JPP Journal of Pharmacy and Pharmacology

JPP 2001, 53: 1653–1669

Received May 11, 2001
Accepted July 15, 2001
ISSN 0022-3573

Department of Applied BioSciences, Institute of Pharmaceutical Sciences, Swiss Federal Institute of Technology (ETH) Zurich, Winterthurerstrasse 190, CH-8057 Zürich, Switzerland

Marco Leonti, Otto Sticher

Especialidad de Botánica, Colegio de Postgraduados en Ciencias Agrícolas, km 36.5 carretera México-Texcoco, 56230 Montecillo, Estado de México, Mexico

Heike Vibrans

Centre for Pharmacognosy and Phytotherapy, The School of Pharmacy, University of London, 29–39 Brunswick Square, London WC1N 1AX, UK

Michael Heinrich

Correspondence: M. Heinrich, Centre for Pharmacognosy and Phytotherapy, The School of Pharmacy, University of London, 29–39 Brunswick Square, London WC1N 1AX, UK. E-Mail: phyto@ulsop.ac.uk

Funding and acknowledgements: Financial support by the S.R.E. (Secretaría de Relaciones Exteriores, México D.F.) and the S.D.C. (Swiss Agency for Development and Cooperation) is gratefully acknowledged. We are grateful to all the healers, midwives and the inhabitants of the region of study for sharing their culture, their friendship and their hospitality. We thank the specialists of the Mexican National Herbarium (MEXU), in particular Dr M. Sousa, A. Reyes, and Francisco Ramos. We are grateful to the I.N.I. for collaboration and the SEMARNAP for the permission to collect plant material. We thank Dr Paul Bremner (ULSOP) for comments on the style of the manuscript.

Ethnopharmacology of the Popoluca, Mexico: an evaluation

Marco Leonti, Heike Vibrans, Otto Sticher and Michael Heinrich

Abstract

Medicinal plants are an essential part of indigenous pharmaceutical systems. We studied the medicinal plants used by the Popoluca of the Sierra Santa Marta (Eastern Mexico). This study is part of a series on the ethnopharmacology of various Macro-Mayan groups. During 16 months of ethnobotanical fieldwork, 614 taxa used medicinally and 4488 individual use-reports were documented. The data are analysed using the concept of the ''healers' consensus'' in order to identify culturally important medicinal plants. The medicinal uses of the plants were grouped into13 illness categories. The responses for each species were summarized for each of the categories and were ordered by frequency of mention. The most frequently recorded medicinal plants of the Popoluca are *Hamelia patens*, used to stop bleeding from wounds, and *Byrsonima crassifolia*, used against diarrhoea. The high-ranked medicinal species were assessed pharmacognostically using published phytochemical and pharmacological data. Popoluca medicinal uses were fairly consistent with published data on active ingredients for those plants for which such data exist. However, data is still lacking for many other species. Toxicological studies are particularly scarce. This study will be used as a basis for subsequent studies on the pharmacology and phytochemistry of medicinal plant species.

Introduction

Natural product research is often based on ethnobotanical information and many of the drugs used today were developed from medicinal plants used in indigenous societies. More importantly, the study of these resources in order to contribute to better health care in marginalized areas is becoming a central task of modern ethnopharmacological research (Heinrich 2000; Heinrich and Gibbons 2001). Although it is generally assumed that medicinal plants used in indigenous cultures have beneficial health effects, little empirical evidence is available to corroborate this idea. One of the first attempts focused on Aztec medicinal plants and showed that a large proportion of the plants used in this historic culture had the effects ascribed to them by the Aztecs (Ortiz de Montellano 1975). Our own group has contributed to this field through several studies on Mexican and Tanzanian cultures (e.g. Heinrich et al 1998; Ankli et al 1999; Schlage et al 2000). A major part of the ethnopharmaceutical research in recent years has been directed towards a better understanding of the pharmacological effects of individual medicinal plants. Phytochemical studies on medicinal plants are relatively abundant. This study focuses on the medicinal plant usage by one Mexican Indian group – its ''ethnopharmacopoeia''. In view of the rapid change that indigenous cultures all

over the world are undergoing, the documentation of this knowledge and its detailed ethnopharmaceutical study is urgent.

The diversity of medicinal plants is very high in a country such as Mexico, in which more than 50 indigenous languages are spoken and which is very well known for its biological diversity (Challanger 1998). There are about 30000 species of higher plants in the country (Toledo & Ordóñez 1993, cited in Challenger 1998). Each region has different local plant resources and from these a basic group of phytotherapeutics is selected (Aguilar et al 1994; Argueta et al 1994; Heinrich et al 1998). The gathering and use of local resources is still an important aspect of the phytotherapeutic traditions in many regions of Mexico.

Recently, we developed a method that allows a stratification of indigenous uses of (medicinal) plants and a comparison of these data on a cross-cultural basis (Heinrich et al 1998; Ankli et al 1999). The number of use-reports (i.e. the number of times a species is reported for a certain use by healers in the community) serves as an estimation of the ethnobotanical importance of a species.

In this study, we report on the medicinal plants used by the Popoluca (also called Nuntajïyï) in the southern part of the Mexican state of Veracruz. The ethnobotany of this group was of particular interest for us, as we had previously studied the medicinal plant use of the Mixe (or Ayuk), a linguistically closely related group in the subtropical lowlands of the state of Oaxaca. Both groups inhabit regions in the humid part of the Istmo de Tehuantepec and the adjoining low-altitude foothills of the mountain ranges of southern and central Mexico. We document and analyse the use of important medicinal plants of the Popoluca. Published phytochemical and pharmacological data are used to evaluate the plants. We also look at the Popoluca's rationale for using these plants.

Background and Methods

General ethnobotanical background

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 because the holarctic and neotropical floristic kingdoms overlap here. In a recently published list (Ramirez-Ramirez 1999), 2700 species were recorded, but there are probably at least 3000 species of higher plants growing in the Sierra (see Chevalier and Buckles 1995 and references therein).

The study area of about 1350 km^2 lies at altitudes between 0 and 1720 m above sea-level. The influence of the more humid climate of the Mexican gulf is particularly noteworthy on the northeastern side of the mountains. Important vegetation zones include the tropical montane cloud forest, the tropical rain forest and a semi-dry oak forest. The latter region was selected by the Popoluca for constructing their settlements.

According to Foster (1969), the Popoluca were (and still are) one of the least studied ethnic groups of Mexico. The word Popoluca is an Aztec defamatory term for barbarians (those who speak gibberish), but the name is now commonly used to designate this ethnic group. The language is closely related to Mixe (previously studied ethnobotanically by Heinrich 1989) and Zoque, and belongs to the Macro-Mayan stock. Other dialects of Popoluca were formerly spoken in the Isthmus of Tehuantepec around Acayucan. The northern part of the Isthmus of Tehuantepec was also the home of the Olmecs (1500–300 BC), one of the first cultures in Mesoamerica, which has left permanent monuments and artefacts, and influenced many of the subsequent cultures in Mesoamerica (Báez-Jorge 1973).

About 30000 Popoluca live in the Sierra de Santa Marta, which is also inhabited by Nahua as well as Zapotec and Mestizo immigrants. The cultural centre is San Pedro Soteapan (Attebet), founded before the conquest, which today has approximately 4000 inhabitants. Despite the growing influence of western civilization, the Sierra Popoluca still retain many aspects of their traditional way of life. In most families, Popoluca is the first or only language. In school, children are educated bilingually, and Mexican government institutions have programmes to encourage the continuous use of the native language.

The economic basis of the Popoluca is the production of maize for subsistence and of coffee as a cash crop. Since land is scarce, young men migrate to the Mexican economic centres to work as day labourers in industry and agriculture or in the military.

Health and healing

The illness profile is typical for such a poor rural area in the tropics. Gastrointestinal illnesses (especially diarrhoea and dysentery) are particularly frequent, as well as infectious and inflammatory afflictions of the skin.

The dermatological complaints are usually not life-threatening, but diarrhoea is still a cause of death, especially among children. Amoebiasis provoked by *Entamoeba histolytica* is endemic. Fever caused by infections of all kinds is frequent. According to the local governmental health-care institution "Secretaría de Salud y Asistencia" (SSA), the last cases of malaria and dengue, which are transmitted by mosquitoes, were recorded in 1996. Snake bites were a frequent life-threatening problem, but the number of cases has dropped in recent years because of the intensifying agricultural practices. In addition, snake bites are now better controlled by antisera. Diabetes type II is becoming a serious health problem of the indigenous population. A diet low in fibre and rich in simple carbohydrates, and generally insufficient nutrition, are the main causes.

Western forms of medical treatment (biomedicine) are provided by the following:

- the SSA and the IMSS (Instituto Mexicano del Seguro Social), two governmental health-care institutions, which provide free treatment and medication in Soteapan and in outlying communities, respectively,
- private medical doctors in the cities of Acayucan, Minatitlan and Coatzacoalcos, which can be reached by a bus-ride of more than two hours, but which are relatively expensive by local standards,
- small grocery stores, which give "advice" on the use of pharmaceuticals and sell these in small quantities (usually as individual tablets).

MEXFAM, a governmental institution that promotes reproductive health, collaborates with local midwives, and gives advice on family planning. The midwives prescribe birth control pills at low cost.

