Bufotenine — A Hallucinogen in Ancient Snuff Powders of South America and a Drug of Abuse on the Streets of New York City

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ABSTRACT: Bufotenine, an isomer of psilocin, is a controlled Schedule I hallucinogenic substance under the New York state and Federal laws. Bufotenine was identified in 42 case samples received at the New York City Police Laboratory since May 1992. The samples were hard, resinous, dark reddish-brown material, sold on the streets as "hashish". A few other cases were also seized in Orlando and Tampa, FL. Natural sources of bufotenine are: (a) plant material, mostly seeds of the genus *Anadenanthera* (formerly *Piptadenia*); (b) plant organs of other genera; (c) toads (*Bufo marinus*, *B. vulgaris*, *B. viridis*, and *B. alvaris*); and (d) mushrooms (*Amanita mappa*, *A. citrina*, *A. porphyria*, and *A. tomentella*). The genus *Anadenanthera* is native to South America and West Indies. Historically, material made from the seeds of genus *Anadenanthera* was, and in isolated areas is still, used by the native Indians of South America and West Indies. Native Indians make intoxicating snuffs from the seeds of *Anadenanthera*. Recently, bufotenine was identified in 1,200-year-old archaeological samples of an *Anadenanthera* material found in an excavated tomb in Northern Chile. Historical and published literature on the pharmacology, toxicology, and biological effects of bufotenine and bufotenine-containing material are reviewed. The case material was probably derived from the seeds of genus *Anadenanthera*. There were no prior reported cases of this material being used outside the native Indian areas of South America and West Indies. Indications are that in New York City this material is smoked in combination with marijuana. Bufotenine in case material can be identified by color tests, thin-layer chromatography, and gas chromatography/mass spectrometry (GC/MS). Though the mass spectra of bufotenine and psilocin (parent compounds and mono-acetyl and di-acetyl derivatives) are very similar, their GC retention times are different. Case samples also gave multiple GC peaks, probably due to the added ingredients during the preparation of this material.

KEY WORDS: Bufotenine, forensic chemistry, genus *Anadenanthera*, hallucinogen, indole alkaloid, tryptamine derivative.

INTRODUCTION

Recently a 1,200-year-old tomb was excavated in the San Pedro de Atacama area of Northern Chile. It contained a mummified body of a male, approximately 45 years old. Chemical analysis of the dark amorphous material found inside two leather pouches next to the body indicated the presence of bufotenine (5-hydroxy-*N*,*N*-dimethyltryptamine), *N*,*N*-dimethyltryptamine (DMT), and 5-methoxy-dimethyltryptamine (5-MeO-DMT) [51]. Recently many samples, which were alleged to be "hashish", were received at the New York City Police Laboratory. They were seized in drug arrests at different locations throughout New York City. The samples were small, candy-like, irregular cubes, resinous in texture and reddish-brown in color. Chemical analysis found bufotenine in all the samples [8]. Bufotenine is a controlled hallucinogenic substance under both federal and New York state laws. This article is an attempt to summarize the literature on bufotenine, its various natural sources and its effects on the body, and the analytical experience accumulated in the author's laboratory.

I. NATURAL SOURCES OF BUFOTENINE

Bufotenine is found in a variety of substances — in (a) plant material, mostly seeds of the genus *Anadenanthera* (formerly *Piptadenia*), (b) plant organs of other genera, (c) toads, and (d) mushrooms. Bumpus and Page [6] noted in 1955 that bufotenine appears in the urine of healthy humans.

A. Plant Seeds and Pods: The Genus *Anadenanthera*

Bufotenine was first isolated by Stromberg [49] in 1954 from the seeds of *Piptadenia peregrina* collected in Puerto Rico. Fish et al. [17] found four indole bases in both the seeds and pods of *P. peregrina* and *P. macrocarpa*. They reported that the pods contain *N*,*N*-dimethyltryptamine (DMT), whereas seeds contain bufotenine, bufotenine oxide, and DMT oxide. In addition, a 5-hydroxyindole base of unknown structure was found in the *P. macrocarpa* seeds.

According to Schultes and Hofmann [46], it was Safford who, in 1916, definitively identified the "cohoba"

reported by the early Europeans as *Anadenanthera peregrina*. Siri von Reis (Altschul) [56,57] did exhaustive and extensive research on the genus *Anadenanthera* toward her doctoral dissertation at Harvard University. She published her work in two volumes and presented the most comprehensive taxonomic, ethnobotanical data on the genus *Anadenanthera* in Amerindian cultures. According to von Reis [56,57], the genus *Anadenanthera* consists of two species, each having two varieties. The names and distribution of these species and varieties are summarized below.

1. *A. Peregrina Var. Peregrina*

A. peregrina var. peregrina occurs in Brazil, British Guyana, Columbia, Venezuela, Grenada, Dominican Republic, Haiti, Puerto Rico, Tobago, and Trinidad. It is probably naturalized in West Indies where it is found as a somewhat weedy tree, inhabiting roadsides and wastelands. In South America it is reported to be cultivated occasionally. It is found between 20 degrees N. latitude to about 15 degrees S. latitude. Its growth habit ranges from a shrub to a tall tree, 3 to 27 m high, with trunk and branches that are not corky.

2. *A. Peregrina Var. Falcata*

A. peregrina var. falcata occurs in southern Brazil and Paraguay. It is found between 15 degrees S. latitude and 25 degrees S. latitude. It is a much shorter tree than the former variety with suberose trunks and branches.

3. *A. Colubrina Var. Cebil*

A. colubrina var. cebil occurs in Argentina, Bolivia, Brazil, Paraguay, and Peru. Its natural growth range is from near the equator to about 30 degrees S. latitude. This variety is a taller tree and is occasionally cultivated. *Piptadenia macrocarpa Benth* is a synonym for this variety. Several seedlings were introduced into Orlando, FL, from Sao Paulo, Brazil, in 1940 by the plantsman Mulford Foster. The plants attained a height of about 13 to 15 m by February 1960 and were probably the only living representatives of *A. colubrina* in the northern hemisphere. Seeds and pods of the Florida trees were analyzed by Fish et al. [17]. It is believed that these trees are no longer in existence in Orlando, FL [32].

4. *A. Colubrina Var. Colubrina*

A. colubrina var. colubrina occurs in Argentina and Brazil. It is a shorter tree than *A. colubrina var. cebil* and can be found between 12 degrees and 27 degrees S. latitude.

B. Plant Organs of the Other Genera

The grass *Phalaris tuberosa* was found to contain variable amounts of bufotenine. The major alkaloids were DMT and 5-MeO-DMT. These dimethylated tryptamines were found to be the cause of the peracute disease. It causes sudden collapse and death or more chronic syndrome, phalaris staggers, characterized by neurological disorders in sheep that graze on this grass [18]. But recent research questions this finding [3]. Bufotenine was also reported to be found in the 80% alcoholic extract of the seeds of *Mucana pruriens DC*. Different parts of *M. pruriens*, except trichomes of pods, contain DMT, its oxide and 5-MeO-DMT, along with bufotenine, whereas trichomes contained only bufotenine [39]. In another reference book on medicinal plants, there is no mention of the presence of bufotenine in *M. pruriens DC.* or *M. urens DC* [31].

C. Toads

In 1934 and 1937, Wieland et al. [60] and Wieland and Wieland [62] isolated bufotenine from toads. In 1936, Jensen and Chen [28] found bufotenidine in Chinese medicine "Ch'an Su" and in the secretions of toads and bufotenine in *Bufo vulgaris* and *Bufo viridis*. Titus and Udenfriend [50] found serotonin and bufotenine in the secretion of the parotid gland of toads. Bufotenine is also reported to be found in *Bufo marinus*, the Australian cane toad [27]. The Sonaran Desert toad is reported to contain 5-MeO-DMT [59]. The name bufotenine is derived from the scientific generic name of toads. (*Bufo* means toad in Latin.)

A few years ago, the authorities in New South Wales, Australia, passed legislation banning the possession of toad slime [35]. The Queensland Police found that some people were smoking the dried skin of the species *B. marinus* to obtain stimulation from bufotenine found therein. As a consequence, bufotenine was declared a schedule 2 substance for the Queensland Drugs Misuse Act of 1986 [53].

The dried secretions of the Sonoran toad, *Bufo alvarius*, have become a recreational drug in the Southwest. The bufotenine-containing secretions of the parotid glands is placed onto the windshield of a car, dried, and smoked in a pipe. *B. marinus* is a common pest in Floridean backyards and dangerous to pets. Although this frog contains bufotenine, it does not, for some reason, achieve blood-brain barrier penetration. The secretions, which can be collected by squeezing the parotid gland with forceps, dries quickly in air to hard, brittle, yellow scales [29].

