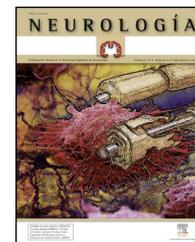




ELSEVIER  
DOYMA

# NEUROLOGÍA

www.elsevier.es/neurologia



## REVIEW ARTICLE

# Hallucinogenic drugs in pre-Columbian Mesoamerican cultures<sup>☆</sup>

F.J. Carod-Artal

Servicio de Neurología, Hospital Virgen de la Luz, Cuenca, Spain

Received 30 March 2011; accepted 5 July 2011

Available online 2 December 2014

### KEYWORDS

Hallucinogens;  
Hallucinogenic fungi;  
Peyote;  
Pre-Columbian  
culture;  
*Psilocybe* spp.;  
*Turbina corymbosa*

### PALABRAS CLAVE

Alucinógenos;  
Culturas  
precolombinas;  
Hongos;  
Peyote;  
*Psilocybe* spp.;  
*Turbina corymbosa*

### Abstract

**Objectives:** The archaeological, ethno-historical and ethnographic evidence of the use of hallucinogenic substances in Mesoamerica is reviewed.

**Results:** Hallucinogenic cactus, plants and mushrooms were used to induce altered states of consciousness in healing rituals and religious ceremonies. The Maya drank balché (a mixture of honey and extracts of *Lonchocarpus*) in group ceremonies to achieve intoxication. Ritual enemas and other psychoactive substances were also used to induce states of trance. Olmec, Zapotec, Maya and Aztec used peyote, hallucinogenic mushrooms (teonanacatl: *Psilocybe* spp.) and the seeds of ololiuhqui (*Turbina corymbosa*), that contain mescaline, psilocybin and lysergic acid amide, respectively. The skin of the toad *Bufo* spp. contains bufotoxins with hallucinogenic properties, and was used during the Olmec period. Jimson weed (*Datura stramonium*), wild tobacco (*Nicotiana rustica*), water lily (*Nymphaea ampla*) and *Salvia divinorum* were used for their psychoactive effects. Mushroom stones dating from 3000 BC have been found in ritual contexts in Mesoamerica. Archaeological evidence of peyote use dates back to over 5000 years. Several chroniclers, mainly Fray Bernardino de Sahagún, described their effects in the sixteenth century.

**Conclusions:** The use of psychoactive substances was common in pre-Columbian Mesoamerican societies. Today, local shamans and healers still use them in ritual ceremonies in Mesoamerica. © 2011 Sociedad Española de Neurología. Published by Elsevier España, S.L.U. All rights reserved.

### Alucinógenos en las culturas precolombinas mesoamericanas

#### Resumen

**Introducción:** El continente americano es rico en hongos y plantas psicoactivas, y numerosas culturas precolombinas mesoamericanas las emplearon con fines mágicos, terapéuticos y religiosos.

**Objetivos:** Se revisan las evidencias arqueológicas, etnohistóricas y etnográficas del uso de sustancias alucinógenas en Mesoamérica.

<sup>☆</sup> Please cite this article as: Carod-Artal F. Alucinógenos en las culturas precolombinas mesoamericanas. Neurología. 2015;30:42–49.  
E-mail address: [fjcarod-artal@hotmail.com](mailto:fjcarod-artal@hotmail.com)

**Resultados:** Cactus, plantas y hongos alucinógenos se utilizaron para provocar estados alterados del nivel de conciencia en ceremonias rituales y curativas. Los mayas ingerían el balché (hidromiel y extracto de *Lonchocarpus*) en ceremonias grupales para lograr la embriaguez. También emplearon enemas rituales con sustancias psicoactivas para inducir estados de trance. Olmecas, zapotecas, mayas y aztecas usaron el peyote, los hongos alucinógenos (teonanacatl: *Psilocybe* spp.) y las semillas de ololiuhqui (*Turbina corymbosa*), que contienen mescalina, psilocibina y amida del ácido lisérgico, respectivamente. La piel del sapo *Bufo* spp. contiene bufotoxinas, con propiedades alucinógenas y fue usado desde el periodo olmeca. El toloache (*Datura estramonio*), el tabaco silvestre (*Nicotiana rustica*), el lirio de agua (*Nymphaea ampla*) y la hoja de la pastora (*Salvia divinorum*) se utilizaron por sus efectos psicótropos. Piedra fúngicas de 3.000 años de antigüedad se han encontrado en contextos rituales en Mesoamérica. Las evidencias arqueológicas del uso del peyote se remontan a más de 5.000 años. Diversos cronistas, entre ellos Fray Bernardino de Sahagún, relataron sus efectos en el siglo xvi.

