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Caption: Large Indian Civet Viverra zibetha, Tricoloured Munia Lonchura malacca and Hoya wightii (Medium-pencil crayon on watercolour paper) © Supriya Samanta.

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Observations on the foraging behavior of Tricoloured Munia Lonchura malacca (Linnaeus, 1766) and its interaction with pearl millet fields in Villupuram District, Tamil Nadu, India

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Abstract: Study of foraging behaviour of Tricoloured Munia *Lonchura malacca* and its interaction in pearl millet crop fields was conducted in six villages of Tindivanam taluk, Villupuram district, Tamil Nadu from April to June 2020. A total of six flocks containing 1,640 birds of Tricoloured Munia were enumerated. The number of birds per flock varied from 60 to 800. They never split into small flocks and maintained the same flock size throughout the day. Tricoloured Munias used nine plant species for roosting. Twelve quadrats (0.3 ha) each of 5 m x 5 m size were laid in the pearl millet fields covering six villages. A total of 10,295 spikes were counted in these plots, and of these 3,785 spikes (36.7%) were found damaged by foraging munias. The maximum damage of 99.6% was observed in Thenputhur village. Along with Tricoloured Munia, five other granivorous birds, such as Baya Weaver *Ploceus philippinus*, Indian Silverbill *Euodice malabarica*, Common Babbler *Turdoides caudata*, Rose-ringed Parakeet *Psittacula krameri*, and White-rumped Munia *Lonchura striata* were also found foraging without any inter-specific competition. Farmers adopted various traditional bird repellent techniques such as beating utensils, throwing pebbles/soil on the crop, placing scarecrows, tying multi-coloured ribbons, and hanging bottles to chase the birds away.

Keywords: Bird repellent, flocking behaviour, granivorous birds, inter-specific competition, roosting plants.

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INTRODUCTION

The Tricoloured Munia Lonchura malacca (Aves: Passeriformes: Estrildidae) is a small, finch-like, granivorous bird. It is native to India and Sri Lanka and was introduced into Costa Rica, Haiti, Venezuela, Japan, Jamaica, and Portugal (BirdLife International 2018). This species is considered endemic to the Indian subcontinent and distributed in the Peninsula from Gujarat to Sri Lanka (Ali & Ripley 1987; Grimmet et al. 1999; Rasmussen & Anderton 2005). Tricoloured Munia population is adaptable to a wide range of habitats such as open agricultural lands, woodlands, grasslands, and scrub lands. The global population size of this species has not been quantified by BirdLife International. The IUCN Red List classified this species as 'Least Concern' (BirdLife International 2018). Though this species is widely distributed in the dry plains of India, only a few authors have recorded the presence of this species in Carnatic region (Cole & Brown 1840), and recent records of the species is from Karur (Salahudeen et al. 2013; Deepan et al. 2017), Coimbatore (Daniel 2017), Villupuram districts, and a few records are from Rajasthan as well (Jamdar 1998; Sharma 1999; Bhatnagar 2013) (https:// ebird.org/species/trimun).

India is a major producer of pearl millet (*Pennisetum glaucum* (L.) R. Br.) and 83% of the country's production occurs in Rajasthan, followed by Uttar Pradesh, Gujarat, and Haryana (www.millets.dactw.nic.in). In Villupuram district of Tamil Nadu is the major producer of pearl millet (Agricultural Times 2016).

Incidents of flocks of *L. malacca* gleaning grains in paddy fields were reported in Colombia (Cubillos *et al.* 2010), Philippines (Llaguno 1975; Reidinger & Libay 1979), and Rajasthan (Bhatnagar et al. 2013). Literature survey revealed that studies are not available on the foraging behaviors of *L. malacca* and its interaction with pearl millet crop fields. Hence, to fill this gap, I decided to take up a study on foraging and roosting behaviors of *L. malacca* and its interaction with pearl millet crop fields. Hence, to fill this gap, I decided to take up a study on foraging and roosting behaviors of *L. malacca* and its interaction with pearl millet crop fields in Tindivanam taluk, Villupuram district, Tamil Nadu.

