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Abstract. The nesting period of the Spotted Munia is from July to November, a period with frequent rains. Built of grass, nests (n = 60) were spherical or dome-shaped, with a lateral entrance-hole oriented mainly along the most frequent wind direction. They were mostly built on twigs within the tree canopy, the majority of them on thorny plant species. The mean depth and diameter of the nests were 12.32 cm and 4.18 cm respectively. Nesting activities were shared by both sexes. Four to six eggs were laid. The incubation period in 17 pairs varied from 10 to 15 days. All the nests (n = 60) were situated on four plant species only, the greatest preference being for *Toddalia asiatica* (50%), followed by *Gymnosporia montana* (25%) and *Acacia chundra* (20%). Although 50% of the nests were found on *T. asiatica*, this plant is a straggler and no nest was built on it if it was not present in association with *G. montana*. For constructing nests the Spotted Munia selected short and small trees in a microhabitat with low canopy cover.

Key words: Spotted Munia, *Lonchura punctulata*, breeding ecology, nesting, nest site, India

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INTRODUCTION

The Spotted Munia is a fairly common resident bird and distributed almost throughout India up to 1500 m.s.l. Apart from description of species and some behavioural information given by Ali & Ripley (1987), the ecology of this species is poorly documented. Recently Sharma & Bhatt (1996) studied the breeding biology. The study was carried out during May 1995 to December 1997.

STUDY AREA

The Mudumalai Wildlife Sanctuary (11°30′–39′N and 76°27′–43′E) is located in the Nilgiris district, Tamil Nadu. It is situated at an average elevation of 1000m. The climate is moderate, and temperatures vary from 14°–17°C during December–January to 29°–33°C during March–May. The annual rainfall varies from 600 mm to 2000 mm which is received in two periods the first with high rainfall (June–August) from the Southwest monsoon and the second with low rainfall (September–November) from the Northeast monsoon. The sanctuary is drained mainly by the perennial river Moyar and partly by various semi-perennials. In correspondence to the rainfall, the vegetation varies from thorn forest in the east to semi-evergreen forest in the west. The study was carried out in the tropical thorn and dry deciduous forests which are dominated by species such as *Acacia* spp. (including *A. chundra, A. leucopholea,* and *A. ferruginea*), *Ziziphus* spp., *Sapindus emarginatus*, and *Erythroxylum monogynum* in thorn forest, *Tectona grandis*, *Anogeissus latifolia, Phyllanthus emblica*, and *Capparis* spp. in dry deciduous forest. In recent years, drastic increase in the human population in and around the sanctuary has considerably altered the thorn forest as majority of the people depend on this forest for various resources. Details of the study area are given by Desai (1991). During study in total 60 nests were found in the thorn forest and none were in dry deciduous forest.

METHODS

A 10 ha plot was laid for the nest-site selection studies in both thorn and dry deciduous forest types. Searches were made for substrate suitable for nesting. An active nest was confirmed if adult birds were seen performing breeding activities (nest building or renovation, incubation, feeding the young) in or adjacent to the nest. The method for determining nest-site selection was similar to that applied in a number of nest site selection studies (e.g. Bechard et al. 1990, Hullsieg & Becker 1990). Variables were set at three levels - nest, nest-substrate and nest-patch:

1) nest — height (m), length (cm), width (cm), depth (cm), orientation, concealment;
2) nest tree — species height (m), species girth class at breast height (cm);
3) nest patch — canopy cover (%), ground cover (%), shrub cover (%), distance to settlement (km), microhabitat (mullah, other), distance to road (km).

„Nest concealment" was estimated by viewing the nest at a distance of 2 m, 5 m, 7 m and 10 m in each of the four cardinal directions (Martin & Roper 1988). Based on the number of points where the nest was not seen, the concealment was evaluated as very low (0–4 points), low (5–8 points), high (9–12 points) and very high (13–16 points).

A 15 m radius (0.07 ha) circular plot centred at nest-substrate was laid for every nest to study the nest-site selection as suggested by Titus & Mosher (1981). Nest-patch variables were measured to identify the microhabitat required for nesting. Distance to road and disturbance on nest-substrate were included to identify whether site selection was affected by human activity. Lopping and cutting signs on the nest-tree were considered as disturbance and measured in percentage. Vegetation cover (shrub and ground) was visually estimated in percentage. Canopy cover immediately over the nest was measured using a hand mirror marked with grid and shaded area was estimated in percentage as canopy cover (Martin & Roper 1988).

