"represent, in the aggregate, nationally recognized competence in virology, rickettsiology, immunology, epidemiology, pediatrics, and microbiology."* But Morris contends that the panel was not an appropriate body to review his work because it was dominated by scientists who receive grant support from the Bureau of Biologics or other federal sources and are thus, in his eyes, compromised in their ability to act independently of the Bureau of Biologics management, with whom Morris is at war.

The proposal to remove Morris was heard by a second employee appeals examiner. At issue, in addition to the charges of scientific "inefficiency," were allegations that Morris was guilty of "insubordination" because he failed to attend and participate in meetings as required, to furnish information requested by his supervisors, and to submit protocols. In a report issued on 24 May 1976, the examiner sustained many of the specific charges and rejected the others. On the insubordination issue, for example, he agreed that Morris had willfully refused to give his superior a scientific paper that supposedly supported his position and that Morris had willfully failed to make presentations at two meetings as directed. And on the question of scientific inefficiency, the examiner agreed with five specific charges about inadequacies in Morris's research, including the failure to keep proper records and to exercise sufficient caution in randomizing and housing mice.

But the examiner, who was not a scientist himself, did not view these transgressions as serious. He found the insubordination, "while in some instances willful, to be generally lacking in malice, and in most instances of minimal seriousness." And he found the scientific inadequacies "to be less substantial even than the reasons related to insubordination. Many are only marginally supported by the evidence and are sustained to a large degree solely on the basis of overwhelming peer opinions rather than conclusive hard (best) evidence of inefficiency." As a result, the examiner concluded that the proposed removal was "excessively severe"; he recommended downgrading the punishment to "a suspension of 5 days without pay."

But Food and Drug Commissioner Schmidt saw the matter differently. In a letter to Morris dated 12 July, he said that those charges which had been sustained by the examiner were ample reason to dismiss Morris. "I cannot agree," he wrote, ". . . to the characterization of the sustained charges of insubordination as being 'of minimal seriousness.' On the contrary, the kind of behavior exhibited by you toward your scientific colleagues and administrative superiors directly challenges the integrity of scientific progress and the ability of the Food and Drug Administration to carry out its mission." Noting that peer review at scientific conferences is one of the principal quality control mechanisms in science, Schmidt added: "The sustained charges of insubordination amply document your blatant disregard for the required participation in scientific conferences and, indeed, your direct disobedience of your immediate supervisor. In such circumstances, there can be no effective quality control of your research program."

Schmidt went on to "most emphatically disagree" with the examiner's contention that Morris's scientific inadequacies were insubstantial. Noting that failure to observe the "rules of good science" can render an entire study useless, Schmidt admonished Morris: "The sustained reasons for your inefficiency include violations of many, if not most, of these elemental rules, including poor experimental design, improper selection and randomization of test animals, poorly controlled experiments or no controls, poorly kept or nonexistent records, and inadequate measuring techniques. In some instances, these flaws were such as to render the experimental results, not to mention the original experimental purpose, meaningless to your scientific peers."

As a result of the sustained charges, Schmidt removed Morris from his position on 16 July. At this writing, Morris is pondering whether to exercise his rights to appeal or take some other step. But he vows never to give up his fight to influence federal vaccine policies along lines that he believes necessary to protect the public health.—PHILIP M. BOFFEY

