DIPHACINONE RESIDUE FROM WHOLE BODIES OF VAMPIRE BATS: A LABORATORY STUDY[1, 2]

Richard J. Burns[3] and Roger W. Bullard[4]

One way of exterminating the vampire bat, a leading destroyer of livestock in the Americas, is to catch some vampires, smear their backs with diphacinone, an anticoagulant, and release them to contaminate other bats in their roosts. This article describes tests designed to determine whether diphacinone residues in the bodies of vampires killed this way could pose a threat to nontarget species.

Introduction

Vampire bats (principally the species *Desmodus rotundus*) feed exclusively on the blood of animals and man. The bats can transmit rabies, and *Desmodus*-transmitted rabies causes serious human and animal health problems throughout Mexico, Central America, and South America. It has been estimated that approximately 1 million head of livestock worth over US $47.5 million (1967 dollar value) die each year of bat-transmitted rabies (*1, 2*).

A recently developed control technique seeks to reduce vampire bat populations by capturing vampires, treating them with a paste containing diphacinone (2-diphenylacetyl-1,3-indandione), and releasing them to contaminate other vampires that groom them in their roosts (*3, 4*). The method has proven effective and consistently reduces bites on livestock by roughly 90 to 95 per cent in areas where it has been applied.

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[3] Predator Ecology and Behavior Project, U.S. Fish and Wildlife Service, Utah State University—UMC 52, Logan, Utah 84322, U.S.A.

[4] Denver Wildlife Research Center, U.S. Fish and Wildlife Service, Bldg. 16, Federal Center, Denver, Colorado 80255, U.S.A.

Vampire bat in laboratory colony (note band on folded wing) preparing to bite a bovine behind the hoof.

Because of its effectiveness, the method is either being used or being proposed for use throughout the affected regions of the Americas.

Until now little information has been available regarding the possible effects of diphacinone residues remaining in the corpses of bats dying from diphacinone intoxication. The study described here was conducted in order to measure these residues, and to determine whether the residue levels found would be likely to pose a hazard for nontarget species.

Procedure

Twenty vampire bats (10 males and 10 females) from a laboratory colony were placed in a plywood cage and allowed to adjust to the new conditions for over three weeks. This long adjustment period reduced the chances of bats dying from causes other than the treatment.

The cage, with dimensions of 63 x 66 x 90 cm, had a plexiglass front and a roosting dome (an inverted metal basin lined with screen) that was 33 cm in diameter and 15 cm deep. The bats were allowed to feed as much as they liked from plastic bird waterers containing defibrinated cattle blood.

At the start of the treatment period two male and two female bats were removed from the cage. Each bat was coated with 1.5 ml of a commercial vampiricide (Suspension Vampiricida Difenadiona, Motomco, Inc., Clark, New Jersey[5]), and all four were returned to the cage to mix with the 16 untreated bats. The vampiricide contained 15.0 mg of diphacinone per ml; hence 90.0 mg of the chemical were introduced into the colony. The dose level and treatment ratio were the same as those suggested for field use in controlling vampire bats (*4*). Each day following treatment all the bats that died were collected. The number dying was recorded, along with each dead bat's sex, treatment history, date of death, and external signs of anticoagulant poisoning.

Gas chromatography testing for diphacinone residue was performed according to established procedures (*5, 6*), using whole bat bodies including the skin and fur. Two untreated bats from the laboratory colony—employed as controls—were tested along with the bats from the treated colony.

Results and Discussion

The two untreated bats showed no diphacinone residues. Treated bats, and bats exposed to treated bats, showed great variations—both in residue levels and dates of death (Table 1). All of the treated and exposed bats died, and 18 of them (90 per cent) showed external signs of anticoagulant poisoning—i.e., bleeding from body openings and subcutaneous capillary hemorrhages. All four treated bats died on or before day 7, while an untreated member of the treated colony survived until day 11. Surprisingly, comparison of residue levels in treated and untreated bats in the treated colony revealed only a slight tendency ($50 > P < 60$, $T = .706$) for treated bats to carry more chemical. But a significant association ($P < .05$, $T = 3.546$; and $P < .05$, $F = 12.755$) was found between the date of death and residue levels; that is, the bats surviving longest were found to have lower residue levels (Figure 1).

The total amount of diphacinone recovered from all the bats was only 1.053 mg, or 1.17 per cent of the 90 mg originally introduced. This low recovery rate was presumably related to: (a) rapid metabolism of the chemical and (b) loss of the chemical on the cage structure (*3*). The amounts of diphacinone lost in each way, however, are unknown.

[5]The use of commercial names does not imply endorsement by the United States Government.

Table 1. Mortality data on 20 bats (4 treated and 16 exposed to diphacinone-treated individuals), showing time of death in days following treatment, sex and treatment status, diphacinone residue levels, and diphacinone recovered from each bat.

