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José Luis Díaz

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Ethnopharmacology and Taxonomy of Mexican Psychodysleptic Plants

JOSÉ LUIS DÍAZ, M.D.*

It has proven difficult to construct a taxonomy of the plants and chemical compounds that affect mental functioning and behavior which is generally acceptable to the many specialists working in the diverse fields embraced by the subject (Bobon 1973). This lack of consensus arises, at least in part, from the fact that psychotropic plants and substances cannot only be analyzed from the perspective of a number of disciplines, but may also be validly classified according to each of them. It is legitimate, for example, to employ botanical nomenclature, although the biodynamic properties and uses are thereby left obscure. Chemical taxonomy is also applicable; however, while having the advantage of indisputable objectivity, this system of nomenclature likewise fails to indicate the pharmacological effects since minor chemical modifications can give rise to major differences in activity. Similarly, an ethnological classification based on traditional usage can be proposed, but these vary widely between cultural groups.

The framework used in this paper is that of psychopharmacology: compounds and plants are grouped together according to a constellation of the most characteristic effects experienced by the majority of healthy individuals after the administration of an intermediate dose. A disadvantage of this perspective is, of course, the subjectivity of the responses. Nevertheless, with the tools of cognitive psychology it is possible to carry out an objective analysis of mental phenomena (Paivio 1975; Tart 1972); this focus has begun to be fruitfully employed in the field of hallucinogens (Siegel 1977). Another limitation to a psychopharmacological approach is the variability of the experience: whether the effects are subjectively or objectively defined, they are subject to environmental influences and determinants of considerable magnitude. Independent of these considerations we believe that a series of fundamental psychological effects can be defined whose nature and course are primarily determined and modulated by culture and personality, and conditioned by the time, place and context in which ingestion occurs (de Ríos 1975; Weil 1972). For example, a sufficient dose of an hallucinogen produces visions in the majority of subjects, although the content, concomitant emotions and interpretation are determined by the aforementioned social and individual factors.

One of the first classifications of psychotropics based on their mental effects was proposed by Louis Lewin (1924). He defined five classes of drugs: *euphorica*, represented by the opiates; *excitantia*, such as coffee; *inebriantia*, characterized by ethanol; *hypnotica*, or sleep-inducers; and *phantastica*, embracing the hallucinogens such as peyote. More than three decades later, Delay and Deniker (1961) proposed another taxonomic model based upon a postulated excitation-depression continuum. *Psychoanaleptics* were defined as those drugs which produce excitation and *psycholeptics* as those which induce depression. The substances which

*Instituto de Investigaciones Biomédicas, Universidad Nacional Autónoma de México, Apartado Postal 70228, México 20 D.F., México; Unidad de Investigaciones Cerebrales, Instituto Nacional de Neurología.

effected qualitative modifications in the mental faculties were called *psychodysleptics*, corresponding to the *phantastica* of Lewin and what are now known as hallucinogens. About the same time, Kline (1959) gave other names to the same trio defined by Delay. The World Health Organization (WHO) uses more restricted categories with terms indicative of pharmacological action. Expressions like minor tranquilizers and antipsychotics are characteristic, and in great measure refer to the effects of compounds employed in clinical psychiatry.

The classification to be proposed here is an elaboration of specific nomenclature within the general framework of the classes of psychopharmacological agents identified by Delay and Deniker. It has the merit of avoiding the terminological confusion of the last decades (Bobon 1973). Under this scheme the psychoanaleptics are composed of the following families: *psychostimulants, euphoriants, antidepressants, anxiety-inducers* and *convulsants*; the psycholeptics include the families of *hypnotic-sedatives, inebriants, minor tranquilizers, antipsychotics* and *antimanics*. We shall attempt to demonstrate that in consonance with these two classes of psychopharmacological agents, the psychodysleptics also comprise several families of substances with clearly discernible psychological and neural effects. It seems indispensable to distinguish these families within the psychodysleptic class since there is such confusion in the terminology at present. This group of substances is referred to with names as diverse as "narcotics," "psychotomimetics," "stupefacients," "hallucinogens" and "psychedelics" – words denoting categories that are not generally applicable, are ambiguous or are weighted with doctrinal implications. There have already been attempts to differentiate between several categories of psychodysleptics. In 1972, Brawley and Duffield separated the "toxic" and "deliriant" agents from the "psychotomimetics." Other authors have made a merely qualitative distinction between the "major" and "minor" psychodysleptics.

As a first step, it is necessary to precisely define the term "psychodysleptic" by the resultant psychological effects. One of the fundamental characteristics of this class of drugs is their ability to induce special states of consciousness which are qualitatively different from the ordinary. Identifiable psychological phenomena present during such states are: sensations of light-headedness or lightness in body; feelings of well-being or wonder; deautomatization of perception such that habitual stimuli appear novel; and, in the majority of cases, stimulation of visual imagination and fantasy. The most basic modification could be conceptualized as an intensification of experience.

Beginning with the general effects, particular families of drugs and plants are distinguished by further specific alterations. Thus, in the class of psychodysleptics, six families can be differentiated at present: *hallucinogens, trance-inducers, cognodysleptics, deliriants, neurotoxins* and *narcotics*. In the following sections, the constellation of mental and neurobiological effects characterizing the first five families will be defined. As the nomenclature to be proposed is based on the ethnopharmacology of Mexican psychodysleptic plants, narcotics are not mentioned since they are not traditionally used. The taxonomic scheme includes both botanical and chemical terminology which constitute objective data. Such chemical and botanical *species* belong to *groups* of substances or plants that generally give rise to a particular pharmacological effect. Several groups make up a *family* of similar effects and various families compose one of the *classes* proposed by Delay. A preliminary attempt to establish a bridge between social (e.g., sacramental) and psychopharmacological (e.g., hallucinogen) categories is made in the discussion.

A well-known species, *Datura stramonium*, and chemical, LSD, will serve to illustrate the proposed taxonomic scheme:

Class	Psychodysleptics	Psychodysleptics
Family	Deliriants	Hallucinogens
Group	Tropane Solanaceae	Ergolines
Botanical species	*Datura stramonium*	–
Chemical compounds	Scopolamine, atropine	LSD

Mexican psychodysleptic plants classified according to this system are listed in Table I and those with uncertain effects appear in Table II. In the following sections, botanical species are described with an emphasis on traditional uses, as well as on the psychological and neurobiological effects which justify their inclusion in specific families. Ethnopharmacological data are analyzed only when they have not been completely presented by other authors or to add new data. Above all, information obtained in our laboratory over the past two years that brings previously published material up to date (Díaz 1977, 1975) is discussed.

HALLUCINOGENS

The term "hallucinogen" strictly refers to a substance that can induce sensorial perception in the absence of a consensually validated stimulus. Although many compounds and exceptional biological states give rise to hallucinations, the group of agents to which this denomination is restricted produce these phenomena in

a clear consciousness. Other hallucinatory states occur within a context of delirium or a dreamlike confusion. Furthermore, the hallucinogens elicit a constellation of psychic modifications which, though regulated by social, environmental and personal determinants, have universal features.

The sequence of alterations in imagination and fantasy can be described as follows: simple geometric patterns; complex images; dreamlike scenes. Some phenomenological characteristics of these images are surprisingly similar between subjects (Siegel 1977). A vision or substantive hallucination also takes place within a progressive modification of the sensorial sphere, beginning with increased vividness and deautomatization of perception; continuing with illusions, simple hallucinations of a geometric character and/or substantive visions of objects or subjects within the external perceptual space; and culminating with dissociative reactions in which all spatial and temporal elements are completely reassembled to form a different reality. Thought remains clear and tends towards an analysis of complex realities and the acceptance of contradictory statements. The change is essentially qualitative, embracing a modality which is intuitive-synthetic-spatial rather than rational-analytic-temporal.

The affective state is greatly intensified; emotions are felt with uncommon force and periods of profound wonder or even ecstasy may eventually be experienced. The components of such a state have been identified as: sensation of unity, transcendence of space and time, deeply positive emotions, wonder, reverence, meaning, ineffability, paradoxicality and transience (Grof 1975). This family of substances produces, therefore, a greater intensification of experience than the rest of the psychodysleptics. Some literary and poetic descriptions have been especially faithful to the phenomenon since they capture the subtlety and complexity of the global changes that take place simultaneously and interdependently in all mental spheres (e.g., Huxley 1954).

A small group of indolic substances make up the chemical species of this family: psilocybin, dimethyltryptamine, LSD and mescaline, a phenethylamine. Of the Mexican plants that are used ritually in sacramental, divinatory or magical contexts, only *teonanácatl* (psilocybin mushrooms) and *péyotl* (*Lophophora williamsii*) can be considered hallucinogens. Peyote has been called the prototype of the hallucinogens indigenous to America. The reader is referred to the extensive historical (Schultes 1969-70; Unsigned 1914), ethnobotanical (La Barre 1969; Aguirre Beltrán 1963; Lumholtz 1902), phytochemical (Bruhn 1975; Bruhn & Bruhn 1973; Kapadia & Fayez 1970) and psychopharmacological (Klüver 1966; Beringer 1927) reports concerning this cactus. The rest of the non-mescaline cacti and composite plants that constitute the ethnobotanical complex of peyote are analyzed in another section since their properties have not been well defined as yet.

Research on *teonanácatl* is equally as voluminous and has been recently summarized (Ott & Bigwood 1978). The original accounts of the historical (Wasson & Wasson 1958), botanical (Guzmán 1959; Heim & Wasson 1958), phytochemical (Hofmann 1970; Hofmann et al. 1958) and psychopharmacological (Nieto 1959; Delay et al. 1958) investigations are particularly fascinating.

Numerous observations on the neurobiological effects of these substances support their inclusion in a specific family. There exist similarities in the actions of the different hallucinogenic molecules on the mesencephalic raphe nuclei whose neuronal bodies give rise to the ascending serotonergic systems that innervate the limbic system and lateral geniculate body. Initially, it was discovered that these neurons are exquisitely sensitive to small systemic doses of LSD (Aghajanian, Foote & Sheard 1968) which reversibly inhibits their spontaneous discharge. Mescaline, psilocybin and other substances produce the same effect with an intensity proportionate to their potency as hallucinogens (Aghajanian, Foote & Sheard 1970). There is evidence that the inhibitory response is the result of interactions with the presynaptic serotonin receptors (Aghajanian & Haigler 1975). Furthermore, the hallucinogens stimulate the dopaminergic receptors in various areas of the brain (Nichols 1976), an effect which is shared with molecules that induce bizarre and automatized movements in animals. The fact that antipsychotic agents block not only the dopaminergic receptors but the psychological effects produced by the hallucinogens as well strengthens the idea that dopamine is involved in their action. Several common molecular conformations and steric models of the hallucinogenic substances have been proposed in order to explain the similarity of their properties (Johnson, Kang & Green 1975).

TRANCE-INDUCERS

The word "trance" evokes a state of quietness and abstraction which characterizes the effect of a series of plants and compounds used ritually in various parts of the world. In contrast to the previous family, these substances do not give rise to qualitative sensorial changes. However, they do induce irritation in response to external stimuli and fascination with forms and textures, although the subject might be primarily inclined to experience his/her inner states. The cardinal

symptom is lethargy: a phase of apathy and quiescence lasting for several hours. Within this context, some alterations occur in the cognitive sphere to which passive attention is given. Visual imagery increases and acquires a dreamlike tone similar to hypnagogic phenomena; in fact, during periods of somnolence, the subject may take these scenes as actual dreams. Concurrently, there is a marked tendency of the intellect towards reflection and concentration. This abstracted state is characteristic of the lethargic phase. Some authors have referred to this effect as a "paralysis of the will," implying that all phenomena associated with the experience occur in the absence of will and are received passively. At the end of the lethargic phase, a total recovery of mental faculties and behavior takes place and there may even arise a state of exceptional lucidity. Within this family are included some chemical species of ergolines, harmalines and substituted amphetamines.

Ololiuhqui

Of all the sacred plants of the ancient Mexicans, it is probable that *ololiuhqui* is the most frequently cited in the texts belonging to the period of the Spanish Conquest and Colonization of Mexico. Sahagún[1] (1950-1969) noted the following facts about these "inebriating and maddening" seeds: they were used by sorcerers to "do evil"; the people who ate them "appear to see visions and frightening things"; and they were employed as a local analgesic for gout (Book II). Hernández[2] (1959-1967) added a botanical description and mentioned that "in the sacrifices of the Indians, when they wanted to consult their gods and receive a response, they would eat this plant and become crazy, seeing a thousand phantoms and visions of the devil who was around them" (p. 73, Book XIV, Vol. II). With inquisitorial zeal, Acosta (1590) later recovered the recipe for the potion used by the priests to sacrifice victims which included *ololiuhqui*. Ruiz de Alarcón (1629) referred to its divinatory use through which "they communicated with the devil." Jacinto de la Serna (1656) also emphasized the importance of the seeds "which they hold in veneration as if they were God." This attitude prevailed throughout the Colonization: the archives of the Inquisition record a multitude of trials of indigenous users, certainly more numerous than those who ingested peyote and *pipiltzintzintli* (Aguirre Beltrán 1963).

