

CHAPTER ONE

A MULTIDISCIPLINARY OVERVIEW OF INTOXICATING ENEMA RITUALS IN THE
WESTERN HEMISPHERE

CHAPTER ONE PART ONE

THE ETHNOBOTANY, CHEMISTRY AND PSYCHOPHARMACOLOGY OF RITUAL ENEMAS IN THE WESTERN HEMISPHERE

1.1.1. Agave species Amaryllidaceae

1.1.1.1. Ethnobotany

Before the conquest, distillation was unknown in the New World, but Mesoamerican Indians were familiar with a variety of alcoholic drinks prepared by fermenting maguey (Agave), maize, honey or pineapple (Tozzer 1913; Gonçalves de Lima 1956; Erosa Barbachano 1976; Furst and Coe 1977). The principal alcoholic beverage of the Aztecs was octli, referred to as pulque by the Spaniards; it was prepared from the sap of Agave species (Gonçalves de Lima 1956; Sahagún 1963; de Barrios 1971). Among the ancient Aztecs, getting drunk without incurring the wrath of society was a privilege of old age; drunkards could receive severe punishments, ranging from public disgrace to death by stoning or beating (Ross 1978).

Wilder drinking habits prevailed among the Huastecs of the Mexican northern Gulf Coast, who were considered barbarian by the Aztecs (Wasson 1980). According to the early chronicler Sahagún (1961), the Huastecs also knew octli, and 'always went about as if drunk'. Several early records speak of rectal administration in connection with their inebriating practices (Bourke 1892; Nordenskiöld 1930; Furst and Coe 1977; Robicsek 1978). The conquistador Diaz del Castillo (1916) gives the following account, clearly from his European point of view: 'About drunkards I do not know what to say, so many obscenities take place among them; I wish to note only one here which we found in the province of Panuco; they make an injection by the anus with some (hollow) canes and distend the intestines with wine, and this is done among them in the same way as among us an enema is applied'. An anonymous companion of Cortés (El Conquistador Anonymo 1941) states: '(they) worship figures showing different forms of pleasure between a man and a woman and figures of human beings with their legs lifted different ways ... the men are great sodomites, cowards, and - bored drinking wine with their mouths - lie down and, extending their legs, have the wine poured into their anus through a tube until the body is full'. A similar description is found in yet another anonymous early record

(Relación Anonima Segunda 1963). The 'wine' in these reports most likely refers to pulque (Von Winning 1972; Furst and Coe 1977). Some caution in accepting the term at face value may be in order, however, since the Spaniards lacked experience with and a vocabulary for hallucinogenic drinks (Wasson 1980).

There is circumstantial evidence that other Middle American peoples besides the Huastecs may have known of ritual alcoholic clysters. Firstly, the worshipped human figures with lifted legs, mentioned by El Conquistador Anonymo (1941), are reminiscent of certain rather poly-interpretible pre-Hispanic clay figurines from the central Veracruz region in Mexico. Evidence of a relationship between these so-called 'bed figures' and the alcoholic beverage pulque has been reviewed by Von Winning (1972). A definite explanation for their peculiar raised leg position cannot be offered, but perhaps it is concomitant with the Huastec way of taking intoxicating enemas (Von Winning 1972; Furst and Coe 1977). Secondly, there is evidence from scenes on classic Maya pottery that the ancient Maya may have taken alcoholic clysters (vide 1.4.2).

1.1.1.2. Chemistry and psychopharmacology

Early Mesoamerican alcoholic drinks were prepared from Agave sap or other sources by fermentation, and only contained about 3-6% of ethyl alcohol (Erosa Barbachano 1976). According to Hegnauer (1963, pers. commun. 1985), Agave species are rich in saponins, and such constituents may well have entered into the pulque drink, as this beverage was not prepared by distillation.

Ethyl alcohol is a reversible general central nervous system (CNS) depressant, and its acute ingestion can lead to an inebriation characterized by stupor (Ritchie 1980; Eckardt et al. 1981). Hallucinations may be expected only after chronic administration, in particular, as signs of a withdrawal syndrome (Thompson 1978). They occur usually after a prolonged drinking bout (Eckardt et al 1981) but are sometimes experienced while the alcoholic is severely intoxicated (Jaffe 1980). Isbell et al. (1955) studied withdrawal symptoms in well-nourished, healthy volunteers, who were given different amounts of 95% alcohol: sudden abstinence induced hallucinations in most of the subjects who had been drinking 383-489 ml for 48-87 days but in none of the subjects who had been taking 266-346 ml daily for 7-34 days.

Taken orally, alcohol can be readily absorbed from the gastrointestinal tract. Since most absorption occurs in the small intestine, the absorption rate depends on the rate of gastric emptying, which in its turn is determined by factors like the

properties of the beverage and the presence of food in the stomach (Wilkinson et al. 1977; Ritchie 1980; Eckardt et al. 1981).

Alcohol is known to affect the actions of many other drugs. Direct interactions occur at the pharmacodynamic level, e.g. when alcohol enhances the deleterious effects on performance and skills of another CNS depressant. Indirect interactions involve the pharmacokinetic level, e.g. when alcohol increases the absorption rate of a drug by enhancing its gastric solubility or the gastrointestinal blood flow (D'Arcy and Merkus 1981). As to classical New World hallucinogens, the medical literature contains some undetailed claims that the drinking of alcohol potentiates the action of tree Daturas (Anonymous 1976a) and of Psilocybe mushrooms (Benjamin 1979; Young et al. 1982). Well-documented clinical studies on this subject do not seem to be available. It has been shown only that atropine taken together with alcohol can impair attention more strongly than either substance alone (Linnoila 1973) and that pretreatment with atropine may cause a reduction in alcohol absorption, presumably because this anticholinergic inhibits the rate of gastric emptying (Gibbons and Lant 1975).

1.1.2. Anadenanthera species

Leguminosae

Anadenanthera colubrina (Vell.) Brenan

var. cebil (Griseb.) Altschul

Anadenanthera peregrina (L.) Speg.

var. falcata (Benth.) Altschul

1.1.2.1. Ethnobotany

Many South American Indians valued a snuff, known as paricá, as a ritual intoxicant (Wassén and Holmstedt 1963; Wassén 1965, 1967; von Reis Altschul 1972). Several tribes of the Amazon Basin made small rubber syringes which were used occasionally to blow paricá into the nostrils (Métraux 1949), but most often to administer clysters prepared with the same intoxicant (Horwitz 1921; Nordenskiöld 1930; von Reis Altschul 1972). Unfortunately the ethnological literature on these practices is often vague, generalizing and repetitious.

The Caripuna Indians of the Brazilian Madeira River are said to have provoked a state of trance by taking paricá in the form of an enema (Horwitz 1921; Métraux 1948a; von Reis Altschul 1972; Wassén 1972a). These statements can be traced back to the

Austrian zoologist Johann Natterer, who undertook several travels in the inlands of Brazil in the first half of the 19th century. He collected numerous ethnographical objects, which are now in the Museum for Ethnology in Vienna. His travelling diaries were destroyed by fire before they could be published, but fortunately there is still a museum inventory of his ethnographical collection, written under his supervision (Kann 1981, pers. commun. 1984).

Number 1050 of the inventory list refers to a small rubber syringe provided with a bird-bone tube: 'Kleine Spritze, besteht aus einem länglichen Ballen aus Gummi elasticum, in welchem ein kleiner Vogelknochen als Rohr steckt, womit die Caripuna berauschende Parica-Klystiere nehmen. Parica heissen die flachen Samenkörner des Angicobaumes, welche zerstoßen und mit der Asche des Imbauvabaumes gemischt, dann mit Wasser angemacht werden. Die Murás, Mauhés, Porupurus und Catauixis nehmen auch solche Klystiere. Man heisst dies tomar paricá'.

Number 1369 of the list is even more interesting, as it describes a large sample of well preserved paricá seeds, collected from the Brazilian Maué tribe: 'Samenkörner des Paricábaumes (in Matogrosso Angico genannt). Diese Körner werden zerstoßen (zerrieben) und mit der Asche des Imbauvabaumes gemischt und dann zum Schnupfen und zu berauschende Klystieren gebraucht. Wird namentlich bei den Mauhés, Muras, Caripunas und andere Nationen gebraucht'.

The rectal use of paricá seeds among the Mura Indians is mentioned not only by Natterer, but also by other early travellers. For this once much feared tribe of the Madeira River, the use of paricá, both as a snuff and as an enema, must have been of outstanding importance (Martius 1867; Nimuendajú 1948b; Wassén and Holmstedt 1963; von Reis Altschul 1972). The initiation ceremony of the Mura started with a general mutual flagellation which was followed by the nasal and rectal application of paricá (Marcoy 1867; Barbosa Rodrigues 1875). Barbosa Rodrigues (1875) states that 'All those who have been flagellated take parica either as snuff or dissolved in water as a clyster... Taken either way, the effect is terrible and so violent that many die of suffocation or fall unconscious, while still others, resisting, continue the dance... Usually, the clyster causes a violent intoxication'. Marcoy (1867) reports that on such occasions the rectal use of paricá was preceded by the snuffing of paricá and the drinking of palm wine in copious quantities. According to Spix and Martius (1831) the Mura clyster had a similar but not so strongly intoxicating effect as the snuff.

Likewise, the Catawishi or Catauxi Indians of the Purús River took a paricá decoction rectally (Horwitz 1921; Cooper 1949; Kennedy 1982). According to Spruce (1864, 1908), paricá was taken as a snuff to speedily induce a sort of intoxication, but 'taken in injection, it is a purge, more or less violent according to the dose'. This statement clearly opposes the general view that such enemas were intoxicating. Spruce adds that before the hunt the Catawishi administered the paricá clyster not only to themselves but also to their hunting dogs for a clearer vision and greater alertness.

The Casharari or Cacharary Indians, an Arawakan tribe of the western Amazon Basin, are reputed to have known paricá clysters (Métraux 1948b, 1949). Drawing from a Portuguese source on these Indians (Máso 1919), Nordenskiöld (1930) describes the effects of the paricá enema as follows: 'After about five minutes it acts in about the same way as intoxication from opium, inducing lovely and blissful dreams. Twenty minutes later the dreamer is fully normal again, and does not appear to suffer from any after-discomfort as is the case after snuffing paricá'.

To the north of the Casharari lived the Omagua or Umaua Indians and further west the Cocama Indians. These Tupian tribes are said to have used powdered curupa leaves which were blown into the nose or administered as a clyster with the help of small rubber syringes (Métraux 1948c). Usually only the Omagua are implicated as curupa users (Veigl 1785; Marcoy 1867; Martius 1867) and there seems to be some doubt about the curupa use among the Cocama (Wassén 1967). According to De La Condamine (1778), the Omagua employed enema syringes especially at feasts, when an obliging host distributed them to all his guests.

Other South American tribes claimed to have taken paricá clysters, are the Maina Indians (Métraux 1949), known merely to have made rubber syringes (Chantre y Herrera 1901; Nordenskiöld 1930), the Poruporo Indians (Natterer, vide supra; Horwitz 1921) and the Pasé, Juri and Uainuma Indians (Métraux 1948c).

The vagueness of the ethnological literature on paricá enemas is especially evident from the absence, or insufficient reliability, of botanical data. Sometimes the source is not identified at all (Horwitz 1921; Métraux 1948b,c; Natterer, vide supra) and sometimes the source is said to be Piptadenia (Métraux 1948a, 1949) or more specifically Piptadenia seeds (Nordenskiöld 1930). The paricá seeds which the Mura used for their clysters (Martius 1867; Barbosa Rodrigues 1875; Nimuendajú 1948b) as well as the curupa leaves from which the Omagua prepared their enemas (Marcoy 1867; Martius 1867; Lowie 1948; Métraux 1948c) have been attributed to a plant named Mimosa acacioides or Acacia niopo.

This leguminous tree has also been known under the binomial Piptadenia peregrina, and is now considered to belong to the genus Anadenanthera which comprises the two species A.peregrina and A.colubrina (von Reis Altschul 1964).

The botanical identifications of paricá clysters correspond well with the once common view that paricá snuffs were generally prepared from seeds of a Piptadenia species, especially P.peregrina (Roth 1924; Lowie 1948; Cooper 1949; Wassén and Holmstedt 1963; Schultes 1967b). Cooper (1949) has rightly cautioned, however, that some of these attributions may not be correct, as exact botanical evidence is lacking in some cases. It has now become clear that the vernacular term paricá is not used exclusively for the genus Anadenanthera, as it also refers to Virola preparations (Schultes 1954; Seitz 1967) and to snuffs containing harmine (Holmstedt and Lindgren 1967). Furthermore, it is uncertain that Anadenanthera peregrina is the species used throughout the Amazon. Schultes (1972a) who speaks of a widespread rectal administration of Anadenanthera in South America, points out in a personal communication (1981) that 'Other species may be used, such as A.colubrina. I believe that A.peregrina is a species primarily of the Orinoco and adjacent parts of the northern Amazonia of Brazil. Whether the species used in the Peruvian Amazon or the central Amazon of Brazil are A.peregrina is questionable. The reason is that snuffs, etc. have not been accompanied by voucher herbarium specimens'. In other words, the geographical distribution of Anadenanthera peregrina is now assumed to be far more limited than was previously believed (von Reis Altschul 1964, 1972; Schultes 1967b). It is quite likely that the Maué and other tribes of the Madeira area prepared enemas and snuffs from A.peregrina. The tree occurs in this region (Schultes 1967b; von Reis Altschul 1972), and the paricá seeds collected by Natterer from the Maué Indians are apparently Anadenanthera seeds (vide 1.3). On the other hand, the tree is unknown anywhere near the area of the Omagua and Cocama, so its use by these tribes of Amazonian Peru is open to serious question (von Reis Altschul 1972; Schultes and Hofmann 1980b). Similarly, there is no good botanical evidence that the Catawishi, Casharari, Pasé, Juri or Uainuma Indians knew A.peregrina (von Reis Altschul 1972).

It should be noted that there are two varieties of Anadenanthera peregrina: the variety peregrina occurs in northern parts of South America and in the West Indies; the variety falcata in southern Brazil and Paraguay (von Reis Altschul 1964).

