

Birds of Gunung Tambora, Sumbawa, Indonesia: effects of altitude, the 1815 cataclysmic volcanic eruption and trade

COLIN R. TRAINOR

In June–July 2000, a 10-day avifaunal survey on Gunung Tambora (2,850 m, site of the greatest volcanic eruption in recorded history), revealed an extraordinary mountain with a rather ordinary Sumbawan avifauna: low in total species number, with all species except two oriental montane specialists (Sunda Bush Warbler *Cettia vulcania* and Lesser Shortwing *Brachypteryx leucophrys*) occurring widely elsewhere on Sumbawa. Only 11 of 19 restricted-range bird species known for Sumbawa were recorded, with several exceptional absences speculated to result from the eruption. These included: Flores Green Pigeon *Treron floris*, Russet-capped Tesia *Tesia everetti*, Bare-throated Whistler *Pachycephala nudigula*, Flame-breasted Sunbird *Nectarinia solaris*, Yellow-browed White-eye *Lophozosterops superciliaris* and Scaly-crowned Honeyeater *Lichmera lombokia*. All 11 restricted-range species occurred at 1,200–1,600 m, and ten were found above 1,600 m, highlighting the conservation significance of hill and montane habitat. Populations of the Yellow-crested Cockatoo *Cacatua sulphurea*, Hill Myna *Gracula religiosa*, Chestnut-backed Thrush *Zoothera doherlyi* and Chestnut-capped Thrush *Zoothera interpres* have been greatly reduced by bird trade and hunting in the Tambora Important Bird Area, as has occurred through much of Nusa Tenggara.

‘in its fury, the eruption spared, of the inhabitants, not a single person, of the fauna, not a worm, of the flora, not a blade of grass’ Francis (1831) in de Jong Boers (1995), referring to the 1815 Tambora eruption.

INTRODUCTION

The 1815 eruption of the Gunung Tambora volcano (2,850 m, c.1,200 km², 8°16’S 117°58’E), Sumbawa, Indonesia, caused a natural disturbance without equal in recorded history. An estimated 80–150 km³ of volcanic material was released (the approximate equivalent to 16,000 Hiroshima bombs or eight times greater than the 1883 Krakatau eruption: de Jong Boers 1995, van Oosterzee 1997). The eruption started on April 5, and was punctuated by violent explosions, heard throughout Indonesia. At Solo (East Java), about 1,000 km to the west, it was reported on April 14 that the ‘explosions were extremely violent.... and resembled the discharge of mortars’ (de Jong Boers 1995). The eruption was also audible on Borneo. Gunung Tambora may have been the highest mountain in South-East Asia, but following several weeks of violent activity, it was reduced from about 4,200 m to 2,850 m (de Jong Boers 1995). Twenty-six of an estimated 10,000 people living in the Tambora area survived, with a total of about 130,000 people killed on Sumbawa, Lombok and Bali (de Jong Boers 1995, van Oosterzee 1997). Subsequently, the year 1816 became known in Europe and America as the year without a summer: up to 40 km³ of dust and ash entered the upper atmosphere, causing global cooling, summer snowstorms and crop failures (van Oosterzee 1997).

The aftermath

In 1819 the Tambora area was described as a moonscape; ‘the ground was still full of cracks and fissures and covered with ash, pumice and tree trunks’,

although in other places some vegetation had re-established (Vetter 1820 quoted in de Jong Boers 1995). Nine years after the eruption the former kingdoms of Tambora and Papekat [Pekat] at the base of Tambora were described as a ‘desolate heap of rubble’ (Schelle and Tobius 1824 in de Jong Boers 1995). Sixteen years later there was a ‘horrendous scene of devastation’, although Francis (1831 quoted in de Jong Boers 1995) observed a few trees on the lower slopes. In 1847 the mountain was still largely stripped of vegetation; the slopes were bare above 2,100 m, but *Casuarina* forest was noted at 2,200 m to 2,550 m (Zollinger 1855). In 1933 Koster and de Voogd described habitat from the lowlands to the peak beginning with ‘fairly barren, dry and hot country’, then they entered a ‘mighty jungle of *Duabanga moluccana*’ with ‘huge, majestic forest giants’ (de Jong Boers 1995). At 1,100 m they entered a montane forest with ‘...a multitude of thin stems’. As they progressed they reached stinging nettles, giant reeds and climbing ferns. Above 1,800 m, they noted a *Dodonaea viscosa*-dominated shrubland with *Casuarina* trees. On the summit they saw ‘barren slopes covered with loose stones’ with sparse *Edelweiss* and *Wahlenbergia*, and viewed a 6 km wide crater.

The extent to which habitat was directly destroyed on Tambora is largely unknown. De Voogd doubted whether the huge *Duabanga moluccana* trees he saw in 1933 could have regenerated and reached such size in little over 100 years (de Jong Boers 1995). The eruption severely affected forest throughout Sumbawa. In 1847 Zollinger observed that ‘many places [that] formerly had a thick covering of vegetation are now blanketed with ash or only have a thin layer of plant growth’. He noted extensive alang-alang *Imperata cylindrica* grasslands in formerly forested areas (Zollinger 1855).

Although details of the geology, chemistry, petrology and geomorphology have been obtained, and information on demographic changes, agriculture and

land-use changes have been described (see Heyckendorf and Jung 1992, de Jong Boers 1995 for references), effectively nothing is known of the impact of the eruption on the fauna. At least one anecdote exists: 'small birds lying dead on the ground' were noted on 12 April 1815 at Makassar, Sulawesi, 400 km to the north of Tambora, having been killed prior to the main eruption (de Jong Boers 1995). Presumably the avifauna on the mountain was extirpated, and the current composition is a result of immigration mostly from elsewhere on Sumbawa, Lombok and nearby islands in Nusa Tenggara.

The island of Sumbawa

Sumbawa, at 15,400 km², is the largest island in the West Nusa Tenggara province and the second largest after Timor in the biogeographic unit of the Lesser Sundas (FAO/UNDP 1982). It is part of the Inner Volcanic Arc (a chain of young volcanic islands, from Sumatra in the west to the Banda islands in the east), and originally evolved from volcanism c. 4 million years ago. Biologically, Sumbawa is closely related to Flores. The island is irregularly shaped (280 km long, 20-100 km wide) and mountainous. Sumbawa is predominantly volcanic, with a limited extent of uplifted limestone in coastal areas, although one major offshore island (Moyo Island, 330 km²) is limestone. The south of Sumbawa is made up of old volcanic hills and low mountains to about 1,900 m; as on Flores, landscapes in the east and north of Sumbawa are dominated by active volcanoes (FAO/UNDP 1982). Two additional islands of importance, Satonda and Sangeang, are both volcanic.

