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The Unfolding Panorama of the New World Hallucinogens

*Richard Evans Schultes**

Knowledge of plants and knowledge of healing or treating disease have been closely linked from man's earliest social and cultural gropings. What may be termed *botany* and *medicine* are still intimately intertwined in primitive societies that have persisted to the present time. From all sources, it may be inferred that the shaman or witch doctor, who represents the oldest professional man in the evolution of human culture, was usually an accomplished botanist.

But what does history itself—human social development since the advent of written records—tell? The answer is the same: botany and medicine were so close that for a great part of man's historical period they were, for most practical purposes, one and the same discipline. And it was so until, about 1500, when the two began to separate from their long wedlock, and to the advantage of both sciences.

Yet the tendency toward some kind of union was hard to break, and even in comparatively recent times there are indications of the persistence of this union. Linnaeus, it is recalled, was a medical doctor. Even a century later, some of the leading botanists were medically trained and practiced their medical profession. Asa Gray, founder of Harvard's Gray Herbarium, and John Torrey, were medical doctors.

With the gradual sophistication of chemistry in the last half of the last century, and the exaggerated abuse, especially in the United States, of "folk medicines," "Indian remedies," and other therapeutic quackery, there set in a countercurrent, a tendency to disparage any ethnobotanical data concerning physiologically active plants and to exalt and exaggerate the potentialities of synthetic chemistry for progress in therapeutics.

Then the revolution set in about thirty-five years ago: the discovery of so many startlingly effective drugs, mostly of plant origin, that there has crystallized the realization that the Plant Kingdom, variously estimated as between 200,000 and 500,000 species, represents virtually an untapped

*See also "Hallucinogens of Plant Origin." *Science* 163, 245-254.

reservoir of unknown chemical structures, many with extraordinarily interesting physiological properties. There has come about, once again, a drawing together of the botanical, pharmaceutical, and medical sciences, albeit a healthier alliance than the one that existed throughout most of man's cultural history (Schultes, 1963c).

Although there have been striking evidences of this *rapprochement* in numerous aspects of recent developments in pharmaceutical chemistry, nowhere perhaps has the evidence been more challengingly provocative than in the study of hallucinogenic or psychotomimetic drugs (Schultes, 1961b, 1963a,b).

Though primitive man tried to find direct palliatives or remedies for his ailments, the psychic effects of drugs were far more important to him than the purely physical. This is readily understandable when it is remembered that most, if not all, primitive cultures attribute sickness and death to supernatural forces. Witchcraft, aided by communion with the spirit world, was the principal tool in the treatment of disease. For this reason, primitive man sought and put an extraordinary value on plants that had sundry strangely unreal, psychic effects that were capable of transporting him beyond the prosaic confines of this mundane environment to exciting worlds of indescribably ethereal wonder. The narcotics, especially those inducing visual and other hallucinations, were primitive man's "medicines" *par excellence* and early secured a firm place in his magic and religious practices, which, though often indistinguishable, were the basis of his medical practice. How did this condition come to pass? Faced with the mystery of a very small number of plants that had strange powers over his mind and body, whereas the great majority had no effects, primitive man had to resort to the only plausible explanation: these psychoactive plants were the residence of divinities or supernatural forces and, therefore, sacred. Civilized man now knows that these "divinities" are chemical compounds, sometimes structurally novel and often of extraordinary phytochemical and physiological interest. Scientific investigation of these plants, thanks to interdisciplinary studies, have led to most unusual, startlingly unexpected discoveries in sundry fields. The impact of these discoveries has demonstrated how vital it is to be ever mindful of the native's beliefs in and reverences for the supernatural origin of these amazing psychoactive properties, that to pass over these beliefs and reverences might easily frustrate and doom to failure the most meticulously prepared scientific search (Schultes, 1960, 1962). And, above all, reports of aboriginal uses of plants must no longer be prejudged.

More than a century ago, in 1855, von Bibra published his *Die nar-kotischen Genussmittel und der Mensch*. This book, the first of its kind,

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considered 17 plant stimulants and narcotics and urged that chemists undertake assiduous study of a field so promising for research and so fraught with enigmas.

Half a century later, in 1911, Hartwich, in his *Die menschlichen Genussmittel*, discussed at length about 30 vegetal narcotics and stimulants and mentioned many others in passing. He pointed out that von Bibra's pioneer work was out of date, that research on the botanical aspects and on the chemical constituents of these plants had, in 1855, scarcely begun but that, by 1911, these studies were either progressing well or had already been completed.