It is sometimes claimed that the Incas, well-known inhabitants of ancient Peru, intoxicated themselves with rectal infusions of

wilka or huilca seeds (Furst 1976a; Furst and Coe 1977). The early chronicler Poma de Ayala (1969) indeed refers to such enemas and another early writer states that Inca witch doctors foretold the future by speaking with the devil, for which they intoxicated themselves with vilca, pouring its juice into the alcoholic beverage chicha or taking it another way (von Reis Altschul 1967, 1972). Most early records, however, including the original report on the vilca clyster, emphasize the laxative properties of vilca seeds (von Reis Altschul 1967) and it is not sufficiently clear whether the seeds helped to produce visions or were taken only for their purgative qualities (Rowe 1946). Poma de Ayala (1969) says that the Incas purged themselves once a month with bilca tauri, half of which was drunk and half of which was taken 'por debajo' to give strength, health and a 200 years life span. Larrain Barros (undated) suggests that the phrase 'por debajo' implies nasal administration, but it is far more likely to indicate the rectal route, not in the least since various forms of the word vilca meant enema, syringe or the giving of an enema (von Reis Altschul 1967, 1972; Wassén 1972b). The botanical source of the vilca clyster is usually thought to be Anadenanthera (Larrain Barros, undated), in particular A.colubrina (Rowe 1946; Furst and Coe 1977). It should be noted that the evidence for this attribution is circumstantial rather than conclusive (von Reis Altschul 1967; Schultes and Hofmann 1980a,b) and that A.colubrina occurs in eastern Brazil, whereas the variety A.colubrina var. cebil is known in Peru (von Reis Altschul 1964).

1.1.2.2. Chemistry and psychopharmacology

Seeds of Anadenanthera peregrina (Piptadenia peregrina) were found to contain one or more of the following indole alkaloids: N,N-dimethyltryptamine (=DMT); its corresponding N-oxide (=DMT-N-oxide); 5-hydroxy-N,N-dimethyltryptamine or bufotenin (=5-OH-DMT); its corresponding N-oxide (=5-OH-DMT-N-oxide); 5-methoxy-N,N-dimethyltryptamine (=5-MeO-DMT) (Holmstedt and Lindgren 1967; Schultes et al. 1977). The question arises of whether the N-oxides might be artifacts, as Saxton (1965) points out that DMT may be oxidized on exposure to air. During storage, DMT and 5-MeO-DMT may transform into 5-OH-DMT (Schultes et al. 1977). A Venezuelan sample was reported as containing as much as 7.4% of 5-OH-DMT (Chagnon et al. 1971). According to Schultes (pers. commun. 1982), this report is not based on identified herbarium voucher specimens. In other samples 5-OH-DMT was present in amounts up to 3.5% (Schultes et al. 1977). DMT, 5-OH-DMT,

DMT-N-oxide and 5-OH-DMT-N-oxide were reported to be present in seeds of Piptadenia macrocarpa (Fish et al. 1955; Iacobucci and Rúveda 1964), now considered to be Anadenanthera colubrina var. cebil (von Reis Altschul 1964). From seeds of Anadenanthera colubrina (Piptadenia colubrina), 5-OH-DMT has been isolated (Holmstedt and Lindgren 1967).

The paricá seeds of the Brazilian Maué Indians, reportedly used as an enema source (vide 1.1.2.1), have recently been submitted to gaschromatographical/ mass-spectrometric analysis. Despite their considerable age, the seeds still yielded as much as 15 mg/g of bufotenin, which corroborates their botanical identification as Anadenanthera seeds (vide 1.3).

DMT is a well-established hallucinogen, which elicits a brief but profound LSD-like response when given in intramuscular doses ranging from 0.7 to 1.1 mg/kg, i.e. 49-77 mg/70 kg (Szára 1956; Rosenberg et al. 1963; Kaplan et al. 1974). Intramuscular administration of 0.25 mg/kg (17.5 mg/70 kg) has similar effects in certain tests measuring psychoticism as the Cannabis constituent Δ^9 -tetrahydrocannabinol (Bickel et al. 1977). In schizophrenics, intramuscular doses of 25-50 mg can induce psychological changes (Turner and Merlis 1959), such as exacerbation of the psychosis (Gillin and Wyatt 1977).

Human experiments with 5-MeO-DMT seem to have been conducted only by Shulgin (1970), who reported briefly that a parenteral dose of 5-10 mg is active. In 1981, the following details were revealed in a letter to me: 'My clinical studies involved a total of 9 subjects, 4 males and 5 females, within the age range of 33 to 65 years. All were healthy volunteers, all with considerable experience with drugs that can alter one's state of consciousness. The parenteral route of administration was in all cases by inhalation of the fused free base suspended on Tanacetum vulgare in cigarette form. The onset of action occurs in less than 60 seconds, reaches a plateau in the 2nd to 3rd minute, and is largely dissipated at 20 minutes, although there may be some lingering awareness for the remainder of an hour. Centrally, there is the loss of some reality sense, some eyes-closed imagery and a general feeling of being enclosed and isolated in a sensory sense. Peripherally, there have been occasional tremors noted, and occasional mydriasis. These effects are from 6 to 10 mg of the free base. I have personally conducted no oral experiments and do not know its effects via this route'.

5-OH-DMT is mostly found to act briefly, altering the perception of colours and sometimes of space, when given in intramuscular doses of 10-15 mg (Isbell, quoted by Turner and Merlis 1959 and by Wassén and Holmstedt 1963) and in

intravenous doses of 4-16 mg (Fabing and Hawkins 1956) or 12-16 mg (Bonhour et al. 1967). In schizophrenics, intravenous quantities of up to 20 mg, given by bolus injection (e.g. 10 mg within 1 min) or by infusion (e.g. 20 mg in 77 min), produced neither visual disturbances nor the psychological changes seen after DMT administration (Turner and Merlis 1959). Many secondary sources doubt the hallucinogenic capacity of 5-OH-DMT following peripheral administration and then point to its poor lipid solubility at physiological pH and its consequent inability to enter the central nervous system readily (Holmstedt and Lindgren 1967; Luchins et al. 1978; Glennon et al. 1979). Experiments with laboratory animals have demonstrated that, in contrast with the lipid soluble DMT (Cohen and Vogel 1972) and 5-MeO-DMT (Sanders and Bush 1967), 5-OH-DMT does not cross the blood-brain barrier in appreciable amounts (Sanders and Bush 1967; Luchins et al. 1978; Glennon et al. 1979). This suggests that the reported effects of 5-OH-DMT may well be somatic symptoms of intoxication rather than signs of true hallucinogenic activity. According to Isbell (1967), it is difficult to say whether 5-OH-DMT is a hallucinogen or not because of its powerful and dangerous cardiovascular effects. For this reason, it is not possible to push the dose in man and it would be difficult to differentiate whether psychotic reactions were due to central effects or to cardiovascular actions.

Oral experiments with Anadenanthera alkaloids have failed to demonstrate hallucinogen-like effects, although the tested amounts were much higher than parenterally active doses. DMT was ineffective in a normal subject who took this compound in quantities of up to 150 mg (Szára 1957), as well as in schizophrenics who received single doses of up to 350 mg (Turner and Merlis 1959). 5-OH-DMT was without effect when ingested by a healthy individual in doses of up to 50 mg (Hofmann 1963) or in doses of up to 100 mg totally (Isbell, quoted by Wassén and Holmstedt 1963). This inefficacy of oral dosing is likely to be due principally to extensive first-pass metabolism. The physicochemical properties of Anadenanthera alkaloids, in particular those of DMT and 5-MeO-DMT (Glennon et al. 1979), exclude a defective absorption. Chemical evidence for inactivation by gastric juices has not been found. DMT and 5-OH-DMT are almost completely metabolized in man when given parenterally; the urinary recovery of unchanged drug was 1-6% of an injected dose of 5-OH-DMT (Sanders-Bush et al. 1976) and as low as about 0.07% in the case of DMT (Kaplan et al. 1974). The structurally related neurotransmitter 5-hydroxytryptamine (5-HT) is promptly degraded by intestinal and hepatic monoamine oxidase

(MAO) when taken orally (Douglas 1980). Although Anadenanthera alkaloids have a dimethylated amino-group, there is experimental evidence that they are inactivated in a similar way. MAO-inhibition prolongs the half-life of DMT in rats (Wang Lu and Domino 1976). Other animal experiments have shown that 5-MeO-DMT is deaminated by MAO and, just as with 5-HT, preferentially by MAO-A (Squires 1975). In a human subject, MAO-inhibition was found to double the urinary excretion of endogenous DMT (Oon et al. 1977). Not only MAO, however, but also hepatic microsomal enzymes may be capable of oxidating the dimethylated amino-group of Anadenanthera alkaloids (Fish et al. 1955). The deamination of 5-HT leads mainly to 5-hydroxyindole acetic acid, which is the principal urinary metabolite (Douglas 1980). Intravenously given 5-OH-DMT was found to be excreted for 68-74% in the form of 5-hydroxyindole acetic acid (Sanders-Bush et al. 1976); whereas in an early study on DMT the urinary excretion of indoleacetic acid, free and in alkali-labile form, accounted for only one-third of the intramuscular dose (Szára, 1956). This implies that deamination is a major metabolic pathway for these compounds, but not the only one, especially not in the case of DMT. This alkaloid was reported to be 6-hydroxylated to the extent of about 5-20% of the administered dose (Gillin and Wyatt 1977).

The N-oxides of DMT and 5-OH-DMT have not been studied extensively by pharmacologists. They are said to have much less cardiovascular activity in the dog and the cat than the bases themselves (Fish and Horning 1956).

1.1.3. Banisteriopsis species Malpighiaceae

1.1.3.1. Ethnobotany

The genus Banisteriopsis which comprises many species of tropical vines, is a major ingredient of certain intoxicating drinks taken in South American rituals (Cooper 1949; Friedberg 1965; Rivier and Lindgren 1972; Schultes 1982). Some recent sources (Furst 1976a; Emboden 1979a) claim that Banisteriopsis may have been taken as a clyster, but fail to provide an original report on such practices. The comprehensive monograph by Friedberg (1965) on the ritual use of Banisteriopsis does not even hint at enemas prepared from this genus. Despite the apparent lack of substantial ethnobotanical data on such dosage forms, the chemistry and pharmacology of Banisteriopsis preparations are discussed here.

1.1.3.2. Chemistry and psychopharmacology

The principal alkaloids in Banisteriopsis species used by natives are beta-carbolines, in particular harmine, harmaline and (+)-1,2,3,4-tetrahydroharmine (Deulofeu 1967; Allen and Holmstedt 1980). The well-studied species B.caapi was found to contain 0.11–0.83% of alkaloids in the stem, 0.14–0.37% in the branches, 0.28–0.70% in the leaves and 0.64–1.95% in the root. These total alkaloid percentages consisted primarily of harmine (40–96%) and, to a lesser extent, of tetrahydroharmine (1–44%) and harmaline (0–17%). Small amounts of harmol, 6-methoxytryptamine and an unidentified compound were sometimes also present (Rivier and Lindgren 1972). More recent analytical work on the same species has revealed that other beta-carbolines may be present as minor components: harmine-N-oxide, harmic acid methyl ester, harmalinic acid, harmic amide, acetyl norharmine, ketotetrahydronorharmine and harmalol (Hashimoto and Kawanishi 1975, 1976; McKenna et al. 1984a). In addition, the pyrrolidine bases shihunine and S-(+)-dihydroshihunine have been shown to occur in Banisteriopsis caapi (Kawanishi et al. 1982).

In a study by Pennes and Hoch (1957), harmine was hallucinogenic at an intravenous threshold dose of 150–200 mg in mental patients, which elicited visual hallucinations in 5 out of 11 patients. Some other effects of these intravenous doses were also produced by oral quantities higher than 300–400 mg, but it is doubtful that indisputable visual hallucinations occurred with oral quantities of up to 960 mg. Naranjo (1967) found harmaline (as the HCl salt) to be hallucinogenic in volunteers at dosage levels above 1 mg/kg intravenously (70 mg/70 kg), or 4 mg/kg orally (280 mg/70 kg). In the same study, racemic tetrahydroharmine elicited subjective effects similar to those of 100 mg of harmaline, when given to a single volunteer by mouth in quantities of up to 300 mg. Vargas (1959) states that harmine, LSD and mescaline produce essentially similar reactions in both normal and psychotic patients, but the volunteers of Naranjo (1967) clearly distinguished the experience with harmaline from an intoxication with mescaline.

It has not been unequivocally established why the psychoactivity of major Banisteriopsis constituents is largely route-dependent. Extensive hepatic first-pass metabolism certainly cannot be discarded as an unlikely cause. In rodents, harmine and harmaline are extensively O-demethylated by hepatic microsomal enzymes (Ho et al. 1971; Burke and Tweedie 1979).

It is doubtful that indigenous Banisteriopsis drinks, known as

ayahuasca, may generally contain mind-altering concentrations of harmine and other major Banisteriopsis alkaloids. Chemical analysis of such drinks from the upper Purús region revealed that an average native dose of 200 ml contained only 6-38 mg of harmine, 1-46 mg of tetrahydroharmine, 0-5 mg of harmaline, 0-20 mg of an unidentified Banisteriopsis constituent and, due to an admixture of Psychotria leaves, 0-32 mg of DMT (Rivier and Lindgren 1972). More recently, McKenna et al. (1984a) found substantially higher alkaloid levels in Peruvian ayahuasca beverages prepared from Banisteriopsis caapi cultivars and Psychotria species. Based on an average of five samples, 100 ml of ayahuasca contained 467 mg of harmine, 160 mg of tetrahydroharmine, 41 mg of harmaline, and, due to the Psychotria admixture, 60 mg of DMT. The intramuscular threshold dose of DMT for producing subjective perception changes is only 30 mg (Szára 1957), so the implication of these analytical results is obvious: DMT can be present in ayahuasca beverages in parenterally active amounts.

This finding is quite interesting, since the beta-carbolines in Banisteriopsis are known as potent reversible MAO-inhibitors (Udenfriend et al. 1958; Pletscher et al. 1959; McIsaac and Estevez 1966; Buckholtz and Boggan 1977; McKenna et al. 1984a). In particular as selective inhibitors of MAO-A (Fowler et al. 1978; Fuller et al. 1981). Since there is evidence that oral tryptamines undergo first-pass inactivation by MAO, especially by MAO-A (vide 1.1.2.2), not surprisingly it is often suggested that the beta-carbolines enhance the effects of DMT (Holmstedt and Lindgren 1967; Furst 1976a; Emboden 1979a; Schultes and Hofmann 1980b; McKenna et al. 1984a). Decisive in vivo experiments have not yet been reported in the literature, but McKenna et al. (1984a) offer in vitro evidence to support this suggestion. It should be noted, however, that inhibition of degradation is not the only reported mechanism of interaction between MAO-inhibitors and DMT. In the sixties, the response to DMT (Sai-Halász 1963), as well as that to LSD (Resnick et al. 1967), was found to be diminished by pretreatment with a non-selective irreversible MAO-inhibitor, and this phenomenon was attributed to elevation of central 5-HT levels by the MAO-inhibitor.

