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ETHNOPHARMACOLOGY OF SACRED PSYCHOACTIVE PLANTS USED BY THE INDIANS OF MEXICO

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INTRODUCTION

Plants regarded as sacred or magical, which function as intermediaries between a person and his deity, have proved to contain psychoactive agents and therefore have been a source of extensive pharmacological scrutiny. The study of these plants has covered, as well, other areas of research from ethnology to botany, chemistry, neurochemistry, and psychiatry. An interdisciplinary research field, properly named ethnopharmacology, has recently developed in an attempt to integrate the methods of these disciplines in order to put our understanding of biodynamic plants used by native peoples in a broader perspective.

Some Indian groups of Mexico have searched extensively for psychoactive plants in their natural habitat. We know of about forty plants belonging to some fifteen botanical families that are used ritually or regarded as sacred by these groups. Some of the plants have been studied intensively but many others still present novel and interesting topics for further research.

The body of this paper covers the general historical, botanical, and ethnological aspects of the Mexican magic plants. A classification of the drugs based on their reported uses and subjective effects is proposed in a section on psychopharmacology. The specific etymological, botanical, ethnological, pharmacological, and chemical information is summarized in a table.

HISTORY

There is extensive evidence of the use of psychotropic plants by several Indian cultures dating from before the Spanish conquest of Mexico (1521–1525). Probably the earliest sacred plant used was the neurotoxic *Sophora secundiflora* used by Paleo-Indians of the desert of northern Mexico and southern Texas about 10,000

years ago (1). Polychrome ceramic pots from Casas Grandes decorated with a spiral very similar to the Huichol symbol of peyote suggests that this plant was used around the tenth century A.D. north of the Tarahumara zone (2). Codices such as the *Codex Magliabechi* (3) and *Codex Vindobonensis* (4) carry representations of mushrooms in ritual scenes associated with Indian priests and deities. The suggestion that these represent sacred mushrooms (3) is strengthened by historical evidence from Spanish colonial sources (5–7) and the modern Indian use of *Psilocybe* mushrooms (3, 8). Stones carved in the form of mushrooms with a human figure at the base or stem have been found in Mayan areas (9), but there are no data on modern usage among the Maya.

There exist two major sources referring to magic plants which date from the years following the conquest. In 1557, the Franciscan friar Bernardino de Sahagún began gathering data on Aztec culture through questionnaires and by interviews of selected informants. All the research was conducted in Náhuatl, the tongue of these learned Mesoamericans. The results of years of analysis of the material were assembled in what is known as the *Florentine Codex* (5) written in Náhuatl from which a Spanish version called *Historia General de las Cosas de la Nueva España* was made (10). In a remarkable and classic section, "Concerning Certain Herbs that Inebriate" [(5), Book 11, pp. 129–31 (see also 11)], he describes *ololiuhqui, peyote, tlápatl, tzinzintlápatl, mixitl,* and *nanácatl,* all of which have been identified (see Table 1).

Toward the end of the sixteenth century, the Spanish physician Francisco Hernández was commissioned by Philip II to collect information on medicinal plants in New Spain. His monumental report [(12) first published in 1649], the product of seven years of travel and observation, contains descriptions of a root called *peyotl de zacatecas* which "shows neither stem nor leaf over the earth and is covered by some sort of wool ... those who ingest it may divine any matter ..." [(12) Book 3, p. 92]. There is little doubt that this plant was *Lophophora williamsii.*

There are valuable descriptions appearing in the archives of the Inquisition [1536–1787 (see 13)], which date from colonial times, of magical plants used in indigenous ceremonies. The archives describe numerous trials and occasional tortures of Indians that used *peyotl, ololiuhqui,* and *pipiltzintzintli* for divinatory purposes. These writers, as well as the chroniclers Ruiz de Alarcón (14) and de la Serna (6), were eager to substitute these practices, then considered demonic, by the Catholic religion. In some cases the zeal of the friars resulted in extensive accounts of the ceremonies and "superstitions" concerning sacred plants (15); these have been very useful for purposes of comparison with modern Indian rituals. A surprising similarity of the liturgy practiced in different cultures and centuries has been found (16), indicating the strength of an oral tradition that survived through centuries of repression.

It is not until the nineteenth century that the attention of scientists was directed again to the sacred plants. In 1888 an institution was created for the study of medical resources of Mexico. A multidisciplinary group of encyclopedic botanists, chemists, physiologists, physicians, and geographers gathered information on approximately one thousand plants in 20 volumes (see 17). The works of the *Instituto Medico Nacional* (1888–1917) include botanical, chemical, and pharmacological data on

ololiuhqui (18), *sinicuiche* (19), *peyote* (18, 20, 21), the noncactaceous *peyotes* (20), and the *Leguminosae* (22).

Numerous investigators of this century have contributed to the study of the botanical identity, chemistry, and use of magic plants: Lumholtz (23) described the use of peyote by the Tarahumara; Heffter (24) isolated mescaline from peyote buttons in 1896 and in 1919 Späth (25) elucidated its chemical structure; Reko (26) conducted important field research on many of the plants in the state of Oaxaca, a major center of divinatory plant use; Schultes (27–31) corroborated, systematized, and disseminated much valuable ethnobotanical information; Wasson (3, 8, 16, 32) discovered and carefully described the modern use of sacred mushrooms and other psychoactive flora, and Hofmann found psilocybin in the magic mushrooms (33) and ergot alkaloids in *ololiuhqui* (34).

BOTANICAL DISTRIBUTION AND IDENTIFICATION

There is extensive documentation of the existence, worldwide, of numerous ritualistic techniques and preparations employed for their mind-altering effects (30, 31). In methods of evoking changes in consciousness, ecstatic states, and mystical experiences, the New World makes more extensive use of plant materials than the Old World. The majority of known plants ceremonially used as psychotropic agents are utilized in the American continents and more than half in Mexico (30, 31). In certain regions such as the Mazatec Sierra, at least four families of psychodysleptics are currently employed (32). The disparity between Old and New World use of psychotropics is probably due to cultural factors, since many psychoactive plants grow in the Old World (31). Furst (35) has suggested that the strength of the Old World religions, primarily Christianity and Islam, may have been a decisive factor in the disappearance of shamanistic traditions in those regions. La Barre (36) has hypothesized that the New World use of plants is a survival from an ancient Paleolithic and Mesolithic shamanistic cult which he traces to the Siberian ancestors of American Indians. Other causes for the differential geographical distribution of use may include regional variations in chemical content. For example, levels of Δ^9-tetrahydrocannabinol (THC), an active factor in *Cannabis sativa*, have been found to vary widely in different locations (37). Further study of the ecology of psychoactive plants is potentially of great interest since it may shed light on some of their unresolved geographical, chemotaxonomic, and ethnologic aspects.

The function of psychoactive compounds elaborated by plants is not understood. In general, naturally occurring alkaloids have an active turnover and complex synthesis, suggesting that they are not merely inert "end products" of metabolism (38). The hypothesis that these biodynamic alkaloids could protect the plant against animal predation, even if logical, has little evidence in its favor. In fact, there appear to be many instances of deliberate association between animals and psychotropic plants (39). For example, the incidence of insect predation in *Datura stramonium* is higher than in any plant of the same econiche. The role of the tropane alkaloids in the physiology and behavior of these insects is presently under study (J. L. Díaz, unpublished data). These observations may have cultural interest, since they could

be one of the mechanisms used by native man as a guide for experimenting with plants. Indeed one of the recurrent transcultural themes in the native experience of psychoactive plants is the role animals play in disclosing the psychoactive properties of plants to man (40).