MATERIALS AND METHODS

Study Area

The present study was carried out in six villages viz., Thenputhur, Pathirapuliyur, Elayandapattu, Veedur, Mozhiyanur, and Nedi in Tindivanam taluk in Villupuram district (11.939 N, 79:492 E) of northeastern

Tamil Nadu (Figure 1). The district spreads over 3,715 km², with a human population of c. 20,90,000 (Figure 1; www.viluppuram.nic.in). Agriculture is the primary occupation of the people. The major crops of the area are paddy *Oryza sativa* L., jowar Sorghum *bicolor* (L.) Moench., pearl millet *Pennisetum glaucum* (L.) R.Br., finger millet *Eleusine coracana* Gaertn., sugarcane *Saccharum officinarum* L., groundnut *Arachis hypogaea* L., and green gram *Vigna radiata* (L.) R.Wilczek. The maximum and minimum temperatures in the district are 36°C and 20°C, respectively and the average annual rainfall is 1,060 mm (www.viluppuram.nic.in).

Methods

Based on information from two persons, suitable habitats were identified, where significant population of Tricoloured Munia persists in six villages of Tindivanam taluk of Villupuram district. These habitats were surveyed from April to June 2020 between 0545 and 1000 h, and again between 1500 and 1800 h, when the birds are usually active during pearl millet cultivation in Villupuram district usually commences, i.e., Chithiraipattam every year sowing in March-April and harvest in May-June. Hence, I have selected this period for study. The number of individual birds on foraging and roosting sites was determined using total count method (Bibby et al. 2000). A total count of individuals of this species was taken when the birds were in foraging and roosting sites. Tricoloured Munia usually live as a flock, roost on nearby vegetation in croplands during night, and move immediately after sunrise around adjacent croplands searching for food. Hence, the number of birds in each flock was counted when they were roosting and foraging. The foraging behaviors, movements of each flock and inter-specific relationships with other granivorous birds were observed in each village continuously for three days using binoculars without causing any disturbance to the birds. The types of trees/shrubs/herbs used by birds for roosting were ascertained. An extent of twoacres of pearl millet crop fields was randomly selected in each of the six villages. A total of twelve acres of pearl millet crop fields were selected for random sampling. Two 5 m x 5 m size quadrats / plots were laid in the selected sites, i.e., two plots per village. Out of the two plots, one was along the edge of crop field and while the other was in the interior of the field. The number of spikes and the number of damaged spikes in each quadrat were manually counted. The time spent by each flock on crop while foraging was measured using the stopwatch feature in smart phones. The exact locations of the croplands where foraging activities of



Figure 1. Study area map: a—India map showing Tamil Nadu | b—Tamil Nadu map showing Villupuram district | c—Villupuram district map showing Tindivanam taluk and villages studied. List of villages are (1) Thenputhur (12.177°N, 79.549°E), (2) Pathirapuliyur (12.177°N, 79.549°E), (3) Elayandapattu (12.023°N, 79.604°E), (4) Veedur (12.059°N, 79.598°E), (5) Mozhiyanur (12.148°N, 79.552°E), and (6) Nedi (12.116°N, 79.576°E).

birds occurred were noted using Garmin Etrex 20x GPS device. Photographs and videos were taken using Nikon P1000 digital camera. The bird repellent techniques were recorded by direct observations in the crop fields in six villages. No questionnaire survey was done in this regard. The collected data were tabulated, analyzed and shown as graphical representation.

RESULTS AND DISCUSSION

A total of six flocks of Tricoloured Munia, one each in each village were identified. A total of 1,640 individuals of Tricoloured Munia were enumerated (Table 1). In addition to flocks of Tricoloured Munia, other granivorous species, such as Baya Weaver (240), Indian Silverbill (26), Common Babbler (19), Rose-ringed Parakeet (11), and White-rumped Munia (8) were also found foraging in pearl millet crop fields. The smallest flock size was 60 birds in Nedi village, while the largest of 800 birds was recorded in Thenputhur village (Table 1).