To test for nest-site selection, except for the nest measurements, all other parameters were compared with similar measurements recorded at randomly selected sites to identify the factors responsible for selecting a nest-site. Random sites were selected based on the place having potential nest-sites and should also be close enough to the used sites. The 20 ha plot established for nest-searching was divided into 80 grids (50×50 m). Grids were plotted on an enlarged topographic map of the study area and numbered. Twenty grids were selected randomly by using lot system and were identified in the study site. Once the approximate grid or site was located, the nearest tree or shrub was made as centre of the random plot. Except for the nest variables, all other variables (nest-tree and nest-patch) were enumerated in the plot as done for the nest-site.

Uni-variate analysis of variances (ANOVA), Mann-Whitney U test, and other simple statistics (mean and SD) were used where appropriate (Sokal & Rohlf 1981). Results are reported as significant if they are associated with a value of $p < 0.05$. The SPSS software (Nouris 1990) was used for the data analyses. Principal Component Analysis was performed on the nest-site characters to determine the most important factors in delimiting the habitat niche of the species. Discriminant Function analysis was performed to identify the factors involved in separating the nest-sites from the random sites.

RESULTS AND DISCUSSION

Nest-morphology and breeding activities

The nesting period of Spotted Munia is July to November, a period with frequent rains. Nests found were globular or dome shaped with a lateral entrance-hole. Grass blades were used to build the nest. Nests were largely built on the twigs present inside the canopy. The mean depth and diameter of the nests were 12.32 ± 1.39 cm and 4.18 ± 0.33 cm respectively. Nesting activities were shared by both the sexes. Only four to six eggs were laid. Incubation period of 17 pairs studied varied from 10 to 15 days (11.8 ± 1.6). Ali & Ripley (1983) reported 16 days as incubation period for Spotted Munia while Sharma & Bhatt (1996) recorded 11 days. The fledging period varied from 18 to 22 days ($n = 17$, $\bar{x} = 20.23 \pm 1.30$) while Sharma & Bhatt (1996) reported 20 to 22 days as fledging period. The difference in the period can be attributed to the changes in the environment such as temperature, availability of food and predators (Vijayan 1984) and probably due to differences in the sample sizes.

Nest-orientation

By placing nest or its entrance towards the most favourable direction, birds reduce their exposure to prevailing winds, avoid direct exposure to severe storms, or get the best insulation conditions (Collias & Collias 1984), thus achieving a favourable thermal environment. In the present study, nest-holes were largely oriented towards NE and SW (Fig. 1). Nests were found during July to November a period with frequent rains from SW and NE monsoon. Entrance of the nests found during July to August (in SW monsoon) were oriented towards NE and those found in later months (in NE monsoon) were oriented towards SW. As orientation were along the wind direction, it can be assumed that it may be to avoid the fall of the heavy rain.

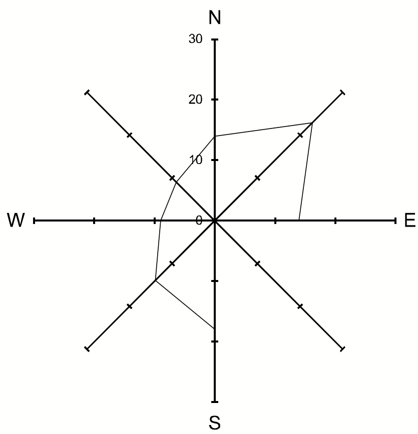

Fig. 1 Entrance orientation (%) of nests studied (n = 60).

Plant selection

All the nests (n = 60) were placed only on four plant species. Birds studied showed a high preference for *Toddalia asiatica* (50% of nests) followed by *Gymnosporia montana* (25%), *Acacia chundra* (20%) and *Zyziphus mauritiana* (5%). No nest was built on *Toddalia asiatica* a straggler, when it was not associated with *Gymnosporia montana*. It showed consistency in selecting thorny plants as nesting substrate. Selection of thorny species (*Acacia* spp, *Toddalia asiatica* and *Gymnosporia montana*) by Spotted Munia can be attributed to the densely interwoven and thorny nature of the those plants which provide sufficient structure to support the dome-nest and also protect the nest from predators (Collias & Collias 1984).

