De Plantis Toxicariis E Mundo Novo Tropicale Commentationes XI'

The Ethnotoxicological Significance of Additives to New World Hallucinogens

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Notwithstanding extraordinary advances in recent years, the study of the New World hallucionogens is far from complete. It may, in fact, be actually on the threshold of greater and more significant discoveries than those standing now on our list of achievements.

Between 80 and 85 species of plants are now known to be employed hallucinogenically in primitive societies of the Americas (23, 24, 25, 28). Three of these species are Old World plants which have not found utilization for psychotropic effects in any part of the Eastern Hemisphere. There are, furthermore, five or six species reportedly used as narcotics, but we are not yet certain of whether or not their effects are truly hallucinogenic. The identification of some of the hallucinogens goes back to the early writings on their uses. Others have either only recently been discovered or else their botanical determination has been accomplished during the last few years.

The literature enumerates some eight or 10 species of New World hallucinogens the source of which is still a mystery and which future research must try to identify.

That is where we stand at the present time. We have come far in our identification of the New World hallucinogens. There is, however, another aspect of our study that has sadly lagged behind and which now cries out for immediate attention before the demise of most, if not all, primitive societies — the repositories of such plant and medicinal lore. That neglected aspect is precisely the use of additives to alter the effects of the principal hallucinogenic preparations. Here we are still standing on the threshold with one hand on the knob of a door just set ajar, not yet opened.

The vital significance of the study of additives to our understanding of hallucinogenic plants has recently become evident (5, 9, 15, 16, 18, 19, 25, 26, 27). Many secondary ingredients of psychotomimetic preparations are of major importance in altering or prolonging the narcotic effects of the principal ingredient.

While it is undoubtedly true that some of the plant additives are used merely for superstitious or magic reasons and have no biological function, nevertheless we can point to examples once considered to be in this category but recently shown to possess actual and potent activity. From now on, concerted emphasis must be directed towards investigation of additives.

Perhaps the hallucinogen with the greatest variety and most interesting additives is the South American drink known variously as *ayahuasca*, *caapi* and *yaje* and prepared basically from the bark of the liana *Banisteriopsis caapi* or *B. inebriansthe* (9, 15, 18, 31). The bark of these two species of the Malpighiaceae contains the B-carboline alkaloids harmine, harmoline and tetrahydroharmine (25,26). Yet we now know that, even though the drink occasionally contains only this plant ingredient, it is often not a simple narcotic but a complex, sometimes involving a number of plant additives. One contemporary investigator of medical practices amongst the Siona Indians of the Colombian Putumayo, for example, claims that these natives recognize 17 different "classes" of yaje and that each of these admixtures "give a different kind of vision" (14). Unfortunately, few of these additives have as yet been identified; but the Siona are widely known as having an extraordinarily rich ethnopharmacopoea, and it is very possible that most, if not all, of these many additives, have psychoactive constituents. Another specialist has assembled for the Barasana Indians of the Rio Piraparana of Colombia a list of 29 named "varieties". Some of these names may be alternate names for the same plant; others may represent age or ecological forms of *Banisteriopsis caapi*; but some undoubtedly refer to different plants that are used as admixtures (13).

Cultivated vine of Banisteriopsis caapi. Rio Piraparana, Vaupes, Colombia. (Photograph by R. E. Schultes)

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Two of the many plant additives to ayahuasca are especially noteworthy because their leaves have been found to contain not the B-carbolines but N,N-dimethyltryptamine. One is *Banisteriopsis rusbyana*, quite generally called *oco-yaje*. The other represents several species of the rubiaceous genus *Psychotria: P. viridis, P. cathargenensis* and perhaps others (4, 5, 15, 26).

The use of oco-yaje has been known for many years, but only very recently has the chemical reason for this admixture been discovered. The addition of the leaves of another species of *Banisteriopsis* the bark of which was never employed has frequently been explained by ethnologists on the basis of superstitious or magic practices. Now we know that there is a very definite chemical basis. One of the most curious anomalies is why *Banisteriopsis rusbyana* possesses dimethyltryptamine in its leaves — when this tryptamine is absent from *B. caapi* and *B. inebrians* — but lacks the B-carboline alkaloids, the active principle in the other two species. This isolation represents the first record of tryptamines in the Malpighiaceae (4, 15).