Day of death (following treatment)	No. of bats dying	Sex and treatment status (T = treated)	Diphacinone residues recovered from each bat	
			Parts per million by weight and (standard error)	Total mg of diphacinone recovered
1	none	—	— —	—
2	2	F	2.07 (.18)	.069
		F (T)	3.03 (.02)	.101
3	none	—	— —	—
4	1	F	4.70 (.05)	.120
5	1	F (T)	1.51 (.10)	.045
6	3	M	2.07 (.02)	.053
		M	2.45 (.13)	.057
		M(T)	2.95 (.05)	.082
7	3	M(T)	0.69 (.02)	.024
		M	3.14 (.29)	.077
		F	3.41 (.08)	.136
8	5	F	0.34 (.00)	.011
		M	0.55 (.05)	.017
		F	1.01 (.03)	.037
		F	1.35 (.10)	.039
		M	1.46 (.10)	.046
9	2	F	0.63 (.02)	.017
		M	1.17 (.19)	.034
10	2	M	0.63 (.02)	.018
		F	1.65 (.03)	.059
11	1	M	0.34 (.00)	.011
Total	20			1.053

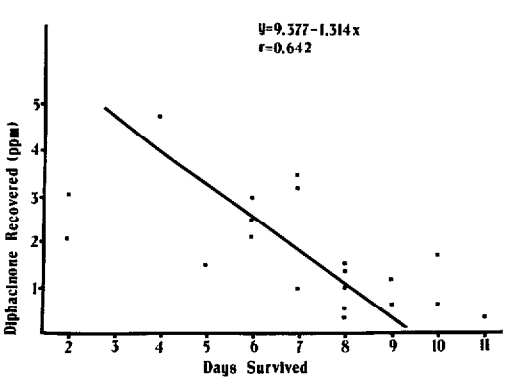

Figure 1. A chart showing the relationship between the quantity of diphacinone (in parts per million) recovered from each bat and the number of days each bat survived.

In general, anticoagulants are not considered very hazardous to nontarget species. Nevertheless, recommendations for their use against rodents usually specify that they should be kept away from nontarget animals (*7*). Actually, reactions to them vary widely among nonrodent species. A recent publication (*8*) on the toxicity of diphacinone for selected mammals, birds, and fish generally showed a wide range of susceptibility, with acute toxicity levels going all the way from 3,158 mg/kg for mallard ducks (*Anas platyrhynchos*) to 0.88 mg/kg (calculated[6]) for beagle dogs.

[6]Data were obtained from beagle dogs fed dog food pellets containing diphacinone. The LD50 for technical grade diphacinone was then calculated from the quantity of pellets the dogs ate.

Reactions to diphacinone among wildlife or animals not commonly used in laboratory studies also appear to vary. Broiler chicks fed 100 mg of diphacinone each did not die, merely showing an increased prothrombin time (*9*). However, some minks (*Mustela vison*) and domestic dogs have died after eating nutria (*Myocastor coypus*) killed with diphacinone (*10*). Field studies using vampire bat control procedures (*4, 11*) have indicated little if any treatment-related mortality among nontarget bats, rats, fish, and amphibians inhabiting caves where anticoagulants were used for vampire bat control.

This study indicates that only about 1 per cent of the diphacinone introduced into a colony remains in the dead bats (about 0.53 mg per bat). Hence we have concluded that the vampire bat control technique in question poses little hazard to nontarget species. Nevertheless, because of possible roost contamination, wide ranges in susceptibility among nontarget species, and lack of information about the susceptibility of wildlife to diphacinone, there is good reason to believe that the control technique should be used carefully, and should be employed only by adequately trained personnel.

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SUMMARY

Rabies transmitted by the bites of vampire bats, principally *Desmodus rotundus*, is thought to kill approximately 1 million head of livestock per year in the Americas. One promising vampire eradication technique involves catching some bats, smearing their backs with the anticoagulant diphacinone, and releasing them to contaminate other vampires that groom them in their roosts.

To find out whether diphacinone residues in the bodies of vampires slain by this method might pose a threat to nontarget species, such residues were measured by means of established gas chromatography procedures. In these tests only 1.17 per cent of the diphacinone used to treat bats was recovered from bat carcasses. This low rate of recovery suggests that the eradication method described poses little danger to nontarget species. Nevertheless, possible roost contamination, a wide range of target species susceptibilities to diphacinone, and lack of information about wildlife susceptibilities in general provide reason for using the technique carefully and for having it applied only by adequately trained personnel.

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WATER-RELATED DISEASES IN THE THIRD WORLD*

Almost 800 million people in the world today suffer from four water-related diseases alone—gastroenteritis, malaria, river blindness (onchocerciasis), and schistosomiasis. The serious lack of safe drinking water throughout the Third World has been underscored, and has shown that the connection between a lack of clean, piped water and disease is now well established. Thus, during a cholera outbreak in a small district of Malawi, the families who escaped the disease were those with piped water which, though untreated, was coming from upstream and was therefore uncontaminated. Those who suffered were those without piped water.

The answer of WHO and other international bodies to this critical lack of safe drinking water and of adequate sanitation has been to designate the period 1981-1990 as the International Water Supply and Sanitation Decade. In order for the Decade's target of "clean water for all by 1990" to be reached, some 140,000 million U.S. dollars will be needed; investment on water supplies in urban areas will have to be increased one-and-a-half times and in rural areas four times, while eight times as much as at present will have to be spent on sanitation.

Progress is already being made. As has been pointed out, "Where governments have committed themselves to the objectives of the Water Decade, particularly with the active collaboration of village communities, improvements have been substantial."†

*Adapted from WHO press release, 7 February 1979.

†Quoted from an article by Iain Guest in *World Health,* January 1979.