

Ethnotaxonomy and ethnopharmacology of psychoactive drug of ancient Mexico

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The use of a considerable repertory of psychoactive drugs, most of them plants or substances derived from plants, was a distinctive characteristic of ancient Mexican cultures. Talking about cultural roots of Aztec people, a sixteenth century Indian informer said to the learned friar Bernardino de Sahagun that, since distant times, Teochichimeca people "knew the qualities, the essence of herbs and of roots. The so-called peyote was their discovery..."⁸(X, 29, p. 173). So, from remote times exists an ancestral culture, a desert people culture that knew the marvelous effects of peyote and some other psychoactive plants and gave them an important place in their religious and medical thought. In fact, this assertion is relative, because also in Teotihuacan, archeological researches has disclosed pictorial representations of *datura* species and *ololiuqui*, a convolvulaceous species, always represented in connection with *Tlaloc*, the god of the rain, making evident that in the most civilized Mesoamerican lands, from very ancient times (at least 3 000 years ago), knowledge of hallucinogenic and other psychotropic elements were well developed. These findings show that both Aztec cultural roots, that of Nomadic Chichimeca and that corresponding to the sophisticated Tolteca people, continuously declined in the realm of a supernatural world opened by psychoactive drugs.

THE USE OF PSYCHOACTIVE SUBSTANCES IN PREHISPANIC MEXICO

– Aztecs extensively used psychoactive drugs and provided them with rich and multiple meanings. Generally speaking these drugs were associated with the possibility to acquire specific powers, from the capacity to travel all over cosmic places to the ability to transform oneself in some animal or in any other dangerous being.

As a very effective means to go beyond human limits, all these substances were covered with a mist of mystery and restricted in its employment to some selected people or to some special occasions. The infractors of taboos related with its use were advised that they at least could be made crazy or fools for ever if early death did not intervene⁹(XI, 7, p. 129).

As in many other cultures, these powerful plants were conceived as inhabited by gods or at least by their representative spirits which can be harmful or beneficent depending whoever approached it and what rituals or purificative measures were previously accomplished. It is evident that, from this point of view, human beings were divided in two main groups: those provided with special powers which had access directly to one or several plants or animals, depending on their magnitude of power, and secondly, those which only could make it guided by someone pertaining to the first group. This could only be done after developing a sometimes very complex ritual.

In that way, the use of psychoactive drugs was restricted. Only special people were allowed to use it commonly, and these people were the "kings" (*tlatoani*) and high priests, all of them invested with powers that make them similar only to gods making it easy to maintain a constant intercourse with the gods and the spiritual world.³² This is the most important function of all these plants and substances, because it became the vehicle to preserve the natural order. This function, also, is the nearest to Wasson's concept of "enteogenic" substances, defining by this term the capability to generate a god inside the people that consume it.³⁸ In Wasson's word people have a god inside their body; for us, (based on our review of prehispanic and early colonial documents), these substances provide its consumers with the capability to fulfill duties and perform functions reserved to spiritual beings. This ability is developed by reinforcing the *tonalli*, one the three human souls which aztec thinkers conceived.¹⁹ This entity for animus is responsible for consciousness and partially for thinking, this last function comparted with another soul settled in the heart, *tonalli* is involved also in the action of providing vital heat to the body and the realization of volitive functions. All these functions are diminished when *tonalli* is altered, especially when it is out of the body. Obviously, the *tonalli* can leave the body in different circumstances, some physiological, like sleep, another pathological, as uncounsciousness, "*susto*", (a Mexican culture-bound syndrome), trance states, hallucinatory processes, action of psychotropic substances. In all these cases, the *tonalli* can travel beyond the limits of the

human world and obtain knowledge of many aspects of the supernatural realm. Then, *tonalli* is responsible for all the knowledge acquired in all these altered states of consciousness, and also for all the actions performed under these circumstances.

In some people, and in certain specific moments, it is convenient to reinforce the activities of *tonalli* and search for, send it or maintain it outside the body. This is precisely the case of kings, which need constantly to be in communication with any of their multiple gods or protector spirits. Many of the government activities were finally religious activities, and these kings were also imbued with sacerdotal duties, charging them with the most delicate functions. Thus, they were the people mostly involved in the daily ingestion of psychoactive substances ingestion.

Studying rutinary *tlatoani* activities is surprising by the immense variety of psychotropics included in their meals and usual beverages, in their pleasure activities, as well as all their ritual obligations. The list is impressive, going from some aromatic flowers with some mind disturbing effects to peyote and hallucinogenic mushrooms^{27, 1}(p. 246). At the end of the meal comes cocoa and diverse vanilla varieties and smoked tobacco mixed with liquid amber and some hallucinogenic flowers, like those called *hueinacaztli* (*Cymbopetalum penduliflorum*) and *teonacaztli* (*Chiranthodendron pentadactylon*)⁸(X, 26, p. 88) or also with *poyomatli*, an until now unidentified plant which was believed to give knowledge of occult and future things¹⁰. Based on the testimony of Lumholtz, at the eve of this century, this plant perhaps corresponds to marijuana²¹(II, p. 124).

