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The Mammals of Southern West Sepik Province, Papua New Guinea: their Distribution, Abundance, Human Use and Zoogeography

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ABSTRACT. A mammal survey was carried out between 1984 and 1987 in southern West Sepik Province, Papua New Guinea. Eleven major collecting localities, as well as some more minor ones, lying at altitudes of between 120 and 3,200 m were investigated. Voucher specimens for 87 indigenous mammal taxa were obtained, but research suggests that mammal diversity in the area may be as high as 120 species. This is the highest mammal diversity recorded anywhere in Australasia. A similar high bird diversity suggests that the area may be one of exceptionally high biodiversity overall. The most diverse mammal assemblages in the study area are found in the midmontane oak forests (between 1,500 and 2,500 m). Seven species, which apparently have no ecological vicars elsewhere in PNG, inhabit these forests. Changing patterns of human exploitation endanger some species. Recommendations aimed at halting this decline are made. The effect of the introduction of cats in one area was assessed as cats were introduced in the middle of the survey period.

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Contents

The aim of this work is to provide a comprehensive account of the mammals of the study area. First, there will be an account of the collecting localities and methods, then an annotated systematic list, and finally a synthetic discussion of several subjects of general interest, including an account of the zoogeography of the mammals of western New Guinea, the impact of introduced species, and the impact upon mammals of traditional and changing patterns of human use. It also offers solutions to conservation problems, and pinpoints areas of particular biotic significance. Data relating to reproduction and diet, and nesting sites etc. are not re-iterated here in detail, but can be found in Flannery *et al.* (1990).

The area chosen for this study lies between 4°30'S and 5°15'S, and 141°06'E and 141°45'E (Fig.1). Although a small study site (5,200 km^2), this region covers much of the homeland of Telefol, Mianmin, Atbalmin and the northern edge of the homeland of the Wopkaimin peoples. The area lies on the northern slopes of the New Guinean Central Cordillera (almost entirely within the northern watershed), almost in the geographical centre of the island of New Guinea. The topography is mainly mountainous, varying between 100 and 4,015 m in altitude (Fig.2). Although incidental collections of mammals have been made in this region in the past, this work represents the first attempt to fully survey its mammals. In all, some 87 mammal taxa were sampled by us, and it is estimated that up to 120 mammal species inhabit this region.

The mammal survey was carried out over four years, with repeated visits to the area being undertaken by the investigators (see Table 1). Only four areas were visited twice or more (Telefomin, Tifalmin, upper Sol River Valley, and the Yapsiei/Betavip area). However, these visits were extremely useful for investigating seasonality and other changes in the mammal fauna.

A wide variety of sampling techniques was used. Much material was collected by local people and purchased by expedition members. Elliott, Conybeare, conventional rat traps and mist nets were also set, and larger mammals were hunted using a spotlight and shotgun. Caves were also explored extensively for bats. Table 2 lists the mammal species obtained and gives our best estimate of some aspects of their biology.

There were several gaps in our altitudinal sampling due to lack of suitable access. Perhaps the most serious is that between approximately 400 and 900 m, where very few mammals were obtained. Because of this it has been difficult to determine the upper and lower altitudinal limits of some foothill-inhabiting species in our study area.

Materials and Methods

The naming of vegetational types (where capitalised) conforms to Paijmans (1976). Colours in the new subspecies description follow the nomenclature of Smythe (1974). A list of Telefol and Mianmin mammal names is given in Table 3. Common English names for mammals follow Flannery (1990). All specimens collected during this survey are housed in the Australian Museum or the Papua New Guinea Museum and Art Gallery. The higher-level classification of the New Guinea bandicoots follows Flannery & Groves (in press). The Appendix contains all tables referred to throughout the text.

The Study Area

People. Much of the study area falls within the 1980 census district 04 (Telefomin). The census divisions that lie within this district and their human populations are as

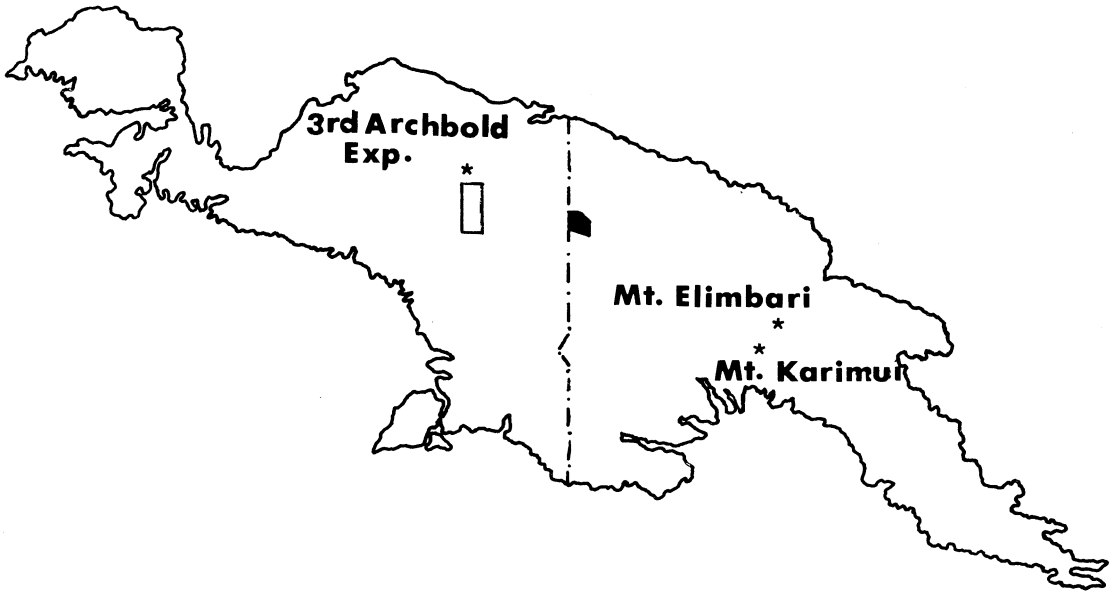

Fig.1. Map showing our study area (in black) and other locations mentioned in the text.

follows; Yapsiei local (491), West Mianmin (802), Atbalmin (2,245), East Mianmin (935), and Telefomin local (5,195), making in all about 10,000 inhabitants.

In the Yapsiei local, East and West Mianmin and Atbalmin census divisions the population is low and people tend to be spread rather evenly in small villages, although some larger population centres do exist. The Telefomin local district holds over half of the people in the area, who tend to be concentrated in the Telefomin, Elip and Ilam Valleys. Here, disturbance through gardening and hunting is at its maximum.

Rainfall. Some rainfall figures exist for Tifalmin, Yapsiei and Telefomin stations. However, data is limited and discontinuous, and all of the Tifalmin data, as well as substantial extracts from that for the other localities, is presented in Table 4. The figures for Yapsiei may be unreliable due to the absence of some daily recordings (R. Attenborough, personal communication). Despite these limitations, it seems that rainfall at Tifalmin is lower than elsewhere in the study area. This was our general impression in the field, and was supported by the observations of the local people. Yapsiei may receive a slightly higher rainfall than Telefomin. There is little suggestion of seasonality in rainfall, although there may be a mid-year peak at Yapsiei.

Major collecting localities. The major collecting localities are shown in Fig. 3. The village of Oboblikmin that is shown is the one located in the Ilam Valley. The Oboblikmin village near Mianmin (which is to the north of the study area) is not shown, being a minor collecting station.

Yapsiei Station and the August/Sepik floodplain. This area was the lowest altitude habitat sampled, parts of the August River floodplain lying as low as 120 m, with the highest parts of the sampled region lying at about 240 m.

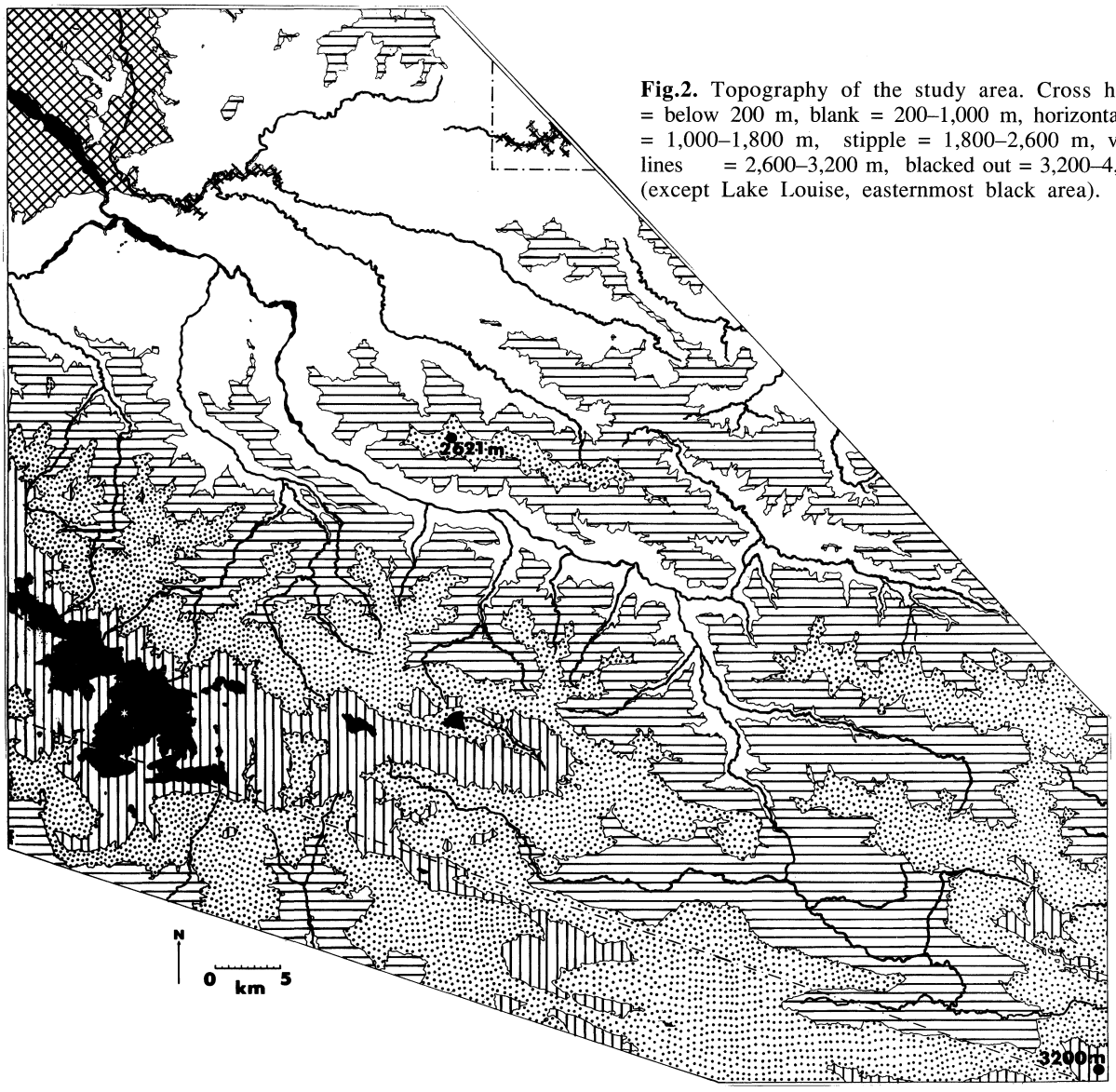

Fig.2. Topography of the study area. Cross hatched = below 200 m, blank = 200–1,000 m, horizontal lines = 1,000–1,800 m, stipple = 1,800–2,600 m, vertical lines = 2,600–3,200 m, blacked out = 3,200–4,000 m (except Lake Louise, easternmost black area).

Rainfall at Yapsiei Station is high (5,000–7,000 mm per annum) with only slight seasonality. Most collecting sites were on the flat-lying alluvial floodplain of the August River. Downstream from Yapsiei Station, this area is largely uninhabited and is only visited during occasional hunting forays. Here, a climax Mixed Alluvium Forest community is developed. Hunting and limited trapping with Elliott traps were the sampling methods used. The forest in the vicinity of Yapsiei Station is disturbed to varying degrees. The Station itself is located on the margin of the floodplain at 200 m, and is inhabited by approximately 450 people (1986) as well as a variable number of refugees. Disturbance ranges from total forest destruction and maintenance of a short, lawn-like grassland on the airstrip and around the main government buildings, to both current and regrowing gardens, through to forest which is being cut over for building materials and firewood. The government station was established at Yapsiei in 1973, and before this the area was not permanently inhabited and was little disturbed. Only limited and largely unsuccessful hunting was undertaken here, and some trapping using both Elliott and snap traps was carried out. However, an extensive mistnetting program was undertaken, primarily in gardens, disturbed forest and around government buildings.

Betavip Village. The village of Betavip is located approximately 14 km east-north-east of Yapsiei Station. However, the only access is along the meandering August River, and the walk is about one and a half days. It is a largely traditional Mianmin village of about 80 inhabitants (with a further 130 in the surrounding area). The village is positioned in a broad and isolated area of riverflats near the junction of the Skgonga and Usake Rivers. Where not disturbed, the alluvial flats support a climax Mixed Alluvial Forest. Disturbance is limited to current and regrowing garden areas, and some localised disturbance associated with the village and attempts to

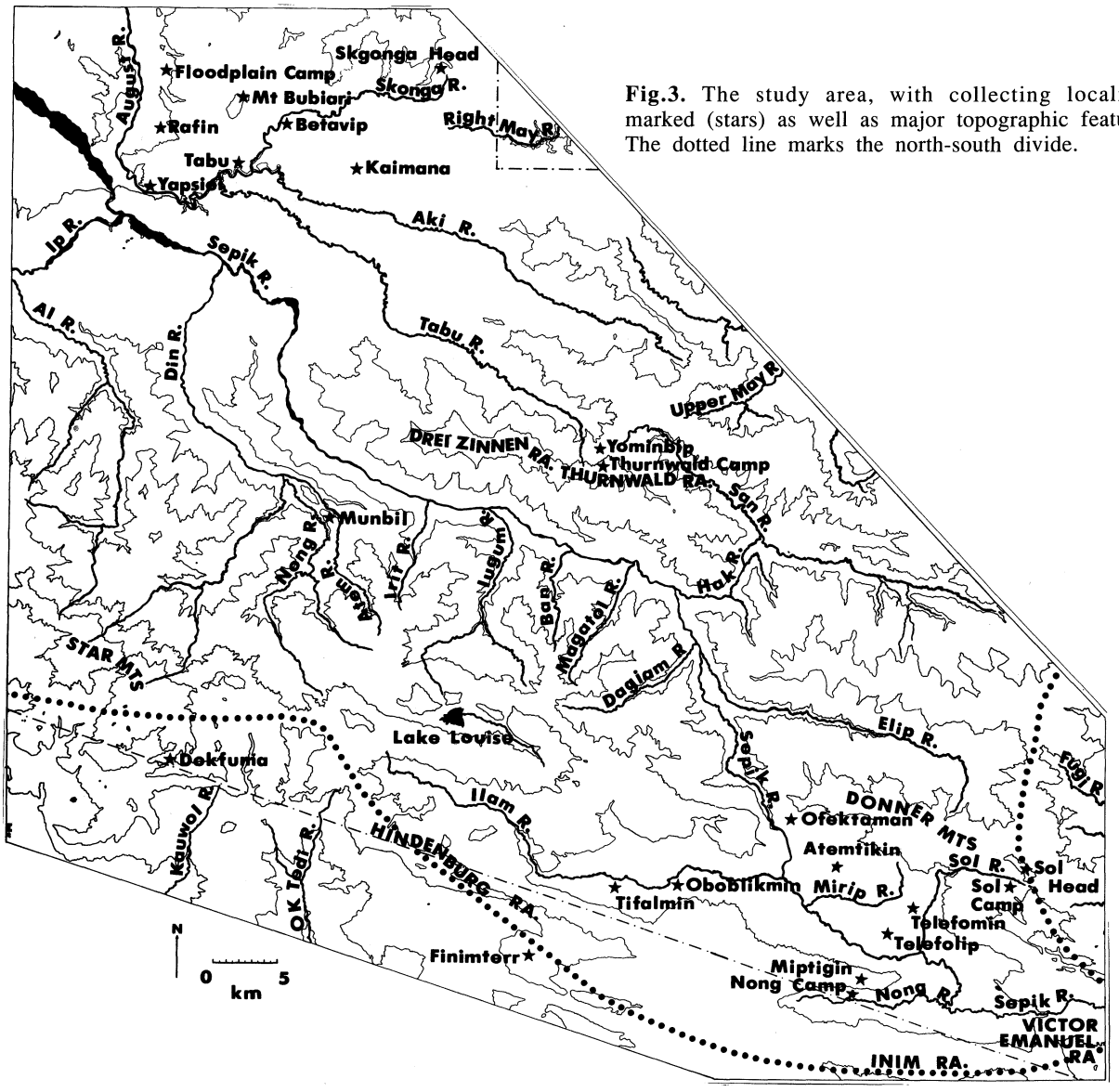

Fig.3. The study area, with collecting localities marked (stars) as well as major topographic features. The dotted line marks the north-south divide.

define an airstrip near the village. Even close to the village there is ready access to climax forest on the floodplain margin and surrounding foothills.

This village was our major basecamp during January 1984 and April 1986. We carried out extensive hunting, trapping and mistnetting. We also employed Mianmin women to collect small mammals and men to hunt larger game, mostly in the 200 to 400 m altitudinal interval.

It seems likely that Betavip Village came into existence in the late 1960's when government patrols became frequent enough to suppress the feuding that necessitated the building of ridgetop villages. However, it is probable that some gardening was always carried out on the Betavip alluvial flats. Thus intensive exploitation of the Betavip area probably dates back less that 20 years.

A number of changes were noted in the Betavip area between 1984 and 1986. These include the translocation of the entire village approximately 1 km to the north-east, the clearing of a long, narrow band of climax or old Secondary Forest to define the space necessary for an airstrip, and the introduction of cats (see discussion). The total population had also grown due to the movement of Mianmin away from Yapsiei Station to locations further upstream on the August River.

Mount Bubiari. Mount Bubiari is the highest peak in the vicinity of Yapsiei and Betavip. Its summit (1,200 m) was investigated briefly during 1984, while hunting forays were made to the lower slopes during 1986. Hunting was the only collecting technique utilised successfully in the area. The 1984 basecamp was established at 900 m, hunting taking place over the altitudes 700 to 1,200 m, while in 1986 most hunting was done over the 400 to 600 m range. Most of the mountain is clothed in climax Mixed Evergreen Forest, although there are some areas of old secondary growth and abandoned village sites as high as 900 m and at least 20 years old. No *Araucaria* are present and the forest is dominated by large-fruited *Castanopsis*. The area is now visited only during occasional hunting forays by Mianmin. The terrain is steep and often rocky, and there is little undergrowth. The forest is stunted and mossy at the summit.

Yominbip Village and the Thurnwald Range. The village is a small, long-established settlement that is at present only intermittently occupied. It is perched atop a steep ridge at 1,000 m on the northern slopes of the Thurnwald Range. Small garden areas are located on the steep surrounding slopes, but there is little flat-lying gardening land available. Climax Mixed Evergreen Forest is abundant close by. The forest is unusually mossy for such low altitudes, particularly on the surrounding ridgetops at 1,300 m. *Araucaria* are absent, but a species of *Phyllocladus* is common in the area even as low as 900 m; *Castanopsis* species are abundant throughout. Low lying, persistent cloud and associated lowered temperatures were a common occurrence during our stay. Trapping and hunting were carried out extensively in climax forest, with some trapping and mistnetting taking place in disturbed patches.

