

## Chapter 21

### The mammal fauna of Wanakipa, Southern Highlands Province, Papua New Guinea

Kristofer M. Helgen, Muse D. Opiang, and William H. Thomas

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#### SUMMARY

We undertook a survey of mammal diversity and indigenous knowledge of mammals in Hewa country, in the vicinity of Wanakipa village, Southern Highlands Province, during July 2008. Specimens collected during this survey document the occurrence of 22 mammal species in the immediate area, including one monotreme, 6 marsupials, 7 rodents, and 8 bats. Two species of conservation concern, the Eastern Long-Beaked Echidna *Zaglossus bartoni* (IUCN Critically Endangered) and Goodfellow's Tree Kangaroo *Dendrolagus goodfellowi* (IUCN Endangered) were documented by trophy skulls and bones kept by Hewa hunters. Three mammals are apparently reported from Southern Highlands Province for the first time: the bent-wing bat *Miniopterus macrocneme*, the long-eared bat *Nyctophilus microtis*, and a rodent species in the *Rattus rattus* species complex. The presence of this last species, an invasive rodent trapped distant from an immediate village commensal context, provides an interesting indication of recent environmental change in the highlands of Papua New Guinea. Hewa informants convincingly communicated their familiarity with more than 20 additional mammal species, including those restricted to higher elevations than we visited during our survey, including one of special conservation concern, the tree kangaroo *Dendrolagus [dorianus] notatus* (IUCN Endangered). Hewa folk taxonomy suggests that three tree kangaroo species may occur in the region, one of which may be the Lowland Tree Kangaroo (*Dendrolagus spadix*) or even a currently undocumented population or unrecognized species. The mammal fauna of Wanakipa appears similar in composition to better surveyed areas of similar elevation situated along the southern margin of the central cordillera in Southern Highlands Province, such as Mt. Sisa and Mt. Bosavi.

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#### INTRODUCTION

The word “Hewa” is a somewhat generic term that refers to a group of shifting cultivators who speak one of the Sepik Hill Stock languages of the Sepik Ramu Phylum (Lewis 2009). They number fewer than 2,000 people and inhabit roughly ca. 65,000 hectares of hilly and sub montane forest in the uppermost catchment of the Strickland River. A wall of limestone cliffs that rise abruptly to over 2,300 m in the south effectively separates the Hewa from the Duna, Paella, and Ipili cultures. As is often the case with people living on the margins of larger societies, the “Hewa” answer to several different names given to them by their more powerful neighbors. They are the Hewa to the Duna, but the Sismen to the Min speakers on the western side of the Strickland River. Those living around the village of Wanakipa now typically refer to themselves as Hewa.

Unlike their highland neighbors, the Hewa do not occupy fertile valleys and are instead scattered throughout the mountains. They prefer to cut their gardens at elevations between 500-1,000 meters and traditionally it was this band of forest that experienced the greatest disturbance from cultivation. The village of Wanakipa is a recent phenomenon. Although Wanakipa has been on the map as a government station since Papua New Guinea's independence in 1975, when Thomas first visited the site in 1988 only four families were living at the station. There was no school or medical aid post. At that time, the Hewa considered the site to

be too hot and malarial, preferring to establish their homes at higher elevations. Their attitudes changed in 1990 with the intervention of the Lutheran Mission and the construction of an airstrip. The airstrip enabled the mission to establish and supply a medical aid post. Access to medicine, though variable, has attracted the Hewa to this formerly undesirable site. Today, Wanakipa has become a village, complete with an aid post, school, and weekly market.

However, outside of Wanakipa, the majority of the Hewa continue to live in scattered households. Their rugged environment and low density settlement pattern has discouraged road building and makes it difficult to provide government services. In these more traditional circumstances, Hewa infant mortality and life expectancy are likely to approach pre-contact rates (Gillett 1991:22). Unlike their highland neighbors, the Hewa do not grow coffee or participate significantly in the modern cash economy. They remain subsistence-oriented horticulturists and traditional environmental knowledge (TK) is still an important aspect of their culture.

Here we summarize our combined efforts, working in association with Hewa naturalists, to characterize the mammal fauna living in the vicinity of Wanakipa during the July 2008 Conservation International Rapid Assessment biodiversity Survey to the upper Strickland Basin.

## MATERIALS AND METHODS

### Data collection and sampling methods

Because the majority of Melanesian mammals can only be reliably identified by comparison with series of museum specimens (Flannery 1995, Bonaccorso 1998, Helgen 2007a), scientific efforts to document mammalian biodiversity in New Guinea require the collection and long-term preservation of voucher specimens. We obtained voucher specimens on the 2008 RAP survey by collecting “trophy” skulls and other bones retained by Hewa hunters, and by a combination of live-trapping (Sherman traps) and lethal trapping (snap traps) for small ground mammals, and mist netting of bats.

Protocols for capture and handling of mammals followed standard guidelines established by the American Society of Mammalogists for animal care and use (Gannon et al. 2007). For each specimen prepared as a museum voucher, standard external measurements were taken with a ruler (total length, tail length, hind foot length with and without the claws, ear length, and in the case of bats, forearm length) and Pesola scales (body mass). The sex and maturity of each specimen were assessed in the field, and microhabitat and other ecological data were noted for each specimen wherever possible. Vouchers were prepared as fluid preparations (fixation in 10% formalin, then transferred to 70% ethanol for long-term storage) or as study skins and/or skeletons. For each freshly collected specimen, liver, kidney, and/or muscle tissue was preserved in 95% ethanol for subsequent genetic analyses. Some small mammals were photographed in life in semi-natural settings. Specimens from the Wanakipa/Tualapa

RAP survey are deposited in the Division of Mammals at the National Museum of Natural History (USNM), part of the Smithsonian Institution in Washington, D.C., along with their associated temporal, geographical, ecological, and mensural data, and genetic samples.

Common names generally follow Flannery (1995) or (for bats) Bonaccorso (1998), but in a few cases (among rodents) where taxonomic changes have necessitated a change in vernacular usage, common names follow Musser and Carleton (2005). Conservation classifications provided for each species (Critically Endangered, Endangered, Least Concern, etc.) derive from the current rankings on the IUCN Red List ([www.iucnredlist.org](http://www.iucnredlist.org)), most recently revised as part of the Global Mammal Assessment, an effort by mammalogists worldwide to summarize the current state of knowledge individually relevant to the conservation of every living mammal species (Schipper et al. 2008).

### Study sites

The mammal survey focused on three sites within several hours' walking distance of the village of Wanakipa (airstrip at 05°15.425'S, 142°31.297'E, situated at 807 m) in Southern Highlands Province (Table 21.1):

#### *Tualapa (July 11-23, 2008)*

A camp and study site was established at Tualapa (05°17.003'S, 142°29.849'E), situated at 1,115 m, in a setting of kunai grassland and forest habitats (see Takeuchi, Chapter 9, this volume).

We established a trap-line in forest and kunai grass for ‘removal trapping’ of small mammals. Fifty medium-sized Sherman live traps and 25 ‘museum special’ snap traps were set each night, for 10 nights, on the forest floor and in vegetation and low trees up to 3 meters above the ground. These traplines resulted in 21 catches (= 3% trap success) representing five rodent species (*Melomys lutillus*, *Melomys rufescens*, *Rattus exulans*, *Rattus foersteri*, *Rattus rattus*; see species accounts below). Two 60 meter pitfall-lines were established and at each line we set 10 pitfall traps, approximately 60 centimeters deep and 5 meters apart, and monitored them for 6 nights. Pitfall traps collected only the small rodent *Lorentzimys nouhuysii* (see species account below). Mist-nets set by day for catching birds were also monitored at night for bat-catching. Ten nights of netting yielded series of *Nyctimene papuanus*, *Paranyctimene* sp., and *Syconycteris australis*, and a single specimen of *Macroglossus minimus* (see species accounts below). Two harp traps were set up along enclosed forest trails for a total of 10 trap nights, but no bats were captured in the harp traps.

Mammals were also documented at Tualapa by working with Hewa hunters. Hunters sourced series of the bats *Miniopterus macrocneme* and *Miniopterus magnater* from a cave near Tualapa, and speared a specimen of the large rat *Uromys caudimaculatus* (see species accounts below). We also obtained “trophy” jaws and crania of various game animals from hunters at Tualapa, some of which were likely brought from the broad vicinity of the village of Wanakipa, including

*Zaglossus bartoni*, *Echymipera kalubu*, *Echymipera rufescens*, *Dendrolagus goodfellowi*, *Phalanger gymnotis*, *Phalanger mimicus*, *Spilocuscus maculatus*, *Uromys caudimaculatus*, and *Dobsonia moluccensis*.

