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Chapter 2

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SUMMARY

A total of 17 frog and two reptile species were documented from montane forests and montane grassland habitats in the Kaijende Highlands region of Enga Province, Papua New Guinea. At least eight of the frog species are undescribed and one of these probably warrants recognition as a new genus. This survey documented the second known population of *Callulops glandulosus*, previously known only from a single specimen collected at 3,340 m elevation on Mt. Kerewa, and a very large species of *Albericus* found at Lake Tawa may represent only the second known population of *A. fafniri*. One other frog, *Litoria becki*, was previously known only from montane grassland on Mt. Wilhelm and Mt. Giluwe and was considered a Vulnerable species in the recent Global Amphibian Assessment. The reptile fauna was depauperate, reflecting the high-elevation focus of this survey. However one of the two species documented, a skink of the genus *Sphenomorphus*, may represent an undescribed taxon.

The open, montane *Cyathea*-grassland habitats typical of the highest elevations of the Kaijende Highlands represent a significant habitat for at least four frogs. Two of these are undescribed species that did not occur in upper montane forests and they are probably restricted to high-montane grasslands. These grassland habitats may be under threat from global warming and the frogs and other fauna that are confined predominantly or exclusively to them should be considered at risk of extinction.

INTRODUCTION

The high-montane herpetofauna of New Guinea's central mountainous spine has been patchily documented. The Archbold Expeditions to Mt. Michael, Mt. Wilhelm, Mt. Dayman and the Lake Habbema area made significant collections of high-elevation herpetofauna that were examined predominantly by R.G. Zweifel at the American Museum of Natural History (e.g. Zweifel 1972). Other significant, but sporadic collections of amphibians and reptiles at high elevations in New Guinea have revealed a fauna dominated by microhylid frogs and small scincid lizards in the genera *Papuascincus* and *Lobulia* (Greer et al. 2005, Zweifel et al. 2005). Large reptiles are generally rare due to the persistently cold wet conditions at these elevations, but a spectacular exception is the rarely encountered Boelen's Python which occurs at elevations exceeding 2,000 m (O'Shea 1996).

Frogs in New Guinea occur at elevations up to 4,000 m elevation (Zweifel 2000) although species richness attenuates markedly at elevations above about 2,000 m, and is extremely low above 3,000 m. The herpetofauna occurring at these high elevations includes a number of interesting evolutionary lineages that are poorly represented at lower elevations (e.g. Greer et al. 2005) and a number of species that appear to be restricted to a unique, alpine grassland/*Cyathea* habitat. Because high-montane environments are thought to be at great risk from cli-

mate change many of these species may be at risk of extinction (e.g. Greer et al. 2005).

Unfortunately logistical difficulties associated with accessing the remote and rugged mountains of New Guinea preclude cost-effective surveys of most areas, and documentation of the species richness and distributions of high-elevation herpetofaunas is far from complete. This clearly constrains attempts to prioritize conservation actions in these vast alpine environments across New Guinea's central cordillera. The survey reported here provides the first data on herpetofaunal assemblages in the previously unsurveyed and sparsely populated Kaijende Highlands region of Enga Province, Papua New Guinea.

METHODS

Study sites

Frogs and reptiles were documented at three major sites: 1) Omyaka and Waile Creek, 2) Paiela Road, and 3) Lake Tawa. Several additional records were obtained serendipitously in the vicinity of Suyan Village. The field schedule and site descriptions are presented in the Executive Summary and a comprehensive description of vegetation types and floristic variation for each site is provided in Chapter 1. The major features of each site that were significant for herpetofaunal assemblages are described below.

Site 1. Omyaka and Waile Creek, High-Montane Grassland

The rolling montane grasslands at Omyaka and Waile Creek presented a mosaic of grassland and *Cyathea*-dominated habitats. Small, slow-flowing streams occurred in the gullies and many of these were choked by dense vegetation. A series of open-water bog habitats (see Chapter 1) were scattered across the grasslands, particularly near the Omyaka Camp. Dense, low-stature moss forest dominated the periphery of the grasslands at Omyaka.

Site 2. Paiela Road, Upper Montane Forest

Collections were undertaken along the Paiela Road at elevations between 2,800–2,900 m. Several torrential streams that intersect the road were searched for tadpoles during the day, and for frogs at night. The dense, mossy forest along the road contained patches of *Pandanus* trees that harbored at least one frog species not documented in any other habitat. Disturbed vegetation and the grassy road verges were also searched at night, and large numbers of *Papuascincus* eggs and adults were discovered under stones at the edge of the road.

