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Publisher: Taylor & Francis

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Journal of Natural History

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/tnah20>

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Published online: 23 Jan 2014.

To cite this article: Yunbiao Hu, Guang Hao, Yingxin Jiang, Peter Pechacek & Yuehua Sun (2014) Breeding ecology of the fulvous parrotbill (*Paradoxornis fulvifrons*) in Wawushan Nature Reserve, Sichuan, China, *Journal of Natural History*, 48:15-16, 975-982, DOI: [10.1080/00222933.2013.826829](https://doi.org/10.1080/00222933.2013.826829)

To link to this article: <http://dx.doi.org/10.1080/00222933.2013.826829>

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Breeding ecology of the fulvous parrotbill (*Paradoxornis fulvifrons*) in Wawushan Nature Reserve, Sichuan, China

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(Received 4 December 2012; accepted 16 July 2013; first published online 23 January 2014)

We studied the breeding ecology of the fulvous parrotbill (*Paradoxornis fulvifrons*) and provide the first description of nests, eggs, fledglings, nesting behaviour and nest sites from China. Nests were bowl-shaped built by both sexes mainly of bamboo leaves, fibrous roots and mosses. They were located within dense bamboo clusters, about 0.70–1.90 m above the ground. The clutch size averaged (mean \pm SD) 3.38 ± 0.72 ($n = 16$) and eggs were oval, pale blue in colour, weighing 1.24 ± 0.10 g ($n = 13$). Both pair-bond members incubated eggs and shared nestling care. Compared with control sites, the nest sites ($n = 33$) had smaller canopy closure ($73 \pm 12\%$ vs $84 \pm 16\%$). Overall nesting success was 18.18% (6/33). We concluded that human disturbance (i.e. tourist hiking on paths close to nest sites) might prompt nest desertion causing the low reproductive success of fulvous parrotbill in the reserve.

Keywords: fulvous parrotbill; *Paradoxornis fulvifrons*; breeding biology; nest-site selection; reproductive success

Introduction

The fulvous parrotbill (*Paradoxornis fulvifrons*) is a resident species inhabiting bamboo clusters in coniferous and mixed forest at an altitude between 1700 and 3500 m above sea level in southwest China, Nepal, northeast India and northeast Burma (MacKinnon and Phillips 1999). The fulvous parrotbill is a bamboo-confined species and rarely strays away from this habitat; it is not globally threatened (Kratter 1997; Zhao 2001; Robson 2007). No details of its breeding biology have yet been reported except for a description of some specimens with active gonads collected in southeast Tibet (Wu 1986).

Lack of life history data is typical for all parrotbills occurring in China. Breeding biology or habitat selection have only been studied in five out of 18 species of the genus *Paradoxornis*; these include the vinous-throated parrotbill (*Paradoxornis webbianus*) (Peng 1985; Guo et al. 2006), the reed parrotbill (*Paradoxornis heudei*) (Wang and Zhou 1988; Dong et al. 2010; Boulord et al. 2011), the grey-hooded parrotbill (*Paradoxornis zappeyi*) (Jiang et al. 2009), the ashy-throated parrotbill (*Paradoxornis alphonsianus*) (Yang et al. 2010) and the golden parrotbill (*Paradoxornis verreauxi*) (Yang et al. 2011).

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Nest-site selection is one of the most important components of the breeding process with a potential to increase breeding success (Cody 1981; Clark et al. 1983). Human-effected disturbance affects distributions, behaviour and reproduction success of birds (Fernández-Juricic 2002; Frid and Dill 2002). Birds have to spend more energy on nest-protecting behaviour when they build nests in places prone to human disturbance, which often ultimately results in nest desertion. Micro-habitat patterns, including distribution of potential human disturbance, have therefore been shown to have serious impacts on nest-site selection behaviour (Collias and Collias 1984; Urban and Smith 1989).

Nest predation is an important determinant of the reproductive success of many birds, especially passerines (Lahti 2009). Nest failure due to predation in open-cup nesting birds, in particular, can be high: 54.9% for six species of passerines (Ricklefs 1969). So nests must be placed in locations where predation of eggs and nestlings is minimized. Here, we tried to explore the impact of human disturbance (i.e. presence of the pedestrians on hiking paths close to the nests) and nest predation on the fulvous parrotbill's nest-site selection behaviour.