On January 3, 1994, local narcotic agents of Angels Camp, CA, charged Bob Shepard, a 41-year old nature and wildlife teacher, for the possession of bufotenine obtained from toads. Police took possession of four toads (*Bufo alvarius*) named Hanz, Franz, Peter, and Brian,

which were collected by Shepard during his camping trip to Arizona. To learn more about bufotenine, investigators have been milking and drying the venom from the four toads, which has the consistency of rubber cement. Shepard shared the procedure with investigators for milking venom from the glands on the toad's legs and behind their eyes [33].

D. Mushrooms

Bufotenine is also known by the synonym, "mappine", which comes from the mushroom *Amanita mappa*. In 1953 Wieland et al. [61] recovered bufotenine from *A. muscaria* (fly agaric mushroom — so called because of its age-old use in Europe as a fly killer), *A. mappa* and *A. pantherina*. Erspamer [13] also found bufotenine in the mushroom *A. mappa*, but Brady and Tyler [4] found no bufotenine in *A. pantherina*. Hofmann [24] indicated that the amount of bufotenine found in *A. muscaria* was inadequate to account for the psychotomimetic properties associated with that species. A brief review of the literature on mushroom toxins can be found in the article by Buck [5].

Wieland and Wieland [63] also comprehensively reviewed the story of isolation and identification of the amanita toxins. Fabing [16] reviewed the historical accounts of fly agaric mushroom use and going berserk. Hoffer and Osmond [23], in their well-known book *The Hallucinogens*, wrote that "The fly-agaric mushrooms are the only other natural source of bufotenine." This statement was later found to be erroneous. Schultes [41] wrote, "There is evidence, too, that the report of bufotenine in *A. muscaria* is in error because of confused identification of the botanical material with another species, *A. citrina* or *A. porphyria*, in which bufotenine is undoubtedly present in the carpophores." Catalfomo and Eugster [7] in their review article on the chemistry of *A. muscaria* wrote, "Bufotenine, another central-acting substance, but only when administered parenterally, was isolated from a German specimen of *A. citrina* and also reported to occur in *A. muscaria* and *A. pantherina*. Investigations of North American species revealed the presence of this indole in *A. porphyria*, *A. tomentella*, and *A. citrina*. It could not be detected in other *Amanita* species including *A. muscaria* and *A. pantherina*. Subsequent analysis of European *A. citrina* revealed the presence of several tryptamine derivatives in addition to bufotenine. Notable was the presence of *N,N*-dimethyltryptamine, a substance which is a psychotropic agent, but occurring in too low a concentration to produce any possible physiological activity of this mushroom. To date there is no indication of its existence in *A. muscaria*." Catalfomo and Eugster [7] also wrote about bufotenine, "Several recent studies have failed to reveal this compound in fly agaric mushroom. In some toxicology texts it is claimed that bufotenine is the hallucinogen agent in *A. muscaria*. This is an error not only because the compound does not exist in this mushroom but also because of the well established fact that bufotenine is inactive when administered orally." The chemical constituents of the *A. muscaria* are ibotenic acid, muscimole, muscazone, and muscarine. The other compounds of *A. muscaria* are choline, acetylcholine, betaine, etc. They are not controlled substances.

According to Schultes [42], *A. muscaria* may be one of man's oldest hallucinogens. The use of this mushroom as an orgiastic and shamanistic inebriant was discovered in Siberia in 1730. The Siberians ingested the mushroom alone, either sun-dried or toasted slowly over a fire, or they took it in reindeer milk or with the juice of wild plants. A very old and curious practice of these tribesmen is the ritualistic drinking of urine from men who have become intoxicated with the mushroom. The active principles pass through the body and are excreted unchanged or as still active derivatives. Consequently, a few mushrooms may inebriate many people.

Recent studies suggest that this mushroom was the mysterious God-narcotic soma of ancient India. Thousands of years ago, Aryan conquerors, who swept across India, worshipped soma, drinking it in religious ceremonies. Many hymns in the Indian Rig-Veda are devoted to soma and describe the plant and its effects. The use of soma eventually died out, and its identity has been an enigma for 2,000 years. During the past century, more than 100 plants have been suggested, but none answer the descriptions found in the many hymns. Recent ethnobotanical detective work, leading to the identification of *A. muscaria*, is strengthened by the reference in the Vedas to ceremonial urine drinking, since the main intoxicating constituent, muscimole (known only in this mushroom), is the sole natural hallucinogenic chemical excreted unchanged from the body.

The nature of the intoxication varies, but one or several mushrooms induce a condition marked usually by twisting, trembling, slight convulsions, numbness of the limbs, and a feeling of ease characterized by happiness, a desire to sing and dance, colored visions, and macropsia (seeing things greatly enlarged). Violence, giving way to a deep sleep, may occur [42]. Tradition established the use of fly agaric by witch doctors of the Lapps of Inari in Europe and of the Yakagir of northernmost Siberia. It has been suggested that the ancient giant berserkers of Norway induced their occasional fits of savage madness by ingesting this mushroom [40].

A. muscaria may be one of the most widely used psychotropic mushrooms in the U.S. It is widely used as a recreational drug in western Washington state, western

Oregon, and northern California. Probably it is used in other areas of the country. *A. pantherina* is widely used in the Pacific Northwest and the concentration of the toxins in *A. pantherina* is considerably higher than in *A. muscaria* [34].

II. PREPARATION AND USE OF SNUFF MATERIALS

Snuffing paraphernalia found in Brazil, Peru, and Chile dates back to ca. 3,000 B.C. The oldest known snuff trays from the Andean region are dated ca. 1,200 B.C. The oldest snuff sample that was chemically analyzed was 1,200 years old [51]. The ceremonial use of a narcotic snuff called "cohoba" by the natives of Haiti was described as early as 1496 by Ramon Pane, who accompanied Columbus on his second voyage. Cohoba was used by the priests to communicate with spirits. Many early writers confused cohoba with tobacco snuff. In 1916, Safford [38] identified the source of the cohoba to be the leguminous shrub *Piptadenia peregrina*, which is now classified as *Anadenanthera peregrina*.

The earliest botanical knowledge of the snuffs in Colombia and Venezuela, which were called "niopo" or "yopo", goes back to the descriptions of von Humboldt and Bonpland [55]. They described how the snuff was prepared by the Indians of the Orinoco (Colombia and Venezuela) region in 1801. Spruce [48] gave a detailed report about this narcotic snuff based on his observations among Indians of the Orinoco basin in 1851.

Indians of the Orinoco valley called the snuff "yopo" or "niopo". It is called "parica" by many South American Indians [9]. These snuffs are called "vilca" or "huilca" in Southern Peru and "cebil" in Northern Argentina [38]. Some other names used are: yopa, nopo, curupa, curuba, noopa, acuja, kurupai, aimpa, cevil, cibil, and hatax [57]. It is also known by the names, cojoba, curuva, hataz, kurupayara, nupa, vopo, and yupa [22].

A. Preparation of the Snuff

Preparation varied from tribe to tribe. The earliest report is by von Humboldt and Bonplard [55]. He observed the Indians of Orinoco preparing the drug in 1801. They broke the long pods, moistened them, and allowed them to ferment. When the pods turned black, the softened beans were kneaded into small cakes with cassava meal and lime from snail shells. These cakes were powdered when a supply of the snuff was desired. Many Indians toasted and pulverized the seeds. Some added an alkaline mixture of lime obtained from the burnt shells of snails or ashes of plant material. Schultes [42] wrote, "Apparently, the ashes are made from a great variety of plant material: the burned fruit of the monkey pot, the bark of many different vines and trees, and even the roots of sedges. The addition of the ashes probably serves a merely mechanical purpose: to keep the snuff from caking in the humid climate." Humboldt mistakenly inferred that the stimulating effects of the snuff was due to the lime. The following methods of preparations are reproduced from von Reis's book [57]: "The bark of a lecythidaceous tree called *coco de mono* is burned and the ashes are added to the pulverized seeds," "some claim that plantain meal is preferable to cassava, and others that oil extracted from the snails serves equally well," "Parica may also be composed of these seeds plus the ashes of a vine, and the leaves of a species of the menispermaceous *Abuta Aubl.* (or *Cocculus DC*)." Some native Indians kept the powder in the form of square tablets [22].

Snuff material has been described from "finely ground and of the color of cinnamon or powdered henna" [37], to "a tawny cinnamon color," "looks like ground coffee," "cinnamon-brown powder," "blackish brown, like ground coffee," "the powder ground from the cakes is reddish brown; that obtained by the simpler methods is very fine, blackish brown, like ground coffee" [57], or "grayish green powder" [42].

B. Methods of Using the Snuff

The use of cohoba was described by Ramon Pane who accompanied Columbus on his second voyage. It was taken in the form of snuff, and inhaled through the nostrils by means of a bifurcated tube [37]. The bifurcated tube was made from the leg bones of herons. Sometimes two hollowed palm nuts were attached to the ends of these tubes. However, inhaling snuff was the most common practice. In some tribes, two persons simultaneously blew into each other's nostrils. But many tribes used it as enema. Of special interest to the present study is the habit of smoking the material. Again, the following references are taken from von Reis's book [57].

