

Roost-Site Preference of Spotted Owlet *Athene brama* (Aves: Strigiformes) in Madurai District, Tamil Nadu, India

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Abstract: Roost-site preference of Spotted Owlet *Athene brama* was studied in Madurai District, Tamil Nadu, India, between 2007 and 2009. A total of 292 roost-sites were located: 229 in/on trees, 43 in man-made structures, 12 in artificial wooden nest boxes and 8 in unused wells. Spotted Owlets selected 15 species of trees for roosting of which majority of them were in *Ficus benghalensis* (42.9%). Mean roost tree height, roost height and DBH were $16.4 \pm 5.29\text{m}$, $9.0 \pm 2.69\text{m}$ and $41.3 \pm 36.10\text{cm}$, respectively. Mean total height of man-made structures was $7.1 \pm 2.14\text{m}$ in which roosting was observed at a height of $6.4 \pm 1.92\text{m}$. Spotted Owlet roosting height ranged between 3.0 and 8.0m in the case of nest boxes with a mean height of $5.9 \pm 1.38\text{m}$. Mean total depth, roost depth of roost-sites in wells were $12.0 \pm 2.55\text{m}$ and $4.8 \pm 1.60\text{m}$, respectively. The surrounding ecological variables viz., distance to nearest tree, building, footpath, electric line, light source, groves and water sources were very closer i.e. within the vicinity of 100m radius to all types of roost-sites. The roosting tree DBH, basal circumference, canopy volume, distance to water sources, groves and building was significantly differed between the roosting sites of rural and urban habitats. Principal Component Analysis (PCA) identified 77.79% of its total variance highly on roost height, canopy volume, basal circumference, distance to groves, roost tree height, DBH, distance to human habitations, number of branches, distance to agricultural lands and distance to light source.

Key words: Spotted Owlet • Roost-site preference • *Ficus benghalensis* • Roost-height

INTRODUCTION

The Spotted Owlet *Athene brama* (Temminck, 1821) is a common nocturnal raptor distributed throughout Southeast Asia including India. It is common in open habitats including farmland and human habitation and has adapted to live in crowded cities also. There are five widely recognized sub-species namely *albida* (Koelz, 1950) of western Asia in Iran and Pakistan; *indica* (Franklin, 1831) of northern India; *brama* (Temminck, 1821) of southern India which is darker than *indica*; *ultra* (Ripley, 1948) of northeastern India and *pulchra* (Hume, 1873) of Southeast Asia from Myanmar and Thailand extending into Cambodia and Vietnam.

Spotted Owlets are nocturnal in habits, but sometimes seen in the day also and generally keep in pairs or family parties of three or four birds. It can often be located by the small birds that mob it while it is perched in

a tree. When disturbed from their daytime site, they bob their head and stare at intruders'. It hunts a variety of insects and small vertebrates like rodents, bats, birds, reptiles and amphibians [1-3]. They may also take scorpions and molluscs [4]. Spotted Owlets nest in cavities often competing with other hole-nesters such as Mynas, Rollers and Parakeets. Spotted Owlets being very familiar to humans, especially because of their loud unpleasant calling have been associated with bad omens. The species name *brama* is from the French name *Chouette brame* and indirectly refers to this owl's Indian habitat by way of homage to Brahma, the Hindu supreme spirit.

Spotted Owlet roost in the day under thick shady vegetation, cavities in trees, man-made structures including functional or non-functional irrigational wells and crevices found in rock cliffs. Except for an ecological study carried out at Hyderabad [2], very little information

on food habits [1-5] and breeding behavior [2, 3, 6] was available in India. But no information is available on roost-sites of Spotted Owllet in India. Acquiring knowledge on the roosting behavior and roost-site preference by the Strigiformes will undoubtedly aid in the management and conservation of any owl species. However, to date, very little is known about these aspects of owls in India. In this paper we present the roost-site preference of Spotted Owllet *Athene brama* in Madurai District, Tamil Nadu, India.