The Sumbawa lowlands have a very seasonal rainfall pattern, with annual totals less than 1,000 mm/year, while the mountains, especially in the south-west, probably have greater than 3,500 mm/year (Monk *et al.* 1997, K. Martin verbally 2000). The wet season occurs mainly from November to March, and the dry season from April to October (RePPProT 1989). Sumbawa occurs in the West Nusa Tenggara Province (including Lombok, Sumbawa, Moyo and Sangeang Island). There are three regencies (*kabupaten*) on Sumbawa, which are based on cultural boundaries (old kingdoms). Sumbawa regency in the west includes management of Moyo island; Dompu in the centre includes about half of the Sanggar Peninsula (including the Tambora volcano) and Satonda, and Bima in the east includes part the northern portion of the Sanggar Peninsula and Sangeang.

Overview of birds in West Nusa Tenggara

The province of West Nusa Tenggara has a relatively poor bird fauna with 254 species, including 185 residents, 57 migrants and 12 vagrants. Sumbawa is about three times larger than Lombok and has

substantially greater forest cover (c.40% versus c.10%) yet it has only 168 resident species compared to 140 on Lombok (White and Bruce 1986, Coates and Bishop 1997, C. R. Trainor unpublished data). For comparison, the total species complement for Flores is about 260 species and for Timor about 240 species (White and Bruce 1986, Coates and Bishop 1997). The composition of the Sumbawan avifauna and that of other West Nusa Tenggara islands is shown in Table 1.

Ornithological history on Tambora

In 1896 Alfred Everett visited Tambora and collected 59 bird species, including the type of Crested White-eye *Lophozosterops dohertyi* (reported in Hartert 1896). Twelve species were noted during natural resource assessments in 1981 (Beudels and Liman 1981). White and Bruce (1986) listed the Island Monarch *Monarcha cinerascens*, for Tambora, though presumably this record is erroneous, and referable to the Everett record for adjacent Satonda Island. Klub Indonesia Hijau (KIH), an Indonesian nature conservation club, undertook an expedition to Gunung Tambora from 16 August to 9 September 1993, reliably listing about 35 species (KIH 1993). Also in September 1993, P. Jepson and S. Schmitt spent several days birding, with limited reporting of these observations in Johnstone *et al.* (1996) and Coates and Bishop (1997). Setiawan (1996) undertook surveys for the Yellow-crested Cockatoo *Cacatua sulphurea* near Labuan Kenanga in October-December 1994. Butchart *et al.* (1996) recommended field surveys of Tambora to better understand its relative importance for key birds and habitats.

METHODS

Ornithological surveys were undertaken on Tambora over a total of 10 days during 9-14 June and 2-4 July 2000, as part of an island-wide assessment to identify key site priorities for the conservation of globally restricted-range and threatened bird species. Birds were recorded aurally and visually by the author, and in the June survey, by the author and D. Lesmana (DL), BirdLife International-Indonesia Programme. The survey targeted closed-canopy forest, however large expanses of savanna in the lowlands were also given priority, including observations in several unusual geological formations associated with the Tambora volcano (Table 2). These latter formations included the adventive craters of Doro Peti and Doro Ncanga (see Heyckendorf and Jung 1992); another adventive crater (Pulau Satonda) was visited briefly, but results are not included here.

Table 1. A summary of the bird composition in West Nusa Tenggara.

| Island | Resident | Migrant | Vagrant | Non-passerine | Passerine | Total |
|------------------------------|----------|---------|---------|---------------|-----------|-------|
| Lombok | 140 | 32 | 4 | 115 | 59 | 174 |
| Gili Islands | 0 | 11 | 2 | 13 | 0 | 13 |
| Sumbawa | 168 | 47 | 6 | 148 | 73 | 221 |
| Moyo | 64 | 22 | 2 | 66 | 22 | 88 |
| Satonda | 31 | 3 | 1 | 28 | 7 | 35 |
| Sangeang | 35 | 3 | 0 | 23 | 15 | 38 |
| Panjang | 5 | 2 | 2 | 8 | 1 | 9 |
| Total for West Nusa Tenggara | 185 | 57 | 12 | 171 | 83 | 254 |

Table 2. Survey localities, altitude and habitat type (see Methods for definitions).

| Site no. | Site name | Coordinates | Altitude (m) | Person-hrs | Habitat | | | | | | | |
|----------|----------------------|---------------------|--------------|------------|---------|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 1 | Site 1 | 8°27'00S 118°06'00E | 0-100 | 4 | ✓ | | | | | | | |
| 2 | Site 2 | 8°27'00S 118°03'30E | 0-100 | 3 | ✓ | | | | | | | |
| 3 | Site 3 | 8°27'00S 118°01'00E | 100 | 1 | ✓ | | | | | | | |
| 4 | Site 4 | 8°26'30S 117°59'00E | 100 | 1 | ✓ | | | | | | | |
| 5 | Site 5 | 8°25'10S 117°56'30E | 100 | 1 | ✓ | | | | | | | |
| 6 | Doro Ncanga | 8°27'00S 117°58'30E | 0-100 | 2 | | ✓ | | | | | | |
| 7 | Doro Peti | 8°22'00S 117°49'50E | 0-100 | 2 | | | ✓ | | | | | |
| 8 | Labuan Kenanga | 8°08'30S 117°46'00E | 0-100 | 3 | | | ✓ | | | | | |
| 9 | Latonda | 8°12'30S 117°45'00E | 250 | 3 | | | | ✓ | | | | |
| 10 | Sorinomo | 8°15'45S 117°48'30E | 350 | 2 | | | | | ✓ | | | |
| 11 | Veneer Products Road | 8°13'30S 117°47'00E | 400 | 2 | | | | | ✓ | | | |
| 12 | Tambora 1 | 8°13'00S 117°47'00E | 400-800 | 4 | | | | | ✓ | | | |
| 13 | Tambora 2 | 8°16'00S 117°53'00E | 800-1200 | 10 | | | | | ✓ | | | |
| 14 | Tambora 3 | 8°16'00S 117°54'00E | 1,201-1,600 | 12 | | | | | | ✓ | | |
| 15 | Tambora 4 | 8°14'00S 117°55'00E | 1,600-2,000 | 12 | | | | | | | ✓ | |
| 16 | Tambora 5 | 8°15'00S 117°56'30E | 2,001-2,400 | 6 | | | | | | | ✓ | ✓ |
| 17 | Tambora 6 | 8°15'30S 117°57'30E | 2,401-2,850 | 4 | | | | | | | | ✓ |

A total of 17 geographically independent sites were surveyed each with 1-12 person hours (Table 2). Survey effort was considered adequate to record the majority of resident bird species at each site.

Conventions

Habitat type follows Monk *et al.* (1997). Avian nomenclature follows Inskipp *et al.* (1996). Bird species were subjectively categorised as resident or non-resident/migrant, and as forest or non-forest dependent based on known habitat fidelity (Coates and Bishop 1997). Restricted-range birds are those with a total global breeding range of 50,000 km² or less (Stattersfield *et al.* 1998). In this paper lowland is defined as land below 800 m and montane as land above 800 m.