Thirteen years later, in 1924, Lewin's *Phantastica—die betäubenden und erregenden Genussmittel* appeared, later to be translated into other languages. A novel kind of book, basic to what is now called *psychopharmacology*, it presented the total picture of some 28 plants that were employed for their stimulating or narcotic properties in many parts of the world. Lewin emphasized the importance of these plants to research in botany, ethnobotany, chemistry, pharmacology, medicine, psychology, psychiatry as well as to ethnology, history, and sociology. "The contents of this book," he humbly understated in the preface, "will provide a starting point from which original research in the above-mentioned departments of science may be pursued." This is exactly what the book has done—and admirably so. Without exaggeration, it may be said that it was Lewin's *Phantastica* that led directly to today's intensive and extensive interdisciplinary interest in narcotics, especially in those called the *hallucinogens*.

If a date were chosen to mark the beginning of the present phase of ethnobotanical interest in New World narcotics, however, it would have to be 1915, the year of publication of Safford's paper entitled "An Aztec narcotic." Even though in this and other papers that appeared some half century ago, Safford fell into several grievous errors that, in some ways, retarded progress, he did succeed in calling attention to the wealth of New World ethnobotanical material still awaiting exploration.

The "prototype," perhaps, of the New World hallucinogens is the peyote cactus, *Lophophora Williamsii* (LaBarre, 1938; Rouhier, 1927; Schultes, 1937a,b,c). Known by many natives of central and northern Mexico, this sacred plant was the center of a significant religious cult in the Aztec world. The rites surrounding its use were driven into hiding for several centuries by the ignorance and bigotry of the Spanish conquerors, but it persisted among the desert peoples of northern Mexico. Furthermore, the plant was discovered during the last half of the past century by marauding Plains Indians from the United States, was brought back, and,

with alterations of form and emphasis, a religious cult peculiar to the Indians of the United States developed and spread, until at present this cult, fully organized into the Native American Church, counts some 200,000 adherents and is practiced as far north as Saskatchewan and as far west as California (LaBarre, 1960). Such is the importance today of a rather insignificant-looking cactus. But the importance of *Lophophora Williamsii* does not end there.

Identified botanically at Harvard University from dried tops brought out from Tarahumare country in the late 1800s by the explorer Lumholtz (1902), peyote immediately attracted chemical and pharmacological attention. There has grown up an astounding body of literature from interdisciplinary research into this cactus. The botanical literature alone is bewildering, and present knowledge of the chemistry of the plant now indicates a total of 13 alkaloids, 1 of which—mescaline, the causative agent of the visual hallucinations—remains perhaps the most interesting (McLaughlin and Paul, 1966). Anthropological awareness of peyote has been and continues to be extraordinarily extensive, while newer fields—art, religion, philosophy, psychiatry—have become active in evaluating the plant and its use (LaBarre, 1960).

It might justifiably be assumed that, given so much interest, the understanding of peyote and unrelated narcotic species of cactus, would be clear and extensive. On the contrary, much remains to be done about the relationship between the Cactaceae and the medico-religious practices of New World aborigines. Lumholtz himself enumerated several species of *Mammillaria* (*M. micromeris*, *M. fissurata*) and *Echinocactus* that the Tarahumare Indians prize and even worship, considering them "demigods who have to be treated with great reverence," since eating them "causes a state of ecstasy" and brings about other physiological changes. It is clear from Lumholtz's notes that the field for narcotic cactuses is rich in northern Mexico. Furthermore, there are numerous species of cactus which, in other parts of Mexico, are classed as "peyote," either because they resemble *Lophophora* or because they produce similar effects. Belonging to the genera *Ariocarpus*, *Astrophytum*, *Aztekium*, *Dolichothele*, *Obregonia*, *Pelecypora*, and *Solisia*, several of them are known to be alkaloidal (Willaman and Schubert, 1961). And even more astounding is the recent discovery of the use as a narcotic by medicine men in Peru of the gigantic columnar cactus, *Trichocereus Pachanoi* (Friedberg, 1959; Gutiérrez-Noriega, 1950), and the report of mescaline in several species of this South American genus (Willaman and Schubert, 1961).

Outstanding as narcotics among the Solanaceae is *Datura*, species of which have an ancient history of magical and religious use in both hemi-

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spheres. In the New World there are two main centers for use of *Datura*: the American Southwest and Mexico, where several herbaceous species, the *toloache* of Mexico, have been and still are employed; and the Andean areas of South America from Colombia to Chile, where sundry species of tree *Datura* have been valued as intoxicants from earliest times.

In Mexico and the American Southwest, several species of this toxic solanaceous genus are, and for centuries have been, employed as divinatory and prophetic intoxicants (Safford, 1920, 1921). The custom persists in the drier parts of this area and seems to be centered mainly around the use of *Datura innoxia*, a plant with strong psychotropic properties attributable to its relatively high content of tropane alkaloids.