**Table 21.1.** Mammal species documented by specimens at Wanakipa stations. ‘Trophy’ refers to specimens collected as trophy material only. Other records reflect animals collected during the survey. Greatest effort was invested in surveying mammals at Tualapa (see text).

| Source                               | Trophy | Putuwe (570 m) | Tualapa (1,115 m) | Umge (1,438 m) |
|--------------------------------------|--------|----------------|-------------------|----------------|
| <b>Monotremata (Tachyglossidae)</b>  |        |                |                   |                |
| <i>Zaglossus bartoni</i>             | X      |                |                   |                |
| <b>Peramelemorphia (Peramelidae)</b> |        |                |                   |                |
| <i>Echymipera kalubu</i>             | X      | X              |                   |                |
| <i>Echymipera rufescens</i>          | X      |                |                   |                |
| <b>Diprotodontia (Macropodidae)</b>  |        |                |                   |                |
| <i>Dendrolagus goodfellowi</i>       | X      |                |                   |                |
| <b>Diprotodontia (Phalangeridae)</b> |        |                |                   |                |
| <i>Phalanger gymnotis</i>            | X      |                |                   |                |
| <i>Phalanger mimicus</i>             | X      |                |                   |                |
| <i>Spilocuscus maculatus</i>         | X      |                |                   |                |
| <b>Rodentia (Muridae)</b>            |        |                |                   |                |
| <i>Lorentzimys nouhuysi</i>          |        |                | X                 |                |
| <i>Melomys lutillus</i>              |        | X              | X                 |                |
| <i>Melomys rufescens</i>             |        |                | X                 |                |
| <i>Rattus exulans</i>                |        | X              | X                 |                |
| <i>Rattus foersteri</i>              |        |                | X                 |                |
| <i>Rattus rattus</i> complex         |        |                | X                 |                |
| <i>Uromys caudimaculatus</i>         |        |                | X                 |                |
| <b>Chiroptera (Pteropodidae)</b>     |        |                |                   |                |
| <i>Dobsonia moluccensis</i>          | X      |                |                   |                |
| <i>Macroglossus minimus</i>          |        |                | X                 |                |
| <i>Nyctimene papuanus</i>            |        | X              | X                 |                |
| <i>Paranyctimene</i> sp.             |        |                | X                 | X              |
| <i>Syconycteris australis</i>        |        | X              | X                 | X              |
| <b>Chiroptera (Minopteridae)</b>     |        |                |                   |                |
| <i>Minopterus macrocneme</i>         |        |                | X                 |                |
| <i>Minopterus magnater</i>           |        |                | X                 |                |
| <b>Chiroptera (Vespertilionidae)</b> |        |                |                   |                |
| <i>Nyctophilus microtis</i>          |        | X              |                   |                |

#### Umge (July 15-17)

A “Fly Camp” above Tualapa was set up at Umge (05°18.245'S, 142°30.704'E), situated at 1,438 m in montane forest (see Takeuchi, Chapter 9, this volume). Helgen visited this camp briefly while Opiang and Thomas stayed at Tualapa. Two nights of trapping with 10 Sherman and 10 museum-special traps yielded no captures. One night of mist-netting with two mistnets around a fruiting fig yielded series of *Syconycteris australis* and *Paranyctimene* sp.

#### Putuwe (July 23-26)

At the close of our survey we camped for 3 nights at a site named Putuwe (05°13.867'S, 142°31.933'E), at 570 m, situated at the junction of the Lagaip and Uruwabwa rivers, amongst village homes and gardens. Mist-nets set by day for catching birds were also monitored at night for bat-catching, resulting in series of *Nyctimene papuanus* and *Syconycteris australis*, and a single capture of *Nyctophilus microtis*. Specimens of *Rattus exulans* were collected in village homes and *Melomys lutillus* was collected in a sweet potato field. Two specimens of the bandicoot *Echymipera kalubu* killed by village dogs were salvaged as museum specimens (see species accounts for all, below). Pitfall traplines were also set up (as at Tualapa) for two nights, but yielded no captures.

## RESULTS

### Annotated species list

#### Order Monotremata, Family Tachyglossidae (Echidnas)

*Zaglossus bartoni* (Thomas, 1907) (Eastern Long-Beaked Echidna)  
**IUCN Red List Status: Critically Endangered:** “Listed as Critically Endangered due to a suspected continuing population decline of at least 80% over the last three generations (i.e., the last 45-50 years) based on direct observation in parts of its range, declines in area of occupancy (reports from hunters), and actual levels of exploitation due to hunting.” (Leary et al. 2008a).

This largest of extant monotremes (5-10 kg) occurs in forests and upland grasslands from sea level (albeit rarely so low) to an elevation of at least 4,150 m along the length of New Guinea’s central cordillera and in the outlying mountain ranges of the Huon Peninsula (Flannery and Groves 1998). It is now rare across much of its geographic range, probably because of widespread and intensive human hunting with the aid of dogs, and it remains common today only in areas of low human population density (George 1978, Flannery 1995). The subspecies in the Hewa region is *Z. b. diamondi*, the distribution of which stretches from Papua New Guinea’s Eastern Highlands to the Paniai (= Wissel) Lakes of Papua Province, Indonesian New Guinea (Flannery and Groves 1998).

The species is hunted and eaten by Hewa, both with and without dogs. Several trophies were collected from Hewa hunters at Tualapa. Some Hewa informants told us that they distinguished two kinds of echidna (apparently using *Taku* as a general term for both), which they called *Wam Taku*

*Haiba* (definitely referring to *Zaglossus*) and *Wam Taku Itu*. The latter may well be the Short-beaked Echidna, *Tachyglossus aculeatus*, which occurs along the southern margin of the central cordillera elsewhere in Southern Highlands Province (e.g. at Mt. Bosavi; Leary and Seri 1997), and may occur in Hewa country. Or it may represent an intriguing, very small echidna, possibly an unnamed species, once captured by Opiang at Crater Mountain on the southern margin of the central cordillera in Eastern Highlands Province (an adult female weighing 1.8 kg). It is also possible that *Wam Taku Itu* is simply another name for *Zaglossus bartoni*. Whatever it may be, the traditional recognition by the Hewa and some other informants in Papua New Guinea of two or three morphological types of echidna (Opiang, pers. obs.) advocate for continuing field and taxonomic studies of the echidna species of New Guinea.

As so little is known about *Zaglossus* reproduction (Flannery 1995, Opiang 2009), we asked Hewa informants what they knew about the subject. They told us that the Long-Beaked Echidna has only one baby at a time, but no informant had seen an echidna so young that it could not walk on its own. The youngest echidnas seen were said to be about 4 human fingers long (about 300 mm?).

To follow up on the results of our survey, Opiang and Thomas are now working with the Hewa to locate active echidna dens. These dens will be marked via satellite locator beacons and monitored by the Hewa. This will hopefully begin to shed light on the identity of the 'second' Hewa echidna, as well as on poorly understood aspects of echidna biology in New Guinea, such as reproduction. It will most definitely engage the Hewa as partners in echidna conservation.

#### Order Peramelemorphia, Family Peramelidae (Bandicoots)

*Echymipera kalubu* (Lesson, 1828)

**IUCN Red List Status: Least Concern.**

*Echymipera kalubu* is a medium-sized bandicoot common at lower to middle elevations throughout most of New Guinea. Familiar to hunters, this animal is commonly hunted and eaten in Hewa country, and we documented a number of trophy skulls and bones. It is apparently referred to by the Hewa name *Wam Wauma* or *Wam Tsua Kiwauma* (*Tsua* being apparently a more general term for bandicoots). Hewa informants describe that it is generally found at lower elevations (1,000 m and lower), that it eats fruit, pandanus, and worms, and that it has litters of four or less. Two specimens that were killed by dogs at Putuwe during our survey were salvaged as museum specimens (USNM 585488 and 585613, adult females).

*Echymipera rufescens* (Peters and Doria, 1875)

**IUCN Red List Status: Least Concern.**

*Echymipera rufescens* is a medium-sized bandicoot that occurs at lower to middle elevations throughout most of New Guinea. Familiar to hunters, this animal is commonly hunted and eaten in Hewa country, and we documented a

number of trophy skulls and bones. It is apparently referred to by the Hewa name *Wam Lokoume* or *Wam Kimafima*.

#### Order Diprotodontia, Family Macropodidae (Kangaroos)

*Dendrolagus goodfellowi* Thomas, 1908 (Goodfellow's Tree-Kangaroo)

**IUCN Red List Status: Endangered:** "Listed as Endangered based on an ongoing population decline of at least 50% over the past three generations (i.e., 30 years) due to actual levels of exploitation from hunting and a decline in habitat quality. It has already been extirpated from significant portions of its range." (Leary et al. 2008b).