Nest-site selection

Nest-site variables were collected for only 26 nests that had good accessibility (Table 1). The canopy cover ($U = 78$, $p < 0.01$), tree height ($F = 13.876$, $p < 0.01$), and tree girth class ($F = 21.3914$, $p < 0.01$) differed significantly between the nesting site and random-site (Table 1). The DFA (stepwise) showed three variables, nest tree girth class at breast height (0.48), height (0.40), and canopy cover (0.57) as significant factors determining nest-site selection. The species showed consistency in selecting short and small sized trees in a microhabitat with low canopy cover. Three components were selected as it showed 62% of the total variance (Table 2) and they were associated with:

1) canopy cover and shade over nest to the positive points and disturbance on nest-tree to the negative point;

2) ground cover and shrub cover;

3) nest tree height and girth class at breasted height, and distance to next tree.

Table 1. Nest site characteristics (n = 26) and comparison with random sites of the Spotted Munia.

Parameter	Nest site	Random site	p
Nest height (m)	2.23 ± 0.64		
Shade over nest (%)	23.64 ± 20.77		
Nest diameter (cm)	4.18 ± 0.33		
Nest depth (cm)	12.32 ± 1.39		
Distance from nearest tree (m)	2.87 ± 2.11		
Disturbance on nest-tree (%)	4.32 ± 17.06		
Concealment	4.77 ± 4.4		
Tree height (m)	3.14 ± 0.78	7.0 ± 4.82	0.00
Tree girth class (cm)	27.45 ± 11.95	51.05 ± 20.40	0.00
Tree density	4.0 ± 0.87	4.15 ± 2.03	ns
Ground cover (%)	70.9 ± 23.89	83.50 ± 32.97	ns
Shrub cover (%)	23.6 ± 20.77	29.50 ± 28.56	ns
Canopy cover (%)	38.4 ± 19.72	78.50 ± 22.95	0.00
Distance to road (m)	460.0 ± 637.0	567.95 ± 636.10	ns

Table 2. Factor loading of various vegetational characteristics with the first three principal components for the nest data.

Variables	PC I	PC II	PC III
Nest tree height	0.33	0.10	0.85
Nest tree girth class	-0.23	-0.10	0.72
Nest height	0.28	0.04	-0.04
Ground cover	-0.20	0.87	0.32
Shrub cover	0.18	0.89	-0.21
Canopy cover	0.88	-0.04	-0.02
Shade over nest	0.79	0.14	-0.16
Distance to trunk	0.19	0.07	-0.01
Distance from next tree	-0.36	0.49	0.56
Distance to road	-0.47	-0.47	-0.31
Disturbance on nest tree	-0.71	0.14	-0.20
Nest concealment	-0.63	-0.02	0.01
Eigen value	3.30	2.54	1.58
% Variance	27.50	21.20	13.20
% Accumulated variance	27.50	48.80	62.00

In most of the cases nests were constructed largely on shrub species that were densely grown with other shrub or short tree species. It is also evident that they largely preferred a combination of shrubs and trees to construct their nest. Murphy (1983) and Martin (1992, 1993) suggested that the predation, which is the primary cause of nest failure, should be the key factor influencing nest-site selection. The Spotted Munia construct their nest mostly during rainy season, hence selection of combination of tree species would give better concealment through more canopy cover (within nest-plant) to protect the chicks from the predators and from rain.