Herbal treatment is of major importance, given the unreliability of the supply of pharmaceuticals and high costs compared with local earnings. Local pharmaceutical practice employs both empirical and symbolic forms of treatment. Symbolic forms of treatment are beyond the scope of this paper, which focuses on pharmaceutical aspects of the Popoluca's use of plants (but see Heinrich 1997 on the linguistically related Mixe). They include praying to the various saints and traditional deities, as well as ritual cleansing ceremonies called "limpias". Healers are consulted if the illness is perceived to be untreatable by the SSA, if the centre of the SSA is closed or if no medicine is available through it. Many Popoluca also distrust the SSA because of previous experiences and prefer the treatment offered by the Popoluca healers.

The type of treatment a patient seeks depends on his/her cultural self-identification, the social and economic conditions, education, and the kind of ailment. According to the Popoluca, illness may have different causes. For example, interfamiliar tensions, strained relations in general and incurring the displeasure of the "Chanecos" (dwarf-like kings of nature dwelling inside the mountains) may bring disease into the family. Disregarding the social and cultural norms of behaviour may cause such displeasure. The disease does not need to hit the guilty person. For example, if parents have strong arguments, the illness will most likely hit their "weaker" children.

"Espanto" or fright is an illness associated with soul-loss and is still commonly diagnosed by Popoluca healers. According to Foster (1951) "a sudden shock, an unexpected encounter with supernatural beings, a fall, or … fear of death from purely natural causes" can cause espanto. Again the Chanecos are thought to be responsible by provoking these accidents and then capturing a part of the victims' soul and keeping it locked up.

Witchcraft, too, plays an important role in the cultural consciousness and is thought to be a cause of chronic illnesses. Brujos (witches) are thought to be instructed by an envious person to "inject" objects into a person's body and the person consequently falls ill. Thermal dichotomy (hot/cold) plays a role in the dietary customs and in medicine. The medicine must have opposing thermal properties. During the dry period, diarrhoea and dysentery are more frequent, as the cysts of the causative organisms are transported onto food with dust. Thus, it is considered to be a hot disease, which in turn needs cold medicine. Being surprised by a sudden cloudburst while working in the milpa (maize field) may be a reason for getting skeleto–muscular rheumatic pains. Lightnings are considered to cause heating of the body. This diagnosis is frequently made during the rainy season in many cases where fever (perceived as a "hot disease") is the main symptom. After parturition, women are not allowed to eat cold foods such as pork meat, iguana and molluscs. The same products are said to be possible agents to provoke congestion of the stomach.

Methods

The data presented in this paper were collected in the subdistricts (municipios) of Soteapan and Hueyapan de Ocampo in southern Veracruz between March 1999 and July 2000. Fieldwork was conducted over the 16 months and focused on collecting information on the medicinal plant use and general ethnographical (background)

Table 1 Quantitative ethnobotanical analysis of the 13 groups of medical use.

Group of medical use	F_{ic}	Use-reports	$\%Ur_{tot}$	Taxa	%Taxa	%Leaf/aerial part	%Root/tuber	%Bark
Diseases of the skin	0.69	973	21.7	303	49.3	70.4	4.7	14.7
Gastrointestinal disorders	0.70	830	18.5	251	40.9	32.7	27.7	26.3
Gynaecology	0.62	566	12.6	218	35.5	21.7	16.6	32.6
Fever and headache	0.71	381	8.5	112	18.2	84.0	4.7	4.4
Urological problems	0.55	345	7.7	157	25.6	34.4	34.7	20.1
Venomous animals	0.54	260	5.8	121	19.7	51.5	17.1	22.7
Culture-bound syndromes	0.47	240	5.4	127	20.7	62.6	2.3	7.9
Respiratory complaints	0.64	219	4.9	79	12.9	52.5	8.4	8.8
Skeleto–muscular disorders	0.52	211	4.7	101	16.4	61.5	12.7	23.5
Problems of the ear	0.54	71	1.6	33	5.4	91.5	1.4	0
Problems of the eye	0.45	53	1.2	29	4.7	42.0	4.0	0
Toothache	0.40	53	1.2	32	5.2	20.8	30.2	7.5
Others	NA	286	6.4	150	24.4	NA	NA	NA

Total number of use-reports is 4488; total number of taxa is 614; F_{ic}, Factor of Informant Consensus; NA, not applicable, $\%Ur_{tot}$, percentage of use-reports contributed to the total amount of use-reports by the respective illness category; Taxa, total amount of plant species contributing to the use-reports of the respective illness category; %Taxa, percentage of the plant species reported for an illness category in respect to the total amount of reported plants species; %leaf/aerial part, percentage of use-reports for the respective illness category that indicate leaves or aerial parts; %root/tuber, percentage of use-reports for the respective illness category which indicate roots or tubers; %bark, percentage of use-reports for the respective illness category which indicate barks.

data, as well as on the preparation of dried herbarium specimens and the collection of samples for further analysis. The research was conducted with the 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) were 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.

The specialists in traditional medicine were first asked about themselves and their experiences as healers. Next, during an excursion to the surrounding area, mostly fields, the specialist showed the plants he knew and used for his pharmaceutical preparations. It was left to the informant to choose the itinerary because he knew best where to find the plants he was willing to show. Subsequently, in a more structured interview, the specialist was asked about the use(s), preparation, application of the plants gathered, as well as about his concepts about healing. The Popoluca words were transcribed according to Hernández-Cruz (1994, 1995) and the Diccionario Popoluca de la Sierra Veracruz (Elson and Gutiérrez 1999).

Our database consists of 4488 use-reports on 614 plant species, contributed by 72 informants. These included 27 women and 45 men aged between 22 and 85. The five groups of informants were: herbalists (curanderos, hierbateros), midwives (parteras), experts of the skeleto–muscular system (hueseros), soul-loss experts (ensalmadores) and snakebite specialists (culebreros). However, the borders between these different groups are fluent. About 50 informants were interviewed at least twice. If required, additional interviews were conducted in order to ensure that all relevant information from the respective healer was obtained.

In order to analyse the cultural importance of an individual species and for a later cross-cultural comparison, the reports obtained were separated into 13 categories of use, grouping the illnesses into relatively well-defined ethnomedical categories (Table 1). The number of use-reports for every species in such a category were ordered in a ranked list, showing species with the largest number of positive responses at the top (cf. Tables 2–11). A species may be listed in more than one category and for the same number of positive responses

the species are arranged alphabetically, first by family and then by genus.

A more detailed analysis of the published phytochemical and pharmacological information was conducted for species with more than 15 use-reports, the only exceptions being "fever and headache" and the smallest groups: "fractures, bruises, general body pain and rheumatic disorders" as well as "problems of the ear, eye and toothache", for which a lower number had to be chosen. This selection was required in order to concentrate the analysis on the ethnopharmaceutically important species. To get data on published phytochemical and pharmacological information on the species, literature searches were performed using the following databases: Medline, Chemical Abstracts, Biological Abstracts, EMBASE: Drugs and Pharmacology, and Current Contents/Life Sciences. Plants of European origin, which are well studied, are not discussed (see Table 4) since such information can be readily found in textbooks (Haensel et al 1999).

The consistency of the use-reports within a category can be evaluated numerically using the Factor of Informant Consensus, F_{ic}(see Trotter and Logan 1986). It gives the relationship between the number of use-reports in each category (n_{ur}) minus the number of taxa used (n_t) and the number of use-reports in each category minus 1. Thus, the F_{ic} is determined as follows:

$$F_{ic} = (n_{ur} - n_t)/(n_{ur} - 1)$$

A value close to 1 indicates a high intracultural consensus (i.e. most healers use the same species for the same illnesses; Heinrich et al 1998). A value close to zero indicates a high variation in the use of species. Thus, plant selection may be more at random, as no plant is very effective, or there is little intracultural exchange of medical plant knowledge.

Results and Discussion

Different disease groups show different levels of cultural consensus, diverse healing strategies as well as different preferences for the plant parts used. F_{ic} was highest (0.71) in the category of fever and headache. This is contrary to the results of previous studies with other ethnic groups, where gastrointestinal illnesses generally had the highest F_{ic}. Eighteen percent of all species and 8.5% of all use-reports are included in this category. As in the previous studies, diseases of the skin (0.69) and gastrointestinal disorders (0.70) also showed a high F_{ic}. Culture-bound syndromes (0.47), problems of the eye (0.47) and toothache (0.40) have relatively low values of F_{ic} (see Table 1).

Leaves and aerial parts of the plant are most commonly used, followed by bark, root/tuber and the seed. Latex, plant saps, fruits and flowers are less frequently used. Leaves and aerial parts of the plant are most frequently (77%) used in categories of illnesses where topical applications are frequent (dermatological diseases, fever and headache). In illness categories that are usually treated with ingested preparations (gastrointestinal disorders, gynaecology and urological complaints), bark and root drugs are more common (52.4%), with leaf and aerial parts accounting for only 34% of the reports (see Table 1). In the following sections, the individual indigenous groups of use are discussed.

