The beta-Carboline Hallucinogens of South America†

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β-Carbolines occur widely but haphazardly in the Angiospermae. They have been found in at least 64 genera in 28 families of the Angiospermae, in both the Monocotyledonae and Dicotyledonae; and, in the Dicotyledonae, in both the Archichlamydeae and the Metachlamydeae. These 64 genera are divided almost equally between the New World and the Old, and several have ranges in both hemispheres (Allen & Holmstedt 1980; Rauffauf 1970; Deulofeu 1967). No β-carbolines have as yet been reported from the Cryptogamae, except in three genera of the Fungi: *Amanita*, *Coriolus* and *Streptomyces* (Allen & Holmstedt 1980). With this type of chemotaxonomic distribution, it is probable that β-carbolines, relatively simply trypthophan derivatives, will be found in many more families as the result of future studies.

The angiospermous families and genera known to have β-carbolines are the following: Alangiaceae (*Alangium*); Apocynaceae (*Amsonia*, *Apocynum*, *Aspidosperma*, *Ochrosia*, *Pleiocarpa*); Bignoniaceae (*Newbouldia*); Calycanthaceae (*Calycanthus*); Chenopodiaceae (*Arthrophytum*, *Hammada*, *Kochia*); Combretaceae (*Guiera*); Cyperaceae (*Carex*); Elaeagnaceae (*Elaeagnus*, *Hippophae*, *Shepherdia*); Gramineae (*Arundo*, *Festuca*, *Lolium*, *Phalaris*); Icacinaceae (*Cassinopsis*); Lauraceae (*Nectandra*); Leguminosae (*Acacia*, *Anadenanthera*, *Burkea*, *Desmodium*, *Mucuna*, *Petalostylis*, *Prosopis*); Loganiaceae (*Strychnos*); Malphigiaceae (*Banisteriopsis*, *Cabi*); Myristicaceae (*Gymnacranthera*, *Virola*); Ochnaceae (*Testulea*); Palmae (*Plectocomiopsis*); Papaveraceae (*Meconopsis*, *Papaver*); Passifloraceae (*Passiflora*); Polygonaceae (*Calligonum*); Rubiaceae (*Arariba*, *Leptactinia*, *Nauclea*, *Ophiorrhiza*, *Pauridiantha*, *Pavetta*, *Pogonopus*, *Psychotria*, *Simira*, *Uncaria*); Rutaceae (*Araliopsis*, *Flindersia*, *Xanthophyllum*); Sapotaceae (*Chrysophyllum*); Simaroubaceae (*Aeschrion*, *Alianthus*, *Parriera*, *Picrasma*); Solanaceae (*Vestia*); Symplocarpaceae (*Symplocos*); Tiliaceae (*Grewia*); Zygophyllaceae (*Faonia*, *Nitraria*, *Peganum*, *Tribulus*, *Zygophyllum*) (Allen & Holmstedt 1980; Gibbs 1974; Rauffauf 1970).

Some of the plants containing these biodynamic constituents have local medicinal or related uses in primitive societies in both hemispheres (Schultes & Farnsworth 1980; Schultes & Hofmann 1980, 1979). Perhaps the most widely employed is the Syrian rue, *Peganum harmala* L., valued over its great extent, from the Mediterranean to Mongolia and Manchuria, for a broad spectrum of therapeutic, alleviative or magical purposes (Holmstedt 1981; Uphof 1968). It has even been suggested as one of the many identifications of the enigmatic soma, the god-narcotic of ancient India and Persia (Flattery 1978).

No group of β-carboline plants, however, has been

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the subject of such widespread interest among anthropologists, botanists, chemists, pharmacologists, psychologists and other investigators than the species of the genus *Banisteriopsis*, which are the source of a hallucinogenic drink used in tropical South America and known variously as *ayahuasca*, *caapi*, *natema*, *pinde* or *yajé* (Schultes & Hofmann 1980, 1979; Naranjo 1970; Friedberg 1965; García-Barriga 1958). Nor perhaps has any other β-carboline plant captured so intimately and irrevocably a place of such all-pervading potency in the life and death of the South American peoples who reverently value it as a medicine, hallucinogen and sacred element that permeates, in their concept, all of Creation (Reichel-Dolmatoff 1978, 1975, 1971; Harner 1973; Dobkin de Rios 1972; Spruce 1908, 1873).

The mind-altering properties of this narcotic drink have made it one of the most basically important aspects of Indian life in the western Amazon. The Kofáns and Jívaros, for example, talk with the spirits or heavenly folk through *ayahuasca* or *yajé*, believing that the drug reveals the real world to them and that daily living is a "lie," an illusion or fantasy; that the "true forces that determine daily events are supernatural and can be seen and manipulated only with the aid of hallucinogenic drugs" (Harner 1973). The Kechwa word *ayahuasca* means "vine of the soul," indicating the importance of the drug to religious belief in Peruvian Indian systems. It may stem from the frequent experience among the Indians that the soul separates from the body and wanders freely during the intoxication, consorting with the ancestors and mystically uniting with the divinities. This may be why Indians say that to drink *ayahuasca* is the equivalent of dying.

Recognizing that the individual must pass from one dimension of existence – or cosmic plane – to another to communicate with the spiritual or invisible world, the Tukanos take *caapi* to effect this transport. The trip represents to them the process of birth and breaking through the wall that separates the two cosmic planes and signifies, according to anthropological studies, the rupture of the placenta. Drinking *caapi* is often interpreted as returning to the "cosmic uterus." Since they insist that they sometimes come to know death while under the influence of the drug, the Tukanos consider the return to the cosmic uterus as an anticipation of death which permits contact with the divinity or visitation with the source and origin of all things (Reichel-Dolmatoff 1975). Tukano medicine men, for example, explain the progression of their hallucinations in their ceremonies and interpret for the other participants the visual and auditory aspects of the trance. The commonly experienced sensation of violently rushing currents of air are the winds pulling the soul along and sending it to the Milky Way, where it feels "enclosed by floating sheets that move and flutter, as if . . . in a room . . . of cloth." And all the while "yellow lights appear that become stronger and stronger, representing the sun, until they give the impression of a mass of luminous bodies in movement" (Reichel-Dolmatoff 1978).

Probably no other New World hallucinogen – even peyote – alters consciousness in ways that have been so deeply and completely evaluated and interpreted. *Caapi* truly enters into every aspect of living. It reaches into prenatal life, influences life after death, operates during earthly existence, plays roles not only in health and sickness, but in relations between individuals, villages and tribes, in peace and war, at home and in travel, in hunting and in agriculture. In fact, one can name hardly any aspect of living or dying, wakefulness or sleep, where *caapi* hallucinations do not play a vital, nay, overwhelming, role.

What are the plants – sacred above all others – and the chemical constituents that hold such power in native societies and such interest for modern investigators in numerous fields of study – anthropology, botany, chemistry, pharmacology, medicine and psychiatry? Only a fraction of what is common knowledge about these plants among the medicine men of aboriginal tribes is actually known to modern science. It behooves modern investigators to tap this valuable and ready source of information before the culture that gave it birth disappears through acculturation or extinction. Modern medical research has already gleaned so much from studies of so-called primitive societies that endeavors toward the investigation and understanding of the knowledge and medicinal practices of these neglected groups should stand in a place of the highest priority in technical programs of research (Schultes & Farnsworth 1980; Schultes 1967).

