EDWARD F. ANDERSON

Peyote and its Derivatives as Medicine

Abstract

Peyote, a cactus consisting of two species, *Lophophora williamsii* and *L. diffusa*, is found in western and southern Texas and northern Mexico, primarily within the Chihuahuan Desert and with a latitudinal distribution of about 1,300 kilometers. *Lophophora williamsii* contains at least 55 alkaloids, the most important of which is mescaline because it produces profound psychotomimetic effects. Western physicians used mescaline for several purposes in the late Nineteenth and early Twentieth Centuries. There has also been limited clinical use of mescaline, as well as other hallucinogens, in the treatment of mental disorders. Peyote extracts exhibit some antibiotic activity. The cactus is not toxic, although one person apparently died due to an overdose of mescaline. Peyote is an important medicine of Native Americans in both Mexico and the United States, and its uses are numerous. Possession of peyote and its derivatives is illegal in the U.S., though Native Americans may use it for religious purposes.

Contents

Introduction

Peyote has a long and fascinating history within Native American cultures of North America; many feel it is one of their most powerful medicines. Indeed, the powerful psychotropic activity of peyote has elicited strong emotions among many Native Americans, who believe it to be "divine". This is powerful "medicine" because it enables them to be in contact with the spirits, who are responsible for their health and welfare. However, others, such as the Roman Catholic clergy who arrived with and following the Spanish conquest of Mexico, believed peyote to be "diabolical" – a plant of the Devil. This conflict of cultures has continued for nearly 500 years. In addition, the views of Native Americans as to what is "medicine" and what – or who – causes illness and injury, make the subject of peyote and its use as medicine both fascinating and timely. Some Western physicians have even used peyote – or its derived alkaloid mescaline – and have felt that it has therapeutic value in dealing with diseases of the mind.