The pharmacokinetics of an ayahuasca beverage with harmine and tetrahydroharmine as its main constituents have been assessed in two volunteers (Rivier and Holmstedt 1982). After a dose of 200 ml, plasma levels were determined to be in the range of 0.01 µg harmine and 0.04 µg tetrahydroharmine per ml by a gas chromatographical/mass spectrometric method. Unfortunately, quantitative data on the composition of the tested drink are no

longer available (Rivier, pers. commun. 1982, 1984).

1.1.4. Brugmansia species

Solanaceae

Brugmansia arborea (L.) Lagerh.

Brugmansia suaveolens (H. and B. ex Willd.) Bercht. and Presl.

1.1.4.1. Ethnobotany

Many South American tribes, especially in western South America, ingested preparations from tree Daturas in a ritual context (Safford 1922; Cooper 1949; Lockwood 1979; Plowman 1981a). Among the Jivaro, headhunters of eastern Ecuador and Peru, the rectal route of administration was employed as well (Wassén 1972b; Emboden 1979a). It is said that a decoction of a tree Datura was drunk or taken as an enema through a straw by Jivaro warriors desiring to gain power and foretell the future (Steward and Métraux 1948). Karsten (1935) tells that a Datura preparation called maikoa was given during the initiation ceremony in the form of a clyster, if the novice could not continue drinking this intoxicating liquid: 'The oldest men of the family or tribe arrange themselves in two parallel rows facing each other. Each man holds a pininga containing a small quantity of maikoa. The novice must now go from the one to the other in due order and take a sip from each pininga, starting with the oldest member of the family. Generally it is easy for him to do this with the first ones, but frequently it is impossible for him to drink from the clay vessels of the last men in the rows. Their contents are then given him in the form of a clyster... It is considered absolutely necessary, it should be understood, that the novice should receive something from the clay vessel of each man'.

Tree Daturas, all of which are native to South America, have usually been regarded as the Brugmansia section of the genus Datura, but on morphological and biological grounds this section is now treated as a separate genus (Lockwood 1979). There is usually no danger of confusing Brugmansia with any other hallucinogen, but when the older literature offers an identification of the plant used, the statement is not usually supported by a voucher specimen (Schultes and Hofmann 1980b). According to Karsten (1935), the maikoa drink was simply prepared by squeezing the juice from the bark of Datura arborea. There has been a tendency in the past, however, to apply this binomial to any white-flowered tree Datura (Bristol et al. 1969), so it is

uncertain how frequently the plant actually did represent Brugmansia arborea. Other authors have attributed maikoa preparations to Datura candida (Emboden 1979a) and to Brugmansia suaveolens (Lockwood 1979).

1.1.4.2. Chemistry and psychopharmacology

As far as is known, all Brugmansia species and hybrids contain tropane alkaloids (Hegnauer 1973; Schultes and Hofmann 1980b), so there seems to be no serious uncertainty about the active principles, even though information on the species utilized is often inconclusive. In most cases, scopolamine, also called hyoscyine, has been isolated as the predominant alkaloid (Evans et al. 1965; Shah and Saoji 1966; Bristol et al. 1969; Leary 1970). Aerial parts of white-flowered Brugmansia trees, referred to as Datura arborea from India (Shah and Saoji 1966) and as Datura candida and its Sibundoy cultivars from Colombia (Bristol et al. 1969), contained about 0.1–0.3% of scopolamine, whereas up to about 1% of this alkaloid could be found in the red-flowered Brugmansia sanguinea (Evans et al. 1965). The structurally related atropine and/or its laevo-isomer hyoscyamine may also be present (Evans et al. 1965; Shah and Saoji 1966; Bristol et al. 1969; Leary 1970). It should be noted that the distinction between these two compounds can be affected by racemisation upon extraction (List and Hörhammer 1972) and by inseparability on a paper chromatogram (Evans et al. 1965; Shah and Saoji 1966; Bristol et al. 1969). Various other minor Brugmansia alkaloids have been isolated, including aposcopolamine, norscopolamine, norhyoscyamine, noratropine, pseudotropine, tropine, oscine and meteloidine (Bristol et al. 1969; Leary 1970).

The central toxicity of the tree Daturas (Anonymous 1976a; Belton and Gibbons 1979) and their pure alkaloids (Longo 1966; Shader and Greenblatt 1971) is commonly known. As the following discussion focuses on scopolamine and atropine, it should be noted that hyoscyamine is the pharmacologically active laevo-isomer of the racemic atropine, of which the dextro-isomer is practically inactive (Shader and Greenblatt 1971; Reynolds 1982).

Ketchum et al. (1973) have demonstrated that parenteral scopolamine and atropine produce a virtually identical syndrome of delirium, when allowances are made for differences in time of action and potency. The delirium lasts for 6–8 h with scopolamine and for 10–12 h with atropine. The intramuscular dose of atropine necessary to produce hallucinations in half the subjects was estimated to be about 0.15–0.17 mg/kg (about 11 mg/70 kg). Intramuscular scopolamine was found to be 7.5, 8 and 11 times as

potent in this respect, dependent on the test employed (mean 8.8 times; about 1.3 mg/70 kg). In a cross-over study by Mirakhur (1978) on peripheral activity of tropane alkaloids, the ratio of equivalent intramuscular to oral doses of atropine appeared to be 1:2 and that of scopolamine about 1:5-6. If these ratios also apply to central activity, the difference in central potency of both alkaloids would be reduced from 8.8 times parenterally to 3.2 times orally. Unfortunately, a cross-over study comparing central effects after ingestion and injection does not seem to be available. It is known only that oral doses of up to 10 mg of atropine sulphate or of up to 3 mg of scopolamine HBr do not induce delirium, whereas 4.5 mg of scopolamine HBr orally causes illusions and hallucinations in half the subjects (Ostfeld et al. 1959; Ostfeld et al. 1960). It may well be that scopolamine and atropine undergo substantial first-pass metabolism, which would explain why the activity of these alkaloids is route-dependent. Neither their physicochemical properties (Windholz 1983) nor the rapid appearance of peak plasma levels after oral administration (Beermann et al. 1971; Chandrasekaran et al. 1978) are suggestive of a faulty absorption. Furthermore, the observed activity ratios correspond rather well with reported urinary recoveries of non-metabolized drug, viz. 30-50% and 70-95%, respectively, for oral and intravenous atropine (Beermann et al. 1971), in contrast with only 4-5% and about 10% for oral and parenteral scopolamine, respectively (Chandrasekaran et al. 1978).

Naturally occurring tropane alkaloids have been found to produce delirium with various ways of administration (Shader and Greenblatt 1971), including tracheal inhalation (Bergman et al. 1980) and tropical application into the eye (Freund and Marin 1970) or on the skin behind the ear (Osterholm and Camoriano 1982). Furthermore, scopolamine (Tonndorf et al. 1953) and atropine (Hyde et al. 1953) have been shown to produce systemic effects when taken nasally.

1.1.5. Capsicum species

Solanaceae

1.1.5.1. Ethnobotany

Roth (1924) has included Capsicum in a review on narcotics and stimulants of the Guiana Indians, because the Makusi of the Rupununi used peppers as a stimulant and excitant. Although Spix and Martius (1828) once experienced a narcotic-like action of pepper (vide 3.4), it is not possible to draw any ethnobotanical

conclusion without further field observations (Schultes 1967a). Roth (1924) also points out that, 'in the Pomeroun district it is a very common practice for the Indian women to give capsicum enemata to themselves and children'. Unfortunately, he fails to indicate whether the intended effect of the Capsicum clyster was stimulation or purgation (Heizer 1944). The latter possibility is strongly supported, of course, by the irritating properties of Capsicum. According to an informant, who may or may not have been joking, the Makusi of the Roraima area use Capsicum to discipline children by anal insertion of the fruit as severe punishment (Gorinsky, pers. commun. 1982). The Jivaro of western South America employed Capsicum clysters for medicinal purposes. For instance, to try to cure patients from the consequences of a snake-bite (Karsten 1935). Among the Shuar-Jivaro, the whole Capsicum fruit is inserted rectally to distract from the pain of the snake-bite and also the broken fruit is rubbed on the wound itself (Van Asdall, pers. commun. 1982).

1.1.5.2. Chemistry and psychopharmacology

The fruits of most Capsicum forms, at least those used in official western medicine, contain the pungent principle capsaicin (Hegnauer 1973; Reynolds 1982), so native preparations are much more likely to have strongly irritating properties than any central effect. Since capsaicin selectively stimulates and then blocks the chemosensitive unmyelinated sensory afferents from the skin and mucous membranes, the initial irritation may be followed by local anaesthesia (Anonymous 1983a).

Perhaps it should be noted that solanine and solanidine have been reported as occurring in Capsicum annuum (Wojciechowska and Dombrowicz 1966) and that solanines are central intoxicants when taken in substantial quantities (Anonymous 1979). Hegnauer (pers. commun. 1983) questions, however, whether Solanum alkaloids are indeed present in the genus Capsicum.

1.1.6. Datura species

Solanaceae

Datura ceratocaula Ort.

Datura innoxia Mill.

Datura stramonium L.

1.1.6.1. Ethnobotany

Herbaceous Datura species have been widely employed by the

aboriginal inhabitants of North and Middle America (Safford 1922; Díaz 1979; Schultes and Hofmann 1980a,b). The ethnological record of their rectal administration is less impressive than the data on Brugmansia enemas (vide 1.1.4.1). In the initiatory ritual of the Algonquin Indians, a tribe of the eastern United States, the youths were kept intoxicated for 18 or 20 days by means of wysoccan liquid (Beverly 1705). The chief ingredient is believed to have been the root of Datura stramonium (Safford 1922; Schultes and Hofmann 1980b). Emboden (1979a) points out that such a prolonged state of intoxication would more easily be maintained through enemas than through oral fluids.

The ancient Aztecs of Mexico have been recorded as taking Datura rectally, but only for medicinal purposes. An authoritative early account on Aztec medicinal plants states that tlapatl leaves were applied in the form of suppositories to relieve fever (Hernández 1959). Tlapatl has been identified as D.stramonium (Safford 1922), but it referred more probably to D.innoxia (Schultes, pers. commun. 1982) or D.ceratocaula (Díaz 1979).

1.1.6.2. Chemistry and psychopharmacology

All herbaceous Datura species contain a mixture of tropane alkaloids, and the principal alkaloids in the leaves are mostly scopolamine and/or hyoscyamine (Hegnauer 1973; List and Hörhammer 1973; Schultes and Hofmann 1980b).

The deliriant activity and pharmacokinetic behaviour of tropane alkaloids are discussed in section 1.1.4.2.

1.1.7. Ilex guayusa

Aquifoliaceae

Ilex guayusa Loes.

1.1.7.1. Ethnobotany

Indians of the South American Montaña region, such as the Jivaro (Karsten 1935), are known to have valued Ilex guayusa as a ritual stimulant and emetic (Cooper 1949; Patiño 1968; Schultes 1972a). Bundles of I.guayusa leaves have been found together with small syringes in an archaeological Tiahuanacoid medicine-man's tomb in Highland Bolivia (Wassén 1972b). This has raised the question of whether guayusa might have been employed as a clyster (Schultes 1972a, 1981a; Furst 1976a). It should be added that the grave also contained Nicotiana fragments in a skin pouch

(Bondeson 1972; Bruhn et al. 1976) and that small syringes were sometimes also used for nasal application (Veigl 1785; Métraux 1949).

1.1.7.2. Chemistry and psychopharmacology

I.guayusa leaves from the grave in question were demonstrated to contain caffeine in amounts of 0.1–1%, whereas 1.8% of caffeine was present in a newly collected specimen (Holmstedt and Lindgren 1972). This well known alkaloid is a CNS stimulant (Stephenson 1977), which only rarely has been reported as eliciting a psychotic reaction, usually after prolonged use of excessive doses (Mc Manamy and Schube 1936; Shen and D'Souza 1979).

1.1.8. Lophophora williamsii

Cactaceae

Lophophora williamsii (Lem.) Coult.

1.1.8.1. Ethnobotany

The ritual use of peyote among North American and Mexican Indians has been documented extensively (Furst 1976a; La Barre 1975, 1981; Schultes and Hofmann 1980a,b). Peyote is mostly eaten in the form of so-called 'mescal-buttons', the dried tops of the cactus, which are usually taken into the mouth, softened with saliva and swallowed without mastication. They can also be soaked in water to yield an intoxicating fluid (Schultes and Hofmann 1980b). The Huichols of the Sierra Madre in western Mexico, renowned for their peyote pilgrimages (Furst 1976a), use peyote in a different way. They only leave one-third of the cactus, and use either the fresh ground form or the dried ground form, thereby masticating a lot (Negrín, pers. commun. 1983). The use of a peyote enema among the Huichols has been reported by the ethnographer Knab who was shown an enema syringe by an elderly female shaman in the community of Santa Catarina (Furst and Coe 1977). In a personal communication (1982) to me, Knab detailed the following: 'Old men and women use a mixture of either fresh ground peyote with its juice or dried peyote mixed with water. Among the Huichols an enema is applied through a short piece of deer bone tied to a bladder. The mixture is applied by filling the bladder, tying the bone to it and sitting on the bladder'. As it is unclear whether the enema will be easily retained this way, it is unfortunate that actual use has not been witnessed. At one

time, Furst (1976a) suggested that the practice probably has a deeper symbolic meaning, as the sacred cactus is equated with and identified as the deer by the Huichols. On reconsideration, he suspects the reported event to have been idiosyncratic and not something to be generalized to Huichol culture, as the practice would be atypical of known Huichol behaviour (Furst, pers. commun. 1982). This view is shared by Negrín (pers. commun. 1983) who seriously questions the truthfulness of the enema story, since the Huichols are very puritanical and would not give such delicate information to a visitor known for only a few weeks. Negrín adds that the Huichols like to reverse things (viz. rectal instead of oral administration) and like to tell scabrous jokes.