When, in 1852, the great English explorer of the Amazon and Andes, Richard Spruce, discovered *Banisteriopsis caapi* (Spr. ex Griseb.) Morton, in the Brazilian Amazon, he wrote plaintively: "This is all I have seen and learnt of caapi or ayahuasca . . . . Some traveller who may follow my steps with greater resources at his command will, it is hoped, be able to bring away materials adequate for the complete analysis of this curious plant" (Spruce 1908, 1873). But even today, 130 years later, this narcotic preparation remains botanically and chemically one of the most poorly understood of the American hallucinogens. The taxonomy of the

Malpighiaceae – the family of the genus *Banisteriopsis* – has been in a chaotic state until comparatively recent times. This state has been due in part to the inadequacy of botanical collections and in part to an actual paucity of taxonomic studies of a monographic nature. Likewise, knowledge of the chemistry has been equally or even more chaotic as a result primarily of both the confused botanical situation and the inexplicable failure of chemists to work with critically identified and vouchered material.

There has never been any doubt about the distinctiveness of *Banisteriopsis caapi*. Spruce collected flowering specimens from the same liana (climbing plant) from which the Tukano Indians in the Rio Uaupés of the Brazilian Amazon had prepared an intoxicating drink. He named the species *Banisteria caapi* Spruce ex Grisebach. According to modern practice, the correct generic name is *Banisteriopsis*. "There were about a dozen well grown plants of caapi twining up to the tree-tops along the margin of the roça (cultivated plot) and several smaller ones. It was fortunately in flower and young fruit, and I saw, not without surprise, that it belonged to the order Malpighiaceae and genus Banisteria, of which I made it out to be an undescribed species and therefore called it *Banisteria caapi*" (Spruce 1908, 1873).

Several years later, Spruce found the same *caapi* in use among the Guahibo Indians of the upper Orinoco in Colombia and Venezuela – where the natives "not only drink an infusion . . . but also chew the dried stem, as some people do tobacco" (Spruce 1908). Again, while at work in Andean Peru in 1857, he found the Záporo Indians taking a narcotic which they called *ayahuasca*, and he wrote that he "again saw caapi planted" and that "it was the identical species of the Uaupés . . . ." (Spruce 1908, 1873).

The earliest published report of any malpighiaceous narcotic, however, was that of the Ecuadorian geographer Villavicencio who, in 1858, wrote of the use along the upper Río Napo of Ecuador of *ayahuasca* in sorcery, witchcraft, prophecy and divination. Although no botanical specimen was taken, the full account, including one on self-intoxication, left no doubt that (as Spruce [1908, 1873] himself stated) although "of the plant itself" Villavicencio "could tell no more than that it was a liana or vine," his "account of its properties" coincided so "wonderfully with what I had previously learnt in Brazil" about *caapi* that it was not difficult to presume that the two were identical.

Later explorers of the Amazon, such as von Martius (1858) and Orton (1871), noted the employment of the narcotic drink in Indian ceremonies, but they failed to shed any reliable information on the botanical source of the drug. Then in 1883, Crévaux reported the use of *yajé*, an intoxicating drink prepared from the bark of a plant, among Indians of Amazonian Colombia, and he referred to an inebriating drink made from a "root" called *caapi* among the Guahibo Indians of the Río Inirida of the Orinoquia of Colombia, unaware apparently that the two were identical drugs.

Reports without botanical voucher material continued to appear. In 1886, Simson wrote that Ecuadorian Indians "drank ayahuasca mixed with yajé, sameruja leaves and guanto wood, an indulgence which usually results in a broil between at least the partakers of the beverage." None of the plant ingredients were identified, but this report deserves attention as the earliest indication that there might be a number of species employed in the mixture. Then a further complication arose in 1890, when Magelli, a missionary, confused *natema* (later shown to be the name of *Banisteriopsis* among the Jívaro of Ecuador) with *maiko*, the much employed tree-datura of these Indians.

The reports of narcotic drinks prepared from lianas continued (Tyler 1894), but no botanical material supported the statements. Writing of the Colorado Indians of Ecuador in 1905, the French anthropologist Rivet referred to *nepi* (*nepe*) as a febrifuge, a violent emetic and an intoxicant, stating that its source was "a liana" (Rivet 1905). Later, in a glossary, he identified the Colorado *nepe* and the Cayapa *pinde* as *Banisteriopsis caapi* (Rivet 1907). A much more recent work on these Indians has likewise referred the cultivated *nepe* of the Colorados to *B. caapi* (von Hagen 1937). There are, however, no authenticating botanical specimens to substantiate these identifications.

A variety of vernacular names appeared: *nepe*, *nepi*, *natema*, *pinde*, *yajé*, among others. Finally, in 1920, Karsten stated his belief that *ayahuasca*, *natema*, *pinde* and *nepe* were all referable to the same species as *caapi*: *Banisteriopsis caapi*. Yet, botanical material on which to base such a belief still was lacking.

The German anthropologist Koch-Grünberg (1909), who worked in the northwest Amazon between 1903 and 1905, wrote that "kaapi" was prepared from a "malpighiaceous shrub." He did collect some botanical specimens, but since this author has not found any of his collections referable to *Banisteriopsis* one must assume that he based his identification on the earlier Spruce report for the same region. Furthermore, he stated that the Karihonas knew the drug and called it "yahé" and hi(d)-yati(d) yahé and that the Tukanos distinguished two kinds of *caapi*: the stronger of the two being cultivated and not the wild type. He wrote to Rivet that he believed that *yajé* of the Karihonas and *mibi* of the Kubeos of Colombia, as well as *kali* of the Yekwanas of Venezuela, were the same drug and that, although he had no botanical evidence to support his belief, all were referable to *Banisteriopsis caapi.*

Reports of travelers and explorers continued to refer to *ayahuasca, caapi* and *yajé* without botanical material (Hardenberg 1918; Whiffen 1915). Perhaps the earliest modern botanical evaluation of the problem of identification of these narcotic preparations was that of Safford (1917) who asserted his belief, based on the literature, that *ayahuasca* and *caapi* were identical. But again, confusion was compounded when the French anthropologist Reinberg (1921), working in Amazonian Peru, suggested that *ayahuasca* and *yajé* might be different plants. On the basis of botanical material, he stated that *ayahuasca* was *Banisteriopsis caapi*, but with reservations he referred *yajé* to an apocynaceous genus Haemadictyon, possibly *H. amazonicum* Bentham, now correctly called *Prestonia amazonica* (Benth.) Macbride.

In 1922, White was the first to report the use of *Banisteriopsis caapi* in Bolivia. White collected material for chemical analysis, but a search in the Botanical Museum of Harvard Univerisity, where much of his material is preserved, has not turned up a voucher herbarium specimen. It was White who likewise indicated admixtures, signaling the leaves of *chacho*, a shrub with small globose red-yellow fruits and possibly also leaves locally known as *cagna* and *guayavoche*. The identity of *chacho* is not known.

