **T** = tranquilizer. **V** = vermifuge. **V1** = vulnerary.

Species	**A**	**A1**	**A2**	**C**	**D**	**D1**	**D2**	**D3**	**E**	**E1**	**F**	**R**	**R1**	**S**	**S1**	**S2**	**T**	**V**	**V1**
Ambrosia peruviana	x																x		
Azorella biloba						x													
Baccharis pentandii	x				x														
Calceolaria cuneiformis								x											
Calceolaria engleriana																	x		
Chenopodium ambrosioides	x											x							
Cinchona calvisa		x									x								
Datura sanguinea	x									x									
Equisetum bogotense		x				x			x										
Erythroxylum coca	x		x								x			x	x				
Gentiana lutea																x			
Gnaphalium quadichaudium										x									
Minthostachys andina	x					x				x			x	x		x			
Mutisa acuminata				x						x									
Myroxylon balsamum	x	x															x		
Nasturtium officinale					x						x								
Nicotiana rustica	x					x				x									
Peperomia inaequalifolium	x	x																	
Plantago tomentosa			x		x									x				x	
Polypodium angustifolium		x	x		x	x			x										
Polystichum aculeatum			x				x			x								x	
Psoralea pubescens		x			x					x	x								
Psittacanthus cuneifolius																x			
Salvia haenkii						x									x				
Senecio tephosiodes			x			x								x					
Solanum radicans							x				x								x
Urtica flabellate						x								x					
Verbena hispida							x				x								
Totals	9	6	5	1	5	8	3	1	2	7	6	1	1	5	2	3	3	2	1

throughout time. The other 21 plants show a decrease in PH and BS values between pre-Columbian usage and present. These differences could be attributed to the scant and fragmentary historical documentation of pre-Columbian medicinal plants.

OBSERVATIONS AND DISCUSSION

Analysis of the pre-Columbian pharmacopoeia elucidates the importance of medicinal plants to the health and healing practices of the Kallawaya. Outside the pharmacopoeia these plants are culturally useful as food, for hygienic purposes, ornamental, and other purposes. These twenty-eight plants are arguably important parts of the traditional cul-

TABLE 3. Other uses of Pre-Columbian medicinal plants in the Kallawaya pharmacopoeia. **A** = aromatic. **B** = used to make broom. **D** = dye. **E** = embalming. **F** = food. **H** = horse injuries. **H1** = Hygiene. **I** = intoxicant. **O**= ornamental. **R** = resin to catch birds.

Species	A	B	D	E	F	H	HI	I	O	R
Ambrosia peruviana			x							
Baccharis pentandii						x				
Calceolaria engleriana									x	
Datura sanguinea									x	
Erythroxylum coca								x		
Minthostachys andina	x								x	
Myroxylon balsamum				x						
Nasturtium officinale					x		x			
Nicotiana rustica								x		
Peperomia inaequalifolia	x					x				
Psittacanthus cuneifolius										x
Solanum radicans		x								

tural, environmental, and biological knowledge of the Kallawaya. Along with plants having a pre-Columbian continuity, the Kallawaya have integrated exotic plants into their pharmacopoeia (Janni & Bastien n.d.). Despite the integration of exotic species into the pharmacopoeia, the 28 plants discussed herein have retained much of their cultural and medicinal importance for over a thousand years.

The diversity of therapeutic uses of these plants is remarkable. Clearly, by the time of Spanish invasion, the Kallawaya had actively investigated the phytomedicinal potential of the local and regional flora. The diversity of therapeutic uses indicates the ethnomedical sophistication of the Kallawaya, and offers a picture of the health and healing concerns of pre-Columbian Kallawaya culture. This information is useful in understanding the epidemiological fluctuations of the Kallawaya throughout time by revealing the patterns of health and sickness that enable us to ask questions as to why they changed. Also, by compiling such data we find the plants that are not only important medicinally, but also have been an integral part of Kallawaya cultural heritage.

Many ethnobotanical investigations compile information in an effort to identify potential new drugs; we have compiled this information to identify plants of cultural importance as well as plants of priority for biological conservation and sustainability programs. Local efforts in conservation offer greater potential results than those of western economists because they represent the intimate local knowledge of the native ecology and long experience with the species in question (Etkin 1998). Assessing the significance of specific taxa with cultural and ecological importance gives us a framework by which conservation of local biota is based on local values (Benz et al. 1996).

The list of 28 plants discussed herein describes a portion of the pharmacopoeia that has been analyzed based on local values. The long-standing persistence of these plants in the Kallawaya pharmacopoeia indicate continued cultural reliance on these taxa in ethnomedical and economic practices. The versatility of these species within the

Table 4. Relative importance values of selected medicinal plants in the Kallawaya pharmacopoeia. **16–17th PH** = number of pharmacological properties sited in 16th & 17th Century Literature. **16–17th Rel PH** = relative number of pharmacological properties sited in 16th &17th Century Literature. (normalized to the maximum value of 1). **16–17th BS** = number of body systems treated, sited in 16th & 17th Century Literature. **16–17th Rel BS** = relative number of body systems treated, sited in 16th & 17th Century Literature. (normalized to the maximum value of 1). **16–17th RI** = relative importance of 16th & 17th Century Medicinal Plants. **20th PH** = number of pharmacological properties, 20th Century. **20th Rel PH** = relative number of pharmacological properties. (normalized to the maximum value of 1). **20th BS** = number of body systems treated, 20th Century. **20th Rel BS** = relative number of pharmacological properties, 20th Century. **20th RI** = relative importance of medicinal plants, 20th Century. **ORI** = overall relative importance. **RI** = ((Rel PH + Rel BS)/2) x 100. **ORI** = (16–17th RI + 20th RI)/2.