There are no indications that peyote has ever been taken rectally north of Mexico (Aberle, pers. commun. 1982; Stewart, pers. commun. 1982).

Peyote is a vernacular term applied to a number of plants (Bruhn and Bruhn 1973). For the Huichols, the common source of peyote is unquestionably Lophophora williamsii (Furst 1976a, 1981; Knab, pers. commun. 1982; Negrín, pers. commun. 1983).

1.1.8.2. Chemistry and psychopharmacology

Mescaline, the main alkaloid in Lophophora williamsii, may occur in peyote to the extent of 6%, but rarely exceeds 1% in the dried whole plant (Crosby and McLaughlin 1973; Kapadia and Favez 1970, 1973). A chemical study on fresh greenhouse-grown peyote revealed an average total alkaloid percentage of 0.4%, consisting mainly of mescaline (30%), pelletine (17%), anhalonidine (14%), hordenine (8%), anhalamine (8%), lophophorine (5%), anhalonine (3%), N-methylmescaline (3%), anhalidine (2%), 3-demethylmescaline (1-5%) and N,N-dimethyl-4-hydroxy-3-methoxyphenylethylamine (0.5-2%) (Lundström 1971). In total, more than 50 alkaloids have been isolated from peyote (Kapadia and Favez 1970, 1973), but Schultes (pers. commun. 1982) may be quite right in wondering how many of these constituents are artifacts.

Mescaline is not the only peyote constituent with pharmacological activity (List and Hörhammer 1976; Shulgin 1979). However, the peyote tetrahydroisoquinoline alkaloids pelletine, anhalonidine, lophophorine and anhalonine are not hallucinogenic in man, even at rather high oral doses (Shulgin 1973, 1979), and neither are the minor phenylethylamine components N-acetylmescaline (Charalampous et al. 1966), N-methylmescaline (Shulgin 1973) and 3,4-dimethoxyphenylethylamine (Shulgin et al. 1966). There does not seem to be clinical evidence for hallucinogenic activity of any minor peyote alkaloid in naturally occurring

quantities (Shulgin 1973, 1979). Studies on certain synthetic modifications of the structure of mescaline have been more rewarding in this respect (Shulgin et al. 1969; Nichols 1981). Consequently mescaline seems to be mainly responsible for the visual hallucinogenic properties of L.williamsii (Shulgin 1979; Schultes and Hofmann 1980b). This classical hallucinogen is usually ingested in quantities between 300 and 500 mg of the sulphate (Shulgin 1979). The average oral dose of mescaline needed for a medium response has been estimated at 3.75 mg/kg, i.e. about 260 mg/70 kg (Shulgin et al. 1969). Schultes and Hofmann (1980b) warn that there is an often overlooked difference between peyote intoxication and mescaline intoxication, but so far as I know, the influence of minor peyote alkaloids on the effects of mescaline still needs to be properly tested in a clinical setting.

Early experiments on the fate of mescaline in man have yielded divergent results (Patel 1968). In a later study, a maximum of radioactivity appeared in the plasma within 3 h of oral administration of ¹⁴C-mescaline to humans; 87% of the dose could be recovered from the urine during the first 24 h, mainly as unchanged mescaline (55-60%) and its inactive metabolite 3,4,5-trimethoxyphenylacetic acid (27-30%) (Charalampous et al. 1966). According to these results, mescaline taken orally is readily absorbed from the gastrointestinal tract without undergoing extensive first-pass metabolism.

1.1.9. Nicotiana species

Solanaceae

Nicotiana rustica L.

Nicotiana tabacum L.

1.1.9.1. Ethnobotany

Neither botanists nor pharmacologists consider tobacco to be a true hallucinogen, but it may be conceptually and functionally indistinguishable from hallucinogens in American Indian ritual practices (Wilbert 1972). The references to its use in indigenous rituals are numerous and there are ethnological reports on its induction of trance-like states analogous to those induced by hallucinogens (Castiglioni 1943; Spinden 1950; Wilbert 1972; Janiger and Dobkin de Rios 1976; Siegel et al. 1977; Robicsek 1978). Several recent secondary sources state that tobacco was taken rectally in the western hemisphere (Schultes 1981a), in particular on the South American continent (Schultes 1972a, 1984;

Furst 1976a; Furst and Coe 1977), but neither the purpose nor other details are clearly mentioned. The main ways in which South American Indians have used tobacco are smoking, snuffing, chewing, drinking, eating and licking (Stahl 1925; Cooper 1949; Wilbert 1975; Hartmann 1981). As to the rectal route, a pre-Hispanic Bolivian grave was found to contain both tobacco fragments and small syringes (vide 1.1.7.1), and early accounts on Surinam (Fermin 1775) and Brazil (Spix and Martius 1831) touch lightly on tobacco enemas. These data, however, can hardly be considered as substantial evidence for the non-medical rectal use of tobacco by South American natives. Neither Schultes (pers. commun. 1981) nor Wilbert (pers. commun. 1982) are aware of any detailed primary reference on this subject.

Decisive data are equally hard to find for Middle America. Several early sources describe the rectal administration of tobacco, but only as a medicinal cure. The 16th century physician Monardes (1574) includes the use of clysters among the various methods of applying tobacco as a medicine, and the *Relación de Texcoco* says that the Spaniards used the herb to clear malaria, 'taking it as a suppository because it purged them' (Pomar 1941). The famous Aztec herbal known as the *Badianus Codex* recommends a 'clystere oriculario' prepared from tobacco and various other ingredients as a remedy for rumbling of the abdomen (Anonymous 1940). Since it would be very peculiar to treat such a complaint by instilling liquid into the ear, I am inclined to interpret this dosage form as a rectal fluid rather than as an auricular one. In another passage of the *Badianus Codex*, a tobacco clyster is recommended to relieve recurrent disease. Emboden (1979a) feels that this enema was designed to produce inebriation, but according to the original text purgation was intended (Anonymous 1940). Evidence suggesting that the ancient Maya may have used tobacco as an ingredient of their ritual enemas is discussed in section 1.4.2.

Drawing from an early French account (De Charlevoix 1744), several references indicate that the Indians of eastern Canada revived those nearly drowned by forcing tobacco smoke up the rectum. Then the victim was hung up by his feet to a tree so that he could cast up the water he had swallowed (Brooks 1937, 1941; Van Wart 1948; Gorter 1953). In past centuries, resuscitation of drowned people by a rectal tobacco fumigation was practised in Europe as well (Brooks 1937, 1938, 1941; Gorter 1953).

The two principal tobacco or *Nicotiana* species which have been employed ritually in the western hemisphere, are *N.tabacum* and *N.rustica*. At the time of the Spanish invasion, the first species was known in Central and South America and much of the West

Indies, and the second one in North America and Mexico (Schultes 1967b, pers. commun. 1982). Although the literature sometimes warns that there is no certain information to prove the existence of N.tabacum in pre-Hispanic Mexico (Spinden 1950), this species is frequently implied to have occurred there (Setchell 1921; Castiglioni 1943; Schultes 1981a). Long after the conquest, N.tabacum which comprises most varieties of commercially grown tobacco, was introduced from the Old World to the North American continent (Schultes 1967b).

1.1.9.2. Chemistry and psychopharmacology

The principal Nicotiana alkaloid is nicotine, as it may account for about 95% of the total alkaloid content of tobacco (Wenusch 1940; Rotenberg 1982). The amount in the leaf of N.tabacum varies widely from 0.6% to 9% (Hoppe 1975; Schultes 1981a), but in commercial cigarette tobacco it seldom exceeds 3% (Siegel et al. 1977; Robicsek 1978). N.rustica usually has a higher nicotine content, which was found to range from 4.5% to 8.6% in African samples and from $1.89 \pm 0.02\%$ to the surprising figure of $18.76 \pm 2.6\%$ in west Mexican samples (Siegel et al. 1977). Minor constituents include many other pyridine alkaloids such as anabasine, anatabine, 2,3'-dipyridyl, myosmine, nicotelline, nicotyrine and nornicotine (Wenusch 1940; Hegnauer 1973; List and Hörhammer 1977). In addition, very small amounts of the beta-carboline alkaloids harman and norharman have been isolated from commercial tobaccos and their smoke; the amounts in the smoke are about 0.01-0.02 mg per cigarette which is some 40-100 times greater than that in the tobacco leaf, indicating that pyrosynthesis occurs in the leaves during burning (Janiger and Dobkin de Rios 1976).

Although practised smokers are tolerant of some of its effects, nicotine is highly toxic and acute poisoning with a dose of 60 mg may cause death due to respiratory failure within a few minutes. It acts on a variety of neuro-effector and chemosensitive sites and has both stimulant and depressant phases of action. The ultimate response of an organ or system is the product of such different and opposing effects. The central nervous system, for instance, is markedly stimulated by nicotine, but depression may follow (Rasche González 1980; Taylor 1980; Reynolds 1982). Although smoking might contribute to mental changes (Janiger and Dobkin de Rios 1976), and extreme acute doses of nicotine could produce hallucinations and catatonia (Siegel et al. 1977), nicotine is not considered to be an hallucinogen from the pharmacological view (Siegel et al. 1977; Taylor 1980; Reynolds

1982). Other constituents in tobacco smoke, such as harman and norharman (Janiger and Dobkin de Rios, 1976), might be hallucinogenic per se, but all of these compounds appear to be present in such small quantities, at least in commercial tobaccos, that any suggestion of endogenous hallucinogens present in tobacco in behaviourally active quantities should be viewed with appropriate caution (Siegel et al. 1977; Baumann et al. 1984).

Recent pharmacological studies have demonstrated that the smoking (Benowitz et al. 1982, 1983), snuffing (Russell et al. 1980, 1981) and chewing (Gritz et al. 1981) of tobacco can all lead to substantial blood levels of nicotine.

Oral nicotine is said to be largely inactivated during its first passage through the liver (Russell et al. 1976; McNabb et al. 1982). It is also said that after oral ingestion of tobacco, the absorption of nicotine is apparently delayed because of slowed gastric emptying, so that vomiting caused by the central effect of the initially absorbed fraction removes much of the tobacco remaining in the stomach (Taylor 1980). Nevertheless, oral tobacco infusions are considered quite toxic and may even be lethal (Harrison 1964; Opitz 1982).

Tobacco is known to affect the pharmacokinetic behaviour of many drugs, but most of these alterations appear to involve stimulation of hepatic drug metabolism by smoking and are caused probably by the polycyclic hydrocarbons present in tobacco smoke (Jusko 1978; Dawson and Vestal 1982; Hansten 1982). I am not aware of clinical studies on the combined use of non-smoked tobacco and a classical New World hallucinogen.

1.1.10. Conclusion

From the ethnobotanical, chemical and psychopharmacological approach to intoxicating enema rituals in the western hemisphere, the following categories of ritual enema ingredients arise:

- 1) It is well established that the plant provides one or more psychoactive principles and the Indian use of the plant as a ritual enema ingredient is confirmed or is quite probable: Agave, Anadenanthera, Brugmansia.
- 2) It is well established that the plant provides one or more psychoactive principles, but the Indian use of the plant as a ritual enema ingredient is not well recorded or is even unlikely: Banisteriopsis, Datura, Ilex guayusa, Lophophora williamsii, Nicotiana.

- 3) The Indian use of the plant as a ritual enema ingredient is confirmed or is quite probable, but it is not well established that the plant provides one or more psychoactive principles: none.
- 4) The Indian use of the plant as a ritual enema ingredient is not well recorded, and it is not well established that the plant provides one or more psychoactive principles:
Capsicum.

CHAPTER ONE PART TWO

RECTAL PHARMACOKINETICS AND EFFICACY OF POSSIBLE RITUAL ENEMA CONSTITUENTS

1.2.1. General introduction

Drug uptake from the rectum does not appear essentially different from that in other parts of the gastrointestinal tract. Passive diffusion through a lipid membrane is probably the main governing mechanism of absorption. In contrast to the small intestine, the rectum has no primary function as an absorbing organ. It is approximately 15–20 cm long, and there are no villi and microvilli on the rectal mucosa. Consequently, the absorption surface is far more limited than that of the duodenum. Under normal conditions, the rectum merely contains 2–3 ml of inert mucus, so the small intestine has much more fluid available than the rectum for drug dissolution from solid dosage forms. Despite these potential disadvantages, it has been demonstrated that numerous drugs reach effective plasma levels when given rectally, and in many countries rectal therapy is generally viewed as a convenient alternative to oral dosing (Senior 1974; Moolenaar 1979; Thoma 1980; de Boer et al. 1982).

Systemic therapy via the rectal route is considered particularly useful when the patient is unwilling or unable to take his medicine by mouth. For instance, because of nausea and vomiting. The preceding pages amply demonstrate that the American Indian has not failed to notice this obvious advantage.

The presence of food in the stomach delays the absorption of many drugs when they are taken orally (Welling 1977; Toothaker and Welling 1980), but this is impossible in the case of rectal application. In other words, when a patient has just enjoyed a meal, drug absorption may be more rapid following rectal administration than it would be after oral dosing.

Another advantage of rectal application may be that the breakdown of acid-labile drugs by the stomach is avoided. Sometimes the rectal route is also recommended as a means to prevent first-pass elimination by liver enzymes (Ansel 1976). There is considerable doubt, however, that an enema usually provides the advantage of adequately bypassing hepatic inactivation. It is true that, while the upper rectal vein drains into the hepatic circulation, the inferior and probably also the middle rectal veins pass directly into the systemic circulation. A complicating anatomical factor, however, is the presence of

anastomoses between the rectal veins (de Boer 1980). Also, rectal dosage forms do not remain in the lower parts of the rectum, but move upward into a higher region (Moolenaar and Schoonen 1980). Studies on the degree of enema penetration indicate that penetration as far as the ascending colon may be achieved and that, depending on the enema volume, penetration at least as far as the descending colon is likely (Lima and Jusko 1980). Therefore, a large enema cannot be expected to provide a substantial by-pass of the liver (Quevauviller and Jund 1951). A recent study on lidocaine has shown that in principle the use of a micro-enema can result in partial avoidance of a hepatic first-pass effect (de Boer et al. 1979). However, in various other experiments with codeine (Moolenaar et al. 1982), 5-methoxy-psoralen (Stolk 1982), paracetamol (Moolenaar et al. 1979), promethazine (Moolenaar et al. 1981), propranolol and salicylamide (de Boer 1980), the systemic availability of a micro-enema did not substantially surpass that of an oral dosage form. It certainly cannot be concluded from these experimental findings that a high-clearance drug will generally show higher systemic availability when it is taken as an enema. Unless the tested compounds were well absorbed after oral ingestion and poorly absorbed following rectal application, this implies that substantial first-pass metabolism may not be avoided even when a non-voluminous enema is used.