It is in the Andes of South America, however, that the genus *Datura* really comes into its own as a narcotic (Schultes, 1965). *Datura* in the Andes is represented by members of the subgenus *Brugmannsia*, all trees and all cultigens unknown in the truly wild state (Bristol, 1966b). Possessing the same tropane alkaloids (atropine, hyoscyamine, scopolamine, etc.) as the herbaceous species of North American *Datura*, albeit in different proportions, the tree *Daturas* of South America apparently enjoyed a more significant role in pre-Spanish cultures than at the present time, when their use is either criminal (in urban civilization) or superstitious (in marginal tribes of the Andes).

The use of tree *Daturas* is at present concentrated along the eastern slopes of the Ecuadorean Andes. No species of tree *Datura* has been found in a truly wild state, that is, far from the possible influence of agricultural man. There are areas (such as the 10,000-ft, mountain-girt Valley of Sibundoy in southernmost Andean Colombia) where the aborigines recognize and vegetatively propagate certain "races" of *Datura*, assigning to them specific native names and distinctive physiological effects. These "varieties" or "races" are morphologically distinguishable, even though there are numerous intergradations which may be due to mutations.

The tree *Datura* species are referred to usually as *D. arborea*, *D. aurea*, *D. candida*, *D. dolichocarpa*, *D. sanguinea*, *D. suaveolens*, and *D. vulcanicola* (Schultes, 1963a,b). Their classification has been confused. A recent treatment (Bristol, 1966b) suggests that there may be, in reality, only several species and numerous cultivars.

The preparation and use of *Datura* narcotics differ widely in the New World. The intoxicant is usually taken in the form of pulverized seeds, often in fermented fruit drinks. The intoxication is fraught with grave dangers because of the extreme toxicity of the alkaloids and their variable concentration of these toxic constituents. The principal alkaloids of

Datura are hyoscyamine, scopolamine, and atropine. The effects usually comprise an initial state of violence, so furious that the partaker must be restrained until a deep, disturbed sleep overtakes him. Visual hallucinations are experienced.

Although their employment as narcotics dates from early times, this genus still offers a fertile field for botanical, chemical, and ethnobotanical research.

One of the physiologically most effective and academically most interesting of the solanaceous narcotics of Sibundoy has been described as a new genus, *Methysticodendron Amesianum* (Schultes, 1955). Known among the aborigines as *culebra borrachera*, this distinctive tree probably has resulted, as suggested in the literature, from one or a series of mutations from *Datura*. Its acceptance by the natives as distinct and its employment by them for specific purposes, in addition to its chemical constitution, indicate the presence of a fundamental problem in which man and his ethnobotanical manipulations are playing a major part in the evolution of a new form of plant life.

Recent studies seem to indicate that it may be a cultivar "derived from one of the white-flowered tree-*Daturas*," possibly *D. candida* (Bristol, 1966b). The natives of the Valley of Sibundoy further recognize and propagate for specific medicinal purposes a number of clones of *Datura* which are variously "atrophied" (Bristol, 1966b; Schultes, 1961b). It has been suggested that these clones or "races," all known by distinctive native names, have arisen through virus infection, for similar monstrosities are known in the Solanaceae and elsewhere to be responses to viral attack. Long field study indicates (Bristol, 1966b), however, that they may "represent" several, or possibly many, genetic lines "and that each cultivar is genetically distinct, quite apart from the possible influence of viruses on the leaves." It is obvious that the tree *Daturas* constitute a genetically highly plastic group and, in the light of this plasticity, it is possible that *Methysticodendron*, like the numerous Sibundoy "races" of *Datura*, may eventually be shown to represent a most extreme variation along these lines of evolutionary development.

A fascinating possibility of adding to our list of solanaceous narcotics lies in further study of *Brunfelsia*, a toxic tropical New World genus of about 25 species, several of which are either known as poisons or employed in folk medicine (Schultes, 1966, 1967a). Evidence for the possible narcotic use of *Brunfelsia* in the Amazonian areas of Colombia, Ecuador, and Peru is quite real but is not yet corroborated by a good body of field observation. Intensive ethnobotanical work may still uncover indications of a former use of *Brunfelsia* as an hallucinogenic agent (there seems to be

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an appropriate chemical constitution), since such a use may once have been common and have disappeared.

There is a poorly understood solanaceous plant, *Latua pubiflora*, called *árbol de los brujos* in Chile, where it grows as a spiny shrub on the coastal slopes from Valdivia to Chiloe (Murillo, 1889). The plant contains tropane alkaloids and is extremely toxic, and especially toxic is the fruit which, if ingested, causes delirium, hallucinations, and insanity. It is said to be employed by the medicine men of the Araucarian Indians, but little reliable ethnobotanical knowledge is available.

