ANTICOAGULANTS—A PROBLEM OF DISTRIBUTION FOR THE HAWAIIAN SUGAR INDUSTRY*

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ABSTRACT: Current rodent control practices for the Hawaiian sugar industry revolve around the use of single grain baits containing anticoagulants in bait stations and zinc phosphide for aerial applications. Neither type of control programs as they are now applied has been very effective against the Norway rat (Rattus norvegicus) which is becoming a major problem species for the industry. As a result, we have sought a more effective anticoagulant, to which the Norway rat is more susceptible, and an improved method of bait distribution. With a knowledge of the month-to-month variation in the field rodents' gestation rate, a new control program is being developed which involves the distribution of diphacinone oats in plastic bags to precede the major annual gestation peaks.

A number of conditions characterize sugarcane culture in Hawaii which have had considerable bearing on rodent damage to the crop. Foremost is the land, delineated by numerous grassy wastelands bordering sugarcane fields. These wastelands serve as reservoirs for the rodent population and are especially important when the adjacent cane is immature and very little food and cover are available elsewhere. Rat migration into the surrounding cane fields is gradual as the cane plant matures, and concurrently damage also increases (Hood et al., 1970).

Another characteristic of the Hawaiian sugar industry is the 2-year growing season. At the end of this 2-year cycle, a minimum of 100 tons of cane can be found in a thick mass of cane stalks and detritus. Damage, which is characterized by a gnawed-out wound of 1 to 3 inches in length on the cane stalk, may reach alarming proportions of 30% or more during the 2-year cycle. Rat control, to be effective, must be carried out over this period in the wasteland when the adjacent field is young and in both infield and wasteland areas as the cane matures.

The Hawaiian sugar industry has established a reputation over the years as one of the most highly mechanized in the world. This emphasis on mechanization is closely related to the rise of the Hawaiian sugar worker as one of the highest paid in the agricultural world. With wages and benefits averaging close to $50 per day, total dependency on hand labor may soon be looked upon as a luxury. The use of anticoagulants does require the extensive use of labor because it is necessary to place a quantity of bait in the field by hand to insure 3 to 5 days of feeding. This is contrary to a machine-oriented industry.

The current practice of applying anticoagulant bait in wax cardboard bait stations is too time-consuming and wasteful. These stations, which are assembled in the field by the men as they walk along the field edges, are placed at 60 foot intervals and filled with 200 g of bait. Assembling, filling and refilling of bait stations is conducted on a year-round basis because it is based on interval feeding and scheduling, irrespective of the population it seeks to control. It has been used for many years by the industry as it is the only known method of distributing a quantity of bait to the field.

It should be emphasized at this point that it is the manner in which anticoagulants are being applied that may be of questionable value. As a form of rodenticide, anti-coagulants are still considered to be a valuable tool for the sugar industry and more so at this particular time due to the growing concern over the rising numbers of Norway rats. The other form of control that the industry utilizes is the aerial broadcast application of zinc phosphide oats over the crop. While it has been effective on the other two species of rats found in Hawaii, the Polynesian (Rattus exulans) and the black rat (Rattus rattus), zinc phosphide appears to be ineffective on the Norway rat as it is presently being applied.

Anticoagulants, however, are effective on the Norway rat, and one in particular, diphacinone, has been most effective in laboratory bioassays. Three-day feedings trials conducted in the laboratory on Norway rats have resulted in an average mortality of 86%. Results of tests conducted on the other two species of rats have been nearly as effective.

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The problem is one of bait distribution or placement. The solution to the problem must be efficacious, on the Norway rat in particular; it must be less dependent on hand labor; it must be applicable to areas in which wasteland is adjacent to both immature and mature cane fields; finally, it must be durable to withstand the extremes of weathering common along the island chain.

The distribution of bait bags may be a possible solution to this problem. Although the idea of distributing bait in plastic bags is not new, the author first tested the concept in 1973. Untreated oat groats tagged with 0.0125% Declomycin (DMCT), an ultraviolet fluorescing antibiotic (Crier, 1970), were placed in plastic bags which were then rolled into foot long tubes using a tarpaper overlay. These bags, each containing 300 g of tagged oats, were tossed into the wasteland at rates of 25 and 50 bags/treated acre. Thirty-three days later, both plots were snap-trapped for 2 consecutive weeks and the captured rats were examined for Declomycin which chelates with calcium of teeth and bones. The concentration of Declomycin was kept at a low level to prevent markings after minimal consumption.