We want to remember here the banquet celebrated when Moctezuma I decided to build the new *Huitzilopochtli* temple in Mexico, only after he ate some mushrooms and took counsel from the god did he arrive at the right choice¹(p. 259). These two examples give us some light to consider the existence of at least two main official trends to psychotropics use: a daily consumption in low doses, maintaining the *tonalli* strength and making it able to accomplish its functions, and a ceremonial use, with a higher intoxication level, oriented to resolve delicate questions.

Two late sixteenth century chroniclers, Alvarado Tezozomoc and Alva Ixtlilxochitl, both descendants of noble Indian families, agreed, in fact, that mushroom consumption was a more extended practice, in only case limited to kings and priests. The sacred mushrooms, called *teonanacatl* by Aztecs signifying "flesh of the gods" or "divine mushroom" according to the most accepted translations of the term, were included in all ceremonial banquets of high social status warriors and merchants, especially in those previously involved in any important military campaign or commercial expedition. In this way, hallucinogenic mushrooms constitute a relatively open category in view of the possibility that people from the most different social levels may be intoxi-

cated through it. In this first case, the world reserved to kings and priests opened its doors to merchants and warriors. After that and depending on special situations, some other people could accede to the supernatural world.

A ritual that always included eating of psychoactive, or preferably, hallucinogenic drugs, was the complex one intending to send a messenger to some precise place in heaven or in the under world, in order to obtain some important supernatural information or direct indications and come back with it to the priest or *tlatoani* that sent him.

Other common uses were that of curative and divinatory rituals, which were extensively disseminated until colonial times, and rediscovered by anthropological research only some years ago. In this sense, some psychotropics were employed intending to induce in both the patient and the curer an altered state of consciousness intending to bring both of them to a supernatural reality in order to find the origin of illness and its remedies. Sometimes, only the doctor takes the marvelous substance and comes back to this world, after a while, with visions and peculiar interpretations about any consulted problem, from witchcraft to disbalance, and from identifying thieves to soothsaying.

If sometimes hallucinogenes were openly cultivated, those practices were hidden all over the Spanish period, emerging only when discovered by religious authorities. Being relegated to marginal people, and mainly to Indians for three centuries, divine plants were converted to devilish features.

THE DISCOVERY OF MEXICAN SACRED PLANTS

Independently from extensive ethnobotanical knowledge all over the country, Mexican psychoactive plants were discovered by Western Cultures only a hundred years ago, when some anthropologists started to travel inland and register rituals involving the use of psychotropic plants.

Among these classical descriptions are that of Lumholtz, about peyote consumption in Tarahumara and Huichol tribes (1902)²², the very interesting Schultes' paper about *ololiuhqui* (1941)²⁸ and the widely known works of Wasson about hallucinogenic mushrooms (1958)^{33, 34, 35, 36}.

From these primary works, scientific interest arose from the most diverse fields: anthropology, botany, phytochemistry, pharmacology, history, etc. Development of research areas was only a question of time.

First came botany, in the sense of taxonomical, ethnobotany and economy botany, and almost simultaneously, anthropology, trying to understand cultural variability and developing the study of cultural functions of psychotropic substances.

SOME ANTHROPOLOGICAL REMARKS

Nowadays, ethnobotany of Mexican psychoactive plants is a relatively well known subject. Results of extensive field work have been compared with historical data and, in this way, the subsistence of a hard prehispanic cultural basis is now absolutely recognized.

The substances employed are the same consumed five hundred years ago, and the desired effects are also the same. The huichol healer (*marakem*) proceed in the same way as did the fifteenth century Aztec priest-doctor. Leaving aside the presence of Christ, the Holy Virgin and some Christian saints, the indigenous prehispanic substratum pervades in litanies and prayers, and obviously in the imaginary structures of world that are made accessible with the drug.

