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THE REASON FOR ETHNOBOTANICAL CONSERVATION

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Nunc vos potentes omnes herbas deprecor,
exoro maiestatem vestrum, quas parens
tellus generavit et cunctis dono dedit.

A Roman prayer to all herbs

In the few parts of the world still not affected by fast encroaching civilization, there exists a wealth of information on the properties of plants that is still available to us. It will not long be there for us to salvage. It has been built up by peoples in primitive societies over millennia by trial and error, for they have had to rely on their ambient vegetation for their foods, medicines and all the other necessities of life (23).

When our civilization arrives with roads, missionary activities, commercial interests, tourism or otherwise, the products of our culture are rapidly adopted and, often even in one generation, replace what has for hundreds of years been a part of their culture. This erosion of native ethnobotanical knowledge and use is nowhere more rapid than in the realm of biodynamic plants-medicinal, narcotic and toxic species (28).

There have long been two strongly divergent poles in our evaluation of the worth of ethnobotanical studies. Many investigators have been carried away with enthusiasm that native peoples have had some special intuition that permitted them to seek out "nature's secrets." Others have cast aside or denigrated all native folk lore as not worthy of serious scientific attention. Naturally, both points of view are extreme and are unwarrented.

Recently, the realization that the aboriginal knowledge of plant properties is of both academic and practical value has matured. And various investigators in sundry fields have recognized the need to save native plant lore before it is entombed with the culture that gave it birth (2, 7).

The Brazilian chemist, Otto Gottlieb, for example, wrote: "Since Indians in the Amazon are often the only ones who know both the properties of the forest species and how they can best be utilized, their knowledge must be considered an essential component of all efforts to conserve and develop the Amazon" (6).

Davies wrote similarly: "The tragedy is that the Indian is one of the main keys to the successful occupation of the Amazon and as he disappears his vast wealth of knowledge goes with him" (3).

Interest in ethnobotany goes beyond

these and other similar statements. The Society for Economic Botany and its journal *Economic Botany* have become increasingly more dedicated to ethnobotany. The Society for Ethnobiology has recently been established and is publishing its own journal. The highly successful *Journal of Ethnopharmacology*, now only in its 15th volume, enjoys worldwide circulation. Europe has several publications specializing in the study of medicinal plants used in native pharmacopoeias. Some Governments-especially Mexico, China and India — are fostering the scientific study of native remedies. The newly organized Society of Ethnobotanists of India has just published a most useful *World Directory of Ethnobotanists*, an up-dating of a *Directory of Ethnobotanists* produced in 1976 by the Ethnobotanical Laboratory of the University of Ann Arbor; the number listed has increased from 150 to 490. Various congresses, meetings and symposia are including sections devoted to ethnobotany. Under the sponsorship of the plant Survival Commission of the prestigious International Union for Conservation of Nature and Natural Resources and the World Wildlife Fund U.S., the Botanical Museum of Harvard University has set up a subgroup on Ethnobotanical Conservation, the purposes of which are to knit together specialists in the many disciplines associated with ethnobotany on a wildlife basis and especially to encourage the conservation of ethnobotanical information in imminent danger of extinction.

Any denigration of native folk medicine is not supported by the contents of western pharmacopoeias nor by the history of some of the most recently discovered drugs from the Plant Kingdom that have revolutionized the practice of modern medicine: the curare alkaloids; penicillin and the many other antibiotics; cortisone and the steroids; reserpine; vincoleucoblastine; the *Veratrum*-alkaloids; podophyllotoxin; strophanthine; physostigmine; and other new therapeutic or research agents (27, 32).

Nor is this denigration supported by chemical and pharmacological investigations of native medicinal plants under current study. One excellent example is the statistical analysis of 25 medicinal plants employed by the Aztecs. Twenty-five have been shown pharmacologically to produce the effects that the Aztecs claimed; four possibly could have the properties reported by the Indians; five-only 20% — seem unable to induce the physiological activities attributed to them in the native medicine (11). A further example is the recent ethnopharmacological analysis of the loganiaceous genus *Buddeja*: a high degree of correlation exists between the wide spectrum of native medicinal uses and what is known of the chemical composition of this genus of 100 species of the tropics and subtropics of both hemispheres (9). Similar correlations in the few groups of plants that have been ethnobotanically studied can be cited.

It is clear that modern science can no longer afford to ignore reports of any aboriginal uses of plants simply because they seem to fall beyond the limits of our credence. On the contrary, these uses should stimulate examination under the impartial searchlight of modern scientific analysis.

Several plant explorers of the past century-von Martius and Spruce, for example, were of the opinion that the Indians of the Amazon utilized a limited vegetal pharmacopoeia (10, 33). In his field notes on *paricá* — the hallucinogenic snuff prepared from *Anadenanthera peregrina* — Spruce wrote: "Throughout the Uaupés, this is almost the sole medicinal agent employed.....I have never known any other remedies applied except occasionally the milk of some tree (and they are not particular as to the species) by

Pourouma ceropiaefolia of the Moraceae. This is one of the fruit trees of the westernmost Amazon that deserves to be introduced into general cultivation in the humid tropics as the source of a delicious fruit. The Maku tribe c the Colombian Vaupés employ the bark as a contraceptive, asserting that its effects cause permanent sterility

Native boy preparing poisoned darts with curare made from *Chondrodendron* on the Río Miritiparaná, Colombian Amazon

Philodendron dyscarpium, employed as a contraceptive in the Vaupes are a of the Amazon of Colombia.

Kamsa medicine man at Sibundoy in the Andes Mountains of southern Colombia (9000 feet altitude). He uses preparations made of solanaceous plants (especially Brugmansia and Methysticodendron spp.) in his diagnosis and treatment of disease.

way of plasters in the case of some wound or internal pain." In another context, Spruce reported: "Among the native tribes of the Uaupés and of the upper tributaries of the Orinoco, niopo or paricá is the chief curative agent" (33).

