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EFFECTIVENESS OF FOUR RODENTICIDES IN DEEPWATER RICE

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SUMMARY

Approximately one-half of Bangladesh floods annually in the summer monsoons forcing field rats to migrate to villages, which then become distinct small islands. Five rodenticides were tested during this period when rats are confined to islands for a one to two month period. A 1% Benzenesulfonic hydrazide (DRC-4575), 0.005% difenacoum, 2% zinc phosphide, and 0.005% brodifacoum baits were provided on separate islands.

The major rodent problem species were Bandicota bengalensis, B. indica, and Rattus rattus. Population reductions on the treated islands were: DRC-4575 90.1%, difenacoum 94.1%, zinc phosphide 87%, and brodifacoum 90%.

Field observations indicated the best period for baiting in deepwater rice is during the first 2 months after the onset of flooding when rats are restricted to a smaller area. Beyond this date both species of Bandicota swim out into fields and live on floating stems in water to 4 m deep. Once rats reinvade the fields, effective control becomes difficult.

INTRODUCTION

The tropic and sub-tropic ecotypes of Southern Asia support large populations of field rodents, with the impacts of these animals upon agriculture frequently documented (See Alam, 1974; Barnette & Prakash, 1975; Deoras, 1971; Poché, Haque, Mian & Sultana, 1980). Self-sufficiency in food production for this region requires improved crop yields by disease and pest control.

The river deltas of Bangladesh, pose numerous problems to traditional methods of vertebrate pest control. Over one-half of the country (72,000 km^2) floods annually during the summer monsoons. Villages in the floodplain become seasonal islands several meters above water level. Typically, flooding starts in mid to late June, with flood waters covering the farmland until October. The floods force rodents to emigrate low-lying terrain and coexist with villagers on the islands. Between November and June, rats disperse from the islands, moving back into the dry-season grain fields as water recede. Effective control of rodent damage is viewed to require adaptation of available methods to the specific cultivation practices in this unique agrosystem.

Farmers in the delta regions of Bangladesh, India, Thailand, and Vietnam grow substantial amounts of deepwater rice. In Bangladesh approximately 10 million ha of rice (1.9 million ha

of deepwater varieties) was cultivated in 1978. These varieties are planted before the monsoons (March-May), and harvested 8 to 10 months later (October-December). As monsoon floods occur, rice stems elongate. The stems contain large air sacs in the mesophyll which permit the plants to float. The distal portion of each stem eventually curves upward, out of the water, until the panicle is from 0.1 to 0.75 m above the surface. Rodents living on islands near the rice swim and move through the floating stems and cut rice plants for food or nest material.

Data regarding rodent damage to deepwater rice are infrequently reported. Catling and Islam (1979) observed disruption of yield experiments in deepwater rice when rats severely damaged test plots. Catling (1979) in a similar study reported a 10% reduction in yield attributable to rats.

The objectives of the current study were to: (1) identify rodent species associated with damage to deepwater rice in Bangladesh and (2) compare the efficacy of 4 rodenticides in controlling rat populations on island villages during monsoon floods, thereby reducing grain storage losses and rodents damage to adjacent rice fields.

METHODS

Study Area

The study was conducted between 10 September and 31 December 1979, in a traditional deep water rice region within the Bouraganga and Ganges river deltas near the village of Agrakola (approximately 10 km WSW of Dacca, Bangladesh). Five island villages, ranging in size from 0.15 to 3.46 ha served as test sites. Water depths between the islands during this study ranged from 2 to 4 m. Table 1 presents descriptive information for each island, many of which are indicative of food sources or cover available to rats.

Rodent Species

Floating bamboo trap stations were positioned in rice fields about 0.5 km away from the study area. Trap placement varied from 20 to 200 m away from islands or high ground. Captured rodents were transported to the Vertebrate Pest Division Laboratory, Joydebpur, for positive identification of the species causing damage to deep-water rice during the flood period.

