BUFO MARINUS: NEW PERSPECTIVES ON AN OLD ENIGMA

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The poisonous toad *Bufo marinus* is native to the New World, where it is a common denizen of low swampy habitats ranging from Florida west along the Gulf Coast to Mexico, then south to Panama and northern South America. In post-Columbian times, it dispersed rapidly throughout the Antilles and south along the Pacific coast of South America, as well as inland into the Amazon basin (Zug 1979). The large paratoid glands on the back of the toad have been described as "veritable chemical factories" (Kennedy 1982, 284); they produce and secrete at least twenty-six compounds, all of which are biologically active. Some of these - the plenylethylamine bases and derivatives such as the catecholamines dopamine, epinephrine, and norepinephrine, as well as a number of indole derivatives such as serotonin - are benign and occur naturally in human tissues. Acting as neurotransmitters, they are the chemical messengers between the synapses which connect individual neurons. These indole derivatives and catecholamines are found in many species and are not toxic in animals. (Anderson n.d.).

However, the venom glands secrete other compounds of considerably greater interest, including bufotenin, a purported hallucinogenic agent (Fabing and Hawkins 1956), and two extremely toxic cardioactive steroids, bufogenin and bufotoxin. These compounds are found in the skin or glands of a number of toads, including the common European species *Bufo vulgaris* (Wieland and Alles 1922), and it is their unique toxic properties that have earned the animal a notorious place in the repertoire of poisoners and black magicians throughout the world.

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As early as Roman times Juvenal (10-128 A.D.) described women using toads (presumably *Bufo vulgaris*) to kill unsuspecting husbands (Chen and Jensen 1929). The toxicity of the venom provided the basis upon which the Talmud differentiated between frogs and toads, classifying the latter with all animals that were poisonous to the touch - a belief that persists to this day in Western societies (Abel and Macht 1911). At the beginning of the fourteenth century, Bishop Guichard of Troyes was accused of poisoning the wife of Philippe le Bel with a preparation of scorpions, toads, and spiders (Chen and Jensen 1929). In that same period, English sorcerers noted erroneously that toads derived their venom from the earth by eating mushrooms –hence the name toadstool– and they commonly prepared poisons using toads that had been macerated in menstrual blood for a month or more (Chen and Jensen 1929). It is to these "menstrums" that Shakespeare referred in *Macbeth:*

> *"Toad, that under cold stone,*
> *Days and nights hast thirty-one*
> *Swelter'd venom sleeping got,*
> *Boil thou first i' the charmed pot".*

Medieval witchcraft boasted a complete collection of such recipes. One from the court astrologer and alchemist for Frederick II reads: "Five toads are shut up in a vessel and made to drink the juices of various herbs with vinegar as the first step in the preparation of a marvelous elixer for the purposes of transformation" (Kennedy 1982).

Soldiers in the Middle Ages believed that a discreet way of killing an enemy was to rub his skin or wounds with the secretions of *Bufo vulgaris*. *Bufo marinus* reached Europe very soon after the voyages of Columbus, and poisoners quickly disco-

vered that when the toad was placed in boiling olive oil, the secretions of the glands could be easily skimmed off the surface (Holmstedt pers. comm.). In early sixteenth-century Italy, poisoners devised sophisticated processes for extracting toad toxins into a salt, which could then be sprinkled on the intended victim's food (Lewin 1920). In fact, so highly regarded was the toxicity of toad venom that at the beginning of the eighteenth century it actually was added to explosive shells and mixed with the saltpeter used to make gunpowder (Chen and Jensen 1939; Chilton et al. 1979). Presumably, the commanders believed that if the cannon did not kill their enemies, the toad toxins would.

Not surprisingly, European physicians incorporated toad venom into their *materia medica* at a very early point. Dried and powdered toad warranted a prominent place as a treatment for dropsy, fever, and a number of other ailments in numerous important pharmacopoeia, including *Thesaurus Pharmakologicus,* written by Johannes Schroder and published in Leyden in 1672, *Pharmacologia,* by Samuel Dale (London 1692), and *The London Dispensatory,* by William Salmon, published in 1702. Michael Etmuller (1644-1683), professor of medicine at Leipzig, noted of the toads that "living toads aroused to the point of fury are venomous, but found dead they are entirely devoid of poison. Transfixed alive in the month of July, dried, powdered and administered in doses of twelve grains on alternate days, they furnish an excellent cure for dropsy. Others administer this remedy in burning fevers at its height. Powdered toad is also an effective remedy against incontinence of urine, and is said to be efficacious because of its anodyne character while its volatile, penetrating salt acts as a diuretic" (Abel and Macht 1911). Toads remained a prominent therapeutic agent throughout the eighteenth century, appearing in *Pharmacopeia Universalis* by R. James (London 1747) and *The English Dispensatory* by John Quincy (London 1749). As late as 1833, powdered toad was mentioned in an important medical compilation, *Pharmacologia,* written by J. A. Paris.

