

Notes on Breeding Behaviour, Ecology, Taxonomy and Vocalisations of Satanic Nightjar *Eurostopodus diabolicus* in Central Sulawesi

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Summary: The Satanic Nightjar *Eurostopodus diabolicus*, rediscovered in 1996, is a hitherto poorly known nocturnal bird endemic to Sulawesi's hill and montane forests with only two documented nest records to date. Here, we describe two further nest records from the Anaso track in Lore Lindu National Park (LLNP), Central Sulawesi, which extend the known breeding season by five months. This suggests the breeding season lasts at least seven months, from March to October. Both nests were on the ground in forest clearings with at least a partial ground cover of ferns and moss, and both contained single chicks. The nestling period was at least 31 days. Our records of vocalizing individuals at 2,300m asl extend the known upper elevation limit of the species. Apparent plumage and vocal differences between birds in North and Central Sulawesi suggest that the species is not monotypic, although further study is needed.

Ringkasan: Taktarau iblis *Eurostopodus diabolicus* yang ditemukan kembali pada tahun 1996, merupakan jenis yang kurang dikenal hingga saat ini dan termasuk jenis burung malam endemik hutan pegunungan Sulawesi dengan dua catatan tentang sarangnya. Di sini, kami akan menjabarkan lebih lanjut mengenai dua catatan tentang sarang dari jalur Anaso di Taman Nasional Lore Lindu (LLNP), Sulawesi Tengah, saat perpanjangan musim berbiak dari lima bulan. Ini menunjukkan musim berbiak setidaknya berlangsung selama tujuh bulan, dari Maret hingga Oktober. Kedua sarang tersebut terletak di tanah pada bagian pembukaan lahan hutan dengan sebagian penutup tanah berupa pakis dan lumut, dan keduanya berisi satu anak. Periode sarang kurang lebih 30 hari. Kami mencatat suara aktif dari individu pada 2.300 mdpl lebih luas diatas batas ketinggian untuk jenis ini. Diagnosis dari bulu dan perbedaan suara antara burung yang berada di Sulawesi Utara dan Sulawesi Tengah menunjukkan bahwa jenis ini tidak monotipik.

Introduction

The Satanic Nightjar *Eurostopodus diabolicus*, also known as Heinrich's Nightjar (Cleere 2010), is one of two species of nightjars endemic to the large island of Sulawesi, Indonesia (Coates & Bishop 1997), the other being the more widespread Sulawesi Nightjar *Caprimulgus celebensis*. Morphologically, the Satanic Nightjar is

unlike the two large, 'eared' *Eurostopodus* nightjars which have been reinstated under *Lyncornis*, of which one species, Great Eared Nightjar *L. macrotis*, also occurs on Sulawesi (Coates & Bishop 1997; Cleere 2010). After the type specimen of *E. diabolicus* was collected in 1931 by Gerd Heinrich near the foot of Mount Klabat on the eastern tip of North Sulawesi, there were no further confirmed records until it was rediscovered at Lore Lindu National Park (LLNP), Central Sulawesi in 1996 (Bishop & Diamond 1997). Bishop & Diamond (1997) found the nightjar in small clearings in montane forest in Mt Nokilalaki and Mt Rorekatimbu, both in Lore Lindu, effectively extending the then known range of the species southwards by about 750 km. Despite the huge gap in distribution and the fact that Lore Lindu is in a biogeographically distinct part of Sulawesi, the species has been assumed without study to be monotypic.

Since its rediscovery, the Satanic Nightjar has been reported from a number of lowland sites (e.g. Buton) although some of these are likely to have resulted from confusion with *C. celebensis* (Riley & Wardill 2003). Most sightings, however originate from along the Anaso trail on Mt Rorekatimbu, LLNP, which is frequently visited by birdwatchers (Boon & Faustino 2005). Riley & Wardill (2003) also reported the species from lowland hill and submontane forests in the Panua and Gunung Ambang Nature Reserves respectively, both on the northern (Minahassa) peninsula. It is thus possible that the species is widely distributed in hill and montane forest across Sulawesi, particularly on the island's mountainous spine, though further field surveys will be needed to confirm this. However, its presumably small geographical range based on earlier accounts, and widespread deforestation in the northern peninsula has led to the species being currently classified as globally vulnerable (Holyoak 2001; IUCN 2011).