**Conclusiones:** El empleo de sustancias psicotrópicas fue muy común en las sociedades precolumbinas mesoamericanas. En la actualidad chamanes y curanderos locales las siguen usando en ceremonias rituales.

© 2011 Sociedad Española de Neurología. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

## Introduction

Hallucinogens are substances that when ingested in non-toxic doses can provoke altered states of consciousness and induce unreal perceptions or distortions of the surroundings. Throughout history, numerous societies have isolated substances with hallucinogenic properties from fungus, plant, and animal sources. From an ethnobotanist's and anthropologist's viewpoint, the American continents provide excellent opportunities for studying a wide array of natural hallucinogens.<sup>1</sup>

The diverse civilisations that flourished in Mesoamerica displayed great knowledge and skill in their use of numerous hallucinogens. Archaeological, ethnohistorical, and ethnographic evidence show that throughout history, pre-Columbian Mesoamerican cultures used hallucinogenic substances in magical, therapeutic, and religious rituals.<sup>2,3</sup> These substances are considered entheogens since they were used to promote mysticism and communication with divine powers. The purpose of using these substances was to enter a trance and achieve greater enlightenment and open-mindedness. The altered state of consciousness the user aimed to reach was characterised by temporal and spatial disorientation, a sensation of ecstasy and inner peace, hallucinations of vivid colours, tendency towards introspection, and an impression of being one with nature and with the gods.<sup>4</sup>

Mesoamerican myths and religions emphasise the role of the priest or shaman as a mediator between the physical and the spiritual worlds, and this situation promoted the use of entheogens in religious ceremonies and prophecy.<sup>5</sup> Shamans, intermediaries between the natural and supernatural realms, would consume numerous psychoactive substances to undertake their shamanic journeys. This would begin when the shaman's spirit left the natural world and continued to wander the supernatural world, making contact with the spirits in order to acquire knowledge about plants, diagnose diseases, or ensure a good harvest or rainy season, before finally returning to his body in the physical world.<sup>6</sup>

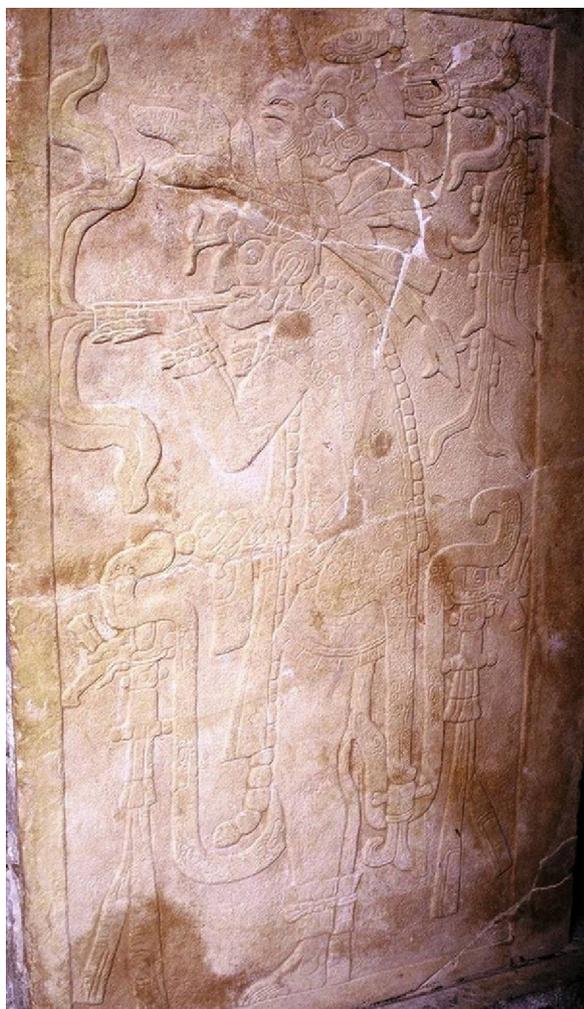
Both Mesoamerican and Andean iconography offer numerous depictions of the shamanic journey and trance state induced by hallucinogens.<sup>7</sup> Furthermore, psychoactive plants were believed to be associated with certain gods, and they had voices that the shaman was expected to convey or adopt after partaking.

