



The avifauna of Mt. Karimui, Chimbu Province, Papua New Guinea, including evidence for long-term population dynamics in undisturbed tropical forest

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SUMMARY.—We conducted ornithological field work on Mt. Karimui and in the surrounding lowlands in 2011–12, a site first surveyed for birds by J. Diamond in 1965. We report range extensions, elevational records and notes on poorly known species observed during our work. We also present a list with elevational distributions for the 271 species recorded in the Karimui region. Finally, we detail possible changes in species abundance and distribution that have occurred between Diamond's field work and our own. Most prominently, we suggest that Bicolored Mouse-warbler *Crateroscelis nigrorufa* might recently have colonised Mt. Karimui's north-western ridge, a rare example of distributional change in an avian population inhabiting intact tropical forests.

The island of New Guinea harbours a diverse, largely endemic avifauna (Beehler *et al.* 1986). However, ornithological studies are hampered by difficulties of access, safety and cost. Consequently, many of its endemic birds remain poorly known, and field workers continue to describe new taxa (Pratt 2000, Beehler *et al.* 2007), report large range extensions (Freeman *et al.* 2013) and elucidate natural history (Dumbacher *et al.* 1992). Of necessity, avifaunal studies are usually based on short-term field work. As a result, population dynamics are poorly known and limited to comparisons of different surveys or differences noticeable over short timescales (Diamond 1971, Mack & Wright 1996).

Here, we report new distributional and ecological observations made during field work on Mt. Karimui, Chimbu Province. Mt. Karimui's avifauna was studied by Jared Diamond in 1965 (Diamond 1972) and we purposely returned to the same ridge he worked. Analysis of elevational changes in Mt. Karimui's avifauna will be presented elsewhere; here, we describe our survey results, including differences from Diamond's historical transect that may reflect avifaunal changes. Tropical bird communities in undisturbed forest are seldom subject to long-term monitoring studies, but populations are thought to be relatively stable (Munn 1985, Greenberg & Gradwohl 1997, Brooks *et al.* 2005, Martinez & Gomez 2013), albeit with local extinctions and colonisations well documented in fragmented forest (Willis 1974, Robinson 1999, Brook *et al.* 2003, Sodhi *et al.* 2004). Finally, we present a comprehensive list of Mt. Karimui's birds, including known elevational ranges and conservation status.

Methods

Study site.—The extinct volcano of Mt. Karimui lies in the southern part of New Guinea's Central Ranges, in Chimbu Province (Fig. 1). Satellite imagery and maps clearly demonstrate Mt. Karimui to be an old volcano with a blown-out caldera. However, when viewed from the Karimui Plateau it appears as a series of discrete peaks. These ridges rise steeply from the relatively level Karimui Plateau (c.1,100 m), and are tallest in the north, where they reach c.2,550 m. Whereas Mt. Karimui is covered in primary forest, a significant part of the fertile Karimui Plateau is under small-scale agriculture, particularly at Karimui Station, a government post c.6 km north-east of Mt. Karimui. For our purposes, we define



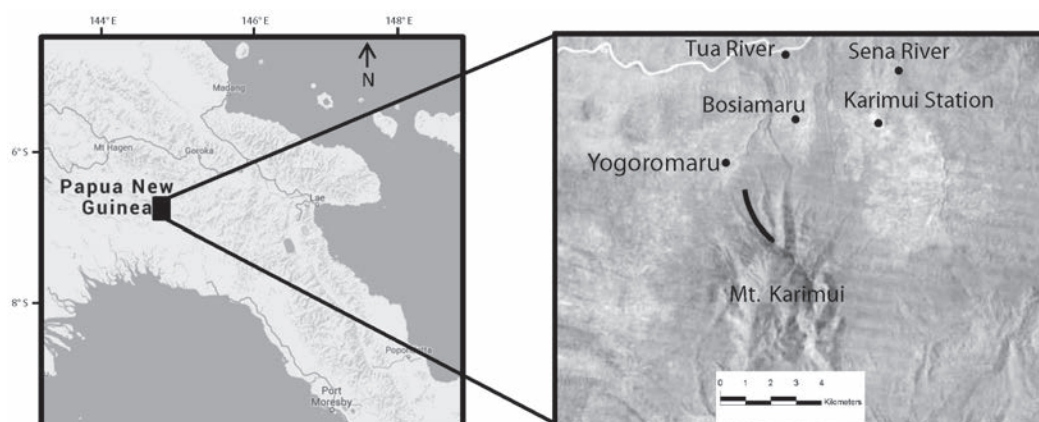


Figure 1. Map of Mt. Karimui, Chimbu Province, Papua New Guinea. The airstrip at Karimui Station, served primarily by small aircraft from Goroka, provides the principal access to the area. Our field work was concentrated on Mt. Karimui's north-west ridge above Yogoromaru village, the same ridge surveyed by Diamond (1972). The transect we surveyed is marked by the black line. See Table 1 for more information on site locations.

the Karimui area as the northern slopes of Mt. Karimui and adjacent Karimui Plateau south and east of the Tua River (see Fig. 1). All field work reported here pertains to this 'Karimui area': the southern ridges, foothills and adjacent lowlands of Mt. Karimui are ornithologically unexplored.

We first visited Mt. Karimui in 2011 during a week-long exploratory visit. We returned for two field seasons in 2012 to survey its birdlife: 13 June to 27 July (June–July) and 12 October to 14 December (October–December). Field work was concentrated on the same ridge studied by Diamond in 1965, Mt. Karimui's north-west ridge located above Yogoromaru village (Diamond 1972, see Fig. 1). In 1965, this ridge was entirely covered by primary forest. Environmental changes in the intervening years have been minor; we found it to be covered with primary forest above c.1,200 m, with the exception of two recently cleared small (c.1 ha) patches, the first a subsistence garden at 1,280 m and the second a clearing at the base of a recently constructed cellphone tower at the summit (2,520 m). To facilitate comparisons with previous data, we avoided surveying in the vicinity of non-forest habitats. We therefore conducted lower elevation field work (at 1,130–1,330 m) on an entirely forested ridge 0.5 km east of Mt. Karimui's north-west ridge (Camp 3, see Table 1), then surveyed the spine of the ridge from 1,330 m to the summit at 2,520 m (based at Camps 1–2, see Table 1). We also visited several lower elevation sites for short periods (see Table 1 for sites and survey effort).

Field work.—We censused bird communities using mist-net surveys, point counts and *ad lib* observations (Table 1). Mist-net surveys in June–July were made along the spine of Mt. Karimui's north-west ridge, with a single mist-net survey at Bosiamaru (see Table 1). Mist-nets touched the ground in order to trap terrestrial species. Along Mt. Karimui's north-west ridge, we used flagging tape to partition the ridge into sections of 25 vertical m (e.g. 1,400–1,425 m). We measured elevation using the barometric altimeter in a Garmin 62S GPS unit, calibrated at Karimui airstrip (1,112 m per Diamond 1972) and using the average of readings taken on multiple days. We mist-netted along the ridgeline in discrete 'segments' of 24–30 nets (corresponding to 100–175 m elevation), and opened nets from 06.00 h to 13.00 h for two days per segment. Mist-nets were not operated in rain. Upon finishing one segment, we moved nets to higher elevations along the same trail and repeated the



TABLE 1
Location of field sites surveyed in the Karimui area, with approximate survey effort and brief habitat description. The vast majority of field work occurred in the vicinity of our three field camps along Mt. Karimui's north-west ridge.

	Elevation (m)	Latitude	Longitude	Survey type	Survey effort	Habitat
Mt. Karimui Camp 1	1,420	06°54.123	144°74.263	Mist-nets; point counts	c.45 man-days	Tall primary forest near base of ridgeline
Mt. Karimui Camp 2	1,890	06°54.693	144°75.250	Mist-net; point counts	c.45 man-days	Primary montane forest with epiphyte- laden trees, some bamboo tangles
Mt. Karimui Camp 3	1,240	06°52.748	144°74.518	Mist-nets; point counts	20 man-days	Tall primary forest at Mt. Karimui's base
Yogoramaru	c.1,100	06°50.672	144°74.178	Qualitative observations	four man-days	Mostly agricultural landscape
Karimui Station area	c.1,100	06°49.254	144°82.473	Qualitative observations	c.20 man-days	Mostly agricultural landscape
Bosiamaru	1,100–1,150	06°50.689	144°80.149	Mist-nets	six man-days	Second growth, heavily hunted
Sena River	750	06°47.735	144°83.475	Qualitative observations of 'salt lick' site	three man-days	Second growth, heavily hunted
Tua River	570	06°45.176	144°78.164	Qualitative observations	two man-days	Mix of second growth and primary forest

process. Our net-line stretched unbroken from 1,330 m to 2,200 m in this fashion. Difficult terrain in the high-elevation elfin forest permitted only scattered mist-netting above 2,200 m and entirely prevented it above 2,400 m. Finally, we mist-netted in lower elevation forest (1,130–1,330 m) along a parallel ridge (described above, Camp 3, see Table 1). Importantly, this mist-net effort closely matches that of Diamond (1972), who likewise ran a nearly continuous mist-net lane along Mt. Karimui's north-west ridge. Unlike Diamond, we did not collect specimens. Instead, individuals trapped were weighed, measured (wing, tail, culmen, tarsus), scored for moult and photographed. We also took blood samples from the brachial vein of the majority of captured individuals. Finally, we clipped the distal portion of the right three outer rectrices, permitting easy diagnosis of recaptures.