A paucity of field surveys and difficulty in accessing remote sites means that Sulawesi's forest-dwelling birds are poorly known and ecological data of many species remain limited, except in localities frequently visited by birdwatchers. The Satanic Nightjar is now a notable exception, thanks to the relative accessibility of LLNP. The first nest for the species was reported from lowland hill forest in the Panua Nature Reserve by Riley & Wardill (2003). Boon & Faustino (2005) reported a second nest from LLNP. In both cases, the nest was on the ground in a forest clearing, with surrounding dried leaves providing excellent camouflage. A photo of an adult and a chick published in Cleere (2010), apparently taken in LLNP in 2006 documents a third nest. However, none of the authors provided further details on nesting due to limited observation periods. Since then, we have found at least two more nests during field surveys on the Anaso track in LLNP in 2009 and 2011. Here we describe these nests and our observations of nesting behaviour of adult nightjars. We also describe the vocalizations of the Satanic Nightjar based on our sound recordings obtained. Finally, we compare the plumage of birds photographed at Lore Lindu with that of the type specimen and one photographed in North Sulawesi.

Site description

The 229,000 ha Lore Lindu National Park in Central Sulawesi Province encompasses a wide altitudinal range of forest types, extending from about 300 m

asl in the lowlands to 2,610 m at the summit of Mt Rorekatimbu, the park's tallest peak, with 64% of its area being located above 1,200 m (Waltert *et al.* 2004). Although much of the forest below 1,200 m has recently been lost due to illegal agricultural expansion and logging at the edges of the park and along the major roads that dissect the park (Waltert *et al.* 2004, 2005; Weber *et al.* 2007), the park still contains significant areas of pristine lower and upper montane evergreen forest, key habitats for the Satanic Nightjar and 78% of Sulawesi's endemic birds (Coates & Bishop 1997), including nearly all of Sulawesi's nocturnal birds.

The Anaso track is a broad, old logging track that starts from approximately 1,600 m asl at the Palu-Wuasa road, leads to Puncak Dingin near the summit of Mt Rorekatimbu (c.01°16.07'S, 120°19.02'E), and ends at Anaso camp. Logging has ceased along the track since the 1980s and the forest is regenerating along both sides (Madika *et al.* 2011). Montane forest here is dominated by oaks such as *Castanopsis acuminatissima* (Fagaceae) and dammar or kauri (*Agathis* sp., Araucariaceae) (Whitten *et al.* 2002). From 2,250 m and above, the forest is lower in stature and is dominated by *Leptospermum* sp. (Myrtaceae) and *Dacrycarpus* sp. (Podocarpaceae) with abundant *Rhododendron* and *Vaccinium* (Ericaceae) in the understorey (Whitten *et al.* 2002).

Nest observations and nesting behaviour

Discovery of first nest

The first nest described here was found by JBCH and DDP in a forest clearing dominated by ferns at 2,060 m asl along the Anaso track on 9 October 2009, and comprised a small depression estimated to be approximately 12–14 cm wide and 1 cm deep (Plate 1). At the time of discovery, only one unsexed adult was at the nest. We are unable to determine whether incubation duties were alternated between two adults, or if the same adult was present at the nest throughout incubation. One egg, measuring 35.0 x 22.0 mm, was perched on top of the tips of dead fern fronds and black moss, and the area surrounding it was littered with dead plant materials (club moss branchlets, leaves and plant stems). The egg was cream-coloured and lightly speckled (Plate 2).



Plate 1: Site of first (2009) nest, with flushed adult.

