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Research Article

Impact of Rodent Outbreaks in Rice Paddies on Incidence of Rodent-borne Zoonosis in Human Populations

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A B S T R A C T

A study conducted in an area encircled by rice paddies on a rodent abundance, population, and flea vector index during normal and rodent outbreak periods revealed that the rodent populations of rice paddies were colonised in rice fields and are not migrated much to the residential areas even during the outbreak years. The predominance of Rattus rattus (94.2%) was recorded among the rodent species in residential premises, whereas in rice paddies, it was lesser bandicoot Bandicota bengalensis (98.9%). Among the structures in a residential area, bakeries were the most infested with pest rodents followed by grocery and vegetable stores. The recorded rat flea index of below 1 from the animals trapped in residential premises and no progression in fever and other ill health conditions among the residents even during field rodent outbreak years show no risk of zoonotic diseases like plague. Rodenticide poison offered through liquids has recorded high intake and control success over the market available ready-to-use bait cakes.

Keywords: Rice Paddies, Bandicota Bengalensis, Rattus, Residential Premises, Flea Index, Zoonosis

Introduction

Globally, the encounter of humans and their livestock with rodents is a common occurrence. Rodents often share their habitat with them for food and shelter. In due course, they play a vital role in the transmission of several dreaded diseases to humans as vectors and reservoirs.[1] Rodents are one of the major biological constraints in rice paddies, especially in riverine deltas, where rice is cultivated under assured irrigation. Rice-growing deltas of the Godavari basin in Andhra Pradesh are known for rodent outbreaks, especially during wet years, and cause significant losses to the rice.[2] The rodent control campaigns under the farmers' participatory adoption is an age-old government programme to combat the rodent problem in rice paddies and often they ignore to treat the residential premises/ structures, although it was listed in the standard operational procedure. In spite of regular community rodent control campaigns, rodent problem is bouncing and re-bouncing with a great challenge to the farmers and field extension personnel (Srinivasa Rao et al., 2018). Further,

many speculate that monsoon fevers are quite common in these areas among the village residents and agricultural workforce for un-diagnosed and unknown reasons. Rat fleas, Xenopsylla spp, play a vital role in vectoring the plague zoonotics among humans and livestock; the two rodent species lesser bandicoot Bandicota bengalensis and house rat Rattus rattus, play a vital role of intermediary host in the plague transmission cycle in India.[1] An attempt was made to find out whether rodent outbreaks in rice paddies trigger the migration of rodent populations from crop fields to residential areas and the potential risk of rodent-borne zoonotic diseases to the humans residing in that area.

Materials and Method

Study Area: The study was conducted in a residential area of 10 km radius surrounded by rice paddies at Maruteru village, Penumantra Mandal, West Godavari district, Andhra Pradesh located at geographical coordinates of 16°38'0" North, 81°44'0" East and 10 m above mean sea level for three contiguous rodent outbreak years, i.e. from 2019 to 2021.

Trapping of Rodents: Rodent pest populations were collected using 18X10'' size multi-catch traps of silver paint coated GI wire make, placed @ 1 per 10 m^2 area from different establishments viz., bakeries, grocery shops, vegetable shops, and residences present in the study area. A total of 50 multi-catch traps were placed randomly in various structures with known signs of rodent activity. Traps were placed aligning the wall (thigmotactically) filled with a piece of onion to lure the animal into the trap. 20 per cent of the traps were placed in open places in the residential area where generally bandicoot activity is present. The traps were left unchanged for a minimum period of 3 days to overcome the neo-phobic behaviour present in the rodent species. Trapping was done twice a month throughout the year. Rice fields spread over 60 acres at Andhra Pradesh Rice Research Institute, Maruteru were used for collecting field rodents using local traps and also by employing rat catchers at frequent intervals, especially during critical stages of the crop growth periods. The monthly catches were segregated species-wise and then sex ratios were worked out for predominant species present in a particular environment.