The botanical identification of *ololiuhqui* as a Convolvulaceae was carried out at the Instituto Médico Nacional de México (National Medical Institute of Mexico, 1885-1917) by Urbina (1903). A certain confusion arose when Safford declared that *ololiuhqui* corresponded to *Datura meteloides*, but Reko (1928) verified the identity proposed by Urbina; subsequently, Schultes (1941) unequivocally established it as *Rivea corymbosa* in a classical work on the ethnobotany of this plant.

The divinatory use of *ololiuhqui* has been frequently reported and there exist extensive reviews on the subject (Bailin 1975; Wasson 1963). At present, this practice is restricted to the state of Oaxaca especially among the Chinantecs (who call it *a-mu-kia*); the Mazatecs (*no-so-le-na*); the Mixtecs (*yuca-yaha*); and particularly among the Zapotecs who use the seeds of *Rivea corymbosa* (*bado, bado shnash*) as well as those of *Ipomoea violacea* (*bado negro, la'aja shnash*). The latter plant may correspond to the *tlitlitzen* ("divine black one") of the Nahuas (Wasson 1963). In general, these seeds are known as *piule* in Oaxaca or *semillas de la Virgen* ("seeds of the Virgin") throughout Mexico. *Piule* is the name of several psychotropic plants, including mushrooms of the genus *Psilocybe* and various Leguminosae of the genus *Rynchosia*. The etymology of the word is uncertain, although it does not appear to be a Náhuatl term. Reko (1945) as well as Wasson (1963) is of the opinion that it is a derivation of the word *péyotl*.

The ritual surrounding the divinatory use of the seeds is similar to that associated with the psilocybin mushrooms and especially with *ska Pastora* (*Salvia divinorum*). Thus, the *curandero* (indigenous healer) often administers the ground seeds to a petitioner in total darkness and silence instructing him/her to speak and thereby reveal the origin of a disease, its treatment or the whereabouts of a stolen object. The ethnological descriptions do not mention the presence of vivid visions, but rather refer to a peculiar state of revelation (Fields 1968). The medical uses of the morning glory seeds in the popular Mexican pharmacopoeia resemble those of other psychodysleptics (Díaz 1976b). Thus, they are widely employed as a local analgesic. Another member of the *Ipomoea* genus, *I. stans*, has a substantial reputation as an anticonvulsant, antichoreic agent and purgative. The latter action is reported for approximately twenty species of *Ipomoea* and was doubtless responsible for the fame of the "root of Jalapa" (*I. jalapa, I. longepedunculata, I. orizabensis* and *I. purga*) during the Colonization. There is no indication that any of these species give rise to psychotropic effects similar to those produced by *ololiuhqui*.

The descriptions of autoexperiences as well as the results of controlled studies with *ololiuhqui* or its active chemical components are fundamentally in agreement that the effects are distinct from those exerted by the

hallucinogens. Reko himself distinguished the actions of the mushrooms from those of the seeds of *ololiuhqui* which he said produced a "somnambulant state" (1945). Osmond (1955), inspired by the work of Schultes, carefully related his autoexperiences with varying amounts of the seeds. The main effect was reported to be an intense apathy or "paralysis of the will" accompanied by indolence, irritability, perception of visual forms with closed eyes, stupefaction and upon their disappearance a notable relaxation and mental clarity.

It was Hofmann's lot to discover his favorite alkaloids derived from ergot in the seeds of the Mexican *ololiuhqui* (1963) that Wasson had sent to him. Hofmann was the first to be surprised since the ergot alkaloids had only been found in the lower mushrooms, especially in the genus *Claviceps*. The principal constituents of *Rivea corymbosa* have been identified as the amide and hydroxyethylamide of lysergic acid; though structurally similar to LSD, they are much less potent and qualitatively distinct. Hofmann (1963) tested the main alkaloids on himself and reported apathy, a sensation of mental emptiness, irritability and a loss of connection with the exterior world.

Despite the chemical similarities, there are differences between some species of *Claviceps* and *Rivea*. While rye ergot is rich in complex lysergic alkaloids of the peptide type such as ergotamine, *ololiuhqui* contains only ergolines, simple lysergic acid amides. However, ergonovine is present in both genera and also has psychoactive properties as Hofmann has recently demonstrated (Wasson, Hofmann & Ruck 1978). The principal effects of this compound are reported to be tiredness, visual imagery, a sharpening of objects within the visual field and an increased inclination to observe inner experiences. The same simple alkaloids that are in *ololiuqhui* are found in *Claviceps paspali*, the parasitic ergot which infests the Mediterranean grass *Paspalum distichum*. Wasson, Hofmann and Ruck (1978) have proposed that this might have been prepared as an aqueous extract and used in the ancient Greek mystery rites at Eleusis. The specific effects of these alkaloids have been corroborated in a double blind study comparing the actions of LSD and the *ololiuhqui* alkaloids (Isbell & Gorodetzky 1966). The difference was clear; the effect of the latter was characterized as "sedative."

The peptide alkaloids of ergot, especially the derivatives ergocornine and 2-Br-α-ergocryptine, induce a long-lasting stimulation of the dopamine receptors in the basal ganglia and nucleus accumbens (Fuxe et al. 1974). Any agent with this stimulatory effect, such as apomorphine and LSD (Nichols 1976), also gives rise to stereotypic behavior. The dopaminergic action of the ergot alkaloids at the hypothalamic level has a neuroendocrinological consequence: the inhibition of prolactin release and an increase in growth hormone release by the hypophysis (Silvestrini, Liuzzi & Chiodini 1978). The pharmacology of the simple derivatives of ergoline is even more complex since, besides exerting a dopaminergic action, they are potent central and peripheral antagonists of serotonin (Müller et al. 1977). The neuroendocrinological implications of these effects are now under study.

Sinicuiche

The first reference to the psychotropic properties of *Heimia salicifolia* was issued from the Instituto Médico Nacional. In his pharmacy thesis, Calderón (1896) stated that "the persons who have taken a decoction or juice of the plant experience a very agreeable inebriation, see all objects as yellow and hear the sound of bells, the human voice or anything else as if produced at a great distance." Years later, a cousin of Blas Pablo Reko, the journalist Victor Reko who transcribed many of his relative's reported experiences with psychotropic plants adding his own fantasies as well, mentioned that the leaves of *sinicuiche* when fermented by the sun produce an inebriating product. Among the effects he described were auditory hallucinations, sound distortion and an increase in the ability to evoke remote memories (Reko 1936).

In 1974, an ethnobotanical investigation was carried out in the areas of the state of Mexico cited by Calderón and Reko (Díaz 1975). The plant is sold as a uteroconstrictor in the herbalist (*yerbero*) stands under the name of *jarrilla* and *sinicuitl*. The vendors, upon being questioned, did not allude to any psychotropic properties. Two autoexperiences with an infusion made from fresh leaves merely produced an intense hypothermia. We later received information that a *curandera* from an arid region in the state of Tamaulipas uses a fermented potion of *sinicuiche* in divinatory ceremonies; however, there has been no opportunity to confirm the existence of this practice firsthand.

Around the same time, Knab (1979) encountered a *curandero* in the state of Veracruz who also uses *sinicuiche* for divinatory purposes. The concoction is prepared with the stemless leaves of *Heimia salicifolia* mixed with water and a little honey. The liquid is left standing in the dark for several days after which it is ready to be ingested. Knab tested this brew and described subtle effects consisting of sedation, lethargy and tinnitus. These ethnobotanical data, essentially in

TABLE I

PSYCHOPHARMACOLOGICAL CLASSIFICATION OF MEXICAN PSYCHODYSLEPTIC PLANTS

Class	Family	Group	Botanical Species	Chemical Compounds
Psychodysleptics	Hallucinogens	*Teonanácatl:* psilocybin mushrooms	*Panaeolus sphinctrinus* *Panaeolus subbalteatus* *Psilocybe caerulescens* *Psilocybe aztecorum* *Psilocybe caerulipes* *Psilocybe cyanescens* *Psilocybe mexicana* *Psilocybe pelliculosa* *Psilocybe semilanceata* *Psilocybe stuntzii* *Psilocybe wassonii* *Psilocybe zapotecorum* *Stropharia cubensis*	Indolamines: psilocybin*
		Péyotl: mescaline cactus	*Lophophora williamsii*	Phenethylamines: mescaline*
	Trance-inducers	*Ololiuhqui:* ergoline Convolvulaceae	*Rivea corymbosa* *Ipomoea violacea*	Ergolines: ergine*, isoergine*, ergonovine* Glucosides: turbicoryn*
		Sinicuiche: quinolizidine Lythraceae	*Heimia salicifolia*	Phenylquinolizidines

*psychoactive compounds

accord with the initial references, establish that the divinatory use of a fermented potion of *sinicuiche* in Mexico still exists. Further psychopharmacological observations are necessary in order to fully substantiate its preliminary identification as a *trance-inducer.*

Sinicuiche and other similar names are probably a derivation of the Náhuatl word *xonocuili*, literally "twisted foot." It is also used to refer to some Leguminosae with large, tortuous, partially exposed roots. It is likely that a number of leguminous plants of the genus *Rynchosia* are psychotropic and they will be discussed later. The Spanish name, *jarrilla*, is applied to other plants that are also used for brooms, such as *Selloa glutinosum* and *Baccharis glutinosa* (Díaz 1976a). Additional names for *sinicuiche* are *cuauxihuitl, huauchinolli, anchinol, rosilla de Puebla* ("little rose of Puebla") and *yerba de las ánimas* ("herb of souls"). The latter term also refers to *Helenium mexicanum* and *Ipomoea orizabensis* (Díaz 1976a). *Huauchinolli* probably means "the burning of wood" and *cuauxihuitl*, meadow fire. These related expressions could indicate psychotropic properties, in view of the abundance of Náhuatl terms signifying heat and fire which were used to designate psychodysleptics (Díaz 1977, 1975). *Heimia*

TABLE I

PSYCHOPHARMACOLOGICAL CLASSIFICATION OF MEXICAN PSYCHODYSLEPTIC PLANTS

Class	Family	Group	Botanical Species	Chemical Compounds
Psychodysleptics	Cognodysleptics	Marijuana: terpene Cannabaceae	*Cannabis sativa*	Cannabinols: Δ^9-tetrahydrocannabinol*
		Terpene Compositae	*Calea zacatechichi*	Germacranolids: caleicine
		Terpene Labiatae	*Salvia divinorum*	Terpenes
	Deliriants	*Toloatzin:* tropane Solanaceae	*Datura stramonium* *Datura inoxia* *Datura meteloides* *Datura ceratocaula* *Datura arborea* *Datura suaveolens* *Solandra guerrerensis* *Solandra brevicalix* *Solandra guttata* *Solandra nitida*	Tropanes: scopolamine*, atropine*
		Yétl: nicotine Solanaceae	*Nicotiana rustica* *Nicotiana tabacum* *Nicotiana trigonophylla*	Piperidines: nicotine*, nornicotine
		Isoxazole mushrooms	*Amanita muscaria*	Muscimol*
	Neurotoxins	Quinolizidine Leguminosae	*Sophora secundiflora* *Genista canariensis*	Quinolizidines: cytisine*
		Erythrinane Leguminosae	*Erythrina coraloides* *Erythrina flabelliformis*	Derivatives of erythrinane

salicifolia is also employed throughout the country as a uteroconstrictor, antipyretic, eupeptic, diuretic and purgative; some of these properties are shared by the aforementioned Convolvulaceae (Díaz 1976b). *Lawonsia inermis* is another member of the Lythraceae or loosestrife family known as *cuauxihuitl* which has been used as a sedative (Díaz 1976b).

The genus *Heimia* is rich in complex alkaloids with a basic structure of phenylquinolizidine including lythrine, sinicuichine, lythricine and especially cryogenine, which is probably responsible for the antipyretic effects (Raffauf 1970). None appear to be psychoactive. It is necessary to study both the fermented product and the dry leaf infusion in order to isolate the compound responsible for the reported mental effects. Nothing can be said at this time concerning the neurochemical actions of these alkaloids.

