

RESULTS OF A PRELIMINARY HIGHLAND BIRD BANDING STUDY AT TARI GAP, SOUTHERN HIGHLANDS, PAPUA NEW GUINEA

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Bird banding was performed in lower montane rainforest of Tari Gap, Southern Highlands, Papua New Guinea, during eight weeks of each of three consecutive years, at seven netting sites. A total of 1 174 captures of 50 species were made, involving 895 individual birds. Of 279 recaptures, 228 were birds we banded and 51 were birds banded during previous studies. Of the 201 individual birds involved in recaptures, only seven of six species were not retrapped at their original capture point. The furthest movement of an individual was 2.7 km by a Papuan Scrubwren *Sericornis papuensis*. Morphometric, moult and brood patch data are presented and discussed.

We caught 50 (54%) of a potential c. 93 species in our study area. The mean capture rate was 0.56 birds per hour by 13 m of mist net, and this is compared with other New Guinea mist-netting results. Longevity records of more than a year are reported for 17 species, the longest being of 61 months. Several species are recorded at new upper altitudinal limits at Tari Gap. Breeding activity increased during September–November, and the percentage of birds moulting increased during September (38%) to January (70%). Moult was noted in 48 species, and seasonal data is presented for 30.

INTRODUCTION

On 12 September 1986 we commenced a bird banding study at Tari Gap, Southern Highlands, Papua New Guinea (5°57'N, 143°10'E), between altitudes of 2 460 and 2 800 m asl. This study was part of our research at Tari Gap (a) to make a general avifaunal survey of the area, (b) to establish banded populations of the rare and geographically restricted Archbold's Bowerbird *Archboldia papuensis*, Ribbon-tailed Astrapia, *Astrapia mayeri* and four other sympatric bird-of-paradise species, and (c) to study the nesting biology of these and other species of birds about which little was known; as a basis for long-term future research in the area (Frith and Frith 1987; 1988a,b,c; 1990a,b,c,d,f; 1992; 1993a and b; unpub. data). Fieldwork was carried out during eight weeks each year over three consecutive years, 8 September to 29 October 1986; 14 October to 5 December 1987; and 19 December 1988 to 10 February 1989.

Vegetation of the Tari Gap is classified as Lower Montane Rain Forest, interspersed with patches of Lower Montane Grassland (Robbins and Pullen 1965). The trees *Nothofagus grandis*

and *Phyllocladus hypophyllus* are conspicuous in the forest canopy, *Pandanus* cf. *P. tectorius* is abundant in the understorey and canopy, and there are extensive areas of dense scrambling bamboo *Nastus* sp. Tree ferns *Cyathea* spp. are abundant, more so on forest watercourses, but on the grasslands are replaced by *Dicksonia* spp.

At this elevation there is no distinct dry season, and rainfall is fairly evenly distributed throughout the year (Perry 1965). During the study periods it rained heavily during most afternoons.

Access to Tari Gap is by the Tari-Mt. Hagen Road (Fig. 1). The Gap is uninhabited except during approximately June to August each year or two, when about 300 local people move into the forest to harvest pandanus fruits, collect firewood and hunt cuscus and other animals. Within the forest are many traditional hunting trails, connecting small clearings and low thatched hunting huts, which we used to traverse the forest. As a result of tree ring-barking for future fire wood stocks, grass fire-lighting, and the active encouragement of *Pandanus* propagation, this forest is in danger of extensive gross modification.

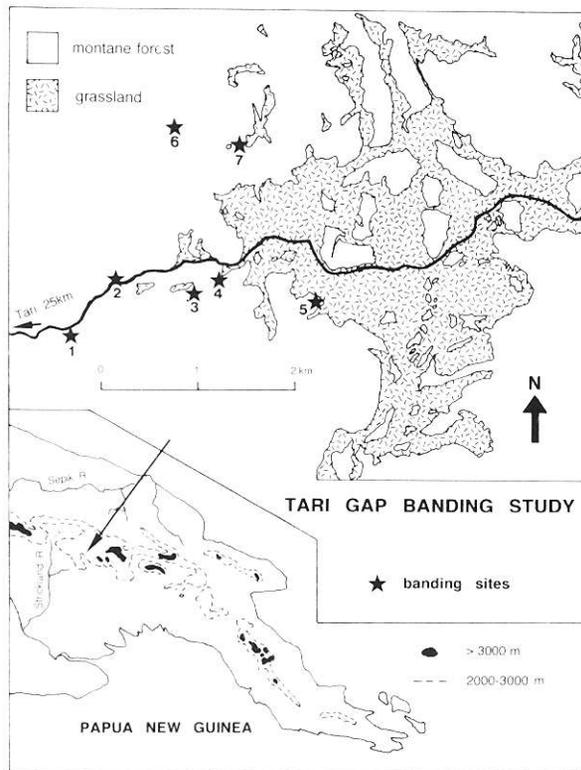


Figure 1. Map of southern Tari Gap, Southern Highland, Papua New Guinea, showing seven banding sites.

Finch *et al.* (1990) provided a locally published annotated list of Tari Gap birds. We mist-netted 50 of the approximately 93 species recorded for the area. Although this banding study is biased toward smaller passerine birds of the subcanopy, it provides useful data on the diversity and relative abundance of the lower strata avifauna at Tari Gap, and presents previously unavailable or limited morphometric data for live endemic highland species. It should be noted that in comparing our measurements of birds with those published in Rand and Gilliard (1967) and elsewhere, we are comparing those taken from live birds with those from skin specimens, and possibly by differing techniques.

Robert W. Campbell (1979–84) and Roy D. Mackay (1982–85) have irregularly and infrequently mist-netted at Tari Gap, and at altitudes below Tari Gap along the Tari-Mt. Hagen road toward the former. We recaptured some of their banded birds (see Results), providing the first longevity

data for some of these species. Recapture data were supplied by the Australian Bird and Bat Banding Scheme (ABBBS), Australian National Parks and Wildlife Service, Canberra. All birds caught by us were banded with ABBBS bands, and measurements were taken in accordance with approved methods (ABBBS 1989), unless noted to the contrary.

We are unaware of any published long-term general avifaunal banding studies carried out in the New Guinea highlands above 2 400 m asl. Diamond (1972) mist-netted birds between c. 1 220–2 490 m in the Eastern Highlands, but for the collection of specimens, and not for banding and release. Filewood (1971) presented results of a long-term study carried out in the lowlands of the Port Moresby area.

We present here data resulting directly from the capture and banding of birds. Additional data, such as those concerning breeding, feeding, vocalizations and behaviour have, and will be, presented elsewhere (Frith and Frith 1987; 1988a,b,c; 1990a,b,c,d,f; 1992; 1993a and b; unpub. data; Finch *et al.* 1990), as has a list of birds seen in the area not mist netted (Frith and Frith 1992).

METHODS

We mist netted at seven sites located at varying distances along 3 km of road (Fig. 1). At each site we erected four 9.15×2.74 m and four 12.2×2.74 m nets per net day, to an effective height of 2.5 m, although occasionally fewer were used. Numbers of nets erected and netting period at sites are summarized in Table 1. Nets were opened between 0600 and 0730 h until heavy afternoon rain commenced. A total of 348.8 hours were spent mist-netting over 49 days during 1986 (= 242.3 h), 1987 (= 95.5 h) and 1989 (= 11 h), with a mean of 7.1 hours per day (Table 1). During 1987 an additional 72.5 h were spent netting close to bowers of Archbold's Bowerbirds. Because we found a number of rare or unknown nests of Archbold's Bowerbird and several birds of paradise during the 1988–89 field work (Frith and Frith 1988a; 1990b and c; 1993a and b; unpub. data), which required intense study, we could perform only minimal bird netting and banding.

Altitude was recorded using an altimeter. Although we did not aim to examine avifaunal differences between sites, since the number of net hours per site varied considerably (Table 1), we compare their capture rates. Net area hours were calculated using the effective height of the net multiplied by its length and hours it was open (Tidemann *et al.* 1988). Mean number of net-area-hours per capture is also presented for each site in Table 1.

Sites (see Fig. 1)

1. 2 460 m asl, in tall open moss forest, directly adjacent to the Tari-Mt.Hagen main road, and badly damaged by native timber cutters.
2. 2 560 m asl, five nets were located just within moss forest mixed with secondary road-edge vegetation, and three were placed on an adjacent cleared, grassy road verge. This site was previously used by R. W. Campbell and R. D. Mackay.
3. 2 630 m asl, c. 330 m from the road, in disturbed forest adjacent to a native hut where many larger trees had been felled or were ring-barked and standing dead or dying; close to adjacent grassland.
4. 2 640 m asl, in forest c. 200 m from the road, along a ridge-top trail bordered by relatively undisturbed moss forest with dense and diverse undergrowth; close to adjacent grassland.
5. 2 700 m asl, c. 400 m from the road in an isolated patch of forest, in a very badly damaged area cleared of many larger trees.
6. 2 800 m asl, c. 1.4 kms from the road, atop a forested peak with tall open relatively undisturbed moss forest with little understorey vegetation.
7. 2 750 m asl, on forested slope and ridge-top c. 1 km from the road, in relatively undisturbed forest with dense undergrowth; close to a native hut and grassland.