1. Atacama tribes of Chile: "It was reported that the seeds, or pods, were burned and the smoke inhaled. If this means of administration is not to be interpreted as a mistaken description of snuffing, then it may be necessary to question again whether or not this was also the method sometimes employed by the Taino, in the West Indies, as some of the earliest reports might be thought to suggest."
2. Taino culture of Caribbean: "I believe that the Taino sometimes may have burned *Anadenanthera* material with tobacco and inhaled the smoke of the two substances together. The practice of inhaling the smoke of the burning seeds of what may well be species of

Anadenanthera is reported for some Indians of British Guiana."

3. Carijona Culture: "Manner of administration: inhaled or smoked."
4. Otomac culture of Orinoco: "It is reported that the fumes of the powder are inhaled or that the powder is sprinkled in the eyes."
5. Mura and Piraha tribes of British Guiana: "Parica taken as snuff powder or dissolved in cold water as a clyster, in a paste or in cigarettes," "they (parica seeds) were rubbed to a powder and the fumes inhaled, or the powder sprinkled in the eyes, nose and ears, to produce a frenzy lasting some hours," "some tribes were purported to intoxicate themselves with fumes of the burning seeds."
6. Maue Culture: "Parica is also taken in enemas and cigarettes."

In the chapter on the phytochemical and pharmacological review, von Reis [57] suggested that, "It might be worthwhile to check, as well, into the reports of the inhalation of burning substances of *Anadenanthera*, as suggested by the information under Atacama. "There is no archaeological evidence that *Anadenanthera* preparations were used in ancient times in any other form but snuff by the people of the Atacama Desert. Of the many snuffing kits examined there are no pipes or burnt residues present. Only snuff trays and tubes were found" [36].

C. The Purposes of Use

Hallucinogenic plants and mushrooms have a special place in primitive societies, where they were revered as sacred. Schultes [41] wrote, "In almost all primitive cultures, sickness and death are believed to be due to interference from supernatural spheres. For this reason, the psychic effects of drugs are often far more important in primitive medical practices than the purely physical ones. Consequently, hallucinogens, above all other plants, are found closely connected with magic and witchcraft, in the treatment of disease and death, and in related religious observances." Safford [37] wrote, "While under the influence the necromancers, or priests, were supposed to hold communication with unseen powers, and their incoherent mutterings were regarded as prophesies or revelations of hidden things. In treating the sick the physicians made use of it to discover the cause of the malady or spirit by whom the patient was bewitched." The chief of the tribe inhales the snuff when matters of importance are discussed in meetings [22]. Mostly shamans and men use the material. The purpose of its use is mostly divinatory, magico-religious, ceremonial, medical, hunting, or as a vice by different cultures [57]. Hunters use this material to clear their vision. Interestingly, the Mayoruna tribe of Brazil and the Matses tribe of Peru use the mucus secreted on the skin of the rain forest frog *Phyllomedusa bicolor* believing that it makes them better hunters [20].

D. Present Use

In 1916, Safford [37] wrote, "The custom of taking a narcotic snuff still prevails in various localities of South America, showing that at one time it was widely spread". Schultes [42] wrote in 1976, "Shortly after their arrival, the European conquerors discovered the use of the snuff under the name cohoba in Hispaniola, but its use completely disappeared with the extinction of indigenous populations in the West Indies." Schultes et al. [45] also wrote in 1977, "While the drug is no longer employed anywhere in the Caribbean islands, the extent of the use of *Anadenanthera peregrina* has still not been clearly defined."

In 1965, Granier-Doyeux [22], member of the World Health Organization (WHO) Expert Committee on Addiction-Producing Drugs, wrote, "For many years little interest was shown in this subject but, in 1948, we were consulted about the matter by the Pan-American Health Office. Our report on it was published in the Public Health Offices Bulletin" [21]. Granier-Doyeux [22] also wrote that, "At the present time, various Indian tribes still take nopo, a vice they have inherited from their forebears."

Schultes and Hofmann [47] in their latest book (1992) stated, "It has recently been reported that a group of Indians in the northern Argentina, the Mashco, still use a snuff prepared from seeds of *A. colubrina*; they also smoke the seeds." They also stated that *A. peregrina* is used today by tribes of the Orinoco basin (yopo) and was first reported in 1946. It is no longer used in the West Indies [43]. von Reis (Altschul) [57] wrote, "If the old uses of *A. peregrina var. peregrina* were to be looked for today in the West Indies at all, the only place where they might yet exist would be in Haiti, among the mountain people who still practice a kind of black magic, strongly African in nature."

Granier-Doyeux [22] also warned in his paper, "Another aspect of this question which should not be overlooked is the association of the drug with other toxic substances, especially alcohol and tobacco." Indications are that New York City drug users are associating this drug with more toxic substances such as marijuana or crack-cocaine. In their book, Weil and Rosen [59] wrote, "Black market DMT is usually a brown solid that smells like moth balls; users place tiny bits of it in the ends of joints made with marijuana, mint or oregano in order to smoke it." Authors didn't specify whether this brown material is synthetic or derived from a plant.

The same authors also wrote,"a new natural source of this drug has recently created interest among psychedelic

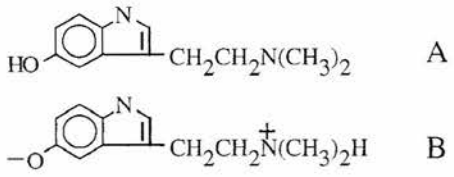
explorers. The Sonoran Desert toad, a huge toad found in Southern Arizona, produces large amounts of 5-MeO-DMT in its venom glands. These can be milked without harming the toad, and the venom can be dried and smoked. Users say the experience is gentler than smoking the synthetic drug. Articles in the tabloid newspapers have sensationalized this story, reporting inaccurately that people are licking toads to get high. Licking toads is dangerous ... Apparently, smoking destroys most of the toxic constituents, sparing the 5-MeO-DMT."

According to Schultes [44], there is traffic in the Amazon and Orinoco regions of these hallucinogens and there is very active trading by civilized (not Indians) curanderos. The use of *Parica* powder is supposedly prohibited by the Brazilian government. The present legal status in other South American and West Indian countries is not known to this author.

III. CHEMISTRY OF THE *ANADENANTHERA* MATERIAL

Stromberg [49] was the first in 1954, to isolate bufotenine from the seeds of *A. peregrina* from Puerto Rico. In 1955, Fish et al. [17] isolated and identified bufotenine, bufotenine oxide, and DMT oxide from the seeds of *A. peregrina* and *A. colubrina*. The pods contain DMT. In addition, a 5-hydroxyindole base of unknown structure was found in *A. colubrina* seeds by paper chromatography, ultraviolet and fluorescence analysis. They gave an empirical formula of $C_{12}H_{16}N_2O_2$ for bufotenine oxide and $C_{12}H_{16}N_2O{\bullet}H_2O$ (hydrated) for DMT oxide.

In 1967, Dr. Horning (co-author of Ref. [17]) said, "In the crystalline form, bufotenine has an ionic structure. However, by certain chromatographic techniques, it is possible to get a second form of bufotenine. I think that probably the second form has a phenolic amine (non-ionized) structure because of infrared spectroscopic evidence. It was obtained in the absence of polar solvents (a non-polar system was used). I think it is fairly clear that in the ionized form, in a polar medium, the compound would not penetrate the blood-brain barrier." [11] These two forms are shown in **Structure 1**.



Structure 1. The non-ionized (A) and ionized (B) forms of bufotenine.

The bark of *A. peregrina* contains monomethyltryptamine (MMT), 5-MeO-DMT, and 5-methoxymonomethyltryptamine (5-MeO-MMT). Dimethyltryptamine was also found in the bark. 5-Methoxymonomethyltryptamine was present in the highest concentration. Holmstedt and Lindgren [26] analyzed six snuff samples using gas chromatography (GC) and mass spectrography (MS). In three of them, 5-MeO-DMT was the main compound. Dime-thyltryptamine was found in five samples as a minor component. Bufotenine was found in substantial amounts in two snuffs. One snuff has equal amounts of bufotenine and DMT, very little 5-MeO-DMT and also harmine. Only one snuff has bufotenine as its main constituent, but also contained DMT and 5-MeO-DMT. Monomethyl-tryptamine and 5-MeO-MMT, not identified in South American snuffs, were found to be present. Only one snuff contained β-carbolines exclusively. *A. peregrina* seeds from Puerto Rico contained bufotenine as the main constituent and *A. peregrina* seeds from West Brazil contained 5-MeO-DMT as the main ingredient. Both seeds contained DMT as the minor constituent [26].