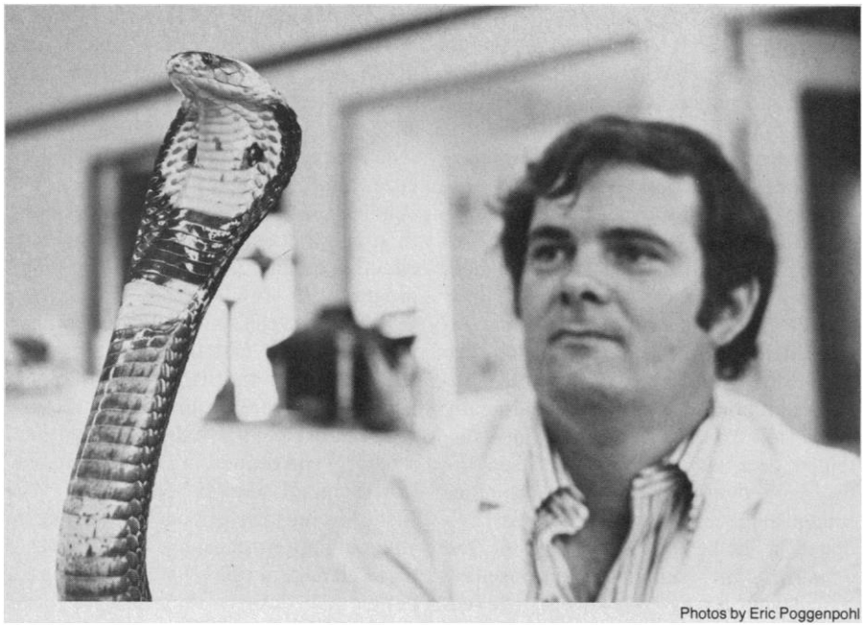
*Members of the panel who prepared the report included Saul Krugman, New York University School of Medicine (chairman); John P. Fox, University of Washington; William S. Jordan, Jr., University of Kentucky College of Medicine; Edwin H. Lennette, California State Department of Health; Kenneth McIntosh, University of Colorado Medical Center; June Osborn, University of Wisconsin Medical School; and Wade P. Parks, National Cancer Institute.

Venoms: Extracting Healing from the Serpent's Tooth

Jack Kilmon was standing around his lab in Baltimore talking about snakes when from the corner of his eye he saw something moving outside. He trotted down the hall, out the open door, and onto the parking lot, a distance of about 40 yards. An intruder? No, a 3-inch-long fuzzy caterpillar. Kilmon is an alert character, and alert is what he very much needs to be in his line of work, which involves daily handling of hundreds of venomous snakes as well as scorpions, black widow spiders, toads—in short, any beast that's poisonous.

Kilmon, 35, has always loved reptiles, particularly snakes, and he has parlayed this devotion into a rapidly growing business which involves the extraction, processing, and sale of venoms to medical researchers around the world. He claims to be the leading producer of venoms in the country, which is probably true since he only has one serious competitor, the Miami Serpentarium. The 12-year-old company, Biologicals Unlimited, is run by Kilmon, his wife, his best friend, and a 19-year-old herpetology student. His menagerie includes anywhere from 500 to 2000 cobras, vipers, and pit vipers (the three families of poisonous snakes), and sundry other creatures including five electric ells (their electric organs are sold for isolation of acetylcholine) and an alligator named Clyde who launches into a terrifying heavy breathing routine whenever anyone approaches the metal bathtub in which he resides. Clyde, who is there mainly for educational purposes (Kilmon gives tours to Boy Scouts and other groups) serves as the house garbage disposal and crematorium—whenever one of the other residents "croaks," as Kilmon puts it, it is delivered after autopsy to the alligator.

As for the venoms: they are becoming rather big in biomedical research, explains Kilmon, owing to rapid advances in molecular biology. Now that researchers are getting close to finding out what happens in nerve transmission, the many enzymes contained in snake venom are



Kilmon holds his favorite cobra, Kay, who appeared with him recently on the television show "To Tell the Truth."

becoming exceedingly useful in elucidating biochemical processes. They also offer promise for improved clinical treatment of a wide variety of nervous, muscular, immunological, and metabolic disorders. Snake venoms contain both hemotoxins and neurotoxins, with one or the other predominating depending on the species. The hemotoxins contain both clotting and anticoagulant factors; the neurotoxins can block impulses, both pre- and postsynaptically, and can aid in their transmission. As a purveyor of venoms, then, Kilmon sits at an unusual hub of a constellation of disciplines—neurology, cardiology, hematology, zoology, molecular biology, and enzymology, to name a few.

Kilmon, a native of Baltimore, never wanted to do anything but work with reptiles, but, as he said, "the trouble with a career in herpetology is it means sitting in a museum looking at pickled snakes." He therefore carved out his own ecological niche. Now, in addition to running the lab, he travels around the world collecting specimens, does some research work in collaboration with other institutions, instructs hospital personnel on clinical management of poisonous bites, and gives lectures and tours to schools and other groups.

Kilmon recently gave *Science* a tour of his facility, a large old brick building, part of a former pickle factory, nestled amongst tall weeds somewhere in Baltimore. He is equally adept at dancing around the floor goading a cobra for the amusement of visitors and at explaining complex chemical phenomena such as the "complement cascade," which is the series of events leading to the formation of antibodies in the blood serum.