One observer (BGF) completed point counts in both 2012 field seasons on Mt. Karimui's north-west ridge. Point counts in June–July were at 1,130–2,520 m ($n = 40$); in October–December at 1,330–2,520 m ($n = 30$). Each point count location was at least 150 m distant from neighbouring point count sites. We conducted five-minute audiovisual point counts, repeating counts on each of three separate mornings (06.00–12.00 h, mostly 06.30–09.00 h). We augmented our quantitative surveys with qualitative observations lacking effort information during the course of field work. Survey effort on Mt. Karimui's ridge was approximately equal between Diamond's July–August transect (33 days) and our June–July (38 days) and October–December (34 days) field seasons, facilitating comparisons. Audio-recordings will be archived at the Macaulay Library of Natural Sounds at the Cornell Lab of Ornithology, Ithaca, NY, while observational data are archived in the Avian Knowledge Network via eBird.



Results

Some 271 bird species occur in the Karimui area, with a further four species reported by local informants (Appendix 1). This total sums extensive field work by ourselves and Diamond, and is probably near-complete. Nevertheless, species richness estimated by Diamond's survey and our own differed: we documented 245 species, Diamond 234. These different totals largely reflect geographic differences in survey effort. Diamond (1972) spent more time at low elevations on the Karimui Plateau and employed native hunters to collect specimens, while our field work was concentrated on Mt. Karimui's slopes. However, research effort on Mt. Karimui's north-west ridge was qualitatively similar between historical and modern transects, suggesting that some of the observed differences may reflect changes in species' populations. Diamond's extensive surveys on Mt. Karimui lack quantitative effort data: our mist-net effort summed 3,665 net-hours, during which time we captured 977 individuals of 91 species. Point counts detected 130 species in 2,082 species / point count combinations. We describe our observations of population dynamics, elevational range extensions and ecological notes for 21 species below.

DWARF CASSOWARY *Casuarius bennetti* / **SOUTHERN CASSOWARY** *C. casuarius*
Cassowaries are New Guinea's largest terrestrial animals and highly valued for their meat (Beehler *et al.* 1986). Informants consistently described them as largely extirpated from the Karimui region, correlating their disappearance to a period of intense hunting in the 1960s and 1970s when metal snares were first used. We never encountered cassowary droppings in the forest—which are frequently encountered where cassowaries are present (BGF pers. obs.)—and saw just one captive bird, a Dwarf Cassowary chick acquired by a Yagoromaru hunter from a remote and seldom-hunted location near the Tua River. The species resident in the Karimui area is Dwarf Cassowary. However, informants described Southern Cassowary as resident in the lowlands south of Mt. Karimui, and reported it to occasionally venture to the Karimui area treated by this manuscript.

COLLARED BRUSHTURKEY *Talegalla jobiensis* /

BLACK-BILLED BRUSHTURKEY *T. fuscirostris*

Talegalla are shy forest-dwellers with braying vocalisations. Due to the difficulty in identifying *Talegalla* vocalisations to species, distributional knowledge is poor. For example, Diamond was unable to identify which *Talegalla* inhabits Mt. Karimui (Diamond 1972) and it was only recently that Collared Brushturkey was documented south of New Guinea's Central Ranges (Mack & Wright 1996). We frequently heard *Talegalla* vocalisations below 1,890 m, eventually photographing a Collared Brushturkey at its mound nest at 1,390 m. We suspect Black-billed Brushturkey also occurs at Karimui and replaces Collared Brushturkey at lower elevations: our best local informant described the green-legged Black-billed Brushturkey as a common resident near the Tua River. We consider this informant credible, as he accurately described the leg colours and preferred elevations of the three megapodes we encountered, the montane Collared and Wattled Brushturkeys *Aepygmodius arfakianus* and widespread Orange-footed Scrubfowl *Megapodius reinwardt*.

PAPUAN EAGLE *Harpyopsis novaeguineae*

We recorded this raptor only a few times: one was observed perched in the canopy at 1,300 m in 2011, and vocalising birds were heard c.3 times in 2012 at our 1,420 and 1,890 m camps. While never abundant throughout its range, this eagle is usually easily detected by voice in forested montane environments (Beehler *et al.* 1986; BGF pers. obs.). Diamond (1972)





noted the species on Mt. Karimui, but did not assess its relative abundance, which often correlates with hunting levels (K. D. Bishop pers. comm.), and we consider it probable that this species is impacted by hunting at Karimui. For example, one local informant showed us a full set of talons from a bird hunted in early 2012 and several informants told us that hunters frequently target Papuan Eagles.

BUFF-BANDED RAIL *Gallirallus philippensis*

Widespread throughout Melanesia, colonising even remote Pacific islands (Beehler *et al.* 1986). We found it relatively common in agricultural areas at Karimui Station. Diamond did not record it. It is unlikely that Diamond overlooked this rail: he surveyed appropriate habitats near Karimui airstrip and collected five Rufous-tailed Bush-hens *Amaurornis moluccana* (Diamond 1972), a more secretive species (BGF pers. obs.). It is therefore probable that Buff-banded Rail—an excellent coloniser (Diamond & LeCroy 1979)—has recently colonised the area, presumably in response to the large increase in agricultural land since 1965.

RUFESCENT IMPERIAL PIGEON *Ducula chalconota*

We regularly heard this montane pigeon on Mt. Karimui. Diamond (1972) was familiar with its distinctive vocalisations, but did not find it on Mt. Karimui. Because columbids regularly undertake seasonal movements and are difficult to detect when not vocal (Diamond 1972), this species may have been overlooked by Diamond or was rare or absent at the time of his survey.

ZOE'S IMPERIAL PIGEON *Ducula zoeae*

We found this lowland species well above its published elevation limit of 1,500 m (Baptista *et al.* 1997). In June–July, it was one of the most commonly detected species on point counts, vocally abundant to c.1,900 m with some heard up to 2,080 m. It probably undertakes seasonal elevational movements: in October–November, we recorded this species infrequently and only below 1,620 m.

STRIATED LORIKEET *Charmosyna multistriata*

Formerly considered absent from Papua New Guinea's southern watershed (Beehler *et al.* 1986). We identified the species on three occasions in November 2012 at our 1,420 m camp. All observations were of small flocks (2–4 birds) in flight, identified by their all-green coloration with yellowish-streaked underparts, distinct from the similar Goldie's Lorikeet *Psitteuteles goldiei*, also present. Lorikeets are difficult to positively identify in flight and our records should be considered provisional. *C. multistriata* is nomadic, often present at a site for several years before disappearing (K. D. Bishop pers. comm.). Our probable records and recent observations from the Crater Mountain area immediately east of the Karimui Plateau (Mack & Wright 1996) suggest this species' wanderings include much of Papua New Guinea's southern watershed.

LORIKEET SP. *Charmosyna* sp.

We observed a vocalising *Charmosyna* in August 2011, when an adult flew by at eye level on the rim of the Karimui Plateau. We judged it to be smaller than Coconut Lorikeet *Trichoglossus haematodus*, the commonest lorikeet at the site, and provisionally identified it as Josephine's Lorikeet *Charmosyna josephinae* based on its relatively large size, very long yellow-tipped tail and red rump. However, we could not conclusively eliminate other *Charmosyna* species (e.g. Papuan Lorikeet *C. papou*) and Josephine's Lorikeet has not been



documented east of Mt. Bosavi (Collar 1997), c.175 km west of Mt. Karimui. This was our sole, possible, observation suggesting it may be an occasional visitor to the region and that future field workers should remain alert for Josephine's Lorikeet.

PESQUET'S PARROT *Psittrichas fulgidus*

Prized for its vermilion and black flight feathers, hunting has extirpated this species in many locations (Beehler *et al.* 1986, Mack & Wright 1998). We did not record it on the Karimui Plateau, where hunting pressure has been intense for at least 50 years (Wagner 1967). In fact, hunting may have formerly almost extirpated the species from the entire Karimui area: Diamond observed the species just once during several months of field work on the Karimui Plateau and on Mt. Karimui. However, we regularly observed pairs or small groups roosting around our 1,420 m and 1,890 m camps, suggesting that it is currently uncommon on the slopes of Mt. Karimui. Local informants reported the species to be fairly common in parts of the Tua River Valley far from human settlements.

PACIFIC KOEL *Eudynamys orientalis*

Regularly heard up to 2,120 m, well above its previously known elevational ceiling of 1,500 m (Beehler *et al.* 1986).

