

- Priddel, D. & Wheeler, R. 1990. Survival of Malleefowl *Leipoa ocellata* chicks in the absence of ground-dwelling predators. *Emu* 90, 81-87.
- Priddel, D. & Wheeler, R. 1994. Mortality of captive-raised Malleefowl, *Leipoa ocellata*, released into a mallee remnant within the wheat-belt of New South Wales. *Wildlife Research* 21, 543-552.
- Short, J. & Smith, A. 1994. Mammal decline and recovery in Australia. *Journal of Mammalogy* 75, 288-297.
- Twigg, L.E. & King, D.R. 1989. Tolerance to sodium fluoroacetate in some Australian birds. *Australian Wildlife Research* 16, 49-62.
- Twigg, L.E. & King, D.R. 1991. The impact of fluoroacetate-bearing vegetation on native Australian fauna; a review. *Oikos* 61, 412-430.
- Twigg, L.E., King, D.R., Davis, H.M., Saunders, D.A. & Mead, R.J. 1988. Tolerance to, and metabolism of, fluoroacetate in the emu. *Australian Wildlife Research* 15, 239-247.

Observations on the Endangered Black-breasted Button-quail *Turnix melanogaster* Breeding in the Wild

A.K. Smyth¹ and J. Young²

¹ Department of Zoology and Department of Geographical Sciences and Planning, The University of Queensland, Brisbane, Qld 4072

² PO Box 57, Trebonne, Qld 4850

EMU Vol. 96, 202-207, 1996. Received 22-9-1995, accepted 28-2-1996

The Black-breasted Button-quail *Turnix melanogaster* is an Australian endemic that is difficult to observe in the wild. It is one of 16 species of *Turnix* button-quails belonging to the family Turnicidae of the monotypic order Turniciformes (Sibley & Ahlquist 1990; Christidis & Boles 1994). Of these species, six are Australian endemics, one is found in both Australia and the Malay Archipelago and the remainder occur in Africa, Madagascar and Asia (Sibley & Monroe 1990). Five species are listed as threatened by the IUCN Red List, three of which occur in Australia: Black-breasted Button-quail, Chestnut-backed Button-quail *T. castanota* and Buff-breasted Button-quail *T. olivii* (Collar et al. 1994). The Black-breasted Button-quail is the only turnicid endemic to vine forest in Australia (Ridley 1983; Marchant & Higgins 1993).

The Black-breasted Button-quail is listed in the IUCN Red List as endangered mainly because its total population is thought to contain fewer than 2500 mature individuals and continues to decline in response to severe fragmentation of its habitat such that no single population is thought to exceed 250 mature individuals (Collar et al. 1994). Under Appendix 2 of CITES (1989), the Australian *Endangered Species Protection Act 1992* and the Queensland *Nature Conservation Act*

(*Regulations*) 1994, the Black-breasted Button-quail is listed as vulnerable. In New South Wales under the *Endangered Fauna Act*, it is listed as a Schedule 12 species.

While the breeding biology of the Black-breasted Button-quail in captivity is well studied (e.g. Phipps 1976; Mills 1985; Shephard 1989; Roulston 1992), there is little information on nidification by wild birds. Most information deals with descriptions of clutches (Campbell 1901; North 1913-14; Barnard 1925; Barry & Vernon 1976) and sightings of hatched young (Jerrard 1927; Hughes & Hughes 1991).

This paper describes new information on the courtship behaviour, nesting behaviour and nests of the Black-breasted Button-quail in the wild documented by John Young in south-east Queensland and north-east New South Wales while searching for nests from 1969 to 1979. For this paper, observations are presented on the breeding activity associated with eight nests at five different locations, including one observation in 1985. John Young, a wildlife consultant and naturalist interested in the breeding biology of birds, was interviewed by Anita Smyth about his observations. A summary of that interview is presented in this paper.