MATERIALS AND METHODS

Study Area: The District Madurai lies between 9°56' N and 78°07'E and covers an area of about 10,88,622sq.km. Madurai, the head-quarter of the District and the oldest inhabited city in the Indian peninsula, is situated on the banks of River Vaigai. The hillocks viz., Pasumalai, Yanamalai, Nagamalai, Alagarmalai and Thirupankundram poses a panoramic landscape of Madurai. The climate is dry and hot, with rains during October-December. Temperatures during summer reach a maximum of 40 and a minimum of 26.3°C. The average annual rainfall is about 85cm. Paddy is the predominant cultivated crop in the study area; however other crops such as sugarcane, banana, jasmine, betlevine, groundnut and sorghum are also cultivated in different regions.

Roost-site Identification: Day roosts of Spotted Owllets were identified systematically surveying the study area by make use of the available roads. Surveys were conducted either by foot or by motorized vehicle. Information provided by the local people was considered during each visit and those sites were all checked. All the roost-sites such as trees, ruined buildings, wells and other man-made structures were inspected systematically. Fresh deposition of regurgitated pellets, white droppings and vocalization were also taken as a clue for the presence of Spotted Owllets.

Roost-site Variables: Total height of roost-site and roosting height was measured in meters from the ground by using an altimeter. Basal circumference and Diameter at Breast Height (DBH) of roost trees were measured using a standard measuring tape. Canopy volume was calculated using the following formula: $V = 4/3 \pi (D/2)^3$; whereas, V = Volume of canopy; D = Diameter of crown.

Mean crown diameter was estimated by averaging the measurements of four canopy cover estimates (north, east, south and west) around the roost trees. Number of cavities and number of primary branches of each roost-site was counted visually. In order to quantify the factors determining the roost-site preference the following ecological variables viz., the distance from each roost-site to the nearest tree, agricultural lands, fallow lands, water sources, groves, human habitations, building, road, foot path, electric line and light source was measured around 1000m radius centered at each roost-site [5].

Statistical Analysis: Unequal variance 't' test was used to compare roost-site variables between rural and urban habitats. Principal Component Analysis (PCA) was performed to determine the most important factors in delimiting the habitat preference of the Spotted Owllet. The MINITAB (version 13.1) statistical software was used for all data analyses. Significance level was set at P=0.05. Statistical inferences were made by following Sokal and Rohlf [7].

RESULTS

A total of 292 roost-sites of Spotted Owllet were observed during the entire study period of 2007-2009 (Figure 1). For the convenience, these sites were grouped and summarized into four broad categories viz., roost-sites in natural trees (N=229), man-made structures (N=43), artificial wooden nest boxes (N=12) and unused wells (N=8).

Roost-sites in Trees: Spotted Owllet used 15 different species of woody trees for roosting in which *Ficus benghalensis* was the most preferred tree (42.9%). Other species of trees used were *Tamarindus indicus* (15.7%), *Enterelobium saman* (9.2%), *Azadirachta indica* (8.7%), *Acacia nilotica* (4.8%), *Ficus religiosa* (3.9%), *Cocos nucifera* (3.5%), *Borassus flabellifer* (3.5%), *Polyalthia longifolia* (2.6%), *Moringa oleifera* (1.3%), *Lansea coromandelica* (1.3%), *Pongamia pinnata* (1.3%), *Mangifera indica* (0.4%), *Morinda tinctoria* (0.4%) and *Terminalia catapa* (0.4%).

Height of trees used for roosting ranged between 4.5 and 30.0m from the ground ($16.4 \pm 5.29m$) of which Spotted Owllet preferred to roost at a mean height of $9.0 \pm 2.69m$ (range: 3.0-16.5m). Mean DBH and basal circumference of the roost trees were $141.3 \pm 36.10cm$