The upper slopes of the Thurnwald Range (1,800–2,000 m) were visited by one of us (L.S.) for a week. This area is uninhabited, and had not been visited in recent years. Hunting and mistnetting were undertaken.

Munbil Settlement. Munbil is located at 900 m in the northern foothills of the Star Mountains. It is a new settlement, being carved out of climax Mixed Evergreen Forest during 1985. At the time of our visit in May 1986 the airstrip was still being lengthened and the newly-made gardens were beginning to produce crops. The settlement is situated on a large flat plateau between the Nong and Atem Rivers and is surrounded by extensive tracts of undisturbed climax forest. The area has a considerable population of Atbalmin which is still growing. The vegetation is far less mossy than at Yominbip and is more typical of lowland forest. No *Phyllocladus* are present, but *Araucaria* clothe nearby ridgetops above about 1,400 m. Limited hunting and extensive mistnetting and trapping were undertaken here. Unfortunately, many traps were set in gardens, and little trapping was successful in primary forest. Small murids were, however, collected by Atbalmin women. Mistnetting was carried out both in disturbed areas and climax forest.

Telefomin Valley. The Telefomin valley supports a human population of 800 to 1,000 people. A large part of the work in this area was carried out in the vicinity of Telefolip and nearby Bogalmin villages, in the most densely-populated central region, and at Ofektaman in the north of the valley. The valley floor consists of a plateau of flat-lying but deeply eroded Quaternary sediments. The plateau lies between 1,400 and 1,500 m, with the Sepik and its tributaries incising it to a depth of about 400 m. In the centre of the valley the plateau supports an anthropogenic grassland, while the small gullies support Secondary Mixed Evergreen Forest in various stages of disturbance. Disturbance usually consists of treefelling for firewood or building materials, but some gardens are also located here. *Araucaria* persist near the sacred village of Telefolip, where they are protected by tradition. Indeed, young plants are relocated and tended here by Telefol.

The history of vegetational change in the Telefomin valley over the past 60 years can be reconstructed with some accuracy. When the explorer Ivan Champion first saw the valley in 1926, it was a mosaic of grassy and forested areas, with the grassland mainly on the plateaus (personal communication). When the present airstrip and station was constructed in 1945 at least part of the ground had to be cleared of climax Mixed Evergreen Forest (if local informants are correct). Today clearing proceeds apace. A sawmill is located on the northern edge of the valley, where some of the last climax forest remaining on the plateau margin is being felled. The remaining forest relics in the central part of the valley are coming under increasing pressure for firewood, building materials and gardening. They are doubtless shrinking, with the smaller ones disappearing. Extensive hunting, trapping, mistnetting and foraging by Telefol were carried out

during 1984, 1985 and 1986. Many caves were also explored for bats.

Tifalmin area. Tifalmin lies in the valley of the Ilam River, with the flat river valley at about 1,300 to 1,400 m. This area was briefly visited in November 1984, and then more extensively investigated in April 1987 and March 1990. The 1980 census gives a population of 326 for the Tifalmin/Bafunmin area. Settlements are scattered throughout the valley, and much of the valley bottom and sides up to 1,700 m are anthropogenic grassland. Some gardens are located on the valley floor, but many are concentrated in a band of disturbed forest at about 1,800 m on the south side of the valley. A noticeable deterioration in the extent of forest cover was noted between 1984 and 1987. However, near the village of Oboblikmin at the eastern end of the valley extensive areas of lowland type rainforest still remain. These shelter *Phalanger orientalis* and other typical lowland species. This type of forest must have existed at some time further up the valley towards Tifalmin, but now only small remnants on very steep ground remain. Our impression, confirmed by local people, was that the Tifalmin area was considerably drier than the Telefomin Valley. Limited rainfall figures would tend to support this.

Extensive hunting was undertaken on the southern slopes of the valley near Tifalmin, at altitudes between 1,800 and 2,400 m, and at Oboblikmin and in low altitude forest remnants near Tifalmin. Trapping was also carried out in the valley floor and in forest at 1,800 m. The numerous caves in the valley were also explored.

Nong River Valley/Miptigin ridge. The Nong River is a small tributary of the Sepik which drains the Inim Range (not the Nong near Munbil). Its headwaters lie to the south-east of Telefomin, and the river flows eastwards to join the Sepik near Feramin. The valley floor near our 1985 basecamp is at 1,500 m. There is no permanent human habitation in the valley, and little disturbance to the climax Mixed Evergreen Forest that clothes it. This is because the area lies on the boundary of the Telefol homeland, and in traditional times was a dangerous place to visit as it was open to surprise attack. There are some *Araucaria*, but the forest is dominated by oaks (*Castanopsis* spp). Fogs were uncommon, and the sky was clear and weather warm during our stay (June). My impression is that the Valley of the Nong River is in a rainshadow, and experiences drier and warmer weather than the Telefomin Valley.

The valley sides are steep, but the floor has extensive flat areas. Extensive hunting, trapping and foraging by Telefol were all carried out in the valley, mostly at below 1,600 m. Limited mistnetting was unproductive, but a number of caves produced Microchiroptera.

Part of the northern rim of the Nong River Valley is a ridge called Miptigin. At our 1985 campsite it rises to 2,100 m, and this area was investigated for several days during 1985. It is dominated by a mossy climax Lower Montane Forest but with some disturbance and anthropogenic grassland along its northern margin. *Phyllocladus* is common, and other podocarps present; moss and epiphytes are abundant. Trapping and hunting were undertaken here.

Sol River Valley. The Sol River Valley is a westwards, then southwards-flowing tributary that enters the Sepik east-south-east of Telefomin Station. Our basecamp during 1984 and 1986 was beside the westwards-flowing headwaters of the Sol at an altitude of between 2,200 and 2,300 m. The floor of the valley at this altitude is gardened by the inhabitants of TelefolipVillage. The valley walls rise sharply to the south, north and east enclosing a relatively flat-lying basin, and gardening is restricted to its lower parts.

Away from the gardened zone, the valley is clothed in climax Lower Montane Forest. Even at altitudes of 2,600 m large fruited *Castanopsis* are common. However, no *Phyllocladus* were seen. The forest does not become very mossy until 2,600 to 2,800 m. The lower part of the valley floor is dominated by gardens and secondary growth in various stages. No major environmental changes were noted between 1984 and 1986. Hunting and trapping were undertaken between 2,200 and 2,800 m, with mistnetting being restricted to between 2,200 to 2,400 m.

Dokfuma Basin, Mount Capella. Dokfuma is a small subalpine herbfield perched on the southern slopes of Mount Capella at 3,200 m. Our campsite was on the edge of the valley, and this was the highest habitat investigated during our survey. The region is uninhabited and has no history of use of any sort according to Wopkaimin informants. However, it is crossed by the Busilmin-Tabubil track, which has been used with increasing frequency since the development of the Ok Tedi Mine. The Dokfuma valley itself is a small frost hollow about 1 km^2 with gentle slopes. The valley floor is covered in subalpine herbs and ferns, with small clumps of treeferns and stunted *Rhododendron* bushes. The valley margins support an open *Dacrycarpus* woodland, with *Phyllocladus*, *Papuacedrus* and *Schefflera* being common. In sheltered areas nearby a dense and extremely mossy Upper Montane Forest is developed. Hunting, trapping and mistnetting were undertaken in and around the basin.

Taxa Obtained

Monotremata

Tachyglossidae

Zaglossus bruijnii (Long-beaked Echidna)

Only two specimens of *Zaglossus bruijnii*, both trophy skulls, were collected during this survey. The skull of an immature animal was obtained from a European aid worker at Telefomin Station, and presumably originated from the area of the Telefomin Valley although the date of its collection is unknown. The second skull, from an adult,

was collected at Oboblikmin Village, near Mianmin Station, and was reported by Mianmin to have come from one of the higher peaks around Oboblikmin.

Although Mianmin from the vicinity of Yapsiei Station (altitude 200 m) know of *Z. bruijnii*, they report that it is not found in their area, but comes from higher altitudes. Similarly, Mianmin from Yominbip Village (altitude 1,000 m) report that the species is not found in the area of the village, but is occasionally caught on the ridges surrounding the village at altitudes above 1,300 m. The species seems to be absent from the Telefomin valley at present, but within historic times was found there, as various European informants have reported seeing animals there before the mid-1970's. It is likely that the influence of the Baptist mission at Telefomin has been a major cause of its decline, as non-Christian Telefol have extremely strict taboos regarding the killing and eating of this species. Indeed, it was guaranteed virtual complete protection in the area controlled by the Telefol in pre-Christian times. At present, however, it is hunted and eaten by many Christians; and others, while they will not eat or kill it, will, if they come across an animal, sell or give it to a less traditionally-minded relative or friend.

The restriction of *Zaglossus bruijnii* to high altitudes (above 1,300 m) in West Sepik Province is surprising given its records from much lower altitudes both in the west of New Guinea (Thomas, 1907) and south of the Papua New Guinean Central Cordillera (at 600 m, Aplin, personal communication). This absence is unlikely to be due to hunting pressure, as some of the Mianmin district has an extremely low (and declining) human population. We regard it as more likely to be a natural absence due to some ecological factors which are as yet unknown.

Marsupialia

Dasyuridae

Dasyurus albopunctatus (New Guinea Quoll)

Dasyurus albopunctatus was obtained at only two localities within the study area, the head of the Sol River, and the head of the Skgonga River. The specimen from the Skgonga was brought in as a fresh skull and skin to Betavip in April 1986, and was reported to have come from a campsite at about 1,000 m. Two specimens were trapped at the head of the Sol River; a subadult female taken in an Elliott trap baited with peanut butter in January 1984, and a subadult male taken in a rat trap baited with a partial *Rattus steini* carcass in March 1986. The second of these captures was made after the traps had been raided, presumably by this animal, and captured rats removed. The animal was finally trapped within 20 m of our base camp, which was inhabited by about ten people and a dog. This species is not eaten by Telefol, who consider it unclean due to its meat-eating habits. Most Mianmin spoken to indicated that this species has a patchy distribution, with it being almost invariably met with at some locations but totally unknown from many others.

Antechinus melanurus (Black-tailed Antechinus)

This species seems to be present throughout the study area, with records from between 200 and 2,300 m. It is, however, generally uncommon. Where data for capture are available, the animals were taken while climbing in low trees, or in nests in trees or bushes. Most captures were from secondary forest, with none certainly known to have come from primary forest. Specimens from lower altitude are larger than those from higher.

Antechinus naso (Long-nosed Antechinus)

The single specimen taken was captured in an Elliott trap at about 1,400 m near Ofektaman. The trap was set in primary forest.

Peroryctidae

Microperoryctes longicauda (Striped Bandicoot)

This species seems to be restricted to altitudes above about 1,400 m in the study area, with two captures coming from the Sol River basin (2,200–2,400 m), a third from Ofektaman, (1,400–1,800 m), and the last from Tifalmin (1,600 m). The Sol River animals were both located in nests among tree roots.

Peroryctes raffrayana (Raffray's Bandicoot)

Four of the six specimens obtained were taken at 1,000 m at Yominbip, a further specimen near Kobobip Village (Betavip area) at about 600 m, and another specimen at Ofektaman (altitude unknown, but between 1,200 and 1,800 m). This pattern of altitudinal distribution broadly fits that reported by Tate (1948b) from the Idenburg River area, with animals most common at about 850 to 1,200 m. The four animals from Yominbip were speared at night by Mianmin lying in wait beside fruiting *Ficus*. These *Ficus* produce fruit at the base of the trunk and roots, and (in May) were bearing heavy crops. Mianmin note that they have a long fruiting period and are a favourite food source of *P. raffrayana*.

Echymipera clara (Dimorphic Echymipera)

This species was only encountered in the lower and middle foothill forests (200–400 m) but it appeared to be moderately common there. A female with a furred pouch young was taken near Tibip Village (Betavip area) in January 1984. In general this species is rarer than *E. kalubu* in the study area, and does not inhabit disturbed forest. No

specimens were taken at Betavip during our 1986 visit.

Echymipera kalubu (Spiny Echymipera)

This species was encountered at the lower to middle altitude collecting localities and was sometimes abundant. In the Telefomin valley (altitude 1,440 m) and at Yominbip (altitude 1,000 m) only a single individual was collected, both in very disturbed situations. However, at Betavip Village during January 1984, 12 individuals were collected over 16 days from forest, regrowth and gardens. On a return visit in April 1986 the species seemed to be much rarer, only two individuals being captured over ten days (both being taken at some distance from the village). Cats had recently (1985) been introduced into the village (with two animals, a male and a female, being present during our stay). The Mianmin villagers attributed the scarcity of bandicoots (and also large spiny rats) to predation by cats. We could see no other reason for the decline, and indeed while hunting at night on several occasions saw cats prowling in the forest where before we had taken bandicoots. Before the introduction of cats, this species was probably an important food source to the people of Betavip.

Echymipera rufescens (Long-nosed Bandicoot)

This is the rarest peroryctid in the study area. It is represented in our collections by only five trophy dentaries and a single subadult male. This last specimen was captured by workers while they were cutting grass around Government buildings at Yapsiei Station in May 1986. The five trophy dentaries were all obtained in 1984 from villages bordering the August-Sepik floodplain. Although hundreds of bandicoot specimens and trophies were obtained in foothill forest away from the floodplain, not a single specimen of *E. rufescens* was included among them. These data suggest a preference by this species for floodplain habitats, and possibly only grassland or grossly disturbed areas on the floodplain. It is almost certainly not an inhabitant of foothill forest.

Macropodidae

Dendrolagus dorianus (Doria's Tree-kangaroo)

Dendrolagus dorianus stellarum n.subsp.

Figs 4–6, Table 5

Type material. HOLOTYPE, AM M17789, puppet skin and skull with dentaries of an adult male. Collected T. Flannery and L. Seri; western end of Dokfuma basin, 3,000 m, Star Mountains, Western Province, Papua New Guinea, 5°01'S 141°07'E, 6 Apr. 1987.

PARATYPES, AM M17790, puppet skin and skull with dentaries of an adult female. Collected T. Flannery and L. Seri; north side of Dokfuma Basin, 3,160 m, Star Mountains, Western Province, Papua New Guinea, 5°01'S 141°08'E, 2 Apr. 1987. AM M19463, subadult male (young of AM M17790) entire in spirit, data as for M17790. AM M16699, puppet skin and skull with dentaries of a subadult male (judging from testes size not yet reproductive). Collected T. Flannery; upper Sol River Basin, 2,800 m, West Sepik Province, Papua New Guinea, 1 Apr. 1986.

Etymology. Of the stars (L.), a reference to the Star Mountains, which is the type locality and most of the known habitat of this taxon.

Diagnosis. *Dendrolagus dorianus stellarum* n.subsp. differs from the remaining subspecies of *D. dorianus* in the following ways: smaller, particularly in dental measurements (Table 5, Fig.7); tail yellow, with long terminal tuft, contrasts greatly with darker body (tail dark, without terminal tuft in *D. d. dorianus* and *D. d. notatus*); no dark patch over shoulders such as seen in *D. d. notatus*; anterodorsal part of body covered in silver 'frosted' hairs, contrasts with more brownish hindquarters, which lack such frosting (only *D. d. mayeri* has similar frosting, but entire dorsal surface frosted over blackish background, hindquarters do not lighten as in *D. d. stellarum* n.subsp.).

Description. Variation in the paratype series will be discussed below in relation to the description of the holotype.

Skin. Skin of holotype represents an adult male with fully-developed testes. Muzzle black, covered in short, black hairs. Forehead covered in short, silver-tipped hairs, differs sharply from fur of neck in texture and colouration. Posterior part of cheeks with cinnamon tinge. Ears black. Front part of dorsum, including neck, close to clove brown but lightly tipped with silver. Silver tipping on dorsal surface of fore and hindlimbs more pronounced, largely obscures brownish underfur. Silverish hairs extend to bases of claws. Fairly well defined but narrow and dark dorsal stripe on posterior half of back, extending from midway up back to base of tail. Posterior half of back much lighter than anterior half, being Van Dyck brown tipped with burnt umber. Ventral surface, including scrotum, uniformly dark, between Clove Brown and Seal Brown. Base of tail encircled with Orange Ochraceous hairs, with remainder of tail being predominantly Ochre Yellow, with a short, dark underfur. Long brush of bright Ochre Yellow hairs extends 110 mm beyond tail tip. 2 hair whorls present, 1 on each flank, approximately 120 mm anterior to tail base (defined as margin of Yellow Ochraceous hairs). Orange Ochraceous hairs extend to distal side of cloaca. Paratype subadult male (AM M16699) extremely similar in colouration to holotype. Testes markedly smaller, animal evidently not yet reproductive. Differs from holotype in being slightly lighter shade on anterior half of body, slightly less reddish across posterior part. Tail brush only 85 mm

long, orange ochraceous hairs encircle cloaca, forming patch 30 mm in diameter.

Female paratype (AM M17790) differs markedly in coat colour from both males. Cheeks markedly more yellowish, forehead less silvery, forehead fur merges with fur of anterior part of back, rather than being sharply differentiated from it. Anterior part of back more densely tipped with silvery hairs, posterior part of back markedly more rufous, with rufous area extending further anteriorly. Tail with greater admixture of yellow hairs, tail tuft (95 mm long) Tawny Ochraceous at tip. Large cream buff spot on venter (130 mm in width, 65 mm in length), between pouch and cloaca, which is separated from tail base by band of dark hairs.

Skull and dentition. As a detailed description of the skull and dentition of a species of *Dendrolagus* has not been given previously, it has been included here. The skull of the holotype is little damaged, only lacking the left paroccipital process. The enamel of M2 is breached by wear.