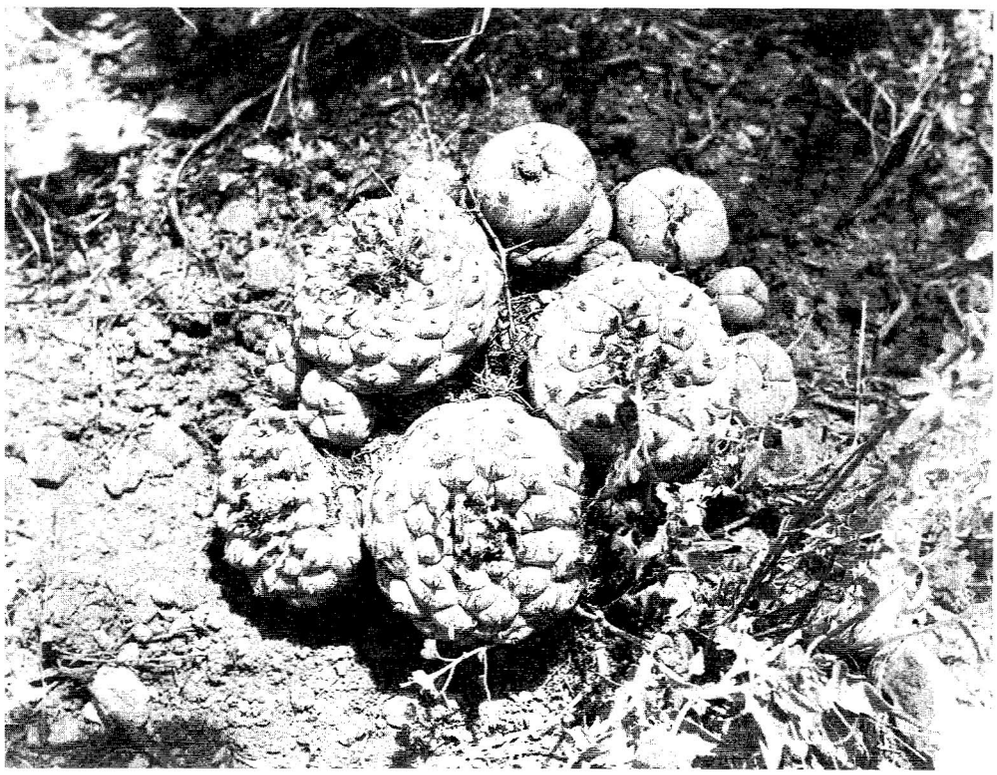

Fig. 1

1. Physical Characteristics of Peyote

Botany of Peyote

The peyote plant is in the cactus family (Cactaceae) and the genus *Lophophora*, of which there are two species: *L. williamsii* (Lemaire) Coulter and *L. diffusa* (Croizat) Bravo H. Both species of *Lophophora* are spineless, blue-green or yellow-green in color, more or less rounded in shape, somewhat depressed in the center, and barely rising above the level of the ground. The plant may be single- or many-stemmed, each of these stems or heads usually 4-12 centimeters (1.5-4.5 inches) in diameter. Although little of the plant protrudes above the ground, it has a large, turnip-shaped root. A single plant consisting of many heads may be more than a meter in diameter. Cacti are characterized as having areoles; these specialized shoots normally produce spines and reproductive structures. However, areoles of *Lophophora* usually bear only tufts of white wool (trichomes) and at certain times of the year flowers or fruits. These areoles are borne in rows along ribs consisting of fused podaria or tubercles, thus producing a distinctive appearance found in few other cacti. The flowers are light pink or white in color and up to 2.2 centimeters (0.75 inch) in diameter (see Figures 1 and 2).

The most widespread species is *L. williamsii*; it occurs in western and southern Texas along the Rio Grande and thence southward in northern Mexico, extending into the state of San Luis

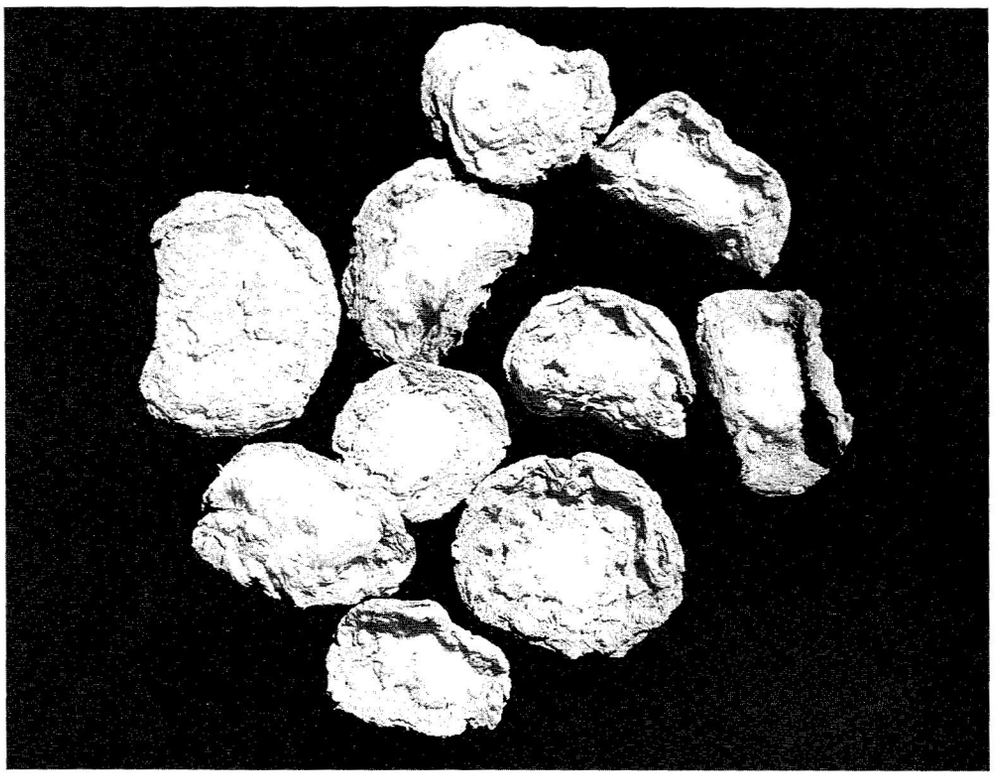

Fig. 2

Potosí. This species can be characterized as occurring in the Chihuahuan Desert, although it occurs in the Tamaulipan Thorn Shrub vegetation in southern Texas and that portion of Mexico which borders it. Peyote is restricted to limestone soils in the vast region of North America lying between the Sierra Madre Occidental and Sierra Madre Oriental from approximately sea level at the Rio Grande to more than 2,000 meters (6,500 feet) elevation farther to the south. This wide-spread cactus is rare only in areas where humans have harvested it for religious purposes, such as in Texas and parts of San Luis Potosí. This species, though highly variable in its appearance, is usually blue-green in color and with distinctly-formed ribs composed of the fused podaria.