For each bird banded we recorded weight with a Pesola balance to 0.1 g degree of accuracy, and measured the length of wing (maximum flattened and straightened) and tail from point of entry into skin of longest (central) feather to its tip with a stopped rule graduated to 1.0 mm. Total head length (THL) was the maximum distance from bill tip to back of skull, and tarsus was measured from the depression in the angle of the intertarsal joint to the distal end of the tarsometatarsus with steel vernier calipers graduated to 0.1 mm. Bill length (anterior margin of skull to tip of bill) and bill width and depth (at anterior nostril) were also recorded for Archbold's Bowerbird and five bird of paradise species. Exposed culmen (see ABBBS 1989) was noted for a few species (see below).

Morphometric data are presented for each species, and for each sex or age group of a species when plumage and/or soft part differences were distinguishable. Where apparently mutually exclusive sexual dimorphism is suggested by measurements in wing length, and are supported by other measurements, we tentatively separate the two groups and discuss them and pertinent literature.

We did not examine birds for moult in detail, merely recording the presence of body and/or flight feather moult in most birds. We noted the presence of a brood patch on a subjective scale of 1 to 3 with regard to its size and degree of vascularization. We recorded weight, moult and presence of brood patch for recaptures caught during the same field trip netting period but for those caught on subsequent visits, also took wing and tail length. We described plumage and soft part colouration if they differed from those given by Rand and Gilliard (1967), Beehler *et al.* (1986) or Coates (1985-90).

We use 'juvenile' for young just out of the nest with a distinctive juvenile plumage and/or gape, and 'immature' for birds that are quite different from the adult and take one or more years to reach maturity. For sexually dimorphic species we use the terms 'female-plumaged' in referring to possible immature males and females and 'sub-adult males' for males changing from immature, female-type plumage to adult male plumage.

We open each species account with the number of individuals we banded and the number of them retrapped. It should be noted that where a subsequent statement refers to numbers of individuals retrapped this may also include birds banded during previous studies. Nesting data for a number of the following species appear in Frith and Frith (1992).

RESULTS

The number of species and captures netted at each site and in total are summarized in Table 1. We caught a total of 50 species, the greatest number of them being netted at Sites 2 and 4, where most time was spent netting. Sites 4 and 7 had the highest, and 5 and 6 the lowest, capture rates (Table 1, see Discussion).

TABLE 1

Periods of time spent mist-netting, numbers of nets used and bird capture rates at seven Tari Gap, Papua New Guinea, sites. See figure and text.

	1	2	3	Net sites		6	7	Total/ mean
				4	5			
No. days @ site	2	9	6	10	7	10	5	49
Total No. hours @ site	15.5	69.8	50.5	82.5	41.0	56.0	33.3	348.5
\bar{X} No. hours @ day	7.8	7.8	8.4	8.3	5.9	5.6	6.7	7.1
No. of species	18	35	27	35	23	22	26	50
No. of captures	56	232	174	356	90	116	150	1 174
No. nets of length: 9.1 m	8	34	25	39	21	40	20	187
12.2 m	8	34	23	37	21	30	20	173
No. net-area-hours	3 309.3	13 885.1	10 705.5	16 874.1	7 194.2	9 979.2	7 089.9	69 037.3
\bar{X} captures @ net-area-hours (10^4)	169.2	167.1	162.5	211.0	125.1	116.2	211.3	170.0
\bar{X} net-area-hours @ capture	59.1	59.6	61.5	47.4	79.9	86.0	47.3	58.8

TABLE 2

Results of examinations of 792 bird captures for moult activity at Tari Gap, Papua New Guinea.

	Sept. 1986		Oct. 1986		Oct. 1987		Nov. 1987		Jan. 1989		Total captures Moulted
	No.	%	No.	%	No.	%	No.	%	No.	%	
Bronze Ground-dove	—	—	8	38	1	100	—	—	—	—	9
Brehm's Tiger Parrot	—	—	3	100	—	—	2	100	—	—	5
Blue-capped Ifrita	—	—	6	0	4	0	—	—	1	100	11
Mountain Mouse-warbler	10	10	10	10	4	25	1	0	—	—	25
Large-billed Scrubwren	14	43	16	38	7	43	17	47	1	100	55
Papuan Scrubwren	17	35	20	40	8	25	11	64	1	100	57
Dimorphic Fantail	10	40	6	33	3	33	4	25	—	—	23
Friendly Fantail	13	31	28	7	8	38	9	67	1	0	59
Canary Flycatcher	1	0	6	17	2	0	2	100	—	—	11
Garnet Robin	2	50	3	33	—	—	—	—	—	—	5
White-winged Robin	4	—	5	40	1	100	7	43	—	—	17
Regent Whistler	2	100	6	17	3	67	2	50	1	100	14
Rufous-naped Whistler	3	0	4	50	3	33	—	—	—	—	10
Wattled Ploughbill	2	0	8	38	3	0	7	43	2	100	22
Fan-tailed Berrypecker	17	6	29	28	17	6	15	27	2	0	80
Crested Berrypecker	3	0	2	0	1	100	2	50	—	—	8
Olive Straightbill	4	50	2	50	1	100	—	—	—	—	7
Red-collared Myzomela	—	—	9	22	8	63	—	—	—	—	17
Black-throated Honeyeater	2	50	7	57	2	100	2	0	—	—	13
Rufous-backed Honeyeater	—	—	6	83	1	100	—	—	2	0	9
Grey-streaked Honeyeater	16	75	30	93	8	75	27	74	8	88	89
Belford's Melidectes	5	80	7	86	1	100	17	100	2	100	32
Smoky Honeyeater	15	53	37	60	15	80	15	87	2	100	84
Mountain Firetail	1	100	6	50	3	0	3	33	1	0	14
Archbold's Bowerbird	—	—	3	67	5	80	6	83	—	—	14
Crested Bird of Paradise	7	57	15	53	4	75	—	—	—	—	26
Loria's Bird of Paradise	1	100	—	—	4	50	—	—	—	—	5
Brown Sicklebill	1	0	4	25	1	100	—	—	—	—	6
Ribbon-tailed Astrapia	5	40	4	75	2	100	1	100	—	—	12
King of Saxony Bird of Paradise	9	44	4	50	4	75	—	—	1	100	18
Other captures (= 18 species)	11	9	14	21	2	100	6	33	2	50	35
Total No. captures and % moulted	175	38	308	43	126	49	156	62	27	70	792

A total of 1 174 captures (all birds caught, including recaptures) were made at the seven standard net sites; 895 were individuals banded by us and the remainder were recaptures, of which 228 (169 individuals) were birds banded by us and 51 (32 individuals) were banded by others. Recaptures do not include birds caught twice during the same day but do include birds retrapped once or more either during the same year or following year(s). Of individuals recaptured 149 were re-caught once, 35 twice, 11 three times, 5 four times and 1 six times, a total of 279 recaptures. Apart from seven individuals of six species (see Discussion), all 201 recaptured individuals were re-netted at their original banding site. In addition, we also netted a Brown Sicklebill and seven

Archbold's Bowerbirds in random nets placed close to bowers (see Methods).

We examined 792 captured birds of 48 species for body and flight feather moult (failing to examine the Glossy Swiftlet and Orange-crowned Fairy-wren). Total moult data, and for each month, are summarized in Table 2. Data for species with less than five, or no, captures in moult are presented collectively in Table 2, but are detailed in the species accounts. Of all captures, 48 per cent were in body and/or flight feather moult. Fewer birds were in moult during September 1986 (38%), October 1986 (43%) and October 1987 (49%) than in November 1987 (62%) and January 1989 (70%).

In the following species accounts we present recapture, moult, and morphometric data and discuss information on age, sex, breeding condition, plumage and soft part colours. Numbers of individuals captured and morphometric data for each species are presented in Table 3, except for the Fan-tailed Berrypecker (Table 4), Archbold's Bowerbird and the birds of paradise (Table 5). We do not repeatedly refer to Table 2 (moult) or Tables 3–5 (morphometric data) in species accounts, unless emphasising a point. We do not mention moult and/or brood patch if absent in all examined individuals of a species. Unless otherwise stated, all recaptures, including those banded by others, were re-caught at their original banding site.

To avoid a complex concluding discussion, noteworthy aspects of each species are briefly discussed in the relevant species account, and the Discussion deals only with general aspects of the avifauna. Species order and nomenclature follow Beehler and Finch (1985).

Black-mantled Goshawk *Accipiter melanochlamys*

One adult netted in ridge-top forest, Site 3, 25 September 1986.

Brown Quail *Coturnix australis*

One individual caught at road verge, Site 2, 28 September 1986, was originally banded as an adult in the same area by R. W. Campbell on 15 July 1984, 2 years, 2 months, 13 days previously.

Rufous Woodcock *Scolopax saturata*

Of two birds flushed from forest floor on 21 November 1987 one flew into a Site 7 net. Its exposed culmen was 80.7 mm.

Bronze Ground-Dove *Gallicolumba beccarii*

Individuals banded: 10, six males, three females and one we failed to note the sex of. Measurements of males and females were similar. Our tail measurements (65–74 mm) are greater than those (in parenthesis) of Rand and Gilliard (1967) for both mainland *G. b. beccarii* (54 mm) and the longer-tailed island form *G. b. johannae* (63 mm). Moult: in four of nine examined.