COGNODYSLEPTICS

In contrast to the hallucinogens, this family of plants and compounds very rarely induces hallucinations. Perceptual modifications are restricted to the deautomatization of perception and a greater vividness discernible in all sensorial spheres. The central effects of

the cognodysleptics are in the cognitive realm, especially in thought and imagination. Changes in thinking include discontinuity in the stream of thought, flights of ideas and alterations in short-term memory with particular difficulty in retrieval. On occasion, ideas of reference, suspicion or frankly paranoid ideation and depersonalization may develop. Visual imagination expands with a proliferation of images that are vivid, shifting, detached from volitional control and generally disconnected from each other. These images are not projected into the external visual sphere, however, as occurs with hallucinogens. Affective alterations are also produced such as feelings of well-being, hilarity or euphoria. Infrequently, there may arise crises of irritability or anxiety often accompanied by ideas of reference or identity problems. A series of plants represented by marijuana, some Labiatae and terpene-containing Compositae induce this array of effects.

Marijuana

Among the divinatory plants of the Nahuas that have not been clearly identified is found *pipiltzintzintli*, "the venerable little children." The archives of the Inquisition record some cases in which users were persecuted. It was described as a cultivated plant with male and female varieties used in a dry form for diagnosis and treatment of disease (Aguirre Beltrán 1963): a portrayal evocative of marijuana. This suspicion is reinforced by a reference of Antonio Alzate (1772) who identified *pipiltzintzintli* as Indian hemp. Lumholtz (1902) discovered that the name *Rosa María* was applied to marijuana; references to this name are profuse in the Inquisition archives, closely associated with peyote (Aguirre Beltrán 1963). Although he does not give his reasons, Reko (1945) writes that *Cannabis* was known as *nocuana cohui* to the ancient Mexicans and even offers a Náhuatl etymology of the word marijuana (*mali* = tuft; *ha huana* = to get drunk). In any case, these data lead to the supposition that the use of marijuana as a psychotropic in the New World was prevalent much earlier than previously thought; in fact, it is probable that it preceded the cultivation of hemp for fiber since Humboldt, in passing through Mexico at the beginning of the nineteenth century, recommended the introduction of *Cannabis* to this end.

In recent times, the divinatory use of marijuana appears to be restricted to the Tepehuas, Tepecanos (Lumholtz 1902) and Otomis of the Sierra de Puebla (Knab 1979). The plant is cultivated by the shamans of the latter group in a specific manner including frequent pruning which produces a globular bush full of resinous exudations. The bush is cut, partially dried and ingested in an infusion. The *curandero* sings during the ceremony, his tone changing as the effects are experienced since his voice then belongs to the supernatural being with whom the plant has put him in contact (Knab 1979).

The medical uses of marijuana as a traditional therapeutic agent are also interesting, especially as they are shared with other psychotropics. It is taken orally as a febrifuge, aperient and antidiarrhetic as are *Calea zacatechichi* and *Tagetes lucida*. Its widespread use as a local antirheumatic agent is also found for supposedly neurotropic composites such as *Artemisia mexicana*, *Cacalia decomposita* and *Senecio praecox* as well as for the solanaceous *Datura stramonium*. Marijuana shares with the latter popular repute as a sedative, hypnotic, analgesic and particularly as an antiasthmatic agent (Díaz 1976b). This ethnobotanical parallelism is explained by the pharmacological similarity of the biodynamic principles of both plants which exert antimuscarinic effects which will be discussed later.

At present, the majority of botanists agree that *Cannabis* should be classified as a member of the family Cannabacea which would include only two genera: *Cannabis* and *Humulus* (Schultes et al. 1974). *Humulus lupulus* is taken orally in Mexico as an anaphrodisiac and eupeptic and is also reputed to be toxic (Díaz 1976b).

The classic description of the psychological effects of marijuana was made by Moreau de Tours (1845) who delineated its principal effects on cognition, especially on short-term memory and time sense. He also described the characteristic euphoria and increase in perceptual sensitivity. Recently, these actions have been experimentally analyzed particularly those related to changes in recent memory. Retrieval is normal when it is immediate; that is to say, when information has to be repeated without any lapse of time. Thus, perception, registration and recollection remain unchanged. Retention of information is faulty, however, when there is an interval between presentation and recollection; therefore, it has been suggested that marijuana selectively affects the process of storage (Abel 1971; Weil, Zinberg & Nelsen 1968).

Time estimation has been more difficult to evaluate since it varies according to whether the test involves reproduction, estimation or production of time periods. Nevertheless, the results as a whole are consistent with the subjective sensation of a slowdown in the passage of time (Bech, Rafaelson & Rafaelson 1974; Melges et al. 1970). As it is feasible that the mechanisms of attention are affected, difficulty in following information could be translated into distorted perspectives and, occasionally, into paranoid ideation. The most active compound in marijuana, Δ^9-tetrahydrocannabinol

(Δ^9-THC) (Mechoulam 1970), might alter the hippocampal functions related to cognition by interfering with cholinergic transmission in the septum-hippocampus pathway which has been implicated in cognitive phenomena (Drew & Miller 1974).

The effects on imagination have not been studied as thoroughly and there persists a certain level of confusion. It is probable that many authors have called the vivid images produced by marijuana "hallucinations." It is important to add that marijuana and some of its component cannabinols affect human sleep phases (Fernández Guardiola et al. 1974); other members of the same psychopharmacological category are used in oneiromancy (dream divination) as we shall now see.

Calea zacatechichi

MacDougall, a North American botanist who worked extensively in the state of Oaxaca, wrote a brief note on the divinatory use of *Calea zacatechichi* by the Chontal Indians (1968). Although he was not present at a ritual ceremony, his bilingual informant stated that the leaves of the plant called *thle-pela-kano* were smoked and imbibed as a tea in order to receive messages of a divinatory nature.

C. zacatechichi is a plant of widespread traditional use in Mexico. Its employment as an aperient was studied during the last century by Sandoval (1882) at the Instituto Médico Nacional; in his thesis, no psychotropic properties were mentioned. *Zacatechichi* is a word of Náhuatl origin meaning "bitter grass." Other popular terms are *ahuapahtli, chichixihuitl* and *xikin* (Díaz 1976a). Another composite, *Galinsoga parviflora*, is also known as *ahuapahtli* and has gastrointestinal effects in common with *C. zacatechichi*. None of these names hint at psychotropic activity. *C. zacatechichi* has been used from early times as an aperient and antipyretic and secondarily as an antidiarrhetic agent and insecticide (Díaz 1976b).

The divinatory use of this plant in the Chontal zone has been reported by only one informant who personally collects and uses it (Díaz 1975). This transculturated Indian distinguishes both an active and inactive variety of the plant which he calls *hoja madre* ("mother leaf"). At present, we are working on the taxonomy of both plants since there is the possibility that the active type is a new species of *Calea*. The dried leaves of the plant are simultaneously administered as an infusion and by inhalation as well as placed under the pillow of the petitioner. During the ensuing sleep, dreams of a divinatory character arise concerning diseases, lost objects or the future. The plant has thereby acquired an important cultural function since the Chontals, together with many other indigenous groups, analyze their dreams for guidance and behavioral indicators. The Chontal *curandero* distinguished the medical use of the plant from that of oneiromancy, since as an infusion and in lesser quantities, he prescribes it for intestinal afflictions and to produce an aversion to tobacco.

Experiences attendant upon the administration of the active variety of *Calea* have been reported in two different situations: in the presence and under the direction of the informant, inhaling and ingesting it before sleep; or during wakefulness usually in an urban setting. The four subjects who underwent the first procedure described the development of somnolence a short while after ingestion, a particularly relaxed nocturnal sleep and vivid dreams during the night. We are carrying out a controlled study of the effects on sleep produced by the chemically separated plant fractions. Its actions during wakefulness were tested in five subjects after several inhalations and the administration of an infusion. With high doses, effects included: sensations of well-being and light-headedness, difficulty in bringing events to mind, somnolence and an intensification of visual imagery, but only with the eyes closed. The effects were quite subtle and ephemeral, since they disappeared within an hour of administration; in fact, the mental changes would not have been noticed if they had not been experienced in isolation and a state of quiescence.

The bitter chemical principle of *zacatechichi* was isolated 20 years ago; nevertheless, it was not until recently that the genus was carefully studied by Ortega at the Institute of Chemistry, Universidad Nacional Autónoma de México (National Autonomous University of Mexico, U.N.A.M.). In collaboration with his group, we have been investigating the chemistry of several of the plants provided by our informant and others collected in different regions. A germacranolid called caleicine, the *p*-hydroxycinnamide ester of junenol (Chávez Soto 1977), was isolated from a sample of *C. zacatechichi* from the state of Veracruz. Junenol has also been found in the fruits of *Juniperus communis*, a member of the Pinaceae family reported to be an eupeptic agent (Díaz 1976b). Thus, this compound might be responsible for the common digestive effects of the two plants. Other substances with the basic structure of caleicine have been isolated from the active as well as the inactive plants provided by the Chontal *curandero*; they are now being screened for the presence of psychoactive compounds. Independently, Bohlmann and Zdero (1977) have reported two new germacranolids in *C. zacatechichi*. It should be mentioned that these molecules are terpenes as are the cannabinols in

TABLE II

MEXICAN PLANTS WITH POSSIBLE OR UNCERTAIN PSYCHODYSLEPTIC EFFECTS

Category	Group	Botanical Species	Chemical Compounds	Possible Family
Ethnobotanical complex of peyote	Phenethylamine cacti	*Lophophora diffusa*	Peyotine, lophophorine, anhalamine	Trance-inducer and/or neurotoxin
		Ariocarpus fissuratus *Ariocarpus retusus* *Obregonia denegrii* *Pelecyphora aselliformis* *Pelecyphora pseudopectinata*	Phenethylamines: hordenine, methyltyramine	Psychostimulants and/or neurotoxins
		Epithelanta micromeris	-	
		Mammillaria heyderii	3,4-dimethoxyphen-ethylamine (DMPEA)	
		Mammillaria craigii	-	
		Mammillaria grahamii	-	
		Coryphanta compacta	DMPEA	
		Coryphanta macromeris	DMPEA, macromerine	
		Echinocereus triglochidiatus	3-Hydroxy-4-methoxy-phenethylamine	
		Mammillopsis senilis	-	
		Pachycereus pecten-aboriginium *Carnegiea gigantea*	Phenethylamines, tetraisoquinolines	Possible psychodysleptics
	Necine Compositae	*Senecio tolucanus* *Senecio praecox* *Senecio cardiophylus* *Senecio grayanus* *Senecio canicida* *Cacalia decomposita* *Cacalia cardofolia*	Pyrrolizidines sesquiterpenic lactones	Deliriants and/or neurotoxins

*psychoactive compounds

marijuana. The sesquiterpene lactones, among them the germacranolids, have antitumoral, cytotoxic and phytotoxic effects. These compounds are responsible for the insecticidal properties and toxicity to predators of the plants which contain them and can cause a contact dermatitis in human beings (Rodriguez, Towers & Mitchell 1976). Their biosynthesis and structure are similar to those of mammalian steroid hormones.

***Salvia divinorum*:**
the *ska Pastora* of the Mazatec Indians

The first reference to this mint was made by Reko, who described some "divinatory leaves" used by the Mazatec and Chinantec Indians in his book *Mitobotánica zapoteca* (1945). A short time later, Weitlaner (1952) told of a ceremony carried out with *hoja de María* ("Mary's leaf") by a Mazatec *curandero*. The plant was classified in the last decade as a species of *Salvia* by Gomez Pompa and was finally identified as a new species of that genus (Epling & Játiva-M. 1962). The material was collected and sent by Wasson who had the opportunity to ingest the plant in a ceremonial setting. He described definite effects similar to those experienced during the initial stages of mushroom intoxication

TABLE II

MEXICAN PLANTS WITH POSSIBLE OR UNCERTAIN PSYCHODYSLEPTIC EFFECTS

Category	Group	Botanical Species	Chemical Compounds	Possible Family
Marijuana-like plants or substitutes	Terpene Labiatae	*Leonorus sibiricus*	Terpenoids	Cognodysleptics
		Nepeta cataria	Terpenoids	
		Salvia spp. (*xiwit*)	-	
		Cecropia obtusifolia	-	
		Canavalia maritima	*l*-Betonicine	
	Terpene Compositae	*Tagetes lucida*	Terpenes: thiophenes	
		Artemisia mexicana	Sesquiterpenes	
		Artemisia absinthum	Thujone*	
	Ephedrine Malvaceae	*Sida acuta*	Ephedrine, pseudoephedrine	Psychostimulants or cognodysleptics
		Sida rhombifolia		
Uncertain	Water lilies	*Nymphea ampla*	Alkaloids	Possible psychodysleptic
	Lycoperdons	*Scleroderma* spp.	Unidentified alkaloids	Possible hypnodysleptics
		Lycoperdon spp.		
		Astraeus spp.		
	"Inebriating"	*Pellaea cordata*	-	
		Rivinia humilis	-	
		Coriaria atropurpurea	-	
	Náhuatl aromatic complex	*Cymbopetalum penduliforum*	-	Possible psychoactive aromatic plants
		Enterolobium cyclocarpum	-	
		Magnolia dealbata	-	

(Wasson 1962). Later, Wasson himself suggested that *S. divinorum* could correspond to *pipiltzintzintli* of the ancient Nahuas (1963), although he subsequently doubted this hypothesis (personal communication).