Collection of Rat Fleas: The successful traps were covered with a cloth bag to avoid the escape of fleas from the animal body before bringing to the laboratory. The collected animals were segregated species-wise based on their morphological characters and sex. The number of animals collected in a month from different structures was also analysed to find the most preferred site by the pest rodents. The collected animals were anaesthetised by placing a cotton swab dipped in chloroform near the animals' nostrils, and then the animals were combed into a white pan for collecting the fleas. The collected rat fleas were examined under a microscope to identify their species and sex based on morphological characteristics. The flea index was calculated as the total number of fleas collected (regardless of species) divided by the total number of hosts examined.[4]

Collection of Data on Incidence of Zoonosis: Data were collected from a primary health centre located in the study area.

Assessment of Rodenticide Baiting: A total of 20 structures (bakeries and grocery shops) with more or less uniform rodent incidence were selected for imposing the treatments. Anticoagulant rodenticide, bromadiolone 0.005% RB @ 50 g and freshly prepared bromadiolone 0.005% liquid bait in 10% jaggery, as per Namala SR,[5] @ 50 ml were applied through bait stations at each location @ 1 bait station per 10 sqm in a selected structure. The daily bait consumption was recorded and bait stations were provided fresh bait on alternate days after removing the leftover bait. This was continued for a week to cover the entire population in the selected facility. The pre-treatment count was recorded by placing 10 tracking tiles at each facility; the tiles with footprints and tail marks were considered positive and the tracking index was arrived at using the formula.[6] Post-treatment tracking index was recorded 15 days after pre-treatment tracking and per cent control success was calculated. Thus the data collected were statistically analysed using t-test to find out the significant effect of the treatment.

Results and Discussion

It is quite evident from the trap catches that the house rat, Rattus rattus was predominant with a 94.24% share in residential premises in the study area. They were 180 in number, among the total catch of 191 animals over three years (Table 1). The proportion of other species was found very meagre including lesser bandicoots B. bengalensis. The situation was quite opposite in rice fields surrounding the residential area, where lesser bandicoots were predominant with a share of 98.98% under huge population build-up. In rice fields, about 4191 trapped rodents were lesser bandicoots out of 4234 total rodents trapped for three consecutive rodents outbreak years. This is quite common as bandicoots are soil-dwelling and prefer to habitat in rice paddies, whereas house rats are non-burrowing and prefer to live near human habitations. Further, it was observed that the build-up of huge populations of bandicoots has not caused the ingression of bandicoots into the habitat of house rats even during the outbreak years, as mostly the emigration of a rodent population from crop fields is influenced by the constraints of space and food, but in existing rice paddies, food and space are available in plenty for the existing as well as emerging rodent populations. Hence the dispersal of bandicoot

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populations from crop fields to residential structures was very meagre and negligible. Agricultural crop fields carry sufficient resources to meet the needs of small mammals like rodents, therefore there was no need of emigration of the pest rodent populations from their native habitat into the areas around the residential premises.

As depicted in Figure 1, the number of female bandicoots was more than the males in rice paddies, during all three years, whereas it was the opposite in the case of house rats in the residential area, where males were more in number than females. The mean sex ratio of bandicoots in rice paddies was 1:1.30 and it was 1:0.65 for house rats in the residential area. As rodents are promiscuous, more females in a population leads to faster breeding and population build-up in a short period. During the years 2020 and 2021, the female population of bandicoots was much higher than the mean ratios and this might have caused the outbreaks in the rice paddies. Even during the rodent outbreak years in rice paddies, the rat populations in residential premises showed no fluctuations in their populations.