WHITE-CROWNED CUCKOO *Cacomantis leucolophus*

This lowland species generally occurs below 1,740 m (Coates 1985). We frequently heard it during both 2012 field seasons up to c.2,200 m, with one record from 2,520 m in July 2012. We have also heard the species at 2,200–2,300 at Hogave, Mt. Michael, Eastern Highlands, and it is regularly encountered at other highland locations (e.g. Ambua Lodge near Tari, Papua New Guinea; K. D. Bishop pers. comm.); It is probably widespread in montane forest.

HOOK-BILLED KINGFISHER *Melidora macrorrhina*

Commonly heard pre-dawn up to 1,870 m. This is a new high-elevation record for this lowland species, which was previously known only to 1,280 m (Woodall 2001).

YELLOWISH-STREAKED HONEYEATER *Ptiloprora meekiana*

This rare and unobtrusive montane species is probably nomadic (K. D. Bishop pers. comm.), and has been recorded only a few times in the Central and Eastern Highlands of Papua New Guinea (Higgins *et al.* 2008). We did not find it in June–July 2012, nor did Diamond record this species in 1965. However, we observed one in a flowering tree at 1,880 m on three consecutive days in October 2012.

BICOLORED MOUSE-WARBLER *Crateroscelis nigrorufa*

Patchily distributed throughout montane New Guinea. When present, it occupies a narrow elevational band between the closely related lowland Rusty Mouse-warbler *C. murina* and montane Mountain Mouse-warbler *C. robusta*. Despite extensive mist-netting effort and numerous mist-netted Rusty and Mountain Mouse-warblers, Diamond did not record Bicolored Mouse-warbler on Mt. Karimui in 1965. In contrast, we mist-netted 16 *C. nigrorufa* in June–July 2012 (1,620–1,940 m) and regularly observed small parties during both field seasons. Given that Diamond operated a series of mist-nets across the entire elevational zone (J. Diamond pers. comm.), we consider it highly unlikely that this species was overlooked by him. Instead, we suggest that this species was very rare or truly absent on Mt. Karimui's north-west ridge in 1965 and has since become relatively common.

**SCRUBWREN SP.** *Sericornis* sp.

We observed small flocks of an unidentified scrubwren (*Sericornis* sp.) on six occasions at 1,280–1,355 m. Flocks comprised 3–8 individuals that foraged 1–12 m above ground. Three were mist-netted at 1,310 m and blood samples taken. They were morphologically similar (if not identical) to Large Scrubwren *S. nouhuysi*, which was commonly seen and mist-netted above 1,470 (AMCF photographs). However, the only *Sericornis* we observed at 1,355–1,470 m was the much smaller Grey-green Scrubwren *S. arfakianus*. Although speculative, these unidentified lower elevation *Sericornis* could represent a new population of Perplexing Scrubwren *S. virgatus*, a phenotypically variable low-elevation species confusingly similar to Large Scrubwren. This possibility is bolstered by recent records of Perplexing Scrubwren in southern Papua New Guinea (J. Diamond pers. comm.). Genetic studies are necessary to evaluate the taxonomic status of these unidentified scrubwrens.

CHESTNUT-BACKED JEWEL-BABBLER *Ptilorrhoa castanonota* /**SPOTTED JEWEL-BABBLER** *P. leucosticta*

Many species in tropical mountains are elevational replacements (closely related species with parapatric elevational distributions: Diamond 1973, Terborgh & Weske 1975, Jankowski *et al.* 2012, Freeman *et al.* 2013). Range borders are often very abrupt, but elevational gaps sometimes exist between two replacements (Terborgh & Weske 1975). For example, Diamond noted a substantial gap between the foothill Chestnut-backed Jewel-babbler and montane Spotted Jewel-babbler on Mt. Karimui (Diamond 1972). This gap appears to have been maintained. We expended significant effort determining *Ptilorrhoa* elevational distributions, and found a gap between the highest Chestnut-backed Jewel-babbler territory at 1,460 m and the lowest Spotted Jewel-babbler territory at 1,510 m.

RUFOUS-NAPED WHISTLER *Aleadyas rufinucha*

Regularly recorded above 1,920 m. Our only record below this was a juvenile mist-netted at 1,300 m, which echoes records of juveniles of other species found well outside their typical elevational distributions in New Guinea, supporting the hypothesis that juveniles disperse beyond regular altitudinal limits (Diamond 1972, Freeman *et al.* 2013).

SINGING STARLING *Aplonis cantoroides*

This urban / agricultural species has greatly expanded its distribution in response to urbanisation of New Guinea's landscape. It was not recorded by Diamond at Karimui in 1965. However, we observed a small flock on four occasions in 2012, in a small grove of fig trees adjacent to Karimui airstrip. Local informants declared that the species had arrived within the past decade, but is only seen in the vicinity of the airstrip.

LAWES'S PAROTIA *Parotia lawesii*

Regularly observed by Diamond (1972), who collected six specimens on Mt. Karimui's north-west ridge. In contrast, despite many weeks of field work at appropriate elevations, our sole observation was a pair at 1,640 m in November 2012. Parotias are vocal and easily detected (BGF pers. obs.) suggesting that the species has declined in abundance along Mt. Karimui's north-west ridge since 1965.

BANDED YELLOW ROBIN *Poecilodryas placens*

Diamond (1972) found this species near Karimui Station, where he collected two specimens and repeatedly observed lone individuals foraging in the understorey. We did not encounter this easily mist-netted and vocally distinctive understorey species in primary





forest at Karimui Station, nor did we detect it during opportunistic field work at lower elevations. However, we were unable to mist-net in lower elevation (<1,000 m) forest on the Karimui Plateau. Thus, it is unclear if the species persists, even patchily, in the region or is truly absent.

We also documented minor elevational records (<250 m above previously reported limits) for 12 additional species. **STEPHAN'S EMERALD DOVE** *Chalcophaps stephani*: mist-netted at 1,390 m, observed at 1,420 m camp, vs. below 1,200 m (Baptista *et al.* 1997). **RED-CHEEKED PARROT** *Geoffroyus geoffroyi*: to 1,240 m, vs. below 1,113 m (Diamond 1972). **VARIABLE DWARF KINGFISHER** *Ceyx lepidus*: mist-netted to 1,385 m, vs. below 1,300 m (Woodall 2001). **WHITE-EARED CATBIRD** *Ailuroedus buccoides*: mist-netted to 1,300 m, vs. below 1,200 m (Mack & Wright 1996). **TAWNY-BREASTED HONEYEATER** *Xanthotis flaviventer*: to 1,660 m, vs. below 1,500 m (Higgins *et al.* 2008). **RUBY-THROATED MYZOMELA** *Myzomela eques*: to 1,310 m, vs. below 1,200 m (Higgins *et al.* 2008). **GREY-GREEN SCRUBWREN** *Sericornis arfakianus*: to 1,780 m, vs. below 1,700 m (Gregory 2007). **YELLOW-BELLIED GERYGONE** *Gerygone chrysogaster*: to 1,030 m, vs. below 800 m (Beehler *et al.* 1986). **GOLDENFACE** *Pachycare flavogriseum*: to 1,920 m, vs. below 1,800 m (Boles 2007). **GOLDEN CUCKOOSHRIKE** *Campochaera sloetii*: to 1,240 m, vs. below 1,100 m (Taylor 2005). **SOOTY THICKET FANTAIL** *Rhipidura threnothorax*: to 1,240 m, vs. to 1,100 m (Boles 2006). **BLACK-FRONTED WHITE-EYE** *Zosterops atrifrons*: to 1,700 m, vs. below 1,460 m (van Balen 2008).

Discussion

Our studies confirm the high avian diversity of Mt. Karimui and the Karimui Plateau: 271 species are documented to occur, a total comparable to other extensively surveyed New Guinean elevational gradients (Freeman *et al.* 2013), and remarkably high given the absence of lakes, marshes and both low-elevation (<500 m) and upper montane forests (>2,500 m) in the Karimui area. Mt. Karimui's avian diversity includes many species detected during our field work but not by Diamond (1972) in 1965. Conversely, we failed to detect several species reported by Diamond (1972).

Avian community dynamics in the tropics have been seldom studied in undisturbed forests. The sparse data that exist support the hypothesis that tropical bird populations are relatively stable through time, especially among forest-dwelling insectivores (Munn 1985, Brooks 2005, Martinez & Gomez 2013). We lack quantitative data to statistically assess population changes in Mt. Karimui's avifauna. Nevertheless, several species may have undergone substantial population changes during this interval. Most obviously, Bicolored Mouse-warbler was apparently absent on Mt. Karimui's north-west ridge in 1965 but relatively common in 2012. We believe this is the most extreme example of population changes in a resident understorey tropical bird in undisturbed forest. Bicolored Mouse-warbler is patchily distributed across New Guinea and inhabits a narrow elevational zone between two more widespread congeners (Beehler *et al.* 1986, Freeman *et al.* 2013), distributional attributes that may predispose this species to local colonisations and extinctions at individual sites (Diamond 1973). Conversely, it seems that the Lawes's Parotia has almost disappeared from Mt. Karimui's north-west ridge since 1965. Examples of local colonisations and extinctions in disturbed tropical habitats are much more common (Diamond 1971), and we documented the probable recent colonisation of agricultural habitats on the Karimui Plateau by Buff-banded Rail and Singing Starling.