The precise botanical identification of magic plants has been a necessary step to further chemotaxonomic, psychopharmacological, and neurochemical studies. The information covering the vulgar and scientific names of magic plants, their uses by Indian groups, major effects,and chemistry is summarized in Table 1. Even though identifications are often a source of academic and scholarly debate, the majority of the sacred plants referred to in the early Náhuatl sources have been identified. Thus, *péyotl* corresponds to *Lophophora williamsii* (18, 20, 21, 27); *ololiuhqui* refers to the seeds of two morning glories, *Rivea corymbosa* (18, 26, 29) and *Ipomea violacea* (32); *teonanácatl* are mushrooms mainly of the genus *Psilocybe* (3, 8); *toloatzin* corresponds to *Datura* species (41, 42) and *picietl* is the wild tobacco *Nicotiana rustica* (32). These Náhuatl names denote a reverence reserved for sacred beings or objects (see etymology in Table 1).

Three sacred plants mentioned during the time of the early colonization have not been identified to the satisfaction of all experts: *pipiltzintzintli, tlápatl,* and *poyomatli*. There are several seventeenth century references to *pipiltzintzintli*, "the venerable child." The archives of the Inquisition describe it as a cultivated shrub with male and female varieties that was dried and used for diagnosis and treatment of disease (13). A century later, in 1772, the learned priest Antonio Alzate (43) identified *pipiltzintzintli* as Indian hemp, *Cannabis indica.* This is a surprising reference since it is generally agreed that *Cannabis* was introduced in the nineteenth century and that it was cultivated neither as a source of fiber nor of drug in Mexico before that time (44). More recently it has been found that some Leguminosae are called *pipiltzintli* (45), and Wasson (32) suggested that this magic plant could correspond to *Salvia divinorum.* The identification most compatible with the data of the Inquisition archives is that of Alzate. It should be acknowledged, however, that the same name might have been given to other plants having similar effects. It is interesting that both *Cannabis sativa* and *Salvia divinorum* belong to the imagery-inducing family of psychodysleptics, as is discussed later.

Tlápatl or *tláppatl* is a word that implies "light of fire" or "red color." Sahagún (5, 10, 11) described the effects of *tlápatl* as a plant that inebriates and he adds: "if he eats it, he will go mad forever, will lose his heart, it will bewitch him" [(5) Vol. 11, p. 129]. He also mentions, *tzinzintlápatl,* a similar plant with a nonspiny fruit. Hernández (12) has included very explicit drawings and references to a group of plants to which *tlápatl, nacazul,* and *toloatzin* belong. His descriptions and drawings clearly match the genus *Datura.* About *nacazul* he states that it is "a species of *tlápatl* (which) in excess produces madness, visions and delirium . . . sometimes it is called *toloatzin*" [(12) Book 3, p. 66]. In this case we have several names referring to related plants within the same genus which give similar effects. The implication is that each name was given to a single species of *Datura.*

Much about *poyomatli* has not been elucidated beginning with its etymology. Hernández (12) writes about two *poyomatlis,* one being a root "with which, through a strange madness, Indians believe that hidden and future things are revealed"

(Book 2, p. 105). The flower of *poyomatli, poyomaxochitl,* is identified by Sahagún (5, 10) as "the jar shape of the cacao flower. It is said that it makes the heart of people whirl, it makes the heart of people turn, makes the heart of people jump" (Book 11, p. 212). At that time the word "heart" referred to what is contemporarily known as psyche (11). The "jar shape" may refer to the flower in a latter stage, or to an early phase of the fruiting pod. Describing the cacao plant, *cacaoquavitl,* he says: "When much is consumed, especially if it is green . . . it makes people drunk, takes possession of people, maddens people, makes the heart of people evil" [(5), Book 11, p. 119].

Many poems written in the Náhuatl language refer to the flower of cacao, to *poyoma* and *poyomatli,* as inebriating substances. In a piece written for performance in pantomime about the fall of Tula, a poet sings about his longing for transcendence through his chanting, which he compares to the scent of flowers (46). Towards the end he intones:

> But the fragrant cacao flower is bursting
> and smelling, Alas! Perfumed *poyomatli* falls as mist (p. 5).

The association between *poyomatli* and cacao may not be merely fortuitous since in the same work Tlacahuipan, a brother of Moctezuma, offers cacao in flower in the following manner: "I spread the precious blossom of *poyomatli,* the flower of cacao" [(46) p. 25]. Reverentially, he refers to *poyomatli* as *quetzalpoyomaxochitl,* the prefix *quetzal* denoting something exquisite or precious. With this evidence it can be safely assumed that at least one *poyomatli* corresponds to *Theobroma cacao* and *poyomaxochitl* to its flower. In order to determine a possible chemical basis for emphasis on the flower and the early fruiting pod we have undertaken the study of the content of xanthines or other possible psychoactive compounds in different parts of the plant during different stages of development. One puzzling aspect of this plant is that it was used as a psychoactive compound in the Valley of Mexico, far from its tropical growing sites. This is also the case of the desert cactus, *Lophophora williamsii.* The statement of Hernández that *poyomatli* corresponds to more than one plant is strengthened by a testament from Xochimilco, a site in the Valley of Mexico, in which is mentioned a *poyomacatl,* a house where *poyomatli* grows. Perhaps this corresponds to the root encountered by Hernández (12) and to the odorous root referred to as *puyomate* in the archives of the Inquisition (13).

In the aforementioned pantomime poems (46) there are also frequent references to aquatic plants that inebriate. The term *quetzalaxochiacatl,* "the precious water flower," may correspond to *Nymphea ampla* (47). This water lily is extensively represented in Mayan art. The suggestion that it was used as a sacred psychotropic during the classic Mayan civilization (48) is supported by analysis of the Bonampak frescos, reports of recreational use of *N. ampla* in the Mayan highlands, and the presence of aporphine alkaloids in the genus (47).

An interesting case of nonspecificity in Indian nomenclature is *piule,* which has been found to refer to psychoactive seeds of *Leguminosae* and *Convulvulaceae* and also to *Psilocybe* mushrooms (17, 32, 45). The etymology of *piule* is obscure but it seems certain that it is not a Náhuatl word. Reko (26) thinks that it is related to

peyote, derived from *pi-yahutli,* a term denoting any psychotropic plant. Wasson agrees that *piule* might be a Zapotec derivation of *péyotl* (32).

That some of these names seem to designate several species of plants suggests two possibilities: either these Náhuatl names could have been given before the conquest to plants sharing similar properties or this nonspecificity might have resulted from the repression and subsequent dispersion of their use after 1520. There is convincing evidence in favor of the first possibility; for example, *zoapatl* is reported as a generic name of five or six plants that produce uteroconstriction. Nevertheless, some names are more specific than others, especially when they designate morphological characteristics of the plant. The common element of the Náhuatl names for psychoactive plants conveys respect or veneration. Sometimes this is evident, as in *teonanácatl* "mushroom or flesh of the gods" (3, 28) while in other cases it is implied only through association, as with *ololiuhqui,* also called *coatl xoxouhqui,* "green snake," signifying something powerful (13). Deference is also expressed through the use of the prefix *quetzal* and the suffix *tzintli.*

The concepts of darkness, the color black, or light frequently occur or are implied in the names of magic plants. For the Náhuatl the term *light* carries the same meaning as the color black. We find in the archives of the Inquisition an "*ololiuhqui* of the dark man." Its counterpart, *tlitlitzen* (*Ipomea violacea*), means "divine black one" (13). *Yahutli* (*Tagetes lucida*) also means "dark one" (47). These denominations seem to imply a dark person or a character that animates the plant which may appear after the ingestion as an image or a culturally determined stereotypic vision (40). Many names refer to the existence of such residing characters or deities of the plant who in some instances would appear or talk during its effects. This is the case with *toloatzin, pipiltzinzintli,* and "*ololiuhqui* of the dark man." When Sahagún (5, 10) says that *cacaoquavitl* takes possession of people there may be an implication of an animistic subject in the plant. Influenced by the conquest and colonization, and as a paradoxical result of repression, these indwelling characters have become transformed from pre-Columbian deities into Christian saints. As early as the seventeenth century the archives of the Inquisition identify *peyote* with the child Jesus (*Niño Jesús*) and with the Virgin Mary (13). Today, *Salvia divinorum* and *Turnera diffusa* are called *la Pastora* "the shepherdess," a possible reference to the Virgin Mary. *Tagetes lucida* is called *Flor de Santa María,* "flower of holy Mary," and the most frequent name for the morning glory seeds is *semillas de la Virgen,* "seeds of the Virgin." Other names use Christian figures such as St. Peter in *peyote de San Pedro* (*Mamillaria heyderii*) and St. Isidore in *San Isidro* (*Psilocybe cubensis*) (17).