Ska Pastora ("Shepherdess leaf") is predominantly utilized in the low, humid regions of the Sierra Mazateca bordering the river Santo Domingo. In several places it is used more frequently than psilocybin mushrooms for divination (Díaz 1975). In these areas, ingestion of psychodysleptics is carried out according to a particular sequence by initiates or apprentices enabling them to become progressively acquainted with the increasingly intense properties of various plants. Shamanic training begins with a number of ingestions of *S. divinorum* until the maximal effects are achieved, continues with "the seeds of the Virgin" which in this zone correspond to *Rivea corymbosa*, and culminates with the mushroom *Stropharia cubensis*, which gives rise to the strongest experience. The same type of preparation is used in each stage: fasting, silence, ceremonial gathering of the plant or mushroom and sexual abstinence. This series of instructions tends to maximize the effects both through increasing the subject's expectations and through creating corporeal conditions favoring the optimum

absorption of the active substances.

The divinatory ritual involving *S. divinorum* begins with the counting of pairs of leaves selected for intactness. Fifteen to 50 pairs are set aside, depending on the weight of the supplicant and the intended intensity of the experience. The bunch of leaves is smoked in copal while the shaman intones a chant marked by two alternating rhythms: emphasized syllables and respiration. The chant invokes both Christian and Mazatec deities, asking their help in the solution of the problem. "May the sun rise very well," repeats the shaman, calling upon the central god of the Mazatecs. The goal of the experience is to see the light, to enter into contact with the sacred. At the end of the chant, the handful of leaves is vigorously squeezed in a cup of water and the resulting extract is drunk by the petitioner or shaman. The candles are extinguished and complete silence is maintained. The user must then talk or sing using the "voice of the little leaf" which brings the solution to the proposed problem (Díaz 1975).

Twelve experiences with this watery potion of *ska Pastora* have been recorded. The first perceptible change occurs several minutes after ingestion consisting of an increase in visual imagery. The forms are not geometrical, but rather comprise complete images which some have described as archetypal, in continual flux and vividly colored. A short time later, a bodily lightness is discernible, accompanied by feelings of well-being or euphoria. This sensation of weightlessness peaks between 15 and 30 minutes after the beverage is taken and may be associated with ataxia and dizziness. These effects disappear within an hour. The injection of crude extracts of the plant into cats produces behavior briefly marked by attention to the visual field, rage and catatonia — also characteristic of other psychodysleptics (Díaz 1975).

It has been particularly difficult to identify the substance(s) responsible for these interesting effects. There exists a great variability or instability in the constituents of *S. divinorum* which has impeded the consistent reproduction of the mental or behavioral alterations, preventing the identification of the active fraction. Some initial observations indicated the presence of nitrogenous compounds, possibly amino acids or amines (Díaz 1975), although they now appear to be of no pharmacological interest. The non-alkaloid fraction seems to be of greater importance since the psychotropic compounds of other Labiatae, such as nepetalactone in *Nepeta cataria* and lagochiline in *Lagochilus inebrians*, are terpenes; furthermore, these compounds are characteristic of the rest of the family of cognodysleptics. The presence of triterpenes in the genus *Salvia* has been known for several decades (Ulubelen & Brieskorm 1975) although they have not been pharmacologically studied. Certain quinones of chemotaxonomic value have been identified in the genus as well (Patudin et al. 1974).

The genus *Salvia* is widely used in Mexican herbal medicine. Among its many members, the most interesting species is *S. hispanica*, called *chia* or *chiantzotzoltic*, whose seeds are sold in the markets to mix with lemonade or to germinate on top of small porous ornamental clay animals. The medical uses of this plant are similar to those of *C. zacatechichi*, especially as a purgative and "against bile secretion." Other species of *Salvia* are employed as antipyretic agents (Díaz 1976b), an apparently common use for this family of plants.

The Labiatae comprise the fourth-ranking family of medicinal plants, in so far as the number of species used for their biodynamic effects. Their most general use is as "antispasmodic" agents, a popular term in the pharmacopoeia of the last century, indicating a relaxing or tranquilizing action. Second, the mints are employed as eupeptic and emmenagogic compounds; and last, the culinary species are reputed to be psychostimulants (Díaz 1976b).

DELIRIANTS

The word "delirium" is here used in its classic sense: a state of clouded consciousness, stupor, confusion, disorientation, distorted perception, restlessness and motor alterations. In psychiatry, these symptoms are grouped together forming the so-called acute psychoorganic syndrome and are present in organic, metabolic and infectious disorders as well as during various kinds of intoxication (Slater & Roth 1969). Some ritual plants used traditionally in Mexico and throughout the world induce this syndrome and are therefore called deliriants.

The cardinal sign of a delirious state is the dimming of consciousness: a particular diminution of attention which ranges from being barely detectable to the development of stupor, and finally, coma. Initially, the directing of attention is hindered and perceptual changes appear, such as illusions. Simultaneously, there are cognitive modifications, especially in understanding, since one's perceptions are not steady and recollection becomes increasingly difficult. Thought is therefore quite fragmented and the voluntary capacity to selectively focus attention is lost. This dysmnesia can further evolve to include ideas of reference and paranoid mentation. Common to this state are images and fantasies of a vivid dreamlike quality which the subject, having lost his/her sense of reality, may interpret as actual events. At the same time, great emotionality is manifested and states of apprehension, anxiety,

irritability and excitation may develop which are closely related to the perceptual and cognitive changes. Motor behavior becomes disorganized: ataxia, dysarthria, restlessness, myoclonia and alternate stuporous and excitatory states are frequent.

***Toloatzin* and *Yétl*:**
Tropane and Piperidine Solanaceae

Among the Mexican plants that interested the first chroniclers of the Nahua culture and horrified the Spanish inquisitors stand out the complex of *toloache*, plants belonging to the genera *Datura* and *Solandra*, widely used from before the Conquest up to the present in shamanic rituals and sorcery.

The Florentine Codex (Sahagún 1950-1969) contains a botanical description of one of the members of this group, *tlápatl*, which permits its identification as *Datura ceratocaula*: "... it gives rise to a thornless flower head, like a lime." The Codex is explicit about the effects: "... it saddens, leads the heart astray ... whoever eats it will go mad forever ... it makes people fast, it makes them suffer." The emphasis on anxiety and apprehension is important, as this description differs significantly from that of the hallucinogens. The early Spanish physician Hernández refers to several plants with the names of *toloatzin, tlápatl* and *nacazul*, although the effects are only briefly described. The Badiano Codex (de la Cruz 1552) contains a famous plate with two drawings of plants that are clearly identifiable as species of *Datura*: *tolohuaxihuitl* pictured with spiny pendant fruits is probably *D. inoxia* and *nexehuac* with smooth fruits may be *D. ceratocaula*.

The ritual importance of tobacco, the *yétl* of the Nahuas, was as great as that of the hallucinogens, although used in a different way and for distinct ends. *Picietl* (*Nicotiana rustica*) as well as *quauyétl* (*Nicotiana tabacum*) were specifically employed to purify sacred spaces and those persons subject to maleficent influences. There is evidence that they were inhaled as stupefacients and exhaled with the magic intention of prophylaxis (Aguirre Beltrán 1963). Of greatest psychopharmacological interest is *tenex yyétl*, a preparation of dry tobacco ground with lime (in proportions of 10 to one) which was thoroughly chewed by moving the bolus between cheek and teeth (Ruiz de Alarcón 1629) in a manner identical to the way coca is used today by the Indian groups of the Andean Highlands. This mixture undoubtedly enhances the efficiency of alkaloid extraction. Hernández (1959-1967) refers to tobacco as an energizer and stupefacient in stating: "... it deadens all sense of sorrow. ..."

Recently, we received information that the Tojolabale Indians of the Chiapas jungle use an as yet unidentified plant in the same way as *tenex yyétl*: as a stimulant in order to walk long distances. It is quite likely that the plant is one of the tobaccos.

The popular uses of the tropane and piperidine Solanaceae are notably alike (Table III) and correspond to those of mandrake and henbane in the Old World. Most commonly, they are employed as local analgesics for the relief of pain associated with such conditions as earaches, bruises, fractures and rheumatism; second, they possess certain properties in virtue of their peripheral anticholinergic effects and therefore are antiasthmatic, purgative, expectorant and mydriatic agents; next, their actions on the central nervous system make them effective in the relief of movement disorders, such as Parkinson's disease; and finally, they are used as psychotropic substances.

The tropane Solanaceae are popularly used in sorcery as stupefacients: secretly and chronically administered in small doses to an unfaithful or prospective mate, the plants fix the loved one's thoughts on the person who dispenses the drug. The saying, "It appears that they've given him *toloache*," is still heard in Mexico in reference to the dazed dreaminess associated with the state of being passionately in love. Ethnobotanical data concerning the shamanic use of *Datura* and *Solandra* is scarce but they are definitely implicated in the spells, poisonings and dramatic modifications of habits that have been observed by Knab (1979).

Ritual use of tobacco is also extensive; the pre-Columbian practice of using it for protection against evil spells and for the purification of spaces and people in cleansing ceremonies survives (Díaz 1975; Wasson 1963). There are reports that large amounts of tobacco mixed with *Tagetes lucida* are administered as a stupefacient among the Huichol Indians (Siegel, Collings & Díaz 1977; Díaz 1975) and it is combined with many other plants throughout America (Janiger & de Ríos 1973). In this last review, the authors comment on the intoxicated states, confusion and dreamlike visions induced by tobacco. A comparison between the stupefacient effects of daturas and tobacco has been conducted by Plowman (1968), who cites multiple instances of the shamanic use of these Solanaceae.

Scopolamine and atropine, found in the *toloache* complex, and nicotine in tobacco interact with two types of cholinergic brain receptors. The tropane derivatives are powerful specific blockers of the muscarinic receptor, while nicotine stimulates the nicotinic receptor. There is evidence that blockage of the muscarinic receptor at the hippocampal level is related

to the deliriant effects. In fact, the degree of a substance's ability to block this receptor has been correlated with its potency as a deliriant (Baumgold, Abood & Aronstam 1977). The reasons for the similar effects exerted by nicotine are less clear.