The famous botanist-pharmacognosist Rusby (1924, 1923a, 1923b) wrote mainly on the physiological effects of *caapi*, but this author has not found any specimen of the basic plant of the drug in Rusby's extensive collections at the Harvard Botanical Museum. The Belgian botanist-explorer Claes (1932, 1931) collected in the uppermost Río Caquetá in Amazonian Colombia. He reported that *yajé* was not, as hitherto reported, a "small bush," but was an enormous forest liana. He stated that the Koreguahes made the intoxicating drink from the bark of *Banisteriopsis caapi* to which they added leaves and stems of another plant that the Indians would not permit him to see. He apparently was able to collect material of the additive, however, although he offered no identification of it; suggesting nevertheless that, according to Wildeman (cited by Claes), *yajé* "might be" *Prestonia amazonica.* This author was unable to locate Claes' herbarium material in Brussels. The pharmacologists Michaels and Clinquart (1926), who worked on Claes' material of the additive, ventured the belief that it represented *Prestonia amazonica.* The French pharmacologist Rouhier (1924) wrote that it seemed that *yajé* and *ayahuasca* might be identical plants but that they had different effects!

When, in 1923, the Colombian chemist Fischer reported on *yajé*, he stated that anatomic and histologic evidence indicated that the liana seemed to be a species of Aristolochia, an "identification" which Rouhier accepted a year later, but subsequently corrected (Rouhier 1926, 1924) when he stated his belief that *yajé* was comparable to *ayahuasca* in its physiological action and dismissed as "doubtful" the determination of *yajé* as *Prestonia amazonica.* At the same time, two other Colombian investigators, Barriga-Villalba (1925) and Albarracín (1925), investigated *yajé*, a "climbing shrub" which the natives did not cultivate because it abounded in the forest.

In 1926, the American traveler MacCreagh wrote about the intoxicant in the Río Tikié in Brazil, but he failed to identify the source beyond stating that it was "concocted from the leaves of a vine." And the English traveler McGovern (1927) encountered *caapi* in the same region, attributing it to "a root."

The period of the late 1920's and early 1930's was characterized by unusual activity in botanical, chemical and pharmacological research on the malpighiaceous narcotics of South America. In 1927, Perrot and Hamet, French pharmacologists, published an inclusive survey pointing out the state of confusion surrounding the botany and chemistry of the drug. They concluded that *yajé, ayahuasca* and *caapi* referred to the same plant, *Banisteriopsis caapi*, and that no apocynaceous species entered the preparation. Replying to these investigators, however, the German botanical specialist on the Malpighiaceae, Niedenzu (1928), working with botanical specimens which, unfortunately, were destroyed in the Berlin Herbarium during the Second World War, indicated that the drug in Ecuador and Peru was made from a mixture: leaves of the malpighiaceous *Mascagnia psilophylla* (Juss.) Grisebach var. *antifebrilis* (R. et P.) Niedenzu and the stem of *Banisteriopsis quitensis* (Ndz.) Morton and *B. caapi*.

Another attempt to put order into the botanical confusion was made by the French taxonomist Gagnepain (1930) in this same period. He decided that *ayahuasca* was "probably" *Banisteriopsis caapi*, but that *yajé* was not; that *yajé* "seemed to be" *Prestonia amazonica*; that fragmentary material showed *yajé* to be "an opposite-leaved vine"; that Rivet and Rouhier had submitted specimens which seemed to represent the same malpighiaceous plant; and that fertile material cultivated in Colombia under the name *yajé* was referable to *B. caapi.* These beliefs led Gagnepain to state that *yajé* in Colombia was the same plant as *caapi* in Brazil, but different from the *yajé* of Ecuador, which, he wrote, approached "*Banisteria ferruginea*." He consequently expressed the opinion that an exact clarification of the identification of *yajé* was far from realization.

At about the same time, the Russian botanist Hammerman (1930, 1929) published an evaluation of this problem, basing his statements on literature reports and on specimens gathered in Colombia in 1925-26 by Voranof and Juzepczuk. He quoted the Colombian newspaper reporter Zerda Bayón (quoted in Perrot & Hamet 1927) who asserted that the Indians of the Caquetá mixed four kinds of leaves to make the drink called *yajé* and indicated that the material collected by Voranof and Juzepczuk gave a variety of different chemical results when chemically analyzed. Hammerman pointed out that there seemed to be several species of *Banisteriopsis* involved, even though most of his material he referred to as *B. quitensis*. He noted that only Spruce had seen in flower a vine actually known by personal experience to have been used in the preparation of the narcotic drink, and he cautiously intimated that the well-recognized variation in preparation, use and effect of the hallucinogen called *caapi*, *yajé* and *ayahuasca* might be due merely to differences in chemical composition of the vegetal ingredients. In 1929, the pharmacologists Keller and Gottauf studied *ayahuasca* from Peru and Bolivia and, although their material lacked leaves or flowers, they referred it to "a *Banisteria*," isolating a harmine-like alkaloid.

A major botanical advance came in 1931, when the American botanist Morton reported on collections made in southern Colombia by the eminent Peruvian field-botanist Klug. From Klug's collections, Morton described a new species of *Banisteriopsis*: *B. inebrians* Morton, and indicated its use as a hallucinogen. But he stated also that at least three species – *B. caapi*, *B. inebrians* and *B. quitensis* – were used and that *Banisteria longialata* Ruiz ex Niedenzu and *Banisteriopsis rusbyana* (Ndz.) Morton may enter into the preparation as additives.

Two Brazilian pharmacologists, Costa and Faria, reported in 1936 that all of the malpighiaceous hallucinogenic preparations were made from *Banisteriopsis caapi*, but these investigators undoubtedly failed to base their statement on study of authenticating botanical material, so that their contribution scarcely advanced understanding of the drug. Three years later, however, Chen and Chen (1939), chemists working in the United States, briefly summarized the literature, indicating their belief that *ayahuasca*, *caapi* and *yajé* all referred to *Banisteriopsis caapi*: "a woody climber that attains a height of 3 to 4 meters and attaches itself to the trunks of large trees" or that is "grown in the northwestern regions of South America." The critical work of Chen and Chen identified the previously reported alkaloids telepathine, *yajé* and banisterine with harmine. The outstanding importance of the research of Chen and Chen lies in their chemical study, an analysis apparently for the first time based on vegetal material that seems to have been identified with voucher botanical specimens. For the "twigs, leaves and roots of caapi" and the "decoction just as used by the Indians" subjected to chemical analysis had been collected by the American botanist Llewelyn Williams (1936) near Iquitos and were determined as *Banisteriopsis caapi*.