Diseases of the skin

In the hot and humid lowlands of Mexico, infectious and inflammatory diseases of the skin, caused by bacteria and fungi, are frequent. Erysipelas (infections with *Streptococcus* spp.) and infections of wounds caused by accidents while cultivating the milpa are particularly important. Scabies is very common owing to the low quality of the water. Half of all recorded medicinal species (49%) are used to treat dermatological disorders, and about a fifth (981) of the use-reports fall into this group (Table 2). The ethnobotanical importance of this group has already been documented with other indigenous groups and F_{ic} is relatively high (0.69), especially if compared with the values of F_{ic} for this group in previous studies (Heinrich et al 1998). Dermatological complaints are treated topically with a washing, cataplasm or dried plant powder. Contrary to previous studies, the Popoluca have a well-defined set of three plants, which are used widely for specific illnesses in the group "diseases of the skin". For example, fresh leaf sap from *Hamelia patens* is applied to stop the bleeding of a wound. The closing of the wound is accelerated by dried leaf powder of *Solanum torvum*, *Solanum rudepannum* or the slimy bark extract of *Heliocarpus* species.

H. patens is a species widely distributed in the neotropics. It is worth noting that this rubiaceous species is one of the most important medicinal taxa of the Popoluca, whereas the Mixe, for example, do not use it at all. As pointed out by Moerman et al (1999), the Rubiaceae are unusual, as some ethnic groups use them frequently, whereas others hardly ever use species of this family as a medicine. It remains to be elucidated why this is the case. Antibacterial activity from *H. patens* was reported by Jimenez Misas et al (1979). The aerial parts

Table 2 Diseases of the skin.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Hamelia patens Jacq.	Rubiaceae	Leaf	Bleeding wounds	32	(3.3)	Chochoday/ Cuma ay/ Cangchocho	Coyolillo
Croton draco Schltdl.	Euphorbiaceae	Latex	Oral infection, dermal infection	26	(2.7)	N¥pin cuy	Sangregado
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	Leaf	Scabies, wounds	24	(2.5)	Tam chich	Arnica
Solanum sp. (*S. rudepannum* Dunal/*S. torvum* Sw.)	Solanaceae	Leaf	Wounds, haemorrhoids	18	(1.8)	Muutsei cuy	Berenjena
Senna pendula (Humb. et Bonpl. ex Willd.) H. S. Irwin et Barneby	Caesalpiniaceae	Leaf	Erysipela, abscess	17	(1.7)	M¥k stogay	
Heliocarpus americanus L.	Tiliaceae	Bark	Abscess, wounds	15	(1.5)	Panats	Jonote
Momordica charantia L.	Cucurbitaceae	Leaf	Scabies, pustules	14	(1.4)	Kundiamor	Cundiamor
Piper sp.	Piperaceae	Leaf	Infected wounds, gangrene, erysipela	14	(1.4)	Tooso	
Psychotria hebeclada DC.	Rubiaceae	Leaf	Erysipela	14	(1.4)	Masan ay	Hoja morada
Jatropha curcas L.	Euphorbiaceae	Sap	Oral infection	12	(1.2)	Cuyukum	Piñon
Phytolacca rivinoides Kunth & C. D. Bouché	Phytolaccaceae	Leaf	Erysipela	12	(1.2)	Masan ay	
Citrus limon (L.) Burm. f.	Rutaceae	Leaf	Erysipela	11	(1.1)	Apitx cuy	Limón
Aloe sp.	Liliaceae	Leaf	Erysipela	11	(1.1)		Sabila
Maytenus belizensis Standl.	Celastraceae	Bark	Wounds	10	(1.0)	Niui cuy	Retamo
Rivina humilis L.	Phytolaccaceae	Leaf	Erysipela	10	(1.0)	Masan ay	
Inga punctata Willd.	Mimosaceae	Bark	Infected wounds	9	(0.9)	Inki	Acotope, Vainilla
Lippia dulcis Trevir.	Verbenaceae	Leaf	Gingivitis	9	(0.9)	Cana ay	Hierba dulce
Loxothysanus sinuatus (Less.) B. L. Rob.	Asteraceae	Leaf	Mycosis	9	(0.9)	W¥y¥ ay	
Dorstenia contrajerva L.	Moraceae	Leaf	Dermal infection	9	(0.9)	Nak ay	Cresta de gallo
Piper amalago L.	Piperaceae	Leaf	Infected wounds, gangrene, erysipela	9	(0.9)	Tooso	
Calea ternifolia Kunth = C. *zacatechichi* Schltdl.	Asteraceae	Leaf	Scabies, dermal infection	8	(0.8)	Tam juñi	Jaral
Buddleia americana L.	Loganiaceae	Leaf	Dermal infection	8	(0.8)	Xiapun ay	Teposan
Psychotria panamensis Standl.	Rubiaceae	Leaf	Abscess	8	(0.8)	Tsus pitx cuy	
Pinus oocarpa Schiede ex Schltdl.	Pinaceae	Resin	Wounds	7	(0.7)	Tyiñcuy	Ocote
Cordia spinescens L.	Boraginaceae	Leaf	Erysipela	7	(0.7)	Y¥k yom tsay	Vara negra
Cecropia obtusifolia Bertol.	Cecropiaceae	Leaf	White spots	7	(0.7)	Mats	Chancarro
Byrsonima crassifolia (L.) Kunth	Malpighiaceae	Bark	Wounds	7	(0.7)	Nanchiñ	Nanchi
Gouania polygama (Jacq.) Urb.	Rhamnaceae	Leaf	Dermal infection	7	(0.7)	Xiapun tsay	Jaboncillo
Vitis tiliifolia Humb. et Bonpl. ex Roem. et Schult.	Vitaceae	Leaf	Dermal infection	7	(0.7)	Y¥k ty¥m tsay	Agras
Philodendron hederaceum (Jacq.) Schott	Araceae	Juice	Erysipela	7	(0.7)	Pasmuj ay	
Odontonema callistachyum (Schltdl. et Cham.) Kuntze	Acanthaceae	Leaf	Erysipela, abscess	6	(0.6)	Naktam ay	
Tabernaemontana alba Mill.	Apocynaceae	Latex	Warts	6	(0.6)	Naa cuy	Huevo de venado
Heliotropium indicum L.	Boraginaceae	Leaf	Dermal infection	6	(0.6)	Tunok kiñi	Cola de alacrán
Senna multijuga subsp. *doylei* (Britton et Rose) H. S. Irwin et Barneby	Caesalpiniaceae	Bark	Wounds	6	(0.6)	Uaxiñ	Palo santiago

Table 2 (*cont.*)

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Baccharis trinervis Pers.	Asteraceae	Leaf	Dermal infection, wounds	6	(0.6)	Tsay mayorga	
Calea longipedicellata B.L. Rob. et Greenm.	Asteraceae	Leaf	Dermal infection	6	(0.6)	Añi mutx ay	
Conyza sp. (*C. bonariensis* (L.) Cronquist/*C. canadensis* (L.) Cronquist)	Asteraceae	Leaf	Dermal infection	6	(0.6)	Jok poy	
Diospyros digyna Jacq.	Ebenaceae	Bark	Mycosis	6	(0.6)	Nuu	Zapote negro
Chaetocalyx brasiliensis (Vogel) Benth.	Fabaceae s.str.	Leaf	Abscess	6	(0.6)	M¥kstogay tsay	
Miconia albicans (Sw.) Triana	Melastomataceae	Leaf	Gingivitis, oral infection	6	(0.6)	Pak tesua	
Cedrela odorata L.	Meliaceae	Bark	Infected wounds	6	(0.6)	Acuy	Cedro
Bocconia frutescens L.	Papaveraceae	Leaf	Scabies, lice, pustules, mycosis	6	(0.6)		Llora sangre
Pothomorphe umbellata (L.) Miq.	Piperaceae	Leaf	Dermal infection, infected wounds	6	(0.6)	Aycuyo cimarrón	Bella dona
Psychotria tenuifolia Sw.	Rubiaceae	Root	Infected wounds	6	(0.6)	Tam txix¥k	Simonillo
Pouteria sapota (Jacq.) H. E. Moore et Stearn	Sapotaceae	Seed	Dermal infection	6	(0.6)	Kuxamñi	Mamey
Solanum nigrum L.	Solanaceae	Leaf	Erysipela	6	(0.6)	Ts¥p¥	
Stachytarpheta jamaicensis (L.) Vahl	Verbenaceae	Leaf	Dermal infection	6	(0.6)	Chi tiuts	Verbena
Xanthosoma robustum Schott	Araceae	Leaf	Dermal infection	6	(0.6)	Pix ay	
Lasiacis ruscifolia (Kunth) Hitchc.	Gramineae	Leaf	Dermal infection	6	(0.6)	K¥kujuki ay	Carisso

Total number of species is 303; total number of use-reports is 973. The species listed represent 49% of all reported uses in this category.
[a]Percentage of use-reports contributed to the group of illness from the respective species.

contain flavanone glycosides, narirutin and rosmarinic acid (Aquino et al 1990; Mahmood et al 1993). Furthermore, the alkaloids, isopteropodine (Ripperger 1977) and ephedrine (Chaudhuri and Thakur 1991), have been isolated.

Little published information is available on *Croton draco* with respect to its usage for oral and dermal infections. An American phytopharmaceutical company studied it in detail, but its development was stopped some years ago. Hernández & Delgado (1992) reported sitosterol, stigmasterol, a mixture of polyprenols and a previously isolated clerodane-type diterpene.