*Dendrolagus goodfellowi* is a red-brown and golden arboreal kangaroo distributed throughout the eastern half of New Guinea's extensive central cordillera, from the Star Mountains region in the west to Milne Bay in the east (Flannery 1995, Flannery et al. 1996), generally in forest at low to middle elevations (Flannery 1995). Related taxa occur in the North Coastal ranges (Torricelli and Foja Mountains: *D. pulcherrimus*), the Huon Peninsula (*D. matschiei*), and in the lowlands of south-central New Guinea (*D. spadix*) (Menzies 1991, Flannery 1995, Flannery et al. 1996, Helgen 2007b).

Goodfellow's Tree Kangaroo is hunted and eaten in Hewa country, and we collected several trophy skulls and bones kept by local hunters. It is referred to by the Hewa name *Wam Inai Tukelo* (*Inai* being apparently a general term for tree kangaroos), and occurs at lower to middle elevations in Hewa country, including around Tualapa. Interestingly, Hewa hunters concurred that there were 3 kinds of tree kangaroos in Hewa country—*Wam Inai Tukelo*, which they associated with photographs and trophy skulls referable to *D. goodfellowi*; *Wam Inai Maputa*, which they stated only occurred high up in the mountains (i.e., 'cold ples tru' in Tok Pisin) and recognized in photographs as Doria's Tree Kangaroo (i.e., *Dendrolagus [dorianus] notatus*, a high elevation tree kangaroo of the central highlands variably recognized as a subspecies of *D. dorianus* or a distinct, closely-related species); and finally *Wam Inai Tabaghali Loi*, the accounts of which we cannot immediately associate with a known species. Hunters stated that *Wam Inai Tabaghali Loi* has a brown body with a darker midline stripe, and is otherwise broadly similar in appearance to *D. goodfellowi*. In accordance with a commonly known story, Hewa refer to *Wam Inai Maputa* as *Ya*, or first born; *Wam Inai Tabaghali Loi* as *Tabaghali*, or second born; and *Wam Inai Tukelo* as *Nom*, or last born.

If not simply a variant of *D. goodfellowi* recognized by folk taxonomy, the most straightforward suggestion for this species' identification would be the Lowland Tree Kangaroo, *Dendrolagus spadix*, a rare species endemic to the lowlands of south-central New Guinea that may well occur in Hewa country, and is similar in size and sometimes appears very similar in coloration to *D. goodfellowi*. However, in our discussions Hewa informants instead universally associated the name *Wam Inai Tabaghali Loi* with both study skin

and living animal pictures of Matschie's Tree Kangaroo, *D. matschiei*, in Flannery's *Mammals of New Guinea* book (Flannery 1995: 134-135, 139), rather than with a figured photographed study skin of *D. spadix* (Flannery 1995: 139).

Matschie's Tree Kangaroo is thought to be geographically restricted to the mountains of the Huon Peninsula in north-eastern New Guinea and to the nearby island of Umboi (Flannery 1995, Flannery et al. 1996), such that it would seem that this identification could be ruled out immediately on geographic grounds. However, it is in this light that we are drawn to revisit an old riddle from the taxonomic history of tree-kangaroos – the 1936 description of *Dendrolagus deltae*, a tree kangaroo identical or very similar to *D. matschiei*, supposedly from Mt. Pratt in Southern Highlands Province – recently discussed by Helgen (2007a):

In 1936, Troughton and Le Souef (1936) named *Dendrolagus deltae*, a tree-kangaroo similar to *D. goodfellowi* and *D. matschiei* (and bearing intimate resemblance to the latter), based on two specimens supposedly collected on Mt. Pratt “in the north-east of the Delta Division” (today in Southern Highlands Province) and received via the Taronga Zoo in Sydney [skins and skulls later deposited in the Australian Museum, Sydney]. “Mount Pratt” is an obscure locality, but apparently refers to an outlying peak to the immediate east of Mt. Bosavi (Lidicker and Ziegler [1968:24]; see map in Monckton [1922]; Laurie and Hill [1954:151] gave the coordinates as “6°31'S, 143°38'E”). Laurie and Hill (1954), Lidicker and Ziegler (1968), and Ziegler (1978:135) credited the type locality of *deltae* as valid, but Groves (1982) rejected it, pointing out the intimate similarity of *D. deltae* to *D. matschiei* and citing earlier doubts of the locality's authenticity as voiced by Kirsch and Calaby (1978). Groves (1982:180) wrote “the reason for the description of *Dendrolagus deltae* is a complete mystery. The answer is perhaps the uncritical acceptance by the authors of the type locality ... the locality of the holotype as reported must have been wrong...” However, in light of Bosavi's endemism, and because the *Dendrolagus matschiei* species-complex (*sensu* Flannery 1993; Flannery et al. 1996) shows a clear tendency toward differentiation in areas offlying the central cordillera (witness *D. pulcherrimus* in the Foja and North Coastal Ranges, *D. matschiei* in the Huon Peninsula, *D. spadix* in the southern lowlands, an unidentified taxon in the Arfak Mountains—Aplin *in litt.*), it now seems rash to reject out-of-hand the original information presented by Troughton and Le Souef (1936), as recent reviewers have done (e.g. Flannery et al. 1996:9; Martin 2005; Groves 2005), at least until stronger negative evidence is available (e.g. as far as I am aware, there have been no modern expeditions to Mt. Pratt; cf. Leary and Seri 1997:86). The more ornate stripe-patterning of the back and tail in *goodfellowi/pulcherrimus* is more highly derived than the simpler pattern in *matschiei* and *deltae*, and it is not inconceivable that these latter forms could represent morphologically-conservative montane taxa within the *matschiei* complex, isolated to the north and south of the eastern central cordillera, respectively.

At least some average differences are apparent between the type series of *deltae* and correctly provenanced specimens of *matschiei* (Lidicker and Ziegler 1968; Groves 1982; my examinations); these and other purported differences require closer critical attention. Certainly it is difficult to understand why the type series of *deltae* (which originated during the time when the Delta region was first being seriously explored), if truly from the Huon Peninsula, was misattributed to an obscure peak in the Kikori River Basin from which no other mammal specimens have ever been collected (and I can find no references, past or current, to a similarly-named peak on the Huon). To me at least, the riddle of the Delta tree-kangaroo lives on for now.

If *Dendrolagus deltae* really is a tree kangaroo similar to *D. matschiei* that occurs along the southern margin of the central cordillera in Southern Highlands Province, this offers an additional possible explanation for the identification of the third Hewa tree kangaroo. Only additional work in collaboration with the Hewa, ideally involving tracking of tree kangaroos and study of tree kangaroo skulls and teeth retained by hunters throughout the area, will help to choose between these hypothetical identities of *Wam Inai Tabaghali Loi*. Is this Hewa designation another name for either *D. goodfellowi* or *D. [dorianus] notatus*, is it perhaps *D. spadix*, or is it even possibly the tree kangaroo that Troughton and Le Souef (1936) named *D. deltae*? Or perhaps yet another explanation awaits us. Tree kangaroos are important animals in the culture of both the Hewa and New Guinea conservation biologists; we hope to work together to solve this riddle of the third Hewa tree kangaroo, second born.

#### Order Diprotodontia, Family Phalangeridae (Cuscuses)

*Phalanger gymnotis* (Peters and Doria, 1875) (Ground Cuscus)

**IUCN Red List Status: Least Concern.**

The Ground Cuscus is a medium-sized to large (mass *ca.* 2-5 kg) terrestrial cuscus that is widespread in lowland and montane forest (sea level to 2,700 m elevation) throughout New Guinea. Familiar to hunters, this animal is commonly hunted and eaten in Hewa country, and we documented a number of trophy skulls and bones. It is referred to by the Hewa name *Wam Wai*.

*Phalanger mimicus* (Thomas, 1922) (Southern Common Cuscus)

**IUCN Red List Status: Least Concern.**

The Southern Common Cuscus is a medium-sized (mass *ca.* 2-4 kg) arboreal cuscus that occurs throughout much of southern New Guinea at relatively low elevations (sea level to at least 800 m) (Norris and Musser 2001). This animal is commonly hunted and eaten in Hewa country, and we documented a number of trophy skulls and bones. It is apparently referred to by the Hewa name *Wam Nabli*. Hunters describe that it occurs in both primary and secondary forest at lower elevations, and that it eats the leaves of the plants referenced by the Hewa names *Me Neki* (scientific name *Pasania* sp.), *Me Paghai* (*Pandanus* sp.), *Me Tsaghal* (*Ficus* sp.), and *Me Tial* (*Castanopsis acuminatissima*).