The second species, *L. diffusa*, is much more restricted in its distribution, occurring only in a disjunct, somewhat unusual portion of the Chihuahuan Desert in the Mexican state of Querétaro. This species is yellow-green in color, with poorly-formed ribs and less distinct podaria. It also tends to feel more spongy. Flowers are white, sometimes with a yellowish cast.

Alkaloids of Peyote

Peyote is remarkable in possessing more than 55 different alkaloids, many of which are unique to the genus. They belong to two main groups, the phenylethylamines and the isoquinolines. Clearly, the most significant alkaloid from the medicinal point of view is a phenylethylamine known as mescaline (3,4,5-trimethoxy-beta-phenylethylamine), for it is highly psychoactive.

Studies by TODD (1969: 397f) and BRUHN & HOLMSTEDT (1974: 353ff) have shown that the two species of peyote differ markedly in alkaloid content. In fact, only *L. williamsii* possesses mescaline. Moreover, it also has hordenine, another relatively common alkaloid in cacti, whereas *L. diffusa* does not. Lophophora diffusa has much larger quantities of pellotine than does *L. williamsii*. The key alkaloids hordenine, pellotine, mescaline, and anhalidine (present in both species) are all derived from tyrosine. Following a relatively well-understood biosynthetic pathway (KAPADIA & FAYEZ 1970: 1712ff, 1973: 9ff; ANDERSON 1980: 128ff), this precursor produces tyramine by demethylation; this is then converted to dopamine. From this, the most common route in *L. williamsii* is the production of nor-mescaline and then mescaline in another two steps. An alternate route from dopamine, apparently followed in *L. diffusa*, is to 3-methoxy-4-hydroxyphenethylamine, and then by at least three further steps to pellotine.

Significantly, only *L. williamsii*, the peyote species with mescaline, has been used by humans. This alkaloid is primarily responsible for the hallucinogenic and mind-altering effects of peyote. Though not an alkaloid with the typical indole nucleus or ring, and thus sometimes referred to as a "protoalkaloid," mescaline nonetheless fits all of the other usual characteristics of the class of organic compounds known as alkaloids. Structurally, mescaline is similar to the neurohormone epinephrine and to amphetamine (ANDERSON 1980: 127). Certain side chains apparently are most responsible for the psychoactive properties; the methoxy group on the number five carbon atom and the hydroxy group on the number four carbon atom seem to be two of the most active sites (SMYTHIES 1963: 18).

Psychotomimetic Effects

The mind-altering effects of peyote have been extensively reported in the literature, and the reader is referred to ANDERSON (1980: 66ff) for a detailed description. Accounts of the psychoactive effects vary widely, but almost all agree that the cactus produces a mental condition that LUDWIG (1969: 10ff) describes as an "altered state of consciousness" in which there are distinct changes in the thinking process, an altered sense of time and space, a loss of self-control, modifications of emotional expression, distortions of bodily images, and (very importantly) an inability to communicate. Others have emphasized three aspects of the peyote experience: (1) abnormal sensory phenomena (all of the senses), (2) abnormal emotional states, and (3) a major change in one's conscious states and attitudes (KLüVER 1966: 51).

The mind-altering effects of peyote can be divided into two stages, the first of which is dominated by bodily symptoms, the second by mental manifestations. The first phase begins about an hour after the plant material is orally ingested. Often this is an unpleasant period characterized by nausea, vomiting, sweating, dizziness, palpitation, and even headache. Other manifestations that have been reported include stomach cramps, a shortness of breath, chest and neck pains, restlessness, tremors, and an urgency to urinate. This difficult phase may last for three to four hours, best described as one of depression, anxiety, and even acute physical discomfort. Some people even fear they are dying.

The second phase rapidly follows the first and, in contrast to the first, many claim it is characterized by euphoria and elation. It is during this period that one experiences dreamy feelings and pleasant fantasies. The first part of this phase is that of great exhilaration, but it is soon followed by profound psychic effects involving visions and distortions of the senses. One of the most remarkable aspects of the latter is that there may be synesthesia of the senses in which the stimulation of one results in sensations in another. Common synesthesia may be visual-auditory, visual-gustatory, visual-tactile, visual-olfactory, visual-kinesthetic, and visual-thermal. However, for most who take peyote the most impressive aspect of the second phase is the

visions or hallucinations. Remarkably, there is little clouding of the consciousness, but because one of the effects of the experience is difficulty of communication, these visions are often difficult to describe. The usual response to these magnificent "technicolor hallucinations" is amazement, awe, and even delight, though a few people experience a deep anxiety.