Dentition. I1/ overhangs I2-3/, has largest diameter of upper incisors. I3/ is larger than I2/, occlusal surface V-shaped with apex oriented anteriorly. 2 small enamel cristae run posterolaterally from internal wing of 'V' to link with lateral one. Canines slightly laterally flattened with small

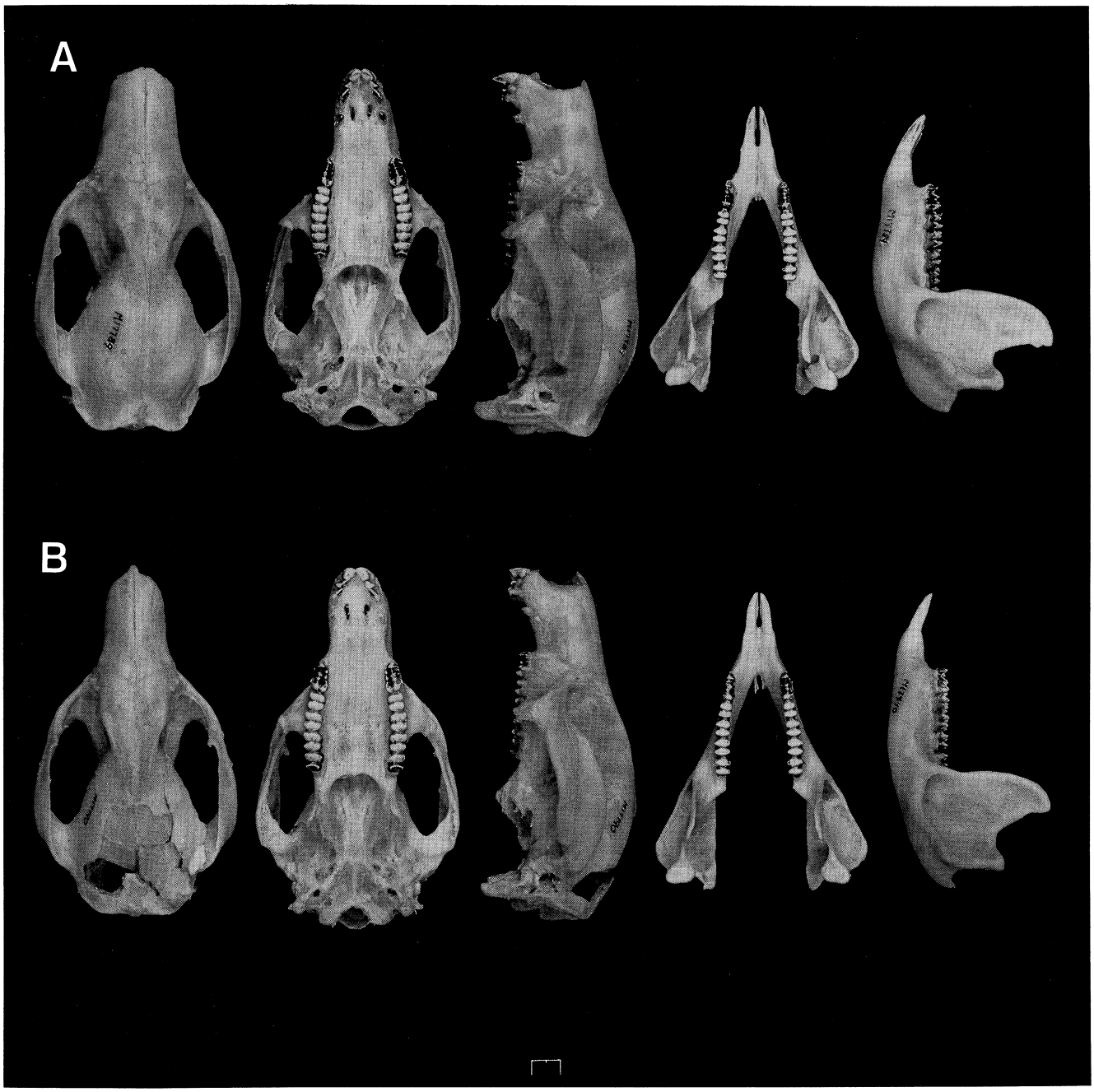

Fig.4. Skulls of A, the holotype (AM M17789) and B, female paratype (AM M17790) of *Dendrolagus dorianus stellarum* n.subsp.

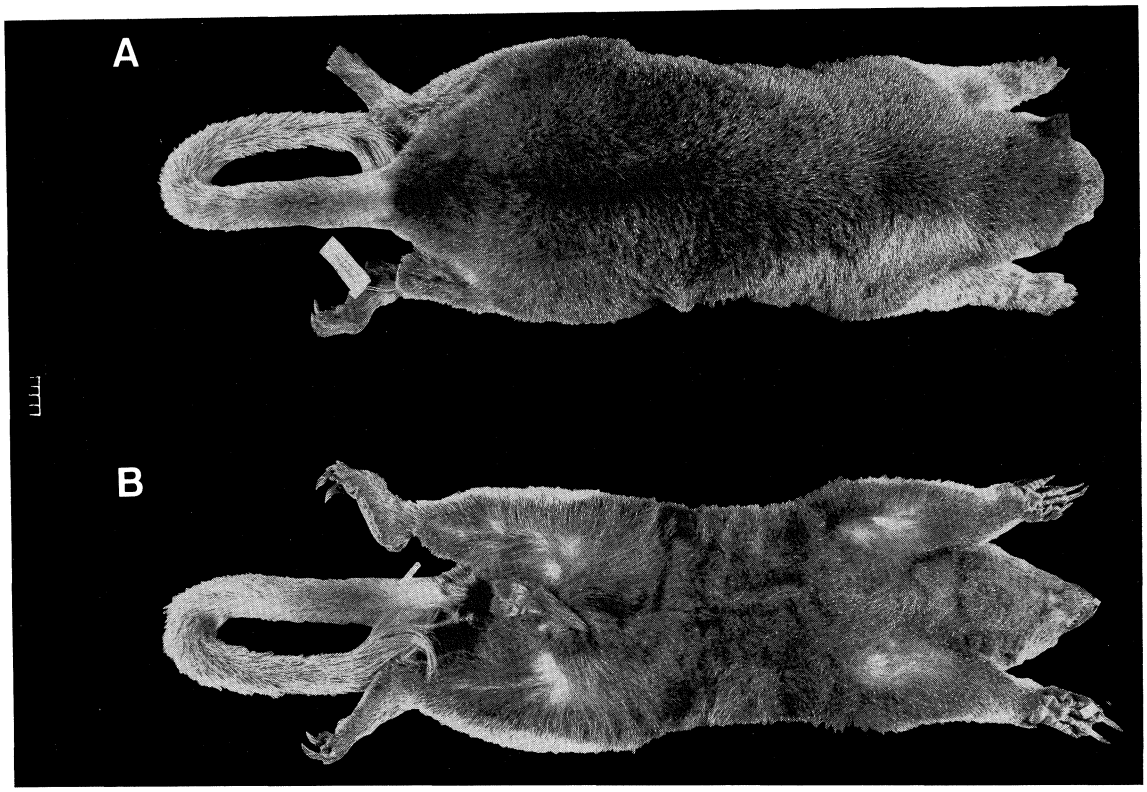

Fig.5. Study skin of the holotype (AM M17789) of *Dendrolagus dorianus stellarum* n.subsp. in A dorsal and B ventral views.

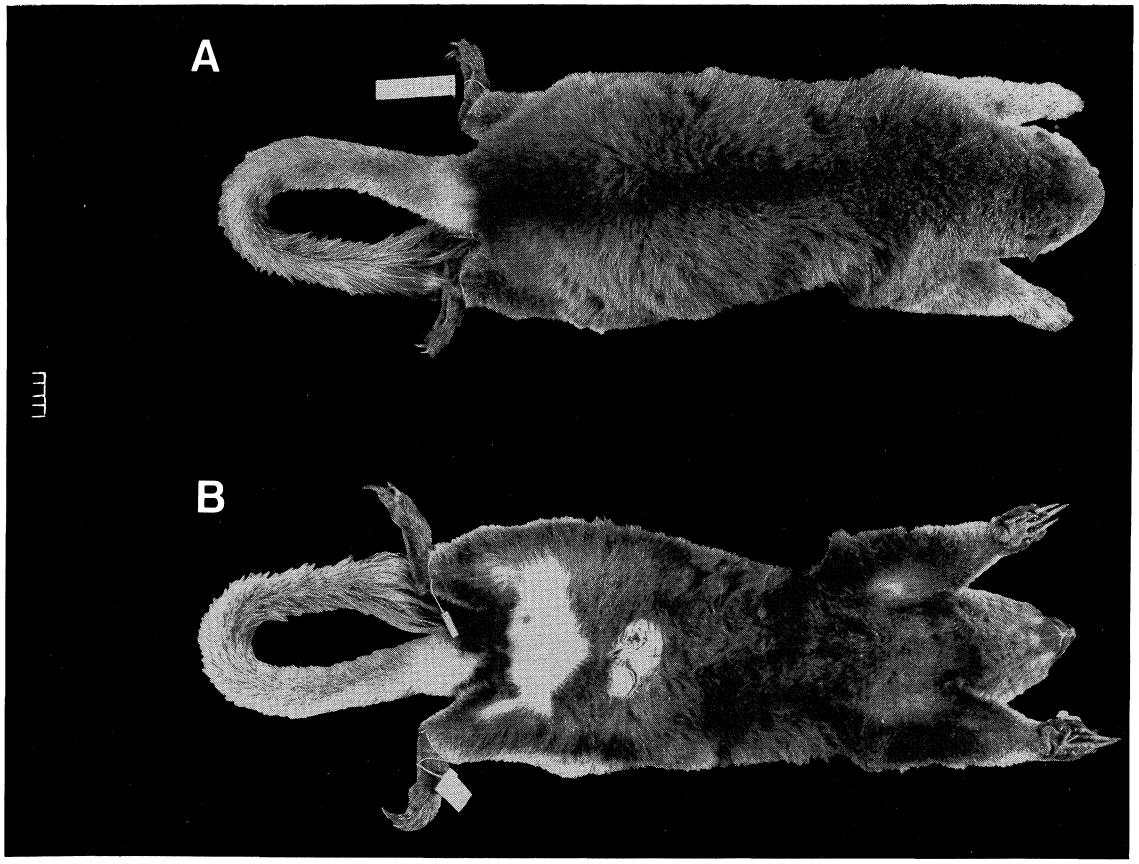

Fig.6. Study skin of the female paratype (AM M17790) of *Dendrolagus dorianus stellarum* n.subsp. in A dorsal and B ventral view.

'heel' at posterior of crown base.

P3/ composed of main blade ornamented by 4 cuspules, a lingual cingulum, a posterolabial and buccal cusp. Anterior and posteriormost cuspules of main crest larger than middle ones. Lingual cingulum moderately well developed. Posterobuccal cusp of left P3/ slightly less well developed than that of right, while posterolingual cuspules on both sides large.

M2/ a simple bilophodont tooth. Anterior cingulum narrow but distinct. All anteroposterior linking weakly developed. M3-4/ similar to M2/, except larger and anterior cingulae broader. M5/ differs from more anterior molars in having hypoloph markedly narrowed.

Lower incisors as in other *Dendrolagus* species. P/3 consists of main blade ornamented with 4 cuspules. Anteriormost the most prominent, divided from rest of tooth by a deep cleft. 2 central cuspules subequal in height, smaller than others, posterior cuspule large, bulbous, long axis deflected slightly posteromedially relative to other cusps.

M/2 a simple, bilophodont tooth with moderately developed paracristid and poorly-developed cristid obliqua. Anterior cingulum low although well developed. M/3-4 differ from M/2 in being larger with narrower anterior cingulae. M/5 closely similar to M/4 except hypolophid narrower.

Skull. Holotype skull represents a fully mature male, however sagittal crest only poorly developed. Frontals also only weakly inflated; much less inflated than any adult *D. d. mayeri*, *D. dorianus dorianus* or *D. d. notatus*. Nasals blunt ended (may have suffered some slight damage). Parietal region lacks heavy pitting present in *D. d. mayeri* and many adult male skulls of other subspecies.

Skull of subadult male paratype differs from holotype in being even smaller, although adult dentition fully in place. Sagittal crest not properly formed (parietal ridges

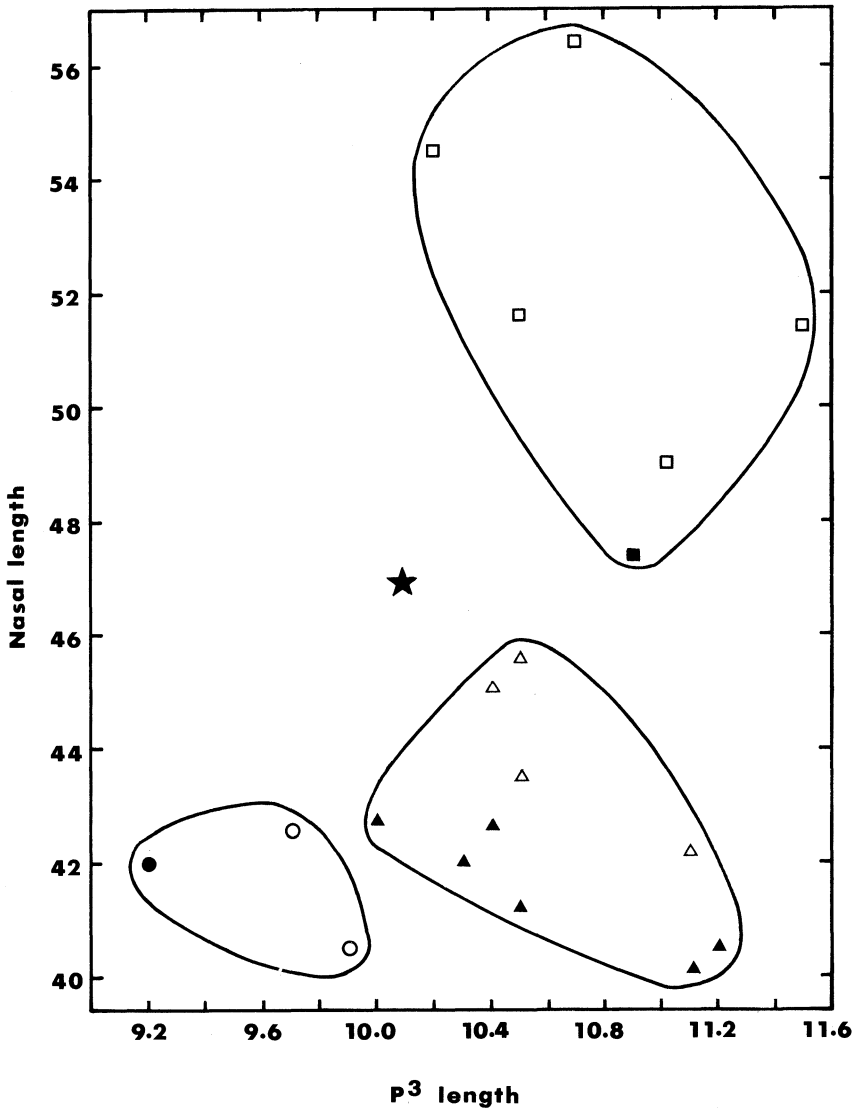

Fig.7. Bivariate plot of nasal length over P3/ length for *Dendrolagus dorianus dorianus* (squares), *D. d. notatus* (triangles), *D. d. mayeri* (star) and *D. d. stellarum* n.subsp. (circles). Solid shapes are for males and open shapes for females. All except *D. d. mayeri* (measurements supplied by Groves), are specimens in the AM collections.

not yet having coalesced), frontals completely unexpanded, indeed being somewhat concave.

Paratype female skull from reproductive animal. Similar in size to paratype male: remarkably narrow rostrum; parietal crest totally undeveloped, with parietal ridges being well separated; frontals concave as in paratype male. Overall, paratype female skull much more gracile than other adult *D. dorianus* skulls examined.

Discussion. Groves (1982) is a comprehensive and largely excellent revision of the genus *Dendrolagus*, based upon the majority of specimens in world museums. It is in the context of this work that the new subspecies is described here. The material examined by us in completing this work is as follows: all *Dendrolagus* specimens held in the Australian and Macleay Museums, Sydney, and the National Wildlife Collections, Canberra, which include the holotypes or lectotypes of *D. dorianus*, *D. spadix* and *D. deltae*; good quality colour photographs of the skin of the holotype of *D. d. mayeri* (kindly supplied by C.P. Groves); notes and measurements of specimens held in Leyden (also supplied by C.P. Groves), and the good quality photographs of the skulls of the holotypes of *D. d. mayeri* and *D. d. notatus* published in Rothschild & Dollman (1936).

Dendrolagus dorianus stellarum n.subsp. shares similarities with both of its nearest geographical neighbours — the subspecies *D. d. mayeri* from far western New Guinea, and *D. d. notatus* from the central highlands. It differs greatly from *D. d. dorianus* from far eastern New Guinea (see Diagnosis; Fig.7) and this subspecies will not be considered further here. *Dendrolagus dorianus notatus* is the subspecies that occurs closest to *D. d. stellarum* n.subsp. It is widespread throughout the central highlands of Papua New Guinea, occurring from Morobe Province in the east (Groves, 1982) to Mount Sisa, Southern Highlands Province in the west (e.g. AM M15723). Mount Sisa lies approximately 150 km east of Telefomin, which is the easternmost known occurrence of *D. d. stellarum* n.subsp. The consistent shape and size difference between the skulls of these subspecies (see Fig.7; Description above), and the distinctive morphology of *D. d. stellarum* n.subsp. (see Diagnosis and Description) suggest that they do not intergrade, but that perhaps their ranges are separated or abut. *Dendrolagus dorianus stellarum* n.subsp. is only known from altitudes in excess of 2,800 m, while *D. d. notatus* can be found below 1,000 m in the Mount Sisa area where altitudinal zones are depressed. It may well be that the Hak/Om low point on the Central Cordillera at 4°55'S 131°45'E (see Zoogeography **in** Discussion) acts as a barrier separating these subspecies.

Dendrolagus dorianus mayeri is known from a single specimen collected on the Wondiwoi Peninsula, which juts into Geelvinck Bay, 450 km to the west of the Star Mountains. This subspecies is morphologically the closest of named subspecies to *D. d. stellarum* n.subsp., both sharing small size and possessing bright yellow or ochre tails. However, they differ in cranial morphology, size and pelage colouration. The similarities between *D. d. stellarum* n.subsp. and *D. d. mayeri* are surprising as the Wondiwoi Peninsula is not part of the Central Cordillera, and is separated from it by several very low lying regions, including the Lake Jamur area and the Wissel Lakes. These landforms must be effective barriers for montane species such as *D. dorianus*. There are no records of living tree kangaroos from the Central Cordillera to the west of the Star Mountains despite intensive mammal collecting (e.g. see Archbold, Rand & Brass, 1942). The westernmost record for a living animal is that from Ok Bon, Mount Antares, in the Star Mountains (Groves, 1982) which is represented only by a skin held in the Leyden Museum. A description supplied by Groves suggests that it is almost certainly *D. d. stellarum* n.subsp.

Hope (1976) records a subfossil fragment referred to *D. dorianus* from Mapala rockshelter, Mount Carstenz (at 3,996 m) which is probably about 5,000 years old. The maxillary fragment (AM F54777) represents a small animal, closest in size among material examined by us to *D. d. stellarum* n.subsp., and it probably represents that subspecies. If *D. d. stellarum* n.subsp. has, as this very limited data may suggest, become extinct throughout most of Irian Jaya during the Holocene, then fears must be held for its continued existence in the Star Mountains area. Its range as currently understood covers only 90 km along the Central Cordillera from Mount Antares in the West to the Telefomin area in the East. Figure 8 shows our estimate of its distribution in Papua New Guinea. This figure is based upon extensive questioning of local peoples throughout the region and our own hunting results, and we are confident of its accuracy. In the Telefomin area, the species is absent from much apparently suitable habitat, which is almost certainly due to overhunting. Indeed, it seems to have been hunted out from all regions less than a full days walk from major settlements in our study area. Even in more remote regions it is rare. For example, two weeks of fieldwork in the upper Sol River Valley (which has a reputation among Telefol as a good place for finding the species) employing renowned tree kangaroo hunters, resulted in the capture of only a single specimen. However, it is currently common in the Dokfuma area of the Star Mountains, the most remote and rarely visited of sampling sites in our region.

A final point regarding its distribution needs to be made, for this species is absent from the Drei Zinnen Range of the study area. Although seemingly suitable habitat, its absence from this range may be due to lack of high-altitude access from the Central Cordillera (Fig.2).