The principal drawback of rectal administration is the risk of interrupted drug absorption by the inability of the subject to retain the dosage form. For instance, retention time was a major determinant of bioavailability in studies on aminophylline suppositories (Zuidema et al. 1976; Anonymous 1980).

A second problem may be a lack of patient acceptability. Rectal therapy is generally recognized as useful in West European countries on the continent, but it is far from common in Britain and in the United States. In a large British study on phenylbutazone suppositories in general practice, 10% of the patients refused to participate, because they were not prepared to accept a suppository, and half of them did not complete the eight-week course (Anonymous 1983b). Opposite views on rectal administration are not only seen in western civilisation, but also in the native societies of South America. The Peruvian Omagua Indians even distributed enema syringes to their guests (De La Condamine 1778), but such instruments were less appreciated among the Abipones of Paraguay (Dobrizhoffer 1822): 'They will not even bear the mention of an enema. In the town of St. Jeronymo, a Spanish soldier who professed the art of medicine, being requested by Father Brigniel to attend upon a

sick Abipon, declared the necessity of an injection. No sooner did the sick man feel the syringe applied to him, than he started furiously out of bed, snatched up a lance, and would have slain the soldier physician, had he not saved himself by hasty flight'.

Another disadvantage of rectal administration arises from the relatively small absorption surface of the rectum. As a consequence, the usefulness of the rectal route may vary considerably with the physicochemical properties of the drug substance and with the biopharmaceutical properties of the dosage form. These aspects of rectal drug administration and their clinical implications are extensively discussed in recent reviews by de Blaey and Polderman (1980), Thoma (1980), and de Boer et al. (1982).

Data on the rectal pharmacokinetics and efficacy of ritual enema constituents are summarized below. It should be borne in mind that the dosage form tested in a western study will differ from the dosage form used in native rituals, and that this may somewhat limit the pertinence of the clinical data to Indian practices. Unfortunately, the ethnological literature rarely describes the properties of the native dosage form. Only in the case of the paricá clysters of the Brazilian Caripuna and Maué Indians, some interesting information is given, viz. the addition of plant ash to the clyster (vide 1.1.2.1). This admixture has an alkaline nature (Rivier 1981), and may thus enlarge the non-ionized proportion of an alkaloid, which in its turn might facilitate the rectal absorption of the alkaloid. An animal study on suppositories with methylhomatropine shows that the rectal mucosa is not generally an impenetrable barrier for ionized drugs (Cramer et al. 1978), but in principle non-ionized molecules diffuse much more easily through the rectal mucosa than ionized ones (Senior 1974; de Boer et al. 1982).

1.2.2. Specific constituents

1.2.2.1. Atropine

Vide section 1.2.2.9.

1.2.2.2. Bufotenin

Vide section 1.2.2.4.

1.2.2.3. Caffeine

The physicochemical properties of caffeine (Windholz 1983) and its rapid and complete absorption after oral administration (Blanchard and Sawers 1982, 1983) suggest that its absorption from rectal dosage forms may well be substantial. Indeed Maier-Lenz et al. (1981), who recently compared the absorption of caffeine and other drugs from a certain multiple drug tablet and suppository called Migräne-Kranit, did not find a large difference between the serum levels of caffeine following oral and rectal application. A recent case report describes two deaths related to unofficial therapy with voluminous coffee enemas, but these were assumed to be due to electrolyte disturbances; toxicological results in both cases indicated that not enough caffeine had been absorbed to cause a substantial toxic effect (Eisele and Reay 1980), possibly because of the difficulty to retain the large volumes used.

1.2.2.4. Dimethyltryptamine and related compounds

There is considerable evidence to suggest that the active constituents of Anadenanthera undergo extensive first-pass metabolism by intestinal and hepatic MAO and by hepatic microsomal enzymes (vide 1.1.2.2). This may well explain why this genus is most often taken nasally, for the nasal route certainly can provide the advantage of bypassing the gut wall and the liver (vide 2.2.1). It is less easy to presume that the rectal taking of Anadenanthera will be advantageous. Since it is likely that the availability of drug metabolizing enzymes in the gut wall decreases in the direction jejunum, caecum, colon, rectum (de Boer et al. 1982), it may be speculated that inactivation by intestinal MAO is avoided by rectal application. There is considerable doubt, however, that the use of an enema is a reliable way to escape hepatic first-pass elimination (vide 1.2.1), so the Anadenanthera tryptamines may still be inactivated following rectal administration. To obtain anecdotal experimental evidence, I took enemas containing up to 125 mg (1.6 mg/kg) of DMT in self-experiments. At the time of the experiment, I was a non-smoker and a regular user of coffee and beer. The highest rectal dose was 185 mg of DMT bioxalate (Schuchardt, Munich) in 15 ml of tap water, and it was taken with the aid of a syringe and a special adaptor, developed for the rectal application of Valium injection fluid (Anonymous 1981). Even though this dose of 125 mg was much larger than 30 mg, the reported threshold dose of intramuscular DMT (Szára 1957), I failed to notice any

discernible effect. The most likely explanation for the inactivity is that first-pass elimination was not completely avoided. Further experiments in more than one volunteer are needed, however, especially with still higher doses, to ascertain whether or not any partial avoidance is possible. So long as such testing has not been done, it can neither be safely excluded nor concluded that Anadenanthera alkaloids produce systemic effects, when orally inactive amounts are taken in the form of an enema.

1.2.2.5. Ethyl alcohol

In view of the good oral absorption characteristics and physicochemical properties of ethyl alcohol (Offerhaus 1979), a rapid and complete absorption should be possible, if it be rectally administered. To test this theoretical view, I twice took 0.5 l of 5% v/v alcohol, once as an oral drink and once in the form of clysters. Solutions were prepared by diluting 26 ml of 96% v/v alcohol (OPG, Utrecht) with tap water to 0.5 l. At the time of the experiment, I was a non-inhaling smoker and a regular user of coffee and beer. A percentage of only 5% was chosen, since a clyster with an alcoholic content of 20% is quite irritating to the rectal tissue (Moolenaar, pers. commun. 1982), and since the early Indian drinks also had low alcohol percentages (vide 1.1.1.2). Because of this choice, the oral drink and the enema had to be voluminous to provide a substantial dose of alcohol. According to the pharmaceutical literature, the volume of an enema should be less than 0.2 l, if it is to be retained in the intestine (Fishburn 1965; Pernarowski 1975). Therefore the total rectal volume was divided in four equal parts, which were administered within 25 min with the aid of a Flex-Klis flacon (Spruyt-Hillen, Vianen). The clysters had been warmed to body temperature before administration, and they were taken in a prostrate position. Due to these precautions, rectal retention of as much as 0.5 l turned out to be quite easy.

As the sole purpose of the experiment was to obtain an impression of alcohol absorption via the rectal route, alcohol blood levels were not monitored by blood analysis, but by simple breath testing with an Intoxilyzer Model 4011 A (CMI, Mintum). The manufacturer of this equipment guarantees an absolute error of less than 0.1 mg/ml. In a calibration test of the used apparatus, zero set values turned out to be more accurate than test mode values and did not deviate more than 0.02 mg/ml from actual blood levels (Zweipfennig, pers. commun. 1984). The results presented here are therefore not test mode values, but zero set values.

The oral dose was taken after an overnight fast, and resulted in maximal blood levels of 0.4 mg/ml at 30-45 min, followed by a practically linear decline to 0.2 mg/ml at 120 min. Similar data were reported by Wilkinson et al. (1977), who tested 30 ml of 95% of alcohol (diluted to 150 ml) in fasting subjects. In the next 25 min, the total rectal dose was administered, and it produced a rise from 0.2 mg/ml to 0.6 mg/ml at 165 min, whereafter at 240 min the level fell again to 0.4 mg/ml in a practically linear way. These results certainly support the theoretical suggestion that alcohol is absorbed well from an enema.

As pointed out in section 1.1.1.2, alcohol may affect the actions of many other drugs directly or indirectly. In the present context it is interesting to note that in an experiment by Moolenaar (pers. commun. 1982), the presence of alcohol enhanced the absorption rate of the drug sodium salicylate from an enema.

1.2.2.6. Harmine

There does not seem to be any study on the rectal taking of harmine. In view of the physicochemical properties of this alkaloid (Hultin 1965), rectal absorption should well be possible. However, harmine may undergo substantial hepatic first-pass metabolism (vide 1.1.3.2), and there is recent evidence that rectal application is not a reliable way of adequately avoiding this phenomenon (vide 1.2.1). Consequently, there is no obvious reason to assume that an enema will be effective if it contains harmine in an orally inactive amount.

1.2.2.7. Mescaline

The solubility profile of mescaline (Windholz 1983) and the reported good absorption of this hallucinogen after oral ingestion (Charalampous et al. 1966) suggests that substantial absorption can be possible after rectal application. This is a theoretical view which still awaits experimental confirmation, for in the only rectal experiment known to me, 200 mg of mescaline in a suppository caused nothing but a dubious mydriasis (Möller 1935).

1.2.2.8. Nicotine

When tobacco is injected into the rectum, it might sometimes operate as a cathartic (Osol and Farrer 1955), but in official Western medicine tobacco enemas certainly are considered obsolete

because of their toxicity (List and Hörhammer 1977). Rectal infusions prepared from 15 to 20 g of tobacco (Fabre et al. 1957) or even as low as 2 g (List and Hörhammer 1977) are said to have caused fatal intoxications, although recovery after 15 g rectally has also been observed (Lewin 1962). A recent case report describes nausea and confusion followed by hypotension and bradycardia due to unorthodox self-medication with an enema prepared apparently from 5-10 cigarettes (Garcia-Estrada and Fischman 1977). Furthermore, nicotine could be recovered from the urine of a male non-smoking subject, who had received this alkaloid via the rectal route (Jenner et al. 1973). In view of these data, there can be no doubt that a tobacco clyster can produce systemic effects.

1.2.2.9. Scopolamine and related compounds

The synthetic quaternary compounds butylscopolamine and methylatropine are very poorly absorbed after rectal administration (Soeterboek et al. 1980), but the natural tropane alkaloids scopolamine and atropine are tertiary compounds, which should allow a better rectal absorption. Suppositories containing belladonna liquid extract were included in the British Pharmacopeia of 1948 (Reynolds 1982). However, there are only vague and conflicting experimental data on the efficacy of rectal atropine and scopolamine. Well-designed studies on the rectal usefulness of natural tropane alkaloids are still awaited.

Tardos et al. (1959) studied the mydriatic activity of rod-shaped suppositories with atropine sulphate in the rat. They reported a very large difference between equivalent intravenous and rectal doses of atropine, viz. 0.02 mg/kg vs. 0.5 mg/kg, for rods prepared from cacao butter, and the difference was even larger when the rod base was carbowax.

Neuwald et al. (1962) examined the mydriatic effect of fatty suppositories with atropine base or atropine sulphate in rabbits. A dose of 20 mg atropine or atropine sulphate produced mydriasis in all animals tested, but a suppository with 10 mg of the sulphate did not have this effect in each rabbit. According to the authors, the large difference in mydriatic efficacy between a rectal dose of 20 mg (6-8 mg/kg) in the rabbit and a systemic dose in man should be attributed to the insensitivity of the rabbit for atropine.

More recently, Hendrickx and Govaerts (1980) compared enemas with 0.00, 0.01, and 0.02 mg/kg of atropine in small children. Apparently, they did not find statistically significant

differences in cardiac and anti-sialogogic activity, but their report is too confusing to permit firm conclusions.

In other investigations, rectal preparations containing one or more natural tropane alkaloids were found to be useful as premedication for children (Chayen and Sarnat 1973; Lindahl et al 1981) and for the facilitation of delivery (Weinstock 1934; Rittmeyer 1935; Lehmann 1952). All these studies were uncontrolled, however, and each tested drug preparation contained at least one other active substance besides the tropane alkaloid(s).

1.2.3. Conclusion

The literature yields convincing evidence that caffeine and nicotine are effective following rectal application. A good rectal efficacy could also be expected from mescaline and from tropane alkaloids, but this is a hypothetical view which still awaits experimental confirmation.

In self-experiments, ethyl alcohol produced substantial blood levels via the rectal route, whereas dimethyltryptamine did not produce any effect when parenterally active quantities were taken as an enema. First-pass elimination is the most likely explanation for the observed inactivity of dimethyltryptamine via the rectal route.

CHAPTER ONE PART THREE

THE CHEMISTRY OF PARICÁ SEEDS OF THE BRAZILIAN MAUÉ INDIANS

1.3.1. Introduction

In 1817, the Austrian Emperor Franz I. gave his daughter Leopoldine in marriage to the later Brazilian Emperor Dom Pedro I. When the Archduchess made the crossing to the New World, she was accompanied by an Austrian expedition, which included the zoologist Johann Natterer (1787-1843). At the request of King Max Joseph von Bayern, the German explorers Spix and Martius also joined this party. Most of the expedition members returned to Europe in 1821, because the Brazilian civil war broke out, but Natterer stayed behind and continued his travels in Brazil until 1835. During this time, he collected not only numerous biological objects, but also almost 2000 ethnological items, which are now in the Museum for Ethnology in Vienna (Kann 1981). Since various Indian tribes from those days have become extinct or have lost their cultural identity, the importance of these early Brazilian ethnographical objects is obvious. There are only two other collections of this kind in the world, viz. the one from Spix and Martius (Zerries 1980), and an unpublished one from a Russian expedition led by the Earl Langsdorff (Kann 1981).

In contrast with Spix and Martius (1823-1831), Natterer never published his travelling diaries, and unfortunately they were destroyed by fire a few years after his death, when the roof of the Viennese court library caught fire. Still remaining, however, is his correspondence to Europe, and the museum inventory of his collection, written under his supervision. Both sources provide valuable information (Kann 1981, pers. commun. 1984).