Site 3. Lake Tawa, Lower Montane Forest and Lakeside Grasslands

This site had the widest variety of habitats for frogs and reptiles. The dense grassy verges of Lake Tawa provided habitat for small tree-frogs, the very wet lower montane forest was a spatially complex environment for terrestrial and arboreal microhylid frogs, and a series of small streams provided habitat for at least one species of torrent-dwelling hylid frog.

Field methods

Surveys were conducted at each site using techniques that followed closely those used in previous RAP surveys (e.g. Richards et al. 2000). At each site, I first identified all accessible habitats and then with 1–3 local assistants conducted intensive searches for frogs and reptiles in each. During the day we searched for heliothermic (basking) reptiles along forest trails and stream banks. Small lizards of the genus *Papuascincus* were collected by hand or after being stunned with a large rubber band. We searched for nocturnal reptiles by walking along forest trails and stream banks at night with a headlamp. Tadpoles were collected by dip-netting in ponds and streams. In torrential streams the dip-net was placed down-stream of rocks, which were then turned to dislodge tadpoles that were hiding underneath. Dislodged tadpoles were swept into the net by the current. Frogs were detected at night by conducting visual-encounter and aural surveys along streams, and in and around small ponds. We also conducted extensive visual and aural searches in the montane grasslands and along forest trails away from water to detect microhylid frogs that have a life cycle independent of free-standing water.

Because frog calls are an important diagnostic character, I recorded the advertisement calls of frogs with a Sony TCM-5000 Tape Recorder and a Sennheiser ME66 microphone. Each species was photographed alive before preparation of voucher specimens. Specimens were euthanized by submersion in chlorotone (for frogs), or with lethal injection of chlorotone for reptiles. Specimens were fixed in 10% formalin solution, and then stored in 70% ethanol. Samples of liver tissue for DNA analyses were extracted from up to five specimens of each species and stored in 95% ethanol.

Voucher specimens will be deposited in the Natural Sciences Resource Centre collection of the University of Papua New Guinea (UPNG), and the South Australian Museum, Australia (SAMA).

RESULTS AND DISCUSSION

A total of 17 frog and two reptile species were documented from three major habitat types in the Kaijende Highlands. Species richness was highest at the lowest-elevation site (11 species at Lake Tawa; ~ 1,120 m) and lowest at the highest-elevation sites (5 species at Omyaka and Waile Creek; ~ 3,100–3,400 m) (Table 2.1).

The reptile fauna was dominated by a single species of *Papuascincus* (see species accounts below). This lizard was abundant on the alpine grasslands and in open sunny areas around Lake Tawa. Large numbers of eggs of this species were found under loose soil beneath rocks along the verge of Paiela Road. A single specimen of a potentially undescribed *Sphenomorphus* was found at Lake Tawa. No snakes were

observed during the survey although it is likely that the Boelen's Python *Morelia boeleni* occurs in the region. Few snakes in New Guinea occur at the elevations we focused on.

The frog fauna was dominated by the family Microhylidae, with 13 of the 17 species (76%) belonging to this group. Eight of the microhylid species (62%) appear to be undescribed but perhaps more significantly two of the three undescribed microhylids documented from the alpine grassland/*Cyathea* habitats were never heard calling from, or found within, forest habitats. These species, namely *Oreophryne* sp. 3 and the putative new microhylid genus (Table 2.1; species accounts, below) may be threatened by modification of these grassland habitats (including modified fire regimes and invasion of grasslands by rainforest) in response to global warming.

The observation that a suite of frogs and lizards across the top of New Guinea's central cordillera appear to be high-montane grassland specialists (see e.g. Zweifel et al. 2005 for further examples) provides a rare faunal perspective on the debate over the origin of these uniquely New Guinean environments (Takeuchi, Chapter 1). There has been disagreement about whether these habitats originated via, and are maintained by, human influence or whether they have a longer evolutionary history. The documentation of numerous small microhylid frogs having morphologies indicative of low motility (short limbs and squat bodies) and with ranges restricted exclusively to these habitats at sites across New Guinea, argues strongly for a long evolutionary history for these environments.

Table 2.1. Herpetofauna species documented in three major habitats in the Kaijende Highlands, Papua New Guinea.