*Spiloglossus maculatus* (Desmarest, 1818) (Common Spotted Cuscus)

**IUCN Red List Status: Least Concern.**

The spotted cuscus is a relatively large possum (3-6 kg) that occurs throughout lower elevations (sea level to 1,500 m) in most areas of New Guinea. Recent work suggests that the species referred to under this scientific name is actually a complex of species that differ in color, body size, and skull and teeth morphology, some of which may occur sympatrically, such that multiple species will eventually be recognized in place of one (Helgen 2007b). The subspecies in the Hewa region is *S. m. goldiei* (Ramsay, 1876). Familiar to hunters, spotted cuscuses are commonly hunted and eaten in Hewa country, and we documented a number of trophy skulls and bones at Tualapa and observed several hats made from the fur of this species being worn in Wanakipa. Hewa folk taxonomy distinguishes two kinds of *Spiloglossus*, known to our informants by the names *Wam Kail* and *Wam Kail Yelekai*. The first, *Wam Kail*, is said to be characterized by females with more and smaller black spots, and males with larger black spots and small white spots. The second, *Wam Kail Yelekai*, is said to be characterized by females being white with black spots, males black with white spots. At present we understand all of these to be color variants of *S. m. goldiei*. Hewa informants mention that spotted cuscuses eat the leaves of a number of trees, referenced by the Hewa names *Me Paghai* (scientific name *Pandanus* sp.), *Me Yat* (*Ficus drupacea*), *Me Eli* (*Diospyros* sp.), *Me Tsihlai* (*Ficus macrocarpa* var. *latifolia*), *Me Toghoh* (*Daphniphyllum gracile*), and *Me Yowal* (*Casuarina oligodon*).

#### **Order Rodentia, Family Muridae (Rats and Mice)**

*Lorentzimys nouhuysii* Jentink, 1911 (Long-Footed Tree-Mouse)

**IUCN Red List Status: Least Concern.**

The saltatorial mice of the genus *Lorentzimys* are widespread in New Guinea, but the taxonomy of the genus, in which only a single species is currently recognized (Flannery 1995, Musser and Carleton 2005) is confused and requires comprehensive revision (see Aplin and Kale, Chapter 18, this volume). Four *Lorentzimys* specimens (USNM 585612, 585614-585616, mass 18 and 19 grams in two adults) were collected in our pitfall traps set in creekside forest at Tualapa. The overall size and reddish chest patch in our series suggest identification as true *L. nouhuysii*, typically a mouse of lower to middle elevation forest habitats (Helgen, pers. obs.). Hewa informants suggested that *Lorentzimys* dens at the base of trees and eats insects as well as leaves of *Me Patu* (*Macaranga* sp.) and *Me Tsaghal* (*Ficus* sp.).

*Melomys lutillus* (Thomas, 1913) (Grassland Melomys)

**IUCN Red List Status: Least Concern.**

This small rodent (weighing 31-58 grams in our sample of adults) is common in many open habitats in New Guinea, especially grasslands at lower middle elevations (Menziez 1996). It was commonly trapped at night at Tualapa and Putuwe, always in kunai grassland, sometimes in grassy areas interspersed with regrowth and gardens.

*Melomys rufescens* (Alston, 1877) (Black-Tailed Melomys)

**IUCN Red List Status: Least Concern.**

This common and widespread semi-arboreal rat is usually associated with secondary habitats (Flannery 1995, Menziez 1996). Three specimens (USNM 585637-585639, adults weighing 48-60 grams) were trapped on the ground in secondary forest at Tualapa – one along a creek, the others at the base of a tree.

*Rattus exulans* (Peale, 1848) (Pacific Rat)

**IUCN Red List Status: Least Concern.**

This small rat, thought to have arrived to New Guinea only in recent millennia (Taylor et al. 1982), was common in disturbed habitats near Wanakipa. It was trapped in the evening and at night in kunai grassland at Tualapa and in village houses at Putuwe (USNM 585618-585623).

*Rattus foersteri* Rümmler, 1935 (Small Spiny Rat)

**IUCN Red List Status: Least Concern.**

Helgen (2007b) applied Rümmler's name *R. foersteri* to eastern New Guinean populations of the rat usually referred to by the name *Rattus steini*, the taxonomy of which requires a detailed overview. A single specimen (USNM 585625, a young adult female) referred to this species was snap trapped at Tualapa, but the microhabitat was not noted.

*Rattus 'rattus'* (Linnaeus, 1758) (Black Rat complex)

**IUCN Red List Status: Least Concern.**

We collected a single rat (USNM 585624, adult male) at Tualapa that appears referable to the "*Rattus rattus* complex" *sensu* Aplin et al. (2003: 172-173), an invasive species and probably a relatively very recent arrival in New Guinea (Taylor et al. 1982, Flannery 1995). Our specimen has a reddish brown dorsum with long black guard hairs, a yellowish venter with gray hair bases, and a dark and relatively hairy tail. This specimen's relatively large size (190 grams), longer tail than head body length (170 mm tail versus 160 mm HB), and black dorsal surfaces of the feet distinguish it from the native *Rattus* of similar body size that might be expected to occur in the area, including *R. leucopus*, *R. sordidus*, *R. steini*, and *R. novaeguineae*. Its long black dorsal guard hairs and large plantar pads preclude its identification as *R. argentiventer*, another non-native *Rattus* recorded from New Guinea (Musser 1973, Taylor et al. 1982). This specimen would probably be best identified as *Rattus tanezumi* under current taxonomy (Musser and Carleton 2005), but ongoing studies of the morphology and genetics of the *Rattus rattus* complex point to a complex taxonomy involving many taxonomic lineages, the distributions, biological attributes, and names for which are not yet clearly resolved (K. Aplin, *in litt.*). The Tualapa specimen was trapped in kunai grass alongside *Rattus exulans* and *Melomys lutillus*, and though taken in a disturbed habitat, it was trapped several kilometers from the village of Wanakipa and not immediately near any concentrated human habitation. This capture is somewhat unexpected given that the most recent summary of New Guinea records of *Rattus rattus*, now several decades old now, recorded the species only from satellite island, coastal,

and major town and city localities only, with very few exceptions, and no records at all originating from the vicinity of the highlands of Papua New Guinea (Taylor et al. 1982). The presence of this invasive species at Tualapa is one indication of environmental disturbance that is probably new to the highlands in recent decades. Other invasive species have spread in Papua New Guinea in recent decades, including plants, insects, and tree diseases (Leps 2002, Kiapranis and Nimiago 2005), presumably in tandem with expanding and increasing impacts of air travel, industry, international trade, and the expansion of the Highlands Highway, which extends from Lae in Morobe Province in the east to Tari (Southern Highlands Province) and Porgera (Enga Province) in the west and may be a major factor in opening the highlands to invasive species from around the world. Broad survey efforts will be needed to understand both the current distribution of *Rattus rattus* and potentially other invasive mammal species, and to begin to evaluate their potential ecological impact on native fauna, if any. The spread of *Rattus rattus* and other invasive murine species has been fingered elsewhere in the decline of native rodents (Smith and Carpenter 2006, Amori et al. 2008, Wyatt et al. 2008, Harris 2009), as on other native fauna, especially birds.

*Uromys caudimaculatus* (Kreff, 1867) (Mottled-Tailed Giant-Rat)  
**IUCN Red List Status: Least Concern.**

This large rat is widespread in New Guinea, but its current taxonomy is in need of a detailed review (Musser and Carleton 2005, Helgen 2007b), an important priority in New Guinea systematic mammalogy. A single specimen (USNM 585512, a young adult female weighing 220 g) was secured by hunters in forest at Tualapa. This species is commonly hunted and eaten in Hewa country, and we documented several trophy skulls and bones. Hewa informants called it by the Hewa name *Wam Ute Tsin*, a name also applied by informants to photographs of *Xenuromys barbatus*, a much rarer large rat of very similar external appearance.

**Order Chiroptera, Family Pteropodidae (Fruit-Eating Bats)**

*Dobsonia moluccensis* (Quoy and Gaimard, 1830) (Greater Bare-Backed Bat)

**IUCN conservation status: Least concern.**

This large (400-600 g), usually cave-roosting bat is one of the most common bats of New Guinea. The subspecies in New Guinea is *D. m. magna* Thomas, 1905. Familiar to hunters, these bats are commonly hunted and eaten in Hewa country, and we documented a number of trophy skulls and bones at Tualapa. Informants used the Hewa name *Nok Teliau* for this bat.

*Macroglossus minimus* (E. Geoffroy, 1810) (Northern Blossom-Bat)

**IUCN conservation status: Least concern.**

This small blossom bat is widely distributed in the lowlands of New Guinea, but is usually considerably less common than *Syconycteris australis* (see below). We mistnetted a single specimen at Tualapa (USNM 585523, adult male, forearm

42 mm) in secondary forest. Informants used the Hewa name *Nok Semina Mea Mea* for this bat (and for *Syconycteris australis*, see below).