In 1977, using GC/MS, Schultes et al. [45] analyzed 120-year-old *A. peregrina* seeds collected by the British botanist Richard Spruce in 1854, from Rio Negro, Brazil. These 120-year-old seeds showed the presence of only bufotenine, in the concentration of 6.14 mg/g. In 1975 they also analyzed mature seeds (*A. peregrina*), freshly collected in Puerto Rico. These seeds contained bufotenine, DMT, 5-MeO-DMT, and 2-methyl-1,2,3,4-tetrahydro-β-carboline (MTHC) in the ratio 80:19:1:traces. The same seeds were analyzed two years later and only bufotenine was found in the concentration of 35.23 mg/g, with no trace of the other alkaloids that were found earlier. Schultes et al.[45] observed that, "This fact might imply that the relative content of the various alkaloids upon storage follows with time a certain pattern. Transformation of alkaloids during storage of botanical material is known to occur. Our observation stresses the importance of storage-time in addition to knowledge of plant part, soil, season, and climatic conditions, when alkaloid analysis is carried out on seeds and on the snuffs prepared from them."

Recently, using a short column GC/tandem-MS technique, Torres et al. [51] analyzed 1,200-year-old snuff samples excavated in the San Pedro de Atacama area of Northern Chile. The analysis demonstrated the presence of the psychoactive alkaloids DMT, 5-MeO-DMT, and bufotenine in both snuff samples. The presence of bufotenine in the snuffs suggests the plant source of this material was the genus *Anadenanthera*.

The molecular structures and related information of indole alkaloids and β-carbolines are shown in **Table 1** for reference.

Table 1. Indole alkaloids and β-carbolines

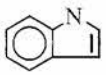
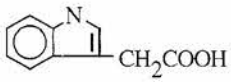
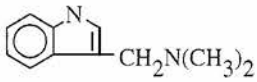
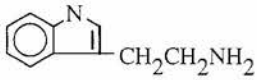
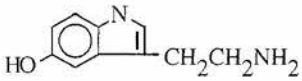
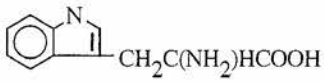
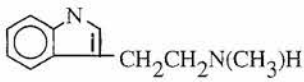
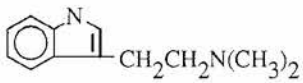
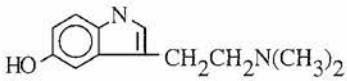
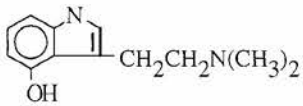
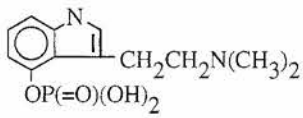
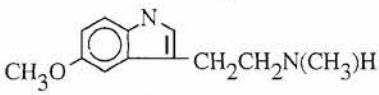
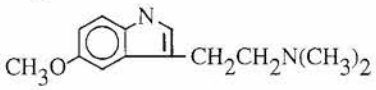
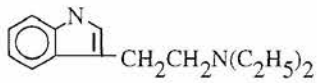
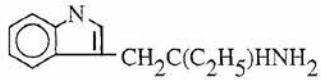
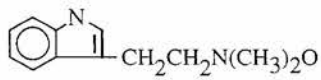
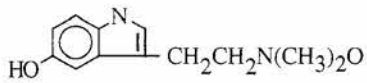
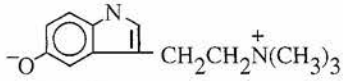
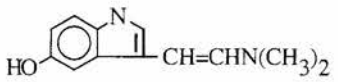
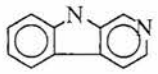
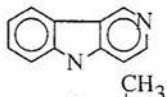
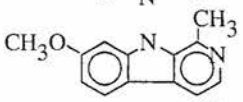
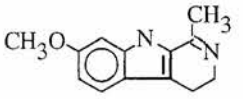
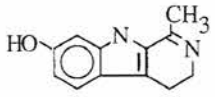
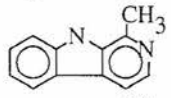
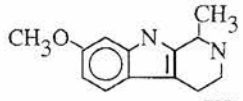
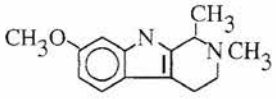
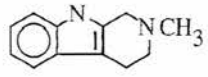
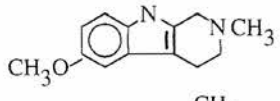
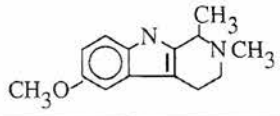
No.	Name	Structure	Mol. formula; Mol. wt.
1	Indole		C_8H_7N; 117
2	Indoleacetic acid		$C_{10}H_9NO_2$; 175
3	Gramine		$C_{11}H_{14}N_2$; 174
4	Tryptamine		$C_{10}H_{12}N_2$; 160
5	Serotonin		$C_{10}H_{12}N_2O$; 176
6	Tryptophan		$C_{11}H_{12}N_2O_2$; 204
7	Monomethyltryptamine (MMT)		$C_{11}H_{14}N_2$; 174
8	Dimethyltryptamine (DMT)		$C_{12}H_{16}N_2$; 188
9	Bufotenine		$C_{12}H_{16}N_2O$; 204
10	Psilocin		$C_{12}H_{16}N_2O$; 204
11	Psilocybin		$C_{12}H_{17}N_2O_4P$; 284
12	5-Methoxy-MMT		$C_{12}H_{16}N_2O$; 204
13	5-Methoxy-DMT		$C_{13}H_{18}N_2O$; 218
14	Diethyltryptamine (DET)		$C_{14}H_{20}N_2$; 216
15	α-Ethyltryptamine		$C_{12}H_{16}N_2$; 188
16	DMT-oxide		$C_{12}H_{16}N_2O$; 204
17	Bufotenine-oxide		$C_{12}H_{16}N_2O_2$; 220
18	Bufotenidine		$C_{13}H_{18}N_2O$; 218

Table 1. (Continued)

No.	Name	Structure	Mol. formula; Mol. wt.
19	Dehydrobufotenine		$C_{12}H_{14}N_2O$; 202
20	β-Carboline (Norharman)		$C_{11}H_8N_2$; 168
21	γ-Carboline		$C_{11}H_8N_2$; 168
22	Harmine		$C_{13}H_{12}N_2O$; 212
23	Harmaline		$C_{13}H_{14}N_2O$; 214
24	Harmalol		$C_{12}H_{12}N_2O$; 200
25	Harman (Harmane)		$C_{12}H_{10}N_2$; 182
26	Tetrahydroharmine		$C_{13}H_{16}N_2O$; 216
27	*N*-Methyltetrahydroharmine		$C_{14}H_{18}N_2O$; 230
28	2-Methyl-1,2,3,4-tetrahydro-β-carboline (MTHC)		$C_{12}H_{14}N_2$; 186
29	2-Methyl-6-methoxy-1,2,3,4-tetrahydro-β-carboline		$C_{13}H_{16}N_2O$; 216
30	1,2-Dimethyl-6-methoxy-1,2,3,4-tetrahydro-β-carboline		$C_{14}H_{18}N_2O$; 230

IV. PHARMACOLOGY, TOXICOLOGY, AND BIOLOGICAL EFFECTS OF BUFOTENINE AND BUFOTENINE–CONTAINING MATERIAL

This is a topic of major confusion, controversy, contradictions, differing opinions, observations, and studies. In the author's opinion, this area requires a fresh study, in view of the fact that bufotenine-containing materials are being misused on New York City streets. Most of the work on this topic was done during the 1950s and 1960s. Many studies and reports on the effects of bufotenine do not agree with the reported historical accounts. There was no correlation among (a) historically observed accounts of the use of *Anadenanthera* snuffs and seeds, (b) chemical constituents found in the seeds and snuffs of *Anadenanthera,* and (c) many studies and reports done on the effects of bufotenine.

A. Historical Observations

The first accounts go back to 1496, to Ramon Pane, as quoted in Schulte's article [41], *Anadenanthera* material "is so strong that those who take it lose consciousness", "almost immediately, they believe they see the room turn

upside-down and men walking with their heads downwards." As quoted by Granier-Doyeux [22], Padre Jose Gumilla wrote (1741) in his book, *El Orinoco Illustrado*, "they have another dreadful way of getting drunk through the nose, using malignant powders called yupa, which drive them completely out of their minds. ... a terror to the Caribs, for they get fighting mad with yupa, wound themselves, and, full of blood and fury, go out to fight like raging tigers." von Humboldt and Bonplard [55] observed, "They reach a special state of drunkenness, which might be called madness, by using the niopo powder. ... Niopo is so stimulating that for anyone not used to it the smallest quantities provoke violent sneezing ..." More recently, Granier-Doyeux [22] stated, "According to the classical descriptions, niopo might be said to have a two-phase action. During the initial period, or phase, the drug has a stimulating effect, producing great excitement in the subject and the onset of hallucinatory delirium ... During the second phase, sleepiness is followed." These are only a few of the accounts.