Distributional ecology.—Distributional data describing range limits of New Guinean birds have been previously used to test hypotheses of community assembly and



diversification (Diamond 1973, Diamond 1986, Mack & Dumbacher 2007). We briefly comment on one well-known pattern—the tendency for closely related species to replace one another parapatrically along elevational gradients (Diamond 1986, Freeman *et al.* 2013). Elevational replacements occur in tropical mountains worldwide in many taxa. Understanding the ecological factors that maintain their parapatric distributions is an active arena of ecological research, focused on answering the question of why elevational gradients contain multiple closely related species that partition elevational space, instead of just one widespread species (Jankowski *et al.* 2012).

However, the contribution of elevational replacements to tropical montane biodiversity is seldom quantified. We updated Diamond's (1972) list of elevational replacements on Mt. Karimui. Nearly all elevational replacements are congeners with similar body sizes and diets. In total, we identified 24 pairs, five trios and two quartets of elevational replacements on Mt. Karimui (71 species; Appendix 1). Why do 71 species with narrow elevational distributions exist instead of 31 more widespread species? Providing a satisfactory answer to this question is beyond our scope, but these statistics demonstrate that elevational replacements comprise a significant portion of Mt. Karimui's avian diversity. Mt. Karimui contains 238 species of forest-dwelling birds (Appendix 1), a total 20.2% higher than it would be if all 40 'ecologically redundant' elevational replacements were excluded. This coarse analysis is one of the first to explicitly quantify the contribution of elevational replacements to montane biodiversity for a taxonomic group (Terborgh & Weske 1975), strengthening the hypothesis that elucidating the evolution of elevational distributions is a key component of understanding montane biodiversity in New Guinea (Diamond 1973, 1986).

Conservation.—Conserving Mt. Karimui's diverse avifauna is a significant challenge. The principal negative impacts on bird populations result from hunting and, increasingly, forest clearance. The latter will almost certainly be the main cause of avifaunal declines in the Karimui area in the near future. Human population on the Karimui Plateau has quintupled since the early 1960s (Wagner 1967; J. Anuabo pers. comm.), with concomitant habitat loss due to both subsistence and cash-crop (e.g. coffee) agriculture, with forest clearance likely to accelerate via current plans to construct a road to Karimui. Conserving entire elevational gradients of primary forest provides watershed benefits to local communities while conserving the vast majority of montane biodiversity and providing space to accommodate climate change-driven range shifts (Laurance *et al.* 2011).

Bird populations may also be impacted by hunting. We did not attempt to document the impact of hunting on Mt. Karimui, but did collect several observations consistent with the hypothesis that it affects populations of several species. Subsistence hunting remains common in New Guinean cultures (Wagner 1967). We frequently encountered boys and men hunting birds with slingshots and / or bow-and-arrows, and observed numerous hunting blinds. The latter are used especially frequently (daily or near-daily) during droughts or if located near 'salt licks' where birds, especially columbids, gather to drink water and / or ingest grit or minerals (Diamond *et al.* 1999, Symes *et al.* 2006). Informants reported regularly taking large numbers (>10) of birds, principally columbids, on single visits to such sites. Lastly, it is common practice to consume eggs or nestlings on encountering an active nest, even of small (<15 g) passerines. It is probable that hunting has significantly impacted populations of certain species. For example, Dwarf Cassowary is extirpated from accessible parts of the Karimui Plateau and Mt. Karimui. Likewise, *Talegalla* brushturkeys are absent from forests around Karimui Station, even in large tracts of primary forest. Additionally, Papuan Eagle and Pesquet's Parrot appear to be largely absent from the Karimui Plateau, although the parrot persists on the lower slopes of Mt. Karimui, in rugged terrain near the





Tua River, and may be increasing. These species are regularly targeted by hunters, and it is probable that their distributions are currently limited by hunting pressure.

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References:

- van Balen, S. 2008. Family Zosteropidae (white-eyes). Pp. 402–485 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 13. Lynx Edicions, Barcelona.
- Baptista, L. F., Trail, P. W. & Horblit, H. M. 1997. Family Columbidae (pigeons and doves). Pp. 60–243 in del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of the birds of the world*, vol. 4. Lynx Edicions, Barcelona.
- Beehler, B. M., Pratt, T. K. & Zimmerman, D. A. 1986. *Birds of New Guinea*. Princeton Univ. Press.
- Beehler, B. M., Prawiradilaga, D. M., De Fretes, Y., Kemp, N. & Sodhi, N. 2007. A new species of smoky honeyeater (Meliphagidae: *Melipotus*) from western New Guinea. *Auk* 124: 1000–1009.
- Boles, W. E. 2006. Family Rhipiduridae (fantails). Pp. 200–242 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 11. Lynx Edicions, Barcelona.
- Boles, W. E. 2007. Family Pachycephalidae (whistlers). Pages 374–437 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 12. Lynx Edicions, Barcelona.
- Brook, B. W., Sodhi, N. S. & Ng, P. K. 2003. Catastrophic extinctions follow deforestation in Singapore. *Nature* 424: 420–426.
- Brooks, D. M., Pando-V., L., Ocmin-P., A. & Tejada-R., J. 2005. The relationship between environmental stability and avian population changes in Amazonia. *Orn. Neotrop.* 16: 289–296.
- Coates, B. J. 1985. *The birds of Papua New Guinea*, vol. 1. Dove Publications, Alderley.
- Collar, N. J. 1997. Family Psittacidae (parrots). Pp. 280–477 in del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of the birds of the world*, vol. 4. Lynx Edicions, Barcelona.
- Diamond, J. M. 1971. Comparison of faunal equilibrium turnover rates on a tropical island and a temperate island. *Proc. Natl. Acad. Sci. USA* 68: 2742–2745.
- Diamond, J. M. 1972. *Avifauna of the Eastern Highlands of New Guinea*. Nuttall Orn. Cl., Cambridge, Mass.
- Diamond, J. M. 1973. Distributional ecology of New Guinea birds: recent ecological and biogeographical theories can be tested on the bird communities of New Guinea. *Science* 179: 759–769.
- Diamond, J. M. 1986. Evolution of ecological segregation in the New Guinea montane avifauna. Pp. 98–125 in Diamond, J. M. & Case, T. J. (eds.) *Community ecology*. Harper & Row, New York.
- Diamond, J. M. & LeCroy, M. 1979. Birds of Karkar and Bagabag Islands, New Guinea. *Bull. Amer. Mus. Nat. Hist.* 164: 469–531.
- Diamond, J. M., Bishop, K. D. & Gilardi, J. D. 1999. Geophagy in New Guinea birds. *Ibis* 141: 181–193.
- Dumbacher, J. P., Beehler, B. M., Spande, T. F., Garraffo, H. M. & Daly, J. W. 1992. Homobatrachotoxin in the genus *Pitohui*: chemical defense in birds? *Science* 258: 799.
- Freeman, B. G., Class, A. M., Mandeville, J., Tomassi, S. & Beehler, B. M. 2013. Ornithological survey of the mountains of the Huon Peninsula, Papua New Guinea. *Bull. Brit. Orn. Cl.* 133: 4–18.
- Frith, C. B. & Frith, D. W. 2009. Family Paradisaeidae (birds-of-paradise). Pp. 404–493 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 14. Lynx Edicions, Barcelona.
- Gill, F. & Donsker, D. 2013. IOC World Bird List (v 3.4). www.worldbirdnames.org (accessed 5 June 2013).
- Greenberg, R. & Gradwohl, J. 1997. Territoriality, adult survival, and dispersal in the Checker-throated Antwren in Panama. *J. Avian Biol.* 28: 103–110.
- Gregory, P. 2007. Family Acanthizidae (thornbills). P. 544–611 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 12. Lynx Edicions, Barcelona.
- Higgins, P. J., Christidis, L. & Ford, H. A. 2008. Family Meliphagidae (honeyeaters). Pp. 498–691 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 13. Lynx Edicions, Barcelona.
- IUCN. 2013. The IUCN Red List of threatened species. Version 2013.2. www.iucnredlist.org (accessed 11 December 2013).
- Jankowski, J. E., Londoño, G. A., Robinson, S. K. & Chappell, M. A. 2012. Exploring the role of physiology and biotic interactions in determining elevational ranges of tropical animals. *Ecography* 36: 1–12.
- Laurance, W. F., Useche, D. C., Shoo, L. P., Herzog, S. K., Kessler, M., Escobar, F., Brehm, G., Axmacher, J. C., Chen, I. C., Gámez, L. A., Hietz, P., Fiedler, K., Pycsz, T., Wolf, J., Merkord, C. L., Cardelus, C., Marshall, A. R., Ah-Peng, C., Aplet, G. H., del Coro Arizmendi, M., Baker, W. J., Barone, J., Brühl, C. A., Bussmann, R. W., Cicuzza, D., Eilu, G., Favila, M. E., Hemp, A., Hemp, C., Homeier, J., Hurtado, J., Jankowski, J., Kattán, G., Kluge, J., Krömer, T., Lees, D. C., Lehnert, M., Longino, J. T., Lovett, J., Martin,