Muscarinic receptors are distributed throughout the brain, although they are particularly abundant in the cerebral cortex and especially in the hippocampus (Kuhar & Yamamura 1976), which explains the effects of the tropanes and Δ^9-THC on recent memory. In contrast, the nicotinic receptors are plentiful in the brain stem nuclei (Morley et al. 1977); however, it is difficult to account for the action of nicotine referring to its possible interaction with these sites alone. It is

TABLE III

DELIRIANT PSYCHODYSLEPTICS: TROPANE AND NICOTINE SOLANACEAE

Botanical Name	Common Name	Popular Uses	Phytochemistry
		Daturas	
Datura stramonium	Toloatzin (N) Toloache (S) Nacazul (N) Hierba del diablo (S) Kieli-sa (H)	Local analgesic Antiasthmatic Expectorant Antipyretic Anaphrodisiac Stupefacient Magic rituals	Tropane alkaloids: scopolamine, 0.3-0.6%, atropine, *l*-hyoscine, others in lesser amounts
Datura inoxia = *D. fastuosa*	Toloache (S) A-neg-la-kia (M) Dekuba (T)	Anaphrodisiac Stupefacient Magic rituals	*Idem*
Datura meteloides	Tolohuaxihuatl (N) Toloache (S)	Local analgesic Stupefacient	*Idem*
Datura ceratocaula	Tlápatl (N) Nexehuac (N) Tornaloco (S)	Local analgesic Stupefacient	*Idem*
		Tree Daturas	
Datura arborea	Tecomaxochitl (N) Floripondio (S) Almizclillo (S)	Local analgesic Hypnotic-sedative Purgative Stupefacient	Tropane alkaloids: scopolamine, 0.1-0.2%, atropine, others in lesser amounts
Datura suaveolens	Almizclillo (S) Floripondio blanco (S)	Local analgesic Antipyretic	*Idem*
		Solandras	
Solandra guerrerensis	Huipatli (H) Hueypahtli (H) Tecomaxochitl (N)	Divinatory Magic rituals	Tropane alkaloids: scopolamine, 0.1-0.2%, atropine Solanine alkaloids
Solandra brevicalix	Kieli (H)	*Idem*	*Idem*

(N), Náhuatl; (S), Spanish; (H), Huichol; (M) Mazatec; (T), Tarahumara

premature to postulate the existence of a cholinergic balance in the brain maintained by the activities of the two types of receptors such that the inhibition of one implies the ascendance of the other. However, the ethnopharmacological data reviewed here would justify such an hypothesis, which is also strengthened by neurobiological data. Thus, muscarinic and nicotinic compounds exercise an antagonistic effect upon the aggressive behavior of the cat (Berntson, Beattie & Walker 1976) and nicotine potentiates the effect of a synthetic antimuscarinic psychodysleptic (Lowy et al. 1977). It is important to note that piperidine is normally

TABLE III

DELIRIANT PSYCHODYSLEPTICS: TROPANE AND NICOTINE SOLANACEAE

Botanical Name	Common Name	Popular Uses	Phytochemistry
Solandra guttata		*Idem*	*Idem*
Solandra nitida	Cutaquatzitziqui (N) Copa de oro (S) Bolsa de Judas (S)	Expectorant Stupefacient	*Idem*
		Nicotiana	
Nicotiana rustica	Piciétl (N) Yétl (N) Piciete (S)	Local analgesic Antiasthmatic Expectorant Purgative Antipyretic Hypnotic-sedative Ritual Stupefacient	Piperidine alkaloids: nicotine, nornicotine, anabasine, others in lesser amounts Traces of harmala alkaloids
Nicotiana tabacum	Tabaco (S) Quauyétl (N) Yétl (N)	Local analgesic Antiasthmatic Expectorant Ritual Stupefacient	*Idem*
Nicotiana trigonophylla	Bawaráka (T) Wipake (T)	Analgesic	
		Solanum	
Solanum nigrum = *S. tuberosum*	Chichiquilitl (N) Hierba mora (S)	Local analgesic Sedative or stimulant Antiparkinsonian Antiepileptic	Solanine and related alkaloids
Solanum torvum	Prendedora (S)	Local analgesic Antiasthmatic	*Idem*
Solanum dulcamara	Dulcámara (S) Jazmincillo (S)	Sedative Stupefacient	Solanine glucoalkaloids Tropane alkaloids

found in neural tissue, especially in the striatal nuclei (Abood, Rinaldi & Eagleton 1961), since a receptor to this molecule may also be present, capable of being stimulated by its chemical congeners, such as the alkaloids in tobacco.

Finally, physostigmine should be mentioned, as it is the substance that reverses the clinical picture elicited by anticholinergic agents and is effective in the treatment of acute psycho-organic syndrome (Granacher & Baldessarini 1975). There may be a cholinergic imbalance in these cases suggesting a pharmacological model for this neuropsychiatric syndrome.

Amanita muscaria

The fly agaric is the beautiful mycorrhizal mushroom represented in illustrations of European tales and legends, mistakenly feared to be as poisonous as its lethal congener *Amanita phalloides*, the death angel. *A. muscaria* is part of an ancient shamanic tradition in Siberia where its ritual use has been documented. Wasson made an exhaustive review of the subject and proposed that *A. muscaria* corresponds to the sacred *Soma* of the classic Vedas (Wasson 1968), a heavily debated hypothesis.

In America this mushroom is portrayed in legends surrounding the thunderbolt from the state of Chiapas and Guatemala. Due to this fact and based on certain interpretations of the Mayan codices, it has been postulated that the fly agaric could be represented in the famous fungiform stones of the classic Mayan found in these areas (Lowy 1974, 1971). The massive destruction of Mayan documents in the first years of the Spanish occupation has prevented further clarification. The hypothesis of the possible ritual use of this and other psychodysleptics continues to be in doubt since no such practices have been documented among contemporary Mayan groups.

Ethnobotanical interest has arisen following evidence of the ceremonial use of this mushroom among the Ojibway in North America (Wasson 1979) and the observations of Knab (1979) in the Valley of Puebla. There, Knab encountered a *curandero* who smokes dried *A. muscaria* mixed with tobacco as an intoxicant and to perform ritual diagnoses.

The psychoactive properties of the fly agaric have been characterized in spite of multiple chemical, pharmacological and ethnological confusions (Ott 1976). It appears that it is possible to distinguish a light intoxication from a heavy one, with important individual variations. Initially there occur unspecific effects such as an increase in visual imagination, greater perceptual acuity, feelings of inner clarity and light sedation. Simultaneously, a lack of muscular coordination or even ataxia may be experienced. In many cases, the effects do not progress beyond this stage, but in particular instances or at higher doses myoclonic spasms and a delirious state marked by confusion, thought alterations and disorientation may develop.

The main active chemical constituents of *A. muscaria* are isoxazole derivatives: ibotenic acid and its decarboxylated product, muscimol. Both have structural characteristics in common with γ-aminobutyric acid (GABA), the principal inhibitory neuroamino acid in the brain. Studies using iontophoretic techniques and local application have shown muscimol to be a potent gabamimetic agent: it binds to nervous tissue in the same way as GABA and stimulates the receptors (Naik, Guidotti & Costa 1977).

Experiments in human beings have also been carried out since there is substantial evidence indicating a GABA deficiency in gabaergic systems underlying several neuropsychiatric disorders, including Huntington's chorea, Parkinson's disease and schizophrenia. Nevertheless, muscimol in doses of 5 to 10 mg does not ameliorate the symptoms of schizophrenia; rather, a deterioration in thought processes is produced, characterized by confusion, intense inner preoccupation, lack of attention and disorientation. In larger quantities, somnolence, vivid dreams, dizziness and myoclonia often occur. In contrast, amounts of less than 5 mg are experienced as anxiety-relieving and calming (Tamminga, Crayton & Chase 1978). The effects of small doses of muscimol are comparable to those of the known tranquilizer diazepam, which also appears to be gabamimetic. However, those deliriant effects evident at higher doses seem to best fit into the picture of anticholinergic toxicity. It is feasible, then, that there exists a functional balance in the hippocampus between acetylcholine as a stimulant and GABA as an inhibitor, which can be altered in the same direction by anticholinergic and gabamimetic agents. In fact, clinically it has been found that atropine potentiates the toxic effect of *A. muscaria*.

NEUROTOXIC PSYCHODYSLEPTICS

The series of plants and compounds presented in this section, besides inducing a psychodysleptic condition often similar to that caused by deliriants, are also toxic to the central nervous system in varying degrees. These latter effects are most frequently manifested in the motor sphere, including differing intensities of paralysis, or the inverse, a continuum of excitation that may culminate in convulsive episodes.

Usually there are peripheral responses as well such as spasms, vomiting or temperature fluctuations.

Papilionidae

It is probable that the first plant ingested in America for ritual purposes was *Sophora secundiflora* since there is evidence of its use 7,000 years ago by tribes settled in northern Mexico (Adovasio & Fry 1976). It appears that this cult of the mescalbean declined as that of peyote began to flourish in the same regions (Jones & Merrill 1979; Schultes 1969-1970). In fact, Mexican sources dating from the Conquest and Colonial times say very little about the mental effects of this and other toxic Leguminosae. *Mescalismo* (mescalbean cult) is amply documented in North American Indian tribes, especially among the Wichita who make extensive use of the seeds to produce vomiting and receive visions during initiation ceremonies (Jones & Merrill 1979).

The first systematic data concerning the psychotropic actions of members of the pea family was provided by the Instituto Médico Nacional. Río de la Loza (1877) identified the *colorín* (*Erythrina coraloides*) as the *tzompanquahuitl* of the ancient Mexicans. He states that the roots were used as diaphoretics and the flowers for food, and that the seeds "always have been considered as a violent poison that produces madness and impotence." In this same thesis is reported the isolation of an alkaloid from the *colorín*, erythrocoraloidine.

In 1879, Altamirano published a large article on native medicinal Leguminosae, a classic in American ethnobotany, in which he recapitulates the multiple uses of the *colorín*: the wood as a substitute for cork, flowers for food and seeds for ornamentation. For the first time, the curare-like effects of an extract of the seeds were described. In relation to *atecuxtli* or *ojo de cangrejo* ("crab eye," *Rynchosia precatoria*), he relates "several stories about these seeds; for instance, the *curanderas*, there called *tepatianas*, secretly administer the powder of these seeds to those whom they desire to harm; and jealous women in order to take revenge on their faithless lovers give them these little black things (*nigritos*) without their knowing it, to produce madness lasting a long time" (p. 90). His physiological experiments led him to conclude that *R. precatoria* is a curarizing agent like the *colorín*, but of less potency and effective only in some animal species. He also refers to *Piscidia erythrina*, the "*colorín* of the fishes"; the Aztecs would cast part of the cortex into the water in order to "intoxicate the fish" and thereby catch them. Altamirano added that "the active principle produces a kind of narcotization in man." There are collections of *Piscidia grandiflora* in the Herbario Nacional de México (National Herbarium of Mexico) about which a similar use is annotated.

B.P. Reko (1928) reported that the seeds of *Dolicholus phaseoloides*, synonomous with *Rynchosia pyramidalis*, "produce madness, according to popular belief" and ascribed the same properties to the so-called *yerba loca* ("crazy weed"), *Astragalus mollisimus*. Later, in the book *Mitobotánica Zapoteca* (1945), he mentioned that the seeds of *Dolicholus longeracemosus* and *D. minumus* were used in Miahuatlan for magical purposes. Reko proposed that the latter species was the *tlitlitzen* of the Nahuas, but more recently Wasson (1963) has identified it as *Ipomoea violacea*. In present botanical nomenclature, *Dolicholus* is equivalent to *Rynchosia* (Grear 1978).

Ethnobotanical data has made this genus a subject of special ethnopharmacological interest of late. Among the psychotropic plants designated as *piule* in the state of Oaxaca are found *Rynchosia longeracemosa* and *R. pyramidalis*. In northern Mexico, *R. precatoria* is used as a local analgesic and is known by names (or variations of names) common to other psychotropics such as *senecuilche* and *pipiltzintli*. In the Dominican Republic a beverage with reported aphrodisiac effects is prepared from the stems of *R. pyramidalis* (Grear 1978). Further systematic study of the psychopharmacology and chemistry of this genus is needed in order to appropriately classify it within the proposed taxonomic scheme.

Recently, information has been published concerning the ethnobotany of other Papilionidae. The Yaqui Indians use *Genista canariensis*, a leguminous plant introduced to the continent, as a minor psychodysleptic (Fadiman 1966). Bye (1979) discovered that the Tarahumara attributed the property of inducing "erotic dreams" to *Erythrina flabelliformis*, known by them as *kaposí*.

Phytochemical research on these Leguminosae permit several pharmacological distinctions to be made. The properties of *Erythrina* can certainly be defined as curare-like. Erthyrinane alkaloids appear to be characteristic of the genus from which dozens of chemical species have been isolated (Hill 1967). Up to now their pharmacology has not been adequately studied. The lupinane alkaloids are restricted to three sub-families of the Leguminosae: *Sophorae, Genistae* and *Podaliriae*. The pharmacological actions of the lupinane alkaloids that have been investigated, especially cytisine, indicate that they are responsible for the effects of the mescalbean (*Sophora secundiflora*) and of the seeds of *Genista canariensis*. Cytisine produces both peripheral

effects, including hypertension, intestinal motility, muscular spasms, mydriasis as well as central effects such as vertigo, delirium, hallucinations and convulsions (Barlow & McLeod 1969). The few reports on the effects of the seeds of *S. secundiflora* agree with those of their isolated alkaloids. Hatfield et al. (1977) have described some autoexperiences with the mescalbean, during which intense migraine, hypothermia, vomiting, cramps, insensitivity to pain, stupor and visions occurred. It is evident that these substances have intense nicotinic effects, which would explain their deliriant activity, in common with the piperidine Solanaceae. However, neurochemical differences are also to be expected which may be responsible for the strong neural toxicity of this family.