Rodenticide Efficacy

The basic procedures used in assessing the effectiveness of rodenticides tested involved monitoring the relative abundance of rodents at weekly intervals throughout the study and application of select rodenticides. Two islands were baited for successive

5-week periods (DRC-4575 and difenacoum) and a 10-week bait application period was provided on two additional islands (zinc phosphide and brodifacoum). One island remained untreated and served as the control.

One week before and during the rodenticide bait applications, a population index of the rodent relative abundance was obtained on each island. A tracking-tile system was used, similar to that described by Lord, Vilches, Maiztegui & Soldini (1970). Twenty-five vinyl floor tiles (30x30 cm) were used on each island. One-half of each tile was coated with mimeograph ink and placed at selected locations on the islands. Ten tiles were used inside dwellings, 5 were placed between dwellings, and 10 were spaced along the island periphery. Tiles were positioned at the respective locations on 2 successive nights per week and the number with rodent tracks recorded each morning.

Table 1

Details of the five islands used in the field trial testing four rodenticides in deepwater rice.

	Island				
	1	2	3	4	5
Area (ha)	0.15	2.32	2.32	3.14	3.46
Height above flood plane (m)	3.8	3.9	3.7	3.6	3.7
No. People	31	38	31	110	180
Dwellings	8	6	12	26	48
Kitchen	4	3	4	17	24
Cow sheds	2	3	2	6	9
Cattle	15	16	16	21	25
Goats and Sheep	4	1	3	12	14
Poultry	50	55	76	105	45
Storage Bins	16	4	9	22	38
Straw/Stub ble Stacks	8	2	3	8	6
Trees	39	16	211	147	278

Formulations for the four rodenticides tested were:

Island 1 : 1% Benzenesulfonic ((3-amino-2, 4, 6-trichlorophenyl) methylene) hydrazide bait (coded as Denver Research Center No. DRC-4575) made from 1% DRC-4575 concentrate, 98% rice, and 1% coconut oil.

Island 2: 0.005% difenacoum bait (3-(3-p-diphenyl-1, 2, 3, 4-tetrahydronaphth-1-yl)-4-hydroxycoumarin) containing 0.1% difenacoum concentrate (supplied by ICI, Ltd., London), 98.5% rice and 1% coconut oil.

Island 3: control

Island 4: 2% zinc phosphide (Zn_3P_2) baid containing 97% whole polished rice, 2% zinc phosphide (94% active ingrediant), and 1% coconut oil.

Island 5: 0.005% brodifacoum bait (3-(3-(4'-bromo(1-1'-biphenyl)-4-yl)-1, 2, 3, 4-tetrahydra-1-naphthalenyl) 4-hydroxy-2H-1-benzopyran-2-one). The bait was supplied as "Talon" and provided by ICI, Ltd. London.

All baits were placed in 30 x 30 x 15 cm wooden boxes with 2 - 8x8 cm entry points for rats. Bait consumption was monitored on a weekly basis. An average of 10 bait boxes were used per island. The baits were formulated and stored in 20 mil plastic bags until used. Bait was dispensed at each bait station in 100g (DRC-4575 and difenacoum)

and 200 g (Zinc Phosphide and brodifacoum) amounts. The bait stations were placed in separate dwellings, and moved to different dwellings every 3 days. After baits had been provided in each dwelling, stations were placed at selected positions along the periphery of the islands.

Data from the population index monitoring were used in determining the efficacy for the four rodenticides tested. The general formula used was:

$$\text{Percent Population Reduction} = \frac{\text{Pretreatment} - \text{Post-Treatment}}{\text{Pretreatment}} \times 100$$

Upon completion of the baiting program, 50 snap traps were set on each island for two successive nights, with the distribution of traps similar to that of the tiles.

