Voodoo Science

A popular claim that a chemical found in puffer fish may be a crucial element in the creation of the zombies of Haitian folklore has been challenged; critics claim contrary evidence was ignored

A young botanist from Harvard University named Wade Davis claims to have discovered a pharmacological explanation for zombies, the "living dead" of Haitian folklore. But his detractors say his assertions are bunk and his methods are unscientific.

The lingering controversy has been sparked in part by the collision of two different worlds of research. In the first world, the intrepid ethnobotanist Davis goes down to the troubled island nation of Haiti. His mission: discover how zombies are made. What Davis found was "a surrealistic landscape" and a country "full of spirits." Armed with cash but scant knowledge of Haitian Creole, Davis immersed himself in the secret societies of the voodoo religion. With sorcerers as paid informants, Davis participated in the preparation of several batches of "zombie powder," and witnessed the exhumation of the corpse of a child from a rural graveyard at night. When Davis emerged from his trials in Haiti, he reported having found the pharmacological underpinning for the zombie phenomenon. Fame and fortune followed.

This romantic world has collided with another world, a less glamorous place of mass spectrometers, gas chromatography, and mouse bioassays, where a group of toxicologists and pharmacologists familiar with the work of Davis are crying foul. Leading the charge is C. Y. Kao of State University of New York Downstate Medical Center in Brooklyn, who has aggressively challenged Davis at every turn. Kao does not mince words: "I actually feel this is an issue of fraud in science." One of Kao's comrades in the dispute, Bo Holmstedt of the Karolinksa Institute in Stockholm, is more restrained: "It is not deliberate fraud. It is withholding negative data. It is simply bad science."

The controversy involves the role of a powerful poison called tetrodotoxin in the creation of zombies. Davis' critics say there is either no tetrododoxin or little in the samples of zombie powder brought back by Davis to support his hypothesis. But there is more to it than that. The pharmacologists are accusing Davis of not playing by the rules by suppressing information that fails to bolster his case, while playing up a number of unconfirmed experiments that are repeatedly cited in his work as "personal communications." Some of the critics seem especially irked because Davis sought out their assistance but allegedly refuses to listen when told his conclusions are not supported by the evidence. "I feel like I've been taken for a ride," says Kao.

The story is complicated by the popular accounts of Davis and the sensational nature of his work. Predictably, there have been a flurry of articles and television programs, for who does not enjoy a good story about zombies now and then? Davis also wrote a popular book in 1985 called *The Serpent and the Rainbow* and then sold the rights to Hollywood, which recently released a rather lurid movie under the same title. Another book about zombies—this time a scholarly treatment based almost entirely on Davis' Harvard dissertation—is scheduled for release in May by the University of North Carolina Press. All of this attention has certainly created bad feelings, with pronouncements from both sides becoming increasingly invidious. Davis says that Kao and others are victims of "old-fashioned jealousy."

The story begins in 1982, when Davis was introduced to the late Nathan Kline, then director of the Rockland State Research Institute in New York. Kline, a pioneer in the use of tranquilizers, wanted Davis to go to Haiti to search for a mysterious powder reputedly used to make zombies. Despite 30 years of work in Haiti, Kline had never succeeded in securing such a sample.

When Davis met Kline, the older man was particularly excited about zombies because he and a colleague in Haiti believed that for the first time they had found a verifiable case, a man named Clairvius Narcisse, who returned to his village after an 18-year absence, claiming to have been made a zombie and sold into slavery. Narcisse has since become quite famous as the object of documentaries by the BBC and ABC. Narcisse's account, though highly intriguing, is far from watertight. Davis himself says that Narcisse had received so much attention by the time he arrived that the case was hard to evaluate. Other anthropologists with years of experience in Haiti discount the reality of zombies. "You hear stories all the time, but you can never actually find a zombie," says Leslie Desmangles of Trinity College in Hartford, Connecticut, a Haitian who has studied the religions of his homeland for the past 15 years.

Davis made several trips to Haiti between 1982 and 1984, collecting a total of eight samples of zombie powder from several voodoo sorcerers, or "bokors" as they are

Springer/Bettmann Film Archive

Night of the Living Dead. *Just enough tetrodotoxin?*

called. Most of the powders contained a variety of ingredients. Some included the fresh remains of a human cadaver, as well as stinging nettles, noxious toads, and one or more species of puffer fish found in Haitian waters. It was the fish that interested Davis, since puffer fish are known to sometimes contain the potent tetrodotoxin. Tetrodotoxin blocks the sodium channels between nerve endings and can cause paralysis and death. Davis says he paid about $300 for each sample, an enormous sum of money in Haiti, which is one of the poorest countries in the Western Hemisphere.

