RODENT CONTROL IN THE DOCKS AT BUENAVENTURA, COLOMBIA[1]

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Experience to date seems to show that a simple method of using anticoagulant rodenticides in conjunction with specific environmental health measures provides an easy way for any health service to carry out rodent control programs.

Introduction

The infestation of the Pacific port of Buenaventura by rats, apart from creating a serious public health problem, causes great damage to the foodstuffs and other commodities stored in the warehouses. So far no diseases appear to have been transmitted by the rats or their ectoparasites, but since cases of bubonic plague were reported in 1967 in several towns in the south of the Continent, there is a potential danger.

During the first three months of 1967, day and night surveys were made of the various buildings at the berthing terminal of the port of Buenaventura with a view to establishing the degree of rat infestation and the material damage caused. The following observations were made:

1) In all the warehouses rodent excrement was found in abundance. In most of the buildings inspected, especially the older ones and those used for food storage, there were also ratholes and other traces.

2) A large number of sacks containing foodstuffs had been destroyed. To give some idea of the damage, in the course of three months the CARE Mission lost 300 packages valued at approximately 96,000 Colombian pesos.

3) Floors and walls were destroyed over considerable areas in the warehouses, and tunnels had been bored along the walls and beneath the concrete floors.

The species of rodent found were *Rattus norvegicus* and *R. rattus*, the former predominating. *Mus musculus* (the domestic mouse) was found only in dwellings in the neighborhood of the terminal.

Application was made to the terminal authorities for permission to tackle the rat problem and they offered economic aid and staff to carry out a rodent control program in the docks.

The general objectives of the program were: (a) to keep the number of rats down to a negligible level; (b) to keep the port installations protected against rats; and (c) to prevent the outbreak of diseases caused by rats or their ectoparasites.

The specific objectives included the following: (a) to reduce the existing rat infestation; (b) to try out different methods and different kinds of poison for exterminating rats; and (c) to develop a simple method or methods of administering not only poisons but any other substances capable of preventing the rat population from increasing.

This study describes the various steps taken to fulfill the specific objectives in the initial three months and lay the foundations for fulfilling the general objectives in the remaining nine months. The time allotted to the program was one year.

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Materials and Methods

Trials with Poisons and Traps

Four warehouses in the Buenaventura berthing terminal were chosen for trials with poisons and traps. In the first, 10 baits were placed; they were poisoned with sodium fluoroacetate (1080) in the proportion of 15 grams to a gallon of water sweetened with sugar. In the second, 0.75 per cent hydroxycoumarin was mixed with Indian corn, one part per 17 parts of the bait, so as to give 42 milligrams of active substance per 100 grams of poisoned bait. The same mixture was placed in the third warehouse but with an extra 5 per cent of sugar. In the second and third warehouses enough bait was placed initially to feed 200 rodents for five days. In the fourth warehouse were placed 100 steel traps of the guillotine type, loaded with cheese.

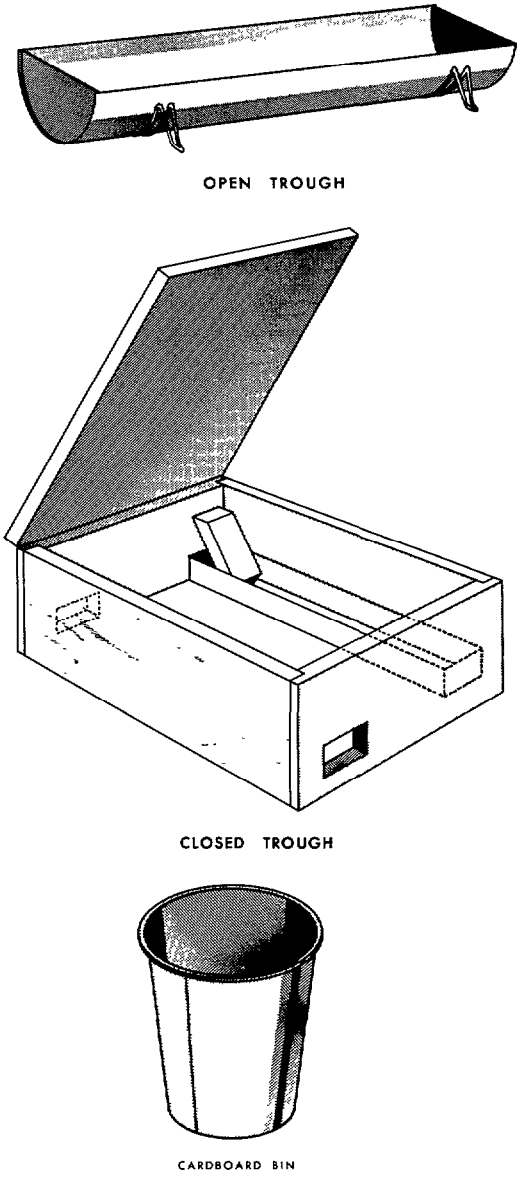
At the end of 10 days of observation the results were as follows. An average of only two rats a day were caught with the traps in the four warehouses combined. Both 1080 and the anticoagulant hydroxycoumarin caused high mortality among the rats, the highest rate being in the third warehouse, where the consumption of bait was greatest.