Table 1 Description of the nest locations of Black-breasted Button-quail *Turnix melanogaster* in New South Wales and Queensland, 1969–85, showing data on observation time, the number of nests located, vegetation and climate of the sites as well as data on the record of Hughes & Hughes (1991).

Site	1	2	3	4	5	Hughes & Hughes 1991
Place	Walcha–Yarrowitch, NSW	Walcha–Yarrowitch, NSW	Dorrigo, NSW	Tenterfield, NSW	Redwood Park, Toowoomba, Qld	Widgee, Qld
Location	30°59'S, 151°35'E	30°59'S, 151°35'E	30°20'S, 152°01'E	29°03'S, 152°01'E	27°35'S, 151°59'E	26°13'S, 152°28'E
Observation time	Oct 1969–70	Dec 1970–71	Nov, early 1970s	Oct–Dec 1972, 1973; Feb–Apr 1974	Oct 1985	1966–72
No. of nests	1	3	2	1	1	—
Vegetation†	Fern Forest	Fern Forest	Fern Forest	Vine Forest	Vine Forest	Vine Forest
Mean rainfall (mm)	813	813	793‡	855	970	1143§
Month of peak rainfall	Jan	Jan	Jan	Dec–Jan	Dec–Mar	Dec–Mar
Peak rainfall (mm)	103	103	103‡	104–114	99–137	134–169§
Mean annual temperature (°C)	19.0	19.0	19.1‡	20.5	21.3	25.6§
Winter months	Apr–Oct	Apr–Oct	May–Sep	May–Sep	Jun–Aug	Jun–Aug
Mean daily minimum for winter months (°C)	–2.2–5.8	–2.2–5.8	0.2–4.0‡	0.5–5.4	5.2–6.4	6.3–7.9§

† Webb & Tracey 1981; ‡ Armidale Station; § Gympie Station.

Methods

Study sites

Approximately 15 nests were found between 1969 and 1985 in south-east Queensland and north-east New South Wales. Eight of these nests, from five sites, were selected as representative of the variation in the breeding activity of Black-breasted Button-quail (Table 1). One site was in south-east Queensland at Redwood Park, Toowoomba, and the other four in north-east New South Wales: one near the Queensland–New South Wales border approximately 30 km north-east of Tenterfield; two sites about 4 km apart in the Walcha–Yarrowitch area approximately 70 km south-east of Armidale and one near Torrigo approximately 1 km north-west of the town. The vegetation at Redwood Park and the Queensland/New South Wales border sites was subtropical vine forest with *Eucalyptus* spp. as emergents. At the Torrigo and Walcha–Yarrowitch sites, the subtropical vine forest was replaced by warm temperate fern forests with emergent *Eucalyptus* spp. Except for one Walcha–Yarrowitch site, all sites were

invaded by *Lantana camara*. Rainfall and temperature at all sites were seasonal (Table 1). The highest rainfall and warmest winter months occurred in the more northerly locations.

Location of nests

Nests of the Black-breasted Button-quail were difficult to find. Therefore, a systematic search technique was used to locate their nests. A search was conducted if pre-nesting behaviour (see Results) was displayed by a pair of birds and/or the species' characteristic foraging scrapes (platelets) were located. A systematic search involved a contiguous set of plots (100 m long by 5 m wide) that was meticulously searched for nests. On average, it took about two weeks of searching on consecutive days before a nest was located, although in one instance, it took about 30 min and on another occasion 11 weeks. On one occasion, the behaviour of a male indicated that it was probably incubating; it was quietly watched and carefully followed until it went back to the nest. On another occasion, as Barnard (1925) did, JY flushed a male from the understorey at ground level and a nest was located.