The study on the behavior of the flocks reveals that the individuals of Tricoloured Munia strictly followed communal roosting and foraging. During the entire study period, the existing flocks never split into many smaller groups. They moved as flocks from morning to evening and maintained the flock size throughout the day. The flock size varies from village to village (Table 2). The flocking behavior varies and the birds took various complicated formations to reach pearl millet crops as well as roosting sites. It was observed that the flocks fly in close formations by performing different manoeuvres. They commence their daily foraging between 0545 h and 0615 h and conclude their foraging before 1800 h. No foraging activities were observed between 1130 h and 1500 h, when the flocks moved to adjacent vegetations for roosting. Continuous observations on the movements of the flock in each village consecutively for three days revealed that the birds never go beyond

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	Name of the village	Total Cultivated area (acres) studied	No. of quadrats laid (5m x 5m)	No. of flocks	No. of birds in a flock	Total no. spikes counted	Total no of spikes damaged	Percentage of damaged spikes
1	Thenputhur	2	2	1	800	1596	1564	99.6%
2	Pathirapuliyur	2	2	1	180	1850	298	16.1%
3	Elayandapattu	2	2	1	300	1810	485	26.7%
4	Veedur	2	2	1	200	1560	450	28.8%
5	Mozhiyanur	2	2	1	100	1680	473	28.1%
6	Nedi	2	2	1	60	1795	515	28.6%
Total		12	12	6	1640	10291	3785	36.7%

Table 1. Details of quadrats, number of flocks, number of birds per flock, and damages to spikes of pearl millet in the study area.

a 2-km radius from the targeted two-acres pearl millet crop. A total of 104 foraging visits of flocks were studied in the six villages. The mean number of visits to pearl millet crop was 10 in the forenoon (0545-1000 h), and seven in the afternoon (1500–1800 h). The total number of foraging visits to crops per day varies from a minimum of 11 to a maximum of 21. In each foraging visit, they stay on the spikes from 10 sec to 80 sec, glean millets and take sudden flight to adjacent places for temporary roosting. Analysis of the duration over the 104 foraging visits showed that the maximum number of visits fell between two duration segments: 41 to 50, and 51 to 60 sec, which accounted for 43.6% of the total visits. This indicates that the optimum time the birds preferred to spend and forage on the crop fields was around 50 seconds (Table 2; Figure 2).

The foraging flocks roost temporarily on powerline cables that cross the crop fields. During non-foraging periods and nights, they use nearby vegetations as roosting sites. This bird uses nine species of plants for roosting. They are: Prosopis juliflora (Sw.) DC., Lantana camara L., Canthium coromandelicum L., Pithecellobium dulce (Roxb.) Benth., Abutilon indicum (Link) Sweet., Azadirachta indica A.Juss., Vachellia nilotica (L.) P.J.H.Hurter & Mabb., Saccharum officinarum L., and Sorghum bicolor (L.) Moench. The duration of stay of this bird on spikes is short as compared to the duration spent roosting on trees / shrubs / herbs. The reason could be that being habituated to disturbance caused by farmers by banging utensils or other means to chase them away from crops, the birds avoid stay on the crops for long duration while foraging. Threat of prolonged exposure to predators while foraging on open crop fields could be another reason. According to eBird India (www.ebird.org), about 21 avian predators occur in Villupuram district. But the common predators observed during the present study in six villages were



Figure 2. Frequency of foraging visits of flocks and time spent on crops for foraging.

House Crow *Corvus splendens*, Large-billed Crow *Corvus macrorhynchos*, Shikra *Accipiter badius*, Sparrowhawk *Accipiter nisus*, White-eyed Buzzard *Butastur teesa*, and Rufous Treepie *Dendrocitta vagabunda*. Gadgil & Ali (1975) stated that the habit of communal roosting helps them to communicate information about source of food and protection from predators. The present observation of huge flock size, communal roosting pattern and foraging enmasse on pearl millet crops probably helps to exchange information about source of food and approach of predators as stated by Gadgil & Ali (1975).