Table 1.Species-wise Distribution of the Total Number of Rodents Trapped from Structures in a Residential Area and Rice Paddies

Years	Species-wise Number of Animals Trapped in Residential Area				Total	Species-wise Number of Animals Trapped in Rice Paddies				Total
	B. b	B. i	R. r	M. m		B. b	B. i	R. r	M. b	
2019	0	0	98	0	98	584	6	2	4	596
2020	5	3	35	2	45	1990	4	4	6	2004
2021	1	0	47	0	48	1617	6	3	8	1634
Total	06	03	180	02	191	4191	16	9	18	4234
B. i- Bandicota indica; B. b- Bandicota bengalensis; R. r- Rattus rattus; M. m-Mus musculus; M. b- Mus boodgua										

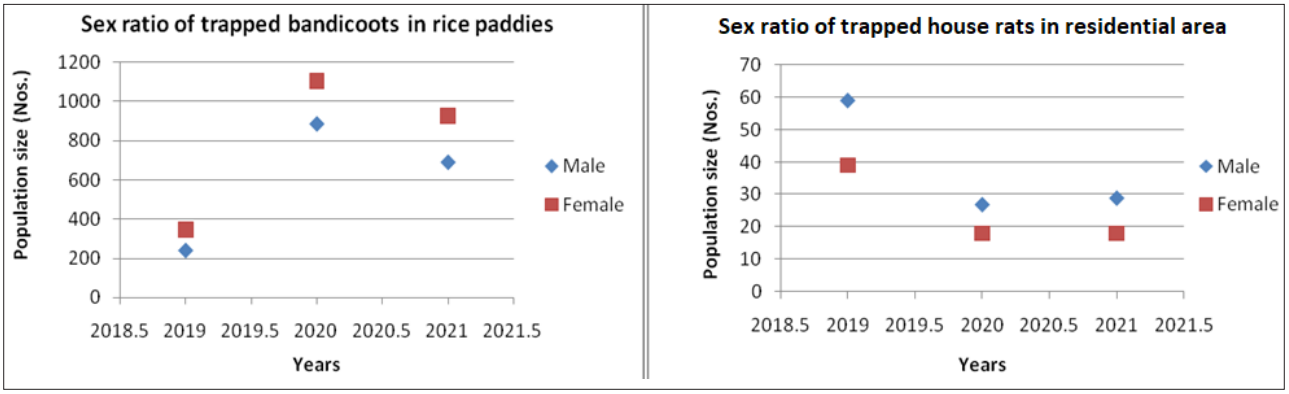

Figure 1.Sex Ratio of (a) Trapped House Bandicoots in Rice Paddies, and (b) Trapped House Rats in Residential Area

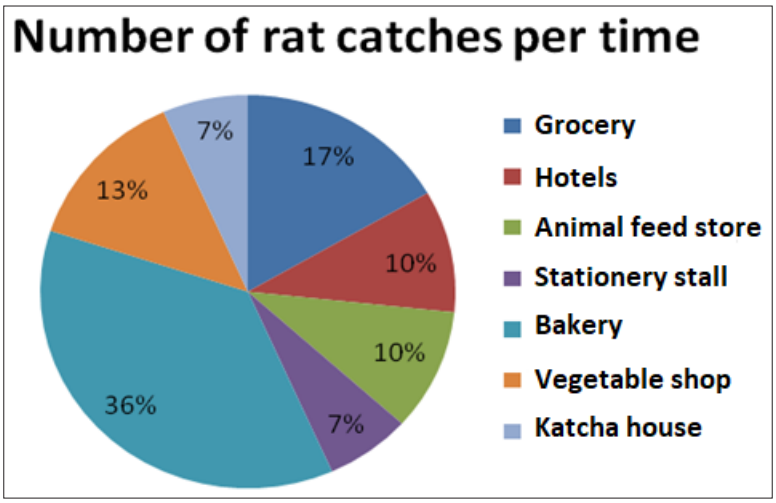

Figure 2.Location-wise Distribution of the Trapped Rats

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As shown in Figure 2, among various establishments present in the residential area in the study, the inhabitation of house rats was found more in bakeries (36%), followed by grocery shops (17%) and vegetable shops (13%). A less incidence of house rats was recorded from houses and stationery shops in the study area. Continuous availability of varied food in bakeries and vegetable shops along with ideal hideouts might have caused the house rat to prefer more of these environs. Therefore much attention should be paid to these establishments while taking any rodent control operations as fair chances exist for distribution of contaminated food among the residents in an area.