Von Martius had the same opinion as Spruce. He wrote: "....of external applications, I have seen only the following. For a wound or bruise or swelling, the milky juice of some tree is spread thick on the skin where it hardens into a sort of plaster and is allowed to remain on until it falls of itself. Almost any milky tree may serve, if the juice be not acrid; but the Heveas (India-rubbers), Sapotads and some Clusias are preferred. Such a plaster has sometimes an excellent effect in protecting the injured part from the external air" (11).

It is not easy to reconcile this opinion of one of the greatest of field botanists who spent five years in the northwest Amazon with my own observations over the past 40 years amongst numerous tribes of the same region. There are, however, several possible reasons. The Indians recognize in general two "kinds" of medicines: those with purely physical effects — and these are known and used by members of the tribe who might be called regular practioners or the ethnopharmacologists of the tribe who do not resort to magic or superstition but whopossess a wide knowledge of the flora and the properties of a great number of species; and the plants with psychic effects — usually the hallucinogens, which are considered to be sacred and which the medicine-man or payé manipulates. Spruce himself stated: "I have never been so fortunate as to see a genuine payé at work.....With the native and still unchristianized tribes I have for the most part held only passing intercourse during some of my voyages. Once I lived for seven months at a time among them on the river Uaupés, but even there I failed to catch a payé. When I was exploring the Jaguarato cataracts.....news came that a famous payé.....would arrive that night and remain until next day; and I congratulated myself on so fine a chance of getting to know some of the secrets of his 'medicine' He did not reach the port until 10 p.m., and when he learned that there was a white payé (meaning myself) in the village, he and his attendants immediately threw back into the canoe his goods....and resumed their dangerous voyage....in the night-time. I was told he had with him several palm-leaf boxes containing his apparatus....I could only regret that his dread of a supposed rival had prevented the interview which to me would have been full of interest; the more so since I was prepared to barter with him for the whole of his materia medica, if my stock-in-trade would have sufficed" (33). Spruce, like most botanists engaged in making general collections of the flora, probably could not devote much attention to time-consuming ethnobotanical research, and in view of his incomparably complete collections of that strongly endemic flora, science is the richer because he spent most of his efforts in floristic botanizing.

For fourteen years — 1941 to 1954 — I was able to live permanently in the northwest Amazon, and I have briefly visited the same region almost annually since 1954, making a total of 24,000 plant collections. Of these, there are notes on the aboriginal uses as medicines, narcotics and poisons of nearly 2000 species. Certainly many uses escaped my attention and will be discovered by future investigators, if they can in some way beat the rapidly advancing acculturation and loss of native plant lore. I have also incorporated reports of plant uses from this region collected by some of my students and colleagues and from herbarium reports.

The flora of the Amazon is extensive — with probably some 80,000 species. One expert has estimated that nothing is known

about the chemical composition of 99.6% of the Amazon's flora (6). Certainly almost all of the biodynamic species for which I have notes have never been chemically analyzed. Some of the uses maybe of little or no practical value, but for many it is possible to see or appreciate their physiological effectiveness. Few may actually be curative, but an appreciable number probably are alleviative. Whatever the case may be, if a plant has any physical activity, it indicates the presence of at least one active chemical constituent. We should know what these constituents are: they may not be of any value in our western pharmacopoeias; they may find wholly different uses in our technology; a few may yield drugs for modern medicine to treat the same conditions for which they are applied in primitive societies. And many species hold promise of the discovery of new chemical compounds, for it is now realized that unstudied tropical flora as rich as that of the Amazon represents a vast emporium of unknown chemical compounds awaiting discovery (32).

What can we say about some of the interesting and promising biodynamic plants of only the northwest Amazon ? Included now in my ethnopharmacological notes and those of several of my students and colleagues are at least 32 species the uses of which suggest possible cardiovascular activity; 90 are involved as probable major ingredients of arrow poisons; 27 seem to be insecticidal or insect-repellent; 57 are employed for their ichthyotoxic properties; four are valued as presumed oral contraceptives; more than 85 are taken as vermifuges; over 100 are believed to be febrifuges; a few are styptics; two dozen are applied to clean or hasten the healing of infected sores and wounds; five or six, it is claimed, relieve conjunctivitis; six are said to be stimulants; 11 are esteemed as hallucinogens or narcotics: and so the list could continue.

It is probable that there are few regions in the world where the indigenous populations possess a fuller acquaintance with the properties of their plants. The region is sparsely populated by numerous tribes of very diverse origins, cultures, languages and methods of using bioactive plants. Until recently the area has been by nature isolated and protected from external penetration, since rapids and waterfalls have rendered navigation impossible. Furthermore, the region is floristically the most variable and the richest in the Amazon Valley. All of these factors have tended to contribute towards the extreme ethnopharmacological wealth of the northwestern sector of the hylea.

The appreciation and utilization of plants for medicinal purposes, however, varies significantly from tribe to tribe. Some — the Colombian Sionas, Kofáns, Witotos, Boras, Yukunas, Tanimukas, Kubeos, Tukanos, Barasanas, Mukunas, Kuripakos, Puinaves and certain tribes of Makús, for example, have rich pharmacopoeias. Other groups — the Waoranis of Ecuador, living in the same species-rich forests — have a dearth of plants therapeutically employed: intensive research indicates that they use only 35 species, 30 of which are valued in treating only six conditions (4); while their neighbours, the Kofáns, have at least 80 species for 27 different ailments (12)

An interesting and possibly significant aspect of the medicinally used plants in the northwest Amazon is their employment most commonly as simples: only rarely are two or more species mixed for therapeutic use — quite in contrast to the usual situation in the preparation of curares.

Peoples on every continent have learned to tip their arrows or darts with poisonous preparations, derived mainly from plants. In number of species so employed, South America is the centre for the use of arrow poisons or curares. And in diversity of ingredients, it appears that the north-

Virola theiodora of the Myristicaceae. In the western Amazon, an hallucinogenic snuff or pills are prepared and employed in magico-religious ceremonies; the resin-like bark exudate is used as an antifungal medicine and as an arrow poison. Manaos, Brazil.