For the most part, later investigators have concurred with the opinions of Hammerman, Gagnepain and Klug that several species of *Banisteriopsis* – if not of other genera – may be involved. Nonetheless, a variety of modern writers continue to cloud the issue, mainly because they do not base their opinions on botanical specimens. In a popular and generally unreliable, though oft-quoted, book, V.A. Reko (1936) reported that *ayahuasca*, *caapi*, *pinde*, *natema* and *yajé* all refer to *Banisteriopsis caapi*. In his dictionary of Amazonian plants, LeCointe (1945, 1934) referred *ayahuasca* and *caapi* to *B. caapi* but *yajé* to "another plant that enters into the composition of the caapi-drink as prepared by some tribes." Pardal (1937, 1936) referred *caapi* to *Banisteriopsis caapi* and *yajé* to *Prestonia amazonica*. The great German toxicologist Lewin (1931, 1929, 1928a, 1928b, 1928c) identified *natema*, *yajé*, *yabé*, *nepe* and *pinde* as *Banisteropsis caapi*, but he suggested that additives – including *Prestonia amazonica* – are on occasion employed.

An interesting note on *ayahuasca* in Peru appeared in 1943 and included a "recipe" for making the intoxicating beverage (Villarejo 1943). Unfortunately, all of the plants employed were identified only with Indian names. According to Villarejo, the beverage prepared in Iquitos has as its chief ingredient the "death vine" (*ayahuasca*), undoubtedly *Banisteriopsis caapi*. Into this decoction, the leaves of a species called "muemueti" are put. According to the informant, the muemueti is responsible for the visual hallucinations. Also entering the preparation is an evil-tasting tuber called "katija" and, to sweeten the drink, leaves and seeds of a plant called "pujana" are added. None of these plants has to date been botanically described.

The Peruvian botanist Herrera (1941) added still another plant to the list of potential sources: he stated that *ayahuasca* in the Valle de Lares is made from *Banisteriopsis metallicolor* (A. Juss.) O'Donnell et Lourteig, but herbarium voucher material was not cited. In the same year, Caller (1941) published in Peru a review of the literature, concluding that *ayahuasca* was prepared from *Banisteriopsis caapi* and that *B. inebrians* was merely a synonym. Other writers on Peru (von Hagen 1957; Szyszlo 1955) have similarly attributed *ayahuasca* exclusively to *B. caapi.*

Nontechnical writers on this topic have continued their own attempts at identification. Padre Placido (de Calella 1944), a Capuchin missionary in southern Colombia, reported that the Siona Indians often add to their hallucinogenic drink called *yajé* a plant called *peji* or *yako-borrachero* or *floripondio* of Mocoa, undoubtedly a species of *Brugmansia.* The British plant collector Sandeman (1947) attributed *yajé* to *Prestonia amazonica.* And, in his book on alkaloids, Henry (1949) identified *ayahuasca*, *caapi* and *yajé* as *B. caapi*, *Banisteria metallicolor* A. Jussieu or *Banisteria lutea* Ruiz ex Grisebach; while the chemists Manske and Holmes (1952) considered that all three drinks were prepared from *Banisteriopsis caapi.* The popular writers Taylor (1949), Hesse (1946) and Möller (1951) all similarly attribute *ayahuasca* and *yajé* to the same species. One of the most chaotic references (Leuenberger 1969) not only attributes the source of the South American malpighiaceous drugs to "*Banisteria caapi*" but states that eight subspecies occur in Mexico! Only a few popular writers have even attempted to consult the scientific literature (e.g., Aaronson & Osmond 1970).

The American botanist Allen (1947), in a description of the Yuruparí ceremony of the Kubeo Indians of the Río Vaupés in Colombia, indicated that the source of *caapi* was *Banisteriopsis caapi*, although this author has not been able to locate specimens of the source plant which he may have collected in the early 1940's. The American botanist Macbride (1950) pointed to *Banisteriopsis caapi*, *B. inebrians* and *B. quitensis* as the principal source of the β-carboline alkaloids in Peru and quoted Morton that *Banisteriopsis rusbyana* and *Banisteria longilata*, known as *oco-yajé* and *chagro panga*, were employed as admixtures, although Morton (1931) failed to mention the latter species.

Apparently, the second of the rare chemical studies on vouchered material was carried out on *Banisteriopsis inebrians* by the American pharmacologists O'Connell and Lynn in 1953. The material was collected by Schultes in the Colombian Putumayo and identified by voucher herbarium collections.

The Brazilian chemists Mors and Zaltzman expressed the opinion in 1954 that chemical examination convinced them that *ayahuasca* and *caapi* both represented *Banisteriopsis caapi*, that *yajé* was not the same narcotic and that yageine was a different alkaloid from harmine. There is no indication that voucher specimens were available in their study. In 1955, Fabre published a historical review, again without the support of botanical material, expressing his belief that the narcotic preparation was made basically from a single species, *Banisteriopsis caapi*, but pointed out that occasionally other plants might be used as additives.

In 1954, Schultes reported the use in Amazonian Brazil of a new species of the malpighiaceous genus Tetrapteris – *T. methystica* R.E. Schultes – in the preparation, without admixture, of the drink called *caapi.* Personal experimentation substantiated its biodynamic effects, but no chemical examination of the species has as yet been possible, since material collected for chemical study was lost when the canoes overturned in rapids. Subsequently, Schultes (1975a) noted another species – *T. mucronata* Cav. – as the source of *yajé* among the Karaparaná tribe in the Vaupés of Colombia.

This was not the first time that *Tetrapteris* had entered the picture. In the Museum of Economic Botany at Kew Royal Botanic Gardens, there are several samples of leaves and twigs sent in from Colombia in 1913 under the name "yajé plant." Sprague (Schultes 1957) wrote on the speciments that they "may be referable to *Tetrapterys* (sic)." This is the first time that a malpighiaceous genus other than *Banisteriopsis* had been mentioned as a source of the narcotic.

Following a number of years of field work in the northwest Amazon, Schultes (1957) published a detailed survey of what had up to that time been reported on the identification of the malpighiaceous narcotics of South America, indicating that the most widely employed species appeared to be *Banisteriopsis caapi*, but that *B. inebrians*, *B. quitensis* and *B. rusbyana* were likewise locally employed; that *Tetrapteris methystica* was employed in Brazil; and that *Mascagnia psilophylla* (A. Juss.) Grisebach var. *antifebrilis* Niedenzu had been reported as a possible source but that the reliability of the report was open to serious doubt.

In 1958 and later in 1975, the Colombian botanist García-Barriga, who had also carried out extensive field work in the Colombian Amazonia, reached the conclusion that the hallucinogenic drink might be prepared from *Banisteriopsis caapi*, *B. inebrians*, *B. rusbyana* or *Tetrapteris methystica.* In 1959, the Colombian ethnobotanist Uscátequí likewise suggested that the evidence pointed to four species: *Banisteriopsis caapi*, *B. inebrians*, *B. rusbyana* and *Tetrapteris methystica.* Emboden, in 1972 and again in 1979, attributed the source of the drink to four species of *Banisteriopsis*: *B. caapi*, *B. inebrians*, *B. quitensis* and *B. rusbyana*; and to *Tetrap-*

teris methystica.