It was decided to use the anticoagulant poisons in the program, since the mixture was extremely effective and the rats appeared to like it. It was also easy to handle and of low toxicity to man and animals. The poison 1080 was rejected because it was difficult to obtain, highly toxic, and had no antidote, so that it was very dangerous to handle.

Three types of feeding troughs were used for the poisoned bait, and the first two will be used throughout the program. They are (Figure 1): *open feeding troughs* of bamboo, 70 cm long and with a capacity of 500 g; *closed feeding troughs,* wooden boxes 35 cm long, 50 cm wide and 35 cm high, with a padlocked lid and an internal device allowing the poison to drip slowly to the bottom as the rats eat the bait; and for the 1080, *waxed cardboard bins* with a capacity of 30 cm^3, fixed to the floor to prevent the rats from spilling the poison.

During the trial period the degree of infestation, habitat, species, and habits of the rats were studied. After the trial period the docks were mapped out to show the dens and nesting-places of the rats and the most suitable places to set the open and closed feeding troughs and the traps. The equipment and

FIGURE 1–Types of feeding troughs used for the poisoned bait trials.



material for the handling of the bait and poison were obtained at the same time. The total working area, open and covered, was 60,000 m^2 (Figure 2).

Specific Activities

Informing and instructing the administrative staff. Meetings were held with employees of the port administration working in the warehouses and with industrial safety staff with a view to supplying them with appropriate general information, enlisting their help, and ascertaining their working schedules and arrangements and the organization of the warehouses. The maintenance staff were similarly asked how garbage was collected and disposed of. All personnel were then given theoretical and practical instruction. A publicity campaign was carried out at the same time by means of printed leaflets, radio discussions, lantern slides, and talks to interested groups.

Sanitation measures against rat infestation. Appropriate sanitation measures were instituted before and during the trapping and poisoning campaign, since environmental sanitation is the most effective weapon in a deratization campaign. The rat population increases or decreases in proportion to the availability of food and suitable habitat. The measures taken were as follows:

1) Metal plates were placed in the walls and concrete slabs in the floors to prevent the rats from gaining access to the interior of the warehouses or other enclosed areas.

2) Metal collars were placed round water outflow pipes or other conduits by which the rats could enter and leave freely.

3) All garbage heaps in the working area and surrounding areas were removed.

4) Movable stalls and canteens set up against the walls of the warehouses for serving food were taken away, to prevent the foodstuffs from being contaminated by the poisons.

5) Drains in poor condition or not in use were blocked up, to prevent them from being used as dens by the rats.

6) A system of stacking was organized in all the warehouses, a space of 50 cm to 1 m being left between the stores and the walls to allow daily inspection of the troughs, free movement of the campaign staff and the dock workers, collection and disposal of dead rodents, and daily cleaning of the warehouses.

7) Strict care was taken to observe the requirement of the International Sanitary Regulations that rat-proof collars should be placed on all cables attaching ocean-going vessels to the wharves.

8) Areas overgrown with weeds were treated with chemicals, and the parts of the working area in which there were many ratholes, and places where garbage was dumped, were generally cleaned up.