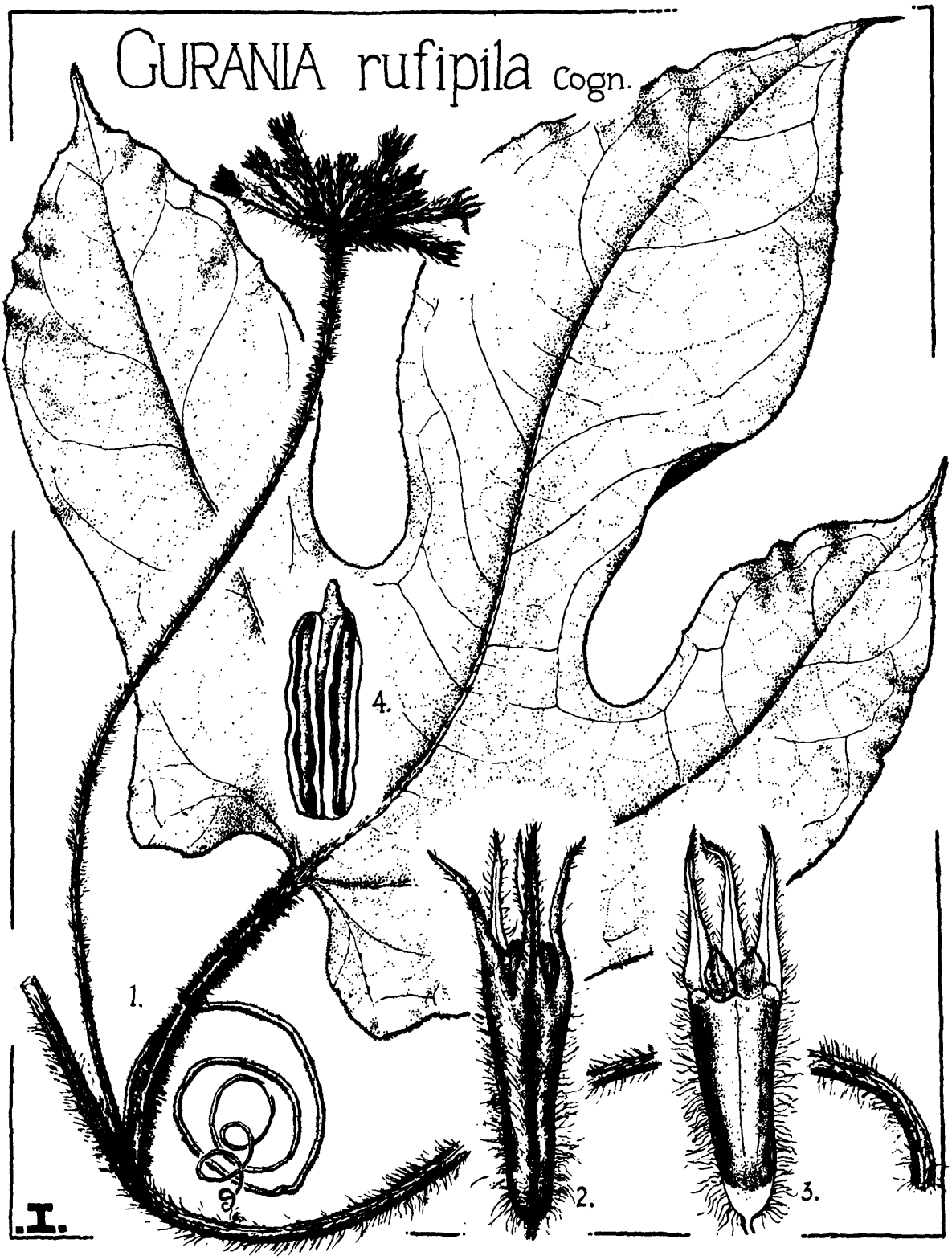
Leaves of guayusa, *Ilex guayusa* of the Aquifoliaceae, on a tree in a 200-year old abandoned plantation near Mocoa, Amazonian Colombia. The Jesuits formerly exported these caffeine-rich leaves to Europe as a medicine; they are still used by Ecuadorian natives.

A recently discovered hallucinogen, the solanaceous *Iochroma fuchsioides*, in the Andes of Colombia near Pasto.

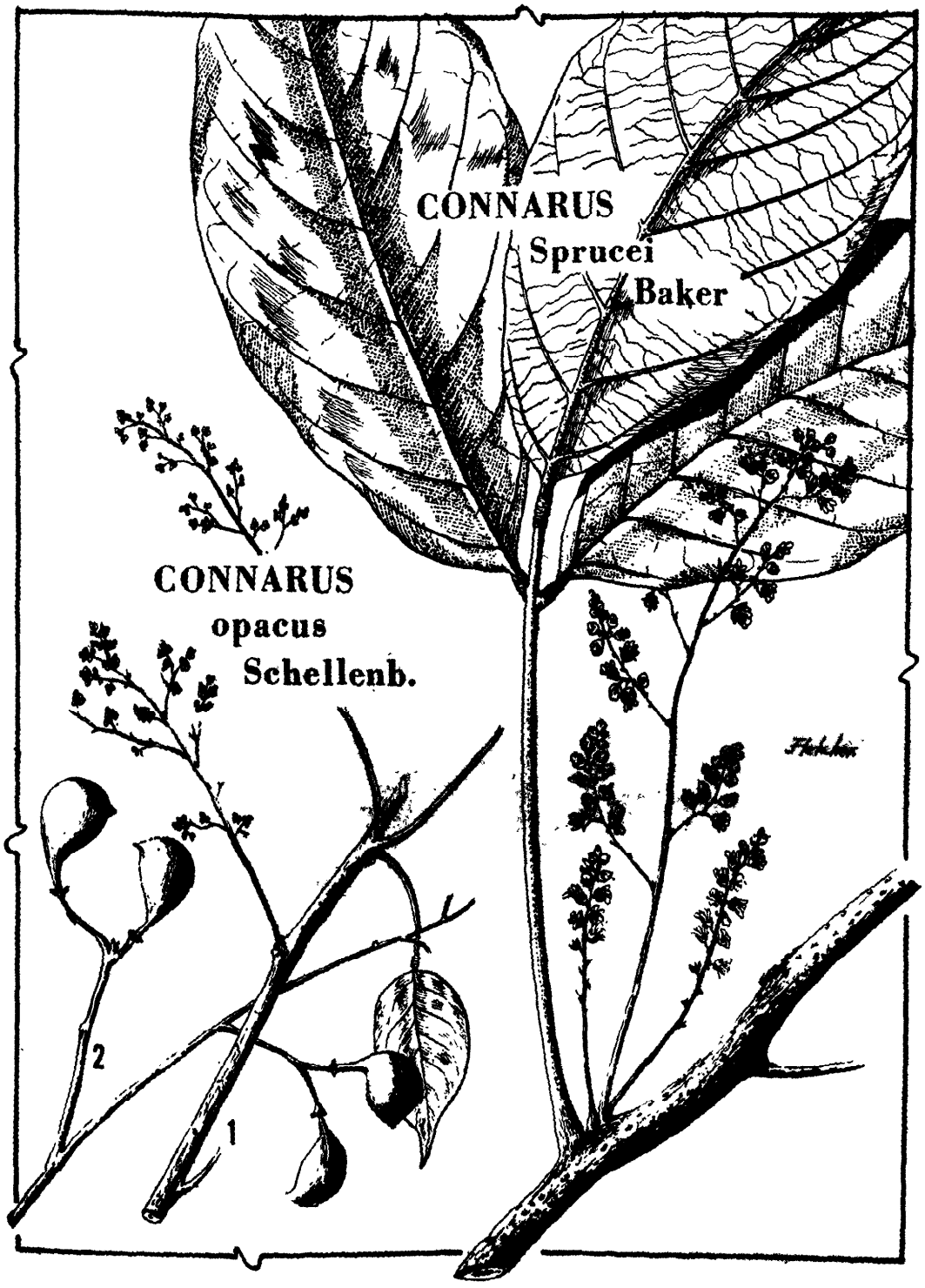
Waika medicine man holding leaves of the acanthaceous *Justicia pectoralis*. These leaves are dried, powdered and mixed with the hallucinogenic snuff prepared from Virola, rio Tototobí, Amazonian Brazil.