Most recently, intensive taxonomic studies on the Malpighiaceae have been published, and these have shed a significant light on the problem of the identity of the drug. Cuatrecasas (1958), in his summary of the Malpighiaceae of Colombia, attributed the basic sources of the drug to two species of *Banisteriopsis*: principally to *B. caapi* and to *B. inebrians* as a less important source. *Banisteriopsis rusbyana*, he stated, was included by some Indians as an additive. "There is no doubt," he wrote, "that other species of the genus and even of other genera of the family may have the same or similar narcotic properties as *B. caapi*. Niedenzu cited a variety (v. *antifebrilis*) of *Mascagnia psilophylla* identified as *ayahuasca*. R.E. Schultes discovered the use of *Tetrapteris methystica* by the Makú Indians and personally experienced its strong hypnotic potency." He accepted *B. inebrians* as a distinct species, pointing out that it differed from *B. caapi* "only in its thicker leaf which is ovate and more shortly attenuate and in its samaras. These constitute in reality the only character of a positive nature to distinguish the species; the samaras have the wing semiobovate and very dilated at the end, with the lower margin strongly contracted towards the base. The size of the stipules (described for this species as larger) seem to be variable, and it is not easy to verify this character without abundant material."

There are several herbarium collections from Peru referable to *Banisteriopsis muricata* (Cav.) Cuatr. to which the vernacular name *ayahuasca* has been assigned (*Herrera 672, Woytkowski 5588*), suggesting the possibility that this species may likewise be used in preparing the intoxicating drink (Bristol 1966). The most recent taxonomic studies on South American Malpighiaceae are those of Anderson (1981) and of Gates (1979). Anderson investigated the species of this family found on the Venezuela-Guiana land mass. He included *Banisteriopsis caapi*, which is cultivated by some of the lowland Indians of the uppermost Orinoco. Gates, in her monographic work, treated *B. inebrians* as a synonym of *B. caapi*, a concept which this author is not ready to accept until more complete specimens are available for study.

Specialists in fields outside of botany are frequently confounded — and often rightly so — by nomenclatural changes occasionally made by taxonomists. In nonbotanical circles, confusion has surrounded the use of the generic epithet *Banisteriopsis* for certain species once assigned to *Banisteria*. When Spruce drew up his description of the plant from which *caapi* was prepared in the Uaupés, he named it *Banisteria caapi*, and the binomial was published by Grisebach (1958): *Banisteria caapi* Spruce ex Grisebach. When Morton (1931) accepted the related genus *Banisteriopsis* as distinct, he made the appropriate nomenclatural transfer: *Banisteriopsis caapi*. There is still, unfortunately, a tendency towards the use of *Banisteria* in reference to species employed in preparing the narcotic malpighiaceous drinks of South America, even (it is to be regretted) in botanical publications (Heywood 1978; Cardenas 1969; Mors & Rizzini 1966; Ducke 1946). An increasing number of technical writers, however, are employing the correct generic epithet.

There is no reason, in this article, to enter into the highly technical arguments for the change. Morton (1931) convincingly set forth the reasons why the epithet *Banisteria* is not available for these species and why, in accord with the lucid arguments of Robinson (1910), the generic epithet must be *Banisteriopsis*. Furthermore, the most recent and thorough taxonomic studies of the Malpighiaceae (Gates In press; Anderson 1981a; Cuatrecasas 1958) have followed Morton in recognizing the generic epithet *Banisteriopsis*.

Richard Spruce, who in 1852 collected the type material of the plant from which the Indians of the Rio Uaupés in Amazonian Brazil prepared *caapi*, was far ahead of botanists of his period (Schultes, Holmstedt & Lindgren 1969). Along with the herbarium specimens, which permitted him to ascertain that the plant was new to science, he collected stems for chemical analysis. "At the feast of Urubú-coara, I learnt that caapi was cultivated in some quantity at a roça a few hours journey down the river," he wrote (Spruce 1908) after having witnessed a ceremony at Urubú-coara, "and I went there one day to get specimens of the plant and (if possible) to purchase a sufficient quantity of the stems to be sent to England for analysis; in both of which objects I was successful . . . there were about a dozen well growing plants . . . twining up to the treetops . . . and several smaller ones. Fortunately, it was in flower and young fruit . . . . My surprise arose from the fact that there was no narcotic Malpighiad on record, nor indeed any species of that order, with strong medicinal properties of any kind."

As long ago as 130 years, Spruce's thinking was chemotaxonomic. In those years, there was little liaison between botanical explorers and laboratory chemists. Botanists seldom bothered to collect material for phytochemical study and, unfortunately, this is too often true even today. In Spruce's case, with the great distance and isolation of the area of his field work and the primitiveness and absence of normal communications, to fail to gather material for chemists might have been sympathetically understood. Notwithstanding these drawbacks, Spruce did make the majestic effort; but, like so many modern botanical collectors, he was frustrated in his attempt.

> I obtained a good many pieces of stem, dried them carefully, and packed them in a large box which contained the botanical specimens and despatched them down river for England in March 1853. The man who took that box and four others on freight in a large new boat he had built on the Vaupés was seized for debt when about half-way down the Rio Negro, and his boat and all its contents confiscated. My boxes were thrown aside in a hut, with only the damp earth for floor, and remained there many months, when my friend Senhor Henrique Antonij of Manános . . . succeeded in redeeming them and getting them sent to . . . Pará. When Mr. Bentham came upon them in England, he found the contents somewhat injured by damp and mould, and the sheets of specimens near the bottom of the box quite ruined. The bundle of the caapi would presumably have quite lost its virtue from the same cause, and I do not know that it was ever analyzed chemically . . . .

It was not analyzed until 117 years later! Perhaps with the state of analytical alkaloid chemistry in the middle of the last century, it was just as well that this critical material was not studied at that time.

With the assistance of the officials at the Royal Botanic Gardens at Kew, the material was located and submitted to analysis in 1969 (Holmstedt 1981; Schultes, Holmstedt & Lindgren 1969). Five pieces weighing in all 26.7 g were available and 11.5 g were worked up for gas chromatography, mass spectrometry and other methods of analysis. The yield of alkaloids was 0.4%. When compared with a recently collected specimen, the percentage was 0.5. The newer material contained, as frequently described, the main alkaloids harmine, harmaline and tetrahydroharmaline. Two minor components were likewise found. By contrast, the Spruce material contained exclusively harmine. It is possible that harmaline and tetrahydoharmaline have with time been transformed into the chemically more stable aromatic β-carboline, harmine.

It is really extraordinary, however, that it took 117 years to answer Spruce's query concerning bioactive constituents in the Malpighiaceae. Would that modern, sophisticated chemical techniques could be applied to other equally significant early collections of biodynamic plants!

Early chemical examination in 1905 on material purported to be "yajé" yielded an alkaloid which Zerda Bayón (quoted in Perrot & Hamet 1927) had called telepathine. Voucher botanical material apparently did not exist. The first serious chemical analysis, however, again suffered from the absence of reliable botanical material. The Colombian chemist Fischer Cardenas (Fischer C. 1923) isolated and studied an alkaloid which he felt was responsible for the activity of the drug; he reserved for it the name telepathine. At about the same time, the Colombian chemist Barriga-Villalba (1925) and pharmacologist Albarracín called the alkaloid yageine. Barriga-Villalba assigned it the formula $C_{14}H_8N_3O_3$ and a melting point of 206°, but it is believed to have been impure, since it does not conform to an aromatic β-carboline structure (Deulofeu 1967). The vine with which Barriga-Villalba worked had been "identified" as *Prestonia amazonica*, but he later abandonded this identification in favor of *Banisteriopsis caapi*.