*Nyctimene papuanus* Andersen, 1910 (Common New Guinea Tube-Nosed Bat)

**IUCN conservation status: Least concern.**

This was the bat we most commonly mist-netted during our survey; it was netted at Tualapa, Umge, and Putuwe. Our specimens closely matched the description and measurements of *Nyctimene papuanus* as described in detail by Andersen (1912). This taxon is usually recognized as a subspecies of *N. albiventer* (Gray, 1863), originally described from Morotai in the North Moluccas, but comparison of these specimens against a large series of near-topotypical *albiventer* from Halmahera at USNM confirms that our New Guinea specimens are much larger and easily distinguished craniodentally from true *albiventer*. The taxonomy of Melanesian *Nyctimene* is highly confused and awaits wholesale taxonomic revision (Nancy Irwin, in litt.). Critical review of museum specimens indicates that several currently unrecognized species, at least one of which is without any scientific name, are incorporated amongst series of specimens usually identified as "*N. albiventer*" from New Guinea (Aplin and Kale, Chapter 18, this volume, Nancy Irwin, in litt.; Helgen, pers. obs.). Informants used the Hewa name *Nok Semina Kotnalua* for this bat.

*Paranyctimene* sp. (Unstriped Tube-Nosed Bat)

**IUCN conservation status: Least concern.**

We mistnetted a series of specimens of a species of *Paranyctimene* (USNM 585520-585522, 585680-585684, forearm 53-57 mm) in primary forest at Umge (alongside fruiting figs and a trickling stream), where it was most common, and in secondary forest at Tualapa. These specimens seem to be larger than typical *P. raptor*, and may represent *P. tenax* (see Bergmans 2001). The taxonomy of *Paranyctimene*, an endemic New Guinea pteropodid genus, is highly confused, and awaits wholesale taxonomic revision (Nancy Irwin, in litt.).

*Syconycteris australis* (Peters, 1867) (Common Blossom-Bat)

**IUCN conservation status: Least concern.**

This common and widespread nectarivorous bat (forearm 42-48 in our sample of adults) was mistnetted at Tualapa (in secondary forest), Umge (in primary forest amongst fruiting figs and a trickling stream), and at Putuwe (in gardens and regrowth). Informants used the Hewa name *Nok Semina Mea Mea* for this bat (and for *Macroglossus minimus*, see above). This was the second most commonly mistnetted bat on our survey after *Nyctimene papuanus*.

**Order Chiroptera, Family Miniopteridae (Bent-Winged Bats)**

*Miniopterus macrocneme* Revilliod, 1914 (Long-Legged Bent-Winged Bat)

**IUCN conservation status: Data deficient** (based on taxonomic uncertainty; Bonaccorso and Reardon 2010; see below).

A sizeable series representing a relatively small species of *Miniopterus* (forearm 40–47) with relatively long legs (tibia 16–19 mm) was collected from a cave near Tualapa. Close inspection of skulls and external features confirms that this series corresponds to the species referred to as *Miniopterus macrocneme* under current taxonomy (Peterson 1981, Hill 1983). This species was cohabitating with the larger bent-winging bat *Miniopterus magnater*, a cave-roosting association previously reported by Bonaccorso (1998:390).

As far as we know, there are no previously published records of *M. macrocneme* from Southern Highlands Province (at least not as compiled by Flannery [1995] and Bonaccorso [1998]), which is surprising, as this is one of the more common bats of central New Guinea. It is apparently especially common in caves in the central cordillera of Western and West Sepik (Sandaun) Provinces (Flannery and Seri 1990, Flannery 1995). The lack of previously published records from Southern Highlands Province reflects the overall paucity of attention given to insectivorous bats in New Guinea to date, both in terms of field survey efforts and in taxonomic reviews of available museum material (Helgen 2007b, Armstrong and Aplin, Chapter 19, this volume).

Species boundaries and nomenclature of the species of *Miniopterus* within New Guinea and across the broader Australasian region remain confused and in need of detailed systematic review, ideally incorporating qualitative anatomical, morphometric, and genetic comparisons across a large array of museum samples representing all major islands and regions and all named forms or putative taxa. At minimum, six biological species occur on the New Guinea mainland (Bonaccorso 1998, Simmons 2005), but the appropriate scientific names, actual geographic distributions across New Guinea and broader Australasian islandscapes, and phylogenetic relationships among these species remain poorly understood, and additional species are likely to be recognized after detailed taxonomic review. At the moment, the taxonomic status of *M. macrocneme* is classified by the IUCN as Data Deficient owing to the taxonomic uncertainty that prevails amongst Melanesian *Miniopterus*. As Bonaccorso and Reardon (2010) explained, “The urgent priority ... is to resolve *Miniopterus* taxonomy and identification in order to understand distribution, abundance, habitat requirements, ecology, and threats ...” (Bonaccorso and Reardon 2010). This is a major priority for systematic mammalogy in the region.

*Miniopterus magnater* Sanborn, 1931 (Western Bent-Winged Bat)

**IUCN conservation status: Least Concern.**

A small series of *M. magnater* (USNM 585772–585776, forearms 49–51 mm, tibiae 19–22 mm) were collected from

the same cave as our series of *M. macrocneme* (see above). Identification of these specimens as *M. magnater* is based on studies of external features and skulls in comparison with the revisionary overviews produced by Peterson (1981) and Hill (1983).

**Order Chiroptera, Family Vespertilionidae (Evening Bats)**

*Nyctophilus microtis* Thomas, 1888 (Papuan Big-Eared [or Long-Eared] Bat)

**IUCN conservation status: Least concern.**

We mist-netted a single specimen of *N. microtis* (USNM 585718, adult male, forearm 39 mm) amongst village environs (homes, gardens, and regrowth) at Putuwe. The identification of this specimen as *N. microtis* was confirmed by Harry Parnaby, global authority on *Nyctophilus* taxonomy (e.g., Parnaby 1987, 1988, 2002, 2009). As far as we know, there are no previously published records of *N. microtis* from Southern Highlands Province (cf. Flannery 1995, Bonaccorso 1998), but its presence in the province was certainly to be expected. *Nyctophilus microtis* is the most commonly recorded *Nyctophilus* in New Guinea, and has been documented in neighboring provinces of Papua New Guinea, including Western, Gulf, and Chimbu Provinces. It is widely distributed in New Guinea, and occurs from sea level to at least 2,600 m (Flannery 1995, Bonaccorso 1998).

**Order Artiodactyla, Family Suidae (Pigs)**

*Sus scrofa* Linnaeus, 1758 (Feral Pig)

Apparently introduced to New Guinea by humans several thousand years ago, pigs occur as both domesticated and wild-living (feral) populations throughout the island of New Guinea (Hide 2004). Wild pigs are important game animals in Hewa country, and domesticated pigs are kept as property at Wanakipa as throughout New Guinea.

**Other species present in the region**

Overall, all species encountered during our survey were expected to occur in the region and our overall results, though based on a short survey, suggest that the Hewa mammal fauna is similar to faunas documented at low to middle elevations at other sites situated along the southern margin of the central cordillera in Southern Highlands Province, such as Mt. Sisa (Dwyer 1990) and Mt. Bosavi (Leary and Seri 1997).

In addition to the 22 species we documented based on specimen-backed evidence, interviews with knowledgeable Hewa informants revealed their familiarity with at least as many additional mammal species. For many of these we were able to apply Hewa names to taxonomic names, based on Hewa informants' recognition of photographs and specimens, and on convincing discussions of the appearance and habits of animals (Table 21.2). Several of these additional mammals are species that are usually restricted to habitats at higher elevations than we were able to visit during our brief survey, such as the tree kangaroo *Dendrolagus [dorianus] notatus* and the cuscus *Phalanger carmelitae*, or are difficult to trap without extensive, focused effort (especially the

amphibious murines *Hydromys* and *Parahydromys*; Helgen 2005a). However, most of the species described by Hewa informants (Table 21.2) likely occur in the vicinity of Wanakipa and the camps from which our survey was based (Tualapa, Umge, Putuwe); our brief visit was simply insufficient to encounter them in the field or to document most of them with captured specimens or trophy material retained by hunters.

## CONSERVATION RECOMMENDATIONS

The results of our survey provide a better understanding of the mammal fauna of a corner of Southern Highlands Province previously little-investigated by mammalogists, and establish the importance of Hewa lands as a region where some of Papua New Guinea's largest and most endangered native mammals (such as *Zaglossus bartoni* and *Dendrolagus goodfellowi*) occur. As we have emphasized elsewhere (Helgen 2007c, Helgen and Opiang, Chapter 20, this volume), few firm steps can be taken with regard to conservation, management, and/or protection of mammals in this region without a more intricate understanding of their distribution, abundance, and threats that they face. Additional survey efforts and more focused research on individual focal species are needed before many specific recommendations for conservation and management be made; below, we highlight priorities for further work in Hewa country specifically and for New Guinea mammalogy in general.