Tithonia diversifolia is a now pantropically distributed noxious weed, which is relatively well-studied phytochemically and pharmacologically. The use of this species for scabies and for washing wounds can presumably be explained by the presence of sesquiterpene lactones, which are potent inhibitors of the transcription factor NF-κB (Bork et al 1997) and have antibacterial effects.

The leaves of *S. torvum* contain the sapogenins, chlorogenine and neochlorogenine (Doepke et al 1975), while the extract has antibacterial activity against Gram-negative and Gram-positive species (Ajaiyeoba 1999). The ethanolic crude extract of the leaves of the closely related *Solanum diflorum* showed strong inhibitory activity on NF-κB activation in EMSA shift experiments at a concentration of 100 μg mL^{-1}. Phaeophorbide A isolated from this species showed a dose-dependent inhibitory effect and inhibited the PMA-induced activation of NF-κB down to a concentration of 2 μg mL^{-1} (Heinrich et al 2001). The physiological relevance of this data remains to be ascertained.

Ground leaves of *Senna pendula* are used for treating abscesses. The bark of *Heliocarpus americanus* is used by both the Mixe and the Popoluca for treating wounds. There are no studies on the phytochemistry of these two species, but it seems likely that with *H. americanus*, the large amount of polysaccharides present contribute to the effect.

Table 3 Gastrointestinal disorders.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Byrsonima crassifolia (L.) Kunth	Malpighiaceae	Bark	Diarrhoea	22	(2.6)	Nanchiñ	Nanchi
Annona reticulata L.	Annonaceae	Leaf	Flatulence	21	(2.5)	Jon yatyi	Anona
Cissampelos pareira L.	Menispermaceae	Root	Dysentery	21	(2.5)	Tyiñi woyo	Redondillo
Tagetes lucida Cav.	Asteraceae	Herb	Stomach-ache	17	(2.0)		Pericon
Teloxys ambrosioides L.	Chenopodiaceae	Leaf	Parasites	17	(2.0)	Epazut	Epazote
Aristolochia sp. (*A. ovalifolia* Duch./ *A. asclepiadifolia* Brandegee)	Aristolochiaceae	Root	Stomach-ache, vomiting	16	(1.9)	Guaco	Guaco
Waltheria indica L.	Sterculiaceae	Root	Dysentery	15	(1.8)	Pun¥g ay	
Quercus oleoides Schltdl. et Cham.	Fagaceae	Bark	Diarrhoea	14	(1.7)	Pop soj	Encino
Pimenta dioica (L.) Merr.	Myrtaceae	Seed, leaf	Stomach-ache, air in the stomach, vomiting	14	(1.7)	Uk suk	Patololote
Mentha sp.	Lamiaceae	Leaf	Stomach-ache, vomiting	13	(1.6)		Menta
Psidium aff. *salutare* (Kunth) O. Berg	Myrtaceae	Root, leaf	Diarrhoea, dysentery	13	(1.6)		Itamo real
Punica granatum L.	Punicaceae	Fruitskin	Diarrhoea	13	(1.6)		Granada
Ruta sp.	Rutaceae	Leaf	Stomach-ache	13	(1.6)		Ruda
Zingiber officinale Roscoe	Zingiberaceae	Root	Stomach-ache	12	(1.4)	Kaxtxan ñiui	Genjible
Persea americana Mill.	Lauraceae	Seed	Gastritis	11	(1.3)	Cuy ty¥m	Aguacate
Psidium guajava L.	Myrtaceae	Bark	Diarrhoea	11	(1.3)	Patan	Guajava dulce
Calea ternifolia Kunth = *C. zacatechichi* Schltdl.	Asteraceae	Leaf	Stomach-ache	10	(1.2)	Tam juñi	Jaral
Croton schiedeanus Schltdl.	Euphorbiaceae	Bark	Stomach-ache, flatulence	9	(1.1)	Tam cuy	Cascarilla
Psidium guineense Sw.	Myrtaceae	Bark, root	Diarrhoea	9	(1.1)	Copa patan	Guajaba sabanera
Coccoloba barbadensis Jacq.	Polygonaceae	Bark	Diarrhoea	9	(1.1)	Pakum	Uvero
Chamaecrista flexuosa (L.) Greene var. flexuosa	Caesalpiniaceae	Root	Diarrhoea	8	(1.0)	Copa uaxiñ	Ortiga
Porophyllum ruderale (Jacq.) Cass.	Asteraceae	Leaf	Stomach-ache	8	(1.0)	Comunk¥ ts¥p¥	Papaloquelite
Croton repens Schltdl.	Euphorbiaceae	Root	Diarrhoea	8	(1.0)	Copa n¥pin cuy/ Soj kobak/Soj muk	
Spondias purpurea L.	Anacardiaceae	Bark	Diarrhoea, hepatitis	7	(0.8)		Conduria
Anethum graveolens L.	Apiaceae	Seed	Stomach-ache	7	(0.8)		Neldo
Artemisia ludoviciana Nutt.	Asteraceae	Leaf	Stomach-ache, parasites	7	(0.8)	Poma ay	Estafiate
Cinnamomum verum J. Presl.	Lauraceae	Bark	Stomach-ache	7	(0.8)		Canela
Malvaviscus arboreus Cav.	Malvaceae	Leaf	Diarrhoea	7	(0.8)	Xoun pocuy	Rompe olla
Psychotria tenuifolia Sw.	Rubiaceae	Root	Diarrhoea	7	(0.8)	Tam txix¥k	Simonillo
Vitis tiliifolia Humb. et Bonpl. ex Roem et Schult.	Vitaceae	Sap	Diarrhoea	7	(0.8)	Y¥k ty¥m tsay	Agras
Ruellia sp.	Acanthaceae	Root	Diarrhoea	6	(0.7)		
Maytenus belizensis Standl.	Celastraceae	Bark	Diarrhoea	6	(0.7)	Niui cuy	Retamo
Matricaria recutita L.	Asteraceae	Herb	Stomach-ache	6	(0.7)		Manzanilla
Hyptis verticillata Jacq.	Lamiaceae	Herb	Flatulence	6	(0.7)	Tsutsbet cuy	Hierba San Martin
Talauma mexicana (DC.) G. Don	Magnoliaceae	Seed	Gastritis	6	(0.7)	Mooyniakcuy	
Eugenia capuli (Schltdl. et Cham.) O. Berg	Myrtaceae	Bark	Diarrhoea	6	(0.7)	Cheks patan, Pop pet cuy	

Table 3 (*cont.*)

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Allium sativum L.	Liliaceae s.l.	Bulb	Flatulence, parasites, stomach-ache	6	(0.7)		Ajo
Musa sp.	Musaceae	Sap	Diarrhoea, dysentery	6	(0.7)	Joko samñi	Platano
Cocos nucifera L.	Palmae	Root	Diarrhoea	6	(0.7)	Coco	

Total number of species is 251; total number of use-reports is 830. The species listed represent 49% of all reported uses in this category.
[a]Percentage of use-reports contributed to the group of illness from the respective species.

Gastrointestinal disorders

Diarrhoea, dysentery, vomiting and stomach-ache are treated systemically with infusions, but flatulence is treated topically. The remedy for diarrhoea and dysentery is almost always astringent (bark and root), with the exception of *Cissampelos pareira* root, which is bitter. Stomach-ache and vomiting, however, are treated with aromatic and bitter herbs. Forty-one percent of all species contribute to the use-reports of this group, which accounts for 18.5% of all reports and consequently has a relatively high F_{ic} (0.70) (Table 3).

The bark of *Byrsonima crassifolia* is commonly used in the treatment of diarrhoea. It is widely used for this purpose in Mexico and is rich in tannins, as are many of the other species used for this purpose in Mexico (Heinrich 1998). Tannins of the proanthocyanidin type were reported by Geiss et al (1995). However, some of the compounds reported were also shown to have in-vitro spasmogenic activity (Bejar and Malone 1993). The extract possesses antibacterial activity against *Staphylococcus* spp., *Salmonella typhi* and other pathogenic bacteria (Martinez-Vazquez et al 1999).

Annona reticulata is not discussed here since the leaves are generally used externally in massages for "ventazon" (flatulence). *Cissampelos pareira* is rich in cytotoxic benzylisoquinoline alkaloids and exhibits antispasmodic action (Morita et al 1993). *Teloxys ambrosioides* is another well-known and widely used Mexican medicinal plant that is also used as a spice. Its main use with the Popoluca is for "expelling intestinal worms" (especially *Ascaris* spp.). The species has well-documented, but relatively weak ascaricidal properties. Its usage has been under discussion for some years because of alleged side-effects (Hegnauer 1964). The high essential oil content in *Tagetes lucida* (aerial parts) is characterized by estragole, methyleugenol and anethole (Bicchi et al 1997). The coumarine- and flavonoid-rich aqueous extract has an inhibitory effect on smooth muscle tissue in-vitro (Jayme et al 1998). This effect, and the essential oil, could be the basis for the treatment of stomach-ache. This therapy seems to be a safe and very appropriate one. Further research on the pharmacological properties of the species and its active constituents would be very important. Six *Aristolochia* species are used against stomach-ache and colics. The systemic use of *Aristolochia* species, known to contain aristolochic acids, is very problematic because of severe toxicological risks. Its reduction products are highly mutagenic and cancerogenic (Haensel et al 1999). The use of these species should be discouraged and the Mexican health authorities should launch appropriate programmes. The analgesic and spasmolytic effect could be due to the essential oil (Waller et al 1990; Sagrero-Nieves et al 1994). The root of *Waltheria indica* is used for diarrhoea with "moco" (white mucus), but no phytochemical or pharmacological information on the root is available.