In 1926, Michaels and Clinquart isolated, again from unvouchered material, an alkaloid which they called yageine. Shortly thereafter, in 1927, Perrot and Hamet isolated a pure substance with a melting point of 258°, calling the alkaloid telepathine and suggesting that telepathine and yageine were identical. A year later, Lewin (1928b) isolated an alkaloid which he named banisterine. This alkaloid was shown to be identical with harmine, known from the Syrian rue, *Peganum harmala* of the Zygophyllaceae (a family closely related to the Malpighiaceae) by chemists from E. Merck: Elger (1928) and Wolfes and Rumpf (1928). Elger worked on material that he received from Hamet, which had been identified at the Royal Botanic Gardens at Kew as *Banisteriopsis caapi*.

Employing ample material collected in the Peruvian Amazon and properly vouchered by Williams, Chen and Chen (1939) isolated harmine from the stem, leaves and roots of *Banisteriopsis caapi* in 1939 and, as has been indicated, confirmed the identification of harmine with banisterine. In 1957, Hochstein and Pardies analyzed material of *ayahuasca* collected in the Peruvian Amazon in the vicinity of Iquitos. Harmine, harmaline and tetrahydroharmine, the latter two in large concentrations, were isolated.

Working on vouchered material of *Banisteriopsis inebrians* collected by Schultes in the Colombian Putumayo, O'Connell and Lynn (1953) found that the stems contained harmine and the leaves "an alkaloid which was partly identified as harmine," thus confirming Chen and Chen's conclusions. Less attention has been paid to *Banisteriopsis inebrians* than to *B. caapi*. Harmaline and harmalol were not encountered. Several years later, Poisson (1965) studied material from Peru called "natema" and critically identified by Cuatrecasas as *Banisteriopsis inebrians* with similar results: the stems contained harmine and small amounts of what seemed to be harmaline.

The most recent analytical work on *Banisteriopsis caapi* was that of the Japanese chemists Hashimoto and Kawanishi (1976, 1975). The Instituto Agronômico do Norte in Belém do Pará was the source of their authentically determined botanical material. Several new organic bases were reported by these workers: harmine N-oxide, harmic acid methyl ester (methyl 7-methoxy-β-carboline 1-carboxylate); harmalinic acid (7-methoxy-3,4-dihydro-β-carboline 1-carboxylic acid); harmic amide (1-carbamoxyl-7-methoxy-β-carboline); acetyl norharmine (1-acetyl-7-methoxy-β-carboline); and ketotetrahydronorharmine (7-methoxy-1,2,3,4-tetrahydro-1-oxo-β-carboline). Whether or not some of these bases may be artifacts is open to serious question. Nevertheless, what little is now known of the chemistry of the family and the ethnobotanical data for biodynamic uses of numerous species in several genera both indicate that the Malpighiaceae deserves much more chemical investigation, since it is obviously much richer in active compounds than presently realized (Schultes 1975a).

It is known that Amazonian Indians employ many plants as additives to the narcotic drink prepared basically from *Banisteriopsis caapi* or *B. inebrians* (Rivier & Lindgren 1972; Schultes 1972; Der Marderosian, Pinkley & Dobbins 1968; Schultes 1957). Only two of the many additives will be considered in this discussion: *Diplopterys Cabrerana (Cuatr.) Gates (Banisteriopsis rusbyana)* and *Psychotria viridis* Ruiz et Pavón. A complete survey of additives has been published by Rivier and Lindgren (1972).

Throughout the course of the botanical and chemical studies of the malpighiaceous narcotics of South America, the use of a plant, which until recently has been known as *Banisteriopsis rusbyana*, is encountered. It was apparently Morton (1930) who, on the basis of Klug's collections, first indicated that this species might enter the preparation as an additive. The plant is called *oco-yajé* or *chagro-panga* in the Colombian Putumayo and adjacent areas of Peru. The name of this plant has subsequently appeared in a number of papers as either the sole source of the narcotic preparation or as one of the ingredients (Schultes & Hofmann 1980, 1979; Agurell et al. 1968; Der Marderosian, Pinkley & Dobbins 1968; Deulofeu 1967; Poisson 1965).

In 1965, Poisson reported finding N,N-dimethyltryptamine in material identified by Cuatrecasas as *Banisteriopsis rusbyana*. In 1968, on the basis of vouchered material collected by Pinkley among the Kofán Indians of Ecuador, Der Marderosian made the corroborative discovery that this additive had N,N-dimethyltryptamine, but no β-carboline alkaloids (Pinkley 1969; Der Marderosian, Pinkley & Dobbins 1968). The natives in this area, as elsewhere in the Amazon, use this additive "to heighten and lengthen the intoxication." This discovery is significant because it represents the first time that a tryptamine has been found in the Malpighiaceae.

More recent work has indicated that this species is cultivated or gathered from the wild over a large area of the western Amazon for use as an admixture, but that it is never used alone in the preparation of an intoxicating drink. *Diplopterys Cabrerana* is now the correct name, according to Gates (1979), not only for *Banisteriopsis rusbyana* but for *B. Cabrerana* Cuatr.[1] The species has hitherto been reported in the literature under the binomial *Banisteriopsis Cabrerana*.

The great difference in chemistry between this species and *B. caapi* – the former with a tryptamine, the latter with β-carbolines – led to the suggestion in 1973 by Schultes and Hofmann that further studies be made: "An incompletely understood species, reported from the Amazon of Bolivia, Colombia, Ecuador and possibly Peru. The extraordinary chemical differences between this species and *B. caapi* and *B. inebrians* suggests that thorough chemotaxonomic studies might cast doubt even on its generic relationships." Current taxonomic studies indicate indeed that *Diplopterys Cabrerana* is not even closely related to that section of the genus Banisteriopsis to which *B. caapi* belongs (Anderson 1981b).

In several far distant parts of the Amazon Valley, the leaves of at least one species of Psychotria – *P. viridis* Ruiz et Pavón – are added to the beverage made from Banisteriopsis (Der Marderosian et al. 1970; Schultes 1967b). Several other species – *P. horizontalis* Swartz, *P. carthaginensis* Jacquin and others – have likewise been suggested as additives. The Kofán Indians of Amazonian Colombia and Ecuador use the leaves of *P. viridis* to strengthen and lengthen the visions induced by the intoxicating drink. In the Acre of Brazil, the leaves of *P. viridis* are valued as an additive. The Kashinahua of eastern Peru and adjacent Brazil employ the leaves of two different species of Psychotria, known by their native names "nai-kawa" and "matsi-kawa" (Der Marderosian et al. 1970). The same custom has been reported from Amazonian Brazil (Prance 1970; Prance & Prance 1970). The chemical constitution of the leaves of *Psychotria viridis* explains the use of this plant as an additive: they contain N,N-dimethyltryptamine, the first evidence of tryptamines in the family Rubiaceae (Der Marderosian et al. 1970).