The results showed that 83% of the 110 rats caught in the 25 bag/acre plot were labeled with Declomycin, and in the 50 bag/acre plot, 81% of the 113 rats were labeled. In addition to the total markings, 92% of the 134 Norway rats that were caught in both areas were labeled (Teshima, 1973). Based on a series of tracer studies that were previously conducted on the aerial broadcast program and the bait station program, it was concluded that this test showed the bagged bait to be potentially superior to the bait stations and comparable to an aerial application over a limited area.

Supported with this information, a series of field tests was installed over a 2-year period using diphacinone-treated oats in the bags. These tests were carried out on three plantations on two islands during summer and winter months. Most of them consisted of post-treatment trapping in treated and nontreated plots as the basis for evaluation, although in a few, pre-and post-treatment trapping was also used. The results of these tests are shown in Table 1.

Table 1. Field results of diphacinone bait bags (concentration 0.025% and rate 25 bags/acre.

		No. of Rats Captured Post-treatment		
Plantation	Field	Treated	Nontreated	% Reduction
McBryde Sugar Co.	806	3	27	89
	802	0	22	100
	616	5	42	88
	612	18	40	55
	600	12	115	90
	803	9	115	92
Mauna Kea Sugar Co.	43B	4	48	92
	60A	6	91	93
	60B	9	70	87
	65B	10	50	80
Puna Sugar Co.	240	13	68	81
	250	13	109	88

In addition to the high level of control, the use of bags offered several features that are considered to be improvements over the bait stations.

1. Because bags are thrown into the wasteland, distribution is less time consuming. Where field edges are bordered by roads, bags can be thrown from trucks. In areas where roads are not present, bags may be thrown from a helicopter as the adjacent cane matures.

2. Because bags can be thrown into the wasteland, a dimension of depth is gained which was previously lacking. Unlike the string of bait stations placed along the edge of the wasteland, throwing bags approaches broadcast application.

3. Bagging of the bait may be automated, further reducing hand labor.

4. Bait quality is preserved because the oats are sealed in plastic bags. This is an important feature for areas that average over 100 inches of rainfall a year.

As testing of these bags proceeded, a pattern of testing was developed that was multipurpose. The following information was provided from a single field test:

1. Efficacy of treatment in treated vs. nontreated plots.
2. Accessibility of bait to the immediate rodent population.
3. Extent of sublethal consumption that occurred as a result of the treatment.

The testing procedure is described below:

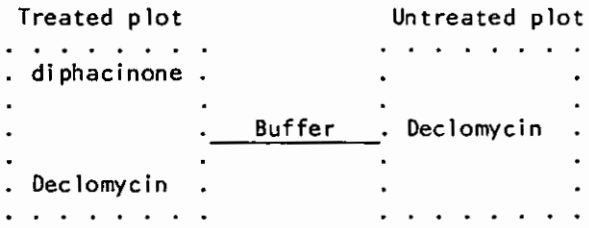
1. The wasteland is divided into two plots: treated and nontreated.

2. The treated plot receives diphacinone-treatment oats in bags; the oats are also tagged with the tracer Declomycin.

3. Oats tagged with Declomycin are also applied in bags in the untreated plot; diphacinone is <u>not</u> used in this plot.

4. Allowing sufficient time after application, both areas are trapped and the captured rats are examined for Declomycin.

5. Illustration:



Results are determined as follows:

1. Compare number of rats caught in treated and nontreated plots to determine efficacy.

2. Determine percent animals active with tracer from the nontreated plot which will indicate the potential of the bags as a method of distribution.

3. Determine percent animals active with tracer in the treated plot which will indicate the degree of sublethal consumption of the bagged bait.

If control is inadequate, then the reason for the lack of control may be found by analyzing the other two results. If the number of marked animals is low in the nontreated plot, then the method of bait distribution may be suspect; if on the other hand, the number of marked animals in the treated plot is high, then the bait or toxicant may be questionable.