Habitats sampled

1. Savanna and grassland: sea level to 200+ m, a highly variable seral habitat regenerating after the 1815 eruption, frequent fires and stock grazing. Grassland dominated by *Themeda triandra* and *Heteropogon contortus* is extensive on flat plains below scattered *Ziziphus mauritania*. In geographically protected sites, such as old lava flows, a gallery forest with clumps of *Ficus* sp., *Timonius timon*, *Ceiba pentandra*, *Ziziphus* and *Terminalia cattapa* (10-25 m) has developed.
2. Tropical dry deciduous forest: at sea level to 200+ m, closed-canopy forest from 10-15 m with numerous deciduous tree species (*Ziziphus*, *Gyrocarpus* and *Schleichera*) and high siam weed *Chromolaena odorata* cover to 3 m.
3. Tropical moist deciduous forest: at 250 m (Latonda), a dense closed forest (60-80% cover) to 25 m with *Ficus* sp. and *Schleichera oleosa*, and high density of vines.
4. Logged lowland evergreen rainforest: from 350-1,100 m, dominated by *Duabanga mollucensis* and *Caboola* 30-60 m tall, with 20-40% canopy cover, dense ground cover of ferns, weeds, shrubs and saplings.

5. Primary lowland evergreen rainforest: from about 1,200-1,600 m, a tall closed-canopy forest dominated by *Duabanga*, *Ficus*, *Calophyllum* sp. (60-80% canopy cover) with numerous epiphytes, lianas, palms, rattan, ferns, seedlings and saplings.
6. Lower montane forest: from 1,600-2,300 m, an open forest (10-30% canopy cover) dominated by *Casuarina junghuhniana* (to 35 m at lower elevation limits, to 10-15 m at upper limits), with tree and other ground ferns, and abundant stinging nettles *Girardinia palmata* and *Urtica bullata*.
7. *Dodonaea viscosa* shrubland: from 2,100-2,800 m a shrubland to 3 m is dominant especially in gullies, occasionally with a *Casuarina* overstorey. Soil, gravel and rocks are dominant above c.2,600 m.

SELECTED ANNOTATED LIST

This list concentrates on key bird species (globally threatened and restricted-range), forest birds, and savanna birds. Previous notable records are briefly mentioned, while the Appendix gives a complete list. Localities given as kilometres are road distances from Bima in East Sumbawa (given on *Peta Rupabumi* topographic map series).

GREEN JUNGLEFOWL *Gallus varius*

Frequently observed in low numbers in coastal savannas, and in forest up to 2,000 m. One male was snared by local people at Sorinomo on 4 July 2000 and purchased by a bird trader for Rp 20,000 (c.\$US 2.50).

WHITE-RUMPED KINGFISHER *Caridonax fulgidus*

Restricted-range

Rare or uncommon in coastal savanna where heard once at Site 1, and several times in moist deciduous forest behind Latonda. Uncommon in montane forest with at least one calling at Tambora 4; unrecorded at Tambora 3 and uncommon in selectively harvested *Duabanga* forest at Tambora 2. Hartert (1896) indicated that this bird was common from the lowlands to about 900 m. A

common forest species on Sumbawa and Flores (Butchart *et al.* 1996, Trainor and Lesmana 2000).

ORIENTAL CUCKOO *Cuculus saturatus*

Common in the lower montane forest from 1,200-2,000 m, where its familiar *puu-puu* calls were frequently heard. Individuals were also occasionally observed at Tambora 2, 3, and 4 perched high in the canopy. Reported at 900 m by Hartert (1896).

RAINBOW LORIKEET *Trichoglossus haematodus forsteni*

One of six endemic subspecies on Sumbawa and associated islands, the *forsteni* population on Tambora appears to be significant with pairs and threes frequently observed or heard from 500-2,000 m (about 6-10 individual contacts/day), probably most frequently at Tambora 3 with seven contacts in a three hour period. Regarded as uncommon to moderately common on Sumbawa by Johnstone *et al.* (1996), but rare according to Butchart *et al.* (1996).

MOLUCCAN SCOPS OWL *Otus magicus*

Recorded only at Tambora 2 in degraded *Duabanga* forest where it vocalised more than seven times. Two were collected from the lowlands (Hartert 1896).

WALLACE'S SCOPS OWL *Otus silvicola*

Restricted-range

Restricted to Sumbawa and Flores; on Tambora this species vocalised at 1,080 m (frequent), 1,280 m (frequent, called seven times between 19h00 and 21h00 with *rrow* notes repeated 1-3, but mostly four times), 1,680 m and 2,100 m, in severely logged *Duabanga* and unlogged *Duabanga* forest. Both Johnstone *et al.* (1996) and Butchart *et al.* (1996) found this owl to be rare on Sumbawa.

ISLAND COLLARED DOVE *Streptopelia bitorquata*

Locally common in grassy savannas, with observations of small flocks feeding along the road at Site 1 and Doro Peti.

SPOTTED DOVE *Streptopelia chinensis*

Frequent to abundant in grassy savanna (0-500 m) with loose flocks of 5-20 observed feeding along the road, including the villages of Calabai (near Latonda), Sorinomo, Pancasila (8°13'S 117°47'E) and Labuan Kenanga. Reported from the 'low country' by Hartert (1896).

LITTLE CUCKOO DOVE *Macropygia ruficeps*

Occasional from the coast to at least 1,900 m, usually singly or as pairs, in flight through the canopy. At Tambora 3 one individual roosted at dusk in the cavity of a massive birds-nest fern *Asplenium nidus* (where it was possibly nesting); three flew through degraded coastal forest at Labuan Kenanga; singles or pairs were observed in coastal savanna at Site 1 and 2; and three singles were observed at Sorinomo. Commonly observed by Beudels and Liman (1981). Everett collected a male and female at 900 m, and an immature from the lowlands (Hartert 1896).

PEACEFUL DOVE *Geopelia striata*

This dove was common in savanna, but absent from semi-evergreen forest and habitats above 500 m.

PINK-NECKED GREEN PIGEON *Treron vernans*

Locally common in savanna and logged *Duabanga* forest. Singles to groups of ten were observed at Site 1 in *Ziziphus* shrubland with scattered *Ficus* (0-100 m elevation, a total of c.30 individuals in three hours). A soft *warr* vocalisation was heard. Two individuals were observed at Sorinomo in logged forest (300 m, 6 July 2000). Green pigeons *Treron* sp. were regarded as common by Beudels and Liman (1981), and a series was collected from 'the low country' Hartert (1896).

BLACK-BACKED FRUIT DOVE *Ptilinopus cinctus*

Frequent in semi-evergreen and montane forest from 700-2,000 m, but absent below about 500 m. At Tambora 4 small groups were notably confiding as they fed in the tall canopy of fruiting trees (probably indicating low hunting pressure). Singles were observed at Tambora 3 and many singles or small flocks (up to four individuals) were observed flying between 45 m tall *Duabanga* trees at Tambora 2. Also frequently heard in selectively harvested *Duabanga* forest (700 m). Noted at 900 m by Everett (Hartert 1896).