JBCH and DDP returned on 6 November and found a young, down-covered nestling at the nest (Plate 3), although no adults were seen in the vicinity. As we were unable to determine the date of hatching, it was not possible to age the chick accurately but we estimated that it was between two to five days old, given that we did not notice any feathers in pin. Finally, DLY and DDP visited on 7 December and found one adult and one chick present at the nest site. By then, the chick's plumage was fairly well-developed although it was much less well-marked than the adult beside it. For instance, the throat, scapulars and belly feathers were all weakly patterned in clear contrast to the adult (Plate 4).

Discovery of nestling from an unobserved nest

On 5 November 2009 JCBH and DDP also found that local harvesters of dammar (*Agathis* sp.) resin had captured a fledgling Satanic Nightjar (Plates 5), which was later released at the site where it was purportedly captured. Clearly a different bird from the one found in October as the site was 3.1 km away, this bird's plumage was not fully developed and it was unable to fly. The fledgling called when it heard the vocalisations of a nearby adult but in 10 minutes of observations, no adult came to attend to it. We were unable to locate the nest of this individual.



JB CHARRIS



JB CHARRIS

Plate 2: Egg in first (2009) nest

Plate 3: Nestling in first (2009) nest when observed on 6 November 2009



D L YONG

Plate 4: Nestling in first (2009) nest when observed on 7 December 2009.



J B CHARRIS

Plate 5: Tail of fledgling captured on 5 November 2009, showing feather sheaths.



R NOSKE

Plate 6: Nestling from second nest on 1 April 2011, showing extensive pin feathers.

Discovery of second nest

On 1 April 2011 (at 14:30 hrs) RN and WR were shown an adult sitting on the ground about 1.5 m from the base of a 3.5 m high cliff face of a small quarry beside the road. The site was at a slightly lower elevation than the nest photographed in 2009. The bird occasionally gaped as it was approached, but eventually flew off, revealing a tiny fawn-coloured chick that weighed 25.0 g at the time (Plate 6 & 7). The chick was banded and estimated to be about seven to eight days old as the crown, wings, spinal tract and neck were covered in pin feathers, and those of the wing-coverts had begun to emerge from their sheaths. The finely pebbled ground beneath where the chick (and earlier, the adult) sat was littered with dead leaves, varying in colour from reddish-brown to pale brownish-grey, thin dead twigs, tiny flakes of bark, and many small whitish-brown stones (plate 8). Within 5 cm of the spot were erect stems of club moss *Lycopodium* sp., and c. 20 cm away, a large patch of ground was densely covered with black moss, giving the ground a charred appearance. There was no depression, nor any other clue indicating that a nest was present.

Threat display

Adults were observed to engage in a peculiar threat display when disturbed at their nests. Once approached, the sitting nightjar opened its bill widely, exposing a bright pink gape and flushing only when approached to less than one metre. At the first nest found by JBCH and DDP, the incubating adult hovered for about 15 seconds after it was flushed, opening and closing its gape several times to expose the bright pink mouth lining. This individual was observed to fly back and forth a few times before finally resting on the ground near the nest with both wings partially opened. Within 30 seconds, the disturbed bird resumed incubation after the observer retreated. Similar behaviour was observed at the 2011 nest (nest 2), although the presence of the observers precluded landing by the sitting bird. These observations were consistent with that of Wardill & Riley (2003) from Mt Ambang, North Sulawesi. When RN and DDP re-visited the above two known nest sites on 1 November 2011, pairs were found at each site. While the pair at the 2009 nest site

flushed as soon as they were approached, one of the pair at the 2011 nest site stood its ground until approached very closely. This bird gaped continually and spread its wings (Plate 7), before eventually flushing, yet no nest or juvenile bird could be found.



R NOSKE

Plate 7: Adult brooding advanced nestling (hidden) in second nest on 1 April 2011.