Similarly, N,N-dimethyltryptamine has recently been found in the leaves of *Psychotria viridis* and one would presume is present in the leaves of the other species employed as additives (5). Before 1970, tryptamines had never been reported from the Rubiaceae. This utilization of *Psychotria* was first reported only in 1967, but an earlier herbarium collection had indicated its use as an additive with *Banisteriopsis caapi (William Burroughs s.n.)* An extraordinarily interesting plant additive recently discovered amongst the Barasana Indians of the Colombian Vaupes is the rubiaceous *Sabicea amazonenis*, the leaves of which are sometimes added "to make the drink sweet instead of bitter". In view of the discovery of N,N-dimethyltryptamine in the rubiaceous genus *Psychotria*, the chemical examination of *Sabicea* acquires special significance as an admixture to the caapi drink.

The addition of plant additives to the drink made basically from the bark of *Banisteriopsis caapi* or *B. inebrians* is not new. One hundred and twenty years ago, the British plant explorer of the Amazon and Andes, Richard Spruce, suggested that the Tukano of the Rio Uaupes of Brazil occasionally add a leaf which they called *caapi-pinima* or "painted caapi" (31). He did not collect voucher material but indicated that it looked like

Tukanoan Indian with stems of three "kinds" of caapi preparatory to making hallucinogenic drinks from the bark. Rio

the apocynaceous *Prestonia* [*Haemadictyon*] *amazonica*. Uncritical or careless quotation by later writers so distorted Spruce's suggestion that the botanical, chemical and ethnobotanical literature is now seriously plagued with uncertainty. Although the use of the leaves of *Prestonia amazonica* has been discredited, there runs through the literature a belief that ayahuasca and caapi are prepared from *Banisteriopsis*, whilst the source of yaje may be attributed to the *Prestonia* (19). The identity of *caapi-pinima* is still unknown.

Even though we are now quite certain that *Prestonia amazonica* is not an additive, two apocynaceous species, both little studied from the chemical point of view but both known to be toxic, are so used (18). The Makuna of Amazonian Colombia may occasionally add crushed leaves of *Malouetia tamaquarina* for cases where divination is expected to present difficulties. In Amazonian Peru what has, without voucher specimens, been determined as a species of *Tabernaemontana* is similarly valued as an additive (9).

Tobacco *(Nicotiana tabacum)* is rather commonly added to the caapi drink in the northwest Amazon (18). It is added usually in the form of a fine powder. Several other solanaceous plants occasionally and locally enter the preparation of the drink. Certain tribes in southern Colombia and Ecuador add the leaves of tree species of *Datura* — themselves hallucinogenic: *peji* amongst the Siona, *huanto* or *guanto* amongst several Ecuadorian groups (18). The solanaceous genus *Brunfelsia* is known to be alkaloidal and enters into South American folk medicine. Because of some of its native names and the special care taken in its cultivation, it has long been suspected that it had been hallucinogenically employed. Recent ethnobotanical field work has established the use of several species amongst the Kofan and Jivaro Indians of Colombia and Ecuador, and there is a distinct possibility that the Kachinaua of Brazil prepare an hallucinogenic drink directly from *B. tastevinii* (27). Mounting evidence indicates that the solanaceous *Iochroma fuchsioides* may likewise be taken with yaje or be added to the yaje drink itself by certain Kamsa medicine men in the high Andean Valley of Sibundoy, Colombia, where the plant is called *borrachero* ("intoxicant").

The solanaceous *Juanulloa ochracea* is called *ayahuasca* in the Colombian Putumayo, a name strongly suggestive of use as an additive to *Banisteriopsis* drinks (27). The active alkaloid parquine is known to be present in the genus *Juanulloa*.

The use of the foregoing several plant additives has at least phytochemical explanation. There are, however, many additives the chemistry of which has not been elucidated. With our limited knowledge of their chemical constitution, we are too quick perhaps to ascribe the use of these additives to superstitious and magic reasons. There is every right to urge chemical study of each of them at as early a date as feasible.