Brehm's Tiger-Parrot *Psittacula brehmii*

Individuals banded: four of each sex, their measurements were similar. Exposed culmen lengths of two males were 18.5 and 19.6 mm, and that of one female 20.2 mm.

Painted Tiger-Parrot *P. picta*

A female banded on 15 October 1987 had body and flight feather moult.

Modest Tiger-Parrot *P. modesta*

A male banded on 6 October 1986 was in flight feather moult.

Glossy Swiftlet *Collocalia esculenta*

One bird hit a Site 2 road-verge net during heavy rain, and we recorded only its weight.

Island Thrush *Turdus poliocephalus*

Individuals banded: four. Only a bird banded on 12 November 1987 was in moult, body and flight feathers.

Logrunner *Orthonyx temminckii*

A female banded on 12 September 1986 and a male on 30 September 1986 both lacked moult. The female was slightly smaller than the male, but this male's wing length of 87 mm was less than the 91–95 mm of Rand and Gilliard (1967).

Lesser Melampitta *Melampitta lugubris*

We banded a male on 15 October 1987 and a female with a brood patch on 31 January 1989. From observations at four active, previously undescribed, nests (Frith and Frith 1990b, in Coates 1990), we were able to sex the birds by iris colour: in females dark brown and in males blood red. The male was slightly heavier than the female but other measurements were similar (Table 3). The male's bill length was 24.6 mm, depth 5.8 mm and width 9.9 mm; the bird was in slight body moult.

Blue-capped Ifrita *Ifrita kowaldi*

Individuals banded: 11, eight adults and three immatures; immatures were identified by an ochre eye-stripe (white in adults, Beehler *et al.* 1986). Immatures are said to have less blue on the crown than adults (Rand and Gilliard 1967), which we did not note, and ochraceous brown tipping to the wing coverts (Coates 1990). Tails of immatures were slightly shorter than those of adults, but other measurements were similar (Table 3). Only the immature netted on 31 January 1989 had active moult of body and flight feathers. This bird is at its upper altitudinal limit at Tari Gap (Beehler *et al.* 1986).

Tawny Grassbird *Megalurus timoriensis*

Individuals banded: two, on 24 September and 7 October 1986, both had body and flight feather moult.

Orange-crowned Fairy-wren *Clytomyias insignis*

Individuals banded: four, obviously fellow flock members, flew into a Site 4 net on 12 September 1986. The species is at its upper altitudinal range limit at Tari Gap as given by Beehler *et al.* (1986).

Mountain Mouse-Warbler *Crateroscelus robusta*

Individuals banded: 30, retrapped five. The longest period between banding and recovery was 13 months, one day. Seventeen birds were male, 12 female-plumaged and one juvenile which resembled a female but had a distinct gape. Males have a cream-coloured iris and females a brown one as indicated in Plate 35 of Beehler *et al.* (1986) but not noted as sexual dimorphism in the text, and by Diamond (1972). Iris colour of immatures of both sexes may be brown or grey-brown (Diamond 1972; Coates 1990). It is possible that some birds we classified as female were immature, although we did not note immature underpart colouration (Coates 1990); we therefore refer to these birds as female-plumaged in Table 3. All female-plumaged birds and the juvenile were slightly smaller than males, particularly in wing length (Table 3), contrary to measurements given by Rand and Gilliard (1967). Molt: in three of 25 examined.

Large Scrub-wren *Sericornis nouhuysi*

Individuals banded: 73, retrapped 17. An adult banded by R. W. Campbell on 13 June 1983 was recaptured on 21 September 1986, 3 years, 3 months, 8 days after banding. Fifteen individuals were recaptured once, 2 twice and 1 three times.

Molt: in 24 of 55 examined; this percentage was similar in September 1986, October 1986, October 1987 and November 1987 (Table 2). Brood patch: in five of 64 examined, on 29 September 1986 (scale 2), 18 October 1986 (1), 22 October 1986 (2), 6 November 1987 (3), 17 November 1987 (3).

It is noteworthy that the large samples measured of this species and of the Papuan Scrubwren show mutually exclusive tarsal lengths and almost mutually exclusive total head lengths (Table 3).

Papuan Scrub-wren *Sericornis papuensis*

Individuals banded: 56, retrapped 22. Five individuals previously banded by others also retrapped, two of which were banded by R. W. Campbell on 12 June 1983 and retrapped by us on 12 and 17 November 1987, 4 years, 5 months after banding. Two of the recaptured individuals were originally banded by R. D. Mackay on 17 and 18 July 1984 and mis-identified as Buff-faced Scrubwrens *S. perspicillatus*. We recaptured one on 21 September 1986 and the other four times (15 and 21 September, 7 and 17 October 1986) and each time confidently identified them on plumage (Beehler *et al.* 1986) and larger size (Rand and Gilliard 1967) as Papuan Scrubwrens. Seventeen individuals were recaptured once, 6 twice, 2 three times, 1 four times and 1 six times. One individual banded by R. D. Mackay near to our Site 1 on 15 November 1985 was recaptured at Site 5 on 18 October 1987, c. 2.7 km distant.

Molt: in 24 of 57 examined; a larger percentage were in molt during November 1987 than in other months (Table 2). A bird captured on 15 September 1986 showed no molt, but had commenced body and flight feather molt by 7 October

1986. Of 62 captures examined, only one, on 24 September 1986, had a brood patch (scale 2). The previously undescribed nest was found (Frith and Frith 1988b).

On 17 November 1987 we netted a juvenile scrubwren with a slight yellow gape, bright buff eye-ring, buff feathers on cheeks and throat, greyish on ear, crown and nape, and olive back, mantle and rump. Its wings were olive with paler bases to the leading edges of the primaries, and there was a black subterminal band on the inner webs of all tail feathers save one central. It weighed 7.9 g, THL was 27.5 mm, wing length 51 mm, tail length 42.3 mm and tarsus 18.9 mm. This bird was lighter and had a shorter wing than Papuan Scrubwrens we measured (see Table 3). No netted Papuan Scrubwrens had a distinctive buff eye-ring. The smaller size of this bird, and its distinct buff facial markings, could indicate a Buff-faced Scrubwren. Buff-faced Scrubwrens have not been recorded at this altitude at Tari Gap (Finch *et al.* 1990), and we did not record any others of this species during our study. As this individual's identity was in doubt, we banded it so that its recapture in a subsequent plumage might provide valuable information concerning the confusing juvenile plumage.

Dimorphic Fantail *Rhipidura brachyrhyncha*

Individuals banded: 24, retrapped five (plus three banded by others). One banded by R. W. Campbell on 16 July 1984 was caught by us on 25 September 1986, 2 years, 2 months, 9 days after banding. Seven individuals were recaptured once and 1 twice.

Most individuals (85%) were dark phase (Mayr and Rand 1937), the remainder being pale form (Beehler *et al.* 1986). Molt: in eight of 23 examined. Two birds had brood patches, one on 18 October (scale 2) and the other 16 November 1987 (1). We retrapped the former on 19 November 1987 with only a trace of a brood patch.

Black Fantail *R. atra*

Rand and Gilliard (1967) gave an altitudinal range of c. 1 000–3 000 m for this species but Beehler *et al.* (1986) revised this to 1 000–2 400 m. We banded eight birds at Sites 1 to 3 (2 460–2 630 m). We banded three male and five female-plumaged birds. We could not sex female-plumaged birds, as immature males resemble females (Diamond 1972). Female-plumaged birds were slightly smaller than males (Table 3).

Friendly Fantail *R. albolimbata*

Individuals banded: 71, retrapped 14. We caught two banded by others; one banded by R. W. Campbell on 13 June 1983 was recaptured by us on 21 September 1986, and was caught again on 28 September 1986, 3 years, 3 months, 15 days after banding. Ten individuals were recaptured once and 5 twice.

Sixty-four individuals were adults; seven in juvenile plumage were smaller (Table 3) and had traces of rufous feathers on some or all of the back, rump, upper wing coverts and tertials. This juvenile plumage is not noted by Rand and Gilliard (1967) and Beehler *et al.* (1986), but is described by Coates (1990).

Moult: in 15 of 59 examined, a greater percentage moulting during November 1987 than in other months (Table 2). Brood patch: in two of 62 examined, on 5 November (scale 1) and 6 November 1987 (1). The former lacked a brood patch on 21 October 1987. Two juveniles were netted during September and five in October 1986.

Black Monarch *Monarcha axillaris*

The presence of this bird at Tari Gap represents an altitudinal record above its documented range of c. 1 160–2 350 m (Rand and Gilliard 1967) and 1 400–2 200 m of Beehler *et al.* (1986). We banded two males and one female. Females were slightly smaller than males (Table 3).

Black-breasted Boatbill *Machaerirhynchus nigripectus*

We banded two males and two females. Females were smaller than males (Table 3). One November 1987 male had body and flight feather moult.

Canary Flycatcher *Microeca papuana*

Individuals banded: nine, retrapped four. We also recaptured an individual, banded by R. D. Mackay on 18 July 1984, on 17 October 1986, 2 years, 3 months after banding. Moult: in three of 11 examined.

Garnet Robin *Eugeryone rubra*

Individuals banded seven: one adult male, one sub-adult male, four females and one juvenile. Adult males were heavier than the young male, females or juvenile (Table 3). The young male's tail was shorter than that of the adult male, and the juvenile's tail was smaller than adults (Table 3).