BLACK-NAPED FRUIT DOVE *Ptilinopus melanospila*

Uncommon or mostly absent from coastal savannas, with a pair observed in a *Terminalia cattapa* tree above a spring at Site 1; also heard inside the Doro Peti crater. Common in semi-evergreen forest from 300-800 m, including highly degraded forest at Sorinomo, and selectively harvested *Duabanga* forest along the PT Veneer Products road.

GREEN IMPERIAL PIGEON *Ducula aenea*

Scarce in coastal savanna, with a single seen (and several heard calling) at Site 1, and several observed at Doro Peti and Labuan Kenanga (the latter in degraded beach forest). Frequent in degraded semi-evergreen forest at Sorinomo and the PT Veneer Products track (300-600 m).

DARK-BACKED IMPERIAL PIGEON *Ducula lacernulata*

Restricted-range

Frequent in heavily logged *Duabanga* forest (1,000-1,200 m), as well as unlogged *Duabanga* mixed rainforest and seasonal montane forest dominated by *Casuarina junghuhniana* up to 2,000 m. It was observed feeding in tall (50-60 m) *Duabanga* trees near Tambora 3. It is intensely hunted throughout its range. The species is distributed from Java to Flores, but the Nusa Tenggara endemic subspecies *sasakensis* is restricted to Lombok, Sumbawa and Flores, with recent calls for a status review because of differences in its plumage and vocalisations, and because of the degree of geographic isolation (Butchart *et al.* 1996). It was considered relatively common above about 800-1,000 m by Butchart *et al.* (1996) and Johnstone *et al.* (1996).

BLACK-SHOULDERED KITE *Elanus caeruleus*

Uncommon in grassy savannas, with four singles either hovering or perched on small trees at Sites 2, 3 and 5 (at the latter site one was seen eating a large *Mabuya* sp. skink while perched on a dead tree branch), and one near Pekat (5 km south of Calabai) on 4 July 2000.

SHORT-TOED SNAKE EAGLE *Circaetus gallicus*

A single was observed by DL as it flew through the canopy of degraded *Duabanga* forest at 1,100 m at Site 1 on 13 June 2000.

CHANGEABLE HAWK EAGLE *Spizaetus cirrhatus*

The taxonomic status of the Nusa Tenggara endemic race is currently the subject of study, and this taxon will possibly be raised to a full species (J. Gjershaug verbally 2001). A single first-year individual was observed at 800 m perched on an exposed branch of a dead tree next to the PT Veneer Products logging track (at 'km 21' from Calabai on 14 June 2000). It sat silently on the branch for several minutes allowing good views of its pale head, neck and chest, and then flew into adjacent forest. There are few recent records of this species on Sumbawa apart from the vicinity of Batu Dulang, Batu Hijau and Tatar-Sepang (all in south-west Sumbawa: Martin and Barclay 1996, Grantham 2000, Jepson *et al.* 2001) and it has been considered scarce or rare (Butchart *et al.* 1996, Johnstone *et al.* 1996). The status, distribution and habitat requirements of this taxon are poorly known in Nusa Tenggara. It has a restricted range, occurs at low population density and is selectively targeted by hunters for the cagebird trade as well as for stuffed specimens (Trainor and Lesmana 2000).

SPOTTED KESTREL *Falco moluccensis*

Uncommon in lowland savanna and grassland (one over a rice field at Latonda and one near Doro Ncanga), but several observed daily in semi-evergreen forest from 500-2,000 m.

ELEGANT PITTA *Pitta elegans*

Occasional in coastal savannas, where recorded in dry deciduous forest, degraded riparian forest and moist deciduous forest (0-300 m). More common in semi-evergreen and montane forest up to at least 1,200 m.

BROWN HONEYEATER *Lichmera indistincta*

Uncommon and local in coastal savanna, abundant in semi-evergreen, montane forest and *Dodonaea* shrubland up to about 2,400 m. Local and sporadically distributed in Nusa Tenggara (Coates and Bishop 1997).

HELMETED FRIARBIRD *Philemon buceroides*

Occasional in coastal savannas with patches of monsoon forest, but particularly common in semi-evergreen forest from 800-1,200 m. Recorded in the 'low country' by Everett (Hartert 1896).

LARGE-BILLED CROW *Corvus macrorhynchos*

Uncommon and local with three records from coastal savannas: a single at Sites 1 (2 July 2000), three at Site 3 on the same date, and two at Site 2.

BLACK-NAPED ORIOLE *Oriolus chinensis*

Frequent in coastal savannas, and degraded *Duabanga* forest from 500-800 m.

WALLACEAN CUCKOOSHRIKE *Coracina personata*

This Wallacean endemic was uncommon and local in montane and semi-evergreen forest. Several were calling at Site 3 on 10 June 2000, and one the following day (giving the typical *plee-urk* call), but found to be frequent

in degraded *Duabanga* forest at 700 m. A male and female were collected from the lowlands by Everett (Hartert 1896).

WHITE-SHOULDERED TRILLER *Lalage sueurii*

Frequently recorded in coastal savanna (0-100 m) but uncommon in highly degraded semi-evergreen forest at Sorinomo. Reported from the lowlands to 900 m (Hartert 1896).

FLORES MINIVET *Pericrocotus lansbergei*

Restricted-range

Frequent in the canopy of montane and semi-evergreen forest from 350-2,000 m, but scarcer in coastal savanna with patches of seral forest. At Site 1, minivets were observed in the canopy of *Terminalia cattapa*. Present in dry deciduous forest at Doro Ncanga and Doro Peti (0-100 m). Considered rare to frequent at various sites by Butchart *et al.* (1996) and Johnstone *et al.* (1996).

BROWN-CAPPED FANTAIL *Rhipidura diluta*

Restricted-range

Widespread from sea level to at least 2,000 m, but most common in *Duabanga* and montane forest from 500-1,800 m. In coastal savannas it was recorded adjacent to a spring at sea level, in mangroves, dry deciduous forest and a shrubland dominated by extensive grass cover. Common in forest (Butchart *et al.* 1996, Johnstone *et al.* 1996).

SPANGLED DRONGO *Dicrurus hottentottus*

This species was widespread and generally common in coastal savanna, especially dry deciduous forest, and also *Duabanga* and montane forest.

CHESTNUT-CAPPED THRUSH *Zoothera interpres*

A single bird vocalised in moist deciduous forest at Latonda (300 m, 3 July 2000). Recorded by Everett at 600 m (Hartert 1896).

CHESTNUT-BACKED THRUSH *Zoothera dohertyi*

Restricted-range

The song of this species was heard infrequently at 800-1,600 m, with sightings by DL in a gully in primary *Duabanga* forest at Tambora 3. One captured by trappers at Sorinomo. Considered locally common to rare in Sumbawan forest by Butchart *et al.* (1996) and Johnstone *et al.* (1996).