The solanaceous *Brunfelsia grandiflora* subsp. *schultesii*, an hallucinogenic plant used medicinally in the western Amazon and as an additive to the narcotic drink ayahuasca or yaje. Collected in Leticia, Amazonian Colombia.

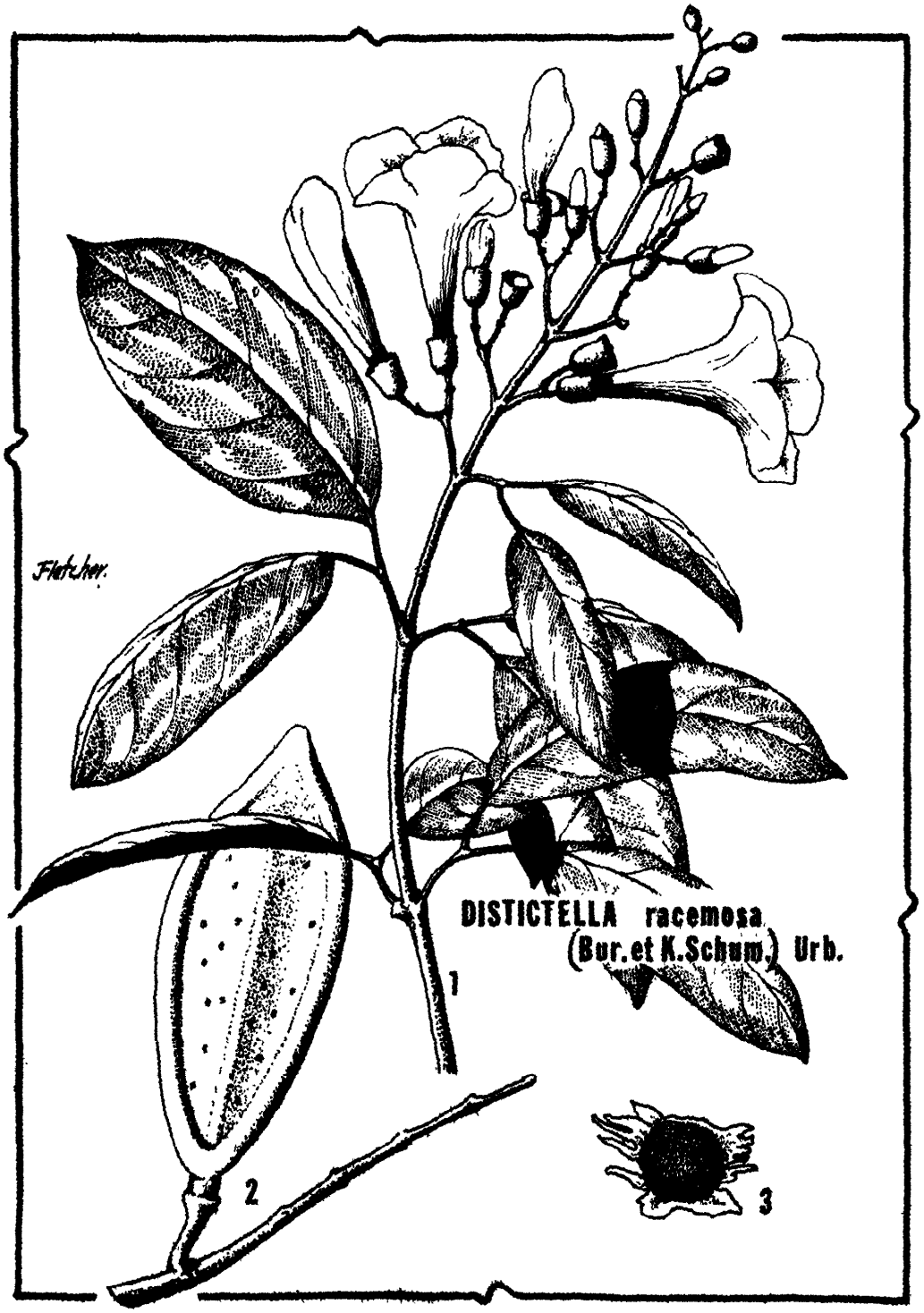
Young student of medicinal plants of the Kamsá tribe in Sibundoy, the southern Andes of Colombia. He is holding leaves and flowers of the highly toxic hallucinogen, *Methysticodendron amesianum* of the Solanaceae.



