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Antiquity of medicinal plant usage in two Macro-Mayan ethnic groups (México)

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Abstract

In the biological sciences the use of medicinal plants in indigenous cultures is commonly seen as being based on a long tradition ('traditional medicine'). However, under normal circumstances, ethnobotanical studies cannot provide evidence on the antiquity of specific uses for medicinal plants since oral traditions have a limited historical depth and archaeological evidence does not provide evidence for the specific medicinal use of a certain plant.

Here, we provide evidence for the antiquity of medicinal plant use in the Olmec region in Mexico by comparing the pharmacopoeias of the linguistically related Lowland Mixe and Zoque-Popoluca. These cultures, separated for about 2000 years, have cognates for vernacular medicinal plant names in common. For fifteen species such cognate names were detected. Also, a statistically significant segment of the medicinal flora is used for similar purposes. Overall, 123 species are shared between the two groups and of these 62 have a similar usage. In nine cases they also have a similar name. These findings make a transmission of such knowledge since the time of the Olmecs highly likely.

Keywords: Medicinal plants; Ethnobotany; History of plant use; Traditional medicine; Mixe/Zoque-Popoluca (México); Macro-Maya

1. Introduction

It is generally assumed that the use of medicinal plants in indigenous cultures is based on a long tradition ('traditional medicine'). However, for cultures with no written records there is practically no evidence available to establish the historical depth of traditional medicinal plant use (Cox, 2000, cf. Pieroni et al., 2002). While archaeobotanical research may provide evidence for the use of food plants widely used in a society and stored so that remains may be detected (e.g. cacao; Hurst et al., 2002), it cannot answer the question of the historical depths of medicinal plant use since archaeobotany does not provide evidence for a species' medicinal use (Leroi-Gourhan, 1975) and it is in fact difficult to establish the exact use context of such findings (Sommer, 1999). Archaeological relicts, comprising dried plant material together with human art in form of paintings, rock carvings, amulets, ceramic artefacts, stone figurines and monuments exist from which the use of plants for magico-religious ceremonies can be derived unambiguously (Schultes, 1998). Overall, proof exists only for some isolated and important species used as stimulants and hallucinogens but not for medicinal plants in their narrower sense.

Establishing the historical depth of medicinal plant use is relevant from a variety of perspectives. Not only would it show unambiguously that indigenous cultures have an *in depth knowledge of certain botanical taxa, which has been transmitted over centuries* prior to it becoming important in the context of developing novel pharmaceuticals or nutraceuticals, but as importantly, such research would demonstrate the historical development of an *intricate relationship between a culture and its environment* (Posey, 2002a). Local knowledge of indigenous peoples includes information about the ecosystem in general, but also about specific plants used as medicine, food, building material and the like. In view of the rapid loss of such knowledge both the documentation of this knowledge as well as a better understanding of its botanico-historical roots has become an essential task of ethnobiology.

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Two independent ethnobotanical studies (Heinrich et al., 1992; Leonti et al., 2001) have resulted in detailed understanding of the medicinal plant use in selected Lowland Mixe and Zoque-Popoluca communities in the Isthmus of Tehuantepec, México. The two cultures have not been in direct contact for many centuries and live in similar ecological environments.

Both their languages belong to the Macro-Mayan linguistic stock, which also includes Yucatec Maya and Tzotzil of Highland Chiapas. The northern part of the Isthmus, including the current settlement area of the Zoque-Popoluca, was the Olmecs' homeland (1500–300 B.C.). The Olmecs were one of the first cultures in Mesoamerica with permanent monuments and influenced many of the subsequent cultures in Mesoamerica. Deciphered epi-Olmec hieroglyphic writings dated to 160 A.D. and assigned to an early form of Zoque implicate that the Lowland Mixe and the Zoque-Popoluca have been separated prior to this date (Justeson and Kaufman, 1993). Thus, two cultures have been without direct contact for about two millennia and only during the last century has some indirect contact been possible. The development of telecommunication and transport infrastructures in the lowlands of México, especially since the 1950s, has increased the contact of both peoples with the dominant Mexican Mestizo culture, but direct contact between the two cultures is still extremely rare.