JBC HARRIS

Plate 8: Adult seen in threat display at first nest

In our most recent observation, a single moulting subadult present at the same ground roost from at least 28 June to 2 July 2012 about 1 km walk above the helipad also gave a threat display that involved gaping, rocking back and forth with spread wing and tail, occasional lunging toward the observer with occasional startling, abrupt growling calls, and loud wing rustling when flushing to another spot about a foot away (PCR). When disturbed by another person more closely the bird flushed, flew some distance away into the forest edge, then flew silently away and never used that roost again (at least until the 12 July).

Description of vocalisations

The scientific and common names of Satanic Nightjar (and the synonym Diabolical Nightjar) has been attributed to its song, sometimes described as a '*plip plop*' and likened to rapid water dripping or the sound of the bird 'pulling out a person's eye' by locals (Collar *et al.* 2001; Holyoak 2001), which in fact refers to the vocalisation that is given in flight (Fig. 1). On 7 December 2009, DLY and DDP located and made recordings of a single bird vocalising at a forest clearing at Puncak Dingin, which notably is the highest point on the Anaso track (2,300 m asl) and the highest recorded elevation for the species. This vocal individual was observed between 18:45 and 19:00 hrs, and was seen to make about six short hawking flights around a forest clearing before flying off around 19:00 hrs. At least two individuals were seen and/or heard near the same spot each evening around dusk from 17–19 July 2011, and further recordings were made by PCR on 18–19 July between 18:18–18:25 hrs.

Our recordings show that two distinctly different song types are given by this species in LLNP. In flight, birds give a series of widely spaced, musical, loud, resonant, abrupt upturned *fwIP!*, *fwIP!*, ... notes (Figure 1a). The starting frequency of each note is c.1 kHz, and the ending frequency is c. 2 kHz; note length is about 0.1 s, and notes are usually about 1 s apart. Sometimes the internote pauses are much longer, or notes are delivered in closely spaced pairs separated by 0.07 s; in these note-pairs the first note is longer, more diagonal on a sonagram, while the second is sharper, more vertical and more abrupt-sounding *fwIP-WIK!*, *fwIP-WIK!* All the recordings of which we are aware of this note type were evidently made in flight, as the sound either increases or decreases in amplitude dramatically as the series progresses (see also Figure 1b, e).

The second main note type (Figure 1b–e) is usually given while perched, judging from recordings available to us. This is a fairly uniform trill of sharp quick musical resonant percussive notes similar in tone to the single or doubled notes, but quickly run-together. In form the trilled syllables are much shorter, only about 0.04 s long, and each note is loudest at the start and trends downward, e.g., *Twik-Twik-Twik*... rather than trending upward and being loudest at the end as in the single notes. The first note of a trill may be distinctly lower in frequency and softer than the remaining notes. The trill may waver slightly in frequency, although it sounds uniform. The range of the trilled notes is about the same as that of the single notes, but reversed, each syllable starting at c.2 kHz and ending at c.1 kHz. Notes are separated from each other by about 0.08 s, twice the length of the notes themselves. The trill strophes range from 2.4–5.7 s in length, with 8–9 syllables/s. There are moderately strong harmonics at about 4 kHz, visible in the clearer recordings.

In another recording (Figure 1b), the trill was given by two individuals, one more distant being joined after 3.1 s by a closer one. Then, several seconds after the trill, a series of single then doubled notes was given in flight. It seems almost certain that both note types were given by the same individual, the trill when perched and the single and doubled notes in flight. During the 2009 encounter, the vocalising individual was perched on a low, bare shrub and sang four times, with an approximately two-minute pause between vocalisations. DLY was able to record one song strophe (Figure 1d). This is similar to Mauro's (2003) description of a

‘bubbling series of up to 36 *kweik* notes, delivered at constant pitch and speed and lasting about 4.7 seconds’ (one syllable per 0.131 sec).

