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Breeding Biology of the Snowy-cheeked Laughingthrush (*Garrulax sukatschewi*)

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ABSTRACT.—Breeding of the poorly known Snowy-cheeked Laughingthrush (*Garrulax sukatschewi*) was studied in a conifer-dominated forest at Lianhuashan (southern Gansu), China. Snowy-cheeked Laughingthrushes nested at sites with fewer conifers and denser shrubs compared with the available vegetation. Bowl-shaped nests were 2.4 ± 0.1 m ($\bar{x}$ ± SE, n = 31) above ground in six plant species. Spruce (*Picea* spp.) was used (74%) more often than expected based on availability at nest sites. The breeding season (early May to mid Jul) was shorter than for other timaliids. Twelve of 20 (60%) nests with known outcomes were successful. The average clutch size was 3.5 ± 0.2 eggs (2–5, n = 21) with 2.7 ± 0.2 hatchlings (2–4, n = 15) and 2.2 ± 0.2 fledglings (1–3, n = 12) per nest. Incubation was by both males and females and lasted 14 days (n = 1); both parents cared for the nestlings for 16–18 days (n = 3). *Received 5 April 2010. Accepted 12 August 2010.*

The Snowy-cheeked Laughingthrush (*Garrulax sukatschewi*) is largely restricted to a range of 28,500 km^2 in the Min Shan Mountains of southern Gansu and northcentral Sichuan, China at elevations of 2,000–3,500 m (Collar et al. 2001). It is inferred to have a small, declining, severely fragmented population because of the destruction of temperate forests in its range through logging and conversion to agriculture (Collar et al. 2001). The species is categorized as Vulnerable by the IUCN (2009).

Understanding a bird's habitat requirements, social behavior, and breeding is essential for successful species conservation (Primack 1993). Apart from a few distribution records (Collar et al. 2001) and the description of a few nesting attempts (Li 1993, Bi et al. 2003), there is little published information on the ecology and conservation status of the Snowy-cheeked Laughingthrush. We provide detailed information on the breeding biology of this species with particular emphasis on nest-site selection and breeding parameters.

METHODS

Study Area.—The study was conducted in a conifer-dominated forest in the Lianhuashan Natural Reserve, southern Gansu (34° 57′ N, 103° 46′ E) as described by Sun et al. (2003). The forest occurs on north-facing slopes at elevations of 2,600–3,300 m; only grasses and shrubs grow on south-facing slopes. Coniferous forest, the most prevalent cover type (42%) in the study area, is dominated by Dragon spruce (*Picea asperata*) and Fargese fir (*Abies fargesii*). The other vegetation types are: (1) mixed coniferous-deciduous forest, including variable amounts of willow (*Salix* spp.) and birch (*Betula utilis* and *B. albosinensis*), and (2) shrublands, including willow, Sea buckthorn (*Hippophae rhamnoides*), and barberry (*Berberis* spp.). Deciduous forest is uncommon in the area and, where it occurs, is adjacent to mixed deciduous-coniferous forest. The mean annual temperature at the study area is ~5.1–6.0° C with a maximum of 34.0° C and minimum of −27.1° C. The climate is semiarid, and the annual precipitation is ~65 cm.

Field Procedures.—We located Snowy-cheeked Laughingthrushes during four breeding seasons (Apr–Jul 2003, 2005, 2007, and 2008) and three non-breeding seasons (late Jul–mid Aug and Oct–Dec 2006, Sep 2007–Jan 2008) within 100 m of a 10.3-km long trail system by direct observations, and noted flock size and social interactions. We also played back calls, i.e., ''hwii-u, hwii-u'' (Collar et al. 2007), of the birds and recorded their response. Nests (27 active and 4 previously used) were located by systematically checking individual trees and shrubs during the breeding seasons.

We measured the following variables for each nest after termination of nesting similar to the method of James and Shugart (1970): altitude, distance to forest edge, species and diameter at

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breast height (DBH) of supporting plants (if ≥2 tree species, all species were recorded), height of the nest above ground, and distance between the nest and the stem of supporting plant. Slope exposure and orientation of the nest relative to the stem of supporting plant were recorded in 45° octants. The surrounding cover was estimated as the average proportion of the nest camouflaged when viewed from three different sides at a distance of 5 m. Overhead cover was estimated as cover that prevented light penetration, in 10% intervals. Locations of nests and inter-nest distances were ascertained with a global positioning system (GPS) (Garmin eTrex Legend® HCx, Olathe, KS, USA).