## Inebriation: balché and the Mayan ritual enemas

Drugs, drinks, and ritual enemas were used in the sacred ceremonies practised all across Mesoamerica. Using or combining different psychoactive plants with intoxicating elixirs was also common. Consumption of many of these substances dates back to the Olmec era (1200-400 BCE). However, researchers are better informed about Mayan and Aztec societies based on Mayan religious texts (the Popol Vuh) and the first outside accounts of Aztec culture from the 16th century.

The Maya (250 BCE-900 AD)<sup>8</sup> consumed an intoxicating beverage called *balché*, which is an infusion of the bark of *Lonchocarpus longistylus* mixed with honey from bees fed on a type of morning glory with a high ergine content. Inebriation was connected with the practice of divination, a ritual intended to enable direct communication with the spirits in order to predict the future or understand events that would otherwise be incomprehensible, including illnesses, shifts in fortune, adverse meteorological events, poor harvests, and the outcomes of combats or wars. Since the alcoholic content of *balché* seemed to have been quite low, it had to be ingested in large quantities in order to provoke an intoxicating effect. During ceremonies, participants' vomit was collected in bags that were then hung around their necks. *Balché* has survived the test of time, and the Maya in the Mexican state of Yucatán still consume it.

Pulque, or 'chi' to the Maya, was another alcoholic drink made by fermenting the sap of the maguey plant. Different ceramic works from the Mayan classic period produced vessels marked with the glyph 'chi'. References to the use of hallucinogenic drinks also appear in the Dresden, Borgia, Florentine, and Borbonicus codices. The Codex



**Figure 1** Temple of the Cross, Palenque. Ceremonial tobacco use.

Vindobonensis shows richly dressed figures drinking pulque. The mural known as ‘The Drinkers’ in Cholula, Puebla (Mexico), shows male and female figures drinking pulque in a group ceremony.<sup>5</sup>

Those who drank balché would also take other psychoactive substances, smoke wild Mesoamerican tobacco (*Nicotiana rustica*), and perform ritual enemas. Tobacco was consumed smoked, inhaled, or chewed; it was also mixed with the leaves of datura (tolohuaxihuitl; *Datura stramonium*) or *Brugmansia* spp. The high psychoactive alkaloid content of these plants intensified the entheogenic effect.<sup>9</sup> Wild tobacco, which the Maya called *piziet*, also played a part in many sacred ceremonies. The Temple of the Cross in Palenque, Chiapas, houses a stela depicting God G smoking tobacco (Fig. 1). In his historical treatise *Historia de Guatemala o Recordación florida*, Francisco Fuentes y Guzmán mentions different uses of tobacco amongst the Maya in the 16th century.<sup>10</sup>

‘‘They also adored and attributed divine power to the herb they call piziet, which is tobacco; their custom is to imbibe the smoke, and thus inebriated, they will invoke the devil to learn about the future and pass on the pleas and wishes commended to them by others. We understand that



**Figure 2** Mayan ritual enema

this practice of augury was reserved for the priests of their demonic and accursed idols.’’

Some substances were used to provide visions and to decrease pain inflicted by self-sacrifice, a typical practice in Mayan culture. For example, *Naab*, a white lotus or water lily found in the lakes and rivers of Guatemala (*Nymphaea ampla*), was smoked or eaten raw for the psychoactive properties of its bulbs and roots. *Naab* makes frequent appearances in Maya iconography, and it is usually associated with death, the underworld gods, and the afterlife.<sup>11</sup> Mayan priests (*chilam*) practised divining and entered ecstatic states to communicate with the gods and forces of nature, or to transform themselves into personifications of corn or rain. The flower of *N. ampla* became a symbol of high lineage and it frequently appears on the headdresses of the Maya elite. This plant was regarded as a link to fertility because it provided food for fish, while water in which it grew made the earth fertile for growing corn.

The Maya used enemas to administer certain substances in order to attain more intense trance states more quickly. Researchers have discovered Mayan classic-period sculpture and ceramics depicting scenes in which hallucinogenic enemas were used in rituals; some figures are shown vomiting while others receive enemas.<sup>12</sup> There are also anthropomorphic terracotta figures demonstrating the self-administration of psychoactive enemas. The iconography on many ceramic vessels from the Mayan late classic period shows some figures chatting as they received enemas (Fig. 2), and pots overflowing with foam from a fermented drink.

Various descriptions from the colonial period (such as the Florentine Codex) describe how enemas were used to combat illness and discomfort of the digestive tract. Enema use was also associated with rites or ceremonies in which participants tried to reach a state of ecstasy through inebriation. Enemas containing alcohol, sometimes mixed with other psychoactive substances, were applied using syringes made of gourd and clay. The god Akan, whom Spanish writers referred to as the Mayan Bacchus, watched over the ritual enemas and bacchanalia.