Results and discussion

Breeding season

Eight nests were found at the five sites in mid-October, November and late December (Table 1). The search effort was uneven among the months mainly because it was determined by the behaviour of the birds, the vegetation structure of their habitat and the experience of the observer. Evidence of clutches collected by Barnard in the late 1800s (Campbell 1901; North 1913–14; Barnard 1925), hatched young in 1926 (Jerrard 1927) and eggshells in 1972 (Barry & Vernon 1976) throughout the geographical distribution of the Black-breasted Button-quail suggest that the breeding season occurs from early November through to February–March. However, the observations of juveniles in all but one month over several years by Hughes & Hughes (1991) indicate that at one locality at least, the Black-breasted Button-quail in the wild can breed in any month of the year as captive birds do (Mills 1985; Shephard 1989). Contrary to Hughes & Hughes (1991), JY's data on nests show a distinct breeding season of only three months (October–December) which may be explained by the differences in daily minimum temperatures among the study sites (Table 1). JY's study sites can experience minimum temperatures ranging from -2.2°C to 6.4°C for three to seven months of the year depending on their locality whereas the study site of Hughes & Hughes (1991) commonly experienced daily minimum temperatures above 6.3°C . Mills (1985) noted that low temperatures affected the breeding season of captive birds in South Australia and it may also influence the onset and cessation of breeding by wild Black-breasted Button-quail in the southern part of its geographical range.

Another factor that may explain the variability in the timing of breeding by Black-breasted Button-quail is variable local rainfall. It has been suggested by several observers that nesting activity is associated with wet periods (e.g. Beruldsen 1980). Hughes & Hughes (1991) described breeding as variable and dependent on rainfall of 100 mm or more falling mostly between late spring and early autumn. On one occasion during the observation period described here, breeding started within a month of a period of consistent heavy rain which preceded a dry period. During the study, local rainfall was not recorded but the records of monthly rainfall for nearby meteorological stations indicate that falls of at least 100 mm were rare, because the highest average monthly rainfall, based on 120 years of record-

ing, was 137 mm over 12 mean rain days in January at Toowoomba. Furthermore, the months of peak rainfall at JY's sites do not correspond with nesting activity (Table 1). Because the distribution of leaf litter and soil invertebrates of vine forest respond to moisture gradients over the forest floor (R. Raven *in litt.* 20 June 1995), it is likely that fog through-fall (L. Hutley *in litt.* 25 July 1995) as well as light rain contributed to this gradient in this study rather than just high rainfall events.

Agonistic behaviour

At one site observed during 14 consecutive days, coveys of two different females repeatedly gave the drumming call and appeared to use non-overlapping activity areas. A brightly coloured female in adult plumage was seen to make continuous sets of platelets while occasionally giving the repetitive drumming call throughout an area of about 9 ha (300 x 300 m) that was situated on the side (but not the top) of a gently sloping ridge. On the other side of the ridge another female in dull-coloured, adult plumage also called but never foraged near the ridge top. The activities of both birds never extended to the ridge top, suggesting that each female had unique activity areas which were probably advertised by the drumming call. Similar to Hughes & Hughes' (1991) findings, no aggressive interactions between the two females and other conspecifics were observed. A few days later, a nest with eggs was found in the activity area of each female.

As suggested by captive studies, the repetition of the drumming call by females may be used to advertise their territories (Mills 1985), which are presumably maintained more often by avoidance behaviour on the part of other females rather than direct aggressive defence. Although Hughes & Hughes (1991) observed territorial behaviour in a female, they were unable to confirm whether it was associated with breeding. JY's data shows that wild female Black-breasted Button-quail, like captive birds, hold territories during the breeding season. Although aggressive behaviour between females has been observed in the wild on one occasion (Marchant & Higgins 1993), it appears to be largely an artefact of captive populations housed in small aviaries (Phipps 1976; Mills 1985; Shephard 1989).

Black-breasted Button-quails are most commonly encountered as coveys consisting of a female and one to three males all year round. However, circumstantial evidence suggests that during breeding males may hold temporary territories around nest sites within larger

female territories. On one occasion, when a female was laying, the male remained nearby and appeared to respond to the call of another male. When it heard the other male calling in the distance, it moved a distance away from the nest site, called and then returned to the nest site. This behaviour suggests that males at least occasionally may hold and actively defend temporary territories at the nest site but in the absence of systematic observations on uniquely marked individuals, it is difficult to know how typical this behaviour is in the wild, especially as it has not been reported in captive birds.