The Leguminosae have given American ethnopharmacology various interesting psychotomimetics. *Sophora secundiflora*, a characteristic shrub of the drier parts of the American Southwest and northern Mexico, bears dark red seeds known as *red beans* or *mescal beans* (LaBarre, 1938; Schultes, 1963a,b). The seeds contain (Willaman and Schubert, 1961) a highly toxic pyridine alkaloid, cytisine, the effects of which are nausea, convulsions, hallucinations, and occasional death from respiratory failure. An early report by the Spanish explorer Cabeza de Vaca mentioned mescal beans as an article of trade among the Indians of the Texas area in 1539, and the Stephen Long Expedition in 1820 reported the Arapaho and Iowa tribes using large red beans as a medicine and narcotic. Mescal beans have been found in a number of archaeological sites in Texas and northern Mexico, all dated before 1000 A.D., and in some instances there appears to be evidence of ritualistic use of the beans.

Indian groups in Texas and northern Mexico formerly ingested these seeds in the ceremonial Red Bean Dance. Various Plains Indians likewise employed mescal beans in distinct patterns of use: as an oracular or divinatory medium, to induce visions in initiation rites, and as a ceremonial emetic and stimulant. The Kiowas and Comanches employ it today only as part of the ornamental dress of the leader of the peyote ritual, pointing perhaps to its earlier use as a narcotic, a role which it lost with the arrival of the much safer and much more spectacularly hallucinogenic peyote.

Several species of the leguminous genus *Rhynchosia* may also have been employed as narcotics in ancient Mexico (Schultes, 1965). In Oaxaca, the red and black beans of *Rhynchosia phaseoloides* and *R. pyramidalis* are known as *piule*, a name employed likewise for the convolvulaceous narcotic *Rivea corymbosa*; and the Chinantec and Mazatec of Oaxaca recognize *Rhynchosia* seeds as toxic (Schultes, 1941b). An as yet uncharacterized alkaloid has been isolated from beans of *Rhynchosia pyramidalis*. *Rhynchosia* seeds have been identified from ancient Aztec

paintings together with mushrooms (Heim and Wasson, 1958); this is another indirect suggestion that they may have been valued as narcotics.

The other known leguminous narcotics are South American and belong to the *Mimosa* group of the family. The Kararí and Pankarurú Indians of eastern Brazil practice the ancient yurema cult, during which a gourd of the yurema-root infusion is given to warriors who experience visual hallucinations (Gonçalves de Lima, 1946). The rite was once much more widespread. It has been learned about from at least three other tribes of the region. The source of this potent beverage is probably the same as that reported under the Portuguese name *vinho de Jurema* and prepared from the roots of *Mimosa hostilis*. An alkaloid was isolated from this plant in 1946 and named nigerine, but this compound has since been shown to be identical with *N,N*-dimethyltryptamine, a constituent found in seeds of several related legumes (Pachter *et al.*, 1959).

One of the most interesting and enigmatic South American narcotics is *Anadenanthera peregrina*, more widely known as *Piptadenia peregrina*. A powder prepared from the beans of this tree is snuffed in northern South America and was formerly snuffed in the Antilles as well (Altschul, 1964). Tobacco, commonly taken as a snuff in the West Indies and South America, has constantly been confused with other snuffs, as in the case of the ceremonial *cohoba* snuff of Hispaniola, mentioned in the very first work (1496) that reported on the ethnology of the Western Hemisphere. It was not until 1916 that *cohoba* was identified as probably the same as the *ñopo* or *yopo* employed as a snuff by the Indians of the upper Orinoco in Venezuela (Safford, 1916).

A number of reports in the literature ascribed the source of Amazonian snuffs to various leguminous trees, and that may have led Bentham to conclude "that all South American trees . . . referred to as the source of narcotic snuff were probably one species and were identical with Linnaeus' *Mimosa peregrina* . . .," a statement that has led to one of the most extraordinarily erroneous generalizations in ethnobotany: that all the narcotic snuffs of South America that were not obviously tobacco must have been prepared from *Anadenanthera peregrina*. In many of the ancient reports of snuffing, it is impossible to distinguish between the use of tobacco and the snuffing of a powder prepared from *Anadenanthera* or of some other plant (Schultes, 1967b). There should, nonetheless, be no uncertainty in modern anthropological and ethnobotanical reports, but there is confusion more often than not.

A map (Cooper, 1949) purporting to show the distribution of the use of *Anadenanthera* snuffs includes the entire Orinoco basin and adjacent areas of southern Venezuela to the east; westward across the northern

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Colombian Andes and much of the Magdalena Valley; down the Andes through Colombia, Ecuador, Peru, and Bolivia; the coastal region of Peru; scattered isolated localities in northern Argentina; and the central and western part of the Amazon Valley. Even though this map is meant to outline the range of the use of several species in this genus—and there have been suggestions that other species have been the source of narcotic snuffs in the southernmost parts of the indicated range—the area for the employment of *Anadenanthera peregrina* is extraordinarily exaggerated. It extends far beyond the known botanical distribution of this tree, even though the range may have been extended by human agency.