- P. H., Patterson, B. D., Pearson, R. G., Peh, K. S. H., Richardson, B., Richardson, M., Samways, M. J., Senbeta, F., Smith, T. B., Utteridge, T. M. A., Watkins, J. E., Wilson, R., Williams, S. E. & Thomas, C. D. 2011. Global warming, elevational ranges and the vulnerability of tropical biota. *Biol. Conserv.* 144: 548–557.
- Mack, A. & Dumbacher, J. 2007. Birds of Papua. Pp. 654–688 in Marshall, A. J. & Beehler, B. M. (eds.) *The ecology of Papua*. Periplus Editions, Singapore.
- Mack, A. L. & Wright, D. D. 1996. Notes on occurrence and feeding of birds at Crater Mountain biological research station, Papua New Guinea. *Emu* 96: 89–101.
- Mack, A. L. & Wright, D. D. 1998. The Vulturine Parrot, *Psitttrichas fulgidus*, a threatened New Guinea endemic: notes on its biology and conservation. *Bird Conserv. Intern.* 8: 185–194.
- Martinez, A. E. & Gomez, J. P. 2013. Are mixed-species bird flocks stable through two decades? *Amer. Natur.* 181: E53–E59.
- Munn, C. A. 1985. Permanent canopy and understory flocks in Amazonia: species composition and population density. Pp. 683–712 in Buckley, P. A., Foster, M. S., Morton, E. S., Ridgely, R. S. & Buckley, F. G. (eds.) *Neotropical ornithology*. Orn. Monogr. 36. American Ornithologists' Union, Washington DC.
- Pratt, T. K. 2000. Evidence for a previously unrecognized species of owl-nightjar. *Auk* 117: 1–11.
- Robinson, W. D. 1999. Long-term changes in the avifauna of Barro Colorado Island, Panama, a tropical forest isolate. *Conserv. Biol.* 13: 85–97.
- Sodhi, N. S., Liow, L. & Bazzaz, F. 2004. Avian extinctions from tropical and subtropical forests. *Ann. Rev. Ecol., Evol. & Syst.* 35: 323–345.
- Symes, C., Hughes, J., Mack, A. & Marsden, S. J. 2006. Geophagy in birds of Crater Mountain wildlife management area, Papua New Guinea. *J. Zool.* 268: 87–96.
- Taylor, P. B. 2005. Family Campephagidae (cuckoo-shrikes). Pp. 40–123 in del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 10. Lynx Edicions, Barcelona.
- Terborgh, J. & Weske, J. S. 1975. Role of competition in distribution of Andean birds. *Ecology* 56: 562–576.
- Wagner, R. 1967. *The curse of Souw: principles of Daribi clan definition and alliance in New Guinea*. Univ. of Chicago Press.
- Willis, E. O. 1974. Populations and local extinctions of birds on Barro Colorado Island, Panama. *Ecol. Monogr.* 44: 153–169.
- Woodall, P. F. 2001. Family Alcedinidae (kingfishers). Pp. 130–249 in del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of the birds of the world*, vol. 6. Lynx Edicions, Barcelona.
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Appendix 1: Complete list of the Karimui area avifauna

Nomenclature follows IOC classification (Gill & Donsker 2013). Conservation status reflects IUCN classification (IUCN 2013), while habitat classifications are based on Beehler *et al.* (1986) and pers. obs. Elevational replacements (pairs, trios and quartets) are based on references (Diamond 1972, Beehler *et al.* 1986) and pers. obs. We note those bird species documented by our recent field work and those by Diamond (1972). We also report elevational distributions at Mt. Karimui of most forest-dwelling species. We describe high elevation limits for many species, and low elevation limits for those species whose lower limit lies above c.1,100 m. Finally, we summarise additional information pertaining to our observations as brief notes. Habitats: F = Forest, Ag = Agricultural, Aq = Aquatic. Conservation status: VU = Vulnerable, NT = Near Threatened, DD = Data Deficient.

English name	Scientific name	Habitat	Conservation status	Elevational replacement	BGF/AMCF Diamond Lower limit (m)	Upper limit (m)	Notes
Southern Cassowary	<i>Casuarius casuarius</i>	F	VU	pair, low			Reported by informants to occur near border of Chimbu and Gulf provinces
Dwarf Cassowary	<i>Casuarius bennetti</i>	F	NT	pair, high			Reported by informants to persist in remote forests, one captive bird in Yagoromaru village





English name	Scientific name	Habitat	Conservation status	Elevational replacement	BGF/AMCF	Diamond	Lower limit (m)	Upper limit (m)	Notes
Wattled Brushturkey	<i>Aepypodius arfakianus</i>	F			X	X			Heard several times around 1,890 m camp
Black-billed Brushturkey	<i>Talegalla fuscirostris</i>	F		pair, low					Reported by informants to occur below c.800 m
Collared Brushturkey	<i>Talegalla jobiensis</i>	F		pair, high	X			1,893	
Orange-footed Scrubfowl	<i>Megapodius reinwardt</i>	F			X	X		1,923	
Brown Quail	<i>Coturnix ypsilophora</i>	Ag							Reported by informants to occur in agricultural land
Salvadori's Teal	<i>Salvadorina waigiuenensis</i>	Aq	VU		X	X			Seen at Sena River (730 m) and Tua River (550 m)
Great Egret	<i>Ardea alba</i>	Aq			X				Seen once at Tua River (550 m)
Pied Heron	<i>Egretta picata</i>	Aq				X			
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	Aq			X				Seen once at Sena River (730 m)
Pacific Baza	<i>Aviceda subcristata</i>	Ag			X	X		1,203	
Long-tailed Honey Buzzard	<i>Henicopernis longicauda</i>	F			X	X		2,263	
Papuan Eagle	<i>Harpyopsis novaeguineae</i>	F	VU		X	X		1,888	Scarce
Pygmy Eagle	<i>Hieraaetus weiskei</i>	F			X				Seen once at 1,300 m
Chestnut-shouldered Goshawk	<i>Erythroriorchis buergeri</i>	F	DD			X			
Doria's Goshawk	<i>Megatriorchis doriae</i>	F				X			
Variable Goshawk	<i>Accipiter hiogaster</i>	Ag			X	X			Seen 3–4 times around Karimui Station
Brown Goshawk	<i>Accipiter fasciatus</i>	Ag				X			
Black-mantled Goshawk	<i>Accipiter melanochlamys</i>	F		pair, high	X	X	1,423	2,143	
Grey-headed Goshawk	<i>Accipiter poliocephalus</i>	F		pair, low	X	X		1,215	
Collared Sparrowhawk	<i>Accipiter cirrocephalus</i>	Ag			X				Seen once near Karimui Station
Swamp Harrier	<i>Circus approximans</i>	Ag			X	X			Seen once at Karimui airstrip
Brahminy Kite	<i>Haliastur indus</i>	F			X	X		2,383	
Nankeen Kestrel	<i>Falco cenchroides</i>	Ag			X	X			Seen twice around Karimui Station
Oriental Hobby	<i>Falco severus</i>	F				X			
Brown Falcon	<i>Falco berigora</i>	Ag			X	X			Seen regularly around Karimui Station



English name	Scientific name	Habitat	Conservation status	Elevational replacement	BGF/AMCF	Diamond	Lower limit (m)	Upper limit (m)	Notes
Forbes's Forest Rail	<i>Rallcula forbesi</i>	F		pair, high	X		1,343	1,763	
Red-necked Crake	<i>Rallina tricolor</i>	F		pair, low		X			
Buff-banded Rail	<i>Gallirallus philippensis</i>	Ag			X				Common around Karimui Station
Lewin's Rail	<i>Lewinia pectoralis</i>	Ag			X				Heard once near Karimui Station
Pale-vented Bush-hen	<i>Amaurornis moluccana</i>	Ag			X	X			Common around Karimui Station
Common Sandpiper	<i>Actitis hypoleucos</i>	Aq			X				Seen along Tua River (550 m)
Australian Pratincole	<i>Stiltia isabella</i>	Ag			X	X			Seen once at Karimui airstrip
Slender-billed Cuckoo-Dove	<i>Macropygia amboinensis</i>	F			X	X		1,903	Very common at lower elevations (below c.1,500 m) and in anthropogenic landscapes
Bar-tailed Cuckoo-Dove	<i>Macropygia nigrirostris</i>	F		largely replaces <i>M. amboinensis</i> at high elevations, but significant overlap	X	X		2,520	Very common at higher elevations (above c.1,300 m), not recorded in anthropogenic areas
Great Cuckoo-Dove	<i>Reinwardtoena reinwardti</i>	F			X	X		2,233	
Stephan's Emerald Dove	<i>Chalcophaps stephani</i>	F			X	X		1,423	
New Guinea Bronzewing	<i>Henicophaps albifrons</i>	F				X			
Cinnamon Ground Dove	<i>Gallicolumba rufigula</i>	F		pair, low	X	X		1,288	
White-breasted Ground Dove	<i>Gallicolumba jobiensis</i>	F				X			
Bronze Ground Dove	<i>Gallicolumba beccarii</i>	F		pair, high	X	X	1,363	2,068	
Pheasant Pigeon	<i>Otidiphaps nobilis</i>	F			X	X		1,693	
Southern Crowned Pigeon	<i>Goura scheepmakeri</i>	F	VU						Reported by elderly local informants to occur near Tua River, but unclear if still present in the Karimui area
Wompoo Fruit Dove	<i>Ptilinopus magnificus</i>	F			X	X		1,033	
Pink-spotted Fruit Dove	<i>Ptilinopus perlatus</i>	F			X	X			Regular at Sena River salt lick (750 m)
Ornate Fruit Dove	<i>Ptilinopus ornatus</i>	F			X	X		2,520	
Superb Fruit Dove	<i>Ptilinopus superbus</i>	F			X	X		1,273	
Beautiful Fruit Dove	<i>Ptilinopus pulchellus</i>	F			X	X		1,243	