For example, a brief description of some of the main tracts in an actual Mazatec ritual acts as an illustration: after inquiring what is the problem that brings the "sick" person to search help through the mushrooms, the healer, who conducts the hallucinatory experience, provides mushrooms to the people in the room and supervises that they eat "them" correctly. Then come monotonous litanies expressing the healer's power and her or his invocations to superior powers are said in the language contained in the sacred book. After periods of absolute silence, the Senora "*suddenly began to moan, low at first, then louder. There were silent pauses, and then renewed humming. Then the humming stopped and she began to articulate isolated syllables, each syllable consisting of a consonant followed by a vowel, sharply pronounced... After a time the syllables coalesced into words and the Senora began to chant...*"³⁷ For a long time these rhythmic voices flooded the atmosphere, accompanied by percussive sounds of clapping hands, slapped knees, smacks on the forehead and whamming on the chest. Wasson, and all the participants in those rituals concede that Maria Sabina, the healer that introduced him to the sacred mushrooms, was a woman "of rare moral and spiritual power". The same is expressed about all genuine Mazatec healers.

The induced "travel" is developed in several stages, going from a terrifying self disintegration, to the possibility of putting order in the hallucinatory experience, reconstruct the adjacent world and control the mushroom effects. This last kind of experience involves, of course, the mastering of the mushroom cultural world, and is not accessible from the start. It requires an extensive and deep preparation.

SOME REMARKS ABOUT AZTEC TAXONOMY OF PSYCHOACTIVE SUBSTANCES

With all these data repertoire in mind, we may now proceed to some ethnotaxonomical considerations. The pervasive presence of specific taxonomical axis, which is sometimes evident, another time hidden in the occult, gives us the chance to observe it and distinguish between different classificatory series.

A SOCIAL CLASS DIVISION.

For example, we can start making an obvious division by taking in account the social class of persons involved in the ingestion of psychotropics. The first commentaries exposed in this same paper corresponds to it. Rulers and priests have a very special place in this way. For them a lot of plants and animals determined by their peculiar virtues are being reserved: the use of a special group was restricted to them, that of remedies intended to the rulers, like the one enumerated in the so called chapter in the *Libellus de medicinalibus indorum herbis*, better known as Codex de la Cruz-Badianus. After analyzing all the elements exposed in that place, one of us proposes that all these compounds are there because of their psychoactive properties³². The priests will be included in this same group, because the religious activities of rulers, and also because the near participation of priests in government duties.

From the top social functions, a long descendent list may be settled, giving way to some less important people to participate in the consumption of psychotropic substances, but this had effect only in special conditions, always involving ritual actions.

This may be a simple classificatory trait, a narrative one.

THE PHYSICAL PROPERTIES.

A second classificatory trend is the one which proceeds after consideration of physical properties. These are, in Mexican prehispanic thinking, those placed in a hot-cold axis. Proposed for the first time, some years ago, in the late sixties, by Lopez Austin incorporating in his personal historical observation some anthropological remarks made before by Aguirre Beltran and Villarroyas, for example, this axis has turn out to be the most important and evident reference point to ethnotaxonomical considerations. All creatures are defined as being more or less hot or cold, and then to be cold, coldest, hot or hottest in an infinite series divided by minimal differences. So peyotl is hot. The same occurs with ololiuhqui, but information is contradictory relating to its prehispanic uses, which insists on its relation with water and thus makes it cold, and that referred to hallucinogenic mushrooms. Then, the first instance, based in hallucinogenic properties, is dubious, because perhaps some of these plants are cold.

This consideration leads us to propose another situation: cold and hot are only external, observable properties, but are always evident for a deep order. Cold would be related to water, to earth and its profundity, the underworld, the "infernal" gods and goddesses, the night, the feminine essence... Hot, with sun, with heaven and the upper floors in the vertical cosmic axis, with celestial gods, with masculinity, with tiredness... Then psychotropic elements may be cold or hot, depending on its cosmological relations and are no longer evident of their primary properties²⁰.

In a very simplified way, we propose to start considering psychotropic substances as divided, in the same way that is uni-

verse, in three main groups: that heavenly, comprehensive to all beings related to the thirteen celestial floors; those living on the earth's surface, and the beings referred to in the nine underworld regions. So, we have some celestial and hot by nature, some cold and infernal, giving here the Mexican prehispanic and not Christian significance to hell; a mixture, a product of an essential oil transitional nature, is the main property of "earth is surface, people and beings".

Classified after multiparametric criteria, peyotl is solar, then heavenly, therefore is hot, and its desert habitat makes it clearly correspond to these references. It also produces hallucinatory processes. In this way, peyotl corresponds to a "solar" group of plants which includes all the hallucinogenic cacti, some plants like cacahuaxochitl (*Quararibea funebris*), tonacalxochitl (*Phædranthus miers*) or tonatiuh ixih (not identified).