We also attempted to shed light on the co-existence of the fulvous parrotbill with the great-hooded parrotbill. Both species occur in close proximity in our study area, are reported to mix together in the non-breeding season, and build their nests of similar materials on bamboos. We therefore expected that they have evolved mechanisms to avoid inter-specific competition for co-existence in the same environment.

Our objectives were to (1) describe nests, eggs and chicks, and (2) provide notes on breeding behaviour and nest-site selection of fulvous parrotbill as well as on its co-existence with grey-hooded parrotbill.

Material and methods

Study area

We conducted field work on the plateau of the Wawushan Nature Reserve at approximately 2830 m above sea level, from April to July in 2003, 2010 and 2011. Wawushan Nature Reserve is an isolated table mountain in Hongya county of Sichuan province in southwest China (29°25'–29°34' N, 102°49'–103°00' E). The area is part of the monsoon climatic belt, with an annual precipitation of 2000 mm and annual temperature of 16.8°C (maximum 36.2°C; minimum –3.3°C). The plateau of the Wawushan Nature Reserve is approximately 9 km² in size and is covered by light forests dominated by Emei fir (*Abies fabric*), mixed with some birch (*Betula utilis*). Most of the firs are mature whereas young trees are extremely rare. The understorey is dominated by bamboo (*Bashania faberi*) and a wide variety of rhododendron species, such as *Rhododendron ambiguum* and *Rhododendron maculiferum*.

Field procedures and data analysis

We systematically searched for nests by following vocal clues of the birds and searching potential nest sites. Shortly after completion of clutches or in the early incubation stage, we recorded egg dimensions and fresh weights. We also took body mass and linear measurements of nestlings (beak, wing, tarsus and tail length) on a daily basis. We considered nest failure if no eggs were laid after the nest was finished,

or when the eggs/nestlings disappeared or were destroyed during the incubation/nestling period. Nesting success was confirmed when at least one nestling aged at least 12 days old fledged.

We characterized the habitat surrounding the nests using a plot of 10 × 10 m with the nest in the centre, and recorded the distance to the nearest hiking path, mean height of bamboos, and canopy closure of the bamboos. We selected random control plots of the same size within a distance between 20 and 100 m from the nest to sample the same parameters as a reference.

We analysed data using SPSS Statistics Version 17.0 for Windows (SPSS Inc., Chicago, IL). A one-sample Kolmogorov–Smirnov test was used to check distribution of the parameters. Parameters that were normally distributed were compared using two independent samples *t*-test, otherwise using Mann–Whitney *U*-test. Data are presented as means ± SD.

Results

Nests

We found 33 fulvous parrotbill nests in bamboo thickets 1.28 ± 0.29 m ($n = 33$) above ground (Table 1). Nests were built by both sexes, were bowl-shaped and mainly made of the leaves and skins of bamboos with some fibrous roots in the inner layer, and a few lichens in the outer layer (Figure 1). The mean inside depth and outside height were 5.31 ± 0.58 cm and 7.12 ± 0.70 cm ($n = 19$), respectively. Among these 19 nests, seven had circular openings with the mean inner and outer diameter of 4.34 ± 0.18 cm and 7.92 ± 0.74 cm ($n = 7$). The remaining 12 nests were slightly elliptical with the mean inside short axis of 4.17 ± 0.41 cm and long axis of 4.75 ± 0.33 cm, while the mean outer short axis and long axis were 8.03 ± 0.76 cm and 9.30 ± 0.99 cm ($n = 12$) respectively.

Egg laying, clutch size and incubation

Egg laying began at least one day after the nest was finished, and one egg was laid per day. In one nest, however, we observed that the female laid eggs only every other day. The mean clutch size was 3.38 ± 0.72 ($n = 16$). Eggs were spotless, oval in shape, and pale blue in colour (Figure 1). Their size averaged 12.26 ± 0.32 by 15.62 ± 0.70 mm, with a fresh weight of 1.24 ± 0.10 g ($n = 13$). Incubation started on the same day that the last egg was laid (Figure 2), involved both sexes and ranged between 14 and 15 days ($n = 2$).