Telefol respect many restrictions regarding the consumption of *Dendrolagus dorianus*. In general, only the most senior males are allowed to consume it. This was brought to our attention when AM M17790 was caught. Although several adult men were present at our camp in the Sol River when the animal was brought in, only one old Councillor was considered senior enough to eat it, the remainder of the meat being carried down the mountain to be consumed by three or four senior men at Telefolip.

Dendrolagus goodfellowi buergersi (Goodfellow's Tree-kangaroo)

The distribution of *D. goodfellowi* was also mapped with some precision (Fig.8). As can be seen, it and *D. dorianus* are allopatric in the study area. This was a surprising find as further east these species are sympatric. The material reported upon here represents the westernmost occurrence of this species in New Guinea. It is restricted to altitudes above 1,000 m, and thus the Sepik forms a barrier to westwards expansion. Extensive questioning of Atbalmin informants (who had gathered at Munbil settlement for a health clinic) confirmed its absence from middle montane forest to the south of the Sepik. Curiously, however, several pieces of *bilas* (decorative material) incorporating tails examined by me indicate that it is present in the southwards-flowing Om River valley north of Telefomin. *Dendrolagus goodfellowi* from the study area are among the largest individuals of this species examined, being similar in size to *D. d. stellarum*. Further to the east, where *D. goodfellowi* and *D. dorianus* are sympatric, there is a marked size difference between the species.

As with *D. dorianus*, this species is sensitive to hunting pressure. We found it to be common at only one locality, Yominbip (1,000 m) in the Thurnwald Range. Here human population is low and declining and the species seems readily caught, even in the vicinity of Yominbip Village itself. Mianmin report that it is found high in the Thurnwald and Drei Zinnin Ranges, probably to the summit (about 2,600 m). Mianmin do not seem to respect any food taboos relating to this species.

Dorcopsis hageni (White-striped Dorcopsis)

As with *Echymipera rufescens* this species seems to be restricted to the August-Sepik floodplain in the study area. Here, however, it is abundant, numerous trophy skulls and

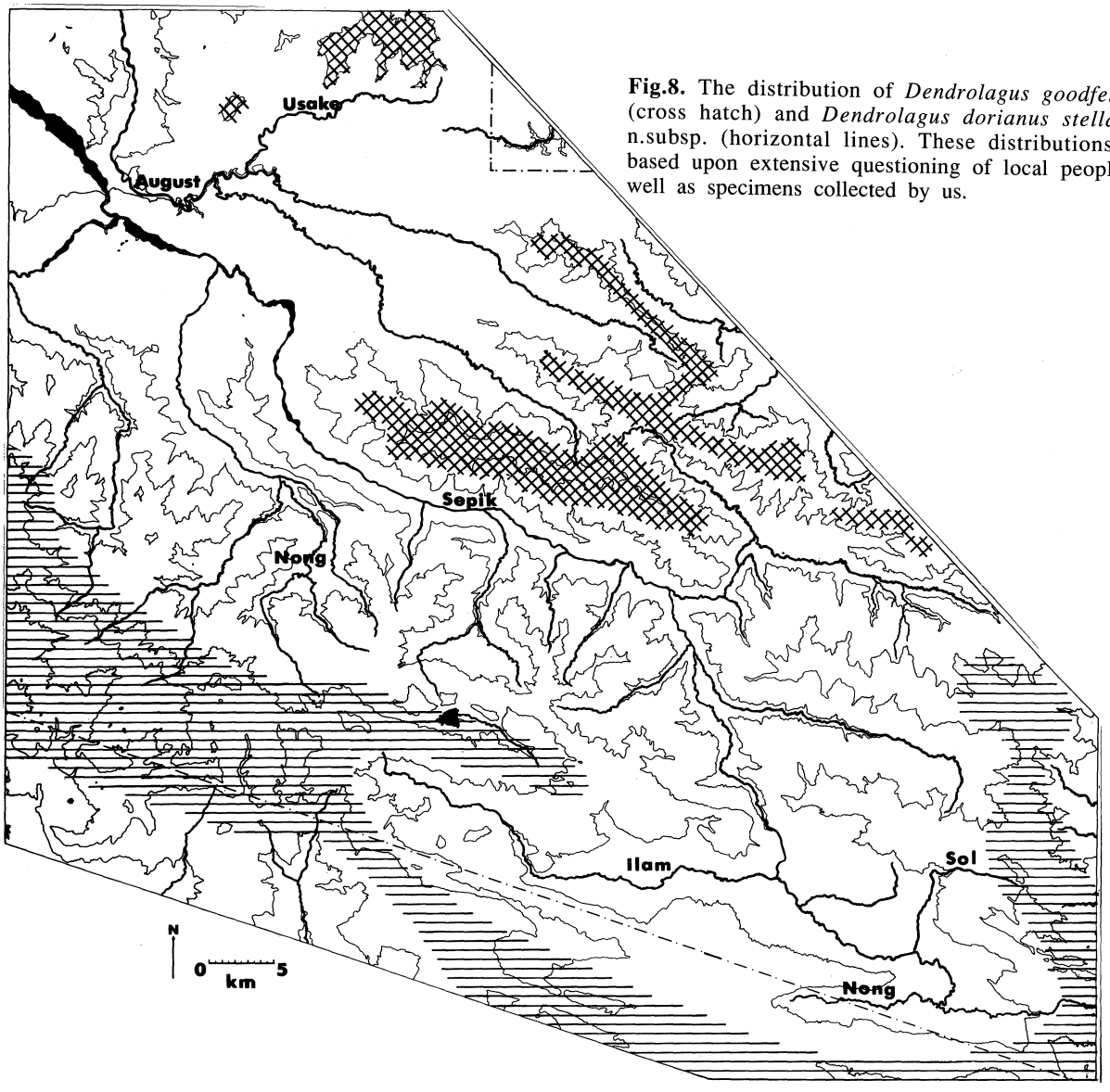

Fig.8. The distribution of *Dendrolagus goodfellowi* (cross hatch) and *Dendrolagus dorianus stellarum* n.subsp. (horizontal lines). These distributions are based upon extensive questioning of local people as well as specimens collected by us.

five whole animals being obtained during brief visits to the floodplain and its neighbouring villages. Extensive work in the low foothill and higher forest has failed to reveal its presence there. A number of Mianmin hunters suggested that two species of *Dorcopsis*-like animals were found on the floodplain. However, we found evidence of only one, which they indicated was the larger of the two 'folk taxa'. *Dorcopsis hageni* may represent an important source of protein for Mianmin who live in villages bordering the floodplain. It is abundant, and is often caught on shingle-banks along the August River, where the Mianmin say it comes to find insects under the shingles.

Dorcopsulus vanheurni (Small Dorcopsis)

All six *Dorcopsulus vanheurni* collected during this study were taken at altitudes of 1,000 m and above, and according to Mianmin informants, 1,000 m is the approximate lower limit of its distribution in the study area. It appears to be common in montane forests between 1,300 and 2,300 m, and may extend to higher elevations, as the foot bones of a small macropodid (probably this species) were found in wild dog droppings at Dokfuma (3,200 m). Wallaby drives are held by Telefol, and informants have related to us that during a drought in the early 1980's a large section of the primary Oak Forest on the south side of the Nong River valley was set alight and approximately 400 *D. vanheurni* were caught as they fled before the flames.

Thylogale brunii (Dusky Pademelon)

This species is rare in the study area and we obtained only a single freshly-caught specimen in foothill forest near Kyemana Village (about 600 m). Trophies were also collected, mostly from villages with access to forest in the 500 to 1,000 m range. This species is unknown in the Telefomin Valley, and is absent also from the higher peaks of the Central Cordillera as well as the Sepik floodplain. No droppings or other sign of this species were found in the Dokfuma herbfield, although in my experience such signs are abundant where the species exists in subalpine grassland in eastern New Guinea. Within the study area, it is often found in primary forest, but Mianmin have mentioned to me that it is most commonly encountered in areas of old landslips where vegetation is regrowing.

Phalangeridae

Spilocuscus maculatus (Spotted Cuscus)

The Spotted Cuscus is not common in this region. Our work resulted in the capture of only a single animal, from Kyemana Village (altitude 600 m) in the Betavip area. However, a number of trophy skulls were collected in the Yapsiei, Betavip and Yominbip areas. The Yominbip area (altitude 1,000 m) may represent the upper altitudinal limit of this species in the study area. The rarity of this species in the study area was unexpected and we cannot account for it. Elsewhere it is much more common and widespread than *S. rufoniger*.

Spilocuscus rufoniger (Black-spotted Cuscus)

Specimens of this rare species were collected at 120 m on the August River Floodplain north of Yapsiei, at Kyemana Village (600 m), and on Mount Bubiari (1,200 m, probably its upper altitudinal limit in the study area). It was always encountered in primary forest. This species is sensitive to overexploitation by the use of shotguns (Flannery, 1990). However, as long as access to cartridges is limited in the Yapsiei area, and cultivation does not become too extensive, this species should continue to survive there.

Strigocuscus gymnotis (Ground Cuscus)

The Ground Cuscus was the most commonly encountered phalangerid in the study area. It was also the most commonly represented animal in trophy collections. We did not encounter it on the August-Sepik floodplain, but found it as low as 300 m in foothill forest in the Betavip area. It was most common at altitudes of around 800 to 1,300 m, but remained as a less common element of the fauna to altitudes as high as 2,600 m. Specimens from above 1,800 m are conspicuously smaller than those from lower altitudes. They usually have denser fur and a light tail tip, features lacking in lower altitude specimens. Considering its abundance, broad distribution, large size, and susceptibility to indigenous hunting techniques it is likely that for the Mianmin at least, this species forms the most important mammalian portion of their diet. It is commonly hunted by day using dogs, but is also smoked out of burrows and shot at night.

Phalanger orientalis (Common Cuscus)

Phalanger orientalis is the most commonly-encountered phalangerid in disturbed forest in the vicinity of villages in the study area. It is also, however, found in primary forest. Records are from as low as 120 m on the August floodplain, andas high as 1,500 to 1,600 m in the Thurnwald Range, although it probably extends higher there. It was also encountered in the floor of the Telefomin Valley at about 1,500 m, but not in the Nong River Valley at the same altitude. While the Nong River Valley is largely undisturbed Oak Forest the Telefomin Valley is a mosaic of grassland and disturbed forest. This may account for the differing altitudinal limits of this species in the two areas. In the Thurnwald Range, *P. sericeus* and probably *P. carmelitae* are absent, possibly allowing *P. orientalis* to reach higher altitudes there than elsewhere.

Because of its occurrence in disturbed habitats, particularly around villages and in old gardens, this species may be an important prey item for those who do not travel far to hunt (i.e. women).

Phalanger matanim (Telefomin Cuscus)

Only four specimens of this newly-described *Phalanger* (Flannery, 1987) were collected during our study. One was from Oak Forest in the Nong River Valley (1,500 m), two from Tifalmin (1,600–1,800 m), and a further specimen from the upper Sol River Valley (2,600 m). This is a rare species, but is favoured by Telefol as a food item because of its subcutaneous fat.

Phalanger vestitus (Stein's Cuscus)

This species was found at only four localities during the present study. A single trophy skull was collected at Yominbip in the Thurnwald Range, two animals were obtained at Ofektaman in the Telefomin Valley (1,400–1,600 m), two at Tifalmin (about 1,600 m), and eight were collected in the Nong River Valley (1,500 m). At the last-mentioned locality, *P. vestitus* was the most commonly-caught large mammal.

It seems that this species is susceptible to habitat disturbance. Older Telefol men have informed me that it was common in the Telefomin Valley itself in their youth, but has declined as clearing and gardening increased with the coming of European technology. Today, the species is rare if it occurs in the main part of the valley at all. It is restricted altitudinally, probably being found only in primary forest at between 1,400 and 1,600 m in the study area.

Phalanger carmelitae (Mountain Cuscus)

This species appears to be uncommon in the study area, with only seven specimens being collected. One each were obtained in the Nong River Valley at 1,500 m, and Ofektaman (1,400–1,800 m), and three at Tifalmin (1,600–2,000 m) and two at Finimterr (2,200–2,400 m). Extensive collecting at 2,200 m and above in the Sol River Valley failed to reveal its presence there, which is curious, for in our small samples from Finimterr and Tifalmin (both relatively high altitude areas) it outnumbered the other *Phalanger* species. Tifalmin and possibly Finimterr are drier than other parts of the study area, and resultant vegetational differences may favour this species over *P. sericeus*. As with *P. matanim*, this species is prized for its subcutaneous fat deposits by Telefol.

Phalanger sericeus (Silky Cuscus)

The Silky Cuscus is abundant at altitudes in excess of 2,200 m along the Central Cordillera in the study area. It is also found as low as 1,500 m in the Nong River Valley, where there is much primary forest. Here, however, it is rare. It is certainly absent at similar altitudes in the more disturbed Telefomin Valley. Above 2,200 m in the Sol River Valley it is by far the most commonly caught phalangerid.

It is concluded that this species is absent from the Thurnwald and Drei Zinnen Ranges for the following reasons. Through an east Mianmin interpreter (who was familiar with the species) we were able to question a large number of west Mianmin inhabitants of both the Thurnwald and Drei Zinnen Ranges regarding this species. All indicated that it did not exist in their area, although a few were familiar with it from visits to the Atbalmin or east Mianmin areas. In addition, no trophy material of this species came to light in the collections we made in this region. The absence of this species from the Drei Zinnen and Thurnwald Ranges is curious, and probably the same factors that account for the absence of *D. dorianus* from the area apply to this species also.

Pseudocheiridae

Pseudocheirus mayeri (Pigmy Ringtail)

This species was found only on the higher parts of the Central Cordillera within the study area. A specimen from Ofektamen may have come from as low as 1,800 m, but elsewhere the species was found at higher altitudes (Miptigin 2,000 m, Sol River Valley 2,200–2,800 m). A dentary fragment was also found in a wild dog dropping at Dokfuma (3,200 m). Between 2,200 and 3,000 m it can be locally abundant. This species is too small to be an object for trophy collection.

Pseudocheirus forbesi (Painted Ringtail)

The Painted Ringtail is an extremely common animal in the area of the Telefomin and Tifalmin Valleys. Here, and possibly in the Thurnwald Range (based on questioning of local people), it probably occurs as low as 1,300 m. It extends as high as 2,300 m in the Sol River Valley, but at these altitudes it is rare. This species seems to be able to exist in small patches of secondary regrowth, and during our work it was regularly caught in such areas in the Telefomin Valley. It is also common in primary forest within its altitudinal range.

Pseudocheirops corinnae (Plush-coated Ringtail)

This species seems to be present only within a very restricted altitudinal range, at about 1,800 to 2,200 m, and even here it is not common. A few specimens were brought in at the Sol River locality, but they seemed to come from the lower part of the valley (2,200–2,300 m). It is certainly absent from altitudes below 1,600 m, as

extensive work in the Telefomin and Nong River Valleys failed to reveal its presence there.

Pseudocheirops cupreus (Coppery Ringtail)

This species has a curious distribution in the study area. Along the Central Cordillera we encountered it only at altitudes in excess of 2,300 m in the Sol River Valley and above 2,200 m at Tifalmin. At these altitudes, however, it was the most abundantly caught large game mammal. Limited work at slightly lower altitudes (Miptigin 2,000 m, Ofektaman 1,400–1,800 m) failed to reveal its presence there, so it is probably limited to the higher altitude areas of the Central Cordillera. However, this species is present in the isolated Thurnwald Range (Fig.2), where two specimens were captured at 1,800 to 2,000 m. As this species seems to have an even more restricted altitudinal distribution along the Central Cordillera than *P. sericeus*, its presence in the Thurnwald Range comes as a surprise. We have no explanation for this distribution at present.

Because it is so common and easily obtained, this species is probably an important element in the Telefol and Tifal diets. Its large numbers in the only trophy collection examined at Telefomin supports this hypothesis.

Acrobatidae

Distoechurus pennatus (Feathertail Possum)

Only three specimens of this species were obtained during our study. One was taken in a small tree in Ebolio Village (160 m), a second in a garden along the Sepik (120 m), and a third in the environs of Yominbip Village (1,000 m). It is probably absent at altitudes in excess of 1,000 m as extensive work in the Telefomin Valley has failed to reveal its presence there. This species was not encountered in primary forest, and seems to be primarily an inhabitant of gardens and disturbed areas. Hyde *et al.* (1984) also record it most often from such habitats on Mount Karimui.

Burramyidae

Cercartetus caudatus (Long-tailed Pigmy Possum)

The Long-tailed Pigmy Possum is most common at altitudes of above 2,000 m in the study area (i.e. Miptigin, upper Sol River Valley), but was also found at Ofektaman (1,400–1,800 m) and the Nong River Valley (1,500 m). A single specimen was taken in the Dokfuma herbfield (3,200 m) in a snap trap. It was encountered both in disturbed habitats and primary forest.

Petauridae

Petaurus breviceps (Sugar Glider)

The Sugar Glider was found in a wide variety of habitats, from the Betavip area (200 m) to the upper Sol River Valley (2,300 m). Curiously, we found no evidence of it in the Telefomin and Nong River Valleys (1,500 m) although it was common in the Tifalmin Valley. The animals collected at Ofektaman and the Sol River localities belong to the subspecies *tafa*, and are darker and smaller than animals from lower altitudes. They may yet prove to represent a distinct species.

Because it is small and agile, this species is difficult to hunt, and is probably only rarely consumed (although often heard and seen) by the local people.

Dactylopsila trivirgata (Striped Possum)

The Striped Possum is represented in our collection by two trophy skulls and two young. The young were taken in the Tifalmin Valley (1,400 m), while one of the trophies was purchased at Yapsiei Station and the other at Yominbip. In addition I observed an animal at about 200 m altitude in the Betavip area during spotlighting, but did not collect it. Informants said that this species was common in the Yominbip area, and thus its small size may account for its rarity in trophy collections. The upper altitudinal limit of this species in the study area may be between 1,300 and 1,500 m as there was no evidence of it at Telefomin (1,500 m), the Nong River (1,500 m) or Ofektaman (1,400–1,800m).

Dactylopsila megalura (Great-tailed Triok)

This species is represented in our collections only by the skins of a female and two well-grown young collected at Tifalmin (1,600–1,800 m), and a tail collected at Ofektaman (1,400–1,800 m). All of these specimens were retained as *bilas* by Telefol and Tifal. This species is rare in the study area and probably occurs only above 1,400 m. It is avidly sought after for *bilas*. Telefol informants report that this species exists sympatrically with *D. palpator*. Unfortunately the habits of this species are so incompletely known that the nature of the niche separation that must exist between these species is unknown.

Dactylopsila palpator (Long-fingered Triok)

Only six specimens were collected, two at 1,500 m in the Nong River Valley and four at Tifalmin (about 1,800–2,000 m). However, the species is almost certainly more widespread than this, as informants knew of it from the Sol River Valley and even the Telefomin Valley. Again, this species is prized for use as *bilas*.

Rodentia

Muridae

Hydromys chrysogaster (Common Water Rat)

This water rat is widely distributed along the rivers and creeks of the region, up to an altitude of at least 1,000 m. We obtained two specimens in the Betavip area (where it appears to be common) and a single individual (dug out of a burrow) at Yominbip (1,000 m). Telefol informants were familiar with a water rat that inhabits the Telefomin Valley (1,500 m), but we could not determine which species it represented.