English name	Scientific name	Habitat	Conservation status	Elevational replacement	BGF/AMCF	Diamond	Lower limit (m)	Upper limit (m)	Notes
White-bibbed Fruit Dove	<i>Ptilinopus rivoli</i>	F			X	X	1,243	2,105	
Dwarf Fruit Dove	<i>Ptilinopus nainus</i>	F			X	X			Regular at Sena River salt lick (750 m)
Purple-tailed Imperial Pigeon	<i>Ducula rufigaster</i>	F		pair, low	X	X		1,283	
Rufescent Imperial Pigeon	<i>Ducula chalconota</i>	F		pair, high	X		1,793	2,272	
Zoe's Imperial Pigeon	<i>Ducula zoeae</i>	F			X	X		2,083	
Papuan Mountain Pigeon	<i>Gymnophaps albertisii</i>	F			X	X		2,333	
Palm Cockatoo	<i>Probosciger aterrimus</i>	F			X	X		1,283	Scarce
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	F			X	X		2,373	
Pesquet's Parrot	<i>Psitttrichas fulgidus</i>	F	VU		X	X		1,903	
Red-breasted Pygmy Parrot	<i>Micropsitta bruijnii</i>	F			X		1,453	2,133	
Yellowish-streaked Lory	<i>Chalcopsitta scintillata</i>	F				X			
Dusky Lory	<i>Pseudeos fuscata</i>	F			X	X		1,653	
Coconut Lorikeet	<i>Trichoglossus haematodus</i>	F			X	X		1,423	
Goldie's Lorikeet	<i>Psittuteles goldiei</i>	F			X			1,933	
Black-capped Lory	<i>Lorius lory</i>	F			X	X		1,508	
Striated Lorikeet	<i>Charmosyna multistriata</i>	F			X				Seen at 1,420 m camp only
Pygmy Lorikeet	<i>Charmosyna wilhelminae</i>	F			X			1,933	
Red-flanked Lorikeet	<i>Charmosyna placentis</i>	F			X	X		1,323	
Fairy Lorikeet	<i>Charmosyna pulchella</i>	F			X	X	1,323	1,961	
Josephine's Lorikeet	<i>Charmosyna josefinae</i>	F			X				Possibly seen once at 990 m, but requires confirmation.
Papuan Lorikeet	<i>Charmosyna papou</i>	F		replaces other <i>Charmosyna</i> at high elevations	X	X			Seen twice, at 1,735 and 1,910 m
Plum-faced Lorikeet	<i>Oreopsittacus arfaki</i>	F			X	X	1,943	2,520	
Yellow-billed Lorikeet	<i>Neopsittacus musschenbroekii</i>	F				X			
Brehm's Tiger Parrot	<i>Psittacella brehmii</i>	F			X	X	1,765	2,235	
Madarasz's Tiger Parrot	<i>Psittacella madaraszi</i>	F			X	X			Seen twice, at 1,820 and 1,910 m





English name	Scientific name	Habitat	Conservation status	Elevational replacement	BGF/AMCF	Diamond	Lower limit (m)	Upper limit (m)	Notes
Red-cheeked Parrot	<i>Geoffroyus geoffroyi</i>	F		pair, low	X	X		1,243	
Blue-collared Parrot	<i>Geoffroyus simplex</i>	F		pair, high	X	X	1,033	1,953	
Eclectus Parrot	<i>Eclectus roratus</i>	F			X	X		1,393	
Papuan King Parrot	<i>Alisterus chloropterus</i>	F			X	X		1,593	
Orange-breasted Fig Parrot	<i>Cyclopsitta guliemitertii</i>	F		pair, low	X	X		1,108	
Double-eyed Fig Parrot	<i>Cyclopsitta diophthalma</i>	F		pair, high	X		1,163	1,243	
Large Fig Parrot	<i>Psittaculirostris desmarestii</i>	F			X	X		1,243	
Ivory-billed Coucal	<i>Centropus menbeki</i>	F			X	X		1,383	
Pheasant Coucal	<i>Centropus phasianinus</i>	Ag			X				One record from near Karimui Station
Dwarf Koel	<i>Microdynamis parva</i>	F			X	X		1,321	
Pacific Koel	<i>Eudynamis orientalis</i>	F			X	X		2,123	
Rufous-throated Bronze Cuckoo	<i>Chrysococcyx ruficollis</i>	F		pair, high	X		1,793	2,520	
White-eared Bronze Cuckoo	<i>Chrysococcyx meyeri</i>	F		pair, low	X	X		1,813	
White-crowned Cuckoo	<i>Cacomantis leucolophus</i>	F			X	X		2,520	
Chestnut-breasted Cuckoo	<i>Cacomantis castaneiventris</i>	F		pair, low	X	X		1,658	Possibly to higher elevations (overlap unclear, Fan-tailed Cuckoo vocally similar)
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>	F		pair, high	X		1,763	2,520	Possibly to lower elevations (overlap unclear, Chestnut-breasted Cuckoo vocally similar)
Brush Cuckoo	<i>Cacomantis variolosus</i>	Ag			X	X			Common in gardens
Oriental Cuckoo	<i>Cuculus optatus</i>	F			X				Seen at Tua River (550 m)
Greater Sooty Owl	<i>Tyto tenebricosa</i>	F			X				Heard regularly at 1,420 m camp
Papuan Boobook	<i>Ninox theomacha</i>	F			X	X		2,520	
Marbled Frogmouth	<i>Podargus ocellatus</i>	F			X	X		1,233	
Papuan Frogmouth	<i>Podargus papuensis</i>	F			X	X		1,233	
White-throated Nightjar	<i>Eurostopodus mystacalis</i>	Ag				X			
Papuan Nightjar	<i>Eurostopodus papuensis</i>	F			X				Seen at Sena River (730 m)





English name	Scientific name	Habitat	Conservation status	Elevational replacement	BGF/AMCF	Diamond	Lower limit (m)	Upper limit (m)	Notes
Feline Owlet-nightjar	<i>Aegotheles insignis</i>	F			X	X		1,893	Vocalisations attributed to this species heard at 1,420 and 1,910 m camps
Wallace's Owlet-nightjar	<i>Aegotheles wallacii</i>	F	DD			X			<i>Aegotheles</i> sp. heard below 1,500 m could not be identified to species
Mountain Owlet-nightjar	<i>Aegotheles albertisi</i>	F		replaces <i>A. wallacii</i> and <i>A. bennettii</i> at high elevations	X			2,520	<i>Aegotheles</i> sp. heard at 2,520 m presumed to be this species based on elevation
Barred Owlet-nightjar	<i>Aegotheles bennettii</i>	F				X			<i>Aegotheles</i> sp. heard below 1,500 m not identified
Moustached Treeswift	<i>Hemiprocne mystacea</i>	F			X	X		1,253	
Glossy Swiftlet	<i>Collocalia esculenta</i>	F			X	X		2,520	
Mountain Swiftlet	<i>Aerodramus hirundinaceus</i>	F			X	X			Commonly seen around Karimui Station
Oriental Dollarbird	<i>Eurystomus orientalis</i>	Ag			X	X		1,243	
Hook-billed Kingfisher	<i>Melidora macrorrhina</i>	F			X	X		1,873	
Shovel-billed Kookaburra	<i>Clytoceyx rex</i>	F				X			
Rufous-bellied Kookaburra	<i>Dacelo gaudichaud</i>	F			X	X		1,283	
Forest Kingfisher	<i>Todiramphus macleayii</i>	Ag				X			
Sacred Kingfisher	<i>Todiramphus sanctus</i>	Ag			X	X			Commonly seen around Karimui Station
Yellow-billed Kingfisher	<i>Syma torotoro</i>	F		pair, low	X	X		1,233	
Mountain Kingfisher	<i>Syma megarhyncha</i>	F		pair, high	X	X	1,493	2,158	
Variable Dwarf Kingfisher	<i>Ceyx lepidus</i>	F			X	X		1,388	
Azure Kingfisher	<i>Ceyx azureus</i>	Aq			X	X			Seen once at Tua River (550 m)
Rainbow Bee-eater	<i>Merops ornatus</i>	Ag			X	X			Seen twice near Karimui Station
Blyth's Hornbill	<i>Rhyticeros plicatus</i>	F			X	X			Seen on 3–4 occasions
Red-bellied Pitta	<i>Erythropitta erythrogaster</i>	F			X	X		1,198	
White-eared Catbird	<i>Ailuroedus buccoides</i>	F		pair, low	X	X		1,303	
Spotted Catbird	<i>Ailuroedus melanotis</i>	F		pair, high	X	X	1,363	1,703	





