Population and nesting characteristics of the Vulnerable White-naped Tit *Parus nuchalis* at Sajjangarh Wildlife Sanctuary, Rajasthan, India

SATISH KUMAR SHARMA & VIJAY KUMAR KOLI

The White-naped Tit *Parus nuchalis* is endemic to India and found in two disjunct areas. It is classified Vulnerable by BirdLife International, mainly due to its restricted distribution and declining population, which is attributed to habitat degradation. We studied the population, distribution and nesting behaviour of the species between January 2007 and December 2009 at Sajjangarh Wildlife Sanctuary, Udaipur, Rajasthan, India, where it was recently discovered. The species was seen throughout the year, but its habitat use changed with the seasons. In summer, sightings were common in the lower-elevation thorny zone, while during the monsoon season birds used the upper-elevation zone, dominated by the salai tree, *Boswellia serrata*. Sightings in winter were few, probably because the population mostly moved to surrounding areas. The species is a secondary cavity nester with nests confined to the salai zone. A total of 12 nests were found in this zone, all on *B. serrata* trees.

INTRODUCTION

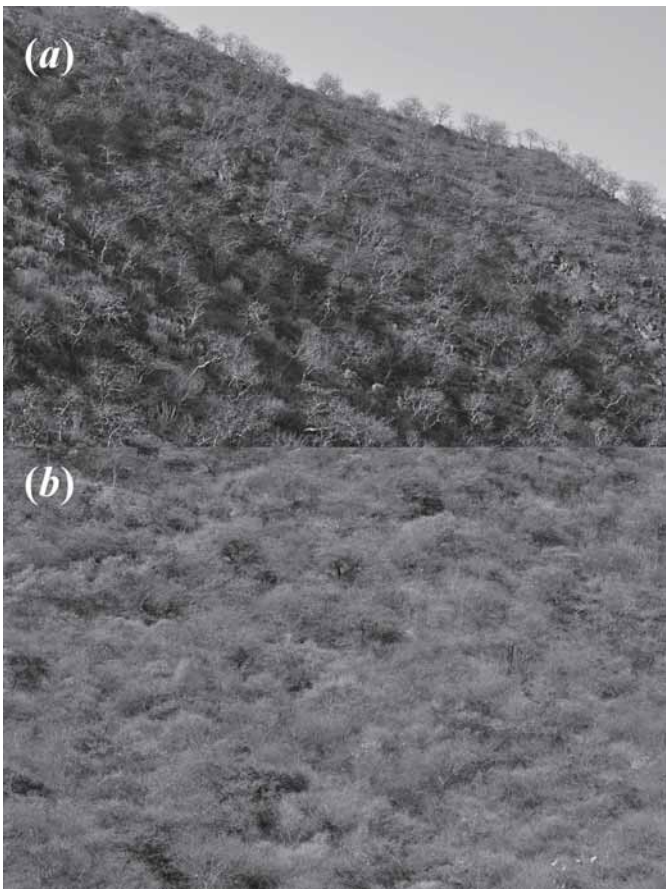
White-naped Tit *Parus nuchalis* is an Indian endemic, restricted to the west and south of the country in two disjunct localities. In the west, its presence has been recorded in northern Gujarat, particularly from Kutch (Tiwari & Rahmani 1996) and Banaskantha districts (Trivedi 2009), while in Rajasthan it has been recorded from Ajmer, Jalore, Nagore, Jaipur, Pali, Jodhpur, Jhalawar (Tiwari 2001, Tehsin *et al*. 2005, Ali & Ripley 2007), Sikar (Sharma 2004), Udaipur (Sharma 2004, Mehra 2004) and Bikaner (Dookia 2007) districts. Ecological and behavioural studies in Gujarat have been carried out mainly in scrub forest (Tiwari & Rahmani 1996), dry deciduous and thorny forests (Joshua *et al*. 2007, Trivedi 2009). The species is classified as Vulnerable (BirdLife International 2001, 2014) due to its restricted range and population decline because of deforestation, invasion by exotic plant species (Tiwari 2001), low availability of tree cavities for nesting (Tiwari & Rahmani 1996) and changing land-use patterns (Joshua *et al*. 2007), including encroachment on natural habitat, overgrazing, lopping of trees for domestic fuel, and habitat fragmentation (Tiwari 2001). The ecology and ethology of this scarce species is little known and after its discovery in Sajjangarh Wildlife Sanctuary, Udaipur district, Rajasthan (Sharma 2004), this project was planned to study the population and nesting characteristics in the recently regenerated forest of this area.