The literature – both botanical and chemical – has been plagued with the "identification" of the narcotic preparations known as *ayahuasca*, *caapi* or *yajé* as a derivative of the apocynaceous *Prestonia amazonica*, better known by its former name *Haemadictyon amazonicum*. A number of technical and popular writers have identified the narcotic as this apocynaceous plant or have presumed that the species was employed as one of the additives. *Prestonia amazonica* has unfortunately, for this belief, been collected only once – in 1859 – and in a locality on the lower Amazon, 1,200 miles in a straight line from the localities where the drug *caapi* is employed. In 120 years, the plant has never been re-collected by botanists, so it is obviously a rare element of the flora of a far distant area, not likely to have been economically employed in preparing a commonly used drug in the western Amazon.

It was apparently Spruce (1908, 1873) who first suggested that *Prestonia amazonica* might enter into the *caapi* picture. He said that *caapi pinima* ("painted caapi") is "an apocynaceous twiner of the genus Haemadictyon, of which I saw only young shoots, without any flowers. The leaves are of a shining green, painted with strong blood-red veins. It is possibly the same species . . . distributed by M. Bentham under the name *Haemadictyon amazonicum* n. sp. It may be the caapi-pinima which gives its nauseous taste to the caapi . . . and it is probably poisonous . . . but it is not essential to the narcotic effects of the Banisteria, which (so far as I could make out) is used without any admixture by the Guahibos, Záparos and other nations out the Uaupés."

This confusion has resulted from a careless interpretation of Spruce's field notes by the French anthropologist Reinberg (1921). One must bear in mind that Spruce, great botanist though he was, was working in the Amazon without any herbarium and months from correspondence with central botanical institutions. He presumed that an additive, which in those far-off wilds reminded him of a new species of Prestonia (Haemadictyon) that he had collected months before, might "possibly" represent the same species. This casual note of a field botanist, for years isolated from laboratory and herbarium facilities, has been taken as a *dictum* by later uncritical investigators, and especially by investigators totally devoid of botanical training.

The most extraordinary error resulting from this misinterpretation was the identification of an aqueous solution by the chemists Hochstein and Paradies (1957) who analyzed what, without any voucher botanical material, they received as "yajé." These chemists assert in a footnote that the "identification" was made by the Peruvian botanist Ferreyra (1959) who informed this author that he never saw botanical specimens.

As a result of this apparently serious report, the literature has continued to insist that *Prestonia amazonica* has a major or minor part in the preparation of *ayahuasca*, *caapi* or *yajé*. In 1960, however, in a review of the alkaloids of the Apocynaceae, Raffauf and Flagler (1960) stated that "the reported occurrence of only one simple indole in the Apocynaceae to date is of sufficient interest to warrant some speculation. The structure looks enough out of place to suggest that the sample studied was not Prestonia . . . ."

Eventually, Schultes and Raffauf (1960) published a historical, botanical and chemical review of the problem which concluded that: (1) There is no botanical support, nor any reliable support in the literature for the assumption that Prestonia (least of all *P. amazonica*) enters the preparation; (2) There is no reliable reference except Spruce's suggestion that any apocynaceous species are used; and (3) There is no evidence that N,N-dimethyltryptamine – the active constituent of the additive presumed by so many to be *Prestonia amazonica* – occurs in this genus.

While β-carboline alkaloids in South American narcotics are usually associated with Banisteriopsis preparations, they have also been found in other hallucinogenically employed plants. The presence of β-carbolines in certain snuffs prepared from species of the myristicaceous Virola and the leguminous Anadenanthera (Schultes & Hofmann 1980), which owe their psychoactivity mainly to tryptamines, was first indicated by Holmstedt and Lindgren in 1967. Six snuffs of uncertain origin were examined. One had small concentrations of 5-methoxy-N,N-dimethyltryptamine and, in addition to simple indoles, contained harmine; one contained only β-carbolines.

At that time, these investigators wrote:

> . . . it is evident that tryptamines, both unsubstituted and substituted in the ring (5-OH and 5-Me-O-) occur, and that both secondary and tertiary amines are present. In addition to this, some snuffs contain β-carbolines, either in combination with the simple tryptamines or solely. In South American botany, β-carbolines (harmine, harmaline and tetrahydroharmine) are usually associated with the species of Banisteriopsis, wherefore it is very likely that this is their origin in the snuffs. Very likely this is an admixture to

the snuff, although definite botanical proof for it is lacking at the moment. To the knowledge of the authors, simple indoles and β-carbolines have not yet been isolated *from the same plant* .... Further botanical and chemical studies are obviously needed to see if the two groups of compounds in the snuff are derived from one plant or a mixture of plants.

Shortly thereafter, the presence of two new β-carboline alkaloids in South American snuffs, prepared from plants of which the major active constituents were known to be tryptamines (Holmstedt & Lindgren 1967), was reported (Agurell et al. 1968). The compound 2-methyl-6-methoxy-1,2,3,4-tetrahydro-β-carboline was isolated from *Virola theiodora* (Spr. ex Benth.) Warburg[2] and the snuff prepared from it, from *V. rufula* (A.DC.) Warburg[2] (not known to be used as a hallucinogen) and from *Anadenanthera peregrina* (L.) Spegazzini. This latter hallucinogenic plant had in addition the β-carboline, 1,2-dimethyl-6-methoxy-1,2,3,4-tetrahydro-β-carboline. A year later, this discovery was reported for a second time (Agurell et al. 1969).

In the decade following these announcements, chemical studies of Virola have been intensified, thanks especially to the fully equipped chemical laboratory aboard the R/V Alpha-Helix which, in its Phase VII of 1977-78 Amazon Expedition, made possible the analysis of freshly collected material of a number of species of Virola and related species with the most modern equipment, including an LKB mass spectrometer. The results of these investigations combined with previous analyses are now in publication (Holmstedt 1982; Holmstedt et al. 1982). They set forth the indole alkaloid composition of some 15 species of Virola, all with voucher specimens, as well as the analyses of species of the myristicaceous genera Compsoneura, Iryanthera and Osteophloem. Species employed in preparing hallucinogenic snuffs, as well as those for which no use is known, were analyzed and reported. This author knows of no tropical American group of plants of interest for its use for hallucinogenic or otherwise psychoactive effects that has been so thoroughly investigated with botanically vouchered material and with the use of the most modern chemical techniques.

It is of interest to the present discussion that trace amounts of β-carbolines have been found in *V. calophylla* Warburg, *V. elongata* and *V. theiodora* – all three the sources of a hallucinogenic snuff. One species not known to be employed in preparing a snuff – *V. cuspidata* (Spr. ex Benth.) Warburg[2] – has β-carbolines as the principal alkaloids (Holmstedt et al. 1982).

The presence of β-carboline alkaloids in preparations made from Virola is biochemically significant. The β-carbolines are monoamine oxidase inhibitors which may potentiate the activity of simple indoles. It is difficult to admit that the presence of β-carbolines, even in trace amounts, with tryptamines is "pharmacologically of no importance" (Holmstedt & Lindgren 1967).