Habitat structure in a 10 × 10 m plot with each nest site or site where laughingthrushes occurred as the center was also measured. Vegetation type was classified as coniferous forest, mixed coniferous-deciduous forest, deciduous forest, or shrubs. Cover (amount of sky obscured), and the numbers of conifers and shrubs with a DBH of >3 cm were also recorded. We made similar measurements to assess the preference of nesting habitats at 38 available sites within 19 territories (2 sites per territory) for comparison.

We took measurements of the eggs and nestlings, once a nest was located, and monitored the nest every 2–4 days, or 1–2 days at critical times, to ascertain laying date, length of incubation, time to fledging, nestling growth, fledging success, and incidence of nest predation. Laying dates were calculated by backdating for nests located when incubation had already begun or nestlings had hatched, using reproductive parameters obtained from clutches for which complete data were obtained.

Incubation or brooding behavior was documented by occasional observations at four nests from a blind to reduce disturbance. Parental behaviors at one nest (containing 2 nestlings) were recorded during days 9–18 after hatching with an infrared video camera placed 0.5 m above the nest. One bird was caught in a mist net 20 m from the nest and marked with red lacquer spots at the end of the tail to check whether both parents (morphologically indistinguishable) incubate or brood at night. Blood (200 μL) was taken for amplification of the CHD gene using the universal P2/P8 primers to ascertain gender (Griffiths et al. 1998). Data from all years were pooled for analysis using SPSS 13.0 for Windows (SPSS Inc. 2004). The percent values were arcsine transformed for *t*-tests and all tests were two-tailed. Values are given as mean ± SE.

RESULTS

Habitat Use and Social Behavior.—Singles, pairs, and groups of Snowy-cheeked Laughingthrushes accounted, respectively, for 10, 78, and 12% of observations ($n = 132$) in the non-breeding season (Sep–Apr). The corresponding figures were 75, 24, and 1% ($n = 120$) for the breeding season (May–Jun). The mean size of groups was 4.0 ± 0.2 (3–6) in the non-breeding season, and most groups (69%) included four individuals. Snowy-cheeked Laughingthrushes occurred in mixed deciduous-coniferous forests (88%), shrublands (9%), and coniferous forests (3%) at elevations of 2,400–3,200 m during all observations ($n = 252$). They seldom foraged in the abundant areas of moss and fallen needles under pure conifer stands, and were absent at higher elevations (3,200–3,560 m), dominated by dwarf willows and barberries, and absent at lower elevations (2,100–2,400 m) where crops, low shrubs, and human dwellings predominated.

Snowy-cheeked Laughingthrushes appeared to be territorial in late April and May. Calls of one pair usually resulted in three to five neighboring pairs calling simultaneously (30 occasions). Playback of calls also initiated calling and/or approaches by 1–2 neighboring pairs to the speaker (7 of 20 occasions at 10 territory boundaries). Two pairs were observed chasing each other on the ground and performing a series of rapid pivoting and ducking movements from side to side while calling harshly in mid May (2 occasions), seemingly to defend territories. Distances between the closest nests (found in 2007) averaged 100 ± 30 m (55–250 m, $n = 10$).

Nest Cycle: Days in Each Period.—Our earliest observation of nest building was on 3 May (2008) and the latest known fledging date was 13 July (2005) with an overall breeding season of ~72 days. Nest building lasted ~8 days (1 nest). There was a lull of 9 ± 1 day (7–12, $n = 5$) after nest completion. Onset of laying extended from 7 May (2008) to 10 June (2005) with a peak in late May. One unspotted greenish-blue egg was laid per day ($n = 8$ eggs in 2 sufficiently monitored nests). Scattered observations at four nests indicated continuous incubation started after laying of the last egg.

All nestlings hatched in the same day ($n = 2$ nests) after 14 days of incubation ($n = 1$ nest),

TABLE 1. Habitat characteristics at nest sites in >14 independent home ranges of Snowy-cheeked Laughingthrushes at Lianhuashan, Gansu, China, during 2003–2008 in comparison with available sites.

	Nest sites (n = 31)		Available sites (n = 38)			
Habitat components	Mean	SE	Mean	SE	t	P
Canopy cover (%)	72	4	55	3	3.15	0.00
Spruce-fir density (trees/ha)	455	68	674	66	−2.28	0.03
Birch density (trees/ha)	206	52	329	59	−1.52	0.13
Shrub density (shrubs/ha)	1,035	95	618	156	2.17	0.03
Shrub cover (%)	66	6	32	4	4.27	0.00

during which each egg lost ~0.07 g (1.2%) of its mass per day on average. Hatchlings, weighing 4.7 ± 0.1 g (4.60–4.75 g; n = 3), were largely naked with dull grayish-red skin and only a few gray-white down feathers on the capital, occipital, middle spinal, and femoral tracts. Nestlings opened their eyes at 7 days of age and fledged at 16–18 days of age (n = 3 nests). Mean nestling mass was 38.9 ± 0.7 g (n = 5) at 15–18 days post-hatching, about 54% of the adult mass (67.8–74.0 g, n = 4). Growth rate (logistic regression model) was estimated to be 0.80 ± 0.01 g/day for three nestlings in one nest.