The monthly trap catches were analysed for both field and residential environs and are depicted in Figures 3 and 4 on the scattered and linear axes. In residential areas, the trap catches were more during the July-October period coinciding with the rainy season, but with non-significant distribution among the months ($R^2 < 50\%$) whereas, in rice paddies, two significant peaks were recorded during February-March and September-October coinciding with the critical vulnerable crop stages in Rabi and Kharif seasons, respectively.

The fleas were extracted in very few numbers from the rats collected in residential premises and the mean flea index was only 0.61 and it had not crossed 1 during any of the outbreak years in the study area (Table 2). This shows no risk of potential spread of zoonotic plague.

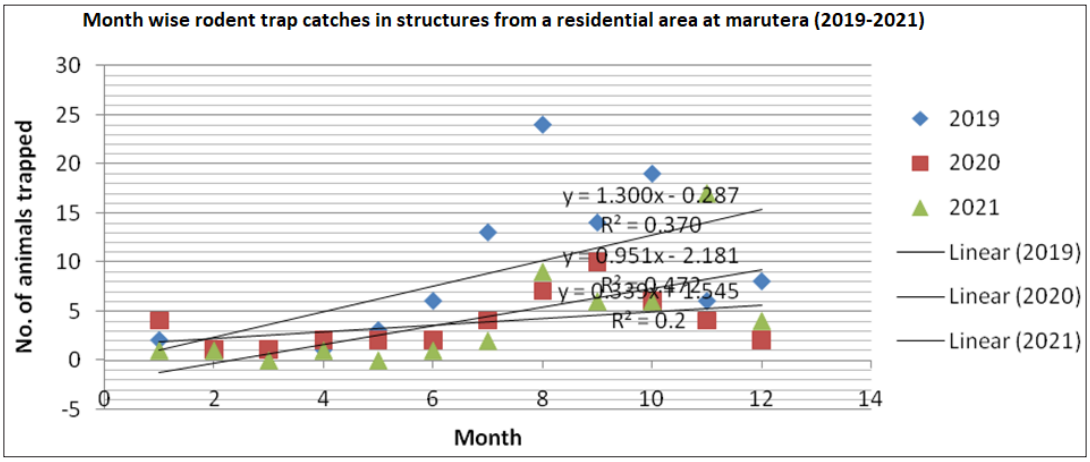

Figure 3.Month-wise Rodent Trap Catches in Structures from a Residential Area at Maruteru (2019-2021)

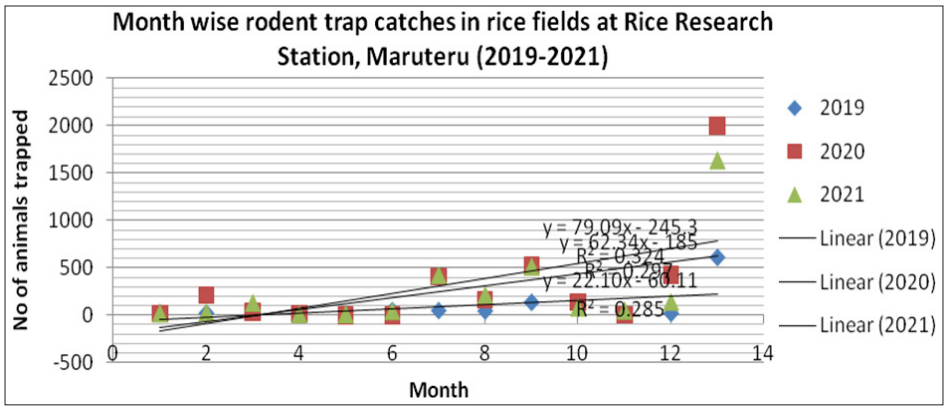

Figure 4.Month-wise Rodent Trap Catches in Rice Fields at Rice Research Station, Maruteru (2019-2021)

Table 2.Rat Fleas Collected and Flea Index from Trapped Animals

Year	Number of Animals Trapped	Number of Animals Combed	Rat Fleas Collected			Rat Flea Index
			Male	Female	Total	
2019-20	98	20	8	6	14	0.70
2020-21	45	20	6	4	10	0.50
2021-22	48	20	6	7	13	0.65
Mean number of fleas collected & mean rat flea index					0.61 ± 2.08	0.61 ± 0.10