USES AND CULTURAL ROLES

Despite colonial persecution and acculturation the magic plants are still in use among numerous Indian groups of Mexico. The intricate relationship between the effects of psychotropic plants, medicine, religion, and belief systems is just starting to be delineated.

Among modern Indian communities, shamans, *curanderos,* (healers), *brujos* (witch doctors), and *yerberos* (herbalists) know about the effects of sacred plants.

It is difficult to define the differences between these people since they are likely to share functions. The pure *yerbero* is an expert in medicinal plants; in Indian communities he will collect them himself or prescribe them to a patient. In urban Mestizo groups he will be found selling herbs in markets. On the other hand the pure *brujo* deals with magic; he uses herbs for their magical properties and his performance will be ritualistic and psychotherapeutic. The *curandero* is a Mestizo or peasant medicine man who combines the knowledge of a *yerbero* and the arts of the *brujo.* Finally, the shaman is the priest of Indian groups, an expert in states of consciousness who has direct access to the Sacred.

The role of social class in the use of psychotropic plants is important. The shaman, for example, occupies a high level in the stratification of Indian groups. The *brujo* is also respected and has special privileges, while the *curandero* and *yerbero* will be found among lower classes. In classic Indian cultures there are indications that the use of magic plants was passed from lower to higher strata of the population, where the knowledge was then concealed in highly elaborate esoteric arts and rituals (40).

One of the most frequent uses of these plants has been and is the location through divination of a lost person, domestic animal, or object (6, 13, 32, 35). In some aboriginal cultures it is common that the shaman, *brujo,* or *curandero* ingest psychodysleptics in order to diagnose illness. While under the influence of the plant the curer may receive visions of the missing item, knowledge of the cause of disease, or direct information from the residing deity of the plant. After the diagnosis the medicine man proceeds to exorcise the supernatural cause of the disease by magical means such as cleansing and suction or to treat the condition by prescribing medicinal herbs (16, 32, 35, 47, 49).

In some instances the magic plants are used to produce disease instead of healing. It is frequent that rival shamans try to damage one another by ingesting hallucinogens and performing special rites.

It has been found that psychotropic plants are used in the rituals of religious feasts. The most well-known of these is the yearly pilgrimage of the Huichols to collect and consume *peyote* (35, 50). In Mazatec country some families perform a religious ceremony with *Psilocybe* mushrooms once a year with no other apparent purpose than to experience and share the effects (47).

Independent of the specific intention, the consumption of psychedelic plants is intimately connected to religion, the central purpose being to come in contact with the Sacred (e.g. 16). In Yaqui (51) and Mazatec (47) cultures there is a protracted procedure for obtaining shamanic powers which involves the repeated ingestion of sacred plants in order to develop comprehensive empirical knowledge of their effects. Such knowledge is essential for initiation as a shaman or a *brujo.*

The magical plants are feared and respected since, as we have seen, they are believed to contain a residing deity or animate principle. The plants are handled with care, often chanted to and smoked in copal incense (32, 47, 52).

There are a series of regulations to be followed before and after the ingestion of psychodysleptic plants, usually involving fasting and sexual abstinence. The ingestion takes place most frequently in darkness and either in silence or during the long monotonous chanting of the shaman (16, 32, 35, 47). These carefully selected

variables maximize the perception of effects by means of sensorial isolation, increased intestinal absorption, directed attention, and psychological expectation. Belief systems, setting, and cultural, biological, and psychological factors affect the nature of the experience (40).

The practice of the rites and ceremonies is usually concealed from the general community involving only the patient and his family, a selected group of pilgrims or the shaman himself. The presence of a guide experienced with the effects of the plants who selects the time, place, dose, and other circumstances of the ceremony is common. The guide may choose to administer the plant to the patient, consultant, apprentice, and/or to himself. During the ceremony he is likely to dance, chant, play musical instruments, or repeat the voice of the plant deity. The invocations frequently include the use of Christian names, even in remote monolingual tribes: St. Peter, St. Paul, and the Virgin Mary are the most commonly invoked (16, 47).

The continuity of the tradition surrounding and knowledge of sacred plants has been insured by the careful selection of apprentices and a rigorous training which involves experience with psychotropic plants, physical and psychological exercises, and exposure to difficult tasks (51). Thus, the shaman becomes an expert in the various states of consciousness including that of religious ecstasy (53). The shamanic flight, descent into hell, and communication with the godhead are brought about and directed by his use of magic plants.

PSYCHOPHARMACOLOGY

The effects of Mexican magic plants have been frequently classified under single labels like "narcotic," "hallucinogenic," or "psychedelic." This terminology is misleading, because our knowledge of both their cultural roles and pharmacological effects has disclosed a wide variety of actions indicating the need for reclassification. Brawley & Duffield (54) proposed in 1972 a division of what are known as hallucinogens into toxicants, deliriants, and psychomimetics. The available information points, however, to the existence of both more subtle and larger differences, even between plants within the same botanical family.

Plants may be considered as psychodysleptics, psychoanaleptics, or even psycholeptics, according to the well-accepted classification of psychotropic drugs proposed by Delay (55). In many instances it is difficult to assign a single psychopharmacological label to a plant since many either have actions that would include them in another group, produce qualitatively different biphasic effects, or have differential dose-related properties. Indeed, the same is true of some well-characterized psychotropics, for instance amphetamine, which could be considered either psychoanaleptic or psychodysleptic depending on dosage. It is of interest why plants with such a variety of actions should be regarded as sacred by Indian groups. Regardless of their differences these plants apparently have important common effects. The capacity to produce a distinct change in the quality of mentation, including light-headedness, a state of wonder, fascination with internal and external perceptions, and intensification of experience is the elementary psychopharmacological property of all the plants considered sacred or magic by the Indians who use them. These effects, which may take place accompanied by sedation, excitation, or

drowsiness, are not in themselves sufficient to classify the plants as psychodysleptics. The opiates, cocaine, and ethanol can produce some of these effects and have been revered by traditional and modern cultures (56). In order to classify a plant as a psychodysleptic it must produce varying degrees of affective, perceptual, imaginative, and thought modifications. As with psycholeptics or psychoanaleptics (55), there are important differences between families of psychodysleptics. A family of psychodysleptics is defined basically by similarities in subjective effects, cross-tolerance, and structure-activity relationships. A classification of Mexican sacred plants is now proposed based on these considerations.

Psychodysleptics

VISIONARY PSYCHODYSLEPTICS The visionary plants are highly revered by Indian groups who use them as a sacrament. The compounds produce important changes in all mental areas: distortion in perception (most notably in the visual sphere); emotional changes which can encompass widely varying states such as elation, serenity, panic, or apathy; and distinct changes in thinking and memory. High doses can produce effects such as depersonalization, profound wonder, dissociative reactions, ecstasy, experience of death, or visions (57, 58). This group is the only one that could properly be called hallucinogenic. There are two groups of chemicals found in these plants which induce similar experiences with only minor differences.