As in so many things, the Chinese were far ahead of their Western colleagues in their knowledge of the properties of toad venom. For centuries they had been forming the toxic secretions into smooth disks which they named Ch'an Su, or "toad venom" in Mandarin. According to the *Pentsao Kang Mu,* a famous herbal written at the end of the sixteenth century, this venom was used to treat toothache, canker sores, inflammations of the sinus and bleeding of the gums. Taken orally, it was said to break up the common cold (Chen and Jensen 1929).

From this list of rather mundane afflictions, it is difficult to appreciate that the Chinese were dealing with an extremely toxic preparation. Although early medical reports are uncertain as to the species of toad used (Tu et al. 1923; Penget et al. 1921; Chen and Jensen 1929), analysis of Ch'an Su (probably *Bufo vulgaris)* revealed the presence of both bufogenin and bufotoxin (Chen and Jensen 1929). Separate studies suggested that Ch'an Su was fifty to a hundred times more potent than digitalis, a powerful cardiotonic derived from the common European foxglove *(Digitalis purpurea),* which had been used as a heart stimulant in Britain since the tenth century (Chen and Jensen 1929). In one experiment a cat was injected with as little as 0.020 grams of crude toad venom; its blood pressure tripled almost immediately and it collapsed following massive heart failure (Abel and Macht 1911). If one was to accept the physiologically absurd equation of men and cats, it would mean that as little as half a gram of dried venom, injected intravenously, would do similar damage to a 150-pound man.

The toxic properties of toads had certainly not been overlooked by the indigenous peoples of the Americas. Lacerdo de Filho reported in 1878 that indigenous groups in the Amazon made an arrow poison from the toad *Bufo agua* (Abel and Macht 1911). According to an early and perhaps exaggerated report (Pagenstecher 1906, cited in Abel and Macht 1911), these preparations were extremely potent; a deer struck by an arrow that had been dipped in the poison survived only two to four minutes, a jaguar perhaps ten.

The action of the toad-based arrow poisons is of particular interest. D-tubocurarine, the principal constituent of the toxic lianas of the Amazon *Chondrodendron sp., Curarea sp., Abuta sp.),* acts as a muscle relaxant, causing death by asphyxiation. The skin of *Bufo marinus,* on the other hand, contains chemical substances resembling the active principles of the strongest African vegetable arrow poisons (Flier et al. 1980). These latter are derived from a number of plants *(Strophanthus kombe, S. gratus, Acokanthera venenata),* and they act in quite a different way. The active compound is ouabain, a powerful heart stimulant. In moderate dosages, ouabain is used today to treat emergency heart failure; in excessive doses, it makes the heart pump wildly until it collapses (Robb 1957).

Given the toxicity of these compounds, it is perhaps difficult to appreciate a controversy that has developed in the anthropological literature in recent years over whether *Bufo marinus* was used as a hallucinogen by New World Indians—in particular by the advanced civilization of the lowland Maya (Dobkin de Rios 1974; Kennedy 1982; Furst 1972). Although the hypothesis initially seems untenable from an ethnobiological point of view, it is worth exploring, for it now appears that a solution may be at hand, and the explanation is one of startling simplicity.

The argument in favour of the toad as hallucinogen has rested until now on several lines of evidence. First, throughout Central America the toad was a prominent symbol, particularly in Mayan iconography (Furst 1972). Numerous Mayan artifacts that have been discovered, including small

ceramic serving bowls, have obvious representations of the toad and especially graphic portrayals of its distinctive paratoid glands (Furst 1974; Kennedy 1982; Dobkin de Rios 1974). Second, at one post-Classic Mayan site on Cozumel Island, Mexico, an archaeologist found that virtually all amphibian remains were *Bufo marinus* (Hamblin 1979). This report complemented an earlier, similar discovery at San Lorenzo, Mexico, that led one prominent archaeologist to suggest that the Olmec civilization used the toad as a narcotic (Coe 1971). Third, one of the substances secreted by the toad is bufotenin, a compound that is found in a hallucinogenic snuff made today by South American from the seeds of *Anadenanthera peregrina.* This member of the Leguminosae is common in the upper Orinoco Valley of Venezuela and elsewhere in South America (Schultes and Hofmann 1980). One report from Western medical literature has suggested that pure bufotenin, injected intravenously into human subjects, induces hallucinations (Fabing and Hawkins 1956). Fourth, the proponents of the hallucinogen hypothesis all cite an unpublished report of the contemporary use of *Bufo marinus* in a hallucinogenic preparation in Vera Cruz, Mexico (Knab n.d., cited in Furst 1974; Kennedy 1982).