STUDY AREA

Sajjangarh Wildlife Sanctuary, only 5.19 km^2 in area, is the smallest sanctuary in Rajasthan. It is located on and around Bansdahara Hill, part of the Aravalli mountain range, about 5 km from the centre of Udaipur city (24.58°N 73.68°E), at an altitude of 630 to 936 m. Prior to the middle of the last century, the area was thickly forested and wild animals were abundant. However, exploitation of the natural resources beyond sustainable limits has left it in a precarious condition, but in 1987 its strategic location and aesthetic, environmental and ecological importance were recognised and it was made a wildlife sanctuary. Effective protection and scientific management by the forest department have resulted in progressive recovery of denuded areas first to scrubland, and subsequently to woodland during the past 25 years. At the time of this study, young shrubs and trees were growing throughout the area, particularly in the lower part. Regeneration could be seen in upper reaches along with a few remnants patches of older forest.

The forest is categorised as tropical dry forest (Champion & Seth 1968) and today there are two distinct zones (Plate 1). Above about 750 m the forest is dominated by the salai tree *Boswellia serrata* and associated species such as *Lannea coromandelica*, *Sterculia urens*, *Ficus arnottiana*, *Euphorbia caducifolia* and *Anogeissus latifolia*, while below this altitude the major species include *Acacia senegal*, *Ziziphus nummularia*, *Z. mauritiana*,

Plate 1. Two different vegetation zones of Sajjangarh Wildlife Sanctuary: (*a*) upper salai zone, dominated by *Boswellia serrata*, (*b*) lower thorny zone, dominated by kumtha *Acacia senegal*, 14 June 2007.



VIJAY KUMAR KOLI

Dichrostachys cinerea, *Grewia tenax*, *G. villosa*, *G. flavescens*, *Prosopis juliflora* and *Acacia nilotica*. *Euphorbia caducifolia* is also seen in few patches. For the purpose of the study, forest above 750 m is described as 'salai zone' (about 25% of the area) and below it as 'thorny zone' (about 75% of the area).

The climate of the area is characterised by three seasons—summer (March–June), monsoon (July–October) and winter (November–February); June and July are the transitional months between summer and monsoon. The maximum daily temperature varies from 45°C in May to 25°C in January, and the minimum night temperature from 26°C in July to 5°C in January. The average annual rainfall in 2007–2009 was 577 mm.

METHODS

The study was carried out from January 2007 to December 2009. As the habitat was open and uniform the line transect method was used (Sutherland *et al*. 2005). Transects were laid on each aspect of the hill i.e. east, west, north and south, to maximise coverage. Because the forest is divided into two zones, four transects were placed in the thorny zone, starting from the periphery (lower slopes) to the mid-heights of the hill, while four were placed in the salai zone, from mid-height to summit. Surveys were made on 8 days (one day for one transect) each month between 06h00 and 19h00. The order of completion of transects was selected randomly each month; each was surveyed only once per month. Birds were located by visual encounter or by means of their distinctive musical call (Tiwari & Rahmani 1996, Trivedi 2009). When the species was encountered, the habitat and the number of birds seen were recorded: solitary, in pairs or in parties. Birds were also followed to locate their nests.

To estimate the change in habitat characteristics with altitude, the reserve was divided into seven horizontal planar sections at 634 m, 684 m, 734 m, 784 m, 834 m, 884 m and 925 m altitude. In each section, five 10×10 m plots were laid out at random on the contour line and the type and number of the plant species in each plot recorded. A minimum 100 m distance was maintained between any two plots. At the end of the survey, the top six species, based on relative abundance, were used to characterise changes in vegetation with altitude.

A nest was considered to be occupied if an adult tit was found entering the nest-hole repeatedly or nestlings were present at any time during the study. The following nesting tree parameters were recorded: species, height, number of main branches, girth at breast height, basal area, distance to next tree, distance to nearest road, path or trail traversed at least daily by vehicles or pedestrians, branch diameter at cavity entrance, nest height above ground, nest opening diameter, cavity type (primary or secondary) and cavity location (on main tree trunk, primary branch, secondary branch or tertiary branch) (Rivera *et al*. 2012).