A very complex relation approximates peyotl with ololiuhqui and teonanacatl. These two last plants are closely related to water, humidity and, so, to Tlaloc and the rain and water gods. To these Tlaloc's plants will be added aggregate, among other plants, iyauhtli (*Tagetes erecta*). This species introduces into this problem a really interesting botanical family—the *Asteraceae* or *Compositae*—which need to be more studied in greater detail. Modern studies on prehispanic religion put in evidence a close relation between Tlaloc with solar gods, mainly in most ancient traditions, like Teotihuacan or Zapotecan; in these ancient peasant cultures, sun and rain are the most valuable vital factors. Tlaloc has some common attributes with sun gods and traces of jaguar features may be one of these.

We now have a first group: plants or animal substances, like jaguar blood or deer horn, for example, related to sun and heavens, of hot nature and very near to Tlaloc and solar gods. Generally speaking, these are hallucinogenic plants or animal substances.

The opposite group is that of night, hell, lunar related substances, near in concept with goddesses, mainly moon and fertility goddesses, but we can not exclude gods like Tezcatlipoca, related to punishment and destruction. Among these substances toloatzin (*Datura meteloides*) take first place, which is only one of many plants of that family very well known in ancient Mexico. These feminine plants have the most fearful effects, including madness and death. Then, it is possible to contrast both groups and characterize them by hallucinogenic versus madness inductors, as symbolical categories of polar cosmic opposites.

Leaving for a moment all these cultural facts, we invite you come with us to have a tour through botany, before arriving at the pharmacological world where we will try to expose the main phytochemical characteristics of Mexican psychotropic plants and its pharmacological properties.

THE BOTANICAL TAXONOMY OF MEXICAN PSYCHOTROPIC PLANTS

Taxonomy of psychotropic plants has been a favorite field for botanists. From Classical Antiquity Teophrastus, Dioscorides and Pliny abounded in descriptions of Helleborus, Solanum, mandrake, poppies... A list which was completed after the sixteenth century by scientists that studied New World plants, like Nicholas Monardes or Francisco Hernandez. Linneus didn't leave aside the subject, publishing an interesting book about Inebriantia, the plants that produce important mental changes and alterations. The works of Richard Evans Schultes, Roger Heim, Pablo Reko and Faustino Miranda opened the field to modern classification.

From the late sixties onwards it was recognized that plants with psychotropic properties come from a limited number of botanical families. Among them, the most important are

- *Cactaceae*, represented by peyote (*Lophophora williamsii*) and other related cactus, like hikuli or bakana (*Coryphantha compacta* Engelm Britt. & Rose), hikuli mulato (*Epithelantha micromeris* Engelm Weber ex Britt. & Rose) and saguaro (*Carnegie gigantea* Engelm Britt. & Rose);
- *Solanaceae*, with all the members of *Datura* genus, known in Ancient Mexico as toloatzin, tlapatl and nexéhuac, and tobacco, with hallucinatory effects registered in historical sources and recently suggested by a Californian research team;
- *Leguminosae*, represented by colorin (*Erythrina americana*), genista (*Cytisus Canariensis*), an interesting plant originating from the Canary Islands and extensively employed as hallucinogenic by Tarahumara Indians, frijol de mezcal (*Sophora secundiflora*) and some mimosa varieties, among them the tepezcohuite which is provided also with important cicatrizing properties;
- *Convolvulaceae* including the famous ololiuhqui (*Turbina corymbosa*) and piule (*Ipomoea violacea*), although all the seeds of these plants receive this same name;
- and last, but not least, mushrooms, from *Agaricaceae* and *Strophariaceae* families, generically called teonanacatl, a nahuatl word that signifies divine mushrooms.

Other families are less important in attending the quantity of species provided with psychotropic action, but some of their specimens are important by their extensive use or because of their dramatic effects. Among these, we can mention the *Lythraceae*, with *Heimia salicifolia*, popularly called sinicuiche, as its representative and the *Lamiaceae* with *Salvia divinorum*.

This enumeration is of course not a comprehensive one. Actually we have noticed a hundred psychoactive plants known and used in Prehispanic Mexico, but our list covers the most influential ones and exemplifies most of the botanical families with this kind of representatives. From a botanically point of view, it is interesting to indicate that all these families correspond to those which in the Old World have psychoactive plants.