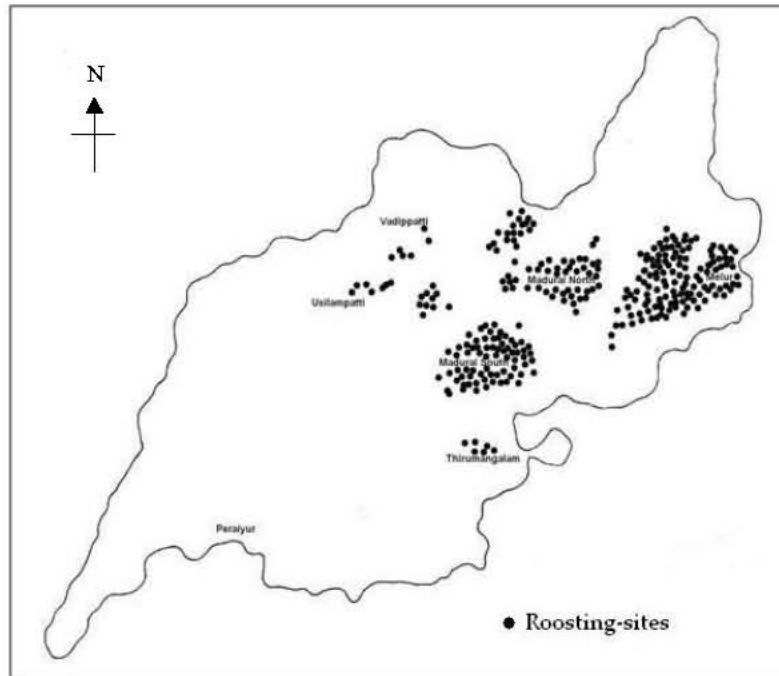


Fig. 1: Distribution of Spotted Owllet roosting-sites in the study area

(range: 12.0-415.0cm) and 306.1 ± 16.42 cm (range: 18.0-985.0cm), respectively. Mean canopy volume was $431.0 \pm 48.53\text{m}^3$ (range: 0-996.5m³). Spotted Owllet used well branched trees for roosting and the number of primary branches varied between 0 and 23 with an overall mean of 9.9 ± 4.67 (Table 1).

Roost-sites in Man-made Structures: On ranking next to trees Spotted Owllet used a variety of man-made structures (N=43) including 24 roost-sites at buildings, 18 in holes on compound walls and one in the temple tower. Mean total height of all the above man-made structures was 7.1 ± 2.14 m (range: 4.0-16.0m) in which roosting was observed at a mean height of 6.4 ± 1.92 m (range: 3.5-14.5m) (Table 1).

Roost-sites in Nest Boxes: Out of 26 wooden nest boxes erected to study the roosting / nesting behavior of Spotted Owllet in the study area 12 nest boxes were used for roosting. Nest boxes were kept in various trees and buildings at a height between 6.0 and 15.0m with a mean of 10.8 ± 2.87 m. Mean height of nest boxes preferred by Spotted Owllet was 5.9 ± 1.38 (range: 3.0-8.0m). Mean number of owllet found per nest box was 1.2 ± 0.45 (Table 1).

Roost-sites in Wells: A total of 8 roost-sites in unused wells were recorded. The total depth of the well ranged from 6.5 to 15.5m with a mean depth of 12.0 ± 2.55 m. Spotted Owllet roosted in the holes found in the inner wall of the well at a mean depth of 4.8 ± 1.60 m (range: 2.5-8.0m). Number of birds per roost-site varied between one and two with a mean of 1.5 ± 0.53 (Table 1).

Ecological Variables: Among the 10 ecological variables estimated around each Spotted Owllet roost-site, at least seven variables such as distance to nearest tree, building, footpath, electric line, light source, groves and water sources were very closer (<100m) to all types of roost-sites (Table 1).

Variation of Roost-site Characters among Habitats:
Rural: Total height of the roost-site (N=251) ranged from 4.0 to 30.0m with a mean height of 14.5 ± 5.94 m. Spotted Owllet roosted at a mean height of 8.3 ± 2.83 m (range: 2.5-16.5m). Mean DBH, basal circumference and canopy volume of the roost tree was 105.6 ± 35.54 cm (range: 0.0-415.0cm), 228.7 ± 13.53 cm (range: 18.0-985.0cm), $327.6 \pm 38.86\text{m}^3$ (range: 0.0-996.5m³), respectively (Table 2).

Table 1: Roost-site and micro-habitat characteristics of Spotted Owllet in the study area. Values are mean ± SD