PLANTS WITH POSSIBLE OR UNCERTAIN PSYCHODYSLEPTIC EFFECTS

Ethnobotanical Complex of Peyote

The ethnobotanical complex of peyote is composed of cacti and composites that are ethnologically, geographically, botanically or chemically related to *Lophophora williamsii*. Although ethnobotanical data for each species is scarce, their phytochemistry and reported usage among native groups indicate the need for further psychopharmacological study.

All the cacti of the peyote complex that have been investigated contain phenethylamines and tetraisoquinolines, usually methoxylated, but mescaline is essentially absent. The only other genus of Cactaceae aside from *Lophophora* rich in mescaline is *Trichocereus* (Smith 1977); *T. pachanoi* is used by shamans on the coast of Peru under the name of *San Pedro* ("St. Peter"). Among the indigenous peoples of Mexico, the Tarahumara Indians have developed the most complex cultural structures around cacti found in their ecosystem (Bye 1979; Pennington 1963; Lumholtz 1902). The reader is referred to the sources just cited and the extensive work of Bruhn, especially his recent reviews published in 1975 and 1973 (Bruhn & Bruhn), for information concerning the Mexican cacti related to peyote. Table IV and the data that follow are based, in large measure, on the work of these four authors.

The principal alkaloid in *Lophophora diffusa* or *peyote de Queretaro*, the only sister species of *L. williamsii*, is peyotine. The absence of mescaline would explain the contradictory results of the first chemical investigations, since these two species were probably not differentiated (Bruhn 1975). In recent months, we have received reports of various autoexperiences following the ingestion of *L. diffusa* carried out by persons who habitually use *L. williamsii* but who have found the abundant quantities of the former available in Queretaro more accessible. The majority had a very disagreeable experience consisting of clumsiness, confusion, general malaise and prolonged diaphoresis. However, two individuals after ingesting a similar dose described pleasant effects characterized by tranquility and mental clarity accompanied by visual and especially auditory images. The auditory phenomena were emphasized by one of the subjects who described an "interior voice" and distortion of external sounds. Controlled studies with this interesting cactus have yet to be done in order to define its actions. Peyotine must be no more than a partial contributor to the overall pattern of response, since only sedative and hypnogenic properties have been ascribed to this alkaloid.

The small cacti belonging to the genera *Ariocarpus, Obregonia* and *Mammillaria* contain simple amines like hordenine, although each species has differing quantities of methylated and methoxylated phenethylamines. When ingested, hordenine functions as a diuretic and intestinal antiseptic. It appears to protect the plant itself against insect predation. There is no indication that hordenine has psychoactive properties. The genus *Coryphanta* contains methoxylated alkaloids with psychostimulant activity characteristic of phenethylamines such as amphetamine. One of these, macromerine, has been preliminarily identified as an hallucinogen in an experiment using an animal model, but this has not been confirmed. Reports of toxicity and the absence of more reliable data have impeded the classification of this genus.

The alkaloids of some columnar cacti are of interest since the ethnobotanical and pharmacological data suggest that they may give rise to psychodysleptic effects. Tetraisoquinolines as well as phenethylamines, in particular 3,4-dimethoxyphenethylamine, have been isolated in *Pachycereus pecten-aboriginum*. The latter substance caused great commotion in biological psychiatry a decade ago upon being postulated as an hallucinogenic product formed from an aberrant methylation of catecholamines and excreted by schizophrenics. However, later studies have shown that excretion is unspecific and that the compound lacks psychoactive properties (Hollister & Friedhoff 1966).

Saguaro (*Carnegiea gigantea*), the large columnar cactus typical of the deserts of Sonora, Arizona and New Mexico, contains arizonine as well as the same tetraisoquinolines found in *P. pecten-aboriginum*: salsolidine, carnegine and gigantine. These tetraisoquinolines are pharmacologically active: salsolidine induces tremors in the mouse; carnegine increases reflex excitability in the frog; and gigantine produces behavior

TABLE IV
CACTI BELONGING TO THE ETHNOBOTANICAL COMPLEX OF PEYOTE

Botanical Name	Common Names	Popular Uses	Phytochemistry
Lophophora diffusa	Peyote de Querétaro (S)	Unknown, confused with *L. williamsii*	Peyotine Lophophorine Anhalamine
Ariocarpus fissuratus	Peyote cimarrón (S) Hîkuli sunami (T) Sunami (T)	Used by runners for endurance	Hordenine N-methyltyramine
Ariocarpus retusus	Falso peyote (S) Chaute (H)	Toxic, poorly studied	*Idem*
Obregonia denegrii	Peyoti (S)	Unknown	Tyramine Hordenine N-methyltyramine
Epithelantha micromeris	Hîkuli rosapari (T) Hîkuli mulato (T/S)	Used by runners for endurance "Increases vision"	
Mammillaria heyderii = *M. craigii*	Peyote San Pedro (S) Witku-ri-ki (T) Cacto bola (S) Biznaga (S)	Used by runners for endurance "Clarifies vision" Produces sleep and dreams Local analgesic Reduces epistaxis	N-methyl-3,4-dimethoxy-phenethylamine
Mammillaria grahamii	Hîkuli (T)	Produces "brilliant colors" and dizziness	

(S), Spanish; (T), Tarahumara; (H), Huichol

classified as hallucinatory in primates, although the minute quantities present in the plant make it difficult to explain the effects of the cactus on human beings (Bruhn & Lundström 1976). Northern tribes in Mexico prepare a fermented beverage from this cactus and ritually drink its juice (*sĭtoli*) in order to "receive songs" (Bruhn 1971). Further botanical and chemical studies are required in order to place these species in the psychopharmacological taxonomy.

The many phenethylamines found in Mexican cacti are intriguing due to their chemical similarity to the brain catecholamines that act as neurotransmitters, involved in normal and pathological mental activities and behavior (Barchas et al. 1978). They are also relevant to the theory of abnormal transmethylation in schizophrenia, according to which a brain methyltransferase might generate psychodysleptic molecules that produce specific symptoms associated with this disease (Gillin et al. 1976). Peyote and related cacti constitute a botanical model for the transmethylation of catecholamines and could facilitate the psychopharmacological analysis of methylated products and tetraisoquinolines.

TABLE IV
CACTI BELONGING TO THE ETHNOBOTANICAL COMPLEX OF PEYOTE

Botanical Name	Common Names	Popular Uses	Phytochemistry
Coryphanta compacta	Bakana (T) Bakánawa (T) Santa Poli (S)	A type of peyote	N-methyl-3,4-dimethoxy-phenethylamine
Coryphanta macromeris		Unknown	Macromerine
Mammillopsis senilis	Chilito (S) Biznaga de chilillos (S)	Considered sacred	
Echinocereus triglochidiatus	Híkuli (T) Wichuri (T) Pitallita (S)	Unspecific mental effects	3-Hydroxy-4-methoxy-phenethylamine N,N-dimethyl-5-methoxy-tryptamine
Pelecyphora aselliformis	Peyotillo (S) Chawé (T) Wichowaka (T)	Peyote substitute Febrifuge Local antirheumatic	Phenethylamines Traces of mescaline
Pelecyphora pseudopectinata	Peyote en Tamaulipas (S)		Hordenine
Pachycereus pecten-aboriginum	Cawé (T) Chawé (T) Wichowaka (T) Cardón (S)	Beverage which produces dizziness and visions	Tetraisoquinolines and phenethylamines: salsolidine, carnegine, 3-hydroxy-4-methoxyphenethylamine
Carnegiea gigantea	Saguaro (S)	Ceremonial fermented beverage Syrup = sítoli (T), "to receive songs"	Tetraisoquinolines: salsolidine, carnegine, gigantine, arizonine

Beginning with the pioneering work of Hernández, two types of peyote have been distinguished: the cactus unequivocally identified as *L. williamsii* and a series of herbaceous plants. The Inquisition archives are full of descriptions of various peyotes apart from the cactus: there are references to "male" and "female" peyotes and to a plant called *Rosa María*. Aguirre Beltrán (1963) has interpreted the latter as a feminine counterpart of peyote, which may correspond to marijuana as previously discussed. An anonymous author of the Instituto Médico Nacional (1899) identified the herbaceous plants called peyote as composites of the genus *Senecio*, one of which is *S. hartwegii*. This writer does not present pharmacological data but speculates that the designation might imply similarities in action. At the same time and working in the same place, Vélez (1897) gathered information on the use of *S. tolucanus* for a pharmacy thesis. The plant was employed by sorcerers for poisonings, with the object of maddening the victims. According to Vélez, the plant corresponds to the *quantlapatzitzinty* (sic) of the Nahuas, a name which contains a suffix denoting reverence as well as *tlápat(l)* (Díaz 1977), both present in the common names of other psychodysleptics. This word means "the

venerable children of the mountain," a term which he also found used in Spanish (*niños del monte*). The "children" are present in the name *pipiltzintzintli*, as we have seen, and in the designation "children of the waters" used to refer to *Psilocybe aztecorum*. One of the culturally determined images found among Mexican Indians is that of hermaphroditic children who act as guides during intoxication with some psychodysleptic plants.

Later, Urbina (1903), the botanist of the Instituto Médico Nacional, identified *Cacalia cardifolia* (*S. cardiophylus*) as the *peyote de Xochimilco*, but did not proffer any further data concerning its pharmacology. *Senecio* and *Cacalia* are botanically closely related and some authors treat them equivalently. In 1945, Reko added the species *S. grayanus* to the list of those known to be called peyote. There are indications that other species of the genus, though not bearing the name of peyote, have been used in the past as neurotropic substances. The botanical explorers Sessé and Mociño identified *S. canicida* as the Nahua *izquimpantli* in 1800, a plant used in the sacrifice of dogs (1887). Martínez (1945) described *palo loco* or *palo bobo* ("crazy stick," *S. praecox*) as an inducer of delirium.

There is no recent data concerning the use of any member of these genera as a psychodysleptic. *S. praecox* and *C. decomposita* are popularly employed as local antirheumatic agents (Díaz 1976b), a frequent medical application for the psychodysleptics as has been pointed out. *S. canicida* is take orally as a febrifuge, although warnings are given about its convulsive activity at high doses (Martínez 1945). Nothing more can be said about the ethnobotany or psychopharmacology of these plants at present. Studies should begin with *S. tolucanus* and *S. praecox*, the species of greatest interest.

The necine alkaloids could be responsible for the virulent effects of some species, since they are abundant in the genus *Senecio* and have been demonstrated to be toxic to peripheral tissues (Warren 1970). Since sesquiterpene lactones are as plentiful in these plants as in other composites (Bohlmann et al. 1977; González, Joseph-Nathan & Romo 1971), it is possible that they might produce the common antirheumatic and even the psychodysleptic and neurotoxic effects of certain varieties of *Senecio* and *Cacalia*.

Other Labiatae and Marijuana Substitutes

Several species of Labiatae appear to have psychotropic properties and may belong to the cognodysleptic family as does the prototypic mint *Salvia divinorum*. Wasson (1962) in his original work on *ska Pastora* included information on the use of two other Labiatae, *Coleus pumila* and *C. blumei*, well-known for their horticultural varieties. No further ethnobotanical data on these mints has been published.

An as yet unidentified species of *Salvia* with the name of *xiwit* is cultivated and used in the northern sierra of the state of Puebla to treat *susto* ("fright," a culturally defined malady). The songs and ceremony reported by Knab (1979) are closely akin to those associated with *S. divinorum* among the Mazatec Indians (Díaz 1975), although the former is smoked and drunk as an infusion for the purpose of dream divination.

Leonorus sibiricus is a Labiatae of Asiatic origin which is known in various zones of the Mayan highlands as *maribuanilla* ("little marijuana"), referring to the morphology of the leaves as well as to the supposed similarity of the effects (Díaz 1975). A difference between this plant and the rest of the mints is the presence of three alkaloids in the genus: leonurine, leonuridine and homorunine (Raffauf 1970). However, neither the pharmacological actions of these compounds nor those produced by the non-alkaloid fraction of the plant are known.

These mints form a specific pharmacological group within the cognodysleptics or imagery-inducers. Among them is *Lagochilus inebrians*, native to Turkestan, which prepared as an intoxicating beverage is used by the Tazik, Tartar and Uzbek tribes. The plant contains lagochiline, a hemostatic and sedative terpene (Schultz 1959). *Calamento* or *hierba gatera* (catnip, *Nepeta cataria*) contains nepetalactone (Waller, Price & Mitchell 1969), a terpene which provokes peculiar behavior in cats (Siegel 1973) and which has been employed as a marijuana substitute (Jackson & Reed 1969). An African Labiatae of the genus *Leonotis* is also reported to be smoked as a replacement for cannabis (Schultes & Hofmann 1973).