2. Background and methods

2.1. Ethnobotanical background

Mixe and Popoluca inhabit two areas in the Mexican states of Oaxaca and Veracruz, respectively. Their subsistence is based on shifting and seasonal cultivation (corn), cash cropping (coffee, citrus fruits), gathering and wage labour.

2.1.1. Popoluca

The Popoluca live on the southern and western slopes of the Sierra Santa Marta, a range of volcanoes between the Lake of Catemaco and the gulf shore. These volcanoes form the southern foothills of the "Sierra de Los Tuxtlas" mountain range, a region particularly well known for its biodiversity: the holarctic and neotropical floristic kingdoms overlap here. In a recently published list (Ramirez, 1999), 2400 species were recorded, but there are probably at least 3000 species growing in the Sierra (Chevalier and Buckles, 1995 and references therein). Important vegetation zones include the tropical montane cloud forest, the tropical rain forest and a semi-dry oak forest.

The data on the Popoluca were collected in the subdistrict (municipios) of Hueyapan de Ocampo in southern Veracruz from March 1999 to July 2000 as well as in Sta. Rosa Loma Larga. Fieldwork was conducted during 16 months and focused on collecting information on the medicinal plant use and general ethnographical (background) data as well as on the preparation of dried herbarium specimens and the collection of samples for further phytochemical analysis. The research was conducted with permit no. DOO. 02.-1750 obtained from the Instituto Nacional de Ecología, Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP). Complete sets of voucher specimens (Leonti 1-599) are deposited at the National Mexican Herbarium MEXU (UNAM, México, D.F.), the Herbarium-Hortorium of the Colegio de Postgraduados de Chapingo CHAPA (Texcoco), IMSS-M (Instituto Mexicano del Seguro Social, México, D.F.), Instituto de Ecología (Xalapa), the Centre for Pharmacognosy and Phytotherapy, The School of Pharmacy, University of London and the ETH Zurich (CH). Identification was largely conducted at MEXU and the Colegio de Posgraduados de Chapingo, in many cases with the help of specialists from these institutions.

2.1.2. Mixe

The land of the Mixe extends mostly through the cool and humid mountains of the *Sierra de Juarez* in the Mexican state of Oaxaca. *San Juan Guichicovi* is the only Mixe-speaking community in the subtropical *Istmo de Tehuantepec*. It is the principal community (*cabecera*) in a subdistrict (*municipio*) of the same name. In 1980, the *municipio* had 20,000 inhabitants, while the *cabecera* 5500–6500 (Heinrich et al., 1992). The data were collected from November 1985 to March 1986 and during several short stays thereafter.

The original vegetation in the region is tropical ombrophilous forest (broad-leaved cloud forests and montane forests) in the humid lowlands to the east and north, and drought deciduous lowland (and submontane) forest in the south. Most of the study area was originally covered by evergreen conifer and oak forest (with *Pinus oocarpa* Schiede and other *Pinus* spp., Pinaceae; *Quercus* spp., Fagaceae) as well as (sub-)tropical evergreen, partly submontane (broad-leaved) seasonal forest types (with *Manilkara zapota* (L.) P. Royen, Sapotaceae; *Coccoloba barbadensis* Jacq., Polygonaceae; *Enterolobium cyclocarpum* (Jacq.) Griseb., Mimosaceae). In higher elevations tropical ombrophilous forests replace the above mentioned vegetation types (Frei et al., 2000).

This primary vegetation has been modified by indigenous manipulation for at least 600 years. Since no archaeological studies have been conducted in the area, the occupation prior to the historical record is uncertain. The current vegetation is heavily influenced by the agricultural activities of the Mixe and Popoluca as well as neighbouring groups.

Complete sets of voucher specimens for this collection are deposited at MEXU, IMSS-M, and the Centre for Pharmacognosy and Phytotherapy, The School of Pharmacy, London.

2.2. Comparative analysis

In order to allow for a cross-cultural comparison, the ethnobotanical reports were separated into 13 categories

of use (CoU), sorting the illnesses into well-defined ethnomedical groups, e.g. dermatological and gastrointestinal illnesses (Table 2). These may differ in importance between the Zoque-Popoluca and the Lowland Mixe and one plant may be used for more than one CoU.