Table 1

Genus	Species	Family
Superior plants		
<i>Cacalia</i> DC.	<i>C. cordifolia</i> L. f.	Asteraceæ
<i>Calea</i> L.	<i>C. zacatechichi</i> Schlecht.	Asteraceæ
<i>Cannabis</i> L.	<i>C. sativa</i> L.	Cannabinaceæ
<i>Carnegica</i> B. & R.	<i>C. gigantea</i> (Engelm.) Britt. & Rose	Cactaceæ
<i>Coryphanta</i> (Engelm.) Lem.	<i>C. compacta</i> (Engelm.) Britt. & Rose	Cactaceæ
<i>Echinocereus</i> Engelm.	<i>E. triglochidiatus</i> (Engelm.)	Cactaceæ
<i>Epithelantha</i> Weber ex B. & R.	<i>E. micromeris</i> (Engelm.) Weber ex Britt. & Rose	Cactaceæ
<i>Lophophora</i> Coult.	<i>L. williamsii</i> (Lem.) Coult.	Cactaceæ
<i>Mammillaria</i> Haw.	<i>M. senilis</i> (Lodd.) Weber	Cactaceæ
<i>Pelecypophora</i> Ehrenb.	<i>P. aseliformis</i> Ehrenb.	Cactaceæ
<i>Pachycereus</i> (A. Berger) B. & R.	<i>P. pecten-aboriginum</i> (Engelm.) Britt. & Rose	Cactaceæ
<i>Erythrina</i> L.	<i>E. americana</i> Mill.	Fabaceæ
<i>Mimosa</i> L.	<i>M. hostilis</i> (Mart.) Benth.	Mimosaceæ
<i>Mucuna</i> Adans.	<i>M. pruriens</i> (L.) DC.	Fabaceæ
<i>Cæsalpinia</i> L.	<i>C. sepiaria</i> Roxb.	Cæsalpiniaceæ
<i>Cytisus</i> L.	<i>C. canariensis</i> (L.) O. Kuntze	Fabaceæ
<i>Rhynchosia</i> Lour.	<i>R. phaseoloides</i> DC.	Fabaceæ
<i>Sophora</i> L.	<i>S. secundiflora</i> (Ort.) Lag. ex DC.	Fabaceæ
<i>Salvia</i> L.	<i>S. divinorum</i> Epl. & Jativa-M.	Lamiaceæ
<i>Heimia</i> L. & O.	<i>H. salicifolia</i> Link & Otto	Lythraceæ
<i>Lobelia</i> L.	<i>L. tupa</i> L.	Campanulaceæ
<i>Coriaria</i> L.	<i>C. thymifolia</i> HBK. ex Willd.	Coriariaceæ
<i>Scirpus</i> L.	<i>S. atrovirens</i> Willd.	Cyperaceæ
<i>Tagetes</i> L.	<i>T. lucida</i> Cav.	Asteraceæ
<i>Tagetes</i> L.	<i>T. erecta</i> Willd.	Asteraceæ
<i>Pernettya</i> Gaud.-Beaup.	<i>P. furens</i> (Hook ex DC.) Klotzch	Ericaceæ
<i>Brusmansia</i> Pers.	<i>B. arborea</i> (L.) Lagerh.	Solanaceæ
<i>Brusmansia</i> Pers.	<i>B. aurea</i> (L.) Lagerh.	Solanaceæ
<i>Datura</i> L.	<i>D. ceratocaula</i> Ort.	Solanaceæ
<i>Datura</i> L.	<i>D. inoxia</i> Mill. (<i>D. meteloides</i>)	Solanaceæ
<i>Datura</i> L.	<i>D. metel</i> L.	Solanaceæ
<i>Petunia</i> Juss.	<i>P. violacea</i> Lindl.	Solanaceæ
<i>Solandra</i> Sw.	<i>S. brevicalyx</i> Standl.	Solanaceæ
<i>Turbina</i> Rafin.	<i>T. coryhmosa</i> (L.) Rafin.	Convolvulaceæ
<i>Ipomoea</i> L.	<i>I. violacea</i> L.	Convolvulaceæ
<i>Nymphaea</i> L.	<i>N. ampla</i> (Salisb.) DC.	Nymphaeaceæ
<i>Oncidium</i> Sw.	<i>O. cebolleta</i> (Jacq.) Sw.	Orchidaceæ
<i>Ungnadia</i> Endl.	<i>U. speciosa</i> Endl.	Sapindaceæ
Mushrooms		
<i>Psilocybe</i>	<i>P. caerulescens</i> Murr.	Strophariaceæ
<i>Stropharia</i> (Fr.) Quélet	<i>S. cubensis</i> Earle.	Strophariaceæ
<i>Conocybe</i> Fayod	<i>C. siligineoides</i> Heim.	Agaricaceæ
<i>Panaeolus</i> Fr.	<i>P. sphinctrinus</i> (Fr.) Quélet	Strophariaceæ
<i>Copelandia</i> Bres.	<i>C. cyanescens</i> (Berk. & Br.) Singer	Coprinaceæ
<i>Lycoperdon</i> L.	<i>L. mixtecorum</i> Heim	Lycoperdaceæ
<i>Lycoperdon</i> L.	<i>L. marginatum</i> Vitt.	Lycoperdaceæ

Only to give some examples we can mention the European and Asian *Datura* species, or mandragora and belladonna among the *Solanaceae*; the existence of *Leguminosae* like *Rhynchosia*, *Mimosa* and *Cesalpinia* species or the extensive knowledge of psychedelic mushrooms in both hemispheres.

