

## A Naturalist at Large

## A Bite to Remember

*One strike and you might be out, if you accidentally meet a viper in a rain forest*

by Robert K. Colwell

After a long morning of research, my companion Bill Sheehan and I headed back to camp down a rain forest ravine in Corcovado National Park, a rugged wilderness in southern Costa Rica, where I had come to teach a course in tropical biology. I didn't see the snake until it was too late. As I jumped from one sand bar to another in the stream bed, I passed a buttressed tree, rooted about waist level in the stream bank. What I hoped was a thorn jabbed the biceps of my right arm, just below the short sleeve of my shirt. But then I saw twin slits in my skin, oozing yellow venom mixed with blood, and caught sight of a thick snake recoiling on the bank. I had always assumed that the strike of a large viper would hit like a fist studded with knives—not like the graceful, even gentle hypodermic pricking I had felt.

"Bill," I yelled upstream, "I've just been bitten by a *Bothrops atrox*!" I frankly have no idea why the Latin name came first to mind. The English name for this snake is actually French—*fer-de-lance*—for the shape of the head. The Spanish name, at least in Costa Rica, is *terciopelo*—"velvet"—for the rich black and tan colors and the sheen of the scales. The Latin name has officially been changed to *Bothrops asper* since I first learned it.

As Bill approached on the run, I had to divert him or he would have taken exactly the route I had followed, risking a second strike. By the time he arrived, I had removed the mesh bag of my insect net for him to tie as a constricting band above the bite on my arm, while I kept an eye on the snake. (A constricting band is a strip of cloth kept loose enough to insert one finger underneath it. The band must be released for ninety seconds every ten min-

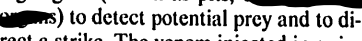
utes to allow surface circulation. If bound so tightly that deep circulation is cut off, the band becomes a tourniquet—which can do more harm to a limb than a snake-bite.) Then, breaking the rules, I ran a half mile to the park headquarters, rationalizing (incorrectly) that running would spread the poison only if the bite were in a leg. Bill stayed behind to kill the snake so it could be positively identified. I yelled for help as I passed the outdoor eating shelter at park headquarters, and the tables emptied.

During the next hour and a half I lay on a bunk in a park guard's room, not at all sure of my future. There was a great deal of scurrying about as three different sets of antisera, with three conflicting sets of instructions in two languages, were gathered. My friend and fellow professor Barbara Bentley took charge, kept the rest of the course members busy and at bay, and began the sensitivity tests for horse-serum allergy on my left forearm.

To produce antiserum, or antivenin, horses are injected with sublethal doses of snake venom, inducing the formation of antibodies to venom proteins. Whole serum from the blood of these horses is reduced to a freeze-dried powder, which is easily reconstituted with sterile water when needed to treat snakebite. The production of snake antisera is the responsibility of the Instituto Clodomiro Picado in San José, Costa Rica's capital city. Antivenins specific to local snakes are produced there and carried at all times during courses given in the field. The antisera, one for vipers and one for coral snakes, are also readily available over the counter in drugstores throughout Costa Rica. While I waited the prescribed twenty minutes for the skin reaction test on my left forearm,

which would determine if I could safely be given antiserum, I watched my right arm swell to twice its usual circumference and thought about all the things I am allergic to—celery, watermelon, walnuts, pollen, guinea pigs . . . and horses (but not to their blood, I hoped).

Soon Bill came in to ask if I wanted to see the snake, which he had killed with a machete after pinning it with a log. I said yes. It was in two pieces, the head severed from the four-foot-long body. I stared at it and felt the weight of its thick body. It was a beautiful creature, wondrously adapted for its life as a predator in ambush. Harry Greene, my colleague at the University of California at Berkeley, has studied the daily life of these snakes by carefully putting miniature radio transmitters down their throats and following their movements in the forest. The marvelously camouflaged fer-de-lance can sit motionless in the same spot for days or even weeks, waiting for a meal to wander by.

Like other vipers, the fer-de-lance uses not only its eyes but also special heat-sensing organs (known as pits, ) to detect potential prey and to direct a strike. The venom injected in a single strike is enough to kill a victim the size of a large rabbit within minutes. Snake venom is extremely complex, varying greatly with the species of snake, its age, and even its geographical origin. Unlike the venom of coral snakes, fer-de-lance venom has no direct effect on the nervous system but digests muscle, destroys blood cells, and causes hemorrhaging and massive edema (swelling).