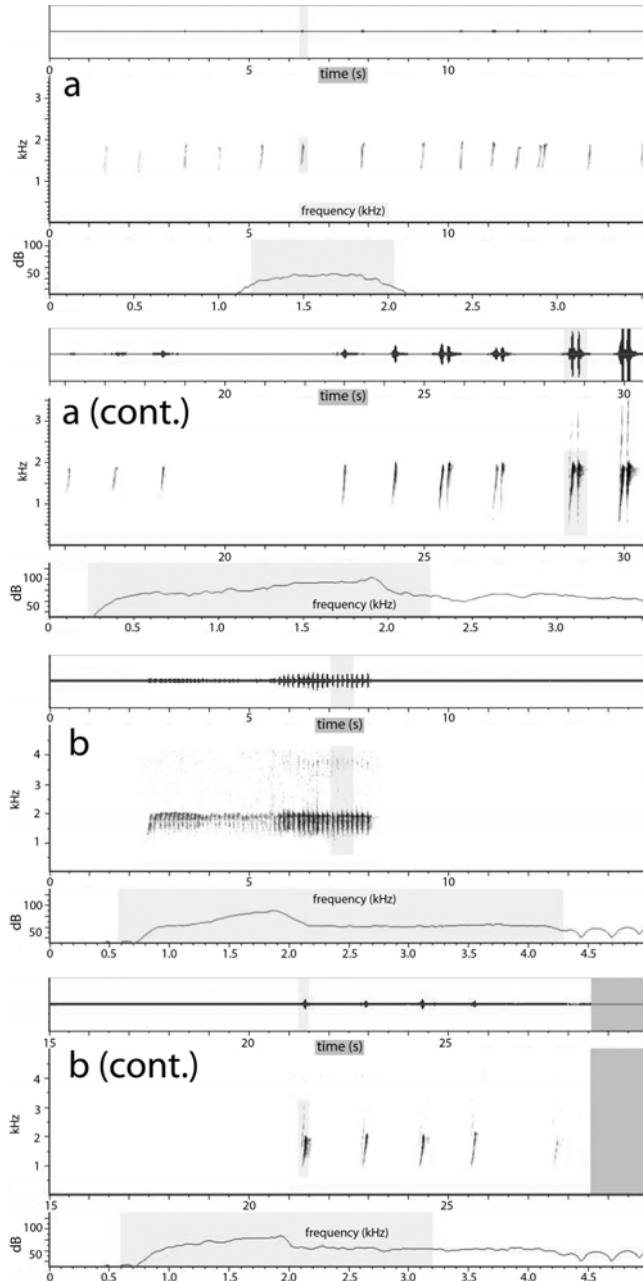


Figure 1: Waveforms (upper bars, showing amplitude), sonograms (middle bars), and spectra (lower bar, showing power profiles) of the song of Satanic Nightjar, a-e from Lore Lindu NP, C Sulawesi, f from Gunung Ambang, N Sulawesi: a) sequence of flight song (Puncak Dingin, 18 Jul 2011, recordist PCR); b) perched song by two individuals then flight song by one (Puncak Dingin, 19 Jul 2011, recordist PCR)