Gynaecology

Thirty-six percent (218) of all species and 13% (566) of all use-reports relate to women's medicine, showing a moderate F_{ic} of 0.62 (Table 4). The preparations are taken as infusions against menstrual complaints and haemorrhage, for accelerating parturition and as an anticonceptive. Anti-abortion medicine is taken as a tea and applied topically as a cataplasm. After delivery, the woman takes a hot hipbath to calm down the inflammation. The mixtures used as a tea for regulating the menstrual cycle always contain red-coloured plant parts. If the uterus is inflamed or dislocated, a hipbath in a decoction of astringent barks is considered appropriate. Two of the most widely used species (*Matricaria recutita*

Table 4 Gynaecology.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Ormosia isthmensis Standl.	Fabaceae	Bark, seed	Haemorrhage, contraceptive	24	(4.2)	May cuy	Coral
Matricaria recutita L.	Asteraceae	Herb	Childbirth	16	(2.8)		Manzanilla
Rosmarinus officinalis L.	Lamiaceae	Leaf	Childbirth	15	(2.6)		Romero
Tradescantia spathacea Sw.	Commelinaceae	Leaf	Haemorrhage	15	(2.6)		Maguey morado
Rhynchosia pyramidalis (Lam.) Urb.	Fabaceae	Seed	Haemorrhage, contraceptive	12	(2.1)	Sinchu ixcuy	Ojo de picho
Desmodium incanum DC.	Fabaceae	Whole plant	Antiabortifacient	11	(1.9)	T¥ pitx nang tsang	Cadillo rojo
Wimmeria bartlettii Lundell	Celastraceae	Bark	Menstrual problems	9	(1.6)		Canserina
Byrsonima crassifolia (L.) Kunth	Malpighiaceae	Bark	Inflamed uterus	8	(1.4)	Nanchiñ	Nanchi
Miconia argentea (Sw.) DC.	Melastomataceae	Leaf	Childbirth	8	(1.4)	Tesua	Tescuate
Hamelia patens Jacq.	Rubiaceae	Root	Inflamed uterus	8	(1.4)	Chochoday/ Cuma ay/ Cangchocho	Coyolillo
Sickingia mexicana Bullock	Rubiaceae	Bark	Haemorrhage	8	(1.4)		Nazareno rojo
Ruta sp.	Rutaceae	Leaf	Childbirth	8	(1.4)		Ruda
Quercus oleoides Schltdl. et Cham.	Fagaceae	Bark	Inflamed uterus, haemorrhage	7	(1.2)	Pop soj	Encino
Zebrina pendula Schinzl.	Commelinaceae	Leaf	Haemorrhage	7	(1.2)	Tsabats uixpin	Hierba del pollo
Gomphrena globosa L.	Amaranthaceae	Flower	Haemorrhage	6	(1.1)	J¥pak mooya	
Mosquitoxylum jamaicense Krug et Urb.	Anacardiaceae	Bark	Haemorrhage	6	(1.1)	Se'mpe	Cedro nogal
Epiphyllum crenatum (Lindl.) Don	Cactaceae	Leaf	Antiabortifacient	6	(1.1)		
Pluchea symphytifolia (Mill.) Gillis	Asteraceae	Leaf	Haemorrhage	6	(1.1)		Salvia
Pimenta dioica (L.) Merr.	Myrtaceae	Seed, leaf	Inflamed uterus	6	(1.1)	Uk suk	Patololote
Pouteria sapota (Jacq.) H. E. Moore et Stearn	Sapotaceae	Seed, bark	Uterine descent	6	(1.1)	Kuxamñi	Mamey
Guazuma ulmifolia Lam.	Sterculiaceae	Bark	Expulse placenta	6	(1.1)	¥k¥	Guazimo
Helicteres guazumifolia Kunth	Sterculiaceae	Fruit	Determine sex of unborn	6	(1.1)	Piniaka	

Total number of species is 218; total number of use-reports is 566. The species listed represent 36% of all reported uses in this category.
[a]Percentage of use-reports contributed to the group of illness from the respective species.

and *Rosmarinus officinalis*) are of European origin and are well-known phytochemically. Both are generally considered to be safe.

Seeds and bark of *Ormosia isthmensis* are used for menstrual problems and as an antifertility agent. The genus is known to be rich in quinolizidine alkaloids and both sparteine and lupanine have been reported from the seeds (Ricker et al 1999). Sparteine is cardioactive and has oxytocic effects causing a moderate increase in the tone and strength of the uterus contraction (Bruneton 1999), which may explain its use as an antifertility agent. The juice of fresh leaves of *Tradescantia spathacea* showed a stimulant activity on mouse uterine tissue in-vitro (Weniger et al 1982), which may have some bearing on its use by the Popoluca in the treatment of menstrual cramps and haemorrhage.

Uses in illnesses associated with fever and headache

This group has the highest F_{ic} (0.71) because it contains only 18% (112) of all species and 8.5% (381) of all use-reports (Table 5). According to the Popoluca, fever and headache are symptoms of the same disease (fever normally "causes" headache) and are therefore treated in the same way. Fever as a symptom is mainly treated with a shower bath using a maceration of different fresh or "cold" leaves, supposed to cool the body. Remarkably, leaves and herbs account for 84% of the plant parts used. The concept behind this application is the humoural system with its hot/cold dichotomy. Because of the external application of most plants, we do not discuss these species in detail, the only exception being the root bark of *Securidaca diversifolia*, which is used systemically in form of a cold maceration. Cmelik & Ley (1984) isolated the known analgesic methyl salicylate from the root bark of its African relative *S. longipedunculata*, while Olajide et al (1998) showed analgesic activity of the extract in-vivo in mice.

Urological problems

In this group, 26% (157) of all species and 8% (345) of all use-reports are included, showing a relatively low F_{ic} (0.55) (Table 6). Urological complaints, such as renal calculus, gonorrhoea and pain while urinating, are commonly treated with a tea or maceration. Root/tuber (35%) or leaf/aerial part (34%) are generally used. Sour drugs are preferred for the treatment of these conditions. Vaginal infections are treated with vaginal douches using a decoction prepared from astringent barks.

Flavonol diglycosides, several other flavonoids (Da Silva et al 2000) and a steroidal saponin (Lin 1996) have been isolated from species of *Costus*. The genus *Anthurium* is known for its methylated flavones. However, there are no pharmacological data supporting the indigenous claims. Chemically, it is the most diverse genus within the Araceae (Williams et al 1981). No information is available on the root constituents of *Anthurium schlechtendalii*.

Plants to counteract bites of venomous animals

Twenty percent (121) of all species are employed against the effects of poisonous animals, whereas only 6% (260) of the use-reports are assigned to this group, resulting in a relatively low F_{ic} of 0.54 (Table 7). Snake bites are treated both systemically and topically. A steam bath with the vapour of boiling herbs is thought to extract the venom from the body. Cleaning the wound with yellow bark decoctions of *Cochlospermum vitifolium* and *Diphysa americana* (both with a yellow colour like snake venom) is said to act as an antidote. Fresh *C. vitifolium* leaves are chewed in cases of the poisoning by the black widow spider and caterpillar hairs. *Cochlospermum* spp. (rhizome) are reported to have antimalarial activity (Presber et al 1991; Benoit et al 1995), but the phytochemistry of the leaves and the cortex is poorly investigated. The toxicological risks associated with the use of *Aristolochia* species (in this case *A. ovalifolia* and *A. asclepiadifolia*), taken orally as an antidote, has already been discussed.

Culture-bound syndromes

We found a low consensus ($F_{ic} = 0.47$) in this group of plants. This appears to be typical for this group of illnesses since we found a similar situation in other cultures (see Heinrich et al 1998). Many species are recorded (21%, 127), but with relatively few use-reports (5.4%, 240) (Table 8). The ritual aspects of treatment are more important than empirical ones. Most plants in this group are employed in ritual cleansing ceremonies ("limpias"). The discussion of such rituals is beyond the scope of this paper. The rituals used in the treatment of disorders seem to be of greater relevance than the use of a specific species. *Phyllanthus* species are the only exception. They are given orally to treat "tsocoicopoya" (sadness). Diverse medical uses of the genus are known from ethnobotanical studies. A multitude of pharmacological effects of members of this genus, especially of *P. niruri*, have been reported and a large number of compounds are known, such as the antihepatotoxic compounds, phyllanthin, hypophyllanthin and triacontanal (Sayamasundar et al 1985). No pharmacological information substantiating the indigenous use is available.