Pearl millet is a 90-day crop and maturing kernels start after 60 days of sowing. The study reveals that the flocks started to visit the spikes after the 65th day when the grains were in milky stage and continued their visit to the crop till harvesting. Frequent attacks on the crops and gleaning of the grains leave the spikes devoid of grains (Image 1). In order to assess the extent of damage to grains in the spikes, a total of 10,295 spikes were sampled in all the 12 quadrats

Foraging behavior of Tricoloured Munia in Villupuram District, Tamil Nadu

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	Name of the village	No. of flock	No. of Tricoloured Munia in the flock	No. of White- rumped Munia	No. of Baya Weaver	No. of Rose- ringed Parakeet	No. of Yellow Common Babbler	Indian Silver bill	Mean no. of visits to crop per day	Duration of foraging in each visit (seconds)
1	Thenputhur	1	800	3	40	6	8	7	18	10-70
2	Pathirapuliyur	1	180	2	30	0	0	4	21	10-70
3	Elayandapattu	1	300	0	50	2	5	11	19	20-60
4	Veedur	1	200	0	30	1	6	2	18	20-60
5	Mozhiyanur	1	100	0	60	0	0	0	18	10-60
6	Nedi	1	60	3	30	2	0	2	11	20-80
	Total	6	1640	8	240	11	19	26	-	

Table 2. Details of different species of birds, numbers, mean visits and duration of foraging in the study area.

(0.3 ha) in six villages and among them, 36.7% spikes (n= 3,785) were found damaged by Tricoloured Munia. Out of 12 quadrats, six quadrats were laid towards the margin of the field and another six quadrats were laid in inner side of the field. Analysis reveals that out of a total 36.7% damages to spikes (3,785), more damages to spikes (1,960 spikes; 19%) were found in the inner side and less damages were reported to spikes (1,825 spikes;17.7%) occurred towards the peripheral region. It indicates that the birds avoid perching and foraging on the peripheral parts of the field. The reason could be the frequent visits of farmers along the bunds and roads and chasing the birds using traditional bird repellent techniques. The maximum damage was observed in Thenputhur (99.6%), followed by Veedur (28.8%), Nedi (28.6), Mozhiyanur (28.1%), Elayandapattu (26.7%), and Pathirapuliyur (16.1). Out of the 1,596 spikes counted in two quadrats (total 50m²area) in this village, 1,564 spikes (99.6%) were found damaged. Reason for the greater percentage of damage could be the availability of sugarcane crops in the adjacent land which provide conducive habitat to the flock for roosting during nonforaging periods and to hide when the farmers chase them away from pearl millet crop. On the 90th day, almost all the spikes in the two-acre land in Thenputhur village were found devoid of any grains and hence, the land holder ploughed the land without harvesting the empty spikes. Hence, foraging was found to cause nearly 100% losses of grains in the two-acre crop. According to the Directorate of Millets Development, the yield of pearl millet grains per acre (rainfed land) in India is c.485 to 600 kg (www.millets.dactv.nic.in). The loss of grains in two-acre crop in Thenputhur village would be 1,942 kg to 2,428 kg. But in the remaining five villages the damage to spikes was found to be only between 16.1% and 28.8%. This could be because of the small flock size consisting of birds ranging in number from 60 to 300. Kale et al. (2012) had stated that in India, the damage to pearl millet and sorghum crops by birds is a major concern. The present study on loss of pearl millet grains by granivorous birds matches the findings of Kale et al. (2012) that the loss of pearl millet crop by birds is a major concern.

The study reveals that among the foraging flocks of Tricoloured Munia, a few individuals of other granivorous birds such as Baya Weaver Ploceus philippinus, Roseringed Parakeet Psittacula krameri, Common Babbler Turdoides caudata, White-rumped Munia Lonchura striata, and Indian Silverbill Euodice malabarica were also observed in the pearl millet crops (Image 2a,b,c). Inter-specific competition between Tricoloured Munia and other species during foraging on pearl millet crops was not observed during the study period (Table 2). Rao & Dubey (2006) had stated that Rose-ringed Parakeet, Baya Weaver, Indian Silverbill, Common Babbler, Common Myna (Acridotheres tristis), and Lonchura spp had caused considerable damage to the pearl millet crops in Gujarat (0.3% to 40%), Andhra Pradesh (1.5% to 9%), Punjab (4% to 5%), and Delhi (60%). In the present study also, it was observed that along with flocks of Tricoloured Munia, other granivorous species such as Baya Weaver (240), Indian Silverbill (26), Common Babbler (19), Roseringed Parakeet (11), and White-rumped Munia (8) were also foraging on pearl millet crops and hence this matches the findings of Rao & Dubey (2006). It indicates that all these granivorous species co-exist and forage on targeted crops in the agricultural ecosystem without any inter-specific competitions between them over sharing of food. Further quantitative study in a wider area is required to estimate the exact extent of damage caused to grain production per hectare by these granivorous birds (Image 1; Image 2a,b,c).