| | Trees | Man-made structures | Nest boxes | Wells |
|------------------------------------|---------------|---------------------|---------------|---------------|
| Roost-site characteristics | | | | |
| Variables | | | | |
| Total height of roost-site (m) | 16.4 ± 5.29 | 7.1 ± 2.14 | 10.8 ± 2.87 | 12.0 ± 2.55 |
| Roost height (m) | 9.0 ± 2.69 | 6.4 ± 1.92 | 5.9 ± 1.38 | 4.8 ± 1.60 |
| DBH (cm) | 141.3 ± 36.10 | -- | -- | -- |
| Basal circumference (cm) | 306.1 ± 16.42 | -- | -- | -- |
| Canopy volume (m ³) | 431.0 ± 48.53 | -- | -- | -- |
| No. of branches | 9.9 ± 4.67 | -- | -- | -- |
| No. of holes | 2.0 ± 1.04 | 2.0 ± 1.98 | -- | -- |
| No. of birds / roost-site | 1.9 ± 0.69 | 1.6 ± 0.62 | 1.2 ± 0.45 | 1.5 ± 0.53 |
| Micro-habitat characteristics | | | | |
| Distance to tree (m) | 4.6 ± 2.61 | 10.0 ± 9.55 | 7.5 ± 4.64 | 7.4 ± 3.30 |
| Distance to agricultural lands (m) | 249.2 ± 32.51 | 285.9 ± 31.72 | 213.9 ± 60.38 | 241.9 ± 49.35 |
| Distance to fallow lands (m) | 275.4 ± 36.81 | 310.3 ± 32.76 | 264.3 ± 72.56 | 275.0 ± 47.95 |
| Distance to foot path (m) | 3.5 ± 2.83 | 2.5 ± 0.27 | 2.2 ± 1.20 | 3.5 ± 6.68 |
| Distance to water sources (m) | 90.8 ± 42.31 | 114.1 ± 21.85 | 55.6 ± 27.06 | 15.1 ± 4.91 |
| Distance to groves (m) | 131.4 ± 78.12 | 158.2 ± 15.54 | 212.8 ± 34.75 | 107.9 ± 37.60 |
| Distance to human habitations (m) | 78.9 ± 68.60 | 42.8 ± 51.73 | 70.8 ± 28.33 | 31.6 ± 21.7 |
| Distance to building (m) | 55.8 ± 28.99 | 32.7 ± 9.05 | 17.2 ± 4.70 | 49.8 ± 15.52 |
| Distance to road (m) | 84.9 ± 27.26 | 47.4 ± 10.73 | 128.7 ± 33.95 | 37.4 ± 11.69 |
| Distance to light source (m) | 32.7 ± 13.55 | 21.4 ± 5.67 | 25.9 ± 6.57 | 25.9 ± 17.09 |

Table 2: Roost-site characteristics of the Spotted Owllet in the study area between rural and urban habitats

| Variables | Roost-site characteristics | | | | | | 't' test | |
|------------------------------------|----------------------------|-------|---------------|--------------|-------|---------------|----------|--------|
| | Rural (N=251) | | | Urban (N=41) | | | | |
| | Min | Max | Mean ± SD | Min | Max | Mean ± SD | t | P |
| Roost-site height (m) | 4 | 30 | 14.5 ± 5.94 | 5.5 | 24.5 | 15.8 ± 5.41 | 1.43 | 0.079 |
| Roost height (m) | 2.5 | 16.5 | 8.3 ± 2.83 | 4.5 | 14.5 | 8.7 ± 2.56 | 1.01 | 0.159 |
| DBH (cm) | 0 | 415 | 105.6 ± 35.54 | 66 | 330 | 142.7 ± 14.54 | 2.36 | 0.011* |
| Basal circumference (cm) | 18 | 985 | 228.7 ± 13.53 | 128 | 735 | 309.0 ± 31.94 | 2.31 | 0.012* |
| Canopy volume (m ³) | 0 | 996.5 | 327.6 ± 38.86 | 187.1 | 789.1 | 401.4 ± 37.88 | 1.75 | 0.042* |
| No. of branches | 0 | 23 | 7.6 ± 5.88 | 6 | 18 | 8.7 ± 3.28 | 1.17 | 0.122 |
| No. of holes | 0 | 12 | 2.0 ± 0.15 | 0 | 6 | 1.5 ± 1.64 | 1.53 | 0.064 |
| No. of birds /site | 1 | 5 | 1.8 ± 0.70 | 1 | 3 | 1.8 ± 0.61 | 0.23 | 0.409 |
| Micro-habitat characteristics | | | | | | | | |
| Distance to tree (m) | 1 | 42 | 5.5 ± 2.24 | 1.5 | 60 | 6.4 ± 3.57 | 0.58 | 0.28 |
| Distance to agricultural lands (m) | 1.5 | 800 | 220.1 ± 10.28 | 36 | 850 | 452.8 ± 35.62 | 0.67 | 0.37 |
| Distance to fallow lands (m) | 5 | 800 | 251.0 ± 5.58 | 60 | 850 | 461.4 ± 35.01 | 0.73 | 0.544 |
| Distance to foot path (m) | 0.5 | 20 | 3.1 ± 2.35 | 0.5 | 20 | 4.5 ± 5.00 | 1.65 | 0.053 |
| Distance to water sources (m) | 0.5 | 425 | 78.5 ± 25.26 | 11 | 500 | 165.4 ± 23.38 | 3.59 | 0.000* |
| Distance to groves (m) | 15 | 430 | 128.9 ± 18.34 | 50 | 500 | 193.5 ± 19.80 | 3.13 | 0.001* |
| Distance to human habitations (m) | 1 | 450 | 79.9 ± 8.72 | 1 | 127 | 23.2 ± 4.10 | 0.11 | 0.021 |
| Distance to building (m) | 1.5 | 350 | 53.0 ± 14.38 | 3.5 | 150 | 36.1 ± 6.41 | 2.18 | 0.015* |
| Distance to road (m) | 1.5 | 425 | 86.2 ± 16.96 | 2 | 220 | 41.2 ± 7.81 | 0.3 | 0.651 |
| Distance to light source (m) | 2 | 350 | 33.3 ± 5.36 | 2 | 54 | 13.4 ± 6.71 | 2.39 | 0.009* |