Using the statistic software "R" (also known as "GNU S", a language and environment for statistical computing and graphics, www.gnu.org) we tested for the statistical probability of getting at least one match with a certain CoU in the two cultures per plant species.

On the base of the proportions of the use categories the probability (P) of striking the same category of use in both pharmacopoeias was tested for each of the 123 plant species. If a plant species is assigned to more than one use category in either or both ethnic groups the probability of striking at least once the same use category gets higher.

The probabilities (P) of all plant species to share at least one use category were summed up. The result reflects the amount of matches to be expected if the two ethnic groups would share the plants at random. The statistical method chosen did not allow us to take the existing double matches (two or three strikes in either ethnic groups) into account which would have yielded a lower P (for the distinct cases) and fewer matches to be expected in total. The statistically relevant range (95% confidence interval) is defined as the expected value $\pm$ two times the standard deviation. Variance is obtained if $P(1 - P)$ is calculated for each of the 123 cases (plants) and then is summed up (Stahel, 1999).

3. Results and discussion

The ethnopharmacopoeias of the two groups have 123 out of 600 (Zoque-Popoluca) and 215 (Lowland Mixe) documented medicinal plants in common. Table 1 summarises the data on fifteen species for which cognate names (i.e. words related in origin) were detected. These are species which are named and used in a similar way by both ethnic groups. In nine cases they also have a similar usage. Clearly most of the names [cuma (P)/cum (M), tsëk/tsëk, pixtyiñ/pix ti'ink, ëkë/ëëk, panats/pa'ants, tyiñcuy/tsiin, mok/mëëk] are morphemes (i.e. words which cannot be divided into smaller meaningful units) and knowledge about these plants goes back at least two millennia.

Some other ones are descriptive and make reference to the habitat [tsa ay/tsak aay—herb of the stone, xoj muk—oak herb, i.e. grows near *Quercus* spp.], the taste [tam huñi—bitter gum/poop taam ujts—white bitter herb] or smell [patscang ay/pats ujts—skunk leaf/herb], the form of the fruit [më aktsa—deer testicle/atsëm tu'ty—pig testicle], or its usage [tsus cuy/tsusxp—snake plant]. While in some of the latter cases it is difficult to ascertain, whether these species are part of the common heritage, the similarity in usage and the detailed observation of the environment common in indigenous cultures clearly point to a common base. In other articles we have argued that, for example, taste and smell are important selection criteria in indigenous cultures like the Popoluca (Leonti et al., 2002), as well as the Mixe (Heinrich, 1998).

Table 1
Popoluca and Mixe plant species with similar names

Latin binominal	Popoluca name	Main use(s), Popoluca	Mixe name	Main use(s), Mixe
Acacia cornigera	juan apitx	gyna	juag aptx (horn of the cow)	derm
Acrocomia mexicana[a]	cuma	gast (diarrhoea)/anemia	cum	gast (parasites)
Anthurium schlechtendalii	tsa ay (herb of [on] the stone)	urol/derm	tsak aay (herb of [on] the stone)	gyna
Bursera simaruba[a]	tsëk	Fever/gast	tsëk	Fever
Calea zacatechichi[a]	tam huñi (bitter gum)	gast (stomach-ache, diarrhoea)/ derm/resp (cough, asthma)/gyna	poop taam ujts (white bitter herb)	gast (stomach-ache)/ fever
Ceiba pentandra	pixtyiñ	cult (to gain weight)	pix ti'ink	derm
Croton repens[a]	xoj muk (oak herb), xoj kobak (oak head)	gast (diarrhoea)/ophtalmological ailments	poop tsaxoj (white stone oak)	gast (dysentery)
Diphysa sp.[a]	tsus cuy	Snake bites	tsuxp	Snake bites
Guazuma ulmifolia[a]	ëkë	gast (diarrhoea)/gyna/derm (wound washing)	ëëk	gast (diarrhoea)
Heliocarpus donell-smithii & *Heliocarpus americanus*[a]	panats ([the] slippery)	derm (wounds, pustules)	pa'ants	derm (wounds)
Quercus oleoides & *Qu.* spp.[a]	pop soj (white oak)	gast (diarrhoea)/gyna (haemorrhages)	pop xoj (white oak)	gast (diarrhoea)/gyna (haemorrhages)
Petiveria alliacea	patscang ay (skunk leaf)	skmu/cult (against black magic)	Pats ujts (skunk herb)	resp (cough, asthma)
Pinus oocarpa[a]	tyiñcuy	derm (infections)/resp (cough)/cult (ritually)	tsiin	derm (infections)/resp (cough)/cult (ritually)
Thevetia ahouai	më aktsa (deer testicle)	derm/skmu	atsëmtu'ty	toothache
Zea mays	mok	gyna/urol	mëëk	gast