Paraleptomys wilhelmina (Short-haired Hydromyine)

A single specimen was caught in a rat trap baited with sweet potato in the Tifalmin Valley at 1,800 m.

Pogonomys macrourus (Chestnut Tree-mouse)

This species seems to be patchily distributed, and where it does occur, is restricted to the altitudinal range about 900 to 1,500 m. It is abundant at Munbil in the Star Mountains (900–1,000 m) where 24 specimens were obtained, and rarer at Yominbip (1,000 m; 2 specimens), the Telefomin Valley (1,400 m; 1 specimen), and the Nong River Valley (1,500 m; 3 specimens). Most animals were obtained by women who dug them out of their burrows, although some were collected at night from trees. Although its lower altitudinal limit in the study area is uncertain (we did little collecting between 400 and 900 m), its upper limit is about 1,500 m, as extensive collecting above this altitude failed to reveal its presence there.

Pogonomys championi (Telefomin Tree-mouse)

Pogonomys championi is a small, grey-bellied *Pogonomys*, related to *P. macrurus* or *P. sylvestris*, that has only recently been described (Flannery, 1988). It was encountered at three localities in the study area. Twenty one specimens were obtained at Ofektaman (1,400 m), one individual was caught in the upper Sol River Valley (2,300 m), and many were obtained at Tifalmin (about 1,800 m). Most if not all of the Ofektaman and Tifalmin animals were dug from burrows by women, while the Sol River animal was taken from a tree at night.

Mallomys rothschildi (Black-eared Giant Rat)

This species seems to be relatively common in the primary forest of the Nong River Valley (1,500 m), and at higher altitudes elsewhere along the Central Cordillera. It is represented in our collections by six individuals, two shot at night, three taken from tree hollows and one (a juvenile) from a cave.

Mallomys rothschildi is a restricted food to the Telefol, being eaten only by women. This custom is still strongly adhered to. Men will not go out of their way to obtain this species, but if one is incidentally encountered they will attempt to capture it to give to a female family member.

Mallomys aroaensis (Grey Black-eared Giant Rat)

A single subadult male was collected at 1,600 to 1,800 m at Tifalmin — it was shot at night. *Mallomys rothschildi* was captured on the same night by the same hunter.

Hyomys goliath (White-eared Giant Rat)

The White-eared Giant Rat is uncommon in the study area. Only three specimens were obtained: a mother and young at Ofektaman (1,400–1,800 m) and a second female at Tifalmin (about 1,800 m). This species is subject to the same food restrictions as *M. rothschildi* by Telefol.

Anisomys imitator (Uneven-toothed Rat)

A specimen was captured in the upper Sol River Valley (2,300 m) in February 1984, and a second at Tifalmin in 1987. It is probably rare locally and is not a restricted food. Telefol informants indicate that this species is sometimes caught by wrapping a frayed plastic sack around the trunk of a fruiting *Pandanus*. This entangles the animal's hands and feet as it climbs the tree.

Uromys caudimaculatus (Giant Mosaic-tailed Rat)

This is the most common large murid below 1,500 m in the study area. At about 1,500 m both this species and *U. anak* were caught in the Nong River Valley. Among Mianmin the teeth of this species are prized as engravers. In their area it is often caught by waiting in ambush beside a fruiting tree.

Uromys anak (Black-tailed Giant Rat)

A single specimen (a subadult female) was collected in the Nong River Valley in July 1985 and a further two at Tifalmin in 1987. It seems to be rare in the study area, and was not subject to any food taboos.

Lorentzimys nouhuysii (Long-footed Tree-mouse)

This species was common at between 2,000 and

2,600 m in the Sol River Valley, with nine specimens caught, and a further two specimens were taken at Ofektaman. Because of its small size it is probably of little more than snack value to local people. Its main habitat seems to be primary forest, and nests containing several individuals were encountered among epiphytes and between rocks.

Xenuromys barbatus (Giant Rock Rat)

This rare murid is represented in our collections by three whole specimens and six pairs of dentaries. All were collected in the Yapsiei-Betavip and Mount Bubiari areas in January 1984 and April 1986. The three whole specimens were all located in lairs in rockpiles in primary forest at between 400 and 1,300 m altitude. The dentaries of both this species and *U. caudimaculatus* are valued for use as engraving tools. Dogs are often used to locate this species.

Pogonomelomys ruemmleri (Ruemmler's Pogonomelomys)

One specimen of this small murid was collected at 2,600 m in the upper Sol River Valley. It was located it the crown of a *Pandanus*. A second specimen was taken in a rat trap at Dokfuma on the herbfield margin at 3,200 m. This species seems to be restricted to upper montane forest and herbfields in the study area.

Pogonomelomys sevia (Highland Pogonomelomys)

A single individual was collected at Ofektaman (1,400-1,800 m). This represents the westernmost record for this species.

Pogonomelomys mayeri (Shaw Mayer's Pogonomelomys)

A female and two thinly-furred young were collected from the crown of a *Pandanus* in a patch of disturbed forest in the Telefomin Valley at about 1,300 m in April 1986 and a second female from a tree hollow in the Tifalmin Valley (about 1,400 m) in April 1987. All three *Pogonomelomys* species seem to be rare in the study area and are probably of little economic importance to the Ok peoples.

Melomys lanosus (Large-scaled Melomys)

Four specimens were collected in the upper Sol River Valley at 2,300 m, a single specimen at Miptigin (2,000 m) and a further 11 at Tifalmin (about 1,800 m). All were caught in primary mossy forest. This murid is a favoured food item, and its consumption is not subject to food restrictions by Telefol.

Melomys rattoides (Beautiful Melomys)

This species has a very restricted altitudinal distribution, but can be abundant where it occurs. Within the study area we recorded it at 900 m at Munbil (two specimens) and 1,000 m at Yominbip (15 specimens). At Yominbip it was the most commonly caught murid, and was obtained by snap-trapping and the excavation of burrows. Most specimens came from primary forest. The species is greatly favoured as a food item at Yominbip because of its abundance and relatively large size (about 200g). Both the localities that yielded this species are at about 900 to 1,000 m altitude, and extensive trapping at both 200 m and 1,500 m failed to reveal its presence higher or lower. People living at these latter altitudes were unfamiliar with it, and thus it appears to have a patchy and limited distribution.

Melomys rubex (Mountain Melomys)

This species was widespread and common at most localities in excess of 1,000 m and up to 2,800 m. However, it was not found at lower stations. Because of its small size this species is probably of little economic importance.

Melomys sp.

Six specimens of a large, dark coloured *Melomys* were trapped near the margin of the Dokfuma herbfield (3,200 m), most in relatively open situations. Although close to *M. rubex* in cranial morphology, their status is currently uncertain.

Melomys rufescens (Black-tailed Melomys)

This species was encountered at most collecting stations at altitudes below 1,500 m, and was most often found in very disturbed environments. Indeed, it was often captured in village environs, even living in the thatch roofs of huts. It is common in the extensive grasslands of the Telefomin Valley. However, we obtained no records from primary forest. Curiously, it did not appear to be looked upon with enthusiasm as a food item.

Melomys platyops (Lowland Melomys)

This species was encountered only below about 300 m in the study area. There, however, it was common. It is certainly not present at altitudes in excess of 1,000 m, as extensive work there failed to reveal its presence. It was present in both primary and disturbed habitats.

Rattus niobe arrogans (Moss Forest Rat)

Nineteen individuals of this distinctive taxon were taken in rat traps set in the subalpine herbfield at Dokfuma, Star Mountains at 3,200 m. Its heavier weight, (R = 45–59, M = 50.0, N = 14 as opposed to R = 34.5–50, M = 42.3, N = 9) and more rufescent colouration make it readily distinguishable from *R. n. pococki.*

Rattus niobe pococki (Moss Forest Rat)

Specimens of this small and very black subspecies of *R. niobe* were taken at 1,800 m at Tifalmin, and between 2,300 and 2,600 m in the Sol River Valley. This taxon appears to be uniform in morphology throughout its altitudinal range, and I could find no evidence of it intergrading into *R. n. arrogans.* Indeed, *R. n. arrogans* probably replaces *R. n. pococki* at between 2,600 and 3,200 m in the study area. This distribution pattern is more suggestive of species than subspecies, and it is likely that future study will show that these two taxa are distinct species.

Rattus sp. cf ***R. niobe***

Three specimens of a *Rattus niobe*-like species were collected (2 at Yominbip, 1,000 m and 1 at Ofektaman 1,400 m). The fur is slightly spinous, the tail uniformly black, and the molars small and relatively simple. The molars in particular are reminiscent of *Rattus praetor.* However, based on dental wear and the proportions of the hindfoot, the specimens are not juvenile *R. praetor.* These rats are just slightly larger than *R. n. arrogans* (head-body length = 126.8–138.8, N = 2 as opposed to 99–120, N = 14). Further revision of the small *Rattus* species of montane New Guinea is clearly necessary.

Rattus verecundus (Slender Rat)

A single specimen of this species, similar in morphology to the subspecies *unicolour*, was trapped at 2,600 m in the Sol River Valley in April 1986.

Rattus steini (Small Spiny Rat)

This is by far the most abundant murid in the study area, and was collected at most stations from 120 to 2,300 m. It was usually trapped in disturbed habitats, and in some areas (e.g. grassland around Telefomin, gardens at Munbil), it was present in plague proportions. However, it was rarely trapped in primary forest.

In the past this species was often eaten by women, but at least among Telefol this practice is falling into disuse, possibly because the rats are foul smelling and display what the Telefol consider to be disgusting habits, and because store bought protein is readily available.

Rattus praetor (Large Spiny Rat)

This species was encountered at Munbil (900 m), and the Yapsiei/Betavip area (200–300 m), where it exists sympatrically with *R. steini.* Both *R. steini* and *R. praetor* seem to be regularly encountered by women while gardening. This species is difficult to distinguish from *R. steini* in the field, and these species are not differentiated in the Atbal and Mian languages.

Megachiroptera

Pteropodidae

Rousettus amplexicaudatus (Rousette Bat)

This species was only encountered in the Yapsiei-Betavip area (200–300 m), where it was very common. Extensive mistnetting failed to reveal its presence at higher altitudes. It appears to breed seasonally in the Yapsiei area, with births in February-March (Flannery, 1990). Despite its abundance, this species is difficult to obtain by any method except mistnetting, and so is rarely obtained by Mianmin.

Pteropus neohibernicus (Greater Flying Fox)

This is the largest of the New Guinean Chiroptera, and as such is a desirable prey item. By day it forms large camps in swampy parts of the August-Sepik floodplain. At night the bats disperse into the foothill forest to altitudes up to 1,000 m. During January 1984 these bats were commonly seen in hill forest in the Yapsiei-Betavip area, but they were not observed in this area in April 1986. Their abundance is doubtless related to the fruiting of forest trees, and thus they are probably an intermittently available food source.

Dobsonia moluccensis (Bare-backed Fruit Bat)

The Bare-backed Fruit Bat was found at virtually all localities visited, except the upper Sol River Valley. Large congregations of this species exist in caves in the valley of the Nong River, and doubtless it is common in other suitable caves in the region. Because it can be found in large numbers and can be readily harvested, Telefol and Mianmin will travel considerable distances to the caves where it exists to trap it. Hundreds of animals are often captured, which must contribute considerably to the diet of the local people at such times. The roosts of this species on Mount Bubiari receive partial protection from a Mianmin belief that the discharging of shotguns in the

caverns inhabited by the bats will incur the displeasure of spirits.

Dobsonia minor (Lesser Bare-backed Fruit Bat)

The altitudinal distribution of this species coincides with that of *Rousettus amplexicaudatus*, being collected only in the Yapsiei-Betavip area below 300 m. It is less common than *R. amplexicaudatus*, however, and seems to be most often caught in mistnets set along overgrown creeks.

Nyctimene cyclotis (Round-eared Tube-nosed Bat)

A single specimen belonging to the subspecies *M. c. certans* was taken at 2,300 m in a mistnet set in a garden in the upper Sol River Valley. This species may represent the Telefol folk taxon *Brulim*. *Brulim* is held in great superstitious dread by most Telefol. It is considered extremely ill fortune to kill one, it being widely accepted that the hunter will die within 48 hours of such an act. Because of this it was not possible to check the species identification with Telefol informants. However, in most particulars this species fitted descriptions of *Brulim* given by several Telefol.

Nyctimene albiventer (Common Tube-nosed Bat)

This species was abundant at all collecting stations from 120 m to 1,000 m. However, it was not taken at stations above this altitude, even though intensive netting was carried out there. The specimens collected by us are highly variable, and more than one biological species may be involved. This and the other small, non-cave dwelling bats of the region are probably of little economic importance to the Ok peoples as they are not readily captured using traditional techniques.

Nyctimene aello (Greater Tube-nosed Bat)

Four specimens were taken in the Yapsiei-Betavip area during April 1986. All three females were lactating. As with *Rousettus amplexicaudatus* and *Dobsonia minor*, this species does not seem to occur at altitudes higher than about 300 m in the study area.

Paranyctimene raptor (Unstriped Tube-nosed Bat)

This species was common at Betavip (200 m, 7 specimens) and present at Munbil (900 m, 3 specimens) but was not taken at Yominbip (1,000 m) or localities at higher altitudes.

Macroglossus minimus (Northern Blossom Bat)

This blossom bat was commonly caught at collecting stations at altitudes from 160 to 1,000 m, and was as common relative to *Syconycteris australis* at higher as at lower stations. It was usually about one sixth as common as *S. australis* (Betavip area 200 m 5.5:1, Munbil 900 m 6.3:1, Yominbip 1000 m 2.3:1). Zeigler (1982) reports that elsewhere in New Guinea it is much more common relative to *S. australis* at 200 m than at 1,000 m.

Syconycteris hobbit (Moss Forest Blossom Bat)

A single specimen was taken at 2,300 m in the upper Sol River Valley. This species was previously known only from Mount Kaindi, Morobe Province (Zeigler, 1982). At both localities it is sympatric with *S. australis*.

Syconycteris australis (Common Blossom Bat)

This was the most widespread and abundantly-caught mammal during our study. However, all specimens were taken from mistnets, and the species is only rarely captured by Ok peoples. It was present at all collecting stations where mistnets were erected, except at Dokfuma (3,200 m) with up to ten specimens being taken per night. Some variation with altitude was noticed, with specimens from higher altitudes being more sombre in colouration.

Microchiroptera

Vespertilionidae

Nyctophilus microtis (Small-eared Nyctophilus)

Two specimens (one of which escaped) were trapped in mistnets set in a clearing in primary forest near Betavip (200m).

Pipistrellus collinus (Mountain Pipistrelle)

A single individual was taken in a mistnet set in a garden in the upper Sol River Valley (2,300 m).

Kerivoula muscina (Fly River Trumpet-eared Bat)

Three individuals were taken from a rolled banana leaf at 1,600 m at Tifalmin. Others were present but escaped.

Miniopterus australis (Little Bentwinged Bat)

Twelve specimens were obtained in a cave situated

approximately 1 km north-west of the northern end of the Telefomin airstrip (1,500 m). The cave was large, open, and easy of access. *Miniopterus macrocneme* was also present. All cavernicolous bats whose colonies are accessible are harvested by Telefol and Tifal for food.

Miniopterus sp.

A single specimen of a large *Miniopterus macrocneme*-like species was taken in a mistnet at 3,200 m in the Star Mountains at Dokfuma. The forearm is larger than typical *macrocneme* from lower altitudes (see Table 6) and for this reason it is treated separately here.

Miniopterus macrocneme (Small Melanesian Bentwinged Bat)

This is the most abundant and widespread of the *Miniopterus* species in the study area. It was encountered in numerous caves, ranging in altitude from 1,400 to 2,600 m. The caves were usually large and relatively open, and were often dry. A sandstone cleft containing only this species was located at 2,600 m near the head of the Sol River Valley. Much of the cleft was in the twilight zone, and when visited in the late morning the bats were torpid. Torpid bats were also located in a large cave in the Nong River Valley at 1,500 m. Caves sheltering *M. macrocneme* were in one case also home to *M. australis*, and in another to *M. magnater*.

Miniopterus medius (Javan Bentwinged Bat)

A single specimen of a bat similar in size to that reported as *M. medius* from the Wau area by Hill (1983) was found roosting in a shallow limestone cave at 1,340 m near Tifalmin. The same cave also sheltered *Hipposideros cervinus* and *Emballonura beccarii*. A small solution tube at the end of the cave was the only area out of the twilight zone. Measurements for the *M. medius* specimen are given in Table 6.

Miniopterus magnater (Western Bentwinged Bat)

Eleven specimens of this large *Miniopterus* were found roosting in large caves in the Nong River Valley and Miptigin ridge (1,500 m and 2,000 m respectively). In one case the caves were shared with the more abundant *M. macrocneme*. Measurements are given in Table 6.

Hipposideridae

Hipposideros ater (Dusky Horseshoe Bat)

A single specimen was taken from a limestone cave at about 1,600 m on the hill south of Tifalmin in April 1987.

Hipposideros corynophyllus (Telefomin Horseshoe Bat)

This species was known previously from a single specimen collected near Telefomin. In July 1985 T.F. Flannery collected a second specimen in the Nong River Valley, which was roosting in a limestone cave with *H. wollastoni* at 1,500 m. During our survey of the Tifalmin area in April 1987 this species was found to be common in caves on hills both to the north and south of Tifalmin, between 1,600 m and 1,800 m. It was often found in association with *H. wollastoni*.

Hipposideros wollastoni (Wollaston's Horseshoe Bat)

This species is widespread and common in the survey area. We encountered it at Telefomin (1,400 m), the Nong River Valley (1,500 m), Miptigin ridge (2,000 m), and Tifalmin at (1,600–1,800 m). It was usually encountered in the deeper and wetter caves, which it often shared with *H. corynophyllus*. Drier and more open caves were usually inhabited by species of *Miniopterus* and *Emballonura*.

Hipposideros cervinus (Fawn Horseshoe Bat)

Only four specimens of this species were taken during our survey. Three were found in a shallow cave at 1,340 m near Tifalmin, while a third was taken in a mistnet set in a clearing in primary forest near Betavip at 200 m.

Hipposideros diadema (Diadem Horseshoe Bat)

A single specimen was shot with a bow and arrow while it was roosting in a low tree near the August River, half way between Yapsiei and Betavip (altitude 200 m), in January 1984.

Rhinolophidae

Rhinolophus arcuatus (Western Horseshoe Bat)

A single specimen was taken from a cave to the north of Tifalmin at about 1,500 m and a further four from west of Tifalmin. The Australian Museum also holds nine specimens collected in 1956 by D. McMichael, at a cave 1.6 km north of Telefomin. These had previously been misidentified as *R. megaphyllus*. It is probable that they are from the same cave (or a nearby one) as the type specimens of *R. a. mcintyrei* Hill & Schlitter, 1986.

Emballonuridae

Emballonura beccarii (Beccari's Sheathtail Bat)

Twenty four individuals were taken from a limestone cave situated at about 1,300 m on the south side of the Sepik River south of Bogalmin in May 1986. A further six specimens were collected in a cave at 1,340 m near Tifalmin in April 1987. Both males and females were represented in both of these collections.