Rhodamin B (1%) dye was added to the DRC-4575. In the event that dead rats were found on Island 1, autopsies were conducted to verify the cause of death. Rhodamin B is a reddish dye that floresces pink under ultraviolet light. All of the obtained rat carcasses were examined externally and internally for evidence of marking. The presence of Rhodamine B dye on the snout and coat of rats or in the gastrointestinal tract was used as indicative of bait consumption. For a detailed description of Rhodamin B procedures, see Evans and Griffith (1973).

RESULTS AND DISCUSSIONS

Rodent Species

Rodents captured from islands adjacent to the study area, in order of abundance, included the black rat (Rattus rattus), lesser bandicoot rat (Bandicota bengalensis), house mouse (Mus musculus), the bandicoot rat (B. indica), soft-furred rat (Millardia meltada), and the field mouse (Mus bodooga) (Poché et al, unpublished data). Before the area flooded, the black rat was the dominant species on the islands, but the rising waters forced Bandicoot rats to immigrate onto the islands. The lesser bandicoot rat then became the dominant species. Before and after water receeded, the bandicoot rats reinvaded fields.

Traps placed on floating bamboo stations in rice fields resulted in the captures of B. bengalensis and B. indica on floating rice stems greater than 200 m from the islands. Rat nests were observed over 500 m from the nearest land. The black rat is apparently confined for the most part to the islands. As part of a long-term study, field and island trapping is continuing and no Rattus have been obtained from fields during the floods. In the Philippines Rattus spp. are a common menace to field crops (Barbehenn, Sumangil and Libay, 1973).

Once the floods enter southern Bangladesh, stem elongation in deep water rice increases rapidly, and after stems attain a length of 1.5 to 2m, sufficient flotation on the water surface provides expanded habitat for the bandicoot rats. Both species of Bandicota swim out and cut rice stems and return to islands, while others take advantage of the spacious floating habitat and remain on the rice until the floods subside. Pregnant Bandicota were captured in fields over 100m from land, indicating that normal reproductive patterns continue on the floating environment. Nests were occasionally encountered and were constructed of leaf blades and stems under a dense rice canopy.

Both B. indica and B. bengalensis are agressive species (See Spillet, 1968 and Frantz, 1975). It is probably that many Bandicota disperse onto the floating rice because of the food shortage, but also the dispersal may occur to avoid inter-and intraspecific conflicts on the densely populated islands. Radio tracking studies are planned to obtain more information on local movements and migrations between fields and islands before and after flooding.

Rodenticide Efficacy

Results of the baiting trials are summarized in Figures 1 and 2. A summary of information for the islands studied is given in Table 1. Islands baited with difenacoum and DRC-4575 forced rodent population

levels to near zero within 5 weeks, while the zinc phosphide and brodifacoum treated islands required more time, since Islands 4 and 5 were larger and the number of bait boxes were limited.

On Islands 1 and 2, bait consumption declined steadily, as did the population indices. Islands 4 and 5, however, displayed erratic cycles in bait consumption. After a bait box remained in an area for several days, consumption declined (Table 2). The box was moved to a new location and rats began to feed heavily for the first few days. The most bait consumption recorded over a 7-day period was 854g of zinc phosphide bait during the sixth week of the study.

Figure 3 presents the response of rodent numbers on the treated islands from three habitats: in and between dwellings, and in scrub along the periphery of the islands. The drop in the rodent relative abundance occurred within two weeks on the islands baited with DRC 4575 and brodifacoum. This suggested that rats living in burrows along the island edge, were moving into dwellings at night in search of food. Farmers confirmed this by stating many rats entered the dwellings at night, but lived in burrows in near the scrub. Although the tracking tile method is a good means of noting relative abundance, it is difficult and almost impossible in this case, to determine species composition on the islands using tiles alone.