Gurania rufipila, one of the numerous cucurbitaceous plants recently found to be toxic. Colombian Amazonas.



Several Amazonian species of Connarus of the Connaraceae are valued as fish poisons or as ingredients in arrow poisons in the Colombian Amazon.



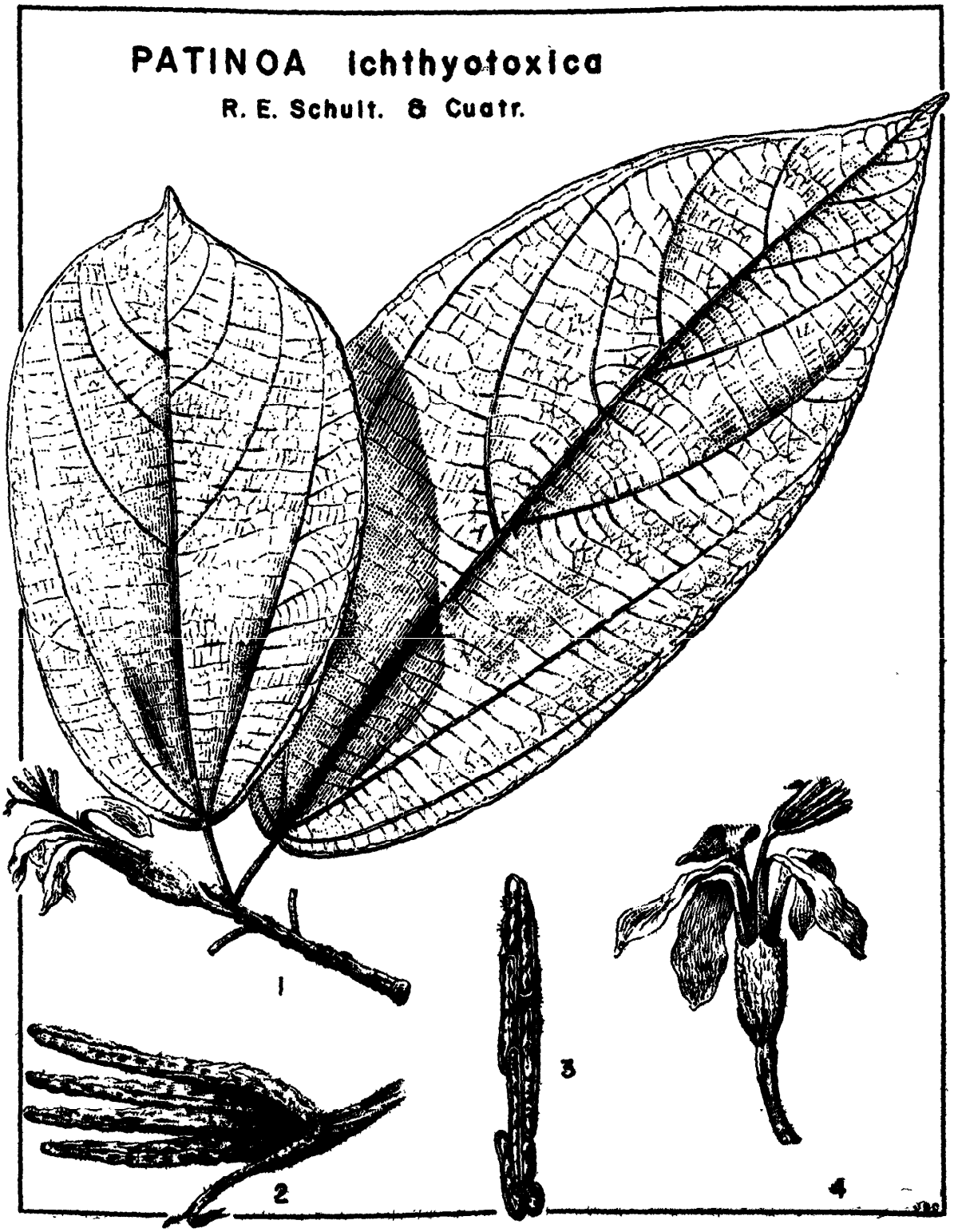
The bark of the bignoniaceous *Distictella racemosa* is esteemed by Barasanas of the Colombian Vaupes as an ingredient of their curare.

Drawing of Richard Spruce as he looked before beginning his 14 years in the Amazon and Andes.