derm, dermatological; gast, gastrointestinal; gyna, gynaecological; urol, urological; cult, cultural syndrome; resp, respiratory; skmu, skelto-muscular.
[a] With shared use and name

Table 2
Relative proportion of the 13 categories of use within the two ethnic groups according to the number of plant species assigned to

Categories of use	Abbreviation	Popoluca	Mixe
Diseases of the skin	(DERM)	21.7	20.0
Gastrointestinal disorders	(GAST)	18.5	20.6
Gynaecology	(GYNA)	12.6	11.8
Fever and headache	(FEVE)	8.5	16.5
Urological problems	(UROL)	7.7	1.9
Venomous animals	(VENO)	5.8	0.9
Culture bound syndromes	(CULT)	5.4	8.4
Respiratory complaints	(RESP)	4.9	6.2
Skeleto-muscular disorders	(SKMU)	4.7	5.0
Problems of the ear		1.6	1.9
Problems of the eye		1.2	0.3
Toothache		1.2	2.2
Others		6.2	4.3

For *Ceiba pentandra*, the mythical tree of the Maya, cognates (Pixtyiñ, (P)/Pix ti'ink, (M)) are employed in both languages, but the medicinal uses differ pointing to an independent development in both ethnobiological traditions. Some striking similarities exist even with the Yucatec Maya, who, for example, name *Diphysa carthagenenis* as Susup/Ts'us'uk and also use it in the treatment of snake bites (Ankli et al., 1999) (Table 1).

In other cases we documented different names but a specific medical usage is common to both cultures (Appendix A). A particularly striking example is provided by two collections of *Crotalaria* (Fabaceae, s.str)—*Crotalaria cajanifolia* (Lowland Mixe) and *Crotalaria sagittalis* (Zoque-Popoluca), which share a very specific and unique usage to prevent children from urinating into the bed. Many other examples of common usage point to a common history in many of these medicinal plants.

Tables 2 and 3 provide the basic date required for the statistical analysis. In Table 2 we present the relative proportion of the 13 categories of use within the two ethnic groups according to the number of plant species assigned to each group. Table 3 shows the probabilities of getting at least one match for the distribution patterns of use categories as outlined in the table for the two ethnic groups. This results in an anticipated number of species with a shared use in the two ethnic groups if these uses are distributed at random. According to the statistical analysis randomly distributed plant uses predict a value within the range of $35 \pm 2 \times 4.5$ matches (95% confidence interval). The fact that our comparison of the 123 shared plant species yielded 62 species with at least one common use indicates that pure coincidence can be excluded to explain this finding. This result is a highly significant indicator for a common cultural heritage and/or common selection criteria for plants used as a medicine (Leonti et al., 2002).

This study thus identifies a small, but highly conserved group of medicinal plants which are part of the medico-botanical heritage of these two Macro-Mayan groups. This group of medicinal plants very likely belonged to the pharmacopoeia of a proto-Mixe/Zoque culture. Combining linguistic evidence and current ethnobotanical data, this study opens a novel corridor to the past and provides evidence for the antiquity of medicinal plant usage in the Olmec region.