Many ceremonies were held underground, in dark caves, which were considered points of access to the underworld. This was thought to intensify the inner vision provided by ingesting psychostimulants and hallucinogens. Furthermore, prolonged fasting, rhythmic music, and dancing, along with use of hallucinogens, provided a favourable setting for contact with the spirit world.

Mayan consumption of alcohol and psychoactive drugs during their religious ceremonies was condemned by the first Spanish priests. Diego de Landa<sup>13</sup> provided the following

description of balché use: “The Indians consumed alcohol and drugs in immense quantities, which gave rise to many evils, including murders. They made wine from honey, water, and the root of a certain tree which they grew just for that purpose. The wine had a very strong flavour and a putrid odour”.

### Sacred mushrooms

The main entheogenic mushrooms belong to the genera *Psilocybe*, *Panaeolus*, and *Stropharia*. The *Psilocybe* genus includes some 230 mushroom species; at least 54 are found in Mexico and they were used for their hallucinogenic properties by pre-Columbian Mesoamerican cultures. Noteworthy examples include *P. semilanceata*, *P. mexicana*, *P. aztecorum*, *P. cubensis*, and *P. caerulescens*. These are small mushrooms with a height range of 2.5-10 cm; the stalks are long, thin, and fibrous, and the caps measure between 1 and 3 cm across.

The main active ingredient present in *Psilocybe* spp. is an indolealkylamine, 0-phosphoryl-4 hydroxy-*N,N*-dimethyltryptamine or psilocybin. Once psilocybin has been ingested, it undergoes dephosphorylation. This process transforms it into psilocin (4-hydroxy-*N*-dimethyltripatmine), which has stronger hallucinogenic properties. Psilocybin can be absorbed in the form of fresh, non-boiled mushroom, or as dried powdered mushroom.

Psilocybin levels vary between different mushroom species, although doses of more than 5 mg provoke hallucinogenic effects. Thirty minutes after ingesting the mushroom, the subject experiences sensations of euphoria, detachment, distortion of the visual field, and introspection with a tendency towards isolation from surroundings. The duration of these trance-like symptoms is 4-6 h. Subjects also exhibit cutaneous and facial flushing, sweating, tachycardia, and increased arterial pressure. High doses (20-30 mg) may provoke cholinergic symptoms including dry mouth, urinary retention, and increase in hallucinations. By 8 hours after consumption, the subject's state will be normal. On some occasions, headache, fatigue, and a feeling of well-being may persist for several days.

The consumption of hallucinogenic mushrooms in ritual ceremonies was widespread among Mesoamerican cultures. Religious practices with sacred mushrooms extended from the Valley of Mexico to the rest of Central America, and they are thought to be at least 3500 years old. The Maya consumed *k'aizalaj Okox* (*Psilocybe cubensis*), known to the Aztecs as *teonanácatl*. These mushrooms were also consumed by the Huastec, Totonac, Mazatec, and Mixtec peoples. Since prehistoric times, the people of Teotenango have had the custom of grinding mushrooms with water on models of temples that were to be constructed, or on stones marked with petroglyphs. Furthermore, archaeological evidence points to mushroom use in Mexico, Guatemala, Honduras, and El Salvador, where the 'mushroom stones' carved to represent hallucinogenic mushrooms have been found. In Kaminaljuyú, Guatemala, researchers found 9 mushroom stones whose stalks are decorated with anthropomorphic figures demonstrating the pre-Hispanic custom of grinding sacred mushrooms into powder.



**Figure 3** Tepantitla mural. Priests bearing psilocybin mushrooms around the god Tlaloc.

The Mixtec god Seven Flowers was depicted with two mushrooms in his hands. A sculpture of Xochipilli, the Aztec god of flowers, was found in the 16th century on the slopes of Popocatepetl. It features a variety of medicinal and hallucinogenic plants and fungi, including *Psilocybe aztecorum*, whose habitat is limited to this region. Other psychoactive plants carved into this sculpture include *Nicotiana tabacum*, *Heimia salicifolia* (sinicuichi), *Turbina corymbosa* (ololiuhqui) and *Psilocybe* spp.

The Tepantitla mural in Teotihuacán, dating to 500 CE, is also very illustrative; it shows the Toltec rain god Tlaloc, with priest-like figures bearing hallucinogenic mushrooms springing up where his raindrops fall (Fig. 3). The Dresden and Madrid codices show mushrooms in Mayan scenes of human sacrifice. Psychoactive mushrooms were also used in the coronation ceremonies of numerous Aztec emperors, including Tizoc, Ahuizotl, and Moctezuma II.