LESSER SHORTWING *Brachypteryx leucophrys*

Local and occasional in mixed lower montane forest from 1,200-1,400 m on Tambora, with several individuals observed at Tambora 3 on lianas close to the ground (13 June 2000). They gave a single or double *tack* call. This species is apparently restricted to Tambora on Sumbawa, but also occurs on Lombok, Timor and possibly Alor in Nusa Tenggara (Coates and Bishop 1997). Everett took specimens at 900 m, with Hartert (1896) noting the great variety of plumage colour of the specimens.

SNOWY-BROWED FLYCATCHER *Ficedula hyperythra*

Occasional in montane forest habitat from 1,400-1,900 m, with several observations of singles in unlogged lower montane forest on Tambora in understorey to 4 m.

'Frequently met with in the hills of Tambora at about 3000 ft [900 m]' (Hartert 1896).

LITTLE PIED FLYCATCHER *Ficedula westermanni*

Occasional in the understorey and subcanopy of lower montane forest. Several singles were observed perching on bare *Casuarina* branches (6-18 m above ground, 1,600 m), with Hartert (1896) reporting them from 900 m.

SHORT-TAILED STARLING *Aplonis minor*

Local and uncommon in semi-evergreen forest from near Pancasila (550-650 m) including a flock of ten on the dead upper branches of a *Duabanga* tree in selectively logged forest. Three were observed along the PT Veneer Product road (450 m) on 3 July 2000. Considered rare in forest by Johnstone *et al.* (1996).

MOUNTAIN WHITE-EYE *Zosterops montanus*

Common above about 1,000 m to at least 2,300 m. Present in *Casuarina* forest and *Dodonaea* shrubs above 2,000 m.

YELLOW-SPECTACLED WHITE-EYE *Zosterops wallacei*

Restricted-range

Widespread and common in coastal savanna habitats including cashew and coffee plantations, under *Duabanga* and degraded forest to about 800 m.

CRESTED WHITE-EYE *Lophozosterops dohertyi*

Restricted-range

Frequent or common in degraded semi-evergreen *Duabanga* forest from 300-1,100 m and montane forest. Everett collected specimens from 300-1,000 m (Hartert 1896).

THICK-BILLED WHITE-EYE *Heleia crassirostris*

Restricted-range

Present in forest from 300-2,000 m.

SUNDA BUSH WARBLER *Cettia vulcania*

Frequent or common, yet elusive, in montane forest from 1,200-2,400 m; it was one of the few species present in *Dodonaea* shrubland above 2,200 m. First recorded for Tambora and Sumbawa in 1993 by P. Jepson (from 1,500-1,850 m), and may represent an undescribed subspecies (Coates and Bishop 1997).

MOUNTAIN LEAF WARBLER *Phylloscopus trivirgatus*

Common in montane forest, 1,000-2,300+ m, including *Dodonaea* shrubland. Reported by Hartert (1896) as common.

AUSTRALASIAN BUSHLARK *Mirafra javanica*

Infrequently recorded as singles in savanna grasslands (0-100 m) but probably under-recorded.

GOLDEN-RUMPED FLOWERPECKER *Dicaeum annae*

Restricted-range

Frequent in semi-evergreen and lower montane forest from 800-2,000+ m, but it is undoubtedly also present in forest at lower elevations.

BLACK-FRONTED FLOWERPECKER *Dicaeum igniferum*

Restricted-range

Common in coastal savanna, degraded village habitat, cashew plantations and degraded *Duabanga* forest up to about 800 m.

PADDYFIELD PIPIT *Anthus rufulus*

Frequently recorded in savanna grasslands from 0-100m. Historically reported from the 'lowlands of Bima and Tambora and hills at 3,000 ft [900 m]' (Hartert 1896).

DISCUSSION

The avifauna

A total of 93 bird species have been reliably reported for Tambora (see Appendix) including 88 considered resident (with two introduced resident species: Sooty-headed Bulbul *Pycnonotus aurigaster* and Eurasian Tree Sparrow *Passer montanus*), and five migrant species (Dollarbird *Eurystomus orientalis*, Sacred Kingfisher *Todiramphus sanctus*, Rainbow Bee-eater *Merops ornatus*, Shining Bronze Cuckoo *Chrysococcyx lucidus* and Arctic Warbler *Phylloscopus borealis*). The Sooty-headed Bulbul was newly reported for Sumbawa during this study (Trainor *et al.* in press). Seventy-six species were recorded in the present study including 73 residents. An environmental gradient associated most strongly with elevation and associated changes in habitat, natural succession following the eruption, logging, plantation habitat, bird trapping and hunting all influence bird species composition on Tambora.

A rich pigeon and dove fauna was present with ten species recorded, and the Metallic Pigeon *Columba vitiensis* is also known from historical data (see Appendix). Granivorous species were significantly richer in lowland habitats, with none of eight granivores recorded in montane habitat above 800 m (where grass seed was undoubtedly highly limited). A greater proportion of birds of montane habitat were insectivorous, and five of the six omnivores were present in montane habitat. Several species possibly benefited from logging based on subjective assessment of their relative abundance: Elegant Pitta, Golden Whistler *Pachycephala pectoralis*, Brown-capped Fantail, Short-tailed Starling (recorded only in logged forest) and Yellow-spectacled White-eye.

Birds along an elevation gradient

In the current study almost every bird species (62 of 73) was recorded below 800 m, with exactly half of these confined to lowland habitat. Only three forest birds were confined to the lowlands (Pink-necked Green Pigeon, Chestnut-capped Thrush and Short-tailed Starling), with the remaining 28 lowland species comprising either habitat generalists (e.g. Lesser Coucal *Centropus bengalensis*, Spotted Dove and Large-billed Crow), savanna specialists (e.g. Black-shouldered Kite and Australasian Bushlark). A total of 31 forest-dependent species were recorded. Of the 11 birds confined to montane habitat, nine were forest birds (including eight species that are typically considered to be specialised hill or montane species: Dark-backed Imperial Pigeon,

Wallace's Scops Owl, Lesser Shortwing, Sunda Bush Warbler, Mountain Leaf Warbler, Snowy-browed Flycatcher, Little Pied Flycatcher and Mountain White-eye).

Eleven restricted-range species were recorded on Tambora: White-rumped Kingfisher, Wallace's Scops Owl, Dark-backed Imperial Pigeon, Flores Minivet, Brown-capped Fantail, Chestnut-backed Thrush, Yellow-spectacled White-eye, Crested White-eye, Thick-billed White-eye, Golden-rumped Flowerpecker, and Black-fronted Flowerpecker. All but Dark-backed Imperial Pigeon are endemic to Nusa Tenggara. Between none and five restricted-range species were recorded at sites below 400 m, but all 11 restricted-range species were recorded between 1,200-1,600 and ten from 1,600-2,000 m. These data highlight the importance of mid-elevation and montane forest as habitat for restricted-range birds on Sumbawa as elsewhere in Nusa Tenggara (Butchart *et al.* 1996, Trainor and Lesmana 2000).