B. Opinions on the Effects of Bufotenine

The chemical aspect of the snuffs and seeds was reviewed in Section III. What is the actual compound to which the effects could be attributed? Humboldt has erroneously attributed the effect to freshly calcined lime. Participating in the discussion on the psychoactive action of various tryptamine derivatives, Dr. Isbell [12] said, "I think that I might speak a little bit about some of the tryptamines other than dimethyltryptamine. One of these is bufotenine. It has been said that bufotenine is not a psychotomimetic drug. I don't think that we should say that. The difficulty is that bufotenine is a drug that has extremely powerful and dangerous cardiovascular effects, and for that reason it is not possible to push the dose in man. Also, it would be difficult to differentiate whether psychotic reactions were due to central effects or to cardiovascular actions. Cardiovascular actions include hypertension and development of an arrhythmia which actually amounts to a ventricular standstill. The auricle does not beat, the beat drops out, and the ventricle takes over, and it is very frightening. Simultaneously with the hypertension and ventricular escapes, one sees spectacular cyanosis in the upper part of the body, similar to that which has been described in the carcinoid flush, which is presumably due to serotonin. So bufotenine is a difficult drug to work in man for this reason."

Torres et al. [51] wrote, "While bufotenine has often been referred to as hallucinogen, current thinking among neurophysiologists is that it is probably not one. In contrast to dimethyltryptamine, 5-methoxy-dimethyltryptamine, and psilocin, to which it is chemically very similar, bufotenine does not readily cross the blood-brain barrier. It can have profound effects on peripheral physiological processes such as heart rate and blood pressure, and these may well provide a significant contribution to the total overall activity of hallucinogenic snuffs prepared from species that contain it ... it is possible, although unlikely, that the bufotenine in these ancient snuff samples arose at least in part from 5-methoxy-dimethyltryptamine by a millennia-long process of hydrolysis."

According to the *Analytical Profiles of the Hallucinogens* [1], "In this (indolealkylamine) series the parent compound tryptamine shows no hallucinogenic activity. *N,N*-disubstitution with small alkyl groups such as methyl (DMT), or ethyl (DET) results in the emergence of modest hallucinogenic activity. Substitution of a 5-methoxy group as in 5-methoxy-DMT results in a further increase in hallucinogenic activity, while substitution of a methoxy group at the 6- or 7-positions of DMT does not yield an active hallucinogen. The 4-hydroxy-DMT derivative, psilocin, shows intermediate activity, but the corresponding 5-hydroxy analogue, bufotenine, has only weak if any, hallucinogenic potential. The relative hallucinogenic activity profile for this series can be summarized as: 5-MeO-DMT > psilocin > DMT > DET > bufotenine. Other structural modifications of the DMT molecule including shortening or lengthening of the 3-ethyl side chain, elimination of the indole nitrogen or reduction of the 2,3-double bond, all result in a decrease or loss of hallucinogenic activity."

Shepard, the nature and wildlife teacher who was arrested in California for the possession of bufotenine milked from toads, told investigators that the difference between LSD and bufotenine was like the difference between milk and whisky. About this toad venom, Greg Elam, the investigator of the case, said, "You better be sitting down, or have a place to lie down, or this will put you down" [33].

C. Studies on the Effects of Bufotenine and Snuffs

Granier-Doyeux [22] studied the action of niopo powder in mice and white rats. The action was two-phased — stimulation, with exultation and hallucinations, followed by a hypnotic state, with a kind of intoxication characterized by loss of reasoning faculties and consciousness. Turner and Merlis [52] studied the effects of actual *Anadenanthera* snuff powders on humans and was summarized by von Reis [57], "They were unable to produce intoxication in human subjects by normally tolerated doses prepared in a variety of ways duplicating Indian methods. Turner and Merlis [52] stated that they were

convinced the Indians were able to tolerate 10 gm of the snuff. This amount contains about 50 mg of bufotenine and up to 10 mg of DMT. The production of intoxication would require that at least 50% of the former and all of the latter be taken into the blood stream within a three to five-minute period. Even the pure compound administered nasally is ineffective. Hence the authors decided that they reject bufotenine and DMT as capable of producing the acute phase of intoxication from *Anadenanthera* snuff."

Granier-Doyeux [22] summarized the striking effects of bufotenine and DMT as follows:

1. There are two main types of effects: psychotomimetic and neuro-vagal.
2. These effects appear extremely quickly.
3. Both types appear simultaneously.
4. Bufotenine produces psychotomimetic effects, with polychrome hallucinations (brilliantly-colored) similar to those produced by LSD-25, but of brief duration.
5. DMT causes marked alteration of space-time perception, a tendency toward "autism" (much greater than that provoked by mescaline) and delusions.
6. As is well-known, in addition to its hallucinogenic effects, bufotenine produces passing psychoses, cyanosis, respiratory anxiety, sweating, paresthesia, mydriasis, and nystagmus.
7. In addition to its hallucinogenic effects, DMT produces psychosis and vagal phenomena (mydriasis, hypertension, dyspnoea, and anxiety).

In 1956, Evarts [14] studied the effect of bufotenine on monkeys. He indicated that the effects of intravenous injection of LSD-25 and bufotenine were similar. In the first 20 min, the monkeys assumed a prone position and became indifferent to noxious stimuli. Later, they began to move in circles. After 1 h, motor coordination had returned. They became normal after 1.5 h. In a dog, I.V. administration of bufotenine in doses of 4 mg/kg caused the same effect, which persisted for about 2 h. In a letter to von Reis (Altschul), another investigator, Raffauf, stated (in 1955) that dogs injected with bufotenine had presented what was described as a "scared to death" syndrome [57].

Fabing and Hawkins [15] studied the effects of bufotenine administered intravenously on humans. A dose of 1 mg produced a sensation of tightness in the chest and a prickling sensation in the face, which persisted for 6 min. Two milligrams produced tightness in the throat and stomach, and the face developed a purplish hue. Four milligrams of bufotenine produced visual hallucinogens of vivid red and black blocks. Eight milligrams produced a deep purple facial color, facial burning, and a sense of calm. After 16 mg, these changes were more pronounced. The purple color remained for 1 h. They concluded that bufotenine is hallucinogenic. There is also linear progression in symptoms as the dose increases. They concluded that the possible role of anoxemia in the production of the hallucinogenic effects of bufotenine requires clarification. Fabing [16] compared the effects of injecting bufotenine in human volunteers to the furious rages of the Berserks of Viking culture who used *A. muscaria* mushrooms. He wrote, "Recent observations on the intravenous injection of bufotenine in man disclose that it is an hallucinogen, and that its psychophysiological effects bear a resemblance to the Berserksgang of the Norsemen in the time of the Sagas."

Bufotenine given intravenously in doses up to 20 mg to schizophrenic subjects did not produce hallucinations, only profound electro-encephalogram changes, loss of consciousness, and intense peripheral action of serotonin character. Turner and Merlis [52] stated that the effects of neither of the amines, bufotenine and DMT, are long-lasting enough to suggest their participation in acute intoxication from *Anadenanthera* snuff. When administered by injection, both compounds acted very rapidly in onset and very briefly in duration. The authors suggested that there might be constituents other than *Anadenanthera* materials in the snuffs used by the Indians that could be responsible for the reputed effects. Finally, they said that the freshness of the material also might influence its potency. The work of Turner and Merlis [52] introduces unexpected questions in the reasoning that generally been held, however tentatively, with regard to the chemicals responsible for the putative hallucinogenic effects of *Anadenanthera*.

D. On Oral Administration of Bufotenine

Like DMT, bufotenine was also found to be ineffective when administered orally in doses of 50 mg [25] or up to 100 mg [58]. De Smet and Rivier [10] wrote, "This inefficacy of oral dosing is likely to be principally due to extensive first-pass metabolism by monoamine oxidase (MAO). The structurally related neurotransmitter serotonin (5-hydroxytryptamine or 5-HT) is promptly degraded by intestinal and hepatic MAO when taken orally. The deamination of 5-HT leads mainly to 5-hydroxyindole acetic acid. Although 5-OH-DMT has a dimethylated amino group, there is evidence from rat experiments that it is also deaminated by MAO in vivo. This may explain why South American natives most often take vegetal sources of 5-OH-DMT in the form of a snuff. So far, however, conclusive clinical support for this assumption has not been published. Human studies on the nasal application of 5-OH-DMT have been conducted in the 1950s, but they have failed to demonstrate hallucinogen-like activity via the nasal route."

South American hallucinogenic drink called, "yage", "ayahuasca", or "caapi" is made from the woody vine genus *Banisteriopsis*. The main chemical constituent is a β-carboline, harmine. Most commonly, the Indians add leaves of another plant that contains DMT, when making the yage drink. Harmine inactivates the enzyme that destroys DMT. In combination with harmine, DMT becomes orally active [59]. A similar combination of β-carbolines and tryptamine derivatives was found in some South American snuffs [10,26].

Bufotenine showed both in vivo and in vitro anticholinestrase activity similar to, but 20 to 30 times weaker than, physostigmine [2].