Phenethylamines Several dozen different phenethylamine molecules (Figure 1, *IV*) have been isolated from cacti, especially from *Lophophora williamsii* (59, 60). This group, of which mescaline (24, 25) (Figure 1, *IV;* 3,4,5=CH_3O; R_1, R_2=H) is the most active compound, produces, aside from visionary effects, intense sympathomimetic responses, euphoria, decreased fatigue, and sleeplessness (21, 57). The neuropsychopharmacology of the rest of the phenethylamines and tetrahydroisoquinolines (Figure 1, *V*) discovered in the cacti family (60, 61) is virtually unknown.

Indoles The indole structure is the nucleus of several hallucinogens including phosphorylated tryptamines such as psilocin (Figure 1, *I;* 4=OH; R_1, R_2=CH_3) and psilocybin (Figure 1, *I;* 4=OPO_3H; R_1, R_2=CH_3) which have been isolated from the magic *Psilocybe* mushrooms (3, 33). These chemicals appear to be responsible for the psychological effects of the mushrooms (58).

Despite structural disparities the powerful semisynthetic ergot-derivative *d*-lysergic acid diethylamide (LSD) [Figure 1, *III;* R=$(CH_2–CH_3)_2$] produces mental effects remarkably similar to mescaline and psilocybin (62). A methylated tryptamine, N,N-dimethyltryptamine (Figure 1, *I;* R_1, R_2=CH_3), produces as intense effects as those described for high doses of the visionary psychodysleptics which begin within five minutes and end one hour after administration (63).

IMAGERY-INDUCING PSYCHODYSLEPTICS This family of compounds produces, aside from the elementary properties of the magic plants, an increase in visual imagery, sensations of weightlessness or heaviness, recent-memory disturbances, distortion in the sense of time, rapid flow of ideas, and thought disorders such as

fragmentations, interruptions of the stream of thought, and occasional delusions. Three groups of chemical compounds comprise this family.

Cannabinoids *Cannabis sativa* is the prototype of this group (64), an important economic plant (source of fiber, oil, and drug) used ritually by peoples in Asia, Africa, and America and recreationally by Westerners (56, 65) from which several dozen dibenzopyran derivatives (Figure 1, *XIII*) have been isolated (66). Δ^9-THC (Figure 1, *XIII;* 1=OH; 3=C_5H_{11}; 9=CH_3) seems to be an active compound of this group (67). In the botanical family of Moraceae, *Cecropia obtusifolia* and species of *Ficus* have the reputation in Mexico of marihuana-like effects.

Coumarins Several Compositae, especially *Calea zacatechichi* (47, 68), produce effects similar to the dibenzopyrans although they are generally milder and briefer. *C. zacatechichi* reportedly enhances dreaming, an effect used for divination by a Chontal Indian in the State of Oaxaca (47). It is suggested that coumarins could undergo chemical modifications either during smoking (the usual route of ingestion) or in vivo to produce benzopyran compounds. Interestingly, other Compositae like *Artemisia absinthium* have strikingly similar psychological actions to *Cannabis sativa* and common characteristics between the active terpenoids of both plants have been noted (69). Another coumarin-containing composite, *Tagetes lucida,* is mixed with wild tobacco (*Nicotiana rustica*) and smoked by the Huichols for alleged psychotropic effects (47, 70).

Labiatae Compounds The prototype of the psychotropic mints, *Salvia divinorum,* produces brief colorful visual images, mild euphoria, and a sense of weightlessness (47). *Leonorus sibiricus* has been used to produce "marihuana-like effects" (47), and other members of this family are used for their psychoactive effects (47, 71). Two compounds have been detected in *S. divinorum* (47) and their structure is presently under study. Some synthetic mescaline analogues such as 3-methoxy-4,5-methylenedioxyphenylisopropylamine (Figure 1, *IV*; 3=CH_3O; 4-5=$-O-CH_2-O-$; α=CH_3; R_1, R_2=H) clearly belong to this family of psychodysleptics (72).

TRANCE-INDUCING PSYCHODYSLEPTICS This group of compounds shares the elementary properties of the magic plants, but is uniquely characterized by producing states of physical lethargy, quietude, apathy, serenity, and abstraction of mind.

Ergot Lysergic acid amide (Figure 1, *III;* R=H_2), its isomer iso-lysergic acid amide, and other ergot alkaloids found in members of Convolvulaceae called *ololiuhqui* (34) produce effects for several hours after the ingestion of the seeds, eventually resulting in a state of mental clarity (73, 74).

Glucosides Various glucosides such as turbicoryn (Figure 1, *XIV;* R_1=H; R_2=$O-(CH-OH)_3-CH_2-OH$) and corymbosine (Figure 1, *XIV;* R_1=$CH_2-O-(CH-OH)_3-CH_2-OH$; R_2=H) found in the seeds of *ololiuhqui* (*Rivea corymbosa*) (75) have been reported to produce mental apathy and physical sluggishness (76).

Heimia alkaloids A fermented potion of *Heimia salicifolia* induces a state of sedation and apathy during which the quality of perceived sound changes (19, 77).

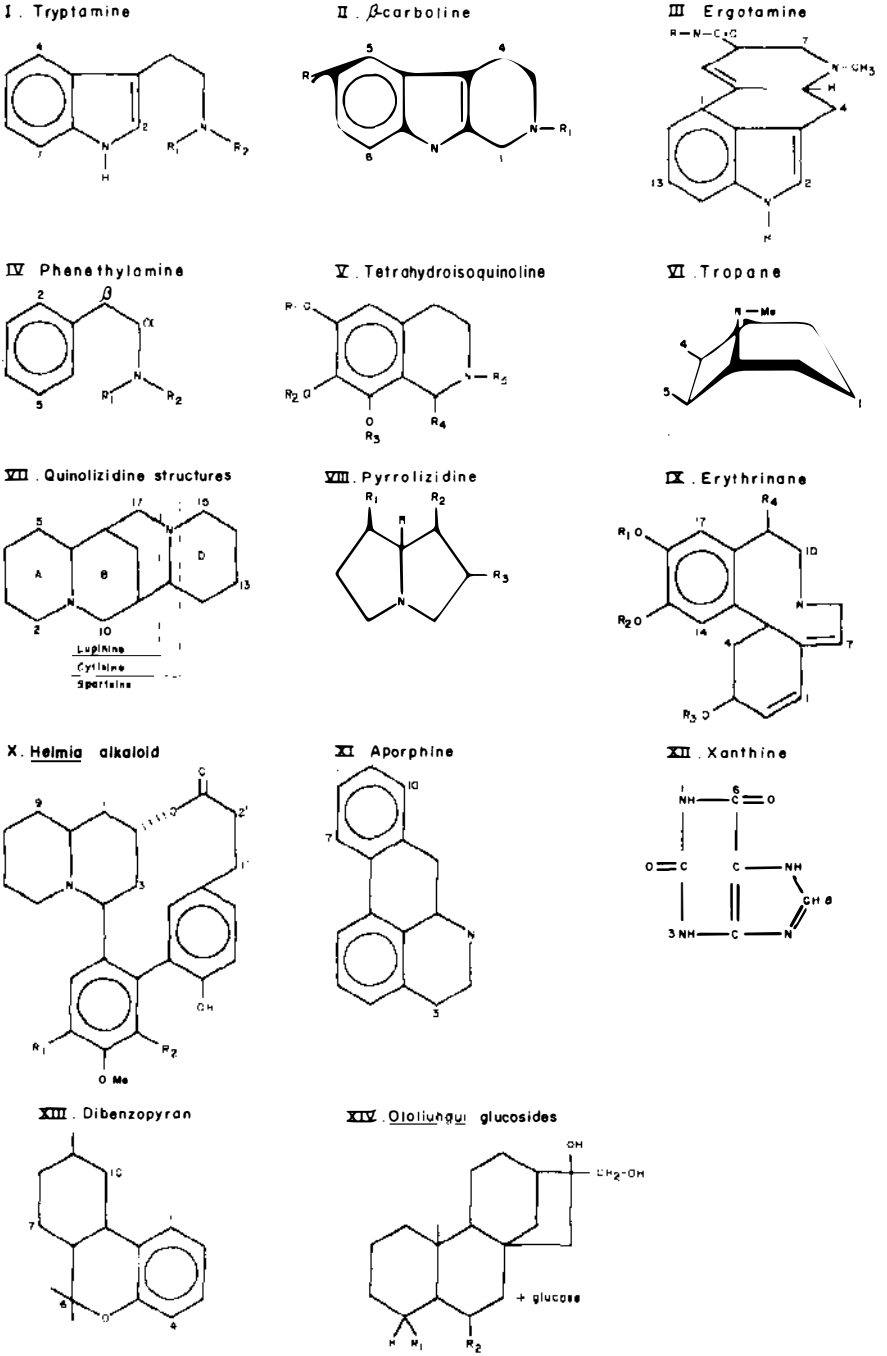

Figure 1 Basic structures of compounds found in Mexican sacred plants.