Courtship and nesting behaviour

Eleven weeks observation of a female and three males at a site in the Walcha–Yarrowitch area indicated that coveys broke up early in the breeding cycle and the males dispersed to areas within the territories of females. At this time the drumming of the female became more frequent and clucking calls of the males were heard for the first time. Each male appeared to restrict its calling and activities to a well defined area which was isolated from the areas of other males. On one occasion, a female was observed to move a distance of about 150–200 m to join a single male for a few days after which time she left that male and met up with another male that was about the same distance away. Again she spent several days with this male and then moved away about the same distance, once again. When the female was not with a male, she was sighted alone, foraging in many different areas of what was thought to be her territory. The female seemed to visit areas where only single males were observed. The lone males did not appear to interact with each other.

At another site in the Walcha–Yarrowitch area, one female and two males (M1 and M2) were observed at close distance during the breeding cycle for four to five weeks. The female did not give the drumming call throughout what was considered her territory. Rather, it was heard two to three times daily over a period of two to three days from a localised area. Within this area, a female and male bird (M1) were located a number of times; the other male (M2) was not sighted. At this time, M1 was uncharacteristically vocal, making sharp clucking noises that appeared to attract the female as she moved towards him in response to his calls. He occasionally made platelets, turning around in them while giving the clucking call. The female, which was also making platelets nearby, walked over to where M1 was at his platelet. She inspected the platelet and then both started mutual preening. Courtship feeding was not ob-

served but it could have been missed. The pair continued to behave in this manner for eight days after which time the female was sighted alone without M1. Two days later, the same female was sighted about 250 m away with a male presumably M2 or even another male, because the males were not identifiable. It was not M1 as he would have been incubating eggs at that time, as argued below. Both behaved in a similar manner as described above. After eight days, neither the female nor M2 were sighted. Twenty days after the female left M1, the nest of M1 was located within his courtship area and, 14 days after the female left M2, his nest was located. JY's data suggest that the female successively laid two clutches of eggs separated by eight to 10 days within about 250 m of each other in the courtship areas of two different males. Therefore, it was logistically impossible that the female was interacting with M1 on the second occasion (above) because incubation of eggs lasted 18 to 21 days in the wild (see below).

Hughes & Hughes' (1991) observations on the agonistic behaviour of wild Black-breasted Button-quail suggest that females may hold territories that are advertised by the drumming call which is not heard all year. Certainly, during the breeding season at least, JY's observations show that females appear to be territorial towards other females but not to males as they commonly formed coveys of three males or less. However, during courtship and nesting, the female was sighted with only one male on any single occasion. Other males, which are occasionally sighted alone by observers (McConnell & Hobson 1995), had dispersed and formed spatially independent areas for courtship and nesting within the female's territory. Within these areas a male courted a female and on one occasion during egg laying, he defended the site by advertising his presence to other males by calling. These areas which were visited by a female in a successive manner may be temporary territories for breeding purposes. Because the female plays no role in the incubation of the eggs (below), this species, at least occasionally, appears to have a successive polyandrous mating system.

Incubation, nests and materials

On one occasion, a female with a male in attendance was observed laying a clutch of eggs, one a day similar to captive birds (Marchant & Higgins 1993). Of all the nests observed, like captive birds, only the male incubated the eggs. The eggs in M1's and M2's nests (above) were very polished (not more than 20 days into

incubation and close to hatching, JY unpub. data) and semi-polished (about 13 days into incubation, JY unpub. data) respectively.

Of the eight nests observed, five clutches had four eggs, two had three eggs and one contained five eggs, mean = 3.88 (*c.f.* mean = 3.5, Marchant & Higgins 1993). Incubation appeared to last 18 to 21 days after the female laid the last egg, which is two to five days longer than that reported for captive birds (Phipps 1976; Mills 1985; Shephard 1989).

