

occurred rarely (Takahashi 2013), suggesting that nests are safer than the external environment for nestlings and we assume that this behaviour evolved in the Marsh Grassbird owing to the safety that the nest provides.

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Re-nesting of the Blood Pheasant *Ithaginis cruentus*

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Introduction

Re-nesting, the laying of a replacement clutch following the loss of an initial clutch, is important to the population dynamics of many avian species. In the case of galliforms, re-nesting by grouse Tetraonidae has been investigated in a number of studies (e.g. Zwickel & Lance 1965, Giesen & Braun 1979, Connelly *et al.* 1993); however, it is little known in pheasants Phasianidae, except for Common Pheasant *Phasianus colchicus* (Gates 1966).

The Blood Pheasant *Ithaginis cruentus* is a ground-nesting bird which inhabits coniferous and mixed coniferous and deciduous forests on the Qinghai–Tibet Plateau and surrounding high mountains, from 2,135 to 4,575 m (Johnsgard 1999). Its nests are placed generally in depressions at the base of trees, rocks or fallen trunks. Most eggs in a clutch (5–10 in our experience) are laid at two-day intervals, and the female starts incubation when the last egg is laid; incubation takes as long as 37 days, in part because the female needs to forage for 6–7 hours a day (Jia *et al.* 2010). Here we provide the first documented report of re-nesting by Blood Pheasants.

Study area and methods

Fieldwork was carried out between 2000 and 2002 at the Lianhuashan Nature Reserve, Gansu province, China (34.93°N 103.73°E). Forest habitat occurs in the reserve on north-facing slopes and some north-east- and north-west-facing slopes between 2,600

and 3,600 m. Only shrubs and grasses grow on south-facing slopes. The area was described in detail by Sun *et al.* (2003).

We captured 13 female Blood Pheasants during early April using a treadle snare (Petrides 1946)—4 in 2000, 5 in 2001 and 4 in 2002. One female which nested in 2001 also nested in 2002 (Table 1). Birds were fitted with necklace transmitters weighing less than 16 g. All birds were also marked with individually coloured leg bands. Radio-tagged birds were monitored from April to July each year.

We monitored the egg-laying behaviour of Blood Pheasants by recording egg temperatures to determine whether the female was on or off the nest. The temperature probe, connected by a conductor to a Gemini datalogger (Tiny Talk II, Gemini Data Loggers UK Ltd, Chichester, UK), was inserted into the bottom of the nest cup directly or was fixed into an egg filled with paraffin wax. The temperature

Table 1. Blood Pheasant *Ithaginis cruentus* breeding results from 2000–2002 at Lianhuashan, Gansu, China.

Year	No. of nests monitored	No. of nests where eggs hatched	Failed nests		Re-nests
			During egg laying	During incubation	
2000	4	2	0	2	0
2001	5	2	0	3	0
2002	5	1	2	2	2

was logged at six-minute intervals. Nests were revisited every 6–7 days to download data. A laying interval of two days between eggs and an incubation time of 37 days was used to determine when laying started.

Results

In total we monitored 14 nesting attempts by radio-marked females during the breeding seasons from 2000 to 2002. Out of nine nest failures, two occurred during the egg-laying period and the remaining seven during incubation (Table 1). The two females that lost their nests during egg-laying re-nested, whereas those that lost their nests later, during the incubation period, did not. Descriptions of the two re-nesting attempts are as follows:

Female 02-66. Her first nest was found at 15h20 on 3 May 2002, at which point she had laid her fourth egg. According to the recordings from the datalogger, the fifth to seventh eggs were laid on 5, 7 and 9 May, and the nest was destroyed by a mammal between 01h00 and 01h30 on 10 May. Female 02-66 was found on her second nest, 100 m away from the first, at 14h43 on 23 May 2002, when the nest contained six eggs. She began to incubate on 25 May after laying the seventh egg of her second clutch. The chicks hatched successfully on 29 June. Our calculations indicated that female 02-66 began her first clutch on 27 April and commenced re-nesting on 13 May, three days after she lost her first clutch.

Female 02-69. On 10 May 2002 we flushed female 02-69 from her nest in a dense stand of bamboo as we approached. The nest contained one egg, but when it was checked on 16 May it still contained only one egg. Apparently she had abandoned the nest, perhaps as a result of the disturbance we had caused. We found her incubating her second clutch, 260 m from the first nest, at 18h38 on 22 May. This nest was destroyed by an unknown predator on 29 May when it contained six eggs. Backdating indicated that re-nesting had begun on 12 May, two days after the first clutch had been abandoned.

Discussion

Based on the above limited observations, we conclude that Blood Pheasants are likely to re-nest, using a different location, soon after the incomplete clutch is destroyed in the egg-laying period but are much less likely to re-nest once incubation has commenced.

Re-nesting behaviour appears to vary among galliforms. In the case of Western Capercaillie *Tetrao urogallus*, the female will re-nest if the nest is predated during the first three days of incubation (Storaas *et al.* 2000). In Sooty Grouse *Dendragapus fuliginosus* and Common Pheasant, re-nesting can occur not only when a first clutch is destroyed in late incubation but also after the loss of a brood (Zwickel & Lance 1965, Dumke & Pils 1979). Re-nesting after the loss of a brood has also been documented in two other species of tetraonid, Red Grouse *Lagopus lagopus scotica* (Kirby & Smith 2005) and Greater Prairie Chicken *Tympanuchus cupido* (McNew & White 2012). However, Rock Ptarmigan *Lagopus muta* hens re-nest after their first nests are predated during egg-laying but re-nesting is rare once incubation has begun (Cotter 1999). Our observations suggest that the re-nesting pattern for Blood Pheasant is similar to that of Rock Ptarmigan.

Changes in nest locations following nest failure have been documented in several species of galliforms, such as Willow Grouse *L. l. lagopus* (Parker 1981), Black Grouse *Lyrurus tetrix* (Marjakangas *et al.* 1997) and Chukar *Alectoris chukar* (Lindbloom *et al.* 2003). In Buff-throated Partridge *Tetraophasis szechenyii*, changes involved not only nest location but also nest type, shifting from ground level to trees (Zhang *et al.* 2011). These changes in location may be a response to avoid revisits by the nest predators (O'Reilly & Hannon 1989, Marjakangas *et al.* 1997).

Blood Pheasants, nesting at relatively high altitudes, have a relatively long egg-laying interval (two days for every egg laid) and

incubation period (37 days) compared with other similar species that breed at lower altitudes. Thus, a possible explanation for the re-nesting pattern of Blood Pheasants is that, if she delays for too long the female does not have sufficient time for a second attempt at egg-laying, incubation and raising a brood, because the young will not otherwise be sufficiently mature to survive the severe winter conditions that are characteristic of Blood Pheasant's habitat.

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