The efficacy of the field trial with the four rodenticides based on the relative abundance of rodents was: DRC-4575 90.1%, zinc phosphide 87%, difenacoum 94.1%, and brodifacoum 90%. The differences in population reduction for the four islands was not significant. The percent reduction in bait consumption, from the period of highest bait take to the completion of the study was: DRC-4575 100%, difenacoum 100%, zinc phosphide 95%, and brodifacoum 84%.

Table 2 Bait consumption data (grams) on four islands treated with rodenticides in deep water rice.

Island Number and Rodenticide	Weeks										
	1	2	3	4	5	6	7	8	9	10	11
1 - DRC 4575	169	61	136	24	0	0					
2 - Difenacoum	397	313	285	76	11	0					
4 - Zn_3P_2	220	158	852	730	180	854	364	450	198	128	40
5 - Brodifacoum	556	471	444	288	380	588	246	404	530	170	92

The efficacy dete minations for the four rodenticides tested in this study indicated good rodent control with all compounds used. Unlike most field conditions, the seasonal islands produced by inundation in the deepwater rice zone of Bangladesh is unique in providing confined test populations in which virtually no detectable local migrations are possible for about a 2-month period (July and August). On the final monitoring period of rat activity few tracks were detected. Marten (1973) judged population estimates based on tracking as precise and far superior to estimates derived from trapping. We, therefore, feel the decline in rodent numbers observed during the baiting program is accurate.

Snap trapping upon completion of the baiting campaign, resulted in only 2 rodent captures. One B. bengalensis was obtained from Island 4 (zinc phosphide) and a second was trapped on Island 5 (brodifacoum) (400 trap nights or a combined 0.5% trap success). This was the first time traps were used on the test islands, indicating rodent activity was extremely low or nearly erradicated. On neighboring islands, where 50 snap traps were set for two consecutive nights on a weekly basis for 8 months before and during this study, trap success fluctuated between 2 and 8%, indicating that rodents in the area are not prone to trap shyness even during frequent and intensive sampling (Mian et al, unpublished data).

Dead rats were found on every treated island. On 22 September 1979 within two hours after placing DRC-4575 bait boxes in dwellings, dead house mice were found on the floor of two buildings. Autopsies revealed ingestion of the chemical as indicated by Rhodamine B marking in the mouth, stomach, and small intestines. The forefeet, whiskers, and hairs around the mouth of each mouse also had visible signs of the red dye.

Outlook for Redenticide Use

DRC-4575 is a promising rodenticide being tested in the U.S. (Matsche and Fagerstone 1977). Its quick mode of action would be a good asset in convincing farmers and villagers to support a control program, since most people are more confident in a control method that produces dead rats quickly rather than anticoagulants, such as warfarin, that allows a rat to die for the most part gradually and within the confines of its burrow. DRC-4575 is highly toxic to rats but apparently is not very toxic to birds (Anon, 1975). Further examination of the rodenticide is programmed and additional field trials will be conducted.

Brodifacoum has proven to be effective, especially in controlling anticoagulant resistant rats. In the U.S., Rowe and Bradford (1976) reported a 91% reduction in *Mus musculus* tracks after treatment, while Dubock and Kaukeinen (1978) observed an 89% decline in Norway

rat (R. norvegicus) tracks following use of the compound. Our findings indicated a 90% reduction in the tracks of five rodents species, demonstrating similar efficacy to the U.S. based studies involving different species.

According to Rennison and Halder (1975), difenacoum produced good field control of Norway rats. Brooks (Personal Com.), using difenacoum, has succeeded in reducing urban rodents in Rangoon, Burma, primarily B. bengalensis and R. exulans. As the data in our study suggest, field control of rodents in deepwater rice with difenacoum was effective and further examination of the compound should be programmed.