*Differ between habitats ('t' test; P<0.05)

Table 3: Principal components derived from the roost-site variables of Spotted Owllet in the study area

| Variables | Principal Components | | |
|--|----------------------|--------|--------|
| | PC-I | PC-II | PC-III |
| Roost tree height | 0.415 | 0.83 | -0.403 |
| Roost height | 0.804 | 0.001 | -0.17 |
| Diameter at breast height (DBH) | 0.22 | 0.633 | -0.545 |
| Basal circumference | 0.763 | 0.484 | 0.435 |
| Canopy volume | 0.794 | -0.421 | -0.006 |
| No. of branches | 0.01 | 0 | -0.602 |
| No. of holes | 0.003 | 0 | -0.001 |
| Distance to tree | 0.001 | -0.002 | 0.431 |
| Distance to agricultural lands | 0.039 | 0.203 | 0.881 |
| Distance to fallow lands | 0.017 | 0.118 | 0.083 |
| Distance to foot path | 0.031 | -0.369 | 0.104 |
| Distance to water sources | -0.034 | -0.221 | -0.478 |
| Distance to groves | 0.615 | -0.191 | 0.214 |
| Distance to human habitations | 0.013 | -0.568 | -0.415 |
| Distance to building | -0.001 | 0.002 | -0.17 |
| Distance to road | -0.241 | 0.104 | -0.133 |
| Distance to light source | 0.321 | 0.271 | -0.562 |
| Explained variance (%) | 43.48 | 21.2 | 13.11 |
| Cumulative percent variation explained | 43.48 | 64.68 | 77.79 |

Note: Underlined values represent high correlations with the respective principal components

Urban: Total height of the roost-site (N=41) varied between 5.5 and 24.5m with a mean height of 15.8 ± 5.41 m. It roosted at a mean height of 8.7 ± 2.56 m (range: 4.5-14.5m). Mean DBH, basal circumference and canopy volume of the roost tree was 142.7 ± 14.54 m (range: 66.0-330.0cm), 309.0 ± 31.94 cm (range: 128.0-735.0cm) and 401.4 ± 37.88 m³ (range: 187.1-789.1m³) respectively.

Ecological variables *viz.*, distance to nearest tree, foot path, human habitation, building, road and light source were closer (within 100m radius) to the roost-sites in both habitats. Roost tree DBH ($t=2.36$; $P<0.05$), basal circumference ($t=2.31$; $P<0.05$), canopy volume ($t=1.75$; $P<0.05$), distance to water sources ($t=3.59$; $P<0.05$), groves ($t=3.13$; $P<0.05$) and building ($t=2.18$; $P<0.05$) was statistically differed among habitats (Table 2).