Nest Location and Description.—Thirty-one nests were in coniferous-deciduous forests (74%) or coniferous forests (26%); they were 13 ± 3 m (2–50 m) from the forest edge, at elevations of 2,800–2,900 m. Laughingthrushes favored northeast-facing slopes (30% of nests) with the mean steepness of 27 ± 1° (5–40°). Nest sites had lower spruce-fir density, higher shrub density, and greater canopy cover and shrub cover than available sites (Table 1), suggesting the birds preferred nest sites with fewer conifers and denser shrubs.

Nests were placed in spruce (74.2%), fir (6.5%), or deciduous shrubs (honeysuckle [*Lonicera* spp.] = 12.9%, willows = 3.2%, vines = 3.2%). Spruce was used more often than expected from observed availability at nest sites (χ^2 = 144.1, df = 2, P = 0.00). Nests were constructed in three types of positions: 2.0 ± 0.1 m (1.3–2.6 m) out from the trunk in larger conifers (DBH = 34 ± 1 m; n = 13), or touching the trunk (<0.3 m) in smaller conifers (DBH = 9 ± 1 cm; n = 11), or attached to the branches and stems of shrubs (DBH = 4 ± 1 cm; n = 7). Heights of nests in larger conifers were greater than in smaller conifers and in shrubs (1.9–3.5 vs. 1.5–3.6 vs. 1.1–2.6 m; $F_{2,30}$ = 4.2, P = 0.03) with an average of 2.4 ± 0.1 m (n = 31) above ground. The average surrounding and above cover at nests were 57 ± 4% (10–90%, n = 31) and 72 ± 4% (30–100%, n = 31), respectively.

Twenty bowl-shaped nests had a mean inside diameter of 9.7 ± 0.2 cm (8.0–12.3 cm), an outside cup diameter of 16.4 ± 0.5 cm (13.5–22.0 cm), an inside depth of 3.6 ± 0.2 cm (2.0–5.0 cm), and an outside height of 7.8 ± 0.5 cm (5.5–15.5 cm). The inner bowl was lined with leaves of *Carex* spp. and thin strands from the stems of honeysuckle, raspberry (*Rubus pungens*), *Sorbaria kirilowii*, *Philadelphus incanus*, and *Spiraea* spp. The outer bowl was made mostly of twigs, mainly mountain ash (*Sorbus* spp.), honeysuckle, *Rhamnus parvifolia* and *Cerasus clarofolia*, and a few birches. Nest weight averaged 62 ± 7 g (35–130, n = 13).

Nest Productivity and Success.—The mean clutch size was 3.5 ± 0.2 eggs (n = 21) with 2-, 3-, 4-, and 5-egg clutches accounting, respectively, for 3, 5, 12, and 1 nests. Eggs averaged 27.1 ± 0.2 mm (24.6–30.5 mm) in length and 19.8 ± 0.1 mm (18.4–21.1 mm) in width (n = 54 eggs in 15 nests). The mass of eggs measured prior to incubation was 5.42 ± 0.13 g (4.90–6.05 g, n = 8).

Overall breeding success was 60% for 20 known-fate nests with 2.7 ± 0.2 (2–4) hatchlings (n = 15) and 2.2 ± 0.2 (1–3) fledglings per clutch (n = 12). Six nests failed due to predation (3 each during the incubation and nestling periods). Nestlings in two nests died after a week of rain (15–22 Jun 2007), during which the air temperature averaged only 5.0° C (−0.1–11° C). One to two unhatched eggs disappeared in 5 of 9 nests and 25–50% (1 or 2) nestlings disappeared in 5 of 12 nests during the nestling period. No eggs disappeared in 15 nests during the incubation period.

Parental Duties.—Both males and females participated in building nests, incubating eggs, and provisioning and brooding nestlings. Pairs defended nests by calling vociferously when we checked the eggs or nestlings. Scattered observa-

tions indicated both parents took turns incubating during the day, achieving constant coverage other than one absence of only 24 sec. Six on-nest bouts were 60, 71, >45, >50, <112, and <125 min, respectively. Only the marked bird (i.e., female) incubated at night (4 observations).