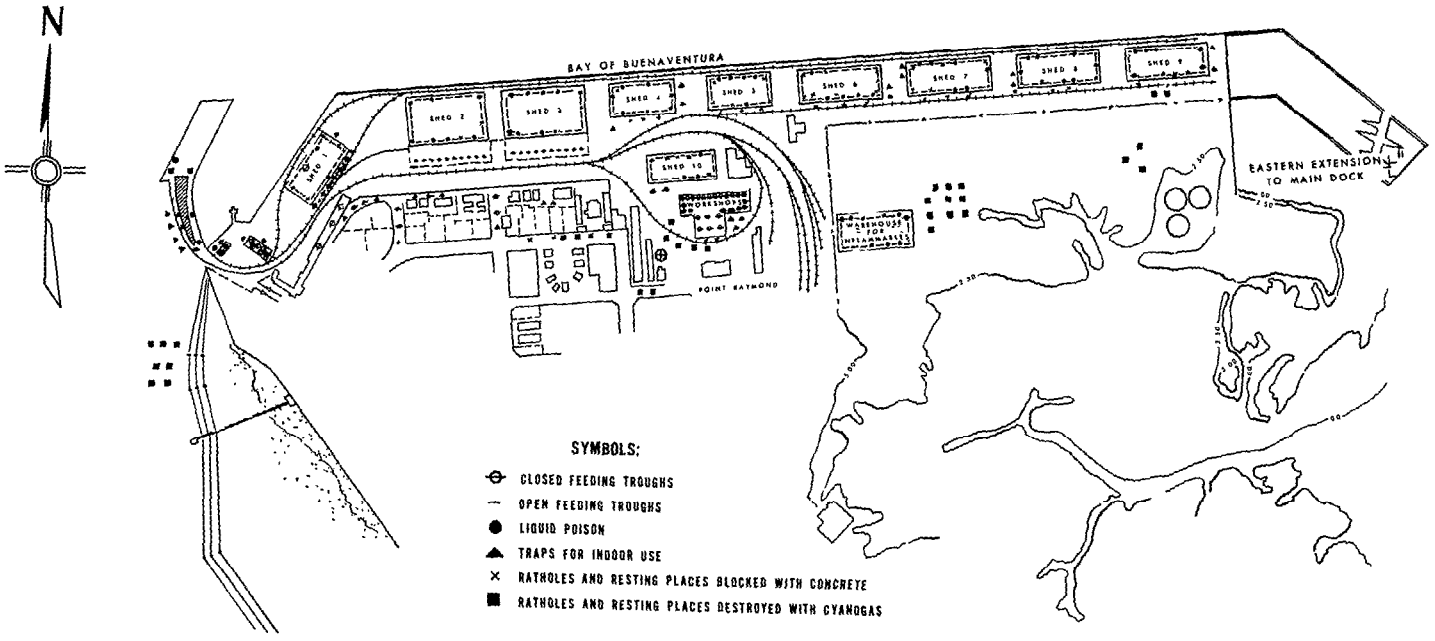
9) A wall 80 cm high and 100 m long was erected at the western boundary of the berthing terminal, to prevent rats from getting into the docks.

Attack phase. This part of the program, the most important, comprised the following activities:

1) Preparation of the bait and poison. In the light of the results obtained in the trial period, anticoagulant poisons of the hydroxycoumarin type were used, in the form of the commercial product "Racumin 57," the concentration of the basic substance being 0.75 per cent. The bait used was Indian corn or "purina," an animal concentrate which rats like. These two foodstuffs were used alternately so that the rats would not grow tired of the bait and refuse it. The mixture was in the proportion of 17 parts of bait to one of poison, and 5 per cent of sugar was added. The concentration of hydroxycoumarin was thus 0.042 g per 100 g of the poisoned bait. It was prepared in a concrete mixer of 50 kg capacity (Figure 3).

2) Calculation of the amount of poisoned bait required. This was based on the known average food consumption of rats, i.e., 15-30 g daily. It is no simple matter to estimate the number of rats in a given place, even approximately, but to cover the working area it was calculated that the troughs would have to hold

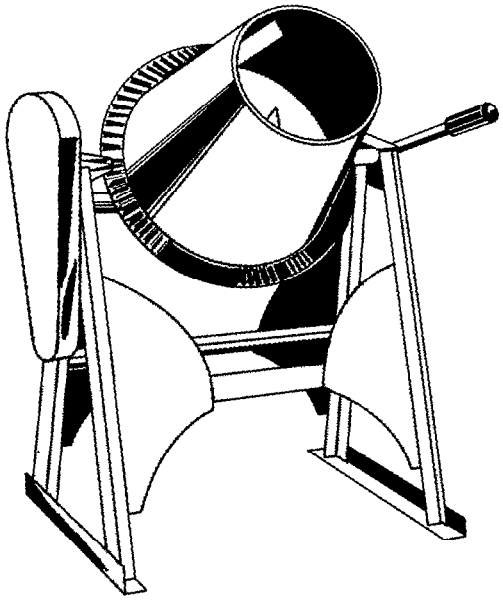
FIGURE 2–Diagram of the port area at Buenaventura, Colombia, where the deratization campaign was carried out.