As I touched the body of the snake that bit me, I felt no rancor—only sorrow for what must have been a case of mistaken identity. The snake had struck from a

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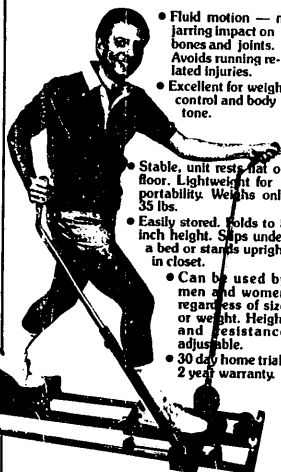
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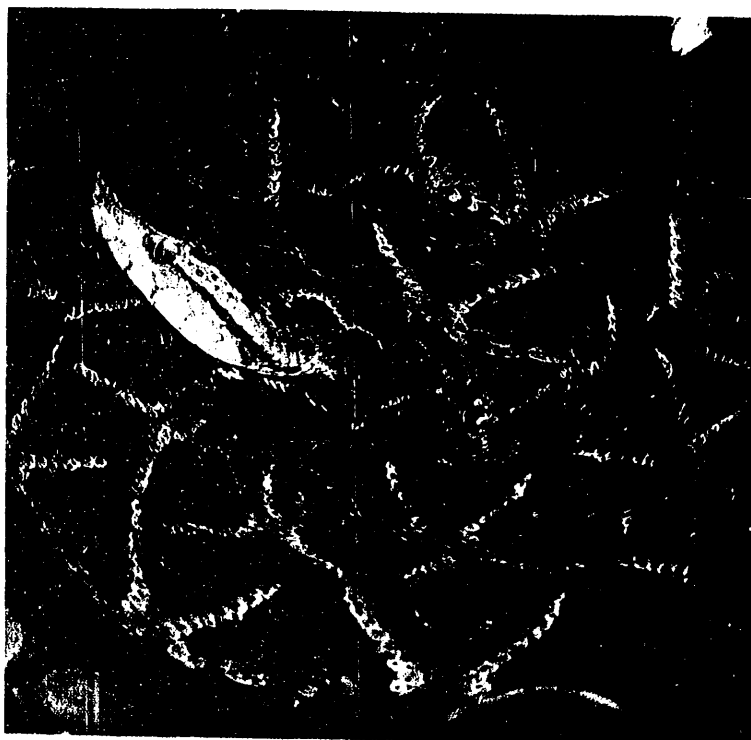
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*The venomous fer-de-lance*

H.W. Greene

good distance off to one side of my path. Because the lower two-thirds of my body had been shielded from its perception by the river bank, the snake may have taken me for something small enough to eat—or perhaps only the exposed part of my arm, below the short sleeve, caught its attention. Someone had opened up the snake's stomach. It was empty, which meant that the venom glands had probably filled to capacity during the time the snake had lain in wait for prey.

Every tropical biologist watches for snakes. After years of fieldwork, we watch in the same unconscious way that the experienced driver watches for a drunk on the freeway. Drunk drivers on freeways, in fact, are much more common than large poisonous snakes within striking distance in tropical forests. I calculate that one such snake is seen for every 400 to 800 person-hours in the field in Costa Rican rain forests. During the fifteen years of courses given there by the Organization for Tropical Studies, there were some 450,000 person-hours in the field without a venomous snakebite. Unfortunately, I had broken that record.

The antivenin allergy test was negative—I could safely receive the antivenin. My friends injected 30 cc into my backside and another 5 near the bite. (The injection in my arm was not only excruciat-

ing but, I later learned, could actually have been harmful, by further blocking local circulation. Antivenin should always be injected in a large muscle away from the area of the bite. In case of sensitivity to horse serum, there is an alternative, although somewhat less effective serum—made from sheep blood—for Costa Rican snakes, but we did not have it.)

Meanwhile, the park guards had used their brand-new radio to call in a four-seater bush plane from San José—normally about a twenty-five minute flight. In spite of bad weather, it made it to our grass airstrip an hour and a half after the bite, and I was carried aboard. One of the students in our group who had experience treating shock accompanied me to San José, Adrenalin kit in hand. The flight was an ordeal. As the air pressure fell, the relative pressure inside my arm rose. We had been at sea level, and San José is at 8,000 foot elevation, so landing didn't help much. Moreover, the air was choppy, and substances in the venom that cause disorientation and nausea had taken hold. I was definitely losing control.