On his round of his creatures' cages, Kilmon wears no protective clothing—he explains that it gets in the way of movement and also of sensing what the animal is up to. He just carries a little tourniquet on his belt. He has never been bitten, which is fortunate as he is allergic to horse serum, the medium for antivenin. He has had one close call: he used to have an Egyptian scarab ring that bore a hieroglyphic inscription invoking the sun-god to protect the scarab's wearer from the serpent's bite. One day he was playing with a king cobra, a beast with a head the breadth of a man's hand and the ability to deliver up to 13 cubic centimeters of venom in one bite. Kilmon slipped and the cobra lunged. One of its teeth snapped down on the ring. (A week later the scarab, its mission accomplished, disappeared—presumably loosened from its setting by the impact of the bite.)

Kilmon's present quarters are somewhat in disarray because he had to move there in a hurry. Last year, at his former location, two 16-year-old boys broke in and stole a tarantula and a dozen rare nonpoisonous snakes (they knew which animals to take because the neighborly Kilman had recently given them a tour of the lab), and let a number of others out of their boxes. The boys were apprehended when one brought the tarantula in to show to his biology class. The snakes were successfully rounded up, although one cobra slithered around the neighborhood for a while, causing "quite an uproar." Kilmon's neighbors and his landlord decided he should move elsewhere. Although the burglary and the move put him out of business for 4 months, it turned out to be all for the best, because he now has ten times as much room as before.

The main floor of the building contains the scientific equipment—a photo lab, bottles and tubes for snake venom extraction, a freezer, a centrifuge, fractionation equipment, a machine to freeze-dry the venoms, and a freezer full of dead snakes.

Below, in the basement, in dark boxes and glass cages, slumber and rustle a collection of animals with the lethal wherewithal to fell a small army. First comes the insectary, where hundreds of scorpions wait in small plastic cups and the black widow spider bides her time (a shipment of 2000 black widows is expected momentarily). The scorpions feed on crickets, the spiders on mealworms and fruit fly cultures. Kilmon extracts their poison with the aid of electrified forceps with which he stimulates their poison glands. Down the hall are the snake rooms, which contain a dazzling variety, ranging from the 12-foot-long king cobra to a rare, and nonpoisonous, albino corn snake. There is a spitting cobra that issues an acidlike spray directed at the eyes. There is an African krait, also known as the two-step because that's how many you supposedly have time to take before dropping dead of its bite. And there is the black mamba, the most dangerous snake alive. Kilmon will take the cobras out and tease them to show them "hood up" and will nudge an irritable rattler, but the mamba stays in its cage—it is "a very fast hyperactive snake," he says, that would flip all over the room and bite everyone in it in a matter of seconds. Also in the snake department are two samples of the beaded lizard (one a Gila monster), the only poisonous lizard extant. (Kilmon says snakes started out as lizards but then took to burrowing and found it more convenient without feet.)

Around the corner is the "small animal laboratory," which might also be called the larder. There a throng of hapless crickets chirp, in company with boxes of rats and mice waiting to be bitten or squeezed to death, depending on which snake they are fed to. There are also some poisonous-warted toads, and some rabbits destined for the Kilmon family pot.

The snakes are maintained at a temperature of 80°F and humidity of 80 percent; otherwise they require very little maintenance. When they arrive, they are given shots of prophylactic antibiotics and some vitamins. The snakes are given a nutritious mixture of beef liver, bone meal, and vitamins, which is ground to a paste and force-fed with a caulking gun

that has a tube attached to it. Feeding usually coincides with the extraction schedule, which comes every 1 or 2 weeks.

Obtaining the venom is a simple procedure: a snake is brought up to the lab and the handler holds its head over a glass funnel covered with a piece of transparent paper. The snake bites down on the paper and the venom dribbles into a vial. The company mixes the venom of hundreds of snakes together in order to get large quantities of dried venom of consistent quality. Supplies are augmented by imports of venom from an office the company has in Hong Kong. There, the cobras are milked at the market before they are prepared for food. It takes 30,000 cobra extractions to make 1 kilogram of dried venom, which would sell for $32,000. The most expensive venom comes from the yellow-bellied sea snake—that costs $3000 per gram.