Montane bird faunas compared

Twelve montane bird species have been recorded on Gunung Tambora including 10 in the current survey. P. Jepson also recorded Scaly Thrush *Zoothera dauma* (Coates and Bishop 1997) and KIH (1993) reported Tawny-breasted Parrotfinch *Erythrura hyperythra*, another hill or montane species. Of these species only Wallace's Scops Owl (endemic to Sumbawa and Flores) is absent from Gunung Rinjani (8°22'S 116°25'E, 3,726

m), on adjacent Lombok Island (Table 3). Gunung Rinjani, the highest mountain in Wallacea, harbours four additional montane species not found on Tambora (see Table 3; Coates and Bishop 1997). The mountains of West Sumbawa reach a peak of c.1,900 m, with limited montane habitat above 1,500 m; consequently the montane bird faunas of these peaks are poorly developed (Table 3). Their composition is identical to that of Tambora, except that two montane/hill species are absent (Lesser Shortwing and Sunda Bush-warbler). Martin and Barclay (1996) have, however, noted the former species in the Tatar Sepang area, but this probably requires confirmation. Butchart *et al.* (1996) failed to record five of the Sumbawan montane bird species during surveys at Puncak Ngengas (8°32'S 117°07'E) and Batu Hijau (9°00'S 116°55'E) and predicted that they would occur at Gunung Tambora. At least three of these (Snowy-browed Flycatcher, Little Pied Flycatcher and Mountain Leaf Warbler) are also known from the extensive Puncak Ngengas-Selalu Legini forest block that they had surveyed (Trainor *et al.* 2000) and the Tawny-breasted Parrotfinch was listed for Batu Dulang by Rensch (1931).

Effects of volcanic cataclysm and variable recolonisation

Only 11 of 19 restricted-range bird species known from Sumbawa were recorded and it is speculated that these absences, bar one, probably relate to the 1815 eruption.

Table 3. Distribution of montane birds on selected mountains of West Nusa Tenggara: Gunung Rinjani (Lombok); Gunung Tambora (north Sumbawa); Puncak Ngengas (West Sumbawa); Batu Pasak/Batu Dulang (8°38'S 117°15'E, west Sumbawa); and Tatar Sepang (9°03'S 116°56'E, south-west Sumbawa). Sources: Rensch (1931) and Trainor *et al.* (2000).

| Species | Gunung Rinjani 3,750 (m) | Gunung Tambora 2,850 (m) | Puncak Ngengas 1,923 (m) | Batu Pasak 1,850 (m) | Tatar Sepang 973 (m) |
|---|-----------------------------|-----------------------------|-----------------------------|-------------------------|-------------------------|
| WALLACE'S SCOPS OWL <i>Otus silvicola</i> | | + | + | + | + |
| BARRED CUCKOO DOVE <i>Macropygia unchall</i> | + | | | | |
| WEDGE-TAILED GREEN PIGEON <i>Treron sphenura</i> | + | | | | |
| DARK-BACKED IMPERIAL PIGEON <i>Ducula lacernulata</i> | + | + | + | + | + |
| SCALY-CROWNED HONEYEATER <i>Lichmera lombokia</i> | + | | + | + | |
| CHESTNUT-BACKED THRUSH <i>Zoothera dohertyi</i> | + | + | + | + | + |
| SUNDA THRUSH <i>Zoothera andromedae</i> | + | | + | + | |
| SCALY THRUSH <i>Zoothera dauma</i> | + | + | + | + | |
| LESSER SHORTWING <i>Brachypteryx leucophrys</i> | + | + | | | |
| SNOWY-BROWED FLYCATCHER <i>Ficedula hyperythra</i> | + | + | + | + | + |
| LITTLE PIED FLYCATCHER <i>Ficedula westermanni</i> | + | + | | + | |
| MOUNTAIN WHITE-EYE <i>Zosterops montanus</i> | + | + | + | + | |
| SUNDA BUSH-WARBLER <i>Cettia vulcania</i> | + | + | | | |
| MOUNTAIN LEAF WARBLER <i>Phylloscopus trivirgatus</i> | + | + | | + | + |
| TAWNY-BREASTED PARROTFINCH <i>Erythrura hyperythra</i> | + | + | | + | |

While the lack of records for Russet-backed Jungle Flycatcher *Rhinomyias oscillans* is unsurprising (recorded once from Sumbawa and probably highly local: Butchart *et al.* 1996), the absence of the remaining seven restricted-range species (Flores Green Pigeon *Treron floris*, Scaly-crowned Honeyeater *Lichmera lombokia*, Bare-throated Whistler *Pachycephala nudigula*, Russet-capped Tesia *Tesia everetti*, Flame-breasted Sunbird *Nectarinia solaris* and Yellow-browed White-eye *Lophozosterops superciliaris*) is exceptional, because habitat is not perceptibly limiting and they are generally widespread in suitable habitat elsewhere (Trainor and Lesmana 2000). These species have either not been able to immigrate because of geographic isolation, have been out-competed by congeners (or both), or are present on Tambora but improbably remain unrecorded.

The Flores Green Pigeon is locally common in forests, especially dry deciduous and moist deciduous types, from Lombok to Alor (BirdLife International 2001). Extensive savanna and dry forest is available in the Tambora lowlands. However, here the congeneric Pink-necked Green Pigeon is a dominant species at the extreme east of its limited Nusa Tenggara range, presumably excluding the establishment of populations of the former species. Flores Green Pigeon appears genuinely rare on Sumbawa: a total of four individuals were recorded from two Sumbawa sites in the 1990s (Butchart *et al.* 1996, Trainor *et al.* in press). Greater survey intensity may be required to detect this species or it may simply be patchily distributed on Sumbawa as on Flores (Butchart *et al.* 1996, Trainor and Lesmana 2000).

Similarly, the Scaly-crowned Honeyeater, a mostly hill or montane species, is likely to have been out-competed by Brown Honeyeater, which is abundant on Tambora from 1,000-2,300 m. On Tambora the Brown Honeyeater is essentially montane, with only a single record in the lowlands. However, in west Sumbawa this species is abundant in the lowlands and replaced by Scaly-crowned Honeyeater in the hills. Such patterns mirror those on Flores where the Brown Honeyeater is a lowland species in the west (e.g. Nanga Rawa) where Scaly-crowned Honeyeater occurs in the highlands, but is a hill and montane species in the east, where the Scaly-crowned Honeyeater is absent (e.g. Mount Egon and also Lewotobi: Trainor and Lesmana 2000).