The Bora and Witoto Indians of Amazonian Colombia and Peru do not utilize Virola as a snuff; they prepare pellets from the resin-like bark exudate and ingest them. The species used are *V. elongata*, *V. Pavonis* (DC) A.C. Smith and *V. theiodora*; and possibly *V. surinamensis* (Rol.) Warburg and *V. loretensis* A.C. Smith. Hallucinogenic tryptamines have been found in all, except in the last two named species.

The tryptamines are believed to be inactive when taken orally, unless they are in the presence of a monoamine oxidase inhibitor. They are experimentally known to be exceedingly psychoactive. No other organic material is added to the Virola-exudate during the preparation of these pellets. The very primitive Makú Indians of the Río Piraparaná in Colombia simply ingest the raw "resin" from the bark of Virola with no admixture (Schultes & Swain 1976; Schultes 1973, 1969). In this form, it is psychoactive. Consequently, it appears that possibly the trace amounts of β-carbolines present in these species of Virola must act as the inhibitor potentiating the activity of the tryptamines.

Quite unlike the situation with the botanical sources of the malpighiaceous narcotics, there has been no confusion concerning the species of Virola used as hallucinogens; for almost all research concerning these narcotics, since 1954, has relied on voucher material. In 1954, *V. calophylla* and *V. calphylloidea* Markgr., and possibly *V. elongata* were signaled as the species most employed in the Colombian Amazon (Schultes 1954a). In 1968, *V. theiodora* was indicated (Schultes & Holmstedt 1968) as a major source. Later studies (Schultes, Swain & Plowman 1978; Schultes & Swain 1976; Schultes 1973, 1969) have greatly enriched the knowledge of the botany of the myristicaceous narcotics.

The only confusion encountered in the botanical studies of the Virola narcotics has resulted from the writings of the Italian anthropologist Biocca (Biocca 1966, 1965; Biocca et al. 1964) who has indicated that the Waika snuff "epena" is prepared from *V. cuspidata*, "*V. punctata*"[3] and *V. rufula*. But no voucher specimens are cited nor are they available. Biocca credits the Brazilian botanist William Rodrigues with the identification of his material, but Rodrigues (1980a) states that he did not determine any specimens from Biocca's expedition, and this author found no voucher specimens in the herbarium at the Instituto Nacional de Pesquisas da Amazônia in Manáos where Rodrigues is based. If these identifications prove to be correct, the information is highly significant: for the principal alkaloids of *V. cuspidata* are harmine bases, not tryptamines; and the bark of *V. rufula* is extraordinarily rich in 5-methoxy-N,N-dimethyltryptamine, while the roots and leaves are equally rich in tryptamines (Holmstedt et al. 1982).

The genus Cabi, closely allied to Banisteriopsis, was described by Ducke in 1943. From the stems and leaves of *Cabi paraensis* Ducke, native to the eastern Amazon of Brazil, Mors and Zaltzman isolated harmine (Siqueira-Jaccoud 1959; Mors & Zalzman 1955). Although included in the folk medicine of the region, this species apparently never has been employed as a hallucinogen (Ducke 1946).

There are several reports concerning the use of Banisteriopsis in other ways than as a drink. Recent indirect evidence from the northwest Amazon opens up the possibility that it may also be used as a snuff. Harmala alkaloids have been reported from snuff powders prepared from a "vine" said to also be the source of an intoxicating drink, but voucher botanical specimens are lacking (Holmstedt & Lindgren 1967). Since neither Anadenanthera nor Virola are vines, the possibility that Banisteriopsis is involved is somewhat enhanced.

In his field notes, Spruce (1908) stated, for example, that "when I was at the cataracts of the Orinoco in June 1854, I again came upon caapi, under the same name, at an encampment of the wild Guahibos, on the savannas of Maypures. These Indians not only drink the infusion, like those of the Uaupés, but also chew the dried stem, as some people do tobacco. From them, I learnt that all the native dwellers on the rivers Meta, Vichada, Guaviare, Sipapo, and the intervening smaller rivers, possess caapi and use it in precisely the same way."

Biocca et al. (1964) reported the isolation of harmine, harmaline and tetrahydroharmine from a snuff called "paricá" and collected from the Tukano and Tariana Indians along the Rio Uaupés in Brazil. These are the same alkaloids found in *Banisteriopsis caapi*. There is again no botanical material on which any identification might be made, and this report is, consequently, equally as unreliable as others in Biocca's writings. Bernhauer (1964) isolated harmine and tetrahydroharmine from a snuff prepared by the Waika Indians along the Rio Demini, an affluent of the Rio Negro of Brazil. According to Bernhauer, the snuff was known as *paricá*, *yopo* and *ebena* — names applied in the region usually to snuffs prepared from Anadenanthera or Virola. Again, botanical vouchers are unfortunately lacking.

The whole fascinating, if somewhat exasperating, story of the identification and chemical constitution of the β-carboline narcotics of South America serves to emphasize how little is known about some of the most widely used and most culturally significant hallucinogens of the American Indians. It further serves to support the statement of Holmstedt and Lindgren (1967): "Once again, one cannot but marvel at the ingenuity of the South American Indians who relentlessly seem to be able to find their way to the right herb containing the most active component." And one must harken back to the wish of Spruce in 1852: "This is all I have seen and learnt of caapi or ayahuasca.... Some traveller who may follow my steps with greater resources at his command will, it is hoped, be able to bring away materials adequate for the complete analysis of this curious plant." Would that the perspicacity of today's botanists and chemists were equally keen in solving the complex problems surrounding these extraordinary mind-altering plants and the preparations made from them.

NOTES

1. *Diplopterys Cabrerana* (*Cuatr.*) *Gates* in *Brittonia* 31(1979)109; *Banisteriopsis Cabrerana* Cuatrecases in *Webbia* 13(1958)493; *Banisteriopsis rusbyana* (Ndz.) Morton in *Journal of the Washington Academy of Science* 21(1931)487; *Banisteria rusbyana* Niedenzu, Ind. Lect. Lyc. Brunsberg 1901 19(1901). Malpigh. (1928)445.

2. The most recent monograph on Virola (Rodrigues 1980b) treats *V. theiodora* provisionally as a synonym of the very variable and "very complex" *V. elongata* (Benth.) Warburg; but, since the two look very different in the field and are widely recognized as distinct by the Indians who use them, this author prefers to consider the two as separate, although related, species. The same monograph places *V. rufula* as a synonym of *V. elongata*. Similarly, it puts the binomial *V. cuspidata* into synonym under *V. elongata*. The chemical differences of *V. rufula* and *V. cuspidata*, however, cast doubt on the disposition of both as synonyms of *V. elongata*.

3. The binomial "*Virola punctata*" has never been validly published and is botanically a *nomen nudum*. Biocca undoubtedly meant to indicate a concept origi-

nally described under the name *Myristica punctata* Spr. ex Benth., also known as *Palala punctata* (Spr. ex Benth.) Kuntze, *nom. illegit.* and *V. elongata* (Benth.) Warburg var. *punctata* (Spr. ex Benth.) Warburg. According to Rodrigues (1980b), this concept is referable to *V. elongata.*

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