Kilmon, who tries to keep up with venom research, does work in cooperation with Johns Hopkins, New York University (his technical adviser is NYU biology professor Joseph F. Gennaro), and the biology division of Edgewood Arsenal, where he aids in the development of antivenin for military use.

He sees a mushrooming market for venoms. At the moment, he says, there are only two drugs available in this country manufactured from venoms, both made by the Baltimore firm of Hynson, Westcott & Dunning. One is Cobroxin (from cobra venom), which, says Kilmon, is a more effective analgesic than morphine. It works by blocking nerve transmission, and only one daily dose is required, whereas for severe pain morphine has to be given every few hours. Unlike morphine, he says, it has no adverse side effects, is not addictive, and there is no problem of the patient building up tolerance to the drug. The other drug is called Nyloxin. Cobra venom mixed with silicic and formic acids, it is used for arthritis pain. Some other venom-based drugs are used abroad. In England, says Kilmon, there is in use as an anticoagulant a drug containing enzymes from the Malayan pit viper. This is alleged to be superior to the anticoagulant heparin in preventing the formation of clots. And over in France, says Kilmon, there is an antiarthritic drug made from bee venom. (He says the Warren Foundation in New York is doing research on bee venom.) More drugs are in the pipeline. Cobra venom shows promise for treatment of amyotrophic lateral sclerosis, better known as Lou Gehrig's disease. There is evidence that enzymes from krait venom can be of use in myasthenia gravis. There have also been experiments using a fraction of cobra venom as an immunosuppressant in myocardial infarctions induced in dogs. The cobra venom factor is supposed to inhibit production of antibodies that the body makes to reject the dead heart muscle, and thereby reduce the extent of the damage. Implications for transplants are obvious.

A drop of venom can be seen at the tip of the exposed fang of a rattlesnake, a member of the viper family. Vipers have teeth that fold back when not in use; cobra fangs are shorter and nonretractable.

Kilmon recently completed some research of his own with opossums. Opossums, it seems, are impervious to snake bites, a fact that Kilmon attributes to a remarkably efficient immune system, a theory reinforced by the fact that opossums also never seem to get cancer. The only effect of snake venom on opossums is a temporary lowering of blood pressure resulting from the venom's properties as a vasodilator. (It is not used for hypertension, though, says Kilmon, because it is so potent and difficult to regulate.) "Every biomedical field has a different application, and an exciting application, for venoms," says Kilmon.

"When you keep these animals you become one of the animals," Kilmon says, and indeed the reptilian layer of his brain seems to be in tune with theirs. He has no illusions about their personalities—the cobra, for example, he characterizes as "sort of dull-witted and hysterical"—but he has fine appreciation for the efficiency and order of nature as manifested through reptilian behavior. Also, "what fascinates me is I am sort of a 'root for the underdog' type of person. Snakes are the underdogs."—CONSTANCE HOLDEN

Nuclear Exports and Proliferation: The French Think They Have a Case

The problem of nuclear proliferation through the export of nuclear fuel facilities has assumed the dimensions of a major policy issue. Publicly, the issue is perceived as a conflict between the United States on one hand and France and West Germany on the other. The French are piqued at the American press for what they regard as the unjustified depiction of France as irresponsible in selling nuclear facilities to countries which might use them to make weapons. At the government level it appears that discussions are being conducted equably. But it is also evident that secret negotiations carried on for well over a year by nuclear exporting countries have not resolved outstanding differences.

The focal point has been the sale of fuel reprocessing facilities to non-nuclear countries by both France and Germany. Reprocessing plants separate spent reactor fuel into fission products, plutonium, and unused uranium. The separated plutonium can be used to make nuclear weapons. The relative ease of "conversion"—the use of plutonium from reprocessed fuel in nuclear devices—is what is causing growing concern among American policy-makers and underlies a reappraisal of policy.

American standard policy has been to urge all countries to become signers of the Nonproliferation Treaty (NPT) and participate in the system of international nuclear safeguards supervised by the International Atomic Energy Agency (IAEA). For its own part, the United States has declined to export fuel facilities—either uranium-enrichment or fuel-reprocessing plants—which could produce weapons-grade nuclear material. And recently, the United States, in effect, began to urge other exporting countries to do the same.

In a statement before a Senate Government Operations panel on 9 March, Secretary of State Kissinger expressed the