Several 16th-century historians (Durán, Sahagún, and Motolinía) described Aztecs using sacred mushrooms during their religious ceremonies. In *Historia de las cosas de Nueva España*, Fray Bernardino de Sahagún (Fig. 4) described the uses and properties of these hallucinogenic mushrooms as follows<sup>14</sup>:

“The little mushrooms that grow in this land are named *teonanácatl*. They grow beneath the hay in the fields and plains. They are round, and their stems are tall and round and slender. Their taste is unpleasant; they cause sore throat and drunkenness. They are used as medicine for fever and gout. No more than two or three should be eaten. Those who eat them see visions and feel fluttering of the heart; the visions they see are sometimes frightening and sometimes humorous. Those few who eat them in excess are driven to lust. Silly and naughty boys are told that they have eaten *nanácatl*”.

In 1959, Albert Hofman isolated psilocin from *Psilocybe mexicana*, and the field of ethnomycology was born. Meanwhile, Gordon Wasson described sacramental use of the mushroom *Psilocybe* spp. among the Mazatec people and interviewed María Sabina, a well-known shaman. Today, Mazatec rituals associated with hallucinogenic mushroom use have been blended syncretically with various Catholic rites. Mushrooms are harvested at dawn and during the new moon, after which worshippers recite Christian prayers and bless the mushrooms in church. The consumption ritual

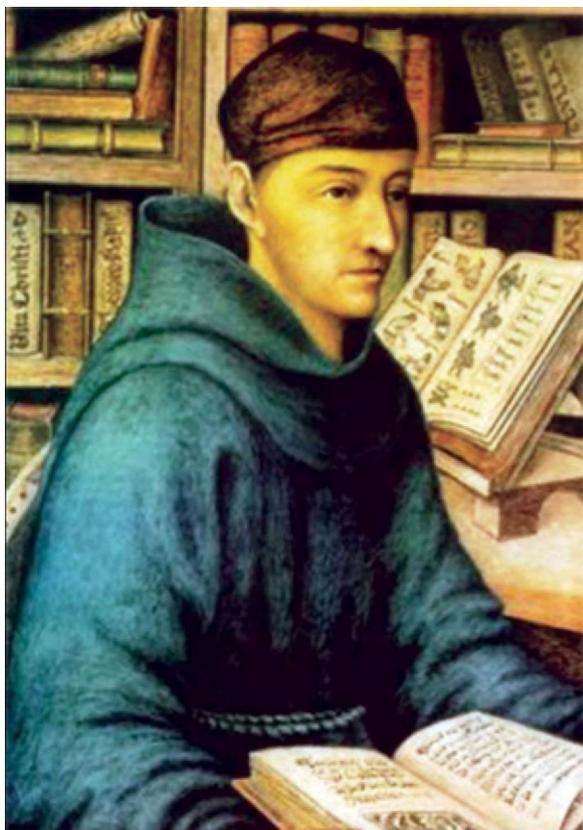


Figure 4 Fray Bernardino de Sahagún

during which *Psilocybe* specimens are ingested a pair at a time must comply with a series of precepts, including fasting and abstinence from sex and alcohol. The ritual takes one night to perform and mushrooms must be placed on an altar and purified with tobacco and incense. This will let the shaman diagnose and treat participants' illnesses.

## Peyote

Peyote (*Lophophora williamsii*) is a rounded spineless cactus containing more than 60 hallucinogenic alkaloids of the phenylethylamine family, and especially mescaline. The liquid extract of the peyote cactus is used to treat cutaneous lesions, snakebite, and scorpion stings, since it contains peyocactin, an alkaloid that has bacteriostatic properties. The term *mescal* is derived from the Nahuatl *mexcalli* (maguey). The term is a misnomer introduced in colonial times because the Spaniards believed that the 'inebriation' produced by peyote was similar to that resulting from drinking pulque.

Mescaline (3,4,5-trimethoxyphenylethylamine) is responsible for the hallucinogenic effect of peyote. Mescaline is found within mescal buttons at concentrations ranging from 1% to 6% and the minimum hallucinogenic dose is between 0.3 and 0.5 g, equivalent to 5 g of dried peyote. Dried mescal buttons from the cactus may be chewed or drunk in an infusion. The typical dose is 4-12 buttons that are extracted from the main stem and cut into slices. Dried peyote has a characteristic bitter taste. Thirty minutes after it has been ingested, it may cause nausea, vomiting, and sympathomimetic effects (mydriasis, diaphoresis,

hypertension, tachycardia, and trembling). The sensory phase lasts at least 6 hours and subjects report colourful visual hallucinations (kaleidoscopic visions), sensation of weightlessness, and altered perception of time and space. Repeated consumption may lead to a degree of tolerance.