**Indigenous knowledge.** Collaborations between biologists and indigenous communities are a fundamentally important aspect of biodiversity survey efforts and broader efforts aimed at biodiversity conservation in New Guinea. Since 1988, Thomas has worked with the Hewa to conserve their bio-cultural heritage (Thomas 2009a). This partnership has focused on the impact of human disturbance on biodiversity, as this “humans as a source of disturbance” approach fit both the Western and Hewa view of the dynamics of traditional gardening. Using birds - a visible and widely appreciated indicator of biological diversity, they have developed a vehicle for the cross-cultural communication of environmental knowledge that enables both the Hewa and the conservation community to engage issues surrounding sustainable development and conservation at the headwaters of the Strickland River (Thomas 2010a, 2010b). In the process, they have also developed the Papuan Forest Stewards Initiative (Thomas 2009b and Chapter 8, this volume) to secure their bio-cultural heritage for future generations. Since traditional environmental knowledge is no longer a sign of backwardness in Hewa society but rather a source of income, an enthusiastic cadre of Hewa naturalists, willing to share their knowledge, has emerged. Collaborating with Hewa naturalists has already revealed many unanswered questions about the mammals with which they share their lands that are conducive to cooperative study, including animals as important to New Guinea conservation biologists as tree kangaroos and echidnas. This survey is the first in what we anticipate will become a steady stream of partnerships between the Hewa

and scientists that will work to conserve the bio-cultural heritage of this region for now and in the future.

**Basic biodiversity survey efforts.** To better understand the immediate fauna of the Wanakipa area, basic biodiversity surveys, such as the survey work discussed herein, will need to continue, incorporating more sites and additional habitats (particularly in higher elevation habitats). Our brief survey in Hewa country has probably documented a relatively modest fraction (probably less than 25%) of the actual Hewa mammal fauna. As indicated by discussions with Hewa informants, further surveys will undoubtedly record many additional mammal species in the area, some of which, like various kangaroo and wallaby species (Table 21.2), are species of conservation concern.

**Focal species of conservation concern.** Targeted ecological studies in collaboration with the Hewa are needed to assess in greater detail the distribution, abundance, and threats faced by what we can label “focal species” for conservation in the region, especially the Long-Beaked Echidna (*Zaglossus bartoni*) and Goodfellow's Tree Kangaroo (*Dendrolagus goodfellowi*), which are likely to be targets of concerted hunting pressure. Wallabies, tree kangaroos, and echidnas have probably disappeared from most areas with high human population density and high hunting pressure throughout New Guinea (Bulmer and Menzies 1972, George 1978, Flannery 1992, 1995; Flannery and Groves 1998, Martin 2005). The fact that *Zaglossus*, at least one tree kangaroo species, and apparently several other macropodids (Table 21.2), all good proxy taxa for understanding hunting pressure, still persist in the vicinity of Wanakipa is a good sign that hunting has not yet resulted in mammal extirpations in the area. On the other hand, the only reason we know that these species occur at Wanakipa is because they are represented in multiple trophy jaw collections held by local hunters, demonstrating that concerted hunting pressure is likely acting on these animals.

**Taxonomy.** Appropriate conservation prioritization for most New Guinea mammals still cannot be evaluated competently without comprehensive taxonomic revisions first laying the groundwork required for understanding taxonomic boundaries, delineating geographic distributions, and identifying characteristics that will allow for straightforward taxonomic identification of specimens. Biologically diverse Melanesian mammal genera especially in need of sweeping taxonomic revisionary overviews include the rodent genera *Paramelomys*, *Uromys*, *Pogonomys*, and *Rattus*, miniopterid bats (*Miniopterus*), the pteropodid genera *Nyctimene* and *Paranyctimene*, and marsupial genera such as *Petaurus*, *Cercartetus*, *Distoechurus*, and *Echymipera*, all of which occur in Hewa country. Additional biological surveys will continue to add much to our knowledge of mammal taxonomy and distribution in New Guinea, but sufficient museum specimens now exist to undertake these principal revisionary goals for most of the island of New Guinea. The taxonomy in use within the enormously valuable standard volumes currently available for New Guinea mammals (e.g. Flannery 1995,

**Table 21.2.** Knowledge of mammals in Hewa country reported by Hewa informants. We report here the Hewa names that we have been able to most satisfactorily associate with taxonomic names of New Guinea mammals, based on Hewa informants' recognition of photographs and specimens, and on convincing discussions of animals' appearance and habits. Information listed as "Informant Knowledge about Local Occurrence and Habits" represents statements from informants about where the species lives, or where it is most likely to be encountered in Hewa country, along with selected notes regarding diet and behavior. Wam is a noun prefix applied to names of terrestrial mammals; Nok is a noun prefix applied to names of bats.

| Taxonomic Name                         | Specimen? | Hewa name              | Informant knowledge about local occurrence and habits   |
|--|-----------|------------------------|---|
| <b>Monotremata (Tachyglossidae)</b>    |           |                        |   |
| <i>Tachyglossus aculeatus</i>          | no        | ? Wam Taku Itu         | 800-1,500 m   |
| <i>Zaglossus bartoni</i>               | trophies  | Wam Taku Haiba         | 800-1,500 m; see species account in text  |
| <b>Dasyuromorphia (Dasyuridae)</b>     |           |                        |   |
| <i>Dasyurus albopunctatus</i>          | no        | Wam Noiam              | predator  |
| <i>Murexia cf. longicaudata</i>        | no        | Wam Ute                |   |
| <i>Murexia melanurus</i>               | no        | Wam Asuaio             |   |
| <b>Peramelemorphia (Peramelidae)</b>   |           |                        |   |
| <i>Echymipera kalubu</i>               | trophies  | Wam Tsua Kiwauma       | 500-1,000 m; eats fruit, worms, pandanus; litters of 4 or less                                |
| <i>Echymipera rufescens</i>            | trophies  | Wam Kimafima           | 500-1,000 m; eats fruits, wild karuka, worms  |
| <i>Peroryctes raffrayana</i>           | no        | Wam Tsua Tabinai       | 1,000-1,500 m   |
| <b>Diprotodontia (Macropodidae)</b>    |           |                        |   |
| <i>Dendrolagus goodfellowi</i>         | trophies  | Wam Inai Tukelo        |   |
| <i>Dendrolagus [dorianus] notatus</i>  | no        | Wam Inai Maputa        | above 1,500 m   |
| <i>Dendrolagus</i> , species uncertain | no        | Wam Inai Tabaghali Loi | said to be brown and marked with a black stripe   |
| <i>Dorcopsis luctuosa</i>              | no        | Wam Pes Luayatania     | found at low elevations (below 800 m) on Lagaip River; swims; eats wild taro and other leaves |
| <i>Dorcopsulus</i> spp.                | no        | Wam Pes Peten          | above 1,500 m   |
| <i>Thylogale</i> sp.                   | no        | Wam Pes Tua            | above 1,000 m   |
| <b>Diprotodontia (Phalangeridae)</b>   |           |                        |   |
| <i>Phalanger gymnotis</i>              | trophies  | Wam Wai                | widespread  |
| <i>Phalanger mimicus</i>               | trophies  | Wam Nabli              | lowland, primary and secondary forest ; eats leaves   |
| <i>Phalanger steini</i>                | no        | Wam Wai Inagheim       | above 1,000 m   |
| <i>Phalanger carmelitae/sericeus</i>   | no        | Wam Autuma             | above 1,000 m, primary forest   |
| <i>Spilocuscus maculatus</i>           | trophies  | Wam Kail               | 500-1,000 m; eats leaves  |
| <b>Diprotodontia (Acrobatidae)</b>     |           |                        |   |
| <i>Distoechurus pennatus</i>           | no        | Wam Kghainam           | widespread, primary forest  |
| <b>Diprotodontia (Burrmyidae)</b>      |           |                        |   |
| <i>Cercartetus caudatus</i>            | no        | ? Wam Tapim            | may be confused with name for <i>Pseudochirulus forbesi</i>                                   |
| <b>Diprotodontia (Petauridae)</b>      |           |                        |   |
| <i>Dactylonax palpator</i>             | no        | Wam Tinali             | 800-1,000 m; eats fruit and insects   |
| <i>Dactylopsila trivirgata</i>         | no        | Wam Amaia              | widespread, primary forest  |
| <i>Petaurus breviceps</i>              | no        | Wam Yelinauwa          | widespread, primary forest  |
| <b>Diprotodontia (Pseudocheiridae)</b> |           |                        |   |
| <i>Pseudochirulus forbesi</i>          | no        | Wam Anis               | above 1,000 m, primary forest; dens in the base of trees; eats leaves only                    |
| <i>Pseudochirulus mayeri</i>           | no        | ? Wam Tapim            | eats pandanus and fruits  |