Of five captures examined two were in moult. A female caught with the juvenile on 21 October 1987 had the last signs of a brood patch. One subadult was netted in October 1986 and the juvenile in October 1987, suggesting this species commenced breeding during August, or earlier.

Black-throated Robin *Poecilodryas albonotata*

Tari Gap is just at, or a little higher than, the documented extreme upper altitude for this species of c. 1 370–2 750 m (Rand and Gilliard 1967) and 1 350–2 700 m (Beehler *et al.* 1986). It was uncommon, and we banded only two individuals.

Lesser Ground Robin *Amalocichla incerta*

We caught one individual on 12 September 1986 in juvenile plumage (as described by Beehler *et al.* 1986).

White-winged Robin *Peneothello sigillatus*

Individuals banded: 25, seven retrapped, 5 once and 2 twice. The longest period between banding and recovery was 1 year, 1 month, 3 days. Twenty individuals were adult and four were in juvenile plumage (as described in Beehler *et al.* 1986). Adult and juvenile measurements were similar (Table 3).

Moult: in six of 17 examined. Brood patch: in two of 22 examined, on 6 November (scale 1) and 21 November 1987 (3). We caught juveniles during September (2 birds) and October (2) 1986 and October (2) 1987, one of which (15 October 1987) was moulting into adult plumage.

Regent Whistler *Pachycephala schlegelii*

Individuals banded: 17, retrapped three; the longest period between banding and recovery being 1 year, 29 days. Ten individuals were males, of which seven were in adult plumage, and three were sub-adult males in female plumage with signs of male adult plumage (i.e., a few black feathers in crown and/or a few orange feathers in abdomen). Six unsexed individuals were in female plumage and one was in female plumage with some remnants of juvenile plumage (Beehler *et al.* 1986, Plate 41). Moult: in seven of 14 examined. The only juvenile was netted on 12 September 1986.

Brown-backed Whistler *Pachycephala modesta*

We caught one individual on 4 January 1989 at Site 7, with moult in its flight feathers.

Rufous-naped Whistler *P. rufinucha*

Individuals banded: 13, retrapped two. A bird banded by R. W. Campbell on 19 November 1982 at Site 2 was recaptured at Site 3 on 16 October 1987, 5 years, 22 days after banding and c. 850 m from its original capture point. Two individuals were recaptured once and one twice. Moult: in three of ten examined.

Little Shrike-thrush *Colluricincla megarhyncha*

We caught two individuals at Site 2 during October 1986 that were considerably smaller than indicated by measurements of Rand and Gilliard (1967). This constitutes an upper altitude record for the species, being higher than the 2 134 and (rarely) 2 150 m recorded by Rand and Gilliard (1967) and Beehler *et al.* (1986) respectively.

Wattled Ploughbill *Eulacestoma nigropectus*

Individuals banded: 19, retrapped three. We also recaptured a bird banded by R. D. Mackay near our Site 1, on 18 November 1982, at Site 4 on 15 October 1987, 4 years, 10 months, 27 days after banding. The distance between these two capture points was c. 1.7 km. Three individuals were recaptured once and 1 twice.

Ten individuals were male, five female, three immature and one juvenile (of Coates 1990). Measurements of both sexes and all ages were similar (Table 3). Wattles of two adult males measured 19.1 and 17.3 mm in vertical depth and 16.0 and 14.00 mm in horizontal width, respectively. One immature had a wattle 5.4 mm deep, demonstrating that young males acquire wattles while retaining some juvenile plumage. The juvenile was netted with a female, presumed to be its parent, on 5 November 1987. One immature was caught on 6 November 1987 and two on 31 January 1989. Moult: in eight of 22 examined. Of birds examined, females were larger than males (Table 3).

TABLE 3 continued
Number of bird captures and morphometric data for 43 species caught at Tari Gap, Papua New Guinea. See Tables 4 and 5.

	Total No. captures		Body weight (g)		Total head length (mm)		Wing length (mm)		Tarsus length (mm)		Tail length (mm)															
	X	n	X	SD	X	SD	X	SD	X	SD	X	SD														
Garnet Robin	7	8.4	0.4	7.9	9.0	7	27.9	0.9	26.5	29.1	7	59.4	1.4	57	61	7	16.7	0.9	15.1	17.4	5	48.5	2.6	45	51	5
Male	1	9.0	-	-	-	1	27.9	-	-	-	1	50.0	-	-	-	1	17.1	-	-	-	1	51.0	-	-	-	1
Sub-adult male	1	8.4	-	-	-	1	27.6	-	-	-	1	61.0	-	-	-	1	17.4	-	-	-	1	47.0	-	-	-	1
Female	4	8.3	0.4	7.9	8.5	4	28.3	0.9	27.1	29.1	4	58.9	1.7	57	61	4	16.9	0.5	16.5	17.2	2	50.0	1.4	49	51	2
Juvenile	1	8.3	-	-	-	1	26.5	-	-	-	1	59.0	-	-	-	1	15.1	-	-	-	1	45.0	-	-	-	1
Black-throated Robin	2	40.2	2.4	38.5	41.9	2	45.0	1.1	44.2	45.8	2	110.0	7.1	105	115	2	24.5	1.4	23.5	25.5	2	78.0	5.7	74	82	2
Lesser Ground-robin	1	34.7	-	-	-	1	43.8	-	-	-	1	80.0	-	-	-	1	40.0	-	-	-	1	64.0	-	-	-	1
White-winged Robin	34	22.8	1.7	18.5	26.7	33	37.3	1.1	35.9	39.0	18	94.9	3.7	89	101	22	28.6	1.1	26.7	30.1	11	67.9	4.8	61	71	11
Adult	28	23.0	1.8	18.5	26.7	27	37.8	1.1	35.9	39.0	16	95.2	3.8	90	101	19	28.3	1.0	26.7	30.1	9	67.0	2.5	64	71	8
Juvenile	6	22.1	1.1	20.3	23.3	6	37.4	1.4	36.4	39.0	3	53.0	3.6	89	93	3	29.4	0.4	29.4	30.0	2	66.0	7.1	61	71	2
Regent Whistler	20	22.7	1.8	19.3	25.4	19	37.7	0.5	37.1	38.5	10	89.4	3.2	84	96	13	24.5	0.6	23.6	25.1	6	69.6	3.4	65	74	7
Male	8	24.0	0.8	23.0	25.4	7	37.8	0.7	37.2	38.5	4	91.8	2.6	89	96	6	24.7	0.4	24.1	25.1	4	70.4	3.3	67	74	5
Immature male	3	22.4	0.6	21.9	23.0	3	37.6	0.6	37.1	38.0	3	88.5	0.7	88	89	2	23.6	-	-	-	1	70.0	-	-	-	1
Female plumage	7	22.4	1.9	19.3	24.4	7	37.8	0.1	37.2	37.9	3	87.0	-	84	89	2	23.6	-	-	-	1	65.0	-	-	-	1
Juvenile	2	19.6	0.7	19.3	20.3	2	37.8	-	-	-	1	86.0	0.7	-	-	1	23.6	-	-	-	1	67.0	-	-	-	1
Brown-backed Whistler	1	20.5	-	-	-	1	36.1	-	-	-	1	90.0	-	-	-	1	23.6	-	-	-	1	67.0	-	-	-	1
Rufous-naped Whistler	17	40.5	3.3	37.1	47.1	15	42.8	0.7	41.8	44.1	10	104.3	3.1	99	108	12	30.1	1.5	28.6	31.5	3	95.0	5.6	90	101	3
Little Shrike-thrush	7	36.7	1.9	35.3	38.0	2	46.3	0.3	46.1	46.5	2	98.0	4.2	95	101	2	26.9	0.5	26.5	27.2	2	80.0	5.7	76	84	2
Wattled Ploughbill	24	20.0	1.5	17.0	23.2	24	33.1	0.9	31.6	35.0	14	72.8	2.7	67	76	17	21.0	1.2	19.8	23.2	8	52.8	2.6	50	57	10
Male	13	19.6	1.0	18.6	21.2	13	32.8	0.5	31.9	33.3	8	72.2	2.5	67	74	9	20.0	0.5	19.8	21.2	4	51.0	1.0	50	52	5
Female	7	20.7	2.2	17.0	23.2	7	33.6	0.6	33.1	34.2	3	74.6	1.3	73	76	5	20.4	-	-	-	1	51.0	2.8	52	56	2
Immature	3	19.9	1.0	19.3	21.1	3	33.3	2.4	31.6	35.0	2	70.5	3.5	68	73	2	22.6	0.9	21.9	23.2	2	54.5	3.5	52	57	2
Juvenile	1	19.1	-	-	-	1	33.2	-	-	-	1	70.0	-	-	-	1	21.0	-	-	-	1	56.0	-	-	-	1
Tit Berrypecker	1	16.8	-	-	-	1	30.2	-	-	-	1	68.0	-	-	-	1	19.1	-	-	-	1	44.0	-	-	-	1
Crested Berrypecker	17	42.8	2.0	40.6	48.4	17	41.4	1.0	39.2	42.3	10	104.3	3.1	99	108	12	30.1	1.5	28.6	31.5	3	95.0	5.6	90	101	3
Olive Straightbill	7	16.4	1.6	16.1	20.5	7	35.6	0.7	34.8	36.9	7	76.7	3.0	74	82	7	22.3	1.3	21.5	23.8	3	59.0	2.0	57	61	3
Red-collared Myzomela	25	10.3	0.7	8.9	11.5	25	33.2	0.9	31.2	34.8	18	62.5	3.1	58	68	19	16.8	0.5	16.1	17.3	10	41.6	2.5	36	45	12
Male	8	10.6	0.5	9.8	11.5	8	32.8	0.4	32.3	33.0	4	53.8	0.5	63	64	4	16.9	0.4	16.6	17.2	2	43.0	1.9	42	44	2
Immature male	8	10.3	0.8	9.3	11.4	8	32.8	0.7	32.2	34.8	6	64.3	2.7	60	68	8	16.9	0.4	16.5	17.0	3	43.3	1.5	42	45	4
Female	8	9.7	0.6	8.9	10.8	8	32.6	1.1	31.2	34.0	6	58.8	1.0	58	60	6	16.6	0.7	16.1	17.2	4	39.4	2.1	36	41	5
Black-throated Honeyeater	15	30.2	2.8	24.8	33.6	15	46.1	1.6	43.3	48.2	12	98.8	6.6	85	108	12	25.4	1.4	23.2	28.1	10	9.4	3.8	66	86	10
Rufous-backed Honeyeater	12	20.0	2.1	18.0	23.7	12	41.0	1.6	39.3	44.0	8	80.1	4.6	72	88	11	25.3	0.8	24.2	26.5	7	70.2	2.2	68	75	9
Male	2	23.6	0.1	23.5	23.7	2	44.0	-	-	-	1	87.5	0.7	87	88	2	25.2	-	-	-	1	70.5	0.5	70	71	2
Female	9	18.9	0.9	18.1	20.6	9	40.6	1.2	39.3	42.7	7	78.5	3.1	72	81	9	25.2	0.8	24.2	26.5	6	70.1	2.5	68	75	7
Grey-streaked Honeyeater	149	26.5	3.4	20.0	32.7	137	45.3	2.3	41.5	50.3	70	93.9	5.6	81	106	91	28.8	2.0	26.0	32.0	32	90.7	5.7	81	102	31
Adult	142	26.6	3.3	20.0	32.7	132	45.3	2.2	41.5	50.3	68	93.9	5.7	81	106	86	28.8	2.0	26.0	32.0	31	90.9	5.8	81	102	29
Juvenile	7	22.8	2.2	20.6	26.4	5	45.2	2.4	43.5	46.9	2	94.0	4.9	88	99	5	29.0	-	-	-	1	88.0	4.2	85	91	2
Belford's Melidectes	41	70.2	11.0	58.6	93.0	38	68.3	4.0	64.4	74.3	21	139.5	7.7	125	154	25	33.2	1.8	30.9	36.2	10	121.1	9.9	112	133	10
Male	15	85.2	5.7	78.0	92.0	13	71.8	2.2	67.3	74.3	8	147.1	6.5	132	132	132	34.8	1.2	34.2	36.2	4	127.3	10.2	112	133	4
Female	26	62.8	2.8	58.5	69.2	25	66.8	1.6	64.4	70.1	13	134.9	4.2	125	141	16	32.1	1.1	30.9	33.7	6	116.2	7.1	104	117	5
Common Smoky Honeyeater	134	58.6	7.5	43.6	81.6	126	48.3	1.6	45.1	52.2	75	116.1	6.3	98	130	77	32.7	1.8	25.3	35.1	38	104.6	6.1	92	119	37
Blue-faced Parrot-finch	1	15.9	-	-	-	1	29.0	-	-	-	1	64.0	-	-	-	1	17.4	-	-	-	1	41.0	-	-	-	1
Mountain Firetail	18	16.3	1.0	17.2	20.0	17	27.2	0.9	25.2	28.0	9	59.3	1.5	67	71	10	24.0	1.2	22.2	26.2	7	48.0	1.2	47	50	7

