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Scientist Discovers Why Cobra Venom Can't Kill Other Cobras

Zoltan Istvan
[National Geographic Channel](#)
February 20, 2004

In a cobra hunt, every move counts.

Zoltan Takacs, a herpetologist and toxinologist (natural-toxins scientist), lunges at a 5-foot long (1.5-meter) Egyptian cobra slithering away in the dry East African grassland of Tanzania.

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The cobra opens its hood—kicking up dust and hissing—and strikes, narrowly missing Takacs's right hand. Takacs jumps away, gathers himself, then quickly moves in and snares the cobra's head with a wooden stick.

In his field lab the Hungarian-born Takacs, who's been fascinated by snakes since childhood, extracts tissue samples from the cobra for genetic analysis. Based at the Yale University School of Medicine in New Haven, Connecticut, Takacs has developed an international reputation for unlocking secrets of venom that promise to have significant medical potential.

But Takacs must endure tremendous risks in the field. "I have to be extremely careful in this tropical wilderness—because I'm far from any hospitals," Takacs said. "Over the years I've lost three good friends and colleagues to snakebites."

Since high school, Takacs, who holds a doctorate in molecular pharmacology from Columbia University in New York, has traveled to more than a hundred countries to collect venomous snakes.

Animal neurotoxins are nature's deadliest weapons. Nearly all creatures, except cobras, die in minutes when cobra venom enters their bloodstreams. At his Yale lab, Takacs explores why.

Cobra Venom

"Neurotoxin is the main lethal component of the cobra venom," Takacs said. "It binds to a receptor on the muscle, therefore preventing the nerve impulses to induce muscle contraction, leading to the cessation of breathing, and death."

The target of cobra neurotoxin, called the acetylcholine receptor, appears to

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This Egyptian cobra (top) was used for research by scientist Zoltan Takacs, shown holding a sea krait in Vanuatu, an island nation in the South Pacific.

Photographs courtesy Dr. Zoltan Takacs

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play a role in Parkinson's disease, schizophrenia, and myasthenia gravis, which debilitates the muscles.

"Snake venoms are extraordinary biological products, with importance in many different fields," said Rick Shine, professor of evolutionary biology at the University of Sydney in New South Wales, Australia. "Understanding their mechanisms of action can help us to design better drugs—as well as to reduce the immense suffering and mortality from bites to humans."

Venomous snakes come in two main families: vipers, such as rattlesnakes, and cobras, such as kraits, mambas, and sea snakes. During the 1970s scientists discovered that vipers' bloodstreams contain molecules that neutralize the lethal components of their own venom.

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Scientist Discovers Why Cobra Venom Can't Kill Other Cobras

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Cobras deal with their venom differently from vipers, the scientists suspected. During the 1990s studies were launched to find out why.

Snake venoms are complex mixtures of peptides, enzymes, and other toxins that target the nerves, muscles, and blood circulation and coagulation. A key to the research was finding how the toxins reacted with muscle receptors.

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Lock and Key

Takacs cloned a cobra's acetylcholine receptor and compared it to acetylcholine receptors from other vertebrates (animals with spinal columns). At the molecular level this cobra receptor looked the same as those in the rest of the vertebrates—except for a single different amino acid.

Takacs' experiments showed that this single difference introduces a bulky sugar molecule onto the cobra receptor. The sugar masks the so-called binding site on the receptor surface—which prevents the neurotoxin from attaching.

"If the sugar is removed, then the cobra receptor will become sensitive to its own

neurotoxin, just as other animals are," Takacs explained.

To prove his theory, Takacs and his colleagues engineered a mouse muscle receptor with a sugar molecule attached—and thus created a mouse receptor that resists cobra neurotoxin.

"Like a keyhole and a key—if you change the keyhole, the key will no longer fit into it," Takacs said. That's the secret to how the cobra avoids its own venom.

"These same venom [and receptor] molecules, once purified, characterized, redesigned, and cloned, can be used in medical research as possible drugs for treating strokes, heart attacks, and metastasis as well," said John C. Perez, a professor at the Natural Toxins Research Center at Texas A&M University-Kingsville.

"These venom and receptor molecules all have important biomedical applications, making Takacs's work much more than just studying snake venom," he added.

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Photographs courtesy Dr. Zoltan Takacs

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For more on cobras, watch [National Geographic Presents: King Cobra](#) Sunday, February 22, at 9 p.m. ET/PT in the United States—only on the National Geographic Channel.

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