The Bare-throated Whistler is one of the most vocal and common species recorded from 400-2,000 m in the hills and mountains of west Sumbawa and west Flores (Butchart *et al.* 1996, Trainor and Lesmana 2000), with Tambora's evergreen forest habitat (especially at 800-1800 m) seemingly ideal. Habitat may not be limiting: competitive exclusion and geographic isolation may play a role. On Tambora the congeneric Golden Whistler *Pachycephala pectoralis* is common to abundant from sea level to almost 2,000 m, perhaps excluding the establishment of Bare-throated Whistler populations (although they do occur together at other localities: Trainor and Lesmana 2000). They may also be poor dispersers: in west Flores Schmutz (1977) considered that the patchy distribution of Bare-throated Whistler, specifically its absence from a dormant volcano (Poco Dedeng), but presence in the nearby Mbeliling forests 8 km away, related to its inability to recolonise a previously active volcanic peak. The nearest Sumbawa

populations of the Bare-throated Whistler are 80-100 km to the south-west of Tambora, isolated by Teluk Saleh. Although not regarded as threatened (BirdLife International 2001), this species is locally distributed on Sumbawa and Flores (c.<3,000 km²) and poorly known on Sumbawa except from several sites in the south-west (Butchart *et al.* 1996, Johnstone *et al.* 1996, Trainor and Lesmana 2000).

The Russet-capped Tesia is endemic to Sumbawa, Flores and Adonara Island (Coates and Bishop 1997, C. R. Trainor unpublished data) and it is one of the most frequently recorded and common bird species in forest, shrub and degraded habitats. For example, on Flores it has been recorded in every (>20) forest block surveyed (Trainor and Lesmana 2000), thus its absence from the Tambora forests is striking. It is a skulking species mostly confined to the understorey of dense habitat; presumably it has been unable to recolonise Tambora following the eruption because expanses of savanna and grassland on the slopes of Tambora have acted as a physical barrier.

The Yellow-browed White-eye is typically a common montane species endemic to Flores and Sumbawa. Its absence from Tambora is surprising because it is common in the mountains of west Sumbawa (e.g. Puncak Ngengas; Butchart *et al.* 1996). Most likely the scattered and isolated nature of mountain-top populations, and the low dispersal ability of this species have limited opportunities for re-colonisation. Conceivably, it may have been excluded by Crested White-eye, which is common on Tambora from the lowlands to about 2,000 m; however, these species co-occur at several forest sites in west Sumbawa and Flores (Trainor and Lesmana 2000, Trainor *et al.* 2000).

The Flame-breasted Sunbird is one of the most widespread and common species in lowland habitats throughout its Nusa Tenggara range: its absence from the savannas and lowland forests of Tambora seems inexplicable. Presumably it too has failed to re-colonise following the eruption.

Bird trade

The recent sharp decline in populations of the Yellow-crested Cockatoo, as well as *Zoothera* thrushes throughout Nusa Tenggara, has been mostly caused by captures for the cagebird market. On Tambora, Yellow-crested Cockatoo, *Zoothera* thrushes, Hill Myna *Gracula religiosa*, Green Junglefowl and Rainbow Lorikeet are captured for cash sale, and Orange-footed Scrubfowl *Megapodius reinwardt* is hunted for food. Habitat loss or degradation through logging may also be a factor in their reduced population densities. The Yellow-crested Cockatoo is nearing extinction on Sumbawa because of high levels of exploitation for the cagebird trade, and it was unrecorded in the present study. A bird trader at Sorinomo indicated that Yellow-crested Cockatoos could still be caught on the south-west slopes of Tambora, but that they occurred deep into the forest. Significantly, Setiawan (1996) reported observations of 26 cockatoos over 10 km of transects at Labuan Kenanga between 20 November 1994 and 1 December 1994, and a Forestry Guard claimed to have observed large flocks (about 100 individuals) north of Hodo in the south-east of Tambora in 1999. Additional surveys for Yellow-crested Cockatoos on the slopes of Tambora should be

a priority for conservation activities for this species on Sumbawa, although the remnant population is likely to be small. In 2001, population surveys were undertaken in south-west Sumbawa (D. Agista verbally 2001).

Local people indicated that Rainbow Lorikeets were captured on the lower slopes of Tambora while feeding at coconuts and *Erythrina* flowers (e.g. at Pancasila village), using decoy birds to attract wild individuals. Throughout Sumbawa this taxon is rare because of capture for the cagebird trade (e.g. Puncak Ngengas, Batu Hijau; Butchart *et al.* 1996). It remains one of the most frequently observed cagebird species on Sumbawa (at Sumbawa Besar, Domphu, Alas and Bima) and the *forsteni* race should probably be considered endangered. It was regarded as rare by Butchart *et al.* (1996) following their 1993 surveys.

One other hole-nesting species went unrecorded. Twenty years ago Beudels and Liman (1981) stated that Hill Mynas were 'very often seen', and Everett recorded them from the lowlands to 1,000 m (Hartert 1896). In 2000, locals from Sorinomo village stated that up to ten Hill Mynas could formerly be trapped daily, by placing nets in fruiting trees. However, this was perceived as no longer possible because of over-exploitation and subsequent population declines.

Populations of Chestnut-backed Thrush and Chestnut-capped Thrush may have been widely extirpated on Tambora prior to this survey. Reports from Batu Dulang (Puncak Ngengas area) as well as Pancasila (Tambora) revealed that *Zoothera* trappers had trapped the Gunung Tambora forests. Known locally as *punglor kepala hitam/merah* the Chestnut-backed Thrush and Chestnut-capped Thrush have been the main target of cagebird trappers throughout Nusa Tenggara in the past decade, with captures totalling hundreds of thousands or perhaps millions of individuals. On 4 July 2000, two *Zoothera* trappers were met leaving the Sorinomo forest in the late afternoon. Between 07h00 and 16h00 they had set a single 50 m long net in the forest, and had caught one Chestnut-backed Thrush. They indicated that it was still possible to catch 20-25 thrushes each day, but it was necessary to go far into the forest, about 6-8 km walk from the village. They reported that pairs or groups of men used to catch 100-200 thrushes per day in 1996-1998. Local informants revealed that its price had peaked at Rp 250,000 each (c. \$US30, more than twice the average monthly salary of local villagers in West Nusa Tenggara) in 1998. However, demand and the price had fallen to about Rp 20,000 (c. \$US2.50) by May 2000. This species prefers primary closed canopy forest from 200-2,000 m, probably favouring 700-1,200 m; it occurs on all the larger Nusa Tenggara islands (Lombok, Sumbawa, Flores, Sumba and Timor). Thus the single voice record of the Chestnut-capped Thrush is at once notable, and disturbing. Levels of international trade have been high, with birds observed in Singapore markets (BirdLife International 2001).

Conservation measures

Various conservation proposals have been put forward for the the Tambora area. An area of 30,000 ha of mostly savanna grassland and gallery monsoon forest was gazetted as a hunting kark (*taman buru*) in the south-east of Tambora (SK/Menhut 676/Kpts/Um/10-1978; FAO/UNDP 1982). It was recommended that this

hunting park join a proposed wildlife sanctuary (also called 'Duabanga moluccana Nature Reserve'; Beudels and Liman 1981) on the northern slopes of Tambora (Tambora Utara), including all forests above 1,000 m (i.e. including *Duabanga* forests at 1,000-1,400 m), and that these reserves and Moyo be integrated into a single conservation reserve (Beudels and Liman 1981).