None of the alkaloids (Figure 1, *X*) found in the plant (78) have been found to be psychoactive, probably because the fermented material has not been studied and the fresh plant is inactive (47).

DELIRIANT PSYCHODYSLEPTICS These are substances inducing confusion, thought and speech disorders, anxiety, clouding of consciousness, and hallucinations.

Tropane The anticholinergic central nervous syndrome induced by species of tropane-containing Solanaceae is typical of the effects of this family (41, 51). Scopolamine (Figure 1, *VI;* 1=O–CO–CH (CH_2OH) Ø; 4–5=–O–) is an active compound responsible, at least in part, for the effects (79, 80).

NEUROTOXIC PSYCHODYSLEPTICS This group of substances produces important effects upon motor, vegetative, and peripheral neural functions in addition to their psychological effects.

Quinolizidine These ubiquitous chemicals (Figure 1, *VII*) found in the family Leguminosae (81) produce a state of stupor, clouding of consciousness, hallucinations, vomiting, and occasional convulsions (22, 26, 30, 45).

Erythrinane The alkaloids of *Erythrina* (Figure 1, *IX*) have curare-like activity and share the effects of the rest of the other neurotropic Leguminosae (22, 45, 82).

Pyrrolizidine The alkaloids of the genus *Senecio* (Figure 1, *VIII;* see 83), poorly understood as psychopharmacological agents, are reputed to be neurotoxic and in some instances to produce delusions (47, 84).

Psychoanaleptics

This class of psychopharmaca has three categories: antidepressant, excitatory, and euphoriant represented by tricyclic compounds, amphetamine, and cocaine respectively. The following Mexican herbs, considered magic, belong to the family of excitatory agents and induce some of the elementary psychopharmacological effects common to the magic plants.

EXCITATORY PSYCHOANALEPTICS These compounds produce increased mental and physical activity, a stimulation of thought processes, and a sense of well-being.

Ephedrine Some ephedrine-containing Malvaceae such as *Sida acuta* and *S. rhombifolia* (85) are smoked for their excitatory properties (47). The effects are similar to *kat* of the Arabs (*Katha edulis*) and the ancient Chinese *Ma Huang* (*Ephedra* spp.) (56) which contain ephedrine (Figure 1, *IV;* R_1=CH_3; R_2=H; α=CH_3; β=OH) and related compounds (85).

Xanthines There is historical evidence that the sacred *poyomatli* used by the Náhuatl as an inebriating agent corresponds to *Theobroma cacao* which contains

xanthines (Figure 1, *XII*), especially theobromine (Figure 1, *XII;* 3,7=CH_3). *Turnera diffusa,* which is used and respected by Yaqui medicine-men and traditionally regarded as an aphrodisiac (86), has been reported to contain caffeine (85). Further chemotaxonomical research is required in this group of plants to ascertain which xanthines or principles are responsible for their reputed actions.

CONCLUSION

The divine, sacred, or magic plants which function as intermediaries between some Mexican Indians and their deities contain compounds that share some elementary psychoactive properties. Six families of sacred plants can be distinguished according to their effects: visionary, imagery-inducing, trance-inducing, deliriant, neurotoxic, and excitatory agents.

After centuries of Western contact with Indian cultures and their magic plants, many of the botanical sources have been identified, chemicals considered responsible for their actions isolated, psychological effects described, and some specific neurochemical effects ascertained. While further specialized research may contribute historical, mythological, ecological, botanical, ethnological, phytochemical, psychopharmacological, and neurochemical information about each plant, it is clear that major advances can be made only by interdisciplinary groups. The capacity to design coordinated and sequential research strategies utilizing the methods of many fields should be the distinguishing characteristic of such groups. The growing field of ethnopharmacology emphasizes the need to understand the uses and effects of biodynamic plants in their cultural contexts as well as their chemical and pharmacological aspects. Social factors are considered to have an instrumental role in the modulation of biological effects of drugs.

Many areas in ethnopharmacology are suitable for interdisciplinary study. Further historical documentation of plants not clearly identified is necessary as well as a reevaluation of the cultural meaning of the ancient use of psychoactive plants. Ethnological work is needed to deepen our understanding of the modern uses of plants within specific cultural contexts, especially the nonvisionary psychodysleptics. Further botanical and chemotaxonomical research is required to isolate bioactive chemicals especially from psychoactive Compositae, Labiatae, Leguminosae, and Solanaceae. The ecology of psychotropic plants especially in relation to animal behavior is a new field. The effects of the majority of the plants and their chemical constituents upon the mind is in an embryonic state of understanding and the study of their actions upon animal behavior, brain chemistry, and physiology promises to be a productive research area in the years to come. Besides the gain in knowledge, some of the practical implications of this type of research are to be noted, especially its relevance to the mind-body problem, source of tools for neuroscience, and possible applications in psychiatry.

I hope that this review will stimulate studies that by coordinating different methods and strategies will yield a broader knowledge of the plants chosen by man to modify his mental functions, thereby expanding our understanding of such functions.

Table 1 Sacred plants used by Indian groups of Mexico

Name and etymology	Indian groups	Botanical sources	Cultural uses and effects	Phytochemistry
		Agaricaceae (Mushrooms)		
Teonanácatl (N)[a] (5) "flesh or mushroom of the Gods" (8)	Evidence of pre-Columbian use by Toltecs (3) and Náhuatl (4, 5).	Initially identified as species of *Panaeolus* (26, 28) and *Stropharia* (87), these mushrooms corresponded mainly to the genus *Psilocybe* in extensive transcultural field research (3, 8).	"Makes the heart whirl. . . saddens, makes people run away, scares them, sees many horrible things or perhaps funny. He runs away, hangs himself, screams. . ." (5, 11). "They eat the mushrooms as communion. . .attribute divinity to them, drink them in *pulque*" (6). Uses: For divination of cause and fate of disease or to resolve important problems by a shaman and suppliant. Regarded as holy in Indian communities that use them as sacraments (3, 8, 16, 32). Effects: Visionary psychodysleptics. Perception modifications. Increased visual imagery. Illusions. Hallucinations. Affective and intellectual alterations. Sympathomimetic effects (3, 89).	Psilocin (I^b; 4=OH; R_1, R_2=CH_3) and Psilocybin (I; 4=OPO_3H;R_1, R_2=CH_3). (33)
Teyhuinti (N) (12) "inebriant" (8)	Mushroom stones from Mayan areas (9). Colonial references (6, 7, 14).			
Quautlannanacatl (N) (6) "mushroom of the woods" (8)	Used by Náhuatl speaking people from Tenango in 1656 (6).	"Small red mushroom from the mountains" (6). Probably *Psilocybe wassonii* (3) =[c] *P. muliercula* (87).		Idem (3)
Badao-zoo, Beya-zoo (Z) "drunk mushroom" (26)	Zapotecs[d] (26)	*Panaeolus sphinctrinus* = *P. campanulatus* (26)		Idem (88)
Di-chi-to nizé, Di-nizé (Mz) "bird mushroom" (3, 90)	Mazatecs (3, 90)	*Psilocybe mexicana* (3.90)		Idem (3)
Nti-si-tho (Mz) "that which springs forth" (3, 90)	Mazatecs (3, 90)	*P. mexicana* (3, 90)		Idem (3)
Piule de churis (S-Z) "small narcotic" (3, 90)	Zapotecs (3, 90)	*P. mexicana* (3, 90)		Idem (3)
Cui-ya-jo-to-ki, Cui-ya-jo-o-tnu (C) "holy mushroom" (3, 90)	Chatino (3, 90)	*P. mexicana* (3, 90)		Idem (3)