table continued on next page

Table 21.2. *continued*

| Taxonomic Name                          | Specimen? | Hewa name                  | Informant knowledge about local occurrence and habits           |
|---|-----------|----------------------------|---|
| <b>Rodentia (Muridae)</b>               |           |                            |   |
| <i>Chiruromys/Pogonomys</i> spp.        | no        | <i>Wam Tu Phutup</i>       | 800-1,500 m; eats leaves, insects, fruit, flowers, and worms    |
| <i>Hydromys</i> cf. <i>chrysogaster</i> | no        | <i>Wam Apalos Peten</i>    | 500-1,000 m; eats frogs, fish, insects and <i>Pangium edule</i> |
| <i>Leptomys ernstmayri</i>              | no        | <i>Wam Tu Tatalip</i>      | eats leaves, insects, worms, grubs, and fruit on forest floor   |
| <i>Lorentzimys nouhuysi</i>             | yes       | <i>Wam Tu Kolotualip</i>   | 800-1,500 m; eats fruits and insects                            |
| <i>Parahydromys asper</i>               | no        | <i>Wam Apalos Cocktua</i>  | 800-1,000 m; diet as for <i>Hydromys</i>                        |
| <i>Uromys caudimaculatus</i>            | yes       | <i>Wam Ute Tsin</i>        |   |
| <b>Chiroptera (Pteropodidae)</b>        |           |                            |   |
| <i>Dobsonia moluccensis</i>             | trophies  | <i>Nok Teliau</i>          |   |
| <i>Nyctimene</i> spp.                   | yes       | <i>Nok Semina Kotmalia</i> |   |
| <i>Pteropus</i> spp.                    | no        | <i>Nok Win</i>             |   |
| <i>Rousettus amplexicaudatus</i>        | no        | <i>Nok Semina Inailolu</i> | lives in caves  |
| <i>Syconycteris/Macroglossus</i>        | yes       | <i>Nok Semina Mea Mea</i>  |   |

Bonaccorso 1998) provides an overly simplistic caricature of the complexity of New Guinea mammal diversity, as renewed detailed systematic reviews continue to demonstrate (e.g., Helgen and Flannery 2004, Woolley 2005, Helgen 2005b, 2007a, Musser et al. 2008, Musser and Lunde 2009, Helgen and Helgen 2009, Parnaby 2009). Currently unnamed or unrecognized biological species are known in almost every Melanesian mammal genus (Helgen 2007a, 2007b, Helgen, pers. obs.). Only once these most taxonomically complex of Melanesian mammal genera are reviewed taxonomically across the sum total of specimens available in world museums will a clearer understanding of mammalian historical biogeography, ecological complexity, and geographic and taxon-based conservation prioritization emerge.

**Invasive species.** The nature and impacts of the spread of invasive mammal species in New Guinea, such as rats in the *Rattus rattus* complex, deserves further study, as brought to light in the present survey. What are the current distributions of invasive rodents and other invasive mammal species in New Guinea, how and where are they spreading, and what impacts do they have on human health, agriculture, and on native fauna and flora? These are important questions that, at least as far as we are aware, are not currently being studied in New Guinea, and will require considerable field work to address.

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#### REFERENCES

- Amori, G., S. Gippoliti, and K. M. Helgen. 2008. Diversity, distribution, and conservation of endemic island rodents. *Quatern. Int.* 182: 6-15.
- Andersen, K. 1912. Catalogue of the Chiroptera in the collection of the British Museum. Vol. 1. Megachiroptera. Second ed. British Museum (Natural History). London.
- Aplin, K. P., P. R. Brown, J. Jacob, C. J. Krebs, and G. R. Singleton. 2003. Field methods for rodent studies in Asia and the Indo-Pacific. Australian Center for International Agricultural Research. Canberra, Australia.
- Bergmans, W. 2001. Notes on distribution and taxonomy of Australasian bats. 1. Pteropodinae and Nyctimeninae (Mammalia, Megachiroptera, Pteropodidae). *Beaufortia* 51: 119-152.

- Bonaccorso, F. J. 1998. Bats of Papua New Guinea. Conservation International Tropical Field Guide Series, Conservation International. Washington, D.C.
- Bonaccorso, F., and T. Reardon. 2008. *Miniopterus macrocneme*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 15 December 2010.
- Bonaccorso, F., and T. Reardon. 2008. *Miniopterus magnater*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 15 December 2010.
- Brass, L. J. 1964. Results of the Archbold Expeditions. No. 86. Summary of the Sixth Archbold Expedition to New Guinea (1959). Bull. Amer. Mus. Nat. Hist. 127: 145-215.
- Bulmer, R. H. and J. I. Menzies. 1972. Karam classification of marsupials and rodents. J. Polynesian Soc. 81: 472-499.
- Dwyer, P. D. 1990. The pigs that ate the garden: a human ecology from Papua New Guinea. University of Michigan Press. Ann Arbor, Michigan.
- Flannery, T. F. 1992. Taxonomic revision of the *Thylomys brunii* complex (Macropodidae: Marsupialia) in Melanesia, with description of a new species. Aust. Mammal. 15: 7-23.
- Flannery, T. F. 1993. Taxonomy of *Dendrolagus goodfellowi* (Macropodidae: Marsupialia) with description of a new subspecies. Rec. Aust. Mus. 45: 33-42.
- Flannery, T. F. 1995. Mammals of New Guinea. Revised edition. Reed Books: Chatswood, New South Wales.
- Flannery, T. F., and C. P. Groves. 1998. A revision of the genus *Zaglossus* (Monotremata, Tachyglossidae), with description of new species and subspecies. Mammalia 62: 367-396.
- Flannery, T. F., R. Martin, and A. Szalay. 1996. Tree kangaroos: a curious natural history. Reed Books. Melbourne.
- Flannery, T. F., and L. Seri. 1990. The mammals of southern West Sepik Province, Papua New Guinea: their distribution, abundance, human use, and zoogeography. Rec. Aust. Mus. 42: 173-208.
- Gannon, W. L., R. S. Sikes, and the Animal Care and Use Committee of the American Society of Mammalogists. 2007. Guidelines of the American Society of Mammalogists for the use of wild mammals in research. J. Mammal. 88: 809-823.
- George, G. G. 1978. The status of endangered Papua New Guinea mammals. In: Tyler, M. J. (ed.). The status of endangered Australasian wildlife. Adelaide: Royal Zoological Society of South Australia. Pp. 93-100.
- Gillett, J. E. 1991. The health of women in Papua New Guinea. Papua New Guinea Institute of Medical Research. Monograph No. 9.
- Groves, C. P. 1982. The systematics of tree kangaroos (*Dendrolagus*; Marsupialia, Macropodidae). Austral Mammal. 5: 157-186.
- Groves, C. P. 2005. Order Diprotodontia. In: Wilson, D. E., and D. M. Reeder (eds.), Mammal species of the world: a taxonomic and geographic reference, third edition. Baltimore: Johns Hopkins University Press. Pp. 43-70.
- Harris, D. B. 2009. Review of negative effects of introduced rodents on small mammals on islands. Biological Invasions 1611-1630.
- Helgen, K. M. 2005a. The amphibious murines of New Guinea (Rodentia, Muridae): the generic status of *Baiyankamys* and description of a new species of *Hydromys*. Zootaxa 913: 1-20.
- Helgen, K. M. 2005b. Systematics of the Pacific monkey-faced bats (Chiroptera: Pteropodidae), with a new species of *Pteralopex* and a new Fijian genus. Syst. Biod. 3: 433-453.
- Helgen, K. M. 2007a. A reassessment of taxonomic diversity and geographic patterning in the Melanesian mammal fauna. Ph.D. thesis. Adelaide: University of Adelaide.
- Helgen, K. M. 2007b. A taxonomic and geographic overview of the mammals of Papua. In: Marshall, A. J., and B. Beehler (eds.). The ecology of Papua (Ecology of Indonesia series Volume VI). Singapore: Periplus Editions. Pp. 689-749.
- Helgen, K. M., and T. F. Flannery. 2004. A new species of bandicoot, *Microperoryctes aplini*, from western New Guinea. J. Zool. (London) 264: 117-124.
- Helgen, K. M., and L. E. Helgen. 2009. Biodiversity and biogeography of the moss-mice of New Guinea: a taxonomic revision of *Pseudohydromys* (Rodentia: Murinae). Bull. Amer. Mus. Nat. Hist. 331: 230-312.
- Hide, R. 2004. Pig husbandry in New Guinea: a literature review and bibliography. Australian Centre for Agricultural Research. Canberra.
- Hill, J. E. 1983. Bats (Mammalia: Chiroptera) from Indo-Australia. Bull. Brit. Mus. (Nat. Hist.), Zool. Ser., 43: 103-208.
- Hutson, T., D. Schlitter, G. Csorba, F. Bonaccorso, and H. Parnaby. 2008. *Nyctophilus microtis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 15 December 2010.
- Kiapranis, R., and P. Nimiago. 2005. A status report on some invasive forest species in Papua New Guinea. In: McKenzie, P., C. Brown, Sun J., and Wu, J. (eds.). The unwelcome guests: Proceedings of the Asia-Pacific Forest Invasive Species Conference. Bangkok, Thailand: Food and Agriculture Organization of the United Nations. Pp. 102-107.
- Kirsch, J. A. W., and J. H. Calaby. 1978. The species of living marsupials: an annotated list. In: Stonehouse, B. N., and D. Gilmore (eds.). The biology of marsupials. Academic Press. London. Pp. 9-26.
- Laurie, E. M. O., and J. E. Hill. 1954. List of land mammals of New Guinea, Celebes, and adjacent islands, 1758-1952. British Museum (Natural History). London.
- Leary, T., and L. Seri. 1997. An annotated checklist of mammals recorded in the Kikori River Basin, Papua New Guinea. Sci. New Guinea 23: 79-100.
- Leary, T., L. Seri, T. Flannery, D. Wright, S. Hamilton, K. Helgen, R. Singadan, J. Menzies, A. Allison, R. James, K. Aplin, L. Salas, and C. Dickman. 2008a. *Zaglossus bartoni*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 15 December 2010.
- Leary, T., L. Seri, D. Wright, S. Hamilton, K. Helgen, R. Singadan, J. Menzies, A. Allison, R. James, C. Dickman, K. Aplin, T. Flannery, R. Martin, and L. Salas. 2008b. *Dendrolagus goodfellowi*. In: IUCN 2010. IUCN Red List