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STRESZCZENIE

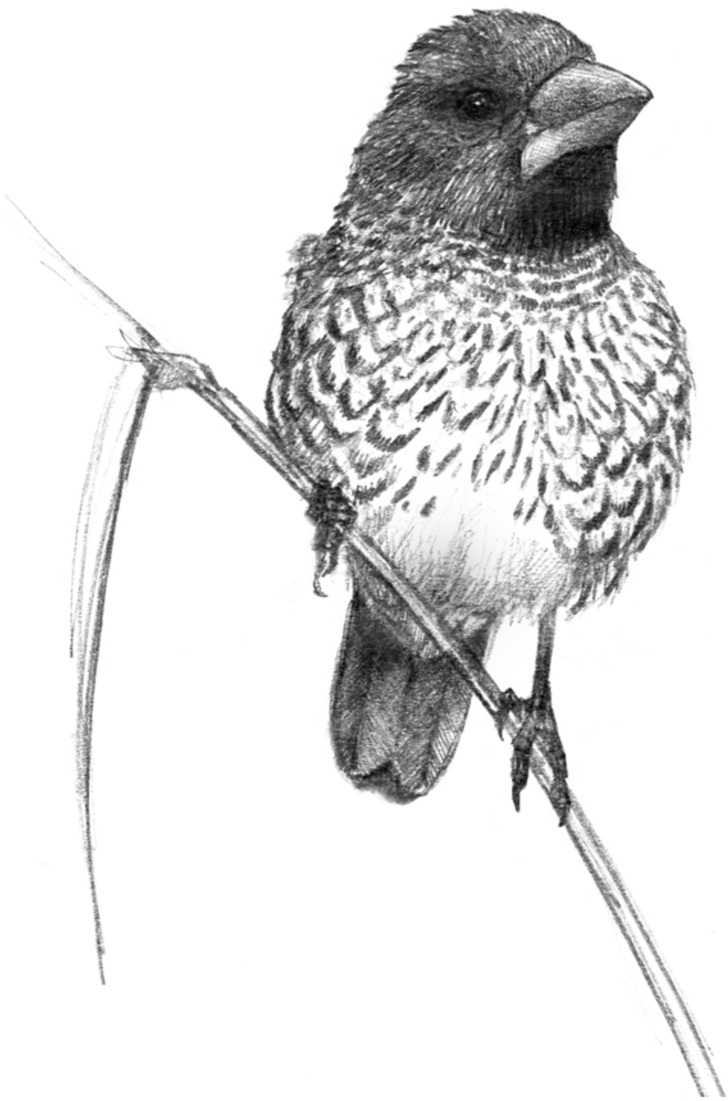
[Biologia gniazdowania mniszki muszkatowej w rezerwacie Mudumalai (płd. Indie)]

Badany gatunek jest w Indiach dość pospolity, jednak jego biologię poznano niedostatecznie. Celem badań było określenie sposobu gnieżdżenia się i czynników środowiskowych decydujących o wyborze miejsca na gniazdo. Prowadzono je od maja 1995 do grudnia 1997 na materiale 60 gniazd, w środowisku wyżynnego (1000 m n.p.m.) lasu cierniowego. Przyjęto metodykę stosowaną w innych podobnych badaniach (np. Bechard et al. 1990, Hullsieg & Becker 1990).

Gniazdowanie trwało od lipca do listopada, w okresie częstych deszczy. Gniazda miały formę kulistą o głębokości 12.32 ± 1.39 cm i średnicy 4.18 ± 0.33 cm, z otworem wejściowym z boku. W wychowaniu lęgu uczestniczyły samiec i samica. Zniesienia zawierały 4–6 jaj. Wysiadywanie u 17 badanych par trwało 10–15 dni (średnio 11.8 ± 1.6). Pisklęta przebywały w gnieździe 18–22 (średnio 20.2 ± 1.3) dni. Otwory gniazd były skierowane głównie na NE i SW (Fig. 1). Zaznaczyło

się zróżnicowanie skierowania otworu gniazd budowanych we wczesnej lub późnej części sezonu lęgowego, co miało znaczenie dla zmniejszenia ekspozycji w stosunku do przeważających kierunków wiatru z deszczem.

Wszystkie 60 gniazd było umieszczonych na 4 gatunkach roślin, których cierniste i gęsto splecione gałęzie stwarzały gniazdu dogodną podstawę. W większości przypadków były to krzewy lub niskie drzewa, wyraźna była też skłonność do wyboru współwystępowania drzew z krzewami. Wśród 14 analizowanych parametrów miejsca gniazdowania (Tab. 1 i 2) istotne znaczenie miała obecność korony drzewa nad gniazdem oraz wysokość i pierśnica drzewa. Autor uważa, że głównymi czynnikami wpływającymi na wybór miejsca gniazdowania była ochrona lęgu przed częstymi deszczami i drapieżnikami.



T. Cofta