Toe negra in Amazonian Peru is the acanthaceous *Teliostachya lanceolata* var. *crispa*, cultivated reputedly for use alone as a narcotic and as an additive to ayahuasca (27). The branches are boiled for most of the day with the bark of *Banisteriopsis caapi*. Whenever it is utilized alone, about ten leaves are gently boiled for seven hours. The effects are said to include loss of sight for three days, during which time conversation with the spirit of the plant is possible. This strange use, discovered only in 1967, should have high priority for chemical investigation — especially in view of the possibility that *Justicia*, another member of the family, may be hallucinogenic (3, 21).

The Chiriare on the Rio Nanay in Amazonian Peru consider the maranthaceous *Calathea veitchiana*, locally called *pulma*, as a "kind of yaje". It is "mixed with ayahuasca to see visions" (27). Biodynamic principles are unknown in the Maranthaceae.

Although no toxic principles are known from the Pontederiaceae, the vernacular name *amaron borrachero* for *Pontederia cordata* in the Colombian Putumayo

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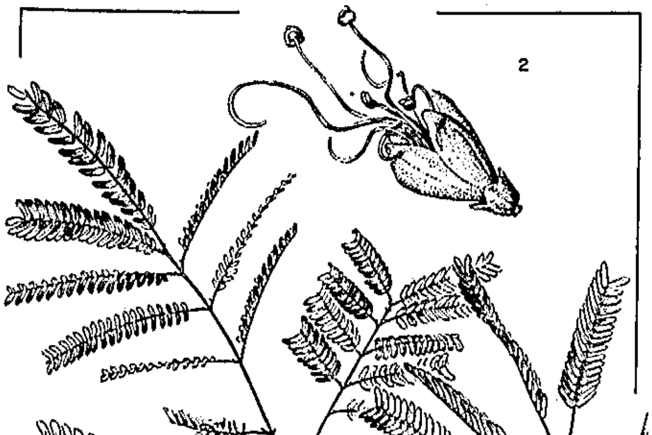
suggests its use as an intoxicant or its possible use as an additive to yaje (27). In the same region, two members of the Amaranthaceae — *Alternanthera Lehmannii* and a species of *Iresine* — have been indicated as additives to yaje, but no biodynamic principles have been found in this family (18).

Recent ethnotoxicological research on the components of ayahuasca amongst the Kulina and Sharanahua of Amazonian Peru — a most detailed and careful study — has indicated a great diversity of plant admixtures (16). *Psychotria* heads the list. Several ferns — *Lygodium venustum* (Kulina: *rami;* Sharanahua: *tchai*) and *Lomariopsis japurensis* (Kulina: *dsuiiteit-seperi;* Sharanahua: *shoka*) — are included, a most interesting addition to our list of possible biodynamic plants, in view of the absence from the ferns themselves of biologically active constituents and in view of the recently discovered use of *Lomariopsis* in folk medicine in the Colombian Amazon. This enumeration of additives continues with the loranthaceous *Phrygilanthus eugenioides* (Kulina: kohobo; Sharanahua: *miya*); the labiate *Ocimum micranthum* (Kulina: *ivoro;* Sharanahua: *fweroro*); a species of *Cyperus* of the family Cyperaceae (Sharanahua: *shako-shagari*); a species of the guttiferous *Clusia:* (Kulina: *appane;* Sharanahua: *miya*); one member each in the genera *Opuntia* and *Epiphyllum:* (Sharanahua: *pukara*) of the Cactus Family; and two other plants, the specimens of which could not be identified.

In Eastern Brazil, in Pernambuco and Paraiba, several tribes employ the root of the leguminous shrub *Mimosa hostilis* in the preparation of a "miraculous drink" known locally as *ajuca* or *vinho de jurema* (11). Another species of *Mimosa* — *M. verrucosa, jurema branca,* from the root of which a stupefacient is said to be prepared — may also sometimes be used in elaborating this drink (25, 26). The jurema cult has all the appearances of an ancient ceremony, during which the potent drink causes warriors, on the eve of battle, to see glorious visions of the spirit lands and the clashing rocks destroying the souls of the dead or the thunder bird shooting out lightning from his head. In 1946, an alkaloid named nigerine was reported from *Mimosa hostilis,* but subsequent study showed that it was synonymous with N,N-dimethyltryptamine (26). This hallucinogenic tryptamine is, of course, present in several species of the related genus *Anadenanthera* from which hallucinogenic snuffs are elaborated in South America (20).