At first there may be only simple images in both pattern and coloring, which constantly change in shape; they are always brightly colored. This early phase of the vision experience is usually followed by one in which there are vividly colored fantasies or hallucinations. These visions may not be able to be distinguished from reality and all of the senses are involved. No longer are there simply geometrical forms, but in this phase brilliantly illuminated scenes and figures appear, constantly changing and filling the mind with a confusion of colors. The total experience usually lasts eight to ten hours, followed by general fatigue and often insomnia.

Toxicity of Peyote

High doses of mescaline produce symptoms similar to those of acute gastroenteritis (BASELT & CRAVEY 1989: 507). The experimental lethal dose of mescaline in rats is 132 milligrams per kilogram of body weight (HARDMAN, HAAVIK & SEEVERS 1973: 301). They also found that the LD50 varied widely in other animals, clearly indicating that not all organisms have the same level of resistance to mescaline. However, there are no recorded cases of deaths due directly to the ingestion of peyote, although a recent report from New Mexico indicated that it was a contributing factor. CHRIS LAWRENCE (personal communication), a physician, described the death of a young Native American man who was given a cup of peyote "tea;" within about three hours he suffered cardiopulmonary arrest and died. LAWRENCE stated that the autopsy showed severe effects of alcoholism, but very low levels of mescaline in the blood or urine. His conclusion was that "death is probably best explained by chronic alcoholism with alcoholic hepatitis with a contributing factor of blood loss from a Mallory Weiss tear, resulting from violent vomiting *induced by ingestion of peyote* [italics mine] (C. LAWRENCE, personal communication). One case of a fatality indirectly due to an apparent overdose of mescaline occurred in California. An individual climbed a steep hill near the ocean and leaped off the edge as if attempting "a swan dive," falling 600 feet to his death. The subsequent autopsy showed high levels of mescaline in his blood, liver, and urine (REYNOLDS & JINRDICH 1985: 183f).

2. Western Medicinal Uses of Peyote

Early Medicinal Uses of Peyote by Western Physicians

In the late Nineteenth and during the first decade or two of the Twentieth Century, some physicians were enthusiastic about the therapeutic effects of peyote, which many referred to at the time as *Anhalonium*, an incorrect generic name for the cactus. Even the *United States Dispensatory* contained a brief summary of peyote and how it could be used medicinally. It was referred to as "*Anhalonium lewinii*." However, about 1920 the entry was removed. The employment of "*Anhalonium*" (peyote) in mixtures provides an interesting insight into other widely used drugs during the last of the Nineteenth Century. For example, an article appeared in the *Therapeutic Gazette* in which a treatment for respiratory ailments was described. The concoction included "*Anhalonium*," digitalis, belladonna, and *Cannabis indica* (marijuana) (LANDRY 1889: 16). Other physicians stated that peyote was a "superior cardiac tonic" (RICHARDSON 1896: 194),

a substitute for morphine (RICHARDSON 1896: 195), and was effective as an antispasmodic (PRENTISS & MORGAN 1896: 6). Apparently the enthusiasm for "*Anhalonium*" remained limited to only a few physicians, others content to use the more familiar stimulants and narcotics.

This medicinal use of peyote by physicians was experimental and without adequate controls. In most cases the recommended dosages (a few drops to a spoonful or two of an alcohol extract in most instances) probably were too small to produce even mild effects. Rather, it was more likely that the other drugs, as well as the alcohol solvent, produced what effects were perceived.

Current Medicinal Uses. The psychotomimetic characteristics of peyote and its derivative alkaloid mescaline led researchers to begin clinical use of it as early as the 1920s (JOACHIMOGLU & KEESER 1924: 1107ff), believing that it produced a psychotic-like condition. This research was continued into the 1960s, but with the availability of LSD-25, and subsequent studies primarily involving this synthetic alkaloid, the clinical rationale for using peyote or mescaline was eliminated (see YENSEN's article here). Since the prohibition of the use of psychotomimetics, there are few further reported uses of peyote or mescaline in modern Western medicine.