Ritual use of peyote in the Americas dates back more than 5000 years, to prehistoric times. Traces of peyote in a ritual context have been found in Cuatro Ciénagas, Coahuila, Mexico and in the Shumla Cave in Texas, together with other shamanic artefacts: ritual deer scapula rattles, bone rods and scrapers, and tubes containing incense.<sup>15</sup> Numerous Mesoamerican cultures, including the Maya and the Aztecs, consumed peyote. *Sophora secundiflora* or mescal bean and the San Pedro cactus also contain mescaline and they were used in prehistoric times in Mesoamerica and the Andes, respectively.<sup>7</sup>

Fray Bernardino de Sahagún described the use of the drug<sup>14</sup>: "There is another herb like mountain prickly pear, named peiottl, which is white and can be found in the north. Those who eat or drink of it see terrifying or absurd visions; this inebriation lasts two or three days and then subsides. It is a delicacy often enjoyed by the Chichimeca, for it is sustaining and spurs them to fight with no thought of fear, thirst, or hunger, and they say that it protects them from all danger."

Users were persecuted by the Inquisition, and the practice was completely prohibited by 1720. At present, the Tarahumara, Tepehúan, and Huichol peoples of northern Mexico, as well as the Navajo and Comanche in the southern United States, use peyote in ritual and curative ceremonies and to promote communication with the spirit world. Peyote rituals are still very much a part of life for the Huichol, who make a yearly pilgrimage from the western Sierra Madre to Wirikuta, the sacred site of peyote in Potosí. This journey requires spiritual purification, abstinence rites, and numerous ritual ceremonies, including shooting arrows into the first cactus to be harvested and honouring it with an offering of corn. The peyote is 'hunted' in this way because the Huichol consider it to be the supernatural guardian of the deer. Modern ceremonies take place at night and peyote consumption is associated with the use of tobacco and other psychoactive plants. Huichol shamanism includes many elements in addition to mescaline consumption: ritual singing, magical flights, and use of drums, all within a religious and ceremonial circle of death and resurrection, a concept shared with Euro-American shamanism.

## Ololiuhqui

The convolvulaceae are a family of herbaceous ornamental plants with infundibular (bell-shaped) flowers. Different species have seeds containing different alkaloids of the LSD family, such as  $\Delta$ -lysergic acid amide (ergine) and isoergine, which act as partial serotonergic agonists.

The seeds of *Turbina corymbosa* (ololiuhqui) and *Ipomea violacea* (tlilitzin) were consumed by the Maya and Aztec for their psychotropic effects on perception and emotions and to induce trance states. They were commonly used by Mixtec and Zapotec peoples in the state of Oaxaca, and they are used to this day by the local healers who conduct

curative and divination ceremonies. Ololihqui is very common in Mexico, and it is a type of morning glory so named because its flowers close during the night to reopen in the morning. In Spanish, it is also known as *quebracajete blanco*, or *flor de la virgen*, since it had religious connotations in the 16th century.

*T. corymbosa* has round coffee-coloured seeds, whereas those of *Ipomea violacea* are black and called *badoh negro*. These seeds are ground into powder and taken in water, and they induce sensory/perception alterations that include visual illusions, synaesthesia, euphoria, memory changes, and discrete somnolence. In its cultural context, in contrast with the practices associated with peyote or hallucinogenic mushroom use, ololihqui is most often taken alone with the healer. The first phase is marked by a psychic void, which is at times accompanied by vasovagal response and vertigo; some hours later, this is followed by a period of intense serenity and sedation.

Ethnohistorical accounts of use of this plant date to the 16th century. During his journey through Oaxaca, court physician Francisco Hernández described how these seeds were used. He reported that a fully hallucinogenic dose contained 100-150 ground seeds dissolved in cold water.<sup>16</sup> In the chapter titled 'Some herbs with intoxicating effects', Fray Bernardino de Sahagún presented the following account of the psychoactive effects of ololihqui:<sup>14</sup>

"There is an herb named coatl xoxouhquij (green serpent), and it grows a seed they call ololihquij. This seed produces inebriation and madness. People mix it in potions to give to those they wish to harm; those who eat it appear to see visions and terrifying things. Sorcerers mix it with food and drink, and so do those who hate others and wish to do them ill. This herb is medicinal and its seed is used to treat gout; ground seeds are applied to the gout-stricken area."