The Natterer collection includes several objects of the Maué, Caripuna and Marauá Indians, which are related to ritual drug taking. Detailed descriptions of these paraphernalia are given by Wassén (1965, 1972a) and Kann (1971). It should be noted that volume three of the renowned Handbook of South American Indians does not discuss the Marauá, but only the Maraguá, who are thought to be a probable subdivision of the Maué (Nimuendajú 1948a).

From the ethnobotanical view, the most interesting item is a large sample of well preserved paricá seeds, collected from the Maué tribe (museum inventory 1369): 'Samenkörner des Paricábaumes (in Matogrosso Angico genannt). Diese Körner werden zerstoßen (zerrieben) und mit der Asche des Imbauvabaumes gemischt und dann zum Schnupfen und zu berauschemde Klystieren gebraucht. Wird namentlich bei den Mauhés, Muras, Caripunas und andere Nationen

gebraucht'.

The tracing of these seeds is important, as it has often been implied that the Maué and Mura Indians of the Brazilian Madeira River prepared paricá snuffs and enemas from Anadenanthera seeds. Up to now, however, these assertions have not been supported by an early collection of the seeds (Schultes 1967b; von Reis Altschul 1972). Furthermore, the seeds are unique in the sense that no other ethnobotanical material from the western hemisphere has ever been directly associated with ritual rectal intoxication.

The seeds have a black-brown colour, a flat and orbicular shape, and a diameter of 1-2 cm. These features are certainly reminiscent of Anadenanthera seeds (von Reis Altschul 1964), and this botanical view is shared by von Reis (pers. commun. 1984). Since there are no clear differences between the seeds of the two Anadenanthera species A.peregrina and A.colubrina (von Reis Altschul 1964), the species cannot be determined without the availability of additional plant parts.

In view of the ethnobotanical importance of the seeds, it was quite interesting to obtain data on their chemical composition. Schultes et al. (1977) isolated 0.6% of bufotenin from seeds of A.peregrina, which Richard Spruce had collected in 1854 from the Guahibo Indians of the upper Orinoco River. It was to be hoped that the even older Maué seeds would also give a positive result, corroborating their botanical identification as Anadenanthera seeds.

1.3.2. Analytical methods

By cooperation of Laurent Rivier (Institute of Legal Medicine, Lausanne), the seeds were submitted to a gas chromatographical/mass spectrometric analysis comparable to that described by Schultes et al. (1977). Details are provided in Appendix A.

1.3.3. Results and discussion

Despite their considerable age, the seeds still yielded as much as 15 mg of the Anadenanthera alkaloid bufotenin per g dry seed matter, as identified by retention time on capillary column and mass spectrum. This chemical finding certainly supports the botanical view that they are Anadenanthera seeds. Other tryptamine alkaloids could not be detected. This is not surprising, since Schultes et al. (1977) report that storage of freshly collected Anadenanthera seeds for two years results in the disappearance of all tryptamines except bufotenin. It can

therefore not be excluded that the Maué seeds originally may have contained more than one alkaloid.

CHAPTER ONE PART FOUR

ENEMA SCENES ON ANCIENT MAYA POTTERY

1.4.1. Introduction

Pottery of the classic Maya civilization, in particular the polychrome pottery of the late classic period (A.D. 600–900), provides much information on this Mesoamerican culture by portraying a variety of scenes like palace scenes, ball games, hunting parties, and special dances after human sacrifice by decapitation (Coe 1975, 1978, 1982; Hellmuth 1978; Robicsek 1978; Robicsek and Hales 1981). Some years ago, Furst and Coe (1977) added a new theme to this list after they had discovered a polychrome Maya jar showing the actual administration of an enema (vide plate 3 of Appendix C). According to early colonial references, the Maya employed clysters for diarrhoea and chills or for a swollen abdomen (Roys 1976), and present-day Maya have been reported as taking the purgative castor oil as an enema to treat constipation (Steggerda and Korsch 1943). Yet the discovered scene was revealing, since it appeared to Furst and Coe (1977) that some non-medicinal ritualistic use of clysters was represented: 'Seven male-female pairs, the women easily distinguished by their robes and long hair, are depicted in two horizontal rows. That one woman is fondling a child suggests a familial setting. The activity being portrayed would have brought blushes to the cheeks of the traditional Maya specialist, for while one man is inserting a syringe into his rectum, this delicate task is being carried out for another male by his consort. One male also has a bulbed enema syringe tucked into his belt. Nine vases, identical in shape to the actual vessel, are painted between the couples, and painted dots at the mouth of each represent a foaming, fermented liquid that is probably balche, the common alcoholic drink among the Maya at the time of the conquest. We must conclude that the people on the vase are taking intoxicating enemas, a practice previously unrecorded for this culture'. The discovery of this crucial vessel allowed the identification of other Maya vase paintings as enema scenes (Furst and Coe 1977), and soon others were also led to believe that the ancient Maya took intoxicating enemas for ritual purposes (Hellmuth 1978; Robicsek 1978; Nicholson and Cordy-Collins 1979; Anonymous 1984; Dobkin de Rios 1984; Torres 1984; Schele, pers. commun. 1985).

In my opinion, there can be little doubt indeed that the enema

scenes on Maya pottery, or at least part of them, represent some kind of ritual. The mere fact that deities or their devotees, and animals or humans dressed up like animals are common actors in these scenes (vide Appendix B) leaves little room for another interpretation. This does not automatically signify, however, that the Maya vases show the use of intoxicating retention enemas. Starting from the assumption that these enemas served a specific ritual purpose, an alternative possibility could be raised, viz. purifying evacuation enemas. The concept of ritual purification falls well within the range of established Indian culture traits. The South American Jivaros, for instance, use a solution prepared from Ilex guayusa as a ceremonial mouth rinse, which is spat out instead of being swallowed (Karsten 1935). With respect to the rectal way of administration, ritual purification may be less well documented, but the Peruvian Incas seem to have employed their vilca clysters for cleansing (Poma de Ayala 1969).

Apart from this argument, the idea that the ancient Maya took enemas to reach or intensify a state of intoxication, is a plausible and attractive suggestion. When the Spaniards arrived in Middle America, they found that the Indians living there were familiar with numerous botanical intoxicants like alcoholic beverages (González de Lima 1956), tobacco (Robicsek 1978) and hallucinogens (Guerra 1967), and that the rectal route was sometimes used to administer an intoxicant (vide 1.1.1.1). It is also beyond question that intoxicating practices had already occurred in Middle America far before the coming of the white man. The recovery of pre-Hispanic smoking pipes (Porter 1948), snuffing equipment (Furst 1974a), peyote buttons (Bruhn et al. 1978), etc. from Mexican archaeological sites all point in this direction. It is therefore worthwhile to trace which ritual intoxicants were known to the Maya, and what evidence for their rectal use can be found in the enema vase paintings themselves. Taking this as a starting point, the following pages first review which enema paraphernalia are shown in Maya vase paintings, and then provide a multidisciplinary outlook on the ethnobotany, chemistry and psychopharmacology of Maya intoxicants. In my iconographical approach, I follow in the track of other researchers. Furst and Coe (1977) were already able to interpret previously baffling objects as enema syringes and to identify a specially shaped jug as a common object in the enema scenes. Coe (1978) subsequently proposed that a certain spiral glyph, number 627 in the Maya glyph catalogue of Thompson (1962), may be the sign for the enema ritual and he added the speculative notion that this glyph represents an anal sphincter muscle. Additional accessories in the enema vase paintings were listed by Nicholas

M. Hellmuth in an unpublished paper from 1978, which still is the only detailed iconographical survey on the subject. A recently revised version of this paper is included in this thesis (Appendix B), and much of the underlying photographic material is also presented here (Appendix C). In the next paragraphs, I refer to the photographs by giving their plate numbers between brackets.

1.4.2. Maya enema paraphernalia

1.4.2.1. Iconographical approach

A principal diagnostic trait of the enema scenes on classic Maya vessels is the presence of an enema syringe. Actual insertion of this apparatus into subjects bending forward is depicted on some early classic pottery (1, 2) and on the late classic vase (3), which led to the discovery of Maya enema scenes (vide 1.4.1). The syringe often has a clearly visible tube (e.g. 7, 10, 16) and an oval bulb with a semi-circle at the middle of the top (e.g. 7, 19, 42), and can thus be distinguished from a round rattle (18, 34). A striking feature of many syringes is their large size (e.g. 16, 19). In modern western practices, enemas larger than 0.2 l are only applied to evacuate the bowels (Fishburn 1965; Pernarowski 1975), so if the size of the syringe is realistic, it would seem to suggest a purifying evacuation enema rather than an intoxicating retention enema. In a recent self-experiment, however, I could easily retain an alcoholic enema with a total volume of 0.5 l by taking certain precautions (vide 1.2.2.5), which takes the edge off this pharmaceutical argument.

Many scenes portray the enema syringe on top of a specially shaped jug (e.g. 7, 10, 19). This type of jug is seen so often in the enema ritual that it is assumed to contain the enema liquid (Furst and Coe 1977; Coe 1978; Hellmuth 1978). This assertion about the function of the jug is probably correct, when it occurs in enema rituals, but its appearance is not limited to such scenes. The jug is also seen, for instance, in scenes of ceremonial self-sacrifice (Stuart 1975) or in simple palace scenes (Coe 1978). Occasionally, the jug is of a small, portable size (e.g. 39, 40), but most scenes display large jugs, standing in front of a participant or near a throne.

In many scenes, something is shown as coming out or sticking out of the jug: this may be scrolls (5, 13, 21), dots (3, 6, 12), rod- and plume-like forms (15, 29, 33, 37, 41), occasionally

arranged in bundles (17), small circular forms (12, 38), larger, often black-eyed circular and oval forms (4, 29, 34, 35, 38), or a large flower (fig.5 in Boglár and Kovács 1983). Even on one bowl, some kind of mammal is shown jumping out of the jug (43). Since the enema may be present in the jug, a closer look at current ideas on the protruding items is certainly warranted.

In an elaborate enema scene, syringes are emitting scrolls (18) similar to those coming out of jugs in other scenes (5, 21). This seems to reinforce the idea that the syringes and jugs in enema scenes have the same content. Coe (1978) identifies the scrolls as stylized smoke. This is an acceptable suggestion, since the classic Maya were undoubtedly a smoking people, and their vase painters often depicted smoke in this way (Robicsek 1978). In another enema scene, cigars and objects that might be small jugs are shown as emitting similar scrolls (13). The smoke symbol would be an appropriate sign, if the jug contained the same plant that was smoked. Alternatively, the scrolls might symbolize odour (Deletaille, pers. commun. 1984) or pungency (Hellmuth, pers. commun. 1980). A pungent clyster would, of course, be more suitable for cleansing than for intoxication.

The display of dots at the mouth of a jug (3, 6, 12) has its counterpart in pre-Hispanic Mexican codices. In Aztec codices, like the Codex Mendoza, such dots indicate the alcoholic drink *octli*, prepared from the maguey plant (González de Lima 1956; de Barrios 1971; Ross 1978). In the Maya Codex Dresdensis from the post-classic period, dots are depicted above a large jug, considered to contain fermented honey wine, because it bears the *cib* sign (Seler 1902; González de Lima 1956; Thompson 1972). In view of such data, Furst and Coe (1977) and Robicsek (1978) may be right to postulate that the dots in Maya enema scenes signify the presence of some fermented liquid, such as the alcoholic honey mead *balché*. For Hellmuth (pers. commun. 1984), the dots do not have a specific meaning.

A definite interpretation of the rod- and plume-like forms in Maya jugs is not yet available. Even if they are prominent (15, 29), it is difficult to come up with a botanical suggestion (Schultes, pers. commun. 1984). The forms should be distinguished from scrolls, for there is a bowl painting where both are coming out of the same jug (fig.120 in Boglár and Kovács 1983). In one scene (37), they merely seem to indicate that fluid is spilling out of a tumbling jug (Robicsek and Hales 1981). Justeson (pers. commun. 1985) feels that the form of the rod-like objects (41) is roughly consistent with maguey leaves, but admits that the execution is not distinctive enough to make a specific botanical identification (vide 1.4.2.2). Hellmuth (1978, pers. commun.

1984) wonders about some forms; they may possibly be plant segments or actual bird plumes, and about others; they might represent cigars or pointed blood-letting perforators. If the correctness of the last suggestion could be proven, this would raise the possibility that the effect of the enema was enhanced by self-torture. The ancient Maya are known to have practised ritual self-mutilation, especially by scarifying the penis or the tongue (Joralemon 1974; Furst 1976b; Robicsek 1978).

The circular and oval forms on top of the jug (12, 29, 34, 35, 38) or coming out of it (4) are as enigmatic as the oblong forms. Robicsek (1978) suggests that the small variety (12, 38) indicates the presence of a fermented liquid, whereas Hellmuth (pers. commun. 1984) feels that the small circles are real objects. The larger variety may also be stacked up in a plate or bowl elsewhere in the scene (8, 17, 18). Coe (1978) remarks about such round objects in a throne scene; they might be the maize preparation tamales, but they look suspiciously like disembodied death-eyes. If food was ingested during the ritual it could have a pharmacological bearing, as the presence of food in the stomach often delays drug absorption after oral ingestion (Welling 1977; Toothaker and Welling 1980), but this cannot happen after rectal application. Hellmuth (pers. commun. 1984) wonders, if the round forms might be some kind of food such as cookie balls or fruits. According to Schultes (pers. commun. 1984), the large round items (4, 8, 38) might possibly represent some kind of fruit, such as that of Annona, which could be eaten or used to prepare a fermented beverage.

Fig.5 of Boglár and Kovács (1983) shows a Maya vase painting with a jaguar next to a large jug, from which a huge flower emerges. The jaguar is wearing a netted bib and a netted headdress, both of which are garments worn in the enema ritual (vide infra). There is also an enema scene, in which an indeterminate creature is holding an enormous flower (13). These scenes open up the possibility that such flowers served as an ingredient of ritual Maya enemas, which raises the issue of their botanical identity. Rands (1953) associates comparable floral forms in Maya art with the American water lily Nymphaea ampla. In accordance with this view, Hellmuth (pers. commun. 1984) considers the flower in plate 13 to represent the water lily. This flower is so stylized, however, that its identification as N.ampla should not be accepted without reserve, and this is also the case with the flower in fig.5 of Boglár and Kovács (1983).