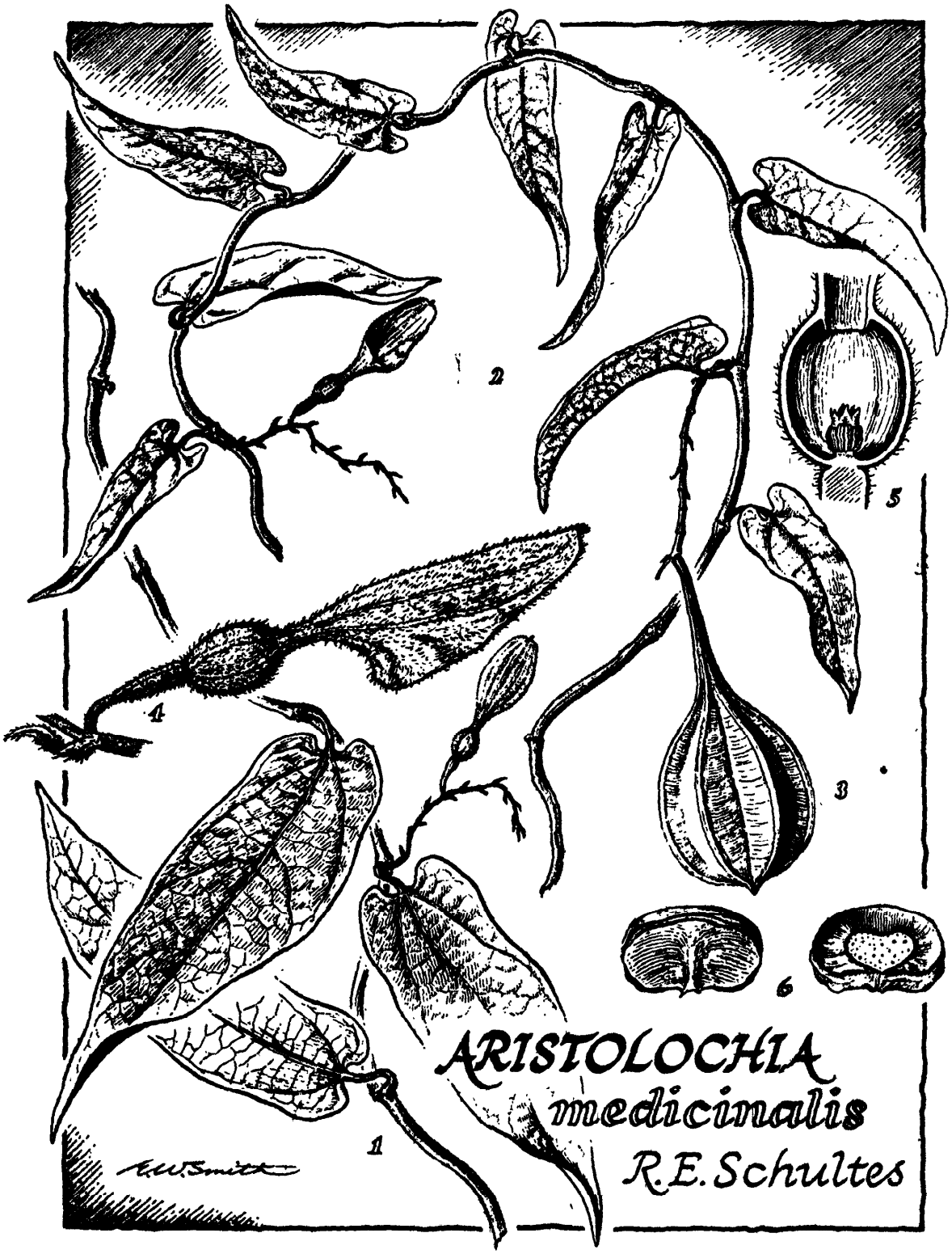
Typical camp for collecting plant specimens and ethnobotanical information in the northwest Amazon. Rio Apaporis, Vaupés, Colombia

A medicine man of the Kofan Indian tribe, Rio Sucumbios, Putumayo, Amazonian Colombia

Colony of the aroid *Philodendron dyscarpium* growing on metamorphosed quartzitic savannah, Vaupés, Amazonian Colombia. The inflorescences are employed by the local aborigines as an oral contraceptive



A curious fish-poison of the northwest Amazon: *Patinoa ichthyotoxica*



A vine of the region of the Vaupés, Amazonian Colombia, employed, its toxicity notwithstanding, in what appear to be epileptic seizures *Aristolochia medicinalis*.

western part of the Amazon represents the epicentre.

Although curares have been carefully studied as sources of medicinally valuable compounds, there remains much to do from this point of view. It would hardly be an exaggeration to state that every tribe (and often every payé) dedicated to the preparation of curare has a different formula.

While most curare formulae call for a number of vegetal ingredients, the most widely prepared Amazon arrow poisons have as their basically active plants members of the Menispermaceae (species of *Abuta, Curarea, Chondrodendron* and other genera) or of the loganiaceous genus *Strychnos*. Alkaloids from the menispermaceous genera have, of course, become extremely important in western medicine during the past 50 years. Recent ethnopharmacological studies have, however, uncovered new sources of curares — even curares prepared of one species.

More than 150 years ago, the German botanist von Martius discovered that Indians on the Rio Japurá in Brazil were preparing a curare based on the annonaceous *Unonopsis veneficiorum* (10, 17). Recently it has been learned that the distant Kofán Indians of Colombia and Ecuador prepared an arrow poison from the fruits of this plant. This species contains bisbenzylquinolic compounds, but it is not known that these constituents can be responsible for the curariform activity. The Kofáns use another annonaceous plant in making a curare: the bark of a small tree of the genus *Anaxagorea*. The Kofán Indians likewise use the fruits of the lauraceous *Ocotea venenosa* which also contain bisbenzylquinolic constituents (12). Another interesting toxic plant utilized by the Kofáns is the thymeliaceous *Schoenobiblus peruvianus*, the fruits of which are the sole ingredients of an arrow poison; they are also a favourite fish poison of this tribe (17). The Thymeliaceae is rich in coumarin derivatives, but these are not believed to have curare activity.

In 1954, a new hallucinogenic snuff was identified in the northwest Amazon, prepared from the resin-like bark exudate of several species of the myristicaceous genus *Virola*. During the study of this interesting use it was discovered that the Waika Indians of Brazil tip their darts with the exudate (with no other ingredient) as a commonly employed curare. While the hallucinogenic principles — tryptamines — have been identified, there is no suspicion of these constetuents can act as an arrow poison (14, 30, 31).

Amongst the other species reportedly used as active components of arrow poisons are *Vochysia columbiensis*, utilized by the Makú Indians of the Río Piraparaná who enjoy the reputation of making the best curare in the region; and the caryocaraceous *Anthodiscus obovatus* from which the Tukanos of the Vaupés prepare with a species of *Strychnos* a relatively strong arrow poison.

While many Indian tribes cultivate species of the euphorbiaceous *Phyllanthus* and the composite *Clibadium* and utilize the bark of wild species of the legume *Lonchocarpus* as fish poisons, many other species of lesser ichthyotoxic value have recently been identified as members of the euphorbiaceous *Nealchornia*, the myrsinaceous *Conomorpha*, the acanthaceous *Mendoncia* and the cannoiracous *Connarus*. A curious fish poison is prepared from the leaves of the araceous *Philodendron crasspedodromum* amongst the Indians of the Vaupés: the leaves, tied up and left to ferment for several days, are then crushed and thrown into still water. The Waoranis of Ecuador esteem the bark of the bignoniaceous *Minquartia guianensis* as an ichthyotoxic agent (4). A very unusual discovery has been the use by the Tikunas of the Colom-

bian Amazonas of the dried pulp of the fruit of the bombacaceous *Patinoa ichthyotoxica;* no chemical constituent from this family is known to have toxic properties (26).