MIMOSA hostilis (Mart.) Benth.

How does the question of additives — the subject of the paper — enter into the problem of *Mimosa hostilis.*

N,N-dimethyltryptamine is believed not to be active when taken orally, unless it be taken with an amine oxidase inhibitor. How then could a drink prepared from *Mimosa hostilis* alone be so potently hallucinogenic — unless an additive with the inhibitor be added unbeknownst to those who have studied the preparation of the drink or unless the jurema root itself possesses an amine oxidase inhibitor? Here is a fascinating challenge for ethnotoxicological research.

The use of hallucinogenic snuffs in South America opens up rich avenues of ethnotoxicological research.

In the northwest Amazon and adjacent parts of the uppermost Orinoco, the blood-red resin from the bark of several species of the genus *Virola* of the Nutmeg Family or Myristicaceae provides a very potent hallucinogenic snuff. The important species are *V. calophylla* and *V. calophylloidea* in Colombia; *V. theiodora* in Brazil and adjacent Venezuela. The identification of this potent snuff — locally known as *epena, nyakwana, parica, yakee* — has been made only in the past twenty years, in spite of the fundamental significance to the religious, magic and

Waika Indians sorting leaves of Justicia pectoralis var. stenophylla preparatory to pulverizing them to add to Virola-resin snuff. Rio Totobi, Territorio de Roraima, Brazil. (Photograph by R. E. Schultes)

medicinal beliefs of the peoples who use it (17, 20, 21).

There is no doubt that snuff prepared from *Virola* resin alone — with an inorganic alkaline ash additive — is psychoactive. We have tested it personally in the field (21). Furthermore, hallucinogenically active tryptamines have been isolated from the species of *Virola* involved. Additives are, however, used on occasion together with the *Virola* bark-resin. What is their role? We still do not know.

Some Indians in northwestern Brazil and the Orinoco headwaters of Venezuela sometimes pulverize the aromatic leaves of the acanthaceous *Justicia pectoralis* var. *stenophylla* — a dooryard, weedy cultigen — and add the finely sifted powder to the snuff prepared from the *Virola* resin (21). The natives assert that they use the acanthaceous additive merely to make the snuff "smell better". It accomplishes this purpose. But is the original purpose of this addition forgotten? Was it originally only to make the snuff "smell better" — or was it to enhance in some way the narcotic effectiveness of the basic *Virola* powder? We do not have the answer. There were initial suspicions that *Justicia* might also contain tryptamines, but subsequent investigations have not borne out these suspicions. Yet we do know now that *Justicia* powder alone may sometimes, according to several independent reports, be the sole source of snuffs used presumably for their psychotomimetic effects (3). This represents a research project fraught with potential avenues of investigation in several diverse fields.

But our interest in *Virola* does not end here.

It has recently been discovered that the Indians of the Colombian Amazonas — the Witoto, Bora and Muinane — prepare little pills or pellets of *Virola* resin for ingestion as an hallucinogenic agent (22). The species most commonly utilized is *Virola theiodora.* These pellets are made with no organic additive at all — merely coated with an ash prepared from burning any of several plant materials. They are highly hallucinogenic and are employed by medicine men to "talk with the little people".

Virola theiodora owes its hallucinogenic activity as a snuff to its content of tryptamines, the most abundant of which is 5-methoxy N,N-dimethyltryptamine (2). This tryptamine presumably is not active when taken orally without an amine oxidase inhibitor. These orally administered pellets prepared by the Colombian Indians have no plant additives — no organic constituent except those perhaps present in the plant itself. Indeed, phytochemical research has disclosed the presence in *Virola theiodora* itself of a B-carboline alkaloid: it is present in exceedingly minute amounts — but apparently in concentrations sufficiently high to exert an effect as an amine oxidase inhibitor and thus to "activate" the hallucinogenic properties of the tryptamines (1).