Species	High-Montane Grassland 3,200 m	High-Montane Moss Forest 2,900 m	Montane Forest 2,100–2,300 m
FROGS			
Hylidae			
Litoria arfakiana		X	X
Litoria becki	X		
Litoria iris			X
Microhylidae			
Albericus fafniri ?			X
Albericus sp. nov. 1		X	X
Albericus sp. nov. 2		X	
Callulops glandulosus		X	
Callulops wilhelmanus ?			X
Choerophryne sp. nov.			X
Cophixalus shellyi			X
Cophixalus sp. nov.	X		
Oreophryne notata			X
Oreophryne sp. nov. 1			X
Oreophryne sp. nov. 2		X	
Oreophryne sp. nov. 3	X		
Gen. nov., sp. nov.	X		
Ranidae			
*Rana daemeli**			
REPTILES			
Scincidae			
Sphenomorphus cf. *cinereus*			X
Papuascincus stanleyanus / *morokanus* complex	X	X	X
Total	**5**	**6**	**11**

*call record only, Suyan Camp, Porgera

Although it is possible that these taxa were 'gap species' in previously forest-dominated landscapes that have taken advantage of rapidly expanding alpine grasslands following the arrival of humans in the New Guinea hinterland, at least for some frog lineages this does not appear to be likely. For example most *Oreophryne* species documented from montane grasslands are squat, short-legged forms with reduced digital discs that are presumably well adapted for living semi-fossorial lives in the montane grasslands (Zweifel et al. 2005). There do not appear to be morphologically similar *Oreophryne* species occupying either closed forest or small forest gaps today. At Omyaka the grassland frogs were not found in forest habitats immediately adjacent to the grassland, despite occurring in high densities within centimeters of the forest edge. Furthermore at the slightly lower elevation Paiela Road site the only forest-dwelling *Oreophryne* was typical of most members of the genus, having long limbs and large digital discs. Although not conclusive these observations indicate an evolutionary response to the high-montane environment rather than a rapid (geologically) colonization of human-induced alpine grassland environments by 'pre-adapted' semi-fossorial and terrestrial forms from surrounding forest.

Apart from the new species discovered in the Kaijende Highlands this survey documented the second known populations of the microhylid frogs *Callulops glandulosus* and *Albericus fafniri*, and the third known population of the hylid frog *Litoria becki*. The former two species were designated as Data Deficient, and the latter as Vulnerable in the recent Global Amphibian Assessment (GAA 2006). *Callulops glandulosus* was common in disturbed roadside habitats along Paiela Road but was not found elsewhere during the survey indicating that it may have narrow altitudinal or habitat requirements. The frogs tentatively identified as *Albericus fafniri* were documented at Lake Tawa only. In general morphology and call structure the Lake Tawa frogs closely resemble *A. fafniri* but they are much larger than the type specimens of that species (e.g. Menzies 1999), reaching nearly 27 mm SVL. This is the largest size recorded for this genus and it is possible that additional studies will reveal that the Lake Tawa population represents an additional undescribed species.

The herpetofauna of the Kaijende Highlands appeared to be poorly known by local informants, presumably because it plays little role in their daily lives. This was reflected in the fact that few local names were provided for the species encountered. All small microhylid frogs, and juveniles of larger microhylids (including *Callulops*) are called 'Fandamonge' in the Ipili language. Adult *Callulops* are called 'Susu'; *Litoria arfakiana* are called 'koko'; and the brightly coloured *Litoria iris* is called 'Sanalia'. The skinks *Papuascincus* sp. and *Sphenomorphus* sp. are called 'ka-u'. These names should be treated with some caution because attempts to clarify local names of herpetofauna met with substantial uncertainty and disagreement among informants. In contrast, local informants eagerly reported that large, edible frogs occurred at lower altitudes, and that these frogs had specific names.

ANNOTATED LIST OF HERPETOFAUNA SPECIES

FROGS

Hylidae

Litoria arfakiana (Peters and Doria, 1878)
A moderately large (SVL 47 mm) torrent-dwelling treefrog. As currently recognized this species is common and widespread in the central mountains of New Guinea. However it is a species 'complex' and the nominate species may be restricted to far-western New Guinea. Günther (2006) has provided a description of the call and tadpole of what is probably 'true' *L. arfakiana*. The Kaijende Highlands population is poorly known, and call data and genetic studies are required. At Lake Tawa a gravid female was captured on low vegetation over a small stream above a waterfall and at Paiela Road a subadult was collected from vegetation adjacent to a rocky torrential stream. The nominate species is considered Least Concern by the Global Amphibian Assessment (GAA).

Litoria becki (Loveridge, 1945)
A moderately large (SVL 34-44 mm) treefrog, previously known with certainty only from montane grassland at the type locality on Mt. Wilhelm, with a possible second population on Mt. Giluwe. At Omyaka and Waile Creek it was found exclusively in and near small open-water bogs in open grassland. Classified as Vulnerable by the GAA, the Kaijende Highlands population represents a significant range extension.