Possible Antibiotic Action. In the 1960s a group of scientists investigated possible antibiotic activities of peyote (MCCLEARY, SYPHERD & WALKINGTON 1960: 247ff; MCCLEARY & WALKINGTON 1964: 361ff). Their studies showed that a peyote extract effectively inhibited a number of penicillin-resistant strains of the bacteria *Staphylococcus aureus*. They named the extract "peyocactin" but did not identify it. Later studies by RAO (1970: 544f) determined that "peyocactin" was the alkaloid hordenine (N,N-dimethyl-p-hydroxyphenethylamine). A separate team of researchers attempted to duplicate the work of MCCLEARY and his associates, but were unsuccessful (MCLAUGHLIN & PAUL 1966: 325). They concluded that "peyocactin" had a definite *in vitro* antiseptic action against several microorganisms.

3. Native American Medicinal Uses of Peyote

Early Uses in Mexico

Archeological evidence shows that peyote has been used by humans for more than 1,000 years (ADOVASIO & FRY 1976: 95; BRUHN, LINDGREN & HOLMSTEDT 1978: 1438); however, other evidence supports the idea that peyote was considered of great importance to Mexican Native Americans more than 2,000 years ago (SCHULTES 1938: 698; FURST 1976: 109). SCHULTES (1940: 178) also commented that peyote "is, without doubt, the most important medicine used among North American Indians at the present time ..." This long use by Native Americans has been mainly in Mexico, although early use of peyote in the trans-Pecos region of Texas is probable (ADOVASIO & FRY 1976: 94). Soon after the Spanish conquest of Mexico, efforts were made to prohibit the use of the cactus. By 1620 the Spanish Inquisition, which had been introduced into Mexico in 1571, officially declared that since the use of peyote was the work of the devil, all Christians were therefore prohibited from using it (LEONARD 1942: 326; ANDERSON 1980: 6). In fact, peyote was even equated with cannibalism by Father BARTHOLOMÉ GARCIA (1760: 14-15). It is still illegal in Mexico, but its use among Native Americans continues there. Many Native Americans believe peyote has an almost magical nature because of its profound effects upon the human mind. Plants having similar biological activities have become associated with magic in most cultures and have persisted for numerous generations (SCHULTES 1987: 32).

Early Spanish reports of peyote referred only to the psychoactive properties of the plant rather than its medicinal use (SAHAGUN 1938: 230; HERNANDEZ 1790: 70-71). However, by the late Nineteenth Century Western explorers began to report numerous medicinal uses of peyote. For example, Dr. EDWARD PALMER's records from his 1878 expedition into Mexico stated (BYE 1979a: 143) that peyote (spelled "biote" by PALMER) was used as a fever remedy and "as an external application for back pains." He also noted that it was used with other plants "for complicated diseases, especially to relieve pain and fever and, like opium, to induce a restful sleep." He further commented that it was used by women to increase lactation.

Present Uses in Mexico

Twentieth Century investigations in Mexico have produced a much more extensive list of medicinal uses of peyote by Native Americans. BENNETT & ZINGG (1935: 294) wrote that among the Tarahumara of Mexico peyote "is considered a cure for many diseases," including bruises, snake bites, and rheumatism. They further commented that "peyote is the ultimate cure when all others have failed." BYE, in more recent ethnobotanical work among the Tarahumara, comments that "peyote enables the shaman to see better and to aid in the treatment of his patient." He further states that the plant is used to treat "various bites, wounds, burns, and rheumatic pains" (BYE 1979b: 27f).

The above statement by BYE emphasizes an important aspect of medicinal plants and their use by Native Americans. The Tarahumara, as most other Native Americans, believe that there are both natural and supernatural causes of illness. A healthy person is one whose soul is content within the body; however, illness may result from the loss of one's soul by the action of some supernatural being – or simply by carelessness (BYE 1985: 77f, 1986: 105). Tarahumara health practices, therefore, primarily involve maintaining a good condition of the souls, both within the body and when they return to it. Specialists or shamans will often use hallucinogenic plants in their curing ceremonies. Peyote, one of the most powerful plants to the Tarahumara, helps maintain a delicate balance. Thus, the cactus is periodically "fed" at fiestas and otherwise treated with great respect.