On the face of it, however, this cumulative evidence is fairly inconclusive. Whether or not Mayan iconography represents the toad *Bufo marinus,* the werejaguar, or any other symbol is for the archaeologists to decide; it is specious at best to argue that if the motifs do represent *Bufo marinus,* one may conclude, *ipso facto,* that the Maya used the toad as a hallucinogen. Symbols, in particular ritual symbols, incorporate a wide range of meanings. Moreover, they are not necessarily diachronically stable. Kennedy (1982) herself points out the remarkable fecundity of the toad. Once could speculate with equal assurance that the toad motifs relate to fertility, to water or rain, or even, given the life cycle of the creature, to some notion of sacred metamorphosis and renewal.

By the same token, it is not always possible to draw a direct relationship between a decorative motif applied to ceramic wares and a purported use of the depicted object itself. Hellmuth, in an amusing comment, has noted that today, in the central market in Guatemala City, native women sell a great variety of modern toad-shaped artifacts. Does this imply, he asks rhetorically, that "these little old ladies secretely imbibe mindexpanding doses of toad-juice cocktails under their counters?" (Hellmuth 1974, 156). Certain investigators (Schultes 1979; Schultes and Hofmann 1980; Sharon 1978) have noted correlations in the provocative shapes and decorations of archaeological artifacts, but they have made such pronouncements only when their conclusions are supported by, contemporary documentation as well as extensive ethnohistorical records of the use of the hallucinogen in the particular region. It is a different and purely speculative exercise to draw conclusions in the complete absence of corroborative ethnographic and/or historical evidence (Dobkin de Rios 1974; Kennedy 1982).

The paucity of such evidence presents yet another apparent flaw in the argument. It seems likely that, if the use of *Bufo marinus* as a hallucinogen was an important enough element of a state religion to warrent iconographic representation, there would be some record of it in the early chronicles. Dobkin de Rios (1974) speculates that the notable absence of ethnohistorical documentation is due to the fact that use of the drugs by the general population was suppressed by the Mayan hierarchy and, in turn, concealed from the Spanish. Yet it was precisely this "diabolical" use of hallucinogens, along with other indigenous religious practices, that the Spanish so zealously ferreted out and described in detail in their writings – if only as a way of rationalizing their own nefarious actions. It comes as no surprise to find extensive accounts of the use of ololoiuqui *(Rivea corymbosa);* teonanacatl *(Psilocybe sp., Panaeolus sp., Conocybe sp.);* peyote *(Lophora williamsii);* San Pedro-achuma *(Trichocereus pachanoi);* cohoba-vilca *(Anadenanthera peregrina);* tlapatl-chamaico *(Datura sp.)* (Schleiffer 1973).

Moreover, although it is true that the Spanish tried to suppress the use of psychotropic drugs in Mesoamerica, they mostly succeeded in driving these practices underground. In the case of virtually all the known hallucinogens, it has been possible to demonstrate the continuity and subsequent modifications of the pre-Columbian practices into colonial times; in most instances, extensive ethnographic evidence exists documenting their contemporary use (Schultes and Hofmann 1980; Sharon 1978; Furst 1972; Davis 1983). What, one is forced to ask, happened to *Bufo marinus?*

At least one ethnohistoric source does mention the use of a toad in a ritual preparation. Peter Furst notes that the "17th century English friar, Thomas Gage, described the Potoman Maya practice of steeping venomous toads in fermented beverages used for ritual intoxication, to give them extra potency" (Furst 1974, 154). The original source, however, is somewhat less precise. It speaks of a chicha consisting of water, honey or sugar cane, tobacco leaves, various roots "which they knew to be strong in action", and a live toad. This mixture was placed in a sealed container "till all that they have put in be thoroughly steeped, the toad consumed, and the drink well strengthened" (Thompson 1970, 120). It appears from the original syntax that the potency of the preparation was believed to be enhanced as much from the month it spent fermenting as from the addition of an unidentified toad.