The syringe on top of the enema jug is sometimes replaced by a cup (20, 27), so ritual drinking must have occurred as well. Hellmuth (pers. commun. 1984) rightly draws attention to the

similarity between these drinking scenes and the Mural de los Bebedores in the pyramid of Cholula at Puebla in Mexico, which is partly shown on the cover of de Barrios (1971) and on the wrapper of Guerrero Guerrero (1980). As some vases show the drinking cup and the enema syringe together (9, 19), both objects could obviously be used in the same ritual. Robicsek and Hales (1981) have elegantly demonstrated that different Maya vases may show successive scenes of one event (Robicsek and Hales 1981), so the enema scenes and drinking scenes may well represent different stages of the same intoxication ceremony.

Occasionally U-shaped objects are displayed on top of the jug (7) or in the hand of actors (3, 18). In one of the scenes, God N is holding such an object in his left hand, while painting his face with his right hand (18). Coe (1978) suggests that it is a paint-pot in this scene, which suggestion corresponds with the painted faces in other scenes showing U-shaped objects (3,7).

The participants in the ritual often wear a special garment around the neck as a bib, analogous to an oyster bib (3, 7, 13). In one scene, a bib-wearing male has his right hand in the jug, apparently to fill up a syringe or cup (26). Hellmuth (1978; pers. commun. 1980) has suggested that the bib is worn in the ritual because of vomiting, as some scenes portray a vomiting creature (24, 25, 27). This remains uncertain, for the bib may also be worn as a head-dress (3), and not every vomiting personage is wearing the bib (24). Robicsek (1978) thinks that the bib is in some way related to the iconography of God N, who regularly wears a netted element in his headdress (e.g. 19). Whatever the bib may mean, the display of vomiting actors does provide a plausible reason why the Maya opted for rectal application. If a subject is vomiting or is going to vomit, the rectal route of administration offers an obvious advantage over the oral one.

Other objects, which may appear together with enema paraphernalia, include vegetation decorating the head of a jaguar (e.g. 13, 28), cigars or cigarettes (12, 13, 14, 32), musical instruments like drums and rattles (18, 34), and bouquet-like objects (35, 36).

A jaguar with a leaf or flower sprouting from the head is often displayed besides a jug and/or with a bib around the neck (e.g. 25, 27, 32). Just like the flower in plate 13 (vide supra), these plant parts are commonly associated with the water lily Nymphaea ampla, even to the point that the jaguar in question is indicated as the Water Lily Jaguar (Coe 1978, 1982; Robicsek 1978; Hellmuth, pers. commun. 1984). Once more, however, a botanical reserve should be kept in mind, since it is difficult, if not

impossible, to exclude all other plants. In this connection, it should be emphasized that the leaf of the so-called Water Lily Jaguar may be much more acuminate (e.g. 28) than the leaf of N.ampla, as judged from photographs of a herbarium specimen (Emboden 1981a) and of the living plant (Torres 1984).

The presence of smokers opens up the possibility that the effect of the enema may have been enhanced by smoking, whereas the presence of musicians could possibly signify non-pharmacological potentiation. There is ample ethnographical evidence that the American Indian valued rythmical music as a means of intensifying drug-induced experiences (Wasson 1980; Dobkin de Rios 1984). The bouquet-like objects are so stylized that it is not possible to interpret them as any known psychoactive plant (Schultes, pers. commun. 1984).

1.4.2.2. Linguistic approach

Mostly, the special jug appearing in Maya enema rituals and related scenes has a plain surface or a simple painted design, but some jugs are provided with an obvious glyph, although not always the same glyph is shown (10, 14, 15, 30, 34, 35, 40, 41). Since the jug is thought to contain the enema, the interpretation of such glyphs is of paramount importance. Most of the jug glyphs cannot readily be found in the Maya glyph catalogue of Thompson (1962). This is not surprising, since Thompson focused on glyphs from monuments and manuscripts and not on glyphs from pottery. Some glyphs can be identified, however, and in one case it is even possible to give an interesting interpretation:

- 1) In his book on tobacco among the Maya, Robicsek (1978) describes a Multiple Resist vase painting with smoking and dancing skeletons (vase A-14). He interprets the infix on a small portable jug in this scene as akbal, the sign of darkness (number 504 in Thompson's catalogue).
- 2) Justeson (pers. commun. 1985) has found the manik glyph, which represents the name of a day (number 671 in Thompson's catalogue), on a large jug (41).

In an unpublished manuscript from 1982 on 'Hieroglyphic evidence for the languages of the classic Maya', Fox and his co-author Justeson (pers. commun. 1985) remark on the occurrence of the manik glyph on the jug in plate 41: 'Logographically, this sign represents the day Manik. The day name in Yucatec is clearly ancient, since the name is preserved from Chol and/or Tzeltal as <manich> in calendrical names in the Comitan Libro de Bautismos (see Baroco 1970: 138, 146) and the Yajalon Libro de Bautismos y Matrimonios (Campbell in press). This day name corresponds to the

day Deer of other Mesoamerican calendars, and the sign is used as a logogram DEER in the codices. The sign is never read phonetically as ke, which Yucatecan ké:h 'deer' terms would suggest as phonetic generalization; however, there is ample evidence for its value či, which presupposes the Cholan-Tzeltalan *čihx 'deer'. This sign origin supports Cholan-Tzeltalan development of either the sign's phonetic value či or semantic value DEER, but indicates nothing concerning a Cholan-Tzeltalan involvement in any spellings which make use of it in either value. Some such spellings, however, do implicate the Cholan-Tzeltalan group. (The figure) illustrates a vase depicting two seated figures, leaning toward a central vessel with cups in their outstretched hands. Long leaves appear to be rising from the (enema?) vase, which is marked with the sign či. We suspect that the sign and the leaves are intended to indicate that the figures are drinking, or are preparing to drink, an alcoholic extract of the maguey. The same sign marks depicted vases in a scene on a polychrome vase which Kerr suggests represents a drunken display. In Cholan and Tzeltalan languages, čih means 'maguey'; či?, whose basic meaning is 'sweet; delicious', means by extension 'alcoholic beverage' or, as an adjective, 'inebriated', while *a:x-či is 'drunkard'. These terms are cognate with Yucatecan kih 'maguey' and ki? 'sweet, delicious; alcoholic beverage; inebriated' and x-ki? 'drunkard'.

In this comment on the manik glyph, two separate steps are taken, viz. the reading of the glyph as 'či' and the connection of this phonetic value with terms like maguey (Agave plant) and alcoholic beverage. Yucatecan parallels of the latter step are easily found in the literature. According to Roys (1976), the Yucatecan Maya had at least nine names all ending in 'ci' for various species of Agave. Bolles (1981) indicates that 'ci' in Yucatecan texts may be translated as wine. With respect to the former step, Justeson sent me a second letter (1985) detailing the following: 'The evidence for the či value is varied. First the contrast between it and the sign T534 la in the words for 'west' and 'east' (čik'in and lak'in) are generally acknowledged, and this is the context that initially suggested the reading. Other good examples in the codices are the spelling k'u-č(i) for k'uč, which verifies the consonant at least; the spelling is in position to be the name of the bird depicted, which is the k'uč 'buzzard'. The sign is in alteration with T669, which has the two values k'a and ča, in spelling what should be the same word in different pages of the Madrid Codex, namely pa-č(a) and pa-č(i). At Chichen Itza, a preposition is spelled i-či-l(a) that must have the function of marking a day as falling within or in a

given tun in the long count; only the prepositions ti?, ič, and ič-il could serve that function, so the spelling i-T671-l(a) makes a prima facie case for both the consonant and vowel of the či value. The sign is used for the day Deer, and *čihx (or chihj in Spanish-based orthography; i.e., my x is the velar fricative, not the š or sh sound) is the word for 'deer' in proto-Tzeltalan, proto-Cholan-Tzeltalan, and perhaps proto-Cholan (I think proto-Cholan is actually *čih, but I'm not positive; the choice depends on data I don't have concerning accent in Chontal, an accented form pointing to *čihx and an unaccented form pointing to *čih). Also, the form of the sign is a pan-Mayan gesture for eating; *či? is proto-Yucatecan for 'to bite; to eat meat' from proto-Mayan *ti? A telling case that the sign T765, used as a verb for enter, represents Yucatecan *ok, Cholan *oč 'to enter', being also the sign for the day name Oc (i.e., *ok or perhaps *o:k); at Tortuguero, which is demonstrably a Cholan site and thus would have read this verb as *oč, there is an infixed or suffixed T671, presumably for či as a phonetic complement to indicate the final č of oč and perhaps the i as a grammatical suffix. The sign is also used in the Madrid in varying spellings of the word for 'bathing, baptism', in texts accompanying baptism scenes; the spellings are somewhat defective, but can be interpreted as i-č(i)-ki or as i-či-VL for ič-k-il 'baptism'; the variation is in order of signs, the first i sometimes being last, but the words are clearly the same so reordering must be assumed.

I think all of this evidence is reasonably solid, with the possible exception of the gestural origin for the či value in pYu *či?. Other contexts that may be interpretable in terms of the či value do not have as much solid semantic control or linguistic control over the terms that are being represented. In all the above examples, it would take special pleading to see other terms or values being involved.

References: k'uč and čik'in contexts: generally known, first argued in 19th century.

'deer' = čihx: first argued, although I'm not sure in quite this form, by Kelley in his phoneticism paper (Fonetismo en la escritura maya, Estudios de Cultura Maya, 1962).

či/ča alternations: James A. Fox and John S. Justeson, "Polyvalence in Mayan hieroglyphic writing", in John S. Justeson and Lyle Campbell, eds., Phoneticism in Mayan Hieroglyphic Writing, pp. 17-76. Institute for Mesoamerican Studies: Albany, 1984

i-č(i)-ki or i-či-VL for ič-k-il 'baptism': also in the above, although the basic baptism reading and the recognition of the i-či elements goes back again to the 19th century.

i-č̣i-l(a) for ič̣-il and T765-č̣i for oč̣ or oč̣-i 'enter(ed)' in Fox and Justeson (1982), "Hieroglyphic evidence for the languages of the Classic Maya", unpublished manuscript (the same one from which you have the discussion of the maguey).

The i-č̣i-l(a) case is also discussed in Peter Mathews and John S. Justeson, "Patterns of sign substitution in Mayan hieroglyphic writing: the Affix Cluster", pp. 185ff of Justeson and Campbell, cited above, but this discussion relies on Fox and Justeson (1982).

pYu *č̣i? 'bite, eat meat' as the basis for the form of the č̣i sign is discussed in Fox and Justeson (1982) and equivalently in a forthcoming source The Foreign Impact on Lowland Mayan Language and Script, Middle American Research Institute Publication 53, Tulane University: New Orleans, by John S. Justeson, William M. Norman, Lyle Campbell, and Terrence Kaufman.'

Since the scene in plate 41 fails to show any specific enema related object, it could be argued that the jug with the manik glyph in this scene contains an oral drink rather than an enema liquid (vide 1.4.2.1). There is another scene, however, where a probable enema syringe is lying on top of a similar jug which is unquestionably ornamented with the same manik sign (14). There is a prefix on the left of this glyph, but it is rather problematic to identify this side-sign (Justeson, pers. commun. 1985): 'The best match in form I think is with T238, AH5, and this would make sense as Ah Chih, 'Maguey' or 'He of Maguey' (or 'Liquor' or 'He of Liquor'). According to Bolles (1981), the phrase 'ah ci' occurs in colonial Yucatecan Mayan texts and may be translated as drunk or drunkard.

As Justeson's linguistic interpretations have great ethno-botanical implications, it appeared essential to obtain an independent expert's comment on the manik glyph. When asked for this second opinion, Schele (pers. commun. 1985) first expressed some reservations:

'Justeson's suggestions seem very plausible to me. He reads the 'manik' hand as chi (he uses linguistic orthography so the diacritic in his comments indicates a phoneme we would record in our alphabetic system as chi). He apparently assumes the pot read in Cholan-Tzeltalan and comments that there is no substantiation for a ki value for the 'manik' hand, which I agree with. The 'deer' term is part of the k/ch correspondence set in Yucatec (keh 'deer')/ Cholan (chih 'deer'). Therefore, his suggested reading does not require a Yucatec chi value for the 'drunken' term is in the same correspondence set. His proposal is possible,

even probable. My only reservation is that there is evidence from the west glyph (Yucatec chik'in/ Cholan ti-k'in) and from other substitutions that the 'manik' hand participated in the correspondence set that requires ch in Yucatec and t in Cholan. The latter glyphs in which the 'manik' hand replaces signs with the value of ti do not have accepted readings as words, so they can only be taken as supporting evidence for the ch/t correspondence set. The 'deer' set is equally strong evidence for the other side. However, the chi reading for the pottery glyph does not have an equivalent in the codices and, therefore, does not require a ki reading in Yucatec. In other words, the 'manik' hand may be used on the pot solely as a phonetic glyph without a meaning assigned to it. I would rate Justeson's reading as a good possibility to be further tested by watching for new examples, but I would not consider it secure enough to be used to prove the 'manik' hand was used for the k/ch correspondence set in the inscriptions, as he seems to be doing. I think the question is still open.'

Just before this thesis went to press, however, Schele (pers. commun. 1985) informed me in a second letter that her former doubts have waned substantially:

'In the process of pursuing other research in the last months, I have found evidence sufficient to convince me that the manik hand T671 was indeed phonetic chi in the Classic period and not ti. I have also been able to see a great many photographs of pottery scenes that include pots, especially the round bodied ones, that have the manik hand on them. The weight of this evidence now makes me about 90% certain that John is correct in his reading of the chi glyphs as "sweet" and "intoxicating".'

1.4.3. Ritual Maya intoxicants

1.4.3.1. Ethnobotany

The principal ethnobotanical question is, of course, which intoxicating enemas the Maya may have taken. An alcoholic liquid, tobacco and hallucinogens have all been proposed as possible ingredients (Furst 1976a; Furst and Coe 1977; Hellmuth 1978; Robicsek 1978; Torres 1984).