It is also important to mention that these botanical identifications have been a very difficult task because the problems inherent in the relation of historical sixteenth century sources (most of them written in nahuatl or coming from pictorial manuscripts), with living plants whose magical actions were usually hidden by the Indian people fearful after almost five hundred years of religious harassment.

PHYTOCHEMISTRY OF PSYCHOACTIVE MEXICAN PLANTS

The importance of having a definite botanical identification of psychoactive plants comes from two main trends: the existing confusion derived from exclusive use of popular names, because synonymy frequently involves different species, and the existence of some phytochemical characteristics shared by members of the same plant family. This last trait makes it possible to formulate a botanical chemotaxonomy that enables one to establish some scientific hypothesis explaining ethnobotanical facts.

Most of the above mentioned plants have been studied chemically, from the early nineteenth century until today, from the first simple alkaloid studies to the most sophisticated modern research.

Perhaps the first substances recognized and studied were the tropanic alkaloids of some European *Solanaceae*, like *Hyoscyamus niger* and *Hyoscyamus albus*, belladonna or some European *Datura* species, the same that are later found in Mexican toloatzin or tlapatl; nevertheless, the first Mexican psychotropic plant recognized as non-existent in Europe and extensively studied was peyotl, primarily classified as *Anhalonium lewinii* from the name of his discoverer, Louis Lewin. A little later, a variety of similar cacti emerged as having analogous effects. Some of them were classified also as *Anhalonium*, i.e. *Anhalonium williamsii*²⁵, and were converted by botanical taxonomists in *Lophophora*.

From 1888, Lewin had identified in peyote an active principle which was called anhalonine and proved to be, "like the plant itself —according to Lewin— an extremely strong stimulant and capable of provoking muscular cramp in laboratory animals"^{16a+b}. With this finding, Lewin inaugurates an epoch of discoveries and surprises. The first was the recognition that cacti, hitherto considered as biologically harmless, may possess considerable toxic properties. To the end of the century, Lewin had discovered four alkaloids in *A. lewinii*, among them mescaline, to which were attributed the vision-producing properties, and only one in *Lophophora williamsii*, pellotine, which had no pharmacological effects of this type⁹.

Recent research proved that peyote, from a chemical point of view, is a more complex plant. Actually 30 alkaloids of phenethylamine and tetrahydroisoquinoline types^{25, 14} have been isolated from it.

In addition to the main active principles reported in the literature, the discovery of dopamine is really interesting²³. It was isolated from other cacti like *Pachycereus pecten-aboriginum* and *Carnegica gigantea*.

It is interesting to note that in the last century some *Senecio* species were included among the peyote complex because of the appearance of its roots. In the very accurate studies at the Instituto

Table 2
Main Peyote alkaloids

Hordenine
M-methyl-4-hydroxy-3-methoxyphenethylamine
3-demethylmescaline + 3,4-demethylmescaline
N,N-demethyl 3-demethylmescaline
Mescaline
N-methylmescaline + N-Formylmescaline + Nacetylmescaline
Anhalamine
Anhalinine
Anhalidine
Anhalonidine
O-methylanhalonidine
Pellotine
Isopellotine
Anhalonine
Lophophorine
Peyophorine

Medico Nacional they were still called Tepic peyote and Peyote from the Valley of Mexico, but correctly classified as *Senecio*. In phyto chemical thesis, this different plant species both contain the same alkaloid types and have similar hallucinatory effects.

The same can be said of two plants employed as peyote substitutes among Tarahumaras, *Oncidium cebolleta* (Jacq.) Sw. and *Scirpus* sp., little studied plants, without any serious chemical screening.

Discovered later by scientists, hallucinatory mushrooms had been well known in all Mesoamerica. Pertaining to a very ample species group, and including also *Amanita muscaria*, which use has been recently documented in ethnobotanical studies in the highlands of Oaxaca, mushrooms constitute a very interesting complex. In the sixties, Albert Hoffmann isolated psilocybine and psilocine, making biological auto-assays¹¹. It is sure that *Psilocybe* and *Stropharia* species have more alkaloids that have so far not been reported as having psychotropic effects.

A big surprise was furnished to the scientific community when ololiuhqui (*Turbina corymbosa*) and tlilitzin (*Ipomæa violacea*), both *Convolvulaceæ*, yielded ergolinic alkaloids related to LSD. Another time it was Hoffmann who obtained from it lysergic acid amide and hydroxyethylamide¹². In *Ipomæa violacea* there are five times more alkaloids than in ololiuhqui³¹ (pp. 66, 67).