Interpretations of the ethnographic data have been equally imprecise. Furst (1974) cites a paper by Carneiro (1970) which suggests that the Amahuaca Indians of Peru introduce frog or toad venom into self-inflicted skin burns to bring on a trance state. Yet neither Carneiro or Furst identify the

animal in question. They use the terms frog and toad interchangeably and take no account of the existence of numerous genera of toxic amphibians completely unrelated to and morphologically dissimilar to *Bufo marinus.*

Those who suggest that the toad was used as a hallucinogen also draw attention to the distribution of *Bufo marinus* remains at a number of archaeological sites (Hamblin 1979; Coe 1971). Michael Coe noted in discussing his osteological remains at San Lorenzo: "These toads are a puzzle, as they cannot be skinned without an extremely dangerous poison getting into the meat. We are now looking into the possibility that the Olmecs used them for a hallucinogenic substance called bufotenine (sic), which is one of the active ingredients" (Coe 1971, 74). As it turns out, a survey of the archaeological literature shows that a significant quantity of *Bufo marinus* remains have been found in middens throughout Central America, leading other archaeologists to believe that pre-Columbian Indians used the toad, not as a hallucinogen, but as food, after carefully cutting away the skin and paratoid glands (Cooke 1979, 1981). In spite of Coe's cautionary words, Richard Cooke (1979) himself butchered and cooked several specimens, which he was pleased to note tasted rather pleasantly like smoked chicken. Based on the temporal and spatial distribution of *Bufo marinus* remains, he proposed that the toad was not used as a drug, but as a survival food, a suggestion partially corroborated by the fact that it is today employed for precisely that purpose by the Campa Indians of the lower Apurimac River in Peru (Weiss pers. comm.).

A central failacy of the hallucinogen hypothesis has been the fact that no one has been able to demonstrate how this reputed toad preparation could have been consumed safely. It is true that the glands secrete bufotenin, a known constituent of South American hallucinogenic snuffs (Schultes and Hofmann 1980). Bufotenin is the methylated derivative of serotenin or 5-hydroxytryptamine. Unlike its parent compound, it is mildly lipid soluable so is weakly capable of crossing the blood brain barrier. Thus is might well have psychotropic properties (Anderson n.d.).

However, also present in the toad venom are the extremely potent cardioactive steroids bufotoxin and bufogenin (Chilton et al. 1979; Chen and Jensen 1929). It is almost certain that ingesting a straight maceration of the paratoid glands would cause cardiac failure long before the recipient would get a chance to experience the putative hallucinogenic properties of bufotenin (Alger 1974). It seems unlikely that the Maya would have been interested in poisoning vast numbers of their priesthood, who presumably would have been the ones taking the drug. Only if some process had been developed that selectively neutralized the toxic constituents could *Bufo marinus* have been made into much of a hallucinogen. Folk healers have often demonstrated a sophisticated biological and chemical knowledge, as is evident in their ability to enhance certain hallucinogenic potions by the careful use of various admixtures (Schultes and Hofmann 1980). However, the knowledge of chemistry and differential solubilities required to eliminate both bufotoxin and bufogenin in an orally ingested preparation would represent, on the face of it, a formidable achievement.

Such a process was not altogether inconceivable. Kennedy (1982) elaborately discusses her suggestion that the Maya used ducks as bioprocessors of the toxin; the idea was that the toad toxins were somehow metabolized, leaving the psychotropic components in the flesh of the bird, which could then be safely consumed. She went as far as demonstrating that ducks could safely eat the toads, but she failed to take the obvious next step of butchering the birds and bioassaying their meat.

A more promising attempt was made by Dr. Timothy Knab, who searched the backcountry of Mexico for evidence of a contemporary curandero who might have preserved the ancient knowledge. It is Knab's unpublished account that is heralded by Kennedy. "Knab", she writes, "has penetrated the arcana of several curanderos in the Veracruz area and details the recipe for the preparation of *Bufo marinus* paratoid glands which eliminates the most toxic compounds" (Kennedy 1982, 285). Furst mentions the "taped interview by Timothy Knab with a curandero from Veracruz describing precisely how a 'brujo' treats the venom extracted from bufo to eliminate or neutralize its more dangerous toxic effects when preparing his magic potion" (Furst 1974, 154). It is to Knab's credit that he is somewhat more modest in reporting his own discovery.

After considerable effort, Knab finally located an old curandero in the mountains of southern Veracruz who claimed to know the formula of a preparation that had not actually been used by his people in fifty years. The old man ground the glands of ten toads into a thick paste, to which he added lime water and the ashes of certain plants. The mixture was boiled all night, or until it no longer smelt foul, and then was added to corn beer and filtered through palm fiber. The liquid was mixed into corn meal and then placed in the sun for several days to ferment. Finally the mixture was heated to evaporate the remaining fluid, and the resulting hardened dough was stored until the time came to rehydrate it to prepare the final potion.