According to the hypothesis touted by Davis, the process of "zombification" works something like this: A victim is administered a powder that contains among other things the dried and pulverized remains of puffer fish, whose livers and reproductive organs may contain tetrodotoxin. At a dosage containing a precise amount of tetrodotoxin, Davis maintains that a victim of zombie powder poisoning could lapse into a state of such low metabolic activity that he might appear clinically dead. This poor soul would then be buried alive, only to be rescued hours later by a sorcerer who digs up the victim, feeds him an hallucinogenic paste, and then sells his newly minted zombie into slavery, often to sugar plantations.

As Davis points out, not all victims of tetrodotoxin poisoning would become zombies. A psychological or cultural predisposition is essential. One has to live in Haiti and believe in zombies to actually become one. It is what Davis calls the "set and setting" of the experience. For example, says Davis, a person who goes into the woods with the purpose of eating hallucinogenic mushrooms usually enjoys his experience. But the person who eats the mushrooms by mistake is often rushed to the emergency room, thinking himself a victim of poisoning.

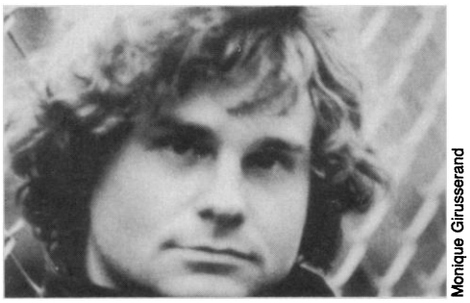
Upon return to the United States after his first trip to Haiti in 1982, Davis provided several samples of zombie powder to Leon Roizin, a pathologist from Columbia Presbyterian Hospital in New York City who has been studying the effects of drugs on the central nervous system for 40 years. As a personal favor to his "old friend" Kline, Roizin agreed to test the crude mixtures on several rats and one rhesus monkey. He administered the zombie powder by rubbing an extract onto the shaved bellies of the rats or by injecting a solution into peritoneal tissue. What happened next was very intriguing. According to the account cited as a personal communication from Roizin to Davis, some rats "appeared comatose and showed no response at all to external stimuli. The electroencephalograph continued to monitor central nervous system activity, and the hearts were not affected. Certain rats remained immobilized for 24 hours and then recovered with no apparent sign of injury." A somewhat similar response was observed in the monkey.

Roizin is upset that the results of this preliminary experiment have been circulated by Davis. "I am very embarrassed," says Roizin, who maintains that he was promised by Kline that the powders would be thoroughly analyzed and that the initial experiment was "just among friends" to see if there was any biological activity. The experiment was never repeated by Roizin and has never been published. Roizin returned all trace of the powders and today refuses to have anything to do with Davis. "Whether someone added some kind of drug, I don't know. How do I know that something was not added to that material?" says Roizin, who reports that he has produced catatonia and immobility in lab animals with other compounds, such as various neuroleptics, analgesics, and hallucinogens.

An experiment like Roizin's, however, was attempted again. In 1984, Davis and John Hartung, a Harvard anthropologist turned medical researcher at SUNY's Downstate Medical Center in Brooklyn, encouraged rats to ingest zombie powder by mixing it with peanut butter. They also rubbed the powder onto the rats' shaved bellies and injected powder in solution into the peritoneal cavities of mice and rats. "We failed completely," says Hartung. The animals did not become immobilized, let alone proto-zombies. Reports Hartung: "It is my suspicion that there was no tetrodotoxin in the samples we tested."

The experiment has never been published, and unlike Roizin's results, is not cited as a "personal communication" by Davis. Hartung defends the silence, stating that "absence of evidence is not evidence of absence." It is a refrain repeated often by Davis and one that drives his critics to distraction. "What does that mean? The burden of proof is no longer on the scientist? Does it mean I can say anything I want and then tell my critics it is up to them to prove me wrong," says John Moore, a physiologist at Duke University Medical Center in Durham who relayed Kao's charges to the University of North Carolina Press, publishers of Davis' new book.