The Huichol, another tribe of Mexican Native Americans who have been able to remain relatively autonomous from the dominant Mexican culture, also employ peyote medicinally to treat numerous ailments, as well as relieve one from fatigue (FURST 1976: 112). The usual method of ingestion is by orally chewing and swallowing the fresh or dry tops of the cactus (widely referred to as "buttons"). The Huichol also reportedly took peyote in the form of an enema, thereby avoiding the strong, bitter taste (FURST & COE 1977: 91). However, a later study questioned the validity of this report, commenting that its actual use in that form has not been witnessed (DE SMET 1983: 145).

Uses in the U.S.

Native Americans of the United States also use peyote as medicine. Like their counterparts to the south in Mexico, they do not distinguish between medicine and religion. The body and the mind are not separate, so when an illness or injury strikes, it is the person, not simply the body or some part of it, that is affected. The spirits or supernatural forces are involved. Therefore, the ailment is combated by ceremonies and the use of "sacred" plants. Peyote is one such plant, so its use in religious ceremonies, particularly those of the Native American Church, is clearly therapeutic. Many Native American tribes designate peyote with the same word as that used for

medicine: *azee* (Navajo), *biisung* (Delaware), *puakit* (Comanche), *makan* (Omaha), and *walena* (Taos) (ANDERSON 1980: 90f).

One major difference between Native American use of peyote in Mexico and in the U.S. is that the ceremonies and other rites of Mexico are performed to *protect* the individual – or even a group – from illness. In the United States, on the other hand, the plant is used in *treating* the patient after he or she has already become sick (LA BARRE 1947: 297). Peyote is such powerful medicine to Native Americans in the U.S. that it is used to treat snakebite, wounds, pneumonia, syphilis, tuberculosis, goiter, malnutrition, cancer, skin diseases, alcoholism, bruises, insanity, rheumatism, arthritis, snake bites, scorpion stings, blindness, consumption, intestinal ills, scarlet fever, swooning, spasms, hemorrhages, toothache, headache, broken bones, breast pains, menstrual disorders, corns, constipation, hiccough, grippe, influenza, colds, diabetes, deep arrow wounds, *Datura* poisoning, cuts, and "various additional infectious diseases" (MCLAUGHLIN 1972: 2f). Peyote is prepared by powdering the dry "button" and packing it "into wounds and around aching teeth, or making it into a paste to rub over burned areas of skin as a pain-relieving ointment" (MCLAIN 1968: 83). The top of the plant is eaten to treat tuberculosis and various "internal ailments" (MCLAIN 1962: 83). Peyote also has a "positive reputation as a specific for childbirth among unlicensed, spiritual midwives, who learned from Native American traditions" (MOUNT 1987: 18). MOUNT further commented (1987: 19) that he "started brewing peyote tea with the first contractions," and gave his wife drinks whenever she wanted them. The children were born happy and healthy.

Clearly, to many Native Americans "peyote protects from almost any conceivable disease or disablement" (LA BARRE 1947: 297), though, of course, it is improbable that peyote (or the psychoactive alkaloid mescaline) is effective against all of these ailments. One must therefore seriously consider the significance of the psychoactivity of the cactus and its psychological benefits. On the other hand, it is possible that some of the peyote alkaloids other than mescaline may have some curative benefits.

The preceding list includes alcoholism, which currently is one of the most serious problems facing Native Americans. There are several published reports of studies to determine if peyote – and the peyote ritual associated with the Native American Church in the United States – is efficacious in the treatment of alcoholism. One noteworthy study showed that the "peyote ritual of the church is successful in the treatment of alcoholics, not because of a powerful drug. Tested in a laboratory or hospital setting, the psychedelic drugs alone only rarely bring about significant attitudinal and behavioral change" (PASCAROSA, FUTTERMAN & HALSWEIG 1976: 518). They concluded that the church's ritual is an "orderly, constructive, and stimulating" mixture of leader, group session, and drug in which there is often positive introspection and group interaction. They further stated that Native Americans only "use the drug-induced altered state of consciousness for insight and exchange during their sessions, and in no way do their daily life patterns require the use of the drug. Their attraction to peyote and the ritual is similar to the patient's reliance on the analyst and does not constitute an addiction in any sense of the word" (PASCAROSA, FUTTERMAN & HALSWEIG (1976: 523).