Table 3
Probabilities for at least one match for the distribution pattern of use categories

Popoluca	Mixe	Probability to get at least one match (%)
1	1	10.6
1	2	20.6
1	3	30.7
1	4	40.1
1	5	48.5
2	1	21.0
2	2	38.7
2	3	53.6
2	4	65.9
2	5	75.2
3	1	30.8
3	2	53.6
3	3	70.1
3	4	81.3
3	5	89.0
4	1	40.2
4	2	66.2
4	3	81.6
4	4	90.7
4	5	95.5
5	1	49.2
5	2	75.9
5	3	89.4
5	4	95.6
5	5	98.5

4. Conclusions

To our knowledge it is the first study which employs a botanico-linguistic approach in order to better understand the plant use in cultures without written history. Our study thus contributes both to a better scientific understanding of the use of botanical resources by indigenous groups like the Popoluca and Mixe, but also offers a method for contextualising indigenous knowledge about botanical resources (Posey, 2002b). This botanical knowledge may no longer be as central to the Popoluca and Mixe as it was just a few decades ago and botanical anthropology is faced with the challenge of understanding as much of this knowledge as soon as possible, and also we need to support these cultures in passing this local knowledge on to future generations. However, this challenge is not just one for a few specialists but for all researchers interested in biological and cultural diversity.

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Appendix A. Popoluca and Mixe medicinal plant species with similar uses (total 62)

Acosmium panamense (Benth.) Yakovlev (RESP-GAST-GYNA) *Acrocomia mexicana* Karw. ex Mart. (GAST) *Adiantum princeps* T. Moore (P)/*Adiantum tenerum* Sw. (M) (GYNA) *Annona muricata* L. (GAST) *Bixa orellana* L. (FEVE) *Bursera simaruba* (L.) Sarg. (FEVE) *Byrsonima crassifolia* (L.) Kunth (GAST-GYNA) *Carica papaya* L. (GAST) *Cassia moschata* Kunth (P[1])/*Cassia fistula* L. (M) (RESP) *Chamaecrista hispidula* (Vahl) H. S. Irwin et Barneby (GYNA) *Chaptalia nutans* (L.) Pol. (DERM) *Cissampelos pareira* L. (GAST) *Crescentia cujete* L. (GYNA) *Critonia quadrangularis* (DC.) R. M. King et H. Rob. (SKMU) *Crotalaria sagittalis* L. (P)/*Crotalaria cajanifolia* Kunth (M) (UROL) *Croton repens* Schltsl. (GAST) *Diphysa americana* (Mill.) M. Sousa (P)/*Diphysa carthagenensis* Jacq. (M) (VENO) *Eryngium foetidum* L. (GAST) *Eugenia acapulcensis* Steud. (GAST) *Gliricidia sepium* (Jacq.) Steud. (FEVE) *Gouania polygama* (Jacq.) Urb. (DERM) *Guazuma ulmifolia* Lam. (GYNA-GAST) *Heliocarpus americanus* L. (DERM) *Heliotropium indicum* L. (DERM-GYNA) *Hymenaea courbaril* L. (RESP-GAST) *Hyptis verticillata* Jacq. (GAST-FEVE) *Jatropha curcas* L. (DERM) *Kalanchoe pinnata* (Lam.) Pers. (FEVER) *Koanophyllon albicaule* (Sch. Bip. ex Klatt) R. M. Krug et H. Rob. (CULT) *Lippia alba* (Mill.) N. E. Br. (GYNA-GAST) *Loxothysanus sinuatus* (Less.) B. L. Rob. (DERM) *Ludwigia octovalvis* (Jacq.) P. H. Raven (DERM) *Machaerium floribundum* Benth. (DERM-GAST) *Malvaviscus arboreus* Cav. (GAST) *Miconia albicans* (Sw.) Triana (DERM) *Mimosa pudica* L. (CULT) *Muntingia calabura* L. (VENO) *Musa* sp. (GAST) *Myroxylon balsamum* (L.) Harms (SKMU) *Parmentiera aculeata* (Kunth) Seem. (RESP) *Parthenium hysterophorus* L. (SKMU) *Pavonia schiedeana* Steud. (FEVE) *Persea americana* Mill. (GAST-GYNA) *Phoradendron quadrangulare* (Kunth) Griseb. (P)/*Phoradendron piperoides* (Kunth) Trel. (M) (DERM) *Pinus oocarpa* Schiede ex Schltdl. (DERM-RESP) *Piper auritum* Kunth (DERM) *Pluchea symphytifolia* (Mill.) Gillis (GYNA-GAST-DERM) *Plumeria rubra* L. (FEVE) *Psidium guajava* L. (GAST) *Psidium guineense* Sw. (GAST) *Quercus glaucescens* Humb. et Bonpl. (GYNA-GAST) *Quercus oleoides* Schltdl. et Cham. (GAST) *Russelia sarmentosa* Jacq. (GAST) *Salvia xalapensis* Benth. (DERM) *Sambucus mexicana* C. Presl ex DC. (RESP) *Scoparia dulcis* L. (DERM) *Spondias purpurea* L. (GAST) *Tagetes lucida* Cav. (GAST) *Teloxys ambrosioides* L. (GAST) *Tithonia diversifolia* (Hemsl.) A. Gray (DERM-SKMU) *Xanthosoma robustum* Schott (DERM) *Zea mays* L. (UROL).