Parental care, growth of nestlings and reproductive success

Of the seven nests containing 24 eggs, 20 eggs hatched and 16 young fledged, giving an overall hatching rate of 83.33% (20/24), and a fledging rate of 66.67% (16/24). Both parents fed their nestlings. In a non-stop 240-minute (13:30–17:30) observation at one nest when nestlings were 10 days old, we recorded feeding 15 times (i.e. an average 3.8 feedings per hour). Nestlings fledged on days 14 and 13, respectively ($n = 2$).

Table 1. Nests of fulvous parrotbill in Wawushan Nature Reserve, Sichuan, China.

Year	<i>n</i>	First nest found	Last nest found	Clutch size	Nests with eggs	Successful nests	Height above ground (m)
2003	12	29 April	30 June	3.75 ± 0.46 (<i>n</i> = 8)	9	4	1.13 ± 0.21
2010	12	21 May	17 June	2.75 ± 0.5 (<i>n</i> = 4)	5	1	1.22 ± 0.25
2011	9	11 May	18 July	3.25 ± 0.96 (<i>n</i> = 4)	5	1	1.56 ± 0.23
Total	33	29 April	18 July	3.38 ± 0.72 (<i>n</i> = 16)	19	6	1.28 ± 0.29



Figure 1. Full clutch laid in the nest of fulvous parrotbills.

We measured three nestlings of one nest on a daily basis (Table 2). At hatching, nestlings had a pink complexion with a few dark feathers on head, spine and wings. The beak was yellow in colour during the first few days. When fledged, the feathers had already developed as in adults, and only a little yellow remained at the base of the beak. Body mass of the nestlings peaked on day 11. Ventral feather growth was still rudimentary when the nestlings fledged on day 13 or 14, and feathers covered about 80% of the ventral surface.



Figure 2. Fulvous parrotbill incubating eggs.

Table 2. Daily measurements and growth of three fulvous parrotbill nestlings from one nest in Wawushan Nature Reserve, Sichuan, China.

Nestling age (day)	Body mass (g)	Beak (mm)	Tarsus (mm)	Wing (mm)	Tail length (mm)
1	1.1	3.2	5.6	/	/
2	2	3.3	7.1	/	/
3	3.1	3.9	9	/	/
4	3.9	4.2	10.5	5.6	2.2
5	4.9	4.2	11.8	8.3	2.4
6	5.8	4.5	14.1	14.8	2.7
7	6.3	4.6	15.2	18.3	3.2
8	6.9	4.9	16.6	22.4	4.9
9	7.8	5.2	18.3	27.6	7
10	7.8	5.4	18.8	29.4	9.1
11	8.1	5.7	19.5	33	11
12	8.1	5.8	19.8	35.8	11.8
13	8	5.9	20.4	38.2	13.6

Note: The data in the table are the averages for three nestlings.

Of the 33 breeding attempts, 14 pairs gave up on nesting before laying eggs, six gave up during the incubation period, six were depredated and only six were successful, while the remaining nest was blown down on a day of bad weather during the

construction period. The nest desertion rate of 66.67% (20/33) accounted for the majority of nesting failures, whereas nest predation only accounted for 18.18% (6/33).

Nest site and nest surroundings

All 33 nests were placed on bamboos and located about 7.83 ± 10.21 m from the nearest hiking path. The mean height of nest-bamboos was 1.60 ± 0.41 m, whereas the height of surrounding bamboo clusters averaged 1.81 ± 0.39 m. Nest sites had smaller canopy closure of bamboos than the random sites [$(73 \pm 12\%$ ($n = 33$) vs $84 \pm 16\%$ ($n = 33$); $Z = -4.791$, $p < 0.001$], while other parameters were not significantly different. Nests that were deserted or depredated were located closer to the nearest hiking path than successful nests [6.80 ± 6.41 m ($n = 20$), or 4.13 ± 3.12 m ($n = 6$), respectively vs. 16.08 ± 19.74 m ($n = 6$)], but the differences were not significant. Because all nest sites were covered by dense bamboo clusters, there were few shrubs (canopy closure mostly $< 10\%$) and trees (mostly with no trees or just one) surrounding the nest.

Discussion

Our observations on fulvous parrotbills are the first of their kind to be published. Bowl-shaped nests were constructed by both sexes mainly of bamboo leaves, and were situated in bamboo thickets 0.70–1.90 m above the ground. Females laid usually one egg per day, and both sexes participated in incubation and nestling care. We observed low overall nesting success of 18.18%.