Field efficacy determinations in erradicating rats confined to islands also point to zinc phosphide as having good potential, provided no shyness develops during ensuing continued use. For this reason more research into the development of a good bait formulation is imperative should the rodenticide be used on a large scale. A formulation developed in Pakistan by Smythe and Khan (1978) may have possibilities as demonstrated in preliminary laboratory trials in Bangladesh (Poché, Sultana, Haque, and Mian 1980). Preliminary laboratory findings have shown zinc phosphide to be efficient against B. bengalensis, but R. rattus from Dacca has demonstrated shyness. The possibility also exists for rodents to develop aversions on rural islands subjected to periodic baiting.

Effective rodent control in Bangladesh deepwater rice is dependent primarily on the use of broad spectrum rodenticides, since at least since rodent species have been collected and identified as pests on islands during the monsoons. The species range in size from the 8g Mus bodooga to the sometimes over 800g B. indica. If the objective for control is primarily oriented to field campaigns, then a good zinc phosphide formulation may be sufficient. However, if the goal is to control field and storage rodent pests, while at the same time address public health problems through rodent control, then a broad spectrum compound for which rats do not develop shyness may be more effective.

Baiting trials and field observations during this study indicated the best period for rodent control operations in deep-water rice is during a 2-month period beginning approximately one week after all fields are flooded and rats have moved onto the islands or higher ground, such as levees or roads. During this time rodents are quite vulnerable to control. Since wheat and beans are the major crops harvested before the deepwater rice is planted in March and April, grain stocks on the islands have been sold or begin to run low by mid-to late summer. The natural food supply for rodents on the island and higher terrain, such as grasses and herbs, is quickly consumed by domestic livestock which crowd onto the little available space with man. At this period bait acceptance increases appreciably, since little other food is available.

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REFERENCES

Ahmed, M.S. 1974. Ecology, distribution and production of deep water rice. pp 1-21, In. Deep Water Rice in Bangladesh. Bangladesh Rice Research Institute. Joydebpur. 156 pp.

Alam, M.Z. 1974. Problems of rat in Bangladesh. Regional training seminar on field rat control and research. 4-15 March. Manila, Philippines. 4 pp.

Anonymous. 1975. Fed. Regist. 40, 26869.

Barbehenn, K.R., Sumangil, J.P., and Libay, J.L. 1973. Rodents of Philippine croplands. The Philippine Agriculturist 66, 217-242.

Barnett, S.A. and Prakash, I. 1975. Rodents of Economic Importance in India. Arnold-Heinemann, New Delhi. 175 pp.

Catling, H.D. 1979. Depwater rice pest management project. Internal Review report. Mimeo. 14pp.

Catling, H.D. and Islam, Z. 1979. Effect of fertilizer on traditional deep water rice varieties in Bangladesh. Proceedings, Deep-water Rice Workshop 157-164. Bangladesh Rice Research Institute, Joydebpur.

Deoras, P.J. 1971. Simple methods of rat reduction in 186 villages in Panvel. pp. 153-158, In: International Symposium on Bionomics and Control of Rodents, Proceedings and Recommendations of Symposium, Kanpur, India. 1968. Eds. S.L. Perti, Y.C. Wal, and A.S. Srivastava.

Dubock, A.C. and Kaukeinen, D.E. 1978. Brodifacoum (Talon TM Rodenticide) a novel concept. 8th Vertebrate Pest Conference. Sacramento, California. 25 pp.

Evans, J. and Griffith, R.E. 1973. A fluroescent tracer and maker for animal studies. J. Wildl. Manage. 37, 73-81.

Frantz, S.C. 1973. Behavioral ecology of the lesser bandicoot rat, Bandicota bengalensis (Gray) in Calcutta. Ph.D. Dissertation, Johns Hopkins University. Baltimore, Md. 219 pp.

Lord, R.D., Vilches, A.M., Maiztegui, J.I. and Soldini, C.A. 1970. The tracking board: a relative census Technique for studying rodents. J. Mammal. 8, 828-829.

Marten, G.G. 1972. Censusing mouse populations by means of tracking. Ecology 53, 859-867.