To estimate cavity availability, cavity sampling was carried out during the summer (non-breeding) season between March and June every year (2007–2009), when most trees are leafless. Transect lines, each 350 m long, were set up in the seven sections and all cavities within 10 m on either side of each line were recorded. There are few nesting data on *P. nuchalis* in the literature; we used a minimum 4 cm diameter cavity opening as an indication of a potential nest site.

Manly's selection index (Manly *et al*. 1993, Krebs 1999) was used to determine nest-site selection in relation to availability in the different habitats each year. Coefficients greater than 1.0 indicate preference, while values less than 1.0 indicate avoidance. Selection coefficients were calculated using the following formula:

$$w_i = \frac{o_i}{p_i}$$

where w_i was the selection coefficient for cavity category i, o_i was the ratio of the number of cavities occupied in category i to the total number of cavities occupied, and p_i was the ratio of the number of cavities in category i located in the habitat to the total number of cavities. SPSS version 17.0 was used for all statistical analysis.

RESULTS

Using the habitat characterisation plots it was shown that the upper zone (above about 750 m) was dominated by salai *Boswellia serrata* (38%), while the lower thorny zone was dominated by kumtha *Acacia senegal* (37%). The relative frequency of the 10 commonest plant species is shown in Figure 1.

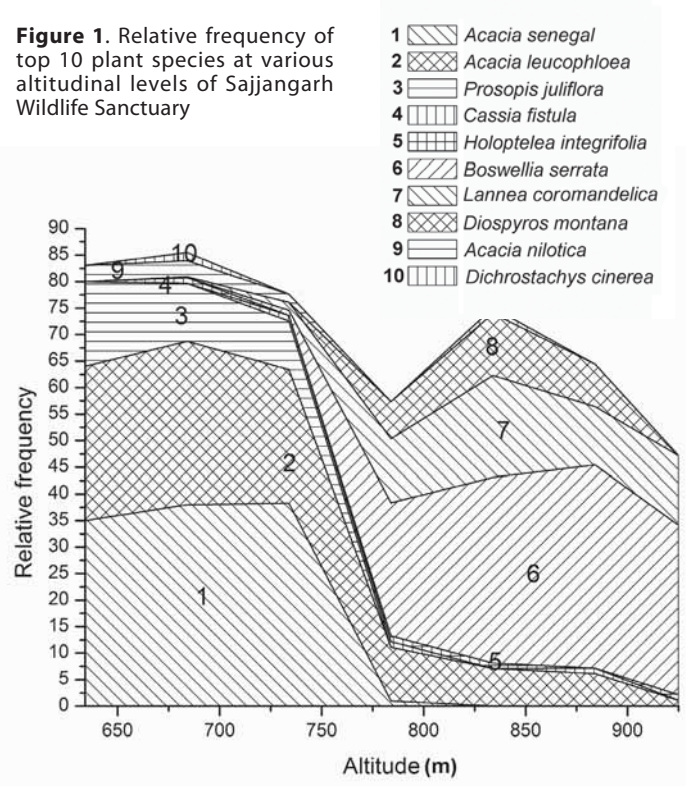


Figure 1. Relative frequency of top 10 plant species at various altitudinal levels of Sajjangarh Wildlife Sanctuary

Parus nuchalis was seen more or less throughout the year in the sanctuary (Table 1): birds were seen on 166 occasions—single birds on 57 occasions, two pairs (sex identified), 43 presumed pairs (but sex not identified) and four times in small parties. All the parties were seen in 2009, groups of five birds were seen on 21 May, 15 June and 16 September and a group of four birds was seen on 12 September. The overall encounter rate was 1.72/km. A total of 90 sightings were recorded in the salai zone and 76 in thorny zone. Numbers changed with season: 11 in winter, 65 in summer and 90 in the monsoon. No meaningful conclusions could be drawn from the winter sightings, but during the summer 74% were recorded in