Evidence that tetrodotoxin plays a central role in the initial phase of the zombification process has proved to be something of a moving target. No one disputes the observation by Davis that bokors add pulverized puffer fish to their zombie powders. What they dispute is the role of tetrodotoxin in transforming victims into the living dead. In Davis' first paper on the topic in 1983, he



Monique Girusserand

Wade Davis *never said there is "an assembly line producing zombies in Haiti."*

reported in the *Journal of Ethnopharmacology* that "the poisons which I collected during my first two expeditions to Haiti are currently being analyzed at the Karolinska Institute in Stockholm and at the University of Lausanne, Switzerland." Then Davis details the "initial experiments" of Roizin and suggests that "3.5 grams of crude poison might put a 73-kilogram human into a comatose, catalyptic state (Roizin, personal communication)." Davis concludes: "These preliminary laboratory results, together with what we know from the field and from the biomedical literature suggest strongly that there is an ethnopharmacological basis to the zombie phenomenon."

In his 1986 Ph.D. dissertation at Harvard, entitled "The ethnobiology of the Haitian zombie," Davis reported the details of Roizin's experiment, yet failed to note his own work with Hartung. As for further proof that tetrodotoxin helps make zombies, Davis wrote: "Laboratory tests have shown both the presence of tetrodotoxin in the samples, and have indicated that the powders when applied topically to rats and monkeys are biologically active." The citation is Davis' 1983 paper in *Journal of Ethnopharmacology*, which contains no evidence for the presence of tetrodotoxin. It also implies that tetrodotoxin was present in all of the samples, which is incorrect. To date, tetrodotoxin has only been found in one sample.

In his latest book, *Passage of Darkness: The Ethnobiology of the Haitian Zombie*, Davis again cites Roizin. In a footnote, Davis adds that "three distinct analytical techniques provided unequivocal evidence that tetrodotoxin is present in [one] sample." The citation is a personal communication from Laurent Rivier at the University of Lausanne.

Tracking the analysis of the various powders is an equally tricky business. The only published data appear in a letter to the journal *Toxicon* from Kao and Takeshi Yasumoto of the Tohoku University in Sendai, Japan. A well-known authority on tetrodotoxin, Kao received two samples of zombie powder from Davis in 1984. Initially very

excited about the research, Kao did some preliminary assays on mice and found no biological activity, so he sent the samples to Yasumoto, who had developed an automated tetrodotoxin analyzer based on high-performance liquid chromatography (HPLC), a method which separates chemical components out of a solution. Kao says that he called upon Yasumoto for help because Yasumoto has been involved in testing the stomach contents of victims of fugu fish poisoning in Japan, where gourmands occasionally eat improperly prepared fugu, a species similar to the puffer fish identified by Davis as ingredients in zombie powder. (Normally fugu should contain only enough tetrodotoxin to give diners tingling lips and a sense of mild euphoria, though sometimes the chef makes a tragic mistake.) Using his HPLC machine and mouse bioassays, Yasumoto found less than 1.1 micrograms of tetrodotoxin per gram of crude material in one sample. In the other sample, they found far less. Kao and Yasumoto called the amounts "insignificant traces." They wrote: "From these results it can be concluded that the widely circulated claim in the lay press to the effect that tetrodotoxin is the causal agent in the initial zombification process is without factual foundation."

At Lausanne, Rivier eventually received six samples of powder from Davis. In letters written in 1983 and 1985, Rivier informed Davis that little or no tetrodotoxin could be found. "I am rather disappointed by these results," Rivier wrote. In 1986, Rivier sent portions of all six samples to Michel Lazdunski, director of the Center for Biochemistry at the University of Nice in France. Using a competitive binding assay that involved radiolabeled tetrodotoxin and the sodium channels of rat brain membranes, Lazdunski's laboratory found 64 nanograms of tetrodotoxin per gram of zombie powder in only one of the six samples. A nanogram is one billionth of a gram. As even Hartung says: "If you asked me to drink 64 nanograms of tetrodotoxin, I would. It's not enough to do anything to a human."

Rivier recently told *Science* that he himself has now found between 5 and 20 micrograms of tetrodotoxin per gram of powder in one sample.

What could possibly account for three laboratories finding such wildly different amounts of tetrodotoxin in the same sample? Rivier attributes the difference to the powder itself, which is both heterogeneous and very alkaline. Kao, in fact, maintains that the powder is so alkaline that tetrodotoxin would be "decomposed irreversibly into pharmacologically inactive products." The *p*H of the samples often exceeds 10, even after the powder is mixed with a buffered solvent. Yet Rivier and Davis contend that *p*H does not express itself in a dry powder. Says Rivier: "The fact that we have found after 3 years tetrodotoxin in powder kept at room temperature means that the powder itself is able to conserve tetrodotoxin for a long time." For his part, Davis reports that the bokors advised him to rub the powder onto the skin of his victim or place the powder in his shoes or to sprinkle the powder on the ground and whisper the victim's name. "The bokors never suggest that you put the powder in solution," says Davis.