Principal Component Analysis (PCA): For this analysis, roost tree characteristics were alone taken. PCA resulted in the extraction of three main components. First three components, which accounted for 77.79% of the total variance, were considered. First component (PC-I) accounted for 43.48% of the total variance, correlated highly with roost height, canopy volume, basal circumference and distance to groves. Second component (PC-II) accounted for 21.20% of the total variance

correlated highly with roost tree height, DBH and distance to human habitations. Third component (PC-III) accounted for 13.11% of the total variance and correlated highly with number of branches, distance to agricultural lands and distance to light source (Table 3).

DISCUSSION

In the present study, Spotted Owllet preferred structurally complex roost trees with well branched, high canopy densities with thick green foliage, large diameter with various height classes of trees for roosting. Spotted Owllet mostly prefers to roost in open limbs of trees, besides cavities/holes. Young *et al.* [8] observed that Spotted Owl roost-sites in South-western Chihuahua, Mexico had more canopy layers, greater canopy closure and greater live tree basal areas. Dense tree canopies were provided well protection from predators, rain, wind, sun light exposure and concealment for the birds [8-11]. Day time temperature is a one of the important factors in selecting the roost-sites in Spotted Owllet has been reported by Barrows and Barrows [12]. According to them Spotted Owls behaviorally facilitated heat loss at ambient temperatures above 27°C. During the study period the mean minimum and maximum temperature in the study area

recorded between 23 and 33.4°C with a hike of 35°C and more in summer (April-June). To compensate this extreme temperature the Spotted Owlet consistently chose well branched trees than that of open canopy trees. Hayward and Garton [13] found that Western Screech-Owls *Otus kennicottii*, Boreal Owls *Aegolius funereus* and Northern Saw-whet Owls *Aegolius acadicus* preferred roosts that provided both thermal protection and concealment. Many investigators have also been reported that the canopy density is related to roost-site selection by various owl species viz., Spotted Owl *Strix occidentalis* [12, 14], Mexican Spotted Owl *Strix occidentalis lucida* [8] and Eastern Screech Owl *Otus asio* [15, 16].

Next to trees the Spotted Owlet preferred to roost in a variety of man-made structures such as holes in compound walls, buildings and temple towers. Man-made structures provide some advantages over natural sites as they provide better protection against the environmental elements viz., temperature and rainfall. During colder months and rainy seasons these sites provided better insulation to Spotted Owlet and their young ones. Man-made structures also offer safety from enemies and predators like monkeys and domestic cats. Crows *Corvus* spp., Common Myna *Acridotheres tristis* and Common Babbler *Turdoides caudatus* were noticed in many occasions mobbing Spotted Owlets whenever they come out from their roost-sites in the day time. But these birds never tried to disturb the owls inside the man-made structures. Using various kinds of man-made structures by the Spotted Owlet in the study area might be to avoid inter-specific competition that exists in the natural trees. Our nest box utilization data also support our findings that Common Myna and Indian Roller *Coracias benghalensis* successfully occupied five Spotted Owlet nest boxes after a long battle and they breed successfully.

In addition to trees and man-made structures, inner wall and earth cuttings of wells were also used as roost-sites in the study area. Pande *et al.* [6] reported similar sites for Spotted Owlets in Maharashtra, India. Utilization of holes in wells, which are often away from human activity, appears to be an adaptive response to as well as to compensate the non-availability of suitable roost-sites.

The proximity of roost-sites to foraging ground with food availability was identified as one of the most important factors in the roost-site preference of Spotted Owlet. The presence of agricultural lands, groves, human habitations, buildings and light sources directly governs and supports various kinds of prey species particularly insects and small mammals. These habitats were mostly

present around the vicinity of roost-sites in the study area. Kumar [2] and Naranthiran [17] also reported that Spotted Owlet preferred roost-sites closer to agricultural lands. The reasons for preferences of agricultural lands and other above habitats by the Spotted Owlets might be due to the availability of high nutritive value food items viz., various arthropod insects, rodents, lizards, etc. Carey *et al.* [18] and Ward *et al.* [19] suggested that Northern Spotted Owls *Strix occidentalis caurina* selected roost-sites based on the distribution of their prey.

We concluded that Spotted Owlet in the study area mostly preferred to roost at sites that are highly secured, closer to foraging ground, limited disturbances from human, escape cover from enemies and predators. However, further radio telemetry studies in future will answer the significance of roosting behavior, roost-site selection and additional ecological information's of Spotted Owlet.

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