The conquistadors soon associated these trance states and the hallucinogenic effect of the seeds with witchcraft and charlatanism, and they refused to recognise the religious and mystical significance of these ceremonies. In 1591, Juan de Cárdenas described the following in his chronicles of the Indies<sup>17</sup>:

"In sooth they tell us that peyote, and ololihque, when taken by mouth, will cause the wretch who takes them to lose his wits so severely that he sees the devil among other terrible and fearsome apparitions; and he will be warned (so they say) of things to come, and all this must be tricks and lies of Satanas, whose nature is to deceive, with divine permission, the wretch who on such occasions seeks him"

### *Salvia divinorum*

*Salvia divinorum*, also known as *pipiltzintli* and *ska María Pastora*, was historically used by Mazatec shamans in Oaxaca. The plant contains salvinorin A, an agonist of the kappa-opioid receptor agonist, and smoking it can produce an altered state of consciousness.<sup>18</sup> The effective dose is 200 µg. The psychoactive effects of *S. divinorum* are very intense and promote a pleasant state of introspection, lack of attention to surroundings, and increased sensitivity to luminous and auditory stimuli. The state of lethargy it induces was used in practising divination. The physiological



Figure 5 Toloache

effects associated with consuming this plant are lower blood pressure and lessened headache. Use of this plant is prohibited in the United States, and it is regarded today as an abused substance among adolescents.

### Toloache

*D. stramonium* is known as toloache or 'devil's herb' in Mesoamerica (Fig. 5). Numerous native peoples of northern Mexico and the southern United States used the plant as medicine, a means of diagnosing disease, to experience their novice visions during puberty rites, and as a hunting aid.

Unlike the different substances that were used to achieve trance states and better perception of consciousness, toloache, with its anticholinergic effect, was used to create states of delirium featuring agitation and intense hallucinations. Researchers in the Mexican state of Hidalgo have discovered pre-Columbian representations of reclining figures with toloache plants growing from their bellies. Toloache was probably used in rites associated with human sacrifice. The Huichol regarded it as the opposite of peyote, which overcomes toloache according to their mythology.

### Teotlaqualli

Teotlaqualli means 'divine food' and it refers to a dark-coloured unguent or paste with which Aztec priests anointed their skin. It was made from extracts of *Nicotiana rustica*, ololihqui, and the ashes of 'poisonous animals'

including spiders, scorpions, and snakes.<sup>19</sup> Even though its full contents are unknown, some authors speculate that in addition to 'divine tar', the unguent could contain substances that would be absorbed transdermally to provoke altered states of consciousness.<sup>19</sup>

The sooty appearance of the priests and healers who used this unguent was thought to indicate witchcraft in colonial times. Fray Diego Durán, in his history book titled *Historia de las Indias de Nueva España e Islas de Tierra Firme*,<sup>20</sup> wrote that "They mixed these things with soot and placed it in vessels and cups before their god like divine food. Daubed with this mixture, they could not help but turn into witches or demons, and see and speak to the devil".

Teotlaqualli was offered to the gods as a divine food. Aztec priests covered themselves with this mixture to reach the proper state of consciousness in which to serve the gods. In some occasions, Aztec emperors and even soldiers were painted with teotlaqualli. Researchers believe that this substance provides the explanation for the dark colouration of some Aztec gods as they are shown in codices.

## Bufotoxins

Bufotoxins, found in the parotid glands of different toad species, are toxic substances with psychoactive properties. In Central America, toads of the *Bufo* genus secrete a milky toxic substance to dissuade predators. Animals that ingest the venom, or eat the toad, may experience cardiovascular and gastrointestinal symptoms. The most severe forms of intoxication may provoke cardiac arrhythmia, diarrhoea, convulsions, or even death due to cardiac arrest.

The Sonoran Desert toad, *Bufo alvarius*, contains a variety of bufotoxins including 5-methoxy-*N,N*-dimethyltryptamine and bufotenin, both of which are hallucinogenic. Other toad species produce bufotenin only; while this substance is psychoactive if smoked or ingested, it is somewhat less potent than other compounds.