Emballonura raffrayana (Raffray's Sheathtail Bat)

Two colonies were located, one in a shallow limestone cave on the north side of the Sepik River south of Telefolip at 1,280 m, and the second in a partially collapsed shale overhang near Yominbip at 900 m. At Telefomin only males (10) were caught while at Yominbip both males and females (16) were taken. Both caves were small and shallow, and were inhabited only by *E. raffrayana.*

Emballonura nigrescens (Lesser Sheathtail Bat)

This species was encountered both in the Yapsiei/ Betavip area, where it was commonly taken in mistnets at dusk, and at Yominbip, where a colony of six were found roosting on the underside of a leaf in a large tree left standing in a garden. It was often active around villages just before and at dusk, and the Mianmin name (Heba-Heba) means 'crowded together', a reference to its roosting habit.

Introduced Mammals

Sus scrofa (Pig)

Wild pigs are common at lower altitudes within the study area. They are abundant on the Yapsiei/Sepik floodplain, and in parts there is considerable disturbance to the forest understorey. At higher altitudes, however, wild pigs become less common. They are extremely rare if present at all in the Telefomin and Tifalmin Valleys, and curiously, are absent altogether in the subalpine grasslands of the Star Mountains. Similar grasslands on Mount Albert Edward, Central Province, support a large feral pig population (personal observation). The domestic pig population in the study area is not large compared to that sometimes seen in the central highlands, possibly due to the relatively small amount of sweet potato cultivation undertaken in the area. However, locally around villages in the Yapsiei area and in the Telefomin valley, understorey disturbance by domestic pigs can be severe.

Canis familiaris (Dog)

The only wild dog population encountered by us was in the subalpine grasslands at Dokfuma. Here dogs seemed plentiful, and Wopkaimin report taking puppies and domesticating them. Domestic dogs are present in most human communities. They are often used for hunting.

Felis catus (Cat)

Domestic and probably wild cats are present in the Telefomin Valley, but do not seem to be common. The spread of cats into more outlying settlements is still continuing, and we had the opportunity to do extensive fieldwork in Betavip Village both before and after the introduction of domestic cats. During 1984, extensive trapping and hunting was carried out around Betavip. When the area was again visited in 1986, a similar program was instituted. In the intervening period two cats had been introduced to Betavip, and some of the faunal differences that we observed are probably related to this. Changes included a drastic decline in the number of spiny bandicoots (*Echymipera* spp.) encountered (see species accounts), as well as a decline in *Rattus steini* and *Rattus praetor* in the immediate village environs. When questioned, Mianmin were well aware of these changes, and attributed them to the cats. The decline in *Rattus* numbers was applauded by the Mianmin, while the loss of bandicoots was regretted as they represented a valuable food resource. Elsewhere cats have been the cause of extinction of several small vertebrates (Diamond, 1982).

Muridae

Only one introduced murid species, *Mus musculus* (House Mouse), was encountered in the study area. It was abundant around settlements and particularly in stores in the Telefomin Valley, but was not seen elsewhere. Both *Rattus exulans* and *Rattus rattus* are unknown in the region, although *Rattus rattus* were obtained around gardens and houses at Bultem village near Tabubil, to the south of the study area. The absence of *Rattus exulans* is remarkable, as it seems to have penetrated into most other areas of human habitation within New Guinea.

Bos taurus (Cattle)

A few cattle exist in the vicinity of Telefomin Station. They are confined to anthropogenic grassland, and are in poor condition.

Discussion

Comprehensiveness of survey and comparison with 3rd Archbold Expedition. Our survey consisted of over six months in the field, with party size varying from

two to six. Although every effort was made to sample in all habitat types in the region, and mammal sampling was our primary goal, it is clear that many species that probably inhabit the region eluded us. Evidence that species exist in the area that we did not encounter comes from four major sources: 1) results of previous expeditions in the area; 2) comparisons with the results of the 3rd Archbold Expedition to the Mount Wilhelmina area, Irian Jaya; 3) folk taxonomies collected from Telefol and Mianmin, and 4) an analysis of known species distributions.

Previous collections. The only previous collections from our study area that include species not taken by us are those made by Abid Beg Mirza and others for the Bishop Museum, Hawaii in 1970 to 1971 and material collected by Dr D. Hyndman and reported upon by Hyndman & Menzies (1980). The British Museum collections include *Macruromys major* (one from Telefomin at 1,500 m), *Mayermys ellermani* (with one specimen taken at Feramin, 8 km south-east of Telefomin at 1,400 m), *Neohydromys fuscus* (at least one specimen from Lake Louise at 2,600 m), *Micromyonomys richardsoni* (one from Telefomin at 1,500 m) and *Pseudohydromys occidentalis* (Lake Louise, 2,600 and 2,800 m).

The Hyndman material includes the only non-fossil remains of *Aproteles bulmerae* known. Although searched for by us at its previously known haunt, no animals were encountered.

Comparisons with 3rd Archbold Expedition. The 3rd Archbold Expedition is the only major mammal survey, apart from our own, to have been carried out over a broad transect on the northern slopes of the New Guinean Central Cordillera. They worked extensively in the Idenburg River — Lake Habbema area in 1938–1939 (Archbold, Rand & Brass, 1942), covering a similar altitudinal transect to us. This area lies 300 to 400 km to the west of our study area, but nonetheless is topographically and faunistically very similar to ours. Indeed, many taxa are shared between these two locations that are not found to the east of our study site. For this reason, it is valuable to compare the results of the two expeditions, as combined the results give a greater understanding of mammal diversity and distribution than the results of one expedition viewed in isolation.

Table 7 lists mammal species recorded by us as well as those from the 3rd Archbold Expedition. The latter list is compiled from the works of Tate (1941, 1942, 1945a,b, 1947, 1948a,b, 1951), and Archbold, Rand & Brass (1942), with some changes made by later systematic reviewers. The altitudinal range that the taxon was encountered within is also given. As can be seen, where a taxon was taken by both expeditions in reasonable numbers, there is usually a good concordance in the altitudinal range that it was located over in both areas. This would suggest that altitudinal zonation is similar at both locations. A more intriguing aspect, however, is the species taken during only one or the other survey. These differences in the species collected can probably be accounted for by two major factors; sampling techniques, and faunal differences. Some absences, however, are not easily accounted for by either factor.

Taxon absences due to sampling. It is clear from Table 7 that the collections made by us are depauperate in small insectivores/carnivores compared with those of the 3rd Archbold Expedition. Indeed, five species of dasyurid and four species of hydromyine murid which were collected by the Archbold expedition (often in abundance) are not represented in our collections. Almost all of these species are widespread in western New Guinea, and indeed, descriptions matching some of these species were obtained from local people in our study area or have been collected there by others. Their absence in our collections therefore is almost certainly due to the limited trapping with protein- rich baits that we undertook. Conversely, the very few smaller megachiropteran and microchiropteran bats obtained during the 3rd Archbold Expedition in all likelihood reflects their limited use of nets, and absence of work in caves. The 3rd Archbold expedition also failed to locate any *Dendrolagus* spp, *Thylogale brunii*, *Phalanger matanim*, *P. vestitus*, *Dactylopsila trivirgata*, and *D. megalura*. Their relations with local peoples seem generally to have been poor, and many of these species were procured for us only by local helpers. It may well be that the lack of some of these species in their collections and their lack of work in caves (to locate caves in our study area almost always required local expertise) was due to a lack of rapport with local landowners. It is also possible, however, that some of these species (e.g. *Thylogale brunii* and *Dendrolagus dorianus*) are extinct in much of Irian Jaya (see Hope, 1976).

Taxon absences due to faunal differences. Several species collected during the 3rd Archbold Expedition in Irian Jaya may simply not exist in our study area. These include *Phascolosorex doriae* (which has never been reported east of the Idenburg River, but is abundant to the west), *Rattus richardsoni* and *Melomys albidens*. These latter two species occur only high in the subalpine and alpine grasslands of the Snow Mountains. Such habitat is very restricted in our study area, and the alpine grasslands of Irian Jaya are well separated from such habitats in Papua New Guinea, making dispersal of species closely tied to alpine grassland habitats difficult. Thus, it may be that these species do not inhabit the limited subalpine areas of the Star Mountains.

Conversely, it appears likely that several species collected by us do not occur in the Snow Mountains/ Idenburg River area. These include *Dendrolagus goodfellowi* (which has not been recorded west of Mount Bubiari, West Sepik Province; this work), *Pogonomelomys sevia* (which has not been recorded west of Telefomin), and the large grey *Melomys* close to *Melomys rubex*, which is known only from Mount Capella. None of these species have ever been recorded from Irian Jaya, and are either common (*Melomys* sp.) or obvious

(*D. goodfellowi*) where they do occur.

Differences of uncertain cause. Several differences between the collections of the 3rd Archbold Expedition and our own work are not readily explained by any of the above causes. These include the absence of *Petaurus breviceps* and *Pseudocheirus forbesi* from the Archbold collections, and the absence of *Melomys lutillus* from ours. *Petaurus breviceps* seems to be abundant and widespread throughout most habitats in New Guinea. It is difficult to believe that it is absent from the area traversed by the 3rd Archbold Expedition. However, it is equally difficult to believe that if it had been present in anything like its abundance elsewhere, that specimens would not have been obtained by Expedition members.

The situation with *Pseudocheirus forbesi* is even more intriguing, for this species is the most abundant pseudocheirid in our study area. It is found in primary forest and secondary growth throughout our study area between 1,400 and 2,300 m. Although the Archbold Expedition obtained all the other pseudocheirid species obtained by us, as well as one species that we did not collect, they did not obtain a single *P. forbesi*. *Pseudocheirus forbesi* is known from the Vogelkop; thus if it is absent in the Snow Mountains/Idenburg River area, this must represent a gap in its distribution. If such a gap exists, it would represent a truly intriguing zoogeographic problem.

Almost as peculiar is the absence of *Melomys lutillus* from our study area. The Archbold Expedition found this species to be abundant in the Baliem Valley. However, extensive trapping shows that it is absent in the Telfomin and the other grassy valleys in our study area. This species is extremely widespread elsewhere in Papua New Guinea, so its apparent absence from the Telefomin area is not readily explained.

Folk taxonomy. Folk taxonomies collected from Mianmin and Telefol include several names for taxa that we did not obtain during our survey. Some taxa were well-enough described that we feel confident that we can identify them. These taxa are as follows: *Hom* (Mianmin) = *Myoictis melas*; *Tning* (Telefol) = *Neophascogale lorentzi*; *Bilbilok* (Telefol) = *Parahydromys asper*; *Dikrus* (Telefol) = molossid bat. All of these taxa were widely recognised among the inhabitants of the study area. Our failure to trap them doubtless stems from the same factors discussed previously.

Analysis of species distributions. Several species have not been recorded in the study area, but may nonetheless occur within it. This applies in particular to such hard to obtain taxa as molossid bats and tree-roosting vespertilionids. Some of these taxa occur to both the east and west of our study area or extremely close to it, but have not yet been recorded from within it. We regard it as highly likely that these taxa do indeed occur within our study area but they are sufficiently rare or difficult to catch that they were missed by our survey. These species include *Antechinus wilhelmina*, *Murexia longicaudata*, *Phascolosorex dorsalis*, *Neophascogale lorentzi*, *Myoictis melas*, *Pseudocheirus canescens*, *Emballonura furax*, *Hipposideros calcaratus*, *Aselliscus tricuspidatus*, *Rhinolophus megaphyllus*, *R. euryotis*, *Phoniscus papuensis*, *Myotis adversus*, *Pipistrellus papuanus*, *P. angulatus*, *Murina florium*, *Miniopterus schreibersi*, *Chaerephon jobensis*, *Mormopterus beccarii*, *Hydromys habbema*, *H. hussoni*, *Crossomys moncktoni* and *Parahydromys asper*.

A number of other microchiropteran species, while currently known only from eastwards of the study area, may well also occur within it, as their absence from western New Guinea is probably due to the paucity of chiropteran survey work done there. These species include *Philetor brachypterus*, *Tadarida kuboriensis*, *Otomops papuensis* and *O. secundus*.

Faunal diversity. Thus our list includes 23 species which could confidently be expected to occur in our study area (on the basis of folk taxonomy or distribution), and a further four poorly known chiropteran species which may occur within it. Thus, in addition to the 87 taxa encountered during our survey and six collected by others, a further 27 taxa may exist in the region. Some of these 27 almost certainly do exist there, while others are more doubtful. Thus the total diversity of indigenous mammals in this region lies somewhere between 93 and 120 mammal species, and more probably near the upper value. This is an astounding total for such a small region, and is, as far as we know, the highest recorded mammal diversity for a similar sized area in the Australasian region. Indeed, it rivals the 145 land mammal species reported for Suriname, a much larger area in the Neotropics (Husson, 1978). Unfortunately, few comparable mammal surveys have been completed in Papua New Guinea, but as a comparison, the work of Hide *et al.* (1984) and Dwyer (1983) can be examined. Hide *et al.* (1984) is a survey of part of the South Chimbu (about 2,997 km^2), at altitudes ranging between 400 to 2,569 m. It yielded only 59 species, which is low even considering that Microchiroptera were poorly sampled. Dwyer (1983) records only 44 species in his survey of the mammals of Mount Elimbari (at altitudes of 1,900 to 2,730 m), Chimbu Province. Interestingly, Beehler *et al.* (1986) note that the upper Sepik is one of the areas of greatest bird diversity in New Guinea, with 165 to 170 resident forest species being present. Thus, our study area may indeed be a region of exceptional biotic diversity, although further research on other groups is needed before this can be confirmed.

The factors that gave rise to and sustain the diversity of mammals in our study area almost certainly include the following: 1) *altitudinal range*. The study area encompasses habitats at altitudes from 120 to 4015 m. Of these we sampled from between 160 to 3,200 m, which ranged from lowlands jungle developed on floodplain, to subalpine herbfield. This range encompasses most of the major habitat types to be found on mainland New Guinea; 2) *local climatic variation*. Although weather patterns are still poorly understood, it is apparent that

rainfall varies markedly throughout the region. Included are some of the wettest regions in New Guinea, but some of the valleys in the middle altitudes seem to lie in rainshadows. This has a dramatic affect on forest composition and structure, and probably upon mammal diversity; 3) *location.* The study area is located almost in the geographic centre of the island of New Guinea. Some species with a predominantly western distribution reach their easternmost limit in the study area, while others with an eastern distribution find their westernmost limit there; 4) *low human population.* The entire region supports only around 10,000 people. Their impact on many areas is as yet slight, and thus some important mid-altitude forests have not suffered degradation and are capable of supporting a diverse mammal fauna. Furthermore, in the more elevated areas pig numbers are low and their damage is correspondingly slight, and other introduced species are not common.

Zoogeography. *Endemism and zoogeographic patterns.* Our study area encompasses the habitat of three species (*Phalanger matanim*, *Pogonomys championi* and *Hipposideros corynophyllus*) that are known as fossil or living animals from nowhere else, and a further four species (*Dactylopsila megalura*, *Paraleptomys wilhelmina*, *Melomys lanosus* and *Hipposideros wollastoni*) which are found only along the Central Cordillera to the west of Telefomin. A further species, *Rhinolophus arcuatus*, although previously known only from the Telefomin area in New Guinea, is now represented by specimens held in the Australian Museum from Southern Highlands Province. A further species, *Pseudohydromys occidentalis*, also has a 'western' distribution. However, it is differentiated from *P. murinus* from eastern New Guinea only on the basis of size, and the relationship between these species is more similar to that between the western and eastern subspecies of *P. sericeus*, *M. longicauda*, and *D. dorianus* rather than the other western endemics which have no eastern counterparts.

The altitudinal zone occupied by these seven 'endemic and western' species is intriguing, for they are not found in the disjunct upper montane forest, but instead are largely restricted to the midaltitude Oak Forest zone. Within the study area the altitudinal range of this zone varies with local topography, but usually lies between 1,500 to 2,000 m. Table 8 lists the endemic species and their altitudinal ranges. This concentration of endemism seems all the more unusual when one considers the fauna of the upper montane zone. For there, although there are often eastern and western New Guinean subspecies pairs (e.g. in *Phalanger sericeus*, *Dendrolagus dorianus*, *Microperoryctes longicauda*), or species pairs (*Pseudohydromys occidentalis/murinus*), there are no species for which ecological vicars do not exist in the east. In the Snow Mountains in central Irian Jaya, however endemic species are found for which there are no obvious vicars elsewhere (e.g. *Rattus richardsoni*, *Melomys albidens*).

In summary then, the overall pattern is that of a ubiquitous lowland fauna (at least north of the Central Cordillera), a midmontane fauna with a significant and diverse endemic or 'western' element which has no eastern counterpart, and an upper montane fauna with many western distributed species or subspecies, all of which have ecological counterparts in the east. The historical factors that could have produced such a pattern are not immediately apparent. The division of the upper montane zone that led to the development of eastern and western subspecies may well be related to the low point on the Central Cordillera that is situated just to the east of our study area (4°55'S, 131°45'E). Here, the top of the Central Cordillera dips to 1,560 m and drops rapidly into the valleys of the Ok Om (south) and the Hak (north). This region has not been examined zoologically, but it seems likely that today it acts as a barrier to the fauna of the upper montane zone. However, 18,000 years ago, when altitudinal zones were markedly depressed and the tree line was at about 2,100 m (Hope & Hope, 1976), the upper montane zone may well have been continuous across it.

The origin of midmontane endemism in Western New Guinea appears to predate the terminal Pleistocene as the distinctiveness of the taxa involved is greater than that of those of the upper montane zone. Their presence implies two major problems: the origin of the endemics and the factors preventing their spread into apparently suitable habitats in eastern New Guinea.

A possible answer to the problem of origin may lie in the tectonic history of New Guinea. Throughout most of the Miocene, the Central Cordillera of New Guinea was an island archipelago. A fundamental and long lasting marine barrier persisted throughout this time a little to the east of present day Telefomin (Flannery, 1990). This area corresponds with the eastern limit of distribution of the endemic species under discussion.

It seems likely that species that formed the original biota of the islands of the Miocene west New Guinean archipelago may have included taxa ancestral to the species that are endemic to that area at present. But why should these species be concentrated in the midmontane zone?

Climatic regimes were clearly quite different in the Australasian region in Miocene times to those that exist at present (Barlow, 1981). It is clear that throughout the Tertiary high mountain ranges have never linked the New Guinean Central Cordillera and eastern Australia (Dow, 1977), and yet somehow species which are extremely poor dispersalists and which are restricted to cool environments and are of Gondwanian origin (e.g. *Nothofagus* spp.) exist in montane New Guinea. At present many such plant taxa are restricted to areas above 900 m (Hartley, 1986), but in the past these data suggest that they must have existed at lower altitudes. With this in mind, it seems probable that climatic change has forced an upwards migration of these Miocene biotas in the New Guinean montane region. Thus it is possible that the fauna and flora characteristic of the midmontane zone at present may have been related to the dominant biota on the Miocene western islands of New Guinea, even near sea level, and that subsequent climatic changes restricted

it to its present altitudes. An alternative explanation of this phenomenon may be that competition with new immigrants from Malesia restricted the original flora and its associated fauna to the midmontane zone, as the majority of low altitude plants found in Papua New Guinea today are of Malesian origin (Hartley, 1986).

The reason as to why these midmontane endemic elements have not spread to the east is not easily understood. They include bats, murids and marsupials — a range of taxa with a presumably wide range of dispersal abilities. Furthermore, no gaps in the midmontane zone have been identified that would retard dispersal. Overall floristic richness also does not seem to be a factor, as Hope (personal communication) suggests that the flora of Irian Jaya and the Telefomin area is, if anything, less diverse than that of the rest of Papua New Guinea. Clearly some factors are at work that we do not understand, and only further research on the biology and ecology of these taxa will provide answers.