The seeds and pods contain bufotenine and *N,N*-dimethyltryptamine and the oxides of both (Holmstedt and Lindgren, 1967). Thanks to several excellent monographic studies (Altschul, 1964; Ducke, 1949), *Anadenanthera peregrina*, in Venezuela, is known to belong to secondary forests, “savannahs, light forests and riversides”; in British Guiana, to be confined to “savannahs and riverside forests”; while in Brazil it is restricted to “savannah-like areas, usually in or near the Rio Madeira and Rio Branco basins.” It is, at least in the present century, far from common in the Amazon basin.

The main area of modern use of *yopo* or *ñopo*, the snuff prepared, usually with an alkaline admixture, from the beans of *Anadenanthera peregrina*, comprises principally the “llanos” of eastern Colombia, the Orinoco basin of Venezuela, and the region eastward across southern Venezuela (Schultes, 1967b). Whether or not some of the intoxicating snuffs reported from the Madeira and other southern tributaries of the Amazon may be attributable to *Anadenanthera peregrina* is doubtful and must await identifiable voucher specimens, but it is highly unlikely, in my opinion, that this species supplies the snuffs of these regions. It is unfortunate that the erroneous distribution of *Anadenanthera* snuffs persists in the literature despite efforts to point out reasons for its abandonment.

It was apparently Safford who first suggested that species of *Anadenanthera* other than *A. peregrina* might represent sources of other snuffs in South America. He identified the *vilca* or *huilca* of southern Peru and Bolivia and the *cébil* of northern Argentina (Altschul, 1964) with seeds of *Piptadenia macrocarpa*, now correctly called *Anadenanthera colubrina* var. *Cebil*, known to contain the same four indole bases that have been isolated from the pods and seeds of *A. peregrina*, and therefore obviously effective as a narcotic snuff.

Safford's identification of *vilca* has been widely accepted, but the evidence, in my opinion, is rather weak, and “there is evidence in the literature and in unpublished materials that *vilca* may involve other plants as

well as *Anadenanthera colubrina* var. *Cebil*, and that it may have been used in forms different from snuff" (Altschul, 1967). An example of the use of vilca other than snuff is the very earliest report of the drug that described the Inca witch doctors' taking the juice of vilca in chicha to induce an intoxication to foretell the future through communion with the devil. Reports of early use of cébil are usually equally vague. Cébil snuffs used at the time of the contact in "the Mataco and Vilela cultures of northern Argentina appear to have been *Anadenanthera*-derived," although the employment of this drug "further south, beyond its natural distribution is less likely."

Whether or not the true identity of the vilca and cébil snuffs, used mostly in cultures now nonexistent and known either from ancient and fragmentary reports or by inference from artifacts in archaeological sites, will ever be known is problematical. It is certain, nevertheless, that *Anadenanthera colubrina* var. *Cebil* is chemically appropriate for the elaboration of an hallucinogenic snuff.

A most mysterious snuff of which almost nothing is known botanically and chemically is said to be prepared from the fruits of the enormous moraceous jungle tree *Olmedioperebea sclerophylla* (Schultes, 1965). It is reputedly employed in the central part of Amazonian Brazil, but it is known only by the general Portuguese term *rapê dos indios* ("Indian snuff"). Voucher specimens for exact botanical determination seem to be lacking in herbarium collections, and phytochemical examination of the fruits apparently has not yielded any psychotomimetic substances.

In 1954, a strange hallucinogenic snuff prepared from the myristicaceous genus *Virola* was reported from Amazonian Colombia (Schultes, 1954b). Tobacco and a mixture of tobacco and powdered coca (*Erythroxylon Coca*) were known to be employed as snuffs in that region (Schultes, 1967b), but both of these preparations were available to the whole male population of certain tribes. Only the witch doctors took *paricá* or *yakee*, a powerful snuff prepared from the red bark resin of *Virola calophylla* and *V. calophylloidea* plus ashes of the bark of a wild species of *Theobroma*.

Virola snuff is known among a number of tribes in eastern Colombia, especially in the basins of the Inirida, Guainía, Vaupés, and Apaporis, where the inhabitants strip bark from the trunks before the sun has risen high enough to heat up the forest. A blood-red resin oozes from the inner surface of the bark. It is scraped off with a knife after congealing, is boiled in an earthen pot for hours until a thick paste is left. This paste is sun-dried, pulverized, sifted through a fine cloth, and finally added to an equal amount of ashes.