Nests were located in the small buttress root of a sapling, the base of a fern or under a crevice formed by a tree root, in association with an understorey of either bracken *Pteridium esculentum*, rasp fern *Doodia aspera*, *Lantana camara* or other weedy plant species. A slight depression (100 x 60 mm) was made in the ground and was lined with either leaves, 'straws' of grass and/or moss. At Redwood Park, the nest was completely exposed without any form of cover, although *L. camara* was nearby. Contrary to the findings of Hughes & Hughes (1991) and Marchant & Higgins (1993) on captive birds, nests did not have a constructed dome or a hood. Except for the nest at Redwood Park, most nests had natural cover formed by the frond of a fern or the overhang of a buttress root. Nest building was not observed on any occasion, so which sex builds nests in the wild remains unknown.

Discussion

Most of the observations on the breeding biology of other turnicids have been made under captive conditions. Observations on the courtship and mating behaviour of *T. melanogaster* in captivity concur with those of *T. sylvatica*, *varia*, *tanki* and *suscitator* (Ridley 1983 and references therein) although Wintle (1975) argues that *T. suscitator* females may not always be territorial as they may sometimes wander freely in search of males and not remain in a fixed activity area. In other turnicids (e.g. *T. tanki*, *T. sylvatica* and *T. suscitator*), both the male and female are involved in nest building unlike *T. melanogaster* where only females have been observed building nests in captivity.

JY's observations show that wild Black-breasted Button-quail can breed in any month of the year; however, the duration of the breeding season appears to be curtailed by local winter temperatures. Agonistic behaviour between females suggests that females are territorial during the breeding season. Males may hold temporary territories for courtship and nesting which are

within a female's territory and possibly defended by call. The species may have a successive polyandrous mating system in which females mate with lone males successively. The female can lay two clutches approximately eight to 10 days apart. However, more research involving individually marked birds and molecular parentage analysis is required to substantiate these inferences.

Acknowledgements

Constructive comments on the manuscript were provided by Anne Goldizen, Ian Owens, Chris Pavey, Wayne Longmore and anonymous. The Queensland Department of Environment and Heritage and the Queensland Department of Primary Industries Forest Service, the Australian Bird Environment Fund, Australian Geographic and the Mary Ethel Reid Trust funded the postgraduate research of Anita Smyth that enabled John Young to be contracted for field work and subsequently interviewed.

References

- Barnard, C.A. 1925. A review of the birdlife on Coomooloolaroo Station, Daringa District, Queensland, during the past fifty years. *Emu* 24, 252-265.
- Barry, D.H. & Vernon, D.P. 1976. Further notes on the birds of Fraser Island and adjacent waters. *Sunbird* 7, 107-111.
- Beruldsen, G. 1980. A Field Guide to Nests and Eggs of Australian Birds. Rigby, Adelaide.
- Campbell, A.J. 1901. Nests and Eggs of Australian Birds Including the Geographical Distribution of the Species and Popular Observations Thereon. Author, Melbourne.
- Christidis, L. & Boles, W.E. 1994. The Taxonomy and Species of Birds of Australia and its Territories. RAOU, Melbourne.
- Collar, N.J., Crosby, M.J. & Stattersfield, A.J. 1994. Birds to Watch 2, The World List of Threatened Birds. Birdlife International, Cambridge, UK.
- Hughes, P. & Hughes, B. 1991. Notes on the Black-breasted Button-quail at Widgee, Queensland. *Australian Bird Watcher* 14, 113-118.
- Jerrard, C.H.H. 1927. Family life of Black-breasted Quail. *Emu* 26, 304-306.
- Marchant, S. & Higgins, P.J. 1993. Handbook of Australian, New Zealand and Antarctic Birds, Vol 2. Oxford University Press, Melbourne.
- McConnell, P. & Hobson, R. 1995. The diet and behaviour of the Black-breasted Button-quail *Turnix melanogaster*. *Sunbird* 25, 18-23.
- Mills, R. 1985. Black-breasted Button-quail. *Bird Keeping in Australia* 28, 17-19.