177,550 g, which would be theoretically enough to feed 8,000 rats daily. The feeding troughs were to have been kept permanently full for cycles of five days at a stretch, these being repeated nine times during the 90 days of the attack phase, as generally recommended in programs of this kind. As a result of the experience gained in the preliminary observation stage, however, it was decided to carry out the work without a break, so as to avoid waste of materials and to keep the personnel working continuously. The experience of the first three months was taken as the basis for calculating how much poisoned bait was needed for the remaining nine months of the program.

3) Distribution of the poisoned bait. Open troughs (165 in number), each containing 500 g of poisoned bait, were placed in 11 warehouses at distances of between 15 and 40 m; and 95 closed troughs (closed as a safety measure and to prevent accidents), each containing 1,000 g of the same bait, were placed in offices and other enclosed spaces. In distributing the poisoned bait consideration was given to the worst infested areas, i.e., those where ratholes were found in abundance or which showed evidence of rat excrement, runs, footmarks or signs of gnawing. In addition to the troughs, 26 traps of the guillotine type were placed in the areas where there were food stalls, in the proportion of two per stall; the results obtained in those areas during the trial phase were poor, but the measure was felt to be necessary to prevent accidents and health hazards that the dead rats might cause.

FIGURE 3–Concrete mixer for preparing the poisoned bait.



4) Control and inspection of the poisoned bait. This was done during the attack phase of the program every day for the first 15 days and thereafter every 2-3 days. As the number of dead rats decreased, more manpower was used for sanitation work.

5) Treatment of ratholes and nesting-places. As a supplementary measure, powdered calcium cyanide was pumped in with a hydrogen cyanide pedal pump (Figure 4). The pump consists of a cylinder with a piston enabling it to suck in and expel; to its lower extremity is attached a 500 cm^3 bottle. The powder is placed in this, and when the pump is operated the powder combines with air to form hydrogen cyanide gas, which passes through a tube 1.20 m long, the other end being inserted into the rathole. The rate at which the powder is fed into the apparatus is controlled by a switch at the lower end of the cylinder. Before the operation was begun talcum powder was pumped into the burrows to indicate where there were escape holes and chinks. These were then blocked with local mud or clay.

The operation of applying hydrogen cyanide gas consisted of filling the bottle with the powder, opening the switch, sucking in and ejecting the product 5-10 times according to the size of the burrow, closing the switch and pumping air only, 10-15 times, and finally removing the tube. The pump was used in open areas only, and by properly trained staff.

6) Collection and disposal of dead rodents. The workmen collected the dead rats daily, counted them, and took them outside the town for disposal. The work was done between 6 a.m. and 8 a.m. so as not to impede the normal work of the docks and also to avoid health hazards. The bait was prepared between

5 p.m. and 6 p.m. and distributed between 6 p.m. and 8 p.m. On holidays the work was carried out between 6 a.m. and 10 a.m. only.

Individual protective measures were taken for the personnel working on the program. General accident prevention measures were also taken, such as the use of gloves and masks and the posting of notices warning against the danger of poison in the places most accessible to the public.

Staff and Materials and Their Cost

The following is a list of requirements, by categories, and their cost in Colombian pesos:

a) *Personnel*	*Per annum*
1 physician, 2 hours daily	13,200
1 local overseer, 2 hours daily	4,500
1 sanitary inspector, full-time	14,400
4 laborers	28,800
Social security benefits (bonuses, holidays, separation pay)	15,687.50