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It was very probably this *Virola* snuff that the German ethnologist Koch-Grünberg (1909) found early in the century among the Yekwana Indians of the headwaters of the Orinoco. He reported that they prepared their narcotic snuff from the bark of an unidentified tree. It is curious and perhaps significant that the related Waiká living on the Rio Tototobí at present call their *Virola* snuff *ñekwána*.

The manufacture of snuff from *Virola* bark has recently been reported from a number of related groups of Waiká Indians from the uppermost tributaries of the Orinoco eastward across the Brazilian-Venezuelan frontier region, where the narcotic is often called *epéna* (Wassén, 1968). Recently contacted groups of these Indians living on northern affluents of the Rio Negro of Brazil usually prepare the snuff with the ashes of the bark of an as yet unidentified leguminous tree, and sometimes with powdered leaves of a fragrant herb of the acanthaceous genus *Justicia*.

Among some of these natives, however, the snuff has no admixture. The Waiká of the Tototobí, for example, dry the resin, pulverize it finely, and blow it into the nostrils in this form. They may occasionally add powder from *Justicia* leaves but assert that this is not essential and merely adds a pleasant fragrance to the snuff. Neither it is considered important by these people to add ashes to the snuff. Most significant is the use of *Virola* resin, without any other ingredients, as an arrow poison by the Tototobí Waiká.

Although the source of *epéna* of the upper Rio Negro tributaries has been reported to be *Virola calophylloidea*, recent ethnobotanical work among the same inhabitants and collections indicate that it is *V. theiodora* that is employed.

Though it has been known that these *Virola* snuffs, like those made from *Anadenanthera*, possess tryptamines, there has not always been certainty about the botanical components of the powder. Examination of Waiká *Virola* snuff prepared from the resin of *V. theiodora* with no admixture has recently shown a content of 8% of 5-methoxy-*N,N*-dimethyltryptamine with traces of other tryptamines.

One of the most curious of the New World hallucinogens is the drink known in the western Amazon as *ayahuasca*, *caapi*, or *yajé* and prepared from sundry malpighiaceae plants (Schultes, 1957). Although not so commonly known as peyote or the Mexican mushrooms, this psychotomimetic drink has nonetheless inspired an undue share of sensational articles that have played fancifully with unfounded claims, especially concerning its presumed telepathic powers.

Despite its obvious great age, this narcotic drink became known to Europeans only about a century ago, and it remains one of the American hallucinogens most in need of clarification and study.

The first mention of *ayahuasca* appeared in 1858 in a book on the geography of Ecuador (Villavicencio, 1858). The drug, attributed to a vine, was taken "to foresee and to answer accurately in difficult cases, be it to reply opportunely to ambassadors from other tribes in a question of war; to decipher plans of the enemy through the medium of this magic drink and take proper steps for attack and defense; to ascertain, when a relative is sick, what sorcerer has put on the hex; to carry out a friendly visit to other tribes; to welcome foreign travellers or, at last, to make sure of the love of their womenfolk." A few years earlier, in 1852, the British plant explorer, Spruce (1908), encountered a liana known as *caapi* in the upper Rio Negro basin of Brazil and precisely identified the drug plant as a new species of the Malpighiaceae, now known as *Banisteriopsis caapi*. The natives of the Rio Negro basin of Brazil and Colombia use it for prophetic and divinatory purposes and to fortify the bravery of male adolescents about to undergo the initiation ceremony into manhood, and it was similarly employed for these purposes a century ago. In 1854, Spruce found the intoxicant being used by the indians along the upper Orinoco; and, in 1857, he identified the *ayahuasca* of the Peruvian Andes as the same narcotic as *caapi*.

Many subsequent explorers of the Amazon have referred to *ayahuasca*, *caapi*, or *yajé*. The range of use of this narcotic now comprises the western Amazon (including Bolivia, Brazil, Colombia, Ecuador, and Peru; the upper Orinoco of Colombia and Venezuela; and the Pacific coast of Colombia). It contains harmala-type alkaloids (Willaman and Schubert, 1961).

Later investigators have shown that other species of *Banisteriopsis* (*B. inebrians*, *B. Rusbyana*) are, especially in the westernmost Amazon at the foothills of the Andes, either the source of the narcotic drink or an additional ingredient in preparing the brew. *Banisteriopsis quitensis* and *B. longialata* have likewise been reported as sources of *yajé*. It has further been suggested that *Mascagnia psilophylla* var. *antifebrilis* might be so employed. Recently, the use of a new species of the allied malpighiaceae genus *Tetrapteris* (*T. methystica*) was authentically shown to be the source of a kind of *caapi* along the Rio Tikié in northwestern Brazil.