We have recently obtained information that a profuse member of the Moraceae family, *guarumbo* (*Cecropia obtusifolia*), is used in place of marijuana. *Guarumbo* is reputed to be a diuretic and cardiac stimulant, although it is more widely utilized as an antiasthmatic and antichoreic agent (Díaz 1976b). In the Andean Highlands, it is dried, ground and chewed with coca. These facts indicate the plant to be of pharmacological interest.

There is indirect evidence that *Canavalia maritima*, a pod-bearing legume that grows on beaches, is dried, crushed and recreatively smoked as a marijuana substitute near the coast of the Gulf of Mexico (Díaz 1975). This plant is not employed in herbal medicine, although its congener *C. villosa*, possibly the *cicimatic*

mentioned by Hernández, may have been used by the Aztecs as an antidiarrhetic and antitussive. The genus *Canavalia* is ethnobotanically related to *Phaseolus* and both were domesticated during prehistoric times (Sauer & Kaplan 1969). Seeds of *Canavalia* have been found associated with ancient tombs and cemeteries located in the Valley of Oaxaca, the Yucatan Peninsula and the coast of Peru; the seeds of another Leguminosae we have reviewed, *Sophora secundiflora*, have also been discovered in extremely old human burial sites. In Peru, it is still believed that *Canavalia* protects cultivated fields against evil influences (Sauer & Kaplan 1969). The genus contains *l*-betonicine, an alkaloid found in composites and Labiatae. Two as yet unidentified alkaloids have been isolated in our specimens from the Gulf of Mexico (Díaz 1975).

According to multiple independent sources, the mallows *Sida acuta* and *S. rhombifolia* are smoked in a dry form as marijuana substitutes in the state of Veracruz (Díaz 1975). *S. acuta* is known as *chichibe* or *malva de platanillo* and *S. rhombifolia* is called *escobilla* or *huinar*; they are medicinally used as local anti-inflammatory agents (Díaz 1976a,b). A *curandera* from the state of Veracruz informed us of the psychotropic effects of these plants. She differentiated the "male" from the "female" variety (*S. acuta* and *S. rhombifolia* respectively) by the length of the flower's peduncle. This sexual duality is often ascribed to psychotropic plants and is one of their traditional magical attributes (Aguirre Beltrán 1963). The genus *Sida* contains ephedrine, phenethylamine and pseudoephedrine (Smith 1977), which might produce a psychostimulatory effect similar to that of *khat* (*Catha edulis*) of the Yemenites (Heacock & Forrest 1974). Nevertheless, more of the chemistry, uses and effects after inhalation of these Malvaceae must be known in order to classify them with assurance.

The botanical diversity of the plants employed as marijuana substitutes is truly surprising, although the common factor of ingestion by inhalation has been established. This method of use may induce chemical alterations and therefore could be of significance in their chemical analysis.

Yaubtli-pericón and Other Terpene Composites

Yaubtli was a major medical and ceremonial plant of the Aztecs, and is described in the Badiano Codex (de la Cruz 1552), the work of Hernández (1959-1967) and especially by Sahagún (1950-1969). The latter wrote that powdered *yaubtli* was thrown in the faces of victims to diminish their sensitivity before being sacrificed during the festivals of Huehuetéotl. *Yaubtli* means "the dark one" (*el oscuro, el moreno*), a name associated with other psychotropics such as *ololiuhqui del moreno* (*Rivea corymbosa*) and its relative *tlitlitzen*, "the divine black one" (*Ipomoea violacea*). According to Náhuatl thought, the color black is hot: a property of psychotropics related to light (Díaz 1975). Little doubt remains that *yaubtli* corresponds to *Tagetes lucida* (Thompson 1923; Reko 1919).

T. lucida is known as *pericón* throughout Mexico and also as *anisillo, curucumún, flor* ("flower") or *hierba de Santa María* ("St. Mary's herb"), *hierba anís, hierba de nube* ("cloud herb") and *tzitziqui* (Díaz 1976a). *Hierba de nube* was mentioned by Hernández and possibly has been resorted to by *graniceros* (shamans who summon hail or *granizo*) of the state of Morelos since that time; they still use this plant in cleansing ceremonies (*limpias*). The name *Santa María* is associated with other plants that are reputed to have emmenagogic effects, such as *Euphorbium odoratum, Chrysanthemum parthenium* and *Pluchea odorata* (Díaz 1976b).

Pericón is a plant of major ethnopharmacological importance in Mexico, due to the extent of its utilization as well as to the variety of attributed actions. Among the 35 medicinal uses of *pericón* which have been cataloged, its application as an emmenagogic, diuretic, antipyretic, aphrodisiac, relaxant and insecticide stand out; some of these actions are shared by *Calea zacatechichi* and *Cannabis sativa*.

Tagetes lucida is currently used for its psychoactive properties only by the Huichol Indians who mix this plant which they call *tumutsáli* with wild tobacco (*Nicotiana rustica*) and smoke it as a peyote substitute (Siegel, Collings & Díaz 1977; Díaz 1975). This preparation, smoked in dry corn husks, produces prolonged episodes of stupor and quiescence, with eyes fixed in a stare or closed. It is difficult to identify which plant is responsible for these effects, although they are similar to the deliriant action of *Nicotiana* previously described.

The ritual use of *pericón* persists in the feast of St. Michael celebrated in many parts of the country, which surely corresponds to the ancient festivals of Huehuetéotl. The flowers are collected during the afternoon of September 28th, sorted into bunches and made into crosses. These are nailed over the thresholds of the houses as a protection against the devil who "runs loose" during that night and whom St. Michael slays upon the dawning of his feast day. The crosses remain all year over the doorways until they are substituted for newly made ones (Díaz 1975). There is obviously a magical parallel between the prophylactic use of *T. lucida* and

tobacco, probably connected to their aroma.

Terpenoids derived from thiopene have been isolated from several species of *Tagetes*, including *T. erecta, T. minuta* and *T. patula*. Of these, α-terthienyl has nematocidal properties (Chan, Towers & Mitchell 1975). Carotenoids, steroids and flavonoids have been identified in *T. erecta* (Muñoz Vélez 1973).

Other terpene composites support their inclusion as a group within the cognodysleptic or imagery-inducing family, typified by *Calea zacatechichi*. *Artemisia mexicana* was known as *iztauhyatl* ("water of the salt deity") which gave rise to the Spanish name *estafiate*. *Iztauhyatl* was widely used in amulets and in the treatment of those "scared by lightning" (Aguirre Beltrán 1963) as was *T. lucida*. Both are still applied during cleansing ceremonies. The genus *Artemisia* is of pharmacological interest since *A. absinthum* is employed as a marijuana substitute and contains an active terpene, thujone, with steric characteristics similar to Δ^9-THC (del Castillo, Anderson & Rubottom 1975).

Water Lilies and Puffballs

Water lilies are frequently depicted in the art of the Indian, Egyptian and Mayan classic civilizations. In 1974, Marlene Dobkin de Ríos suggested that *Nymphea ampla*, an American water lily, was a Mayan psychotropic. This proposal is strengthened by several findings: their ritual representation in frescos at Bonampak; information about the recreational use of stems and bulbs in the Highlands of the Chiapas; and the presence of aporphine alkaloids in the genus (Díaz 1975). These data favor the identification of *N. ampla* as the *quetzalaxochiácatl* of the Nahua poets (Díaz 1977). Recently, phytochemical and psychopharmacological investigations on this water lily have been conducted in our laboratory. Several alkaloids have been isolated from the submerged parts of plants collected in the lakes of Montebello, the region where reports of their recreational use were received. The author has carried out several autoexperiences with the intact material and extracts. On one occasion, 7 g of the pulverized dried bulb were ingested and on another, an aqueous extract equivalent to 35 g of the bulb was taken. There were no detectable psychological modifications. Tests with larger quantities of the fresh material are being planned and we are in the process of determining the structures of some of the isolated alkaloids. These water lilies merit further ethnopharmacological study since sedative and analgesic properties have been attributed to them by herbalists (Díaz 1976b). Also, there are numerous representations of *N. caerulea* in Theban tombs where they appear associated with mandragora and poppies in shamanic contexts (Emboden personal communication).

In the last few years, the ethnobotany and pharmacology of puffballs have been extensively investigated in our laboratory since according to Heim and Wasson they are used for divination among the Mixtec Indians (Heim 1967). About 10 species of lycoperdons belonging to the genera *Astraeus, Scleroderma, Lycoperdon* and *Vascellum* which were collected in the High Mixtec zone have been studied. There, they were indiscriminately classified as divinatory by the informant of Heim and Wasson. None of these fungi produced psychotropic effects during wakefulness nor contained known psychoactive molecules. A species of *Scleroderma* proved to be gastrointestinally toxic (Díaz 1975; Ott et al. 1975). Many of them are edible and are applied locally to induce hemostasis or to accelerate the formation of scar tissue around a wound. Interviews with *curanderos* in the High and Low Mixtec zones yielded no further information. Taking these data into consideration, we can assert that the puffballs which have been studied do not produce any psychotropic effects during the waking state in the quantities ingested.

Nevertheless, it should be pointed out that the informant referred to the fungi's divinatory properties during sleep (Díaz 1975), a use we have encountered for various plants and which can be experimentally investigated. Several more clues of an ethnobotanical nature (Bye 1979; Knab 1979; Díaz 1975; Heim 1967) prevent this chapter concerning the possible psychotropic action of lycoperdons from being fully closed. The name *jitamo real* ("royal dust mushroom") by which these little mushrooms are called in the Mixtec region is applied to some conceivably psychoactive species of the genus *Ephedra* and *Pellaea cordata* (Díaz 1976a). However, this designation might be an allusion to the hemostatic properties shared by these species (Díaz 1976b).

Nahua "Inebriating" and Aromatic Plants

Pellaea cordata, a Polypodiaceae, has been proposed to be a possible inebriant since Martínez (1945) thought it to be among the plants listed by Hernández as having this effect. No alkaloids have been reported in this family and no subsequent ethnobotanical information has been uncovered. The Phytolaccacea *Rivinia humilis* which may correspond to the *amatlaxiotl* of the Florentine Codex and is now known as *coralillo* and *hierba mora* (Díaz 1976a) is a similar case. *Tlacopétatl* which appears to be *Coriaria atropurpurea* has been reported to be an hallucinogen (Schultes & Hofmann 1973) and is reputed in Mexico to be a cardiac

stimulant, toxin and convulsant (Díaz 1976b).

Of greater interest is a series of aromatic plants mentioned as "inebriating" in the sources dating from the Conquest. One of them, *Cymbopetalum penduliforum*, a member of the Annonaceae or custard-apple family, was known by the names *teonacaztli* and *xochinacaztli*. The Florentine Codex is quite explicit concerning the effects of the former: "One shouldn't drink much because it comes out in people; it inebriates like the mushrooms" (Sahagún 1950-1969: Book II, p. 120). Later, there is the statement: ". . . it is the name of the flower. It is drunk in cacao, smoked with tobacco." *Teonacaztli* is a term which signifies "divine ear" or "divine pod." The fruit is an eupeptic and anti-asthmatic (Díaz 1976b), two common actions of the cognodysleptics. This plant could be related to or even be one of the *poyomatlis* sung about by the Nahua poets; a plant so named and also described by Sahagún has been identified as cacao (*Theobroma cacao*) (Díaz 1977). Nevertheless, there probably are references in Náhuatl poetry to other plants called *poyomatli* apart from cacao, since the descriptions do not fit the botanical characteristics of this member of the chocolate family (Knab 1979) or those of the foul-smelling root referred to as *puyomate* by Hernández and in the Inquisition archives. Even today, fermented beverages with cacao as the main ingredient are prepared in Mame territory as well as during the yearly fair celebrated in Cholula (Knab 1979). *Poyomatli* continues to be a problem, insofar as its botanical identification, since the sources from the time of the Spanish domination of Mexico contain very different descriptions. In recent discussions with Knab, we have reached the conclusion that the name is unspecific and embraces various species. The term *poyomatli* may have been used in Náhuatl poetry in a metaphorical manner, referring to the intoxicating nature of the poetry itself rather than to the properties of a flower.