The trials described up to this point have dealt with the treatment aspects of a control program. Wastelands have already been established as the area of concern. Therefore with a knowledge of what to use and where to use it, consideration was focused on trying to establish when to use it. It was concluded that knowledge of the reproductive tendencies of the target species would best answer this question. Information such as this

could possibly transform a worthy program that is ill-timed into one that is applied to produce maximum effect. It is with this utility in mind that a gestation study was started in March of 1975. Results to date have revealed a definite pattern of reproduction exhibited by the field rodents.

The study was conducted at three plantations on two of the four islands where sugarcane is grown. During each month, 400 snap traps were set for a 2-week period on each of the three plantations. Trapping was conducted in wasteland adjacent to cane fields that ranged in age from 0 to 4 months. All of the females were examined for the presence of embryos. The percentage of females pregnant was used to determine peak breeding seasons; the weight of each of the animals captured will be used to determine the percentage of immature animals which should closely follow the cyclic trends of the breeding seasons. Figure 1 plots the percentage of females pregnant by month and is computed on a 3-point moving average.

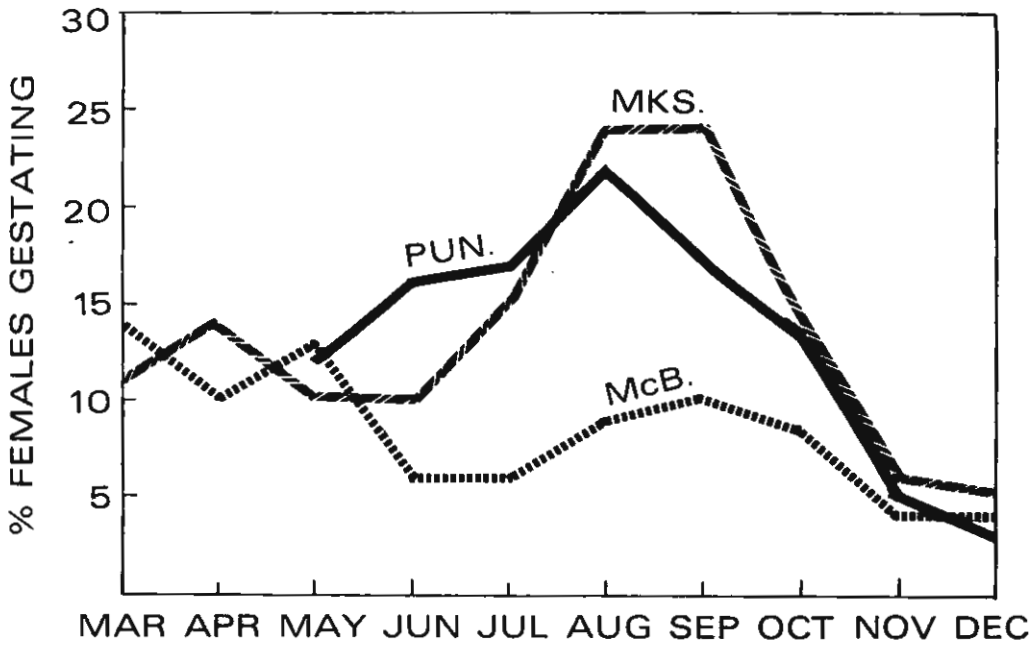


Figure 1. Percentage of females pregnant, computed on a 3-point moving average, that were trapped at three plantations in 1975.

With available information, a series of 2-year field tests has been started at four plantations to determine the effect that the control program will have on cane damage. Briefly described, the control program consists of applying bagged oat groats treated with 0.025% diphacinone at the rate of 25 bags/acre. Treatment will be restricted to the wasteland and will be applied during the months of January and June. The theory is to reduce the rodent population in the wasteland prior to its anticipated buildup. In doing so the cyclic population peaks may be flattened to an acceptable level and ultimately reduce the influx of rats from wasteland into adjacent cane.

Development of this program is essentially an improvement in technique. The method of bait distribution is basically an extension of the bait station. The lack of alternate compounds to anticoagulants has been a compelling reason for trying to improve on what is currently available. In some respect, this has been a blessing in disguise for it has forced us to use each program to its full potential. It has made for a more efficient operation which is a creditable quality for any industry.

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