English name	Scientific name	Habitat	Conservation status	Elevational replacement	BGF/AMCF	Diamond	Lower limit (m)	Upper limit (m)	Notes
MacGregor's Bowerbird	<i>Amblyornis macgregoriae</i>	F			X	X	1,693	2,243	
White-shouldered Fairywren	<i>Malurus alboscapulatus</i>	Ag			X	X		1,253	
Orange-crowned Fairywren	<i>Clytomyias insignis</i>	F			X	X			Family groups seen at 2,160 m and 2,350 m
Ruby-throated Myzomela	<i>Myzomela eques</i>	F			X	X		1,313	
Red Myzomela	<i>Myzomela cruentata</i>	F		trio, middle	X	X		1,423	Lower elevation limit unclear (not observed below 1,300 m)
Papuan Black Myzomela	<i>Myzomela nigrita</i>	F		trio, low	X	X		1,243	
Red-collared Myzomela	<i>Myzomela rosenbergii</i>	F		trio, high	X	X	1,273	2,520	
Green-backed Honeyeater	<i>Glycichaera fallax</i>	F			X			1,198	
Yellowish-streaked Honeyeater	<i>Ptiloprora meekiana</i>	F			X				Seen twice at flowering tree at 1,880 m
Rufous-backed Honeyeater	<i>Ptiloprora guisei</i>	F			X	X	1,783	2,520	
Plain Honeyeater	<i>Pycnopygius ixoides</i>	F		pair, low	X	X			Seen once at 1,010 m near Karimui Station
Marbled Honeyeater	<i>Pycnopygius cinereus</i>	F		pair, high	X	X			Seen once at 1,420 m camp
Spotted Honeyeater	<i>Xanthotis polygrammus</i>	F			X	X		1,363	
Tawny-breasted Honeyeater	<i>Xanthotis flaviventer</i>	F			X	X		1,663	
Meyer's Friarbird	<i>Philemon meyeri</i>	F				X			
New Guinea Friarbird	<i>Philemon novaeguineae</i>	F			X	X		1,243	
Long-billed Honeyeater	<i>Melilestes megarhynchus</i>	F			X	X		1,633	
Common Smoky Honeyeater	<i>Melipotes fumigatus</i>	F			X	X	1,338	2,520	
Olive Straightbill	<i>Timeliopsis fulvigula</i>	F			X	X	1,633	2,063	
Black-throated Honeyeater	<i>Caligavis subfrenata</i>	F		pair, high	X	X	1,423	2,520	
Obscure Honeyeater	<i>Caligavis obscura</i>	F		pair, low	X	X		1,243	
Yellow-browed Melidectes	<i>Melidectes rufocrissalis</i>	F		pair, high	X	X	1,338	2,520	
Ornate Melidectes	<i>Melidectes torquatus</i>	F		pair, low	X	X	1,333	1,888	
Mottle-breasted Honeyeater	<i>Meliphaga mimikae</i>	F		pair, low	X	X		1,313	
Mountain Honeyeater	<i>Meliphaga orientalis</i>	F		pair, high	X	X	1,423	1,883	





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Scrub Honeyeater	<i>Meliphaga albonotata</i>	Ag			X	X			Common around Karimui Station
Mimic Honeyeater	<i>Meliphaga analoga</i>	F			X	X		1,163	
Yellow-gaped Honeyeater	<i>Meliphaga flavirictus</i>	F				X			
Puff-backed Honeyeater	<i>Meliphaga aruensis</i>	F			X	X		1,158	
Rusty Mouse-warbler	<i>Crateroscelis murina</i>	F		trio, low	X	X		1,773	
Bicolored Mouse-warbler	<i>Crateroscelis nigrorufa</i>	F		trio, middle	X		1,623	1,943	
Mountain Mouse-warbler	<i>Crateroscelis robusta</i>	F		trio, high	X	X	1,873	2,520	
Pale-billed Scrubwren	<i>Sericornis spilodera</i>	F		quartet, lowest	X	X		1,513	
Papuan Scrubwren	<i>Sericornis papuensis</i>	F		quartet, highest	X	X	1,943	2,520	
scrubwren sp.	<i>Sericornis</i> sp.	F			X				See species account
Large Scrubwren	<i>Sericornis nouhuysi</i>	F			X	X	1,473	2,426	
Buff-faced Scrubwren	<i>Sericornis perspicillatus</i>	F		quartet, high middle	X	X	1,703	2,013	
Grey-green Scrubwren	<i>Sericornis arfakianus</i>	F		quartet, low middle	X	X	1,378	1,783	One possible record from 1,200 m near Bosiamaru
Brown-breasted Gerygone	<i>Gerygone ruficollis</i>	F			X	X	1,447	2,380	
Large-billed Gerygone	<i>Gerygone magnirostris</i>	F			X				Seen/heard at Sena River (730 m)
Yellow-bellied Gerygone	<i>Gerygone chrysogaster</i>	F			X	X		1,033	
Ashy Gerygone	<i>Gerygone cinerea</i>	F			X	X	2,515	2,520	
Green-backed Gerygone	<i>Gerygone chloronota</i>	F			X	X		1,383	
Fairy Gerygone	<i>Gerygone palpebrosa</i>	F			X	X		1,243	
Goldenface	<i>Pachycare flavogriseum</i>	F			X	X		1,923	
Loria's Satinbird	<i>Cnemophilus loriae</i>	F		pair, low	X	X	1,423	2,428	
Crested Satinbird	<i>Cnemophilus macgregorii</i>	F		pair, high	X	X			One male seen at ridge summit (2,520 m)
Yellow-breasted Satinbird	<i>Loboparadisea sericea</i>	F	NT		X	X	1,433	1,933	
Black Berrypecker	<i>Melanocharis nigra</i>	F		pair, low	X	X		1,463	
Fan-tailed Berrypecker	<i>Melanocharis versteri</i>	F		pair, high	X	X	1,388	2,520	
Streaked Berrypecker	<i>Melanocharis striativentris</i>	F			X	X	1,453	1,873	





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Spotted Berrypecker	<i>Rhamphocharis crassirostris</i>	F			X	X	2,103	2,323	
Dwarf Longbill	<i>Oedistoma iliolophus</i>	F			X	X		1,653	
Pygmy Longbill	<i>Oedistoma pygmaeum</i>	F			X	X		1,288	
Slaty-headed Longbill	<i>Toxorhamphus poliopterus</i>	F			X	X		1,993	
Tit Berrypecker	<i>Oreocharis arfaki</i>	F			X	X	1,338	2,520	
Crested Berrypecker	<i>Paramythia montium</i>	F			X	X			Flock seen just below summit of ridge (2,490 m)
Spotted Jewel-babbler	<i>Ptilorrhoa leucosticta</i>	F		trio, high	X	X	1,508	2,142	
Blue Jewel-babbler	<i>Ptilorrhoa caerulescens</i>	F		trio, middle	X				Heard at Tua River (550 m)
Chestnut-backed Jewel-babbler	<i>Ptilorrhoa castanonota</i>	F		trio, low	X	X		1,458	Lower elevation limit not determined
Yellow-breasted Boatbill	<i>Machaerirhynchus flaviventer</i>	F		pair, low	X	X		1,308	
Black-breasted Boatbill	<i>Machaerirhynchus nigripictus</i>	F		pair, high	X	X	1,243	2,393	
Lowland Peltops	<i>Peltops blainvillii</i>	F		pair, low		X			
Mountain Peltops	<i>Peltops montanus</i>	F		pair, high	X	X		2,105	
Black Butcherbird	<i>Cracticus quoyi</i>	F			X	X		1,508	
Hooded Butcherbird	<i>Cracticus cassicus</i>	F			X	X		1,333	
Great Woodswallow	<i>Artamus maximus</i>	F			X	X			Common around Karimui Station
Black-faced Cuckooshrike	<i>Coracina novaehollandiae</i>	Ag				X			
Stout-billed Cuckooshrike	<i>Coracina caeruleogrisea</i>	F			X	X		1,593	
Boyer's Cuckooshrike	<i>Coracina boyeri</i>	F				X			
Common Cicadabird	<i>Coracina tenuirostris</i>	Ag			X				Vocalising bird seen near Karimui Station
Black-shouldered Cicadabird	<i>Coracina incerta</i>	F			X				Single seen on north slope of Mt. Karimui (1,250 m)
Grey-headed Cuckooshrike	<i>Coracina schisticeps</i>	F		pair, low	X	X		1,363	
Black Cicadabird	<i>Coracina melas</i>	F			X	X			Pair seen at Tua River (550 m)
Black-bellied Cuckooshrike	<i>Coracina montana</i>	F		pair, high	X	X	1,338	2,303	
Golden Cuckooshrike	<i>Campochaera sloetii</i>	F			X	X		1,243	
Varied Triller	<i>Lalage leucomela</i>	F			X	X		1,423	