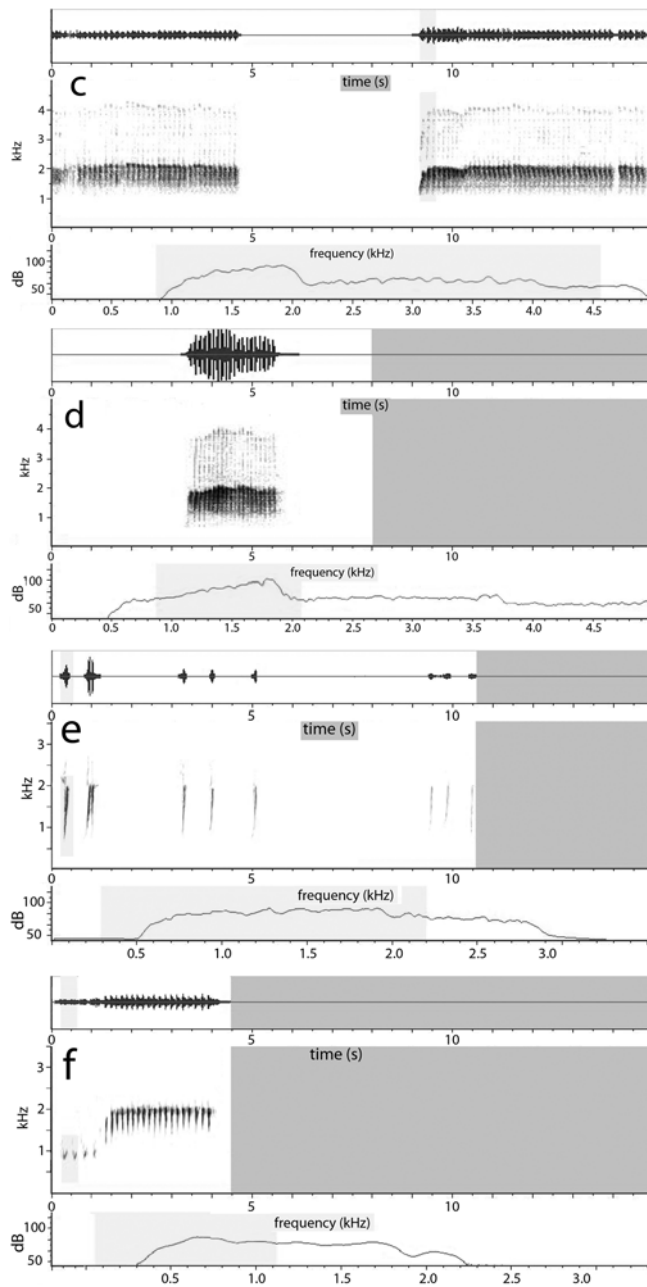


Figure 1: Continued. c); perched song (Puncak Dingin, 18 Jul 2011, recordist PCR); d) perched song (Puncak Dingin, 7 Dec 2009, recordist DLY, xeno-canto, XC#57231); e) song of bird seen in flight, dawn, 4 Apr 2000, above Anaso track, recordist F. R. Lambert, AVoCet, AV#5112); f) from 1450 m, Gng. Ambang; (not seen, 17 Mar 2009, recordist Philippe Verbelen, AV#3310).

In July 2012, silent individuals were observed briefly on several evenings flying around Puncak Dingin and lower down at the helipad, and on 8 July a silent individual was observed for about 10 minutes flying around the treetops at the helipad. At least during July, vocalizing appears to be infrequent, even during periods of activity. In the sole recording from North Sulawesi (Figure 1f), the trill is preceded by a few soft, lower, more nasal, slurred *qu/wick!* notes (maximum power c. 6.5 kHz), similar to those occasionally given by some other nightjars. The trill itself is slower, with 7 notes/s (vs. 8-9/s), but is otherwise similar to that of birds from Central Sulawesi.

Habitat preference

In over 50 field days of intensive bird sampling across an elevation gradient from 1800 m to 2400 m, JBCH, DDP and DLY found Satanic Nightjars only along the Anaso track and again, usually in densely vegetated clearings by the edge of the track, where single birds or pairs were observed roosting during daytime. Adult Satanic Nightjars were only observed once inside the closed canopy of the forest during our field work (RN, WR). During our point count surveys for nightbirds, we failed to find the species whether by sight or by vocalisation even after we had detected most other expected species of nightbirds (Harris *et al.* 2009). The Satanic Nightjar appears to be locally common at least on Mt Rorekatimbu, frequently using forest clearings for roosts or nesting. On the other hand, intensive sampling on three other well-forested mountains in LLNP from 480–2340 m failed to detect the species. This sampling comprised 102 x 10 minute point counts conducted at night on Mts. Nokilalaki, Dali, and Rano Rano in May–June 2010 and January–February 2011 (JBCH unpubl. data). Given these observations, it appears reasonable to conclude that both natural and man-made forest clearings at least, are ecologically important to the species.