[1] (P)—Popoluca, (M)—Mixe.

Appendix B. Popoluca and Mixe medicinal plant species with different uses (total 61)

Abelmoschus moschatus Medik. *Acacia cornigera* (L.) Willd. *Andira galeottiana* Standl. *Annona purpurea* Moc. et Sessé ex Dunal *Annona reticulata* L. *Anthurium schlechtendalii* Kunth *Artemisia ludoviciana* Nutt. *Asclepias curassavica* L. *Begonia heracleifolia* Schltdl. et Cham. *Biophytum dendroides* (Kunth) DC. *Buddleia americana* L. *Calea ternifolia* Kunth = C. *zacatechichi* Schltdl. *Calea urticifolia* (Mill.) DC. *Capsicum* sp. *Cecropia obtusifolia* Bertol. *Cedrela odorata* L. *Ceiba pentandra* (L.) Gaertn. *Cochlospermum vitifolium* (Willd.) Spreng. *Critonia morifolia* (Mill.) R. M. King et H. Rob. *Curatella americana* L. *Datura stramonium* L. *Desmodium incanum* DC. *Doliocarpus dentatus* (Aubl.) Standl. *Enterolobium cyclocarpum* (Jacq.) Griseb. *Epaltes mexicana* Less. *Erythrina* sp. *Gnaphalium attenuatum* DC. *Impatiens balsamina* L. *Lantana camara* L. *Lantana trifolia* L. *Lygodium venustum* Sw. *Mirabilis jalapa* L. *Momordica charantia* L. *Nicotiana* sp. *Ocimum micranthum* Willd. *Passiflora foetida* L. *Pedilanthus tithymaloides* (L.) Poit. subsp. *tithymaloides Peperomia tetraphylla* (G. Fost.) Hook. et Arn (P) *Peperomia quadrifolia* (L.) Kunth (M) *Petiveria alliacea* L. *Pimenta dioica* (L.) Merr. *Piper aduncum* L. *Piper amalago* L. *Pityrogramma calomelanos* (L.) Link *Porophyllum ruderale* (Jacq.) Cass. *Sechium edule* (Jacq.) Sw. *Senna occidentalis* (L.) Link *Senna spectabilis* (DC.) H. S. Irwin et Barneby *Sida acuta* Burm. f. *Sida rhombifolia* L. *Siparuna andina* (Tul.) A. DC. *Solanum schlechtendalianum* Walp. *Solanum torvum* Sw. *Stachytarpheta jamaicensis* (L.) Vahl *Tabebuia rosea* (Bertol.) DC. *Tabernaemontana alba* Mill. *Tagetes erecta* L. *Tagetes filifolia* Lag. *Thevetia ahouai* (L.) A. DC. *Turbina corymbosa* (L.) Raf. *Ximenia americana* L. *Zamia loddigesii*Miq.

Note: Excluded from both appendices are plants introduced from outside of neotropical America (e.g. *Allium sativum*—garlic).

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