Fan-tailed Berrypecker *Melanocharis versteri*

Individuals banded: 96, retrapped 21. We also captured four individuals banded by others, including a male banded by R. D. Mackay on 6 November 1982 and recaptured by us on 21 September 1986, 3 years, 10 months, 15 days later. Another bird, banded by R. W. Campbell in female plumage on 19 November 1982, was recaptured by us on 21 September 1986 in male plumage 3 years, 10 months, 2 days later. Twenty individuals were recaptured once, 3 twice, 1 three times and 1 four times. The last bird, female-plumaged and banded on 12 September 1986, was recaptured at the same site four times, the last being on 31 January 1989, when it had a trace of a brood patch; the time between banding and last recovery was 2 years, 4 months, 19 days. All recaptures were netted at their original banding site with two exceptions, a female banded at Site 6 on 5 October 1986 recaptured at Site 1 on 26 October 1987 (a distance of c. 2.3 km) and a male banded in female plumage on 15 September 1986 at Site 2 caught at Site 7 on 9 November 1987 (a distance of c. 2 km) with only traces of remnant female plumage (see below).

Rand and Gilliard (1967) noted that males are smaller than females in wing measurement (male 61, female 68 mm) and our data clearly show this (Table 4). We found that females are much heavier (\bar{x} = 18.2 g) than males (\bar{x} = 12.6 g). Tail length in males is, however, considerably longer than in females of the subspecies *M. v. maculiceps*, presumably represented at Tari Gap. Using these criteria, we tentatively sexed all female-plumaged birds in Table 4. Males fell into three age categories: (a) glossy-black adult males (16 individuals), (b) sub-adult males in female plumage but with either traces of male plumage showing (i.e., a few black iridescent head feathers, or few black feathers in upper tail coverts or in breast) or almost fully black plumage with remnants of female plumage (i.e., remains of olive feathers in crown and on leading edges of secondaries and tail coverts) (13); and (c) immatures in female plumage (19). Weights and measurements were similar for each male age category. We also banded 40 immature or adult females with higher body weights and eight juveniles in (subjectively) softer textured female plumage with an obvious yellow gape. Juveniles were not attributed a sex, although at least three of them fell within the higher female weight category, and their tails were shorter than those of adults (Table 4).

Moult: in 14 of 80 examined. Three female-plumaged immature males, caught on 15 and 28 September and 18 October 1986, were in sub-adult male plumage when recaptured on 9, 12 and 19 November 1987 respectively. One was moulting to the glossy-black adult plumage, while another was not moulting but had some olive feathers in its crown and olive on the leading edges of its secondaries and in its upper tail coverts; we failed to examine the third individual for moult. Seven of the other ten sub-adults were not in moult. It would, therefore, appear that males take at least two, or even three, years to acquire full adult plumage.

Of 80 captures examined, only five of the larger females had a brood patch, on 29 October 1986 (scale 2); 16 October (1, and caught with a juvenile), 9 November (1, 1) and 17 November 1987 (1). Juveniles were caught in nets during September (1 bird) and October (4) 1986, and in October (2) and November (1) 1987.

Tit Berrypecker *Oreocharis arfaki*

Common in small parties at Tari Gap, but we caught only one male, in body moult on 28 October 1986.

Crested Berrypecker *Paramythia montium*

Individuals banded: 13, three retrapped, 2 once and 1 twice. Moult: in two of eight examined. Brood patch: in two of ten examined, on 12 October 1986 (scale 2) and 6 November 1987 (1).

Olive Straightbill *Timeliopsis fulvigula*

Individuals banded: seven, four of which in moult. Brood patch: in one of seven examined (scale 1) on 19 October 1987. These birds represent a high altitude record for the species, previously recorded up to 1 900 m (Rand and Gilliard 1967), 2 500 m (Beehler *et al.* 1986) and 2 700 m (Coates 1990).

Red-collared Myzomela *Myzomela rosenbergii*

Individuals banded: 24, retrapped one 14 days later. Sixteen individuals were male, seven were in female plumage, and we failed to record plumage details of one. Eight males were in adult plumage, and the remainder had female plumage with signs of adult male plumage, varying from a few black feathers on the throat to a black tail and back and complete red collar. We could not sex female-plumaged individuals, because immature males look like females (Rand and Gilliard 1967). Female-plumaged birds were smaller than sub-adult and adult males, particularly in wing and tail length (Table 3). Moult: in seven of 17 examined, mostly during October 1986 (Table 2).

Black-throated Honeyeater *Lichenostomus subfrenatus*

Individuals banded: 14, retrapped one 22 days later. Moult: in seven of 13 examined.

Rufous-backed Honeyeater *Ptiloprora guisei*

Individuals banded: 12. This species is similar to the Grey-streaked Honeyeater *P. perstriata*, but is distinguished from it by a russet wash on back and smaller size (Beehler *et al.* 1986). Our Rufous-backed Honeyeaters were smaller in weight and size than Grey-streaked Honeyeaters, although there was some overlap in size range of total head length, wing and tarsus measurements (Table 3). Moult: in eight of nine examined.

We did not identify sexes herein by measurements alone (see Methods); however the literature indicates that the sexes of this species are clearly separable on wing length, the females being smaller (Rand and Gilliard 1967; Diamond 1972). It is noteworthy that nine of our birds had wing lengths of 72–81 mm and the other two of 87 and 88 mm. The latter two birds were also the heaviest. Because all measurements except tail and tarsus are mutually exclusive between what we assume to be the two sexes, we separate them in Table 3, but emphasize that this is tentative.