Video recordings at one nest (86.8 total hrs) indicated both adults brooded the young in the day but not at night on days 9–18 of the nestling period. Diurnal activities ended at 1841 hrs ± 10 min in 6 days. Length of on-nest bouts decreased slightly as nestlings grew larger, whereas length of off-nest bouts increased with means of 12.3 ± 0.9 min (2–65 min) and 18.8 ± 1.8 min (1–133 min), respectively. Brooding attentiveness decreased from 57% (day 11) to 21% (day 17), except for a sharp rise (58%) on day 14. Parents provisioned nestlings at a frequency increasing from 2.0 (day 11) to 6.0 times/hr (day 16) and decreased to 0 times/hr (day 18) with an overall average of 4.0 ± 0.2 times/hr (0–9 times/hr). Adults provisioned nestlings more intensively in the morning than in the afternoon, but with two peaks at 1200–1300 and 1700–1800 hrs. Frequency of removing (or eating) feces from the nest averaged 1.5 ± 0.2 times/hr (0–4 times/hr, $n = 65$). The two young fledged synchronously at 0713 hrs on day 18.

DISCUSSION

Nesting Phenology and Nests.—Egg-laying (7 May–10 Jun) by Snowy-cheeked Laughingthrushes was similar to the Giant Babax (*Babax waddelli*) (Lu 2004). It was shorter than other common *Garrulax* species at similar latitudes, including Plain Laughingthrush (*G. davidi*) (late Apr–late Jul; Luo et al. 1992) and Brown-cheeked Laughingthrush (*G. henrici*) (May–Aug; Lu et al. 2008).

Nests of Snowy-cheeked Laughingthrush were placed higher than those of other *Garrulax* species in low bushes (1.1–3.8 vs. 0.5–1.5 m) (Cheng et al. 1987, Ali and Ripley 1996, Lu et al. 2008). Nest sites were lower than those of Giant Laughingthrush (*G. maxima*) (2.4–7.0 m), which were built in conifers (Wang et al. 2010).

Nesting Success.—We observed partial loss of broods and unhatched eggs, possibly removed by parents but not predators. Similarly, the Chinese Hwamei (*G. conorus*) was reported to move eggs to a new nest when adults found people approaching the ongoing nest (Zhang 2002). Human predation of eggs or nestlings was not considered a threat, as local people were discouraged from frequenting our study area because of research on other endemic birds. Possible predators range from the diurnal Spotted Nutcracker (*Nucifraga caryocatactes*), Northern Goshawk (*Accipiter gentilis*), and Siberian chipmunk (*Eutamias sibiricus*) to the nocturnal leopard cat (*Prionailurus bengalensis*), all of which are common in the study area.

Social Unit and Breeding Density.—Snowy-cheeked Laughingthrushes were in pairs (78%) during the non-breeding seasons, and most groups (69%) appeared to be units of two pairs, as two birds each foraged close and moved in different directions when we approached, similar to the previous description ''It was in pairs in both winter and summer'' (Dresser and Morgan 1899:271).

The Snowy-cheeked Laughingthrush has been described as ''rare'', ''fairly common'', and ''uncommon'' (Collar et al. 2001). The shortest distance (55 m) between nests was greater than that of Elliot's Laughingthrush (*G. elliotii*) (30 m, Li and Huang 1991; 35 m, Jiang et al. 2007). Ten active nests were found in an area of 1.2 km^2 in 2007 (17 birds/100 ha), suggesting the density of Snowy-cheeked Laughingthrush is possibly moderate in the well-managed natural reserve.

CONSERVATION IMPLICATIONS

Spruce rather than fir was highly selected as nest substrates (70 vs. 6%), even though both are dominant (513 ± 71 vs. 161 ± 42 trees/ha, Sun et al. 2007), possibly because firs mainly occur inside coniferous forest, where the birds seldom nest. Snowy-cheeked Laughingthrushes preferred to nest in spruce and forage in mixed deciduous-coniferous forest, indicating the presence of spruce with abundant shrubs may be essential habitat requirements and the importance of protecting alpine scrub vegetation adjacent to and within the coniferous forest.

The birds at Lianhuashan were restricted to narrower altitudes (2,400–3,200 m) than has been reported by others (2,000–3,500 m; Stattersfield et al. 1998), possibly due to previous logging and conversion of forest to croplands. The forest in the Lianhuashan Mountains is highly fragmented and 77% of forest patches are smaller than 10 ha due to logging over the past 30–40 years (Sun et al. 2006). Arrow bamboo (*Sinarundinaria nitida*) clumps within the coniferous and coniferous-deciduous forests were nearly clear-cut by local people. The short breeding season, the degraded

and fragmented habitat, and the restricted range suggest the critical vulnerability of the Snowy-cheeked Laughingthrush.

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