It might be of additional interest here to point out that the Maku Indians of the Colomibian Vaupes often take the crude *Virola* resin without any admixture or preparation — for its narcotic effects (30). Here again the built-in amine oxidase inhibitor must apparently be at work.

There are other tropical American hallucinogenic preparations which apparently can use to advantage certain plant additives. And there undoubtedly are other examples still to be disclosed by future research.

One of the most interesting preparations — and, in spite of its obvious great age, only recently uncovered — is *cimora,* an hallucinogenic drink prepared basically from the columnar *San Pedro* cactus *Trichocereus pachanoi* (6, 7, 8, 10, 12, 29). This cactus, as well as other species in the genus, contains the well known hallucinogenic phenylethylamine alkaloid mescaline (26). The cactus may be used alone; and, in fact, pieces of the seven-ribbed stem are sold in native markets in Andean Ecuador and Peru where it is employed. We know, therefore, that a drink prepared from the San Pedro cactus can be — like the well known Mexican peyote cactus

(*Lophophora Williamsii*) — hallucinogenically active as a direct result of its content of mescaline. Why, then, are plant additives sometimes put with the active material of *Trichocereus*? One reason might be that the admixtures are desired to enhance, lengthen or otherwise alter the mescaline-induced effects of the San Pedro cactus.

The identity of some of the cimora drink additives we know — and we know that several of them may indeed be of themselves potently hallucinogenic. Of others we know phytochemically nothing.

In Peru, *Neoraimondia macrostibas* may sometimes be an additive (8). No chemical analysis of this large columnar Andean cactus has been made. Also occasionally added to the drink in Peru is *Isotoma longiflora*, a member of the Campanulaceae, a family with known psychoactive principles (8). The euphorbiaceous *Pedilanthus tithymaloides*, likewise frequently used as an admixture, is highly aromatic as a result of organic acids (8). Some Peruvian medicine men add *condorillo*, a species of *Lycopodium* (6). In view of the recent discovery in this pteridophyte genus of unusual types of alkaloids, this report has exceptional interest. Reports that a tree-species of *Datura* may be added to cimora can be easily understood because of the strongly hallucinogenic character of this solanaceous genus rich in tropane alkaloids (8). In addition to the species mentioned above, at least one other unidentified plant, known in eastern Peru as *hornamo*, is employed in preparing cimora (6).

Clearly our study of the use of additives to the New World hallucinogenic preparations has so far posed more questions than it has solved. The study has brought out into perspective the urgent need and the potential value of investigating this long neglected phase of ethnotoxicological lore. Anthropological, biochemical, botanical and phytochemical information lies waiting to be uncovered by an interdisciplinary attack on the problem.

We are coming, even with the initial steps in this study, to realize that American Indians rarely add ingredients to their sacred hallucinogenic preparations for purely capricious purposes. However they may nowadays rationalize the use of an additive, it may basically have a valid pharmacological reason underlying its intrusion into religiously or magically important narcotic formulae.

Flowers of Brunfelsia sp. Rio Guaumues, Comisaria del Putumayo, Colombia. (Photograph by T. Plowman)

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OPINION/COMMENTARY

To Be Basic is Basic

In the December 1971 issue of the Plant Science Bulletin, the Editor, in response to an article on the use of bryophytes to indicate air pollution and soil minerals, made the comment "The bryologist has become relevant just as the rest of us must!" No matter the intent of that statement, it seems that the word "relevant" has just about assumed the proportion of a stenciled heading when it comes to discussions of where modern science might, or indeed must, be going. In most grant applications and in the final paragraph of research papers, one is almost expected to intellectualize on how his or her special interest *can perhaps* feed the starving masses or cure cancer. It was indeed stunning and refreshing to find an introduction to a recent paper that read in part . . . "They (heterodont sharks) have no commercial importance and are usually regarded as harmless to man". (1)

Unfortunately, this new direction has been aided and abetted by even NSF jumping on the "see me, I am relevant" bandwagon. Note for instance that in showing the NSF logo, we find SCIENCE describing it as "The National Science Foundation, in keeping with the trendiness of the times, has chosen to emphasize its concern for humanity and cooperation by adopting a new seal that depicts little hand-holding people arrayed around a circle containing a map of the world"(2). It also now appears that the Sea Grant Program is exclusively interested in becoming a combined USDA-EPA of the sea rather than trying to encourage research into some of the fundamental biological questions underlying the marine environment.