Litoria iris (Tyler, 1962)
A small (SVL 30-38 mm) swamp- and pool-dwelling treefrog that is common and widespread in the mountains of central and eastern New Guinea. It was abundant at Lake Tawa where males called from grass around the lake verge. Classified as Least Concern by the GAA. Two specimens collected by locals in the vicinity of Suyan, Porgera, lack call data but differ sufficiently from the Lake Tawa specimens to indicate that they may represent a different, undescribed species (Photo 72).

Microhylidae

Albericus fafniri Menzies, 1999
A very large (SVL to 27 mm), scansorial species of *Albericus*. Found only at Lake Tawa where males called from low vegetation in wet Lower Montane Forest after rain. This species is tentatively identified as *A. fafniri*, a species previously known only from the type locality near Mendi (Menzies 1999). The Lake Tawa population has a call and morphology similar to, but is much larger than, the type series of *fafniri*. Further studies are required to determine its taxonomic status. *Albericus fafniri* was considered Data Deficient by the GAA.

Albericus sp. nov. 1 (Photo 70)
This small (SVL 14-18 mm) scansorial species was found at Lake Tawa and, less commonly, at Paiela Road. At both sites males called from very low foliage (< 0.5 m high) in wet mossy forest after rain. It is an undescribed species.

Albericus sp. nov. 2
A medium-sized (SVL 17-19 mm) arboreal species; found only at Paiela Road where males called exclusively from *Pandanus* trees in Upper Montane Forest. Many individuals called from > 5 m high making collections difficult. It is an undescribed species.

Callulops glandulosus (Zweifel, 1972)
A moderately small (SVL 34-44 mm) species of *Callulops* previously known only from a single specimen collected at Mt. Kerewa (Zweifel 1972). It was common, but occurred patchily, at Paiela Road where males called from the base of dense grass tussocks after heavy rain. The Kaijende Highlands population represents a range extension of 57 km from the type locality and is only the second known population of this species. It was considered Data Deficient by the GAA.

Callulops wilhelmanus ? (Loveridge, 1948)
A moderately large (SVL to ~ 55 mm) species of *Callulops* found only at Lake Tawa Camp. This species was uncommon, or at least difficult to detect. Males called infrequently in the early morning around camp. This species lacks digital discs and may be *Callulops wilhelmanus* but differs from other populations of that species by having a distinctly mottled (vs. uniform) venter and in having juveniles with a dramatically blotched dorsal color pattern.

Choerophryne sp. nov.
A tiny (SVL 9-10 mm) terrestrial-scansorial frog; This undescribed species was found only at Lake Tawa where males called from semi-concealed positions in litter and low foliage in wet mossy forest after rain. Calling was restricted to approximately two hours each day, between ~ 5.30 and 6.30 pm, and again briefly at dawn in wet conditions.

Cophixalus shellyi
A small (SVL to ~18 mm) terrestrial-scansorial frog. It was found only at Lake Tawa where males called on bright sunny days from deep in litter. Calls were heard only infrequently at night, from low in dense foliage. This species was commonly encountered in litter in the camp during the day. Classified as Least Concern by the GAA due to its wide distribution in the mountains of New Guinea, *C. shellyi* is in fact a complex of at least four species each with distinct calls.

Cophixalus sp. nov. 1 (Photo 71)
A moderately small (SVL 17-21 mm) undescribed species of *Cophixalus*. Differs from most congeners by lacking distinct digital discs. Males called from deep in humus in montane grassland at Omyaka and Waile Creek, and under shallow litter and humus at the forest verge at Paiela Road. At Omyaka calling males were found guarding egg clutches deep within moss clumps.

Oreophryne notata Zweifel, 2003
Zweifel (2003) recently described this small (SVL 15.5-18 mm) arboreal species. It was common in mossy lower montane forest at Lake Tawa where males called from leaves up to 3 m above ground at night after rain. It was previously known from several sites in Southern Highlands Province and a single locality in Western Province (Zweifel 2003).

Oreophryne sp. nov.1
This moderately large (SVL 23-28 mm), undescribed species has greatly expanded finger and toe discs. It was common in mossy forest at Lake Tawa where males called intermittently from low foliage (< 2 m high) at night after heavy rain.

Oreophryne sp. nov. 2
A medium-sized (SVL 21-26 mm) scansorial species that shares with *O. notata* a distinct, inverted-U mark on the snout. It differs from that species by its larger size and advertisement call. It was found only in Upper Montane Forest at Paiela Road where males called from low foliage after heavy rain at night. During the day several specimens of this undescribed species were found under stones next to the road.