Grey-streaked Honeyeater *P. perstriata*

Individuals banded: 93, retrapped 32. We also recaptured eight individuals banded by others. One banded by R. W. Campbell on 12 June 1983 was recaptured by us on 18 October

1986 and 19 November 1987, 4 years, 5 months, 7 days after banding. Two recaptured individuals were originally banded and identified by R. D. Mackay on 11 July and 12 July 1984 as Rufous-backed Honeyeaters *P. guisei*, but when we retrapped them on 28 October 1986 (both birds) and 12 November 1987 (one bird), we confidently identified them as Grey-streaked Honeyeaters on both plumage and larger size (see above). Their measurements fell well within the range we recorded for Grey-streaked and were larger than any Rufous-backed Honeyeater we examined (see Table 3), except for one tarsal measurement which was the same (26.5 mm) as the largest Rufous-backed we measured. Thirty individuals were recaptured once, 5 twice, 4 three times and 1 four times. One individual, banded on 24 September 1986 at Site 4, was recaptured four days later at Site 2 on 28 September 1986, a distance of c. 1.1 km.

We caught 87 adults and six in juvenile plumage (of Rand and Gilliard 1967). These juveniles were lighter in weight, had a shorter tail than adults (Table 3) and had a grey iris as opposed to the green of adults.

Rand and Gilliard (1967) recorded an adult male wing length of 98 mm and female wing length of 92 mm. Our measurements show that 43 captures had a wing length of 92 mm or less (minimum 81 mm), 27 a wing length of 98 mm or more (maximum 106 mm), and 16 a wing length of 93 to 97 mm inclusive. The smaller-winged birds had a mean tail length of 85.9 mm ($n = 13$; $SD = 2.94$; range 81–91 mm) and mean weight of 24.4 g ($n = 42$; $SD = 2.56$; range 20.9–32 g); and the longer-winged birds had a mean tail length of 94.5 mm ($n = 10$, $SD = 4.7$; range 87–102 mm) and mean weight of 29.3 g ($n = 25$; $SD = 2.1$; range 26.4–33.5 g). Birds with intermediate wing lengths had a mean tail length of 94.8 mm ($n = 6$; $SD = 4.9$; range 90–102 mm) and a mean weight 26.9 g ($n = 16$, $SD = 3.5$; range 20–31 g). Although it appears likely our smaller birds were female and the larger ones male, we have not separated the sexes in Table 3.

Moult: in 73 of 89 examined; the percentage of moulting birds was high during each month we banded (Table 2). Brood patch: in five of 99 examined, on 25 September (scale 2), 9 October 1986 (3), 16 October (1), 21 October (1) and 12 November 1987 (1). Juveniles were netted during November 1987 (5) and January 1989 (1). The previously undescribed nest was found (Frith and Frith 1988b).

Belford's Melidectes *Melidectes belfordi*

Individuals banded: 34, retrapped two. We also recaptured one individual, banded by R. W. Campbell on 4 February 1984, on 17 November 1987, 3 years, 9 months, 13 days after banding. One individual was recaptured once, 1 twice and 1 three times.

Rand and Gilliard (1967) noted that the wing of females was considerably shorter than that of males. While we did not attempt to sex the birds in the field, the following analysis of morphometric data appears useful.

Based on weight alone, our captures are divisible into two distinct sizes: heavier birds with a mean weight of 85.2 g (range 78–93 g) and lighter ones with a mean of 62.6 g (range 58.5–69.2 g). Wings of heavier birds were considerably longer,

and we assume these were male. Indeed, all measurements of heavier birds were larger although there was slight overlap between measurements of presumed males and females for wing, tail and total head lengths (Table 3). We therefore separated morphometric data for the sexes in Table 3, but emphasize that this is tentative.

Moult: in 30 of 32 examined; the percentage of moulting individuals was high during all months of study (Table 2). Brood patch: in two of 33 examined, on 18 September 1986 (scale 2) and 6 November 1987 (1).

In Diamond's (1972) experience, Belford's *Melidectes* "remains in the crowns, [and] is rarely netted" but our 37 captures clearly indicate this was not the case in the Tari Gap forests during our study periods.

Common Smoky Honeyeater *Melipotes fumigatus*

Individuals banded: 98, retrapped 17. We also recaptured three individuals banded by others, including one banded by R. W. Campbell on 6 November 1982 and recaptured by us on 7 October 1986, 3 years, 11 months after banding. This individual was banded at Site 2, first recaptured by us at Site 4 on 12 September 1986, and again recaptured back at Site 2 on 7 October 1986, a movement between sites of c. 1.1 km each way. Ten individuals were recaptured once, 6 twice, 2 three times and 2 four times.

Rand and Gilliard (1967) noted that wing length is longer in males than females and gave a male wing length of 117 mm for the subspecies *M. f. goliathi*, which presumably occurs at Tari Gap. Wing lengths of this subspecies given by Diamond (1972) ranged from 100–119 mm ($\bar{x} = 113$) for males and 101–108 mm ($\bar{x} = 105$) for females. Gilliard and LeCroy (1961) gave weights of males of this subspecies as 54–66 g and of females as 47.6–57 g; and Diamond (1972) gave values of 46–68 g ($\bar{x} = 56.1$) for males and 44–57 g ($\bar{x} = 49.9$) for females. While it would appear males are larger than females, we combine the data in Table 3, as there is much overlap in weights and wing lengths.

Moult: in 57 of 84 examined, the highest percentage being during October and November 1987 (Table 2). Brood patch: in seven of 88 examined, on 12 September (scale 1), 7 October (1) and 9 October 1986 (1); 15 October (1, 1, 2), and 9 November 1987 (3).

Blue-faced Parrot-Finch *Erythrura trichroa*

We banded one immature at Site 3 on 29 October 1986. Darker blue facial feathers were replacing pale chalky blue ones. Its bill depth at the front of the nostrils was 8.1 mm and bill width 7.0 mm.

Mountail Firetail *Oreostruthus fuliginosus*

Individuals banded: 12, retrapped five. A bird banded by R. D. Mackay on 17 July 1984 was recaptured on 28 September 1986, 2 years, 2 months, 11 days later. Moult: in five of 14 examined. The previously undescribed nest was found and examined (Frith and Frith 1990a).

TABLE 4

Morphometric data for 129 Fan-tailed Berrypecker captures at Tari Gap, Papua New Guinea.

	Total No. Captures	Body weight (g)					Total head length (mm)				
		\bar{X}	SD	range		n	\bar{X}	SD	range		n
Male: Adult	22	12.6	0.7	10.8	13.8	21	29.9	0.58	29.2	31.0	31
Sub-adult	16	12.8	0.7	11.5	13.8	16	29.5	0.98	27.4	30.4	7
Female plumaged	24	13.3	0.7	11.0	14.4	24	29.8	1.37	27.9	33.1	14
Female: Immature or adult	59	18.2	1.3	16.5	21.0	55	31.3	1.68	29.2	33.1	33
Juvenile: Male or female	8	14.2	2.3	10.7	17.6	7	30.0	1.60 [†]	27.2	31.5	6

TABLE 5

Number of bird captures and morphometric data for Archbold's Bowerbird and five Bird of Paradise species at Tari Gap.

	Total No. Captures	Body weight (g)				
		\bar{X}	SD	range		n
Archbold's Bowerbird — Male	4	180.9	5.6	173.5	186.5	4
Sub-adult male	2	187.3	3.9	184.5	190.0	2
Female	2	169.5	9.2	163.0	176.2	2
Female plumaged	6	160.0	14.7	143.0	179.5	6
Crested Bird of Paradise — Male	4	107.1	11.2	94.0	119.5	4
Female	7	90.9	4.2	88.0	95.5	7
Female plumaged	16	92.2	10.2	73.6	113.0	16
Loria's Bird of Paradise — Male	2	99.0	0.7	98.5	99.5	2
Female plumaged	4	85.8	5.1	81.0	93.0	4
Brown Sicklebill — Female plumaged	6	144.8	3.8	140.0	151.5	6
Ribbon-tailed Astrapia — Male	6	144.3	9.2	133.5	158.5	6
Female	2	145.5	16.3	134.0	157.0	2
Female plumaged	9	131.8	4.6	121.0	137.5	9
King of Saxony Bird of Paradise — Male	4	86.5	3.5	83.0	91.0	4
Female	1	75.3	—	—	—	1
Female plumaged	16	80.5	6.9	69.0	96.0	15

	Total No. Captures	Tail length (mm)				
		\bar{X}	SD	range		n
Archbold's Bowerbird — Male	4	166.5	6.9	157	172	4
Sub-adult male	2	155.0	9.9	148	162	2
Female	2	136.0	5.7	132	140	2
Female plumaged	6	143.7	11.5	132	160	6
Crested Bird of Paradise — Male	4	86.8	2.2	85	90	4
Female	7	85.7	2.1	82	88	7
Female plumaged	16	86.3	3.3	82	96	16
Loria's Bird of Paradise — Male	2	76.5	2.1	75	78	2
Female plumaged	4	78.7	5.9	72	83	3
Brown Sicklebill — Female plumaged	6	279.2	19.7	253	305	6
Ribbon-tailed Astrapia — Male	6	141.4	22.4	87	159	5
Female	2	322.0	—	—	—	1
Female plumaged	9	246.0	69.4	153	328	8
King of Saxony Bird of Paradise — Male	4	89.0	8.5	83	95	2
Female	1	90.0	—	—	—	1
Female plumaged	16	89.5	4.1	82	97	14