Fulvous parrotbills had a smaller clutch size (3.38 vs 4–5) and smaller egg mass (1.26 g vs 1.50 g) than the vinous-throated parrotbill (Guo et al. 2006). Compared with the grey-hooded parrotbill (Jiang et al. 2009), the clutch size (3.38 vs 3.10) and egg mass (1.26 g vs 1.30 g) of these two species were very similar. Fulvous parrotbills also had similar clutch size to (3.38 vs 3.50), but bigger egg mass (1.26 g vs 1.06 g) than the golden parrotbill (Yang et al. 2011). These results probably reflected the similar life history of the parrotbills, and specifically the body size of these four species.

The vinous-throated parrotbill, the grey-hooded parrotbill and the fulvous parrotbill all build bowl- or cup-shaped nests while the golden parrotbill built cup-shaped nests with a semi-domed design. Nest materials are nearly the same for the latter three species, mostly leaves and skins of bamboos, whereas in the vinous-throated parrotbill, nest materials include grasses, leaves of bamboo, reed bush, dry skins of reed, etc. (Kim et al. 1995; Robson 2007). The vinous-throated parrotbill breeds in various habitats such as scrubs, forest edges, bamboo groves, reeds, marshes, plant nurseries whereas the remaining three species breed in bamboo clusters.

We observed high nest desertion rates mainly during the nest construction period and before the eggs were laid, especially in 2010 and 2011. This may have been caused by human activities, and additionally by the challenging microclimate. Nests of the fulvous parrotbill were usually located in places less than 10 m from the nearest hiking path, sometimes as close as 1 m. Tourists visited the Wawushan Nature Reserve mostly from April to August, which corresponded with the breeding season of many birds (unpublished data). In 2003, 11,600 tourists came to Wawushan from April to August, while in 2010 this number increased 10-fold reaching 177,000

tourists (Sichuan Tourism Administration Information Centre, unpublished data). Hence, the nesting birds were exposed to an increasing human presence, which may have prompted nest desertion, hence affecting the reproductive success of fulvous parrotbills in the reserve. Additionally, nice days without precipitation rarely existed during the breeding season (i.e. almost every day was rainy or cloudy with fog), for example, we recorded one nest in the nest-building stage that was blown down on a bad weather day.

Nest predation only accounted for 18.18% of the total nesting loss, and hence was smaller than in many other passerine birds – e.g. 44.44% in golden parrotbills (Yang et al. 2011), or 45.38% in white-bellied redstarts *Hodgsonius phaenicuroides* (own unpublished data). Because of small sample size and high desertion rate, as well as lack of data on predators, we could not draw a general conclusion as to how nest predation affected breeding success and nest-site selection behaviour of fulvous parrotbills.

The nest sites of fulvous parrotbills had smaller canopy closure than random sites. We proposed this was a trade-off between the need for concealment of the nest and the need for maintaining some view of the surroundings, as in other small passerine birds, e.g. song thrush *Turdus philomelos* (Götmark et al. 1995). The moderate canopy closure may help the fulvous parrotbill to detect humans or predators near the nest in time, then the parents and the young birds may keep silent and delay any movements, so avoiding detection. This, combined with high nest desertion rates, may somehow explain the low nest predation rate that we observed.

Anecdotal evidence based on nine nests indicated that the grey-hooded parrotbill selected nest sites in bamboo clusters with denser canopy closure ($83 \pm 12\%$ vs $73 \pm 12\%$) and farther away from the nearest hiking path (31.61 ± 33.86 m vs 7.83 ± 10.21 m) than fulvous parrotbills (unpublished data). We speculated that the grey-hooded parrotbill might be more sensitive to human disturbances. The co-existence of both species may be facilitated by the selection of different nesting places at micro-habitat level.

We conclude that our data on eggs, nests, breeding behaviour and habitat use of the fulvous parrotbill reflect common patterns of life history in parrotbills. Human disturbance probably prompts nest desertion, which affects the overall reproductive success of the birds in the Reserve.

Acknowledgements

We thank the staff of the Wawushan Nature Reserve for their assistance in the field. Our study was funded by the National Natural Science Foundation of China (no. 31270468), and the British Petroleum (BP) Conservation Programme.

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