Although much more careful field work needs to be done before the whole picture is clearly in focus, there is every probability that the active ingredients of the *ayahuasca-caapi-yajé* narcotics are malpighiaceae plants.

A number of other plants are occasionally added to the beverage, but rarely do they appear to be essential to the intoxication that is being sought. In the westernmost Amazon of Colombia, Ecuador, and Peru, the leaves of *Alternanthera lehmannii* or of the toxic *Malouetia tamaquarina*

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are sometimes added. The addition of material of the rubiaceous genus *Psychotria* is not uncommon, especially in Peru. In all of these cases, however, the admixture seems to be nearly or wholly without intoxicating effect.

In 1921, through a misinterpretation of one of Spruce's field notes, it was suggested that the narcotic drink called yaji in Colombia and Ecuador was derived from *Prestonia* (*Haemadictyon*) *amazonica* (Schultes and Raffauf, 1960). This suggestion has, unfortunately, been so widely accepted and disseminated that it has clouded with confusion the study of these malpighiaceae narcotics of South America. It has now been conclusively shown that *Prestonia* does not enter into the preparation of any known South American narcotic; the genus is, however, an interesting one and, belonging to the Apocynaceae, a family rich in active principles, merits serious phytochemical examination.

There remain to discuss several hallucinogens of the ancient Aztecs that are still employed in modern Mexico.

The utilization in the Mazatec country of Oaxaca of leaves of several members of the Labiatae has opened up new vistas in our search for psychotomimetic plants. One of these, *Salvia divinorum*, known as *yerba de la pastora*, is a native species (Wasson, 1962). Its narcotic effects have been proved, although as yet no psychoactive constituent has been isolated from it. Employed by the inhabitants when other local intoxicants are scarce or out of season, this *Salvia* has been suggested as representing the *pipiltzintzintli* of the Aztecs. Two species of the allied genus *Coleus* (*C. blumei* and *C. pumila*), both introductions from the Old World, have been reported (Wasson, 1962) to be similarly used in Oaxaca. This narcotic employment of members of the mint family assumes more than ethnobotanical interest in view of the existence in Turkestan of another reputedly intoxicating mint, *Lagochilus inebrians*, from which an active crystalline principle, lagochiline (a polyhydric alcohol), has been isolated (Tyler, 1966).

The early chroniclers of Mexico occasionally mentioned *ololiuqui*, the sacred, vision-inducing, lentil-like seed of a vine with cordate leaves. Its illustrations by several writers, most precisely by the Spanish physician, Hernández (1790), leave no question that they represented a morning glory. Most of the chroniclers were ecclesiastics who railed violently against this "diabolic seed" that the people esteemed as a divine messenger capable of taking man's mind to spirit realms. But the identity of *ololiuqui* was in doubt for four centuries. No morning glory has ever been found in use as a sacred hallucinogen. Furthermore, intoxicating constituents were unknown in the morning glory family. Then,

in 1916, a categorical denial (Safford, 1916) that *ololiuqui* could be convolvulaceous was published, and, on the basis that the Aztecs were misleading the Spaniards to protect a sacred plant, an identification of *ololiuqui* as a species of *Datura* was offered. With no tangible evidence beyond the known toxicity of *Datura*, such an opinion was unfounded, yet it was immediately and widely accepted.

In spite of several objections to this "identification," it was not until the 1930s that actual botanical voucher specimens of *Rivea corymbosa* were made. They allowed *ololiuqui* to be referred to the Convolvulaceae and the statements in the early reports to be substantiated (Schultes, 1941a). Even though psychiatric experiments indicated the hallucinogenic effects of the seeds of *Rivea corymbosa* (Osmund, 1955), chemists were unable to isolate active principles until 1960, when the presence of amides of lysergic acids and of *d*-lysergic acid, chanoclavine and elymoclavine, substances hitherto known only from the fungus ergot (*Claviceps purpurea*), were isolated from this morning glory (Hofmann, 1961, 1963).

More recently, seeds of a second morning glory, *Ipomoea violacea*, have been identified as an hallucinogen in relatively wide use in Oaxaca (Wasson, 1963), and the same active principles have been isolated from them as from the seeds of *Rivea corymbosa* (Hofmann, 1963). During the last few years, in fact, chemical studies have shown that psychoactive indoles are comparatively widespread in the Convolvulaceae.

The early Mexican chroniclers likewise reported, and on a number of occasions, the religious use among the conquered peoples of intoxicating mushrooms called *teonanacatl* or "flesh of the gods" in Nahuatl. As in the case of *ololiuqui*, most of the chroniclers violently attacked such a loathsome pagan custom, and church persecution drove this interesting native cult into hiding for four centuries.