Foraging behavior of Tricoloured Munia in Villupuram District, Tamil Nadu

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Image 1. Pictures of Lonchura malacca in pearl millet crop fields: a & b—Flock attacking pearl millet crop | c & e—Flock perched on spikes and gleaning grains | d—Individual bird gleaning grains | f—Spikes devoid of grains. © M. Pandian

Bird repelling techniques adopted by farmers

Techniques used to repel birds from crops in the six villages reveals that farmers had uniformly adopted the practices of beating utensils / iron barrels and throwing pebbles / soil randomly on the crops to chase the birds from morning to evening except the period from 1200 h to 1500 h when the birds were usually non-active. In Nedi village, the farmers tied reflective multi-coloured pieces of cloth on dry twigs and erected them in the fields. In Thenputhur village, empty bottles were hung

by strings to make noises when wind causes them to collide with each other. Two scarecrow structures each in the shape of human figures were found fixed in the crop fields in Veedur and Nedi villages. Subramanya (1982) had stated that farmers in India use shining ribbons, noise making devices, and scarecrows to repel birds from crop lands. The present observation of farmers using scarecrows, multi-coloured ribbons, and making noise by beating utensils / iron barrels as bird repellent techniques matches with the observations

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Image 2. Pictures showing forage and bird repellent methods used by farmers: a—Pair of foraging *Ploceus philippinus* | b—Foraging *Psittacula Krameri* individual | c—*Turdoides caudata* pluck grains | d—Beating of utensil | e—Multi-coloured ribbons tied to twigs | h—Hanging empty bottles. © M. Pandian

of Subramanya (1982). Even after adoption of these traditional techniques by farmers, the flocks containing Tricoloured Munia and other granivorous birds had attacked the crops and caused loss of grain productions in the study area (Image 2c,d,e). Hence, a detailed study is required on the impact of various traditional bird repellent techniques on the flocks. No incidents of killing of birds or use of any lethal techniques against granivorous birds were observed in the study area. This

shows that even after undergoing economic loss due to the birds, the farmers had eco-friendly attitude by not harming the birds.

CONCLUSION

A total of 1,640 individuals of Tricoloured Munia were counted in six flocks covering six villages.

Proraging behavior of Tricoloured Munia in Villupuram District, Tamil Nadu

Tricoloured Munia caused damages to the spikes ranging from 16.1% to 99.6% resulting in economic loss to the farmers. Other granivorous birds such as Baya Weaver, Rose-ringed Parakeet, Common Babbler, White-rumped Munia, and Indian Silverbill were also found foraging along with Tricoloured Munia. This indicates that the region provides a suitable habitat to diverse avifauna. Further quantitative study in a wider area is required to estimate the exact extent of damage caused to grain production per hectare by these granivorous birds. Based on my observations, the following measures are proposed:

(a) Local community, particularly land holders, and agricultural workers should be sensitized to understand the need to preserve the precious populations of avifauna.

(b) A detailed systematic survey on the population status, behavior of flocks and impact of these birds on the pearl millet crops covering the entire state may be carried out to help in drafting an action plan to conserve the avifauna of agro-ecosystem.

(c) Eco-friendly approaches by using traditional and non-lethal techniques have to be adopted for protecting pearl millet crops from depredatory birds.

(d) Efforts must be taken to study birds' habitat and formulate policies to reduce bird-farmer conflicts and promote biodiversity conservation.

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