Although Knab had persuaded the curandero to prepare the potion, under absolutely no circumstances would the recalcitrant old man actually sample it. Only very reluctantly did he consent to give a dose to Knab. From what happened, it appears that he knew something the anthropologist did not. Knab's intoxication was marked by sensations of fire and heat, convulsive muscle spasms, a pounding headache, and delirium. He writes of his experience:

> The drink starts to take effect within a half hour; profuse sweating is noted along with a sudden increase in heart beat. The heart beat becomes continuously harder and stronger. A pronounced chill sets in with twitching of the facial and eye muscles. A pounding headache and delirium shortly follow the onset of twitching. During this delirium, the individual is unable to walk, sit up or move about, as he lies in a specially excavated depression in front of the fire. This state usually lasts from three to five hours and wears off slowly (Knab n.d.).

Knab reports no hallucinations, and from his subjective description of the intoxication it appears that he merely suffered the initial symptoms of a severe poisoning (Knab pers. comm.). He never did find out whether or not the preparation actually neutralized any of the toxic compounds, for the preparation was never analyzed.

Yet another unresolved issue in the controversy is the pharmacological activity of the purported hallucinogenic agent itself, bufotenin. Virtually every report that characterizes bufotenin as a psychotomimetic dates to a single experiment completed by a medical doctor, Howard Fabing, in the 1950s. Fabing obtained permission to inject bufotenin intravenously into a number of inmates at the Ohio State Penitentiary. The recipient of the mildest dose complained of prickling sensation in his face, nausea, and slight difficulty in breathing. With a higher dosage these symptoms became more pronounced and the subject's face and lips became purplish. The final dose caused mild hallucinations and delirium, and the skin turned "the colour of an eggplant", indicating that the drug was preventing oxygen from getting to the blood. The hallucinations were ephemeral. Three minutes after injection, the subject vomited, and at the time, "he saw red spots passing before his eyes and red-purple spots on the floor. Within two minutes, these visual phenomena were gone, but they were replaced by a yellow lens filter" (Fabing and Hawkins 1956, 887), That is the extent of the hallucinations experienced by any of the recipients of the bufotenin injections.

Turner and Merlis (1959) attempted but failed to replicate these results. They noted that upon muscular injection of bufotenin, the recipient "suddenly developed an extremely rapid heart rate; no pulse could be obtained; no blood pressure measured ... onset of auricular fibrillation ... extreme cyanosis developed". Massive resuscitative procedures were immediately implemented and fortunately the pulse eventually returned to normal (Chilton et al. 1979). After the failure of this and other experiments the investigators concluded that "we must reject bufotenin as capable of producing the acute phase of cohoba *(Anadenanthera perigrina)* intoxication" (Chilton et al. 1979, 64).

On the basis of this and other reports, Schultes himself concluded, "it seems probable that 5-OH-DMT (bufotenin) does not contribute to the psychotomimetic activity of the snuffs" (Schultes and Hofman 1980, 90). In other words, even assuming that a folk preparation could eliminate the toxic constituents in the toad venom, it became questionable whether bufotenin alone would be hallucinogenic. This issue was never resolved by a full range of experiments, including different techniques of administering the drug, but the doubts cast on the psychoactive properties of bufotenin led many to conclude that *Bufo marinus* could not have been used as a ritual narcotic, let alone serving as the basis of a state religion.

Crosscutting this negative evidence, however, and perhaps beginning to resolve the matter once and for all is the important recent discovery by Dr. Andrew Weil of the University of Arizona (pers. comm.) of a group of individuals in New Mexico, U.S.A. who apparently have been using the toad as a ritual hallucinogen for several years. Their means of administration is simple and direct. They milk the paratoid glands by hand, taking some care to avoid contact between the secretions and their mucous membranes. They then smoke the toad venom and, according to preliminary reports, the psychoactive effects are unmistakeable while the noxious side effects one might expect from the associated compounds in the secretions are negligible. If true, this discovery suggests that the cardioactive steroids bufogenin and bufotoxin may be denatured by smoking, while the potential of the active constituent, presumably bufotenin, is fully realised. The form of administration is consistent with the known pharmacological properties of other tryptamines. In general, those compounds may be smoked or absorbed as snuffs; ingested orally they are in most instances inactive. The full significance of Weil's discovery will be determined by a battery of field and laboratory experiments.

For the moment, however, he has provided the only firsthand, concrete evidence of the psychoactive properties of this remarkable amphibian.

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