Legal Status of Peyote and its Derivatives

The United States Comprehensive Drug Abuse Prevention and Control Act of 1970 specifically lists peyote and mescaline as Schedule I controlled substances. Thus, possession of them is illegal, and people have been prosecuted and imprisoned for having them. This federal regulation specifically exempts members of the Native American Church from prosecution and imprisonment for the religious use of peyote (ANDERSON 1980: 205ff). However, a recent Supreme

Court decision narrowed the claim of peyotists to use peyote with impunity by allowing individual states to regulate peyote as a drug, and by regarding such regulation as not aimed at controlling a religious practice and therefore not under First Amendment protection. Under this decision States are allowed again to regulate the use of peyote, but they may specifically exempt the religious use of peyote if they so choose (ABERLE 1991: iii). Therefore, although most states in general follow the current federal regulations, some have enacted laws that are much more restrictive with regard to the use of peyote by Native Americans in their religious practices. (Editor's note: Late in 1993 the U.S. Congress passed the Religious Freedom Restoration Act, overturning the Supreme Court decision in *Employment Division v Smith* which enabled states to restrict religious practices without evidence of "compelling interest". This act does not, however, fully cover Native American's religious freedom.)

4. Conclusions

The long medicinal uses of peyote by Native Americans in both the U.S. and Mexico strongly suggest that this cactus may, indeed, have true therapeutic properties. Perhaps it is best that the possible therapeutic properties of peyote not be dismissed on the basis of the limited amount of laboratory research that has been performed and the present lack of interest in its use in Western medicine. SCHULTES & HOFMANN (1980: 200) emphasize that there is a real "difference between peyote intoxication and mescaline intoxication." Probably the entire peyote plant with its numerous alkaloids, some of which may have synergistic effects upon one another, may not only produce different hallucinatory effects when ingested, but they may also have different therapeutic actions. Further investigations seem to be warranted.

5. Literature

Aberle, D.F.
1991 The Peyote Religion among the Navajo. 2nd Edition, reprint. Norman: University of Oklahoma Press.

Adovasio, J.M. & G.F. Fry
1976 Prehistoric psychotropic drug use in northeastern Mexico and Trans-Pecos Texas. In: Economic Botany *30:* 94-96.

Anderson, E.F.
1980 Peyote: The Divine Cactus. Tucson: University of Arizona Press.

Baselt, R.C. & R.H. Cravey
1989 Disposition of Toxic Drugs and Chemicals in Man. 3rd. Edition. Chicago: Chicago Year Book Medical Publishers.

Bennett, W.C. & R.M. Zingg
1935 The Tarahumara, an Indian Tribe of Northern Mexico. Chicago: University of Chicago Press.

Bruhn, J.G. & B. Holmstedt
1974 Early peyote research: an interdisciplinary study. In: Economic Botany *28:* 353-390.

Bruhn, J.G.; Lindgren, J.E. & B. Holmstedt
1978 Peyote alkaloids: identification in a prehistoric specimen of *Lophophora* from Coahuila, Mexico. In: Science *199:* 1437-1438.

Bye, R.A., JR.
1979a An 1878 ethnobotanical collection from San Luis Potosí: Dr. Edward Palmer's first major Mexican collection. In: Economic Botany *33:* 135-162.
1979b Hallucinogenic plants of the Tarahumara. In: Journal of Ethnopharmacology *1:* 23-48.

1985 Medicinal plants of the Tarahumara Indians of Chihuahua, Mexico. In: Two Mummies from Chihuahua, Mexico, R.A. Tyson & D.V. Elerick, eds., pp. 77-104. San Diego: San Diego Museum of Man.
1986 Medicinal plants of the Sierra Madre: comparative study of the Tarahumara and Mexican market plants. In: Economic Botany *40:* 103-124.

De Smet, P.A.G.M.
1983 A multidisciplinary overview of intoxicating enema rituals in the Western Hemisphere. In: Journal of Ethnopharmacology *9:* 129-166.

Furst, P.T.
1976 Hallucinogens and Culture. San Francisco: Chandler & Sharp.

Furst, P.T. & M.D. Coe
1977 Ritual enemas. In: Natural History *86(3):* 88-91.

García, FR.B.
1760 Manual para Administrar los Santos Sacramentos etc. México: Rivera.

Hardman, H.F.; Haavik, C.O. & M.H. Seevers
1973 Relationship of the structure of mescaline and seven analogs to toxicity and behavior in five species of laboratory animals. In: Toxicology and Applied Pharmacology *25:* 299-309.

Hernández, F.
1790 De Historia Plantarum Novae Hispaniae Opera cum Editatum Inedita, ad Autographi Fidem et Integratem Expressa. Matriti: Ibarra Heredum.