A second major area of zoogeographic interest in this region is the species that reach their westernmost limit in the area. Only two species clearly fall into this category, *Dendrolagus goodfellowi* and *Pogonomelomys sevia*. Others, such as *Syconycteris hobbit*, may do so but their ranges are so poorly known at present that such a designation would be premature. The distribution of *D. goodfellowi* is unusual in the study area as it does not inhabit the Central Cordillera proper, but rather the outlying foothills and ranges to the north of the Sepik. It reaches a natural western limit to its distribution at Mount Bubiari, which is the last outlier reaching over 1,000 m before the Sepik begins its vast curve back to the east (Fig.2). This suggests that the formation of the Sepik drainage predates the evolution of *D. goodfellowi*, otherwise this species would probably be found on both sides of the river. The reason that *D. goodfellowi* is not found to the south of the Sepik, however, is not so apparent. Forests suitable to support it must be found in the upper Sepik drainage. Why it has not managed to use these forests as a bridge to infiltrate the extensive midmontane forests to the south of the Sepik remains mysterious.

The distribution of *Pogonomelomys sevia* is less well understood. Its westernmost limit is apparently the Telefomin valley where it is rare, although to the east it can be common in the mid to upper montane forests. There appear to be no ecological vicars for it to the west, and no barriers to its dispersal in that direction either. An explanation for this distribution must await further study.

Human effects on mammals. Through hunting, burning and gardening, humans have a great effect on wild mammals in the study area. The effects of hunting are quite different from that of burning and gardening, which are sometimes associated, so the human impact will be dealt within two parts.

Hunting. Those species most affected by hunting in the study area are the large mammals. These include both *Dendrolagus* species, *Zaglossus bruijnii* and possibly *Thylogale brunii*. A further species severely affected is the bat *Aproteles bulmerae*. Both *Aproteles bulmerae* and *Zaglossus bruijnii* have suffered drastic declines in the study area in recent times. Before the 1960's *Zaglossus bruijnii* seems to have been relatively common in the vicinity of Telefomin Station. It was protected by tradition, and thus was not hunted. As traditional beliefs broke down under missionary influence, the species became rarer, so that today it is almost unknown in the region of the station. The rapid extinction of this species in some areas of the central highlands reported upon by George (1978) may soon follow in much of the Telefomin area if some protection is not again granted.

Parallels between *Aproteles bulmerae* and *Zaglossus bruijnii* are remarkable. For *A. bulmerae* has also become extinct in the highlands, albeit in prehistoric times (Menzies, 1977). A single colony was located in our study area by D. Hyndman in 1975. It occupied a deep doline which was extremely difficult to access, called Luplupwintem on the Finimterr Plateau. The colony doubtless survived because of the inaccessibility of its main roost. Unfortunately, Finimterr is crossed by a track leading from Tifalmin to Bultem. With the development of the Ok Tedi Mine, this path began to receive frequent traffic. Shotguns also became more widespread. This combination proved fatal to the Luplupwintem colony. The cave has been checked on several occasions for bats, but none have been seen since 1977, when two were observed circling the roost. Conversations with Wopkaimin hunters indicate that literally hundreds of animals were shot at a time when one shotgun was taken into the cave in the mid 1970's.

In both the case of *A. bulmerae* and *Z. bruijnii* it seems that the delicate balance between these species and humans has been upset with the coming of European ideas and technology. If both species still exist in the study area, their continued existence is probably tenuous. More research and government action is necessary to ensure their safety.

Dendrolagus dorianus, *D. goodfellowi* and possibly *T. brunii* have suffered some local extinction, but are still secure in at least part of the study area. Although probably hunted to extinction in parts of the Telefomin area, *D. dorianus* is still common in the more remote parts of the Star Mountains. It should remain secure there for the foreseeable future. Likewise, *D. goodfellowi* has probably been adversely affected in some of the outlying parts of its range around Yapsiei, but is apparently secure on the higher slopes of the Thurnwald Range. The status of *T. brunii* is uncertain. Elsewhere in Papua New Guinea it is common. However, in our study area it is rare. This may be due to hunting and clearance at middle altitudes, or it may be natural.

Burning and gardening. Burning, gardening and the building of dwellings has had a beneficial effect of some species, and a detrimental effect on others. Species capable of utilising disturbed habitats, such as *Echymipera rufescens*, *E. kalubu*, *Rattus praetor*, *R. steini* and *Melomys rufescens* can be abundant around villages, in gardens, and even in anthropogenic grasslands near the larger settlements. Indeed, some species such as

E. rufescens may depend upon human maintained habitats for their existence in the study area.

Gardening and burning have, however, destroyed considerable amounts of primary forest, particularly in the Telefomin and Tifalmin areas. Here, anthropogenic grassland now occupies large tracts once covered by primary midmontane forest. Midmontane forest between 1,500 and 2,500 m, particularly the lower Oak zone, supports the largest diversity of mammals of any habitat in the study area. Indeed, seven species which are not found elsewhere in Papua New Guinea are confined to this zone. Figure 9 shows the approximate extent of the 1,500 to 2,500 m zone, and the parts of it that have been disturbed by human activity. Much of this disturbed area is now either anthropogenic grassland, early secondary growth, or gardens. Although there appears to be no immediate danger to the endemic midmontane mammals from gardening and burning, such a threat could arise if the human population undergoes an increase.

Conservation priorities. Conservation initiatives are urgently needed in three different areas in order to maintain the exceptionally rich mammalian assemblage currently found in the study area. These are as follows: *Preservation of Aproteles bulmerae.* The only living individuals of this endemic genus and species of fruit bat known were taken within the study area in 1975 (see species accounts). Their only known roost was Luplupwintem, a huge doline south-west of Tifalmin. This roost has been deserted for several years. It is imperative that swift action be taken to try to locate any further roosts of this unusual species. We suggest that suitable caves may exist in the Inim Range, between Telefomin and Bolivip in Western Province. This region is topographically similar to the Luplupwintem area, and contains many large dolines. If such roosts are found, the strictest measures must be implemented to protect them from the overexploitation that destroyed the Luplupwintem colony. We suggest that a total ban on

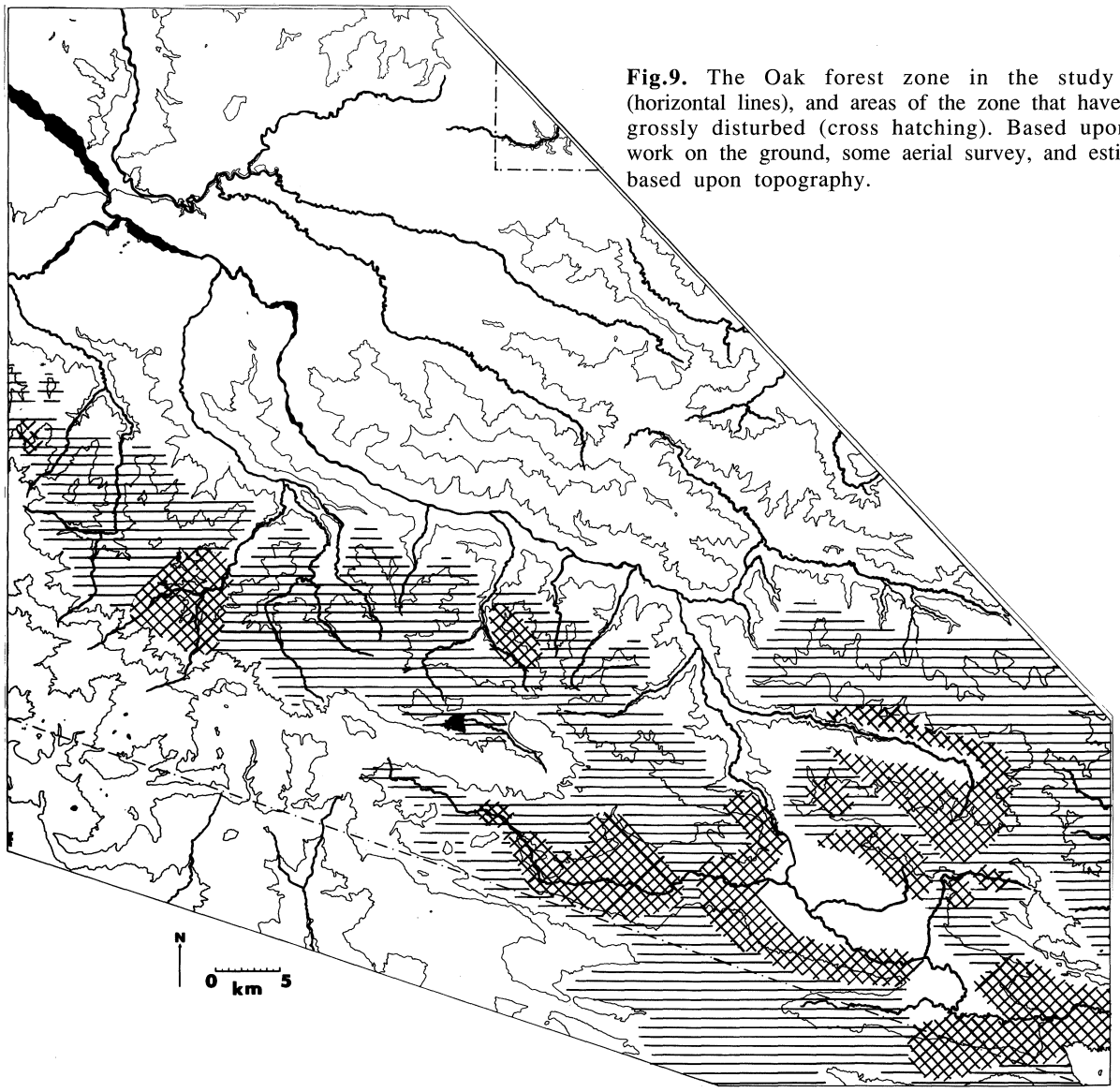

Fig.9. The Oak forest zone in the study area (horizontal lines), and areas of the zone that have been grossly disturbed (cross hatching). Based upon our work on the ground, some aerial survey, and estimates based upon topography.

entering the cave may be the best method of protection.

Conservation of the Oak Forest zone. Conservation of the Oak Forest zone within the study area is a more difficult but no less vital an objective. This zone (between 1,500 and 2,500 m) is the only known habitat of the seven species listed in Table 8 within Papua New Guinea. Furthermore, the bulk of the mammal species to occur within the region inhabit this zone.

The extent of the Oak Forest zone within the study area is shown in Figure 9. This figure is an estimate based upon topography, the author's experience in this field, and the result of aerial reconnaissance. The extent of disturbed habitat shown is based on the same data. It is clear from this figure that the zone is of limited extent, and that disturbance within it is already considerable. This disturbance will almost certainly grow, particularly in areas of high or growing human population density, such as around Telefomin, Tifalmin and Munbil.

It would be desirable to establish wildlife management areas in parts of this zone, so as to ensure partial, long term protection for large areas of this rich biota. Two areas that may be particularly suitable for such management areas are the Nong River Valley south of Telefomin, and parts of the upper Ilam Valley. The Nong River Valley is particularly important, for it is the only large expanse of undisturbed Oak Forest in the 1,500 to 2,000 m zone in the Telefomin area. It seems to have survived because historically it was at the boundary of two disputing groups, and because it is somewhat difficult of access. There are very few gardens in the area at present, so swift action may allow implementation of a wildlife management area.

Management of large game species. The large game species which seem sensitive to overhunting in the area include *Zaglossus bruijnii*, *Dendrolagus dorianus* and *D. goodfellowi*. Traditionally, these species received considerable protection, at least in areas controlled by Telefol. *Zaglossus bruijnii* received almost total protection, while *D. dorianus* could be eaten only by a few senior men. While these restrictions still hold among the more traditionally minded, hunting by others has had a drastic affect on the populations of these species. Perhaps as a remedy, respect for traditional beliefs and their conservation value could be taught in schools in the area. This, plus the remoteness of some of the habitat of these species, may confer long term protection.

Summary

1) A survey of southern West Sepik Province has shown that between 93 and 120 mammal species inhabit the region. This is the highest diversity recorded for a similar sized region in Australasia.

2) Within this region, maximum diversity is in the midmontane oak forest, where seven species exist that are not found elsewhere in Papua New Guinea.

3) Human activity threatens some mammal species in the region. Further research, and legislative and educational action is urgently needed to avoid extinctions.

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APPENDIX

Table 1. Times of field work and participants from 1984-1987 for mammal survey of West Sepik Province.

Year/Month	Locations/working days	Participants
1984 (Jan. Feb.)	Yapsiei (12)	Flannery, Van Dyck, Krogh, Gardner, Attenborough
	Betavip (16)	Flannery, Van Dyck, Krogh, Gardner, Attenborough
	Mount Bubiari (4)	Flannery
	Ofektaman (5)	Van Dyck
	Sol River (6)	Flannery
1984 (Aug.)	Tifalmin (3)	Seri, Kinbag
1985 (July)	Nong River (6)	Flannery, Steer
	Telefomin (2)	Flannery, Steer
	Miptigin (4)	Flannery, Steer
1986 (Mar.-May)	Sol River (8)	Flannery, 5 Australian Museum Society volunteers
	Munbil (6)	Flannery, 5 Australian Museum Society volunteers
	Yapsiei (7)	Flannery, Seri
	Betavip (7)	Flannery, Seri
	Thurnwald Range (5)	Seri
	Telefomin (8)	Flannery, Seri
	Yominbip (13)	Flannery, Seri
1987 (Apr.)	Dokfuma (8)	Flannery, Seri, Cogger
	Tifalmin (7)	Flannery, Seri, Cogger
1990 (Mar.)	Tifalmin (4)	Flannery

Table 2. The altitudinal range (Alt.Ra.), habitat preference (Habitat), vertical strata (Vert.St.), body weight (Wt) and diet of the mammal species collected during out survey.

Taxon	Alt.Ra.	Habitat	Vert.St.	Wt (kgs)	Diet
Zaglossus bruijnii	0-4,150	primary forest, alpine grasslands	terrestrial	7.0-16.0	worms
Dasyurus albopunctatus	0-3,500	all forest	all	0.58-0.71	vertebrates
Antechinus melanurus	0-2,800	all forest	all	0.026-0.07	vertebrates/ invertebrates
Antechinus naso	1,000-2,800	primary forest	all	0.037-0.062	invertebrates
Microperoryctes longicauda	1,000-4,000	primary forest, alpine grasslands	terrestrial	0.35-0.67	invertebrates
Peroryctes raffrayana	60-3,900	primary forest	terrestrial	0.65-1.0	invertebrates
Echymipera clara	300-1,200	primary forest	terrestrial	0.83-1.7	fruit/invertebrates
Echymipera kalubu	0-2,000	all habitats	terrestrial	0.45-1.5	fruit/invertebrates
Echymipera rufescens	0-1,200	secondary forest, grasslands	terrestrial	1.0-2.0	fruit/invertebrates
Dendrolagus dorianus	800-3,996	primary forests	all	6.5-14.5	leaves
Dendrolagus goodfellowi	1,200-2,865	primary forests	arboreal	6.7-8.6	leaves/fruit
Dorcopsis hageni	0-400	primary forests	terrestrial	5.0-6.0	leaves/fruit
Dorcopsulus vanheurni	800-3,100	primary forests	terrestrial	1.5-2.3	leaves/fruit
Thylogale bruinii	0-4,200	primary forest, alpine grasslands	terrestrial	3.0-10.0	leaves/grass
Spilocuscus maculatus	0-1,200	all forest	arboreal	2.3-6.0	leaves/fruit
Spilocuscus rufoniger	0-1,200	primary forest	arboreal	5.5-6.6	leaves/fruit
Strigocuscus gymnotis	0-2,700	all forest	all	1.5-4.9	leaves/fruit
Phalanger orientalis	0-1,500	all forest	arboreal	1.6-3.5	leaves/fruit
Phalanger matanim	1,500-2,600	primary forest	arboreal	1.1-2.0	leaves/fruit
Phalanger vestitus	1,200-2,200	primary forest	arboreal	1.4-2.4	leaves/fruit
Phalanger carmelitae	1,400-3,660	primary forest	arboreal	1.0-2.0	leaves/fruit
Phalanger sericeus	1,300-3,900	primary forest	arboreal	1.7-2.4	leaves/fruit
Pseudocheirus mayeri	1,500-3,600	primary forest	arboreal	0.11-0.21	leaves
Pseudocheirus forbesi	500-2,300	all forest	arboreal	0.45-0.84	leaves

Table 2 (cont'd).