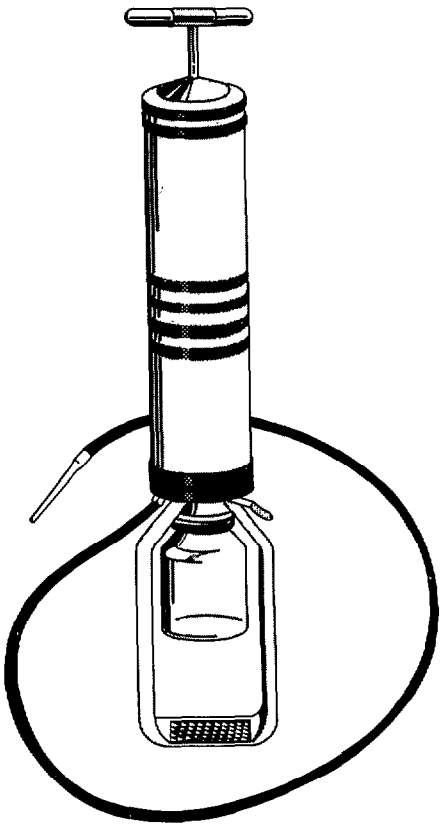
b) *Equipment and apparatus*	
2 pedal pumps	706
1 mechanical mixer	3,000
170 closed wooden feeding troughs	1,700
4 wooden pincers to pick up dead rats	40
24 pairs of rubber gloves	312
4 enamelled scoops	48
4 metal garbage cans	100
3 lanterns	90
250 open bamboo feeding troughs for the bait	375
4 garbage cans with lids, for collecting the dead rats	120
1 table	150
100 guillotine-type traps	333
1 large knife	20
1 medium-sized hammer	25
170 padlocks for the closed feeding troughs	1,700
6 rainproof capes	720
6 overalls	360
6 pairs of rubber boots	480
6 protective masks for the preparation of poison and the application of hydrogen cyanide gas	360

c) *Poison and bait*

	First three months		Remaining nine months		
Racumin 57	110 kg	2,552	30 kg	696	3,248
Sugar	400 kg	800	25 kg	50	850
Purina	750 kg	1,650			1,650
Corn	1,500 kg	4,800	440 kg	1,408	6,208
Drum of hydrogen cyanide gas	1	581			

d) *Unforeseen expenses*	$12,000
Total (Colombian pesos)	$126,163.50

FIGURE 4–Pump used for producing hydrogen cyanide gas.



In this total expenditure the cost of personnel was 90,987.50, material and equipment 10,639.00, and poison and bait 12,537.00 Colombian pesos.

It should be noted that the cost of sanitation work generally is not included in this amount.

Results

By the end of the first three months of the program 11,626 dead rats had been collected. This number is assumed to be considerably less than the total number of rats exterminated, since it does not include those dying inside their dens and in other inaccessible places, as well as those falling into the sea. The number is also less than it should have been, because the cleaning staff of the berthing terminal did not count the dead rats at the start of the program, either because they did not know how to go about it or because it was new to them (Table 1 and Figure 5).

The rat infestation index, 0.20 rats per m^2 at the start of the campaign, had dropped to 0.015 by the end of the first phase. The infestation rate was calculated as follows:

$$\frac{\text{Dead rats collected}}{\text{area}} = r \times m^2$$

The following amounts of *poison and bait* were used in the *first three months:*

Racumin 57 (hydroxycoumarin 0.75)	126 kg
Corn	1,500 kg
Purina	950 kg
Sugar	300 kg
Total	2,876 kg

The average amount of poisoned bait per rat found dead was 251.5 g.

Sanitation work included the destruction of burrows, 68 of which were treated with hydrogen cyanide and 41 blocked with concrete, the total number treated being 109.

The environmental health measures listed in Table 2 are of fundamental importance in deratization programs.

TABLE 1–Rats exterminated in the first phase of the deratization campaign at Buenaventura, Colombia, 1967.

10-day periods	Rats exterminated	Percentage
1-10	1,333	11.3
11-20	1,825	15.5
21-30	2,142	18.2
31-40	2,103	17.8
41-50	1,432	12.1
51-60	1,005	8.5
61-70	1,196	10.1
71-80	498	4.2
81-90	266	2.3
Total	11,800	100.0

FIGURE 5–Percentage of rats killed in relation to the length of the deratization campaign, in days.