Table 1 *(Continued)*

Teotlaquilnanácatl (N) (3, 90)	Nahua (3, 90)	*P. mexicana* (3, 90)	Similar effects found with psilocybin (58).	Idem (3)
Piule de barda (S) (3, 90)	Zapotecs (3, 90)	*P. mexicana* (3, 90)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
A-mo-kia (Ch) "for divination" (3, 90)	Chinantecs (3, 90)	*P. mexicana* (3) *Panaeolus sphinctrinus* (26)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Di-chi-tó ki-shó (Mz) *Derrumbe* (S) "land slide" (3, 90)	Mazatecs (3, 90)	*Psilocybe caerulescens* var. *mazatecorum* (3)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Razón mbei (S-Z) "mushroom of reason" (3, 90)	Zapotecs (3, 90)	*P. caerulescens* var. *mazatecorum* (3)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Cui-ya-jo-o-su (C) "powerful sacred mushrooms" (3, 90)	Chatino (3, 90)	*P. caerulescens* var. *nigripes* (3)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Derrumbito negro (S) "black little landslide" (3, 90)	Mazatecs (3, 90)	*P. caerulescens* var. *nigripes* (3)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Apipiltzin (N) (3, 90)	Nahua (3, 90)	*P. aztecorum* (3)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Siwatsitsíntli (N) "little women" (3, 90)	Nahua (3, 90)	*P. wassonii* (3) = *P. muliercula* (87)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Santitos (S) *Netochutáta* (Mt) "sacred little ancestors" (91)	Matlazingas (91)	*P. wassonii* (3) = *P. muliercula* (87)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Di-shi-tjo-le-rra-ja (Mz) "divine manure mushrooms" (3, 90)	Mazatecs (3, 90)	*P. cubensis* (87) = *Stropharia cubensis* (3)	Idem (3, 8, 16, 32, 58, 89)	Idem (3)
Di-nizé ta-a-ya (Mz) "mountain bird" (3,90)	Mazatecs (87)	*P. yungensis* (87) *P. isauri* (87) *P. caerulipes* (87)	Idem (3, 8, 16, 32, 58, 89)	Psilocybin not found in *P. yungensis* (3)

Table 1 *(Continued)*

Name and etymology	Indian groups	Botanical sources	Cultural uses and effects	Phytochemistry
		Cactaceae (Cactus family)		
Peyote (S) (5) from *péyotl* (N) "covered by silk," "to prick, stimulate" (13), "bud," "shining one"	Evidence of pre-Columbian use by Chichimecas and Toltecs (5, 12) as well as north of Tarahumara area (2). Extensive evidence of use during colonial times (6, 13, 14, 21).	*Lophophora williamsii* = *Anhalonium lewinii* (20, 27)	Visionary psychodysleptic. Perception modifications. Increased visual imagery. Illusions. Hallucinations. Affective and intellectual alterations. Sympathomimetic effects. Euphoria. Decreased fatigue. Sleeplessness (21, 57).	Mescaline (*IV*; 3, 4, 5=CH_3O; R_1, R_2=H) (24, 25); biosynthesized from dopamine by activity of an O-methyltransferase (38, 59). Several dozen β-phenethylamines and isoquinolines such as anhalonidine (*V*; R_1, R_2, R_4=CH_3; R_3, R_5=H) (60).
Híkuli, Híkuli wanamé, Híkuli walula saeliami (T) (23, 52)	Tarahumara (23, 52, 92)	*Lophophora williamsii* (23)	Idem (21, 57). Used by Tarahumara long-distance runners (23, 52). Used sacramentally.	Idem (59, 60)
Hicuri (H) (35, 50, 93)	Huichol (35, 50, 93) Cora (50)	*Lophophora williamsii* (35, 50)	Idem (21, 57). Collected in yearly pilgrimage by the Huichol. Used sacramentally (35, 50).	Idem (59, 60)
Peyote cimarrón (S) *Híkuli sunami* (23) *Sunami* (T) (17)	Tarahumara (23, 52)	*Ariocarpus fissuratus* (23)	Used by runners for endurance (23).	Hordenine (*IV*; 4=OH; R_1, R_2=CH_3). N-Methyltyramine (*IV*; R_1=CH_3; R_2=H) (95).

Table 1 *(Continued)*

Falso peyote (S) (94) *Chaute* (H) (17)	Huichol (94)	*A. retusus* (94)	"Toxic." Poorly understood (94).	Idem (95)
Hikuli rosapari (T) *Hikuli mulato* (T-S) (23, 92)	Tarahumara (23, 92)	*Epithelantha micromeris* (23, 92)	Used by runners for endurance. "Increases vision" (23, 92).	—[e]
Peyote San Pedro (S) (17) *Witculiki, Wichuriki* (T) from *wichuwa-ka* (T) "madness" (52)	Tarahumara (52)	*Mammillaria heyderii* (52, 61)	Used by runners for endurance. "Clarifies vision" (52, 61).	N-methyl-3,4-dimethoxyphenethylamine (*IV*; 3,4=CH_3O; R_1=CH_3; R_2=H) (61)
Chilito, *Biznaga de chilillos* (S) (61)	Tarahumara (61)	*Mammillopsis senilis* (61)	Considered sacred by Tarahumara (61)	—
Bakana, Bakánawa (T) (52)	Tarahumara (52)	*Corypantha compacta* (52)	"A form of *hikuli*"; effects not defined (52).	N-methyl-3,4-dimethoxy-β-methoxyphenethylamine (*IV*; 3,4=CH_3O; R_1=CH_3; R_2=H; β=CH_3O) (96)
Hikuli (T) (52) *Pitallita* (S) (17)	Tarahumara (52)	*Echinocereus triglochidiatus* (52)	"Important mental changes" (23, 52)	Alkaloids isolated but not identified (see 52)
Chawé, *Wichowaka* (T) (92), *Cardón* (S) (17)	Tarahumara (52, 92)	*Pachycereus pecten-aboriginum* (52)	"Dizziness and visions" (92)	3-Hydroxy,4-methoxyphenethylamine (see 52)
Peyotillo (S) (61)	Used in San Luis Potosí (61, 97)	*Pelecyphora aselliformis* (61)	Used for fever and as a *peyote* substitute (61)	Several β-phenethylamines (61, 97), including trace amounts of mescaline (97)