E. Effects of DMT and 5-MeO-DMT

On the effects of DMT, Weil and Rosen wrote [59], "DMT is peculiar among the psychedelics in that it cannot be used by mouth; an enzyme in the stomach breaks it down before it can enter the bloodstream. Users of the isolated black-market chemical either smoke it or, less frequently, inject it intramuscularly. Sometimes, a single inhalation of such a joint will be sufficient to initiate a 5- to 10-minute trip of remarkable intensity. The effect may begin before a person can remove the joint from his lips and usually reaches its peak within the first minute. Some users lose all awareness of their surroundings, being overwhelmed by visual hallucinations. Fans of DMT say it gives an ultimate psychedelic rush; needless to say, this experience can be quite frightening to someone unprepared for it. After 15 min, the strong effects subside, and after 30 min users again feel normal. Because of its short duration of action, DMT is known as businessman's trip." About 5-MeO-DMT, they wrote, "It gives an equally powerful rush when smoked, but instead of visual hallucinations, the smoker experiences complete dissolution of reality. Some users describe this trip as a rocket ship into the void. Addiction to DMT and 5-MeO-DMT is unknown is due in part to the rapid development of tolerance to their interesting effects. When smoked regularly, they soon become ineffective."

Gallagher et al. [18] studied the effects of di-methylated tryptamines on sheep to determine the cause of the phalaris staggers. They reported, "Parenteral administration of small doses of the alkaloids of *P. tuberosa* to unanaesthetized sheep and to small laboratory animals causes profound disturbances of the central nervous system, producing the same group of neurological signs displayed by sheep with acute phalaris staggers. The most potent of the alkaloids in producing central nervous system disorder is 5-methoxydimethyltryptamine, followed by 5-hydroxydimethyl-tryptamine and dimethyltryptamine."

V. ANALYSIS OF CASE MATERIALS AND *A. PEREGRINA* SEED

In May 1992 the author's laboratory received case samples alleged to be hashish. The samples were small, candy-like, irregular cubes, resinous in texture, and reddish-brown in color. They were packaged in small clear red zip-lock plastic bags, and weighed approximately 0.6 to 1.0 g. Since November 1992, 41 more cases were received. Some of the big pieces of the case material show smooth surface on some sides and sharp cut edges and striations on other sides, indicating that the pieces were cut from a bigger pie or cake while it was still soft. When received at the laboratory, the samples were very hard and difficult to cut or break. They were seized at different locations throughout the five boroughs of New York City.

One seed of *A. peregrina*, provided by Dr. Barnaby, New York Botanical Garden Herbarium, was analyzed by the author using GC/MS technique. This seed was from a ripened pod collected in 1969, from Parana, Brazil.

A. Thin Layer Chromatography (TLC) and Color Tests

Approximately 0.1 g of the case material was ground to fine powder and soaked in 0.5 mL of methanol for 10 min, shaken for a few minutes and centrifuged. The extract of the sample was streaked on a thin layer chromatography (TLC) plate along with a bufotenine reference spot. The plate was developed almost to the end using solvent system TA (methanol/ammonia, 100:1.5) [30]. The bufotenine spot was developed using Van Urk's reagent (prepared by adding 10 mL HCl to a solution of 1 g *p*-dimethylaminobenzaldehyde in 100 mL ethanol).

In reference to the solvent front, the adopted solvent system resulted in the following R_f values: bufotenine, 0.35; psilocin, 0.39; and psilocybin, 0.05.

Bufotenine shows distinct color changes when tested with the Van Urk reagent and Weber Test (three drops of freshly prepared 0.1% Diazo Blue B (*o*-dianisidine tetrazotized)) [19]. Van Urk reagent generated a purple color on concentrated methanol extract and on a powdered sample of bufotenine. A concentrated methanol extract of bufotenine turned red when tested in the first step of the Weber Test. The color changed to blue in the second step in which two drops of concentrated HCl were added [19].

B. Gas Chromatography/Mass Spectrometry

1. Case Materials

Gas chromatography/mass spectrometry analyses were performed on direct extract and TLC band scrapings, both underivatized and derivatized [8]. For direct analysis of

the extract, the clear liquid resulting from the centrifugation step in the extraction process was injected into the GC/MS. For testing the TLC band scrapings, the band corresponding to the bufotenine spot was marked on the TLC plate and the band was scraped using a spatula. Scrapings were finely powdered and transferred to a test tube. A minimum amount of methanol was added to the test tube to immerse the scrapings, shaken for a few minutes, and then centrifuged. The clear liquid was then injected into the GC/MS system, which gave a single GC peak.

Derivatization was easily achieved by adding twice the volume of acetic anhydride to the concentrated methanolic extract of the sample or the standards in a test tube, and warming the test tube (approximately 50 °C) near the injection port for 20 min.

a. Non-derivatization Products

Total ion chromatograms obtained from the direct extract of four case materials are presented in **Figure 1** using the conditions described in the footnote for **Table 2**. The retention characteristics of the peaks that appear at approximately 6.2 min in these four chromatograms are comparable with that of bufotenine standard. A section of chromatogram in Figure 1a is expanded and compared with the total ion chromatogram of psilocin and bufotenine standards as shown in **Figure 2**.

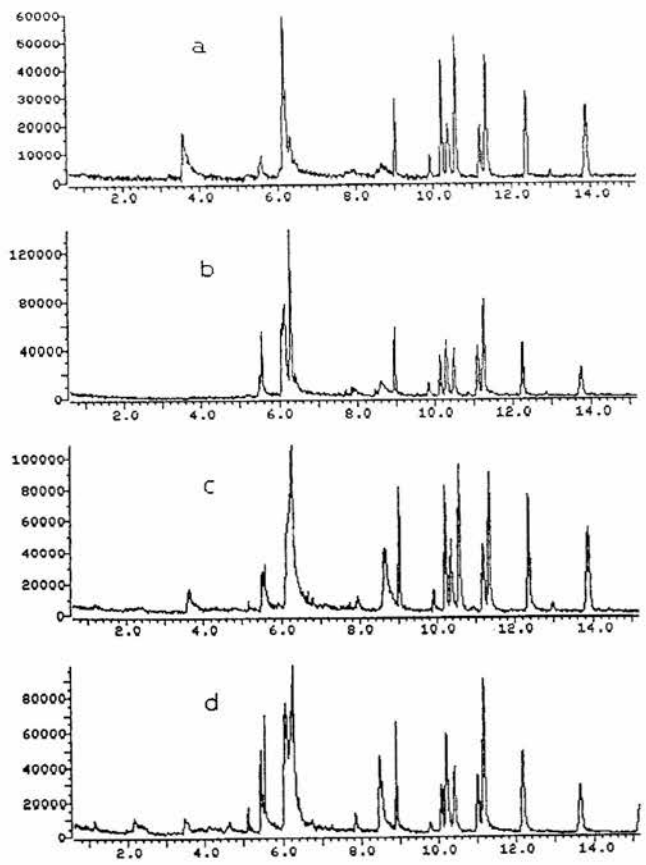


Figure 1. Total ion chromatograms of direct extracts from four different case samples.

Table 2. Gas chromatographic retention times (min)[a] of underivatized and derivatized bufotenine and psilocin

Sample Status	Bufotenine	Psilocin	Case Sample
Underivatized	6.05	5.75	6.05
Monoacetyl derivative	6.50	6.35	6.50
Diacetyl derivative	7.10	6.90	7.10

[a] Chromatographic conditions: HP-1 methyl silicone, 12-m x 0.2-mm (0.33-µm thickness); injector, transfer line, and oven temperatures: 250 °C, 280 °C, 100–270 °C at 23 °C/min, respectively. Data obtained using an HP5890/HP5970 GC/MS system (Hewlett-Packard: Palo Alto, CA).

The mass spectra of the peaks identified as psilocin and bufotenine (Figure 2a) are compared with that obtained from the 6.2 min peak (Figure 2b) and shown in **Figure 3**. Mass spectra of bufotenine and psilocin/psilocybin could not be readily distinguished, but their retention times were different as shown in Table 2. Retention times varied slightly (approxmately 0.1 min) with concentration, especially in case samples. The relative intensities of the minor peaks in the mass spectra — like ions m/z 146 and 204 — also vary.

Though mass spectra of psilocin and bufotenine could not be readily distinguished, there are some minor differences. These differences could be made more pronounced by eliminating the base peak m/z 58 as shown in Figures 3d, 3e, and 3f. In bufotenine the intensity of the m/z 146 ion is much more intense than the m/z 130 ion, whereas in psilocin the difference is not as distinct. In bufotenine, the

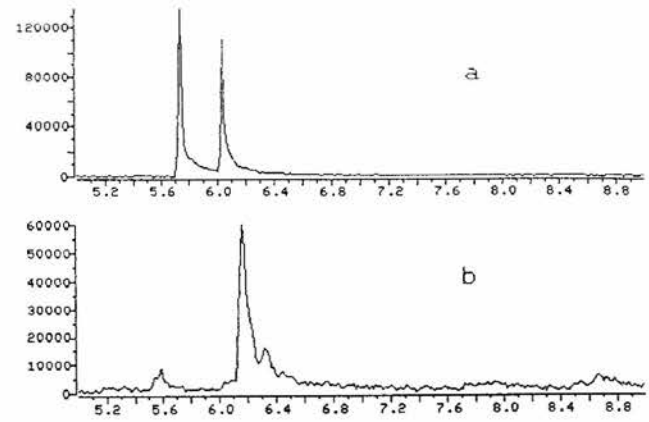


Figure 2. Comparison of retention times of: (a) standard psilocin and standard bufotenine and (b) an alleged bufotenine peak in a case sample.