Respiratory complaints

Thirteen percent (79) of all species and 5% (219) of all use-reports were assigned to this group. The F_{ic} is 0.64 (Table 9). Cough, asthma and pertussis are the most common respiratory complaints. The most frequently mentioned therapy consists of a hot and honey-sweetened infusion of aromatic plant parts or a syrup. This is a generally useful form of treatment for minor respiratory complaints. Several introduced taxa are used in this group and it is possible that respiratory complaints

Table 5 Fever and headache.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Gliricidia sepium (Jacq.) Steud.	Fabaceae s.str.	Leaf	Fever, headache	41	(10.7)	Paaki	Cocuite
Bursera simaruba (L.) Sarg.	Burseraceae	Leaf	Fever, headache	37	(9.7)	Ts¥k	Palo mulato
Spondias purpurea L.	Anacardiaceae	Leaf	Fever, headache	23	(6.0)		Conduria
Justicia spicigera Schltdl.	Acanthaceae	Leaf	Fever, headache	19	(5.0)	Chich	Pote de la tiñadora; Añil
Clerodendron ligustrinum (Jacq.) E. Br.	Verbenaceae	Leaf	Fever, headache	19	(5.0)	Muts	Moste
Tamarindus indica L.	Caesalpiniaceae	Leaf	Fever, headache, measles, chickenpox	18	(4.7)		Tamarindo
Securidaca diversifolia (L.) S. F. Blake	Polygalaceae	Root	Fever	14	(3.7)	Kipats ay	Balsamillo
Cestrum nocturnum L.	Solanaceae	Leaf	Fever, headache	13	(3.4)	Mok xoxay	Huele noche
Mecardonia procumbens (Mill.) Small	Scrophulariaceae	Leaf	Fever	11	(2.9)		Chotete
Ocimum basilicum L.	Lamiaceae	Herb	Fever, headache	10	(2.6)		Albahaca
Rosa sp.	Rosaceae	Flower	Fever, headache	8	(2.1)		Rosa concha
Bryophyllum pinnatum (Lam.) Oken	Crassulaceae	Leaf	Fever, headache	7	(1.8)		Maravilla
Iresine diffusa Humb. et Bonpl. ex Willd.	Amaranthaceae	Leaf	Fever, headache	6	(1.6)	Tsus tunuk koso	Tlan cuaya
Sambucus mexicana C. Presl ex DC.	Caprifoliaceae	Leaf	Fever, headache	6	(1.6)		Sauco
Melia azedarach L.	Meliaceae	Leaf	Fever, headache	6	(1.6)		Tarai

Total number of species is 112; total number of use-reports is 381. The species listed represent 62% of all reported uses in this category.
[a]Percentage of use-reports contributed to the group of illness from the respective species.

were less common in earlier times and that the healing concept was introduced by the Spaniards or the Mexican Mestizos.

Fractures, bruises, general body pain and rheumatic disorders (skeletal–muscular disorders)

Sixteen percent (101) of the plant taxa and 4.7% (211) of all reports referred to this group, leading to the relatively low F_{ic} (0.52) (Table 10). Bruises are often treated systemically with an infusion, whereas sprains are carefully massaged. Rheumatic complaints are treated with a cataplasm, whereas muscular pain is treated by washing the affected part with heated medicinal plants or a decoction. Sesquiterpenes, sitosterol, octacosanol and oleanonic acid are reported from the bark of *Cedrela odorata* (Campos et al 1991), but the available literature does not allow conclusions on the appropriateness of the indigenous usage.

Problems of the ear, eye and toothache

This group shows a low intracultural consensus, which can be explained, at least in part, by the few use-reports gathered (Table 11). Aching ears and inflamed inner ears are treated with heated leaf juice introduced onto or into the ear. *Plectranthus amboinicus* is the most frequently cited species and a native of South Africa, but is now found in home gardens in many regions of Mexico and Central America. Its ethnobotanical uses on this continent are not very well known (perhaps because it has been rarely identified botanically, as it flowers only irregularly). The Popoluca heat a succulent leaf on the ''comal'' (a large plate made out of clay and used on the fire in the preparation of tortillas) and the warm sap is squeezed into the aching ear. The essential oil, with δ-3-carene, carvacrol, camphor and γ-terpinene as main components (Vera et al 1993), has antibacterial and fungicidal activity (Prudent et al 1995).

The sap of astringent plants is applied into the eye in order to clean the retina. *Croton repens*, which is most

Table 6 Urological problems.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Costus sp. (*C. pictus* D. Don/ *C. pulverulentus* C. Persl)	Zingiberaceae	Stalk, root	Pain while urinating, gonorrhoea	23	(6.6)	Chimpa tutu	Caña agria
Anthurium schlechtendalii Kunth	Araceae	Root	Renal calculus, renal pain	17	(4.9)	Tsa ay	Raiz de piedra
Begonia heracleifolia Schltdl. et Cham.	Begoniaceae	Stalk	Pain while urinating, renal pain	14	(4.0)	Leon k¥, Katxu kanapoki	Mano de leon, Caña agria
Smilax domingensis Willd.	Smilacaceae	Tuber	Gonorrhoea, renal pain	13	(3.8)	Mom	Axquiote; Guatotole
Arthrostemma ciliatum Pav. ex D. Don	Melastomataceae	Herb	Pain while urinating	12	(3.5)	Katxu kanapoki	Caña agria quadrata
Byrsonima crassifolia (L.) Kunth	Malpighiaceae	Bark	Vaginal infection	9	(2.6)	Nanchiñ	Nanchi
Cnidoscolus liebmannii (Müll. Arg) Lundell	Euphorbiaceae	Root	Vaginal infection	6	(1.7)	Kenuk	Chichicastle
Quercus oleoides Schltdl. et Cham.	Fagaceae	Bark	Vaginal infection	6	(1.7)	Pop soj	Encino
Tradescantia spathacea Sw.	Commelinaceae	Leaf	Pain while urinating, renal pain	6	(1.7)		Maguey morado

Total number of species is 157; total number of use-reports is 345. The species listed represent 31% of all reported uses in this category.
[a]Percentage of use-reports contributed to the group of illness from the respective species.

Table 7 Plants to counteract bites of venomous animals.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Cochlospermum vitifolium (Willd.) Spreng.	Cochlospermaceae	Leaf	Snake bite, Black widow, caterpillar hair irritation	18	(6.9)	Puts cuy	Pongolote
Aristolochia sp. (*A. ovalifolia* Duch/*A. asclepiadifolia* Brandegee)	Aristolochiaceae	Vine, root	Snake bite	18	(6.9)	Guaco	Guaco
Muntingia calabura L.	Elaeocarpaceae	Bark	Black widow	14	(5.4)	Capuli	Capulin
Cissampelos pareira L.	Menispermaceae	Root	Snake bite	8	(3.1)	Tyiñi woyo	Redondillo
Diphysa americana (Mill.) M. Sousa	Fabaceae s.str.	Bark	Snake bite	6	(2.3)	Tsus cuy	Chipile
Simaba cedron Planch.	Simarubaceae	Seed	Snake bite	6	(2.3)		Cedrón

Total number of species is 121; total number of use-reports is 260. The species listed represent 27% of all reported uses in this category.
[a]Percentage of use-reports contributed to the group of illness from the respective species.

frequently used, has not yet been studied phytochemically and there are no data to support the indigenous claims. Although the genus *Croton* is well known for its irritant diterpene-esters, the Popoluca do not report irritant effects.

Toothache is treated with fresh plant sap on cotton, administered topically, or by chewing parts of fresh roots. Some of these saps are said to break the aching tooth in part. *Acmella radicans* (= *Spilanthes ocymifolia*) roots and leaves are used. The same species is also known as a popular Salvadoranian folk remedy against toothache and contains *N*-2-phenylethylcinnamamide, which is a pungent olefinic alkamide with insecticidal and mucuous membrane anaesthetic properties (Borges

Table 8 Culture-bound syndromes.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Phyllanthus spp. (*P. niruri* L. & *Phyllanthus* sp.)	Euphorbiaceae	Herb	Sadness	19	(7.9)	AntuñikY ay	
Amphitecna tuxtlensis A. H. Gentry	Bignoniaceae	Fruit	Wood ghost	9	(3.7)	Makti jeepe	Jicara del duende
Hyptis verticillata Jacq.	Lamiaceae	Herb	Bad spirits, heat of death	9	(3.7)	Tsutsbet cuy	Hierba San Martin
Mimosa pudica L.	Mimosaceae	Whole plant	Crying child, insomnia	9	(3.7)	Mong mong ay	Dormilona
Cecropia obtusifolia Bertol.	Cecropiaceae	Leaf	Bad spirits	8	(3.3)	Mats	Chancarro
Plumeria rubra L.	Apocynaceae	Flower	Love in vain, shame, love heat	7	(2.9)	Puutx mooya	
Ocimum basilicum L.	Lamiaceae	Herb	Bad spirits	6	(2.5)		Albahaca
Biophytum dendroides (Kunth) DC.	Oxalidaceae	Whole plant	Sadness	6	(2.5)	Coco ay	Palmita
Polygala paniculata L.	Polygalaceae	Whole plant	Crying child	6	(2.5)	Uehi ay	

Total number of species is 127; total number of use-reports is 240. The species listed represent 33% of all reported uses in this category.
[a]Percentage of use-reports contributed to the group of illness from the respective species.