Table 1 *(Continued)*

Name and etymology	Indian groups	Botanical sources	Cultural uses and effects	Phytochemistry
		Compositae (Composite family)		
Thle-pela-kano (Co) "god's leaf" (68) *Hoja madre* (S) "mother leaf" (47) *Zacatechichi*[f] (N) "bitter grass" (17)	Chontal (47, 68)	*Calea zacatechichi* (47, 68)	Imagery-inducing psychodysleptic. Brief and mild marihuana-like effects. Traditionally used to increase appetite. Used by Chontal to induce divinatory dreams (47).	Coumarins, lactones, terpenes (see 47)
Yauhtli, Yyahitl, Yyahutli (N) "dark one" (47) *Pericón*[f] (S) (17, 47)	Classic Náhuatl (5, 12)	*Tagetes lucida* (26)	Used for numbing senses of sacrificial victims (5)	Coumarins, lactones, terpenes (see 47)
Tumutsali (H) (70)	Huichol (47, 70)	*Tagetes lucida* (47, 70)	Huichol psychotropic smoking mixture with *Nicotiana rustica* (47, 70)	Coumarins, lactones, terpenes (see 47)
Peyote de Tepic (S) (18, 20)	—	*Senecio hartwegii* (18, 20)	These noncactaceous *peyotes* may have been used as psychotropic agents. Neurotoxic. Poorly defined CNS actions (47).	The genus *Senecio* is rich in pyrrolizidine alkaloids [(*VIII*), see 83].
Peyote del Valle de Mexico (S) (18, 20)	—	*Senecio* spp. (18, 20)	Idem (47)	Idem (see 83)
Peyote de Xochimilco (S) (18, 20)	—	*Senecio cardiophylus* (18, 20)	Idem (47)	Idem (see 83)
Peyote (S) (18, 20)	—	*Senecio grayanus* = *Senecio cervarifolius* (18, 20)	Idem (47)	Idem (see 83)

Table 1 *(Continued)*

Quantlapatzinzintli (N) *Rabanillo* (S) (84)	—	*Senecio tolucanus* (84)	Used to madden enemies (84)	Idem (see 83) "Toxisenecine" (84)
Palo loco (S) (98) "crazy stick"	—	*Senecio praecox* (98)	"Produces delusions" (98)	Idem (see 83)
		Convolvulaceae (Morning Glory Family)		
Ololiuhqui (N) (5, 12) "round thing" *Coaxihuitl, Coatl xoxouhqui* (N) (5) "green snake" (13)	Used in pre-Columbian times by Náhuatl (5, 12). Documentation of use during colonial times (6, 13, 14, 99).	*Rivea corymbosa* = *Turbina corymbosa* = *Ipomoea sidaefolia* (18, 26, 29, 32)	Although the effects in the early chronicles were compared to *peyote,* these seeds are trance-inducing psychodysleptics. Biphasic effects: apathy, listlessness, sedation, fatigue, ultimately resulting in mental clarity. These effects are produced by seeds (73), ergot alkaloids, (74) and turbicoryn (75).	Ergot alkaloids, such as *d*-lysergic acid amide (*III*; $R=H_2$) and its isomer (34). Glucosides: turbicoryn (*XIV*; $R_1=H$; $R_2=O-(CH-OH)_3-CH_2OH$) and corymbosine (*XIV*; $R_1=CH_2-O-(CH-OH)_3-CH_2-OH$; $R_2=H$) (75).
Piule (Z) (26, 32) Semillas de la Virgen[f] (S) "seeds of the Virgin" (17, 32)	Zapotecs (26, 32)	*R.corymbosa* (26, 32)		
A-mu-kia, Huan-mei (Ch) (29)	Chinantecs (29)	*R. corymbosa* (29)		Idem (34, 75)
No-so-le-na (Mz) (29)	Mazatecs (29)	*R. corymbosa* (29)	Idem (73–75)	Idem (34, 75)
Badoo, Bevan-la-si (Z) "mystical being" (26)	Zapotecs (26)	*R. corymbosa* (26)	Idem (73–75)	Idem (34, 75)
Tlitlitzen (N) "divine black one" (13)	Used during colonial times (13).	*Ipomoea violacea* = *I. tricolor* (32)	Idem (32)	Ergot alkaloids (34)
La' aja schnaash (Z) (32)	Zapotecs (32)	*I. violacea* (32)	Idem (32)	Idem (34)
Badoh negro (Mz-S) (26)	Mazatecs (26)	*I. violacea* (32)	Idem (32)	Idem (34)
Jicama del monte (S) "root of the mountain" (26)	Zapotecs (26)	*Exogonium bracteatum* (26)	Roots consumed for "narcotic effects" (26)	—

Table 1 *(Continued)*

Name and etymology	Indian groups	Botanical sources	Cultural uses and effects	Phytochemistry
		Cyperaceae (Sedge family)		
Bakánoa, Bakanawa, Bakana (T) (52)	Tarahumara (52)	*Scirpus* spp. (52)	Revered by the Tarahumara. "Profound sleep during which long distances are traveled" (52).	Harmala alkaloids [*II* (see 85)]
		Erythroxylaceae (Coca family)		
—	Yaqui (45)	*Erythroxylon* spp. *E. coca* *E. tabascence* (45)	Doubtful report of a Yaqui religious dance in which endurance was enhanced by eating bread made with coca leaves (45)	Cocaine (*VI*; 1=COO-Ø; 2=COO-CH_3) (see 85)
		Labiatae (Mint family)		
Ska Pastora (Mz-S) "shepherdess leaf" (47, 71)	Mazatecs Chinantecs (26, 47, 71)	*Salvia divinorum* (100)	Used for divination and in shamanic training. Imagery-inducing, short-acting psychodysleptic. Sense of weightlessness. Affective alterations (47).	Two unidentified active compounds. Terpenes (47)
Marihuanilla (S) (47) "little marihuana"	Grows in Zoque territory (47)	*Leonorus sibiricus* (47)	May be smoked as a marihuana substitute (47)	Leonurine, leonuridine (see 47)
Macho (S) "male" (71)	Mazatecs (71)	*Coleus pumila* (71)	Report of use similar to *Salivia divinorum* (71)	—
Nene (S) "baby" *Ahijado* (S) (71)	Mazatecs (71)	*C. blumei* (71)	Idem (71)	—

Table 1 *(Continued)*

		Lauraceae (Laurel family)		
Canela (S) "cinnamon"	Grows in the state of Chiapas	*Cinnamomum zeylanicum*	Reports of marihuana-like effects in mixture with tobacco (45)	—
		Leguminosae (Pea family)		
Tzompanquahuitl (N) (17, 22) *Colorín*[f] (S) *Chilicote* (S) *Patol*	May have been used in Mexico in colonial times (22, 26)	*Erythrina coraloides* (22)	Curare-like effects. Neurotoxic. Stupor. Convulsions. Paralysis. Hallucinations (22, 82).	Erythrinane alkaloids [*IX* (see 82)]
Kaposí, Aposhí (T) *Chilicote*[f] (S) (17,52,92) coral bean	Tarahumara (52, 92)	*E. flabelliformis* (52)	Causes "erotic dreams." Used in medicine. Known nerve toxin (26, 52).	Idem (see 82)
—	Yaqui (101)	*Cystius canariensis* = *Genista canariensis* (101)	Used by medicine-men to induce visions (101)	Quinolizidine alkaloids, especially cytisine [*VII* (see 81)
Piule (Z) (17) *Negrito* (S) (45)	Possible pre-Columbian representations (30). Zapotecs (26).	*Rhynchosia longeracemosa* = *R. pyramidalis* (26)	Used to produce "visions" (26)	Quinolizidine alkaloids [*VII* (see 81)]
Frijolillo, Chilicote (S) (1) Mescal bean, red bean	Pre-*peyote* cult in northeastern Mexico and southern Texas (1). Referred to by Cabeza de Vaca during the conquest (see 31).	*Sophora secundiflora* *Sophora speciosa* (V. H. Jones and W. L. Merrill, submitted for publication; see 30, 31)	Dizziness, numbness, hypothermia, stupor, visions (V. H. Jones and W. L. Merrill, submitted for publication; see 30, 31)	Quinolizidine alkaloids: cytisine, N-methylcytisine, sparteine [*VII* (see 102)]
Frijol del mar (S) (47) "bean of the sea"	Seeds found in graves in Oaxaca, Yucatan and Peru (300 BC - 900 AD) (103)	*Canavalia maritima* (47)	Smoked as a marihuana substitute on the Gulf Coast of Mexico (47)	*l*-Betonicine (see 47, 85)