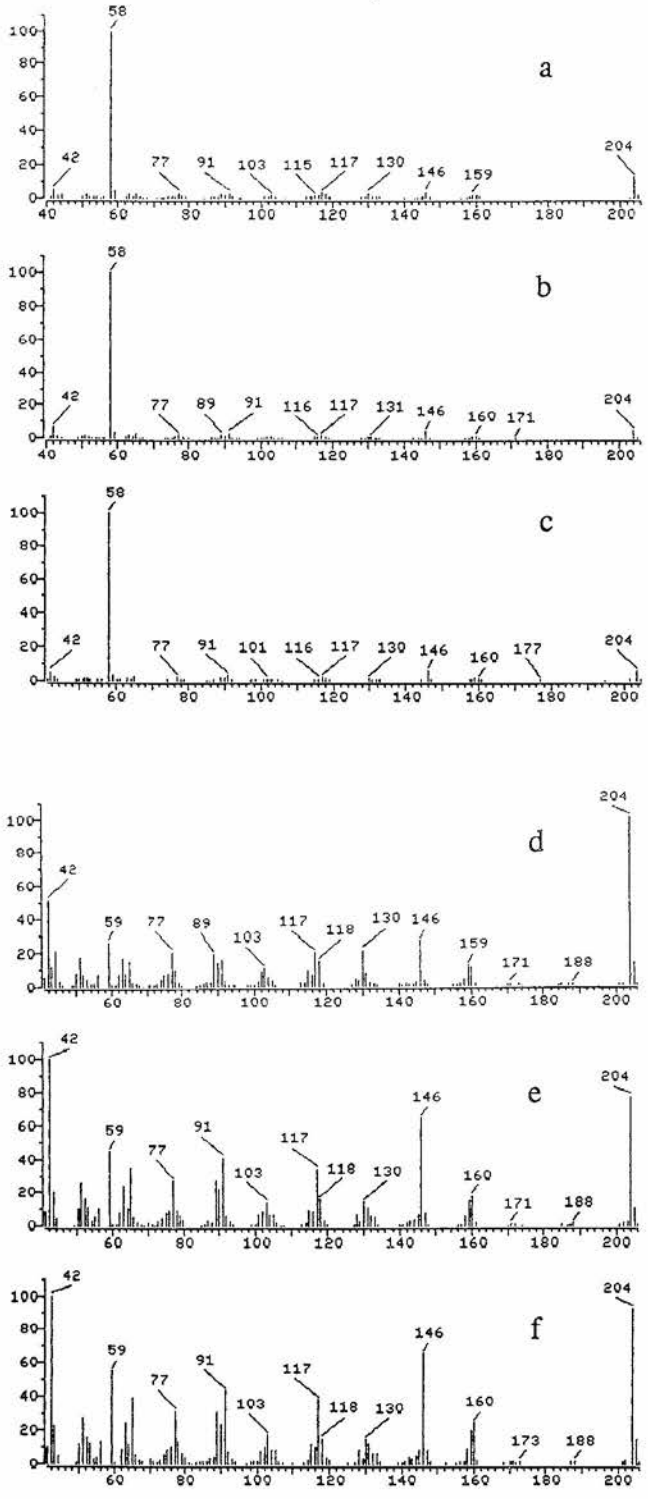


Figure 3. Comparison of mass spectra of: (a) standard psilocin, (b) standard bufotenine, and (c) an alleged bufotenine peak in a case sample; (d) standard psilocin with base peak m/z 58 removed, (e) standard bufotenine with base peak m/z 58 removed, and (f) an alleged bufotenine peak in a case sample with base peak m/z 58 removed.

m/z 117 ion is much more intense than the m/z 115 and 118 ions, whereas in psilocin the former ion is only slightly more intense than the latter ones [54].

A much clearer ion chromatogram was obtained when the TLC band scraping was used. A sample chromatogram and the mass spectrum identified as bufotenine are shown in **Figure 4**.

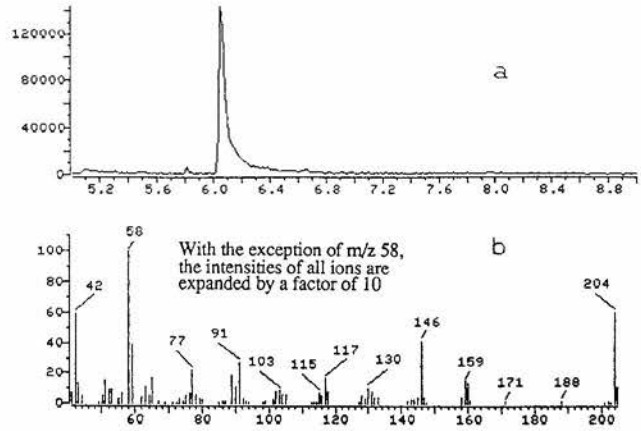


Figure 4. Total ion chromatogram (a) and mass spectrum (b) obtained from the extract of the TLC band (from a case sample) corresponding to bufotenine standard.

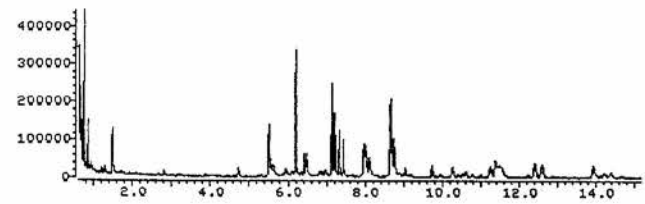


Figure 5. Total ion chromatograms of the derivatized products from the extract of a case sample.

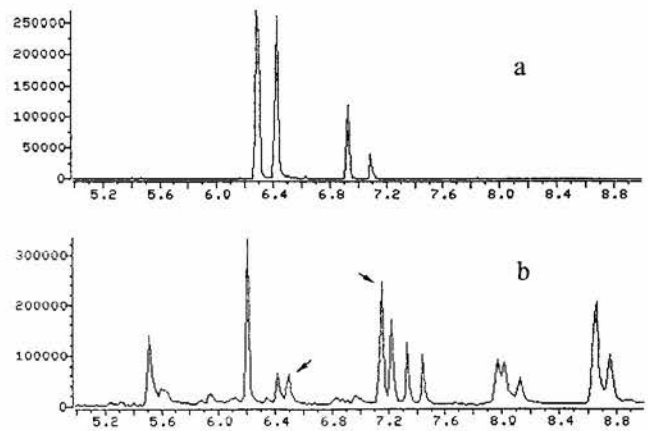


Figure 6. Comparison of retention times of the derivatization products of: standard psilocin and standard bufotenine (a) and peaks derived from alleged bufotenine in a case sample (b).

b. Derivatization Products

The total ion chromatogram of a derivatized case sample extract is shown in **Figure 5**. A section of this chromatogram is expanded (**Figure 6**b) and compared with the ion chromatogram obtained from the derivatization products of psilocin and bufotenine standard (Figure 6a). Both mono- and di-acetylated products are obtained when the described derivatization procedure is applied to the case sample and the psilocin and bufotenine standards.

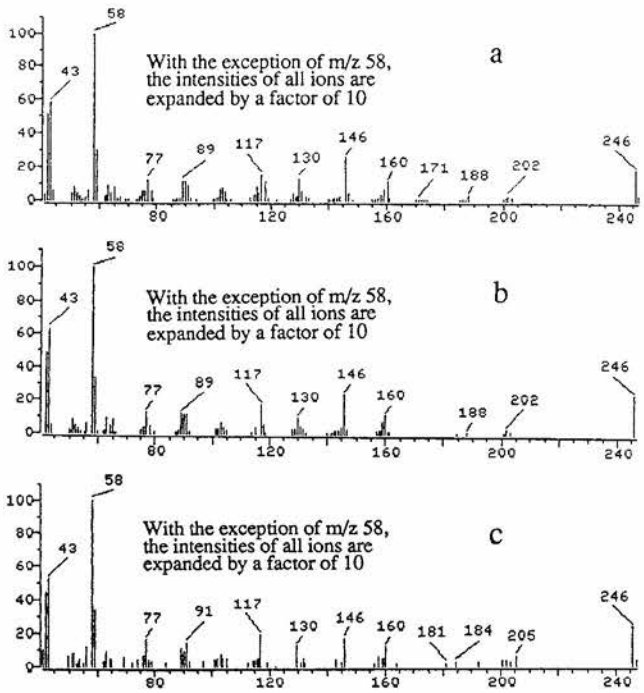


Figure 7. Mass spectra of mono-acetylated products of: psilocin standard (a), bufotenine standard (b), and alleged bufotenine peak in a case sample (c).