Table 1. Season-wise sight records of *Parus nuchalis* in Sajjangarh Wildlife Sanctuary, Rajasthan, from 2007 to 2009. *pair including male and female; [§] pairs but sex unidentified

		Number of *Parus nuchalis*			
Year	**Zone**	Winter	Summer	Monsoon	Total
2007	thorny	2	8 (3[§])	8(2[§])	18
	salai	3	2(1[§])	13(6[§])	18
2008	thorny	5	14(1*, 4[§])	6	25
	salai	0	8(4[§])	31(12[§])	39
2009	thorny	1	26(4[§])	6	33
	salai	0	7	26(1*,7[§])	33

Table 2. Main characteristics (mean ± s.d.) of the twelve *Boswellia serrata* trees used by *Parus nuchalis* in Sajjangarh Wildlife Sanctuary

Parameters	Value
Nest height m	3.64 ± 1.17
Nest tree height m	6.60 ± 1.68
Nest opening diameter cm	5.20 ± 1.49
Girth at breast height cm	125.66 ± 39.82
Basal area m^2	1.35 ± 0.93
Cavity branch diameter cm	44.33 ± 26.75
Nearest tree distance m	6.08 ± 3.82
Nearest road distance m	12.25 ± 13.15
Number of main tree branches	2.66 ± 1.15

the thorny zone, whereas in the monsoon season 78% were in the salai zone.

The White-naped Tit is a secondary cavity nester—twelve different nests were found, two in 2007 (on 23 & 25 July), six in 2008 (on 10 June, two on 8 July, two on 9 July and one on 27 July) and four in 2009 (on 17 & 20 June and two on 27 July). The two nests found in 2007 were re-used in 2008 and five nests found in 2008 were re-used in 2009. Cavities were available in the salai zone and provided by two tree species: *Boswellia serrata* and *Lannea coromandelica*. All observations of nesting were in the salai zone in *B. serrata* trees. No suitable cavities were seen in trees in the thorny zone. Cavity selection coefficient (w_i) values for *B. serrata* were 0.5 in 2007, 1.25 in 2008 and 1.0 in 2009. Characteristics of the nesting trees are shown in Table 2. All nesting trees were young to middle-aged trees and 11 nests were in green branches with one, found in 2007, in the dried butt of a branch. Birds nested in the monsoon season and at this time they are very vocal. The highest nest was at 920 m near the Monsoon Palace. Four nests were located less than 50 m from a water source, while eight were more than 100 m from water. At Gorella view point, on 27 July 2008, a male and female were watched for nearly an hour from about 11h00, as they pulled and collected threads for their nest from a piece of gunney bag lying on the road—the nest tree was located about 25 m away. Evidently fibres were being used for lining the nest cavity. Tourist vehicles on the road did not disturb their activities. During summer 2008, three *P. nuchalis* nest sites were occupied by Chestnut-shouldered Petronias *Petronia xanthocollis* and two nests by Brahminy Starling *Sturnus pagodarum*. Frequently these birds were seen clinging to and entering holes in the area.

DISCUSSION

The study shows that the sanctuary appears to support a healthy population of *P. nuchalis*, which can be seen throughout the year but which shows a preference for different habitats during different seasons. Tiwari & Rahmani (1999) observed that *P. nuchalis* preferred scrub forest in Kutch, which is dominated by *Acacia leucophloea*, *A. nilotica*, *Prosopis cineraria*, *Ziziphus jujuba*, *Capparis aphylla*, *Salvadora oleoides*, *S. persica* and *Grewia tenax*. In the same district, Joshua *et al*. (2007) reported that the species was sighted mainly in large *Acacia*, *Prosopis* and *Salvadora* patches along dry riverbeds. In Jessore Sloth Bear Sanctuary, Gujarat, thorny forests are the typical habitat for *P. nuchalis* (Trivedi 2009). Hussain *et al.* (1992) made similar observations in Kutch. Some studies (Uttangi 1995, Lott & Lott 1999) in southern India also support its preference for dry thorny scrub forest. Dookia (2007) reported its presence in the Thar Desert; massive planting of *Acacia tortilis* in the Indira Gandhi Canal Command Area has produced thorny-xeric vegetation, which has attracted many new bird species in these areas, including *P. nuchalis*.