Table 1 *(Continued)*

Name and etymology	Indian groups	Botanical sources	Cultural uses and effects	Phytochemistry
		Lythraceae (Loosestrife family)		
Sinicuiche (S) (19) from *xonocuilli* (N) "crooked foot" *Jarilla* (S) (47) *Yerba de las ánimas* (S) (17) "soul shrub"	Used by modern Nahua (19, 77) and in southern Veracruz (T. Knabb, personal communication)	*Heimia salicifolia* = *Nosoea salicifolia* (19)	As a fermented potion, produces sedation, auditory distortions. Uterotonic agent (19, 77; T. Knabb, personal communication).	*Heimia* alkaloids: Cryogenine (*X*; 1′-2′=CH=CH; R_1=OCH_3; R_2=H) (78). Psychoactive principles unknown (47).
		Malvaceae (Mallow family)		
Chichibe (S) *Malva de platanillo* (S) *Malva colorada* (S) (17, 98)	Used on the Gulf Coast near the Popoloca region (47)	*Sida acuta* (47)	Smoked as an energizer and marihuana substitute (47)	Ephedrine (*IV*; 3,4=OH; R_1, R_2=H; α=OOH; β=OH) (see 85)
Escobilla (S) *Huinar* (S) (17)	Idem (47)	*Sida rhombifolia* (47)	Idem (47)	Idem (see 85)
		Moraceae (Mulberry family)		
Pipiltzintzintli[g] (N) (43) "venerable child" *Marihuana* (S)	Used as a psychotropic by Indians in 1772 (43). Ritually used by Tepehua and other groups (T. Knabb, unpublished observations).	*Cannabis sativa* (104)	Imagery-inducing psychodysleptic. Affective and thought alterations (64).	Dibenzopyran derivatives (*VIII*): Δ^9-tetrahydrocannabinol (*XIII*; 1=OH; 3=C_5H_{11}; 9=CH_3) (67) and several dozen other cannabinoids (66)

Table 1 *(Continued)*

		Nymphaeaceae (Water lily family)		
Quetzalaxochiatl[g] (N) "precious water flower" (see 47) *Lila acuática* (S) (17) "water lily"	Possible Mayan hallucinogen (48). Represented in ritual scenes in Mayan art (47, 48). Inebriating water plants mentioned in Náhuatl poetry (46, 47).	*Nymphea ampla* (47, 48)	Modern recreational use in Mayan areas. Reports of prolonged and powerful hallucinatory effects (47).	Aporphine alkaloids in the genus *Nymphea* [*XI* (see 47)]. One alkaloid isolated in *N. ampla* from Mayan region (47).
		Solanaceae (Nightshade family)		
Tlápatl (N) "fire light," "red color" *Nacazul, Mixitl, Tolohuaxihuitl* (N) (5, 12) *Toloache*[f] (S) from *toloatzin* (N) "bowing venerable lord" and other names such as *toloachi, toloche, tolovachi, chamico* (17, 41)	Extensively used by Indian, mestizo, and urban groups from pre-Hispanic (5, 12) to colonial (99) and modern times (41, 45, 51)	*Datura* spp., section *Dutra*: *D. innoxia* = *D. metel*; section *Stramonium*: *D. stramonium* (30, 31, 41, 42).	Deliriant psychodysleptic. Anticholinergic CNS toxin. Delirium. Hallucinations. Anxiety. Disorientation (41). Used in shamanic training (51).	Tropane alkaloids, especially *l*-scopolamine (*VI*; 1=O-CO-CH(CH_2OH)-Ø; 4-5=-O-) (see 79)
Dekuba, Tibuwari, Wichuri (T) (52)	Tarahumara (52)	*D. innoxia* (92)	Idem (41). Mixed with *tesguino*, a fermented maize drink. Used in shamanic rites (92).	Idem (79)
Kieli-sa (H) (35, 93)	Huichol (35, 93)	*D. stramonium* (35, 93)	Idem (41). Myths exist of a "datura person" (93).	Idem (79)

Table 1 *(Continued)*

Name and etymology	Indian groups	Botanical sources	Cultural uses and effects	Phytochemistry
Tecomaxochitl (N) *Floripondio*[f] (S) (17)	These trees are found associated with Indian houses in many areas (30, 31) (e.g. Mazatecs, Mixtecs)	*Datura* spp., section *Brugmansia:* e.g. *D. arborea, D. sanguinea, D. suaveolens* (30, 31, 42).	Intense initial agitation followed by a long disturbed sleep with vivid images (30, 31)	Idem (79)
Nexchuac (N) *Torna-loco* (S) (98) "maddening"	—	*Datura* spp., section *Ceratocaulis:D. ceratocaula* (98)	Deliriant psychodysleptic	Idem (79)
Huipatli, Tecomaxochitl (N) (98)	Ancient Náhuatl and modern use in Guerrero (98).	*Solandra guerrerensis* (98)	Deliriant psychodysleptic (98)	Idem (85)
Kieli (H) "god-plant" (105)	Huichol (105)	*Solandra brevicalix* (105)	Deliriant psychodysleptic. Worshiped as a deity. Said to produce fearful visions (105).	Idem (85)
Yetl (N) (5, 12, 13) *Quauyetl* (N) (13) tobacco	Indian religious use in pre-Columbian (5, 12) and colonial times (13, 14, 99). Widely used by modern Indian groups (32, 47).	*Nicotiana tabacum* (13)	Smoked and applied to ward off evil spirits in many Indian groups (32, 47). Suggested hallucinogenic action (106).	Nicotine, harmala alkaloids [*VI* (see 106)]
Picietl (N) (5, 12, 13) wild tobacco	Idem (5, 12, 13, 14, 32, 47, 70, 99)	*Nicotiana rustica* (13, 32)	Idem (32, 47, 106). Hallucinogenic mixture with *Tagetes lucida* used by the Huichol (47, 70).	Idem (see 106)

Table 1 *(Continued)*

Camotillo (S) from *camotli* (N) potato (45)	Mayan groups (45)	*Solanum tuberosum* (45)	Leaves are neurotoxic. Possible impairment of consciousness when ingested (45).	Saponine, solanine (see 45, 85)
		Sterculiaceae (Chocolate family)		
Poyomatli (N) *Poyomaxochitl* (N) *Cacaoaquauitl* (N) (5)	Náhuatl (5)	*Theobroma cacao* (see text)	Flower or early fruiting pod of cacao revered and used by ancient Náhuatl (5), especially poets [(46) see text]	Xanthine derivatives, especially theobromine (*XII*; 3,7=CH_3) (see 85)
		Turneraceae (Turnera family)		
Damiana[f] (S) (86) *Hierba de la pastora* (S) (17) "shepherdess herb"	Yaqui (86)	*Turnera diffusa* (86)	"Aphrodisiac." Used by northern Indians as an invigorator (86, 98)	Caffeine (*XII*; 1, 3, 7=CH_3) (see 85)

[a] Capital letters after the name indicate language: C, Chatino; Ch, Chinantec; Co, Chontal; H, Huichol; Mt, Matlatzinga; Mz, Mazatec; N, Náhuatl; S, Spanish; T, Tarahumara; Z, Zapotec.
[b] Roman numerals correspond to chemical formulas pictured in Figure 1.
[c] Synonymous botanical denominations are denoted by an equals sign.
[d] Unless otherwise indicated, the plants are used in modern times by these groups.
[e] No information was found in regard to this category.
[f] Vulgar names used all over Mexico to designate the particular species.
[g] The identification of the vulgar name with the species is tentative.

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