PSYCHOPHARMACOLOGY

From the eighteenth century, Linneus had classified certain plants that produced conscience and behaviour alterations under the generic name "Inebriantia"¹⁸. A century ago, Lewin proposed the first detailed classification to design the different pharmacological actions on the mind. He proposed a new generic groups: narcotic substances, and divided it in "euphorica" or mental sedatives, "phantastica" or hallucinogenic substances, "inebriantia", now limited to alcohol and some anaesthetics, "hypnotica" and "excitantia"¹⁷. After midcentury, Delay and Deniker proposed another classification, a functional one, reducing the genera to psycholeptic, psychoanaleptic and psychodysleptic and grouped some families in each one of them⁴. In this paper, we only deal with psychodysleptics, and adopt the family division proposed by Diaz in 1972 for Mexican plants⁵. So we consider hallucinogenics, trance inductors, cognodysleptics and dream state inducing substances, causing delirious states and neurotoxic psychodysleptics⁶, following in this last item the proposal of Brawley and Duffield (1972). Generally, this classification corresponds to the most relevant trends of the American College of Psychopharmacology, distinguishing psychotropic drugs affecting perceptual-neuromotor functions, those with effects over cognition and memory and those affecting associative learning and functions³⁰.

HALLUCINOGENIC SUBSTANCES

The most important plants in this group are peyote and teonanacatl (hallucinogenic mushrooms). The alkaloids involved are indolics like psilocybin, dimethyltryptamine, LSD and a phenethylamine, mescaline.

Peyote hallucinations have been described in anthropological literature from the last years of the nineteenth century. The mescaline isolation opens the research field and the experimental study of its pharmacological characteristics. By now the first psychiatric studies in peyote alkaloids are in the classics authors. These are that of Kluver¹⁵ and Beringer^{1a}, which contains precise descriptions of the hallucination's characteristics with special emphasis of colored visions and of important auditive components, the latter especially in the last moments of the intoxicating experience or after some days of repetitive use.

It is necessary to point out that this field is, in reality reduced to testing the effects of the pure alkaloids. It is clearly necessary to conduct comparative studies between complete plant

and mescaline ingestion²⁴, as the Lewin 1924's asserts there is only one recorded. It is also important to design studies in relation to long term and repetitive doses, in conditions more similar to that observed in ritual use. Another research strain is that of analyzing the separate effects and pharmacological characteristics of all the other alkaloids different from mescaline, which are studied at a biosynthesis level but no more^{3, 13}.

The peyote use constitutes really a complex, that goes beyond simple pharmacology to religious significance, and involves also the employment of a relatively large number of cactus species that include *Coryphantha compacta*, called Bakana and Wichuri, provided with phenylethylamines; *Epithelanta micromeris*, called hikuli like true peyote, containing phenylethylamine alkaloids and terpenes and renowned to develop, in the medicine-man, a "clear" sight that makes him capable of communicating with distant curers, sorcerers and spirits; some cacti of the genus *Ariocarpus*, with the same type of alkaloids, but renowned to be stronger than peyote in its effects and, therefore used in witchcraft; *Pelecyphora aseliformis*, called peyotillo, little peyote, with an unknown chemical composition; some species of *Echinocereus* a very little studied plant which seems to have tryptamine and *Mammillaria* species, specially *Mammillaria heydenii*, containing N-methyl 3,4-dimethoxyphenylethylamine, which produced in shamans a deep sleeping syndrome with dreams about very long distances, sometimes a cosmic trip²⁹ (pp. 66-71).

Besides the peyote group, there is another cactus with hallucinogenic properties. These are called saguaro, whose botanical name is *Carnegia gigantea* and *Pachycereus pecten-aboriginum*, called by Tarahumara Indians cauve or wichowaka, this last word signifying madness. From the first at least four alkaloids have been isolated: 5-hydroxycarnegine, corcarnegine, 3-methoxytyramine and arizonine, the later being a very active tetrahydroquinoline alkaloid²⁹ (pp. 76-77). To the *Pachycereus* are said to cause hallucinatory effects and the capability of turning people crazy. These properties are clearly related to its alkaloids: 4-hydroxy-3-methylphenylalanine and four tetrahydroisoquinolines²⁹ (pp. 66-67). It is convenient to add *Oncidium cebolleta* and *Scirpus* sp., whose chemical constituents have not been studied, but with strong hallucinogenic effects that were confirmed ethnobotanically.