One of the old chroniclers referred to mushrooms that "are harmful and intoxicate like wine" so that those who eat of them "see visions, feel a faintness of heart and are provoked to lust"; and, in another reference to the fungi, he described the intoxication minutely. None of the references to the sacred mushrooms, however, is more thorough than that of Hernández (1790), who spoke of three kinds of hallucinogenic mushrooms worshipped by the natives. Some, he wrote, "cause not death but madness that on occasion is lasting, of which one symptom is a kind of uncontrolled laughter . . . these are deep yellow, acrid and of a not displeasing freshness. There are others again which, without inducing laughter, bring before the eyes all kinds of things, such as wars and the likeness of demons. Yet others there are not less desired by princes for their festivals and banquets, and these fetch a high price. With night-long vigils are they

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sought, awesome and terrifying. This kind is tawny and somewhat acrid."

Notwithstanding these and other such specific reports, nothing was actually known about these mushrooms until recently. Even more inexplicable is the wide acceptance of a patently erroneous assertion (Safford, 1916), made in 1916, that, as in the case of ololiuqui, the early Spanish chroniclers had been misled and beguiled by the Indians who, in order to protect the true teonanacatl, indicated that mushrooms represented this narcotic.

It was suggested that teonanacatl and the dried head of the peyote cactus were one and the same narcotic, notwithstanding the fact that the cactus grows only in the deserts of central and northern Mexico, hardly a propitious environment for mushrooms.

In spite of its wide acceptance, there were protests, but it was not until the 1930s that actual specimens of mushrooms employed in religious rites in the Mazatec Indian country of Oaxaca were collected and reported. The first to be identified was *Panaeolus campanulatus* var. *sphinctrinus* (Schultes, 1939). Later, intensive field research in Mexico, especially during the 1950s, has disclosed the narcotic use of some 20 other species in four genera among nine Indian groups (Heim and Wasson, 1958). The most important of them are *Psilocybe mexicana*, a small, tawny inhabitant of wet pastures, apparently the most highly prized of the hallucinogenic mushrooms; *P. aztecorum*, called "child of the waters" by the Aztecs; *P. zapotecorum* of marshy ground and known by the Zapotecs as "crown of thorns mushroom"; *P. caerulescens* var. *mazatecorum*, the so-called "landslide mushrooms" that grow on decaying sugar cane bagasse; *P. caerulescens* var. *nigripes*, the native name of which means "mushrooms of superior reasoning"; and *Stropharia cubensis*.

The religious use of mushrooms goes back apparently beyond 1000 B.C. among the highland Maya of Guatemala, even though they are not so employed there at present (Heim and Wasson, 1958). The existence of the mushroom cult in such remote times has been inferred from the abundant presence of archaeological artifacts now called "mushroom stones" and consisting of an upright stem with a manlike figure crowned with an umbrella-shaped top. Their meaning has long been an archaeological mystery; they are now thought to represent a kind of icon connected with mushroom worship.

A psychoactive constituent of most unusual structure for plant tissue has been found in a number of the sacred Mexican mushrooms: psilocybine, an indole derivative with a phosphorylated side chain, actually an acidic phosphoric acid ester of 4-hydroxydimethyltryptamine (Hofmann,

1958), a substance allied to such naturally occurring compounds as *bufotenine* and *serotonine*. Psilocybine has been isolated from *Panaeolus*, *Psilocybe*, and *Stropharia*. Another constituent sometimes found with psilocybine is psilocine, an unstable indolic compound occurring in minute amounts (Hoffer and Osmund, 1967; Hofmann, 1958).

The curious intoxication—marked by a kaleidoscopic play of visual hallucinations in color, muscular relaxation, flaccidity, mydriasis, followed by a period of emotional disturbance such as extreme hilarity and difficulty in concentrating—is due primarily, perhaps exclusively, to psilocybine.

Even such a superficial treatment of the American plant hallucinogens illustrates how much of a basis modern ethnobotanical and ethnopharmacological research has for the fast-unfolding panorama of the search for new psychoactive species of possible promise in modern medicine (Schultes, 1963c). Sundry lines of investigation which are suggested by what is now known should most certainly be followed, but, in view of the rapid disintegration of primitive New World cultures, it behooves all researchers to pursue every line open to them. A random sampling of the Plant Kingdom for psychoactive substances presents one approach. Another consists of more intensive examination of early records, fantastic though many may be; reports of any aboriginal use of a plant cannot be ignored merely because they seem to fall beyond the limit of credibility. A third and very promising approach, and one that has only recently attracted attention, is a search through the larger herbaria of the world for collectors' reports of such uses of plants. Still the most promising and certain approach, however, would appear to be intensive ethnobotanical investigation in the field of those primitive cultures that are as yet wholly or partly intact, before the beliefs and practices peculiar to these cultures pass forever from the mind and memory of man.

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