An elderly nurse greeted my entry into the emergency room at the hospital with an intravenous rig. I was so near the end of my rope that I must have let out a cry when she put the needle in, because she said sternly, "*Silencio, Señor! Esto es un*



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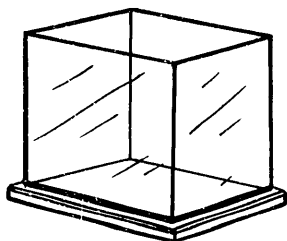
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hospital!" I vividly remember the remark because it forced me to get a firm grip on myself for the first time since boarding the airplane. Besides, it marked the moment when I began to feel that I actually would survive if I followed the orders of this crusty *comandante* of the emergency room. A huge dose of Demerol disappeared down the tube into my grateful body, followed by another 60 cc of antivenin, antitetanus serum, and several million units of penicillin. (One cubic centimeter of fer-de-lance venom contains about two million bacteria of a half dozen species, and tetanus is common on viper fangs.)

For the next three days I watched a dozen fellow humans come and go in the intensive care room, where I was kept because of the threat of bleeding. None of the other patients stayed for more than a day, and the only one who was conscious could not talk. In spite of the excellent care and facilities, a victim of a road accident and a man who suffered repeated heart attacks died as I watched. Then there was Alejandro, age sixteen, who had ruptured his esophagus while vomiting after drinking too much with some older friends. He was later to be my ward mate.

I think you are supposed to be unconscious when in intensive care. The lights were left on twenty-four hours a day and the staff chattered constantly to keep themselves alert and sane when nothing urgent was happening. I was grateful for my fluency in Spanish, but even so, I had difficulty getting anyone to tell me what was going on in my body or what dangers were keeping me in intensive care. Because my right arm was held in traction to keep the swelling down, I had to lie flat on my back under the fluorescent lights. From the wall clock I knew how much time had passed. There were no meals to punctuate those days, just changes of the glucose drip. Snake venom includes something that makes you too nauseated to hold even water down, let alone solid food.

No matter how unpleasant the nausea and how intense the pain, it is usually the "hemorrhagic fraction" of the venom of the fer-de-lance and related snakes that ultimately kills its natural prey and is responsible for most human fatalities as well. Victims bleed to death. The bleeding can be from internal organs (the staff in intensive care constantly checked my urine for the presence of blood) or from the eyes or ears—anywhere but from the bite itself, which is too swollen to leak from the tiny fang wounds. Rattlesnake venom, on the other hand, does not have much effect on the ability of blood to clot—hence the traditional recommendation to cut across the fang wounds and suck out the venom.

It is mortally dangerous to cut anyone bitten by a fer-de-lance or one of its relatives of the genus *Bothrops*.

Despite the immediate and proper treatment with antivenin, the low platelet count and the loss of certain clotting factors in my blood were sufficient to keep its clotting time eight times normal for the first day (hemophiliacs have a clotting time of about half that). Fortunately, I sprang no leaks while my blood was healing, although the hospital staff was ready for any emergency with appropriate drugs on a tray at my side. However, the i.v. had to be moved often to a new site because of local hemorrhaging; when there were no more usable veins in my left arm, my legs and even my feet were pressed into service. I later discovered that an appeal had gone out for O-negative blood, to match mine.

My right arm continued to swell and discolor for two days; the swelling eventually included my right shoulder and the whole right side of my torso, and I could no longer keep my head from tilting to the left. In addition to the clotting problem, another concern was circulation to the lower part of my right arm—past the immensely swollen area of the bite. The pulse in my hand was checked every hour. Had it weakened sufficiently, the doctors said they would have had to "make some deep incisions to release the pressure on the deep arteries" (a fasciotomy) to save the arm itself. They told me it would be helpful to make a fist now and then. I made a great many fists, and my pulse stayed strong enough.

Moving from intensive care to a ward—with a real bed, real food, and lights that went out at night—was like coming back to Earth after spending three days strapped into a cramped spacecraft plagued with disasters. My arm was still hoisted up on a rope, and there were still frequent and ever more creative changes of site for the i.v. tube, but I now had peers, alive and awake, to talk to; visitors were allowed (first, my wife, Mary-Claire, who had come from California, and later other friends); there were meals, sunrises and sunsets, and at last, the swelling was beginning to subside. Alejandro of the ruptured esophagus was already there, complaining about the bland liquid diet he was allowed. His friends smuggled in small cans of fruit juice, cookies, and candy bars, which he hid under some magazines and enjoyed when the nurses were out of sight. My euphoria was short-lived. On my second day in the ward the serum sickness began.