Table 9 Respiratory complaints.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Bougainvillea sp.	Nyctaginaceae	Flower	Cough, pertussis, asthma	12	(5.4)		Bugambilia
Eucalyptus sp.	Myrtaceae	Leaf	Cough	11	(5.0)		Eucalipto
Pityrogramma calomelanos (L.) Link	Adiantaceae	Leaf	Cough, pertussis	10	(4.5)	Y¥k chimal	
Hibiscus rosa-sinensis L.	Malvaceae	Flower	Cough	10	(4.5)		Tulipan
Artemisia ludoviciana Nutt.	Asteraceae	Leaf	Cough	9	(4.1)	Poma ay	Estafiate
Gnaphalium attenuatum DC.	Asteraceae	Leaf	Cough	8	(3.6)	Poma ay cimarrón	Gordolobo
Cinnamomum verum J. Presl.	Lauraceae	Bark	Cough	7	(3.2)		Canela
Allium sativum L.	Liliaceae	Bulb	Cough	7	(3.2)		Ajo
Calea ternifolia Kunth = *C. zacatechichi* Schltdl.	Asteraceae	Leaf	Cough	6	(2.7)	Tam juñi	Jaral
Citrus aurantium L.	Rutaceae	Fruitskin, leaf	Cough	6	(2.7)	Tsootso	Naranja
Lantana camara L.	Verbenaceae	Leaf	Cough	6	(2.7)	Kanmuk	Cinco negritos

Total number of species is 79; total number of use-reports is 219. The species listed represent 42% of all reported uses in this category.
[a]Percentage of use-reports contributed to the group of illness from the respective species.

del Castillo et al 1984; Hegnauer 1989; Molinatorres et al 1996).

Conclusion

This study is the first ethnopharmaceutical study on the Popoluca. It uses an interdisciplinary method combining pharmacognosy/botany, anthropology and (ethno-) pharmacology.

The selection of plants within the ethnopharmacopoeia of the Popoluca is based on a systematic selection of plants as medicines using culture-specific concepts (e.g. taste and smell properties, hot and cold dichotomy), which have been discussed, in part, in this

Table 10 Skeleto–muscular disorders.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
Cedrela odorata L.	Meliaceae	Bark	Bruise, effusion of blood	13	(6.1)	Acuy	Cedro
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	Leaf	Rheuma, bruise, bodypain	6	(2.8)	Tam chich	Arnica
Dioscorea floribunda M. Martens et Galeotti	Dioscoreaceae	Root	Rheuma, bruise	6	(2.8)	Puutx naaku	Barbasco amarillo

Total number of species is 101; total number of use-reports is 211. The species listed represent 12% of all reported uses in this category. [a]Percentage of use-reports contributed to the group of illness from the respective species.

Table 11 Species used for problems of the ear, problems of the eye and against toothache.

Plant species	Family	Plant part used	Main use(s)	Use-reports	%[a]	Popoluca name	Spanish name
(a) Problems of the ear							
Plectranthus amboinicus (Lour.) Spreng	Lamiaceae	Leaf	Earache	12	(16.9)		Oregano
Vernonia deppeana Less.	Asteraceae	Leaf	Earache	11	(15.5)	Ux cuy	
(b) Problems of the eye							
Croton repens Schltdl.	Euphorbiaceae	Sap	Retina complication	7	(13.2)	Copa n¥pin cuy/ Soj kobak/ Soj muk	
(c) Toothache							
Acmella radicans (Jacq.) R. K. Jansen	Asteraceae	Root, leaf	Toothache	9	(16.4)	Niui sotyi	
Solanum sp. (*S. rudepannum* Dunal/*S. torvum* Sw.)	Solanaceae	Root	Toothache	6	(10.9)	Muutsei cuy	Berenjena

Total number of species is (a) 33, (b) 29, (c) 32; total number of use-reports is (a) 71, (b) 53, (c) 53. The species listed represent (a) 32%, (b) 13%, (c) 28% of all reported uses in the respective category. [a]Percentage of use-reports contributed to the group of illness from the respective species.

paper. The application of astringent teas for the treatment of diarrhoea and the use of bitter and aromatic teas in the case of stomach-ache has previously been reported by our group in other cultures (Brett and Heinrich 1998). This example points to common selection criteria, which seem to be a Pan-Mesoamerican tradition. For many taxa, our analysis of phytochemical and pharmacological data provides some rationale for the usage of the plants by the Popoluca. This analysis also points to important gaps in our knowledge about bioactive constituents of the species used, but the lack of pharmacological or phytochemcial data on a certain species should not be interpreted as proof of a lack of activity. Of particular toxicological concern with respect to indigenous medicinal plants are taxa that do not have noticeable toxic effects in the short-term, but which produce such effects after prolonged exposure. Plants containing pyrrolizidine alkaloids or aristolochic acid are common examples. Our analysis provides a scientific basis for programmes aimed at reducing the frequency of use of such species.

The data presented here are the basis for a series of further studies, which will look at specific details of the medicinal plant usage of the Popoluca, including:

- a pharmacological screening of the plants collected in the regions against a variety of targets and subsequent phytochemical studies,
- a comparison with the use of medicinal plants of the linguistically closely related Mixe (Heinrich 1989),
- an analysis of the criteria for selecting species as medicinal

plants. Although there are about 3000 plant species known in the region, only about 500 are culturally important as medicinal plants. The strategies used by the Popoluca to select these species will be analysed.

As proposed recently, the concept of ethnopharmacology is specifically relevant with respect to further developing indigenous ethnopharmacopoeias. In this study, we demonstrate the breadth of the ethnopharmacology approach to medicinal plants and point to its potential as a basis for further studies, not just in natural products research combining pharmacology and pharmacognosy, but also with respect to anthropological aspects of the study of indigenous medicinal plants. Finally, these data should also serve as a basis for biodiversity conservation and community development.

References

Aguilar, A., Camacho, J. R., Chino, S., Jáquez, P., López, M. E. (1994) *Herbario Medicinal del Instituto Mexicano del Seguro Social*. Instituto Mexicano del Seguro Social, México D. F.

Ajaiyeoba, E. O. (1999) Comparative phytochemical and antimicrobal studies of *Solanum macrocarpum* and *Solanum torvum* leaves. *Fitoterapia* **70**: 184–186

Ankli, A., Sticher, O., Heinrich, M. (1999) Medical ethnobotany of the Yucatec Maya: healers' consensus as a quantitative criterion. *Econ. Botany* **53**: 144–160

Aquino, R., Ciavatta, M. L., De Simone, F., Pizza, C. (1990) A flavonone glycoside from *Hamelia patens*. *Phytochemistry* **29**: 2358–2360

Argueta, V. A., Lano Asseleik, L. M., Rodarte, M. E. (1994) *Atlas de las plantas de la medicina tradicional Mexicana*. México D. F. Instituto Nacional Indigenista, México D. F.

Báez-Jorge, F. (1973) *Los Zoque-Popolucas. Estructura social* (2 edn). Dirección General de Publicaciones del Consejo Nacional para Cultura y las Artes/Instituto Nacional Indigenista, México D. F.

Bejar, E., Malone, M. H. (1993) Pharmacological and chemical screening of *Byrsonima crassifolia*, a medicinal tree from Mexico. Part I. *J. Ethnopharmacol.* **39**: 141–158

Benoit, F., Valentin, A., Pelissier, Y., Marion, C., Dakuyo, Z., Mallie, M., Bastide, J. M. (1995) Antimalarial activity *in vitro* of *Cochlospermum tinctorium* tubercle extracts. *Trans. R. Soc. Trop. Med. Hyg.* **89**: 217–218

Bicchi, C. Fresia, M., Rubiolo, P., Monti, D., Franz, C., Goehler, I. (1997) Constituents of *Tagetes lucida* Cav. ssp. *lucida* essential oil. *Flav. Frag. J.* **12**: 47–52

Borges del Castillo, J., Vasquez-Bueno, P., Secundino-Lucas, M., Martinez-Martir, A. I., Joseph-Nathan, P. (1984) The *N*-2-phenylethylcinnamamide from *Spilanthes ocymifolia*. *Phytochemistry* **23**: 2671–2672

Bork, P. M., Schmitz, M. L., Kuhnt, M., Escher, C., Heinrich, M. (1997) Sesquiterpene lactone containing Mexican Indian medicinal plants and pure sesquiterpene lactones as potent inhibitors of transcription factor κB (NF-κB). *FEBS Lett.* **402**: 85–90

Brett, A. J., Heinrich, M. (1998) Culture, perception an the environment: the role of chemosensory. *Angew. Botanik* **72**: 67–69

Bruneton, J. (1999) *Pharmacognosy, phytochemistry, medicinal plants* (2nd edn) Lavoisier, Paris

Campos, A. M., Oliveira, F. S., Machado, M. I. L., Braz-Filho, R., Matos, F. J. A. (1991) Triterpenes from *Cedrela odorata*. *Phytochemistry* **30**: 1225–1229

Challanger, A. (1998) *Utilización y conservación de los ecosistemas terrestres de México, pasado, presente y futuro*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México D. F.

Chaudhuri, P. K., Thakur, R. S. (1991) *Hamelia patens*: a new source of ephedrine. *Planta Med.* **57**: 199

Chevalier, J. M., Buckles D. (1995) *A Land without gods: process theory, maldevelopment and the Mexican Nahuas*. Zed Books, London

Cmelik, S. H. W., Ley, H. (1984) Some constituents from the root bark of the African violet tree (*Securidaca longipedunculata* Fres.) *Trans. Zimbabwe Sci. Assoc.* **62**: 28–32

Da Silva, B. P., Bernardo, R. R., Parente J. P. (2000) Flavonol glycosides from *Costus spicatus*. *Phytochemistry* **53**: 87–92

Doepke, W., Nogueiras, C., Hess, U. (1975) Ueber den steroid-alkaloid- und sapogeningehalt von *Solanum torvum*. *Pharmazie* **30**: 755

Elson, B. F., Gutiérrez, D. G. (1999) *Diccionario Popoluca de la Sierra Veracruz. Serie de vocabularios y diccionarios indígenas "Mariano Silva y Aceves"* 41. Instituto Ligüistico de Verano, A. C. México D. F.