Oreophryne sp. nov. 3
A small (SVL 16-22 mm) undescribed frog found only in high-montane grassland adjacent to the Porgera Reservoir at Waile Creek. Males called from ~20–50 cm high in *Poa keysseri keysseri* clumps after rain. It was absent from Upper Montane Forest at the same elevation (3,100–3,200 m) in this area and its distribution in the grasslands was also patchy and may be influenced by subtle differences in vegetation. For example while this species was common in grass tussocks adjacent to the Porgera Reservoir it was absent from *Chionochloa archboldii*-dominated grassy habitats at nearby Omyaka during several days of field work at that site.

New genus, new species (Photo 73)
A very distinctive, short-legged microhylid frog (SVL 19-27 mm). Many specimens exhibit bright orange coloration on the dorsum and venter. This species was found only in high-montane grassland at Omyaka, and was absent from similar habitats at nearby Waile Creek. Males called from holes in moss on the ground, from small burrows in the edges of *Sphagnum* / *Oreobolus* bogs, or occasionally from low perches on the stems of *Cyathea* trees. This new species exhibits a number of myological features that are unique to the *Albericus* / *Choerophryne* clade of Australopapuan microhylid frogs but differs conspicuously from all known members of this group in a number of morphological features. It probably warrants recognition as a new genus. Genetic, osteological and myological studies are underway.

Ranidae

Rana daemeli (Steindachner, 1868)

A large (SVL ~ 80 mm) riparian species that is widespread in the southern and northern lowlands of New Guinea and in Cape York Peninsula, Australia. Several specimens were heard calling in a small densely vegetated stream at Suyan Camp during this survey. The elevation of this population (~2,200 m asl) is unusually high for this predominantly lowland species.

Reptiles

Scincidae

Papuascincus stanleyanus/morokanus

A common species that was active in the sun at all sites. It belongs to a taxonomically difficult complex of montane skinks. Final identification remains to be determined, but the Kaijende Highlands population is likely to represent a known species of this complex. Large numbers of lizards were found beneath stones along the edge of Paiela Road during the day, and numerous egg clutches of this species were found buried in shallow soil beneath these stones. Some clutches appeared to be recently laid, and others contained eggs that were mature and that hatched during handling. A number of clutches appeared to be 'communal', containing eggs at a number of different stages.

Sphenomorphus sp. cf. *cinereus*

A moderately large terrestrial/semi-fossorial skink. This genus is taxonomically chaotic. The single specimen captured at Lake Tawa appears to represent an undescribed taxon related to *S. cinereus* (G. Shea, pers. comm.).

CONSERVATION RECOMMENDATIONS

The Kaijende Highlands represent a vast wilderness area of spectacular visual beauty and the montane forests and grasslands are home to a number of frog species that may be endemic to this area. There are a number of conservation 'positives' in the region:

- The area is remote and human population density is low.
- The region is spectacularly beautiful so tourism is a potential source of future income if developed carefully in collaboration with local landowners.
- The nearby Porgera Mine is well situated to assist with long-term studies of the environment, particularly studies of the impacts of climate change on montane fauna and flora.

There are also a number of threats to the area's herpetofaunal diversity:

- The Omyaka and Waile Creek grasslands are on major traditional trading routes. Traffic on these walking trails is heavy so hunting of large game is common although the small and potentially endemic frogs are of little interest to local landowners as a resource.
- Increased traffic on these trails risks a major increase in the frequency of fires that have the potential to significantly alter these alpine grassland assemblages.
- Global warming may significantly alter these high-montane environments. One potential outcome of changed temperature and moisture regimes is the expansion of forest habitats into montane grasslands. This would undoubtedly lead to the eventual extinction of at least two and possibly more of the grassland frog species.

Specific recommendations

1. Work with local communities to formalize the Conservation Area currently proposed for the Kaijende Highlands.
2. Encourage local communities to draft regulations for this protected area that take particular account of burning practices to minimize the impact of this activity on vulnerable grassland habitats and their herpetofaunal species.
3. Produce a color-illustrated booklet about the region's herpetofauna and general biodiversity for local communities, to promote interest and enthusiasm in their biological heritage.
4. Encourage local communities to protect critical habitats. For frogs this includes identifying through follow-up surveys the distribution of grassland species within the protected area and then targeting areas with significant populations for conservation action.
5. Examine the costs/benefits/likelihood of success of establishing a long-term monitoring program, run by trained local assistants, of populations of 3–4 target taxa including the new genus and other grassland-restricted frogs.

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