Matsche, G. H. and Fagerstone, K.A. 1977. Effects of a new rodenticide, Benzenesulfonic acid hydrazide, on prenatal mice. J. of Toxicol. and Envir. Health 3, 407-411.

Poché, R.M., Mian, M.Y., Haque, M.E., and Sultana, P. 1979. Rodent damage to Bangladesh wheat. J. Wildl. Manage. Submitted.

Poché, R.M., Sultana, P., Haque, M.E., and Mian, M.Y. 1980. Studies with zinc phosphide on Bandicota bengalensis and Rattus rattus in Bangladesh. Bangladesh J. of Zoology Submitted.

Rennison, B.D. and Hadler, M.R. 1975. Field trials of difenacoum against warfarin-resistant infestations of Rattus norvegicus. J. HYG. Camb. 74, 449-455.

Rowe, F.P. and Bradfield, A. 1976. Trials of the anticoagulant rodenticide WBA 8119 against confirmed colonies of warfarin-resistant house mice (Mus musculus L.) J. Hyg. Camb. 77, 427-431.

Smythe, W.R. and Khan, A.A. 1978. Instructions for the preparation and use of zinc phosphide rat cakes for the protection of agricultural crops in Pakistan. Vertebrate Pest Center Report. Karachi, Pakistan. 4 pp.

Spillett, J.J. 1968. The ecology of the lesser bandicoot rat in Calcutta. Ph. D. dissertation. Johns Hopkins University. Baltimore, Md. 233 pp.

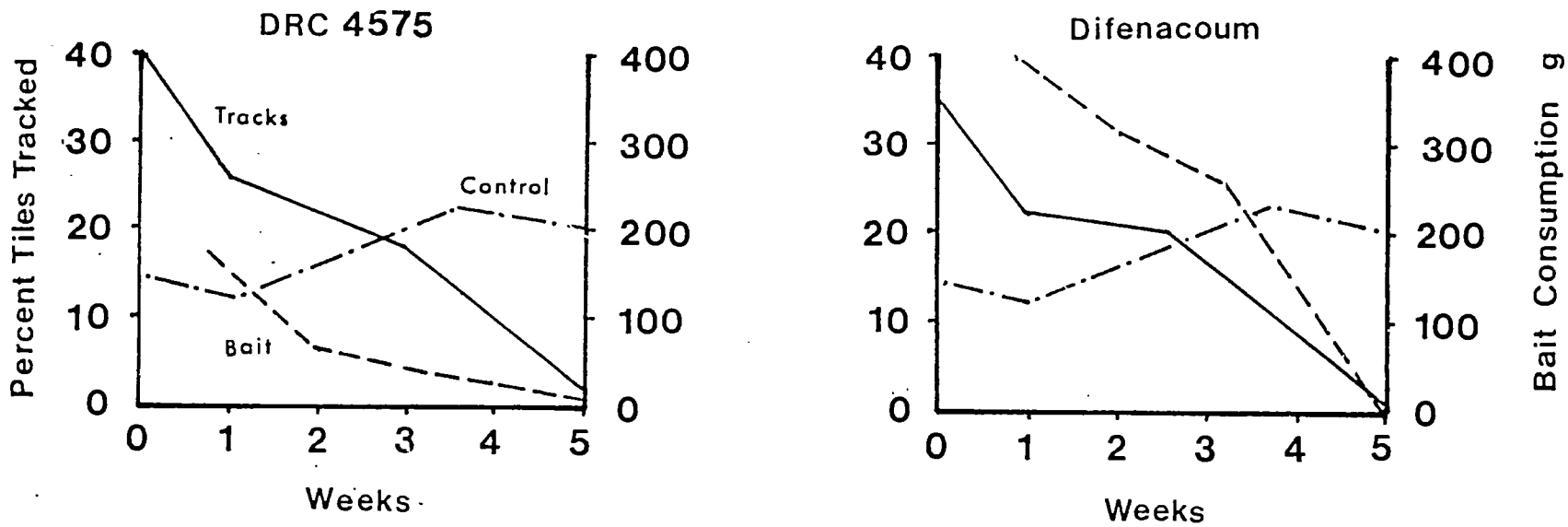

Figure 1. The relative abundance of five rodent species and bait consumption of DRC-4575 and difenacoum on two islands subjected to a 5-week baiting program. The relative abundance on the control island is also shown.