As outlined above, the enema scenes themselves present a fair amount of evidence to support the first suggestion. It is well established that alcoholic beverages were known to the Maya in early-contact times (Tozzer 1913; Landa 1978). Rectal use of such preparations has not been recorded for the Maya, but it is

reported for other early native inhabitants of Middle America (vide 1.1.1.1). The balché drink of the Maya has been described as a mild intoxicant, concocted of fermented honey and water, to which was added the bark or root of the balché tree Lonchocarpus violaceus (= L.longistylus) (Roys 1943, 1976; Gonçalves de Lima 1956; Gonçalves de Lima et al. 1977; Landa 1978). This admixture has been reported to contain antibacterial longistylin (Delle Monache et al. 1977), but it is not known to contain any hallucinogenic principle. According to early sources, there were other alcoholic beverages as well: their base is said to have been pineapples and sugar-cane (Tozzer 1913), or honey, together with maize or the root of an Agave, and roots of unidentified plants (Roys 1943). It should be added, however, that sugar-cane cannot have entered into the composition of pre-Hispanic Maya drinks, as this plant was introduced by the Europeans (Schultes, pers. commun. 1984; Coe, pers. commun. 1985).

The use of tobacco among the Maya has been reviewed extensively by Robicsek (1978). In contrast with the sources on alcohol, early historical records on the Maya relating to tobacco appear to be questionable and confusing. There can be no doubt, however, that numerous Maya vase paintings from the classic period portray fumigatories, which are often provided with smoke scrolls (e.g. 13). As pointed out in section 1.4.2, enema paraphernalia are occasionally shown to emit similar scrolls. With respect to the botanical identity of the fumigatories on Maya pottery, Robicsek (1978) rightly remarks: 'Of course, the only way to state with absolute certainty that the ancient Maya indulged in tobacco smoking would be to discover tobacco cigars or cigarettes or pipes stuffed with tobacco (preferably still smoking) in Classic graves. Unfortunately, the only bona fide discovery of tobacco at a Maya site was the cache of cigars discovered by C. Rudy Larios in Group H at Tikal. This (review), however well supported, is, therefore, speculative. The only thing we know for certain is that the Mayas smoked something. This something was most likely tobacco, a conclusion based on archaeological material found at Classic and post-Classic sites, stone monuments, ceramic artifacts, and codices.'

The conjecture that the Maya employed hallucinogenic clysters necessitates a glance at the current ideas about Maya hallucinogens. The only hallucinogen which is suggested again and again as a possible ritual Maya intoxicant, is the psilocybian mushroom (Dobkin de Rios 1974; Robicsek 1978; Torres 1984). Apart from the chemical and pharmacological data (vide 1.4.3.2), the evidence includes linguistic findings (entries found in early Maya vocabularies relating to inebriating

mushrooms), botanical findings (psilocybian mushrooms found in the Maya region), and archaeological findings (mushroom-shaped stone objects found at pre-Hispanic Maya sites) (Greene Robertson 1972; Lowy 1977; Mayer 1977; Wasson 1980; Torres 1984). Not every scholar, however, considers the mushroom-shaped stone objects as substantial evidence of the Maya mushroom use in early times (Brown 1984). It should also be noted that the evidence of such use is not associated with the central Maya area, from which most enema vase paintings originate, but with other Maya regions, especially with the Highlands. Even though it cannot be excluded that mushrooms could have been brought into the central region by trade (Brown 1984; Mayer, pers. commun. 1984), it is certainly not safe to claim that the Maya prepared ritual enemas from mushrooms. The vase paintings fail to provide any evidence for this conjecture. The mushroom-shaped objects, which sometimes appear in front of a face on classic Maya pottery, unquestionably represent nose-beads.

The fly agaric Amanita muscaria also occurs in the Maya highlands and it has sometimes been suggested that it is represented in post-classic Maya codices (Lowy 1972; Torres 1984), but the objects interpreted as mushrooms might also be rattles, maces or fans (Thompson 1972; Robicsek 1978). At present, there would not seem to be paramount evidence that the ancient Maya may have preferred the fly agaric to psilocybian mushrooms (Mayer, pers. commun. 1984).

The literature on ritual plants mentions various other potential Maya intoxicants besides mushrooms, but all of these possibilities still require more evidence from chemical and pharmacological studies (vide 1.4.3.2) and/or from the ethnobotanical field, before they can be accepted without hesitation.

The divinatory tsité tree of the Popol Vuh, a famous epic of the Quiché Maya, is said to have been an Erythrina species (Girard 1960; Schultes 1972b). In 1970, Furst (1974b) presented a paper about this subject at the Annual Meeting of the Society for American Archaeology in Mexico. This paper is no longer available (Furst, pers. commun. 1985). Rumours that Guatemalan shamans ingest Erythrina beans for ritual purposes are still extremely tenuous and open to doubt (Schultes and Hofmann 1980b).

Dobkin de Rios (1974) has put forward that the Maya may have taken the water lily Nymphaea ampla in a ritual context, but other scholars did not generally approve of this idea. More recently, the available evidence for the suggestion that the water lily was a ritual Maya plant has been surveyed by Emboden (1981a, 1981b) and by Torres (1984). Enema paraphernalia and

plant parts associated with the water lily are known to occur together in Maya vase paintings. In one case, a possible water lily flower is even shown to emerge from the specially shaped jug, which features in enema scenes on other vases (vide 1.4.2). This raises the possibility that the flower could have entered into the composition of ritual Maya enemas. It is still insufficiently clear, however, whether or not Nymphaea ampla can serve to induce a central intoxication (vide 1.4.3.2). Consequently, it would be unwise at this stage to discard alternative explanations, such as nutritional, sexual, or symbolic purposes, as being impossible. There is a vague claim, for instance, that the farinaceous rootstocks of N.ampla are edible (Sturtevant 1972). This corresponds with a herbarium annotation that the bulbs of an indeterminate Nymphaea species from Mexico are dug and eaten during the dry season (von Reis Altschul 1973). Furthermore, the rootstock of N.ampla is said to be considered an aphrodisiac in Yucatan (Morton 1981). It should be noted that these ethnobotanical data refer to the submerged parts and not to the flowers. A non-materialistic suggestion is offered by Furst (pers. commun. 1982) who feels that the Maya water lily 'is a perfect visual metaphor for the connection between the surface of the water, or the earth, and the watery lower regions.'

Dobkin de Rios (1974) has also suggested toad poison as a ritual Maya intoxicant, but this conjecture was not generally approved of either. There is a classic Maya vase which displays one or more jugs together with a toad-like creature, characterized by its 'ear' with three dots (30), but it is unclear whether it is a toad or a frog.

The Maya flora is known to include Datura candida (Hopkins 1974), but Schultes (pers. commun. 1982) doubts very much that this tree occurred in Central America in ancient times, as all the Brugmansia species are South American. Toh-ku, of which the Maya made many medicines for hemorrhoids, has been identified as Datura innoxia (Roys 1976), but there is no ethnobotanical record that the Maya intoxicated themselves with this plant. And, its characteristic spiny fruit does not occur in classic enema scenes. Litzinger (1981) has reported that ceramics resembling the spiny fruit of Datura have been found in the Maya area, but Hellmuth (pers. commun. 1981) feels that these may represent the stem of the Ceiba tree rather than the fruit of Datura. The latter view is supported by the cylindrical form of spiny ceramics from the Amátitlan Lake in southern Guatemala, which I have seen in the Museum for Ethnology in Vienna. What is more, Litzinger (pers. commun. 1982) himself informed me that the

present-day Lacandon Maya still make spiked ceramic vessels, and refer to the spikes as to those of the Ceiba tree, which is an important symbolic plant for them.

1.4.3.2. Chemistry and psychopharmacology

Data on alcohol, tobacco and Daturas can be found in sections 1.1 and 1.2.

The truly hallucinogenic nature of Psilocybe mexicana and related mushrooms is well documented; both psilocybin, which is usually the main active principle, and psilocin, which may be present as well, are LSD-like hallucinogens (Schultes and Hofmann 1980a,b; Beug and Bigwood 1982; Young et al. 1982). The medium oral dose of psilocybin, which elicits symptoms similar to those induced by about 2 g of dried Psilocybe mexicana, is said to be 4-8 mg; doses of 6-20 mg evoke more profound psychic changes than doses of up to 4 mg (Delay et al. 1958; Heim et al. 1958; Hofmann 1963; Berkenbaum 1969; Schultes and Hofmann 1980b). Experimental data on the rectal application of Psilocybe alkaloids do not seem to be available. The physicochemical properties of psilocybin (Windholz 1983) are not suggestive of a good and rapid absorption from rectal dosage forms.

The fly agaric Amanita muscaria is also frequently classified as an hallucinogen. Its major active principles are stated as being ibotenic acid and muscimol, which is probably not a genuine constituent but an artifact formed during drying or extraction (Eugster 1967; Wasson 1967; Gray 1978; Schultes and Hofmann 1980a,b). Recent analytical work suggests that the muscimol content may decrease with time: fresh material was found to contain 0.15-0.22%, calculated on dry matter, whereas a maximum of 0.02% could be detected in 3-5 year old samples (Stijve 1982). Clinical evidence for hallucinogenic activity is not so impressive as it is in the case of psilocybian mushrooms. Ott (1976) ingested about 30 g of dried caps, and this resulted in sedation and slight visual phenomena. McDonald (1978) drank an aqueous extract from 30 g of the dried mushroom, and did not experience hallucinations or obvious visual distortions. He also gave an oral dose of 12 g/72 kg body wt to healthy volunteers, who partly reported visual and auditory distortions, but not overt hallucinations. Plomp (1982) felt some heightened perception of colours and deeper awareness, but 'no sensational action' from oral doses up to five fresh caps. A truly visionary experience has no more been found in clinical experiments with isolated constituents. In healthy subjects, ingestion of 7.5-10 mg of muscimol elicited changes in mood, affective detachment and

loss of concentration, but hallucinations did not occur. In the same study, ibotenic acid in a dose of 75 mg produced a weaker and less characteristic effect (Theobald et al. 1968). In schizophrenics, oral administration of 7-10 mg of muscimol caused exacerbations of certain psychotic manifestations, but deterioration of hallucinations was not observed (Tamminga et al. 1978). Studies on the fate of tritiated muscimol in the mouse indicate substantial metabolism and poor penetration of the intact substance into the brain (Ott et al. 1975; Maggi and Enna 1979), so it is open to question that the behavioural effects of muscimol are due to the compound itself. Muscimol has extreme water-solubility, but also a low molecular weight (Eugster 1967). It is rather difficult to predict from these properties, whether or not muscimol will be absorbed well after rectal application.

The genus Erythrina appears to be rich in alkaloids, many of which have a peripheral curare-like action (Deulofeu 1959; Boekelheide 1960; Hill 1967; Dyke and Quessy 1981). Central depressant and convulsant activity has also been reported for some Erythrina alkaloids, but the intensity of action was considerably lower than that observed in the case of peripheral activity (Boekelheide 1960). Pharmacological evidence for hallucinogenic properties appears to be lacking (Schultes and Hofmann 1980b; Dyke and Quessy 1981).

Early phytochemical data on the genus Nymphaea have been reviewed by Hegnauer (1956). According to this survey, Nymphaea alba contains the non-alkaloidal compound nymphaline with digitalis-like activity, and a mixture of unstable alkaloids with hypno-sedative effects. The Old World species Nymphaea caerulea has been tested by Emboden (1979b; pers. commun. 1984) who twice drank a decoction of its flower buds. The effect of the decoction was very mild and more akin to a hypnotic, but there were alterations in visual and auditory perception. With respect to Nymphaea ampla, the water lily of the New World, Torres (pers. commun. 1985) has recently informed me of an experiment with negative results: 'About 2 months ago, a psychiatrist friend, tried to experience the hallucinogenic effect of Nymphaea ampla collected in Lake Petén Itzá (in the center of the Maya Classic area), in Petén, northern Guatemala, with absolutely no effects. The experiment was done according to instructions given me by Emboden'. Various sources indicate that N.ampla contains apomorphine-like alkaloids (Emboden 1979a, 1981a; Schultes and Hofmann 1980a; Dobkin de Rios 1984; Torres 1984). For instance, Emboden (1979a, 1981a) claims that apomorphine-like compounds as well as nupharine and nupharidine were found in the flowers of N.ampla and that aporphine could be extracted from its bulbs and

roots. All such statements are said to be based on the analytical work of Díaz on N.ampla (Emboden, pers. commun. 1984; Dobkin de Rios, pers. commun. 1985; Torres, pers. commun. 1985). So far as I have been able to ascertain, however, this investigator has merely reported the isolation of an unidentified alkaloid from the leaves (Díaz 1976, 1977) and several unspecified alkaloids from the submerged parts (Díaz 1979). As to the possible psychopharmacology of N.ampla, Díaz (1976) points at the presence of tetraisoquinoline, benzylisoquinoline and aporphine alkaloids in other Nymphaeaceae, and subsequently at the central dopaminergic activity of apomorphine, which has an aporphine structure. It should not be overlooked, however, that only aporphines like apomorphine and N-propylaporphine, which have (or obtain in vivo) an intact dopaminergic moiety in their structure, may be expected to have substantial dopaminergic activity (Pinder et al. 1971; Cotzias et al. 1976). In a later publication, Díaz (1979) reports on auto-experiences with the intact bulb and extracts. On one occasion, 7 g of the pulverized dried bulb were ingested and on another, an aqueous extract equivalent to 35 g of the bulb was taken. There were no detectable psychological modifications. It should be noted that Díaz (1976, 1977, 1979) does not provide experimental data on the flowers of N.ampla. This is rather unfortunate, for if the Maya used the water lily as a ritual intoxicant, this anatomical section is the most likely plant part to have served this purpose (vide 1.4.2).

It has been demonstrated that poison from the skin glands of various Bufo species contains bufotenin (Bonhour et al. 1967; Schultes and Hofmann 1980b). This tryptamine alkaloid is extensively discussed in section 1.1.2.2. Besides bufotenin, steroidal bufogenins and bufotoxins, with a similar chemical structure and cardiotoxic action as scilla glycosides, may be present (Stoll 1937; List and Hörhammer 1972; Flier et al. 1980). The cardiotoxicity of these compounds would obviously place severe restrictions on the use of toad poison in ritual practices (Alger 1974).

1.4.4. Conclusion

The enema scenes on classic Maya pottery undoubtedly represent rituals and may very well indicate that the ancient Maya took intoxicating enemas in a ritual context. This idea is quite contrary to the traditional view that the ancient Maya were a contemplative people, who did not indulge in ritual ecstasy. The occasional display of vomiting actors would seem to provide a

plausible reason why the Maya opted for rectal application. Some scenes present a fair amount of evidence that an alcoholic beverage may have been taken rectally. Other scenes open up the possibility that tobacco and the water lily may have served as an enema ingredient. It is sometimes speculated that the latter plant is hallucinogenic, but pharmacological confirmation of this view is still awaited.