The mass spectrum of the mono-derivatized psilocin (**Figure 7**a) cannot be differentiated from the mass spectra obtained from the mono-derivatized bufotenine standard (Figure 7b) and the case sample (Figure 7c). However, the retention time information can be used to differentiate between the psilocin and bufotenine derivatization products.

Similarly, the mass spectra of the di-acetylated products are shown in **Figure 8**. Again, the retention time data along with the mass spectra data, are useful for the identification of bufotenine in the case sample.

c. Other Components in Case Materials

The components extracted from the case materials depend on the extraction procedure used. More of the components were extracted into methanol if soaked for a longer time or with other solvents like petroleum ether. A

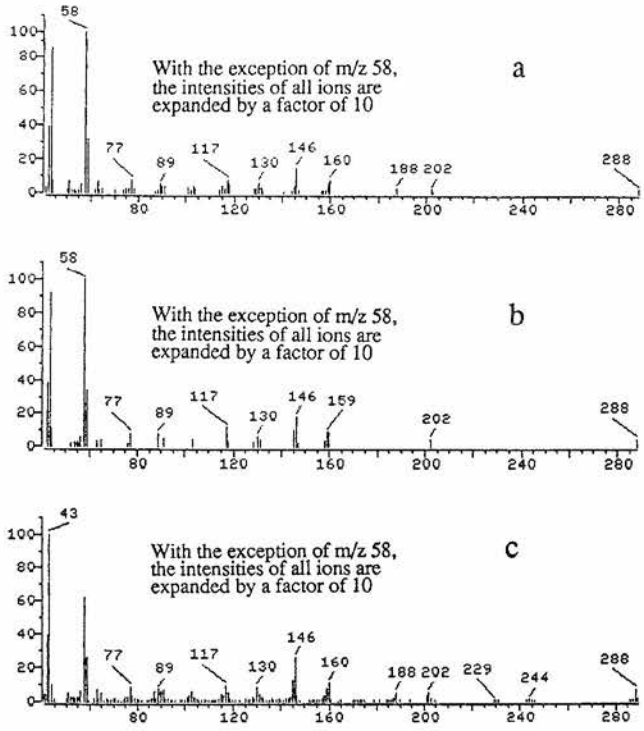


Figure 8. Mass spectra of di-acetylated products of: psilocin standard (a), bufotenine standard (b), and alleged bufotenine peak in a case sample (c).

later section of the case material chromatogram shown in Figure 1a is expanded and shown in **Figure 9**a. The mass spectra of many distinct peaks are shown in Figures 9b–9g. No attempt was made to identify these peaks except cholesterol (Figure 9f). Many of these peaks are probably from the ingredients added during the preparation process.

Palmitic acid (5.6 min), linoleic acid (co-elutes or shows up as a split peak next to the bufotenine peak at 6.2 min) and cholesterol (12.4 min) was found in case samples (Figures 1a–1d).

2. Seed

A total ion chromatogram obtained from the extract of an *A. peregrina* seed is shown in **Figure 10**. Peaks 1, 2, 3, 4, and 5 are identified as naphthalene, palmitic acid, DMT, bufotenine, and linoleic acid, respectively. The presence of naphthalene is probably due to the use of moth balls in the herbarium.

Anadenanthera seeds may also contain some other tryptamine derivatives such as DMT, 5-MeO-DMT, etc. Gas chromatography/mass spectrometry analysis of samples showed only one tryptamine alkaloid-bufotenine. But TLC showed at least three other intense spots when

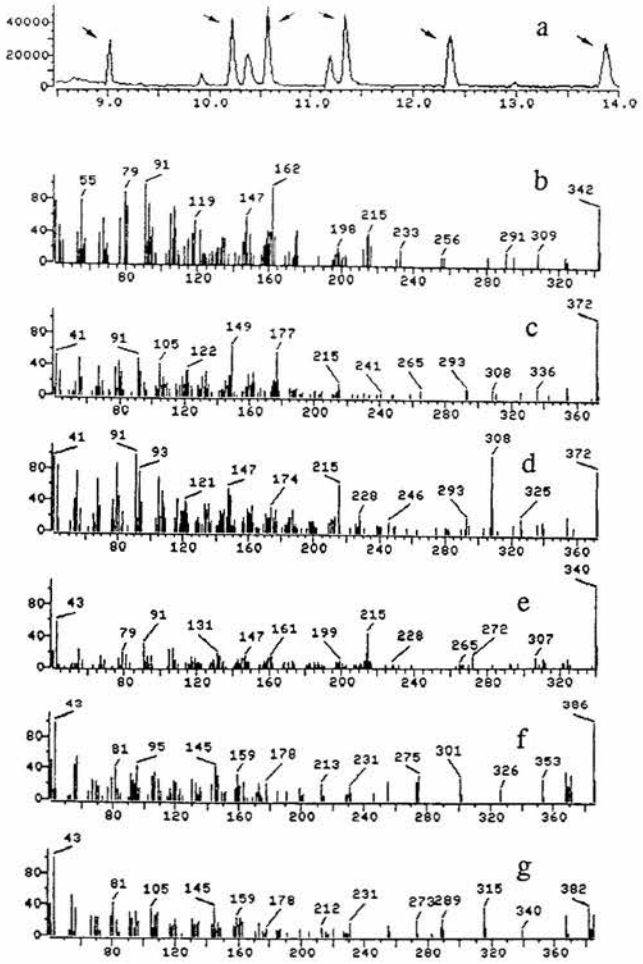


Figure 9. An expanded section of the total ion chromatogram (Figure 1a) obtained from a case sample (a) and mass spectra (b–g) of six peaks shown in the chromatogram.

sprayed with Van Urk's reagent. This matter is still under investigation.

CONCLUDING REMARKS

Bufotenine in case samples can be identified by color tests, TLC, and GC/MS. Additional confirmation can be obtained from the retention times and mass spectra of mono- and di-acetylated derivatives of bufotenine. Many other peaks are also present, some of which were identified as palmitic acid, linoleic acid, and cholesterol.

Bufotenine was never identified before in case samples in the New York City Police Laboratory. Schultes [40–47], author of many books and papers on hallucinogens of plant origin and Professor of Biology and Director of Botanical Museum of Harvard University (Emeritus), has indicated in a personal communication [44] that he has not heard of any such cases in the United States.

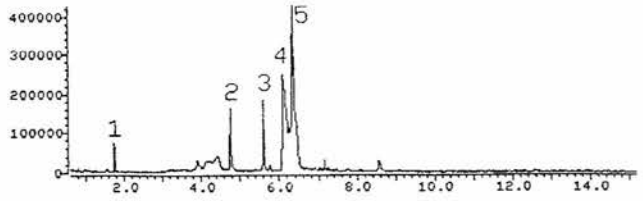


Figure 10. Total ion chromatograms of the extract of an *Anadenanthera* seed. Peaks are identified as naphthalene (1), palmitic acid (2), DMT (3), bufotenine (4), and linoleic acid (5).

Though conclusive evidence is lacking, this author believes that the bufotenine-containing material seized in New York City is derived from the seeds of genus *Anadenanthera*. The possibility of this material coming from mushrooms was ruled out after consultation with Dr. Roy E. Hallings, Curator of Mycology, The New York Botanical Gardens. It is also a remote possibility that the toads are the source. Dr. Michael Balick, Director of the Institute of Economic Botany, and Dr. Rupert Barnaby, at the New York Botanical Gardens also studied the sample and they believe that it appears to be resinous plant material. They couldn't identify the plant origin in the absence of seed or plant parts. A small amount of the sample was heated in a test tube. It burned vigorously liberating white fumes and brownish oily droplets.

The origin of this material is still a puzzle and the effectiveness, when smoked, is unknown. Seizure of small quantities of this material indicates that it is not available or sold in large quantities. Whether this is a passing fancy or an emerging trend, only time will decide. This author learned recently that a few cases were also seized in Orlando and Tampa, FL [54].

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seum (Emeritus), Harvard University, who has inspired people in many fields with his almost six decades of wonderful research in the field of hallucinogens of plant origin, including many years of living with Indians in deep jungles of South America, for his kind clarifications, advise, and directions. His books and articles have fascinated and inspired the author to make this humble attempt.

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After obtaining a graduate degree in chemistry, he worked as a lecturer in chemistry. In 1970, he joined the office of the Government Examiner of Questioned Documents, Central Forensic Institute, Government of India, Hyderabad, India. Until 1977, he was first an Assistant Central Intelligence Officer Gr. I and later an Assistant Government Examiner of Questioned Documents. In 1977, he joined the Forensic Science Laboratory, Police Department, State Government of Andhra Pradesh, Hyderabad, as Assistant Director, and served in that capacity until August 1980. Through 1980 and 1981, he was a graduate student and an adjunct lecturer in Forensic Science at John Jay College of Criminal Justice, New York. In 1981, he joined the New York City Police Laboratory.

His field of interest is GC/MS analysis of drugs of abuse, teaching, and working on unusual and interesting cases received at the Police Laboratory, New York City.