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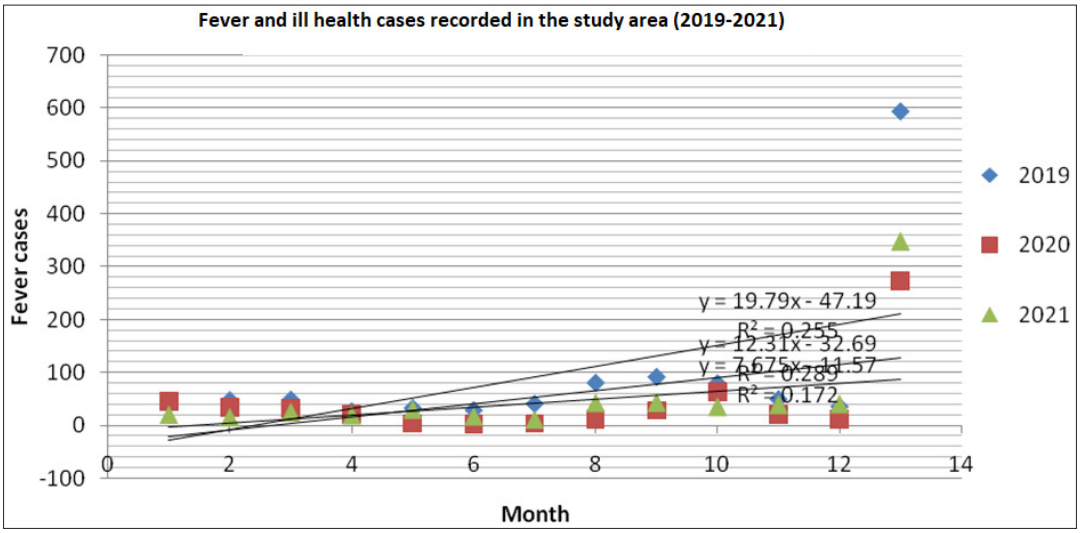

Figure 5.Fever and Ill-health Cases Recorded in the Study Area (2019-2021)

Table 3.Efficacy of Bromadiolone 0.005% applied in Liquid Form in Residential Premises

Treatment	Bait (g/ml) Placed at Each Point	No. of Bait Points	% Bait Consumed Per Day	Tracking Index		% Control Success
				Pre-treatment	Post-treatment	
Bromadiolone 0.005% RB (Solid form)	50 g	10	17.5 ± 3.3	70.0	40.0	42.9
Bromadiolone 0.005% bait (Liquid form)	50 ml	10	29.5 ± 7.9	80.0	10.0	87.5
T-test						Sig. (5.3 > 2.3)

The data collected from the primary health centre also showed that the distribution of fever (ill-health cases) cases was very normal and there was no surge during any of the rodent outbreak years (Figure 5).

Rodenticides often play a crucial role in community rodent control programmes though they are not ideal for use in residential areas due to various reasons like risk of secondary poisoning and safety of non-target organisms. However, they are found very reliable, cheap and practical for covering larger areas in a stipulated period. In the present study, the consumption of bromadiolone 0.005% was more when applied in liquid form than the regular ready-to-use bait cakes. The consumption was almost double when bromadiolone was used in liquid form and resulted in a high control success of 87.5% (Table 3).

Conclusion

The populations of rodent species in rice paddies were colonised in rice fields and did not migrate much to the residential areas even during the outbreak years, as the crop ecosystem is much abundant with food and habitat resources. In resource-abundant ecosystems like crop ecosystems, there was a clear understanding between the species with nil or minimal competition in food and habitat sharing. Rodenticide poison offered through liquids has recorded high intake and control success over the market available ready-to-use bait cakes as rodents need some water after every meal and liquid rodenticides play a vital role in rodent management in structures.

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Conflict of Interest: None

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