University of North Carolina Press

Bokor with porcupine fish. *Sizing up a possible source of tetrodotoxin.*

Tetrodotoxin can cause an array of symptoms in lab animals, from wobbly legs to death. Blood pressure may drop and stay quite low. There is shallow breathing and wide paralysis. Without the aid of a respirator, Kao says, the animal usually dies. In cases of tetrodotoxin poisoning in humans, Bruce Halstead of the World Life Research Institute of Colton, California, reports that victims also suffer from decreased blood pressure. In Halstead's *Poisonous and Venomous Marine Animals of the World*, he states: "The muscles of the extremities become paralyzed and the patient is unable to move. As the end approaches the eyes of the victim become glassy. The victim may be comatose but in most cases retains consciousness, and the mental facilities remain acute until shortly before death."

In Japan, cases of fugu fish poisoning are not uncommon. About 100 people a year die from the delicacy. From the Japanese scientific literature and from newspaper accounts, Davis cites several cases of fugu fish poisoning where a victim lingers at the brink of death, but recovers. Says Kao: "If it happens, it is a very, very rare event."

The amount of tetrodotoxin necessary to produce the pharmacological effects that Davis attributes to zombification is unclear. Kao reports that 10 micrograms of pure tetrodotoxin per kilogram of body weight produces a lethal dose in 50% of the lab animals tested. According to the report from Lazdunski's laboratory in Nice, at 64 nanograms of tetrodotoxin per gram of crude poison, a bokor would have to administer 10 kilograms of powder to his victim to produce a lethal dose in 50% of his victims. Of course, the bokors are not trying to kill their victims, only to place them into a state resembling death. Using Rivier's latest figures, a bokor might only have to administer about 70 grams of poison or less. Kao reluctantly concedes that this "is getting into the ballpark of feasibility."

And it is through this window of feasibility that Davis presents his case. "It could well be that my hypothesis is in need of work or is incorrect, but it is not fraudulent," says Davis, who adds that because his critics approach his research as pharmacologists or toxicologists, they fail to appreciate the cultural context. The bokors can always rationalize their failures, says Davis. If a bokor overdoes it and kills a victim "too completely," no one is the wiser. It is a call from God. *Mort bon dieu*. While if a bokor fails to produce a state of near death, he can always try again. Davis notes: "The zombie powders are not manufactured by Merck Sharp & Dohme." Also, the puffer fish may harbor varying amounts of tetrodotoxin depending on the season and its sex.

Says Davis: "I've never maintained there is some kind of assembly line producing zombies in Haiti." He admits that it is, at best, a rare event. "I'm not even saying that it is happening today," says Davis.

Davis does indeed have his supporters. Harvard professor Richard Evans Schultes, the grand old man of ethnobotany, calls his former student "a solid anthropologist and a good botanist and a very good field man with a promising future." As for Davis' hypothesis linking zombies to tetrodotoxin, Schultes says he did not scrutinize that aspect of the dissertation. "I don't know anything about the pharmacology of all this," says Schultes. Indeed, there were no pharmacologists or toxicologists on Davis' dissertation committee.

Irven DeVore, an anthropologist at Harvard who was on the committee, considers the Davis hypothesis "interesting but unproven." Like Schultes, DeVore judged the research as a work of anthropology, not pharmacology. "Red flags did not go up in my mind," says DeVore. "But if Davis has gone well beyond his data, he should have his wrist slapped."

As for paying for samples, this is a gray area. Anthropologists and field biologists often give mirrors, clothing, and sometimes cash to native people in exchange for information or assistance. Davis says that since Haitians are expected to pay for zombie powders, why shouldn't he?

The exhumation of the corpse, however, raises more troubling questions. Holmstedt calls the act "disgusting." Kao correctly points out that Davis did not just witness a grave-robbing, he commissioned it by paying a bokor to make zombie powder for him. The exhumation, though, does not bother Schultes: "I think they exhume people all the time. I don't see any problem there." Mark Plotkin, an ethnobotantist at the World Wildlife Fund and a former student of Schultes, says that Davis did not pay the bokor to exhume corpses, he paid for zombie powder.

DeVore, however, says that Kao might have a point. "I think the issue is whether Davis paid someone to do something he never does, or rarely does, or paid him to do something he routinely does," says DeVore. "There is a difference."

Says Timothy Plowman, an ethnobotantist at the Field Museum in Chicago: "We're expected to participate in a lot of weird things in the field that we wouldn't do back home." DeVore adds that "anthropologists are forever witnessing something illegal." In his own research on the bushmen of the Kalahari, for example, DeVore says that "there is elephant poaching going on all around us."