TABLE 4 continued

\bar{X}	Wing length (mm)			n	\bar{X}	Tarsus length (mm)			n	\bar{X}	Tail length (mm)			n
	SD	range				SD	range				SD	range		
63.6	1.8	60	66	12	23.8	0.7	22.7	24.3	5	80.0	2.8	78	83	5
65.1	0.9	64	67	9	23.7	0.7	22.9	24.3	3	73.8	2.9	72	78	4
65.9	1.8	63	69	15	23.7	1.0	22.8	26.4	10	70.6	8.3	62	87	10
71.2	1.5	68	74	34	24.6	0.9	23.7	26.6	23	70.1	2.7	62	74	22
67.6	4.2	61	72	7	24.0	0.9	23.1	25.2	5	63.4	3.3	58	67	5

TABLE 5 continued

\bar{X}	Total head length (mm)			n	\bar{X}	Wing length (mm)			n	\bar{X}	Tarsus length (mm)			n
	SD	range				SD	range				SD	range		
65.6	1.1	64.6	66.7	4	166.3	2.9	164	170	4	43.9	2.4	40.4	45.9	4
66.9	0.1	66.8	66.9	2	163.5	0.7	163	164	2	44.5	—	44.5	44.5	2
65.4	1.6	64.2	66.5	2	154.3	0.7	154	155	2	40.7	0.8	40.1	41.2	2
65.1	0.7	64.0	66.1	6	156.3	6.7	146	165	6	42.4	0.7	41.3	42.9	5
53.8	0.7	52.9	54.5	4	110.5	1.3	109	112	4	41.9	2.3	38.6	43.8	4
50.7	1.9	48.2	53.6	7	111.0	2.0	109	115	7	40.9	1.5	38.3	42.6	7
50.9	1.5	48.8	53.8	16	108.8	3.4	102	112	16	41.1	1.9	37.6	44.0	16
56.2	0.1	56.1	56.3	2	102.5	3.5	100	105	2	39.5	1.5	38.4	40.5	2
53.2	0.8	52.3	53.8	3	100.0	—	100	100	3	39.3	1.1	38.2	40.3	3
106.7	3.2	102.4	111.9	6	153.2	4.2	148	159	6	45.4	2.0	42.6	47.8	6
60.5	1.7	59.0	63.4	5	173.6	4.3	170	181	5	41.5	1.2	40.2	42.8	5
60.9	0.5	60.5	61.2	2	158.5	2.1	157	160	2	43.5	—	—	—	1
60.7	1.3	59.0	63.1	8	158.3	4.2	163	166	8	40.6	1.2	39.0	42.5	8
50.1	0.6	49.6	50.5	2	126.5	3.5	124	129	2	31.3	0.8	30.7	31.8	2
47.7	—	—	—	1	108.0	—	—	—	1	32.0	—	—	—	1
49.7	0.8	48.7	51.2	14	118.9	4.4	114	130	14	31.6	1.7	28.1	34.5	13

\bar{X}	Bill length (mm)			n	\bar{X}	Bill depth (mm)			n	\bar{X}	Bill width (mm)			n
	SD	range				SD	range				SD	range		
33.0	0.7	32.2	33.7	4	9.6	0.6	8.7	10.0	4	9.1	0.5	8.6	9.7	4
33.5	1.3	32.5	34.4	2	9.5	1.1	9.4	9.6	2	8.5	0.3	9.4	9.6	2
34.3	0.6	33.8	34.7	2	10.2	0.1	10.1	10.2	2	9.6	0.1	9.5	9.7	2
33.5	0.6	32.5	34.2	6	9.4	0.3	9.1	9.7	6	8.4	0.7	7.3	9.1	6
26.7	2.2	23.5	28.4	4	—	—	—	—	—	—	—	—	—	—
25.7	1.0	24.7	27.3	7	6.0	0.4	5.7	6.2	2	6.0	—	—	—	2
26.6	1.8	24.5	30.1	15	5.4	0.4	5.1	6.9	3	5.5	0.2	5.4	5.7	3
28.3	1.3	27.3	29.2	2	6.0	0.1	5.9	6.0	2	7.3	0.1	7.2	7.3	2
26.6	0.6	25.9	27.0	3	5.5	0.2	5.3	5.6	2	6.5	0.1	6.4	6.6	2
79.6	3.8	75.3	86.0	6	7.1	—	—	—	1	6.7	—	—	—	1
32.9	1.2	31.6	34.7	5	—	—	—	—	—	—	—	—	—	—
30.4	—	—	—	1	—	—	—	—	—	—	—	—	—	—
32.8	2.5	26.9	35.5	7	0.7	69.0	79.9	2.0	2	7.2	—	—	—	1
24.6	—	—	—	1	—	—	—	—	—	—	—	—	—	—
23.5	—	—	—	1	—	—	—	—	—	—	—	—	—	—
24.5	0.6	23.7	25.4	13	7.2	0.2	7.1	7.4	3	5.5	0.6	5.0	6.2	3

Archbold's Bowerbird *Archboldia papuensis*

Individuals banded: nine, four in nets immediately adjacent to bowers and five in nets at standard sites. The capture of five birds in standard nets well away from known bowers indicates that this bowerbird not infrequently flies at lower levels in the forest. Four individuals were fully crested, bower-owning males; two were assumed to be young males lacking crests as they were calling at bowers before being flushed into nets. We consider two to have been females, one because a male was displaying to it before it hit a net, the other because it nested the following year. Of the remaining six unsexed female-plumaged birds, one was apparently a young of the previous season; it was small (Table 5) and its plumage generally brownish, with extensive brown-yellow on its primary coverts and primary bases and a suggestion of an extensive brownish 'wing bar' across the centre of the secondaries and six inner primaries. In addition, the nape, rear crown and cheek feathers were particularly brown, the lower abdomen feathers had a yellowish-brown wash, there were downy russet feathers in the flanks, and a small whitish gape. This was clearly not an adult bird that had become browner with wear (as is described by Rand 1940).

Weight, wing, tail and tarsus measurements of males were larger than those of females and female-plumaged birds, but no single measurement exclusively so (Table 5). The maximum crest lengths of adult males averaged 88.3 mm (range 85.8–90.8 mm). Weights of this species have not been previously published.

Moult: in 11 of 14 examined, only the crested males caught on 27 October 1987, and 2 November 1987 lacking signs of it. The fourth crested male had slight moult only in underwing coverts on 15 October 1986. Other birds were in body moult, five quite actively so. Five birds had commenced wing moult in late October and in November; two birds were also in tail moult.

On 23 November 1989 we discovered the first reported nest and egg of this species (Frith and Frith 1988a), and the following season found nine active nests during late December and in January (Frith and Frith, unpub. data). We discovered that adult males decorate the bower 'mat' with plumes from the King of Saxony Bird of Paradise (Frith and Frith 1990d).

Crested Bird of Paradise *Cnemophilus macgregorii*

Individuals banded: 27, of which four were adult males, seven sexable females (see below) and the remainder unsexed female-plumaged birds. Males were, almost exclusively, considerably heavier than confirmed females and, to a lesser extent, female-plumaged birds, but were similar in other measurements (Table 5). No bird was seen in the recently described grey plumage (Frith and Harrison 1989), but a nestling was conspicuously greyer than its presumed female parent (Frith and Frith 1993b; see also plate 427 in Coates 1990).

Moult: in 11 of 26 examined (Table 3). Six females had a brood patch on 6 October (scale 3), 8 October (1, 2), 14 October 1986 (1.1), and 16 October 1987 (2). On 18 October 1987 we netted a female and a young bird of similar size,

which we assume to have been her offspring. Breeding biology data from two active nests of this species will be published elsewhere (Frith and Frith 1993b).

Loria's Bird of Paradise *C. loriae*

We caught two male and three female-plumaged birds, one of the latter being recaptured a week later at the same site. Males were heavier and larger than female-plumaged birds, except in tail and tarsal lengths (Table 5). Of five captures examined, three were moulting. No bird was seen in the recently described grey plumage (Frith 1987).

Brown Sicklebill *Epimachus meyeri*

We banded six female-plumaged birds, two of which were in moult.

Ribbon-tailed Astrapia *Astrapia mayeri*

Individuals banded: 15, retrapped two, seven and nine days after initial capture. Five individuals were males, two females (each with a brood patch) and nine unsexed female-plumaged birds.

Wing lengths of confirmed females and female-plumaged birds were considerably and exclusively shorter than of males (Table 5). Tail length varied considerably in female-plumaged birds. Male tail measurements in Table 5 do not include the ornate elongated central pair. Three of the five males were young birds, with remnants of female plumage but with a fully developed 'pom-pom' above the base of the upper mandible and black-tipped white central tail feathers, which measured 135, 320 and 510 mm. The central tail feathers of the other two, fully plumaged adult males measured 880 and 960 mm.

Moult: in eight of 12 examined. Two females had a brood patch on 2 October 1986 (scale 3) and 5 November 1987 (2). A number of active, previously undescribed nests were found, and will be described and discussed elsewhere (Frith and Frith 1993a).