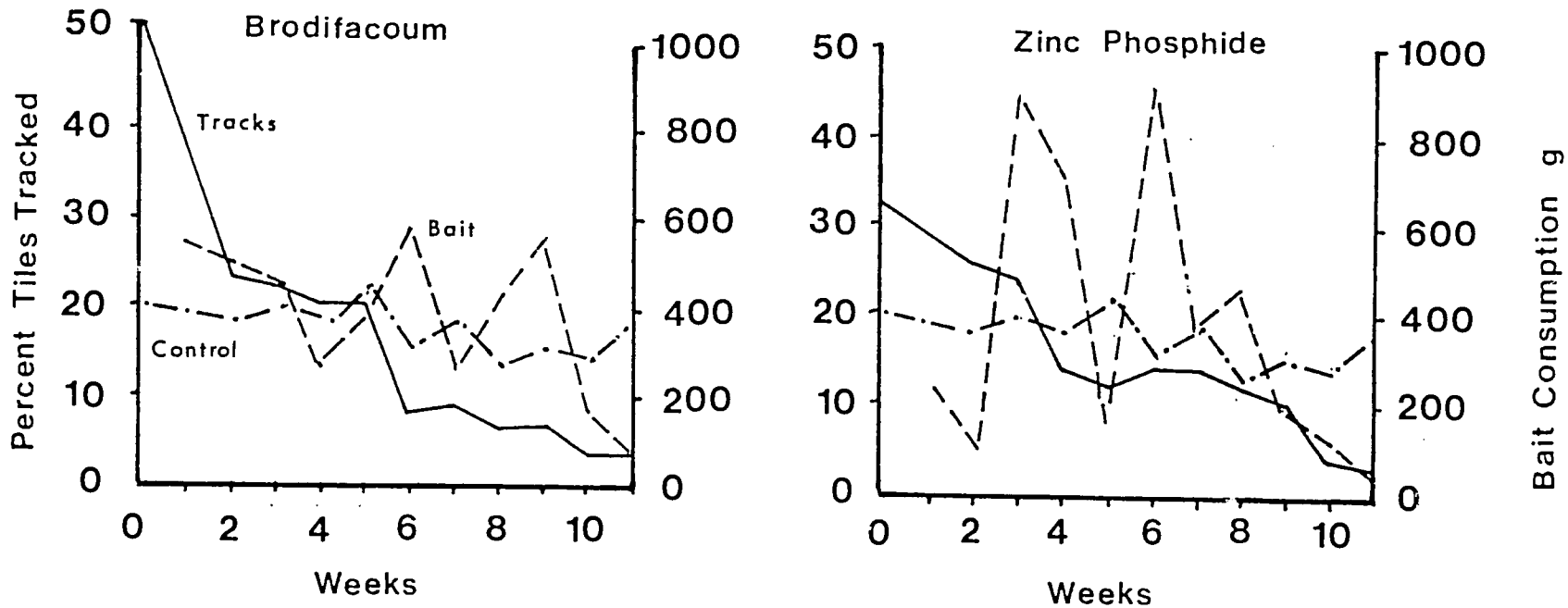

Figure 2. The relative abundance of five rodent species and bait consumption of brodifacoum and zinc phosphide on two islands subjected to an 11 week baiting program.