Joachimoglu, G. & E. Keeser
1924 Kakteen Alkaloide. In Handbuch der Experimentellen Pharmakologie, A. Heffter, ed., pp. 1107-1113. Berlin: Springer Verlag.

Kapadia, G.J. & M.B.E. Fayez
1970 Peyote constituents: chemistry, biogenesis, and biological effects. In: Journal of Pharmaceutical Science *59:* 1699-1727.
1973 The chemistry of peyote alkaloids. In: Lloydia *36:* 9-35.

Klüver, H.
1966 Mescal and Mechanisms of Hallucination. Chicago: University of Chicago Press.

La Barre, W.
1947 Primitive psychotherapy in Native American cultures: peyotism and confession. In: Journal of Abnormal and Social Psychology *42:* 294-309.

Landry, S.F.
1889 Notes on *Anhalonium Lewinii*, *Embelia ribes*, and *Cocillana*. In: Therapeutic Gazette, 3rd Serial, *5:* 16.

Lawrence, C.
Personal Communication.

Leonard, I.
1942 Peyote and the Mexican inquisition. In: American Anthropologist *44:* 324-326.

Ludwig, A.M.
1969 Altered states of consciousness. In: Altered States of Consciousness, C. Tart, ed., pp. 9-22. New York: John Wiley.

McCleary, J.A.; Sypherd, P.S. & D.L. Walkington
1960 Antibiotic activity of an extract of peyote (*Lophophora williamsii* (Lemaire) Coulter). In: Economic Botany *14:* 247-249.

McCleary, J.A. & D.L. Walkington
1964 Antimicrobial activity of the Cactaceae. In: Bulletin of the Torrey Botanical Club *91:* 361-369.

McLain, L.
1968 A study of peyote. In: Clinical Toxicology *1:* 81-85.

McLaughlin, J.L.
1972 Peyote – An Introduction. Paper presented 24 April at the symposium on Peyote, Houston, Texas. Mimeographed.

McLaughlin, J.L. & A.G. Paul
1966 The cactus alkaloids. I. Identification of N-methylated tyramine derivatives in *Lophophora williamsii*. In: Lloydia *29:* 315-327.

Mount, G.
1987 Testimonials for healing and childbirth. In: The Peyote Book, G. Mount, ed., pp. 18-19. Arcata, CA: Sweetlight Books.

Pascarosa, P.; Futterman, S. & M. Halsweig
1976 Observations of alcoholics in the peyote ritual: a pilot study. In: Annals of the New York Academy of Sciences *273:* 518-524.

Prentiss, D.W. & F.P. Morgan
1896 Therapeutic uses of mescal buttons (*Anhalonium Lewinii*). In: Therapeutic Gazette 3rd Serial, *12:* 4-7.

Rao, G.S.
1970 Identity of peyocactin, an antibiotic from peyote (*Lophophora williamsii*), and hordenine. In: Journal of Pharmacy and Pharmacology *22:* 544-545.

Reynolds, P.C. & E.J. Jindrich
1985 A mescaline associated fatality. In: Journal of Analytical Toxicology *9:* 183-184.

Richardson, D.A.
1896 A report on the action of *Anhalonium Lewinii* (mescal button). In: New York Medical Journal *64:* 194-195.

Sahagún, FR.B.
1938 Historia General de las Cosas de Nueva España. Mexico, D.F.: Pedro Robredo.

Schultes, R.E.
1938 The appeal of peyote (*Lophophora williamsii*) as a medicine. In: American Anthropologist *40:* 698-715.
1940 The aboriginal therapeutic uses of *Lophophora Williamsii*. In: Cactus and Succulent Journal (U.S.) *12:* 177-181.
1987 Ecology and ethnopharmacological conservation. In: Social Pharmacology *1:* 30-40.

Schultes, R.E. & A. Hofmann
1980 The Botany and Chemistry of Hallucinogens. 2nd Edition. Springfield: Charles C. Thomas.

Smythies, J.R.
1963 The mode of action of mescaline. In: Hallucinogenic Drugs and Their Psychotherapeutic Use, R. Crocket, R.A. Sandison, and A. Walk, eds., pp. 17-30. Springfield: Charles C. Thomas.

Todd, J.S.
1969 Thin-layer chromatography analysis of Mexican populations of *Lophophora* (Cactaceae). In: Lloydia *32:* 395-398.