Foster, G. M. (1951) Some wider implications of soul-loss illness among the Sierra Popoluca. In: *Homenaje al Doctor Alfonso Caso*. Sociedad Mexicana de Antropología, México D. F., pp 167–174

Foster, G. M. (1969) The Mixe, Zoque, Popoluca. In: Vogt, E. (ed.) *Handbook of Middle American Indians*. Vol. 7. *Ethnology*, Part 1. University of Texas Press, Austin, pp 448–477

Geiss, F., Heinrich, M., Hunkler, D., Rimpler, H. (1995) Proanthocyanidins with (+)-epicatechin units from *Byrsonima crassifolia* bark. *Phytochemistry* **39**: 635–643

Haensel, R., Sticher, O., Steinegger, E. (1999) *Pharmakognosie – Phytopharmazie*. (6th edn). Springer, Berlin-Heidelberg

Hegnauer, R. (1964) *Chemotaxonomie der Pflanzen* 3. Eine uebersicht über die verbreitung und di systematische Bedeutung der Pflanzenstoffe. Birkhaeuser, Basel, Stuttgart

Hegnauer, R. (1989) Chemotaxonomie der Pflanzen 8. Eine Uebersicht über die verbreitung und die systematische Bedeutung der Pflanzenstoffe. Birkhaeuserverlag, Basel, Boston

Heinrich, M. (1989) *Ethnobotanik der Tieflandmixe* (*Oaxaca, Mexiko*) *und Phytochemische Untersuchungen von* Capraria biflora L. (*Scrophulariaceae*). Dissertationes Botanicae 144. J. Cramer, Berlin, Stuttgart

Heinrich, M. (1997) Herbal and symbolic forms of treatment in the medicine of the lowland Mixe (Oaxaca, Mexico). In: Romanucci-Ross, L., Moerman, D. E., Tancredi, L. R. (eds) *The Anthropology of medicine*. 3rd edn. Bergin and Garvey, Westport, Connecticut, London, pp 71–95

Heinrich, M. (1998) Indigenous concepts of medicinal plants in Oaxaca, Mexico: lowland Mixe plants classification based on organoleptic characteristics. *Angew. Botanik* **72**: 75–81

Heinrich, M. (2000) Ethnobotany and its role in drug development. *Phytother. Res* **14**: 479–488

Heinrich, M., Gibbons S. (2001) Ethnopharmacology in drug discovery: an analysis of its role and potential contribution. *J. Pharm. Pharmacol.* **53**: 425–432

Heinrich, M., Ankli, A., Frei, B., Weimann, C., Sticher, O. (1998) Medical plants in Mexico: healers' consensus and cultural importance. *Soc. Sci. Med.* **47**: 1863–1875

Heinrich, M., Bork, P. M., Schmitz, M. L., Rimpler, H., Frei, B., Sticher, O. (2001) Phaeophorbide A from *Solanum diflorum* interferes with NF-κB activation. *Planta Med.* **67**: 156–157

Hernandez, J., Delgado, G. (1992) Terpenoids from aerial parts of *Croton draco*. *Fitoterapia* **63**: 377–378

Hernández-Cruz, B. (1994) *Nuntajïyï' Lengua Popoluca*, *Veracruz*. *Primer ciclo*, *Parte II*. Secretaría de Educación Pública. Formal S. A. México D. F.

Hernández-Cruz, B. (1995) *Nuntajïyï' Lengua Popoluca*, *Veracruz*. *Primer ciclo*, *Parte I*. *Secretaría de Educación Pública*. Formal S. A. México D. F.

Jayme, V., Cortes, A. R., Aoki, K. (1998) Effect on rat uterus contractility of *Tagetes lucida* Cav. leaf extracts. *Phyton* (Buenos Aires) **62**: 161–165

Jimenez Misas, C. A., Rojas Hernandez, N. M., Lopez Abraham, A. M. (1979) Contribucíon a la evaluación de plantas Cubanas. VI. *Rev. Cubana Med. Trop.* **31**: 45–51

Lin, R. C., Hanquet, B., Lacaille-Dubois M. A. (1996) Aferoside A, a steroidal saponin from *Costus afer*. *Phytochemistry* **43**: 665–668

Mahmood, N., Pizza, C., Aquino, R., De Tommasi, N., Piacente, S., Colman, S., Burke, A., Hay, A. J. (1993) Inhibitory HIV infection by flavanoids. *Antiviral Res.* **22**: 189–199

Martinez-Vazquez, M., Gonzalez-Esquinca A. R., Cazares Luna, L., Moreno Gutierrez M. N., Garcia-Argaez A. N. (1999) Antimicrobal activity of *Byrsonima crassifolia* (L.) H. B. K. *J. Ethnopharmacol.* **66**: 79–82

Moerman, D. E., Pemberton, R. W., Kiefer, D., Berlin, B. (1999) A comparative analysis of five medicinal floras. *J. Ethnobiol.* **19**: 49–67

Molinatorres, J., Salgado-Garcia, R., Ramirez-Chavez, E., Del Rio Rosa, E. (1996) Purely olefinic alkamides in *Heliopsis longipes* and *Acmella* (*Spilanthes*) *oppositifolia*. *Biochem. Syst. Ecol.* **24**: 43–47

Morita, H., Matsumoto, K., Takeya, K., Itokawa, H. (1993) Azafluoranthene alkaloids from *Cissampelos pareira*. *Chem. Pharm. Bull.* **41**: 1307–1308

Olajide, O. A., Awe, S. O., Makinde, J. M. (1998) Pharmacological screening of the root extract of *Securidaca longipedunculata*. *Fitoterapia* **69**: 245–248

Ortiz de Montellano, B. (1975) Empirical Aztec medicine. *Science* **188**: 215–220

Presber, W., Herrmann D. K., Hegenscheid, B. (1991) Wirkung eines extraktes aus *Cochlospermum angolense* (''Burututu'') auf *Plasmodium berghei* im mausemalaria-suppressionstest. *Angew. Parasitol.* **32**: 7–9

Prudent, D., Perineau, F., Bessiere, J. M., Michel, G. M., Baccou, J. C. (1995) Analysis of the essential oil of wild oregano from Martinique (*Coleus aromaticus* Benth.) – evaluation of its bacteriostatic and fungistatic properties. *J. Essent. Oil Res.* **7**: 165–173

Ramirez-Ramirez, F. (1999) *Flora y vegetación de la Sierra de Santa Marta*, *Veracruz*. PhD Thesis, Facultad de Ciencias, Universidad Nacional Autónoma de México, México D. F.

Ricker, M., Daly, D. C., Veen, G., Robbins, E. F., Sinta, M. V., Chota, J. I., Cyzgan, F. C., Kinghorn, A. D. (1999) Distribution of quinolizidine alkaloid types in nine *Ormosia* species (Leguminosae-Papilionideae). *Brittonia* **51**: 34–43

Ripperger, H. (1977) Isolierung von isoteropodin aus *Hamelia patens*. *Pharmazie* **32**: 415–416

Sagrero-Nieves, L., Bartley, J. P., Provis-Schwede, A. (1994) Essential oils of the leaves from *Aristolochia ovalifolia* Duch. *J. Essent. Oil Res.* **6**: 189–190

Sayamasundar, K. V., Singh, B., Thakur, R. S. (1985) Anti-hepatotoxic principles of *Phyllanthus niruri* herbs. *J. Ethnopharmacol.* **14**: 41–44

Schlage, C., Mabula, C., Mahunnah, R. L. A., Heinrich, M. (2000) Medicinal plants of the Washambaa (Tanzania): documentation and ethnopharmacological evaluation. *Plant Biol.* **2**: 83–92

Trotter, R. T., Logan, M. H. (1986) Informant consensus: a new approach for identifying potentially effective medicinal plants. In: Etkin, N. L. (ed.) *Plants in indigenous medicine and diet*, *behavioural approaches*. Redgrave Publishing Company, Bredford Hills, New York, pp 91–112

Vera, R., Mondon, J. M., Pieribattesti, J. C. (1993) Chemical composition of the essential oil and aqueous extract of *Plectranthus amboinicus*. *Planta Med.* **59**: 182–183

Waller, G. R., Sagrero-Nieves, L., Sgaramella, R. P. (1990) Composition of the essential oil from *Aristolochia asclepiadifolia* (Aristolochiaceae) roots. In: Bhattacgaryya, S. C., Sen, N., Sethi, K. L. (eds) *Proceedings of the 11th International Congress of Essential Oils, Fragrances and Flavours*. Vol. 4 *Chemistry – Analysis and Structure*. Aspect Publishing, London, pp 79–81

Weniger, B., Haag-Berrurier, M., Anton, R. (1982) Plants of Haiti used as antifertility agents. *J. Ethnopharmacol.* **6**: 67–84

Williams, C. A., Harborne, J. B., Mayo, S. J. (1981) Anthocyanin pigments and leaf flavonoids in the family Araceae. *Phytochemistry* **20**: 217–223