Davis defends his actions in Haiti, saying that he simply played the role of participant-observer. In his interviews, Davis often mentions that his work has helped elevate voodoo from a folk cult to a legitimate religion in the minds of outsiders. Some of Davis' critics are not so sure. "Davis complains about the popular accounts of zombies, but here he has contributed to the very same thing," says Holmstedt. Desmangles of Trinity College says that the film made from Davis' book, complete with snakes crawling out of a zombie's mouth, "has taken us back 100 years."

For now, at least, the mystery of the zombies remains unsolved, despite all the noise and attention. For Davis, the zombie research might be over. It will at least have to wait until he finishes two other book projects that are occupying his time these days in Vancouver. Though Davis may make another trip to Haiti, he says he does not plan on becoming a "zombiologist." Says Davis: "My purpose was not to generate absolute truths." Kao agrees with that. ■ **WILLIAM BOOTH**

ADDITIONAL READING

E. W. Davis, "The ethnobiology of the Haitian zombi," *J. Ethnopharmacol.* **9**, 85 (1983).

W. Davis, *Passage of Darkness: The Ethnobiology of the Haitian Zombie* (Univ. of North Carolina Press, Chapel Hill, 1988).

T. Yasumoto and C. Y. Kao, "Tetrodotoxin and the Haitian zombie," *Toxicon*, **24** (No. 8), 747 (1986).

Japanese Views on Science Compared to U.S. Attitudes

The Japanese are less inclined to irrational scientific beliefs than Americans, more inhibited about research in controversial areas, and less optimistic about the promises of automation, according to recent polls in which similar questions about science were asked in Japan and the United States.

Some of the results have been published for the first time in the National Science Foundation's biennial report on manpower and research trends, *Science & Engineering Indicators—1987*.

The data on Americans' attitudes about science were collected in a national survey of 2005 adults taken for NSF in 1985 and 1986 by the Public Opinion Laboratory of Northern Illinois University. A similar survey, using many of the same questions, was conducted by the office of the Japanese Prime Minister in March 1987.

Sizable majorities in both countries think the benefits of science and technology outweigh the harmful results. However, interesting differences appear on individual items. For example, the impact of science and technology on "the individual's enjoyment of life" was judged to be positive by 69% of Americans but only 46% of Japanese. More than 40% of both samples thought the impact on "moral values" is negative. But 25% of Americans saw a positive impact compared with 5% of the Japanese.

Striking differences between the two nationalities emerged with regard to views about the effects of science and technology on work and employment. Among Americans, 79% thought the effects positive; only 40% of the Japanese did. The Japanese were more pessimistic about automation, with only 13% believing that it will create more jobs than it eliminates—compared with 48% of the Americans. Americans also felt much more strongly that automation is necessary to meet foreign competition.

In the category of "acceptance of scientific thinking," the surveys revealed that both Japanese and Americans believe smoking is bad for health and accept the theory of continental drift. But high proportions of Americans—between 43% and 47%—expressed disbelief in human evolution, belief in the alien origin of UFOs, belief in "lucky numbers," and belief that rocket launchings change the weather. Only 34% of Japanese believed in UFOs, and only 12% rejected evolution. The report notes that even at the highest educational level, "about one-fourth of Americans with graduate degrees believe space activities affect the weather, believe in lucky numbers, or do not believe in evolution."

Japanese also demonstrate much more conservatism when it comes to research and government regulation. Whereas 68% of Americans favor research to expand the human life span to 100 years, 64% want studies that might discover intelligent beings in outer space, and 52% want research on creating new life forms, the comparable percentages for the Japanese were 20%, 36%, and 10%.

"The Japanese public is much more willing than the American public to stop research in certain areas," the report noted. A full 67% said no to research that could lead to new forms of animal or plant life, and 44% oppose research on weather modification, compared to a 60% approval in this country.

Scientists stand in high regard in both countries, but Americans (55% of the sample) are much more likely to believe that "because of their knowledge, scientific researchers have a power that makes them dangerous." Nonetheless, the Japanese, unlike the Americans, favor more government regulation on food additives, atomic power plants, pharmaceuticals, and genetic engineering.

The NSF report also relates that the Challenger disaster and the Chernobyl accident do "not seem to have harmed the generally high level of public support for science and technology." The same group of American respondents was questioned before and after the Challenger accident, and it turned out that the number who thought that the benefits of scientific research in general and the space program in particular exceed the risks actually went up after the accident. ■

CONTANCE HOLDEN