The other very important hallucinogenic group is that of mushrooms. The main species involved are from the genera of *Psilocybe* and *Stropharia*, both rich in psilocybin and psilocin, alkaloids with well known pharmacological properties studied from 1957 by Delay³, and after wards experimentally in Mexico by Nieto. Phenomenologically the psilocybe and stropharia hallucinations are characterized by a deep sense of soul liberation, visions of geometric figures either sharp edges, bright colors and, at first experiences a depersonalization and a lost sense of reference structure. This last item disappears after some

time, when intoxicated people learn to recover control over his or her mind. In some individuals, depending on the dosage, the emotional conditions, the personal drug sensitivity and cultural factors involved, the intoxicating experience can evolve in an acute psychosis characterized by strong anxiety.

Presumably, psilocyn and psilocibyn acts over specific neuronal cells, mainly at serotonergic systems in limbic system and lateral geniculus corpus, this last fact can be evidenced by the presence of visual phenomena. These neurones are also very sensitive to small LSD systemic doses, similar to mushroom alkaloid doses necessary to develop hallucinations.

The pharmacological and ethnopharmacological studies on Mexican hallucinogenic mushrooms are still promising to be an important field of research. The study of small actions is only at its early stages and only discriminative studies directed to make differences between biological basic effects and culturally learned phenomena are mentioned. In the same way, experimental psychoses studies, started in the late fifties, have only continued on an irregular basis.

TRANCE INDUCTORS

In recent years, studies of altered states of consciousness, attracted attention over trance states, its cognitive possibilities and its cultural applications.

There are some effective trance inductors among Mexican psychotropic plants. The most celebrated is *ololiuhqui* (*Turbina corymbosa*), a plant that was recognized early and classified by Urbina in 1903³¹ and erroneously identified as a *Datura* species by Safford in 1916, a mistake maintained by Lewin in 1924 and corrected by Reko in 1928²⁶ and definitively by Schultes²⁸ thirteen years later. Its chemical composition explains its psychopharmacology and its uses as an excellent divinatory drug that provokes dreams, provided with cognitive elements, among them the possibility to identify thieves, sorcerers or spirits involved in illness. It differs completely from the hallucinogenic plants producing lethargy, indolence, irritability; when the eye is closed some visual fantasies appear, always maintaining a real mental accuracy, but all these symptoms are accompanied by a palsy of the will that converts the intoxicated person to a simple spectator, to an observer.

Similar to *ololiuhqui* is *Ipomoea violacea*, another *Convolvulaceae* provided with a hard charge of the same alkaloids.

The Virgin Herb (*Salvia divinorum*) comes from an other botanical family employed in divinatory rituals by ancient Aztecs and Mazatecs and causes similar effects as *ololiuhqui*. No definitive chemical studies about it are available to date and any of the chemical components isolated and seems to deserve attention; nevertheless it works in practice, may be due to terpenic components. In some way its effects have been compared with that of marijuana, including hypnagogic image production in superficial sleep phases⁵.

Calea zacatechichi is qualified as dream state inducing in the most recent researches. In fact, it produces somnolence, sometimes being soporiferous; it causes a very tranquil state and one feels and hears the pulse and the heart beat.

In the same group we include *Heimia salicifolia*, called *sinicuiche*, that is a trance inductor which is capable of producing hallucinations when employed in high doses. It produces very selective auditive hallucinations, and is also utilized to remember ancient events, also those that occurred before birth. It contains alkaloids of the quinolidine type and cryogenine, the latter being responsible for its febrifuge properties, whereas some of these alkaloids seem psychoactive.

NEUROTOXIC AND DELIRIOGENIC PLANTS

The main group in this section is that of *Datura*. As we have seen in this same paper of botanical paragraphs, *Datura* species are abundant and were also abundantly utilized in prehispanic and Colonial Mexico. Nevertheless, ethnobotanical information is really poor with respect to ritual uses, but is abundant when speaking about magics, specially love magic and black magic, where it is employed to make people crazy. All the group constituents provoke all the intoxication symptoms of tropane alkaloids like atropine, scopolamine and hyoscamine, all of them present in high doses. Loss of memory and changes of the level of consciousness are specifically related to this plant genera. Curiously, prehispanic taxonomists classified *Datura* as a nocturne plant, a dangerous plant which can only be used by really powerful sorcerers.

CONCLUSION

From these few data we think it is possible to proceed to a more functional classification that expresses faithfully ancient Mexican preoccupations and give us access to a better understanding of that marvelous culture. The analysis of phytochemistry and modern considerations about the functional characteristics of the central nervous system, enable one, to realize detailed studies of these substances on specific receptors discerning the compatibility of psychotropic effects as detected clinically by Aztec healers and modern phytochemical science. From an endocultural point of view, the separation between hallucinogenic substances, madness inductors, trance inductors, wellbeing producers, etc. gives us the possibility to develop studies with the intention to explore the role of the different states of consciousness in prehispanic cultures and the social scope associated to them.

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