Species	16–17th PH	16–17th Rel PH	16–17th BS	16–17th Rel BS	16–17th RI	20th PH	20th Rel PH	20th BS	20th Rel BS	20th RI	ORI
Minthostachys andina	7	1.0	10	1.0	100	3	0.6	4	0.6	60	80
Erythoxylum coca	5	0.7	6	0.6	65	3	0.6	5	0.8	70	68
Urtica flabellata	5	0.7	7	0.7	70	3	0.6	3	0.5	55	63
Nicotiana rustica	5	0.7	5	0.5	60	2	0.4	5	0.8	60	60
Polypodium angustifolium	2	0.2	1	0.1	15	5	1.0	6	1.0	100	58
Baccharis pentandii	2	0.2	7	0.7	45	2	0.4	4	0.6	50	48
Equisetum bogotense	5	0.7	5	0.5	60	2	0.4	2	0.3	35	48
Plantago tomentosa	2	0.2	3	0.3	25	4	0.8	4	0.6	70	48
Senecio tephosiodes	5	0.7	4	0.4	55	1	0.2	4	0.6	40	48
Myroxylon balsamum	7	1.0	5	0.5	75	1	0.2	1	0.2	20	48
Cinchona calvisa	2	0.2	2	0.2	20	3	0.6	5	0.8	70	45
Chenopodium ambrosiodes	2	0.2	4	0.4	30	2	0.4	4	0.6	50	40
Azorella biloba	3	0.4	2	0.2	30	2	0.4	3	0.5	45	38
Psoralea pubescens	0	0.0	0	0.0	00	4	0.8	4	0.6	70	35
Mutisa acuminata	0	0.0	0	0.0	00	2	0.4	6	1.0	70	35

Table 4. continued

Species	16–17th PH	16–17th Rel PH	16–17th BS	16–17th Rel BS	16–17th RI	20th PH	20th Rel PH	20th BS	20th Rel BS	20th RI	ORI
Datura sanguinea	3	0.4	3	0.3	35	1	0.2	3	0.5	35	35
Gentiana lutea	1	0.1	1	0.1	10	3	0.6	4	0.6	60	35
Polystichum aculeatum	2	0.2	1	0.1	15	3	0.6	3	0.5	55	35
Psittacanthus cuneifolius	2	0.2	2	0.2	20	2	0.4	4	0.6	50	35
Solanum radicans	1	0.1	1	0.1	10	2	0.4	3	0.5	45	28
Salvia haenkii	0	0.0	0	0.0	00	3	0.6	3	0.5	55	28
Verbena hispida	0	0.0	0	0.0	00	4	0.8	2	0.3	55	28
Calceolaria cuneiformis	3	0.4	1	0.1	25	1	0.2	2	0.3	25	25
Peperomia inaequifolia	0	0.0	0	0.0	00	2	0.4	3	0.5	45	23
Gnaphalium quadichaudium	0	0.0	0	0.0	00	2	0.4	3	0.5	45	23
Calceolaria engleriana	2	0.2	2	0.2	20	1	0.2	1	0.2	20	20
Nastrium officinale	1	0.1	1	0.1	10	1	0.2	2	0.3	25	18
Ambrosia peruviana	0	0.0	0	0.0	00	2	0.4	2	0.3	35	18

pharmacopoeia and outside it also makes conservation priorities more compelling. Several taxa are used for more than one therapeutic (Table 2) or pharmacological (Table 4) property and several are used for a variety of economic uses (Table 3). Conservation initiatives focused on biological diversity alone neglect the socio-cultural importance of some taxa. By using ethnobotanical research to target taxa of such importance we have a chance to protect biological diversity and in the process also protect and sustain traditional cultural knowledge, indigenous health care systems, and plants of particular cultural significance. Conservation and sustainability initiatives that focus on community level priorities allow us to work on several problems at once. Direction based from an ethnobotanical perspective (e.g. analyzing indigenous pharmacopoeias) gives us the opportunity to address problems of social, cultural and biological importance. The data discussed here provides only a part of a broader investigation that should include fieldwork and interviews to more accurately determine current social and biological needs.

The loss of local knowledge and biological diversity should be the primary concern of every ethnobotanist. Organizing at local levels with an ethnobotanical framework simultaneously protects biological and cultural diversity. Losing tribal elders and the knowledge they encapsulate is losing information on the biological environment of the surrounding area. Conservation and sustainability programs that are sensitive to biocultural issues like these will help protect traditional cultural knowledge and biodiversity for future generations.

CONCLUSION

Analysis of the pre-Columbian continuity of the Kallawaya pharmacopoeia reveals plants of cultural and medicinal importance that should be targeted for conservation and sustainability programs. The persistence of use of these plants throughout centuries of healing, as well as their role outside the pharmacopoeia for a variety of economic uses elucidates the importance of these plants to the cultural heritage of the Kallawaya. By focusing conservation efforts on plants of cultural importance we not only recognize indigenous environmental knowledge, we also have the opportunity to protect biological diversity. With overwhelming predictions of 60,000 plus higher plant species to become extinct by the middle of the next century, ethnobotany must be a leader in identifying conservation and sustainability priorities by analysis of local needs. Just as local knowledge has been tapped for new drug leads, we must go to it in the future to determine conservation priorities.

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