The overall encounter rate (1.72/km) in this study is higher than previously found. White-naped Tit is present in Kutch (Joshua *et al*. 2007) and Banaskantha (Trivedi 2009), Gujarat, but encounter frequencies are low: 0.18/km in Jessore Sanctuary (Trivedi 2009), while Joshua *et al*. (2007) encountered only 18 individuals in Narayan Sarovar Sanctuary; Tiwari & Rahmani (1996) recorded 41 individuals in their four-year study period in Kutch. Hussain *et al*. (1992) observed 43 individuals (27 sightings) in the same area between 1976 and 1991. Some studies (Tiwari 2001, Chhangani 2002, Sharma 2004, Tehsin *et al*. 2005, Dookia 2007, Sangha 2008, Kala 2011) in Rajasthan have also confirmed its scarcity and patchy distribution in the state but did not determine a clear population trend. In southern India there is little information apart from some reports of its occurrence (Uttangi 1995, Lott & Lott 1999).

Our observations of 12 nests add substantially to the known information about nesting behaviour of this species. Tiwari & Rahmani (1996) identified a single nest of *P. nuchalis* in a 5 m tall old *Salvadora persica* tree and recognised its association with this tree species in Kutch, where it provides holes for nesting and roosting. We observed a difference in encounter frequency between the two forest types that might be associated with nesting during the monsoon season (May–August). The sanctuary forests are regenerating and lack large, old or dead and decaying trees, and the young regenerating thorny forest provides almost no nesting sites. However, in the salai zone trees with soft and smooth wood, such as *B. serrata* and *L. coromandelica*, are used by many wood-boring species such as Rufous Woodpecker *Micropternus brachyurus*, Yellow-fronted Pied Woodpecker *Dendrocopos mahrattensis*, Lesser Golden-backed Woodpecker *Dinopium benghalense* and Coppersmith Barbet *Megalaima haemacephala* (Sharma 1998). Cavity development begins when branches are broken by the wind or Hanuman Langurs *Semnopithecus entellus* and subsequently, during the rainy season, rainwater enters and rotting is started by wood fungi. Although *L. coromandelica* is common in the upper reaches and holes are also available in their trunks and branches, not a single hole was occupied by *P. nuchalis*, even though these holes are occupied by *Petronia xanthocollis* during the summer. During the rainy season, hollows in *L. coromandelica* are filled with a dirty, white, highly viscous and gummy secretion which may make them unsuitable for the tits. In contrast, the hollows in *B. serrata* are 'all-weather hollows' that can be used in all three seasons. This may be a major reason why *P. nuchalis* selects only *B. serrata* for nesting in the study area. The smooth surfaces of the trunks of this species also restrict access of predators such as snakes.

After the end of the breeding season winter starts and there are few sightings of *P. nuchalis* in either forest zone of the sanctuary. The insect population decreases in winter and the *P. nuchalis* population disperses to nearby thorny areas or probably towards warmer areas where insect availability is better. Most trees flower and fruit during the summer in India's tropical deciduous forests (Singh & Kushwaha 2006), including the study area. At the end of winter, *Acacia leucophloea* fruit ripen while *A. senegal* fruit ripen in summer. Heavy infestation by the larvae of some (unidentified) insects is seen in the fruit pods of these trees. These are an important source of food for *P. nuchalis*. Since these plant species are abundant in the lower thorny zone (Figure 1), the tit congregates in this zone in the summer to feed on the larvae.

ACKNOWLEDGEMENTS

The authors are grateful to the forest department, Rajasthan, and officials of Sajjangarh Wildlife Sanctuary for supporting this study. Technical support

by Ramchandra Meghwal was very helpful in preparing the final version of the paper, as were the comments of two anonymous reviewers.

REFERENCES

Ali, S & Ripley, S. D. (2007) *Handbook of the birds of India and Pakistan*. Second edition. Delhi: Oxford University Press.

BirdLife International (2001) *Threatened birds of Asia. The BirdLife International Red Data* Book. Cambridge: BirdLife International.

BirdLife International (2014) Species factsheet: *Parus nuchalis*. Downloaded from http://www.birdlife.org on 10/06/2014.

Champion, H. G. & Seth, S. K. (1968) *A revised survey of forest types of India*. New Delhi: Government of India.