- of Threatened Species. Version 2010.4. <www.iucnredlist.org>. Downloaded on 15 December 2010.
- Lepš, J., V. Novotný, L. Čížek, K. Molem, B. Isua, W. Boen, R. Kutil, J. Auga, M. Kasbal, M. Manumbor and S. Hiuk. 2002. Successful invasion of the Neotropical species *Piper aduncum* in rain forests in Papua New Guinea. *Appl. Vegetat. Sci.* 5: 255-262.
- Lewis, P. M. (ed.). 2009. Languages of the world. Sixteenth Edition. Dallas Texas. SIL International.
- Lidicker, W. Z., Jr., and A. C. Ziegler. 1968. Report on a collection of mammals from eastern New Guinea, including species keys for fourteen genera. *Univ. Calif. Publ. Zool.* 87: 1-60.
- Martin, R. 2005. Tree-kangaroos of Australia and New Guinea. CSIRO Publishing. Collingwood, Victoria.
- Menzies, J. I. 1991. A handbook of New Guinea marsupials and monotremes. Kirsten Press. Madang, Papua New Guinea.
- Menzies, J. I. 1996. A systematic revision of *Melomys* (Rodentia: Muridae) of New Guinea. *Aust. J. Zool.* 44: 367-426.
- Monckton, C. A. W. 1922. Last days in New Guinea: being further experiences of a New Guinea Resident Magistrate. John Lane the Bodley Head Ltd. London.
- Musser, G. G. 1973. Zoogeographical significance of the Ricefield rat, *Rattus argentiventer*, on Celebes and New Guinea and the identity of *Rattus pestivulus*. *Amer. Mus. Novitates* 2511: 1-30.
- Musser, G. G., and M. D. Carleton. 2005. Family Muridae. In: Wilson, D. E., and D. M. Reeder (eds.). *Mammal species of the world: a taxonomic and geographic reference*. Third Edition. Johns Hopkins University Press. Baltimore, Maryland. Pp. 894-1531.
- Musser, G. G., K. M. Helgen, and D. P. Lunde. 2008. New Guinea rodents (Muridae, Murinae): systematic review of *Leptomys* with descriptions of two new species. *Amer. Mus. Novitates* 3624: 1-60.
- Musser, G. G., and D. P. Lunde. 2009. Systematic reviews of New Guinea *Coccymys* and "*Melomys*" *albidens* (Muridae, Murinae), with descriptions of new taxa. *Bull. Amer. Mus. Nat. Hist.* 329: 1-129.
- Norris, C. A., and G. G. Musser. 2001. Systematic revision within the *Phalanger orientalis* complex (Diprotodontia, Phalangeridae): a third species of lowland gray cuscus from New Guinea and Australia. *Amer. Mus. Novitates* 3356: 1-20.
- Opiang, M. D. 2009. Home ranges, movement and den use in *Zaglossus bartoni*, from Papua New Guinea. *J. Mammal.* 90: 340-346.
- Parnaby, H. E. 1987. Distribution and taxonomy of the long-eared bats, *Nyctophilus gouldi* Tomes, 1858, and *Nyctophilus bifax* Thomas, 1915 (Chiroptera: Vespertilionidae) in eastern Australia. *Proc. Linn. Soc. New South Wales* 109: 153-174.
- Parnaby, H. E. 1988. Systematics of the long-eared bat genus *Nyctophilus*. Ph.D. thesis. Sydney, University of New South Wales.
- Parnaby, H. E. 2002. A new species of long-eared bat (*Nyctophilus*: Vespertilionidae) from New Caledonia. *Austral. Mammal.* 23: 12-124.
- Parnaby, H. E. 2009. A taxonomic review of Australian Greater Long-eared Bats previously known as *Nyctophilus timoriensis* (Chiroptera: Vespertilionidae) and some associated taxa. *Aust. Zool.* 35: 39-81.
- Peterson, R. L. 1981. Systematic variation in the *tristis* group of the bent-winged bats of the genus *Miniopterus* (Chiroptera: Vespertilionidae). *Can. J. Zool.* 59:828-843.
- Schipper, J., et al. 2008. The status of the world's land and marine mammals: diversity, threat, and knowledge. *Science* 322: 225-230.
- Simmons, N. B. 2005. Order Chiroptera. In: Wilson, D. E., and D. M. Reeder (eds.). *Mammal species of the world: a taxonomic and geographic reference*. Third Edition. Johns Hopkins University Press. Baltimore, Maryland. Pp. 312-529.
- Smith, K. F., and S. M. Carpenter. 2006. Potential spread of introduced black rat (*Rattus rattus*) parasites to endemic deer mice (*Peromyscus maniculatus*) on the California Channel Islands. *Divers. Distr.* 12: 742-748.
- Taylor, J. M., J. H. Calaby, and H. M. Van Deusen. 1982. A revision of the genus *Rattus* (Rodentia, Muridae) in the New Guinean region. *Bull. Amer. Mus. Nat. Hist.* 173: 177-336.
- Thomas, W. H. 2009a. How do they see it? Traditional resource management, disturbance and biodiversity conservation in New Guinea. In: Heckler, S., and R. Wilson (eds.). *Landscape, process and power: re-evaluating traditional environmental knowledge*. Berghahn Books. Oxford. Pp. 140-155.
- Thomas, W. H. 2009b. The Forest Stewards Initiative: a new institution for safeguarding traditional ecological knowledge in Papua New Guinea. *J. Roy. Soc. New Zealand* 39: 187-191.
- Thomas, W. H. 2010a. Finding common ground: birds, biodiversity, and the implications for collaboration with traditional landowners in New Guinea. *Environ. Manag.* 45: 82-92.
- Thomas, W. H. 2010b. Everyone loves birds: using indigenous knowledge of birds to facilitate conservation in New Guinea. In: Tidemann, S., and A. Gosler. *Ethnoornithology: birds, indigenous peoples, culture and society*. Earthscan. London. Pp. 265-278.
- Troughton, E. le G., and A. S. Le Souef. 1936. Two new tree-kangaroos from Papua, with notes on allied forms. *Aust. Zool.* 8: 193-197.
- Woolley, P. A. 2005. Revision of the three-striped dasyures, genus *Myoictis* (Marsupialia: Dasyuridae), of New Guinea, with description of a new species. *Rec. Aust. Mus.* 57: 321-340.
- Wyatt, K. B., P. F. Campos, M. T. P. Gilbert, S.-O. Kolokotronis, W. H. Hynes, R. DeSalle, P. Daszak, R. D. E. MacPhee, and A. D. Greenwood. 2008. Historical mammal extinction on Christmas Island (Indian Ocean) correlates with introduced infectious disease. *PLoS ONE* 3(11): e3602.
- Ziegler, A. C. 1978. Evolution of New Guinea's marsupial fauna in response to a forested environment. In: Stonehouse, B. N., and D. Gilmore (eds.). *The biology of marsupials*. Academic Press. London. Pp. 117-138.