- North, A.J. 1913-14. Nest and Eggs of Birds Found Breeding in Australia and Tasmania, IV. Spec. Cat. 1 Australian Museum, Sydney.
- Phipps, G. 1976. Breeding the Black-breasted Turnix. Australian Aviculture 30, 130-134.
- Ridley, M.V. 1983. A review of the ecology and behaviour of button-quails. Journal of World Pheasant Association 8, 50-61.
- Roulston, G. 1992. The Black-breasted Button-quail *Turnix melanogaster [melanogaster]*. Australian Aviculture 46, 157-160.
- Shephard, M. 1989. Aviculture in Australia. Black Cockatoo Press, Melbourne.
- Sibley, C.G. & Ahlquist, J.E. 1990. Phylogeny and Classification of Birds. Yale University Press, New Haven.
- Sibley, C.G. & Monroe, B.L. 1990. Distribution and Taxonomy of Birds of the World. Yale University Press, New Haven and London.
- Webb, L.J. & Tracey, J.G. 1981. Australian rainforest patterns and changes. Pp. 605-694 in Ecological Biogeography of Australia. Ed. A. Keast. Junk, The Hague.
- Wintle, C.C. 1975. Notes on the breeding habits of the Kurichaine Button-quail. Honeyguide 82, 27-30.

White-winged Choughs *Corcorax melanorhamphos* Using a Stick Nest

Elaina M. Tuttle and Stephen Pruett-Jones

Department of Ecology and Evolution, University of Chicago, 1101 East 57th Street, Chicago, Illinois 60637, USA

EMU Vol. 96, 207-209, 1996. Received 28-2-1996, accepted 29-2-1996

Bird nests are typically species-specific in their structure and overall form and this can be sufficiently great that nest structure can be used as a character in constructing phylogenies (e.g. Rowley 1970; Winkler & Sheldon 1993). In the Australian mud-nest builders (subfamily Corcoracinae, Family Corvidae; Sibley & Monroe 1990) both the White-winged Chough *Corcorax melanorhamphos* and the Apostlebird *Struthidea cinerea* build large bowl-shaped mud nests. Previously, no variation in nest type has been reported for either of the two species, although choughs have been observed to place their mud nests inside an abandoned stick nest (North 1901). Here, in contrast, we report observations of White-winged Choughs nesting in a stick nest.

White-winged Choughs are communal, insectivorous birds that live in groups of 2-20 individuals (Rowley 1978; Heinsohn 1991, 1992). Choughs start breeding in July and August and every individual in the group contributes to all aspects of nest building and parental care (Heinsohn 1991, 1992). The nest resembles a pottery bowl and is constructed out of mud and fibres (Rowley 1975, 1978). Nest building may last several days to months since each layer of mud must harden before fresh layers are added (Rowley 1975, 1978). Nest building skills appear to be learned since young birds

often accompany and watch building adults, and have even been seen to accidentally damage a nest while attempting to help build it (Rowley 1975, 1978).

On 17 October 1995 at Brookfield Conservation Park, South Australia we observed an adult White-winged Chough brooding two chicks in a stick nest (Fig. 1). The nest was approximately 7 m above the ground in a fork of a 12 m high mallee eucalypt tree. We spent three hours watching the nest on 18 October and again on 20 October for a total of 6 hours. One chick appeared older and slightly more active than the other, but both chicks were approximately 14 days old and just starting to grow feathers. Four adults attended the nest; one always brooded the young while the other three birds foraged. During 32 observed feeding visits, foragers tended to arrive simultaneously. The first adult to feed the chicks was also the one that disposed of faecal sacs and later remained to brood; the original brooder then became a forager.

During 19 October a severe storm moved into the Park and lasted four days. On the second day of our observations (20 October) the stick nest remained intact but we noticed that only one chick remained in the nest. The adults continued to brood and feed this chick. On 21 October the single young was still present but on 22 Oc-