I should interject that applied research is, of course, the benefactor of mankind. There is an ever-present need for those few, bright individuals who can gather the correct information from a huge stockpile of data, and tie the pieces together into a functional whole. And, that need will never diminish. My point is, rather, that basic research, unbridled by the pragmatic constraints of private industry, or "experiment station" funded projects, will always be the cornerstone of all scientific knowledge. If we cease exploring and generating the basic ideas of the biological and physical world, then the applied fields and all of their technology will enter into steep declivity. It must be remembered that applied work is a "using" discipline rather than a "generating" one.

Perhaps we are seeing a type of C. P. Snow dichotomy within science itself. We find developers and producers on one hand and users on the other, with both sides becoming more and more mutually exclusive. Alternately, science, or at least those in a place of power, faced with a tremendous library of basic data, is now beginning to say that we should no longer gather random data (or perhaps have data producers), but we must begin to use those data. Such reasoning is logically viable only if, at the time of decision, we know and understand all of the facts pertaining to the problem at hand. If some of the basic information is still unrecorded, then any decision has to be tenuous.

It might be argued that money is the real cause of this shift in thinking towards the pragmatic rather than the pure. Unfortunately, it is ever so much easier for one administrator to go before a higher administrator and explain his need of more money in terms of applied research rather than for him to present a knowledgeable justification for some estoteric bit of basic science being done back in the laboratory. This problem is then compounded in that those with the ultimate money granting powers, the legislature or Board of Trustees, often have absolutely no knowledge of how any science works, either pure or applied, and they too take the course of least effort and expound the wonders of more food and less disease rather than trying to understand the background information which makes such advancements possible.

A glowing monument to the shallowness that can result from slighting basic research in favor of more highly visible applied work, can be found in the Philippine rice project. For the past few years uncomfortable rumors have been heard that the new "miracle" rice was not all it had been touted to be. One of the major television news programs, a few years back, ran a feature on how the new rice was not as palatable as the usual "inferior" rice. Such a trivial thing as bad taste, was, however, soon to be overlooked as the people realized the wondrous benefits of this new crop. Now, Mr. Marvin Harris writing in the June-July 1972 issue of Natural History Magazine lays open the threads of the Green Revolution fabric for all to see. The new rice appears weak on a number of fronts including taste, pathogen resistance, fertilizer needs, water needs, etc. The obvious rhetorical question is — Could a well-financed, nonagriculturally oriented, basic research program have ameliorated any of these problems. Instead, the various philanthropic organizations continue to cling to their grand plans of instant success through better crop breeding. This type of vision appears a bit myopic.

It now seems clear to me what the basic scientist must do. Rather than trying to mold our efforts towards an unnatural, nonattainable, immediately pragmatic goal, we must set out to educate our administrators, legislators, and voters on the value of basic research as the firm foundation upon which applied research is built. It isn't going to be an easy task. The amount of money for basic research is at best remaining steady (at least in election years) or more often decreasing. Applied organizations such as USDA, AID and the private groups often have a paid public relations staff to grind out their propaganda. The basic researcher, on the other hand, often has only himself in his laboratory. But, we must try. Research results should go to the local newspapers or national weekly magazines. I think that often these sources would use our work but mostly only hear from the more-organized public relation groups mentioned above. If we don't educate the public on the necessity of basic work, we have only ourselves to blame as the well dries up.

Let me close with a few examples of how one must build a solid set of often unrelated facts before theory and pragmatic usage can be developed. I offer the following for your consideration.

From Harvey A. Miller's enjoyable article on bryophytes (PSB, December 1971) I would point out that without the initial basic taxonomic studies, how is one to distinguish between *Radula* or *Orthotrichum* as being more sensitive than *Mnium hornum* to SO_2. The original taxonomists, I am quite sure, never gave soil mineral content a thought when differentiating between *Gymnocolea acutiloba*, *Racomitrium sudeticum* and *Cephalozia*