In this context a series of fragrant plants recommended for use by the Aztec governors in the Badiano Codex should be mentioned among which stand out *hueynacaztli* (*Enterolobium cyclocarpum*) and *elexóchitl* (*Magnolia dealbata*). The former was identified as *teonacaztli* in the Florentine Codex; there is also an unmistakable reference to *elexóchitl* as an inebriant. Viesca Treviño (1977) has suggested that this aromatic complex may exert psychodysleptic effects, but neither the chemical composition of the identified plants nor their present ethnobotanical uses support this speculation (Díaz 1976b). He has also formulated the plausible hypothesis that the heavily perfumed odor of these plants could play the magic role of balancing the pathogenic influence of "bad air" (*mal aire*). It is possible that due to this action such names as *ehecapatli* ("air medicine") were used for certain plants. Again, it must be stressed that one must be cautious in applying the term "inebriant" in the literal chemical sense to these plants and flowers. From the very fact that all of them are aromatic and acknowledging the symbolic value of flowers for the Nahua poet, it could be conceived that this term metaphorically is applied to the intoxication of the spirit through poetry. However, the references to these plants in the Florentine Codex justify an ethnopharmacological analysis of the Náhuatl aromatic complex, which should begin with *teonacaztli* and *elexóchitl*.

Bakana

In an extensive ethnobotanical study conducted in the Tarahumara Sierra, Bye (1979) reported that a member of the sedge or Cyperaceae family of the genus *Scirpus* is employed in many parts of the region as an analgesic, antipsychotic and possible divinatory agent. The ingestion of these "little balls" or subterranean tubers is said to induce a deep sleep during which one travels great distances, speaks with dead relatives and sees brilliant colors. The genus *Scirpus* contains alkaloids of the harmaline variety (Raffauf 1970), which would place it in the same family as the South American *ayahuascas*. Harmalines have been found to induce a somnolent state with an increase in visual imagery (Naranjo 1967). The ethnobotanical and pharmacological data basically coincide permitting the provisional classification of this plant as a trance-inducer.

DISCUSSION

The number of botanical species with psychodysleptic properties traditionally used by indigenous cultures that have been detected by the sciences represented in the field of ethnopharmacology are steadily increasing. The native consumption of such plants is greatest in Mexico, both in the number of species employed and in the extent and variety of their use. Independent of the purposes of their consumption and application and of the psychopharmacological differences between them, all the psychodysleptic plants are used in ritual contexts intimately related to religion. It is probable that the fundamental property of the psychodysleptics – the alteration of the habitual state of consciousness – has led them to be considered special, divine or sacred and appropriate for use in religious ceremonies.

The objectives of the rituals centered around psychodysleptics are several. Sacramental practices

imply the intention of establishing contact with the sacred to produce ecstasy. On the other hand, divinatory rituals are carried out so as to enable the shaman to detect the origin and treatment of a disease or the whereabouts of a missing object or person. Oneiromancy is a particular type of divination which is performed with the aid of plants: they are ingested in order to receive a desired response during dreaming. Finally, in the context of magic and sorcery, there are rituals for the purposes of inflicting harm (*daño*), purification and exorcism which involve the external or internal use of plants.

Regardless of their specific psychological actions, the plants that have been studied are ritually used for all the aforementioned purposes; however, there appears to be a correlation between the preferred use and the plant's effects. Thus, the hallucinogens are sacramental plants par excellence, but are employed for divination as well. The trance-inducers and cognodysleptics are predominantly utilized for divinatory ends and some of them for oneiromancy, but they are also sacramental. Using the cartography of conscious states proposed by Fischer (1976, 1975), it can be said that the hallucinogens induce a state of ecstasy of an ergotropic type, while the trance-inducers produce a trophotropic climax. In contrast, the deliriants and neurotoxins appear to be used primarily in the working of magic and sorcery; to produce disturbances in the user; to purify or exorcise a possessed patient; and to stupefy or drive mad one's enemies. This correspondence between the ethnobotanical uses and psychopharmacological effects is preliminary and will require further correction and amplification.

The stimulation of imagination and fantasy by psychodysleptics could constitute one of the reasons for their common uses, especially divination. A mental image is a spatial representation of an interior experience which has some of the characteristics of perception, although it is a purely psychoneural phenomenon. Direct access to these images is available only through introspection, but they are susceptible to interindividual systematization due to the comparable characteristics of these internal events which are apparent in methodical autoreports (Kosslyn & Pomerantz 1977; Paivio 1975). Fantasy is a succession of mental images with a cohesive theme, in many instances of a symbolic nature (Singer 1966). The relationship between images and hallucinations has been the subject of several studies. These phenomena present qualitative differences which refute the idea that an hallucination is simply a case of exaggerated imagination. One of the important distinctions is centered around the issue of control: while hallucinations usually burst unbidden into the field of consciousness, mental images are voluntarily modifiable (Brett & Starker 1977). It has recently been proposed that mental images and fantasy do not merely represent reactivations of past sensorial experiences, but rather constitute true creations and are part of the process of original investigation in science as well as in art and philosophy (Khatena 1978; Shepard 1978). It is tempting to speculate that some of the traditional uses of the psychodysleptics are related to the pharmacological stimulation of imagination and fantasy – surely the motive for the fortunate term *phantastica* coined by Lewin. This property might explain the divinatory and even the sacramental use of these plants, since the user could thereby expect to be placed in contact with culturally-determined mythological images.

In this paper the medical uses of the Mexican psychodysleptics have been emphasized. As has been discussed in the previous sections, many of the empirical applications are clearly justified by the pharmacological facts, indicating that the methods employed in traditional herbal medicine are adequate to reveal the properties of plants. However, in other cases validation is lacking; for example, many of the psychodysleptics are employed to combat fever, despite the known fact that they increase body temperature. There could be a cultural explanation related to the importance of the qualities of "cold" and "hot" in Náhuatl medicine. The psychodysleptics, being pre-eminently "hot" plants, could either be used homeopathically, since they produce effects similar to the symptoms or because of the subjective sensation of cold which is produced by the pharmacological elevation of temperature.

The majority of these plants, including peyote, *ololiuhqui*, marijuana, the Solanaceae and psychodysleptic composites, are also commonly used as local analgesics. The central pain-relieving properties of some of them, such as marijuana (Braude & Szara 1976), have been extensively documented, but it is difficult to account for their effectiveness in local applications. It must be pointed out that a pharmacological basis for all the traditional uses of medicinal plants cannot be expected. In many cases, there are culturally-determined beliefs which must be recognized in order to explain the existence of a particular usage and its efficacy.

Ethnopharmacology is of interest not only because of its multidisciplinary aspects, that is, the coordinated labor of various specialists on a single subject or problem, but also because of the interdisciplinary possibilities: the creation of bridges between the data, methods and theoretical frameworks of several fields. The latter could give birth to novel heuristic approaches,

the generation of hypotheses and, eventually, different methodologies: true scientific hybrids. Some of these bridges are being expanded, for example, the field of ethnobotany, but others have yet to be built. These include the relation between the neural and the cultural; between phytochemistry and animal behavior in the same ecosystem; between the social and the biological. At present, there is not only a lack of systemic models from which practical plans for work could be developed, but also of cooperative communication between the diverse disciplines.

Since the study of psychodysleptic plants has been criticized for the supposed absence of technological applications, it should be pointed out that the knowledge generated by ethnopsychopharmacology is of a theoretical, basic and therapeutic nature, and can be divided into several categories: basic information; tools for the neurosciences; uses in medicine, psychology and the philosophy of science; and the recovery and possible application of this information to indigenous communities.

Justification of basic science as an expression of the creative impulse is not in debate, at least in the field of medicine: there exists ample documentation that the significant therapeutic advances have risen directly or indirectly from basic research. It is clear, however, that in each country the field of basic research to be emphasized should be related to social priorities. In Mexico, the sources of information concerning psychotropic plants could not be more available, more widespread, have greater relevance to the native population or have been less taken advantage of as a subject for study by the present scientific community, with notable exceptions (e.g., Perezamador et al. 1964; Guzmán 1959; Nieto 1959).

Ethnopharmacology has generated molecules that have promoted an exponential increase in the knowledge of the nervous system. For example, it would not be an exaggeration to state that the accumulation of information concerning aminergic transmitters in the brain is at least partially due to the attempt to discover the mechanism of action of the hallucinogens. Several compounds of crucial importance in the neurosciences today, such as scopolamine, muscimol and the ergolines have risen from the field.

The therapeutic potentiality of these substances in psychiatry and medicine has not been fully explored and in many cases has not even been considered. Schools of psychiatry divide their possible applications into two areas, assumed to be antagonistic: the development of models of psychopathology that could yield information concerning the brain mechanisms of psychosis; and the therapeutic utilization of psychodysleptics in medical ailments, whether or not of a psychiatric nature. A critical appraisal indicates that both points of view are theoretically justified, but that neither has been developed with methodological rigor. In the first case, it does not seem warranted to regard the responses provoked by psychodysleptics as a model of psychosis, but rather as mimicking some symptoms or syndromes (Gillin et al. 1976); in the second, there is a lack of controlled clinical investigation which would allow conclusions to be drawn. Such research has not been undertaken since many people think that grave social risks will be incurred, although it appears justifiable as long as the appropriate controls are applied. Among the already established medical applications of the psychodysleptics are found the administration of hallucinogens to patients with terminal cancer (Grof et al. 1977), ergot derivatives in endocrinological disorders (Müller et al. 1977) and cannabinols in pain and glaucoma (Braude & Szara 1976).

The psychodysleptics have been used in cognitive psychology to interindividually evaluate sensorial experiences (Siegel 1977), a line of research which could provide objective models of conscious experience. In the field of psychotherapy, they have been employed as tools in the analysis and systematization of the dynamics of unconscious mental processes (Grof 1975).

The relevance of the data supplied by ethnopsychopharmacology to the age-old philosophical problem of the mind/body relationship is evident. The psychotropic drugs constitute a valuable means of inducing psychological and cerebral alterations, which may facilitate the establishment of bridges between both facets of our reality and ultimately support a monist theory (Díaz 1979). In the establishment of qualitative changes in consciousness, modifications in the way of seeing and interpreting reality also take place: a true conceptual metamorphosis that has opened traditional scientific methods and interpretations to discussion. This epistemological questioning has centered on the nature of knowledge and its acquisition during different states of consciousness (Tart 1972). It has been speculated that the states of consciousness evoked by the psychodysleptics enable shamans to detect complex patterns of environmental information which could explain their documented divinatory and therapeutic efficacy (Robinson 1977).

The central point in the debate surrounding psychodysleptics is precisely their capacity to modify individual consciousness. Many observers are of the opinion that this constitutes a health risk while others argue that, on the contrary, mental health and personal

development may be promoted by such an alteration. It is apparent that although the risks are real, the outcome depends on the user's attitude. The application of plants and substances to the exploration of individual consciousness is a legitimate end when carried out in a responsible and careful manner, as is often done in traditional cultures. One can distinguish *use* from *abuse* in these cases, as with the common drugs that individuals elect to take – a distinction that can be established by objective biological, medical, psychological and social criteria. For example, the use and abuse of tobacco and alcohol is differentiated in our culture by means of such criteria, fundamentally based on the factor of risk. We are still far from having loosened the cultural attachments to the accepted drugs so that the necessary information is made available to establish parameters for the majority of the psychodysleptics.

The rescue of the ancestral knowledge of the indigenous populations is urgent, due to their dramatic extinction. The analysis of the sacramental, divinatory and magic plants provides direct access to the very cosmological center of these cultures, indispensable for the development of an adquate conceptualization. The investigation of the therapeutic techniques carried out in ritual contexts that involve the use of drugs has been important for the development of models of transcultural psychiatry and the estimation of the effectiveness of traditional medicine (Chiappe Costa 1977). However, the work of ethnopharmacology does not lie solely in the construction of a model of an indigenous culture, but also in the active involvement of the trained specialist. The scientist does not come as an "impartial" observer, but rather as a participant observer; not only with the desire to extract facts, but also as an apprentice with a capacity for self-criticism and sympathy: the only stance that will permit an eventual cross-fertilization or mutual flow of information. This implies not a difference in methodology, but in attitude. Fortunately this occurs more and more frequently in those who work among native groups.

In line with these ideas, it should be added that the technical application of ethnopharmacology should involve not only the development of medicines and research material, but also the promotion of health within an overall strategy of ecodevelopment applicable to the cultures that have generated the information. This theme will be developed further in a forthcoming work.

NOTES

1. Francisco Hernández, the personal physician of King Philip II of Spain, was commissioned to study the medicinal plants of New Spain in the sixteenth century.

2. Fray Bernadino de Sahagún gathered data on Aztec culture by interviewing selected informants in the Náhuatl tongue during the second half of the sixteenth century.

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