Taxonomy

Although *Eurostopodus diabolicus* has always been considered monotypic, this treatment may be erroneous. Comparisons of the sole specimen (AMNH 461232), a female collected in North Sulawesi (Plate 9), with one photograph of a bird from Mt Mahawu, North Sulawesi (<http://ibc.lynxeds.com/photo/heinrich039s-nightjar-eurostopodus-diabolicus/single-bird-perched-low-forest-understory>), and many photographs from Anaso track, LLNP, primarily from orientalbirdimages.org, show that there are marked apparent differences corresponding to geography. Intriguingly, Wardill & Riley (2003) also noted plumage differences between the type and individuals observed in Mt Ambang and hinted at the possibility that another *Eurostopodus* nightjar similar to *E. diabolicus* may occur on Sulawesi (Wardill, J. *in litt.* 2012).

We noted that two individuals from North Sulawesi show neither grey patches in the scapulars nor on the upper tail surface while all those from Central Sulawesi have large, obvious pale grey patches in the scapulars, and the upper tail surface is primarily pale grey. However, according to J. Wardill (*in litt.* 2012), birds he observed at Mt Ambang in northern Sulawesi also had pale grey scapular patches; further confirmation is needed. In addition, the female type specimen has a large

bright buffy throat patch while this is either white or appears paler buffy in Lore Lindu birds in photos. This apparent difference may be due to preparation style of the type, and it may be that males have whiter throats than females; clearly further data is needed. Most if not all Lore Lindu birds show strong bright white oval breast feather tips, but these appear weaker and browner in the North Sulawesi type and the live bird photographed at Mt Mahawu.



Plate 9: Holotype of *E. diabolicus* at the American Museum of Natural History

The apparent difference in speed of trill song between birds from North and Central Sulawesi is likely to be of significance in an assessment of its taxonomic status. We do not know whether birds from North Sulawesi also give the single or doubled flight notes, or whether birds from Central Sulawesi also give the soft low introductory notes.

Clearly, further study and specimen material will be necessary to establish the characters and taxonomic status of the possibly undescribed form from Lore Lindu. We have inadequate information on the morphology and vocalisations of *E. diabolicus* from North Sulawesi, and obtaining more photographs and recordings should be a high priority. Playback experiments using recordings from the two populations may be informative, however, in PCR's experience in 2011 and 2012, playback did not result in discernible response even by nearby birds and may be of limited value in eliciting vocal responses.

Discussion

Although the Satanic Nightjar is regularly encountered on the Anaso track, LLNP, as inferred from multiple birdwatcher reports (e.g. Hutchinson 2010; Farrow 2010), there are few observations of nesting behaviour. Prior to our observations, there were only three other known nest records of Satanic Nightjar. Our field work

enables us to further describe two nesting attempts and we were able to observe nesting progression for one of the nests for over two months. Consistent with the findings of Boon & Faustino (2005) and Riley & Wardill (2003), we observed that all nest sites were in small forest clearings near the forest edge, but not inside closed-canopy forest, suggesting that the species is dependent on natural forest clearings provided by landslips and large tree falls. On the other hand, given that all known records of the species were in the vicinity of undisturbed forest, it is likely that the species is dependent on the close proximity of such forests for foraging, and it will be premature to conclude that the species can tolerate large-scale habitat modification (Riley & Wardill 2003; Boon & Faustino 2005) on present information. We failed to find any Satanic Nightjars during either diurnal or nocturnal sampling of three other mountains with largely pristine montane forest in LLNP (JBCH unpubl. data), suggesting Mt Rorekatimbu may be a localised centre of abundance for the species given the extensiveness of favoured habitat. Further nocturnal field sampling, with vocalisation playback that may increase detection rates (Sekercioglu 2010) should be conducted to evaluate local densities and habitat preferences of the species in the park. However, as noted above, we have only heard this species infrequently even when it was seen foraging, and then only for brief periods just before dusk, and even less often and very briefly at dawn.