Dried skins of *Bufo* spp. have been used to induce trance states since Olmec times. Proof of the above is that remains of these toads have been found in ceremonial complexes alongside Olmec priests, and ceramic figures of *B. alvarius* have also been found in ritual settings.<sup>21</sup> Ceremonial vessels featuring the sacred toad have also been discovered. Historians of the 16th century stated that the Maya added tobacco and the skins of the common toad *Bufo marinus* to their alcoholic drinks to increase their potency. The K'iche' group of the Maya still uses the skin of this amphibian as an ingredient in their balché.

## Conclusions

At present, numerous hallucinogenic substances derived from mushrooms and plants are still used in the indigenous societies of Mesoamerica, and these societies have elaborated complex ceremonies to prevent the abuse of these substances. Peyote cactus and psilocybin mushrooms

are consumed in religious and therapeutic ceremonies. The American Indian Religious Freedom Act specified that sacramental use of peyote was permitted for members of the Native American Church. Hallucinogens were linked to the theocratic, political, and religious complex of Mesoamerican pre-Columbian societies. In modern indigenous cultures, however, hallucinogens are viewed as an instrument permitting the continuity of the shamanic complex, induction of altered states of consciousness, and performance of curative ceremonies. The abuse of these substances for hedonistic purposes is a recent development in post-modern European-American societies. Use or abuse of these substances should be considered when young people are examined in hospital emergency departments with symptoms of delirium or altered level of consciousness.

## Conflicts of interest

The author has no conflicts of interest to declare.

## References

1. Carod-Artal F. Síndromes neurológicos asociados con el consumo de plantas y hongos con componente tóxico (II). hongos y plantas alucinógenos, micotoxinas y hierbas medicinales. *Rev Neurol*. 2003;36:951–60.
2. Manzanilla L, López Luján L, editors. *Historia antigua de México*. México, DF: Editorial Porrúa; 2001.
3. Carod-Artal FJ, Vázquez-Cabrera CB. An anthropological study about epilepsy in native tribes from Central and South America. *Epilepsia*. 2007;48:886–93.
4. Schultes RE, Hoffman A. *Plantas de los dioses: orígenes del uso de los alucinógenos*. México: Fondo de Cultura Económica; 1982.
5. Grube N, Mayas L, editors. *Una civilización milenaria*. Colonia: Koneman; 2001.
6. Furst PT. *Alucinógenos y cultura*. Madrid: Fondo de Cultura Económica; 2002.
7. Carod Artal FJ, Vázquez Cabrera CB. Mescalina y ritual del cactus de San Pedro: evidencias arqueológicas y etnográficas en el norte de Perú. *Rev Neurol*. 2006;42:489–98.
8. Thompson JES. *Grandeza y decadencia de los mayas*. México: Fondo de Cultura Económica; 1984.
9. Elferink JGR. The narcotic and hallucinogenic use of tobacco in pre-Columbian Central America. *J Ethnopharmacol*. 1983;7:111–22.
10. Francisco. In: Navarro L, editor. *Fuentes y Guzmán*. Madrid: Historia de Guatemala o Recordación florida; 1882.
11. Emboden WA. The mushroom and the water lily: literary and pictorial evidence for *Nymphaea* as a ritual psychotogen in Mesoamerica. *J Ethnopharmacol*. 1982;5:139–48.
12. De Smet PA, Hellmuth NM. A multidisciplinary approach to ritual enema scenes on ancient Maya pottery. *J Ethnopharmacol*. 1986;16:213–62.
13. de Landa D. *Relación de las cosas de Yucatán*, vol. 16. Madrid: Historia; 1985.
14. Fray Bernardino de Sahagún. *Historia general de las cosas de Nueva España*. México: Porrúa; 1985.
15. Terry M, Steelman KL, Guilderson T, Dering P, Rowe MW. Lower Pecos and Coahuila peyote: new radiocarbon dates. *J Archaeol Sci*. 2006;33:1017–21.

16. Hernández Francisco. *Historia natural de Nueva España. Obras completas*. México: UNAM; 1959.
17. Juan de Cárdenas. *Problemas y secretos maravillosos de las Indias*. Madrid: Alianza Editorial; 1988.
18. Halpern JH. Hallucinogens and dissociative agents naturally growing in the United States. *Pharmacol Ther*. 2004;102:131–8.
19. Elferink JG. Teotlaqualli: the psychoactive food of the Aztec gods. *J Psychoactive Drugs*. 1999;31:435–40.
20. Durán D. *Historia de las Indias de Nueva España*. México: Editorial Porrúa; 1967.
21. Coe M. *The Olmec world. Ritual and rulership*. Princeton: The Art Museum, Princeton University; 1996.