Chhangani, A. K. (2002) Avifauna of Kumbhalgadh Wildlife Sanctuary in the Aravalli Hills of Rajasthan. *Zoos' Print J.* 17: 764–768.

Dookia, S. (2007) First record of Pied Tit *Parus nuchalis* in Thar desert of Rajasthan. *Indian Birds* 3: 112–113.

Hussain, S. A., Akhtar, S. A. & Tiwari, J. K. (1992) Status and distribution of White-winged Black Tit *Parus nuchalis* in Kachchh, Gujarat, India. *Bird Conserv. Internatn.* 2: 115–122.

Joshua, J., Gokula, V. & Sunderraj, S. F. W. (2007) Status of Pied Tit *Parus nuchalis* in Narayan Sarovar Sanctuary, Gujarat, India. *Indian Birds* 3: 91–93.

Kala, H. (2011) Assessment of the population of White-naped Tit (*Parus nuchalis*) and its Thorn Forest habitat in Southern Aravalli Hills, Rajasthan, India. Unpublished final report for the Rufford Small Grant Foundation.

Krebs, C. J. (1999). *Ecological methodology*. Second edition. Menlo Park CA: Benjamin Cummings.

Lott, E. J. & Lott, C. (1999) On the occurrence of White-naped Tit *Parus nuchalis* in southern India. *Forktail* 15: 93–94.

Manly, B. F. J., McDonald, L. L. & Thomas, D. L. (1993) *Resource selection by animals: statistical design and analysis for field studies.* First edition. London: Chapman & Hall.

Mehra, S. P. (2004) Sighting of White-naped Tit *Parus nuchalis* at Udaipur. *Newsletter for Ornithologists* 1: 77.

Rivera, L., Politi, N. & Bucher, E. H. (2012) Nesting habitat of the Tucuman Parrot *Amazona tucumana* in an old-growth cloud-forest of Argentina. *Bird Conservation International* 22: 398–410.

Sangha, H. S. (2008) The birds of Sambhar Lake and its environs. *Indian Birds* 4: 82–97.

Sharma, S. K. (1998) Avian fauna of Sajjangarh Wildlife Sanctuary. *Newsletter for Birdwatchers* 38 (2): 25–27.

Sharma, S. K. (2004) New sight records of Pied Tit *Parus nuchalis* in Rajasthan. *J. Bombay Nat. Hist. Soc.* 101: 162–163.

Singh, K. P. & Kushwaha, C. P. (2006) Diversity of flowering and fruiting phenology of trees in a tropical deciduous forest in India. *Annals of Botany* 97: 265–276.

Sutherland, W. J., Newton, I. and Green, R. E. (2005) *Bird ecology and conservation: a handbook of techniques*. New York: Oxford University Press.

Tehsin, R. H., Tehsin, S. H. & Tehsin, H. (2005) Pied Tit *Parus nuchalis* in Pali district, Rajasthan, India. *Indian Birds* 1: 15.

Tiwari, J. K. (2001) Status and distribution of the White-naped Tit *Parus nuchalis* in Gujarat and Rajasthan. *J. Bombay Nat. Hist. Soc.* 98: 26–30.

Tiwari, J. K. & Rahmani, A. R. (1996) The current status and biology of the White-naped Tit *Parus nuchalis* in Kutch, Gujarat, India. *Forktail* 12: 95–102.

Trivedi, P. (2009) Observations on the globally threatened Pied Tit *Parus nuchalis* at Jessore sanctuary, Gujarat. *Indian Birds* 5: 7–10.

Uttangi, J. C. (1995) A rare occurrence of the globally threatened White-naped Tit, *Parus nuchalis*, in areas of Dharwad, Karnataka, India. *Newsletter for Birdwatchers* 36: 114–115.

***Satish Kumar SHARMA**, Assistant Conservator of Forests, Wildlife Sanctuary Jaisamand, Jaismand Post, Udaipur 313 905, Rajasthan, India.*
Email: sksharma56@gamil.com

***Vijay Kumar KOLI**, Wildlife Research Laboratory, Department of Zoology, University College of Science, Mohanlal Sukhadia University, Udaipur 313 001, Rajasthan, India.*
Email: vijaykoli87@yahoo.in