Table 1. Details of nesting records of the Satanic Nightjar, including the first two described records. LLNP, Lore Lindu National Park. The record based on Markus Lagerqvist's photograph in Cleere (2010) is not presented here due to lack of detailed information.

Coordinates	Elevation (m asl)	Locality	Date first found	Contents	Source
0.28°N, 121.56°E	~ 345	Panua Nature Reserve	12 May 2000	1 egg	Riley & Wardill (2003)
No information	~1,600	Anaso, LLNP	2 Jul 2003	1 egg	Boon & Faustino (2005)
1.3037°S, 120.3085°E	2,060	Anaso, LLNP	9 Oct 2009	1 egg	This paper (nest 1)
1.2779°S, 120.3189°E	~2,245	Anaso, LLNP	5 Nov 2009	1 fledgling	This paper (nest not observed)
1.3103°S, 120.3085°E	2,016	Anaso, LLNP	1 Apr 2011	1 young nestling	This paper (nest 2)

Our nesting observations extend the known breeding season of May to July earlier by two months (early March) and later by three months (October) (Table 1). The nest which we found on 1 April already contained a young chick, which meant that assuming an incubation period of between 22 to 30 days, as is typical for other *Eurostopodus* nightjars (Cleere 1994; Higgins 1999), the egg of the second nest must have been laid within the first two weeks of March, four months earlier in the year than Boon & Faustino's (2005) nest record on the Anaso track. Based on our age estimate of the chick on 6 November 2009, the egg of the first nest was probably laid around the second week of October. On 7 December, 30 days later, the chick already had fully formed adult plumage, suggesting a nestling period of at least 31

days. Unfortunately we did not return afterwards to determine the precise date of fledging.

The display behavior we documented for the adult seen incubating on October 2009 appears to be typical for caprimulgids and has also been reported by Riley & Wardill (2003). Interestingly, in both observations including ours, the nightjar was reluctant to flee, flushing only when approached to about one metre. Shortly before flying off, the nightjar engaged in an apparent threat display, opening its bill wide to expose its pink gape, consistent with Riley & Wardill's (2003) observations. The individual we observed however hovered for a while and repeatedly opened and closed its bill, eventually landing some distance on the ground away from the nest with wings partly outstretched.

The Satanic Nightjar was one of Sulawesi's most poorly known birds until its rediscovery in 1996 (White & Bruce 1986; Bishop & Diamond 1997), having been 'lost' for nearly 60 years. However, given our findings, it is perhaps now one of the best known nightbirds on Sulawesi. Our recent records of the species not only extend the known upper elevation limit, but suggest that the species has a fairly wide distribution that extends from the hills well into upper montane forests. Since montane forest is still largely intact in Sulawesi, the species is possibly not as threatened as previously thought and this could justify a revision of its conservation status in future. During our 28 June-7 July 2012 observation period, we located a minimum of four and maximum of eight nightjars between the helipad and Puncak Dingin. However, at least along the Anaso track, increasing disturbance in the form of campers, dammar collectors, and photographers at the few flat open spots preferred by the nightjar for roosting may be resulting in birds becoming shy and hard to find at least during the day. Future field work should attempt to locate populations in other poorly surveyed parts of Sulawesi where the species possibly occurs, especially in the well-forested Latimojong and Mekongga mountains. Collection of specimen material will be necessary in order to describe the North-central Sulawesi population to science (assuming it proves to be distinct), and further sound recordings and documentation of morphology from North Sulawesi will also contribute greatly to understanding the taxonomy of this species. Similarly, more field work on Sulawesi's other nightbirds, many of which remain poorly known is urgently needed to determine their ecology, distribution and conservation status.

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