It started with wall-to-wall red welts—hives—on my chest. The reaction soon



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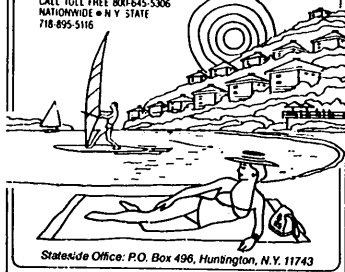
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spread over my shoulders and down my back, cropped up on my thighs and buttocks and then on my face and scalp, all within a few hours. Everything burned; everything itched. The nurses had to wait for orders from a doctor, of course, before they could do anything, and although I'm sure they knew what was happening to me, they weren't willing to tell me. I assumed that I had suddenly developed an allergy to one of the drugs they were giving me—penicillin, Demerol, or codeine. More than four days had passed since the horse serum was pumped in, so that couldn't have been the cause. By good fortune, the physician on rounds the next morning was Dr. Falcon, an immunologist, who was delighted to explain my condition to the four medical students touring the wards with him. When he learned that I was a biologist, he included me in his Socratic teaching session, fortunately asking me questions commensurate with my amateur status as an immunologist: "Now, Dr. Colwell, what happens when a foreign protein enters the body?" "Antibodies." "Señorita Gomez, how many days until the antibody titer equals the concentration of antigens?" "Four to six."

So the cause of the welts was the horse serum after all, and my gigantic case of hives was a perfectly normal reaction to having 90 cc of some other species' serum protein added to my own xenophobic system. Serum sickness, though, is not an allergic reaction, in the proper sense. The hives appear when human antibodies reach a concentration about equal to horse antigen. Each antibody molecule couples with an antigen molecule. These complexes are unfortunately not soluble in the blood, so they are deposited in capillary beds throughout the body, where they cause hives and, in more severe cases, produce other more dire, internal reactions (such as kidney failure). The antibodies, however, continue to form and link up with existing complexes, which go back into solution in the blood when there are two antigen molecules attached to each antibody molecule.

All this I learned in my ward bed from Falcon, the friendly immunologist. He also reassured me that everything I had experienced was normal for a properly, promptly treated viper bite, and that I was lucky there was not more tissue damage. He told me that, in Costa Rica, there are some five hundred bites from poisonous snakes each year—about one for every 4,500 people. Three-quarters of these bites are caused by the fer-de-lance. Before the development of specific antivenins, the death rate was high. Nowadays, virtually all victims receive medical

treatment, and only 3 percent die, although a larger percentage suffer some permanent disability.

Fortunately, Falcon's knowledge of immunology had a practical side. He ordered generous doses of cortisone and antihistamine added to my i.v. cocktail—the cure for the cure for the snakebite. The hives slowly subsided, and the cortisone dose was decreased daily for the following ten days. (If a high dosage is withdrawn abruptly, the endocrine system goes haywire.) It became clear that there would be no severe damage to my arm and no surgery was needed to make it functional again. Nine days after I had entered the hospital, I felt well enough to talk my way out, on the condition that I take it easy and use the medications according to a complicated ritual.

My arm was still quite unusable, very stiff from a large internal clot in the area of the bite, where a good proportion of my original platelets and clotting factors lay entombed. The area of the clot, perhaps six inches long and four wide, was very hot for about six weeks, as my white blood cells digested the clot. Eventually, my arm was essentially as good as new. When I left the hospital, I spent a fine day in the countryside with my wife, breathing real air and taking stock of life. She had to leave for California the next day to return to our five-year-old daughter, but I stayed in Costa Rica to pursue some field research I had planned with a group of my graduate students from Berkeley, who were scheduled to arrive in a few days. I was to go through a period in which every step in the rain forest took courage, but gradually my fears lessened.

On my third day out of the hospital, the course I had been teaching ended, and all my colleagues and students arrived together in San José. I was waiting for them, with my arm in a sling, but alive and well. They greeted me with great intensity, partly due to relief that the pessimistic predictions that had reached them in the field had not come to pass and partly, I believe, from pride in a job well done—each of them had contributed to saving my life after the fer-de-lance bite. But something else was also involved. What happened to me could just as well have happened to any one of them, and they sensed that from the start. Their joy was for their own lives as well as mine. That night we all went dancing. I didn't dance much, but I can't remember when I've enjoyed it more.

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