Taxon	Alt.Ra.	Habitat	Vert.St.	Wt (kgs)	Diet
Pseudocheirus corinnae	1,200-2,500	primary forest	arboreal	0.93-1.1	leaves
Pseudocheirus cupreus	1,200-3,996	primary forest	arboreal	1.3-2.3	leaves
Distoechurus pennatus	0-1,900	secondary forest	arboreal	0.038-0.062	fruit/invertebrates
Cercartetus caudatus	1,500-3,450	all forest, grasslands	arboreal	0.017-0.024	fruit/invertebrates
Petaurus breviceps	0-3,000	all forest	arboreal	0.069-0.114	sap/invertebrates
Dactylopsila trivirgata	0-2,300	all forest	arboreal	0.23-0.47	invertebrates
Dactylopsila megalura	± 1,400	primary forest	arboreal	0.40	invertebrates
Dactylopsila palpator	1,200-2,800	primary forest	arboreal	0.32-0.55	invertebrates
Hydromys chrysogaster	0-1,900	aquatic	terrestrial	0.21-0.50	invertebrates
Paraleptomys wilhelmina	1,800-2,800	primary forest	terrestrial	0.034	invertebrates
Pogonomys macrourus	0-1,800	all forest	arboreal	0.03-0.06	leaves/fruit
Pogonomys championi	1,400-2,300	all forest	arboreal	0.3-0.06	leaves/fruit
Mallomys rothschildi	1,550-2,500	primary forest	arboreal	0.93-1.5	leaves
Mallomys aroaensis	1,000-2,400	primary forest	arboreal	0.9-1.5	leaves
Hyomys goliath	1,500-2,800	all forest	terrestrial	0.75-0.95	plant matter
Anisomys imitator	0-3,500	all forest	arboreal	0.38-0.58	nuts
Uromys caudimaculatus	0-1,925	all forest	arboreal	0.40-0.701	fruit/nuts
Uromys anak	850-2,800	primary forest	arboreal	0.45-1.0	fruit/nuts
Lorentzimys nouhuysi	80-2,700	primary forest	arboreal	0.01-0.02	?
Xenuromys barbatus	75-1,200	rocks, primary forest	terrestrial	0.9-1.1	fruit
Pogonomelomys ruemmleri	1,900-3,600	primary forest, alpine grasslands	all	0.03-0.04	? invertebrates/fruit
Pogonomelomys sevia	1,400-3,100	all forest, grasslands	all	0.05	? invertebrates/fruit
Pogonomelomys mayeri	400-1,300	all forest	arboreal	0.08-0.11	? invertebrates/fruit
Melomys lanosus	1,300-2,800	primary forest	terrestrial	0.12	? invertebrates/fruit
Melomys rattoides	900-1,400	primary forest	terrestrial	0.17-0.23	? invertebrates/fruit
Melomys rubex	900-3,000	all forest	terrestrial	0.03-0.06	? invertebrates/fruit
Melomys sp.	3,200	alpine, grasslands	terrestrial	0.04-0.06	? invertebrates/fruit
Melomys rufescens		secondary forest, grasslands	arboreal	0.03-0.1	? invertebrates/fruit
Melomys platyops	0-1,200	all forest	terrestrial	0.07-0.10	? invertebrates/fruit
Rattus niobe	762-4,030	forest, grasslands	terrestrial	0.04-0.06	? invertebrates/fruit
Rattus sp.	1,000-1,400	forest	terrestrial	0.06-0.07	? invertebrates/fruit
Rattus verecundus	150-2,750	forest	terrestrial	0.09-0.13	? invertebrates/fruit
Rattus steini	20-2,800	forest, grasslands	terrestrial	0.11-0.22	? invertebrates/fruit
Rattus praetor	0-1,200	forest, grasslands	terrestrial	0.17-0.23	? invertebrates/fruit
Rousettus amplexicaudatus	0-1,805	forest	flying	0.078-0.11	fruit
Pteropus neohibernicus	0-1,000	forest	flying	0.73-1.4	fruit
Dobsonia moluccensis	0-2,700	forest	flying	0.36-0.60	fruit
Dobsonia minor	0-600	forest	flying	0.07-0.09	fruit
Nytimene cyclotis	830-2,300	forest	flying	0.05	fruit
Nytimene albiventer	0-1,650	forest	flying	0.02-0.03	fruit
Nytimene aello	0-990	forest	flying	0.08-0.09	fruit
Paranyctimene raptor	0-1,000	forest	flying	0.02-0.03	fruit
Macroglossus minimus	0-1,000	forest	flying	0.01-0.02	nectar
Syconycteris hobbit	2,300-2,400	forest	flying	–	nectar
Syconycteris australis	0-3,000	forest	flying	0.01-0.02	nectar
Nyctophilus microtis	200-990	forest	flying	0.006-0.008	insects
Pipistrellis collinus	1,700-2,450	forest	flying	0.007	insects
Kerivoula muscina	20-1,800	forest	flying	0.005	insects
Miniopterus australis	0-1,500	forest	flying	0.007-0.009	insects
Miniopterus sp.	3,200	grassland	flying	0.01	insects
Miniopterus macroneme	0-2,300	forest	flying	0.008-0.01	insects
Miniopterus medius	+ 1,360	forest	flying	0.01	insects
Miniopterus magnater	0-2,100	forest	flying	0.01	insects
Hipposideros ater		forest	flying	0.01	insects
Hipposideros corynophyllus	1,600-1,800	forest	flying	0.015	insects
Hipposideros wollastoni	550-2,000	forest	flying	0.005-0.008	insects
Hipposideros cervinus		forest	flying	0.003-0.01	insects
Hipposideros diadema		forest	flying	0.03-0.04	insects
Rhinolophus arcuatus		forest	flying		insects
Emballonura beccarii	0-1,300	forest	flying	0.004-0.005	insects
Emballonura raffrayana	0-1,320	forest	flying	0.004-0.005	insects
Emballonura nigrescens	0-1,000	forest	flying	0.003-0.004	insects

Table 3. Telefol and Mianmin names for mammal taxa collected during this work.

Taxon	Telefol	Mianmin
Zaglossus bruijnii	Egil	Yakeil
Dasyurus albopunctatus	Kutinim	Tangtangib
Antechinus melanurus	Foomkayok	Bumtaing
Antechinus naso	—	—
Microperoryctes longicaudata	Warem	—
Peroryctes raffrayana	Ibin	Duwin
Echymipera clara	—	Kiyok
Echymipera rufescens	—	Aiyal
Echymipera kalubu	Aiyal	Aiyal
Distoechurus pennatus	—	Mayfagam
Cercartetus caudatus	Finareng	—
Petaurus breviceps	Silek	Mayfagam
Dactylopsila trivirgata	Triok	Kwidiaim
Dactylopsila megalura	Defem, Triok	—
Dactylopsila palpator	Triok	—
Dorcopsulus vanheurni	Autom	Soyabu
Dorcopsis hageni	—	Titiabu
Thylogale brunii	Simulim	Sumul
Dendrolagus dorianus	D'bol	—
Dendrolagus goodfellowi	Timboyok	Yemma, Timboyok
Pseudocheirus forbesi	Sobim	—
Pseudocheirus mayeri	Dom	—
Pseudocheirus corrinae	Dabam	—
Pseudocheirus cupreus	Kayang	Hito
Strigocuscus gymnotis	Quoyam	Quoyam
Phalanger orientalis	Ibim	Maetol, Ibim, Aligin
Phalanger vestitus	Nelem	—
Phalanger carmelitae	Tim Matanim	—
Phalanger matanim	Matanim	—
Phalanger sericeus	Kutip	Satol
Phalanger maculatus	Selip	Tekeib
Phalanger rufoniger	Selip	Tekeib
Hydromys chrysogaster	? Bidok	Ayam
Pogonomys macrourus	Elam	Ilam
Pogonomys championi	Elam	—
Mallomys rothschildi	Resen	—
Mallomys aroaensis	—	—
Hyomys goliath	Trossin	? Afut
Anisomys imitator	Apsal	—
Uromys anak	Quotal	—
Uromys caudimaculatus	Ditip	Quaterib
Xenuromys barbatus	—	Boboyomin
Lorentzimys nouhuysi	Ifum	—
Pogonomelomys ruemmleri	Karung	—
Pogonomelomys mayeri	Karung	—
Pogonomelomys sevia	Karung	—
Melomys lanosus	Mankan	—
Melomys rattoides	—	Temeya
Melomys rubex	Ingat	Briazu
Melomys rufescens	Aubil	Dawan
Melomys moncktoni	—	Abul
Rattus niobe	Titok	—
Rattus verecundus	? Titok	—
Rattus steini	Senok	Senok
Rattus praetor	—	Senok
Nyctophilus microtis	—	—
Pipistrellus collinus	—	—
Emballonura beccarii	—	—
Emballonura raffrayana	—	—
Emballonura nigrescens	—	Heba-heba
Miniopterus australis	Ibrup	—
Miniopterus magnater	Ibrup	—
Miniopterus macrocneme	Ibrup	—

Table 3 (cont'd).

Taxon	Telefol	Mianmin
Hipposideros corynophyllus	—	—
Hipposideros wollastoni	—	—
Hipposideros cervinus	—	—
Hipposideros diadema	—	—
Rousettus amplexicaudatus	—	Sagamal
Pteropus neohibernicus	—	Sewi
Macroglossus minimus	—	Raulabo
Syconycteris australis	Timinim	Raulabo
Syconycteris hobbit	Timinim	—
Dobsonia moluccensis	Segam	Ketab
Dobsonia minor	—	—
Nyctimene cyclotis	? Brulim	—
Nyctimene albiventer	—	Raulabo
Nyctimene aello	—	? Uleulelabu
Paranyctimene raptor	—	? Uleulelabu, Raulabo

Table 4. Rainfall data (in mm) for some localities within the study area. The data for Yapsiei is approximate as some figures are underestimates and others are missing (R. Attenborough, personal communication).

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Tifalmin 1980	23	182	370	187	160							
Yapsiei 1980	448	265	175	802	750	205	433		544	457	444	470
Yapsiei 1982	260	592	450	887	481	630	259	383	228	383	407	480
Telefomin 1980	192	164	365	320	348	264	197			266	188	266
Telefomin 1982		173	132	319	227	246	80		41	161	130	97
Telefomin 1983	147	260	175	147	327	222	84	57	283	283	245	249
Telefomin 1984	347	319	294	394	520	422	423	385	447	382	168	300
Telefomin 1985	296	389	193	325	211	224	260	444	334	343	205	280

Table 5. Cranial measurements of *Dendrolagus dorianus* specimens held in the Australian Museum used in this study. CBL = condylobasal length, BIZYW = bizygomatic width, MASTOID W = mastoid width, NAS.L. = nasal length, X = mean, R = range, N = sample size, L = length, W = width, M2/-M2/W = width from the external faces of the molars.

		D.d. stellarum n.sp.		*D.d. notatus*		*D.d. dorianus*	
		male	female	male	female	male	female
CBL	X	118.1	110.8	118.3	115.5	125.5	121.0
	R	117.5-118.7	110.8	112.8-122.8	111.0-119.6	123.1-128.5	121.0
	N	2	1	3	7	4	1
BIZYW	X	64.8	66.2	67.1	66.5	74.1	71.9
	R	61.0-68.6	66.2	66.2-71.5	61.4-70.3	71.3-76.7	71.9
	N	2	1	3	7	4	1
MASTOID W	X	46.8	42.1	50.3	50.3	52.4	48.0
	R	42.7-50.9	42.1	49.2-52.2	47.9-53.3	47.5-57.1	48.0
	N	2	1	3	7	4	1
NAS.L.	X	41.4	42.0	44.3	41.6	52.1	47.1
	R	40.5-42.3	42.0	42.2-45.7	40.1-42.8	49.0-56.3	47.1
	N	2	1	3	6	4	1
P3-M5/L	X	35.7	33.5	37.5	36.8	38.1	38.6
	R	35.1-36.2	33.5	36.5-38.5	35.4-39.5	36.5-39.1	38.6
	N	2	1	3	7	5	1
P3/L	X	9.8	9.2	10.7	10.6	10.8	10.9
	R	9.7-9.9	9.2	10.4-11.1	10.0-11.2	10.2-11.5	10.9
	N	2	1	3	7	5	1
P3/W	X	6.3	5.8	6.4	6.2	6.6	6.4
	R	6.2-6.3	5.8	6.0-6.7	5.5-6.8	6.2-7.0	6.4
	N	2	1	3	7	5	1
N2/W	X	5.9	5.7	6.4	6.2	6.3	6.1
	R	5.8-5.9	5.7	6.0-6.6	5.9-6.6	6.1-6.5	6.1
	N	2	1	3	7	4	1
M2/-M2/W	X	32.2	30.0	32.9	32.6	34.1	31.5
	R	31.9-32.4	30.0	31.5-34.7	31.5-34.0	32.9-35.1	31.5
	N	2	1	3	7	4	1

Table 6. External measurements of *Miniopterus* specimens (see text). X = mean, R = range, N = sample size, STD = standard deviation.

		Miniopterus magnater	*Miniopterus australis*	*Miniopterus macrocneme*	*Miniopterus* sp.	*Miniopterus medius*
Forearm	X	49.3	42.3	42.1	46.4	47.1
	R	45.0-51.3	41.0-45.0	40.0-43.5		
	N	10	12	14	1	1
	STD	2.22	1.05	1.07		
Head-body	X	51.1	41.8	46.0	47.3	59.5
	R	44.3-55.8	38.0-47.0	42.0-50.0		
	N	8	10	19	1	1
	STD	4.18	2.81	2.17		
Tibia	X	20.1	12.0	18.5	19.3	20.0
	R	18.9-20.8	11.0-13.0	17.5-19.4		
	N	10	12	19	1	1
	STD	0.65	0.45	0.57		
Ear	X	11.5	10.1	9.7	11.2	14.7
	R	9.0-13.5	8.0-12.0	8.6-11.0		
	N	9	12	19	1	1
	STD	1.31	1.10	0.75		
Weight	X	15.1	7.9	8.6	10.5	12.1
	R	11.0-18.0	7.0-9.0	7.2-10.0		
	N	10	12	33	1	1
	STD	2.26	0.56	0.78		

Table 7. Comparisons of mammals collected during our work (A) and that of the 3rd Archbold Expedition (B). The latter is from the literature only; Alt.Ra. = Altitudinal range.

Taxon	A		B	
	No.	Alt.Ra.	No.	Alt.Ra.
Zaglossus bruijnii	2	1,300-1,500 m ?	1	2,800 m
Murexia longicaudata	–		10	75 m
Myoictis melas	–		13	upper Idenburg Valley
Phascolosorex doriae	–		?	1,200-1,800 m
Neophascogale lorentzii	–		96	2,400-3,500 m
Antechinus naso	1	1,400 m	22	1,500-2,400 m
Antechinus wilhelmina	–		11	2,100-2,800 m
Antechinus melanurus	6	240-2,300 m	4	50-450 m
Dasyurus albopunctatus	3	1,000-2,300 m	17	Idenburg River
Peroryctes raffrayana	6	600-1,400 m	31	75-2,150 m
Microperoryctes longicauda	4	1,400-2,400 m	74	1,200-3,950 m
Echymipera clara	7	200-400 m	13	75-850 m
Echymipera kalubu	20	120-1,400 m	36	50-75 m
Echymipera rufescens	1	200 m	3	75 m
Cercartetus caudatus	22	1,400-3,200 m	30	1,500-4,000 m
Distoechurus pennatus	3	160-1,000 m	–	
Petaurus breviceps	17	200-2,300 m	–	
Dactylopsila trivirgata	2	1,300 m	–	
Dactylopsila palpator	7	1,500-1,800 m	9	850-2,800 m
Dactylopsila megalura	4	about 1,400 m	–	
Pseudocheirus mayeri	13	1,500-3,200 m	40	"Mount Wilhelmina"
Pseudocheirus canescens	–		2	100 m
Pseudocheirus forbesi	40	1,400-2,400 m	–	
Pseudocheirus corinnae	10	1,500-2,300 m	21	2,100-2,450 m
Pseudocheirus cupreus	20	1,800-2,800 m	14	1,650-1,900 m
Spilocuscus rufoniger	4	120-1,200 m	1	75 m
Spilocuscus maculatus	1	about 600 m	24	50 m Idenburg River
Phalanger orientalis	31	120-1,500 m	5	Middle Idenburg River
Phalanger sericeus	13	1,500-2,600 m	22	3,000-3,300 m
Phalanger matanim	4	1,500-2,600 m	–	
Phalanger vestitus	13	1,400-1,600 m	–	
Phalanger carmelitae	7	1,500-2,400 m	–	
Strigocuscus gymnotis	37	200-2,600 m	10	75 m
Dorcopsulus vanheurni	6	1,400-1,800 m	19	1,200-2,700 m
Dorcopsis hageni	9	120-200 m	?	Middle Idenburg River
Thylogale brunii	1	600 m	–	
Dendrolagus dorianus	4	2,800-3,200 m	–	
Dendrolagus goodfellowi	4	1,000-1,300 m	–	
Paraleptomys wilhelmina	1	1,800 m	78	1,800-2,800 m
Pseudohydromys occidentalis	–		5	3,225-3,600 m
Microhydromys richardsoni	–		1	850 m
Hydromys habbema	–		29	3,225-3,600 m
Hydromys chrysogaster	3	200-900 m	7	800 m
Parahydromys asper	–		16	1,200-2,800 m
Lorentzimys nouhuysi	11	1,400-2,600 m	12	850-2,700 m
Macruromys major	–		4	1,200 m
Mallomys rothschildi	6	1,500-2,300 m	14	2,200-3,800 m
Mallomys aroaensis	1	1,600 m	–	
Hyomys goliath	3	1,400-1,800 m	5	2,200-2,800 m
Anisomys imitator	2	1,400-2,300 m	84	1,200-2,800 m
Pogonomys championi	41	1,400-2,300 m	–	
Pogonomys sylvestris	–		66	2,200-2,800 m
Pogonomys macrourus	30	900-1,500 m	1	850 m
Xenuromys barbatus	3	400-1,200 m	1	75 m
Uromys caudimaculatus	3	400-1,500 m	20	50-1,200 m
Uromys anak	3	1,500-1,800 m	15	850-2,800 m
Pogonomelomys mayeri	2	1,320-1,400 m	1	400 m
Pogonomelomys ruemmleri	2	2,800-3,200 m	43	2,800-3,500 m
Pogonomelomys sevia	1	1,400 m	–	
Melomys lanosus	16	1,800-2,300 m	119	1,500-2,800 m
Melomys rattoides	17	900-1,100 m	31	850-1,200 m

Table 7 (cont'd).

Taxon	A		B	
	No.	Alt.Ra.	No.	Alt.Ra.
Melomys lutillus	–		151	1,600-2,200 m
Melomys rufescens	25	200-1,500 m	6	1,600-2,200 m
Melomys rubex	33	1,400-3,200 m		?
Melomys platyops	10	160-240 m		?
Rattus praetor	29	200-900 m	8	75-1,500 m
Rattus steini	95	160-2,300 m	148	1,600-2,800 m
Rattus verecundus	1	2,600 m	–	
Rattus richardsoni	–		56	3,560-4,050 m
Rattus sp. cf. *R. niobe* ?	3	1,000-1,400 m	–	?
Rattus niobe arrogans	19	3,200 m	±500	2,200-4,000 m
Rattus niobe pococki	6	1,400-2,300 m	67	1,800-2,150 m
Melomys albidens	–		3	3,225 m
Pteropus neohibernicus	5	160-240 m	?	Idenburg River area
Pteropus macrotis	–		7	Idenburg River area
Dobsonia moluccensis	15	160-1,500 m	6	Idenburg River area
Dobsonia minor	10	200-240 m	7	Idenburg River area
Nyctimene albiventer	39	200-1,000 m	1	Idenburg River area
Nyctimene cyclotis	1	2,300 m	–	
Nyctimene aello	4	200 m	–	
Paranyctimene raptor	10	200-900 m	–	
Rousettus amplexicaudatus	27	200 m	–	
Macroglossus minimus	29	200-1,000 m	–	
Syconycteris hobbit	1	2,300 m	–	
Syconycteris australis	132	200-2,300 m	3	Idenburg River
Hipposideros calcaratus	–		10	Idenburg River
Hipposideros cervinus	4	200-1,300 m	–	
Hipposideros ater	1	1,600 m	–	
Hipposideros diadema	1	200 m	–	
Hipposideros corynophyllus	25	1,500-1,800 m	–	
Hipposideros wollastoni	31	1,400-1,800 m	–	
Rhinolophus arcuatus	5	1,600 m	–	
Miniopterus magnater	11	1,500-2,100 m	2	Upper Idenburg River
Miniopterus medius	1	1,340 m	–	
Miniopterus sp.	1	3,200 m	–	
Miniopterus macrocneme	38	1,500-3,200 m	–	
Miniopterus australis	12	1,500 m	–	
Nyctophilus bifax	–		1	850 m
Nyctophilus microtis	1	200 m	–	
Pipistrellus collinus	1	2,300 m	–	
Kerivoula muscina	3	1,600 m	–	
Emballonura beccarii	30	1,300 m	–	
Emballonura raffrayana	26	900-1,300 m	–	
Emballonura nigrescens	13	200-1,000 m	–	

Table 8. Altitudinal range (in metres) of the seven western and endemic species found in the study area. * = based on local informants only; # = from the Tabubil area, where altitudinal zones are markedly depressed.

Taxon	range in study area	range elsewhere
Phalanger matanim	1,500-2,600	—
Hipposideros corynophyllus	1,500-2,000	—
H. wollastoni	1,400-1,800	580#-1,800
Dactylopsila megalura	1,500-2,000*	1,400-2,000
Paraleptomys wilhelmina	1,800	1,800-2,800
Pogonomys championi	1,400-2,300	1,400-2,800
Melomys lanosus	1,800-2,300	1,500-2,800