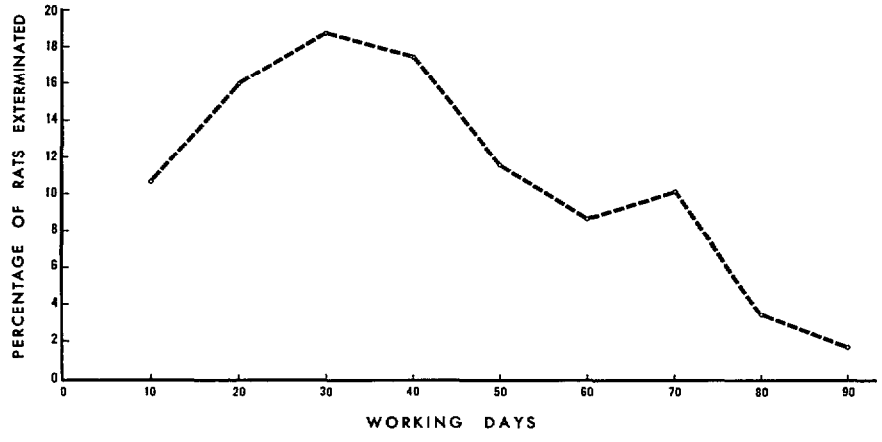


TABLE 2–Sanitation measures, Buenaventura, 1967.

Details of measures	Warehouses	Other buildings	Total
Protective walls (m^2)		100	100
Repairs (m^2)	809	812	1,621
Cleaning of the boundary area of warehouse No. 11	9,000		9,000
Walls raised (m^2)	490		490
Walls separated (m^2)	290		290
Drains constructed (m)		140	140
Rat-proof collars fitted	100		100
Doors repaired	30		30
Roofs repaired (m^2)	1,750		1,750

On the basis of the definitely decreasing number of dead rats collected in the last 10 days of the attack phase, it was calculated that in the maintenance phase the poisoned bait was consumed by an average of 100 rats daily. The total amount of poison consumed was 25.5-30 kg, plus the proportionate amount of bait.

It was found that the *very high rainfall and humidity* at Buenaventura had a bad effect, increasing the normal cost of the poisoned bait by some 20-30 per cent.

Unpleasant odors caused by dead rats were prevented by stepping up the search and moving the stored cargoes, gangplanks, etc., so that the dead rats could be taken away. When it was suspected that bad smells came from the ratholes, the entrances and crevices were blocked up with clay. Deodorants were not used in the program, but it is suggested that where there are sewers or other arrangements for removal of excreta, deodorants should be used, in the form of aerosols with a chemical basis, as available commercially.

Considering the abundance of food in the warehouses, the ease of access, the high reproductive capacity of rats, and the absence of any kind of rat control previously, the *infestation index* was low. The poor resistance of the rats may be due to the presence of man and natural pressures in the environment.

Although resistance to anticoagulant poisons has been found elsewhere, e.g., in Great Britain, none has so far been observed here, doubtless because the poisons have only recently come into use in programs like the present one. This aspect of the matter will probably be the subject of later investigations.

Conclusions

Anticoagulant rodenticides of the hydroxycoumarin type are very effective, cheap, and of low toxicity. In view of these qualities and their ease of use, they can be employed with advantage not only in public health programs but also in any other activity or industry in which rodent control is required.

The *treatment of ratholes with hydrogen cyanide gas* is simple, practical, and effective, provided adequate precautions are taken.

For the success of these programs *sanitation measures* are essential—adequate collection and disposal of garbage, total prevention of access to places where foodstuffs are stored, construction of rat-proof buildings, and adaptation of existing warehouses.

The funds to finance rodent control programs are fully justified in view of the damage the rats do to foodstuffs and stores, the hygienic nuisance they cause, and the threat they pose to the health of the community.

The *method described* is suitable for rodent control in galleries, markets, and warehouses containing foodstuffs. It can also be used with any other substance or ingredient intended for the same purpose.

To supplement this type of activity in the docks of international ports there should be deratization of ships, using hydrocyanic acid gas or other rodenticide gases. It is essential, however, to have technical staff and adequate equipment for this purpose.

Summary

Rats are a hazard to health and cause great damage to foodstuffs and other commodities. For that reason many countries are at present carrying out deratization programs in the dock areas of international seaports and assigning priority to rodent control in their public health programs.

The problem of rodent control was studied in the port installations at Buenaventura, Colombia, with a view to determining the best method of dealing with it, especially as the installations are now being transformed and modernized. The need for a rat control program was indicated by the degree of infestation and by the damage caused by the rats, even though there was no evidence of their causing disease in man.

Traps and poisons were tested by the traditional methods, and it was found that anticoagulant poisons of the hydroxycoumarin type were the most suitable for the program.

On the basis of the results of the trial a one-year program was drawn up, divided into two phases: an *attack phase* of three months and a *maintenance phase* covering the remaining nine months.

The results of the first phase are described. They show that the rodenticides used are highly effective and easy to handle, and that sanitation measures are an essential adjunct.

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