King of Saxony Bird of Paradise *Pteridophora alberti*

Individuals banded: 17, retrapped three, 2 once and 1 twice. The last was banded on 12 September 1986, in female plumage, and retrapped at the same site on 15 October 1987 and 21 January 1989 still in female plumage; 2 years, 4 months, 16 days between banding and last recapture.

Three individuals were fully plumaged males, one a female with brood patch (scale 1 on 7 October 1986), and the remainder unsexed female-plumaged birds. Weights and wing lengths of the female and female-plumaged birds were smaller than those of adult males (Table 5).

Moult: in ten of 18 examined (Table 2). The female had a brood patch (scale 1) on 7 October 1986. In January 1989, we discovered the first known nest and egg of this species (Frith and Frith 1990c). Male Archbold's Bowerbirds use the presumably moulted ornate adult male head plumes of this bird of paradise as bower decorations (Frith and Frith 1990d).

DISCUSSION

As this is but the first long-term bird banding study in the New Guinea highlands (but see Diamond 1970, 1972), lengthy discussion is unwarranted, the major value of our study being the presentation of capture/recapture, altitudinal and morphometric data for little known highland endemics. Breeding records, other than noting the presence of brood patches on captured birds, is presented and discussed elsewhere (Frith and Frith 1992).

While we are unaware of any accounts of other New Guinea highland banding studies, other than Diamond's (1970, 1972) reports of capture rates, several lowland banding studies have been conducted at Brown River near Port Moresby, Central Province (Filewood 1971; Bell 1971, 1977, 1982)

Filewood caught a total of 41 species (not 44 as reported by Bell 1982) during 25 netting days (usually between *c.* 0630 and 1100 hrs) over a full year, with the numbers of hundreds of feet of mist nets used varying from 3.0 to 10.8 per day. This gave a mean capture rate of 9.4 individuals per netting day and an overall average retrap rate of 30.8 per cent. Bell (1977) caught 45 species during his 12-month study in Brown River lowland rainforest, and with the addition of a further 12 months stated he had increased this number to 57, although only listing 46 species netted (Bell 1982: 27 and Appendix). He (1977) apparently erected 4 × 13 m nets for three hours during *c.* 13 visits to his lowland rainforest study area and caught 57 (63%) of a total of 91 species in the area, of which 86 were resident. Subsequently, he (Bell 1982) mentioned four 13 m nets erected for up to a full day each month. During the present study, we caught 50 (54%) of a potential *c.* 93 species in the area (Finch *et al.* 1990). Bell used three (1977) or four (1982) 13 m mist nets for between three hours and a full day each month.

Diamond (1970) records the following number (undefined) of species in an area (in parenthesis) and number of birds caught per net-day for the New Guinea mainland locations and habitats: Madang, coastal lowland rainforest (132) = 0.82 birds; Mt. Albert Edward, montane forest (59) = 1.41 birds; Mt. Albert Edward, subalpine mossy forest (31) = 0.71 birds.

It is difficult for us to compare our capture rates with those of Filewood (1971), Diamond (1972) and Bell (1977, 1982), because of differing numbers and sizes of nets. Using the sometimes conflicting data (e.g., Bell 1977, 1982) presented by these authors, we have, however, reduced all results to the mean number of birds caught per hour by 13 m of mist net, given that our effective net height was 2.5 m, Bell's was 1.8 m and Filewood's was unstated. The resulting figures are, the present study 0.56, Filewood 0.24 and Bell 0.21 mean number of birds caught per hour by a 13 m net. Diamond's capture rate was not calculated as he provided no figure for time per net-day.

Because of previous bird banding in Tari Gap by others, we recorded maximum intervals between date of banding and last recapture of more than a year for 17 species. The only non-passerine record is the Brown Quail of 26.5 months. Of the passerines, a Mountain Mouse Warbler, White-winged Robin and Regent Whistler were recaptured 13 months after capture; Dimorphic Fantail, Canary Flycatcher, Mountain Firetail and King of Saxony Bird of Paradise between 26 and 29 months; Large Scrubwren, Friendly Fantail, Fan-tailed Berrypecker, Belford's Melidectes and Common Smoky Honeyeater between 39 and 47 months; and Papuan Scrubwren, Rufous-naped Whistler, Wattled Ploughbill and Grey-streaked Honeyeater between 53 and 61 months. Because our study periods included the peak of breeding at Tari Gap and none of these birds (except a male Fan-tailed Berrypecker) were juvenile or immature at the time of capture, at least a further 6–12 months can be added to these longevity records. Results of this preliminary banding study thus provide the first longevity records for upland rainforest-dwelling small passerines. Results of lowland New Guinea rainforest (Filewood 1971; Bell 1971) and tropical Australian upland rainforest studies (Frith and Frith 1990e, unpub. data) also present longevity records. The considerable number of years that a small passerine may live in Australasian forests remains one of the novel, if no longer surprising, findings of recent banding studies (Filewood 1971; Tidemann *et al.* 1988; Frith and Frith, unpub. data), and no doubt future long-term banding studies will add more such data.

The Blue-capped Ifrita, Orange-crowned Fairy-wren, Black Fantail and Black-throated Robin were recorded at or just above their known upper altitudinal limits, and the Olive Straightbill *c.* 100 m, the Black Monarch *c.* 300, and the Little Shrike-thrush *c.* 600 m above their previously reported altitudes (Rand and Gilliard 1967; Diamond 1972; Beehler *et al.* 1986). The presence of the Log-runner at Tari Gap, where it was subsequently found breeding (Frith and Frith *in* Coates 1990), represents a significant extension of its previously known range (Frith and Frith 1987a).

That the smaller passerines at Tari Gap are conspicuously sedentary was clearly demonstrated, by the recapture of 194 individuals at only their original capture net sites. Filewood (1971) and Bell (1971) presented data indicative of the extreme sedentary nature of birds elsewhere in Papua New Guinea rainforests, and Dowsett (1985) found this to be so over 10 years of banding in montane forests of Malawi, Africa, as we have in Australian upland tropical rainforests (Frith and Frith, unpub. data). Our only seven significant records of movement between net sites were of *c.* 850 m by a Rufous-naped Whistler, *c.* 1.1 km by a Common Smoky Honeyeater and Grey-streaked Honeyeater, *c.* 1.7 km by a Wattled Ploughbill, *c.* 2 and 2.3 km by a Fan-tailed Berry-pecker and *c.* 2.7 km by a Papuan Scrubwren.

That Sites 4 and 7 had the highest, and Sites 5 and 6 the lowest, capture rates (Table 1) may be in part because the former two were entirely (Site 4) or mainly (Site 7) along a ridge top in relatively undisturbed forest with diverse undergrowth, whereas Sites 5 and 6 were in badly disturbed and exposed open peak-top forest respectively. Bell (1982), conversely, caught more birds in more disturbed lowland rainforest.

We can say little about breeding as indicated by the presence of a brood patch on captured birds, as our combined netting studies only cover the period 8 September to 31 January (lacking data for December), with considerable variation in netting activity from month to month and each year (Table 1). It would be misleading to calculate the percentage of our total monthly captures showing a brood patch: for most species we could not identify immature birds and could not, therefore, define the total number of potentially incubating birds. Of the 46 captures recorded with a brood patch we netted 10.9 per cent in

September 1986, 30.4 per cent in October 1986, 21.7 per cent in October 1987 (Octobers combined 52.1%), 34.8 per cent in November 1987 and 2.2 per cent in January 1989. Thus, our limited data, combined with other breeding information obtained (Frith and Frith 1988a,b,c; 1990a,b,c,f; 1992; 1993a and b; unpub. data), clearly indicate an increasing level of incubation within the sub-canopy and understorey passerine avifauna over September to November.

Results in Table 2 clearly indicate that the percentage of birds in moult increases over the months September–January (38–70% respectively), subsequent to most breeding activity.

Few birds with brood patches were also moulting. A Dimorphic Fantail had a well developed brood patch when caught on 18 October 1987 and only a trace of one when retrapped on 19 November 1987; it was in tail moult on both occasions. A Fan-tailed Berrypecker had a well developed brood patch on 29 October 1986 and tail moult. A Grey-streaked Honeyeater on 9 October 1986 had a large brood patch and tail moult only; another on 21 October 1987 had a slight brood patch and slight body moult; and a third with slight brood patch on 12 November 1987 was moulting in wings and tail and on the body.

Two Common Smoky Honeyeaters on 15 October 1987 had slight brood patches; one was in body moult only, the other in wing, tail and body moult. A third, caught several times, had a well developed brood patch on 15 October 1987 and no moult, but on 21 October 1987 had only a slight brood patch and was moulting in the tail. A Belford's Honeyeater with a well developed brood patch on 18 September 1986 was in body moult only; one on 26 October 1986 had a slight brood patch and was in wing moult only; another on 6 November 1987 had a slight brood patch and wing, body and tail moult. Our limited data thus suggest that, overall, moult followed the peak in breeding activity.

The areas involved in the present study are between 15 and 20 km from the comfortable accommodations and facilities of Ambua Lodge, a popular resort destination for bird watches and ornithologists. We encourage future visitors there, with all appropriate bird netting and banding permits, to obtain valuable data from recaptured birds by netting in the areas indicated in Figure 1.

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