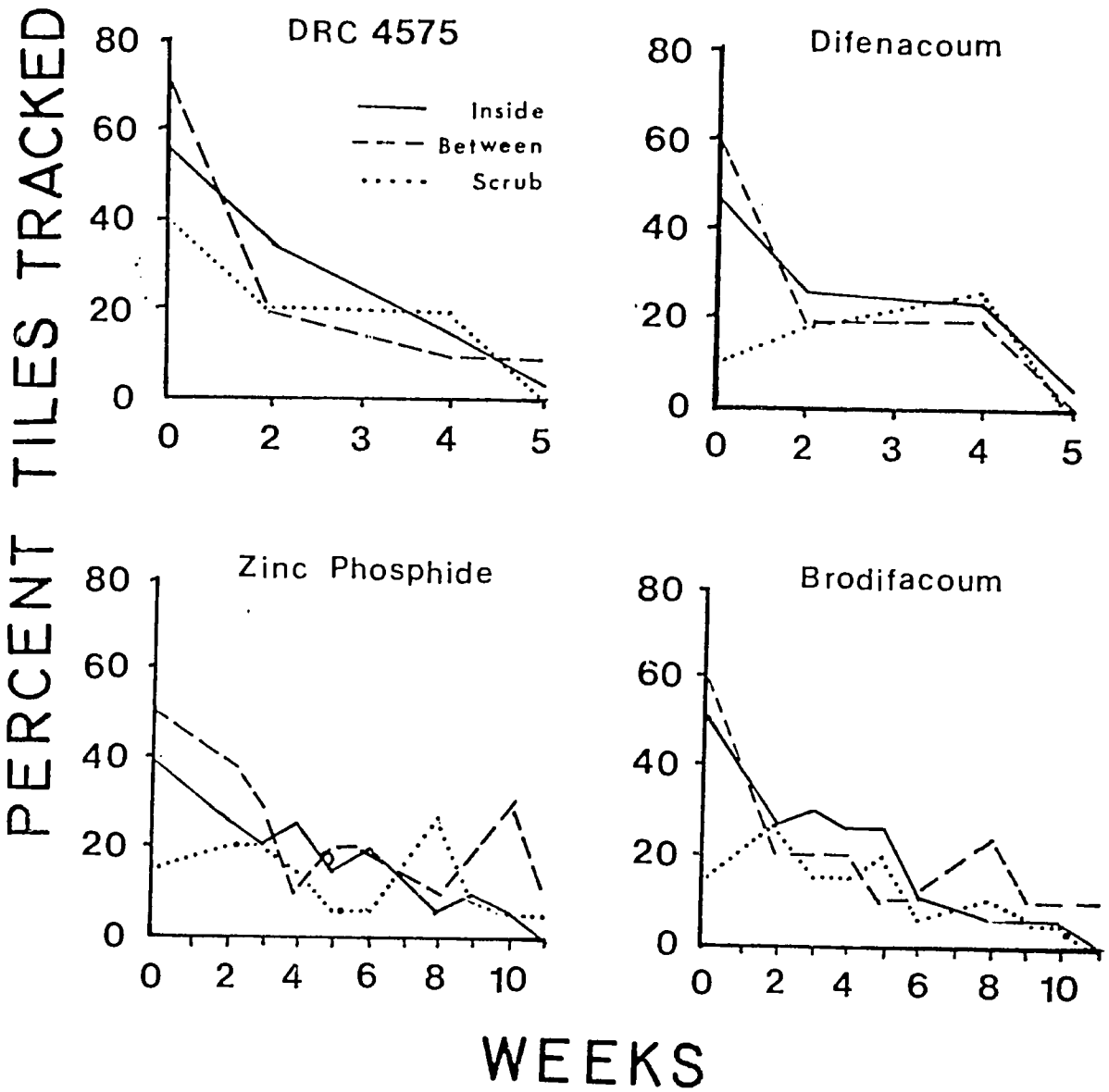

Figure 3. The relative abundance of five rodent species in three locations on the treated islands (inside houses, between houses, and along island perifery in scrub) based on a tracking-tile index.