There are many plants that the natives classify as poisonous and for which they have no use. Especially interesting are cucurbitaceous species in the genus *Gurania,* a family that deserves closer phytochemical study.

Several species of the marcgraviaceous genus *Souroubea* are valued in the Vaupés as the source of calmative teas administered to elderly natives suffering from "susto" (psychological fear) or to induce sleep. Two or three plants — especially the cultivated cucurbitaceous *Cayaponia ophthalmica* — are employed, apparently with some success, in treating conjunctivitis, a very frequent condition in the region (15).

One of the medicinal uses most worthy of scientific evaluation is the application of the reddish resin-like bark exudate of several species of *Virola* and of the guttiferous *Vismia* to fungal infections of the skin, an extremely common affliction in the wet tropics (31). The condition often seems to clear up with this treatment for 10 or 15 days, but whether it represents a cure or merely suppression cannot be known at the present state of our technical understanding. Recent preliminary chemical studies have yielded several chemical constituents from *Virola* – lignans and neolignans – that may possibly account for antifungal activity (6). Other plants are employed in treating infections of the skin or of the mucous membrane of the mouth: the gum extracted from the pseudobulbs of the orchid *Eriopsis sceptrum,* a decoction of the bark of several species of *Vochysia,* an infusion of the leaves of *Souroubea crassipetala* and the powdered bark of the rubiaceous *Calycophyllum acreanum* and *C. spruceanum* (24). A warm decoction of the leaves of *Anthurium crassinervium* var. *caatingae* is used by the Kubeos as an ear-wash to relieve a painful condition due probably to fungal infection.

One of the commonest medicinal plants of the Makunas is the malpighiaceous *Mezia includens:* the root is considered to be strongly laxative when crushed and soaked in water in which farina flour (from *Manihot esculenta*) has been sitting for several hours. The boiled leaves make an emtic tea and, when they are applied warm as a cataplasm on the abdomen, are said to help a condition that seems to be hepatitis.

Despite its toxicity, *Aristolochia medicinalis* is administered in the Vaupés to calm what appear to be epileptic seizures. The treatment is reported sometimes to be worse than the disease, since use of this tea, it is alleged, can cause insanity if not used with caution.

Only several species were encountered in use as presumed oral contraceptives: *Philodendron dyscarpium, Urospatha antisyleptica* and *Anthurium tessmannii* — all members of the aroid family. The Bara-Makú of the Río Piraparaná, who call the moraceous *Pourouma cecropiaefolia, we-wit-kat-tu* ("no children medicine") scrape the bark from the root, rub the scrapings in water and give the drink to women; according to the natives, the drink can cause permanent sterility (25). These same Indians report that the leaves of *Vochysia lomatophylla* in warm chicha (a slightly fermented drink made from *Manihot esculenta*) has aborifacient properties. It is perhaps significant that the distant Campa Indians of Peru also value this *Vochysia* as a possible contraceptive.

Several plants are widely employed as styptics to staunch the flow of blood from wounds: *Helosis guianensis* of the Balanophoraceae; *Costus erythrocoryne* and *Quiina leptoclada* of the Zingiberaceae and

Quiinaceae, respectively.

A recently published ethnobotanical study of the bignoniaceous genus *Martinella* may be extremely significant. An extract of the root of *M. obovata* is widely employed throughout northern South America as an "eye medicine." References to this use over such an extensive area is "compelling evidence that *Martinella* contains medically useful properties" (5). In the Vaupés, another bignoniaceous liana — *Arrabidea xanthophylla* — is valued in treating conjunctivitis.

The number of species for which vermifugal and febrifugal properties are claimed is naturally very high in view of the prevalence of intestinal parasites and various fevers, especially malaria. Very few of the plants so employed have been chemically or pharmacologically examined, although numerous species belong to genera recognized as having astringent properties. It will be sufficient to mention several members of the solanaceous genus *Brunfelsia* in connection with febrifugal activity: *B. chiricaspi, B. grandiflora* and *B. grandiflora* subsp. *Schultesii.* The ingestion of a decoction of the leaves rapidly induces a sensation of chills: in fact, the vernacular name *chiricaspi* means "chill plant." In addition to this febrifugal use, these plants have additional applications in local medicine: in treating rheumatic pains and arthritis as well as snakebites. They may occasionally be added to the hallucinogenic drink ayahuasca (prepared from the malpighiaceous *Banisteriopsis caapi*) in order to lengthen and intensify the psychoactivity of the narcotic. And *Brunfelsia,* taken alone, can itself have hallucinogenic effects (13, 25). Yet little is known of the chemistry of such a well known and highly esteemed native medicine. Recent chemical studies of *B. grandiflora* subsp. *Schultesii* disclosed a novel convulsant — pyrrole-3-carboxyamidine — which has been named brunfelsamidine, but it is not clear that this represents the physiologically active constituent (9).

Ethnopharmacology has recently been defined as "the observations, identification, description and experimental investigation of the ingredients and the effects of indigenous drugs." It is clearly a highly interdisciplinary field. It is"... not just a science of the past, utilizing an outmoded approach. It still constitutes a scientific backbone in the development of active therapeutics based upon traditional medicine of various ethnic groups. Although not highly esteemed at the moment, it is a challenge to modern pharmacologists" (2, 7).

In addition, then, to its academic interest to anthropology and botany, a major reason for ethnopharmacological conservation is the search for potential new therapeutic agents for western medicine. The pharmaceutical industry in the United States has attained in the prescription market alone annual sales in excess of $3,000,000,000 from medicinal agents first discovered in plants, many of them found in use amongst unlettered peoples in aboriginal societies the world around (27). Can we afford any longer to neglect this prolific and promising treasure-trove of ethnopharmacological knowledge that may not long be available to us for the benefit of mankind ?