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Varied Sittella	<i>Daphoenositta chrysoptera</i>	F				X			
Mottled Whistler	<i>Rhagologus leucostigma</i>	F			X	X	1,323	2,520	
Wattled Ploughbill	<i>Eulacestoma nigropectus</i>	F			X	X	1,913	2,263	
Rufous-naped Whistler	<i>Aleadyras rufinucha</i>	F			X	X	1,303	2,398	
Crested Pitohui	<i>Ornorectes cristatus</i>	F			X	X		1,353	
Black Pitohui	<i>Melanorectes nigrescens</i>	F		pair, high (with Little Shrikethrush)	X	X	1,573	2,453	
Rusty Whistler	<i>Pachycephala hyperythra</i>	F		trio, low	X	X		1,353	
Brown-backed Whistler	<i>Pachycephala modesta</i>	F			X	X	1,810	2,220	
Grey Whistler	<i>Pachycephala simplex</i>	F			X	X		1,463	
Sclater's Whistler	<i>Pachycephala soror</i>	F		trio, middle	X	X	1,243	1,913	
Regent Whistler	<i>Pachycephala schlegelii</i>	F		trio, high	X	X	1,753	2,520	
Black-headed Whistler	<i>Pachycephala monacha</i>	Ag			X	X			Common around Karimui Station
Rusty Pitohui	<i>Pseudorectes ferrugineus</i>	F			X	X		1,143	
Little Shrikethrush	<i>Colluricincla megarhyncha</i>	F		pair, low (with Black Pitohui)	X	X		1,753	
Long-tailed Shrike	<i>Lanius schach</i>	Ag			X				Regular at Karimui airstrip
Southern Variable Pitohui	<i>Pitohui uropygialis</i>	F		pair, low	X	X		1,231	
Hooded Pitohui	<i>Pitohui dichrous</i>	F		pair, high	X	X		1,658	Lower elevation limit not determined
Brown Oriole	<i>Oriolus szalayi</i>	F			X	X		1,443	
Pygmy Drongo	<i>Chaetorhynchus papuensis</i>	F			X	X		1,713	
Spangled Drongo	<i>Dicrurus bracteatus</i>	F			X	X		1,273	
Willie Wagtail	<i>Rhipidura leucophrys</i>	Ag			X	X			Common around Karimui Station
Northern Fantail	<i>Rhipidura rufiventris</i>	F			X	X		1,423	
Sooty Thicket Fantail	<i>Rhipidura threnothorax</i>	F			X	X		1,243	
White-bellied Thicket Fantail	<i>Rhipidura leucothorax</i>	F			X	X			Seen once near Karimui Station
Black Fantail	<i>Rhipidura atra</i>	F			X	X	1,241	2,520	
Chestnut-bellied Fantail	<i>Rhipidura hyperythra</i>	F		pair, low	X	X		1,658	





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Friendly Fantail	<i>Rhipidura albolimbata</i>	F		pair, high	X	X	1,633	2,520	
Dimorphic Fantail	<i>Rhipidura brachyrhyncha</i>	F			X	X	1,573	2,520	
Rufous-backed Fantail	<i>Rhipidura rufidorsa</i>	F				X			
Black Monarch	<i>Symposiachrus axillaris</i>	F			X	X	1,188	1,913	
Spot-winged Monarch	<i>Symposiachrus guttula</i>	F			X	X		1,183	
Black-winged Monarch	<i>Monarcha frater</i>	F			X	X		1,623	
Golden Monarch	<i>Carterornis chrysomela</i>	F			X	X		1,193	
Frisled Monarch	<i>Arses telescopthalmus</i>	F			X	X		1,273	
Torrent-lark	<i>Grallina bruijnii</i>	Aq			X	X		1,213	
Grey Crow	<i>Corvus tristis</i>	F			X	X		1,233	
Lesser Melampitta	<i>Melampitta lugubris</i>	F			X		1,943	2,520	
Blue-capped Ifrit	<i>Ifrita kowaldi</i>	F			X	X	1,793	2,356	
Crinkle-collared Manucode	<i>Manucodia chalybatus</i>	F			X	X		1,433	
Trumpet Manucode	<i>Phonygamus keraudrenii</i>	F			X	X		1,423	
Short-tailed Paradigalla	<i>Paradigalla brevicauda</i>	F			X	X			Seen once at 1,820 m
Princess Stephanie's Astrapia	<i>Astrapia stephaniae</i>	F			X	X	1,713	2,520	
Lawes's Parotia	<i>Parotia lawesii</i>	F			X	X			Pair seen once at 1,640 m
King of Saxony Bird-of-paradise	<i>Pteridophora alberti</i>	F			X	X	1,893	2,520	
Superb Bird-of-paradise	<i>Lophorina superba</i>	F			X	X	1,283	1,982	
Magnificent Riflebird	<i>Ptiloris magnificus</i>	F			X	X		1,473	
Black Sicklebill	<i>Epimachus fastosus</i>	F	VU		X	X	1,683	2,520	
Black-billed Sicklebill	<i>Drepanornis alberti</i>	F			X	X			One mist-netted at 1,710 m
Magnificent Bird-of-paradise	<i>Diphyllodes magnificus</i>	F			X	X		1,709	
King Bird-of-paradise	<i>Cicinnurus regius</i>	F			X	X			Singles at Sena (730 m) and Tua (550 m) Rivers
Raggiana Bird-of-paradise	<i>Paradisaea raggiana</i>	F			X	X		1,623	
Blue Bird-of-paradise	<i>Paradisaea rudolphi</i>	F	VU			X			





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Banded Yellow Robin	<i>Poecilodryas placens</i>	F	NT		X				
Black-throated Robin	<i>Poecilodryas albonotata</i>	F			X	X	1,703	2,520	
White-winged Robin	<i>Peneothello sigillata</i>	F		quartet, highest	X	X	2,333	2,520	
Slaty Robin	<i>Peneothello cyanus</i>	F		quartet, high middle	X	X	1,673	2,398	
White-rumped Robin	<i>Peneothello bimaculata</i>	F		quartet, lowest	X	X		1,283	
White-faced Robin	<i>Tregellasia leucops</i>	F			X	X	1,198	1,718	
White-eyed Robin	<i>Pachycephalopsis poliosoma</i>	F		quartet, low middle	X	X	1,218	1,698	
Torrent Flyrobin	<i>Monachella muelleriana</i>	F			X	X			Seen at Sena (730 m) and Tua (550 m) Rivers
Canary Flyrobin	<i>Microeca papuana</i>	F		trio, high	X	X	1,763	2,520	
Yellow-legged Flyrobin	<i>Microeca griseiceps</i>	F		trio, middle	X		1,093	1,423	
Olive Flyrobin	<i>Microeca flavovirescens</i>	F		trio, low	X	X		1,313	
Garnet Robin	<i>Eugerygone rubra</i>	F			X	X	1,753	2,333	
Northern Scrub Robin	<i>Drymodes supercilialis</i>	F			X	X		1,393	
Lesser Ground Robin	<i>Amalocichla incerta</i>	F			X	X	1,794	2,105	
Island Leaf Warbler	<i>Phylloscopus maforensis</i>	F			X	X	1,321	1,961	
Australian Reed Warbler	<i>Acrocephalus australis</i>	Ag			X				Present around Karimui airstrip
Papuan Grassbird	<i>Megalurus macrurus</i>	Ag			X	X			Common around Karimui Station
Black-fronted White-eye	<i>Zosterops minor</i>	F			X	X		1,703	
Singing Starling	<i>Aplonis cantoroides</i>	Ag			X				Flock regular at Karimui airstrip
Yellow-faced Myna	<i>Mino dumontii</i>	F			X	X		1,353	
Russet-tailed Thrush	<i>Zoothera heinei</i>	F			X	X	1,473	1,643	
Pied Bush Chat	<i>Saxicola caprata</i>	Ag				X			
Red-capped Flowerpecker	<i>Dicaeum geelvinkianum</i>	F			X	X		1,723	
Black Sunbird	<i>Leptocoma sericea</i>	Ag				X			
Blue-faced Parrotfinch	<i>Erythrura trichroa</i>	F			X	X	1,493	2,313	
Streak-headed Mannikin	<i>Lonchura tristissima</i>	F			X				Seen twice around Karimui Station
Hooded Mannikin	<i>Lonchura spectabilis</i>	Ag			X	X			Common around Karimui Station