The entire Tambora volcano has recently been identified as an Important Bird Area (IBA) by Rombang *et al.* (in press), one of 43 circumscribed areas in Nusa Tenggara which meet internationally recognised criteria based on their biodiversity significance. Interestingly, during the initial IBA work consideration was given to relegating the Tambora site to a 'secondary area' or dropping it altogether, because many of the restricted-range bird species present are represented in many (>10) of the other Nusa Tenggara IBA sites (W. Rombang verbally 2001). However, in the final analysis it was retained as an IBA. Clearly Tambora is one of the most important landscapes in West Nusa Tenggara: Jepson and Monk (1995) included it as part of a critical minimum set of sites aiming to adequately meet species and habitat representation for West Nusa Tenggara.

Threats to habitats and species are logging (legal and illegal), fire, grazing, agroforest (especially coffee) expansion and hunting. Specific conservation recommendations are beyond the scope of this article.

Further study

The Tambora area provides a range of interesting research possibilities. Extensive and diverse forests (and savanna) are habitat for bird species of international interest such as Yellow-crested Cockatoo and Chestnut-backed Thrush. Further study would be valuable to expand on some of the preliminary results compiled here and would also have practical value. Research into the environmental correlates of bird species composition and altitude, as well as season, various land and natural resource issues (e.g. hunting), and comparative analyses of montane bird faunas throughout Nusa Tenggara (or Wallacea) would also be interesting avenues of inquiry.

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Colin R. Trainor, BirdLife International-Indonesia Programme, PO Box 310/Boo, Bogor, Indonesia. Current address: RMB B203 Cardigan 3352, Victoria, Australia. Email: halmahera@hotmail.com

| Species | Status | Previous records and altitude (m) | | | Study sites | | | | | | | | | | | | | | | | | | | | | |
|---|--------|-----------------------------------|-----|-----------|-------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|---|---|---|---|---|
| | | Hartert | FAO | KIH | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | | | | | |
| MOUNTAIN WHITE-EYE <i>Zosterops montanus</i> | R,F | | | 500-1,000 | | | | | | | | | | | | | | | | | 3 | 3 | 3 | 3 | | |
| LEMON-BELLIED WHITE-EYE <i>Zosterops chloris</i> | R | present | | | 3 | 4 | | 2 | 2 | 3 | 4 | 2 | | | | | | | | | | | | | | |
| YELLOW-SPECTACLED WHITE-EYE <i>Zosterops wallacei</i> | R,RR | low | | | 4 | 3 | | | | 2 | 4 | 5 | 3 | 4 | 3 | 4 | | | | | | | | | | |
| CRESTED WHITE-EYE <i>Lophozosterops dohertyi</i> | R,RR,F | 300-900 | | | | | | | | | | | | | 3 | | 3 | 4 | 4 | 3 | | | | | | |
| THICK-BILLED WHITE-EYE <i>Heleia crassirostris</i> | R,RR,F | | | | | | | | | | | | | | 2 | | 3 | 4 | 4 | 3 | | | | | | |
| SUNDA BUSH WARBLER <i>Cettia vulcania</i> | R,F | | | | | | | | | | | | | | | | | | | | | | 3 | 3 | 4 | |
| ARCTIC WARBLER <i>Phylloscopus borealis</i> | PM | low & 900 | | | | | | | | | | | | | | | | | | | | | | | | |
| MOUNTAIN LEAF WARBLER <i>Phylloscopus trivirgatus</i> | R,F | 900 | | | | | | | | | | | | | | | | | | | | | 3 | 4 | 2 | 3 |
| AUSTRALASIAN BUSHLARK <i>Mirafra javanica</i> | R | low | | | | | | | 2 | 3 | | 3 | | | | | | | | | | | | | | |
| GOLDEN-RUMPED FLOWERPECKER <i>Dicaeum annae</i> | R,RR,F | | | | | | | | | | | | | | | | | | | | | | 3 | 3 | 3 | 2 |
| THICK-BILLED FLOWERPECKER <i>Dicaeum agile</i> | R | low | | | | | | | | | | | | | | | | | | | | | | | | |
| BLACK-FRONTED FLOWERPECKER <i>Dicaeum igniferum</i> | R,RR | low | | | | | | | 3 | | | | | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | | |
| BROWN-THROATED SUNBIRD <i>Anthreptes malacensis</i> | R | | | 500-1,000 | | | | | | | | | | | | | | | | | | | | | | 2 |
| OLIVE-BACKED SUNBIRD <i>Nectarinia jugularis</i> | R | low & 900 | | | | | | | 3 | 4 | | 3 | | 4 | 4 | 3 | 3 | 4 | 3 | | | | | | | |
| EURASIAN TREE SPARROW <i>Passer montanus</i> | Ri | | | | | | | | | | | | | | | | | | | | | | | | | |
| PADDYFIELD PIPIT <i>Anthus rufulus</i> | R | low & 900 | | | | | | | 3 | 2 | 3 | | 4 | | | | | | | | | | | | | |
| RED AVADAVAT <i>Amandava amandava</i> | R | | | 500-1,500 | | | | | | | | | | | | | | | | | | | | | | |
| ZEBRA FINCH <i>Taeniopygia guttata</i> | R | | | | | | | | 4 | | | 2 | 2 | | 3 | 2 | | | | | | | | | | |
| TAWNY-BREASTED PARROTFINCH <i>Erythrura hyperythra</i> | R,F | | | 500-1,500 | | | | | | | | | | | | | | | | | | | | | | |
| BLACK-FACED MUNIA <i>Lonchura molucca</i> | R | present | | 500-1,000 | | | | | 4 | 2 | | | | | | | | | | | | | | | | 2 |
| SCALY-BREASTED MUNIA <i>Lonchura punctulata</i> | R | | | | | | | | | | | | | | 2 | 4 | | | | | | | | | | |
| PALE-HEADED MUNIA <i>Lonchura pallida</i> | R | | | | | | | | | | | | | | | | | | | | | | | | | 2 |

Key

Threat category (from BirdLife International 2001):

CR = Critically endangered

NT = Near Threatened

Status:

R = Resident, AM = Migrant from Australia, PM = Palearctic migrant, Ri = Resident, introduced, RR = restricted-range species (Stattersfield *et al.* 1998), F = forest-dependent (based on Butchart *et al.* 1996, Coates and Bishop 1997, Trainor and Lesmana 2000).

Previous records and altitude:

Hartert: present = recorded but altitude not noted; low = lowlands (about 0-300 m), 600 m = 2,000 ft, 900 m = 3,000 ft (from Hartert 1896)

FAO: + = recorded as present by Beudels and Liman (1981)

KIH: Presence and elevation given for records by KIH (1993)

Study sites: (refer to Table 2 for details)

Presence and subjective assessment of relative abundance at each site are given for project records, where: 1 = rare, 2 = uncommon, 3 = frequent, 4 = common, 5 = abundant.