REFERENCES

1) ALTSCHUL, S. VON R. "Ethnogynocological notes in the Harvard University Herbaria". *Bot. Mus. Leafl.,* Harvard Univ. 22 333-343. 1970.
2) BRUHN, J.C. AND B. HOLMSTEDT "Ethnopharmacology : objectives, principles and perspectives". In E. Reinhard and J.L. Beal [Eds.] *Natural Products as Medical Agents.* Hippocrates, Stuttgart 405-430. 1982.
3) DAVIES, S.H. *Victims of the Miracle — Development of the Indians of Brazil* 1977
4) DAVIS, E.W. AND J.A. YOST "The ethnobotany of the Waorani of eastern Ecuador" in *Bot. Mus. Leafl.,* Harvard Univ. 29 : 159-218. 1983.
5) GENTRY, A.H. AND K. COOK "*Martinella* (Bignoniaceae) : a widely used eye medicine of South America" *Journ. Ethnopharm.* 11 : 337-343. 1984.

6) GOTTLIEB, O "Chemical studies on medicinal Myristicaceae from Amazonia" *Journ. Ethnopharm.* 1 : 309-343 and personal comm 1979

7) HOLMSTEDT, B. AND J G. BRUHN. "Ethnopharmacology — a challenge". *Ibid.* 8 : 251-256. 1983.

8) HOUGHTON, P.H. "Ethnopharmacology of some *Buddleja* species". *Ibid.* 11 : 293-308. 1984.

9) LLOYD, H A , H.M. FALES, M.E. GOLDMAN, D.M. JERINA, T. PLOWMAN AND R.E. SCHULTES. "Brunfelsamine: a novel convalsant from the medicinal plant *Brunfelsia grandiflora*". *Tetrahed. Letters* 26 : 2623-2634. 1985

10) VON MARTIUS, K.F P. *Systema Materiae Medicae Vegetabilis Brasiliensis.*

11) ORTIZ DE MONTELLANO, B. "Empirical Aztec medicine" in *Science*. 188 215-220. 1975.

12) PINKLEY, H.V. *The Ethnoecology of the Kofán.* Unpubl. Ph.D. thesis, Harvard University, Cambridge, Mass. 1973.

13) PLOWMAN, T. "*Brunfelsia* in ethnomedicine". *Bot. Mus. Leafl.*, Harvard Univ. 25 : 289-320. 1977.

14) SCHULTES, R.E. "Plantae Austro-Americanae V. De plantis principaliter Colombiae observationes". *Ibid.* 16: 241-260 1954.

15) —— "Plantae Colombianae XVIII. De plantis regionis amazonicae notae" *Ibid.* 20 : 317-324. 1964.

16) —— "De plantis toxicariis e Mundo Novo tropicale commentationes I". *Ibid.* 21 : 265-287. 1967.

17) —— "De plantis toxicariis e Mundo Novo tropicale commentationes IV". *Ibid.* 22 : 133-164. 1969.

18) —— "De plantis toxicariis e Mundo Novo tropicale commentationes VII. Several ethnotoxicological notes from the Colombian Amazon". *Ibid.* 22 345-352. 1970.

19) —— "De plantis toxicariis e Mundo Novo tropicale commentationes XIII. Notes on poisonous or medicinal malpighiaceous species of the Amazon". *Ibid.* 24 : 128-131. 1975.

20) —— "De plantis toxicariis e Mundo Novo tropicale commentationes XXIII. Notes on biodynamic plants of aboriginal use in the northwestern Amazon". *Ibid.* 26 : 177-197. 1978.

21) —— "De plantis toxicariis e Mundo Novo tropicale commentationes XXVI. Ethnopharmacological notes on the flora of northwestern South America". *Ibid.* 28 : 1-45. 1980.

22) —— "Richard Spruce, an early ethnobotanist and explorer of the northwest Amazon and northern Andes" *Journ. Ethnobiol.* 3 : 139-147. 1983.

23) —— "From ancient plants to modern medicine" in *1984 Yearbook of Science and the Future.* Encyclopedia Britannica, Inc., Chicago, Ill. 172-187. 1983.

24) —— "De plantis toxicariis e Mundo Novo tropicale commentationes XXXIV. Biodynamic rubiaceous plants of the northwest Amazon". *Journ. Ethnopharm.* 14 : 105-124. 1985.

25) —— "De plantis toxicariis e Mundo Novo tropicale commentationes XXXV. Miscellaneous notes on biodynamic plants of the northwest Amazon". *Ibid.* 14 : 125-158. 1985.

26) —— AND J. CUATRECASAS. "De plantis toxicariis e Mundo Novo tropicale commentationes IX. A new species of ichthyotoxic plant from the Amazon". *Ibid.* 23 129-136. 1972.

27) —— AND N.R. FARNSWORTH "Ethnomedical, botanical and phytochemical aspects of natural hallucinogens" *Ibid.* 28 123-214. 1980.

28) —— AND A. HOFMANN. *Plants of the Gods : Origins of Hallucinogenic Use.* McGraw-Hill Book Co., New York. 1979.

29) —— AND —— *The Botany and Chemistry of Hallucinogens.* Charles C. Thomas, Springfield, Ill. Ed. 2. 1980.

30) —— AND B. HOLMSTEDT. "De plantis toxicariis e Mundo Novo tropicale commentationes II. The vegetal ingredients of the myristicaceous snuffs of the northwest Amazon". *Rhodora* 70 : 113-160. 1968.

31) —— AND ——"De plantis toxicariis e Mundo Novo tropicale commentationes VIII. Miscellaneous notes on myristicaceous plants of South America". *Lloydia* 34 : 61-78. 1971.

32) —— AND T. SWAIN. "The Plant Kingdom : a virgin field for new biodynamic constituents" in N. Fina [Ed.] *The Recent Chemistry of Natural Products, including Tobacco.* Philip Morris Science Symposium, 2nd...Proceedings, New York. 133-171. 1976.

33) SPRUCE, R. "On some remarkable narcotics of the Amazon Valley and Orinoco" in *Ocean Highways : the Geographical Review.* n.s. 55, 1 : 184-193. 1873.